A proactive water supply shortage response plan focusing on the Green Industry in the Rand Water supply area.

by

Leslie Higham Hoy

Student Number 3697-936-8

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SUPERVISORS: Professor Dr LR Brown
Professor Dr RM Hendrick

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DECLARATION:

I, Leslie Higham Hoy (ID number 6212055292085), declare that this dissertation entitled, "**A proactive water supply shortage response plan focusing on the Green Industry in the Rand Water supply area**", is my own work, and that all the sources that I have used or quoted, have been indicated and acknowledged by means of complete references. Prior to the commencement of the research project, both the researcher and the UNISA library conducted a literature review, and ascertained that no other similar research has been conducted in South Africa, prior to the registration of this project.

Signature:________________________ Date:_________________

SUMMARY AND KEY WORDS

Summary.

Water is a symbol of life. It affects all organisms on earth and its importance is emphasised in times of drought. The human population growth places more demands on our natural resources. As pressures on the available water increases, more measures are required to utilise water sustainably. South Africa is classified as a water stressed country with less than 1700 cubic meters of water available per person per year. Rand Water supplies water to approximately 11 million people in Gauteng. During times of drought, restrictions imposed are aimed mainly at the broader Green Industry. This research investigated international strategies, existing restrictions in Gauteng, and undertook a survey within the Green Industry to determine the most appropriate response. This research proposes a new water supply shortage response plan for Rand Water in Gauteng with a total of four levels of restrictions implemented at different stages of water stress in the system.

Key words: Drought; Green Industry; Rand Water; water restrictions; water allocation framework; water Conservation; water demand management; Water Supply Shortage Response Plan.

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ABBREVIATIONS AND ACRONYMS

CMA	Catchment Management Agency
DWAF	Department of Water Affairs and Forestry
ENSO	El Niño Southern Oscillation.
GDP	Gross Domestic Product
GI	Green Industry
IERM	Institute of Environmental and Recreation Management (Africa)
ITPF	International Turf Producers Association
IUCN	The World Conservation Union
LIA	Landscape Irrigation Institute
LHWP	Lesotho Highlands Water Project
NWA	National Water Act
PAR	Participatory Action Research
RW	Rand Water
RWB	Rand Water Board
SA	South Africa
SADC	Southern African Development Community
SAGIC	South African Green Industries Council
SALI	South African Landscape Institute
SANA	South African Nursery Association
SAWS	South African Weather Services
SFSW	Strategic Framework for Water Services
TCTA	Trans Caledonian Tunnel Authority
UK	United Kingdom
UNCED	United Nations Conference on the Environment and Development
WDM	Water Demand Management
WSA	Water Services Act
WWF	World Wildlife Fund

GLOSSARY

Action research	Is essentially research that is applied and practical, is driven by the need to solve practical real world problems where research and action are integrated (Denscombe, 1998:57-59).
Agricultural drought	When there isn't enough soil moisture to meet the needs of a particular crop, at a particular time. When extended dry periods and general lack of rainfall, result in the lack of moisture in the root zone of the soil (*Droughts – Dust Storms – Black Blizzards*, "s.a.")
Aridity	Is a permanent feature of climates that receive little rain.
Biosphere	Provides the essential components of life: water, air, food, a place to live and a place in which other members of our species can be found, and with whom relationships can be forged. In essence, there is only one biosphere to provide a living space for all organisms that inhabit the planet (Jones, 2004:3).
Carbon dioxide (CO_2)	A naturally occurring gas. Also a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the earth's radiative balance. It is the reference gas against which other greenhouse gases are measured, and therefore has a Global Warming Potential of 1 (Green Facts Toolbox, 2008).
Catchment	In relation to a watercourse or watercourses or part of a watercourse. It refers to the area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points (NATIONAL WATER ACT(Act No 36 of 1998)
Climate	The term that refers to the average and common weather conditions of an area over a number of years.
Climate change	Refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. (*Green Facts Toolbox*, 2008).

Conservation	In relation to a water resource, means the efficient use and saving of water, achieved through measures such as water saving devices, water-efficient processes, water demand management and water rationing (NATIONAL WATER ACT Act No 36 of 1998).
Desertification	Is a long term ecosystem change. The sum of the geological, climatic, biological and human factors that lead to the degradation of the physical, chemical and biological potential of lands in arid and semi-arid zones, and endanger biodiversity and the survival of human communities. - means land degradation in arid, semiarid and dry sub-humid areas, resulting from various factors, including climatic variations and human activities (UNEP, 1995). - desertification is the degradation of arid, semi-arid and dry sub-arid areas and is usually caused by the over-use of natural resources by humans. The landscape created due to this desertification process, may take on the form of a desert, making one think that it was caused by nature and not by man. Desertification may often be visibly associated with areas that receive 500mm of precipitation, or less, in a year. Depending on the definition, desertification occurs in 110 countries, more than 80 occurring in developing countries, and they cover between 33 and 40 percent of the land area on earth. (Jones, quoting Hulmes and Kelly, Wellens and Millington and Barrow 2004:184).
Desertisation	Is a natural process, which means that new deserts are formed over hundreds of years, due to natural changes in climate. (Jones, quoting Hulmes and Kelly, Wellens and Millington and Barrow 2004:184).
Drought	Abnormally long period of insufficient rainfall (*Encyclopedia.com. "s.a.").* When the demand for water exceeds the available supply, or when there is widespread water shortages or projections of shortages (*What is drought*, 1996-2004).
El Niño	Is a meteorological phenomenon attributed to the warm water of the Pacific coast that slips back to Peru, rather than being forced on to Indonesia, by strong winds. El Niño is the warming of sea-surface temperatures in the equatorial Pacific Ocean, which influences atmospheric circulation, and consequently rainfall and temperature in specific areas around the world (http://www.weathersa.co.za 18 October 2004).

	Significant warming of the waters in the eastern Pacific Ocean, usually off the coast of South America, which results in shifts of world-wide weather patterns. Can cause prolonged periods of drought or floods. In South Africa, El Niño is associated with prolonged droughts (*Meteorological Terms:Glossary*, 2003).
Environment	An area controlled by a particular and limited conjunction of climatic, edaphic and biotic spheres.
Evaporation	The process by which liquid changes into gas. It depends on the vapour pressure of the air, its temperature, wind conditions and the nature of the ground surface (Arnold, 2003:214). The evaporation of water from the earth's surface.
Evapotranspiration	The evaporation of water from the earth's surface, plus transpiration from vegetation, represented either by actual observed amounts (*actual evapotranspiration*) or the potential evapotranspiration. (Evapotranspiration, 2009)
Green Industry	The bodies constitute of and limited mainly to the South African Green Industries Council (SAGIC), but inclusive of the general gardening end users.
Grounded theory	Theory developed inductively from data, rather than by hypothesis testing.
Hydrological drought	Deficiencies in surface and sub-surface water supplies. Occurs when surface and sub-surface water supplies are below normal (*Droughts – Dust Storms – Black Blizzards*, "s.a.").
La Niña	Is characterized by unusually cold ocean temperatures in the eastern equatorial Pacific. It is the opposite of El Niño. La Niña is associated with above normal rain, over the summer rainfall areas of South Africa. (*Meteorological Terms:Glossary*, 2003)
Land degradation	Reduction or loss, in arid, semi-arid and dry sub-humid areas, or the biological or economic productivity and complexity or rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands, resulting from land uses or from a process, including processes arising from human activities and habitation patterns such as: I. Soil erosion caused by wind and/or water; II. Deterioration of the physical, chemical and biological or economic properties of soil; and III. Long-term loss of natural vegetation (UNEP, 1995).

Meteorological drought	Based on the precipitation's departure from the normal, over some period of time, or any lack of rainfall over a long period of time (*Droughts – Dust Storms – Black Blizzards*, "s.a."). The degree of dryness in comparison to "normal" or average amounts of rainfall, for a particular place. Less than 75% of normal rainfall is regarded as a severe meteorological drought (*What is meant by a Meteorological Drought*, "s.a.").
Participatory research	Is the collective generation of knowledge, which leads to the planning and achievement of joint objectives (Collins, 1998:2). Is a process where the participants are actively involved in the planning and implementation of the research outcomes, and are thus empowered. The researcher is dependent upon the participation of the affected "community" members (Kruger & Welman. 2001:190).
Precipitation	Any or all of the forms of water particles, whether liquid or solid, that fall from the atmosphere and reach the ground (*Meteorological Terms: Glossary*, 2003).
Price Elasticity (of demand for total water usage)	Is a ratio, by which the water demand would be reduced by, should there be an increase in the price of water. Example: If the price elasticity was – 0.17, should the price of water be increased by 10%, the total demand for water would be reduced by 1.7%.
Price elasticity	When the demand changes a great deal for a given change in price, demand is said to be elastic.(Stephenson, 1999:116)
Price inelasticity	When demand does not change very much, compared to the change in price, demand is said to be inelastic (Stephenson, 1999:116).
Pollution	Means the direct or indirect alteration of the physical, chemical or biological properties of a water resource, so as to make it - *(a)* less fit for any beneficial purpose, for which it may reasonably be expected to be used; or *(b* harmful or potentially harmful - *(aa)* to the welfare, health or safety of human beings; *(bb)* to any aquatic or non-aquatic organisms; *(cc)* to the resource quality; or *(dd)* to property (NATIONAL WATER ACT Act No 36 of 1998) *(ee)* riparian habitat includes the physical structure and

	associated vegetation of the areas associated with a watercourse, which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency (NATIONAL WATER ACT Act No 36 of 1998) sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas
Rand Water supply area	The physical area and supply areas that are approved in terms of law, where Rand Water is allowed to distribute water to (Also known as the Rand Water water supply area)
Socio-economic drought	The situation that occurs when physical water shortages begins to affect people (*Droughts – Dust Storms – Black Blizzards,* "s.a.")
Watercourse	*a)* A river or spring; *b)* A natural channel in which water flows regularly or intermittently; *c)* A wetland, lake or dam into which, or from which, water flows; *d)* Any collection of water which the Minister may, by notice in the *Gazette,* declare to be a watercourse. A reference to a watercourse includes, where relevant, its bed and banks (NATIONAL WATER ACT Act No 36 of 1998).
Water Conservation	The minimisation of loss or waste; the care and protection of water resources; and the efficient and effective use of water. (*Water Conservation and Water Demand Management Strategy for the Industry, Mining and Power generations sectors*, 2004).
Water demand management.	A management approach that aims to conserve water by controlling demand, which involves the application of selective incentives to promote efficient and equitable use of water (Arntzen et al., 2000:15). The adaptation and implementation of a strategy, by a water institution or consumer to influence the water demand and usage of water, in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services, and political acceptability (*Water Conservation and Water Demand Management Strategy for the Industry, Mining and Power generations sectors*, 2004).
Water Efficiency	The accomplishment of a function, task, process, or result with the minimum amount of water feasible; or an indicator of the relationships

	between the amount of water needed for a specific purpose, and the amount of water used, occupied or delivered (*Water Efficiency, 2009)*).
Water restrictions.	Specific set of water use regulations, within a water supply shortage response plan.
Water supply shortage response plan.	Is a plan consisting of a series of water conservation methods at various levels that will allow municipal entities (local authorities) to minimise or avoid water shortages, all together, mainly during unusually day events.

Chapter 1
INTRODUCTION

1.1 INTRODUCTION

It is a known fact that there would be no life without water. This is revealed in Genesis 1 verses 1 and 6 where the bible indicates that the entire earth was covered with water, and later separated into water vapour in the sky, and water on the earth (Tyndale House Publishers, 1997:5-6). Life as we know it, is only possible because water was produced "soon" after the beginning of time. It is also known that humans, as well as all fauna and flora, have a huge percentage of their composition being of water. Life on earth is simply not possible without water, and is hence a symbol of life.

South Africa is a multicultural nation of people, beliefs, religions, and expressions. Many of these play out in and are associated with water.

- To the San people, it is a symbol of life.
- The legendary Rain Queen (Queen Modjadji) in Limpopo Province, is said to have power over drought and rain.
- In Nongome (Kwazulu Natal), where seven streams meet to form the Isikhwebezi river, the waters at this junction are said to have healing powers.
- The Christian faith uses water in baptism, as a sign of acceptance of the Christian faith, and as a symbol of leaving the old ways and taking on the new life-giving, Christ-centred way.
- Islam indicates that water has qualities of being, life giving, sustaining and purifying.
- For the Hindus, water is instilled with powers of spiritual purification.
- In Judaism, ritual washing restores and maintains a state of ritual purity (Exploring Water Culture, 2006:40-41).

It is a sign of wealth to live near water, have a view over water, to build a shopping complex/office complex around water (*pers obs.*). Besides all the calming and psychological effects, to have water, and to seemingly have control over water, offers an indirect and unspoken control and power base, from which to live, work and "present" oneself.

In order to contextualise the thought flow process for this study, it has been necessary for the researcher to graphically demonstrate the particular aspect about which this study revolves. Annexure J illustrates this thought process and several of the interconnecting aspects.

Water, like religion and ideology, has the power to move millions of people. Since the very birth of human civilisation, people have moved to settle close to water, people journey down it, people fought/fight over it, and all people, everywhere and everyday, need it (*The Global Water Crisis*, “s.a”). Even landscapes, from ages past to present, rely on water as being central to their needs, and therefore also central to the many other positive aspects of the landscape.

Humans need water to survive, to work, to eat, to live healthily, and to participate in recreation! Ironically, it is exactly these very same activities that have resulted in the earth’s water becoming less attainable, and more polluted (unavailable). The human race through its own activities and desires is causing its own downfall. The more society grows, and people push the limits, and place demands on each other, the more we place demands on the natural systems around us. As pressures on available water increase, so more measures are required to reallocate water from one sector of the economy to the next, or from one region to another, using policies, infrastructures or regulations, all at huge costs and sacrifice. This thought is captured well by Gorbachev, (*The Global Water Crisis*, “s.a”) states, “Water is the most important single element needed in order for people to achieve the universal human right to ‘a standard of living, adequate for the health and well-being of himself and his family’". This thought is backed up by statements from Biswas & Uitto (eds.) (2000:xiii) stating that, 80 percent of diseases and 30 percent of deaths in the developing world are caused by unsafe drinking water, 4 million plus children die annually from water borne diseases.

Myers (1994: 10) states that “Spaceship Earth” has finite resources, and we as humans depend upon these resources for our very existence. We are, on the whole, unable to create more of this finite resource, except by changing its state (icebergs) or chemical composition (desalination), both at huge cost and it would therefore, only be available to the wealthy people of this world.

Depending on the source, writers generally state that between the years 2015 and 2033, South Africa will run out of water resources to cope with the anticipated population growth, consumption, and other needs of water. It is therefore all the more urgent that planning to mitigate this must start now. Richard & Rouault (2003: 489-500) concluded in their research that drought occurs often in South Africa, in all climatic areas, at all times of the year, with different intensity, spatial extension and duration, and that each drought will have its own signature. Droughts are therefore unavoidable but our response to it is important.

Myers (1994: 10) also states that it is the earth's green cover (bacteria and blue green algae) (Thomas, 1981:24), and then plant life that first released life-giving oxygen into the atmosphere, and still continues to do so. Plants provide the basis of all food chains, mediate water cycles, stabilise microclimates and protect the living soil. Plants are the foundation of the biosphere. Plants are also the basis for our very basic human existence, ranging from sustenance, to medical assistance, to psychological/emotional assistance, to our physical wellbeing (jobs and recreation).

Plants are used extensively in the Green Industry it is almost as if the green industry is known, wanted and needed, but in times of drought the current users of the Industry, such as architects, businesses etc, tend to easily turn their backs on this industry, and treat it like "Cinderella", being locked away and not appreciating what it provides, in the form of environmental, psychological and physical wellbeing of the very earth itself. The loss of plants during a drought is inevitable, but the loss comes with a price. Often in communities where this price cannot be afforded, the loss is never replaced adequately. As a result, future generations loose out because of the current generation's shortsightedness in its decisions of how water supply shortage response plans are produced and executed.

1.2 WHY THE STUDY WAS UNDERTAKEN

The Rand Water supply area does not have sufficient water resources within its own area of supply, in order to meet the demand for water. As a result, it was required many years ago already, to dam areas for water storage . This has been increased over the last few decades, to the extent that water for this region is being stored and "piped" to the area, from neighbouring Lesotho, at huge cost to the users and the environment. Currently, Gauteng and the Rand Water, water supply area does not have a single, generally accepted water shortage response plan/strategy or set of water restrictions that could be referred to as current (updated within the last 5 years and easily available to the public) and that can be used in times of drought to reduce the amount of water used/implemented in the Green Industry, in an organised methodical manner that is understood, agreed to, and implemented by all relevant role players. Furthermore, with increasing urbanisation, increasing pressures on the environment, changes in legislation, the accepted notion that humans are more important than the environment, and the associated dangers of global warming, the need to be more prepared for the next possible drought in this supply region, becomes ever more important, daily. Various legislative frameworks, inclusive of municipal by-laws, do exist, but inadequately describe what is required when a drought (water shortage) is anticipated, or is at hand.

With the continued, increased scarcity of portable water in places of high water demand, becoming apparent in South Africa, as well as the associated increase in costs, to secure and provide this portable water, to the populace, tensions will rise, and in some instances it is predicted that wars may even be fought to secure these rights (Myers, 1994: 16). The current water laws in South Africa give everyone the right to clean, portable water, as well as the right to 6kl of free potable water monthly. Droughts, being the natural and catastrophic phenomena that they are, and are capable of being, are unpredictable and cause untold damage to both the natural and unnatural environment, inclusive of human life. In order to prevent this, government, being the custodian of these water supplies, must were possible, first of all plan for and store water for times of drought and must also timeously intervene, to prevent untold destruction. The Constitution of South Africa indicates that "Everyone has the right of access to sufficient food and water the state must take reasonable legislative and other measures to achieve the progressive realisation of each of these rights"(South Africa, 1996: sec 27(1-2)). The decision to build the next dam, to cater for the water needs of this region, has already been made, and feasibility studies are already underway, to determine the location. Again, this dam will be a few hundred kilometres away from the end user. Presently, the Department of Water Affairs and Forestry has an elaborate system of managing the water supplies on a high level basis. They will also in times of low water levels implement water saving targets, but do not dictate specific preventative measures (restrictions) to users lower down the chain (Rademeyer, 2006). Any water saving quotas imposed onto Rand Water by DWAF, must in turn be handed down to municipalities, and other customers who receive water from Rand Water. Municipalities, must then by way of ordinance (by-law), declare certain water restrictions that are believed will achieve the desired amount of water savings.

Rand Water (RW), as part of its customer service, assists local authorities in various matters. One of these being, the assistance with water conservation related matters. RW also engages other end users through various forums, to promote the wise use of water in various aspects, most often through the Water Wise initiative.

During the drought of the 1990's that occurred in the Gauteng region, it was only when there was very little water left in the Vaal Dam Water Supply System, that Government imposed water restrictions on Rand Water and Municipalities. In a series of full page adverts, placed by Rand Water, on 7 May 1995 (1995:8), 14 May1995 (1995:8) and again on 21 May 1995 (1995:8), entitled "The Shocking Truth", Rand Water indicated that there were only 112 days, 104 days and 97 days, respectively, of water supply left in the Vaal Dam. The municipalities also imposed a single set of water restrictions onto the end consumer at the last minute, which had been created without apparent consultation.

Unfortunately, with these restrictions came confused messages. Firstly, the public thought that Rand Water was responsible for the restrictions on end users. Secondly, different municipalities, bordering each other, produced different sets of restrictions, which caused confusion amongst water users. Lastly, the water restrictions were perceived by the organised Green Industry, to be aimed primarily at the green industry and home water users, not taking into account the fact that although these sectors are potentially high water users, they are also a high economic and employment sector of the economy. A "knee jerk" very quick intervention was used by Rand Water (who was seen, incorrectly, by the industry as the imposer of the restrictions) to try and influence municipalities, to at least attempt to change limited sections within the restrictions, to be more common, as well as influencing the changing of others altogether. Only some were achieved successfully.

The very essence of what this study is aimed at is to investigate the possibility of an improved and proactive drought management strategy, for the Green Industry of the Gauteng region (Rand Water supply area), which is the economic heartland of South Africa. Systems are dynamic and ever changing and hence the strategy itself needs to be considered in the light of charge and development.

Due to the fact that the "association" of water in horticulture, and horticulture in human lives, is a complex one, it has been necessary, in this study, to paint a very broad picture of the many aspects of the topic. The complexity, the interwoven nature, the inter-dependent make-up, and the many different aspects have been expressed, to ensure that they are not seen in isolation, but as parts of an inter-linked system.

1.3 PROBLEM

When droughts occur and are subsequently declared by government, the negative impact on society as a whole is massive. The consequences are not only immediate, but have other long-term impacts that are seldom, if ever, really worked through and adequately assisted by government.

Although water restrictions have existed, and were imposed in the past within the Rand Water supply area, these specific restrictions have not been in use since 1996, nor have they been re-assessed or modified, while many municipal staff members are not aware of their existence within their own departments. Municipal staff are able to point to the latest water service by-law, which will cover all aspects of water services within the municipality, excluding water restrictions themselves. However, current water restriction policies should exist in some form or another, on the books of all Gauteng municipalities.

There is no evidence that they (water restrictions) have been updated or modified since 1994, even with the latest process, whereby municipalities have revised their water service by-laws. Similarly, no available single concept on water restrictions, or flexible water supply shortage response plan, is available for the Rand Water supply area. It also seems that, the current restrictions (implemented in 1995) were compiled without much, if any, industry or public consultation process.

This study is, therefore, aimed at developing a generally accepted water supply shortage response plan, for the Green Industry of Gauteng (being the Rand Water, water supply area).

1.4 HYPOTHESIS

H_0

A comparative analyses of local and international data, as well as data results from a structured questionnaire, pertaining to water supply shortage response plans, will make no difference in the compilation of such a plan for the Rand Water supply area.

H_1

A comparative analyses of local and international data, as well as data results from a structured questionnaire, pertaining to water supply shortage response plans will positively result in the compilation of such a plan for the Rand Water supply area.

H_2

A comparative analyses of local and international data, as well as data results from a structured questionnaire pertaining to water supply shortage response plans will negatively affect the compilation of such a plan for the Rand Water supply area.

1.5 OBJECTIVES

The objectives of this study are to:

1. Investigate what water restrictions are currently available within the Rand Water supply area (Gauteng based).
2. Investigate what water supply shortage response plans are available internationally.
3. Investigate the willingness of selected SAGIC members and municipalities to have the water restrictions investigated.

4. Compare results of existing available Gauteng based restrictions, international restrictions, as well as survey results.
5. Develop new improved restrictions that will be seen as more flexible from the comparisons made.
6. To create through the involvement of selected role players a more flexible set of water restrictions for the Rand Water supply area that will result in a new proposed water supply shortage response plan for the water supply area.

Chapter 2
LITERATURE REVIEW AND SITUATIONAL OVERVIEW

2.1 WATER RESOURCES IN THE WORLD

As indicated previously, water is one of the natural resources that links everyone and everything, either directly or indirectly. It may, to a greater or lesser extent, have influences that cross borders and oceans. It may also be one localised event in an area, or it may have a much broader and wider influence that is felt either immediately, or much later. It is therefore important, that even when investigating the concept of a water shortage response plan on a local provincial level, that the broader global context must be considered.

2.1.1 Available Water - World

The world's water resources are estimated at 1.4 billion (thousand million) km^3 (Loucks & Gladwell, 1999:12). Of the world's water, 97.4% is in the oceans and 2.6% is on the land. According to Ward & Robinson (as quoted by Merrit, 1997: 5) of this 2.6% water on land, 76.4% of it is trapped in the ice caps and glaciers, 22.8% is ground water and the remaining 0.6% is available as surface water (Table 2.1). This equates to 218 400 km^3 of water being available on land for use, and 8 299 200 km^3 of water available underground. The paradox of the reality is that while we are never going to exhaust our water supply, we are also not able to increase it (ITPF, "s.a.":7). Similarly, there's as much water in the world today, as there was thousands of years ago, and it's the same water that was around when dinosaurs roamed the earth (*55 Facts, Figures, & Follies of Water Conservation*, 2004).

Table 2.1 Available water within the world (Adapted from Liphadzi, 2007:16).

All Water		**All fresh water**		**All easily available surface water**	
	Percentage		Percentage		Percentage
Oceans	97.4	Ice Caps and glaciers	76.4	Lakes	52
Fresh Water	2.6	Ground water	22.8	Soil Moisture	38
		Easily accessible surface fresh water	0.6	Atmospheric water vapour	8
				Rivers	1
				Water within living organisms	1

(Updated diagram for above data in Annexure L)

By the year 2025, 3 billion people, scattered over 52 countries, will experience water stress or chronic water shortages (Serageldin, 1995:2). Knox (1991), of the University of Florida, indicates that for Florida, increased urbanisation and periodic drought are placing greater demands on water supplies. Even countries such as Jordan, with supposed huge financial resources, but in dry areas, have problems of insufficient water supply (Montaigne, 2002:8-50).

The world average internal renewable water supplies are 40.9 thousand cubic meters as compared to Sub-Saharan Africa having only 3.8 thousand cubic meters. Similarly when comparing the percentage of population living on less than 1 000 cubic meters of water per annum, the world average is four percent whilst Sub-sahara is double at eight percent (Table 2.2).

Table 2.2 Average amount of water available per capita per region. (Adapted from Serageldin, 1995:2)

Region *	**Annual internal renewable water resources**		**Percentage of population living in countries with scarce annual per capita resources**	
	Total (thousands of cubic meters)	Per capita (thousands of cubic meters)	Less than 1000 cubic meters	Between 1000 and 2000 cubic meters
Sub-Saharan Africa	3.8	7.1	8.0	16.0
East Asia & the Pacific	9.3	5.3	<1.0	6.0
Middle East & North Africa	0.3	1.0	53.0	18.0
Canada and the United States	5.4	19.4	0.0	0.0
World	40.9	7.7	4.0	8.0

* Note: not all regions have been included.

When one of the inputs or outputs to the usable storage is altered in the global water balance, life-styles have to change (Eaglin *et al.*, c1997:4). Where drought occurs, people caught up in this situation are compelled to change and alter their lifestyle. Otieno & Ochieng (2004:669) indicate that increased population and human activities, will make water unavailable in the environment.

One third of European countries have less than 5 000 cubic metres of water available per head, per year, with Malta having less than 100 cubic metres/head/year. The United Kingdom has between 2 000 and to 5 000 cubic metres of water available per head/year (European Environmental Agency, 1997:5).
This lack of water does force certain countries, at times, to entertain the thought of war, for this scarce resource.

2.1.2 Wars over Water

"As more people seek greater amounts of declining resources, conflicts erupt" (Myers, 1994: 16). The need for water has already been so intense that wars have been fought, and communities have been divided. Water in the Middle East is more important than oil. The 1967 war between Israel and Syria, was as a result of competition for water, from the Jordan River. Turkey has been accused, by both Syria and Iraq, of depriving them of much needed water, as it proceeds to build a series of dams along the Euphrates River. It is also predicted by the United Nations that wars in Africa, over the next 25 years, are likely to be fought over the rights and access to water, and that this will most likely be first to start, in areas where rivers and lakes are shared (*World Water Crisis*, 2004). As a result of ongoing war over water rights, 350 000 Somalian people died during 1992 (*Droughts – Dust Storms – Black Blizzards*, "s.a.").
Without treaties in place between South Africa and Lesotho, who knows if this in itself could not become a reality, by virtue of the fact that Gauteng relies so heavily on the water from Lesotho, for its livelihood.
Many of the water supplies that could cause potential conflict, are river boundaries dividing the various nations.

2.1.3 Sharing river boundaries

Where water flows across borders - and becomes crucial in regions of religious, territorial or ethnic tension it is important to address the matter timoeusly and correctly. In the world there are 261 international water basins, and all need careful management and negotiation. Inter-state cooperation (such as between SA and Lesotho) is essential in the search for regional water solutions (*The Global Water Crisis*, "s.a").

South Africa (SA) shares four (4) major river systems with neighbouring countries, namely, the Orange/Senqu (Lesotho and Namibia), the Limpopo (Botswana, Zimbabwe and Mozambique), the Incomati (Swaziland and Mozambique) and the Usutu/Pongola-Maputo (Swaziland and Mozambique), (Pillay, 2005:21). In each case it requires careful management by SA, to ensure that the international agreements reached regarding these common waters, are met.

Louw (2004:17), reported that Zimbabwe planned to draw water from the Zambezi for its drought prone Matabeleland region. This, he reported, could fuel conflict in the region, as Zimbabwe is not allowed to draw water from this source, without approval from the Southern African Development Community countries that share the Zambezi basin. Louw also quoted hydrologist McDonald, “Competition for the river should be a wake-up call for states to pursue national interests cognizant of others. There is a great potential for conflicts in the proposed project: he warned”.

Africa, and more particularly Southern Africa, is not blessed with an abundance of water in many areas. Instead, there are several, very large river basins that hold lots of water, which several countries tap into.

2.1.4 Available water – Africa

In many areas of Africa and Asia, demand is already exceeding supply. This broad thinking is backed up by Green *et al*. (2000:287), where they state that many parts of the developing world will experience large increases in relative water demand, and that arid and semi-arid regions will face the additional challenge of absolute water scarcity, by the year 2025.

According to Nejjar, as quoted by Nduru (2007) in Africa, 25 countries are expected to experience water scarcity or water stress in the next 20 to 30 years. This translates into 16% or 230 million people in Africa’s population facing water scarcity by 2025, and 32% or 460 million people living in water-stressed countries by that time.

The South African Development Community (SADC), in combination with other sponsors, produced a report dealing with water resources management. Of the twelve countries in Southern Africa, only two are predicted they will have the same water positive situation in 2025 as they had in 1995, one being Namibia (Table 2.3). Unfortunately, the water situation of South Africa is predicted in this report, to move from one of water stress to that of absolute scarcity (SADC, IUCN, SARDC, World Bank 2002:8-9).

Table 2.3 Current (1995) and predicted (2025) population size and water scarcity. Adapted from (SADC, IUCN, SARDC, World Bank 2002:8-9)

Country*	1995		2025	
	Population (millions)	**Water scarcity index**	**Population (millions)**	**Water scarcity index**
South Africa	39.4	Water stress	50.1	Absolute scarcity
Lesotho	1.9	Quality & dry season problems	3.4	Water stress
Swaziland	0.9	Quality & dry season problems	1.8	Quality & dry season problems
Namibia	1.5	Adequate	2.4	Adequate
Botswana	1.4	Adequate	2.2	Quality & dry season problems
Zimbabwe	11.5	Quality & dry season problems	17.3	Water stress
Mozambique	15.4	Adequate	26.7	Quality & dry season problems

* Note: not all 12 countries have been included.

2.1.5 Available water - South Africa

Kebotlhale and Naraghi (2004:681) state that of the 19 water management areas in South Africa, 11 are in need of water transfers, pointing towards a distinct lack of water in certain regions where it is needed. They also point out that approximately 18 million people in South Africa (mainly in semi-rural and peri-urban municipalities) are without adequate sanitation (Kebotlhale & Naraghi, 2004:684). World-wide, two-thirds of urban waste water doesn't even get treated, much less recycled (Montaigne, 2002:8-50). Therefore, should sanitation improve, more water will no doubt be required, and similarly, increased water use will add to the problems of untreated water making its way back into the river systems.

Davies and Day (1998:7-8) indicated that taking into account the anticipated slowest population growth and the smallest demand for water, the demand for water supplies in South Africa will be fully committed some time between 2003 and 2015, and that by 2020 the demand will exceed surface water supply, and that by 2040 demand for both surface and underground water will have been surpassed.

Similarly, in 1998, it was stated in Local Government Digest (1998:55) that South Africa was classified as a water stressed country, because there was less than 1 700 cubic meters of water per person per year. And that if water was not used wisely, it would reduce by the year 2025 to less than 1 000 cubic metres of water per person. This is supported by, The International Water Management Institute (1996: as quoted by Otieno and Ochieng, 2004:668), which estimates that by 2025, South Africa will experience a physical water scarcity, with annual fresh water availability of less than 1 000 m^3 per capita, which is the index for water scarcity. This indicator of shortages was confirmed yet again in 2004, by the parliamentary editor for the Business Day newspaper, when it was stated that R 21 billion was approved by Government to construct twenty new dams, in twenty years, in South Africa, to prevent consumption from exceeding supply in 2020, if SA’s current water infrastructure was not improved (Hartley, 2004:).

Some interesting and alternate views are offered by Prof Laker (2005:28), who quotes a paper by Scotney and van der Merwe, presented at the Southern African Irrigation Symposium (1991). The total water runoff per annum of South Africa was 53 500 million cubic metres, and of this about 60% (32 100 million cubic metres) could be economically exploited. He further indicates that in 1990, the total water demand by consumers (including irrigation, municipalities, industries and other) was 17 800 million cubic metres, which he indicates will leave an amount of 14 300 million cubic metres of water available for an economically exploitable surplus. Similarly, the water demand for 2010 is estimated to be 23 300 million cubic metres of water, which will still leave an estimated amount of 8 800 million cubic metres (27.4%) of water available as exploitable surface water. It does, however, seem that Laker did not take into account, the amount of water reserve required for natural ecosystems functioning to continue.

In “*Our Liquid Assets*” (2006:5), it is stated that the gold-fields around Gauteng were allowed, early last century, to dewater ground water, twice the capacity of the Vaal Dam. This practice is still occurring as mines require to work at great depths, keeping their operations going and in the process pumping out millions of litres of water.

As population numbers increase, and as lifestyles change, so do the demands on available water. According to the report from the United Nations Centre for Human Settlements (Habitat) the population growth between 2015 (40 377 000) and 2030 (47 644 000), for South Africa, will be 0.6% (Habitat,2001:268-286).

Often statistic sources vary in their manner of report and in the statistics themselves. An example being (table 2.4), from the United Nations Development Programme, which indicates populations in 1999 higher than figures quoted from the United Nations Centre for Human Settlement (Habitat) for 2000.

Table 2.4 Population size and GPD per capita for South Africa (Adapted from UN Development Programme, 2001).

Country*	Total area (000sq km)	Population (million, 1999)	GDP per Capita (in PP US$)
South Africa	1 219 090	42.8	8 908

The population of South Africa (Table 2.5) is expected to increase from 39 477 000 in 1995, to approximately 50 160 000 in the year 2025, and that as a result of various factors, there will be a sharp reduction in the availability of water per person, per year, from 1 266 m³, to 997 m³ (a reduction of some 22% of available water per person is predicted).

South Africa will not have, enough of its own water resources to meet its future requirements. Increased population, together with increased pressure on the water resources, also places large amounts of other pressures on the natural systems within our universe. One such problem, that is causing all sorts of other problems, being climate change, or more often referred to as global warming.

Table 2.5 Available water – Southern and Central Africa (Adapted from SADC, IUCN, SARDC, World Bank 2002:25-47).

Country*	Total annual renewable freshwater available (cu km/yr)	Population in 1995 (000)	1995 Per Capita water availability (m³)	Population in 2025 (000)	2025 Per Capita water availability (m³)	Total Freshwater withdrawal (m³/p/yr)	Estimated year 2000 per capita withdrawal (m³/p/yr)
South Africa	50	39 477	1 266	50 160	997	13.31	302
Lesotho	5.2	1 930	2 694	3 400	1 529	0.05	23
Swaziland	4.5	908	4 956	1 800	2 500	0.66	631
Namibia	45.5	1 590	28 616	2 460	18 496	0.25	138
Botswana	14.7	1 459	10 075	8 904	6 476	0.11	67
Zimbabwe	20	11 526	1 735	17 395	1 150	1.22	90
Mozambique	216	15 400	14 026	26 730	8 080	0.61	35

* Note: not all regions have been included.

2.2 FACTORS AFFECTING WATER AVAILABILITY.

2.2.1 Climate Change and Global Warming

Climate change is a natural process, whereby both the earth and its atmosphere, alter to accommodate the change in the amount of energy received from the sun. The cycle, moves through both warm and cold periods and takes hundreds of years. During this change, temperature and rainfall are affected either positively or negatively. Unfortunately, the lifestyles of humans are affecting this negatively, and as a result, certain plants and animals as well as humans may not be able to adapt fast enough (The National Agricultural Directory 2007:56).

Global warming is a phenomenon much debated about, and it is said to affect the entire world. It is adding to the reduction of glaciers, and in the long term will result in flooding in some areas, as well as water shortages in others. Himalayan glaciers are melting at a rate of 10 to 15 metres a year. Three of Nepal's snow-fed rivers are losing volume. India's Gangotri glacier is receding at a rate of 23 metres a year (Tighe, 2005:6). Norway's Blomstrandbeen glacier has, since 1960, retreated at a rate of 35 metres per year (2005:6).

In the article, *Chill! Earth has Blown Hot and Cold Before* in the *Saturday Star* (12 February 2005:6), it indicates that previously the earth has had two warm peaks, between the years AD 1000 and AD 1100, and then in the 16th and 17th centuries there was a time of significant cooling. According to Scientists at Stockholm University (2006:13), this temperature swing was in the region of 0,65ºC to 0,9ºC, which is significant. A previous warming event, had a temperature change in the order of 0,5ºC. These natural climatic shifts, are caused as the earth shifts in orbit and "wobbles" on its axis. New research also demonstrates that natural events can worsen man-made global warming. Already the earth's surface has warmed by 0.7ºC to 0.8ºC since 1900, and the 1990's were the hottest decade on record. At the same time, as the earth's surface temperature increases, so will sea water temperatures.

Adams (2006:38-39) indicates that the debate over whether the earth is warming up or not, is over, and she then makes some eye-opening statements, namely:

> Climate disruptions feed off one another, accelerating destruction.
>
> Burning of forests reduces oxygen, retains less water and increases drought.
>
> Less ice will equate to more heat, as ice reflects nearly all of the sun's energy, while the oceans absorb much more (of the energy received by vegetation and soils 20% is reflected, whilst oceans reflect 10% water and ice reflects 90% or it's energy received).

> Global average temperatures will increase from 14.43ºC in 2000, to around 16ºC to 19ºC in 2100, thereby melting ice caps. The worst case scenario (melting of Greenland and Antarctica) being a rise of 72 m, which will inundate many coastal areas.

In an article Global warming apocalypse in 1 000 years predicted (2006:13) it stated that by the year 3 000, sea levels will start rising, and the total increase could reach 11.4m, which dwarfs the estimates by the International Panel on Climate Change that stated that sea levels will rise by 16cm to 69cm by 2080.

It is estimated by Myers (1994:112) that since 1940 the average earth's temperature has increased by 0.6ºC, and that this trend may continue. By 2100 sea levels may rise by 40cm, which will lead to many coastal areas (heavily populated), being flooded.

The Climate change report (Myers), and the International Panel report differ vastly from the Time magazine report (Adams). Ultimately, this study is not dealing with the difference in sea levels or their changes, and therefore, these differences are not under investigation, but rather when considering the picture as a whole, the fact is that global warming will affect our available water resources.

When compared on an average global scale, between 1860 and 2000, the nine warmest years for the global temperature have occurred since 1980, according to Intergovernmental Panel on Climate Change, as quoted by the National Drought Mitigation Centre in USA (*Drought and Climate Change*, 2006). The increase in global temperatures, is confirmed by Jones (2004:120) stating that the atmosphere will be about 4.5ºC warmer by the end of the present century than it was in 2000. The aspect of global warming is again confirmed by Doherty, Hulme *et al.*(2005:30-34), who indicate that Africa's future warming could occur at a rate of 0.2ºC to 0.5ºC per decade (ie between 2ºC to 5ºC over the next 100years). Hanlon (2006:15) quotes a report in the Nature Magazine that states that summers with temperatures of 40ºC will, in future, become the norm rather than the exception.

In a study by Jacek & Maarten as quoted by Van Rensburg (2006:18), climate change will also affect Botswana, where a 10% drop in rainfall will play out in such a way that only 23% of the Delta's current surface area will be retained.

At a conference, discussing Ground Water and Climate change in Africa (*The Kampala Statement groundwater and climate in Africa,* 2008), one of the observations made, was that rainfall and freshwater from rivers and lakes will become more variable, and thus unreliable, as a result of climate change (groundwater being the source of drinking water for more than 75% of Africa's population).

External factors impact on water and have the ability to negatively impact on our water resources. According to Ashwell and Hoffman (2001:127), between 1940 and 1989, average summer temperatures in South Africa increased between 0.8°C and 2.7°C. This will negatively impact on evaporation. Added to this problem, is the strain on our world water systems that carry and harbour water born diseases (four of the five main diseases) that kill as many as 25 million people in developing nations each year (Myers, 1994:118).

Although the global water supplies are at present sufficient to meet the needs of the entire world population the problem is that these resources are not evenly distributed, and while many people spend time fighting floods, at the same time, somewhere else in the world, others are experiencing droughts. Combined with this, are the erratic nature of rainfall patterns that occur in the same place over short periods of time. The large numbers of sudden floods world-wide, as well as in South Africa, are testimony to this (Davies & Day, 1998:312). The rivers that flow to the west coast of South Africa are drying up the fastest, and predictions are that the region could become a semi-desert area in the next 20 years. It is also feared, that the unknowns of climate change are difficult to predict, and therefore, additional special monitoring of the Western Cape will be required (Van Der Merwe, 2005:4). According to Yeld (2005:14), Western and Northern Cape are most at risk from climate change and it's associated warming. Projections are that drying will occur from west to east with a weakening of winter rainfall.

A sense of urgency must therefore be created, to ensure that all water users inclusive of the Green Industry are prepared for, and work towards the next drought. Similarly, there are views that indicate that efficient water management is not only the key to the future, but also the key to mitigating current and future water crises. This was re-iterated in a statement by the World Water Council of the 3rd World Water Forum (WWC, 2002), which ended in a statement from the 2nd World Water Forum meeting held in The Hague in 2000 - "while there are water crises in many parts of the world, they are not crises caused by a lack of resources, but crises caused by poor water management".

2.2.1.1 Specific sides effects for Gauteng region

Ashwell and Hoffman (2001:128) indicate that some climate change models suggest that doubling atmospheric carbon dioxide will have the following side effects on the South African climate:

A 10% to 20% decrease in summer rainfall over the central interior.

An increase in the frequency of floods and droughts.

A gradual linear increase in the mean annual temperatures, making the country on average, 1.5°C to 2.5°C hotter by 2050.

A 5% to 20% increase in rates of evapotranspiration.

A 30% increase in runoff in Eastern, Southern Africa.

Changes in biomes, and large areas of the Karoo becoming desert.

In their paper, Doherty, Hulme *et al.* (2005:34) predict significant decrease in December to February rainfall, ranging from 15% to 20% that will occur over South Africa and Namibia. This may be interpreted that Gauteng will not only have to deal with hotter summers and warmer winters, but drier periods and less rain, as well as the increased pollution of our water supplies. To add to this, will be an increased population and increased demands on the water supplies, by this population.

Yeld (2005:14) also indicates that despite fewer rainfall events, they are likely to be heavier, and the agricultural sector will be affected by rising temperatures and increased water scarcity. In some ways the Green Industry is not too far removed from the agricultural industry, and therefore these predictions need to be cautioned as well.

Already in South Africa, erratic climatic conditions have resulted in water storage in dams changing virtually overnight, from very low storage levels to being 100% full and more. Evidence of this is that the Vaal Dam (1995-1996) went from being only 14% full to being 110% full within a matter of days (Davies & Day 1998:312). Similar situations also occurred, in the dams that supply Cape Town, in 2007.
Regarding the agricultural sector, which, by the very nature that one is considering plants, is to an extent "similar" to the horticultural industry, the following aspects have been identified that will affect this industry as a result of climate change:

A reduction in crop yields and productivity with increased temperature.

An increase in pest attack.

A limit in the availability of water.

An increase in drought periods.

A reduction in soil fertility (The National Agricultural Directory 2007:56).

2.2.2 El Niño

Sea currents and temperatures play a large role in creating high and low pressure areas, as well as either drawing in cold/hot air or moisture laden air that forms clouds. One such phenomenon that affects the Southern African weather conditions being the El Niño event.

Some of the factors that may influence the development of a drought, can be attributed to the oceans that buffer our continents. Two such phenomena are El Niño and La Niño (*What is El Niño*, 2004). El Niño is also referred to as El Niño Southern Oscillation (ENSO). A description of the El Niño event is offered by Smit (2002:22). During non-El Niño (normal conditions) the trade winds blow towards the west, across the tropics, so that the sea surface is about 0.5 meter higher at Indonesia than at Ecuador. The sea surface temperature is also about 8ºC higher in the west, with cool temperatures off the South American coast. When this occurs, this part of South America experiences warmer and wetter weather than usual. The water is warmed, by as much as 4°C higher than usual. Rainfall then follows the warm water eastward, with associated flooding in Peru. The eastward displacement also results in much less rain for countries such as Indonesia, Malaysia and Northern Australia. The eastern half of Southern Africa, including most of the summer grain areas and many of the timber plantations, also expect to be drier in this time (Fiske, 1997:384). The El Niño meteorological phenomenon brings about dry conditions for South Africa's summer-rainfall regions, and better than normal rainfall for the winter-rainfall regions (Smit, 2002:22). This event occurs every two to seven years, and will last for three or more seasons, whilst it develops through several phases. (Philander, 1990; as quoted by O'Brien, & Vogel. 2003:11-14).

An example of the El Niño effect on South Africa being: According to Kupha (2004:14), South Africa experienced full El Niño in 1982/3 and in 1991/2. For the 2004/05 seasons he predicted another full-scale El Niño, which would deliver above average spring rains and below average summer rains. On 25 June 2004 Kupha (2004:15), reported that the likelihood of El Niño occurring in the summer of 2004/05 was lessening, due to the change in sea surface temperatures in the Pacific.

The El Niño event can account for as much as 30% to 35% of climate variation in parts of the SADC region (Makarau, *et al.* 1997; as quoted by O'Brien, & Vogel. 2003:11-14). It is also reported that the ENSO events are usually associated with droughts in the SADC region, with the drought of 1982/83 as a recent example (Lindesay, 1998; as quoted by O'Brien, & Vogel. 2003:11-14). This statement is, however, not to be cast in stone, as is evident from 1992 when there was only a moderate El Niño event, but the most severe drought in 150 years was experienced over Southern Africa, (Cane, 2000; as quoted by O'Brien, & Vogel. 2003:11-14) .

Meteorological and climatological models are seldom able to provide a sound basis for any prediction of future weather patterns (Preston-Whyte & Tyson 1988:339). No area, and especially an economic and residential area such as Gauteng, can be impulsively reliant on these unpredictable changes in weather patterns, for its future. Other forms of stability and interventions are required.

2.2.3 Rainfall and climate

The rainfall and climate of an area under normal circumstances, play a huge role and influence economic activities, including ornamental horticulture throughout the world.

The world annual average rainfall is about 860 mm per annum, and the average for South Africa is 497 mm per annum, with 65 % of the country receiving less than 500 mm per annum and 21% of the country receiving less than 200mm per annum. Rainfall generally declines from 800 mm in the East of the country, down to below 200mm in the West of the country. The average rainfall, taken over a 30 year period for the Rand Water supply area, is 654.25 mm (RW, 2005). The amount of water that South African rivers receive a year, is 50 billion m^3 (Water by numbers, 2005:4).

Of all the rain that falls to earth, about two thirds evaporates back into the atmosphere, and of the remaining water, about one half flows back into the sea, unused (Serageldin, 1995:1). Over most of South Africa, the annual potential evaporation ranges from 1 100mm to more than 3 000 mm (South Africa. 1986. Department of Water Affairs: 1.3). According to Tyson (1986:5), the yearly evaporation varies from a minimum in winter to a maximum in summer. The mean annual pan evaporation ranges from around 4 000 mm in the Upington area, around 2 000 mm in Cape Town, around 1 500 mm in Durban, and around 2 000 to 2 500 mm in the Gauteng. Evaporation itself exceeds rainfall, which adds to the pressures on the water systems, water storage facilities and Green Industry water users. The rainfall throughout South Africa is limited to different seasons of the year, with the Gauteng region receiving mainly summer rainfall.

The available water needs to be cared for in a responsible manner, to ensure that sufficient water is available for social, economic and leisure activities, as well as for ecosystems.

2.2.4 Rainfall and climate in Rand Water supply area

Due to the fact that the RW supply area is a large, irregular shaped area over varied climatic zones, it is not possible to obtain a single rainfall figure, that covers the entire area. As a result, the nearest available rainfall station figures have been used.

Johannesburg is situated at the center of the Rand Water supply area (not from a geographical aspect). The highest temperature over a 30-year period for Johannesburg from 1961 to 1990 is 35 ºC and the average annual rainfail is recorded as 713 mm (Table 2.6). Johannesburg is situated at 26º 08'S and 28º 14'E and is 1694 m above sea level.

Table 2.6 Thirty year climate data for Johannesburg (*Climate data Johannesburg*, 2003).

Month	Temperature (ºC)				Precipitation		
	Highest recorded	Average daily maximum	Average daily minimum	Lowest Recorded	Average annual (mm)	Average number of days with>= 1mm	Highest 24 hour rainfall (mm)
Year average	**35**	**22**	**10**	**-8**	**713**	**99**	**188**

Towards the North of the Rand Water Supply region, the weather changes to become hotter and dryer. The highest temperature over a 30-year period for Pretoria from 1961 to 1990 is 36 ºC and the average annual rainfail is recorded as 674 mm (Table 2.7). Pretoria is situated at 25º 44'S and 28º 11'E and is a height of 1330 m above sea level.

Table 2.7 Thirty year climate data for Pretoria (*Climate data Pretoria,* 2003).

Month	Temperature (ºC)				Precipitation		
	Highest recorded	Average daily maximum	Average daily minimum	Lowest Recorded	Average annual (mm)	Average number of days with>= 1mm	Highest 24 hour rainfall (mm)
Year average	**36**	**25**	**12**	**-6**	**674**	**87**	**160**

In the Eastern area of supply, the rainfall pattern increases, with average colder days and average lower temperatures. This is very evident for the figures from Bethal. The highest temperature over a 30-year period for Bethal from 1961 to 1990 is 34 ºC and the average annual rainfall is recorded as 711 mm (Table 2.8).

Table 2.8 Thirty year climate data for Bethal (*Climate data Bethal*, 2003).

Month	Temperature (ºC)				Precipitation		
	Highest recorded	Average daily maximum	Average daily minimum	Lowest Recorded	Average annual (mm)	Average number of days with>= 1mm	Highest 24 hour rainfall (mm)
Year average	**34**	**22**	**8**	**-9**	**711**	**90**	**88**

It is also possible to observe that in the far Western area of the Rand Water supply area, the temperatures are much hotter, and rainfall almost 30% less than in the Eastern area. The highest temperature over a 30-year period for Pilansberg from 1961 to 1990 is 40 ºC and the average annual rainfail is recorded as 519 mm (Table 2.9). Pilansberg is the closest weather station to Rustenburg (which is the western supply area for Rand Water).

Table 2.9 Thirty year climate data for Pilansberg (*Climate data Pilansberg*, 2003).

Month	Temperature (ºC)				Precipitation		
	Highest recorded	Average daily maximum	Average daily minimum	Lowest Recorded	Average annual (mm)	Average number of days with>= 1mm	Highest 24 hour rainfall (mm)
Year average	**40**	**28**	**12**	**-5**	**519**	**69**	**65**

Rand Water's own rainfall figures (61 years and 101 year average) to the supply area indicate that the average rainfall for eastern area is 720 mm, 744 mm in the central area, 723 mm in the western area (not near Pilansberg), 678 mm in the southern area and 664 mm in the northern area (for the year ended 30 June 2005) (Table 2.10). These measurements do, however, not include the far outer limited areas.

Table2.10 Rand Water distribution area long term average rainfall figures (RW, 2005).

Region	Area	Average annual (mm)	Number of days	101 year average
Eastern	Boksburg, Benoni, Springs, Brakpan and Nigel rainfall stations	584.7	43.7	720.7
Central	Johannesburg, Germiston, Roodepoort and Alberton.	644.8	43.7	744.7
Western	Krugersdorp, Randfontein, Rainfall stations and area to Blyvooruitzicht.	678.9	48.6	723.8
Southern	Vereeniging rainfall stations and area south of Johannesburg	548.6	36.5	678.0
Northern*	Pretoria rainfall stations and area north of Johannesburg	631.3	43.9	664.3
*For 61 years only				

The average rainfall, as recorded by Rand Water (61 years) themselves is, however, slightly less (617 mm) than the 30 year average, available from the National weather service (654 mm)

When observing rainfall figures an indication of the extremes in rainfall patterns, is not given. This study is, however, not focussing on the extremes of flooding, but rather on the extremes of drought.

2.3 FACTORS AFFECTING WATER AVAILABILITY – DROUGHTS, DESERTIFICATION & WATER LEAKS

Climatic changes have the ability to alter the landscape over a long period of time and this does plan a role in the entire water cycle.

2.3.1 Desertification

Besides the factors of climate change, droughts and El Niño, the reality is that the Green Industry of the world and South Africa, also have to deal with the broad problems associated with desertification, as an added problem.

World wide, every year the process of desertification degrades a further 21 million hectares, to a condition of near complete uselessness (Myers, 1994: 42) . Two thirds of Africa is either desert or drylands, and 73% of Africa's agricultural drylands, are already degraded (Ashwell & Hoffman 2001:4). Jordaan (2006:30) is in agreement with the 73% of degraded lands, and he adds that environmental destruction costs Africa R 45 billion a year.

Jones (2004:184), quoting Hulmes & Kelly, Wellens & Millington, and Barrow, distinguishes between desertification and desertisation. Desertisation is a natural process where new deserts are formed over hundreds of years, due to natural changes in climate. Desertification is the degradation of arid, semi-arid and dry sub-arid areas, and is usually caused by the over use of natural resources, by humans. The landscape created, due to this desertification process, may take on the form of a desert, making one think that it was caused by nature and not by man.

According to Preston-Whyte & Tyson (1988:325), the whole of Namibia, and Botswana and more than half of South Africa are rated as potential desert, with large areas of central and northern South Africa, at more than high risk.

2.3.2 What is a drought?

Drought is normal to every climate and area on earth, and a change in weather patterns should not be seen as the only cause of a drought. As has already been alluded to, drought can be induced through expanding populations, large irrigation schemes, climate change, weather patterns, and diversion of water supplies from areas of more to areas of less.

"Unlike other natural disasters, drought does not have a clearly defined beginning and end. As a result, our reaction to drought traditionally has not been timely" (Planning for Drought, The Hydro-Illogical Cycle, 2003). This statement is supported by others, indicating that drought is slow to take effect and the indirect effects can reach devastating proportions, which rival and even surpass that of floods, hurricanes and tornados (*Spotting drought before it's to late,* 2004).

According to the University of Nebraska, a general definition of drought is, "when a shortfall in precipitation creates a shortage of water, whether it is for crops, utilities, municipal water supplies, recreation, wildlife or other purposes" (*Spotting drough*t *before it's to late*, 2004).

There are various categories and definitions of drought, which are understood, interpreted and experienced differently by various sectors of the population and society, depending on how and when one is affected - According to Wilhite (as quoted by Backeberg & Viljoen, 2003: Iran) . These categories include meteorological drought, agricultural drought, hydrological drought, socio-economic drought (*Spotting drough*t *before it's to late*, 2004) and irrigation drought (Backeberg & Viljoen 2003: Iran) (Figure 2.1).

Drought must not be confused with aridity or with desertification, as the latter two are more permanent features, but can be brought on and intensified as a result of a drought.

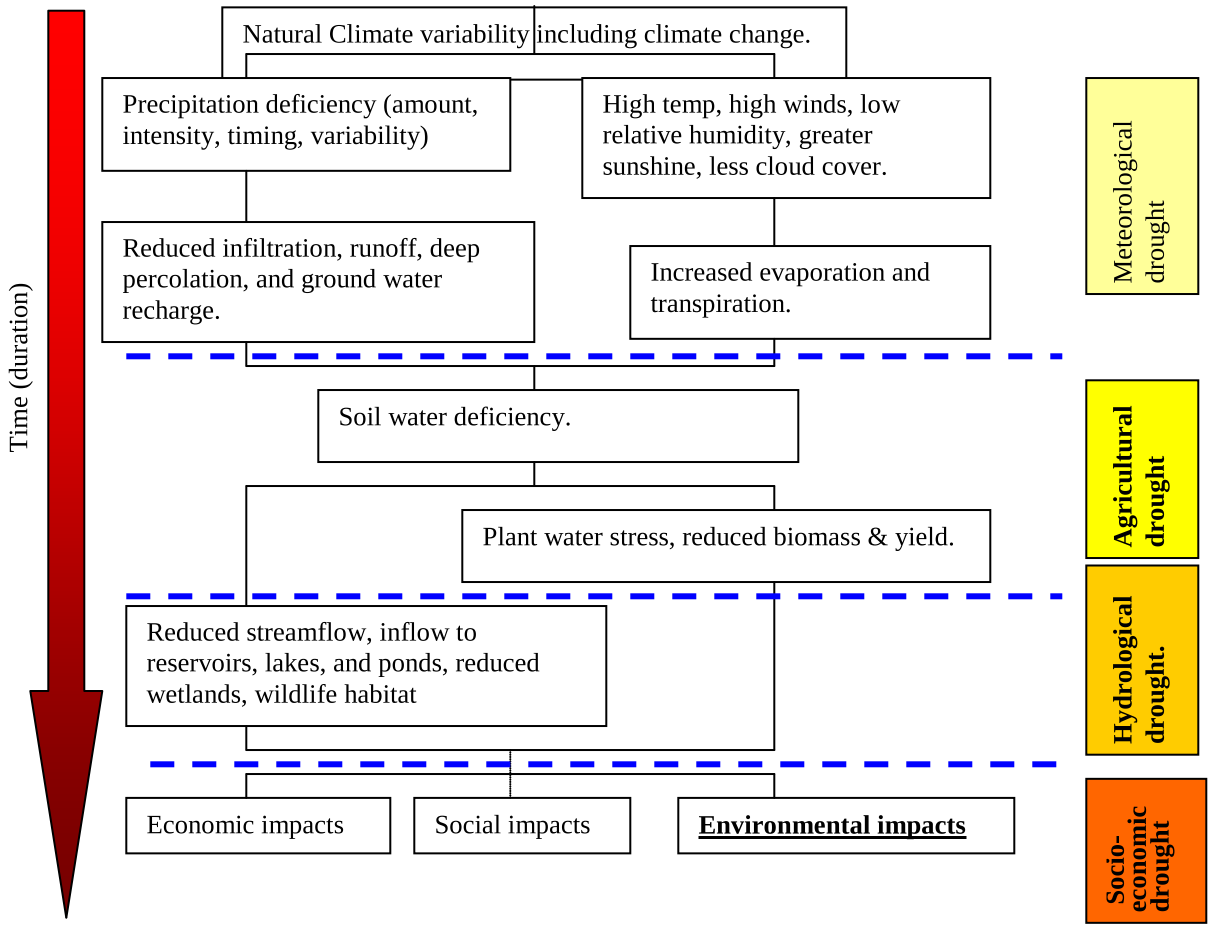

Figure 2.1 Definitions of drought, graphically demonstrated (Adapted from *What is drought*, 2006*)*.

Regardless of a definition, it cannot be unilaterally accepted or taken for granted that a drought in area A is as intense as in area B, of the same region. Localised factors (for example geographic, climatic and social conditions) will, must and do play a huge role in this situation. The difficulty comes in, when a meteorological drought is being experienced, and then becomes a hydrological drought, but due to existing available water supplies, it has not been converted into a socio-economic drought. At what point does one/government declare a drought, and at what point does one implement drought (Water supply response plan) measures?

Obviously gardens, garden centres, growers and parks cannot be left unaffected by different types of droughts, as they come and go, sometimes even during a single season.

It may, however, be wise to consider regional definitions for, and responses to drought, as this may place more emphasis on local conditions, local resources and local situations. Similarly, the need to have in place, regional strategies to address any form of drought, is hugely important. One such region may be the Rand Water supply area, whose water is derived from the Vaal River supply system.

2.3.2.1 Why be concerned about a drought?

In real terms, droughts are generally short lived (one to ten years), although there are some that never "seem" to end. Some droughts affect very small areas of a country, whereas others seem to stretch over vast tracts of land. Likewise, a drought in one area e.g. the catchment areas for Rand Water, may drastically affect the ability to supply sufficient water to the end source, over 300 km away, whilst in the actual supply area, such as Johannesburg, there may be no drought at all. In fact, it could be experiencing localised flooding. This could and does cause confusion in the minds of end users. The side effects of any drought, but more particularly those that are very extreme (either by intensity or duration), can be catastrophic. It may affect, or result in situations such as:

- Reduced socio-economic activity.
- Increased soil erosion (soil becoming bare and then being lost either to wind erosion or water erosion when water again flows over this barren soil), and physical change to the soils and structure.
- Reduced food stocks (food security).
- Loss of all forms of life resulting in environmental loss.
- Extinction of species.
- Potential wars with neighbours, from whom water is currently extracted.
- Reduced water stocks.
- Social change of people (drought can cause depression in some cases, as well as barren landscapes being perceived more negatively).
- Displacement of people, wildlife and livestock.
- Financial loss to the country, region or industry.
- Production loss (industry and agriculture as well as the Green Industry).
- Aesthetical loss (as a result of plants in the landscape dying).
- Loss of tourism (lush regions experiencing drought loose their aesthetical appeal and as a result people tend not to enjoy or visit these areas).

It is a known fact that droughts occur all over the world at different times, and that the extent, length and severity of the drought will affect each country, local populations and individuals in different ways. The impacts of drought have the ability to be greater than any other natural disaster. As society "develops" and changes, drought conditions are compounded by our "advanced" state, and this continues to place more and more pressure, not only on the limited available water resources, but also on the environment as a whole, often at our own peril.

A drought may refer to a period of a few dry days, or a succession of many dryer days over a period of time. It may also point to a gradual change from what is known as wet (for any specific location), to a gradual drying out of an area, due to a prolonged lack of rain. This gradual change will slowly negatively affect crops, irrigation, urban supplies and stored water supplies. As a result, a drought may seem to appear out of nowhere, or it may be something that slowly creeps up, until the intensity is so great that the effects are felt as a drought (Fredericksen.1992:8).

Simultaneously, during a declared drought when a water supply response plan is in operation, most end users will cut back on water use, and change their lifestyles and water use habits. When the drought is over, many end users soon loose their sense of drought awareness (water conservation) and revert to a sense of apathy. Unfortunately, when this process is later reversed and drought again rears its head, these same users need to quickly re-learn to change their habits. This is known as the hydrological-illogical cycle (Figure 2.2). In a garden or landscape, as much as what the users are able to chop and change their habits the plants and fauna within the garden are most certainly unable to change their growth habits, in an instant. The result being that many gardens and landscapes suffer, because they are not used to not being without water.

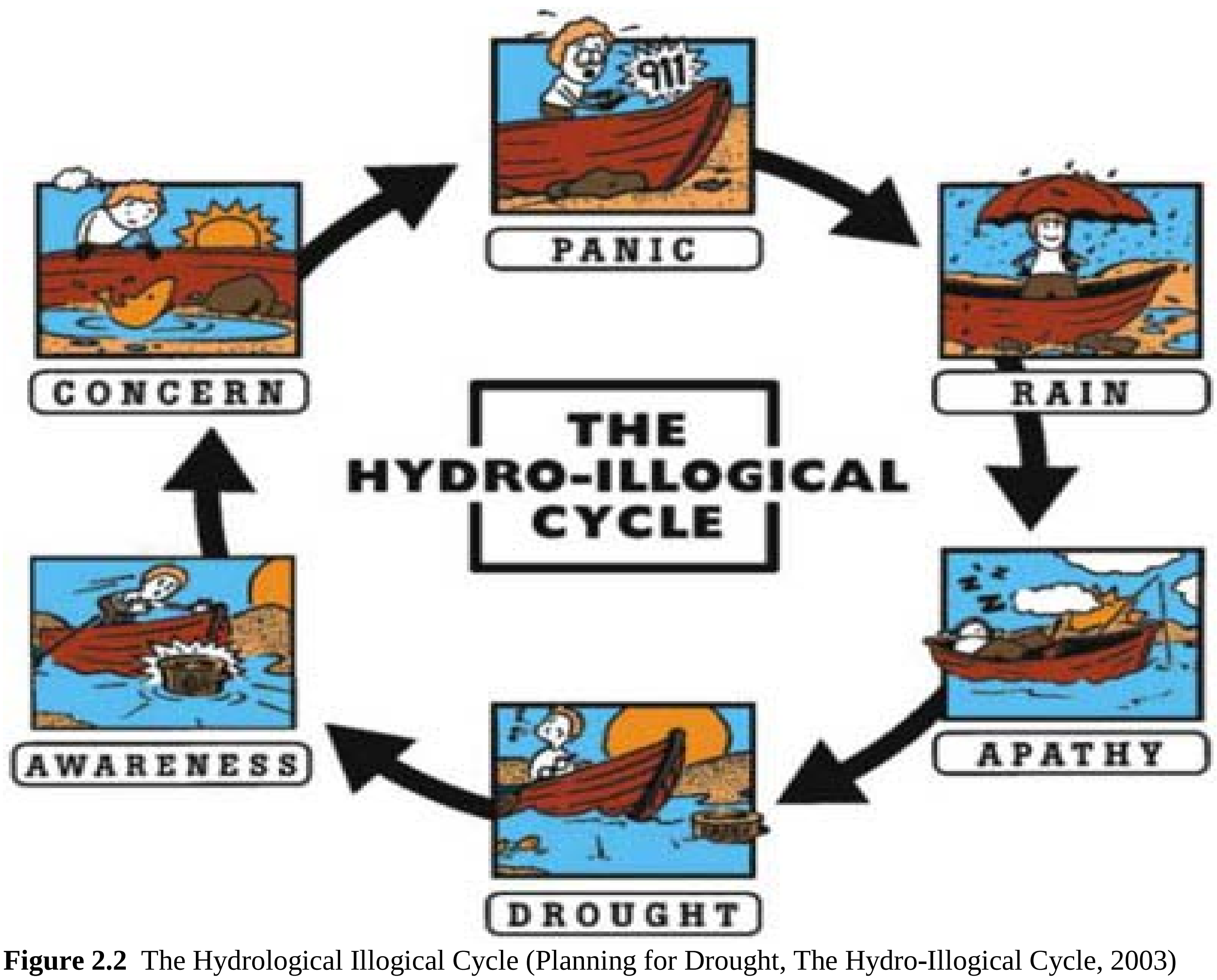

Figure 2.2 The Hydrological Illogical Cycle (Planning for Drought, The Hydro-Illogical Cycle, 2003)

In the USA, several systems are used to plan for, and predict drought. Some of these being, the Standardised Precipitation Index, the Palmer drought severity Index, the Crop moisture index, the Reclamation drought index and Deciles (*What is drought*, 2006).

In South Africa, the South African Weather Service (SAWS) produces various forecasts, to assist with economic and social decisions. Output is compiled by obtaining information from models and general circulation models (GCMs) run at SAWS, and GCMs run at the University of Cape Town (UCT), the European Centre for Medium-Range Weather Forecasts (ECMWF), the United Kingdom Met Office (UK Met-Office) and the International Research Institute for Climate Prediction (IRI). Seasonal forecast specialists from the SAWS, UCT and the Agricultural Research Council then produce the forecasts, based on the model output and expert interpretation on the current climatic conditions (*Seasonal Forecast for Southern Africa*, 2008).

In South Africa, and more particularly the Rand Water supply area, the main system used to predict available water, is the "Operating analysis for the Total integrated Vaal River system (using the Water Resource Planning Model)". The custodian of this system is DWAF.

In Africa and Australia, drought is the main agricultural constraint, affecting more than 44% of Africa and more than 55% of Australia. It is interesting to note that areas located between latitudes 15 and 20 degrees north and south, often experience drought. These countries being West Africa, South Africa, Brazil, Australia and India (*Droughts – Dust Storms – Black Blizzards*, "s.a."). According to Basher *et al.* (2005:273), Southern Africa has experienced a total of 73 disasters over the period 1973 to 2002. These were made up of droughts (35), floods (28) and windstorms (20). They also indicate that between 1993 and 2002, 110 956 000 people were affected by drought in Africa.

Each day, that one moves away from the last good rain, is possibly one day closer to the next drought. In the words of Backeberg and Viljoen (2003: Iran), "If past cyclical rainfall patterns will continue, indications are that the next drought period in South Africa is imminent". South Africa is periodically afflicted by severe and prolonged droughts, which are often terminated by severe floods. South Africa experienced a drought, amongst others, from 1925 to 1933, from 1944 to 1946, from 1950 to 1952, from 1962 to 1971 (South Africa. 1986. Department of Water Affairs: 1.5 to 6.16) and from 1982 to 1995 (Backeberg & Viljoen, 2003:Iran). Preston-Whyte & Tyson (1988:323), indicate four wet and five dry periods can be identified in South Africa, between the period 1905 to 1990 (Table 2.11).

Table 2.11 Dry and Wet periods for South Africa 1905 to 1990, (Adapted from Preston-Whyte & Tyson 1988:323)

Years	Number of Years	Wet or dry period
1905/6 – 1915/6	11	Dry
1916/7 – 1924/5	9	Wet
1925/6 – 1932/3	8	Dry
1933/4 - 1943/4	11	Wet
1944/5 – 1952/3	9	Dry
1953/4 – 1961/2	9	Wet
1962/3 – 1970/1	9	Dry
1971/2 – 1980/1	10	Wet
1981/2 – 1989/90	9	Dry

According to Tyson (as quoted by Backeberg & Viljoen, 2003: Iran), in summer rainfall areas, a pattern of nine – ten years of below average rain is followed by an above average rainfall. Fredericksen (Fredericksen.1992:8) also indicates that serious droughts of five to eight years in duration occur, that prolonged periods of reduced precipitation will also occur, and that "their occurrence, severity and duration are quite impossible to predict". Neville (1908), (as quoted by Tyson 1986:67), found evidence of eighteen year periodicity in rainfall in Natal, while Cox (1925), (as quoted by Tyson 1986:67), found evidence of a fourteen year oscillation in the rainfall of Cape Town. According to Vines (1980), (as quoted by Tyson, 1986:75), there is an existence of spatial dependence of both eighteen and eleven year oscillations in the South African rainfall. This concept is supported by Visagie (1980), (as quoted by Tyson, 1986:75), and is said to be stable over a 376 year period, when assessing annual growth rings on trees, *Widdringtonia cedarbergensis.*

Similarly, Tyson (1986:147-161) compared the high and low pressure zones, looking at the mean affect of Southern Africa. When observing wet spells (annual data for 9 years) as well as a dry spells (data for 10 years), he concluded that "wetter conditions" on the scale of days, seasons, and years are all associated with lower pressure over the subcontinent and increased pressure over the Gough Island region of the Atlantic Ocean, and that the reverse applies during "drier conditions". J van den Berg (climatologist), as quoted by Grobbelaar (2005:21) indicted that although wet and dry cycles are referred to, above normal rainfall can be expected in as much as 40% of an entire cycle, and added to this, above normal rainfall may occur towards the end of a dry cycle.

If the study of Preston-Whyte & Tyson (Table 2.12) were to be plotted forward (in the most simplistic manner), from the period of their actual study, using their own predictions of nine to ten years, then it could be concluded and predicted. that a day cycle will be experienced up until 2010/11. However, in itself this is not sound practice.

Table 2.12 Projected data forward from study by Preston-Whyte & Tyson (*Adapted from Preston-Whyte & Tyson, 1988:323)

Years	Number of Years	Wet or dry period
1971/2 – 1980/1*	10	Wet
1981/2 – 1989/90*	9	Dry
1990/91 – 1999/2000	9	Wet
2000/01 – 2009/10	9	Dry
2010/11 – 2020/21	9	Wet

2.3.3 Level of drought impact on water use

Whether a drought is extensive or short term, it will have an impact on the water use in an area. Hoy (1997) stated that through the drought period of 1983 to 1985, water consumption supplied by Rand Water dropped from an average of 2338ML per day to 1730ML per day. This indicated a drop of 35%. It took a further six years, until 1991, for the water use patterns to recover back to the 1983 level. In 1983 the average supply was 2328ML per day. It was also stated that again in 1995, water supply dropped from 2833ML per day to 2469ML per day in 1996. The drought broke in early 1996. Unfortunately, by 1997 the water supply was back up to 2800ML per day (RW, 2004-2005). Water supply by Rand Water is indicative of water consumption (inclusive of the Green Industry).

2.3.3.1 Some primary factors that determine the impact of a drought

According to the University of Nebraska, the National Drought Mitigation Centre in USA, planning for a drought usually involves the need to choose or create an index that will be used to identify and quantify departures from the normal. This could be for example rainfall, snow pack, stream flow, available stored water, underground water levels, and other water supply indicators (*Spotting drough before it's to late*, 2004). Several planning tools are used in different countries around the world (see Chapter 2.3.2.1.

Fredericksen (1992:10) identifies five primary factors that determine the level of impact of a drought. These being -sources of supply, categories of water users, level of water utilisation, water quality and institutional.

It is useful to expand each of the above, with particular application to the research area.

1) Source of water supply.

The source of water supply is critical when evaluating what measures have to be in place. For example, if the source is a single river system, or a series of boreholes with very little storage facilities, then the potential impacts become more. Fortunately this is not the case with the water supply for Rand Water. Rand Water obtains its water from the Vaal catchment area, but there are also two interbasin transfer schemes that take place, that assist in supplementing the water supply of the region. These being, the Tugela –Vaal Water Transfer scheme (which pumps water more than 500 m up and over the Drakensburg mountains from the Tugela River in KwaZulu-Natal, into the Vaal River via the Sterkfontein dam (Davies & Day,1998:14)), and the Lesotho Highlands Water Project (LHWP), which will transfer water from the Khatse Dam to the Ash /Liebenbergsvlei River, and then into the Vaal River. The amount of water transferred is 600 million to 630 million m^3 per annum (Viljoen, 2004). There is a total of six dams/weirs in the whole water supply chain for this region, and their combined water storage capacity is 8 171 211 ML. With the estimated total water use of the system being 1 307 577 ML per year, for Rand Water Fig 3.16).

2) Categories of water users.

The Vaal River system supplies water to Rand Water, as well as other users. The top seven users of water from this system are:

40% Rand Water

15.5% Vaal Harts/Lower Vaal Irrigation

12.4% Other irrigation

9.9% River and Wetlands losses

9.7% Eskom

4.3% Other towns & industries.

3.1% Sasol II & III (van Rooyen, 2008)

The water sold by Rand Water to its major customers can be categorised as follows (2004-2005 figures in brackets) (RW, 2004-2005) , Johannesburg Metropolitan Municipality 41% (42%), Ekurhuleni Metropolitan Municipality 23% (24%), Tshwane Metropolitan Municipality 16% (17%), Emfuleni Metropolitan Municipality 7% (7%), all other Municipalities 13% (10%) (RW, 2003). For an analysis of the entire system, and all users of the system, it is necessary to have a global picture of who the users are, what percentage of water is used by each sector, when the water is needed, and how critical it is to the survival of that sector (can they use other sources such as recycled water).

3) Level of water utilisation.

The available water stored in Raw Water sources is, 8 171 211 ML, in Rand Water station reservoirs, 213 608 ML, in service reservoirs (portable water), 5 636 202 ML. Therefore, the total of stored water in the Rand Water water-supply system is approximately 14 021 021 ML (RW, 2003), while the amount of water utilised within the system for portable water being 1 307 577 ML per year (RW, 2004-2005). This means that without consideration of normal rainfall, or what is required within the system for other uses or the ecological reserve, the system has enough water for 6.3 years of demand (based on 2003-2004 figures). In October 2008, it was predicted by the DWAF that the population for Gauteng will reach 12.27 million by 2025, and that the requirement yield for the total system will have increased to 2 947 million m^3/annum.

4) Water Quality.

All water within Rand Waters area of supply, is polluted to some degree or another, either from industrial or residential effluent, or from soil particles (erosion) and farm effluent (fertilizers and pesticides). All the water that is treated and pumped by Rand water, is treated to the South African National Standard SABS 241:1999: Class 1 (RW, 2003).

5) Institutional.

The Department of Water Affairs and Forestry is the custodian of all water within the Republic of South Africa. Within this framework, they have set out Catchment Management Agencies (many of which have yet to be established in practice), to manage set catchment areas. Water Supply Authorities, such as Rand Water, have been "allocated" certain defined geographic limits of supply area, and within this, the Local Authorities have the responsibility to ensure that water is supplied to the end user. The supplier of water to the end user can be different from the local authority, but must be appointed by the Local Authority. Each tier has its own regulatory framework within the Water Act. Cross-linked into this, is the Disaster Management Act No57 of 2002, which is applied only in times of need.

2.3.4 Water leaks, and wastage

Often the argument is used by the Green Industry that they should not be targeted in times of drought, due to the fact that many leaks go unchecked and are not repaired, and should be addressed first, because that is literally "water going down the drain". Although this research is not intended to address this matter, the amount of water that is lost from leaks, needs to be placed into perspective, in relation to the amount of water used by different sectors in industry.

At an international meeting held in September 2008, it was estimated that every day, more than 45 million m^3 of drinking water is lost in the world's water systems. This could serve nearly 200 million people. Added to this one third of water is lost in developing countries (*Press Release – The World Loses 45 million Cubic Metres of Water Every Day,* 2008*)*. One report, comparing World and SA percentages of leaks, places the losses in SA at a staggering 62% (**Table 2.13)**.

Table 2.13 Water use by different countries and percentage water loss associated (Buckle, H. & McKenzie *et al.* 2003:199).

Type of use or country*	**Per capita consumption (litres/head/day)**	**Percentage losses**
Standpipe (South Africa)	25	62
Jordan	50	44
United Kingdom	150	21
United States of America	400	9

*Note that not all countries have been included.

Unaccounted for water, supplied for domestic purposes, amounts to between 35% and 50% in world wide studies (Otieno and Ochieng, 2004:669).

In research undertaken by (Bhagwan *et al*. 2004:573), to benchmark leakage from water reticulation systems in South Africa, the following information was produced, after evaluating 30 water utilities in South Africa:

The annual average real loss of water is 340 litres per connection, per day, which compares well to the international average of 276 litres per connection, per day.

The unavoidable annual real losses are 59.93 litres per connection, per day.

2.3.5 Alien Invader Plants

South Africa has other problems such as alien invader plants (exotic). These plants occur throughout the country. Studies have found that non-native (exotic invader) tree species reduce the surface run-off nationally by 3.2% (Trees don't save water, 2005:8).

It is estimated that alien plants reduce the run-off of water in SA by 3 300 million m^3 per year (The National Agricultural Directory 2007:56). This is also equated to 7% of the available water run-off. This aspect is covered again, under the aspects of Water Wise principles.

2.4. FACTORS AFFECTING WATER USE

The primary users of all pumped, dammed and treated water are humans, and therefore it is necessary that this major focus of water use also be considered.

2.4.1 Population growth and economic growth

It is not only climate change that adds stress to the amount of water available to us, but also the ever increasing population. Logic should tell us that if, for example, 100 people had 100 000 litres of water available to them, this would allow 1 000 litres each. If that population increased to 200 people, it would reduce that same available amount of water to 500 litres each. It should therefore, be obvious that as more people are added to the world, or Rand Water supply area, that the same water resource will be under even greater pressure.

2.4.1.1 Population growth and economic growth - World

As stated in *Country Experiences with Water Resources Management* (1992: 33), many nations are expanding at a rate of between 2% and 4% annually, which equates to populations in those nations doubling, every 4 to 2 years respectively. In 1950, 30 percent of the global population lived in cities, and by 1995 this had risen to a total of 45% of the global population (Biswas, & Uitto (eds)2000:xii). According to Davies & Day (1998:312), it is estimated that by 2020, some 5 000 million of the world's potential 7 000 million people, will be city-dwellers. It was estimated that world-wide, the population would grow by 90 million people annually, increasing stress on the already stretched resources of the planet (Serageldin, 1995:10-11).

The world population was estimated at almost 6.25 billion in the year 2000 (Myers, 1994:14). Jones (2004:3) indicates that population growth has created an increased demand for natural resources, causing increased extraction of resources from the biosphere. Consequently, some parts of the biosphere will be overused and will deteriorate, for example use of water.

Table 2.14 Predicted population growth to 2030 for selected regions (Biswas, & Uitto (eds)2000:4).

Increase in population by region 1995 - 2030			
Region*	**Population in millions**		**Percentage increase**
	1995	**2030**	
Africa	720	1600	116 %
North America	295	368	24 %
Oceania	29	39	36 %

* Note: not all regions have been included.

Bos *et al*, as quoted by Biswas and Uitto (eds)(2000:4), predict that the, populations growth of developing countries will be higher than that of developed countries (Table 2.14). As a result, natural resources in those countries have to be placed under more strain. According to Serageldin(1995:10-11), it was estimated that by the year 2 000, 300 million Africans would be living in water scarce countries on the continent. In Africa and Asia some 30-35% of the populations live in urban areas, with the highest urban growth rates to be experienced in Asia and sub-Saharan Africa (Biswas, & Uitto (eds) 2000:xii-xv), which is already being placed under pressure for lack of water.

2.4.1.2 Population growth and economic growth - Gauteng

In 2004 it was estimated that the population of South Africa was 46.6 million. The population for Gauteng being 9.1 million, Free State 2.7 million, Mpumalanga 3.1 million, and North West 3.7 million (*Mid year population estimates, South Africa,* 2004).

South Africa is divided into nine provinces. The country is also divided into catchment areas, and each catchment area has a different bulk-water service provider, appointed in terms of the Water Service Act, 1997 (Act No. 108 of 1997). Some catchment areas run across different provincial boundaries. Rand Water supplies water to the following provinces - Gauteng (majority), North West (in part), Free State (in part) and Mpumalanga (in part). Rand Water's client base includes the metropolitan municipalities of Johannesburg, Tswane and Ekurhuleni, and thirteen (13) other municipalities, including mines and direct industries (RW, 2004-2005). Provinces and catchment areas do not match each other spatially.

Since 2003, most municipalities have been authorized as water services authorities, and these local or district municipalities are ultimately accountable to residents and consumers, for the delivery of water services and sanitation. It is therefore, the onus of the water service authority, to make arrangements to provide water services within its area of jurisdiction. Water Boards (such as Rand Water) are owned by the state, and provide regional water services in the form of both bulk services, to more than one water services authority, and retail services, on behalf of the water services authority (Mettler. 2005:22).

Information from Central Statistics (CSS) in 1995, suggests the following information about Gauteng:

17% of all South Africans live within Gauteng.

It is the second most populous province (94% populated).

It is the most urbanized province of South Africa.

67% (two thirds) of the population are economically viable.

It is the most densely populated province in SA (approximately 375 people per km²).

It accounts for nearly 38% of the value added, in the economy of SA (Lestrade-Jefferis, 1997:1-44).

Other facts regarding Gauteng as quoted by the Human Sciences Research Council (1998:3-55) are:

It covers 1.54% of the surface area of South Africa.

39% of the country's Gross Domestic Product (GDP) is generated here.

89% is urbanized.

Facts pertaining to Gauteng taken from the South African Institute of Race Relations (2006):

It has 2.9 million households, 9.8% of which are without water and 22.3% of which are without formal housing.

Gauteng is 18 000 km^2 in size (RW, 2007).

The population of South Africa is currently 47.4 million, and the population for Gauteng is currently 19.4% (9.5million) of the whole country (Oxford Business Group, 2008).

Gauteng also accounts for one third of the country's GDP. As more and more people flock to Gauteng so its services are constantly stretched (Oxford Business Group, 2008). This would include a stretch on water services. The use of water services does vary, according to different sectors of the population.

2.4.2 Water use consumption patterns within sectors of populations

2.4.2.1 Water use World

It is not only the growth in population that places pressure on our natural resources, but also the needs of human consumerism, where almost one billion over-affluent people, enjoy lifestyles that impose grossly disproportionate pressure, on our planetary ecosystem. This consumerism, together with technological know-how, allows us to use, misuse and over-use stocks of natural resources (Myers, 1994: 16).

The use of water throughout the world is estimated at, irrigation accounting for 69%, industry 23%, and domestic use 8% (Myers, 1994:102). According to Kirby (2000), the World Water Council believes that by 2020, the world will need an additional 17% more water than is available, if the world is to be fed. This is physically not possible, except through better utilisation of existing water resources.

As society becomes more "advanced" (consumerism), so the need for, and use of more water increases (Supported by the research undertaken by Pretorius and Schutte 1997:127-133). Myers (1994:102) reveals that the absolute minimum amount of water required by each person is 5 litres a day, although a realistic figure is 20 litres per day. Jones (2004:111) quotes World Bank figures that the minimum water required to sustain **every aspect** of human life, is about 25 liters per day. Contrary to this, is the developed world, where the need averages at between 100 litres (including industry) and 500 litres per person, per day (Myers, 1994:102), Similar views are expressed by Pretorius and Schutte, (1997:127-133). A comparison of the amount of water used (in different countries) per capita for three families is as follows: New York (USA), 300 litres per day; Nigeria, 120 litres per day; India, 25 litres per day (Myers, 1994:102).

According to UNESCO, the main water users, as per income group and categories, point to interesting water use trends with low and middle income countries using 82% on agriculture and 8% on domestic use, as opposed to 30 % for agriculture and 59% for domestic use in high income countries (Table 2.15).

Table 2.15 Water use per sector for income group per income (*Water and Industry*, "s.a.").
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Main water users as per income group			
	Agricultural	**Industrial**	**Domestic**
World average	70 %	22%	8%
Low and middle income countries	82%	10%	8%
High income countries	30%	11%	59%

The maximum daily supply of water per person in some of the major cities of the world, as quoted by Biswas & Uitto, from the Bureau of Waterworks (1994), indicates that Cape Town (as the SA example) is the lowest (Table 2.16) at 426 l/person.

Table 2.16 Water consumption & use patterns of major world cities (Biswas, & Uitto (eds) 2000:xii-xv).

City	Population served (10^3)	Length of distribution pipes (km)	Length of distribution pipes per 10^3 people served (km).	Maximum daily supply per person (litres)
Bangkok	4 800	8 086	1.7	479
Cape Town	2 200	3 094	1.4	426
Rome	2 830	4 810	1.7	636
Geneva	304	911	3.0	829
Detroit	3 469	5 517	1.6	1 764
Tokyo	10 928	21 484	2.0	513

According to the U.S. Geological survey, the average per capita use of water in the USA is 359 l/day, for those who supply their own water, and 459 l/day for that sector of the population that are supplied with water from a public source (Estimated use of water in the United States in 1990, 1995).

In Australia, the annual domestic water consumption per average household is 250 kl/year, or 350 l/person/day (*Urban Water Use Statistics in Australia*, "s.a."). In 2002-2003, it was estimated that the average annual household water use in Melbourne municipalities (Australia), ranged from 150 to 316 kl/month (Highlights of Bulletin 7, 2005). In 1975-76, the average household water consumption in Perth (Australia), was 500 kl/year. Water restrictions were imposed (as a result of a drought) and by 1981-1982 the average water use, per household, had dropped to 300 kl/year (Bill & Veck (2000:E1-K-17)).
As societies have expanded and increased, and as the world water situation has worsened, the concepts of "water footprint" and "virtual water" have taken root. These are still relatively new concepts. The water footprint of a country is defined by Chapagain and Hoekstra (2007:35-48), "as the volume of water needed for production of the goods and the services consumed by the inhabitants of the country". Water is required for the production of every commodity that exists, whether it be food, clothing, technology, cars etc. Virtual water (or external water footprint) on the other hand, is the import of goods from one country to another, where the goods produced by the first country used *X* amount of water in the growth, production or manufacturing process. The concept is one, where in reality it applies to real water and is a metaphorical term. This concept of virtual water has, as it were, also been the reason why many wars over water have managed to be avoided (Hachelaf, *et al.2006*:3-52). The water footprint for South Africa is indicated in table 2.17.

Table 2.17 Water footprint by consumption category for selected countries. (Chapagain,A.K. and Hoekstra, A.Y. 2007:35-48)

Country	**Population (millions)**	**Water footprint**	**Water footprint by consumption category**				
			Domestic water	**Agricultural goods**		**Industrial goods**	
		Per capita (m^3/cap/yr)	**Internal water footprint (m^3/cap/yr)**	**Internal water footprint (m^3/cap/yr)**	**External water footprint (m^3/cap/yr)**	**Internal water footprint (m^3/cap/yr)**	**External water footprint (m^3/cap/yr)**
South Africa	42	931	57	644	169	26	33
Australia	19	1393	341	736	41	64	211
USA	280	2483	217	1192	267	609	197
Global/average	5994	1243	57	907	160	79	40

The increasing demands on systems will result in these water systems, at some stage, reaching their maximum output, and if the entire system is not controlled, that very system on which populations depend for survival, could collapse.

2.4.2.1.1 Over utilization of water

From a world perspective, some examples given by Davies and Day (1998:10-12) of over use of water, site: Firstly, the Aral Sea was once a vast freshwater sea, and as a result of huge irrigation schemes, has now become a pesticide – polluted salt lake. Secondly, rivers in the United States, such as the Colorado, have so many dams and water abstraction schemes attached to them that they no longer reach the sea. Finally, the Murray – Darling River in Australia, the fourth largest river in the world, has been reduced to a stream at its mouth, as a result of the large amount of water abstracted upstream.

The Northern region of Africa is traditionally very dry, with water limited to selected areas only. The Southern region is of concern, as it has one of the lowest runoff coefficients.

Water withdrawals by selected regions in Africa, indicate that in general, traditional agriculture requires and uses the spoils of available water withdrawals (Table 2.18).

Table 2.18 Water withdrawals per sector for various African regions. (*General summary Africa…*, 2005)

African Region	Withdrawals by sector					
	Agriculture	Communities	Industries	Total	As % of total	As % of internal resources
	$x10^6 m^3/yr$	$x10^6 m^3/yr$	$x10^6 m^3/yr$	$x10^6 m^3/yr$	%	%
Northern	65 000 (85%)	5 500 (7%)	5 800 (8%)	76 300 (100%)	50.9	152.6
Central	600 (43%)	600 (43%)	200 (14%)	1 400 (100%)	0.9	0.1
Southern	14 100 (85%)	3 000 (16%)	1 800 (9%)	18 900 (100%)	12.6	6.9

* Note: not all regions have been included.

2.4.2.2 Water use - South Africa

In South Africa, domestic water use, which includes water used in the garden it is indicated at being 17% of the total water used as compared to industrial use being 11% and agriculture 72% (Table 2.19).

Table 2.19 Water use for Southern African countries per sector (Adapted from SADC, IUCN, SARDC, World Bank 2002:25-47).

Country		Water use					
	Total freshwater withdrawal (cu km/yr)	Domestic % of total water use.	Industrial % of total water use.	Agricultural % of total water use.	Domestic (cu m/person/yr)	Industrial (cu m/person/yr)	Agricultural (cu m/person/yr)
South Africa	13.31	17	11	72	51	33	218
Lesotho	0.05	22	22	56	5	5	13
Swaziland	0.66	2	2	96	10	15	606
Namibia	0.25	29	3	68	40	4	94
Botswana	0.11	32	20	48	22	13	32

The allocation of water in South Africa is prioritised into four different categories of order, namely:

1. Basic human needs.
2. Ecological needs.
3. Allocations for international obligations, international basin transfer, and strategic needs for future needs.
4. All other uses are authorised according to criteria of equity, efficiency and sustainability (Liphadzi, 2007:5).

In South Africa, the use of water is quoted by Ashwell & Hoffman (2001:69) as being, 60% agricultural use (including irrigation), 18% environmental use, 11.5% urban and domestic use, and 10,5% mining and industrial use. Water demand projections for South Africa indicate an annual growth rate of 1.5% between the years 1990 and 2010, made up of 3.5% for urban and industrial use, and 1% for irrigation (*Review of Water Resource Statistics by Country*, "s.a."). Productive water users at household and village based level, are predicted to more than double the water supply volumes, and must therefore, also be better recognised so that rural water supply can become more demand responsive, and sustainable (Otieno and Ochieng, 2004:669). This is yet another pressure on the available water systems.

Water use in any particular area will be affected by the main types of activities and industries of these areas, and as a result, there is no single simple solution available for each and every municipality, or province, or water supply authority. For example, the wet industry uses large amounts of water but is also most likely to have the ability to recycle this water effectively within the same unit of operation. On the other hand, household water users use much less water per individual household, but have very limited ability to recycle and reuse this water, and are in some cases also restricted from doing so, due to municipal by-laws.

Looking at South Africa, Holtzhausen (2005:11) offered, consumption of water use in poor areas can be as low as 15 l to 20 l of water per day, while in rich urban areas water use can be as high as 150 l to 200 l per day. The Water Research Commission report (1994:17) indicates a use in SA, of 166 l per capita, per day, and high income users (29% of the population) using 54% of the water. As a result of increased users, and increased high income users, RW has had an increase in water use/supply every year between the period 2000 – 2007 (Table 2.20).

Table 2.20 Rand Water, water sales and percentage growth per year (RW, 2004-2005) , *(RW, 2007).

Financial year	**Total average Rand Water sales (AADD) ML/d**	**Percentage growth (year on year)**
2000/2001	3 005 (ML/d)	2,2%
2001/2002	3 143 (ML/d)	4,6%
2002/2003	3 340 (ML/d)	6,3%
2003/2004	3 414 (ML/d)	2,2%
2004/2005	3 452 (ML/d)	1,1%
2005/2006*	3 457(ML/d)	0.15%
2006/2007*	3 550(ML/d)	2.69%

Placing this water use of RW in more perspective, the ten largest users of water from Rand Water, have also all shown increased growth in water use between 2004/05 and 2006/07. The two largest users namely City of Johannesburg Metropolitan Municipality and Ekurhuleni Metropolitan Municipality have grown in water consumption by 2.2% and 2.5% respectively (Table 2.21).

Table 2.21 Water supplied by Rand Water per supplier and percentage growth for 2004/2005 and 2006/2007 *(RW, 2004-2005) , #(RW, 2007).

Consumer	Average Monthly consumption *	% Growth *	Top ten customers split #
City of Johannesburg Metropolitan Municipality	36 627 740	2.2%	41.54%
Ekurhuleni Metropolitan Municipality	21 222 839	2.5%	26.19%
Tshwane Metropolitan Municipality	14 375 890	4.3%	16.15%
Emfuleni Local Municipality	5 866 333	0.4%	5.89%
Odi Retail Water	1 821 554	1.3%	2.01%
Mogale City Municipality	1 760 472	1.7%	2.18%
Rustenburg Local Municipality	1 621 405	3.2%	1.95%
Govan Mbeki Municipality	1 363 353	12.4%	1.67%
Metsimaholo Local Municipality	1 250 886	3.4%	1.36%
Impala Platinum Mine	1 054 670	9.9%	1.06%

Of the water used in the total Vaal River system (van Rooyen,2008) Rand Water is the largest single user of water at 40.6%, with the Vaal Harts irrigation system being the second biggest user at 15.5% (Figure 2.3).

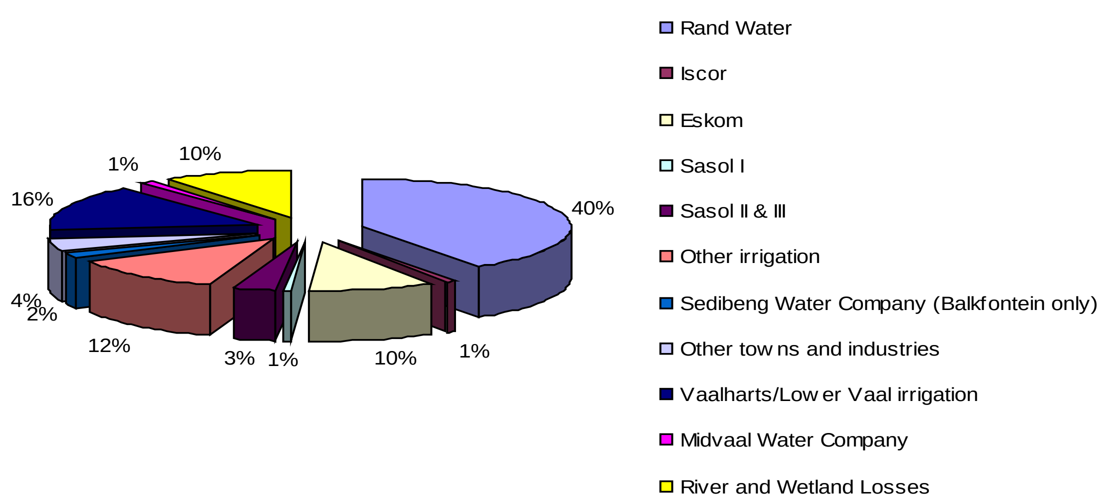


Figure 2.3 Water demand from the Vaal River Water System (van Rooyen, 2008).

In the 2006/07 Annual Report, Rand Water also predicts that its water use will increase from the average amount of 3 550 (ML/d) to 6 000 ML/d by 2014 (RW, 2007). While predicted growth in water use by institutions may be beneficial for the bottom line, they are not necessarily beneficial for the future state of natural resources.

2.4.3 Predicted Water Use Patterns

2.4.3.1 Predicted water use patterns - South Africa

In research undertaken by Pretorius and Schutte (1997:127-133), based on the population estimated at 43.5million people in 1994 (as quoted in Ministry for Welfare and population Development, 1995), two aspects were investigated. Firstly, the "full water demand" for individuals, taking into account all their requirements. Secondly, the full water requirements of the estimated 1 million people born in 1995, and projected until the newborns of 1995 had reached an age of 20 in 2015. Assumptions were based on estimates only. The water balance was based on different population profiles and different levels of lifestyle, to allow for the arrival at a figure for predicted water demand, for the additional 1 million people.

Their findings and calculations were as follows:
Domestic water use included the components of drinking, personal hygiene, sanitation and gardening. Set against this, is the assumption made by the International Water Supply Association (IWA, 1995), that the average specific water consumption in 1993 in South Africa, for people that had water reticulation systems, was 276 l/per capita per day (1/c.d).

Pretorius and Schutte (1997:127-133) estimated that water use in the garden would change between 1994 and 2015 for their study population. This would change from 0 l/c.d (liter per capita per day) to 5 l/c.d for shack type housing, from 18 l/c.d to 20 l/c.d for very small houses, from 26 l/c.d to 35 l/c.d for small houses, flats with small gardens, from 100 l/c.d to 80 l/c.d for larger houses anf cluster units and from 200 l/c.d to 100 l/c.d for houses with extensive gardens. This points to an increase in use for lower income or smaller units and an decrease in use of higher income or larger units (Table 2,22 & Table 2.23).

Table 2.22 Current (1994) and predicted (2015) water use in the garden by South Africans (Adapted from Pretorius & Schutte 1997).

	Domestic Water use 1994		Projected Domestic Water use for 2015		
Level of living index	Water use (l/c.d)		Water use (l/c.d)		
	Garden	Total for House, garden and pool	Garden	Total for House, garden and pool	Corrected for 10% loss
Very Low	0	24	5	36	40
Low	18	50	20	93	102
Moderate	26	80	35	119	131
High	100	250	80	211	232
Very High	200	450	100	293	322

Very high: Very high income, very large house and stand with extensive gardening activity. Direct water use > 300 l per capita per day (l/c.d).
High: High income, large house or flat or cluster housing, moderate garden. Direct water use 200 to 300 l/c.d.
Moderate: Moderate income. Small house or flat, small garden. Direct water use 100 to 250 l/c.d.
Low: Low income. Very small house. Direct water use 50 to 150 l/c.d.
Very low: Very low income. Shack type housing. Direct water use <50 l/c.d. The majority of rural dwellers living in traditional dwellings are included in this group.

In order for Pretorius and Schutte to estimate the domestic demand for water, by the year 2015, they made the following assumptions:

- Awareness of water conservation will increase. Tariffs will increase. The high levels of consumption will decrease, or remain stagnant, mainly due to people going for smaller gardens and changes in gardening practices.
- Due to increased standards of living, water consumption in the low and moderate consumption groups, will also increase. It is also assumed that the use of washing machines and dishwashers will increase, resulting in an increase in water use per capita.
- Water losses will not exceed 10%. This does not include figures for unaccounted for water (including unmetered usage and meter inaccuracies), which can be as high as 20% – 30%.

Their figures indicate that the projected domestic demand for water, accounts on average, for only about 20% of the total water demand of an individual. The largest portion of an individual's water requirement (80%) is required for the production of food, consumed goods, and for employment opportunities.

Table 2.23 Current (1994) and predicted (2015) domestic water use by South Africans (Adapted from Pretorius & Schutte 1997).

Projected domestic water use by 2015.					
	Water use per capita per day				
Level of living index.	**1994**	**2015**	**Diff in water use.**	**% growth or decline**	**Description.**
Very Low	24	40	16	40%	Very low income, shack type house.
Low	50	102	52	50%	Low income, Very small house
Moderate	80	131	51	38%	Moderate income, small house/flat. Small garden
High	250	232	-18	-8%	High income, Large house/flat/ cluster. Moderate garden.
Very high	450	322	-128	-40%	Very high income, Very large house & stand. Garden actively.

.

Pretorius and Schutte (1997:132) conclude that for one million people, introduced into the population in 1995, their water demand will, in the year 2015, be 638 ML/d (for the entire group and for all water needed, both in the home and to produce and processes food and goods needed for their lifestyle). This is equivalent to almost one quarter of the average daily water supply of Rand Water in 1994/95, and provides an indication of the tremendous pressure that will be placed on our water resources, as a direct consequence of population growth.

As a general world overview, Green *et al*. (2000:284) somewhat contradicts Pretorius and Schutte (1997:127-133), by concluding that there will be a decrease in water use per capita between 1995 and 2000, from 640 m^3 to 580 m^3 per year, although they admit their calculation is conservative.

However, le Roux (2003:47), indicates that within the next ten years the South African government will implement projects to expand basic services, and assist the poor in climbing the water ladder. This will be done, by first supplying stand pipes in yards, then water in the house, and then hot and cold running water in the house. Pretorius and Schutte as well as Muller, all assume that domestic water use will increase, as a result of improved water use lifestyles.

In an interview with Stanford (1997:61), Asmal indicated that the water demand in the Gauteng area (Vaal River), would increase at such rates that by the year 2033, the supplies would run out, and it would be necessary to start obtaining water from the ocean As a result it would be necessary to phase in schemes at various intervals. By 2009 the Thukela & Senqu scheme is required and by 2023 the Mzimvubu scheme (Figure 2.4).

Vaal River: Phasing of schemes based on current water demand estimates:

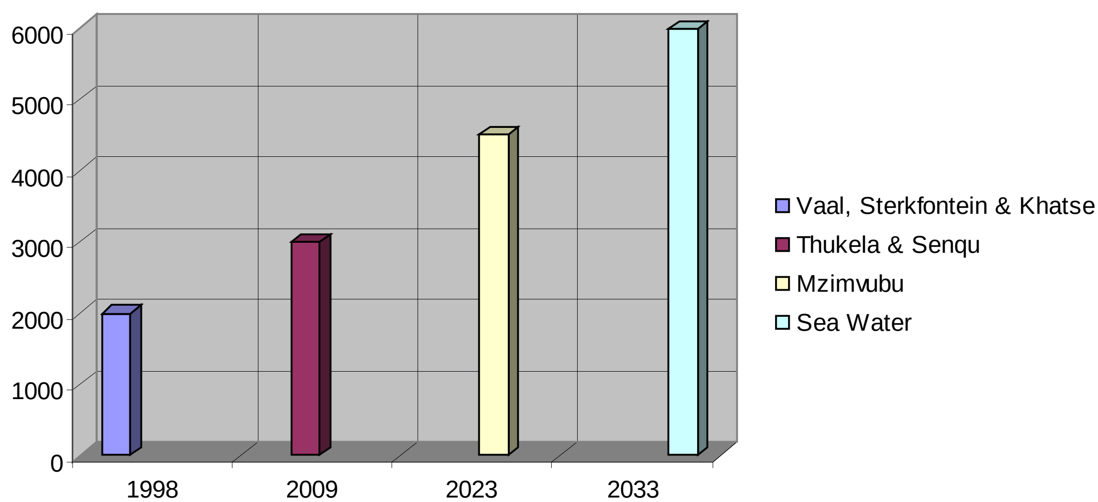


Figure 2.4 Phasing in, of various water schemes for RW water supply area, based on current demand. Adapted from (Stanford, 1997: 61)

In 1998 it was reported by Chalzislergou, in an interview with Dr P Roberts (Director General DWAF) (1998:7), that Rand Water and DWAF were investigating Water Demand Management in the Vaal River system. It was estimated that between 1999 and 2005, the yearly growth rate for water requirement would be on average 8.1%, and that between 2005 and 2030 it was estimated to be about 3.9%.

In the report, Vaal River Continuous investigations (Phase 2) - Annual Operating analyses 2004/05, the then current water use and predicted water use, for the Eastern sub-system of the Intergrated Vaal River system, was mapped. The historical water use, as well as several predicted future scenarios were mapped. The most commonly accepted scenario at that stage was that of RW (2004 with AIDS). According to this estimate, the water requirements for RW after 2019, will be above 1 500 million m^3/a (Figure 2.5).

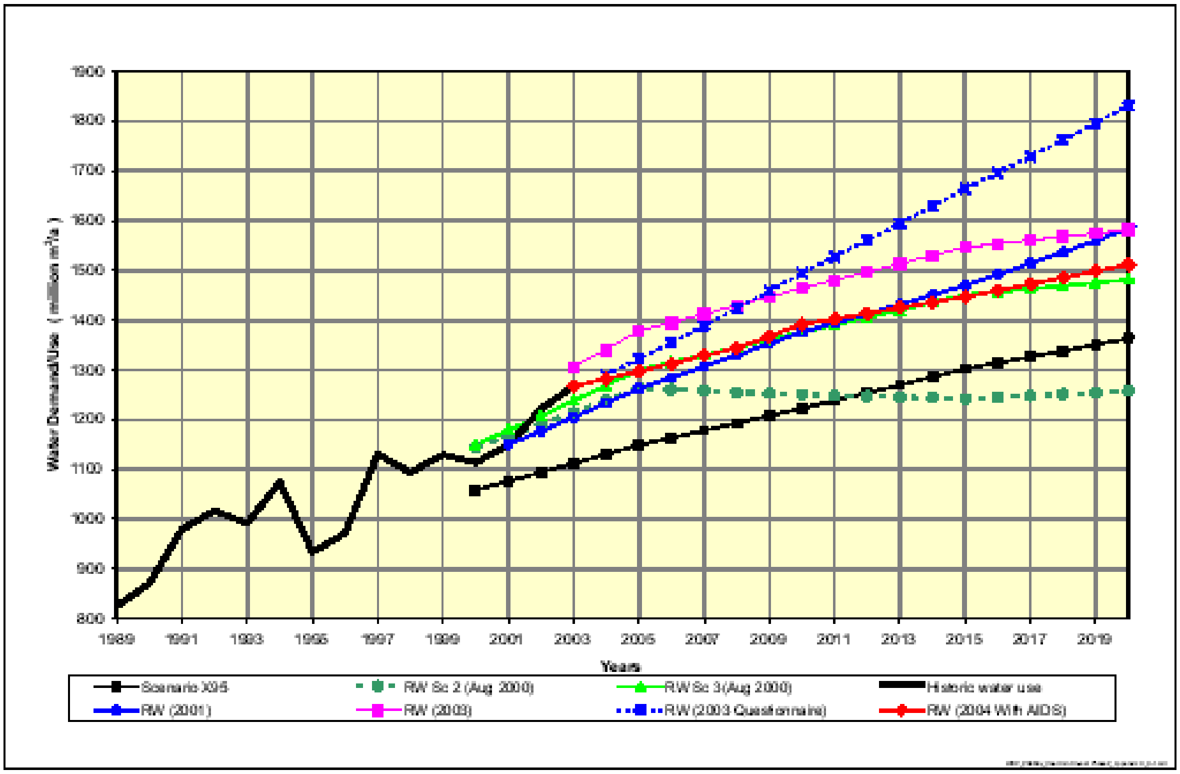


Figure 2.5 Predicted future water requirements from the Vaal River System to 2019. (DWAF, 2004/5)

In spite of many predictions and calculations, it does not seem possible to exactly calculate water use and water demand growth into the future, as the following extracts indicate.

In 1998, Rand Water was budgeting for a 2.5% growth rate in water use for the following five years (1998:51). According to Mr J Connolly (1999), Corporate Planner at Rand Water, the living patterns and demographic behaviours of Rand Water's customers are changing, with the main growth coming from low-income market, while the wealthy are moving away from large properties to flats and town houses. Despite there being a total of six dams/weirs in the total water supply chain for the Rand Water supply region, and their combined water storage capacity is 8 171 211 ML which was estimated by Mr J Connolly to be sufficient for eleven years, he pointed to the following – A prediction of a 5% reduction in water use over the next ten years, due to economics, costs and water saving actions by councils (Connolly, 1999).

In 2003, it was stated by Lushaba, the Chief Executive of Rand Water, that prior to 1996 an annual increase in consumption of water of around 4% was experienced, but that since 1996, the anticipated growth rate in water use had dropped to around 2% per year, and was expected to remain at around 2% in the immediate future (Ebersohn, 2003).

In 2004, Viljoen indicated, in an interview that information from DWAF pointed to a 1% - 2% growth in water demand. In 2005, Rand Water predicted growth rates for each of the areas that it supplies water to. This was projected over the period 2005 to 2020. These projections being:

Area 1 - City of Johannesburg, 2.7% growth.

Area 2 – Ekurhuleni, 2.76% growth.

Area 3 – Tswane, 2.67% growth.

Area 4 – Emfuleni, Midvaal, Metsimaholo & Ngwathe, 1.15% growth.

Area 5 – West Rand, Mogale, Randfontein, Westonaria & Merafong, 1.0% growth.

Area 6 – Rustenburg, 2.87% growth.

Area 7 – Lesedi & Govan Mbheki, 1.07% growth factor (Rand Water, 2005:4).

The water use growth rate for Rand Water increased by 3.5% for the 2007/08 year, which is above the desired amount required by DWAF, as quoted by J Maré (2008), Strategic Projects Engineer of Rand Water. This sentiment was reiterated by Van Rooyen (2008) at a presentation to the Rand Water Services Forum, where he indicated that additional systems would be required by approximately 2016, and decisions needed to be made in the very near future on this matter (Figure 2.6).

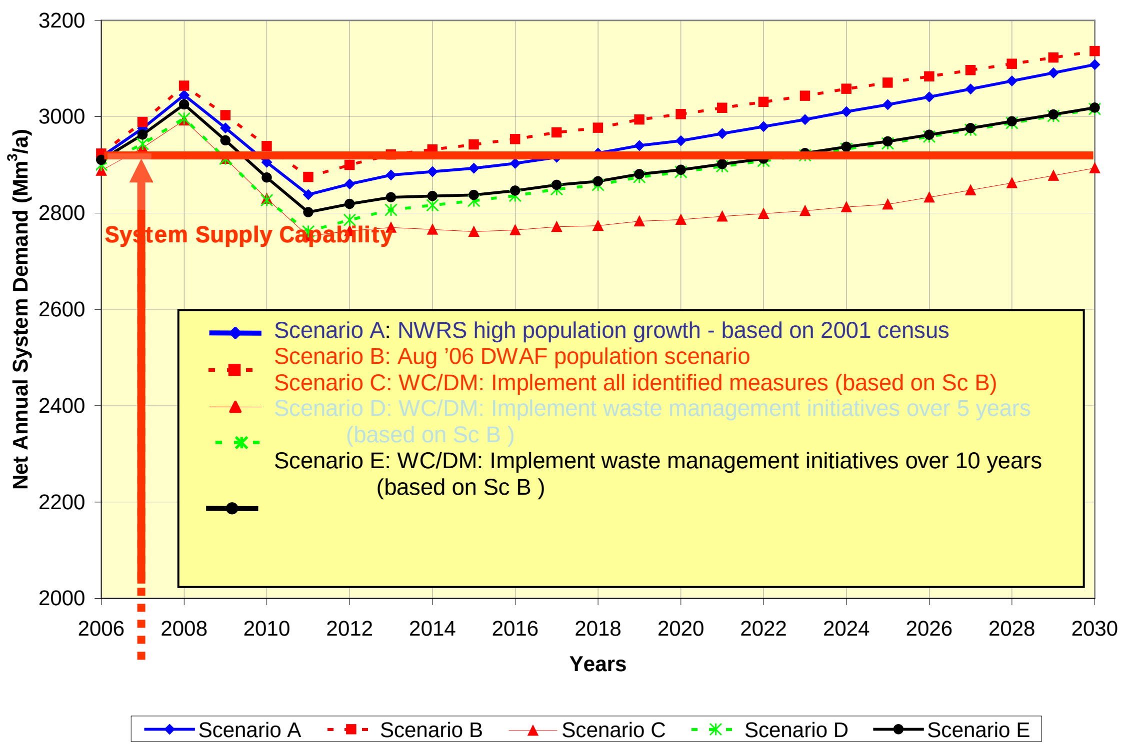


Figure 2.6 Supply system capabilities vs net water requirements for the total Vaal River System Supply Scheme (van Rooyen,2008).

Water can be supplied and new schemes can be built to supply end users needs, but one has to ask at what cost. Similarly, during periods of drought, cost is often used as a factor to force users to use less water. In either of these scenarios, cost could inhibit the use of water by users. This could be seen as both positive and negative.

2.4.4 The Value of Water - Paying for it

One of the often claimed statements that will assist in curtailing excessive water use, is to ensure that users pay for it, and that they pay enough for it. Cherny (2005), it was indicated that for the current drought situations in Australia, pricing was the main economic tool to ensure that people realize the value and scarcity of water.

Biswas and Uitto (2000:15) quote a study by McIntosh and Yñiguez, who in 1997 conducted a study on fifty water utilities in thirty one Asian countries. On the issue of cost of water, they concluded that in those cities where the average monthly bill for water use was under US $1, consumption was extravagant and wastage was high.

As stated by Barghouti & Feder *et al.* (1992:33), "often, water users do not pay an amount for water that reflects the true cost to deliver it. Consequently, there is no incentive for them to conserve water, nor to invest in more efficient water user systems". This is most likely true and has been true in South Africa as well, but according to Labrum (2003:23), the implementation of the National Water Act No 36 of 1998 (NWA) has had an affect on increasing awareness of water management issues, within both private and public sectors. Water is now recognised as a critical component of any environmental management system, and strategies to improve water use are particularly important to the mining industries, which have a high water demand.

It is essential that water be given a commercial value by users. Many traditional farming practices, use huge amounts of water to produce their crops. The cost of this water is minimal, and in some cases wastage is high. Amongst all the other climate change factors facing irrigation users, inefficient use is just another problem factor. Jones (2004:134) quotes Rosegrant, who stated that unfortunately where flood irrigation is used, up to 75% of the water may never actually reach the intended crop. Contrast this to modern drip irrigation, of which 90% reaches the crop. Unfortunately, drip irrigation is used for only 1% of the world's irrigated area.

Giving a commercial value to water, is also sometimes difficult for traditional South African subsistence and rural communities, who believe that water is a natural God-given phenomenon, and is there for the taking and without payment. In some mindsets, water is in the rivers and is there for everyone to use, and no one should have to pay for this, or for the basic right of access to this water, or for the basic cost of this water (pers.obs). Some people believe that their access to water is a right, and that there should be no fee to this. Unfortunately, the situation is not as simple as this, and costs are continuously incurred for catchment management, for capital infrastructure, for water abstraction, purification, pumping and associated infrastructure maintenance, as well as many other costs. There are also costs associated with scarcity, economic use, social, cultural and environmental values. Buckle reiterates the mindset of the cost of water, in an interview with Ryan (2001:17). Buckle states that creating clean drinking water, from the rain at its source to the end of the homeowner's tap, all costs money. This is supported, as stated by Winpenny (1994), (as quoted by SADC, IUCN, SARDC, World Bank 2002:107-108), the cost of supplying water is significant, and includes physical costs of storage, purification and distribution, catchment management, as well as ecosystem management. He also states that the effect of low prices of water, is that users have no incentive to use water wisely or efficiently, or to treat it as a scarce good economic resource.

Stepped water pricing, is one mechanism of achieving cost recovery for water, without disadvantaging the poor. The basic water supplies are provided at low cost, and beyond that users face stepped increases for the amount of water they use. These stepped price increases are only possible, in areas where the supply of water is reliable. This stepped price increase system, together with other water conservation mechanisms, can result in significant water saving. This was the case in Hermanus, where a 32% reduction in water use was achieve within the first summer, after having stepped price increases, as well as other water conservation measures, introduced (SADC, IUCN, SARDC, World Bank 2002:107-108).

The increasingly high cost of the provision of water, is again reiterated by Biswas and Uitto ((eds) 2000:13). In the developing world, most of the easily exploitable water sources have already been developed. Those sources that have yet to be developed are geographically and environmentally more complex to handle, and therefore, the cost of obtaining and bringing that water to those in need, is progressively more expensive. The complexity of these projects can add as much as 80% additional costs to the project. This aspect seems to be true, when considering additional water supply schemes for the RW water supply area. This was confirmed by the Trans Caledonian Tunnel Authority (TCTA) in October 2008, who indicated that because new schemes where required to be built and financed, for the RW supply area, that costs would have to be increased on an ongoing basis for models produced up to 2024 (Figure 2.7).

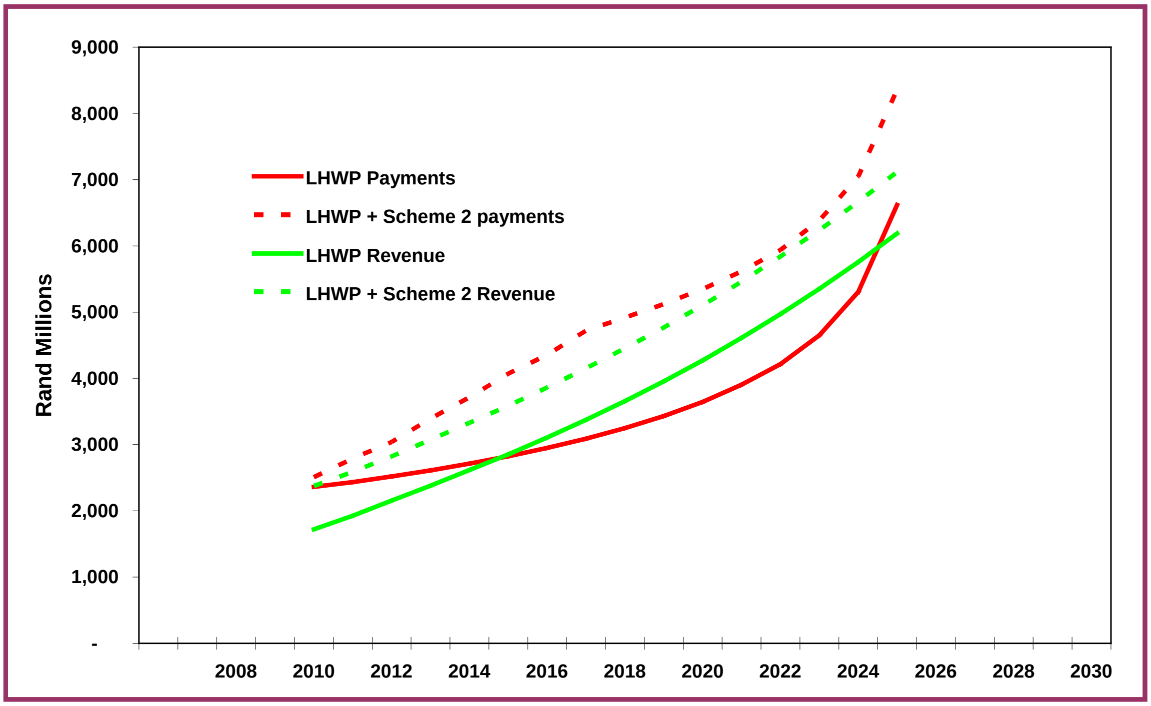


Figure 2.7 Vaal River System: Revenue and Payments vs LHWP1 – High Demand(TCTA, 2008).

In 1999, Stephenson (1999:115-121) quoted the cost of water as being R5/m³ (US 80c), and more in Germany. The cost in SA at the time was R3/m³ (US 50c), and in some African countries it is actually free. The future is likely to see increasing costs of water in South Africa. There are also indirect costs, and associated consequences of not having water. It was calculated by SADC, IUCN, SARDC, and World Bank (2002:46) that the 1991-1992 drought had the following impacts on South Africa. There was a reduction of 1.8% in real disposable income, 0.5% increase in consumption expenditure, an increase of 0.8% in the rate of inflation, and the net negative effect of at least R 1 200 million on the current account of the balance of payments. Further to this, a total of around 49 000 agricultural jobs were lost, and 20 000 formal sector jobs, (not in agriculture) were also lost.

Poverty is a reality of life and has been around for many years negatively affecting people's ability to pay for water use and any associated sanitation. The World Bank Poverty Fact Sheets as quoted by United Nations Centre For Human Settlements (Habitat) indicates that 290 900 000 people in Sub-saharan Africa live on less than $ 1 /day (Table 2.24).

Table 2.24 Number of People (million) living on less than $1/day 1998 (Habitat, 2001: 14).

Number of People (million) living on less than $1/day					
Region*	**1987**	**1990**	**1993**	**1996**	**1998(est)**
Sub-Saharan Africa	217.2	242.3	273.3	289.0	290.9

* Note: not all regions have been included.

The improved or reduced economic activity and growth of an area, will affect the demands made on water supplies of an area. According to Serageldin (1995:13), the demands on water supplies, and the cost of getting water from point A to point B, are key factors to consider. The further the source of water, and the higher the elevations of pumping, the more the cost of that water will be to supply to the end user. This is similar to Rand Water, having to obtain water from approximately 300 km away, then having to pump it up a gradient of at least 380 m, over a total distance of 70 km (Ebersohn, 2003). Water is then gravity fed, for a further distance of approximately 90 km to the Rustenburg area. In 1998, the cost of purchasing water, from the Department of Water Affairs and Forestry, was 40% of the total cost of water (1998:51). By 2004, this had risen to 53%. This interprets as, the total average charge for potable water by Rand Water to be 269.69 cents per kilolitre for 2004-2005. This cost is made up of the raw water tariff by DWAF, the Trans Caledonian Tunnel Authority (TCTA), and the in-house operating cost of Rand Water (RW, 2004 - 2005).

Amongst the users paying for water from Rand Water is the Green Industry. Generally the water that is used by this industry, in the residential and office complex units, is referred to as domestic water use, whilst on a wholesale perspective, this water usually falls within the agricultural sector use.

2.5 FOCUS ON THE GREEN INDUSTRY AS A MAJOR WATER USER

2.5.1 Size of the Green Industry, World & South Africa

It needs to be noted that potentially, the Green Industry, home garden industry and all associated industries (excluding edible horticulture-agriculture) contribute significant jobs and finances to the South African economy, in direct methods (employment, sales etc), as well as indirect benefits, such as social wellbeing, physical health, and psychological aspects.

Marrow (1987:3) indicated that landscape activities were governed by the available resources of space, energy, finance and water. The horticultural industry in all its forms revolves around, not only the availability of water, but the cost, quality and reliability of supply.

In 1999, United States home owners spent $50.9 billion to improve, install and maintain their gardens. It is also reported, by the National Gardening Association (USA), that between 1995 and 1999, Americans spent $213 billion on their yards and gardens (ITPF, “s.a”:15).

The Australian garden market (Table 2.25) was worth $5.71 billion in 2003 (figure in Aus $ 000 and GST inclusive).

Table 2.25 Australian Green Market spend 2003 (New report shows latest trends in the Australian market, 2004:1) .

Category	Amenity*	Garden Maintenance	Retail	Propagators	Total	Share
Greenlife	$ 692 851	$ 12 072	$ 1 035 641	$ 109 701	$ 1 850 265	32.4%
Allied trade	$ 193 882	$ 10 141	$ 1 432 279	-	$ 1 636 302	28.6%
Café & gifts	-	-	$ 89 326	-	$ 89 326	1.6%
Services & bulk	$ 815 934	$ 460 682	$ 862 235	-	$ 2 138 851	37.4%
Total	$ 1 702 668	$ 482 895	$ 3 419 482	$ 109 701	$ 5 714 745	-
Share	29.8%	8.4%	59.8%	1.9%	-	-

*Amenity includes landscapers, government, revegetation and plant hire.

Unpublished research, undertaken by Staples in 1999 (obtained from Andrews), on the landscaping, interior landscaping and golf course industry of South Africa indicates that the estimated Green Industry market value in 1999 was R 1 314 000 000 (Table 2.26).

Table 2.26 Estimated South African Green Industry spend 1999 (Staples as quoted by Andrews, G. 2007).

Description	**Turnover**
Interior Installation	R 10 000 000
Interior maintenance	R 84 000 000
Exterior Maintenance	R 400 000 000
Exterior Installation	R 600 000 000
Golf course Installation	R 40 000 000
Golf Course Maintenance	R 180 000 000
TOTAL	**R 1 314 000 000**

Andrews has worked actively in the industry for approximately twenty years, and has herself been involved with water conservation programmes within the industry.

In 2007, the Australian Nursery Industry contributed more than $ 5.5 billion annually, to the national economy (McDonald, 2007:8-9). In 2007 (Table 2.27), the same industry in South Africa, was estimated by Roets & Cloete, as being worth R 3.3 billion (2007). This data is unpublished, and is based on the expert opinion and calculations of Roets (2007) in his discussions with Cloete.

Table 2.27 Estimated South African Green Industry spend 2007 (Roets, 2007).

Description	**Turnover**
Nursery Growers	R 450 000 000
Instant Lawn	R 450 000 000
Landscape Architect	R 550 000 000
Landscape Maintenance (including town councils)	R 600 000 000
Pot Plant industry	R 300 000 000
Golf course construction	R 30 000 000
Machinery	R 350 000 000
Nursery sales & other environmental work	R 570 000 000
TOTAL	**R 3 300 000 000**

It has not been impossible for the researcher to obtain accurate published information, regarding the economic size and value of the ornamental horticultural industry (Green Industry) in South Africa or Gauteng.

Besides the economic value that the Green Industry injects into South Africa and Gauteng, there are many other benefits that must be noted, and could be lost, if the effects of an extended drought are ever brought to bare on this industry. These are addressed in a later sub-chapter.

2.5.2 The Value of Horticulture and Plants to Humans

Although often not openly given the support it deserves, ornamental horticulture plays an enormous, and often unseen, valuable role in the lives of all people who come into contact with it (directly or indirectly). The "unseen" benefits unequivocally help mankind, but most unfortunately go away, when drought is declared without much planning, and community education and/or input. It's only when these items are lost that some of their benefits become evident.

The International Turf Producers Federation ("s.a":12), state that the benefits of well maintained landscapes are not widely understood, and therefore, this area of society has become an easy soft target, for it is the first to be hit with water conservation measures. Unfortunately, most of the benefits (direct and indirect, physical and psychological) of the Green Industry are difficult to quantify, or have not been quantified financially, which is why Andrews ("s.a":38) made the statement that, "Landscaping is usually not regarded as a priority". A current MSc dissertation, "A feasibility assessment of the application of environmental valuation methods on Rand Water open-space", being undertaken (Bouwer,2008), is investigating methods of placing a financial value on urban parks and properties. This may go some way to assisting this process.

In order to ensure that plants are not only used, but appreciated and cared for correctly, especially during times of drought, the total value of a plant needs to be appreciated. Some of these unseen benefits include amongst others the following:

2.5.2.1 Oxygen

Oxygen is vital to all living forms on earth. An area of 232.25 m^2 of lawn, can produce enough oxygen for a family of four (Let’s get Water Wise, “s.a.”).

2.5.2.2 Psychological

Professor Fjeld (1995) undertook studies in Norway that involved sixty-two people, who were asked questions and were exposed to specific plant settings in offices. Some of the results being - 69% indicated that plants were important to indoor surroundings, 50% indicated that they would revisit a shopping centre, because of the plants that made it more pleasing, and 70% indicated that they visit a shopping centre more frequently, because of the plants that created a better atmosphere.

The psychological effects of not having plants, in a drought situation, are supported by researchers working in rural Australia with woman. According to ABC Science Online, as quoted by Holzhausen (2005:9) in “Drought as traumatic change”, the example was sited that even for some rural woman, the simple loss of their gardens can be a major trauma, despite more wide ranging impacts of drought being inflicted around them.

Parks and gardens are also able to evoke memories of activities, plants, animals and events (Aldous & Binkley, 2001:8) , which are all important to our well being as humans in this pressurized world.

2.5.2.3 Reduced sickness

Goodwin et al (as quoted by Aldous & Binkley, 2001:6) indicate that, both passive and active interactions with plants, are able to change a person’s psychological response. This includes, amongst others, blood pressure, heart rate and muscle tension. Bennett et al (as quoted by Aldous & Binkley, 2001:6) documented that interaction with plants, helps people who suffer from everyday stress and mental fatigue, to recover more quickly.

2.5.2.4 Physical fitness, body health & stress relief

According to Gies (2006:9), study after study indicates that when people are unable to have access to parks, they often go without exercise, which results in a prevalence of obesity. This is most common amongst low income communities.

It has also been reported that residents in apartments, with even limited view of trees and grass, report less mental fatigue (Kuo, 2001; as quoted by Gies, 2006:16).

Similarly, savannah type settings are able to raise up feelings of peacefulness, tranquillity and relaxation. Also, by simply viewing these settings, one is able to decrease fear and anger, while enhancing mental alertness, attention and cognitive skills (Frumkin, as quoted by Gies, 2006:16).

2.5.2.5 Catering for the aged

Senior citizens represent the fastest growing population segment in the world. As people age, they become more inclined to engage in gardening and plants (Aldous & Binkley, 2001:10).

2.5.2.6 Carbon sinking/sequestration

With the ever-increasing threat of climate change, the need to mitigate any aspect of it, is growing in importance. Urban plants and forests reduce carbon in the atmosphere through the process of photosynthesis, which absorbs carbon dioxide into the plant's biomass, releasing oxygen in return (Croucamp & Grobbelaar. "s.a": 26). Rosenfeld, in a study, calculated that urban trees (in Los Angeles) will each sequestrate between 13,5 to 55 kg of carbon annually, while forest trees will sequestrate between 4.5 to 11 kg each, per year (as quoted by Akbari, 2001).

2.5.2.7 Air conditioning and temperature control

As temperatures are likely to continue increasing for the next while, and simultaneously, the energy crisis in SA is not likely to disappear quickly, it is important to alleviate the side effects thereof. According to the City of Virginia Beach Department of Public Works, placing three well positioned trees around a home, can reduce the air-conditioning needs by as much as 10% – 50%. Similarly, concrete expanses, known as heat islands, can have temperatures that are between 5º - 9º higher than surrounding areas with plants and other vegetation (Let's get Water Wise "s.a."). Large paved and tar-surfaced areas, build up enormous amounts of heat quickly, and are very slow at dissipating this heat. Trees and plants help with the shading of these areas, and cooling the air through transpiration (Croucamp & Grobbelaar. "s.a.": 27).

Moffat and Schiller (1994:9) indicate that amongst others, dense trees will reduce temperature, more so than reflective paints on houses. A study, quoted by Moffat and Schiller (1994:10), was able to show that with proper placement of a plant shelterbelt, the winter fuel consumption of a home was reduced by 33%.

2.5.2.8 Noise barrier

Trees and turf grass areas have the capability of reducing the noise levels in neighbourhoods, by as much as 50% (Let's get Water Wise, "s.a."). Shrubs and trees planted in combination, are able to reduce traffic noise levels by up to 6 dB (Fang, et al 2003:187-195). Good placing of berms, planted with trees, shrubs and groundcovers, are able to reduce noise levels by as much as 80% (Moffat, & Schiller 1994:30).

2.5.2.9 Flood attenuation

The prediction of more extreme weather patterns, including wetter wet periods, may in future need to be controlled using more natural methods, to reduce erosion, as well as reducing the speed of runoff water. Natural flood control can be successfully accomplished, through the careful use of planting along riverbanks, and in watershed areas (Croucamp & Grobbelaar, "s.a.": 46).

2.5.2.10 Reducing and slowing down soil erosion

Ashwell & Hoffman (2001, 27-28) indicate that already back in 1923, the then Drought Commission (of S.A) indicated that soil erosion, was identified as the key factor aggravating the effects of drought. It is a known fact that plant roots, and particularly the fibrous roots of grasses, assist much in holding soil together, as do the leaves in reducing sheet erosion (Ashwell & Hoffman, 2001:80), caused by raindrops splashing on the soil surface. It is therefore, important to have a drought management plan that will enable plants, as far as possible, to survive a declared drought.

2.5.2.11 Reduction in loss of soil water content

Natural mulches, in the form of organic matter or stones, will reduce the loss of water evaporated from the soil, and result in more mulch being made available to the plants for use. This is backed by research from Anderson notes (in press).

2.5.2.12 Waste water treatment

Treating waste water will not only assist in creating a healthy riparian environmental with its own associated side effects, but will allow for this treated water to be used, more particularly in times of drought, for the betterment of the Green Industry. Waste water treatment, through artificially created wetlands, can purify the waste water, so that it can safely be put back into the environment, or used for such purposes as agriculture and parkland watering (Croucamp & Grobbelaar, "s.a.": 23-24).

2.5.3 Water use – World Horticultural Industry

Research by the American Water Works Association Research Foundation, and quoted by the ITPF ("s.a.":10), regarding urban water use patterns conducted in fourteen United States and Canadian cities concluded:

> The mix of indoor versus outdoor water use, depended on climate. For example, in hot climates like Phoenix, Tempe and Scottsdale, 56-67% of water is used outdoors, whereas in Tampo, Waterloo and Ontario, 22-38% of water is used outdoors.
>
> Because outdoor water use is more discretionary than indoor use, it can more easily be decreased when prices are increased.
>
> Houses with installed irrigation systems, use 35% more water than those without.
>
> Houses that use automatic timers to irrigate, use 47% more water than those without.
>
> Homes with drip irrigation, use 15% more water than those without drip irrigation.
>
> Houses that use hand held hoses, use 33% less water than other households.
>
> Houses that have a maintained garden, use 30% more water than houses with no garden at all.

This trend is confirmed for residents of Utah (USA), where it was indicated that between 60% to 70% of their urban water supply was used on the garden (Utah's urban residents use more water per capita than any other part of the population in the U.S, 2004).

According to Frederickson (1992:30), the consumptive use figures for residential and commercial establishments, are lower in developing countries, as opposed to developed countries like the United States. An example being:

> Of the water used for domestic purposes, as quoted by Denver Water Colorado, at least 50% of water consumed by households is used in the garden (*55 Facts, Figures And Follies of Water Conservation,* 2004).

In a report, Water Conservation and Recycling, by Sydney Water for 2003-2004, it was indicated that 16.4% of total water supplied was used in the garden, and 3% was used for swimming pools and hoseing down (Sydney Water Corporation, 2003-2004).

In the Australian Institute of Horticulture news, the following statements are made, regarding water use in the garden (The statement on water use, confirms similar claims by Sydney Water from 2003-2004):

> The assertion is that 40% of home water consumption is used for the garden.
> 16% of Sydney Water’s potable water use is used outdoors
> 25% of Yarra Valley Water’s (in Victoria) domestic water is used in the garden.
> In South East Queensland, 11% of potable water is used outdoors in the garden.
> In Brisbane, the assertion is, 40% - 50% of potable water is used in residential gardens.
> An examination of the 2003 - 2004 Queensland local government figures, indicates 32% of water does not go down the drain. Of this 32%, 12% is used on other outdoor activities, such as watering of the garden. This means (according to the analysis of the Australian Institute of Horticulture), that less than 10% of potable water is used on the garden & landscape. Gardeners therefore, “waste” 2-3% of the water, as apposed to leaks with 15% (Water usage scapegoats, 2006:26-27).

2.5.4 Water use – SA Horticultural Industry

The total water yield in South Africa is 13 trillion litres of water per annum. The second largest user of water is the urban water use at 25.25% (Figure 2.8).

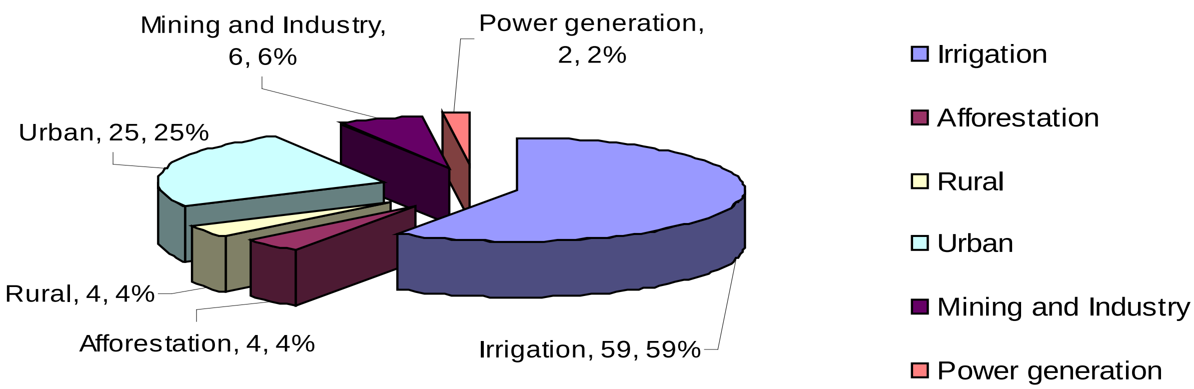


Figure 2.8 Water use by sector for South Africa. (Liphadzi, 2007:26)

The ultimate garden, to showcase a high standard of living, is one with a pool, and a large garden with lawn. These are two of the highest consumers of domestic water (Davies & Day, 1998:324). They also indicated that of the water used in the household, the following water use split was indicated, Garden 35%, toilet 29 %, bath 20 %, laundry 13 %, and cooking 3 % (Davies & Day, 1998:8-9).

In 1997, the Hermanus Municipality (predominantly a residential area with a large proportion of holiday makers) estimated that 26% of residential water use, was used outdoors (Hermanus Municipality, 1997). Again in 1999, they stated that 30% of water consumption, is used for watering gardens (*Greater Hermanus water conservation programme*, 1999).

In 1989, a report by the WRC indicated that water use in the gardens, in the Rand Water supply area, was 21% (1989).

Water use in SA was quoted by Pillay (2005:21) as being:

62% irrigation.

27% domestic and urban use.

8% industries

3% commercial forestry.

The study by Bill & Veck (2000:E1-K-17), in the Alberton and Thokoza area in Gauteng, where 150 households were surveyed in face to face interviews (interviewees estimated their water use), produced amongst results that indicated that water use in the garden in middle and upper income groups was 14%, while in lower income groups it was estimated at 10% (Table 2.28).

Table 2.28 Water use by households for Alberton and Thokoza (Bill & Veck, 2000:E1-K-17).

	Alberton middle income group	**Alberton upper income group**	**Alberton total group**	**Thokoza**
Average water usage (Kilo-litres per month)	23	28	26	20
Indoor usage	83%	80%	81%	83%
Outdoor water usage	17%	20%	19%	17%
• Garden	14%	14%	14%	10%
• Car	1%	1%	1%	3%
• Other	2%	5%	4%	4%

It can therefore be deduced from the available literature, that in SA, domestic water use is approximately 25% to 27% of water used in the water sector, and that of this water, water use in the garden will make up approximately 14% to 35%.

2.5.5 Affects of Drought and Interventions on the Green Industry and the End Consumer

As stated in the manual, Water Right, by the ITPF (International Turf Producers Federation) ("s.a.":17), "temporary water restrictions will not cause severe loss of established plant material or landscape integrity and value. Extended restrictions or long term bans can be devastating, not only to plants, but also to a large segment of the area's economy and possibly even to the environment". The negative side-effects of a prolonged and severe drought, does not only impact the Green Industry, its clients and its workers, but also those industries that are indirectly associated with the Green Industry, such as tourism and home owners.

As stated in *Country Experiences with Water Resources Management* (1992: 15-18), from 1987 to 1990, California (USA) was in the grip of severe drought. In 1991 it broke. Horticultural implications to this, were that 100 000 acres of urban trees and vines were in danger of being lost permanently.

The situation of reduced available water and increased demand, by increasing numbers of end users, is being taken so seriously that, in some parts of the world, separate by-laws/ordinances are being implemented. These are being applied, regardless of whether there is a drought period in play or not. Examples of these include:

- In Volusia County, Denland Florida, ordinances require that 50 percent of each new home's yard is to include water wise plants, instead of water thirsty grass and lawn. Owners will only be allowed to water half the yard, leaving the other half to the elements, and landscape irrigation standards and guidelines have had to be developed (Strict FL water conservation law on deck. 2004).

2.6 <u>MANAGEMENT OF WATER</u>

2.6.1 Water Laws, Regulations & Positions Papers

In order to ensure that the water resources, that are required by people, industry, environment and the Green Industry are available and correctly managed, it is important that the laws and regulations are in place, on a municipal, national and international level, assist with this governance. Only extracts applicable to water conservation, and security of water, have been investigated.

2.6.1.1 Water laws & regulations & Positions papers - World

Internationally, various initiatives and stances are taken, to try and ensure that world-wide water is preserved, and people have access to a safe, natural resource.

The 1992 Dublin Water Conference identified several principles:
1) Water is a common, shared resource.
2) Water should be treated as an economic good (Habitat, 2001: 119).

Since Dublin and Habitat II, there have been increasing calls for the need to recognize a 'human right' to water (Habitat, 2001: 119). Mikhail Gorbachev indicates that the world's growing population is the cause of water crisis, but also a source of its solution, in the form of people-power. "These people must have a voice, and the means necessary to use it" (The Global Water Crisis, "s.a").

Urban water demand, also has serious environmental impacts on water resources, as a result of over exploitation of fragile freshwater reserves. UNCHS (Habitat) and UNECP initiated a project in 1999 to assist African cities to manage water more effectively, in the areas of water conservation, water demand management, and protection from the efforts of urbanization (Habitat, 2001: 121).

In a response to the negative effects of climate change, in December 2007, the Kyoto Protocol was adopted at a conference of the parties in Kyoto, Japan. It was decided and agreed upon, by all industrialised countries, that they would reduce their greenhouse gass emissions by 5%, when compared to the 1990 levels. This would be done during 2008 to 2012. This is a legally binding treaty, inclusive of South Africa (The National Agricultural Directory 2007:58).

2.6.1.2 Water laws & regulations & Positions papers - South Africa

Droughts, being the natural and catastrophic phenomena that they are, and are capable of being, are unpredictable, causing untold damage to both the natural and man-made environment, inclusive of human life. In order to prevent this, the government, being the custodian of these water supplies, must first of all plan for, and store water, and in times of drought must timeously intervene where possible. The Constitution of South Africa amongst others indicates the three rights “Every citizen has the right to choose their trade, occupation or profession freely” (South Africa, 1996: sec.22); “Everyone has the right to an environment that is not harmful to their wellbeing, to have the environment protected…through measures that … promote conservation.” (South Africa, 1996: sec 24 (a-b)); “Everyone has the right of access to ...sufficient food and water, the state must take reasonable legislative and other measures … to achieve the progressive realisation of each of these rights” (South Africa, 1996: sec 27 (1-2)). All countries have laws that govern different aspects of the water environment and water use, as does, South Africa. The previous Water Act of 1956, was based mainly on riparian principles, and those who had land with reliable water, were the only ones who had access to it (le Roux, 2003:28-30). The South African Constitution states that access to water is a basic human right, and the National Water Act of 1998 (NWA) and the Water Service Act of 1997, assists in underpinning this right. Arising out of the NWA are various other requirements, including the creation of Water Management Areas, to be managed by Catchment Management Agencies (CMA), who will be responsible for monitoring water resources, and enforcing compliance with licence conditions. South Africa has been divided into nineteen water management areas, and it has been proposed that there be nine CMA’s, each with a governing board and operating staff. RW will receive water and service from one such CMA.

2.6.1.2.1 The National Water Act (NATIONAL WATER ACT Act No 36 of 1998)

This is an over-arching legislation that encompasses all of the main issues regarding water in SA. Other legislation is then brought into being that "speaks" to the NWA.

In Chapter 1, the fundamental principles of the Act are:
"Sustainability and equity are identified as central guiding principles in the protection, use, development, conservation, management and control of water resources. These guiding principles recognise the basic human needs of present and future generations, the need to protect water resources, the need to share some water resources with other countries, the need to promote social and economic development through the use of water and the need to establish suitable institutions in order to achieve the purpose of the Act. National Government, acting through the Minister, is responsible for the achievement of these fundamental principles in accordance with the Constitutional mandate for water reform. Being empowered to act on behalf of the nation, the Minister has the ultimate responsibility to fulfil certain obligations relating to the use, allocation and protection of and access to water resources".

The purpose of the National Water Act (NWA) is to, amongst others:
"ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways which take into account amongst other factors -

(d) promoting the efficient, sustainable and beneficial use of water in the public interest;

(f) providing for growing demand for water use;

(k) managing floods and droughts",

2.6.1.2.2 Water Services Act

Water Services Act, No 108 of 1997, General sections (WSA Act No 108 of 1997).

Section 4 of the WSA sets out conditions for the provision of services, which must, amongst others, relate to at least water conservation and the prevention of wasteful or unlawful use of water provided by the water board.

Section 21 of the WSA act requires that municipalities draft water service by-laws.

Section 29 of the WSA provides for the primary activity of providers, such as Rand Water, to provide water services, to other water services institutions (water service authorities, water service providers, a water board or a water service committee) within its service area.

2.6.1.2.3 Disaster Management Act

In 2003, the Government of South Africa published the **Disaster Management Act** (Disaster Management Act 57 of 2002.), in which certain important matters are raised and dealt with, namely:
"The national disaster management framework must reflect a proportionate emphasis on disasters of different kinds, severity and magnitude that occur or may occur in Southern Africa".
"Facilitate disaster management capacity building, training and education".
"Promote disaster management research".
"The objective of the National Centre is to promote an integrated and co-ordinated system of disaster management, with special emphasis on prevention and mitigation, by national, provincial and provincial organisations of state, statutory functionaries, other role-players involved in disaster management and communities"
The National Centre must –
"Collect information on all aspects of disasters and disaster management and process and analyse such information. It must also take steps to disseminate this information, especially to communities that are vulnerable to disasters."

The national database must also contain extensive information on, amongst others, early warning systems, prevention and mitigation. The National Centre is also required to give advice and guidance to all organs of state, the private sector, non-governmental organisations, and communities, to assess and prevent or reduce the risk of disasters. This implies an increased commitment, to strategise towards preventing and mitigating the effect and severity of disasters. There is also an implication on the Minister, to ensure that steps are taken to prevent the escalation of a disaster, or to minimise a disaster, and also to ensure that a post-disaster recovery and rehabilitation process is implemented (Disaster Management Act see South Africa. 2002).

The good intentions and planning of Government in creating and legislating various laws and policies, need to be brought down from the more senior levels to the public and end users. There is a need for them to be translated into achievable action plans, and achievable end results, so that end users will not "fight" against plans and systems, but see the logic of them for every users long term benefit. The end user must also be made aware of the consequences of long term drought, or short severe drought, and how it will impact on their economic, social and recreational needs. This will also help them to plan in advance for their own events and possible "disaster", and allow them also to implement their own action plans, to assist them over and above what governmental agencies will undertake.

2.6.2 Water Use Regulator Attempted

Since the drought of 1994/95, there has been one known attempt at producing water use regulations for the Green Industry (Draft National Water Supply regulations. 1998), but these have yet to be officially put in place by Government. This process is currently being re-investigated. With no known common plan in place to address the long term water requirements, in the Rand Water water-supply area, the problems of the last drought (1994/95) could be repeated, if there is no long term, agreed, water conservation shortage response plan for the region (supply area). The current by-laws, and even those that are presently being re-written, do not make specific detailed allowance for addressing any possible water shortage, in a manner that could benefit both parties (local government and Green Industry).

2.6.3 By-laws

All municipalities have by laws that do, to some extent or another, included the supply as well as the restriction of water at certain times. No specific reference or addendum, referring to a drought management plan or water restrictions, is available for Johannesburg.

The examples of available and current by-laws are very broad in themselves, and do not address any specifics or details in terms of how, when, and what water restrictions are to be introduced and at what stages. These may be seen as operating principles, but none of them were made available to the researcher by the various municipalities.

2.6.4 Water Storage & Supply Systems, and Responsibility for their Management

In order to ensure compliance with legislation at all levels, it is necessary to have in place sufficient and reliable water storage and supply systems, for the needs of the environment, communities and industry.

2.6.4.1 Responsibility for South Africa's national water management

After four years of planning, in late 2005, Cabinet announced the creation of a national water infrastructure agency that would control South Africa's national dams and water pipelines. In effect, it is likened to the "Eskom" of the water industry. This new water utility would control assets of over R40bn, manage sales of R2bn to water supply authorities, and oversee the R21bn construction programme involving twenty new dams (Lunsche, 2005:1-2).

In terms of the National Water Act, the Trans Caledonian Tunnel Authority (TCTA) was originally set up to assist with the treaty signed between the DWAF and the Government of Lesotho, for the building of the Lesotho Highlands Water Project (LHWP). The TCTA is a non-profit organisation. Since then, Government has expanded the mandate of the TCTA, to assist with other similar projects. The DWAF plan and project the future water requirements of the country, in all catchments areas. The TCTA build and manage selected facilities (dams) on behalf of the DWAF. The DWAF obtain water from the TCTA, and then sell that on to Rand Water, who then sell this on to Municipalities, who then sell this on to the public and industry (Figure 2.9) (TCTA, 2008).

In a document entitled Strategic Framework for Water Services (SFWS) by DWAF, identified several challenges facing the water sector. One being that by striving to achieve the objectives of SFWS the following will be attained:

- to improve the efficiency of water use through appropriate demand management and conservation initiatives.

Municipalities, via water boards, will remain the responsible entity for supplying water to the end consumer. The DWAF will remain primarily responsible for policy, monitoring, regulation and planning of work. Some of the building blocks, such as enabling legislation, and a start up business plan, still need to be put into place (Lunsche, 2005:1-2) that will allow this new national water infrastructure agency to be created.

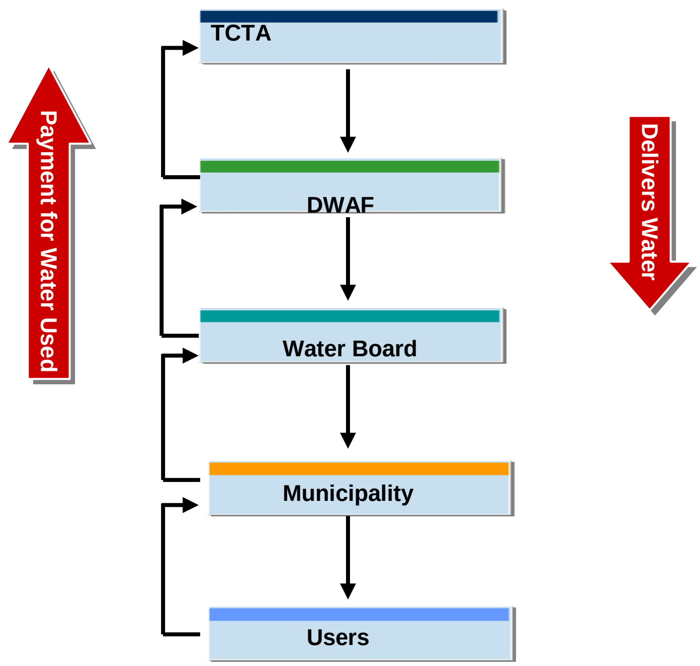


Figure 2.9 Water supply chain and collection of revenue between TCTA and end user (TCTA, 2008).

2.6.4.2 Responsibility for the supply of water by municipalities

Since July 2003, most municipalities have been authorized as water services authorities. These municipalities are ultimately accountable to residents and consumers, for the delivery and curtailment of water services.

Water Boards are owned by the state, and provide regional services in the form of bulk services, to more than one service authority.

Service authorities are responsible for ensuring that structures, such as governance contracts and by-laws are in place. Currently, some of these by-laws are in the form of one level of water restriction, aimed at a 30% saving of water.

Although the primary responsibility for ensuring water service provision is with the water service authorities (municipalities), the water service providers are accountable to these municipalities, while central government (national) will still play a leadership role in this reform process. This reform process is likely to be completed over a period of about ten years.

2.6.4.3 Rand Water history and water supply area

The city of Johannesburg started, when gold diggers flocked to the area in the 1800's. In 1888, the Johannesburg Waterworks Estates and Exploration Co Ltd was founded, and they built the first reservoir with a daily demand of 3.4 megalitres. In 1895, the population of the area was at around 100 000 people, and water consumption was 4 megalitres per day. The available supply was 6.8 megalitres per day. During this year the town suffered its greatest water shortage. At the time, several private water companies were also operating. In 1899, the Boer War broke out, and as a result, most of the population left Johannesburg. In 1901, a commission was set up, and it recommended the establishment of the Rand Water Board. In 1903, the Rand Water Board (RWB) was established, via an Ordinance. On 1 October 1993, the name of Rand Water Board was changed to that of Rand Water (RW). In 2007, it was considered to be Africa's largest public utility, supplying more than eleven million people, in and around Gauteng (RW, 2007).

More than 99% of water abstracted and treated by RW is surface water. In 2004, RW had the capacity to supply 5 184 million litres of water per day (Rand Water keeps Johannesburg's wheels turning, 2004:21). However, the average actual supply is 3550 million litres per day (RW, 2007).

The Rand Water supply area is not a geographically, evenly shaped distribution area (Figure 2.10). The basic far-lying distribution area ranges from Pretoria/Winterveld in the North, to Rustenburg in the West, to Bethal in the East, and Heilbron in the South (Figure 2.11). For the purpose of this study, Johannesburg, in Gauteng, is taken as the centre of the supply area. In order to meet the water demand in all the far reaching areas it is required that RW have in place a reliable and suitable pipeline network (Figure 2.12).

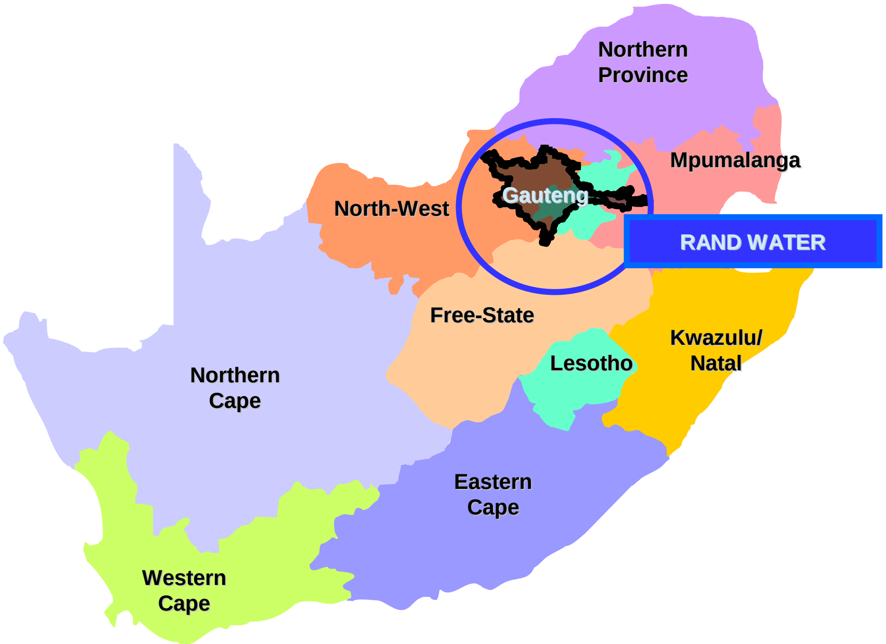


Figure 2.10 Map of South Africa indicating the Rand Water Supply Area.

Figure 2.11 Rand Water Supply Area Indicating Major Towns.

Figure 2.12 Typical example of Rand Water infrastructure layout**.**

2.6.4.4.Water availability in Upper Vaal

Rand Water obtains its water from the Upper Vaal catchment area. This includes water that has been stored and transferred, both from Lesotho and Kwazulu-Natal. Van Rooyen (2005:23), in the Landbou Weekblad, indicates that in the Upper Vaal supply area, the available water is less than 4000 million m^3 per year, whilst the need is 5000 million m^3 /year, and the resource potential is less than 4000 million m^3 per yr.

The extent of need, for the many transfer schemes, illustrates the importance of realising that nothing is to be done in isolation, and therefore, the need for water conservation measures is enhanced.

2.6.4.5 Water storage dams

The storage of water in dams from transfer schemes is important, as this allows for water to be retained during periods of excess supply, for use during periods of reduced natural availability. In areas of low rainfall, as well as in areas where it does rain every few days, this is more pronounced. It is even more essential, where the end user is over 300 km away from the rainfed source of the water.

World-wide, there are 45 000 large dams, each more than 15m high (*Watersheds of the World, "s.a")*. Second to China is the United States, as the second most "dammed" nation (*The Global Water Crisis*, "s.a"). According to Montaigne, these dams are responsible for catching 14% of the world's precipitation runoff, and provide water for up to 40% of the irrigated land (Montaigne, 2002:8-50). According to the World Wildlife Fund (WWF), 59% of the world's large river systems are fragmented by dams with 3 - 6 times more water being held in reservoirs than in natural rivers. To add to these close to 400 dams, over 60 m in height, are under construction at present around the world (>80 in China, 50 - 60 in Iran, 50 - 60 in Turkey, 50 - 60 in Japan, 10 - 20 in India and 10 - 20 in Spain) (*To Dam or not to Dam?,* 2006).

The regional renewable water resources of Africa, with distinction being made between water resources generated from precipitation falling in that region (internal renewable resources) and those that include transfers from neighbouring countries (global renewable resources), indicate that Southern Africa has the second highest amount of renewable water resources available. This does, however, include large rivers such as the Zambezi within this region, which is many hundreds of kilometres from Gauteng (Table 2.29).

Table 2.29 Regional renewable water resources of Africa (*General summary Africa: Water resources,* 2005)

African Region*	Area	Precipitation	Internal renewable resources			
	(1000km²)	(km³/yr)	(km³/yr)	(mm/yr)	% of total	% of precip
Northern	5 753	411	50	8.7	1.2	12.2
Central	5 329	7 621	1 946	365.2	48.8	25.5
Eastern	2 916	2 364	259	88.8	6.5	11.0
Southern	4 739	2 967	274	57.8	6.9	9.2

* Note: not all regions have been included

The proposed First Edition National Water Resource Strategy (as quoted by Otieno & Ochineg, 2004:669) reports that, "despite the increasing entries of competing water users, sufficient resources are available (for SA as a whole) to meet all priority water requirements for the next 25 years, **provided they are managed well**".

In South Africa, 40% of the rivers are seasonal (Ashwell & Hoffman, 2001:67). South Africa also has twenty three dams, with a full supply capacity of over 2 000 million m³ (Water by numbers, 2005:4). There are also about 320 major dams, with a total combined capacity of more than 32 400 million m³ (Start Saving or Start Paying Report Warns, 2007:27). As a region, South Africa has over 500 000 dams, ranging from irrigation dams, to farm dams, to large storage facility dams (SADC, IUCN, SARDC, World Bank 2002:42). Although South Africa has needed to build and continues to build many dams and reservoirs as water storage facilities, to ensure a more secure water supply, there has also been a need to negotiate building dams and transferring water from neighbouring Lesotho into Gauteng. Despite these efforts, in future there will still not be enough water from within the boarders of South Africa and neighbouring Lesotho, to supply future local demand. According to Stanford, in an interview with Professor K Asmal, Minister of Water Affairs and Forestry (1997:61), after 2033 obtaining additional water, either from neighbours or the sea, will be both difficult and costly, and competition for the remaining water and potential for conflict is bound to increase (Figure 2.4). This was partially confirmed in 2004, in another statement, where Louw indicates that South African plans to draw up to four billion cubic meters of water annually, from the Zambezi, once the Lesotho Highland Water Project is fully developed (Louw, 2004:17).

At the Rand Water Water Services Forum, tariff consultation meeting on 15 October 2008, it was indicated that two scenarios exist, for the future planning requirements of water supply for the Rand Water supply area. The first scenario being the Thukela Water project with the building of two dams, namely the Mielietuin dam and transfer scheme, as well as the Jana dam. The second scenario being the Lesotho Highlands further phase building of the Polihali dam and transfer scheme. It was also indicated that a decision on which scheme to implement needs to be made by March 2009, and the next dam needs to be in place by 2016, because of the high rate of growth in demand for water (van Rooyen,2008).

According to Alemu *et al.* (2001) (as quoted by SADC, IUCN, SARDC, World Bank 2002:42), South Africa is one of the countries in the region that has grossly inadequate artificial storage facilities.

It is essential in any country or local situation, to have in place a buffering or water storage ability, to accumulate water for high water demand periods or for periods of drought. These high water demand periods may include, amongst others, peak tourism, peak domestic or industrial use times, peak growing season, excessive heat and low rainfall, and prolonged periods of lack of rainfall.

A stressed system (several years of below average rainfall) will buckle under the pressure, should a sudden severe shortage be imposed.

According to Buckel as interviewed by Ryan (2001:17), "For years, the focus of industry was on water supply management – any shortfall would be met by new dams and infrastructure. But there is no longer a bottomless government funding, and the public will no longer be able to afford the high water tariffs". Buckel also believes that the single largest cost component of water, is the building of new dams, pipelines and sewerage works. Through water conservation/water demand management, the building of new dams and infrastructure can be deferred, and the cost of water can similarly be deferred. Failure to manage now, results in costs later down the line.

In an article, "Start Saving or Start Paying Report Warns" (2007, 17), it is stated that with more people flocking to South African cities, increased strong growth in the mining sector, increased power generation by Eskom and a continual high demand for water by the agricultural sector, increased pressure is being place on the available water stored within the dammed systems. Added to this pressure is the demand from new home owners and golfing estates, increased tourism and industrial growth.

When the Lesotho Highlands scheme was being developed (to cater for these increasing demands on this natural resource) it was estimated that 56% of the water from the upper reaches of the Orange River would be diverted into the Vaal River, to service Gauteng (Laker 2005:30).

2.6.4.6 Rand Water Supply Schemes and Water Source (current)

Rand Water obtains the majority of its water from the Vaal River. There are various sources of water that not only link into this, but also feed into the Vaal River. Together with the "feeder" system, are a number of dams and transfer schemes. Some dams, such as the Vaal, are not considered to be the most ideal for the storage of water, due to their large surface area and the shallowness of the dam, which results in high evaporation. Other dams, such as the Khatse and Sterkfontein, are extremely deep and are based at high altitudes, and as a result, evaporation from these dams is lower. Details on the storage system are displayed in Figure 2.13, whilst a diagrammatic version indicating transfer schemes is shown in Annexure F.

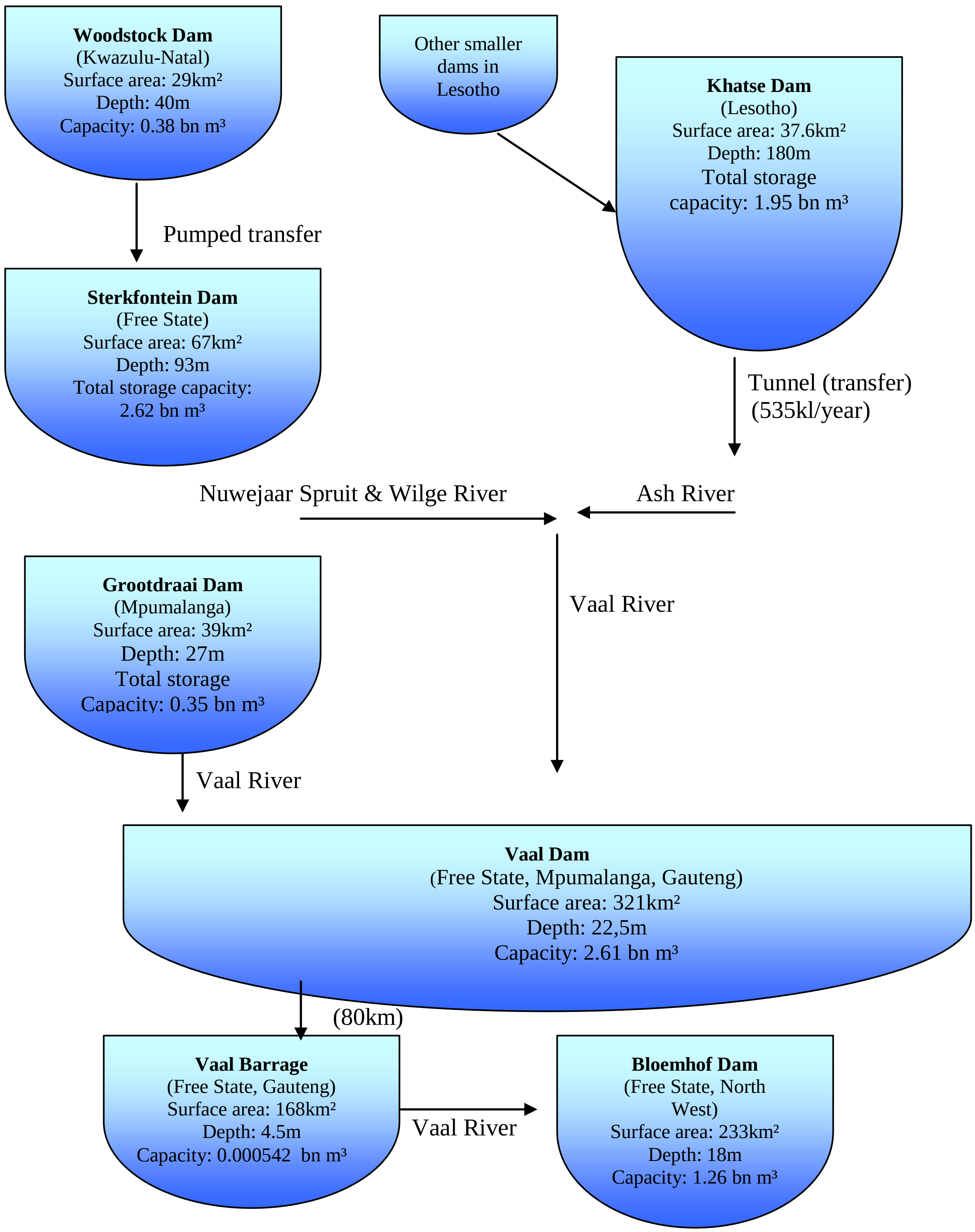


Figure 2.13 Supply schemes and water source for Rand Water (Adapted from (Ryan, 2001:16)(Fourie, 2001:7), (Rodrigues, 2003:21), (RW, 2004-2005) , (RW, 2007) and (Kopping, 2008:50)).

2.6.5 Water Demand Management and Water Restrictions

2.6.5.1 Water demand management

The definition of Water Demand Management (WDM), as used by The World Conservation Union (IUCN), is " a management approach that aims to conserve water by controlling demand, which involves the application of selective incentives to promote efficient and equitable use of water" (Arntzen *et al.*, 2000:15). The efficiencies that need to be achieved within the system, can and should be achieved at all levels of the supply chain, from the intermediate levels to the final consumer (Arntzen *et al.*, 2000:16). WDM is thus a very broad ranging mechanism, aimed at reducing the use of water as well as the inefficient use of water. This is graphically illustrated in four levels (Figure 2.14) namely, country, bulk water supplier, local authority and final consumer.

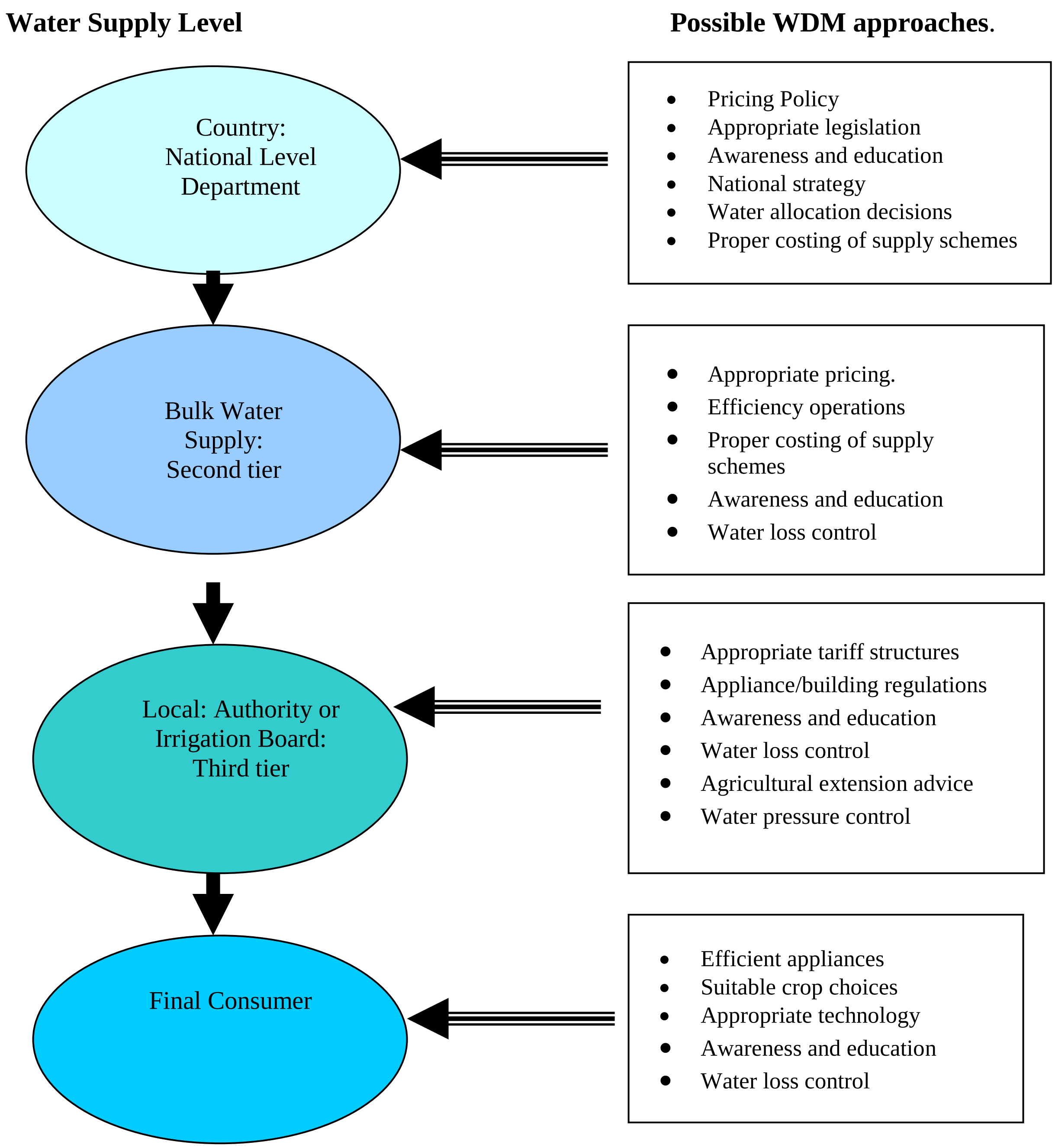


Figure 2.14 Water supply chain and areas where efficiencies can be obtained. (Arntzen *et al.*, 2000:18)

The current methods and tools, used for water demand management approaches in the Southern African countries are:

- Economic measures
- Regulations
- Education and awareness raising
- Technology improvements
- Water loss control

- Water re-use and recycling (Arntzen *et al*., 2000:25-33)

In the process of WDM, according to Wolfe (2006-2007), "rather than just accessing, treating and distributing greater supplies of water, which can be expensive and bad for the environment, a demand management approach attempts to modify users' demand for water. This can be accomplished by reducing water consumption and, perhaps more critically, completing tasks with less water (i.e., being more efficient)".

WDM, therefore, looks at a much broader picture than other forms of water use regulation, such as water restrictions, water regulations, water conservation and water supply response plans.

The National Water Act (Act 36 of 1998) and the Water Services Act (Act 108 of 1997) have provided an enabling environment for WC/WDM. Newly established institutions, with roles and responsibilities, are expected to integrate WC/WDM into their activities (*Water Conservation and Water Demand Management Strategy for the Industry, Mining and Power generations sectors*, 2004).

2.6.5.2 Water restrictions/regulations and water efficiency

The methods of regulation (restrictions) are used mainly during periods and instances of drought and water shortage. These regulations are often in the form of water restrictions, which will limit users to amounts of water, times of watering or methods of watering. Generally, water restrictions in themselves do not change long-term water use habits, as the restrictions are mainly implemented only during times of crisis. This is primarily because the restrictions themselves do not address the underlying issues, but merely the use factor of water itself. Current water restrictions, for the Green Industry within the Gauteng region, only address the water use during drought times at one level, and do not address habits during periods of good to medium rainfall.

Water demand management includes a large range of initiatives that will include, and go beyond, a water supply shortage response plan (water restrictions on several levels). Whilst a water supply shortage response plan is one that is seen to address a specific niche, it is imposed mainly during (but not limited to) times of drought, and is aimed at achieving a specific short-term water saving. It is also aimed predominantly at the horticultural and outdoor living industry/market. As part of a process to change the mindset of the Green Industry and its consumers, it is necessary to educate them on many levels, on how to best save and conserve the use of water.

Water efficiency is not to be confused with water restrictions. Water efficiency is achieved when a task or process is undertaken using the least amount of water. It can also be an indicator of the amount of water required for a specific purpose (*Wikipedia*, 2009).

2.6.6 Education and Water Conservation in The Green Industry

As the conservation of water does not seem to come naturally to most people, unless strict legal controls are enforced, it is therefore, important to educate all interested and affected parties in the many diverse aspects of water conservation. This helps reduce the need for more water, the need for additional infrastructure, the need to impose water restrictions in times of drought, as well as any negative effects if drought is declared.

Ecosystems are resilient only up to a certain threshold, and can collapse when pushed too far (*How do we get more Crop from Every Drop?,* "s.a"). It is therefore, important that we learn to care for these ecosystems, and address the environmental problems before we allow them to collapse.

Several water conservation, educational methods are used in different parts of the world, inclusive of the Rand Water area of supply.

2.6.6.1 Education on Water conservation/Water demand management

Buckle *et al.* (2003:156-7) states that school education is probably the most important aspect of education and awareness, when looking at Water Demand Management (WDM). Children who are convinced of the need for, and benefits of WDM, will convey the message to their parents. Parents on the other hand, can at times be very fixed in their ways. Stephenson (1999:115-121), in his study on demand management theory of water supply in South Africa, concludes by stating, "long-term education of consumers is seen as a necessity".

Within the world of horticulture, there are several approaches that have been taken, to introduce and create an ethic of water conservation amongst the gardening public and horticultural industry. In America, the term and associated water conservation actions are Xeriscaping™ (Duble *et al.*, "s.a.") and Water Wise Gardening (Santa Clara Valley Water District. Rules of Thumb for Water-Wise Gardening, 2005:7). In South Africa, the term Water Wise Gardening, or Water Wise® (registered by Rand Water as a brand), are most commonly used.

Xeriscaping™ comes from the Greek word meaning dry (Texas Water Development Board. 1991:1), and has seven educational principles that are seen as guidelines, namely: planning and design; soil analysis; practical turf areas; appropriate plant selection; efficient irrigation; mulches; and appropriate maintenance (Duble *et al.*, "s.a.").

Preliminary analysis (Table 2.30) of data suggested an average of 16% to 40% water savings, after implementation of Xeriscaping measures. The studies that contributed to this information are summarised in table (Texas Water Development Board City of Austin, 1994:1).

Table 2.30 Water savings after implementing Xeriscaping™ principles (Texas Water Development Board City of Austin, 1994:6).

Study	**Sampling Method**	**Number of sites**	**Analysis Method**	**Xeriscaping Savings**
Meas, Arizona	Selected rebate participants and a random control group.	150	Univariate	142 gpd (33% difference)
East Bay M.U.D., California	Random sample	1 040	Univariate	209 gpd (42%)
North Marin Residential California	Random sample with a questionnaire assessing additional predictors.	382	Multivariate	126 to 207 gpd (25%)
City of Austin Phase I: 1992	Units selected from a Xeriscape newsletter and a bulk mailing with a 5% response rate.	100	Univariate blocking for lot size.	107 gpd (40% saving for small lots)
City of Austin Phase I: 1993 (Adjusted for bias)	Units selected from a Xeriscape newsletter and a bulk mailing with a 5% response rate.	100	Multivariate correction of sampling bias	67 gpd (16%)

Water Wise Gardening in Santa Clara Valley Water District has four main principles that are subscribed to, namely: design (Zones, lawn, irrigation system and hard landscape); groundwork (Soil, and plant choice); water wisely (Time, scheduling, length, and slope); and maintenance (Check irrigation, fertilizing, pest control, and mulching) (Santa Clara Valley Water District. Rules of Thumb for Water-Wise Gardening, "s.a").

The principles of Water Wise Gardening, as used in South Africa by Rand Water are: design; zoning; mulching; watering; appropriate lawn; plant selection; maintenance; alien plants; wetlands; water recycling; and soil improvement (Principles of Water Wise gardening – poster). On other occasions, when the need has arisen, Rand Water has reduced this to only six principles namely: design; zoning; watering; appropriate lawn; plant selection; mulching; and soil improvement (Rand Water, Wonderful Water Wise Gardening, "s.a").

One negative aspect of any educational programme is that one can never be assumed that the training process has “arrived”, because at that stage the awareness levels are inclined to drop. It is precisely at this time that the need to re-educate the Green Industry arises, and the need to “pump in” huge amounts of funding and resources emerges yet again.

2.6.6.2 Water Wise principles and water conservation specifics

The biomes of South Africa are a good indicator of what type of vegetation, and what type of landscape should actually be in place, as quoted by Ashwell and Hoffman (2001:17). All over South Africa, residents and designers clamber for new, different and “over the top” designs. The greater Johannesburg area has been described as a tropical jungle, when seen from the outer limits of our atmosphere. Is this wrong? Should it not be the grassland that the highveld is supposed to be? People’s requirements and desires (residents and business parks) will unfortunately not let that happen, especially when one considers the many households in this region, and their very diverse opinions and aspirations. Acocks (as quoted by Bredenkamp & Brown 2003:7) classified the majority of the highveld (Gauteng area) as a Bankenveld (False Grassland Type). This Bankenveld is described as, “ an open savannah, that is a bushveld vegetation, but it has been changed to, and maintained as a grassland by regular veld fires”. They also refer to various physiological studies that indicate that, the Bankenveld vegetation consists of a variety of grassland and bushveld communities. They conclude their study by indicating that, under the current climatic conditions, the Bankenveld is situated in a climatic transition zone, between temperate grassland and subtropical savannah.

As much as 91% of South Africa’s land surface can be described as arid, semi-arid or dry sub-humid (Ashwell & Hoffman, 2001:17), with Gauteng being part of this greater area.

With this information in mind and while trying to juggle the unnatural requirements and desires of gardeners, clients and developers, the Water Wise principles, as presently put forward by Rand Water, need to be balanced against the reality of the current and predicted South African weather and climatic scenario. Gardens designed and managed along these principles will be more likely to “survive” during times of drought.

2.6.6.2.1 Mulching

According to Andrews (2004) Estates Superintendent Research of Rand Water, personal trials regarding mulching, having shown a significant reduction in water loss from the soils in young plantings of plants. For every 50 mm of mulch, 16 mm of rainwater is retained (Davey, 2004:8). According to the Colorado State University, using mulch reduces evaporation, and can reduce irrigation needs by up to 50% (Neibauer, & Waskom, 2004).

In a letter from Savory (2005:7), of the Africa Centre for Holistics, he quotes a study by the University of Namibia on the use of mulches and leaf litter. He indicates that without mulches and leaf litter, of all the precipitation that falls, 83% is evaporated, 10% runs off and 7% penetrates the soil, whilst the adding of leaf litter and mulch results in 10% evaporation, 10% runoff and 80% penetrating the soil. Moffat, & Schiller, (1994:30) complement the statements of Savory by indicating that mulch will reduce evaporation and runoff by as much as 90%.

2.6.6.2.2 Design

Design includes a total site investigation into the needs of the user, site requirements, external factors, water use zones, use areas of the site, slopes and water harvesting techniques. It is the first aspect of any new or refurbished site that must be investigated and implemented (Ashwell & Hoffman, 2001:14). The University of Florida advocate natural or ecological landscaping, as a form that will conserve water (Knox, 1991).

It is necessary to develop a plan for the garden, that groups plants according to their water needs. A wise landscape plan can save up to 50% on water usage in the garden (Sims, 2004).

2.6.6.2.3 Watering and irrigation

Appropriately designed and operated irrigation systems can reduce water use, by 20% or more (Conservation Info and Tips, 2005). The best designed system in the world, if not used correctly, will waste water. Different watering systems, such as pop-ups and drippers, should not be designed or included in the same irrigation system (Sims, 2004). Drip irrigation systems, used correctly, apply water to the base of plants, and can as a result reduce water loss in the garden by between 20% and 50% (Moffat, & Schiller, 1994:51).

Position sprinklers so that they do not water on pathways and driveways and do not water on windy days (Sims, 2004). Deep watering once a week is far better for the plants than trying to water daily. While daily watering encourages shallow root systems, which is not in the long term good of the plants/garden (Sims, 2004). These plants struggle more during drought.

Watering times are critical. In most cases it is recommended that watering not be undertaken between 10h00 and 14h00. This thinking is supported by the United States department of Agriculture (Efficient watering of Turf, 1996:16). In their book focusing on Africa, Buckle & McKenzie, *et a.l* (2003:148) indicate that watering between 10h00 and 16h00 should be avoided.

2.6.6.2.4 Appropriate lawn and lawn treatment

Most affluent home and business owners, want to see green grass all year round, regardless of the climatic zone. This is possible and achievable, but at great water cost, and against nature's design for the natural highveld/ bankenveld (Bredenkamp & Brown 2003:7). On the highveld, in areas where frost occurs, most lawns enter a semi-dormant phase during winter. It is at this time, when consumers want to work against nature, and huge amounts of water are then used to keep grass green and to keep the effects of frost at bay. It is estimated that a grassed area of 800 square feet, is more than enough lawn for the average American family. Similarly, lawns are considered to be watered far too often, and therefore, waste huge amounts of water. For large lawned areas, it would be better to replace some of the lawn with drought hardy ground cover (Moffat, & Schiller, 1994:94).

2.6.6.2.5 Plant selection

Plant selection is very important when it comes to water wise gardening. It is, however, unable to stand on its own as a concept, and is linked specifically to zoning, maintenance, and watering. Plant selection entails choosing the correct plant, for the correct water use zone, the correct location, and the correct garden setting. However, once a plant is chosen, and planted in a zone within the garden, it can (within limits) adapt and change its water use patterns. The International Turf Producers Federation ("s.a.":9) indicates, "while many alternative plants are able to survive on little applied water, they become high water users when consumers over-irrigate them in an effort to develop pleasure landscaping".

Selection also entails looking at the drought tolerance of a plant. The drought tolerance, of any selected plant, is its ability to survive for a given period of moisture stress (Nuss, 1996). The more it can withstand this period of stress, the more drought tolerant it is. It is also to choose plants for the South African garden that originate from similar climatic zones, such as Australia, Mediterranean and California (Sims, 2004). This aspect becomes even more important, as the effects of climate change take shape.

2.6.6.2.6 Zoning

The notion of zoning requires that plants with similar water needs, be planted together in appropriate areas (zones) of the garden, thereby reducing maintenance and water use, and increasing plant growth (Moffat, & Schiller 1994:95).

Basically, three zones are anticipated for any garden or design - these being high, medium and low water zones. The high water zone should be very limited in size, and should focus on entrance areas, entertainment areas and focal points (10% to 20% of the garden area). The medium water zone would be the bulk of the garden, with perennials small shrubs and ground covers (25% to 60% of the garden). The low water zone would be placed in, “out of the way” areas, or to the back of the medium zone, and would typically have large shrubs, trees and even “unkempt” grass areas, and would seldom, if ever, be watered (40% to 60% of the garden). A shrub/tree area would typically start off as a medium water zone, and as plants matured, would be weaned off to become a low water use zone. The size, location and type of garden will determine to what extent each of the high, medium and low water zones must occupy the garden. The concept of zoning and grouping is also advocated by Knox of the University of Florida (USA) (1991) and Buckle *et al.* (2003:149).

2.6.6.2.7 Soil improvement

Soil is the basic growing medium for any plant. As this study deals with water conservation, what happens in the soil, influences the soil’s ability to absorb, retain and utilise water. The ability of any plant to survive, during a period of drought, begins with the quality and water holding capacity of the soil (Nuss, 1996). Adding organic matter to the soil helps with binding particles, soaking up water like a sponge, and later releasing the water as plants require it (Moffat, & Schiller, 1994:93). It is, therefore, extremely important that the soil is fed with natural products, such as compost, on an ongoing basis.

2.6.6.2.8 Water recycling & reuse

As indicated earlier, water for domestic use can range from 300 L to 459 L per day. Considering that between 30% and 50% of this is used for domestic use, it would be possible to recycle a substantial amount of this water. Used water in the home, is usually categorised into black and grey water. Black water is any water soiled with faeces, or containing fats or meats, and should never be used directly in the garden. Waste or grey water from the home, can be used in the garden. However, it is advisable that certain precautions be taken (Nuss, 1996). Grey water from the house should be used in a responsible manner. Systems are available on the market, that will "clean and purify" the water to acceptable standards for garden use (http://www.biolytix.co.za, 10 January 2005).

It is possible and advisable to use rainwater tanks, to collect excess rainwater for later use in the garden. Surface run-off water should, as far as possible, be captured & diverted back into the garden. During dry periods access to grey water, rain water (tanks) and run off water becomes more critical.

2.6.6.2.9 Maintenance

Maintenance of a garden, in a water wise manner, includes, but is not limited to, annual replenishment of mulches, continual removal of any weeds (that take up valuable water), adjustment of sprinkler heads to suit plant growth, and the application of composts to the soil.

2.6.6.2.10 Alien plants

Invasive alien plants (IAP) in SA cause huge destruction, not only to the broader environment, but also to the water resources of our country. It is estimated that IAPs waste 7% of SA's water resources. Approximately 45% of the thirty plants introduced from Australia, have become problem plants, part of which has resulted in over 10 million hectares of land being invaded. If nothing is done, the problem will double within fifteen years. It is estimated that the cost of controlling IAPs in South Africa will amount to R 600 million a year over, twenty years. This excludes the cost, of the loss of water to our natural system, as a result of their water uptake. Removing alien plants results in, amongst others, preserved biodiversity, reduced soil erosion, increased streamflow (Hosking, & Du Preez. 2002:23-28), more available water for our needs, and reduced strain on the system.

2.6.6.2.11 Wetlands

It is estimated that 50% of SA's wetlands have already been destroyed. Some of the problems, that result in the degradation of wetlands, include: drainage, for pasture and crops; overgrazing and incorrect burning; encroaching timber production; incorrect sighting of dams and over-abstraction; road building; erosion and mining.

Wetlands offer the Green Industry many indirect benefits, which must be communicated, to ensure their protection. Some of these benefits are: attenuation of floods; reduced erosion; trapping of sediment; recharging of ground water; filtration of water; and maintaining a base flow of streams and rivers during dry periods. Preservation of large wetlands together with their baseflow, is critical in assisting with more constant water flow from source to dam, which alleviates the impact of drought.

2.6.7 Water Supply Shortage Response Plan (WSSRP)

Although the term Water Supply Shortage Response Plan (WSSRP) is often used internationally it points to a broader concept of water conservation that includes, at times, a legislative component, a communication aspect, a law enforcement aspect and many different water restrictions. In some cases the term WSSRP is used fairly loosely, and at others it focuses very specifically on levels of water restrictions. Some examples sited in Annexure H were not used in the actual analysis of the research project. More recent documents, obtained particularly from the USA point more towards using the term WSSRP, than Water Conservation Strategy or Water Conservation Plan.

2.6.8 Water resource management in Namibia (case study) (Biggs & Williams, 2001:10-37)

Namibia is Southern Africa's most arid country. Its potential evaporation exceeds precipitation by between two and five times. Water consumption in the country is estimated as follows - 56% from underground sources, 20% from ephemeral rivers and 24% from perennial border rivers. Rainfall across the country varies from just 20mm to 700mm per annum, and of this, 83% evaporates, 1% contributes back to ground water recharge, and 2% is harvested in surface storage facilities.

At the beginning of the 1980's, the average water consumption was 600 - 700 litres/person/day, in the affluent areas of Windhoek. Integrated water resource management (IWRM) was introduced in the early 1990's, to reduce consumption to a safe yield level. To date (2001), the average consumption has been reduced to 180 ℓ/p/d. This use is considered to still be above many other African countries.

Several areas of intervention were used to manage the water situation in Windhoek. These being:

1. Supply side.

This involves looking at Sources of water supply as well as Conjunctive use of water (entails using surface water first and underground water later).

2. Demand side

Although Windhoek experienced a 6% growth in population, it only experienced a 7.7% increase in total water consumption over a nine-year period. Between the period 1990 and 1998 the daily per capita water consumption dropped from 201 l/p/d to 130 l/p/d.

A number of direct water demand interventions were introduced such as reusing water, prohibiting of watering between 10h00 and 16h00, efficient watering systems and education programs. Those relevant to the research are listed in table 2.31.

Table 2.31 Water demand interventions introduced to Windhoek (Adapted).

Policy (policies were approved and implemented in Windhoek)
Maximum reuse of water- including semi-purified effluent for irrigating municipal areas etc. Plot sizes - reduced for new developments, and higher density housing encouraged etc. Reduction of municipal water use - reduced by 50% for public gardens, etc.
Legislation
Gardens - watering prohibited between 10h00 and 16h00. Swimming pools - must be covered when not in use.
Technical measures
Lowering of unaccounted for water - leakage detection carried out, repair programmes in place etc. Efficient watering methods - proper irrigation systems for municipal gardens.
Public campaigns and awareness
Education programmes - lectures in schools and other educational institutions. Advice on efficient gardening methods - including suitable flora, and efficient watering techniques. Community empowerment in formerly neglected areas - training of community based gardeners.

Biggs & Williams (2001:10-37) conclude by stating that IWRM, although it has achieved certain successes, will continue to be a challenge, in meeting and managing the growing demand for water, and in enhancing the water supply system of Windhoek.

What is of interest to this research, from this Namibian case study, is that they have introduced a number of permanent initiatives, some of which are aimed primarily at the Green Industry.

2.7 MANAGEMENT OF WATER – DROUGHT MANAGEMENT AND RESTRICTIONS

2.7.1 When to start planning for the next drought

Serageldin's (1995:15-16) interpretation of the United Nations Conference, on the Environment and Development (UNCED), in Rio de Janeiro and at other subsequent gatherings, is that there has been an emphasis on moving away from the notion of developing new water supplies, and rather focusing on: comprehensive management; economic behaviour; policies to overcome market and government failures; incentives to provide users with better services; and technologies to increase the efficiency of water use. This places the emphasis on water not only being available for human use/need, but also as an integral part of ecosystems, a natural resource, as well as a social and economic good. It focuses more on consistent rules and regulations amongst role players, to ensure policy cohesion and public support, as well as ensuring the sustainability of the water environment for multiple users.

SADC (2002:17), listed several factors, that contributed to the realisation, that a regional coordination mechanism for water resources was required. Some factors being:

Recurrent droughts (particularly in 1991/92 and 1994/95).

Occasional flood disasters.

Increasing demand for water.

The possibility of conflicts over access to water.

According to Backeberg and Viljoen (2003: Iran), the next drought is imminent. To start planning for a drought, when it has arrived, is too late. It is, however, never too late to start doing something. The effects of starting late, are not as beneficial as good, early proactive planning. Landscapes that are planned correctly, will take anywhere from five to ten years, to reach and start demonstrating, maturity in the form and intention of their original design. This will differ from region, to region even within the Rand Water supply area, as the climatic zone, vegetation type and soil type changes, are vast. The success of a garden/landscape is in its need to be designed properly, and then matured over time in a manner that will ensure it is more water conserving than if it were not correctly nurtured according to water wise principles, and within a framework of water demand management. Similarly, if correct irrigation systems are to be installed they need to be done up from. The same applies to recycling water systems that need to be in place, and in use, long before a drought.

In most parts of South Africa, a roof area of 100 m^2 can provide 50 m^3 (50 tonnes) of water a year - enough for 150 litres a day (Davies & Day, 1998:350). This concept is good, but not practical for the majority of home owners, as it would require storage space, which they don't have, as well as a reliable weather pattern that delivered the correct amount of rain each year. Although the costs of implementing water collection systems in the landscape are excessive, the long-term benefits of the system, are what need to be recognised.

Water supply within the Vaal system is monitored, and reported on, by the Department of Water Affairs and Forestry. Within their total reporting system, is the need to account for the predicted assurance, of water supply. The 2005 report (Table 2.32) indicated that 70% of the demand for domestic water in the Vaal System could be supplied with at least 99% assurance, a proportion of 50% of domestic water in the Vaal System can be supplied at the high assurance level (DWAF, 2005).

Table 2.32 DWAF assurance of water supply priority classifications (DWAF, 2005)

User		**User priority classification (assurance of supply)**		
		Low (95%)	**Medium (99%)**	**High (99.5%)**
		Proportion of water demand supplied (%)		
1	Domestic	30	20[1]	50[2]
2	Industrial	10	30	60
3	Strategic industries	0	0	100
4	Irrigation	50	30	20
Curtailment levels	0	1	2	3

This type of detailed planning, allows for management of DWAF to manage the entire water resource system, on a more global scale, and to monitor the amounts of water required, to be transferred within the different systems of the entire catchment area. This planning also reduces the effects of localised drought, and the need to impose any form of water restriction. One downfall to this, is that no summary version of this report, cascaded down to consumer level and therefore there is no understanding of this plan within the Green Industry.

2.7.2 Components to be Monitored for Drought Management

Fredericksen (1992:11) suggests three different components of drought management. Firstly, monitoring, analysis and defining conditions. Secondly, drought management measures. Thirdly, implementation criteria.

Considering these factors, the following may need to be considered for the Rand Water supply area:

1) Monitoring, analysis and defining conditions.

The available water, set against the demand for certain quantities of water, will constantly be changing from day to day, season to season, and from product output to demand. Although it is possible to use current water use trends (set against the anticipated growth in population and demand for water from the different sectors), to determine what amounts of water will be required in the future, averaged out over any given year, it would also be necessary to monitor (amongst others) the weather patterns (both current and future and ever changing) to estimate their possible impact on water supply, as well as potential input of water into the entire system.

2) Drought management measures.

The Vaal water supply system is monitored and reported on, by the DWAF, on an annual basis, to manage the total amount of water in the system, against the predicted usage and requirements of the system. It is necessary to have in place, drought mitigation measures, for all levels, and for all sectors of water use, within the system. It is necessary to have different measures, for different levels of drought severity, which are unambiguous, easily implemented, and easily monitored. All measures will need to be continuously updated, to keep pace with such aspects as demand growth, total available water stored in the system, and very long-term changes in weather patterns for the country, or region as a whole.

3) Implementation criteria.

The DWAF has set out high - level implementation criteria, in the form of the percentage water savings that needs to be achieved, should water levels reach pre-determined limits. Drought management measures will need to be set out and implemented in a pre-determined sequence, so that all users know what is expected of them, and when these measures will be implemented. The above concept is supported by Macy (as quoted by Fredericksen 1992:12).

The researcher has not been able to establish from governing levels below the DWAF, whether any such complete and comprehensive system exists, is implemented or is enforced within the Rand Water supply area, although within municipalities, certain water demand management initiatives, such as leak fixing and pressure reducing mechanisms, are being implemented.

Davies and Day (1998:341) suggest several ideas for water-demand management, which result in a reduced need for excessive capital outlay. These ideas being:

Education programmes, in and out of schools.

Tax incentives for drip irrigation and Xeriscape gardens.

Adopt a "carrot and stick" approach to water savings.

Institutional arrangements to cover capital, running and environmental costs.

Serageldin (1995:16 – 28) has identified several aspects that can be used as a framework, for improving management of water resources. These include a comprehensive cross - sectional approach, appropriate incentives (pricing), and environment and health aspects.

Serageldin (1995:16) indicates that comprehensive water management, is best achieved with the help of institutions, such as "river basin" organisations, or coordinating committees, that will encourage water related agencies to, "coordinate and establish mutually agreed priorities for investment, regulation, and allocations, and to ensure that policy, planning and regulatory functions are separated from operational functions at each level of government".

2.7.3 Case study on "Water Rationing and Transferable Rations" by Lund and Reed (1995: 429-437)

Their case study is based on an American situation. Water rationing is a common demand management approach, during severe droughts. The system of transferable water rations is based on volumetric rations, granted by the water provider to the end users. This transferable water, would be tradable for cash to other water users.

Lund and Reed indicate that traditional water rationing during a drought, usually restricts individual households and enterprises, to water use below a given level. Where heterogeneous households or enterprises exist, this may cause conflict, and will not contribute positively towards the final conservation goal. Simple rationing of a scarce resource is economically inefficient, in that available water is not necessarily targeted for the highest and best economic uses.

Lund and Reed refer to the drought in the West of the USA, with particular reference to a drought in California in 1976-1977 & 1987-1992. Water rationing in the USA has usually been introduced as a last resort, in urban drought management. In response to this, water districts and water users have found water conservation to be an inexpensive and effective method of saving water, and delaying the need for additional resources.

Lund and Reed quote Mercer and Morgan (1989), quoting several forms of water rationing that have been practiced or proposed in the management of droughts. These being:

2.7.3.1 Rationing by fixed allotment

This approach involves rationing water use, by allocating water use by volume, to each user.

2.7.3.2 Rationing by percentage reduction

This approach involves rationing water use, to a percentage of the water used, prior to the restrictions being implemented. An example being, a water use reduction to be 75% of what it was.

In an interview with van der Linde of the Overstrand Municipality in Hermanus, 2005), in his opinion, water restrictions should be aimed at the amount of water to be used and should use a combination of both water restrictions and water price increases, in order to achieve restrictions effectively. Linking everything through, to what they term as a Residential Unit Equivalent (RUE), Hermanus has based the water use for one RUE on 28 kl. Guest houses, for example, may receive 2 RUE’s.

2.7.3.3 Rationing by price

This approach involves increasing the price of water during a drought. One method of price increase involves block rate tariff increases, which penalizes water use above a given ration amount. Weber (1989) as quoted by Lund and Reed, indicates that because factors such as season, income, geographic location, temperature and climatic conditions influence price conditions, it is impossible to adequately predict or control water usage, using price alone.

2.7.3.4 Rationing by restricting specific water users

This is usually water restrictions that prohibit or restrict certain types of water use. This may include restrictions on car washing, sidewalk washing, fountains and landscape watering.

2.7.3.5 Rationing by service outage

This is often used in less developed countries, where metering, and other means of curtailing water consumption are ineffective. It involves rationing water, by means of rotational service outages, allowing different sectors within a city, several hours of water service each day, as indicated by Chau (1993) as quoted by Lund and Reed.

2.7.3.6 Accumulating conservation credits

Some systems allow users to receive credits, for water conservation beyond their allotted ration. This could encourage additional water conservation.

2.7.3.7 Transferable water rations

This involves the trading of rationed water supplies, by customers within a single municipal and industrial water utility district. The right to buy water from the water utility, at a specified price, is transferred from one user to another. Transferring rations allows users to sell their excess allotment to those in need.

2.8 CONCLUDING STATEMENT

There is a limited supply of water, which is not increasing. It is in huge demand from humans, and as technology, populations and "civilisation" increase, so the demands and pressures on this limited resource increases. Further to the problems of natural cycles, of droughts and other extraneous events, climate change is adding to the problems of available water. It is therefore, necessary that water be stored in large volumes from various sources, and be moved and used as and when required to meet the demands. The Green Industry, in all its broader specialities, is one that is often seemingly forgotten about, and yet the unseen and hidden values of this industry are innumerable to society at large. Despite this, however, this industry is most often the first to be hit by water restrictions during times of drought. In order to mitigate this, water conservation initiatives have been introduced with limited success. The current available systems are presently, unfortunately insufficient within themselves, to assist in a somewhat flexible system of water reduction, within the Green Industry during dry times.

Chapter 3
Methodology and Procedures

3.1 INTRODUCTION

The purpose of this section, is to present an overview of the research methodology process applied and followed, to formulate a water supply shortage response plan, concentrating on the Green Industry in the Rand Water, water supply area (which is mainly situated in the province of Gauteng). Once the problem statement was formulated, it was then determined that the best research process to follow, was a combination of qualitative and quantitative action research.

In this chapter, the research approach employed in the course of this study will be discussed and expanded upon. The relationship of the researcher to the data, the relationship of the industry to the data, the methods of data collection, and the sample group composition will be discussed. The validity and the reliability of the study, and the results will be explained.

3.2 THE RESEARCH PROCESS

3.2.1 Relationship of the researcher to the data

To answer the epistemological question, the researcher is a trained horticulturist with almost 26 years of experience in the fields of horticulture, landscaping and environmental management. During the drought of 1994/5 in Gauteng, it was the responsibility of the researcher to liaise with the Green Industry, municipalities and the public, regarding water restrictions, water conservation measures and to assist with the clarity of data. Since then the researcher has been actively involved in the accumulation, interpretation and breakdown of water conservation information and data to be distilled to the public and industry. This has mainly been achieved on the main through the use of the Rand Water, Water Wise brand, where the Green Industry and people’s habits are challenged, and encouraged to change from one of “water wasting” to one of being Water Wise. The researcher is in no way a policy expert, but has rather approached this research from a perspective of producing a more fair and equitable use of this scarce resource, especially in times of a declared drought.

3.2.2 Methodology

The research followed a basic process of observation, empirical generalisation, theory development and hypothesis formulation as outlined by Marshall (1997:18) (Figure 3.1).

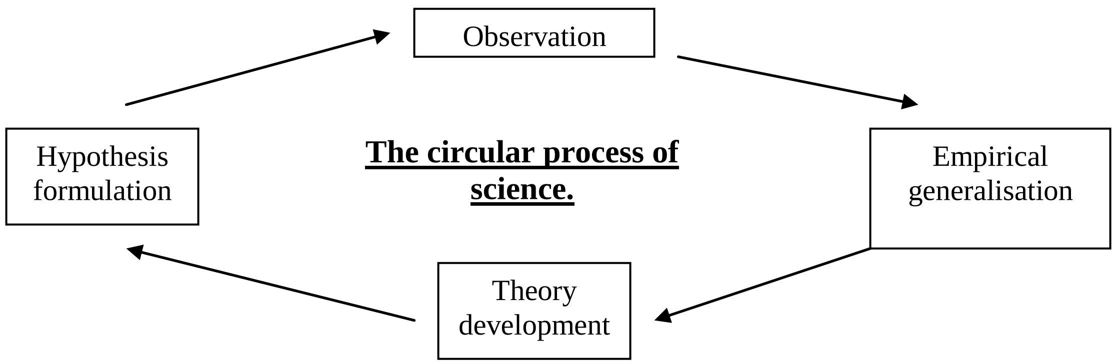


Figure 3.1 Basic research process diagram.

The methodology of this research study comprised two broad phases. Initially an exploratory and scoping phase was established, by conducting a literature review, a comparative study of available and existing Water Restrictions of Local Authorities within the Gauteng province, and a comparative study of selected available international drought response plans and water supply shortage response plans. This was followed by an applied research phase, directed at establishing a single water supply shortage response plan, concentrating on the selected "paid up" SAGIC members (SANA, SALI, IERM and LIA) of the Green Industry, in the Rand Water, water supply area.

The grounded theory process was chosen for its focus on the systematic gathering and analysis of data. It being grounded in reality, to facilitate strategies that will allow for the development and management of a water supply shortage response plan. This participatory action research process using a constructivist approach will provide for an emerging perspective, rendering a water supply shortage response plan as a baseline from which to work in future.

3.2.2.1 Literature search and initial investigations

The literature search comprised a review of available, pertinent, applicable data from International, African, South African, Gauteng and Rand Water sources, covering many aspects associated, both directly and indirectly, with this research. It included investigations into the effects of the introduction of water supply shortage response plans on the Green Industry, the benefits of the Green Industry to the broader community, and the need for participation, by interested and affected parties, when planning for, and introducing water supply shortage response plans (water restrictions on various levels). This was followed by discussions with certain selected stakeholders in Central Government, Local Government, Rand Water and SAGIC, to establish the possible need for a more flexible water supply shortage response plan, for the area. The initial discussion, with Central Government, took place with Mr D Naidoo (Director Water Conservation Demand) in 2005. Due to changes in government structures, it was necessary to continue discussions with Mr T Masike (Directorate: Water Use Efficiency). Mr Masike recommended that further discussions be held with Mr S Rademeyer (Chief Engineer – NWRP) and Mr P van Rooyen (WRP Consulting). In these discussions, with government employees, it was unanimously agreed that there was a need for a flexible water supply shortage response plan, for the Rand Water, water supply area. Simultaneously, a presentation with a questionnaire was made to the Rand Water, Water Service Forum (Body constituted by Rand Water, to address members of all servicing local authorities on water related matters). This original questionnaire is attached as Annexure G. Members of the Water Services Forum agreed that this questionnaire was a necessary requirement. Basic questions on water restrictions in general, as well as specific restrictions from the local authorities were handed out to members of the forum. The response to this questionnaire was exceptionally poor. However, some feedback was used as a guideline for the process that was to come.

The current restrictions (1994/95) for various municipalities in Gauteng, were used as a basis for the way forward, in determining a flexible water supply shortage response plan.

The researcher simultaneously obtained copies of water restrictions, from available institutions in the USA and Australia. The reason that these two countries were chosen was that:

- Climatic conditions are similar (in the broad sense).
- They are seen to be the leaders in the field of water conservation strategies.
- Similar systems of large water storage systems and piped bulk reticulation, exist.
- Intermittent droughts are experienced there.
- The Green Industry in those countries also experience a negative impact, during periods of proclaimed drought.

- A fair amount of information on water restrictions, is available on the internet.
- Many towns/states/municipalities have active water conservation, educational programmes aimed at residents.

3.2.2.2 Focus Groups and Questionnaire

The available restrictions from municipalities, mainly in Gauteng, as well as international restrictions were evaluated by the researcher. The Gauteng restrictions were used as a basis, with common concepts from both sources being combined into an initial questionnaire. The Green Industry questionnaire (Annexure E) was aimed at eliciting information on water restrictions in general, as well as specific restrictions, from identified SAGIC members (Green Industry).

The broader Green Industry within South Africa (inclusive of Gauteng), is made up of formal and informal sectors, and even within the formal sector there are organisations that do not form part of a parent body such as the SAGI Council. It was, therefore, impossible within the financial and resource constraints of the researcher, to establish a research study on organised and non-organised (informal) levels of the Green Industry in Gauteng, and still achieve a workable research result. The researcher, therefore, used a Stratified sample approach to this study, up to the stage of the final draft questionnaire. The Stratified sampling was decided on, because the SAGIC umbrella represents a homogeneous subset of the Green Industry, which in turn consists of nine different organisations. These organisations, within themselves, represent homogeneous subsets (although not all nine organisations/subsets would be directly affected by the water supply shortage response plan) (Collins, 1998:97). Only four of the major subsets of SAGIC, namely SANA, SALI, LIA and IERM, were used in the questionnaire process, as they would be the most directly affected by the existing water supply shortage response plan, due to the type of work they undertake, and the source of their water.

Using and implementing a stratified sampling method, and in particular a disproportionate stratification was considered most appropriate for this research study as;

A stratified sample often requires a smaller sample, which saves money.

A stratified sample can guard against "unrepresentative" samples.

With disproportionate stratification, the sampling fraction may vary from one stratum to the next.

If variances differ across strata, disproportionate stratification can provide better precision than proportionate stratification, when sample points are correctly allocated to strata.

With disproportionate stratification, the researcher can maximize precision, for a single important survey measure (*Statistics Tutorial*, 2007).

> Within the Green Industry, members do not have the funds, time or inclination, to spend hours at a time in focus groups, working through questionnaires, and as a result, any other method of sampling (other than disproportionate stratification) would not allow for selected representatives from the SAGIC subset, to represent and decide on the member's interests. This was evident by the fact that the researcher had to make numerous efforts to contact the SAGIC body, before any response at all was obtained and even at that stage, the response was considered as very poor.
> Hence, disproportionate stratification allowed the researcher to use only selected (volunteer/co-opted) members of the SAGIC subset in focus groups.

Focus groups were used in this research, as they are an accepted method of social scientific research, (Kahan 2001:131) and according to Ward, Bertram and Brown (as quoted by Kahan 2001:131), focus groups provide consistent results.

The questionnaire was presented to a stakeholder group to ensure the focus of the questions was correct, and that the desired results would be achieved. The industry was then approached to recommend and nominate representatives, to form a nominal group. The industry was very reluctant to respond to this request, and consequently the researcher approached the Green Industry representatives, directly. The amended questionnaire was then surveyed, with a nominal group. Feedback from the nominal group was then placed into a draft, final questionnaire. Once this stage was completed, the final questionnaire was produced and presented, to selected stakeholders as identified under the SAGIC umbrella. Concerns were raised that there were too many questions in the questionnaire, for respondents to adequate give meaningful input. The initial questionnaire was then reduced from sixteen pages (draft) to nine pages (proposed final). This was, however, still felt to be very long and complex in its design.

What was possible to achieve, was the refocusing and realignment of proposed restrictions into different levels, to allow for what participants in the survey saw as, the most ideal manner of achieving the desired results, without undue harm to the industry or the long term water supply.

Rand Water employed the services of Marketing Surveys & Statistical Analysis (MSSA) in June of 2008, on behalf of Rand Water's Organisational Development Research Department (RW-ODRD), to undertake the survey of identified (SANA, SALI, LIA and IERM) formal Green Industry sectors. RW-ODRD (Mrs S. Reed) and MSSA together, reworked the questionnaire to streamline it further, to allow for improved data gathering. The questionnaire was then forwarded to the researcher, for final comment and corrections, to ensure that the integrity of the questions was not lost in the summarising process.

The questionnaire, was now reduced from nine pages to seven, then taken to Reed (Manager: Organisational Development – Research, Rand Water), to improve on the questioning structure, wording and layout, before finally presenting it to industry. Although still considered to be too long, in order to ensure that all aspects of the questionnaire were addressed, Reed and the researcher, were in agreement that all remaining questions were relevant and necessary.

Lists of all current members of SANA, SALI, LIA and IERM, for the Rand Water water supply area, were obtained from their respective organisations, and submitted to Rand Water's Organisational Development Research Department. The industry role players were questioned in the following manner - by telephone interviews and through a semi-structured questionnaire.

In total, the list of members supplied to the researcher, contained 889 names, with representation as follows:

Name of association	**Number of members**
Institute of Environment and Recreation Management (IERM)	362
Landscape Irrigation Association (LIA)	116
South African Landscape Institute (SALI)	202
South African Nursery Association (SANA)	209
Total	**889**

By the fieldwork cut off date, 94 successful interviews had been achieved, representing a 10.57% response rate. Feedback from interviewers, indicated that the contact list contained a large number of members that were incorrect or invalid, due to respondents not being available anymore, at the given number, or because of a change of employer, etc. Of those members contacted, only about one in six interviewees were willing to participate in the study. Some interviews were terminated after a short period, due to the length and complexity of the questionnaire. As part of the process, in response to the feedback from MSSA, some data clean up was required. This resulted in the following changes:

Name of association	**Number of members**
Institute of Environment and Recreation Management (IERM)	354
Landscape Irrigation Association (LIA)	92
South African Landscape Institute (SALI)	163
South African Nursery Association (SANA)	167
Total	**776**

This data clean up included a reduced number of interviews from 94 to 85, representing a response rate 10.95%.

The data from MSSA was coded and captured in SPSS, a statistical software package. The analysis involved the constructing of basic frequency and descriptive tables. MSSA also undertook to conduct a quality control on 10% of the interviews gathered, by means of cross-checks, to ensure the validity and accuracy of the data.

The process followed should be understood as one of a spiral, of continual improvement, and not as one of a flat structure. Each procedure within the spiral process was undertaken, constantly ensuring that observation, reflection and action took place.

Although the basic spiral used, is one of Action Research, it should more correctly be referred to as, a Participatory Action Research Spiral (PAR). This method of research was favoured, as it creates a shared ownership of the research studies amongst participants, it focuses on community-based analysis of social problems, and it is oriented towards community action (Kemmis & Mc Taggart, 2003:337) and public perception of policy formulation (Kahan 2001:131). All three of these attributes are of importance and relevance to this research, in some form or another, and at different levels of "importance". Similarly, it was anticipated that, "participants make, and learn from changes they make as they go" (Kemmis & Mc Taggart, 2003:359), which would enable for a more inclusive, dynamic and appropriate result. In other words, the participants and the researcher would learn from the very same process of doing. As further confirmation, Morgan (as quoted by Kahan 2001:131) "sees that the inter-active quality of focus groups are a source of data and insights that would be difficult to obtain from other methods". The topic of water restrictions is seen from within the Green Industry, as a sensitive issue, causing much debate. This is mainly as a result of the negative repercussions, restrictions seem to have on the industry, each time they are applied. Basch (as quoted by Kahan 2001:131), "claims that focus groups provide an easy way to learn about ideas and opinions, especially on sensitive topics", as in this particular case.

The PAR research spiral, is described by Kemmis & Mc Taggart (2003:381), as self-reflective cycles that involve

- "Planning a change,
- acting and observing the process and consequences of the change,
- reflecting on these processes and consequences,
- re-planning,
- acting and observing,
- reflecting, and so on…"

3.2.2.3 Analysis of final results

The results of the research and survey were then analysed and compared, in the following ways.

- International against each other.
- Gauteng against each other.
- Other South African data.
- Gauteng against international.
- Finally the current survey results were analysed.

The final product of all analyses being, the suggested new water supply shortage response plan, for the Rand Water, water supply area.

3.2.2.4 Concluding remarks on the methodology process

Due to the specific type of study, and the need for a drought to be in place, for the suggestions to be implemented, the researcher was unable to test recommendations emanating from the study groups and survey (Although testing was not part of the intended study). This research deals specifically with the assessing of the current aspects of water restrictions as compared to an improved and more flexible water supply shortage response plan, and not with the actual implementation of such a plan. Similarly the observation and consequences of change would require a declared drought, before the plan was implemented and tested, and the results recorded.

Lastly, this research does not seek to investigate or determine to what extent each proposed restriction and level of a more flexible plan, can or will achieve the desired water saving percentage as proposed for each level.

3.3 <u>ACTION RESEARCH SPIRAL MODEL USED</u>

The spiral model used, was first of all sourced from various authors, adapted for this study, and then diagrammatically presented, in order to demonstrate precisely how this study evolved and worked through the various stages (Figure 3.2). The model must be used as an upward spiral, illustrating continual improvement. Once the top of the spiral has been reached, in theory, the process could or should repeat itself, but each time, at a “higher and improved” level of knowledge and understanding.

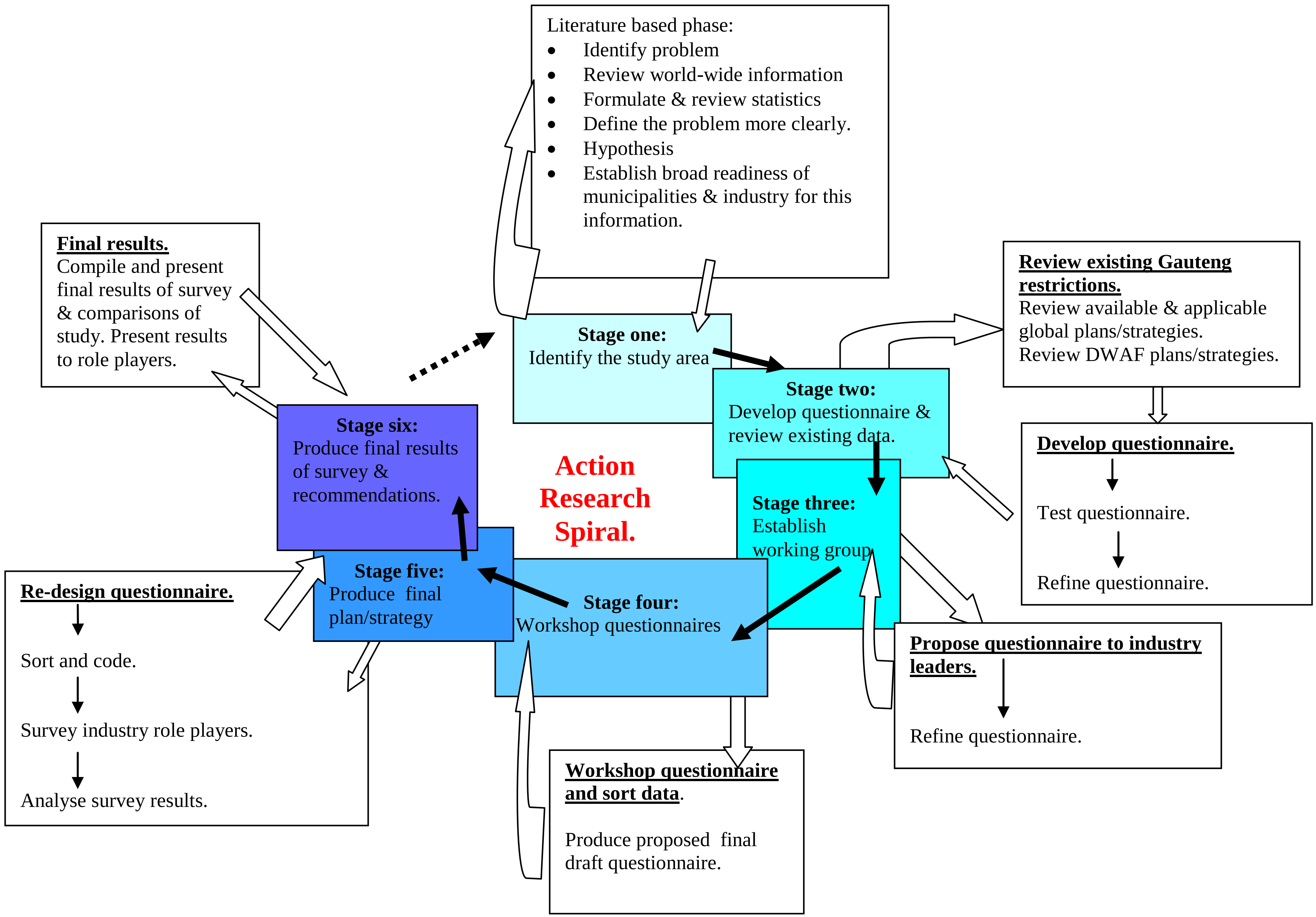


Figure 3.2 Action spiral model, used for this research. (Adapted from : Marx, 2005 Kervin, "s.a.", Kruger & Welman (2001:11), & Kemmis & Mc Taggart, 2003:382.

Chapter 4
ANALYSIS OF EXISTING RESTRICTIONS

4.1 INTRODUCTION

Although very limited data was available, regarding the 1983 drought and associated restrictions, more current, detailed and reliable water restriction data was available from the 1995 water restrictions, for use in the analysis.

When considering "best practice", for water restrictions, it is always important to note and understand the context of that best practice. Best practice may be the water restrictions that achieve the most saving in the least amount of time, or it could be the one that has been achieved through a participative approach and thereby achieving the best by-in result, or it could be a combination of both results (percentage saving) - participation/by-in and long term change. There is no known standard system, throughout South Africa or other countries observed of defining what should be included within restrictions, and to what extent they should be implemented at different stages. It is, therefore, not possible to compare identical to identical. What has been possible is the identification of anticipated percentage savings that municipalities and water service providers hoped to achieve, as well as broad criteria. As South African restrictions generally did not refer to a specific amount of water saved, and generally did not go beyond two levels (Cape Town), the anticipated percentage of water to be saved from other countries, was used. Similarly, because the base for use was Gauteng and a large amount of the available data was old, the broad criteria as identified by the researcher, were used as a base for comparison.

The aim of the research was not to assess how much water would be saved by each restriction, or set of restrictions, but rather to determine a more equitable, participatory-inclusive and flexible method of progressive water restrictions, as part of a water supply shortage response plan.

The international data obtained were gleaned from "organisations" that provided/published useful information, that allowed for some broad sense of comparison to the South African data. When comparing the municipalities/states or regions with each other (Table 4.1), some other aspects were also considered:

Table 4.1 Climatic and geographic information regarding towns/areas where water restrictions were compared.

Municipality/Town/Region	**Annual average rainfall (mm).**	**Experienced drought since 1995**	**Longitude & latitude (Approximate)**	**Height above sea level (m), average.**	**Ave Temp high in degrees C (Summer)**	**Ave Temp Low in degrees C (Winter)**
Johannesburg – SA[1]	713	Yes	26º08'S and 28º14'E	1753 to 1807	22	10
Cape Town – SA (*Cape Town Rainfall,*) (*Cape Town,*)	554	Yes	33° 55' South/ 18° 25' East	6	14 to 30	6 to 21
Victoria (State) – Australia (*Victoria's Climate,* 1993)(*Geography of Victoria,* 2008) (Note* -Victoria's height above sea level ranges from 0 m to 1980 m. It was taken as an average)	Ranges from 250 to 1520.	Yes	Ranges from 141º01'59 East (in the east) to 149º45'14 East (in the west), and 34º11'38 South (in the north) to 37º50'28 South (in the south)	0 to 1980 (average 990)	Ranges from low 20's to low 30's	Ranges from 3 to 10.
Sydney – Australia Encyclopaedia Britannica (2006)	1200	Yes	33° 55' South/ 151° 17' East	42	22	13
South East Water Authority (Area) – Australia (Note* for average height, and temperatures those of Melbourne were used as it is the main centre for that area.)	653	Yes	Ranges from 38° 20' South/145° 46' East (in the east), 38° 18' South/144° 40' East (in the west), 37° 50' South/144° 58' East (in the north), to 38° 20' South/144° 40' East (in the south).	10	23	8
Poway – USA http://www.ci.poway.ca.us/Index.aspx?page=25 (8 August 2008)	240	Yes	32° North / 117° West	148	26.1	9.4
City of Arlington (Texas) – USA (*Arlington,* "s.a.")	856	Yes	32°69' North / 97°12' West	Ranges from 141 to 209.	35	14
City of Fort Collins – USA (*Fort Collins, Co,* 2008)	368	Yes	40° 35' 7" North/ 105° 5' 2" West	1518	22	-3

4.2 GAUTENG BASED DATA

A total of twenty-one water restriction “plans”, from municipalities of 1994/95 were obtained, by the researcher. Some covered specific towns, while others covered metropolitan areas. There was, therefore, some overlap where towns occurred within a metropolitan area. At the time during 1994/5, the researcher was requested by Rand Water, as part of its service provision to the municipalities, to assist with the uniformity of the message that was sent out, and to influence change in the restrictions themselves, where possible. It was also necessary to assist with the many phone calls from end users, requesting information on these by-laws, as well as clarity on their interpretation. The lack of uniformity in restrictions was identified five years earlier, when the WRC commissioned a report (1989), in which one of the conclusions mentioned “the lack of uniformity of restrictions, tariffs and the need for a controlling/advisory body”. The report stated, that this caused confusion, especially where consumers shared a common source of supply. The report stated, that the nursery industry felt, that there was a lack of insight into the process, because blanket restrictions were applied. It indicated that there was a lack of uniformity in policy, with regard to water savings. It needs to be mentioned that to some extent, the current municipalities are attempting to involve end users in the new water services by-laws by means of advertising that new by-laws are available for public scrutiny and comment, and by inviting the public to be involved in the process. Mogale city advertised such a process in October 2008 (Mashitisho, 2008:27). As referred to in chapter 2.6.3, it is felt that even the new Water Service By-laws are hugely inadequate, in addressing the matter of a water supply shortage response plan for the Green Industry.

In order to ensure that the data being used were as current as possible, the municipal structures, as they exist in 2008, were contacted in order to obtain the latest copy of their water supply/services by-laws. The same municipalities were contacted in September and October 2008.

Many staff members at the municipalities were unable to provide copies of restrictions, let alone any updates. Water supply by-laws were obtainable from the following municipalities:

- Ekurhuleni Metropolitan Municipality
- Mogale City Local Municipality
- City of Johannesburg
- Midvaal Local Municipality
- Govan Mbheki Municipality

Unfortunately, with these by-laws, no specific reference was made to specific water conservation measures, other than to indicate that restriction of water use would be implemented, in the event of a water shortage, drought or flood (Midvaal Municipality - Water Service By-laws, “s.a.”, Govan Mbeki municipality 2004 –Water & Sewer Services By-laws and Mogale City - Water Service By-laws, “s.a.”), or in the event of there being scarcity of available water (City of Johannesburg Water Service By-laws, 2008), or at any time (Ekurhuleni - Water Supply By-laws, “s.a.”). The City of Johannesburg by-law also made reference to the repealing of Standard by-laws for Randburg, Sandton, Roodepoort, Midrand, and Johannesburg, as well as reference to the repealing of water supply by-laws as applied by the municipalities of Alexandra, Diepmeadow, Dobsonville and Soweto (Water Service By-Laws, 2008).

Some municipalities did indicate that they were in the process of updating their by-laws, and that they would be available within the next six months (estimated April 2009).

The twenty-one plans were analysed and many differences were found between the listed items, and between the different municipalities. Each of the twenty-one plans were analysed against twenty-seven criteria (which were created after studying all the restriction tables obtained). The criteria chosen were based on the main aspects raised in the various water restrictions. Some plans made no references to any of the criteria, while others made many. (A sample of the Water Restrictions indicating criteria is seen in Annexure B.) When compared with each other there was very little consistent application of all the rules (criteria) in any of the plans. Some examples are, that in 100% of the plans reference was made to the watering hours/days in residential gardens, while only 5% of the plans made reference to watering of mine dumps, 24% made reference to watering of lawns, 43% made reference to watering down of paved surfaces, 90% made reference to “Bona fide” landscapers and only 71% made reference to “bona-fide” nurseries (Table 4.2). This meant that in some municipalities work could continue “as usual”, depending on the public’s interpretation, while in other municipalities, specific restriction plans were enforced. These inconsistent messages sent through to the various end users, by the different municipalities, caused confusion (minutes of meeting 3 August 1995 of City of Johannesburg 1995) as well as disenabling the media from sending out one uniform message. Each of the water restrictions obtained from the local authorities was compared against a set of criteria obtained after studying all the restriction tables found.

Table 4.2 Summary comparison of water restrictions of twenty-one local authorities in Gauteng.

Criteria of comparability* (Main criteria identified in the by-laws available) description.	**Total municipalities**	**Total with this restriction**	**% of total municipalities investigated.**
Surcharges and Offences	21	11	52
Period of restrictions	21	2	10
Residential gardens -Watering hours and months	21	21	100
Garden hoses	21	13	62
Recreation facilities	21	19	90
Government & municipal parks/facilities	21	17	81
Bona fide nurseries	21	15	71
Bona fide landscapers	21	19	90
Free running water from municipal system.	21	16	76
Toilet systems	21	18	86
Car washing and Commercial car wash facilities.	21	21	100
Swimming pools - private	21	18	86
Use of buckets	21	16	76
Sprinklers and drip irrigation.	21	13	62
General notice on using water sparingly	21	4	19
Leaking taps	21	7	33
Water use for pubic and residential gardens by religious groups.	21	4	19
Mine dumps	21	1	5
Lawns	21	5	24
Paved areas.	21	9	43
Boreholes	21	7	33
Water Features	21	4	19

*Note these are the criteria and not the full list or wording of restrictions.

From the analysis in Table 4.2, it is clear that the restriction published by local authorities, when compared across the board, were inconsistent in the aspects raised. For example 100% made reference to restrictions in car washing and Commercial car wash facilities, whilst only 62% made specific reference to garden hoses, and only 62% made reference to sprinklers and drip irrigation.

As an example of the erratic differences within the detail of various restrictions, and even details of the information within the categories of each restriction, some of the actual restrictions (criteria) are analysed in Table 4.3.

A comparison of water restrictions of twenty-one local authorities in Gauteng regarding specifics of watering in residential gardens, revealed that watering times varied from two days per week to seven days per week, and similarly, watering hours varied from two hours per week to forty-eight hours per week (Table 4.3).

Table 4.3 Watering in residential gardens of twenty-one local authorities.

Local authority	**Residential gardens**								
	Number of days allowed to water per week/dwelling			**Number of hours allowed per week/dwelling**					
	2days	**3days**	**7days**	**2hrs**	**3hrs**	**4hrs**	**6hrs**	**14hrs**	**48hrs**
Randfontein	1			1					
Johannesburg	1			1					
Edenvale/Modderfontein metropolitan substructure.			1					1	
Boksburg			1					1	
Akasia	1			1					
Northern Pretoria metropolitan substructure	1			1					
Pretoria	1			1					
Alberton		1			1				
Easton Vaal metro		1			1				
Meyerton		1			1				
Fochville		1				1			
Germiston		1					1		
Johannesburg transitional metropolitan council		1					1		
Westonaria		1					1		
Benoni	1			1					
Heidelburg town council	1				1				
Kempton park / Tembisa		1			1				
Midrand		1			1				
Krugersdorp	1								1
Springs	1					1			
Southern Pretoria metropolitan substructure.	1								1
TOTAL	**10**	**9**	**2**	**6**	**6**	**2**	**3**	**2**	**2**
Percentage of the total of 21 data sets.	**48%**	**43%**	**10%**	**29%**	**29%**	**9%**	**14%**	**9%**	**9%**

Percentages have been rounded off.

From the data (Table 4.3) on water restrictions by local authorities that apply to residential gardens, it can be concluded that ten local authorities (48%) permitted residents to apply water for two days per week, nine (43%) permitted three days watering, and two (10%) permitted watering for seven days per week. The inconsistency in this message between the highest and lowest, within one province, is huge (38%). Similarly, 29% of municipalities allowed only two hours watering per dwelling per week, and 29% allowed three hours watering per week, compared to 9% of municipalities that allowed forty-eight hours watering per week per dwelling.

Table 4.4 Comparison of water restrictions of twenty-one local authorities in Gauteng regarding watering within Bona fide nurseries and Bona fide landscapers.

Local authority	Bona fide Nurseries					Bona fide landscapers						
	Number of days allowed to water per week.	**Number of hours allowed per week/nursery**				**Number of days allowed to water per week/landscaper.**	**Total length of time allowed to water. (Weeks)**		**Total hours allowed to water/project**			
	7 days	14	21	28	168	7days	3 wks	12wks	42 hrs	63 hrs	168 hrs	No details
Akasia	1			1		1	1		1			
Alberton	1			1			1					1
Benoni	1			1			1					1
Boksburg						1	1		1			
Easton Vaal metro	1			1		1	1		1			
Edenvale/Modderfontein metropolitan substructure.	1	1				1	1		1			
Fochville						1		1	1			
Germiston	1	1				1		1			1	
Heidelburg town council	1			1		1	1		1			
Johannesburg	1	1				1	1		1			
Johannesburg transitional metropolitan council						1		1			1	
Kempton park / Tembisa	1		1			1	1			1		
Krugersdorp												
Meyerton	1			1		1	1		1			
Midrand	1		1			1	1			1		
Northern Pretoria metropolitan substructure	1			1		1	1		1			
Pretoria	1			1		1	1		1			
Randfontein												
Southern Pretoria metropolitan substructure.	1				1		1					1
Springs	1			1		1	1		1			
Westonaria						1		1			1	
TOTAL	**14**	**3**	**2**	**8**	**1**	**16**	**15**	**4**	**11**	**2**	**3**	**3**
Percentage of Total of 21 data sets.	**67%**	**14%**	**10%**	**38%**	**5%**	**76%**	**71%**	**19%**	**52%**	**10%**	**14%**	**14%**

From the analyses of Table 4.4, of water restrictions by local authorities that apply to bona fide nurseries again no common thread can be found amongst the local authorities' restrictions. Only fourteen local authorities (67%) of the twenty-one municipalities actually mentioned restrictions on bona fide Nurseries. Similarly, when considering the number of hours that nurseries were allowed to water per week, this ranged from fourteen hours (three local authorities or 14%) to one hundred and sixty-eight hours (one local authority or 5%). All of the fifteen municipalities who mentioned water restrictions allowed watering for a total of seven days per week.

When considering bona fide landscapers in the above analyses (Table 4.4) of water restrictions by local authorities, nineteen (90%) indicated that water restriction were applicable. Only 71% of municipalities allowed watering for a mere three weeks whilst 19% allowed watering for an enormous twelve weeks. When comparing the total possible amount of hours that could be used by a landscaper to water a new site, this ranged from forty-two hours (52% of examples) to one hundred and sixty-eight hours (14% of examples).

The water restrictions analysed in Gauteng only had one level, i.e. all the restrictions were implemented at once. The required water saving was 30% from the Green Industry. No other levels of restrictions were available for analysis from these municipalities in Gauteng.

4.3 GAUTENG MUNICIPAL DATA

Between the time of 1994 and 2008, the municipal boundaries within Gauteng were changed. The same towns and area are reflected, however their borders have been changed. In some cases local authorities have been joined together to form one metropolitan area (Table 4.5).

Table 4.5 Municipal name changes between 1994 and 2008. (http://www.demarcation.org.za (17 November 2008)

Municipal name 1994/5	Restriction receive from 1994/5	Municipal name as at 2008	Restriction received for 2008	Water supply/services by-laws received as at October 2008	Who was spoken to in municipality (2008)	Portfolio of person.
Alberton	Yes	Ekurhuleni Metro	No			
Benoni	Yes	Ekurhuleni Metro	No			
Boksburg	Yes	Ekurhuleni Metro	No			
Edenvale/ Modderfontein metropolitan substructure.	Yes	Ekurhuleni Metro	No	Yes	Mr N Franklin	Director Water Operations
Germiston	Yes	Ekurhuleni Metro	No			
Kempton park / Tembisa	Yes	Ekurhuleni Metro	No			
Springs	Yes	Ekurhuleni Metro	No			
Easton Vaal metro	Yes	Sedibeng	No	No	No response	No response
Fochville	Yes	Sedibeng	No	No	No response	No response
Heidelburg town council	Yes	Lesedi	No	No	No response	No response
Johannesburg	Yes	Johannesburg City	No	Yes	No response. Therefore obtained off web. (City of Johannesburg http://www.joburg.org.za/ (19 November 2008))	
Johannesburg transitional metropolitan council	Yes	Johnannesburg City	No			
Krugersdorp	Yes	Mogale City	No	Yes	Mr J Viljeon	Municipal Manager
Meyerton	Yes	Midvaal	No	Yes	Ms A Willemse	Snr Admin Officer
Akasia	Yes	City of Tshwane	No			
Midrand	Yes	City of Tshwane	No			
Northern Pretoria metropolitan substructure	Yes	City of Tshwane	No	No	No response	
Pretoria	Yes	City of Tshwane	No			
Southern Pretoria metropolitan substructure.	Yes	City of Tshwane	No			
Randfontein	Yes	Randfontein	No	No		
Westonaria	Yes	Westonaria	No	No	Mr Van Niekerk	Municipal Manager
Leandra	No	Govan Mbheki municipality	No	Yes	Mr Muanza	Technical Director

It was also not easy to obtain copies of the Water Service by-laws. In many cases, people were not available, or took weeks to get back to the researcher. The Water Service by-laws do not make any particular reference to water restrictions specifically, except for what is referred to in chapter 2.6.3.

4.4 OTHER SOUTH AFRICAN DATA

As only one water restriction was obtainable from outside the Rand Water supply area, no comparison could be made amongst these municipalities. However, a limited comparison between the Gauteng based restrictions and those of Cape Town is possible.

Table 4.6 Cape Town data – watering of residential gardens. (Summary version)

Local authority		**Residential gardens**			
		Number of days allowed to water per week/dwelling		**Number of hours allowed per week/dwelling**	
	Level of restriction	**1day**	**7days**	**20min**	**119hrs**
Cape Town	Water Demand Manage		1		1
	Level 1		1		1
	Level 2 (20%)	1		1	

Table 4.7 Cape Town data – watering of nurseries and new landscapes. (Summary version)

Local authority		Bona fide nurseries		Bona fide landscapers*		
		Number of days allowed to water per week.	**Number of hours allowed per week/nursery**	**Number of days allowed to water per week/landscaper.**	**Total length of time allowed to water. (Weeks)**	**Total hours allowed to water/project**
	Level of restriction	7 day	168	7 day	N/A	No details
Cape Town	Water Demand Manage	1	1	1	1	1
	Level 1	1	1	1	1	1
	Level 2 (20%)	1	1	1	1	1

***Note:** Nothing specific is mentioned about landscaping or new landscapes, and therefore, it is interpreted that no restrictions for normal gardens apply.

When compared, there was very little consistency in all the rules (criteria), between the two sets of plans (Table 4.4 and Table 4.7), an example being, that in both cases references were made to the watering hours/days in residential gardens, the watering of lawns, the watering down of paved surfaces, and the watering of nurseries, but only selected Gauteng restrictions referred specifically, to “Bona fide” landscapes and addressed the watering time allowed. This means that in some municipalities, confusion may exist over when, and to what extent, a new landscape could be watered. Gauteng municipalities only had one level of water restriction introduced at a 30% water saving level, whilst Cape Town have introduced a Water demand management level as well as two other levels. The second level requiring a 20% water saving.

Both Cape Town and Gauteng made mention of restrictions in gardens, whilst Cape Town made reference to lawns, with only a quarter of Gauteng doing so. At level two in Cape Town, only drip irrigation is allowed, whereas in Gauteng 62% made reference to sprinklers and drip irrigation (Table 4.2 and Table 4.6).

When comparing the saving for level two restrictions (20%), with reference to residential gardens, it can be concluded that Cape Town (Table 4.6) only allows for one day of watering for twenty minutes, whilst the worst case scenario (30%) for Gauteng (Table 4.3) allows for two days watering, and a total of three hours per week. The best case scenario for Gauteng, allows for seven days watering and a total of fourteen hours watering (Edenvale and Boksburg) or two days watering for forty-eight hours (Krugersdorp and Southern Pretoria Metrolpolitan substructure). When considering that Cape Town advocate only drip irrigation, the effectiveness and consistency, of the two lots of restriction systems, must be questioned. Cape Town, however, did allow for sprinklers to be used for twenty minutes, but this was only for users who are establishing newly planted, indigenous type, drought-resistant grass lawns (e.g. Buffalo, fynkweek, Cynodon, etc). This was interpreted by the researcher as new landscapes.

When looking at the watering of residential gardens, parks and lawned areas specifically, in Cape Town there seems to be no logic in moving from a total of one hundred and nineteen possible hours of watering per week at level one down to twenty minutes of watering at level two.

4.5 PROBLEMS ENCOUNTERED WITH THE SOUTH AFRICAN DATA

Access to the existing data in municipal records, is extremely difficult to achieve. Staff within the municipal system, are unaware of what documents and by-laws are in place, or of those that go back to 1995, seemingly, because these by-laws have not been used since then.

Contacting the correct person within local authorities has been difficult. The water and sanitation department contact employees were unable to help, mainly because they are unaware of any such legislation or any updates. Implementation of legislation would be a challenge, should a drought occur.

Analyses of restrictions that are not all based on identical criteria, methodologies or goals are problematic**.**

4.6 INTERNATIONAL DATA AND EXAMPLES

Several examples of restrictions were available from international sources. However, many, examples had information that was incomplete and, therefore, not suitable at all. Several had many different levels of water restrictions, as opposed to Sydney, for example, that only had three levels, plus a voluntary level. It was decided that the voluntary level of Sydney (requiring a 7% water saving) would be used as level 1 (voluntary restrictions).

Despite these constraints, the researcher had decided that the few examples obtained from other countries would be used as a guide together with that which was available from within South Africa, from both historical information and current information. Six examples (Table 4.8), with sufficient information, (although with some gaps) were obtainable from other countries.

The six examples used were from

- Victoria - Australia
- Poway - USA
- City of Arlington (Texas) - USA
- Sydney - Australia
- City of Fort Collins - USA
- South East Water Authority – Australia

In the analyses of restrictions from other countries, when comparing the amount of water that it is anticipated would be saved (as a result of implementing the restrictions), it was not possible to compare all, as some (such as Victoria Australia) made no reference to anticipated amount of water saving at all. However the average anticipated saving was still calculated based on available figures. Each international water restriction that was obtained, was converted into a Word table form, that allowed for further analysis (An example of Victoria's restrictions in Annexure D, and an extract from the table analysis is in Annexure C). Each restriction was then converted into an Excel table, with particular details pertaining to each identified category. This allowed for detailed analyses on for example, the number of hours allowed to water, at each stage, for each category.

Table 4.8 International data - Comparison of the amount of water that was required to be saved at each new level introduced.

Comparison of international local authority stages and anticipated amount of water to be saved in each.												Average of all six examples.	
Victoria-Australia		Poway - USA		City of Arlington (Texas) - USA		Sydney Australia		City of Fort Collins - USA		South East Water Authority - Australia		Max saving	Min saving
Stage	Reduction required	Stage	Reduction required	Stage	Reduction required	Stage	Reduction required	Stage	Reduction required	Stage	Reduction required	%	%
1	Not mentioned	**1**	Not mentioned	**1**	Not mentioned	**1**	7%	**1**	1-10%	**1**	2.50%	6.5	3.5
											Mild restrictions		
2	Not mentioned	**2**	10%	**2**	10%	**2**	20%	**2**	11-20%	**2**	8%	16	13
							Maximum reduction				Medium Restrictions		
3	Not mentioned	**3**	10-19%	**3**	10%-19%	**3**	30%	**3**	21-30%	**3**	12%	24	21
											High Restrictions		
4	Not mentioned	**4**	20-29%	**4**	20% - 29%	**4**	50%	**4**	Greater than 30%	**4**	17.50%	32.5	32.5
											Critical Restrictions		
		5	30-39%	**5**	30-39%							39	30
		6	40 -49%	**6**	Min of 40%							49	40
		7	50%	**7**	50% or more							No data	50

In order to reduce the complexity of some systems, and create a total of four stages, certain plans from local authorities were condensed into four levels (Table 4.9). In the Gauteng survey (2008), four levels were used to gauge a response from industry. The following modifications were undertaken to the international restrictions; Poway and Arlington were reduced from 7 to 4 levels (Level 1 and 2 condensed to level 1, level 3 and 4 condensed to level 2, level 5 and 6 condensed to level 3 and level 7 condensed to level 4).

Included in the process of reducing levels, the potential reduction in water that is required at each level was also analysed. It was also possible to obtain both the minimum and maximum anticipated water savings for each level. The average maximum water saving for level one being 7.9%, for level two 19.2%, for level three 31.1% and for level four 39.5% (Table 4.9).

Table 4.9 International data, reduced levels - Comparison of the amount of water that was required to be saved at each new level introduced.

Comparison of international local authority stages and anticipated amount of water to be saved in each. Modified restrictions, condenced restrictions for Poway and Arlington into 4 levels from 7. Level 1 & 2 condenced to level 1, level 3 & 4 condenced to level 2, level 5 & 6 condenced to level 3 and level 7 condenced to level 4.												**Average of all six examples.**	
Victoria-Australia		**Poway - USA**		**City of Arlington (Texas) - USA**		**Sydney Australia**		**City of Fort Collins - USA**		**South East Water Authority - Australia**		**Max saving**	**Min saving**
Stage	**Reduction required**	**Stage**	**Reduction required**	**Stage**	**Reduction required**	**Stage**	**Reduction required**	**Stage**	**Reduction required**	**Stage**	**Reduction required**	**%**	**%**
1	Not mentioned	**1**	10%	**1**	10%	**1**	7%	**1**	1-10%	**1**	2.50%	7.9	6.1
											Mild restrictions		
2	Not mentioned	**2**	15-24%	**2**	15-24%	**2**	20%	**2**	11-20%	**2**	8%	19.2	13.8
							Maximum reduction				Medium Restrictions		
3	Not mentioned	**3**	35-44%	**3**	35-39.5%	**3**	30%	**3**	21-30%	**3**	12%	31.1	26.6
											High Restrictions		
4	Not mentioned	**4**	50%	**4**	50%	**4**	50%	**4**	Greater than 30%	**4**	17.50%	39.5	39.5
											Critical Restrictions		

In order to create a basis for comparison with the 1994/95 water restrictions, the international data was also analysed, and simplified into three main sets of data. Namely - number of days that watering was allowed, the number of hours that watering was allowed per week, and the levels of water restrictions (Table 4.10 to table 4.12). A direct comparison across the examples was not possible, mainly due to the fact that the total reflects a reference to hours of water use, or hours permitted per dwelling, based on all levels of water restrictions. It is also important to note that, due to the fact that restrictions covered all levels of restrictions, some references to no watering being permitted on any day at any time, were recorded. This reference was mainly evident, in the last stage of restrictions, for that particular "local authority". Where no data was available a zero was recorded, and the total for that level was averaged using all examples only where data was available.

Due to fact that most references did not allow watering at level 4, any available results were therefore divided by the total of all six references. What was possible, was to obtain an average of data for the six international examples.

Table 4.10 International - Residential water restrictions of six international examples.

Residential watering hours (for all 6 examples)			
Local authority		**Number of days allowed to water per week/ dwelling**	**Number of hours allowed per week/dwelling**
	Level of restriction	**Days**	**Hrs/week**
Victoria State - Australia	One	3.5	14
Poway - USA (old level 1 & 2 - average)	One	4.5	80
City of Arlington - USA (old level 1 & 2 - average)	One	2	40
Sydney - Australia	One	0	0
City of Fort Collins - USA	One	2	32
South East Water - Australia	One	3.5	14
Total for Level 1		15.5	180
Average		3.10	36
Victoria State - Australia	Two	3.5	14
Poway - USA (old level 3 & 4 - average)	Two	4.5	64
City of Arlington - USA (old level 3 & 4 - average)	Two	4.5	72
Sydney - Australia	Two	3	54
City of Fort Collins - USA	Two	2	32
South East Water - Australia	Two	3.5	14
Total for Level 2		21	250
Average		3.5	41.67
Victoria State - Australia	Three	2	8
Poway - USA(old level 5 & 6 - average)	Three	0.75	12
City of Arlington – USA (old level 5 & 6 - average)	Three	1.5	24
Sydney - Australia	Three	2	36
City of Fort Collins - USA	Three	2	4
South East Water - Australia	Three	2	8
Total for Level 3		10.25	92
Average		1.71	15.33
Victoria State - Australia	Four	0.00	0.00
Poway – USA (old level 7 - average)	Four	0.00	0.00
City of Arlington - USA (old level 7 - average)	Four	0.00	0.00
Sydney - Australia	Four	0.00	0.00
City of Fort Collins - USA	Four	0.00	0.00
South East Water - Australia	Four	0.00	0.00
Total for Level 4		0.00	0.00
Average		0	0.00

For residential watering hours at level 1 restrictions, watering is allowed for 3.10 days per week or 36 hrs per week (5.14 hrs/day). For residential watering hours at level 2 restrictions, watering is allowed for 3.5 days per week or 41.67 per week (5.95hrs per day). For residential watering hours at level 3 restrictions watering is allowed for 1.71 days per week or 15.33 per week (2.19 hrs per day). For residential watering hours at level 4 restrictions no watering is allowed at all (Table 4.10). The lack of information in some levels (where a zero was recorded) and the researchers understanding of what exactly was required, may have skewed the results. It is possible to observe a general trend of reduction in average the numbers of days and hours permitted to water as restrictions progress from level 2 to level 4.

In the international data, no specific reference was made to restricting water use in either nurseries, garden centres or landscapers, and therefore, no comparative table could be produced for this aspect.

There are only a few clear guidelines available with regard to the watering of recreation facilities. For watering hours of recreation facilities at level 1 restrictions, on average watering is allowed for 4.75 days per week or 76 hours per week (10.86 hrs per day). For watering hours of recreation facilities at level 2 restrictions, watering is allowed for 3.87 days per week or 69 hours per week (9.86 hrs per day). For watering hours of recreation facilities at level 3 restrictions watering is allowed for 2.80 days per week or 44 hours per week (6.29 hrs per day). For watering hours of recreation facilities at level 4 restrictions no watering is allowed at all **(Table 4.11).** The lack of information in some levels (where a zero was recorded) and the researchers understanding of what exactly was required, may have skewed the results. It is however possible to observe a general trend of reduction in average the numbers of days and hours permitted to water as restrictions progress from level 1 to level 4.

Table 4.11 International – Recreation facilities water restrictions of the six examples.

Recreation facilities (Private, commercial, government and local authority) watering hours (for all six examples)			
Local authority		Number of days allowed to water per week/dwelling	Number of hours allowed per week/dwelling
	Level of restriction	Days	Hrs/week
Victoria State - Australia	One	0	0
Poway - USA (old level 1 & 2 - average)	One	0	0
City of Arlington - USA (old level 1 & 2 - average)	One	0	0
Sydney - Australia	One	0	0
City of Fort Collins - USA	One	6	96
South East Water - Australia	One	3.5	56
Total for Level 1		9.5	152
Average		4.75	76
Victoria State - Australia	Two	0	0
Poway - USA (old level 3 & 4 - average)	Two	3	48
City of Arlington - USA (old level 3 & 4 - average)	Two	3	76
Sydney - Australia	Two	0	0
City of Fort Collins - USA	Two	6	96
South East Water - Australia	Two	3.5	56
Total for Level 2		15.5	276
Average		3.87	69
Victoria State - Australia	Three	2	16
Poway – USA (old level 5 & 6 - average)	Three	1	16
City of Arlington – USA (old level 5 & 6 - average)	Three	3	76
Sydney - Australia	Three	0	0
City of Fort Collins - USA	Three	6	96
South East Water - Australia	Three	2	16
Total for Level 3		14	220
Average		2.80	44
Victoria State - Australia	Four	0	0
Poway – USA (old level 7 - average)	Four	0	0
City of Arlington - USA (old level 7 - average)	Four	0	0
Sydney - Australia	Four	0	0
City of Fort Collins - USA	Four	0	0
South East Water - Australia	Four	0	0
Total for Level 3		0	0
Average		0	0.00

Table 4.12 International – Lawn, water restrictions of the six examples.

Lawn watering restrictions (for all 6 examples)			
Local authority		**Number of days allowed to water per week/dwelling**	**Number of hours allowed per week/dwelling**
	Level of restriction	**Days**	**Hrs/week**
Victoria State - Australia	One	3.5	14
Poway - USA (old level 1 & 2 - average)	One	4.5	80
City of Arlington - USA (old level 1 & 2 - average)	One	4.5	80
Sydney - Australia	One	3	54
City of Fort Collins - USA	One	2	32
South East Water - Australia	One	3.5	14
Total for Level 1		21	274
Average		3.50	45.67
Victoria State - Australia	Two	0	0
Poway - USA (old level 3 & 4 - average)	Two	3	80
City of Arlington - USA (old level 3 & 4 - average)	Two	2.5	40
Sydney - Australia	Two	3	54
City of Fort Collins - USA	Two	2	32
South East Water - Australia	Two	3.5	14
Total for Level 2		14	220
Average		2.80	44
Victoria State - Australia	Three	0	0
Poway - USA(old level 5 & 6 - average)	Three	0.75	12
City of Arlington – USA (old level 5 & 6 - average)	Three	1	16
Sydney - Australia	Three	2	36
City of Fort Collins - USA	Three	2	32
South East Water - Australia	Three	2	8
Total for Level 3		7.75	104
Average		1.55	20.80
Victoria State - Australia	Four	0	0
Poway – USA (old level 7 - average)	Four	0	0
City of Arlington - USA (old level 7 - average)	Four	0	0
Sydney - Australia	Four	0	0
City of Fort Collins - USA	Four	1.3	21
South East Water - Australia	Four	0	0
Total for Level 4		1.3	21
Average		0.22	3.5

The guidelines available with regard to the watering of lawns are not always as clear and understandable as expected. For watering hours of lawns at level 1 restrictions, on average watering is allowed for 3.5 days per week or 45.67 per week (6.52 hrs per day). For watering hours of recreation facilities at level 2 restrictions, watering is allowed for 2.8 days per week or 44 hours per week (6.28 hrs per day). For watering hours of recreation facilities at level 3 restrictions watering is allowed for 1.55 days per week or 20.80 hours per week (2.97hrs per day). For watering hours of lawns at level 4 restrictions only one reference to watering is allowed namely 0.22 days per week or 3.50 hours per week (0.5 hrs per day) **(Table 4.12).** The lack of information in some levels (where a zero was recorded) and the researchers understanding of what exactly was required, may have skewed the results. It is however also possible to observe a general trend of decrease in the average number of days and hours permitted to water as restrictions progress from level 1 to level 4.

The available data for watering of residential gardens, when interpreted, indicates that for level 1 water restrictions, there seemed to be generally less watering allowed, than for the second level of water restrictions. This does not seem logical or practical, when inspecting this from a horticultural perspective, however, this data was not altered in any way. One possible explanation for this, could be that the researcher did not interpret the international data correctly, but was also unable to verify this, as correspondence feedback did not answer this particular question for the researcher. However, in all other cases for level two and three restrictions, there is a clear reduction in the amount of days and hours of watering that is allowed. For level 4, it is generally accepted that when a 40% saving of water is required, that no water for ornamental gardening activities is tolerated or allowed. Nurseries and landscape construction businesses, seem to be exempt from any such restrictions. This was, however, never specifically verified, and could also emerge as insufficient interpretation of restrictions by the researcher.

4.7 PROBLEMS ENCOUNTERED WITH INTERNATIONAL DATA

Although water restrictions were obtained from several international sources, problems existed. Namely:

1. The researcher was not always able to interpret restrictions easily.
2. Terminology used was different to that which is referred to in South Africa.
3. Feedback from international contacts and sources, to the researcher, was at times poor, and in most cases non-existent.
4. When feedback was obtained the timing and response to questions was unreliable.
5. All examples obtained, had more than one level of water restriction, which ranged from between four and seven levels.

6. Some examples were encouragingly detailed, whilst others were brief, and left many unanswered questions.
7. Many examples were incomplete, with some data missing in places.
8. Funds and time did not permit the researcher to investigate this in person, in the countries in question, which could have yielded improved results and clarification.

4.8 CONCLUSION

The available international water restrictions analysed, indicate more depth, in the form of more levels of restrictions, than those available from South Africa. It was however possible to reduce the number of water restriction levels within selected WSSRP to four to allow for analyses across plans. It was possible to extract average data for each level in the form of number of days per week allowed to water as well as the average number of hours allowed to water per week. Gaps do exist, within the information available internationally, and unfortunately this is not easily obtainable. These gaps are, that for some international examples, there is no data available for level one. Gaps could also be experienced with the interpretation of international data.

Chapter 5
Questionnaire and Analysis of Data

5.1 INTRODUCTION

Herewith the results and findings of a survey conducted by Marketing Surveys & Statistical Analysis (MSSA), in June of 2008, on behalf of Rand Water's Organisational Development Research Department, for the researcher.

Telephone interviews and a semi-structured questionnaire were used to gather the data. The interviews were conducted by MSSA, in May and June of 2008. The questionnaire was developed by Rand Water's Corporate Marketing Research Development Department in conjunction with MSSA.

The organisations of SANA, SALI, IERM and LIA made a contact list available containing the names of members representing these four associations, that were based within the Gauteng Province. As indicated in chapter 3.2.2.2 this list containing a total of 776 valid names.

By fieldwork cut-off date, a total of 85 successful interviews were obtained. This equated to a 10.95% response rate. Data was coded and captured in SPSS, a statistical software package. The analysis involved the construction of basic frequency and descriptive tables. MSSA undertook a quality control on 10% of the interviews gathered, by means of back-checks, to ensure the validity and accuracy of the data.

According to Alreck and Settle, response rates of between 5% and 10% should be achievable (1985:45). However, according to Blair and Chun (as quoted by Lavrakas 1993:81) a 20 to 30 minute telephone survey can yield a success rate of 25% to 35%, while Frey (as quoted by Lavrakas 1993:81) indicates a success rate of 40%, and still Collins *et al*. (as quoted by Lavrakas 1993:81) reported conversion rates of 20%. It does, however need to be stated that the Rand Water survey was approximately 35 to 45 minutes long, and of an extremely complex nature. This could have lead to the low response rate.

5.2 INDUSTRY INFORMATION OBTAINED

The questionnaire was targeted at the registered person of the company, or institute concerned. The questionnaire response revealed the following information, about the Green Industry within Gauteng - 67% of respondents were male. The majority of respondents were aged between thirty-one and sixty years of age with 40% being owners/partners in the business, and 28% being in top management. The majority (58%) have ten or more years of experience in the industry, with more than 46% working for longer than ten years, for the same organisation. It could be concluded from this that those who responded to the questionnaire were not only experienced within the Green Industry, but were also of the relevant position to know and be able to make decisions.

The respondents for each institute were 51% (SANA), 32% (IERM), 14% (LIA) and 13% (SALI).
When asked where they obtain their water from (recognising that some may obtain from more than one source) -
36 used boreholes, (70% of water used).
6 collected rain runoff, (33% of water used).
7 from a bulk water supplier, (56% of water used).
46 from their municipality, (70% water used).
4 from rivers (78% of water used).
1 from tanks. (5% of water used).
(The amount of water used by percentage, as indicated in brackets, is not limited to 100%)

In response to the question, “Does your local authority have water restriction by-laws?” - 19% indicated yes, 65% indicated no, and 16% were uncertain. For those who responded yes, they were asked to what extent they were aware, of what these water restrictions were. Only 44% of the yes respondents were positive to a great extent of what these water restriction are (Figure 5.1).

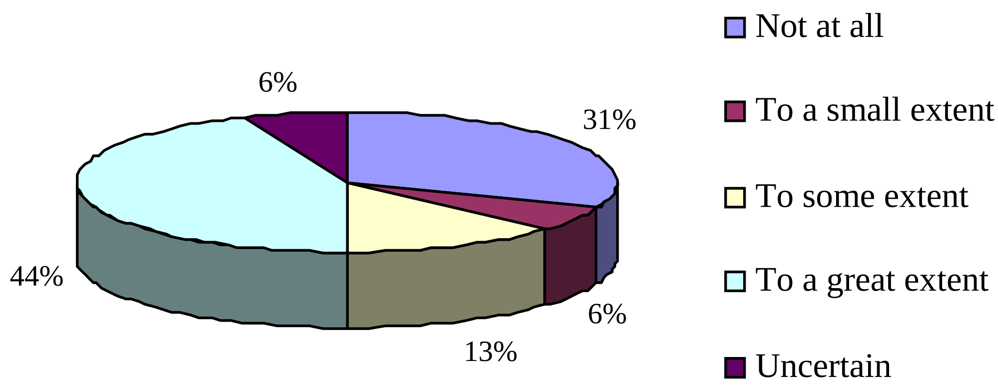


Figure 5.1 Awareness levels of water restrictions amongst the Green Industry.

Only 32% of respondents indicated that they had been affected by drought, while 68% indicated that they were either, not sure if they had been affected, or had not been affected.

When asked to what extent their organisation had been affected, by the drought of 1994/5, 35% indicated that they were not affected at all, whilst 65% were affected in some form (Figure 5.2).

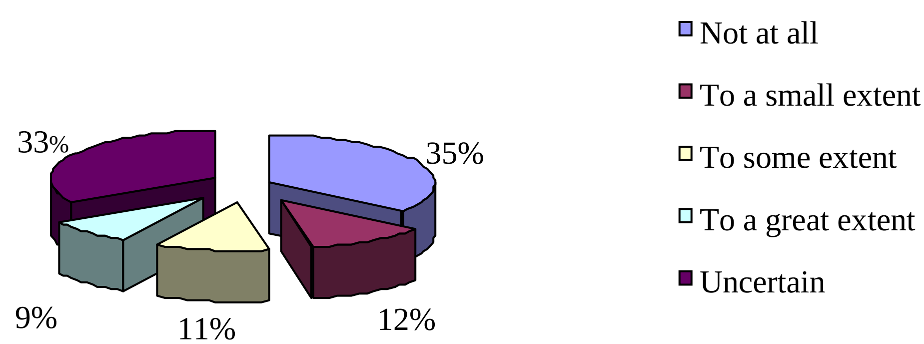


Figure 5.2 Extent to which the Green Industry organisations have been affected by the 1994/95 drought.

The four largest local authority supplying water to the Green Industry during 1994/95 are Tswane, City of Johannesburg, Ekurhuleni and Mogale city (Fig 5.3).

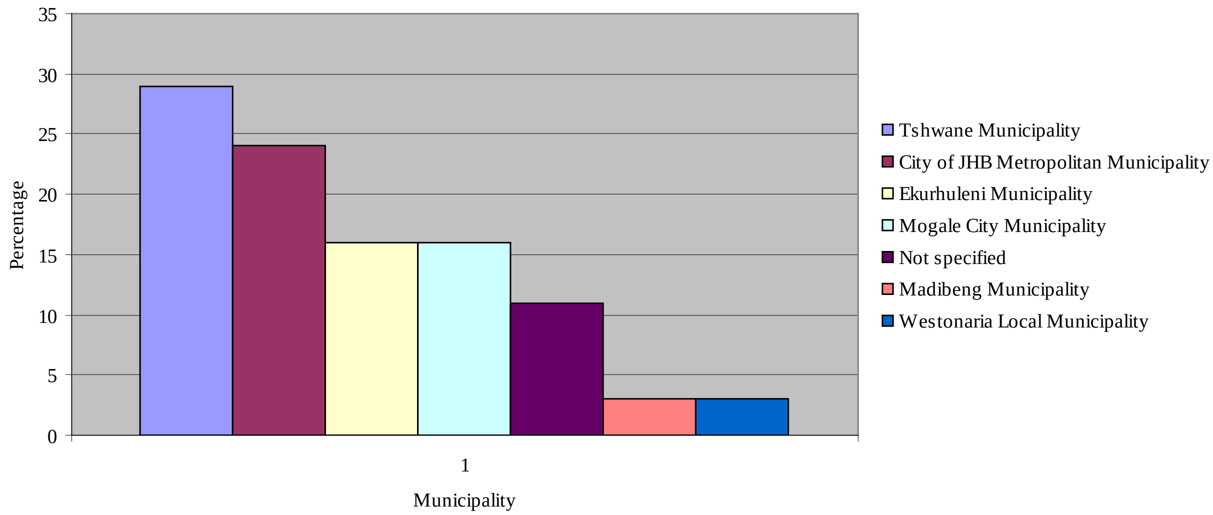


Figure 5.3 Municipality supplying water to the Green Industry.

The response to the query of who was the bulk supplier in 1994/5, indicated that RW was the bulk supplier of water in 58% of the responses, while a further 32% were unsure of who their bulk supplier of water was (Figure 5.4).

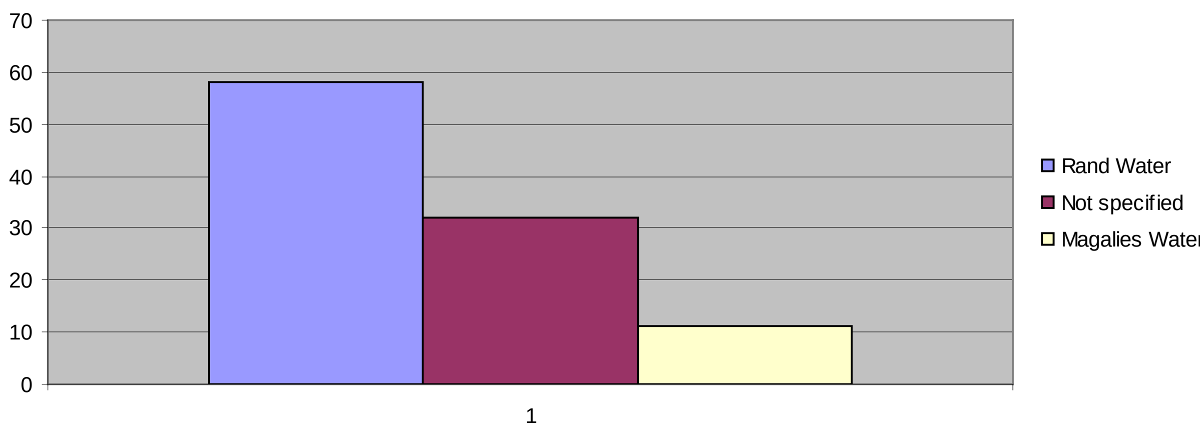


Figure 5.4 Bulk Water supplier, supplying water to the Green Industry

From the responses received, it is possible to conclude that the target audience was in fact correct, was situated within the RW, water supply area, and that this audience was to some extent both aware of, and involved with, water conservation measures.

5.3 ANALYSIS OF COMMENTS FROM PARTICIPANTS ON WATER RESTRICTIONS

During the final reworking of the questionnaire, it was suggested by the research company, MSSA, and Reed that the questions be reduced, condensed and where possible, combined. This resulted in the grouping of questions, into seven basic categories. Where it was possible, questions were excluded regarding hours and days of watering. The basic question groups were:

- Watering of residential garden, office parks, industrial parks, all government & municipal grounds and facilities (Excluding lawns).
- Watering facilities (Private, commercial, government and local authority).
- Implementation of water restrictions on specified recreation facilities.
- Watering of lawns (Inclusive of residential, business, industrial and government).
- Watering of new landscapes, nurseries and garden centres (Bona fide).
- Implementation of restrictions on other listed activities.
- Other general comments on water restrictions.

As a response, respondents were asked to indicate how they would like to see future water restrictions implemented.

The guideline offered, to the respondents as a lead for their opinions, was:

* **Level 0** will apply to all situations regardless of a drought or no drought.
* **Level 1** will mean that a 20% saving is required of the industry/users.
* **Level 2** will mean that a 30% saving is required of the industry/users.
* **Level 3** will mean that the severest water restrictions are in force, and human survival mode is in play (40% saving required).

The amount of water saving, was based on the comparison of international local authority stages, and the anticipated amount of water to be saved in each, with restrictions being condensed from as many as seven levels into four levels. However, because the first level (Level 0) would be implemented at all times, no water saving was estimated. This Level 0 could be equated to the abridged Level 1 of international restrictions, which require a maximum of 7.9% water saving (Table 4.9).

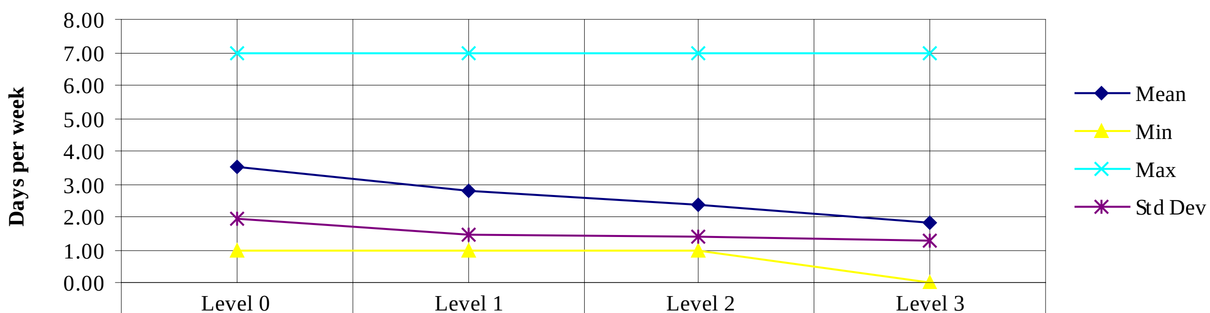
In some cases, respondents were allowed to give only one response per question, and in others, they were allowed multiple responses, hence not all graphs add up to 100%.

For the purposes of analysis, respondents who answered, “Any day per week”, were taken, by the researcher, to mean every day. In relation to the data set, the results of these respondents, would then have been added to the data set for each and every day. It could possibly be argued that they could, therefore just as well be left out. Consequently the data results were left as they were received and the days that the respondents reflected as specific days, were inclusive of those respondents who recommended any day.

Referring to new landscapes, nurseries and garden centres the term “Bona fide” was used as this was the exact wording used by local authorities in 1994/5. This would encourage continuity.

5.3.1 Watering of residential gardens, Office Parks, Industrial Parks, all Government & municipal grounds and facilities (Excluding lawns)

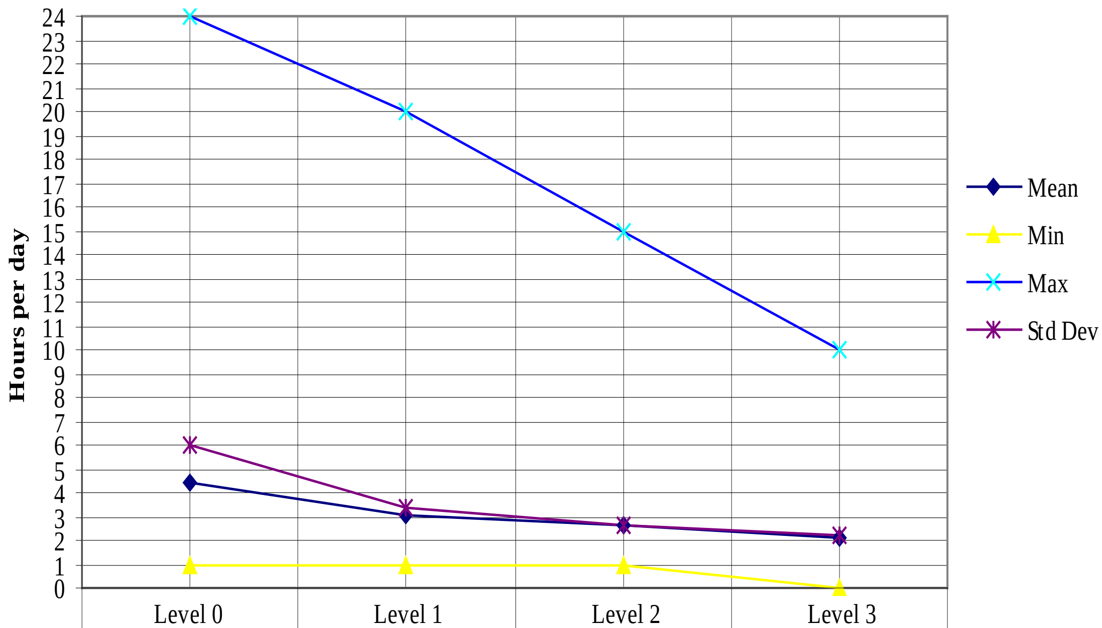
A general point of note is that respondents indicated that watering hours should be reduced as one moved from a point of no drought, to a point of severe drought. The mean for the number of days required to water ranged from 3.49 days per week (level 0), to 1.80 days per week in level 3 (Figure 5.5). This resulted in a decrease of use of approximately 48% across the four levels.



	Level 0	Level 1	Level 2	Level 3
Mean	3.49	2.77	2.36	1.80
Min	1.00	1.00	1.00	0.00
Max	7.00	7.00	7.00	7.00
Std Dev	1.96	1.45	1.37	1.28

Figure 5.5 Number of days allowed to water per week, for residential gardens, office parks, all government and municipal parks, grounds and facilities (excluding grass).

When analysing the number of hours that respondents agreed should be watered per day, there was a corresponding decrease from level 0 to level 3. The mean number of hours for which watering of residential gardens, office parks, all government and municipal parks, grounds and facilities (excluding grass) as agreed was reduced from 4.5 hours per day in level 0 down to 2.1 hours per day in level 3 (Figure 5.6).



	Level 0	Level 1	Level 2	Level 3
Mean	4.46	3.09	2.65	2.08
Min	1.00	1.00	1.00	0.00
Max	24.00	20.00	15.00	10.00
Std Dev	6.01	3.32	2.58	2.21

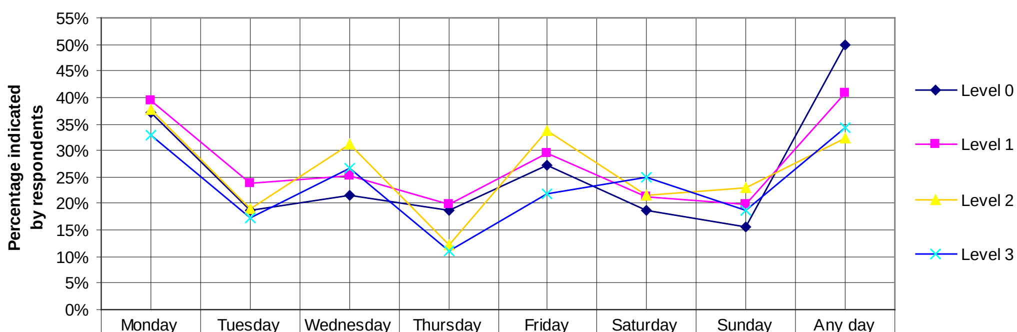
Figure 5.6 Number of hours per day, per level, for the watering of residential gardens, office parks, all government and municipal parks, grounds and facilities (excluding grass)

When multiplying the mean figure of days per week, by the hours per day, to obtain a total for the recommended hours of watering per week participants grasped the concept and need for a distinct reduction in the amount of time allowed to water, as one progressed up the levels. For the total hours of watering of residential gardens, office parks, all government and municipal parks, grounds and facilities (excluding grass) per week, it can be concluded that 15.57 hours be allowed for level 0, 8.56 hours for level 1, 6.25 hours for level 2, and 3.74 hours for level 3 (Table 5.1).

Table 5.1 Total hours per week for the watering of residential gardens, office parks, all government and municipal parks, grounds and facilities (excluding grass).

Water for residential gardens, office parks, all government and municipal parks, grounds and facilities (excluding grass)

	Level 0	Level 1	Level 2	Level 3
Days per week	3.49	2.77	2.36	1.8
Hrs per day	4.46	3.09	2.65	2.08
Hrs per week	**15.57**	**8.56**	**6.25**	**3.74**



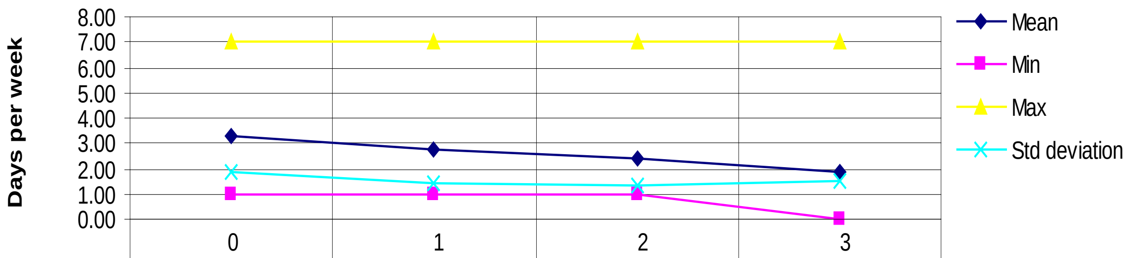
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Any day
Level 0	37.14%	18.57%	21.43%	18.57%	27.14%	18.57%	15.71%	50.00%
Level 1	39.44%	23.94%	25.35%	19.72%	29.58%	21.13%	19.72%	40.85%
Level 2	37.84%	18.92%	31.08%	12.16%	33.78%	21.62%	22.97%	32.43%
Level 3	32.81%	17.19%	26.56%	10.94%	21.88%	25.00%	18.75%	34.38%

Figure 5.7 Preferred days of the week to water per level, for the watering of residential gardens, Office Parks, Industrial Parks, all government & municipal grounds and facilities (Excluding lawns).

It is of interest to note that the majority of responses, on all levels, indicated watering on Monday, Wednesday, Friday and any day. It is surprising that neither Saturday nor Sunday received a large percentage, though this may be attributed to the fact that 24% of respondents, were from municipalities and government organisations, most of whom, do not operate over weekends. It also needs to be noted that, by and large, watering percentages decreased, as levels were increased. Interestingly, there was a slight spike in the need for watering on Wednesdays and Saturdays, for level three (Figure 5.7).

5.3.2 Watering of recreation facilities (Private, commercial, government and local authority)

The mean for the number of days required to water recreation facilities (private, government and local authority) ranged from 3.32 days per week (level 0), to 1.90 days per week in level 3 (Figure 5.8). This resulted in a decrease of use of almost 43% across the four levels.

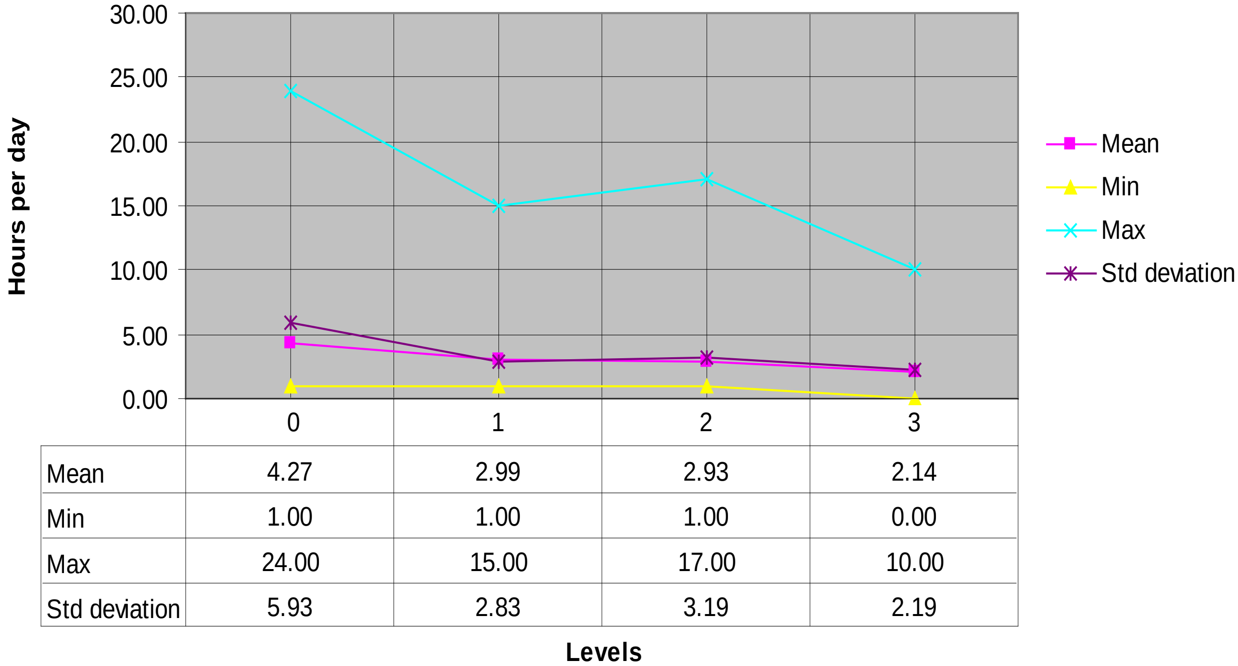


	0	1	2	3
Mean	3.32	2.72	2.42	1.90
Min	1.00	1.00	1.00	0.00
Max	7.00	7.00	7.00	7.00
Std deviation	1.86	1.47	1.37	1.49

Levels

Figure 5.8 Number of days per week, for the watering of recreation facilities (Private, commercial, government and local authority).

When analysing the number of hours that respondents agreed should be watered per day, there was a decrease from level 0 to level 3. The mean number of hours for which watering of recreation facilities (Private, commercial, government and local authority) as recommended was reduced from 4.27 hours per day in level 0 down to 2.14 hours per day in level 3 (Figure 5.9). The decrease in hours from level 2 to level 3 is negligible at 0.06 hours per day.



	0	1	2	3
Mean	4.27	2.99	2.93	2.14
Min	1.00	1.00	1.00	0.00
Max	24.00	15.00	17.00	10.00
Std deviation	5.93	2.83	3.19	2.19

Figure 5.9 Number of hours per day for the watering of recreation facilities (Private, commercial, government and local authority).

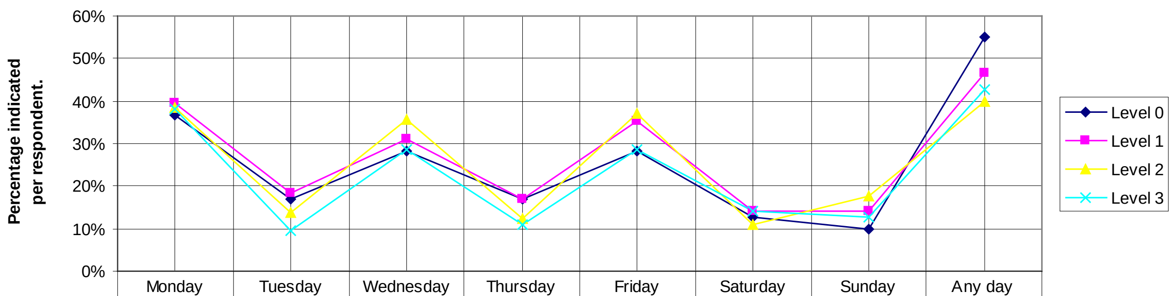
Respondents indicated that the watering of recreation facilities was reduced, as further levels were added. There is, however only a slight decrease in the number of recommended hours between level 2 and 3. This could be attributed to two issues. One being, the reluctance to impose less watering, which will cause damage to these facilities, and the other being, the recognition within the industry of the underlying importance of these facilities to members of the public, especially during times of drought (as alluded to earlier, regarding the importance of the industry as well as the psychological benefits).

When multiplying the mean figure of days per week, by the hours per day, to obtain a total for the recommended hours of watering per week overall participants agreed with a distinct reduction in the amount of time allowed to water, as one progressed up the levels. For the total hours of watering of recreation facilities (Private, commercial, government and local authority) per week, it can be concluded that 14.17 hours be allowed for level 0, 8.13 hours for level 1, 7.09 hours for level 2, and 4.06 hours for level 3 (Table 5.2).

Table 5.2 Total hours per week, for the watering of recreation facilities (Private, commercial, government and local authority).

Watering of recreation facilities (Private, commercial, government and local authority)

	Level 0	Level 1	Level 2	Level 3
Days per week	3.32	2.72	2.42	1.9
Hrs per day	4.27	2.99	2.93	2.14
Hrs per week	**14.17**	**8.13**	**7.09**	**4.06**



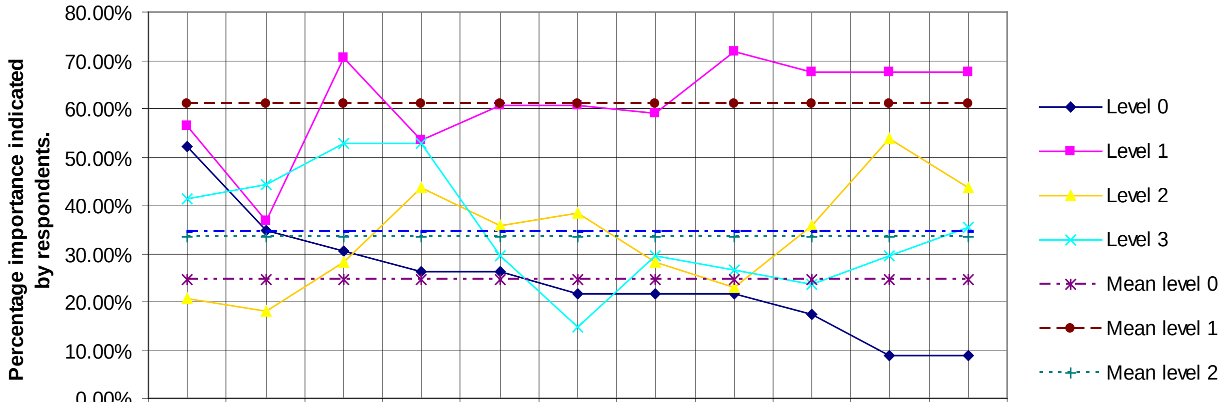
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Any day
Level 0	36.62%	16.90%	28.17%	16.90%	28.17%	12.68%	9.86%	54.93%
Level 1	39.44%	18.31%	30.99%	16.90%	35.21%	14.08%	14.08%	46.48%
Level 2	38.36%	13.70%	35.62%	12.33%	36.99%	10.96%	17.81%	39.73%
Level 3	38.10%	9.52%	28.57%	11.11%	28.57%	14.29%	12.70%	42.86%

Figure 5.10 Preferred days for watering of recreation facilities (Private, commercial, government and local authority)

The trend in requiring watering on Monday, Wednesday, Friday and any day, is similar to that of the watering of residential gardens (Figure 5.7). However, the weighting of responses, is less for recreation facilities (Figure 5.10), than for gardens. This could be attributed either to the fact that in general respondents viewed the importance of gardens as being greater than that of recreation facilities or that over 68% of respondents, were not from municipal structures (IERM), where many of the recreation facilities are usually found.

5.3.3 Implementation of water restrictions on specified recreation facilities

For this particular question, respondents were asked, at what level water restrictions should be implemented, for each specified recreation facility.



	Tennis court (Grass)	Artificial turf	Playing surface/ turf	Golf course rough	Horse racing tracks	Golf course green	Cricket pitch	Bowling green	Athletic s tracks/fi	Golf course fairway	Cricket outfield
Level 0	52.17%	34.78%	30.43%	26.09%	26.09%	21.74%	21.74%	21.74%	17.39%	8.70%	8.70%
Level 1	56.34%	36.62%	70.42%	53.52%	60.56%	60.56%	59.15%	71.83%	67.61%	67.61%	67.61%
Level 2	20.51%	17.95%	28.21%	43.59%	35.90%	38.46%	28.21%	23.08%	35.90%	53.85%	43.59%
Level 3	41.18%	44.12%	52.94%	52.94%	29.41%	14.71%	29.41%	26.47%	23.53%	29.41%	35.29%
Mean level 0	24.51%	24.51%	24.51%	24.51%	24.51%	24.51%	24.51%	24.51%	24.51%	24.51%	24.51%
Mean level 1	61.08%	61.08%	61.08%	61.08%	61.08%	61.08%	61.08%	61.08%	61.08%	61.08%	61.08%
Mean level 2	33.57%	33.57%	33.57%	33.57%	33.57%	33.57%	33.57%	33.57%	33.57%	33.57%	33.57%
Mean level 3	34.49%	34.49%	34.49%	34.49%	34.49%	34.49%	34.49%	34.49%	34.49%	34.49%	34.49%

Figure 5.11 Introduction of water restrictions at specified levels, per recreation facility type.

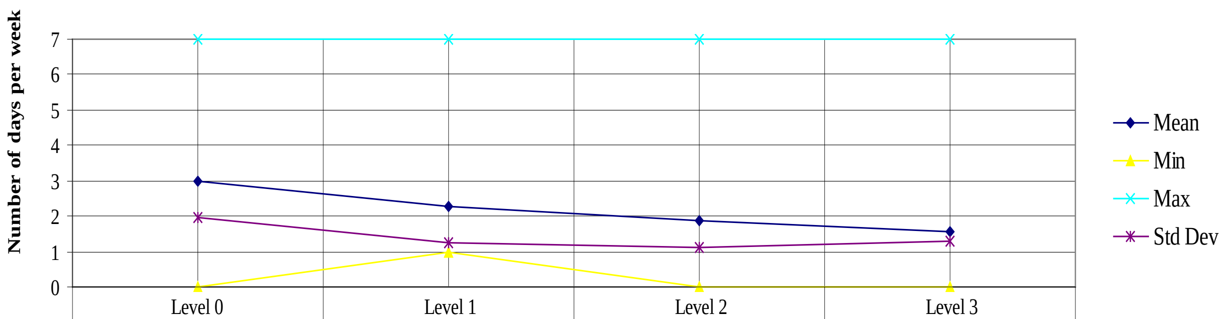
From the analyses of results in Figure 5.11, it is evident that participants felt that water restrictions should be applied in the following order, as levels of restruction were introduced.

- Level 0 – No facilities to be included.
- Level 1 – Grass tennis courts, playing surface, golf course rough, horse racing track, golf course green, cricket pitch, bowling green, athletic track, golf course fairway and cricket outfield.
- Level 2 – No facilities to be included at this level,
- Level 3 - Artificial turf.

Implementation thereof, would be imposed in conjunction with trends for hours and days, as concluded in chapter 5.3.2.

5.3.4 Watering of lawns (Inclusive of residential, business, industrial and government)

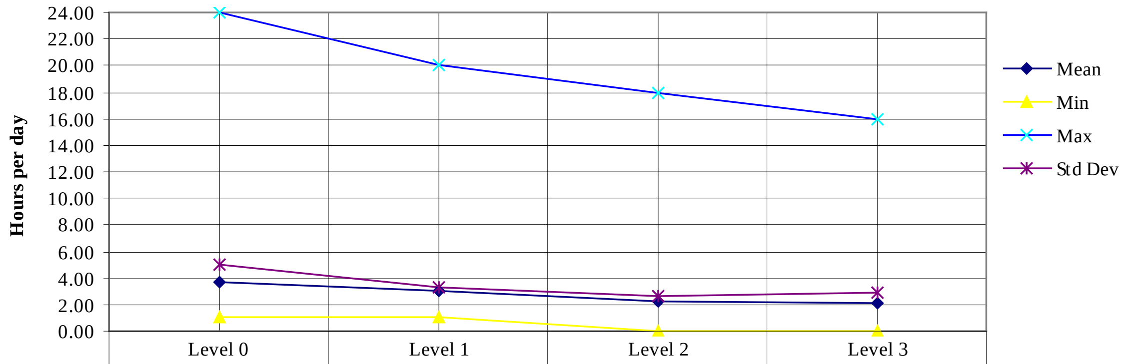
A general point of note is that respondents indicated that watering hours should be reduced as one moved from a point of no drought (level 0), to a point of severe drought (level 3). The mean for the number of days required to water ranged from 3 days per week in level 0 to, to 1.58 days per week in level 3 (Figure 5.12). This resulted in a decrease of use of approximately 47% across the four levels.



	Level 0	Level 1	Level 2	Level 3
Mean	3.00	2.27	1.89	1.58
Min	0.00	1.00	0.00	0.00
Max	7.00	7.00	7.00	7.00
Std Dev	1.98	1.24	1.11	1.29

Figure 5.12 Number of days allowed per week, to water lawns (Inclusive of residential, business, industrial and government).

When analysing the number of hours that respondents agreed should be watered per day, there was a corresponding decrease from level 0 to level 3. The mean number of hours for which watering of lawns (Inclusive of residential, business, industrial and government) was reduced from 3.63 hours per day in level 0 down to 2.1 hours per day in level 3 (Figure 5.13).



	Level 0	Level 1	Level 2	Level 3
Mean	3.63	2.97	2.20	2.10
Min	1.00	1.00	0.00	0.00
Max	24.00	20.00	18.00	16.00
Std Dev	4.95	3.34	2.63	2.85

Figure 5.13 Number of hours allowed per day, to water lawns (Inclusive of residential, business, industrial and government).

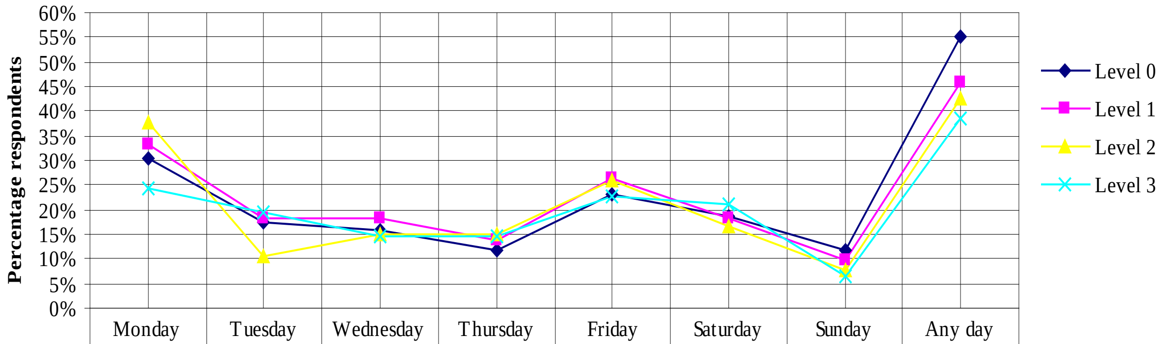
When multiplying the mean figure of days per week, by the hours per day, to obtain a total for the recommended hours of watering per week, participants understood the concept and need for the distinct reduction in the amount of time allowed to water, as one progressed up the levels. For the total hours of watering of lawns (Inclusive of residential, business, industrial and government) per week, it can be concluded that 10.89 hours be allowed for level 0, 6.74 hours for level 1, 4.16 hours for level 2, and 3.32 hours for level 3 (Table 5.3).

Table 5.3 Total hours per week, for the watering of lawns (Inclusive of residential, business, industrial and government).

Watering lawns (inclusive of residential, business industrial and government)

	Level 0	Level 1	Level 2	Level 3
Days per week	3	2.27	1.89	1.58
Hrs per day	3.63	2.97	2.2	2.1
Hrs per week	**10.89**	**6.74**	**4.16**	**3.32**

When considering days to water, for the watering of lawns, only three specific responses stood out for each level, namely Monday, Wednesday and any day (Figure 5.14). The response for any day watering, far outweighed other responses. Response for all three levels indicated that Sunday and Thursday were the least popular days on which to allow watering of lawns.

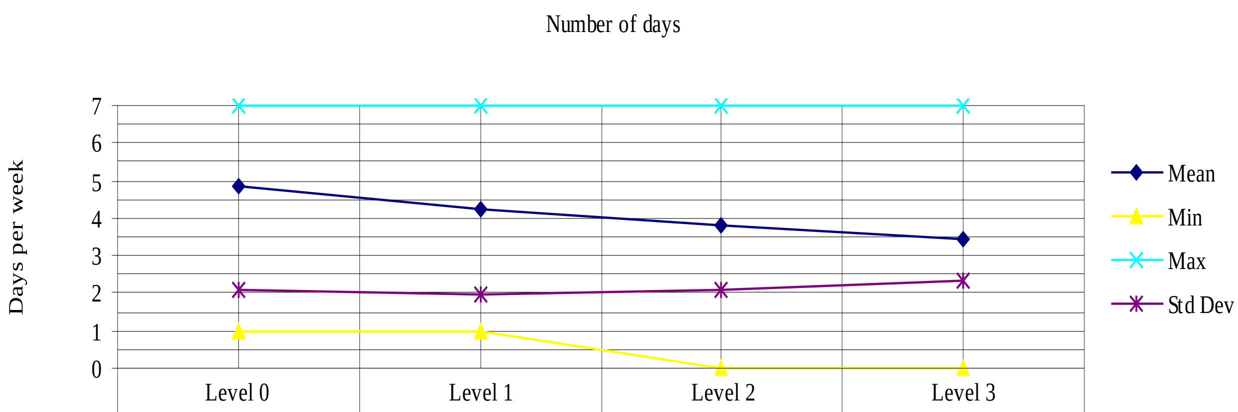


	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Any day
Level 0	30.43%	17.39%	15.94%	11.59%	23.19%	18.84%	11.59%	55.07%
Level 1	33.33%	18.06%	18.06%	13.89%	26.39%	18.06%	9.72%	45.83%
Level 2	37.88%	10.61%	15.15%	15.15%	25.76%	16.67%	7.58%	42.42%
Level 3	24.19%	19.35%	14.52%	14.52%	22.58%	20.97%	6.45%	38.71%

Figure 5.14 Preferred days of week allowed, for the watering of lawns (Inclusive of residential, business, industrial and government).

5.3.5 Watering of new landscapes, nurseries and garden centres (Bona fide)

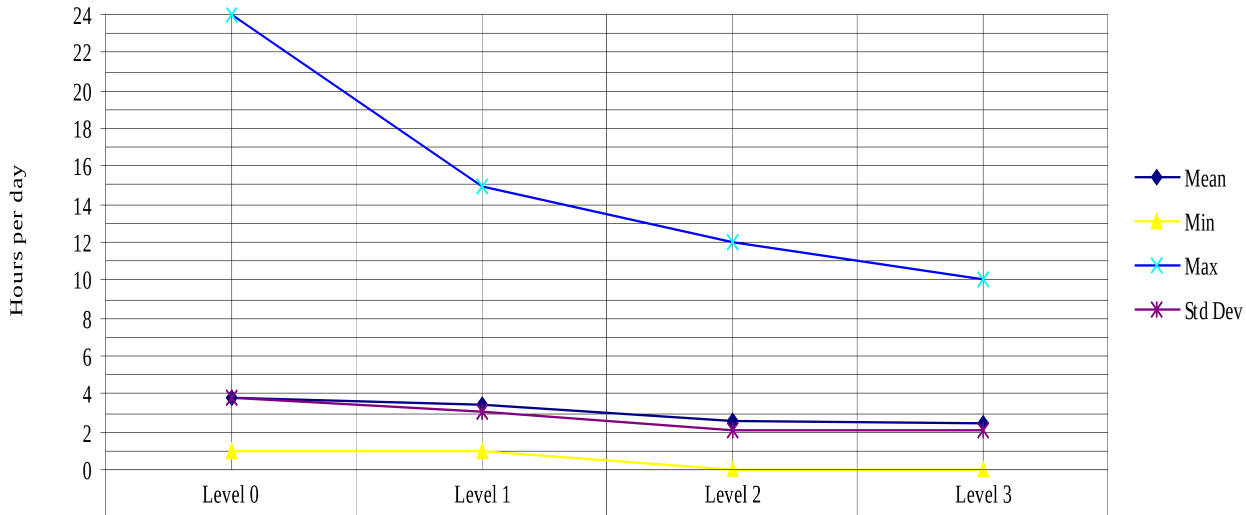
The watering of (bona fide) new landscapes, nurseries and garden centres received the highest rating when compared to gardens and lawns. These responses could be due to the industry rating themselves highly, or because, as an industry, they could experience other economic knock-on effects, during times of water restrictions. The mean for the number of days required to water ranged from 4.85 days per week in level 0 to, to 3.41 days per week in level 3 (Figure 5.15). This resulted in a decrease of use of only 29% across the four levels. This category also received the smallest decrease in water use between level 0 and level 3. This could be attributed to the fact that 51% of respondents indicated they belonged to SANA, 14% to LIA, 13% to SALI and 32% to IERM (respondents were allowed to indicate multiple response for their business). The largest portion of respondents do seem to come from the landscaping and nursery trade.



	Level 0	Level 1	Level 2	Level 3
Mean	4.85	4.22	3.82	3.41
Min	1.00	1.00	0.00	0.00
Max	7.00	7.00	7.00	7.00
Std Dev	2.09	1.98	2.10	2.35

Figure 5.15 Number of days per week allowed, for watering of new landscapes, nurseries and garden centres (Bona fide).

When analysing the number of hours that respondents agreed should be watered per day, there was a corresponding decrease from level 0 to level 3. The mean number of hours for which watering of new landscapes, nurseries and garden centres (Bona fide) was reduced from 3.80 hours per day in level 0, to 3.39 hours per day in level 1, to 2.57 hours per day in level 2 and down to 2.41 hours per day in level 3 (Figure 5.16).



	Level 0	Level 1	Level 2	Level 3
Mean	3.80	3.39	2.57	2.41
Min	1.00	1.00	0.00	0.00
Max	24.00	15.00	12.00	10.00
Std Dev	3.85	3.09	2.08	2.04

Figure 5.16 Number of hours per day allowed, for the watering of new landscapes, nurseries and garden centres (Bona fide).

When multiplying the mean figure of days per week, by the hours per day, to obtain a total for the recommended hours of watering per week, participants clearly understood the concept and need for the distinct reduction in the amount of time allowed to water, as one progressed up the levels. For the total hours of watering of new landscapes, nurseries and garden centres (Bona fide) per week, it can be concluded that 18.43 hours be allowed for level 0, 14.30 hours for level 1, 9.82 hours for level 2, and 8.22 hours for level 3 (Table 5.4).

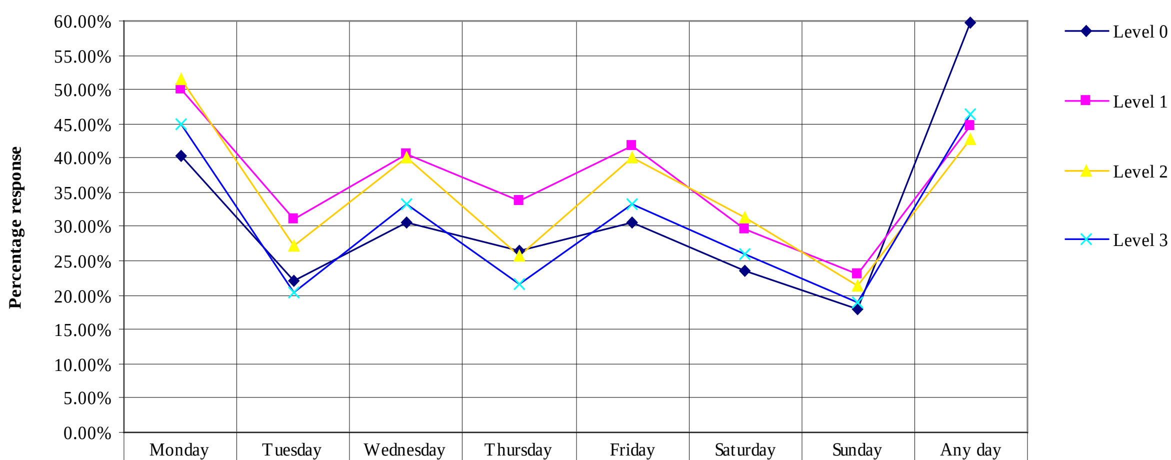
Table 5.4 Total hours per week, for the watering of new landscapes, nurseries and garden centres (Bona fide).

Watering new landscapes, nurseries and garden centres (Bona fide)

	Level 0	Level 1	Level 2	Level 3
Days per week	4.85	4.22	3.82	3.41
Hrs per day	3.80	3.39	2.57	2.41
Hrs per week	**18.43**	**14.30**	**9.82**	**8.22**

When comparing Table 5.1, 5.2, 5.3 and 5.4 it is evident that watering of lawns received the lowest amount of allowed hours per week across all four levels whilst watering of new landscapes, nurseries and garden centres (Bona fide) received the highest amount of allowable hours across all four levels. Watering of residential gardens, office parks, all government and municipal parks, grounds and facilities received the second highest overall allowable watering hours followed by watering of recreation facilities.

Although when studying the individual levels watering of residential gardens, office parks, all government and municipal parks, grounds and facilities received higher allowable watering times for level 0 and level 1, whilst watering of recreation facilities received higher allowable watering times for level 2 and level 3 respectively.



	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Any day
Level 0	40.28%	22.22%	30.56%	26.39%	30.56%	23.61%	18.06%	59.72%
Level 1	50.00%	31.08%	40.54%	33.78%	41.89%	29.73%	22.97%	44.59%
Level 2	51.43%	27.14%	40.00%	25.71%	40.00%	31.43%	21.43%	42.86%
Level 3	44.93%	20.29%	33.33%	21.74%	33.33%	26.09%	18.84%	46.38%

Figure 5.17 Preferred days allowed, for the watering of new landscapes, nurseries and garden centres (Bona fide).

The majority of responses, on all levels, indicated watering on Monday, Wednesday, Friday and any day. Sunday received a very low percentage (Figure 5.17). This may be attributed to the fact, that most landscape firms do not operate over weekends, and industry would have to pay double rates, to specially bring staff in to water on Sundays. It needs to be noted that, by and large, watering percentages decreased, as levels were increased. Interestingly, there was a slight spike in the need for watering on Wednesdays and Saturdays, for level three.

5.3.6 Implementation of restrictions on other listed activities

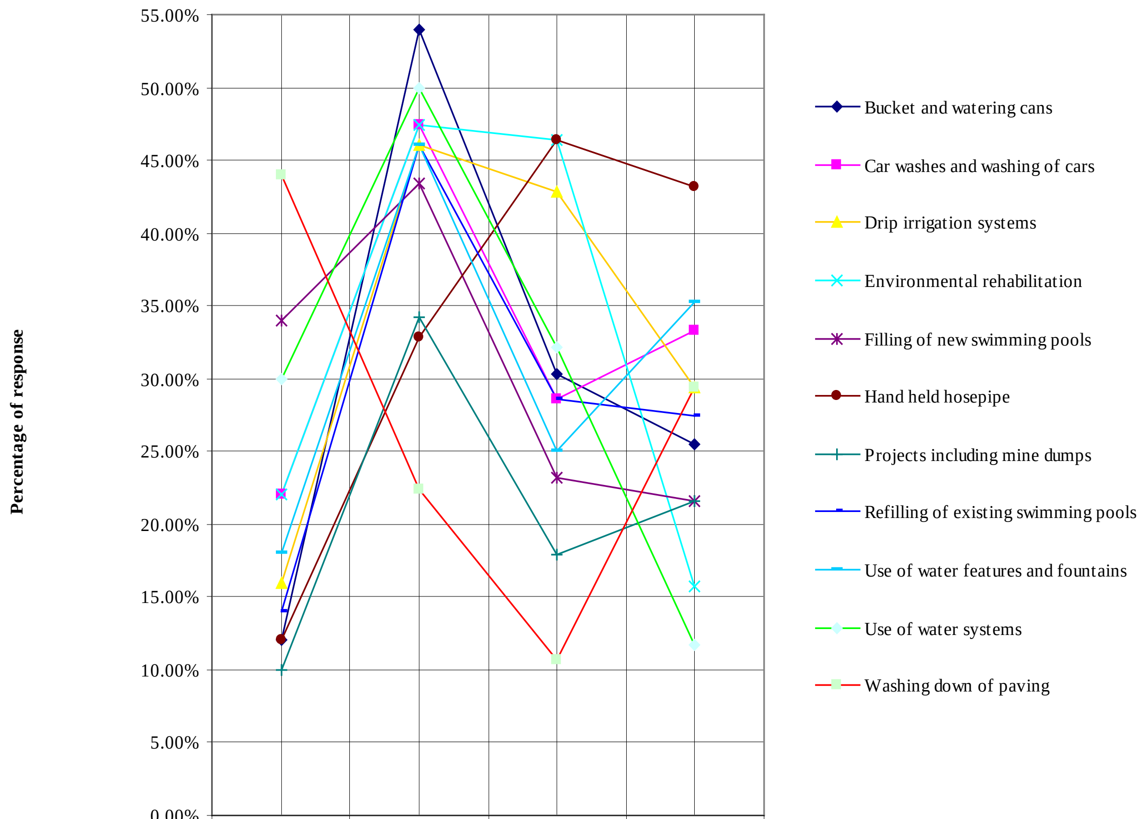
In order to accommodate a number of other general aspects that were listed, either in the Gauteng restrictions, or the international restrictions, respondents were only asked "At what level should the following water restrictions be implemented?", and not about how many hours per day or days per week, as this was not applicable in many instances.

This question allowed respondents to indicate, whether restrictions should be implemented at more than one level or not, which could skew the result slightly. However, if the highest scores (for each category) are taken as the point at which respondents indicated that water restrictions should be implemented for each activity, then restrictions should be introduced at the following levels (Figure 5.18). The percentage response indicated in brackets:

- Level 0 – Washing down of paving (44%).
- Level 1 – Bucket and watering cans (53.95%), use of watering systems (50%), car washes and washing of cars (47%), environmental rehabilitation (this was, however, exceptionally close to level 2 as well) (47.37%), drip irrigation systems (46.05%), filling of swimming pools (43.42%), projects including mine dumps (34.21%), filling of new swimming pools (43.42%), refilling of existing swimming pools (46.05%), use of water features and fountains (46.05%).
- Level 2 – Hand held hosepipe (46.43%).
- Level 3 – No activities for water restrictions were suggested to be introduced at this level.

Anomalies are evident in level three where some respondents felt that certain activities, namely: washing down of paving, projects including mine dumps, use of water features and fountains, and car washes and washing cars, should be introduced at this level. However, these responses did not outweigh the responses in previous levels, and therefore, the highest response rate was still taken as the proposed level of introduction.

There is also no clear and outright indicator (percentage response) from those surveyed at what level restrictions should be implemented. This is evident by the fact that the highest score received was for introduction of the use of bucket and watering cans at level 1 with 53.95 response rate. From a practical horticultural and water conservation aspect it is also strange that respondents indicated that the use of hand held hosepipes as a restriction be introduced only at level 2, whilst introduction of the use of buckets and watering cans be introduced at level 1. It could be that this is genuinely what the respondents felt, or that this was towards the end of an already lengthy questionnaire and respondents were not focussed or that the question itself was not clear enough.



	Level 0	Level 1	Level 2	Level 3
Bucket and watering cans	12.00%	53.95%	30.36%	25.49%
Car washes and washing of cars	22.00%	47.37%	28.57%	33.33%
Drip irrigation systems	16.00%	46.05%	42.86%	29.41%
Environmental rehabilitation	22.00%	47.37%	46.43%	15.69%
Filling of new swimming pools	34.00%	43.42%	23.21%	21.57%
Hand held hosepipe	12.00%	32.89%	46.43%	43.14%
Projects including mine dumps	10.00%	34.21%	17.86%	21.57%
Refilling of existing swimming pools	14.00%	46.05%	28.57%	27.45%
Use of water features and fountains	18.00%	46.05%	25.00%	35.29%
Use of water systems	30.00%	50.00%	32.14%	11.76%
Washing down of paving	44.00%	22.37%	10.71%	29.41%

Figure 5.18 Levels at which to introduce other water restrictions on listed activities.

5.3.7 Other general comments on water restrictions

In this section of the questionnaire, respondents were asked to indicate merely yes/no or uncertain. Although these questions did not all emanate from original data, they are some of the important principles of water wise gardening, and it was felt by the researcher to be extremely important, to obtain this data, and to include some of these in a proposed water supply shortage response plan. All responses, barring three, received a “yes” score of above 80% (Figure 5.19). The three that received the lowest “yes” scores were, “Water restrictions must apply to all sources of water, municipal as well as other sources, such as boreholes and dams” (65%), “No watering should be allowed between the hours 10h00 and 15h00” (59%), and “No watering should be allowed between the hours 10h00 and 14h00 (October to February)” (62%).
It could therefore be concluded (based on the high percentage of positive response) that all other general restrictions listed in Figure 5.19 should definitely be included as part of a water supply shortage response plan for Gauteng. These being

- Users who exceed the anticipated percentage of water saving should pay a very heavy fine.
- Users who do not abide with the water restrictions should pay heavy fines as determined by municipal structures
- All surface runoff water must be captured on site and recycled.
- The user of water retention granules and wetting granules by contractors must be enforced.
- Mechanisms such as moisture meters and rain sensors must be compulsory on automated irrigation systems.
- All new landscapes must be zoned into high, medium and low water use zones.
- Plants must be sold with labels indicating which are high, medium and low water use plants.
- The use of mulches in new landscapes should be compulsory.
- Use of grey water is encouraged in the garden.
- In all cases where hosepipes are used a trigger nozzle must be fitted

The three that received the lowest “yes” scores could also be included in the final proposed plan as their scores although not as high as the others are still above 51%. These being

- Water restrictions must apply to all sources of water, municipal as well as other sources, such as boreholes and dams
- No watering should be allowed between the hours 10h00 and 15h00
- No watering should be allowed between the hours 10h00 and 14h00 (October to February)

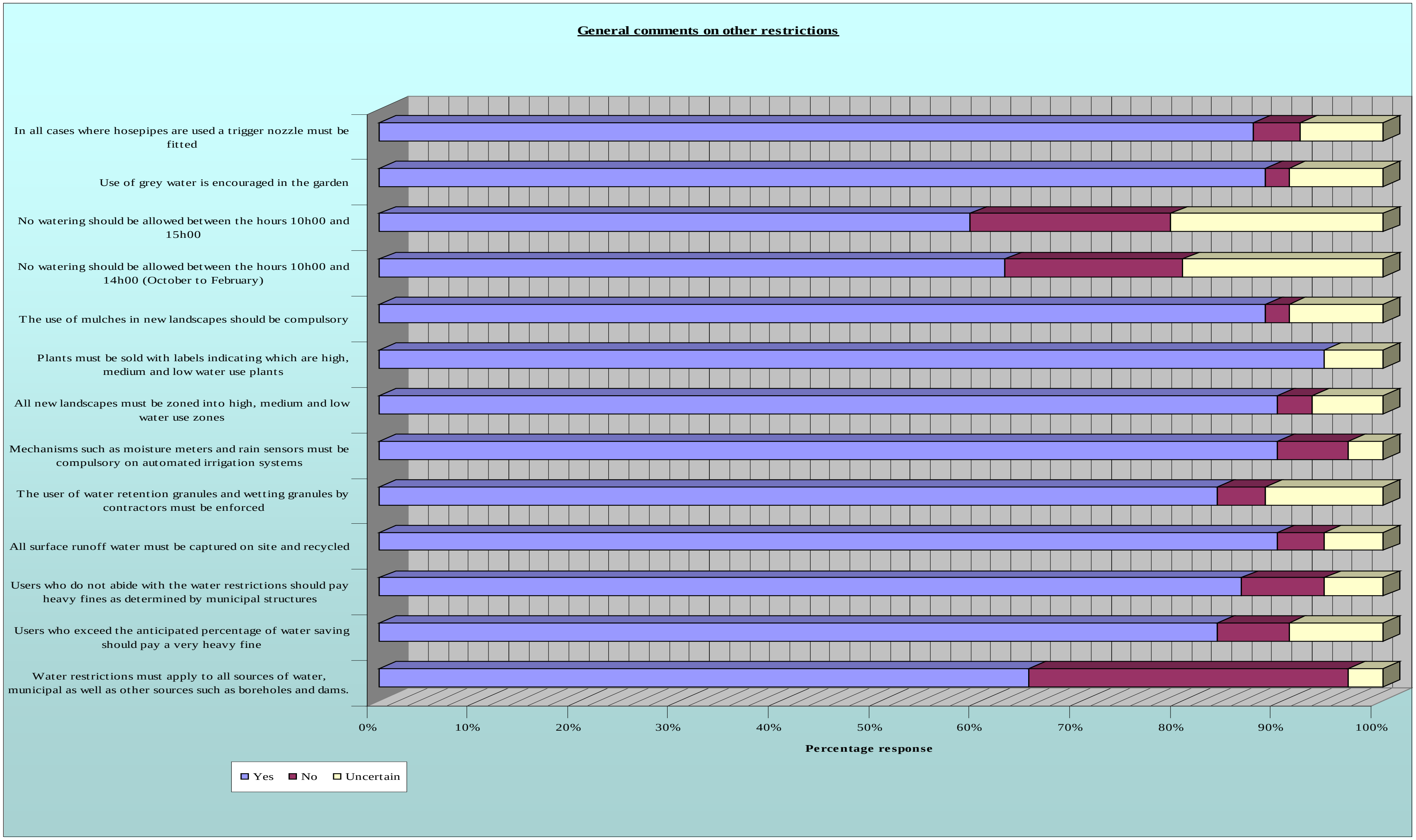


Figure 5.19 General comments by participants on other restrictions

5.4 PROBLEMS ENCOUNTERED

Proportional response

Only those people, whose names appeared on the official institution lists were contacted, and, therefore, the effect on larger, versus smaller companies was not able to be measured on a proportional basis. For example, a large organisation employing a thousand people, with a huge turnover, would have the same possibility of affecting the scores, as would a one man business with a very small turnover. The basis for this argument is however mitigated by the type of research process undertaken (Participatory Action Research, stratified sampling).

Measuring too many items

In hindsight, the questionnaire took approximately 45 minutes to complete, which, as alluded to previously, was too long. This was confirmed by the survey company, MSSA. It is, therefore, possible to conclude, that as a result of the many questions asked, the data response incidence may have been negatively affected. The problem of having too many questions, is confirmed by Monger (2006:8).

Chapter 6
Comparison of Gauteng, International and Selected Survey data

6.1 INTRODUCTION

In order to achieve this comparison , the information obtained from the survey was compared with the available restrictions in Gauteng, as well as with the available restrictions internationally.

From the responses received in the survey, it is evident that respondents view as essential:

- The need for a more flexible system of water restrictions.
- The individual restrictions being part of a larger plan.
- The need to prioritise restrictions into different levels.
- The need to prioritise their own needs for their specific industry (almost self regulation).
- The need for some form of water supply shortage response plan.
- The need to be consulted, thus they took the time to complete this lengthy, yet valuable questionnaire.

Only five additional water restriction suggestions were raised by respondents, and in each case the suggestion had a 1% response rate, indicating that only one percent of respondents raised each of the five new suggestions. This also supports the conclusion that respondents were satisfied, that their suggestions and restrictions had been included in the survey.

When analysing the nursery, landscape and garden centre data, the 1994/95 Gauteng data was combined into one figure at level 2, for comparison purposes, although it was listed separately. For all other levels the reference to 1994/95 restriction data for nurseries, landscapes and garden centres was recorded as n/a (not available). There was no reference at all to international industry restrictions, and therefore their value in this aspect is zero (0). This lack of data was not ideal for this aspect of the analysis.

6.2 COMPARISONS BASED ON RESEARCH AND ANALYSIS

The information obtained from all three sets of data, were compared in broad terms on a high level, and where possible, compared on similar aspects. This was done to try and gain clarity on a possible final recommendation.

In tables 6.1 to 6.6 the data from the Gauteng 1994/95 restrictions, available international data and the survey data were compared. In the tables Gauteng refers to the 1994/95 restriction data, international refers to the data available from international sources, and survey refers to the survey conducted within the Green Industry as part of the research project.

International comparisons of the amount of water to be saved produced results that indicate, that the average maximum amount of water saving for level one will be 7.9%, for level two 19.2%, for level three 31.1% and for level four 39.5% (Table 4.9). The questionnaire against which Green Industry members were surveyed offered the guideline that level 0 will apply to all situations regardless of a drought or no drought, level 1 will mean that a 20% saving is required of the industry/users, level 2 will mean that a 30% saving is required of the industry/users, level 3 will mean that the severest water restrictions are in force, and human survival mode is in play (40% saving required). This Level 0 of the survey could be equated to the abridged Level 1 of international restrictions, which require a maximum of 7.9% water saving (Table 4.9).

The anticipated amount of water to be saved in each level would apply to the total group of restrictions for that level (0,1,2,or 3).

6.2.1 Watering of residential gardens, office parks, industrial parks, all government & municipal grounds and facilities (Excluding lawns)

The comparative average for level 0 is 4.80 hours per day with an average of 3.30 days per week. This equates to a total watering time of 15.75 hours per week. The comparative average for level 1 is 4.52 hours per day with an average of 3.14 days per week. This equates to a total watering time of 14.70 hours per week. The comparative average for level 2 is 2.57 hours per day with an average of 1.75 days per week. This equates to a total watering time of 4.47 hours per week. The comparative average for level 3 is 1.04 hours per day with an average of 0.90 days per week. This equates to a total watering time of 1.87 hours per week (Table 6.1). The amount of hours considered for level 3 is substantially higher than what is commonly used in international examples.

Table 6.1 Comparison **-** Watering of residential gardens, office parks, industrial parks, all government & municipal grounds and facilities (Excluding lawns).

Watering of residential gardens, office parks, industrial parks, all government & municipal grounds and facilities (Excluding lawns)				
	Level	**Mean hrs per day**	**Mean days per week**	**Mean hrs per week**
Gauteng	0	n/a	n/a	n/a
International	0	5.14	3.10	15.94
Survey	0	4.46	3.49	15.57
Average comparative total	0	4.80	3.30	15.75
Gauteng	1	n/a	n/a	n/a
International	1	5.95	3.50	20.83
Survey	1	3.09	2.77	8.56
Average comparative total	1	4.52	3.14	14.70
Gauteng	2	2.86	1.19	3.40
International	2	2.19	1.71	3.74
Survey	2	2.65	2.36	6.25
Average comparative total	2	2.57	1.75	4.47
Gauteng	3	n/a	n/a	n/a
International	3	0.00	0.00	0.00
Survey	3	2.08	1.80	3.74
Average comparative total	3	1.04	0.90	1.87

* In the table n/a means that no data was available.

When considering the watering of residential gardens, office parks, industrial parks, all government & municipal grounds and facilities (Excluding lawns), the results of the survey indicates that self-regulation from the South African Green Industry, will result in less time being allocated to watering, for level 0 and level 1, and more for level 2, and level 3.

6.2.2 Watering of recreation facilities (Private, commercial, government and local authority)

The comparative average for level 0 is 7.56 hours per day with an average of 4.04 days per week. This equates to a total watering time of 32.87 hours per week. The comparative average for level 1 is 6.42 hours per day with an average of 3.30 days per week. This equates to a total watering time of 23.16 hours per week. The comparative average for level 2 is 3.78 hours per day with an average of 2.57 days per week. This equates to a total watering time of 10.00 hours per week. The comparative average for level 3 is 1.07 hours per day with an average of 0.95 days per week. This equates to a total watering time of 2.03

hours per week (Table 6.2). The amount of hours considered for watering of recreation facilities at level 3 is substantially higher than what is generally used in international examples.

Table 6.2 Comparison - Watering of recreation facilities (Private, commercial, government and local authority).

Watering of recreation facilities (Private, commercial, government and local authority)				
	Level	**Mean hrs per day**	**Mean days per week**	**Mean hrs per week**
Gauteng	0	n/a	n/a	n/a
International	0	10.86	4.75	51.57
Survey	0	4.27	3.32	14.18
Average comparative total	0	7.56	4.04	32.87
Gauteng	1	n/a	n/a	n/a
International	1	9.86	3.88	38.20
Survey	1	2.99	2.72	8.13
Average comparative total	1	6.42	3.30	23.16
Gauteng	2	2.13	2.50	5.32
International	2	6.29	2.80	17.60
Survey	2	2.93	2.42	7.09
Average comparative total	2	3.78	2.57	10.00
Gauteng	3	n/a	n/a	n/a
International	3	0.00	0.00	0.00
Survey	3	2.14	1.90	4.07
Average comparative total	3	1.07	0.95	2.03

* In the table n/a means that no data was available.

When considering the times for watering of recreation facilities (Private, commercial, government and local authority), the results of the survey indicate that self-regulation from the industry, will result in less time being allocated to watering, for level 0, 1 and 2, and more time for level 3 (where international data allowed absolutely no time at all).

6.2.3 Watering of lawns (Inclusive of residential, business, industrial and government)

When considering the watering times for lawns the comparative average for level 0 is 5.08 hours per day with an average of 3.25 days per week. This equates to a total watering time of 16.86 hours per week. The comparative average for level 1 is 4.63 hours per day with an average of 2.54 days per week. This equates to a total watering time of 12.17 hours per week. The comparative average for level 2 is 1.72 hours per day with an average of 1.15 days per week. This equates to a total watering time of 2.92 hours per week.

The comparative average for level 3 is 1.30 hours per day with an average of 0.90 days per week. This equates to a total watering time of 1.71 hours per week (Table 6.3). The hours considered for watering of recreation facilities at level 3 is substantially higher than what is generally used in international examples.

Table 6.3 Comparison - Watering of lawns (Inclusive of residential, business, industrial and government)
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Watering of lawns (Inclusive of residential, business, industrial and government)				
	Level	**Mean hrs per day**	**Mean days per week**	**Mean hrs per week**
Gauteng	0	n/a	n/a	n/a
International	0	6.52	3.50	22.83
Survey	0	3.63	3.00	10.89
Average comparative total	0	5.08	3.25	16.86
Gauteng	1	n/a	n/a	n/a
International	1	6.29	2.80	17.60
Survey	1	2.97	2.27	6.74
Average comparative total	1	4.63	2.54	12.17
Gauteng	2	0.00	0.00	0.00
International	2	2.97	1.55	4.61
Survey	2	2.20	1.89	4.16
Average comparative total	2	1.72	1.15	2.92
Gauteng	3	n/a	n/a	n/a
International	3	0.50	0.22	0.11
Survey	3	2.10	1.58	3.32
Average comparative total	3	1.30	0.90	1.71

* In the table n/a means that no data was available.

When considering the watering of lawns (Inclusive of residential, business, industrial and government), the results of the survey indicate that self-regulation from the industry, will result in less time being allocated to watering for level 0 and 1, and more time for level 2 and 3 (where international data allowed minimal time, especially for level 3).

6.2.4 Watering of new landscapes, nurseries and garden centres (Bona fide)

The only data that was available for this analyses was from the survey (for all three levels) and from the 1994/95 Gauteng restrictions (for level 2 only). Analyses of watering times for new landscapes, nurseries and garden centres, indicates the average for level 0 is 1.90 hours per day with an average of 2.43 days per week. This equates to a total watering time of 9.21 hours per week. The comparative average for level 1 is 1.69 hours per day with an average of 2.11 days per week. This equates to a total watering time of 7.15 hours per week. The comparative average for level 2 is 2.01 hours per day with an average of 3.61 days per week. This equates to a total watering time of 11.34 hours per week. The comparative average for level 3 is 1.20 hours per day with an average of 1.70 days per week. This equates to a total watering time of 4.10 hours per week (Table 6.4).

Table 6.4 Comparison - Watering of new landscapes, nurseries and garden centres (Bona fide).

Watering of new landscapes, nurseries and garden centres (Bona fide).				
	Level	**Mean hrs per day**	**Mean days per week**	**Mean hrs per week**
Gauteng	0	n/a	n/a	n/a
International	0	n/a	n/a	n/a
Survey	0	3.80	4.85	18.42
Average comparative total	0	1.90	2.43	9.21
Gauteng	1	n/a	n/a	n/a
International	1	n/a	n/a	n/a
Survey	1	3.39	4.22	14.29
Average comparative total	1	1.69	2.11	7.15
Gauteng	2	3.46	7.00	24.21
International	2	n/a	n/a	n/a
Survey	2	2.57	3.82	9.81
Average comparative total	2	2.01	3.61	11.34
Gauteng	3	n/a	n/a	n/a
International	3	n/a	n/a	n/a
Survey	3	2.41	3.41	8.20
Average comparative total	3	1.20	1.70	4.10

* In the table n/a means that no data was available.

Comparisons were only available for level 2. When considering the watering of new landscapes, nurseries and garden centres (Bona fida), the results of the survey indicate that self-regulation from the industry, will result in less time being allocated to watering for level 2. This result was mainly due to the fact that no data was available from sourced international data sets, for the regulation of the industry by themselves. However, when comparing the 1994/95 restrictions to the survey results, it could be concluded that the industry will in fact police itself more rigorously, than if restrictions were imposed by the local authority.

The huge jump in total number of hours from level 1, to level 2 is inconsistent and is therefore flagged as an anomaly.

6.2.5 Implementation of restrictions on other listed activities

The data for these aspects were not based on actual days/times water use but rather on whether or not they should be applied or not. The international data was not assessed to ascertain at what level water restrictions on other listed activities should be included. Due to the nature of the water restriction analyses, all 1994/95 Gauteng data would be applicable to level 2. The survey data as analysed in Figure 5.18 did however indicate some idea at what level these restrictions should be implemented.

- Level 0 – Washing down of paving (44%).
- Level 1 – Bucket and watering cans (53.95%), use of watering systems (50%), car washes and washing of cars (47%), environmental rehabilitation (this was, however, exceptionally close to level 2 as well) (47.37%), drip irrigation systems (46.05%), filling of swimming pools (43.42%), projects including mine dumps (34.21%), filling of new swimming pools (43.42%), refilling of existing swimming pools (46.05%), use of water features and fountains (46.05%).
- Level 2 – Hand held hosepipe (46.43%).
- Level 3 – No activities for water restrictions were suggested to be introduced at this level.

Table 6.5 Comparison - Restrictions on other listed activities.

Restrictions	Reference to, in data studied/obtained		
	1994/5 Gauteng	International	2008 Survey
Bucket and watering cans	Yes	Yes	Yes
Car washes and washing of cars	Yes	Yes	Yes
Drip irrigation systems	Yes	Yes	Yes
Environmental rehabilitation	No	No	Yes
Filling of new swimming pools	Yes	Yes	Yes
Hand held hosepipe	Yes	Yes	Yes
Projects including mine dumps	Yes	No	Yes
Refilling of existing swimming pools	Yes	Yes	Yes
Use of water features and fountains	Yes	Yes	Yes
Use of water systems	Yes	Yes	Yes
Washing down of paving	Yes	Yes	Yes

When comparing the three different data sets for other listed activities, it is evident that all three did refer to so degree to the "other listed activities" that require implementation, as part of a water supply shortage response plan (Table 6.5). There is however no clear guideline that indicates at what level they should be implemented, except for the 2008 survey data (which already alluded to could have reservations on the accuracy of the levels of introduction).

6.2.6 Other general comments on water restrictions

When comparing the three different data sets, it is evident that only two of the issues raised in the questionnaire by the researcher, were referred to in the 1994/95 Gauteng restrictions, and five issues were addressed by international based local authorities.

Table 6.6 Comparison - Other water wise aspects to consider in a water supply shortage response plan.

Restrictions	Reference to in data studied/obtained		
	1994/5	International	2008 survey
Water restrictions must apply to all sources of water - municipal as well as other sources such as boreholes and dams.	No	No	Yes
Users who exceed the anticipated percentage of water saving, should pay a very heavy fine	Yes	Yes	Yes
Users who do not abide by the water restrictions, should pay heavy fines as determined by municipal structures	Yes	Yes	Yes
All surface runoff water must be captured on site and recycled	No	No	Yes
The use of water retention granules and wetting granules by contractors, must be enforced	No	No	Yes
Mechanisms such as moisture meters and rain sensors, must be compulsory on automated irrigation systems	No	No	Yes
All new landscapes must be zoned into high, medium and low water use zones	No	No	Yes
Plants must be sold with labels indicating which are high, medium and low water use plants	No	No	Yes
The use of mulches in new landscapes should be compulsory	No	No	Yes
No watering should be allowed between the hours 10h00 and 14h00 (October to February)	No	Yes	Yes
No watering should be allowed between the hours 10h00 and 15h00	No	Yes	Yes
Use of grey water is encouraged in the garden	No	No	Yes
In all cases where hosepipes are used a trigger nozzle must be fitted	No	Yes	Yes

The fact that respondents of the 2008 survey replied positively to all restrictions is constructive. Of the 3 that received the lowest scores (Water restrictions must apply to all sources of water, municipal as well as other sources, such as boreholes and dams, No watering should be allowed between the hours 10h00 and 15h00 and No watering should be allowed between the hours 10h00 and 14h00 (October to February)), the two that refer to watering times are also referred to in international references (Table 6.6.). It is also known good water

wise practice not to water during certain times of the day.

Chapter 7
DISCUSSION AND RECOMMENDATIONS

7.1 INTRODUCTION

In order to arrive at the recommendations made in the research, it was necessary to consider the original water restrictions obtained from the Rand Water, water supply area, dating back to 1994/5, the water restrictions obtained from international examples, as well as the results of the survey conducted with the selected SAGIC members in 2008. The 1994/95 restrictions, having been used as a baseline, were the basis for comparison with both the international, and the survey data sets. As was indicated previously, the 1994/95 restrictions aimed at only 30% water saving, and were thus matched at the level 2 restrictions and influenced this level only.

The conclusions are based on the information analysed in chapters 4, 5 and 6. The data used for analysis were based on information that was not always consistent, mainly because data sets, and the methodology used in the data sets, were not identical. Consequently the international data was used merely as a guide. Where the international data was much higher (eg more days or more hours per day recommended) than the 2008 survey data, and skewed the average data (higher), the 2008 survey data results were used. This approach was taken as the 2008 survey data was seen as more accurate, it was participative (industry was included), it is current, and it provides the potential for a greater “buy-in” from the Green Industry and end users.

Some results from the survey were not conclusive enough to draw specific recommendations. For example some results showed that watering was required on three days, but when tested, the highest percentage of responses pointed only to two specific days, with the remaining top responses being divided between two or three other days (eg Watering of recreation facilities, response rate for Level 0 indicated 3 days, with the preferred days being as indicated - Monday (37%), Tuesday (17%), Wednesday (28%), Thursday (17%), Friday (28%), Saturday (13%) and Sunday (10%)). In some cases two possible days were recommended. This details would need to be agreed to during final implementation.

When considering the response rate for the implementation of restrictions on ‘other listed activities’, the activities with the highest response rate for that level, were indicated to have the restrictions implemented at that level.

In order to address the inconsistencies of the present system currently operation in Gauteng (Rand Water, water supply area), all the recommendations made in this report would be applied across the entire area, to ensure consistency of application, consistency of understanding, and consistency in communicating the message to all end users.

7.2 RECOMMENDATIONS BASED ON RESEARCH AND ANALYSES

The recommendations are on the whole, based on observations and discussions found in chapter 5.3 and chapter 6. When referring to days and hours allowed for watering, the observations reflect figures to two decimal points. For practical implementation purposes, these have been rounded off, as it would not be practical to water a garden or lawn for 4.45 hours. In this case, it would be rounded off to 4 hours, similarly 4.50 hours would be round off to 5 hours.

The recommendations would form part of a water supply shortage response plan for the Green Industry in the Rand Water, water supply area. The survey results take president over other results argued in 7.1.

It could also be argued that as level 0 is aimed at being applied all the time, either there should be no limit to the days or hours or both, except for compliance with recommendations set out in chapter 7.2.7. This could apply to all categories.

7.2.1 Restriction levels

Some international data consisted of seven levels of restrictions, whilst the 1994/95 Gauteng data consisted of one level (30 % saving) . In order to reduce the complexity of the systems, certain plans of local authorities were condensed into four levels (Chapter 4.6). The Gauteng 1994/95 data slotted into level three of the four levels. In the Gauteng survey (2008), four levels were also used to gauge industry response. Not one response was received that spoke negatively into the four levels of restrictions. Calculations indicate that the first level (level 0) will save an estimated 7.9%. This figure was rounded up to 8%.

It should, therefore, be concluded (as offered in chapter 5.3) that four levels of water restrictions should be implemented, to achieve savings as follows:

Level 0 – Implemented all the times to achieve a 8% saving of water use.

Level 1 - Implemented to achieve a 20% saving of water, during times of declared drought.

Level 2 - Implemented to achieve a 30% saving of water, during times of declared drought.

Level 3 - Implemented to achieve a 40% saving of water, during times of declared drought.

This would allow for a more flexible system, when compared to the single level system introduced in 1994/95.

7.2.2 Watering of residential gardens, office parks, industrial parks, all government & municipal grounds and facilities (Excluding lawns)

Results and discussions from chapter 5.3.1 and 6.2.1 provide the basis for this conclusion.

In order to obtain a 8% saving of water at level 0 restrictions, it is required that residential gardens, office parks, industrial parks, all government & municipal grounds and facilities (Excluding lawns), be watered three days per week for a total of four hours per day. Watering should be allowed on Mondays, Wednesdays, Fridays and Saturdays. Total allowed watering time for the week should be no more than 16 hours.

In order to obtain a 20% saving of water at level 1 restrictions, it is required that residential gardens, office parks, industrial parks, all government & municipal grounds and facilities (Excluding lawns), be watered three days per week for a total of three hours per day. Watering should be allowed on Mondays, Wednesdays and Fridays. Total allowed watering time for the week should be 9 hours.

In order to obtain a 30% saving of water at level 2 restrictions, it is required that residential gardens, office parks, industrial parks, all government & municipal grounds and facilities (Excluding lawns), be watered two days per week for a total of three hours per day. Watering should be allowed on Mondays and Fridays. Total allowed watering time for the week should be 6 hours.

In order to obtain a 40% saving of water at level 3 restrictions, it is required that residential gardens, office parks, industrial parks, all government & municipal grounds and facilities (Excluding lawns), be watered two days per week for a total of two hours per day. Watering should be allowed on Mondays and Wednesdays. Total allowed watering time for the week should be 4 hours.

7.2.3 Watering of recreation facilities (Private, commercial, government and local authority)

Results and discussions from chapter 5.3.2 and 6.2.2 provide the basis for this conclusion.

In order to obtain a 8% saving of water at level 0 restrictions, it is required that the watering of recreation facilities (Private, commercial, government and local authority) be undertaken on three days per week, for a total of four hours per day. Watering should be allowed on Mondays, Wednesdays and Fridays. Total allowed watering time for the week should be 14 hours.

In order to obtain a 20% saving of water at level 1 restrictions, it is required that the watering of recreation facilities (Private, commercial, government and local authority) be undertaken on three days per week, for a total of three hours per day. Watering should be allowed on Mondays, Wednesdays and Fridays. Total allowed watering time for the week should be no more than 9 hours.

In order to obtain a 30% saving of water at level 2 restrictions, it is required that the watering of recreation facilities (Private, commercial, government and local authority) be undertaken on two days per week, for a total of three hours per day. Watering should be allowed on Mondays, and Fridays. Total allowed watering time for the week should be 7 hours.

In order to obtain a 40% saving of water at level 3 restrictions, it is required that the watering of recreation facilities (Private, commercial, government and local authority) be undertaken on two days per week for a total of two hours per day. Watering should be allowed on Mondays and either Wednesdays or Fridays. Total allowed watering time for the week should be 4 hours.

7.2.4 Watering of lawns (Inclusive of residential, business, industrial and government)

Results and discussions from chapter 5.3.4 and 6.2.3 provide the basis for this conclusion.

In order to obtain a 8% saving of water at level 0 restrictions, it is required that the watering of lawns (Inclusive of residential, business, industrial and government) be undertaken on three days per week, for a total of four hours per day. Watering should be allowed on Mondays, Fridays and Saturdays. Total allowed watering time for the week should be 12 hours.

In order to obtain a 20% saving of water at level 1 restrictions, it is required that the watering of lawns (Inclusive of residential, business, industrial and government) be undertaken on three days per week, for a total of three hours per day. Watering should be allowed on Mondays, Fridays and two other days-either Tuesdays or Saturdays. Total allowed watering time for the week should be no more than 7 hours.

In order to obtain a 30% saving of water at level 2 restrictions, it is required that the watering of lawns (Inclusive of residential, business, industrial and government) be undertaken on two days per week, for a total of two hours per day. Watering should be allowed on Mondays, and Fridays. Total allowed watering time for the week should be 4 hours.

In order to obtain a 40% saving of water at level 3 restrictions, it is required that the watering of lawns (Inclusive of residential, business, industrial and government) be undertaken on two days per week, for a total of one hour per day. Watering should be allowed on Mondays, and Fridays. Total allowed watering time for the week should be 3 hours.

7.2.5 Watering of new landscapes, nurseries and garden centres (Bona fide)

Results and discussions from chapter 5.3.5 and 6.2.4 provide the basis for this conclusion.

In order to obtain a 8% saving of water at level 0 restrictions, it is required that the watering of new landscapes, nurseries and garden centres (Bona fida) be undertaken on five days per week, for a total of four hours per day. Watering should be allowed on Mondays, Tuesdays, Wednesdays, Thursdays and Fridays. Total allowed watering time for the week should be no more than 18 hours.

In order to obtain a 20% saving of water at level 1 restrictions, it is required that the watering of new landscapes, nurseries and garden centres (Bona fida) be undertaken on four days per week, for a total of three hours per day. Watering should be allowed on Mondays, Wednesdays, Thursdays and Fridays. Total allowed watering time for the week should be 14 hours.

In order to obtain a 30% saving of water at level 2 restrictions, it is required that the watering of new landscapes, nurseries and garden centres (Bona fida) be undertaken on four days per week, for a total of three hours per day. Watering should be allowed on Mondays, Wednesdays, Fridays and Saturdays. Total allowed watering time for the week should be 10 hours.

In order to obtain a 40% saving of water at level 3 restrictions, it is required that the watering of new landscapes, nurseries and garden centres (Bona fida) be undertaken on three days per week, for a total of two hours per day. Watering should be allowed on Mondays, Wednesdays, and Fridays. Total allowed watering time for the week should be 8 hours.

7.2.6 Implementation of water restrictions on specified recreation facilities

Results and discussions from chapter 5.3.3 and 6.2.5 provide the basis for this conclusion.

When considering at what level, water restrictions should be implemented for specifically identified recreation facilities, the following is recommended:

Level 0 – None.

Level 1 – Bowling greens, playing surface/turf, golf course fairway, golf course green, golf course rough, cricket outfield, cricket pitch, athletics tracks/fields, horse racing tracks, tennis court (Grass).

Level 2 – None.

Level 3 – Artificial Turf (However, a high proportion of responses felt that Artificial Turf should never be restricted from water use).

Implementation thereof, would be imposed in conjunction with trends for hours and days, as specified in chapter 7.2.3.

7.2.7 Other general comments on water restrictions

Results and discussions from chapter 5.3.7 and 6.2.6 provide the basis for this recommendation. Responses to additional, prompted questions indicated a high degree of agreement that other important aspects be included as part of a total water supply shortage response plan, for the Rand Water, water supply area. These items would be applicable to levels 0 through to levels 3, regardless of aspects. These general requirements should stipulate that:

1. Water restrictions must apply to all sources of water – municipal, as well as other sources, such as boreholes and dams.
2. Users who exceed the anticipated percentage of water saving, should pay a very heavy fine.
3. Users who do not abide by the water restrictions, should pay heavy fines as determined by municipal structures.
4. All surface runoff water must be captured on site and recycled.
5. The use of water retention granules and wetting granules by contractors, must be enforced.
6. Mechanisms such as moistures meters and rain sensors, must be compulsory on automated irrigation systems.
7. All new landscapes must be zoned into high, medium and low water use zones.
8. Plants must be sold with labels indicating which are high, medium and low water use plants.
9. The use of mulches in new landscapes should be compulsory.
10. No watering should be allowed between the hours of 10h00 and 14h00 (October to February).
11. The use of grey water be encouraged in the garden.
12. In all cases where hosepipes are used, a trigger nozzle must be fitted.

7.2.8 Implementation of restrictions on other listed activities

Results and discussions from chapter 5.3.6 and 6.2.6 provide the basis for this recommendation. The following restrictions should be introduced at each level as indicated:

- Level 0 – Washing down of paving.
- Level 1 – Use of bucket and watering cans,
  Use of watering systems (all nurseries, landscapes, lawn, recreation facilities) except for:
  Drip irrigation systems,
  Car washes and washing of cars,
  Drip irrigation systems,

Filling of new swimming pools,
Refilling of existing swimming pools,
Projects including mine dumps,
Use of water features and fountains.

- Level 2 – Hand held hosepipe,
  Environmental rehabilitation.
- Level 3 – No activities introduced at this level.

The results for these specifically identified activities were, however, not conclusive and clear enough from the responses received, to be able to indicate that these **must** be implemented at the level indicated. The researcher has made recommendations, but as a result of some unclear aspects, further study on these specific activities is suggested. Similarly the specific wording for each activity will need further refinement.

7.3 CONSTRAINTS OF THE RESEARCH

During the study, in the interpretation of the results and in the concluding of the results, the following problems were encounted:

- Information was extremely difficult to obtain from international sources.
- International information, although seen as progressive and more flexible, is difficult to compare with that which is found in South Africa.
- No new (post 1994/95) specific water restriction data was available, from any of the municipalities within the Rand Water, water supply area.
- The questionnaire that was developed, was considered to be too long, despite the many attempts to reduce its length and complexity. This affected the number of responses received, from the identified SAGIC members.
- Some results although penned were not conclusive enough, and may require further probing in future.

7.4 FURTHER POSSIBLE RESEARCH

From this study, the following further research could be recommended:

- Whether the proposed restrictions could in fact save the amount of water estimated in the plan.
- Whether this model could be implemented, as is, in other regions of South Africa, or whether modifications would be required.
- Clarification on the implementation requirements within a water supply shortage response plan of "other listed activities".
- In order to obtain even more clarity on some aspects of restrictions it could be possible to undertake this process again on a "higher" improved level (as outlined in Figure 3.2).

Chapter 8
GENERAL CONCLUSION

8.1 GENERAL CONCLUSION

Without assuming to be a global warming expert, a water supply shortage response plan industry specialist expert, or a legal expert, the researcher has successfully been able to assess the macro and micro situation; analyse the available data (locally and internationally); include new research data; and recommend a practically implementable water supply shortage response plan, focusing on the Green Industry in the Rand Water, water supply area (although there is still room for improvement). This has in no way compromised the Green Industry or the data produced, but has rather added to the knowledge of data available, for an improved decision making process.

It can be concluded that the hypothesis H_0 **is not correct.**

The available 1994/95 water restrictions from the Rand Water, water supply area, are inflexible in that they consist of one level only, and this is aimed at a 30% saving in water. The analysed international data, and the questionnaire results data, both consist of four (4) levels of restrictions, all making up a water supply shortage response plan. The comparisons did allow for sufficient credible data to be extracted, and compiled into a single water supply shortage response plan.

It can be concluded that the hypothesis H_1 **is correct.**

By comparing the available 1994/95 water restrictions from the Rand Water, water supply area, the international data, and the questionnaire results data, the researcher was able to positively compare sufficient data, to allowed for the compilation of a water supply shortage response plan, for the Rand Water, water supply area (addressed in chapter 7).

It can be concluded that the hypothesis H_2 **is not correct.**

At no time in the analyses of the data, was it not possible to find areas of comparison. Similarly, the conclusions reached in the research project were all able to be used in a positive sense.

The objectives of this study were to:

a. Investigate what water restrictions are currently available within the Rand Water, water supply area (Gauteng based).

This was achieved from the 1994/95 data, in that twenty-one water restrictions were obtained. The new Water Service Supply regulations (by-laws) were only partly investigated, as only five regulations were obtained from the new municipal system. However, of the five that were obtained, two were from the larger municipal areas, namely Johannesburg City and Mogale City.

b. Investigate what water supply shortage response plans are available internationally.
Several examples were obtained internationally, but ultimately only six examples were selected as they had sufficient data to be used in the analyses. These were also used in the comparative analysis against the 1994/95 restrictions, and the 2008 survey results.

c. Determine the willingness of selected SAGIC members and the municipalities to investigated water restrictions.

This was achieved in three processes. Firstly, when the research process commenced, it was addressed at the Rand Water Services Forum, where it was agreed to. Secondly, during the work shopping of the questionnaire with Green Industry (no objections were received). Thirdly during the survey process, no member of the SANA, SALI, LIA or IERM objected to the restrictions in any formal sense.

d. Compare results of existing available Gauteng based restrictions, international restrictions, and as survey results.

All the available results for Gauteng, the International data, and the questionnaire feedback, were analysed in broad categories, namely:

Watering of residential gardens, office parks, industrial parks, all government & municipal grounds and facilities (Excluding lawns).

Watering of recreation facilities (Private, commercial, government and local authority).

Watering of lawns (Inclusive of residential, business, industrial and government).

Watering of new landscapes, nurseries and garden centres (Bona fida).

Water restrictions on specified recreation facilities.

Other general comments on water restrictions.

Restrictions on other listed activities.

From the comparative process, it was possible to arrive at conclusions, and to formulate a proactive water supply shortage response plan.

e. Develop new improved restrictions that will be seen as more flexible, from the comparisons made.

   A final set of improved, flexible, and inclusive water restrictions, on several levels that will constitute a water supply shortage response plan, has been recommended within the body of the research paper.

f. Create a more flexible set of water restrictions, for the Rand Water, water supply area, that would involve selected role players, and that would result in a new proposed water supply shortage response plan, for the water supply area.

   The research process involved selected Green Industry members (SANA, SALI, LIA and IERM) in the initial exploration process of the study, in the design of the questionnaire, and in the survey itself.

The problem statement addressed three main questions, namely:

What aspects of the current water supply shortage response plan (water restrictions) system in Gauteng, needs to be changed, to make it more flexible, to deal more effectively with droughts in the province, and to contribute positively to sustainable water utilisation?

What in the current plan, needs to be changed, to allow for a water supply shortage response plan to be consistently applied across the Rand Water, water supply area?

What should be done to engage the Green Industry, when compiling a water supply shortage response plan?

All three problems were addressed. It was shown that:

- The current available (1994/95 Gauteng) water restrictions have only one level of restriction, aimed at a 30% water saving, and the new Water Service by-laws are also hugely inadequate within themselves as they do not mention much detail at all. The proposed new water supply shortage response plan, acts on four levels, ranging from an anticipated 8% saving of water to a 40% saving of water in the landscape. The proposed system also allows for progressive "tightening" of restrictions, as each higher level of the plan is implemented. This will assist in a more sustainable utilisation of the available water supply. The new proposed plan also has several general comments on water restrictions that will positively contribute towards sustainable water utilisation.

- The current system (by-laws and restrictions) is applied across Gauteng in a very broad sense, but the wording is not identical, the methodology is insufficient, and the knowledge of any actual restrictions existing is poor amongst the people contacted at local authority level. The proposed water supply shortage response plan refers to one plan to be applied across the entire Rand Water, water supply area.
- Research has already shown, as far back as 1989 (WRC report No:168/1/89), that it is necessary to consult affected parties. The presentations by the researcher, to industry, the focus groups, and the survey, all confirmed that consultation in the improvement and formulation of a water supply shortage response plan, that will affect their industry and customers, is necessary. The Green Industry was engaged in all major stages of the process.

The proposed new Water Supply Shortage Response Plan, for the Rand Water, water supply area, across Gauteng will:

- be based on having permanent identified restrictions, that will allow for an estimated 8% of water saving at all times, even in times of plentiful water.
- have a total of four levels of restrictions, to be implemented at different stages of water stress in the system.
- allow for 20% to 40% water saving in the Green Industry, depending on water system requirements during restrictions, before all watering is banned.
- contribute positively towards conserving water during times of a declared drought, in a manner that will relieve stress on the entire system.
- be seen as a standard, consistent plan, across the entire supply area (mainly Gauteng).
- allow for ease of user interpretation and implementation.
- will be applicable to private consumers, government institutions, and the Green Industry (all role players).
- allow for flexibility in application, depending on what percentage of water saving is required,
- have more “buy-in” than in the past, because the process was one that involved the end user in consultation.
- allow for a certain amount of self-regulation, within the users (industry and consumers).

The proposed Water Supply Shortage Response plan, for the Rand Water, water supply area, will still need to be negotiated with central government and local government as well as the Green Industry, before it can be finally accepted and adopted across the region for implementation, to ensure that if, and when the next drought is declared, that water restrictions will be gradually imposed on the industry, in a structure and flexible manner, to the benefit of all parties inclusive of the environment.

SUMMARY

At present South Africa is categorised as a water stressed country. The predictions are, that by 2025, the situation in South Africa will change to one of absolute scarcity. These sentiments are echoed by more than one quarter. It is also recognised that government cannot endlessly stand by, while people in general use and waste more and more water, every day. In order to meet these growing demands, there is an ever increasing need, to build bigger and more costly infrastructures. These range from dams in the catchment source, all the way to infrastructures needed to deliver water to municipalities, suburbs, and even peoples' homes and industries. To try and meet this demand, implies huge costs to the environment as well as to the end consumers pockets.

The World, Africa, South Africa and even Gauteng Province, all face numerous challenges with regard to water availability, water security and water supply. Not one is unaffected by the many changes and challenges, that face their available water, and not one has a single solution to these challenges. Planet Earth, or "Spaceship Earth", has finite resources. World water resources are estimated at 1.4 billion km^3, of which only 2.6 % is available on land, with only 0.6% being available as surface water. While our water supply will never be exhausted, it will also never be increased.

As the world population increases (2 000 mill in 1990 – 5 000 million in 2020), and as we become more modernized, so does our need for water increase (direct usage and indirect usage). When more people seek greater amounts of this declining available resource (water), conflicts do erupt. By the year 2025, 3 billion people in 52 countries, will experience chronic water shortages. Already, in areas of Africa, demand is exceeding supply. Studies (2002) predict that South Africa's population will grow from 39.4million (1995) to 50.1 million (2025), which may catapult the country, even faster than predicted, from one of "water stress" (1995) to "absolute scarcity" (2025) . The Gauteng Province of South Africa covers 1.54% of the surface of South Africa, accounts for 19.1% of the entire population, and is 89% urbanized. Rand Water supplied 2800ML of water per day, in 2004 (RW, 2004-2005), to 11 million people in the region. Rand Water is the main provider of bulk potable water to Gauteng Province, as well as limited areas of other neighbouring provinces. The dams supplying water to this region, are situated (except for the Vaal dam) ± 300km away (Khatse in Lesotho and Sterkfontein in SE Free State). Once this water reaches the first treatment works, it still has to be pumped a further ± 250km, to its furthest area of supply in Rustenburg.

To cope with these pressures facing South Africa, different initiatives have been/are being put into place. In 1997 Professor K. Asmal, Minister of Water Affairs and Forestry, indicated that after 2033, obtaining additional water would be both costly and difficult. In 2004 Ms B. Sonjica, Minister of Water Affairs and Forestry, announced that R21 billion had been approved, to build 20 dams over the next 20 years, to meet the countries future needs. On 15 October 2008, it was indicated by van Rooyen, that in order to ensure security of future water supplies, for amongst others, the Rand Water supply region, two scenario's exist. The first being the Thukela Water project, in Kwazulu Natal, and the second being the building of the Polihali dam and transfer scheme, as additions to the current Lesotho Highlands scheme. A decision on which scheme to implement, needs to be made by March 2009, as the next dam already needs to be in place by 2016 (van Rooyen, 2008).

Besides the direct human demand for water, other extremely important factors come into play, and affect both the existing water supply, and the ability of the hydrological system to "deliver" the amount of water required. El Niño is a weather phenomenon, which originates in the Pacific ocean, but its affects are felt all the way around the globe, also negatively affecting the South African rainfall patterns. Climate change is another phenomenon, which is not only a South African induced phenomenon, and yet is predicted to cause catastrophic changes, to the climate and rainfall patterns over South Africa. As if these two major phenomena were not enough, cyclical droughts occur over the subcontinent every 9 to 19 years (depending on source of research). The last major drought to occur over Gauteng, was in 1994/95. During this drought, when restrictions for the region were promulgated, some problems arose. The perception was that restrictions were implemented only at the last minute, without much planning; communication about this was limited and late, and each different municipality created/enacted its own restrictions, which caused confusion. Restrictions were not well thought through, and impacted negatively on the public, as well as on the "green" industry. The green industry blamed the bulk supplier (Rand Water), for the restrictions imposed, rather than addressing the real implementers, that being, the local municipality. The whole approach seemed to be one of a knee-jerk reaction, rather than being one of good planning with a single message being understood by all. Surprisingly though, a few years earlier, amongst many other recommendations that emanated from studies pertaining to the 1982/83 drought, it was stated that the public should be consulted on the water restriction process, before implementation. To add insult to injury, new water service supply by-laws are in the process (2008) of being draughted by municipalities, and although the public is invited to participate, these by-laws do not address the detail of a water supply shortage response plan. Instead (all those observed), they merely refer to the fact that during times of shortage, water restrictions will be implemented. What water restrictions, no-one is yet able to answer.

The Green Industry is one of those necessary evils or the "Cinderella" in life. What it contributes to the economy, in job creation, in many unseen psychological, emotional, and physical benefits, is only sometimes possibly appreciated, years later when the results of this industry are lost. Drought affects the

Green Industry as directly as it affects agriculture. It is to some extent mitigated by the fact that many homeowners have water in their yards. However, factors, such as increasing the cost of water, and limiting water supply in times of drought, negatively impact this industry. The current system (dating back to 1994/95 restrictions) in Gauteng municipalities, of introducing extreme water restrictions, aimed at a 30% saving of water, is sudden, and the impacts of this decision are not only drastic and felt instantly, but also have devastating long term effects. Unfortunately the positive aspects of this Green Industry and its ripple effects are not fully understood, known and therefore not fully appreciated. It is therefore important that something be done to assist and reduce the impact of drought on this industry.

The facts remain that water resources are scarce; pressures are increasing as a result of green industry and public use; weather patterns are changing; the El Niño effect returns periodically; the natural environment will be negatively affected; and the **next drought will occur**. It is therefore **essential,** that planning be undertaken to protect our environment, and to "empower" the green industry and municipalities for future generations. It is for this reason that there was the need to investigate the current water restrictions and by-laws, compare them to available international examples, as well as to respond to a structured questionnaire from the Green Industry, and then ultimately recommend a water supply shortage response plan.

In order to achieve this, the following was undertaken in the research project: An investigation of current water restrictions available within the Rand Water supply area; To ascertain the occurrence of water supply response plans, available internationally; To procure input in proposed individual water restrictions, from the Green Industry; Finally, the development of a more flexible yet uniform water supply shortage response plan, for the water supply area.

The process of data gathering involved a comprehensive literature search, an analysis of twenty one sets of available municipal water restrictions for Gauteng, and an analysis of limited, obtainable international water supply shortage response plans. Subsequent to this, a survey was formulated using focus groups (nominal groups), and was later refined with the aid of a professional researcher at Rand Water.

It was decided to use a stratified sample, because the SAGIC umbrella represents a homogeneous subset of the Green Industry, which in turn consists of nine different organisations, which in themselves represent homogeneous subsets. Only four of the major subsets of SAGIC, namely SANA, SALI, LIA and IERM, were used in the questionnaire process, since they would be the most directly affected by the existing water supply shortage response plan (water restrictions), due to the type of work they undertake, and the source of their water use.

Finally, the three sets of data (old restrictions, international examples and survey data) were compared and recommendations made accordingly. It is possible, with input from appropriate industry, to formulate a water supply shortage response plan, that can be introduced at various levels (four in this case - one for permanent measures and three for times of water shortage). This will allow for incremental amounts of water to be saved, through gradually introducing harsher methods of water restrictions, as a drought becomes more serious. The main focus areas of the proposed plan being:

- The watering of residential gardens, Office Parks, Industrial Parks, all government & municipal grounds and facilities (Excluding lawns).
- The watering of recreation facilities (Private, commercial, government and local authority).
- The watering of lawns (inclusive of residential, business, industrial and government).
- The watering of new landscapes, nurseries and garden centres (Bona-fide).
- Water restrictions on specified recreation facilities.
- Other general comments on water restrictions, and
- Restrictions on other listed activities.

Recommendations have been made for each of the four levels (Level 0 to 3), in each focus area. This includes a specific watering schedule; The duration of watering periods; The days watering should be undertaken; Water sources are to be included; Watering systems to be used; How plants should be sold; When not to water; and Types of products and activities to be included in the plan.

This proposed water supply shortage response plan, contributes positively towards conserving water, during times of declared drought, in a manner that will relieve stress on the entire water system, and associated infrastructure. The consistency of measures, will apply across the entire Rand Water supply area (mainly Gauteng), thus allowing flexibility for different drought situations, and reducing misinterpretation. The plan is applicable to private consumers, government institutions and the Green Industry.

This plan has involved more consultation than previous publicised systems, which will encourage acceptance and ultimately lead to a certain amount of self regulation within the users (industry and consumers).

El Niño, climate change, droughts, other natural disasters, as well as increased pressure from an ever growing population, are here to stay for now. It is only through being proactive, consultative and analytical, that any system can be improved upon, to enable it to assist suppliers and end users with the available resources- allowing them to be used more wisely, and thereby setting aside sufficient reserve for current and, more importantly, for future generations. This water supply shortage response plan, will assist the many other existing initiatives (eg Water Wise Gardening campaign, and Water Demand Management), to work towards achieving a more positive end result.

After analyses of data from oversees water supply shortage response plans, existing available Gauteng restrictions as well as questionnaire results from the Green Industry on possible water restrictions, it was possible to develop a proposed water supply shortage response plan for Gauteng. In this process the objectives of the study were achieved.

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ANNEXURE A

DETAILED COMPARISON OF WATER RESTRICTIONS OF TWENTY-ONE LOCAL AUTHORITIES IN GAUTENG.

Criteria of comparability* (Main criteria identified in the by-laws available)description.	Randfontein	Johannes-urg	Edenvale/ Modderfontein metroploitan substructure.	Akasia	Alberton	Easton Vaal metro	Fochville	Pretoria metroplitan	Benoni	Boksburg	Germiston	Heidelburg town council	Kempton park / Tembisa	Krugersdorp	Meyerton	MidRand	Johannesburg transitional metropolitan council	Springs	Pretoria	Southern Pretoria metropolitan substructure	Westonaria	Total municipalities	Total with this restriction	% of total municipalities investigated.
Surcharges and Offences		1	1		1				1	1	1		1			1		1	1		1	21	11	52
Period of restrictions				1				1														21	2	10
Residential gardens -Watering hours and months	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	21	100
Garden hoses	1	1	1			1	1		1		1		1		1	1	1			1	1	21	13	62
Recreation facilities		1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	19	90
Government & municipal parks/facilities	1	1	1	1	1	1	1	1	1			1	1		1	1	1	1	1		1	21	17	81
Bona fide nurseries		1	1	1	1	1		1	1		1	1	1		1	1		1	1	1		21	15	71
Bona fide landscapers		1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	21	19	90
Free running water from municipal system.		1	1	1		1	1		1		1	1	1		1	1	1	1	1	1	1	21	16	76
Toilet systems		1	1	1	1	1	1	1	1		1	1	1		1	1	1	1	1	1	1	21	18	86
Car washing and Commercial car wash facilities.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	21	100
Swimming pools - private		1	1	1	1	1	1	1	1		1	1	1		1	1	1	1	1	1	1	21	18	86
Use of buckets		1	1	1	1	1	1	1	1			1	1		1	1	1	1	1	1		21	16	76
Sprinklers and drip irrigation.	1	1	1	1		1	1	1					1		1	1	1		1	1		21	13	62
General notice on using water sparingly												1	1			1		1				21	4	19
Leaking taps		1					1			1	1						1	1			1	21	7	33
Water use for pubic and residential gardens by religious groups.				1	1			1											1			21	4	19
Mine dumps									1													21	1	5
Lawns			1				1		1		1						1					21	5	24
Paved areas.		1	1		1		1			1	1		1	1							1	21	9	43
Boreholes		1	1				1			1	1							1			1	21	7	33
Water Features							1				1						1				1	21	4	19

*Note these are the criteria and not the full list or wording of restrictions.

ANNEXURE B

SOUTH AFRICAN (RAND WATER SUPPLY AREA) MUNICIPAL WATER RESTRICTIONS 1995 (Sample only)

	Criteria of comparability	**HEIDELBERG**	**RANDFONTEIN**	**JOHANNESBURG**	**EDENVALE/MODDERFONTEIN METROPOLITAN SUBSTRUCTURE.**
1	Notice in terms of Government Notice.	Water restrictions from 1 July 1995. Residents drawn to water restrictions which were implemented in its area of jurisdiction.	Due to water restrictions implemented by the Rand Water Board, the Transitional Local Council of Randfontein took the following resolution: That a saving of 20% be accomplished by residential and business consumers and be implemented as from the first account delivered after 1 September 1995.	It is hereby notified that with effect from date of publication hereof, the water restrictions which became effective from 19 May 1986 in terms of section 17 read in conjunction with Section 84 of the Councils Water Supply By-laws are amended as follows;	Furthermore, in light of the urgency to conserve water, the council decided to impose the following water restrictions with effect from 1 September 1995.
2	Reference to Rand Water			The Rand Water Board requires that all automatic toilet flushing systems be turned off when not in use.	Due to the water crisis and the resulting increase in the water tariffs from Rand Water, The council resolved to implement the following amendments to its water tariffs with effect from 1 August 1995
3	Sliding scales & quotas		The additional rate for water supplied exceeding each consumers own average less 20% per month will be calculated as follows. R2.00 additional per kl consumed exceeding the prescribed consumption for September 1995, R3.00 additional per kl for October 1995, R4.00 additional per kl for November 1995. R5.00 additional per kl for December 1995 onwards.		Dwelling houses: for each kl or part thereof used: Up to 24kl – R1.33/kl 25kl to 45 kl – R2.00/kl 46kl to 65kl – R3.20/kl calculated on total consumption. >65kl – R4.00/kl calculated on total consumption.
4	Surcharges and Offences			Any persons failing to observe these restrictions will be prosecuted.	Any person using municipal water in contravention of these restrictions is guilty of an offence under one of the Water Supply By-laws and shall be prosecuted without prior warning.
5	Period of restrictions				
6	Residential	Domestic gardens may be	Houses and agricultural	Hoses held in the hand, micro-	The watering of residential gardens, with

	Criteria of comparability	HEIDELBERG	RANDFONTEIN	JOHANNESBURG	EDENVALE/MODDERFONTEIN METROPOLITAN SUBSTRUCTURE.
	gardens -Watering hours and months	watered on Wednesday between 14:00 and 15:00 and on Saturdays between 10:00 and 12:00 only.	holdings, connected to the Council's water supply with uneven numbers may water on Tuesday and Saturday between 17:00 and 18:00, while even numbers water on Wednesday and Sundays between 18:00 and 19:00. These times and dates were adopted for the use of garden hoses, drip or micro irrigation systems. Please note that the garden hose must be held in the hand.	mist, drip irrigation systems or permanently installed sprinkler systems may be used for watering residential gardens On Tuesdays between 16h00 and 17h00 and Saturdays between 14h00 and 15h00 for properties with even street numbers; On Wednesdays between 16h00 and 17h00 and Sundays between 14h00 and 15h00 for properties with uneven street numbers.	hoses and irrigation systems, be permitted between 17h00 and 19h00 from Monday to Sunday.
7	Garden hoses				
8	Recreation facilities	Playgrounds, sports fields, cricket pitches, bowling greens and golf tees (fairways of golf course excluded) may be watered on Tuesday and Thursday between 09:00 and 12:00		The use of water for watering sports facilities including the watering of playing fields, golf courses and race courses is prohibited. Any means may be used for the watering of cricket pitches, bowling greens and putting greens of golf courses (but not golf course fairways) between 07h30 and 09h30 on Mondays and Thursdays, Subject to such conditions as may be laid down by the City Engineer, any means may be used for the watering of race courses on two days a week, provided a saving in consumption of 30 percent over the corresponding period in 1982 be attained.	
9	Government & municipal parks/facilities	Government and provincial gardens, municipal parks and gardens as well as gardens at business undertakings may be watered on Tuesday and Fridays between 09:00 and 12:00	Schools, State Department, Old Age Homes and the Connie Mulder Centre may water their gardens on Wednesday between 08:00 and 10:00	Hoses held in the hand, micro-mist, drip irrigation or permanently installed sprinkler systems may be used for the watering of Government, Provincial and Municipal parks and gardens between 09h30 and 10h30 on Tuesdays and Fridays. Hoses held in the hand, micro-	The watering of Government, Provincial (including schools) and municipal gardens, parks playing fields, sports grounds, cricket pitches, bowling greens and greens of golf courses (excluding golf course fairways) and gardens of industrial and business undertakings, maybe permitted by any method but only from 09:00 to 12:00 on Mondays to

	Criteria of comparability	HEIDELBERG	RANDFONTEIN	JOHANNESBURG	EDENVALE/MODDERFONTEIN METROPOLITAN SUBSTRUCTURE.
				mist, drip irrigation or permanently installed sprinkler systems may be used for the watering of commercial and industrial undertakings between 09h30 and 10h30 on Tuesdays and Fridays.	Fridays. The use of sprinklers for irrigating lawns is prohibited.
10	"Bona Fide" nurseries	"Bona Fide" Nurseries may water plants on any day between 09:00 and 13:00		Any means may be used between 07h30 and 09h30 daily for watering of plants at bona fide nurseries.	The use of water by Bona fide nurseries shall be permitted by any method on any day, for two hours at the utmost as determined by the Town Engineer.
11	"Bona Fide" landscapers	Water may be used daily by "Bona Fide" landscapers and gardening contracts for the establishment of the garden between 10:00 and 12:00 for a maximum period of 3 weeks after the establishment of the garden. A permit has to be obtained beforehand by the contractor from the local authority. The permit will be issued in the contractors name and provisions will be made for the occupant of the particular stand to use the water on the contractors behalf.		Any means may be used by bona fide landscape gardeners, designers, contractors and property owners for watering newly laid-out gardens daily, either between 07h30 and 09h30 or between 15h00 and 17h00 for a period of three weeks from the date of commencement of planting, subject to a permit obtained from the City Engineer authorizing such use of water in respect of each property.	The use of water by Bona fide landscape gardens and landscape designers and contractors for newly established gardens is permitted by any method except sprinklers, for two hours at the utmost as determined by the Town Engineer and only for a period of three weeks from the date of commencement of planting, provided that permit authorizing such use of water has been issued by the Town Engineer in respect of each property or garden. The permit must be issued to the landscaper but allowance may be made for the occupier of the property to which it pertains to utilize water on the landscaper's behalf.
12	Free running water from municipal system.	It is prohibited to channel water in gardens or any other areas from a running tap connected to the municipal supply system.		Free running taps for gardening or other purposes are prohibited. No wastage of water will be allowed.	The leading of water for gardening or any other watering purposes from a free running tap connected to a municipal supply system is prohibited.
13	Toilet systems	All automatic toilet flushing system in all buildings have to be turned off during non working hours when such building has been vacated by the public and/or personnel, cleaners excepted.		The Rand Water Board requires that all automatic toilet flushing systems be turned off in all buildings after normal business hours, that hoses be disconnected from taps at all times other than during permitted watering hours,	All automatic toilet flushing systems shall be turned off in all buildings during times when such buildings are normally vacated by the public and/or staff other than cleaning staff.
14	Car washing and Commercial car wash facilities.	Hosepipes may not be used to wash vehicles, except where such hosepipes are part of the	Vehicles may not be washed with hoses.	The use of water for the washing of vehicles by any means other than with buckets is prohibited.	The use of hoses for washing vehicles shall be permitted, other than hoses used in conjunction with commercial vehicle

	Criteria of comparability	HEIDELBERG	RANDFONTEIN	JOHANNESBURG	EDENVALE/MODDERFONTEIN METROPOLITAN SUBSTRUCTURE.
		commercial carwash installation.		Commercial car washing machines may be used for the washing of vehicles, provided a saving in consumption of 20 percent over the corresponding period in 1982 is attained.	washing installations and equipment.
15	Swimming pools - private	Water may not be used to fill swimming pools except when. a) Filling newly built swimming pools (once only) and the filling of swimming pools which had to be emptied for repair purposes. A permit has to be obtained from the local authority. b) Topping up swimming pools due to normal evaporation and backwash of filters.		The use of water for the filling of swimming pools is prohibited except for; a) The filling of newly constructed swimming pools: b) The filling of swimming pools that have been emptied for the purposes of repair, subject to permission being obtained from the City Engineer: c) The replacement of water losses due to evaporation.	No permits are required for the filling of swimming pools.
16	Use of buckets	Gardens may be watered at any time with buckets and watering cans.		The use of water for gardening and horticultural purposes, by any means other than buckets or watering cans is prohibited.	The watering of gardens by means of buckets and watering cans shall be permissible at any time.
17	Sprinklers and drip irrigation.		These times and dates were adopted for the use of garden hoses, drip or micro irrigation systems. Please note that the garden hose must be held in the hand.	Hoses held in the hand, micro-mist, drip irrigation systems or permanently installed sprinkler systems may be used for watering residential gardens	The use of sprinklers for irrigating lawns is prohibited. Permits are no longer required for the use of irrigation systems.
19	General notice on using water sparingly	Residents are kindly requested to use water sparingly to prevent the implementation of further restrictions.			
20	Leaking taps			All leaking taps and pipes are to be repaired as soon as the problem becomes evident. Water feature using either cascading or fountain style shall have their water flow rates reduced for	

	Criteria of comparability	**HEIDELBERG**	**RANDFONTEIN**	**JOHANNESBURG**	**EDENVALE/MODDERFONTEIN METROPOLITAN SUBSTRUCTURE.**
				daytime use and shall be turned off after dark.	
21	Water use for pubic and residential gardens by religious groups.				
23	Mine dumps				
24	Lawns				The use of sprinklers for irrigating lawns is prohibited.
25	Paved areas.			…and that the use of water for washing of paved areas be discontinued except where it is essential for health reasons.	The use of hoses for the washing of driveways (including public garages), any surface or other area is prohibited.
26	Boreholes			For their own convenience, persons or organisations using borehole water for gardening, sporting or horticultural purposes are requested to display a notice to this effect in a prominent position on their properties.	Borehole Water: may be used, but please display a sign “Borehole Water” at your gate to avoid complaints
27	Water Features				

ANNEXURE C

WATER ALLOCATION FRAMEWORK FOR VICTORIA AUSTRALIA IN TABLE FORM.

Item & stage	Victoria - Australia Water framework				
Stage		Stage 1	Stage 2	Stage 3	Stage 4
Residential and Commercial Gardens and Lawns	Irrigation systems.	Manual sprinklers must not be used except between the hours of 6:00 am and 8:00 am and between the hours of 8:00 pm and 10:00 pm on alternative days[1]. Automatic sprinklers must not be used except between the hours of midnight and 4:00am on alternative days[1].	Manual sprinklers must not be used except between the hours of 6:00 am and 8:00 am and between the hours of 8:00 pm and 10:00 pm on alternative days[1]. Automatic sprinklers must not be used except between the hours of midnight and 4:00am on alternative days[1].	Garden areas (other than lawn) may be watered only as required by a manual dripper system or hand-held hose fitted with a trigger mechanism between 6am – 8am and 8pm – 10pm; or an automated dripper system only as required between midnight - 4am; on specified days[2] Note: No other sprinkler system is allowed	
	Lawns		Watering of lawns is BANNED	Watering of lawns is BANNED	All outside watering is BANNED. No watering at any time, by any means.
	Hand held hoses.	Hand-held hoses with a trigger nozzle, a bucket or watering can may be used at any time.	Hand-held hoses with a trigger nozzle, a bucket or watering can may be used at any time.		
Public Gardens and Lawns	Irrigation systems	Manual sprinklers must not be used except between the hours of 6:00 am and 8:00 am and between the hours of 8:00 pm and 10:00 pm on alternative days[1]. Automatic sprinklers must not be used except between the hours of midnight and 4:00am on alternative days[1].	Manual sprinklers must not be used except between the hours of 6:00 am and 8:00 am and between the hours of 8:00 pm and 10:00 pm on alternative days[1]. Automatic sprinklers must not be used except between the hours of midnight and 4:00am on alternative days[1].	Garden areas (other than lawn) may be watered only as required by a manual dripper system or hand-held hose fitted with a trigger mechanism between 6am - 10am and 8pm - midnight; or an automated dripper system only as required between midnight - 8am; on specified days[2] Note: No other sprinkler system is allowed.	
	Lawns		Watering of lawns is BANNED	Watering of lawns is BANNED	All outside watering is BANNED. No watering at any time, by any means.
	Hand held hoses	Hand-held hoses with a trigger nozzle, a bucket or watering can may be used at any time. Notwithstanding the above, a public garden may be watered in accordance with an approved Water Conservation Plan.	Hand-held hoses with a trigger nozzle, a bucket or watering can may be used at any time. Notwithstanding the above, a public garden may be watered in accordance with an approved Water Conservation Plan.		
Sporting		Some specified playing surfaces	Some specified playing surfaces	Watering banned on non-exempt	

Item & stage	Victoria - Australia Water framework				
Stage		Stage 1	Stage 2	Stage 3	Stage 4
Grounds		are exempt from the above restrictions. Please contact your local water business for more information.	are exempt from restrictions. Please contact your local water business for more information.	playing surfaces e.g. grassed oval or fairway. Exempt surfaces (e.g. cricket pitch, tennis court, golf and bowling green, and running track) can be watered by manual dripper systems and hand-held hoses only as required between 6am - 10am and 8pm - midnight, or on automated watering systems only as required between midnight - 8am on specified days[2].	All outside watering is BANNED. No watering at any time, by any means.
Paving, concrete and other hard surfaces		Hosing banned except for construction purposes or in emergency; or for health or safety hazard.	Hosing banned except for construction purposes or in emergency; or for health or safety hazard.	Hosing banned except for construction purposes or in emergency; or for health or safety hazard.	Hosing banned except for construction purposes or in emergency; or for health or safety hazard.
Vehicles		A bucket, high pressure cleaning device or commercial car wash can be used at any time for vehicle washing. A hand-held hose fitted with a trigger nozzle can only be used for pre-rinsing and rinsing.	Hand-held hoses cannot be used at any time for vehicle washing. A bucket, watering can, high pressure cleaning device or commercial car wash can be used.	Water must not be used to clean a vehicle except by means of a commercial carwash (which use less than 70 litres of water per vehicle where water is drawn from your local water business reticulated water system); or a bucket filled directly from a tap (and not by means of a hose) to clean vehicle windows, mirrors and lights and for spot-removing corrosive substances.	A vehicle may only be washed for health and safety reasons, in which case the windows and lights must be washed and rinsed by means of a bucket, filled directly from the tap (not by hose). Commercial car washes which use water from a source other than your local water business reticulated water system can be used.
Residential or Commercial Pools and Spas		To fill or top up a new or existing pool or spa with a capacity 2,000 litres or less, a hand-held hose fitted with a trigger nozzle, a watering can or a bucket must be used. Pools and spas of greater than 2000 litres capacity must not be filled unless a Water Conservation Plan has been submitted to your local water business and approved.	To fill or top up a new or existing pool or spa with a capacity 2,000 litres or less, a hand-held hose fitted with a trigger nozzle, a watering can or a bucket must be used. Pools and spas of greater than 2000 litres capacity must not be filled unless a Water Conservation Plan has been submitted to your local water business and approved.	All previous exemptions are void. Cannot be filled, added to or replaced without prior written aopproval.	Cannot be filled, added to or replaced without prior written approval. Can be topped up by bucket only.
Special notes.		[1] Alternate days means odd numbered houses can water on odd dates of the month and even numbered houses can water on	[1] Alternate days means odd numbered houses can water on odd dates of the month and even numbered houses can water on	[2] Specified days means Sunday and Wednesday for odd-numbered properties. Saturday and Tuesday for even-numbered and unnumbered	**Emergency Procedures** If it is considered by a water business that Stage 4 restrictions are insufficient

Item & stage	Victoria - Australia Water framework				
Stage		Stage 1	Stage 2	Stage 3	Stage 4
		even numbered dates. Both odd and even numbered houses can water on the 31st of the month. Where there is no house number the property is considered an even numbered house.	even numbered dates. Both odd and even numbered houses can water on the 31st of the month. Where there is no house number the property is considered an even numbered house.	properties. No watering on Monday, Thursday and Friday.	to reduce consumption to a level adequate to meet future demands at that level of restriction, water businesses may declare emergency measures to further restrict water consumption in the specified area. Such measures may involve restricting the volume of water available to consumers or restricting the use of water in industries which are not affected by Stage 4 restrictions. Emergency measures would not be declared without the written approval of the State Minister or Ministers responsible for water resource management.

http://www.dse.vic.gov.au/DSE/wcmn202.nsf/LinkView/B06B63833D18AA4DCA257211001312D9B4D07B20BF8AB51ACA2572100009B86F (26 February 2007)

ANNEXURE D

WATER ALLOCATION FRAMEWORK FOR VICTORIA AUSTRALIA AS EXTRACTED FROM INTERNET.

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Water

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About Water Restrictions

There are now four stages of urban water restrictions applicable for the whole of Victoria. The following information provides summary of the key restrictions that may be in place for urban water users under Stage 1 to Stage 4 water restrictions.

Water Restriction

The following information provides a summary of the key restrictions in place for urban water users under Stage 1 to Stage 4 water restrictions.

Stage 1 Water Restrictions Fact Sheet
Stage 2 Water Restrictions Fact Sheet
Stage 3 Water Restrictions Fact Sheet
Stage 4 Water Restrictions Fact Sheet

PLEASE NOTE:

This information is provided as a guide ONLY.

CHECK with your local water authority for information on water restrictions that may be in place in your area. While all restriction policies are based on Victorian Uniform Drought Water Restriction Guidelines for the State, there may be minor variations in the details to account for local conditions.

Restrictions are only applicable to customers on a reticulated supply. These restrictions do not apply to customers using rainwater or bore water.

Exemptions from water restrictions, to cover certain circumstances, can be applied for through your local water authority.

Penalties

Water restrictions must be followed. If you are served with a warning notice and still breach the restrictions, you may have yc water supply restricted and face fines or jail.

STAGE 1 WATER RESTRICTIONS FACT SHEET

The following provides a summary of key Stage 1 water restrictions. Contact your local water business for further informatior on water restrictions that may be in place in your area.

Residential and Commercial Gardens and Lawns

Manual sprinklers must not be used except between the hours of 6:00 am and 8:00 am and between the hours of 8:00 pm ar 10:00 pm on alternative days[1].

Automatic sprinklers must not be used except between the hours of midnight and 4:00am on alternative days[1].

Hand-held hoses with a trigger nozzle, a bucket or watering can may be used at any time.

Public Gardens and Lawns

Manual sprinklers must not be used except between the hours of 6:00 am and 8:00 am and between the hours of 8:00 pm ar 10:00 pm on alternative days[1].

Automatic sprinklers must not be used except between the hours of midnight and 4:00am on alternative days[1].

Hand-held hoses with a trigger nozzle, a bucket or watering can may be used at any time.

Notwithstanding the above, a public garden may be watered in accordance with an approved Water Conservation Plan.

Sporting Grounds

Some specified playing surfaces are exempt from the above restrictions. Please contact your local water business for more information.

Paving, concrete and other hard surfaces

Hosing banned except for construction purposes or in emergency; or for health or safety hazard.

Vehicles

A bucket, high pressure cleaning device or commercial car wash can be used at any time for vehicle washing. A hand-held hose fitted with a trigger nozzle can only be used for pre-rinsing and rinsing.

Residential or Commercial Pools and Spas

To fill or top up a new or existing pool or spa with a capacity 2,000 litres or less, a hand-held hose fitted with a trigger nozzle, a watering can or a bucket must be used.

Pools and spa's of greater than 2000 litres capacity must not be filled unless a Water Conservation Plan has been submitted to your local water business and approved.

[1] Alternate day's means odd numbered houses can water on odd dates of the month and even numbered houses can water on even numbered dates. Both odd and even numbered houses can water on the 31st of the month. Where there is no house number the property is considered an even numbered house.

STAGE 2 WATER RESTRICTIONS FACT SHEET

The following provides a summary of key Stage 2 water restrictions. Contact your local water business for further information on water restrictions that may be in place in your area.

Residential and Commercial Gardens and Lawns

Watering of lawns is BANNED

Manual sprinklers must not be used except between the hours of 6:00 am and 8:00 am and between the hours of 8:00 pm and 10:00 pm on alternative days[1].

Automatic sprinklers must not be used except between the hours of midnight and 4:00am on alternative days[1].

Hand-held hoses with a trigger nozzle, a bucket or watering can may be used at any time.

Public Gardens and Lawns

Watering of lawns is BANNED

Manual sprinklers must not be used except between the hours of 6:00 am and 8:00 am and between the hours of 8:00 pm and 10:00 pm on alternative days[1].

Automatic sprinklers must not be used except between the hours of midnight and 4:00am on alternative days[1].

Hand-held hoses with a trigger nozzle, a bucket or watering can may be used at any time.

Notwithstanding the above, a public garden may be watered in accordance with an approved Water Conservation Plan.

Sporting Grounds

Some specified playing surfaces are exempt from restrictions. Please contact your local water business for more information.

Paving, concrete and other hard surfaces

Hosing banned except for construction purposes or in emergency; or for health or safety hazard.

Vehicles

Hand-held hoses cannot be used any time for vehicle washing. A bucket, watering can, high pressure cleaning device or commercial car wash can be used.

Residential or Commercial Pools and Spas

To fill or top up a new or existing pool or spa with a capacity 2,000 litres or less, a hand-held hose fitted with a trigger nozzle, a watering can or a bucket must be used.

Pools and spa's of greater than 2000 litres capacity must not be filled unless a Water Conservation Plan has been submitted to your local water business and approved.

[1] Alternate day's means odd numbered houses can water on odd dates of the month and even numbered houses can water on even numbered dates. Both odd and even numbered houses can water on the 31st of the month. Where there is no house number the property is considered an even numbered house.

STAGE 3 WATER RESTRICTIONS FACT SHEET

The following provides a summary of key Stage 3 water restrictions. Contact your local urban water business for further information on water restrictions that may be in place in your area.

Residential and Commercial Gardens and Lawns

Watering of lawns is BANNED

Garden areas (other than lawn) may be watered only as required by a manual dripper system or hand-held hose fitted with a trigger mechanism between 6am – 8am and 8pm – 10pm; or an automated dripper system only as required between midnight - 4am; on specified days[2]

Note: No other sprinkler system is allowed.

Public Gardens and Lawns

Watering of lawns is BANNED

Garden areas (other than lawn) may be watered only as required by a manual dripper system or hand-held hose fitted with a trigger mechanism between 6am - 10am and 8pm - midnight; or an automated dripper system only as required between midnight - 8am; on specified days[2]

Note: No other sprinkler system is allowed.

Sporting Grounds

Watering banned on non-exempt playing surfaces e.g. grassed oval or fairway.
Exempt surfaces (e.g. cricket pitch, tennis court, golf and bowling green, and running track) can be watered by manual dripper systems and hand-held hoses only as required between 6am - 10am and 8pm - midnight, or on automated watering systems only as required between midnight - 8am on specified days[2].

Paving, concrete and other hard surfaces

Hosing banned except for construction purposes or in emergency; or for health or safety hazard.

Vehicles

Water must not be used to clean a vehicle except by means of a commercial carwash (which use less than 70 litres of water per vehicle where water is drawn from your local water business reticulated water system); or a bucket filled directly from a tap (and not by means of a hose) to clean vehicle windows, mirrors and lights and for spot-removing corrosive substances.

Residential or Commercial Pools and Spas

All previous exemptions are void. Cannot be filled, added to or replaced without prior written aopproval.
[2] Specified days means Sunday and Wednesday for odd-numbered properties. Saturday and Tuesday for even-numbered and unnumbered properties. No watering on Monday, Thursday and Friday**.**

STAGE 4 WATER RESTRICTIONS FACT SHEET

The following provides a summary of key Stage 4 water restrictions. Contact your local water business for further information on water restrictions that may be in place in your area.

Residential and Commercial Gardens and Lawns

All outside watering is BANNED. No watering at any time, by any means.

Public Gardens and Lawns

All outside watering is BANNED. No watering at any time, by any means.

Sporting Grounds

All outside watering is BANNED. No watering at any time, by any means.

Paving, concrete and other hard surfaces

Hosing banned except for construction purposes or in emergency; or for health or safety hazard.

Vehicles

A vehicle may only be washed for health and safety reasons, in which case the windows and lights must be washed and rinsed by means of a bucket, filled directly from the tap (not by hose). Commercial car washes which use water from a source other than your local water business reticulated water system can be used.

Residential or Commercial Pools and Spas

Cannot be filled, added to or replaced without prior written approval. Can be topped up by bucket only.

Emergency Procedures

If it is considered by a water business that Stage 4 restrictions are insufficient to reduce consumption to a level adequate to meet future demands at that level of restriction, water businesses may declare emergency measures to further restrict water consumption in the specified area. Such measures may involve restricting the volume of water available to consumers or restricting the use of water in industries which are not affected by Stage 4 restrictions. Emergency measures would not be declared without the written approval of the State Minister or Ministers responsible for water resource management.

Water users should contact their local water authority for detailed information about restrictions which apply in their area. Link to water authorities ...

For general information about DSE please contact:
Customer Service Centre: 136 186
TTY: 1800 122969
VBIL: 1800 240 667
Email: customer.service@dse.vic.gov.au
Department of Sustainability and Environment, Victoria, Australia

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This document was last reviewed on 18/01/2007 http://www.dse.vic.gov.au/DSE/wcmn202.nsf/LinkView/B06B63833D18AA4DCA257211001312D9B4D07B20BF8AB51ACA2572100009B86F

26 February 2007

Permanent Water Saving Rules

The Victorian Government is committed to reducing demand for water and ensuring the efficient use of water at all times.

Action 5.4 of the Our Water Our Future White Paper requires all water authorities to introduce Permanent Water Saving Rules which are developed at the local level and suitable for local conditions. This commitment recognises that inefficient and unacceptable uses of our valuable water resources should no longer be permitted.

Melbourne introduced Permanent Water Saving Rules on 1 March 2005. The five key Permanent Water Saving Rules are:

- Use manual watering systems only between 8pm and 10am
- Use automatic watering systems only between 10pm and 10am
- Fit your hose with a trigger nozzle
- No hosing paved areas
- Apply to fill a new pool

Penalties apply to those who don't follow the Rules.

Water authorities have the power to grant exemptions from restrictions for those with special needs (e.g. shift workers, infirm individuals who cannot use buckets) and have principles in place to ensure the consistent treatment of exemption applications.

Details on the Permanent Water Saving Rules for Melbourne are available on the Our Water Our Future website or from your retail water authority's website.

The regional water authorities will be developing and implementing their Permanent Water Saving Rules in 2006. More information on these can be found on individual regional water authority's websites.

While Permanent Water Saving Rules won't prevent the need for water restrictions during major drought periods, they will help to stop water wastage and encourage all of us to value this precious resource for the long term.

For general information about DSE please contact:
Customer Service Centre: 136 186
TTY: 1800 122969
VBIL: 1800 240 667
Email: customer.service@dse.vic.gov.au
Department of Sustainability and Environment, Victoria, Australia

Printer friendly version

This document was last reviewed on 03/08/2006

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26 February 2007

Annexure E

WATER CONSERVATION QUESTIONNAIRE FOR THE GREEN INDUSTRY 2008

INTERVIEWER, PLEASE NOTE THE FOLLOWING ABOUT THIS STUDY:

The purpose of this research project is to investigate the current water restrictions and associated data that are in existence within municipal structures. It is also aimed at determining whether an improved "system" of water restrictions could be created and be proposed to the local authorities for implementation as an alternative. This will greatly benefit the Green Industry and their customers.

This questionnaire has been designed to help determine the respondents' knowledge, awareness and implementation of water conservation measures/initiatives and obtain some suggestions for a way forward. On completion of the results, the research will be made available to the SA Green Industry.

PERSON TO BE INTERVIEWED:
Green Industry players - **Owner/manager/financial manager**
In NO instances can the secretary, PA, etc. be interviewed.

SECTION A1: INTERVIEWER INFORMATION

Name and surname: .... Telephone no: ....

/A1

I, the interviewer, was fully briefed by my supervisor regarding the survey and sample specifications. I also read the briefing document, worked through the questionnaire and fully understand the interview process. I conducted the interview and checked if all questions were answered.

Signature: .... Date: ....

SECTION A2: DATA CAPTURER

Name and surname: ....

/A2

SECTION A3: INTERNAL DATA CONTROL (FOR INTERNAL USE)

PAGE AND QUESTION NUMBERS WITH ERRORS	TICK IF ERRORS SORTED OUT	TICK IF ERRORS BACK-CHECKED	PAGE AND QUESTION NUMBERS WITH ERRORS	TICK IF ERRORS SORTED OUT	TICK IF ERRORS BACK-CHECKED

/A3

SECTION A4: INTERVIEW INFORMATION (INTERVIEWER MAKE SURE TO COMPLETE.)

Call history	Date of interview	Time started	Time finished	Total time in minutes	Reasons for failed attempt
First attempt					
Second attempt					
Third attempt					

/A4

SECTION A5: CO-ORDINATOR INFORMATION

Name and surname: .... Telephone no: ....

/A5

I, the coordinator/supervisor fully briefed all interviewers and made sure that they understood the interview process and sample specifications. I also checked the questionnaire and made sure that all questions have been answered satisfactorily.

Signature: .... Date: ....

INTERVIEWER: Good day, I am from MSSA, a market research house. We are conducting a SURVEY AMONGST PEOPLE IN THE GREEN INDUSTRY TO OBTAIN THEIR OPPINIONS ABOUT WATER RESTRICTIONS AND OTHER WATER WISE MATTERS

Name of respondent:		/A6
Physical address of organisation:		/A7
Contact details:	**Office:** **Cell:** **E-mail address:**	/A8

Which Green Industry organisation are you a member of?	South African Nursery Association (SANA)	1	
	Landscape Irrigation Association (LIA)	2	
	South African Landscape Institute (SALI)	3	
	Institute of Environment and Recreation Management (IERM)	4	/A9

[Interviewer: Please read the following to the respondent before commencing with the interview.]

The last major drought to hit the Gauteng area of South Africa occurred in 1995/6. During that drought government imposed water saving quotas onto the water supply authorities such as Rand Water who in turn passed these quotas onto municipalities. Municipalities in turn reacted by imposing water restrictions onto the end user.

The SA Green Industry has an opportunity to be proactive to conserve resources that will positively influence it's consumers to be more environmentally responsible and sustainable.

The information obtained from members and used in this research process will be kept **completely confidential**. Only generalized results will be published and **no specific user information/details will be published or made known** to anyone. **Your honest and detailed information will help** in taking this research to the next level and to ensure that an improved result is obtained for the sake of the Green Industry.

SECTION B: DEMOGRAPHICS

1. What is your gender?

Male	1	
Female	2	/1

2. What is your age?

20 to 30 yrs	1	
31 to 40 yrs	2	
41 to 50 yrs	3	
51 to 60 yrs	4	
60+ yrs	5	/2

3. What is your title?

Mr	1	
Ms/Mrs	2	
Dr	3	
Prof	4	
Other (please specify)	5	/3

4.1 Which organisation do you work for?
..../4.1

4.2 Into which municipal area does your organisation fall?
..../4.2

5. What is your current position within your organisation?

Owner/Private	1	
Top management	2	
Middle management	3	
Supervisor	4	
Other (please specify)	5	/5

6.1 How many years of experience do you have in the Green Industry? .... years /6.1

6.2 When did you start working at your current organisation (e.g. 2001)? ..../6.2

7. Please provide us with an industry description by **a)** indicating which percentage (%) of your current or mainline business falls under which of the following industry descriptions and **b)** the annual business turnover (not profits), to the nearest million, for each respective industry player your organisation is involved with.

Industry description	a) %		b) Annual business turnover in millions of Rands e.g. R7.5 million	
Landscape Irrigation Association (LIA)		/7a.1		/7b.1
South African Landscape Institute (SALI)		/7a.2		/7b.2
Institute of Environment and Recreation Management (IERM)		/7a.3		/7b.3
Indoor Plantscapes of South Africa (IPSA)		/7a.4		/7b.4
Lawn Mower Association (LMA)		/7a.5		/7b.5
International Plant Propagations Society (IPPS)		/7a.6		/7b.6
Green Keepers Association (GCF)		/7a.7		/7b.7
South African Nursery Association (SANA)		/7a.8		/7b.8
Ornamental Growers Ass		/7a.9		/7b.9
Rose Growers Ass		/7a.10		/7b.10
Allied trade Ass		/7a.11		/7b.11
Indigenous Plant Growers Ass		/7a.12		/7b.12
Garden Centre Ass		/7a.13		/7b.13
Bedding Plant Growers ass		/7a.14		/7b.14
Other (please specify)		/7a.15		/7b.15
TOTAL	100 %	TOTAL ANNUAL TURNOVER	R	/7b.16

8. Please indicate the number of staff employed by your organisation.

	Number of staff	
Owner/Private		/8.1
Top management		/8.2
Middle management		/8.3
Supervisor		/8.4
Other (please specify)		/8.5
TOTAL NUMBER OF STAFF		/8.6

9. Please indicate **a)** the amount of water <u>(in kilolitres)</u> used by your organisation <u>per annum</u> as well as **b)** the percentage (%) usage from each of the sources below.

	a) Kilolitres		b) %	
Borehole		/9a.1		/9b.1
Collected from rain/runoff		/9a.2		/9b.2
Direct from bulk water authority		/9a.3		/9b.3
Municipal		/9a.4		/9b.4
Other (please specify)		/9a.5		/9b.5

[Interviewer: Please read the following definitions to the respondent and make sure they understand the meanings]

For the purposes of this questionnaire the terms <u>drought management plan</u> and <u>water conservation plan</u> are interpreted as having <u>the same meaning.</u>
Water restrictions are seen as different rules such as when to water or not.
Drought management plans are seen as a "controlled" map of moving from one state of water scarcity to the next. Water restrictions would form part of a drought management plan.
Drought is a long term and continuous period during which the rainfall recorded is below the average. A drought is not related to the actual amount of rain received but rather to deviations from the norm. For example, a Free State wheat farmer who normally receives 600mm a year might go bankrupt if he receives only 400mm (Earle & Beagle, 1990:38).

SECTION C: GENERAL QUESTIONS

10.1 Does your local authority have water restrictions by law?

Yes	1
No	2
Uncertain/Don't know	99

/10.1

10.2. Please answer the following questions:

	Not at all	To a small extent	To some extent	To a great extent	Uncertain	
If YES, to what extent are you aware of what these water restrictions are?	1	2	3	4	99	/10.1
To what extent has your current organisation <u>ever</u> been affected by water restrictions in the past?	1	2	3	4	99	/10.2
What year was this?						/10.3
To what extent has your current organisation <u>ever</u> been affected by drought in the past?	1	2	3	4	99	/10.4

SECTION D: WATER RESTRICTIONS 1995/6
(If you were not part of your current organisation during the 1995/6 water restrictions please proceed to question 15)

[Interviewer please note if respondents is uncertain or does not know – DK]

11. Please answer the following questions:

Which local municipality did your organisation fall under at that time?		/11.1
Who was your organisation's bulk water supplier at that time? E.g. Rand Water or Magalies Water		/11.2

12. To what extent did your local authority or bulk water service supplier, satisfactorily do the following:

	Not at all	To a small extent	To some extent	To a great extent	Uncertain	
Did your local authority <u>provide support</u> in the form of information to your organisation during the last water restrictions?	1	2	3	4	99	/12.1
Did your bulk water service provider (e.g. Rand Water or Magalies Water) <u>provide support</u> in the form of information to your organisation during the last water restrictions?	1	2	3	4	99	/12.2
Did your local authority <u>communicate these restrictions</u> to your organisation prior to enforcing them?	1	2	3	4	99	/12.3
Did your local authority <u>ask you for input and comments</u> regarding any of the water restrictions prior to enforcing them?	1	2	3	4	99	/12.4
Did the water restrictions imposed in 1995/6 in Gauteng work at the time?	1	2	3	4	99	/12.5
Did they change your long term outlook on water usage?	1	2	3	4	99	/12.6

13.1 Did the water restrictions influence your business negatively?

Yes, negatively	1
No, not at all	2
Uncertain/Don't know	99

/13.1

13.2 If YES, please motivate your answer.

....

..../13.2

14. Which of the following aspects encouraged your business to conserve the most water in 1995/6? *(Can select **more** than one)*

Water restrictions	1
Water price increases	2
Water source ran dry/low? (e.g. borehole/dam, etc.)	4
Environmental consciousness	5
Other (please specify)	6

/14

SECTION E: MEDIA

15. Please indicate if you think each of the following media sources have successfully communicated the water conservation message to the green industry. Please provide an answer for each.

	Yes	No	Uncertain	
Newspapers	1	2	99	/15.1
Gardening magazines	1	2	99	/15.2
General magazines	1	2	99	/15.3
Radio	1	2	99	/15.4
Television	1	2	99	/15.5
Billboards	1	2	99	/15.6
Adverts	1	2	99	/15.7
Advertorials in magazines	1	2	99	/15.8
Newsletters from industry institutions	1	2	99	/15.9
Rand Water Horticultural and Water Services Forum	1	2	99	/15.10
Monthly municipal billing service information	1	2	99	/15.11
Flyers	1	2	99	/15.12
Emails	1	2	99	/15.13
Internet sites	1	2	99	/15.14
Other (please specify)	1	2	99	/15.15

SECTION F: LOCAL AUTHORITY CURRENT INFORMATION

16.1 Does your local authority run educational programs that promote water conservation practises to end users?

Yes	1
No	2
Uncertain/Don't know	99

/16.1

16.2 If YES, please describe what they are.

....
....
....../16.2

SECTION G: RAND WATER's WATER WISE® BRAND

17. To what extent has the Water Wise® brand done the following:

	Not at all	To a small extent	To some extent	To a great extent	Uncertain	
Assisted your organisation in any way?	1	2	3	4	99	/17.1
Influenced your customers in any way?	1	2	3	4	99	/17.2
Had a positive influence on your organisation?	1	2	3	4	99	/17.3
Had a positive influence on your customers?	1	2	3	4	99	/17.4
Helped your organisation conserve water?	1	2	3	4	99	/17.5
Helped your customers become more aware of water conservation?	1	2	3	4	99	/17.6
To what extent do you associate the Water	1	2	3	4	99	/17.7

Wise® brand with a positive image?						
To what extent does the Water Wise® brand assist in promoting water conservation?	1	2	3	4	99	/17.8

18. Please answer the following questions:

	Yes	No	
Have you ever visited the Rand Water website? (www.randwater.co.za)	1	2	/18.1
Have you ever used any of the Rand Water information (e.g. brochures) to assist your organisation with water conservation?	1	2	/18.2

19. Please explain how the Water Wise® brand can offer support to your organisation?

………

………/19

SECTION H: COMMUNICATION TO CUSTOMERS

20. Please answer the following question:

	Yes	No	Uncertain/ Don't know	
Does your organisation currently communicate to your customers about water conservation?	1	2	99	/20

21. Which of the following media sources does your organisation **a)** currently use to communicate to your customers about water conservation and **b)** which one of these sources do you think is most effective? *(Choose only **one)***

	a) Currently use		b) Most effective	
None	0	/21a.1		
Flyers	1	/21a.2	1	/21b.1
Training and training courses	2	/21a.3	2	/21b.2
Displays	3	/21a.4	3	/21b.3
Newsletters	4	/21a.5	4	/21b.4
Talks	5	/21a.6	5	/21b.5
Adverts in gardening and specialized magazines	6	/21a.7	6	/21b.6
Adverts in local papers inclusive of caxtons	7	/21a.8	7	/21b.7
E-mail	8	/21a.9	8	/21b.8
Internet site	9	/21a.10	9	/21b.9
Radio	10	/21a.11	10	/21b.10
Television	11	/21a.12	11	/21b.11
Other (please specify)	12	/21a.13	12	/21b.12

SECTION I: STAFF COMMUNICATION

22. Does your organisation currently communicate to your staff about water conservation?

Yes	1	
No	2	
Uncertain/Don't know	99	/22

23. Which of the following methods does your organisation **a)** currently use to communicate to staff about water conservation and **b)** which one of these sources do you think is most effective? *(Choose only **one)***

	a) Currently use		b) Most effective	
None	0	/23a.1		
In-house training and training courses	1	/23a.2	1	/23b.1
External training courses	2	/23a.3	2	/23b.2
Hands-on training	3	/23a.4	3	/23b.3
Written information (e.g. brochures, leaflets, magazines)	4	/23a.5	4	/23b.4
Other (please specify)	5	/23a.6	5	/23b.5

SECTION J: POSSIBLE FUTURE WATER RESTRICTION METHODS

[Interviewer: Please explain the following levels to the respondents.]

Level 0 will apply to all situations regardless of a drought or no drought. Level 1 will mean that a 20% saving is required of the industry/users. Level 2 will mean that a 30% saving is required by the industry/users. **Level 3 will mean that the severest water restrictions are in force and human survival mode is in play (40% saving required).**

For each level of saving please mention the restriction you think is applicable.

I. IN TERMS OF WATERING RESIDENTIAL GARDEN, OFFICE PARKS, INDUSTRIAL PARKS, ALL GOVERNMENT AND MUNICIPAL PARKS, GROUNDS AND FACILITIES (EXCLUDING GRASS/LAWNS).

24. Which water restriction method should be implemented during each of the following levels of water saving? For Level 0 mention the **a)** number of days per week allowed to water, **b)** number of hours allowed per day and **c)** preferred days of the week watering allowed. Do the same for Level 1, 2 and 3.

Saving required	a) Number of days per week allowed to water		b) Number of hours per day		c) Preferred days of the week watering allowed								
Level 0 (during normal years)		/24a.1		/24b.1	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/24c.1
Level 1 (20% saving required)		/24a.2		/24b.2	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/24c.2
Level 2 (30% saving required)		/24a.3		/24b.3	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/24c.3
Level 3 (40% saving required)		/24a.4		/24b.4	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/24c.4

II. IN TERMS OF RECREATION FACILITIES (PRIVATE, COMMERCIAL, GOVERNMENT AND LOCAL AUTHORITY).

25. Which water restriction method should be implemented during each of the following levels of water saving? For Level 0 mention the **a)** number of days per week allowed to water, **b)** number of hours allowed per day and **c)** preferred days of the week watering allowed. Do the same for Level 1, 2 and 3.

Saving required	a) Number of days per week allowed to water		b) Number of hours per day		c) Preferred days of the week watering allowed								
Level 0 (during normal years)		/25a.1		/25b.1	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/25c.1
Level 1 (20% saving required)		/25a.2		/25b.2	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/25c.2
Level 2 (30% saving required)		/25a.3		/25b.3	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/25c.3
Level 3 (40% saving required)		/25a.4		/25b.4	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/25c.4

26. At what level should water restrictions be implemented for each of the following facility types?

Restrictions of facilities	Level 0 (during normal	Level 1 (20% saving required)	Level 2 (30% saving	Level 3 (40% saving required)	Should never be considered

	years)		required)		
Golf course rough	1	1	1	1	1
Golf course fairway	2	2	2	2	2
Golf course green	3	3	3	3	3
Cricket outfield	4	4	4	4	4
Cricket pitch	5	5	5	5	5
Bowling green	6	6	6	6	6
Tennis court (grass)	7	7	7	7	7
Playing surface/Turf (rugby/soccer fields)	8	8	8	8	8
Athletics tracks/fields	9	9	9	9	9
Horse racing tracks/fields	10	10	10	10	10
Artificial turf	11	11	11	11	11
Other (please specify)	12	12	12	12	12
	/26.1	/26.2	/26.3	/26.4	/26.5

III. IN TERMS OF LAWNS (INCLUSIVE OF RESIDENTIAL, BUSINESS INDUSTRIAL AND GOVERNMENT/MUNICIPAL)

27. Which water restriction method should be implemented during each of the following levels of water saving? For Level 0 mention the **a)** number of days per week allowed to water, **b)** number of hours allowed per day and **c)** preferred days of the week watering allowed. Do the same for Level 1, 2 and 3.

Saving required	**a) Number of days per week allowed to water**		**b) Number of hours per day**		**c) Preferred days of the week watering allowed**								
Level 0 (during normal years)		/27a.1		/27b.1	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/27c.1
Level 1 (20% saving required)		/27a.2		/27b.2	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/27c.2
Level 2 (30% saving required)		/27a.3		/27b.3	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/27c.3
Level 3 (40% saving required)		/27a.4		/27b.4	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/27c.4

IV. IN TERMS OF NEW LANDSCAPES AS WELL AS NURSERIES AND GARDEN CENTRES - *BONA FIDA*

28. Which water restriction method should be implemented during each of the following levels of water saving? For Level 0 mention the **a)** number of days per week allowed to water, **b)** number of hours allowed per day and **c)** preferred days of the week watering allowed. Do the same for Level 1, 2 and 3.

Saving required	**a) Number of days per week allowed to water**		**b) Number of hours per day**		**c) Preferred days of the week watering allowed**								
Level 0 (during normal years)		/28a.1		/28b.1	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/28c.1
Level 1 (20% saving required)		/28a.2		/28b.2	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/28c.2
Level 2 (30% saving required)		/28a.3		/28b.3	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/28c.3
Level 3 (40% saving required)		/28a.4		/28b.4	Mon	Tue	Wed	Thu	Fr	Sa	So	Any day	/28c.4

IV. OTHER WATER RESTRICTIONS

29. At what level should the following water restrictions be implemented?

	Level 0 (during normal years)	Level 1 (20% saving required)	Level 2 (30% saving required)	Level 3 (40% saving required)	Should never be considered
Filling of new swimming pools	1	1	1	1	1
Refilling of existing swimming pools	2	2	2	2	2
Hand held hosepipe	3	3	3	3	3
Bucket & watering cans	4	4	4	4	4
Drip irrigation systems	5	5	5	5	5
Environmental rehabilitation	6	6	6	6	6
Projects including mine dumps	7	7	7	7	7
Washing down of paving and hard surfaces	8	8	8	8	8
Use of water features and fountains	9	9	9	9	9
Car washes and washing of cars	10	10	10	10	10
Use of water systems (all nurseries, landscapes, lawn, recreation facilities) except drip irrigation systems	11	11	11	11	11
	/29.1	/29.2	/29.3	/29.4	/29.5

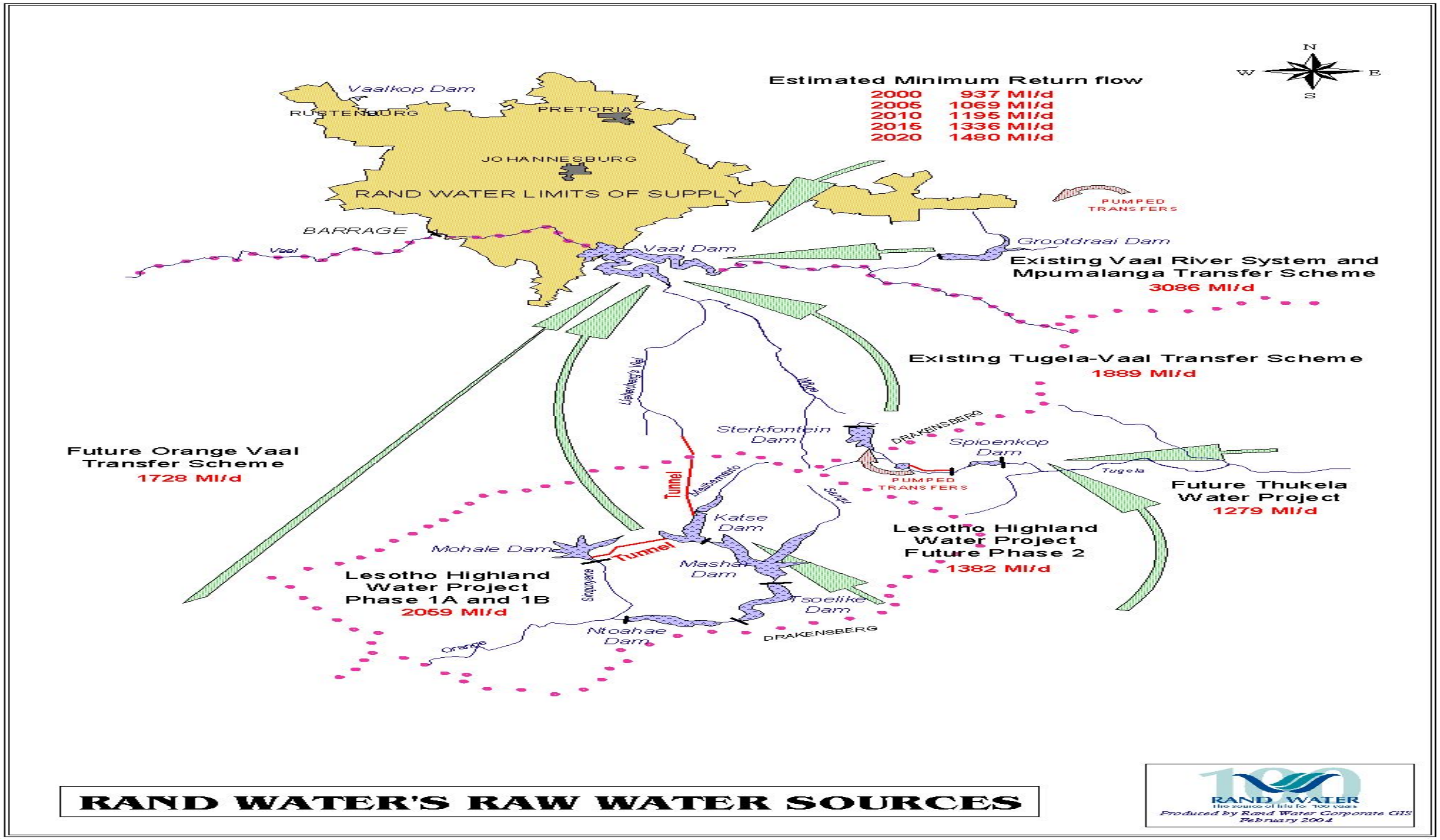
30. Please answer the following questions:

	Yes	No	Uncertain/ Don't know	
Water restrictions must apply to all sources of water, municipal as well as other sources such as boreholes and dams	1	2	3	/30.1
Users who exceed the anticipated percentage of water saving should pay a very heavy fine	1	2	3	/30.2
Users who do not abide with the water restrictions should pay heavy fines as determined by municipal structures	1	2	3	/30.3
All surface runoff water must be captured on site and recycled	1	2	3	/30.4
The use of water retention granules and wetting granules by contractors must be enforced	1	2	3	/30.5
Mechanisms such as moistures meters and rain sensors must be compulsory on automated irrigation systems	1	2	3	/30.6
All new landscapes must be zoned into high, medium and low water use zones	1	2	3	/30.7
Plants must be sold with labels indicating which are high, medium and low water use plants	1	2	3	/30.8
The use of mulches in new landscapes should be compulsory	1	2	3	/30.9
No watering should be allowed between the hours of 10h00 and 14h00 (October to February)	1	2	3	/30.10
No watering should be allowed between the hours of 10h00 and 15h00	1	2	3	/30.11
Use of grey water is encouraged in the garden	1	2	3	/30.12
In all cases where hosepipes are used a trigger nozzle must be fitted	1	2	3	/30.13
Other (please specify)	1	2	3	/30.14

THANK YOU VERY MUCH FOR YOUR FRIENDLY CO-OPERATION!!!

ANNEXURE F

RAND WATER, RAW WATER SOURCES AND TRANSFER SCHEMES



(Rand Water, 2005:4)

ANNEXURE G

Water Conservation Questionnaire to Council members.

This questionnaire has been designed to help determine the status of water conservation measures/initiatives of municipalities serviced by Rand Water. You are asked to provide some information and where possible to also provide suggestions for a way forward.

Name:____
Organization:_____________________________________
Position:____
Date:____
Contact details: (Optional)
Tel:____________________________
Cel:____________________________
Fax:____________________________
E mail:__________________________

The author of this document would like to contact you once this is completed to obtain more information and copies of your plans and water restrictions.

(*For the purposes of this questionnaire the terms drought management plan and water conservation plan are interpreted as the same meaning.)*

Restrictions are seen as different rules such as when to water or not.

Water conservation **plans** are seen as map of moving from one state of to another.

No	Questions	Yes	No	Don't Know
1.	Does your municipality have water restrictions in place?			
2.	Can these restrictions be enacted immediately, if needs be?			
3.	Does your municipality have activities or education programs that promote water conservation practices to its users?			
	What are they?			
4	Do you know what the water restrictions are for your own council?			
4a.	Can you name two (2) of the water restrictions of your municipal list Name them: a) b)			
5.	Are your water conservation measures consistent with other municipalities in Gauteng or other municipalities served by Rand Water.			
6.	Are your consumers aware of what the current water restrictions are for your municipality?			
	How are they informed?			
7.	Does your council ever impose water restrictions on their own decision without government intervention?			
8.	Do you ever educate your communities on water conservation matters for the **home**?			
8a	If yes, what media do you use for this education (eg rates letter, newspaper, special flyer etc)			
9.	Do you ever educate your communities on water conservation matters for the **garden**?			
9a	If yes, what media do you use for this education (eg rates letter, newspaper, special flyer etc)			
10.	Water restrictions were last imposed in Gauteng in ± 1995.			

10a	Did they work at the time?			
10b	Did they change the long term culture of your residents?			
11.	What aspect encouraged the most saving of water in 1995.			
11a	Water restrictions?			
11b	Water Price increases?			
11c	Combination of water price increases and water restrictions?			
	For later contact by Rand Water	**Title/Name**		
12.	Who at your council managers the water restrictions			
13.	Who at your council decides what restrictions must be on the list.			
14.	Who at your council decides when restrictions are to be imposed.			
15.	Who at your council decides when restrictions are to be lifted			
		Name		
16.	Who (which department) from Government tells/informs your council when to impose water restrictions.			
	Water conservation Plans:	**Yes**	**No**	**Don't know**
17.	Does your municipality have a specific water conservation **plan** in place?			
18.	When last was the water restriction **plan** revisited and updated.(Year)			
19.	Do you know what the water restriction **plans** are of any of your neighboring municipalities?			
20.	Are your water conservation **plans** consistent with other municipalities in Gauteng or other municipalities served by Rand Water.			
21.	Are your consumers aware of what the current water restriction **plans** are for your municipality?			
	How are they informed?			
		Yes	**No**	**Don't know**
24.	Do you think that having common water restriction or common drought management plan throughout the Rand Water Supply are is a good idea?			
24a	State why.			
25.	Would you or your municipality/council like to be involved in developing a single drought management plan for the Rand Water Supply area (Gauteng and surrounds)?			
25a	If yes who: Contact tel No: E-mail: Position:			

Information of Leslie Hoy: Tel - 011-9001580/1
Cel - 082 389 0302
Fax - 011-9002108
E-mail lhoy@randwater.co.za

Thank you for your time in completing this form.

ANNEXURE H

FOCUS AREAS OF VARIOUS INTERNATIONAL WATER SUPPLY SHORTAGE RESPONSE PLANS

Place	Country	Title used	Current regional supply shortage situation	Policy principles and administration measures to address water shortages	Communication of measures	Conservation measures and levels of implementation	Enforcement and possible fines	Water budgets	Stakeholder engagement to set up system.	Process to appeal for exemption	Trigger levels to implement the conservation measures	Conservation measures used during normal times as well.
Las Virgenes Municipal Water District (*Water Shortage Response Plan*, 2008)	USA	Water Shortage Response Plan	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
North Carolina Water (*Water Shortage Response Plan Guidelines,* "s.a")	USA	Water Shortage Response Plan	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No
Town of Cary (*Water Shortage Response Plan, 2007)*	USA	Water Shortage Response Plan		Yes	No	Yes	Yes	No	No	No	Yes	No
Nebraska ((*Water Shortage Emergency Response Plan*, "s.a")	USA	Water Shortage Emergency Response	Yes	Yes	Yes	Yes	No	No	No	No	Yes	No
The Village of Bald Head Island (*Water Shortage Response Plan*, "s.a.")	USA	Water Shortage Response Plan	No	Yes	No	Yes	Yes	No	No	No	No	No
Victory (state)	Australia	Water allocation framework	No	Yes	No	Yes	No	No	No	No	No	Yes
New South Wales (*NSW Water Conservation Strategy, 2000)*	Australia	Water Conservation Strategy	Yes	Yes	Yes	Yes	No	No	Yes	No	No	Yes

The Researcher has grouped certain categories together, due to the huge range in classification, by different municipalities. Terminology has also been altered where required, to use the similar terms/phrases. Where it has not been clearly stated or implied the answer has been taken as no.

ANNEXURE I

RESIDENTIAL GARDEN WATER RESTRICTIONS FROM 1994/95 FOR GAUTENG

Restriction	Municipality	Number of days allowed to water per week/ dwelling			Days allowed to water										Number of hours allowed per week/dwelling						Type of watering permitted per dwelling							Buckets	Free flowing water
		2	3	7	None	Mon	Tues	Wed	Thur	Fri	Sat	Sun	Not specific	Alternate	2	3	4	6	14	48	Bucket/ watering can	Hand held hosepipe/ garden hoses.	Micro system	Drip system	Any watering system	No mention of system	Permanently installed sprinkler system/ Irrigation systems	Buckets allowed any time.	No free flowing water or channelled water from taps etc.
Houses and agricultural holdings, connected to the Council's water supply with uneven numbers may water on Tuesday and Saturday between 17:00 and 18:00, while even numbers water on Wednesday and Sundays between 18:00 and 19:00. These times and dates were adopted for the use of garden hoses, drip or micro irrigation systems. Please note that the garden hose must be held in the hand.	**Randfontein**	1						1			1				1							1	1	1					
Hoses held in the hand, micro-mist, drip irrigation systems or permanently installed sprinkler systems may be used for watering residential gardens On Tuesdays between 16h00 and 17h00 and Saturdays between 14h00 and 15h00 for properties with even street numbers; On Wednesdays between 16h00 and 17h00 and Sundays between 14h00 and 15h00 for properties with uneven street numbers.	**Johannesburg**	1					1	1			1	1			1							1	1	1			1	1	1

Restriction	Municipality	Number of days allowed to water per week/ dwelling			Days allowed to water										Number of hours allowed per week/dwelling						Type of watering permitted per dwelling							Buckets	Free flowing water
		2	3	7	None	Mon	Tues	Wed	Thur	Fri	Sat	Sun	Not specific	Alternate	2	3	4	6	14	48	Bucket/ watering can	Hand held hosepipe/ garden hoses.	Micro system	Drip system	Any watering system	No mention of system	Permanently installed sprinkler system/ Irrigation systems	Buckets allowed any time.	No free flowing water or channelled water from taps etc.
The watering of residential gardens, with hoses and irrigation systems, be permitted between 17h00 and 19h00 from Monday to Sunday.	**Edenvale/ modderfontein metropolitan substructure.**			1		1	1	1	1	1	1	1							1			1					1	1	1
The watering of gardens only be allowed between 17:00 and 18:00 daily effect from 1 August 1995.	**Boksburg**			1		1	1	1	1	1	1	1							1							1			
Dwelling gardens may only be watered on Tuesdays and Saturdays between the following times. Tuesdays: During August 1995 to April 1996: 18:00–19:00During May 1996 to July 1996 17:00-18:00 Saturdays: 08:00-09:00	**Akasia**	1					1	1			1	1			1											1		1	1
Dwelling gardens may only be watered on Tuesdays and Saturdays between the following times. Tuesdays: During August 1995 to April 1996: 18:00–19:00During May 1996 to July 1996 17:00-18:00 Saturdays: 08:00-09:00	**Northern pretoria metropolitan substructure**	1					1				1				1											1		1	
Residential gardens may only be watered on Tuesdays and Saturdays during the following times: Tuesdays: During the months August to April 18:00 to 19:00, during the months May to July 17:00 to 18:00Saturdays: 08:00 to 09:00	**Pretoria**	1					1				1				1											1		1	1

Restriction	Municipality	Number of days allowed to water per week/ dwelling			Days allowed to water										Number of hours allowed per week/dwelling						Type of watering permitted per dwelling							Buckets	Free flowing water
		2	3	7	None	Mon	Tues	Wed	Thur	Fri	Sat	Sun	Not specific	Alternate	2	3	4	6	14	48	Bucket/ watering can	Hand held hosepipe/ garden hoses.	Micro system	Drip system	Any watering system	No mention of system	Permanently installed sprinkler system/ Irrigation systems	Buckets allowed any time.	No free flowing water or channelled water from taps etc.
The watering of residential gardens is prohibited except by way of buckets and watering cans. Gardens may be the premises hereinafter mentioned. Premises with even street numbers on Tuesdays, Thursdays and Saturdays, between 16:30 and 17:30 from 1 May to 31 August (both days inclusive) and for the rest of the year on Tuesdays, Thursdays and Saturdays between 17:30 and 18:30Premises with uneven street numbers on Mondays and Wednesdays, between 16:30 and 17:30 and on Saturday between 15:00 and 16:00 from 1 May till 31 August (both days inclusive) and for the rest of the year on Mondays and Wednesday between 17:30 and 18:30 and on Saturdays between 16:00 and 17:00	**Alberton**		1			1	1	1	1		1					1					1								
The watering of residential gardens with hoses held by hand be permitted on alternate days between 17:00 and 18:00 except Sundays. Properties with even street numbers will be allowed to water their gardens on Mondays, Wednesdays and Fridays.	**Easton vaal metro**		1			1	1	1	1	1	1					1						1						1	1

Restriction	Municipality	Number of days allowed to water per week/ dwelling			Days allowed to water										Number of hours allowed per week/dwelling						Type of watering permitted per dwelling							Buckets	Free flowing water
		2	3	7	None	Mon	Tues	Wed	Thur	Fri	Sat	Sun	Not specific	Alternate	2	3	4	6	14	48	Bucket/ watering can	Hand held hosepipe/ garden hoses.	Micro system	Drip system	Any watering system	No mention of system	Permanently installed sprinkler system/ Irrigation systems	Buckets allowed any time.	No free flowing water or channelled water from taps etc.
Properties with uneven street numbers will be allowed to water their gardens on Tuesdays, Thursdays, and Saturdays.																													
The watering of residential gardens with hoses held by hand be permitted on alternate days between 17:00 and 18:00 except on Sundays. Properties with even street numbers will be allowed to water their gardens on Mondays, Wednesdays and Fridays. Properties with uneven street numbers will be allowed to water their gardens on Tuesdays, Thursdays and Saturdays.	**Meyerton**		1			1	1	1	1	1	1					1						1						1	1
The watering of residential gardens with hoses and irrigation systems, be permitted on alternate days between 17:00 and 19:00. Properties with even street numbers will be allowed to water their gardens on Mondays, Wednesdays and Saturdays. Properties with uneven street numbers will be allowed to water their gardens on Tuesdays, Thursdays, and	**Fochville**		1			1	1	1	1		1	1					1					1					1		1

Restriction	Municipality	Number of days allowed to water per week/ dwelling			Days allowed to water										Number of hours allowed per week/dwelling						Type of watering permitted per dwelling							Buckets	Free flowing water
		2	3	7	None	Mon	Tues	Wed	Thur	Fri	Sat	Sun	Not specific	Alternate	2	3	4	6	14	48	Bucket/ watering can	Hand held hosepipe/ garden hoses.	Micro system	Drip system	Any watering system	No mention of system	Permanently installed sprinkler system/ Irrigation systems	Buckets allowed any time.	No free flowing water or channelled water from taps etc.
Sundays.																													
The watering of residential gardens with hoses and irrigation systems be permitted on alternate days between 17:00 and 19:00. Properties with even street numbers will be allowed to water their gardens on Mondays, Wednesdays and Saturdays. Properties with uneven street numbers will be allowed to water their gardens on Tuesdays, Thursdays and Sundays. The use of sprinklers for irrigating lawns is prohibited.	**Germiston**		1			1	1	1	1		1	1						1				1					1		1
The watering of all residential gardens with hoses held by hand and irrigation systems be permitted on alternate days between 17:00and 19:00 only. Properties with even street numbers will be allowed to water their gardens on Mondays, Wednesdays and Saturdays. Properties with uneven street numbers will be	**Johannesburg Transitional Metropolitan Council**		1			1	1	1	1		1	1						1			1	1					1	1	1

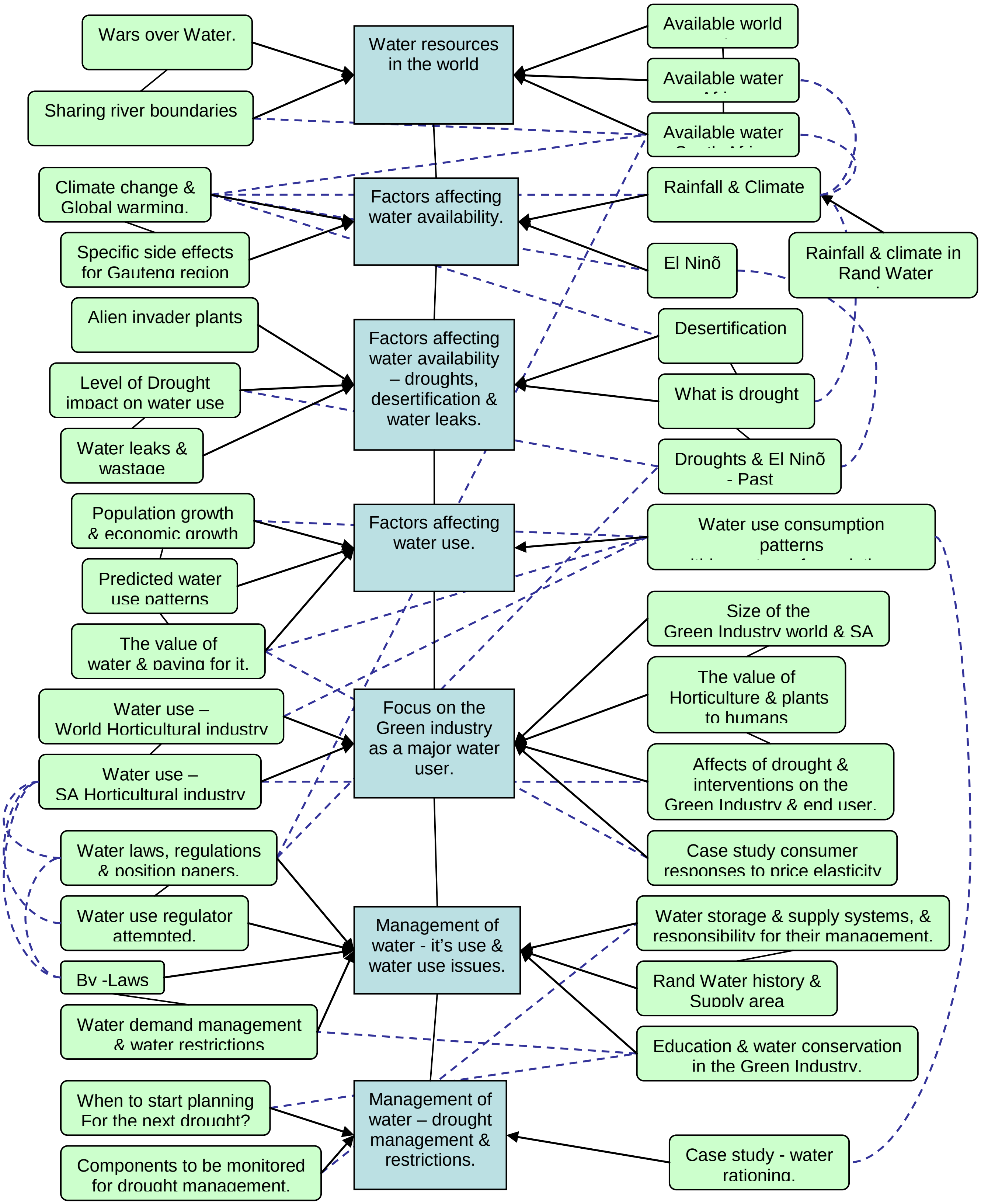
Restriction	Municipality	Number of days allowed to water per week/ dwelling			Days allowed to water										Number of hours allowed per week/dwelling						Type of watering permitted per dwelling							Buckets	Free flowing water
		2	3	7	None	Mon	Tues	Wed	Thur	Fri	Sat	Sun	Not specific	Alternate	2	3	4	6	14	48	Bucket/ watering can	Hand held hosepipe/ garden hoses.	Micro system	Drip system	Any watering system	No mention of system	Permanently installed sprinkler system/ Irrigation systems	Buckets allowed any time.	No free flowing water or channelled water from taps etc.
allowed to water their gardens on Tuesdays, Thursdays and Sundays.																													
The watering of residential gardens using hosepipes and irrigation systems is allowed on alternate days between 17:00 to 19:00. Properties with even street numbers are allowed to water on Mondays, Wednesdays and Saturdays. Properties with uneven street numbers are allowed to water gardens on Tuesdays, Thursdays and Sundays.	**Westonaria**		1			1	1	1	1		1	1						1				1					1		1
The watering of all gardens including Government, provincial, and municipal gardens and parks as well as gardens of industrial undertakings by any means other than buckets and watering–cans is prohibited except for the following, The watering of gardens with hand held hoses, or drip or micro irrigation on Wednesdays and Saturdays between 17:00 and	**Benoni**	1						1			1				1							1	1	1				1	1

Restriction	Municipality	Number of days allowed to water per week/ dwelling			Days allowed to water										Number of hours allowed per week/dwelling						Type of watering permitted per dwelling							Buckets	Free flowing water
		2	3	7	None	Mon	Tues	Wed	Thur	Fri	Sat	Sun	Not specific	Alternate	2	3	4	6	14	48	Bucket/ watering can	Hand held hosepipe/ garden hoses.	Micro system	Drip system	Any watering system	No mention of system	Permanently installed sprinkler system/ Irrigation systems	Buckets allowed any time.	No free flowing water or channelled water from taps etc.
18:00 they may be watered by any method.																													
Domestic gardens may be watered on Wednesdays between 14:00 and 15:00 and on Saturdays between 10:00 and 12:00 only.	**Heidelburg Town Council**	1						1			1					1										1		1	1
The watering of residential gardens with drip irrigation, micro spray systems, or hoses held by hand will be permitted on Tuesdays, Thursdays and Saturdays between 17:00and 18:00 only. The watering of gardens by means of buckets and watering cans shall be permissible at any time.	**Kempton Park / Tembisa**		1				1		1		1					1					1	1	1	1				1	1
The watering of all residential gardens with drip irrigation, micro spray systems, or hoses held by hand will be permitted on Tuesdays, Thursdays and Saturdays between 17:00and 18:00 only. The watering of gardens by means of buckets and watering cans shall be permissible at any time.	**Midrand**		1				1		1		1					1					1	1	1	1				1	1

Restriction	Municipality	Number of days allowed to water per week/ dwelling			Days allowed to water										Number of hours allowed per week/dwelling						Type of watering permitted per dwelling							Buckets	Free flowing water
		2	3	7	None	Mon	Tues	Wed	Thur	Fri	Sat	Sun	Not specific	Alternate	2	3	4	6	14	48	Bucket/ watering can	Hand held hosepipe/ garden hoses.	Micro system	Drip system	Any watering system	No mention of system	Permanently installed sprinkler system/ Irrigation systems	Buckets allowed any time.	No free flowing water or channelled water from taps etc.
Residential gardens may only watered on the following days;Properties with even street numbers on Mondays and Thursdays.Properties with uneven numbers on Tuesdays and Fridays.	**Krugersdorp**	1				1	1		1	1										1						1			
The watering of all gardens, including Government, Provincial and Municipal gardens and parks, as well as gardens of industrial undertakings, by means other than by buckets, watering cans, drip irrigation and micro-spray systems (pipes with internal diameters small than 5mm) shall be prohibited. This prohibition applies also to the watering of playing fields and sportsgrounds, but not to cricket pitches, bowling greens and greens of golf courses. The use of micro systems shall be prohibited to 17:00 to 19:00 on Mondays and Thursdays.	**Springs**	1				1			1								1						1					1	1
House gardens may be watered with a hand held hosepipe as well as drip and micromist sprinkler systems on Wednesdays and Saturdays.	**Southern Pretoria Metropolitan Substructure.**	1						1			1									1		1	1	1				1	1
Total local councils who had that "event".		10	9	2	0	11	16	15	13	5	19	8	0	0	6	6	2	3	2	2	4	13	7	6	0	6	6	14	16

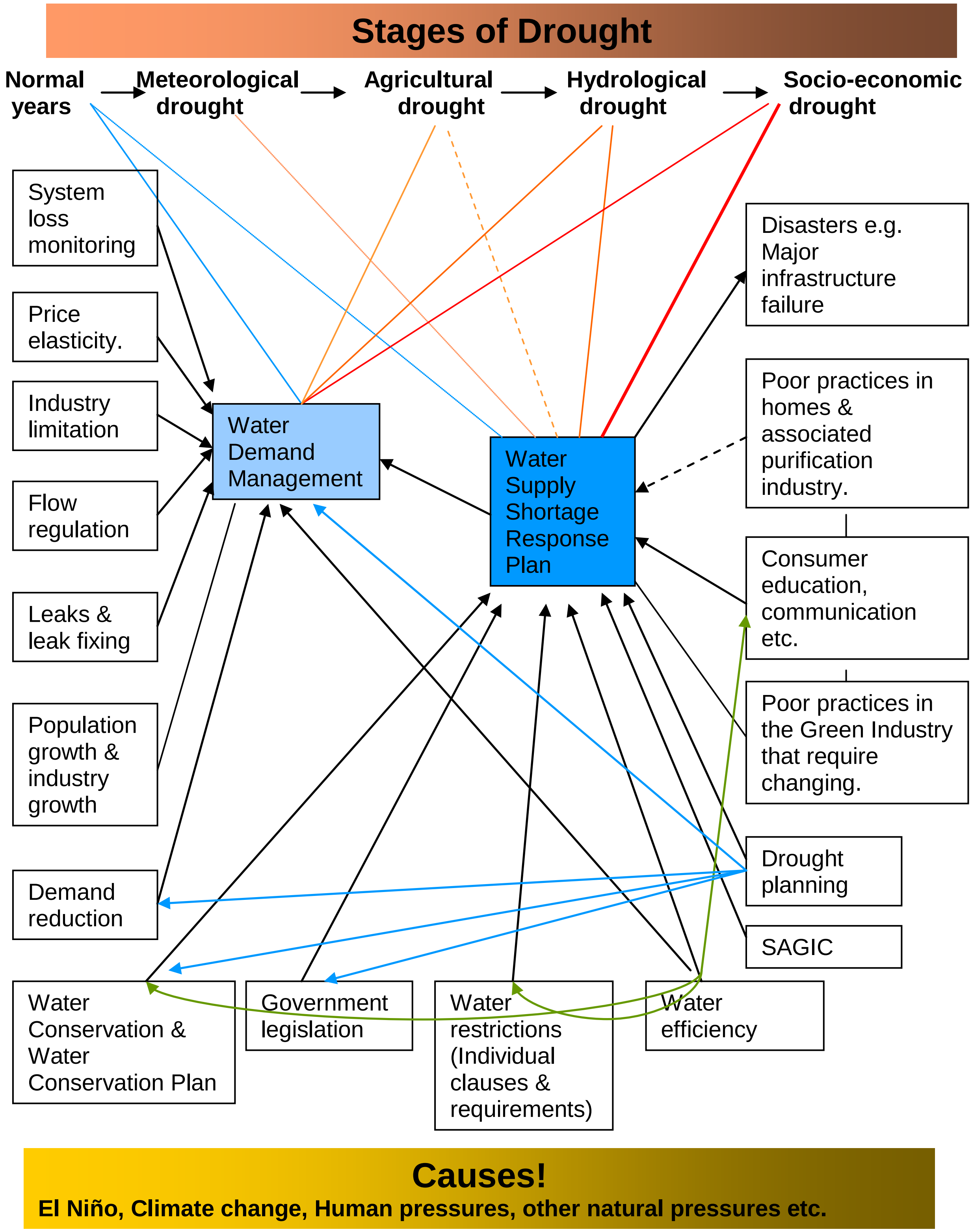
ANNEXURE J

OUTLINE OF MAIN ASPECTS OF LITERATURE REVIEW



Annexure K

RESEARCHERS INTERPRETATION OF WHERE WSSRP FOR THE GREEN INDUSTRY FITS IN WITH SOME OTHER MECHANISMS AND PROCESSES.



*Note: Only major links mapped

AVAILABLE WATER WITHIN THE WORLD (ADAPTED FROM LIPHADZI, 2007:16).