NATIONAL WATER RESOURCE QUALITY STATUS REPORT:

INORGANIC CHEMICAL WATER QUALITY OF SURFACE WATER RESOURCES IN SA – THE BIG PICTURE

Department of Water Affairs and Forestry
Institute for Water Quality Studies

First Edition
2002

Republic of South Africa

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EXTENDED EXECUTIVE SUMMARY

NATIONAL WATER RESOURCE QUALITY STATUS REPORT:

INORGANIC CHEMICAL WATER QUALITY OF SURFACE WATER RESOURCES IN SA - THE BIG PICTURE

1. PURPOSE OF THE REPORT

The aim of this report is to provide information on the major inorganic chemical water quality constituents of surface waters across South Africa to water resource managers, scientists, decision-makers, and the public. It is intended to provide an overview of the status of surface chemical water quality according to the water quality requirements of two water user sectors, namely, domestic water use and irrigated agriculture water use.

2. BACKGROUND

Water is an excellent solvent and transport medium for particulates, and as such it tends to become contaminated both by natural processes such as erosion, and dissolution of salts geologically present in soils, as well as by man-induced processes and wastes. The latter are both natural e.g. the contamination of runoff water with excreta, as well as artificial, such as the contamination of water with industrial effluents and synthetic chemicals such as pesticide residues.

Water can thus be contaminated by a whole host of substances including:

- Physical soil and clay particles and organic detritus from storm runoff
- Microorganisms, such as bacteria, viruses, and parasites, from the soil and environment and animal and human wastes.
- Chemical constituents, which can be subdivided into (a) major inorganic chemical salts (such as sodium, chloride, calcium, sulphate, etc.), (b) minor inorganic chemical salts (such as ammonia, fluoride, phosphate and trace metals such as iron, manganese, copper, etc.) and (c) organic substances such as pesticide residues, for example.
- Radioactive substances (which usually occur only in minute concentrations under natural conditions).

This report concentrates mainly on the status of water quality in South Africa, as reflected in predominantly the mineral salt composition. Mineral salts arise both naturally from soil erosion and washout of salts naturally present in the soil, as well as the contribution from human settlements and activities. Land use activities include both domestic (e.g. leading to nutrient enrichment or eutrophication) and industrial (e.g. the contamination of surface waters by acid mine drainage water containing constituents such as sulphate arising from the accelerated oxidation of sulphur bearing minerals in exposed rock consequent to mining operations).

In addition to the information on the major inorganic water quality constituents, information is also given in this report on the nutrient status of selected impoundments in South Africa as reflected by the so-called trophic status of the water bodies.

This report does not deal with the microbiological status of the water resources, as this information is not readily available yet. However, as a general rule, it must be assumed that all surface water has the potential for microbiological contamination, and needs to be disinfected before drinking.

3. ASSESSMENT METHODOLOGY

3.1 Assessment Basis

To simplify the assessment and to present the information in such a way that it would be useful for water resource management purposes, South Africa is divided into 19 Water Management Areas (WMAs).

Water quality is assessed on the basis of its fitness for use by the domestic and irrigated agriculture water user sectors. These are the two user groups that generally have the most stringent requirements for water quality (with the possible exception of the aquatic environment). Agriculture often does not have the opportunity to pretreat the water to the desired quality before using it. Industry either has similar requirements to those of the above two water users or has the ability to conduct the necessary treatment of the raw water for it to be suitable for their purposes (*e.g.* industries with specific water quality requirements).

The water quality constituents selected for this study are largely limited to those of relevance to domestic and irrigated agriculture water use. The two sets of water quality constituents used as indicators for these water user sectors are:

Table 3.1 Water quality constituents used in the assessment of fitness-for-use for domestic and irrigated agriculture water use

Domestic Use	Irrigated Agriculture Use
Nitrate +Nitrite as N (NO_3+NO_2 (as N))	Chloride (Cl)
Ammonia as N (NH_4 (as N))	Electrical Conductivity (EC)
pH	pH
Potassium (K)	Boron (B)
Total Dissolved Salts (TDS)	Sodium Adsorption Ratio (Ca; Na; Mg)
Fluoride (F)	
Turbidity	
Sodium (Na)	
Magnesium (Mg)	
Chloride (Cl)	
Calcium (Ca)	
Sulphate (SO_4)	

The assessment classification system used for the assessment of the suitability of water for domestic purposes is based on that described in the Assessment Guide for the quality of Domestic Water Supplies (DWAF, DOH and WRC, 1998) and the water quality guidelines presented in the South African Water Quality Guidelines (DWAF, 1996a and DWAF, 1996b, for irrigated agriculture).

Water quality guidelines or criteria are scientific and technical information provided for a particular water quality constituent in the form of numerical data and/or narrative descriptions of its effects on the fitness of water for a particular use or on the health of aquatic ecosystems.

3.2 Data Collection

The water quality data that were used in the assessment of the fitness for use of South Africa's surface water resources for domestic and irrigated agricultural use were collected as part of the so-called National Chemical or Salinity Monitoring Programme. This programme has been in operation since the early 1970's and samples are regularly collected at approximately 1 600 monitoring stations at a frequency that varies from weekly to monthly sampling. The samples

collected for this programme are analysed at the laboratories of the Institute for Water Quality Studies and the data is stored on DWAF's database and information management system, namely the Water Management System (WMS).

3.3 Sample Site Selection

As far as sample site selection for the status report is concerned, two levels of sampling sites were selected from the chemical water quality database, namely:

- a national level sample site set, and
- a more comprehensive site set selected for each WMA.

The national site set is comprised of sites ideally as close to the downstream end of each tertiary drainage region with a sufficient record length of relatively regular frequency.

The individual WMA sample site sets are based on the national set with the addition of all other sample sites within the WMAs that have sufficient record length and frequency, irrespective of their location within the WMA. Sites are only excluded when their sampling frequencies are too erratic or sparse, or where there are better sample sites geographically close to them. This was done to identify river reaches with sampling sites where water quality problems are prevalent.

3.4 Study Period

A study period of 5 years was used for assessing the water inorganic chemical quality status of surface water resources extending from the beginning of 1996 to the end of the year 2000. The median (the most commonly) observed concentration for each variable is used in comparison with the domestic and irrigation use guidelines.

3.5 Presentation of Results

The assessment results are presented in a series of Tables and Maps. The symbols used in the assessment maps are referred to as Guideline Compliance Pie Diagrams and illustrate the median concentrations for each of the constituents depicted over the study period. Median constituent concentrations are depicted in a "pie wedge" that only projects beyond the circular "pie" when the concentration falls outside of the *Very Good* range in the case of the domestic use guidelines or the Target Water Quality Range (TWQR) in the case of the agriculture guidelines. If it does project beyond the *Very Good* range then the colour and extent of the projection indicates the extent of exceedence of the median value.

Information from the Trophic Status Project is also included in the report. The trophic status on a national scale of selected impoundments across South Africa, specifically those impoundments managed by DWAF, is reflected in a Table. Information is also given on a priority ranking for the 49 selected impoundments indicating the relative need for eutrophication management.

4. RESULTS AND CONCLUSIONS

Various land uses, notably mining and agriculture and the degradation of land, modify the water quality in many parts of the country. At a national scale, however, land cover and geology influence water quality predominantly. Since the bulk of the country is still in a moderately natural state, it is only on proceeding to a finer level of detail, such as the WMA level, that problem areas become more easily apparent.

4.1 Water Quality Status for Domestic Use

The main water quality problems throughout the country for domestic use relate to the widespread elevated salt levels (high TDS values) and elevated fluoride (F) levels in certain locations.

Water with elevated TDS tastes salty and does not slake thirst. The elevated salt levels (as expressed by TDS concentrations) also decrease the aesthetic value of water. Consumption of the water may not produce adverse health effects in the short-term, but there is a slight possibility of salt overload in sensitive individuals in the long term. TDS levels were especially elevated in the Lower Orange, Fish to Tsitsikamma and Gouritz WMAs. It would appear that these elevated levels are due to natural reasons. The Breede and Berg WMAs have elevated TDS levels when considering the individual WMA sample sites.

High F levels were evident in the lower Olifants WMA. Health effects and tooth staining can be expected at the concentrations evident at selected sample sites.

At a WMA scale, pH values were also seen to deviate in various parts of the country. The pH was low in the Klip Spruit (of the Olifants WMA) and would likely result in irritation of the mucous membranes of water users in this area. It is likely that the source of the low pH is the acid mine drainage from the coalmines and mine dumps in the area. A notable effect of the low pH would be "burning eyes" with the use of the water for recreational purposes.

Magnesium (Mg), sulphate (SO_4), chloride (Cl), sodium (Na) and potassium (K) were also elevated in various parts of the country.

4.2 Water Quality Status for Irrigation Use

From an irrigated agriculture use perspective, the sodium adsorption ratio (SAR), electrical conductivity (EC), pH and chloride (Cl) were elevated in various regions of the country.

There were high pH levels in the Luvuvhu and Letaba, Crocodile (West) and Marico, Olifants, Usutu to Mhlatuze, Mzimvubu to Keiskamma, Upper Orange and Lower Orange WMAs.

The Fish to Tsitsikamma and Gouritz WMAs had low pH values and high SAR, EC and Cl values; making irrigated agriculture in these WMAs more challenging, and limiting crop selection to more salt tolerant crops.

The Thukela WMA had high pH values, with the Upper and Middle Vaal WMAs having high EC values.

The South Western Cape (Breede and Berg WMAs) had low pH values evident in some cases and elevated SAR, EC and Cl concentrations, again limiting the potential for growing salt sensitive crops.

4.3 Trophic Status of Selected Impoundments

South Africa has disturbingly high levels of nutrient enrichment in many of its impoundments. This is something that requires urgent attention. The most enriched impoundments are often those that have the greatest concentration of humans in their catchment areas.

Apart from the aesthetic aspects of water with a "pea-soup" appearance, eutrophication leads to the frequent occurrence of toxic algal blooms, with the danger of fish and cattle deaths, and the induction of gastro-enteritis in humans.

5. RECOMMENDATIONS

The following recommendations are proposed:

- Revision of the existing monitoring network is necessary to terminate sampling at unnecessary sites and expand the network to cover more adequately the sensitive problem areas or those areas with insufficient sampling sites.

- Role players must be informed of the impact of land uses that result in deterioration in the water quality. This is especially important for mining and agriculture.

- Ways to improve the water quality at those negatively impacted sites must be investigated.

- Water users at sites where the water that could be detrimental to their health should be informed to take appropriate precautions. Safe water should be provided to those domestic users who have no access to a safe and healthy water supply.

- Water resources should be protected, in particular the more pristine water sources, in order that their quality does not deteriorate as a result of a change in land use or management practice.

- The trophic status monitoring and assessment programme should be expanded to include more of the impoundments throughout the country and appropriate land use management practises should be encouraged to prevent or minimise large loads of nutrients entering the aquatic environment.

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NATIONAL WATER RESOURCE QUALITY STATUS REPORT:

INORGANIC CHEMICAL WATER QUALITY OF SURFACE WATER RESOURCES IN SOUTH AFRICA - THE BIG PICTURE

1. PURPOSE OF THE STUDY

The aim of this report is to provide information on the major inorganic chemical water quality constituents of surface waters across South Africa to water resource managers, scientists, decision-makers, and the public. It is intended to provide an overview of the status of the chemical water quality of surface water resources according to the water quality requirements of two water user sectors, namely, domestic water use and irrigated agriculture water use.

2. INTRODUCTION AND BACKGROUND

Water is an excellent solvent and transport medium for particulates, and as such it tends to become contaminated both by natural processes such as erosion, and dissolution of salts geologically present in soils, as well as by man-induced processes and wastes. The latter are both natural e.g. the contamination of runoff water with excreta, as well as artificial, such as the contamination of water with industrial effluents and synthetic chemicals such as pesticide residues.

Water can thus be contaminated by a whole host of substances including:

- Physical soil and clay particles and organic detritus from storm runoff.
- Microorganisms, such as bacteria, viruses, and parasites, from the soil and environment and animal and human wastes.
- Chemical constituents, which can be subdivided into (a) major inorganic chemical salts (such as sodium, chloride, calcium, sulphate, etc.), (b) minor inorganic chemical salts (such as ammonia, fluoride, phosphate and trace metals such as iron, manganese, copper, etc.) and (c) organic substances such as pesticide residues, for example.
- Radioactive substances (which usually occur only in minute concentrations under natural conditions).

The Constitution of South Africa guarantees everyone a right of access to water and a right to an environment that is not harmful to their health or well-being. Section 24 of the Bill of Rights states that:

"Everyone has the right

(a) to an environment that is not harmful to their health or well-being; and

(b) to have the environment protected for the benefit of present and future generations, through reasonable legislative and other measures that

(i) prevent pollution and ecological degradation;

(ii) promote conservation; and

(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

The Department of Water Affairs and Forestry, as a custodian of the water resources of South Africa must manage and ensure efficient, equitable and sustainable use of our limited water resources. It is, therefore, the responsibility of the Department to support sustainable operations of potable water and sanitation systems, to monitor and evaluate access to services and to

provide the national resource management function with resource quality and technical information.

Status reporting is an obligation of the Department of Water Affairs and Forestry in terms of the National Water Act (Act 36 of 1998). A comprehensive status report would cover a range of water quality problems, including:

- inorganic chemical water quality (major ions and trace metals),
- trophic status of water resources,
- microbiological water quality,
- organic chemical water quality,
- aquatic ecosystem health, and
- radioactivity levels in water resources.

In the broader perspective, status reporting should ideally be carried out on a regular basis for surface water, groundwater and estuaries.

2.1 National Water Quality Monitoring Programmes

DWAF has had a national monitoring programme (the so-called Chemical or Salinity monitoring programme) in place since the early 1970's, as well as established assessment procedures for assessing the inorganic chemical water quality of surface waters. For this programme, samples are regularly collected at approximately1 600 monitoring stations on rivers, at a frequency that varies from weekly to monthly sampling.

A Trophic Status Monitoring Programme is conducted on a much smaller scale for selected South African impoundments that are managed by the Department of Water Affairs. The design of a more extensive Eutrophication Monitoring Programme has been completed and the Trophic Status Programme will be integrated with this programme as soon as it becomes operational.

A national microbiological water quality monitoring programme has been designed and is currently being implemented. At present only a limited sampling network exists and work is underway to extend this network, however, it will be several years before it can provide a national indication of the microbiological water quality.

Organic surface water resource quality sampling occurs for a very small number of sampling sites and no national network is feasible at present because of the costs of sampling and analysis. Initiatives are underway to develop a National Toxicants Monitoring Programme that will include monitoring of organic and heavy metal pollutants. Radioactivity monitoring is done at a regional level only where such problems exist.

This report concentrates mainly on the status of water quality in South Africa, as reflected in predominantly the mineral salt composition. Mineral salts arise both naturally from soil erosion and washout of salts naturally present in the soil, as well as the contribution from human settlements and activities. Land use activities include both domestic (e.g. leading to nutrient enrichment or eutrophication) and industrial (e.g. the contamination of surface waters by acid mine drainage water containing constituents such as sulphate arising from the accelerated oxidation of sulphur bearing minerals in exposed rock consequent to mining operations).

In addition to the information on the major inorganic water quality constituents, information is also given in this report on the nutrient status of selected impoundments that are monitored in South Africa as reflected in the so-called trophic status of the water bodies.

This report does not deal with the microbiological status of the water resources, as this information is not yet readily available. However, as a general rule it must be assumed that all

surface water has the potential for microbiological contamination, and needs to be disinfected before drinking.

3. ASSESSMENT METHODOLOGY

3.1 Assessment Basis

Water quality is assessed on the basis of its fitness for use by the domestic and irrigated agriculture water user sectors. These are the two user groups that generally have the most stringent requirements for water quality (with the possible exception of the aquatic environment). Agriculture often does not have the opportunity to pretreat the water to individual requirements before using it. Industry either has similar requirements to those of the above two water users or has the ability to conduct the necessary treatment of the raw water for it to be suitable for their purposes (*e.g.* industries with specific water quality requirements).

The water quality constituents selected for this study are largely limited to those of relevance to domestic and irrigated agriculture water use. The two sets of water quality constituents used as indicators for these water user sectors are reflected in Table 3.1.

Table 3.1 Water quality constituents used in the assessment of fitness-for-use for domestic and irrigated agriculture water use

Domestic Use	Irrigated Agriculture Use
Nitrate +Nitrite as N (NO_3+NO_2 (as N))	Chloride (Cl)
Ammonia as N (NH_4 (as N))	Electrical Conductivity (EC)
pH	pH
Potassium (K)	Boron (B)
Total Dissolved Salts (TDS)	Sodium Adsorption Ratio (Ca; Na; Mg)
Fluoride (F)	
Turbidity	
Sodium (Na)	
Magnesium (Mg)	
Chloride (Cl)	
Calcium (Ca)	
Sulphate (SO_4)	

The assessment classification system used for the assessment of the suitability of water for domestic purposes is based on that described in the Assessment Guide for the quality of Domestic Water Supplies (DWAF, DOH and WRC, 1998) and the water quality guidelines presented in the South African Water Quality Guidelines (DWAF, 1996a and DWAF, 1996b, for irrigated agriculture).

Water quality guidelines or criteria are scientific and technical information provided for a particular water quality constituent in the form of numerical data and/or narrative descriptions of its effects on the fitness of water for a particular use or on the health of aquatic ecosystems.

The two sets of water quality constituents were used as indicators for the relevant water user sectors and the motivation for including these indicators are presented below (DWAF, DOH and WRC, 1998; DWAF, 1996a; DWAF 1996b). The indicators can be linked to specific problems that may be associated with specific land uses and activities. These water quality problems include salination (measured by TDS), acidification by mines and atmospheric deposition and potential toxicity (measured by pH), the impact of erosion (measured by turbidity), nutrient and other problems associated with sewage treatment works and excess fertiliser application in agriculture (measured by constituents such as NH_4 and NO_3+NO_2).

The water quality constituents selected for the assessment of fitness for domestic use have been divided into two groups (Domestic Use – "Health" and Domestic Use – "Salinity") for map representation reasons; primarily since there are too many constituents to be presented clearly on one diagram. The "Health" set includes those variables where there may be a more health-related impact on domestic users, while those constituents in the "Salinity" set are most often those that have an aesthetic (taste and/or scaling) effect on domestic users. The properties of these indicators are described in more detail in the Tables below.

The assessment classification system used for the assessment of the suitability of water for domestic purposes is based on that described in the Assessment Guide for the quality of Domestic Water Supplies (DWAF, DOH and WRC, 1998) and the South African Water Quality Guidelines: Domestic Use (DWAF, 1996a) and for irrigation agriculture, the South African Water Quality Guidelines - Agricultural Use: Irrigation (DWAF, 1996b). The classification system that describes the effects of the different classes of water on the various domestic uses is presented below (Table 3.2 and Table 3.3).

Table 3.2 Domestic "Health" Set: Water quality constituents relevant to the health of domestic water users (DWAF, 1996a and DWAF, DOH and WRC, 1998)

Constituent	Range	Colour Classification	Suitability for Domestic Use
TDS (mg.ℓ^{-1}) The TDS concentration provides a measure of the salination of water. It can be enhanced by, for example, excessive use of fertilisers or by the discharge of industrial waste products into a water body or river. TDS also affects the taste of the water, and at high concentrations does not slake thirst.	0 – 450	Blue **Very good water quality**	No health effects.
	450 – 1000	Green **Good water quality**	Insignificant effect on sensitive groups.
	1000 – 2400	Yellow **Fair water quality**	Slight possibility of salt overload in sensitive groups and a slightly salty taste.
	2400 – 3400	Red **Poor water quality**	Possible health risk to all individuals and a salty taste.
	> 3400	Purple **Not acceptable water quality**	Increasing risk of dehydration and a very salty taste.
NO_3+NO_2 (as N) (mg. ℓ^{-1}) Nitrate plus nitrite is common in groundwater samples, particularly in areas of intensive agricultural activity, or where pit latrines are used. Severe toxic effects are possible in infants (DWAF, DOH and WRC, 1998).	0 – 6.0	Blue **Very good water quality**	Negligible health effects.
	6.0 – 10.0	Green **Good water quality**	Insignificant risk.
	10.0 – 20.0	Yellow **Fair water quality**	Slight chronic risk of blue baby syndrome to some babies.
	20.0 – 40.0	Red **Poor water quality**	Possible chronic risk to some babies.
	> 40.0	Purple **Not acceptable water quality**	Increasing acute health risk to babies.
NH_4 (as N) (mg. ℓ^{-1})* Ammonium may be indicative of organic waste in the water or excess runoff from fertilised agricultural lands. High concentrations of ammonia can give rise to nitrite that is potentially toxic to infants (DWAF, 1996a).	0 – 1.0	Blue **Very good water quality**	No health or aesthetic effects.
	1.0 – 2.0	Green **Good water quality**	Possible taste and odour complaints.
	2.0 – 10.0	Yellow **Fair water quality**	Consumer complaints of objectionable taste and odour. Disinfection by chlorine can be compromised.
	> 10.0	Red **Poor water quality**	Danger of formation of nitrite. Chlorination is severely compromised.
pH The pH value has a marked effect on the taste of the water and also indicates possible corrosion problems (DWAF, DOH and WRC, 1998).	< 3.0	Brown **Not acceptable water quality**	Acid burns.
	< 4.0	Red **Poor water quality**	Severe irritation of mucous membranes.
	4.0 – 4.5	Salmon **Fair water quality**	Irritation of mucous membranes.
	4.5 – 5.0	Yellow **Good water quality**	Mild irritation of mucous membranes.
	5.0 – 9.5	Blue **Very good water quality**	No health effects.
	9.5 – 10.0	Light blue **Good water quality**	Mild irritation of mucous membranes.
	10.0 – 10.5	Light pink **Fair water quality**	Irritation of mucous membranes.
	10.5 – 11.0	Pink **Poor water quality**	Severe irritation of mucous membranes.
	> 11.0	Purple **Not acceptable water quality**	Alkali burns.
F (mg. ℓ^{-1}) Fluoride (F) is often elevated in groundwater in hot, arid areas and can cause damage to the skeleton and mark teeth (DWAF, DOH and WRC, 1998).	< 0.7	Blue **Very good water quality**	No health effects.
	0.7 – 1.0	Green **Good water quality**	Insignificant health effects on sensitive groups and insignificant tooth staining.
	1.0 – 1.5	Yellow **Fair water quality**	Increasing effects in sensitive groups and tooth staining.
	1.5 – 3.5	Red **Poor water quality**	Possible health effects in all individuals and marked tooth staining.
	> 3.5	Purple **Not acceptable water quality**	Increasing risk of skeletal damage.

* Ammonium guideline only sourced from DWAF (1996a)

Table 3.3 Domestic "Salinity" Set: Constituents of concern and water quality guidelines to assess the suitability for domestic use (DWAF, 1996a and DWAF, DOH and WRC, 1998)

Constituent	Range	Colour Classification	Suitability for Domestic Use
Ca (mg. ℓ^{-1}) Calcium can cause scaling in electrical appliances and reduce the lathering properties of soap.	0 – 80	Blue **Very good water quality**	No health effects.
	80 – 150	Green **Good water quality**	Insignificant effects.
	150 – 300	Yellow **Fair water quality**	Increased effects in sensitive groups only.
	> 300	Red **Poor water quality**	Chronic health effects in sensitive groups only.
Mg (mg. ℓ^{-1}) Magnesium (Mg) affects the taste of water, being bitter at high concentrations (DWAF, DOH and WRC, 1998).	0 – 70	Blue **Very good water quality**	No health effects.
	70 – 100	Green **Good quality water**	Insignificant health effects in sensitive groups only.
	100 – 200	Yellow **Fair water quality**	Increasing effects in sensitive groups only.
	200- 400	Red **Poor water quality**	Potential diarrhoea in all new users (some adaptation is possible).
	> 400	Purple **Not acceptable water quality**	Diarrhoea in all individuals.
SO_4 (mg. ℓ^{-1}) Sulphate is particularly common in mining areas and may cause diarrhoea, particularly in users not accustomed to drinking water with high sulphate levels (DWAF, DOH and WRC, 1998). It also affects the taste of the water.	0 – 200	Blue **Very good water quality**	No health effects.
	200 – 400	Green **Good water quality**	Insignificant health effects.
	400 – 600	Yellow **Fair water quality**	Slight chance of diarrhoea in sensitive groups, but disappears with adaptation.
	600 – 1000	Red **Poor water quality**	Possibility of diarrhoea. Poor adaptation in sensitive individuals.
	> 1000	Purple **Not acceptable water quality**	High chance of diarrhoea. No adaptation.
Cl (mg. ℓ^{-1}) Chloride is often elevated in hot, arid areas and may cause nausea and vomiting at very high concentrations (DWAF, DOH and WRC, 1998). It also affects the taste of water at higher concentrations.	0 – 100	Blue **Very good water quality**	No health effects.
	100 – 200	Green **Good water quality**	Insignificant health effects.
	200 – 600	Yellow **Fair water quality**	Increasing health risk to sensitive groups.
	600 – 1200	Red **Poor water quality**	Possible long-term health effects.
	> 1200	Purple **Not acceptable water quality**	Dehydration in infants, nausea and vomiting.
Na (mg. ℓ^{-1}) Sodium affects the taste of water.	0 – 100	Blue **Very good water quality**	Negligible health effects.
	100 – 200	Green **Good water quality**	Insignificant health effects.
	200 – 400	Yellow **Fair water quality**	Slight risk to some sensitive groups.
	400 – 1000	Red **Poor water quality**	Possible health risk, particularly in sensitive groups.
	> 1000	Purple **Not acceptable water quality**	Definite health risk.
K (mg. ℓ^{-1}) Potassium affects the taste of water and may also be bitter at high concentrations (DWAF, DOH and WRC, 1998).	0 – 25	Blue **Very good water quality**	Negligible health effects.
	25 – 50	Green **Good water quality**	Insignificant health effects.
	50 – 100	Yellow **Fair water quality**	Slight risk to some sensitive groups.
	100 – 500	Red **Poor water quality**	Possible health effects.
	> 500	Purple **Not acceptable water quality**	Definite health risk to all individuals.

The effects of the different classes of water on irrigated agriculture are listed in Table 3.4.

Table 3.4 Water quality guidelines applicable to the Irrigated Agriculture Use (DWAF, 1996b)

Constituent	Range	Colour Classification	Suitability for Irrigated Agriculture
SAR The Sodium Adsorption Ratio is an index of the potential of a given irrigation water to induce sodic soil conditions. Negative effects associated with soil sodicity include: reduced crop yield and quality as a result of sodium uptake through the roots of sodium sensitive plants; and impaired soil physical conditions (reduced soil permeability) (DWAF, 1996b).	≤ 2.0 TWQR	Blue **Very good water quality**	Should prevent sodium toxicity from developing, provided that water is applied to the soil surface, limiting sodium uptake through the roots.
	2.0 – 8.0	Green **Good water quality**	The most sodium-sensitive crops absorb toxic levels of sodium through roots. Crops vary in sensitivity.
	8.0 – 15.0	Yellow **Fair water quality**	Sodium-sensitive crops absorb toxic levels of sodium through roots. Crops vary in sensitivity.
	> 15.0	Red **Poor water quality**	All sodium-sensitive crops absorb toxic levels of sodium through root uptake. A number of economically important crops can be irrigated without sodium toxicity developing.
EC ($mS.m^{-1}$) Electrical Conductivity is increased when increasing levels of salt are present in the irrigation water, which introduces salt into the soil profile. When little or no leaching of the salt takes place from the soil profile, salt accumulates and saline soil is formed (DWAF, 1996b). Yield is reduced in crops that are sensitive to soil salinity.	≤ 40 TWQR	Blue **Very good water quality**	Should ensure that salt-sensitive crops can be grown without yield decreases when using low frequency irrigation systems.
	40 – 90	Green **Good water quality**	A 95% relative yield of moderately salt-sensitive crops can be maintained by using a low frequency irrigation system.
	90 – 270	Yellow **Fair water quality**	A 90 % relative yield of moderately salt-tolerant crops can be maintained by using a low frequency irrigation system.
	270 – 540	Red **Poor water quality**	An 80 % relative yield of moderately salt-tolerant crops can be maintained by using a low frequency irrigation system.
	> 540	Purple **Not acceptable water quality**	These waters can still be used for irrigation of selected crops provided sound irrigation management is practised and yield decreases are acceptable.
pH The pH value of water does not have direct consequences except at the extremes (DWAF, 1996b). The adverse effects of pH result from the solubilisation of toxic heavy metals and the protonation or deprotonation of other ions.	< 6.5	Red **Not Very good water quality (acid)**	Increasing problems with foliar damage.
	6.5 – 8.4 TWQR	Blue **Very good water quality**	Should not cause foliar damage
	> 8.4	Purple **Not Very good water quality (alkali)**	Increasing problems with foliar damage
Cl ($mg.\ell^{-1}$) Chloride is an essential plant micronutrient and is relatively non-toxic to most crops (DWAF, 1996b). However, when the accumulated chloride concentration in leaves exceeds the crop's tolerance, injury symptoms develop in the form of leaf burn that affect crop production (DWAF, 1996b).	< 100 TWQR	Blue **Very good water quality**	Should prevent accumulation of chloride to toxic levels in all but the most sensitive plants.
	100 – 175	Green **Good water quality**	Crops sensitive to foliar absorption accumulate toxic levels of chloride when foliage is wetted.
	175 – 350	Yellow **Fair water quality**	Crops moderately sensitive to foliar absorption accumulate toxic levels of chloride when foliage is wetted.
	350 – 700	Red **Poor water quality**	Crops moderately sensitive to foliar absorption increasingly accumulate toxic levels of chloride when foliage is wetted.
	> 700	Purple **Not acceptable water quality**	Crops tolerant to foliar absorption increasingly accumulate toxic levels of chloride when foliage is wetted.
B ($mg.\ell^{-1}$) Boron is an essential plant nutrient that is toxic to plant growth at low concentrations (DWAF, 1996b). Boron tends to be found in association with saline conditions.	< 0.5 TWQR	Blue **Very good water quality**	Should prevent accumulation of boron to toxic levels (through root uptake) in all but the most sensitive plants.
	0.5 – 1.0	Green **Good water quality**	Crops very sensitive to boron accumulate toxic levels (through root uptake). Plants start to display symptoms of foliar injury and/or yield decreases.
	1.0 – 2.0	Yellow **Fair water quality**	Crops sensitive to boron accumulate toxic levels and start to display foliar injury and/or yield decreases.
	2.0 – 4.0	Red **Poor water quality**	Crops moderately sensitive to boron accumulate toxic levels and start to display foliar injury and/or yield decreases.
	> 4.0	Purple **Not acceptable water quality**	Crops moderately tolerant to boron accumulate toxic levels and start to display foliar injury and/or yield decreases.

3.2 Land Cover

Land cover and land use is known to affect water quality. The human activities conducted on land adjacent to rivers and water bodies have an impact on the water quality in a number of ways. Disturbing the land cover may result in erosion and, therefore, increase turbidity, the discharge of treated and untreated wastes into rivers increases the nutrient and ammonia levels, and the diffuse release of excess fertilisers applied to agricultural fields entering rivers and water bodies affects the nutrient balance, amongst other impacts. The geology and natural plant growth also have an impact on water quality and may result in elevated levels of various constituents even in the absence of disturbance by human intervention.

A vast range of land cover types is evident over South Africa (Map 1 and Table 3.5). This would lead one to believe that the water quality would also reflect this complexity by exhibiting a range of specific water quality problems and characteristics. Appendix 8.2 presents the four most dominant (by aerial extent) land cover types in each of the 19 Water Management Areas (WMAs). This information may be of interest to certain readers of this report.

The land cover types reflected in Map 1, Table 3.5 and Appendix 8.2 are extensive and certain effects can be expected of various land cover and land use types. For example:

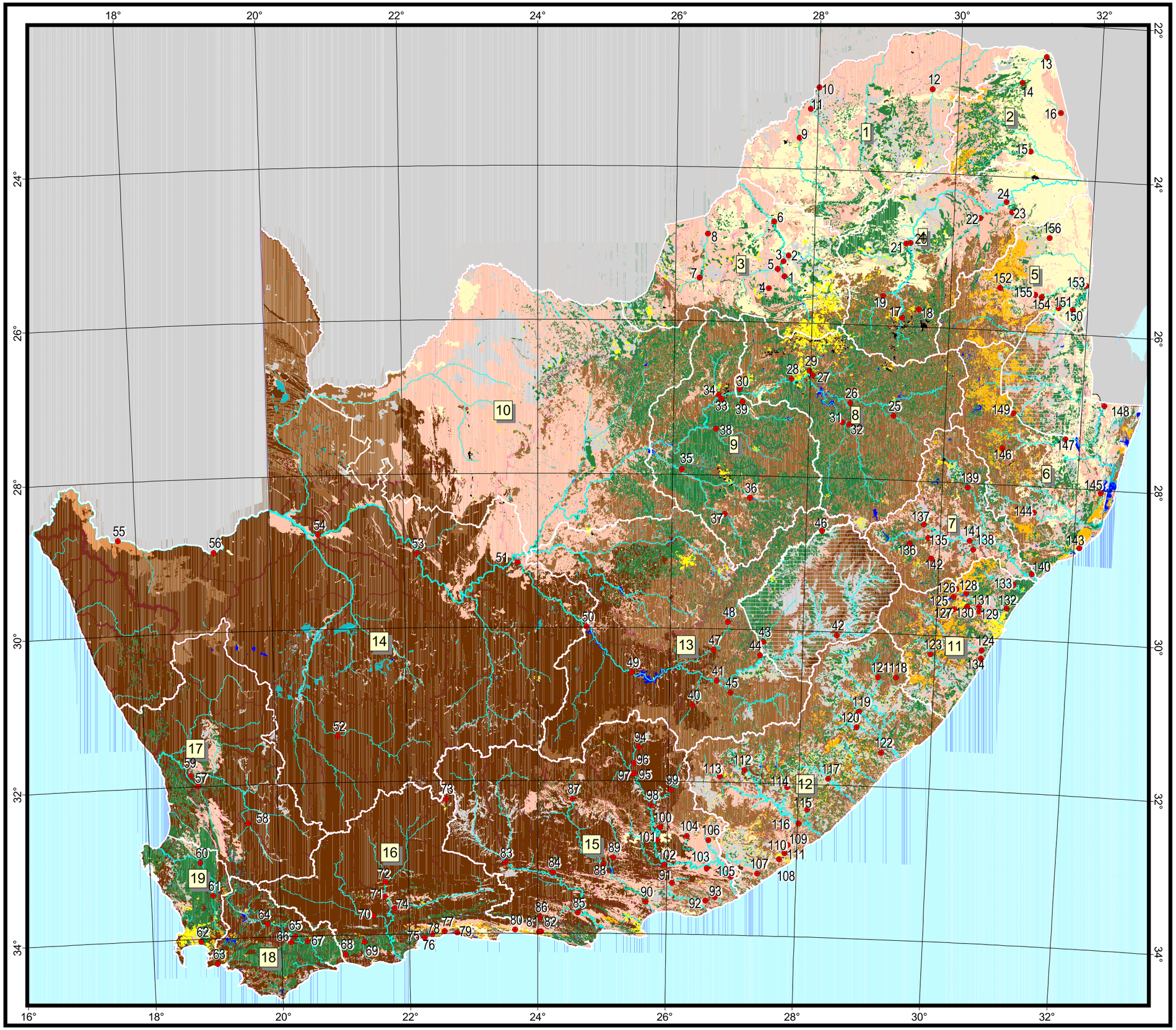
- Mining and quarries can be expected to be associated with deterioration in water quality due to the exposure of elements previously covered by soil or deep underground to rainfall and runoff. Specific types of mining would be expected to be associated with elevated levels of specific water quality constituents, such as sulphate in the case of coal mining.
- Cultivated lands can also be expected to be associated with specific water quality perturbations, such as: increased turbidity due to increased soil erosion of exposed land; and increased nutrient and salt concentrations due to return flows of fertiliser-carrying irrigation water. If herbicides and pesticides were used, then these could also be expected to make their way into water courses after rain or irrigation events (these substances are not included in this study).
- Various types of degraded lands are often a result of unsustainable human and livestock pressure on the land, with associated increases in turbidity due to the surface cover being removed and then rainfall and runoff carrying the soil to the nearest water course.
- Urban or built-up areas are often associated with increased levels of nutrients and other pollutants.
- Bush, shrub, herb, forest and grassland, if natural and undisturbed, would not be expected to be a reason for water quality perturbations since the vegetation cover should shield the soil from the erosive effects of rainfall and the ground cover should also protect the soil surface.
- Plantations may be associated with higher levels of nutrients if the plantations are fertilised and also higher turbidity levels since there is implicit disturbance in the planting, tending and harvesting of plantations.

The land cover in the vicinity of each sample site (based on Map 1) is presented in Table 3.5.

Map 1 Land cover of South Africa (after Fairbanks *et al.,* 2000)

National assessment of water quality

Map1
Land cover of South Africa
(after Fairbanks et al., 2000)



Major land cover classes from the National Land Cover database:
http://www.sac.co.za/geoinfo/nlc_report.htm

- 01: Forest
- 02: Bush
- 03: Shrub
- 04: Herb
- 05: Grass
- 06: Plantation
- 07: Water
- 08: Wetland
- 09: Degraded
- 10: Cultivated
- 11: Urban
- 12: Mining

0 100 200 Kilometres

Albers Equal Area projection
Clarke 1880 spheroid
24°E central meridian
18°S 32°S standard parallels

iwqs@dwaf.gov.za
http://www-dwaf.pwv.gov.za/iwqs/

2002-04-24 13:43

Table 3.5 List of land cover in the vicinity of national assessment sample sites selected, grouped per WMA

No.	Sample Site Number	Location of the Site	Land Cover in the Vicinity of the Site
Limpopo WMA			
9	A4H013Q01	Mokolo River at Moorddrift/Vught	Bush and Forest
10	A5H006Q01	Limpopo River at Botswana/Sterkloop	Bush and Degraded land
11	A5H008Q01	Palala River at Ga-Seleka/Bosche Diesch	Bush
12	A7H001Q01	Sand River at Waterpoort	Bush and Forest
Luvuvhu and Letaba WMA			
13	A9H011Q01	Luvuvhu River at Pafuri/Kruger National Park	Forest
14	A9H012Q01	Luvuvhu River at Mhinga	Cultivated land and Forest
15	B8H008Q01	Great Letaba River at Letaba Ranch	Forest and Cultivated land and Bush
16	B9H003Q01	Shingwidzi River at Kanniedood Dam/Kruger National Park	Bush
Crocodile (West) and Marico WMA			
1	A2H019Q01	Roodekopjes Dam on Crocodile River: Down Stream Weir	Bush and Cultivated land
2	A2H021Q01	Pienaars River at Buffelspoort	Forest and Cultivated land
3	A2H059Q01	Crocodile River at Vaalkop/Atlanta	Bush and Cultivated land
4	A2H094Q01	Bospoort Dam on Hex River: Down Stream Weir	Bush
5	A2H111Q01	Vaalkop Dam on Elands River: Down Stream Weir	Bush
6	A2H116Q01	Paul Hugo Dam on Crocodile River: Down Stream Weir	Cultivated land and Bush
7	A3R003Q01	Kromellenboog Dam on Little Marico River: Near Dam Wall	Bush and Cultivated land
8	A3R004Q01	Molatedi Dam on Great Marico River: Near Dam Wall	Bush and Degraded land
Olifants WMA			
17	B1H010Q01	Witbank Dam on Olifants River: Down Stream Weir	Grass, Cultivated land, Urban and Mining
18	B1H015Q01	Middelburg Dam on Little Olifants River: Down Stream Weir	Grass, Cultivated land and Urban
19	B2H015Q01	Wilge River at Zusterstroom	Grass, Cultivated land and Urban
20	B3H001Q01	Olifants River at Loskop North	Degraded land and Cultivated land
21	B3H021Q01	Elands River at Scherp Arabie	Cultivated land and Forest
22	B4H011Q01	Steelpoort River at Alverton	Bush and Cultivated land
23	B6H004Q01	Blyde River at Chester	Bush and Cultivated land
24	B7H009Q01	Olifants River at Finale/Liverpool	Cultivated land, Degraded land and Bush
Inkomati WMA			
150	X1H003Q01	Komati River at Tonga	Forest and Cultivated land
151	X1H014Q01	Mlumati River at Lomati	Forest, Plantation and Cultivated land
152	X2H013Q01	Krokodil River at Montrose	Plantation
153	X2H016Q01	Krokodil River at Tenbosch/Kruger National Park	Cultivated land and Forest
154	X2H022Q01	Kaap River at Dolton	Bush, Cultivated land and Plantation
155	X2H032Q01	Krokodil River at Weltevrede	Bush and Cultivated land
156	X3H008Q01	Sand River at Exeter	Forest, Bush and Degraded land
Usutu to Mhlatuze WMA			
143	W1R004Q01	Lake Msingazi at Arboretum	Cultivated land and Plantation
144	W2H005Q01	White Mfolozi River at Overvloed/Ulundi	Bush, Grass and Degraded land
145	W3H015Q01	Hluhluwe River at Valsbaai/St Lucia Inflow	Bush, Plantation and Cultivated land
146	W4H004Q01	Bivane River at Welgelegen/Pivaansbad	Grass and Plantation
147	W4H006Q01	Phongolo River at M'Hlati	Forest and Cultivated land
148	W4H009Q01	Phongolo River at Ndume Game Reserve	Forest, Bush and Cultivated land
149	W5H022Q01	Assegaai River at Zandbank	Grass and Plantation
Thukela WMA			
135	V1H001Q01	Tugela River at Tugela Drift/Colenso	Grass and Bush
136	V1H010Q01	Little Tugela River at Winterton	Cultivated land and Grass

No.	Sample Site Number	Location of the Site	Land Cover in the Vicinity of the Site
137	V1H038Q01	Klip River at Ladysmith Townlands/Army Camp	Grass, Urban and Bush
138	V2H008Q01	Mooi River at Keate's Drift	Grass, Cultivated land and Degraded land
139	V3H010Q01	Buffalo River at Tayside	Grass, Cultivated land and Plantation
140	V5H002Q01	Tugela River at Mandini	Cultivated land, Bush and Grass
141	V6H002Q01	Tugela River at Tugela Ferry	Grass, Cultivated land and Degraded land
142	V7H012Q01	Little Boesmans River at Estcourt	Grass and Bush
Upper Vaal WMA			
25	C1H002Q01	Klip River at Sterkfontein/Delangesdrift	Grass and Cultivated land
26	C1H017Q01	Vaal River at Villiers (Flood Section)	Cultivated land and Grass
27	C2H004Q01	Suikerbosrand River at Uitvlugt (RW S2)	Cultivated land, Grass and Urban
28	C2H005Q01	Riet Spruit at Kaal Plaats (RW RV2)	Cultivated land, Urban and Grass
29	C2H071Q01	Klip River at Kookfontein/Vereeniging Rail Bridge	Cultivated land and Urban
30	C2H085Q01	Mooi River at Hoogekraal/Kromdraai	Cultivated land and Grass
31	C8H001Q01	Wilge River at Frankfort	Grass and Cultivated land
32	C8H027Q01	Wilge River at Ballingtomp	Grass and Cultivated land
Middle Vaal WMA			
33	C2H007Q01	Vaal River at Pilgrims Estate/Orkney	Cultivated land and Grass
34	C2H073Q01	Skoon Spruit at Goedgenoeg/Orkney Bridge	Grass and Urban
35	C4H004Q01	Vet River at Fizantkraal/Nooitgedacht	Cultivated land and Grass
36	C4R001Q01	Allemanskraal Dam on Sand River: Near Dam Wall	Grass, Cultivated land and Bush
37	C4R002Q01	Erfenis Dam on Great Vet River: Near Dam Wall	Cultivated land and Grass
38	C6H003Q01	Vals River at Mooifontein/Bothaville	Cultivated land, Grass and Urban
39	C7H006Q01	Renoster River at Arriesrust	Cultivated land and Grass
Lower Vaal WMA			
		No sites met the selection criteria	
Mvoti to Umzimkulu WMA			
123	T5H007Q01	Mzimkulu River at Bezweni/Island View	Cultivated land, Grass, Plantation and Degraded land
124	U1H006Q01	Mkomazi River at Delos Estate	Bush and Cultivated land
125	U2H001Q01	Mgeni River at Howick	Cultivated land, Grass, Plantation and Urban
126	U2H006Q01	Karkloof River at Shafton	Cultivated land, Grass and Plantation
127	U2H011Q01	Msunduze River at Henley Dam	Grass and Cultivated land
128	U2H014Q01	Albert Falls Dam on Mgeni River: Down Stream Weir	Cultivated land and Grass
129	U2H022Q01	Msunduze River at Inanda/Nomfihlelo	Grass, Bush and Cultivated land
130	U2H041Q01	Msunduze River at Hampstead Park/Moto-X (Darville)	Grass and Urban
131	U2H043Q01	Mgeni River at Inanda/Mgeni Confluence (Mngs)	Grass, Cultivated land and Degraded land
132	U3H005Q01	Hazelmere Dam on Mdloti River: Down Stream Weir (Hmro)	Cultivated land and Urban
133	U4H008Q01	Canal (Left) from Mvoti River at Hlazane/Glendal	Cultivated land and Bush
134	U8H003Q01	Mpambanyoni River at Umbeli Belli	Cultivated land and Bush
Mzimvubu to Keiskamma WMA			
107	R1H015Q01	Keiskamma River at Farm 7/Howard Shaw Bridge	Bush and Grass
108	R2R003Q01	Bridle Drift Dam on Buffalo River: Near Dam Wall	Shrub and Bush
109	R3H001Q01	Gqunube River at Outspan	Bush and Grass
110	R3H003Q01	Nahoon Dam on Nahoon River: Down Stream Weir	Bush, Urban and Grass
111	R3H004Q01	Nahoon Dam on Nahoon River: Pipe to Purification Works	Grass and Bush
112	S1R001Q01	Xonxa Dam on White Kei River: Near Dam Wall	Grass, Bush, Cultivated land and Degraded land
113	S3H006Q01	Klaas Smits River at Weltevreden/Queenstown	Grass, Bush and Degraded land
114	S5H002Q01	Tsomo River at Wyk Maduma/Tsomo	Degraded land, Cultivated land and Grass
115	S7H001Q01	Gcuwa River at Butterworth	Bush, Grass and Degraded land
116	S7H004Q01	Great Kei River at Area 8 Sprigs B/Transkei Border	Bush and Grass
117	T1H004Q01	Bashee River at Bashee Bridge	Degraded land and Cultivated land
118	T3H004Q01	Mzintlana River at Slangfontein/Kokstad	Grass and Cultivated land

No.	Sample Site Number	Location of the Site	Land Cover in the Vicinity of the Site
119	T3H005Q01	Tina River at Mahlungulu	Degraded land and Cultivated land
120	T3H006Q01	Tsitsa River at Xonkonxa/Tsitsa Bridge	Degraded land, Cultivated land and Grass
121	T3H008Q01	Mzimvubu River at Kromdraai/Inungi	Grass, Cultivated land and Degraded land
122	T7H001Q01	Mngazi River at Mgwenyana 22/Mngazi	Grass, Cultivated land and Degraded land
Upper Orange WMA			
40	D1H001Q01	Wonderboom/Stormboom Spruit at Diepkloof/Burgersdorp	Shrub and Bush
41	D1H003Q01	Orange River at Aliwal North	Grass, Cultivated land and Shrub
42	D1H005Q01	Orange River at White Hill (Lesotho G4)	Grass
43	D1H006Q01	Kornet Spruit at Maghaleen	Grass and Cultivated land
44	D1H009Q01	Orange River at Oranjedraai	Grass, Cultivated land and Degraded land
45	D1H011Q01	Kraai River at Roodewal	Grass and Cultivated land
46	D2H012Q01	Little Caledon river at the Poplars	Cultivated land and Grass
47	D2H036Q01	Caledon River at Kommissiedrift	Shrub, Grass and Cultivated land
48	D2R004Q01	Welbedacht Dam on Caledon river: Near Dam Wall	Grass and Cultivated land
49	D3H013Q01	Orange River at Roodepoort	Shrub and Bush
50	D3R003Q01	Vanderkloof Dam on Orange River: Near Dam Wall	Shrub and Cultivated land
Lower Orange WMA			
51	D3H008Q01	Orange River at Marksdrift	Shrub, Bush and Cultivated land
52	D5H021Q01	Sak River at De Kruis/Williston	Shrub
53	D7H008Q01	Orange River at Boegoeberg Reserve/Zeekoebaart	Shrub, Bush and Cultivated land
54	D7H015Q01	South Canal from Orange River at Kakamas/Neusberg	Shrub, Bush and Cultivated land
55	D8H003Q01	Orange River at Vioolsdrift	Herb
56	D8H008Q01	Orange River at Pella Mission	Shrub and Grass
Fish to Tsitsikamma WMA			
81	K8H001Q01	Kruis River at Farm 508 Pineview	Cultivated land and Bush
82	K8H002Q01	Elands River at Kwaai Brand Forest Reserve/Witelbos	Cultivated land, Bush and Urban
83	L3R001Q01	Beervlei Dam at Windheuvel	Shrub and Degraded land
84	L6H001Q01	Heuningklip River at Campherspoort	Shrub and Bush
85	L7H006Q01	Groot River at Grootrivierspoort	Shrub, Bush and Cultivated land
86	L8H005Q01	Kouga River at Stuurmanskraal	Shrub, Bush and Cultivated land
87	N1H013Q01	Mackiesputs Eye at Graaf-Reinet/Van Reyneveldspas	Bush, Grass, Urban and Cultivated land
88	N2H007Q01	Sundays River at De Draay	Shrub
89	N3H002Q01	Voël River at Rietvley	Shrub and Bush
90	N4H003Q01	Sundays River at Addo Drift East/Addo Bridge	Bush, Shrub and Cultivated land
91	P1H003Q01	Boesmans River at Donkerhoek/Alicedale	Bush, Grass, Shrub and Cultivated land
92	P3H001Q01	Kariega River at Smithfield/Lower Waterford	Bush, Grass and Forest
93	P4H001Q01	Kowie River at Bathurst/Wolfscrag	Bush, Grass and Cultivated land
94	Q1H012Q01	Teebus River at Jan Blaauws Kop/Beaconsfield	Shrub and Cultivated land
95	Q1H017Q01	Right Canal from Great Fish River at Katkop/Zoutpansdrift	Shrub and Cultivated land
96	Q1H022Q01	Grassridge Dam on Great Brak River – Outlet to River	Shrub and Cultivated land
97	Q2H002Q01	Great Fish River at Zoutpansdrift	Shrub and Cultivated land
98	Q4H013Q01	Tarka River at Bridge Farm/Tarka Bridge (New Weir)	Shrub, Grass and Cultivated land
99	Q4R002Q01	Kommandodrift Dam on Tarka River at Kommandodrift	Shrub
100	Q6H003Q01	Baviaans River at Botmansgat/De Klerkdal	Shrub, Bush and Cultivated land
101	Q7H003Q01	Great Fish River at Leeuwe Drift	Shrub, Cultivated land and Forest
102	Q8H011Q01	Little Fish River at Rietfontein/Junction Drift	Shrub and Bush
103	Q9H001Q01	Great Fish River at Fort Brown Peninsula	Bush and Shrub
104	Q9H002Q01	Koonap River at Adelaide	Bush and Shrub
105	Q9H018Q01	Great Fish River at Matomela's Reserve/Outspan	Shrub, Bush and Cultivated land
106	Q9H029Q01	Kat River at Fort Beaufort	Bush, Degraded land and Cultivated land
Gouritz WMA			

No.	Sample Site Number	Location of the Site	Land Cover in the Vicinity of the Site
68	H8H001Q01	Duiwenhoks River at Dassjes Klip	Shrub and Cultivated land
69	H9H005Q01	Goukou River at Farm 216 (SWQ 4A-11) D/S River	Cultivated land
70	J1H019Q01	Groot River at Buffelsfontein/Van Wyksdorp	Shrub
71	J2H010Q01	Gamka River at Huisrivier	Shrub, Bush and Cultivated land
72	J2H016Q01	Gamkapoort Dam on Gamka River: Down Stream Weir	Shrub and Bush
73	J2R004Q01	Gamka Dam on Gamka River: Near Dam Wall	Shrub
74	J3H011Q01	Olifants River at Warm Water	Shrub, Cultivated land and Plantation
75	K1H005Q01	Moordkuil River at Banff	Shrub, Cultivated land and Plantation
76	K2H004Q01	Great Brak River at Vishoek	Shrub
77	K3H001Q01	Kaaimans River at Upper Barbiers Kraal	Bush and Plantation
78	K3H003Q01	Maalgate River at Knoetze Kama/Buffelsdrift	Cultivated land, Shrub and Bush
79	K4R002Q01	Swart Vlei at Ronde Valley/Hoogekraal	Bush, Plantation and Cultivated land
80	K7H001Q01	Bloukrans River at Lottering Forest Reserve	Forest, Plantation and Bush
Olifants/Doorn WMA			
57	E1R001Q01	Bulshoek Dam on Olifants River: Near Dam Wall	Shrub and Cultivated land
58	E2H002Q01	Doring River at Elands Drift/Aspoort	Shrub
59	E2H003Q01	Doring River at Melkboom	Shrub, Cultivated land and Bush
Breede WMA			
63	G4H007Q01	Palmiet River at Farm 562- Welgemoed/Kleinmond	Shrub and Herb
64	H4H024Q01	Robertson Canal from Bree River at De Goree	Shrub and Cultivated land
65	H5H005Q01	Bree River at Wagenboomsheuvel/Drew	Cultivated land and Shrub
66	H6H009Q01	Riviersonderend at Reenen	Cultivated land and Shrub
67	H7H006Q01	Bree River at Swellendam	Cultivated land and Shrub
Berg WMA			
60	G1H031Q01	Berg River at Misverstand/Die Brug	Cultivated land
61	G1H036Q01	Berg River at Vleesbank/Hermon Bridge	Cultivated land and Shrub
62	G2H015Q01	Eerste River at Faure	Cultivated land, Urban and Shrub

3.3 Data Collection and Availability

The water quality data that were used in the assessment of the fitness for use of South Africa's surface water resources for domestic and irrigated agricultural use were collected as part of the so-called National Chemical or Salinity Monitoring Programme. This programme has been in operation since the early 1970's and samples are regularly collected at approximately 1 600 monitoring stations at a frequency that varies from weekly to monthly sampling. The samples collected for this programme are analysed at the laboratories of the Institute for Water Quality Studies and the data is stored on DWAF's database, namely, the Water Management System (WMS).

The number of sample records per sample site for the study period (1996 to 2000) is presented in Table 3.6. The value is based on the number of Total Dissolved Salts (TDS - which is approximately equivalent to Dissolved Major Salts "DMS" in WMS terminology) results per sample site over the review period of five years. There is some variability as regards the number of records for other constituents, but TDS was considered to be an adequate indicator of the availability of data per sample site.

3.3.1 Trophic status

The only information that was available from other projects covering a national scale was that of the Trophic Status Project (van Ginkel *et al.,* 2001). The Trophic Status Project (TSP) considered the trophic status of selected impoundments across South Africa, specifically those impoundments managed by DWAF.

The trophic status of an impoundment refers to its level of enrichment with plant nutrients (van Ginkel *et al.,* 2001), that is, how productive the system is. An impoundment may be described as being *oligotrophic* (low productivity), *mesotrophic* (moderate productivity), or *eutrophic* (very productive).

The relative desirability of the various trophic status classes is influenced by the intended use of the impoundment. From a water resources perspective, the *oligotrophic* state is most desirable since it reflects the cleanest water (requiring the lowest level of purification so that it is suitable for domestic use). At the opposite end of the spectrum, the water in a *eutrophic* impoundment is the least desirable from a domestic use perspective because it will need a much higher level of purification before it is suitable for drinking purposes. The *mesotrophic* state is situated between the two extremes.

The study conducted by van Ginkel *et al.* (2001) included the following impoundments across the country, subdivided into the following WMAs:

The Luvuvhu and Letaba WMA

- the Ebenezer Dam; Magoebaskloof Dam and Tzaneen Dam.

The Crocodile (West) and Marico WMA

- the Bon Accord Dam; Buffelspoort Dam; Hartbeespoort Dam; Klipvoor Dam; Kosterrivier Dam; Lindleyspoort Dam; Rietvlei Dam; Roodekopjes Dam; Roodeplaat Dam and Vaalkop Dam.

The Olifants WMA

- the Bronkhorstspruit Dam; Loskop Dam; Middelburg Dam and Witbank Dam.

The Usutu to Mhlatuze WMA

- the Klipfontein Dam.

The Upper, Middle and Lower Vaal WMAs

- the Allemanskraal Dam; Bloemhof Dam; Boskop Dam; Erfenis Dam; Grootdraai Dam; Koppies Dam; Sterkfontein Dam and Vaal Dam.

The Mvoti to Umzimkulu WMA

- the Albert Falls Dam; Inanda Dam; Midmar Dam; Nagle Dam; Hazelmere Dam and Shongweni Dam.

The Mzimvubu to Keiskamma WMA

- the Bridledrift Dam and Laing Dam.

The Upper and Lower Orange WMAs

- the Gariep Dam; Cook's Lake; Disaneng Dam; Lotlamoreng Dam and Setumo Dam.

The Fish to Tsitsikamma WMA

- the Bo-Lang Vlei; Groen Vlei; Onder-Lang Vlei; Ronde Vlei; Sedgefield Lagoon; Swart Vlei and Wilderness Lagoon.

The Berg WMA

- the Misverstand Weir; Voëlvlei Dam and Wemmershoek Dam.

The assessment of the trophic status at each of these impoundments is presented later in the report (Section 4.4).

3.4 Sample Site Selection

To simplify the assessment and to present the information in such a way that it would be useful for water resource management purposes, data from suitable sampling sites were selected from each of the 19 Water Management Areas (WMAs).

As far as sample site selection for this report is concerned, two levels of sampling sites were selected from the chemical water quality database, namely:

- a national level sample site set
- a more comprehensive site set selected for each WMA.

The WMAs are (see Map 2):

1. the Limpopo,
2. the Luvuvhu and Letaba,
3. the Crocodile (West) and Marico,
4. the Olifants,
5. the Inkomati,
6. the Usutu to Mhlatuze,
7. the Thukela,
8. the Upper Vaal,
9. the Middle Vaal,
10. the Lower Vaal,
11. the Mvoti to Umzimkulu,
12. the Mzimvubu to Keiskamma,
13. the Upper Orange,
14. the Lower Orange,
15. the Fish to Tsitsikamma,
16. the Gouritz,
17. the Olifants/Doorn,
18. the Breede, and
19. the Berg WMA.

The rationale behind the sample site selection was based on the overall sample site selected for a national assessment of surface chemical water quality, with the addition of all other suitable water quality sample sites within the various WMAs. A suitable water quality sample site is considered to be one with an adequate level of sampling (not too infrequent or sparse) over the chosen study period. An adequate and regular frequency of samples is necessary to ensure that

the statistical analyses of the data set provide results that are representative of the study period. The selection of suitable sample sites is a qualitative process.

Since the intention is to make the best use of the available data, sample site selection may be more rigorous in those WMAs with a large number of frequently sampled sites than those WMAs that do not have a high density of sample sites with regular samples having been taken.

For the national assessment:

For the national assessment, a sample site is selected for each tertiary drainage region, ideally as close to the outflow point of the tertiary drainage region as possible, as a descriptor of the water quality within that drainage region. In those cases where no suitable site exists, the next closest site with a suitable data record is selected.

For the WMA-level assessment:

For the WMA-level assessment, sample sites in the national assessment sample site set are used together with additional sites with sufficient data throughout each tertiary drainage region in order to better be able to link land use types and activities with the water quality sampled in the rivers.

Map 2 presents the location of the national assessment sample sites as listed in Table 3.6.

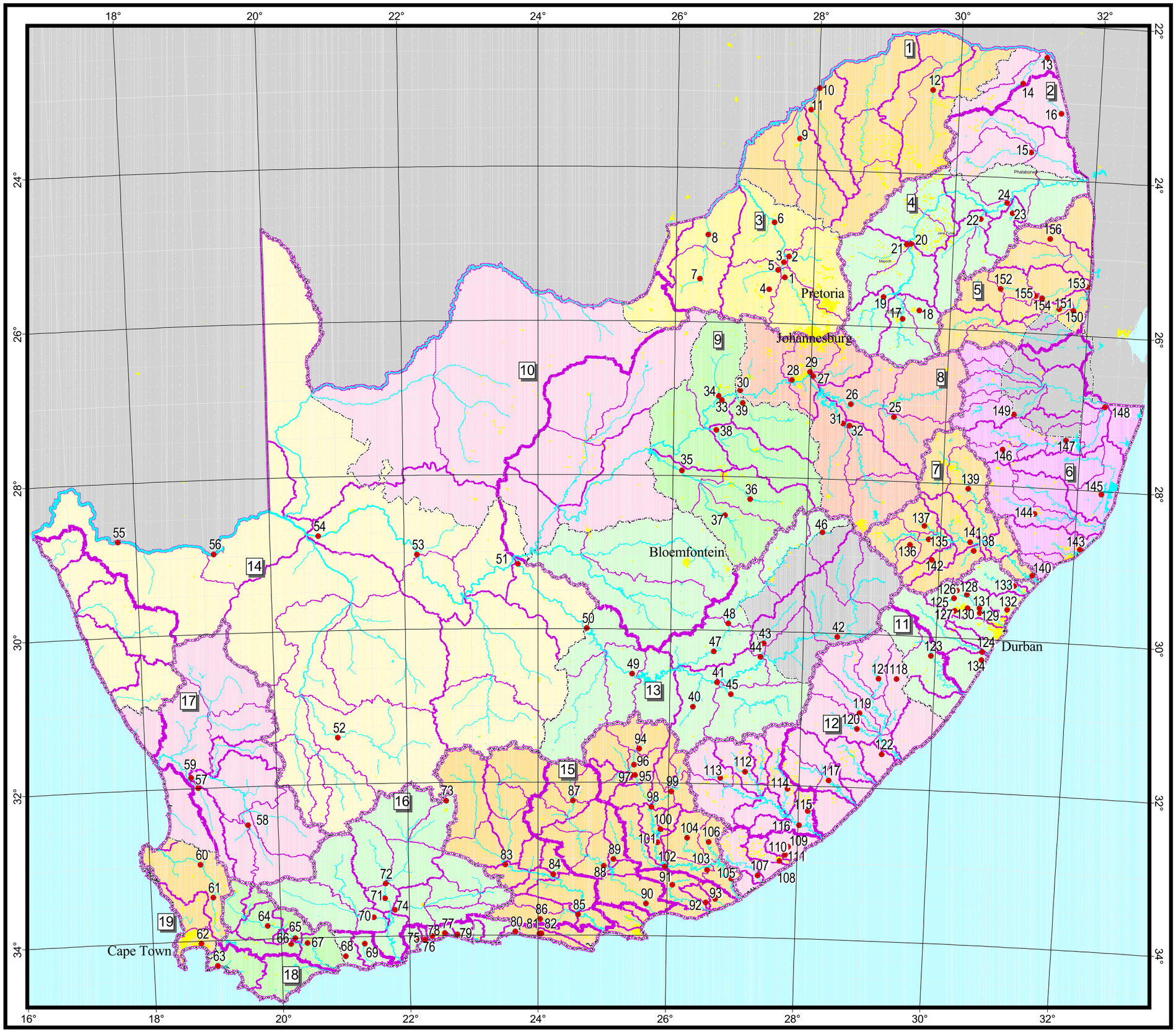
Table 3.6 contains a list of all of the sample sites selected for the national assessment of chemical surface water quality. Both the WMS code and the older DWAF sample site number of each site are given. Refer to Map 2 for the geographical location of the sample sites throughout the country. The number in the first column in Table 3.6 corresponds with the sample site number on Map 2.

Map 2 The location of the national assessment sample sites

National assessment of water quality

Map 2

Location of national assessment sample sites



- Sample site
- River
- Water management area
- Primary drainage region
- Secondary drainage region
- Tertiary drainage region
- Dam, lake
- Urban area

Water management areas

1 - Limpopo
2 - Luvuvhu and Letaba
3 - Crocodile(West) and Marico
4 - Olifants
5 - Inkomati
6 - Usutu to Mhlathuze
7 - Thukela
8 - Upper Vaal
9 - Middle Vaal
10 - Lower Vaal
11 - Mvoti to Umzimkulu
12 - Mzimvubu to Keiskamma
13 - Upper Orange
14 - Lower Orange
15 - Fish to Tsitsikamma
16 - Gouritz
17 - Olifants/Doorn
18 - Breede
19 - Berg

0 100 200 Kilometres

Albers Equal Area projection
Clarke 1880 spheroid
24°E central meridian
18°S 32°S standard parallels

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Table 3.6 List of national assessment sample sites selected grouped per WMA

No.	WMS Code	Sample Site Number	No. of Records	Location of the Site
Limpopo WMA				
9	90334	A4H013Q01	88	Mokolo River at Moorddrift/Vught
10	90340	A5H006Q01	42	Limpopo River at Botswana/Sterkloop
11	90341	A5H008Q01	55	Palala River at Ga-Seleka/Bosche Diesch
12	90370	A7H001Q01	51	Sand River at Waterpoort
Luvuvhu and Letaba WMA				
13	90398	A9H011Q01	103	Luvuvhu River at Pafuri/Kruger National Park
14	90399	A9H012Q01	128	Luvuvhu River at Mhinga
15	90524	B8H008Q01	112	Great Letaba River at Letaba Ranch
16	90583	B9H003Q01	110	Shingwidzi River at Kanniedood Dam/Kruger National Park
Crocodile (West) and Marico WMA				
1	90167	A2H019Q01	133	Roodekopjes Dam on Crocodile River: Down Stream Weir
2	90168	A2H021Q01	131	Pienaars River at Buffelspoort
3	90203	A2H059Q01	255	Crocodile River at Vaalkop/Atlanta
4	90220	A2H094Q01	46	Bospoort Dam on Hex River: Down Stream Weir
5	90230	A2H111Q01	126	Vaalkop Dam on Elands River: Down Stream Weir
6	90233	A2H116Q01	128	Paul Hugo Dam on Crocodile River: Down Stream Weir
7	90325	A3R003Q01	32	Kromellenboog Dam on Little Marico River: Near Dam Wall
8	90326	A3R004Q01	52	Molatedi Dam on Great Marico River: Near Dam Wall
Olifants WMA				
17	90412	B1H010Q01	227	Witbank Dam on Olifants River: Down Stream Weir
18	90414	B1H015Q01	218	Middelburg Dam on Little Olifants River: Down Stream Weir
19	90442	B2H015Q01	202	Wilge River at Zusterstroom
20	90444	B3H001Q01	196	Olifants River at Loskop North
21	90458	B3H021Q01	114	Elands River at Scherp Arabie
22	90473	B4H011Q01	95	Steelpoort River at Alverton
23	90491	B6H004Q01	122	Blyde River at Chester
24	90506	B7H009Q01	89	Olifants River at Finale/Liverpool
Inkomati WMA				
150	102933	X1H003Q01	212	Komati River at Tonga
151	102935	X1H014Q01	79	Mlumati River at Lomati
152	102958	X2H013Q01	95	Krokodil River at Montrose
153	102963	X2H016Q01	293	Krokodil River at Tenbosch/Kruger National Park
154	102965	X2H022Q01	90	Kaap River at Dolton
155	102975	X2H032Q01	182	Krokodil River at Weltevrede
156	103014	X3H008Q01	43	Sand River at Exeter
Usutu to Mhlatuze WMA				
143	102832	W1R004Q01	62	Lake Msingazi at Arboretum
144	102834	W2H005Q01	182	White Mfolozi River at Overvloed/Ulundi
145	102871	W3H015Q01	150	Hluhluwe River at Valsbaai/St Lucia Inflow
146	102897	W4H004Q01	55	Bivane River at Welgelegen/Pivaansbad
147	102898	W4H006Q01	49	Phongolo River at M'Hlati
148	102901	W4H009Q01	27	Phongolo River at Ndume Game Reserve
149	102914	W5H022Q01	99	Assegaai River at Zandbank
Thukela WMA				
135	102695	V1H001Q01	84	Tugela River at Tugela Drift/Colenso
136	102704	V1H010Q01	58	Little Tugela River at Winterton
137	102718	V1H038Q01	72	Klip River at Ladysmith Townlands/Army Camp
138	102740	V2H008Q01	62	Mooi River at Keate's Drift
139	102755	V3H010Q01	200	Buffalo River at Tayside

No.	WMS Code	Sample Site Number	No. of Records	Location of the Site
140	102779	V5H002Q01	79	Tugela River at Mandini
141	102781	V6H002Q01	76	Tugela River at Tugela Ferry
142	102797	V7H012Q01	56	Little Boesmans River at Estcourt
Upper Vaal WMA				
25	90585	C1H002Q01	275	Klip River at Sterkfontein/Delangesdrift
26	90597	C1H017Q01	275	Vaal River at Villiers (Flood Section)
27	90615	C2H004Q01	322	Suikerbosrand River at Uitvlugt (RW S2)
28	90616	C2H005Q01	283	Riet Spruit at Kaal Plaats (RW RV2)
29	90654	C2H071Q01	273	Klip River at Kookfontein/Vereeniging Rail Bridge
30	90668	C2H085Q01	308	Mooi River at Hoogekraal/Kromdraai
31	90859	C8H001Q01	279	Wilge River at Frankfort
32	90884	C8H027Q01	273	Wilge River at Ballingtomp
Middle Vaal WMA				
33	90618	C2H007Q01	244	Vaal River at Pilgrims Estate/Orkney
34	90656	C2H073Q01	240	Skoon Spruit at Goedgenoeg/Orkney Bridge
35	90795	C4H004Q01	147	Vet River at Fizantkraal/Nooitgedacht
36	90809	C4R001Q01	71	Allemanskraal Dam on Sand River: Near Dam Wall
37	90810	C4R002Q01	87	Erfenis Dam on Great Vet River: Near Dam Wall
38	90847	C6H003Q01	137	Vals River at Mooifontein/Bothaville
39	90853	C7H006Q01	255	Renoster River at Arriesrust
Lower Vaal WMA				
No suitable sites were located at the time of sample site selection				
Mvoti to Umzimkulu WMA				
123	102606	T5H007Q01	38	Mzimkulu River at Bezweni/Island View
124	102620	U1H006Q01	54	Mkomazi River at Delos Estate
125	102621	U2H001Q01	N/A	Mgeni River at Howick
126	102624	U2H006Q01	N/A	Karkloof River at Shafton
127	102626	U2H011Q01	N/A	Msunduze River at Henley Dam
128	102629	U2H014Q01	N/A	Albert Falls Dam on Mgeni River: Down Stream Weir
129	102632	U2H022Q01	N/A	Msunduze River at Inanda/Nomfihlelo
130	102651	U2H041Q01	N/A	Msunduze River at Hampstead Park/Moto-X (Darville)
131	102653	U2H043Q01	N/A	Mgeni River at Inanda/Mgeni Confluence (Mngs)
132	102675	U3H005Q01	N/A	Hazelmere Dam on Mdloti River: Down Stream Weir (Hmro)
133	102679	U4H008Q01	194	Canal (Left) from Mvoti River at Hlazane/Glendal
134	102693	U8H003Q01	59	Mpambanyoni River at Umbeli Belli
Mzimvubu to Keiskamma WMA				
107	102504	R1H015Q01	78	Keiskamma River at Farm 7/Howard Shaw Bridge
108	102525	R2R003Q01	74	Bridle Drift Dam on Buffalo River: Near Dam Wall
109	102526	R3H001Q01	37	Gqunube River at Outspan
110	102527	R3H003Q01	27	Nahoon Dam on Nahoon River: Down Stream Weir
111	102528	R3H004Q01	53	Nahoon Dam on Nahoon River: Pipe to Purification Works
112	102534	S1R001Q01	16	Xonxa Dam on White Kei River: Near Dam Wall
113	102545	S3H006Q01	52	Klaas Smits River at Weltevreden/Queenstown
114	102553	S5H002Q01	55	Tsomo River at Wyk Maduma/Tsomo
115	102565	S7H001Q01	45	Gcuwa River at Butterworth
116	102568	S7H004Q01	58	Great Kei River at Area 8 Sprigs B/Transkei Border
117	102573	T1H004Q01	34	Bashee River at Bashee Bridge
118	102586	T3H004Q01	58	Mzintlana River at Slangfontein/Kokstad
119	102587	T3H005Q01	46	Tina River at Mahlungulu
120	102588	T3H006Q01	45	Tsitsa River at Xonkonxa/Tsitsa Bridge
121	102590	T3H008Q01	60	Mzimvubu River at Kromdraai/Inungi

No.	WMS Code	Sample Site Number	No. of Records	Location of the Site
122	102615	T7H001Q01	40	Mngazi River at Mgwenyana 22/Mngazi
Upper Orange WMA				
40	101788	D1H001Q01	151	Wonderboom/Stormboom Spruit at Diepkloof/Burgersdorp
41	101789	D1H003Q01	253	Orange River at Aliwal North
42	101790	D1H005Q01	16	Orange River at White Hill (Lesotho G4)
43	101791	D1H006Q01	127	Kornet Spruit at Maghaleen
44	101793	D1H009Q01	127	Orange River at Oranjedraai
45	101795	D1H011Q01	113	Kraai River at Roodewal
46	101808	D2H012Q01	59	Little Caledon river at the Poplars
47	101816	D2H036Q01	99	Caledon River at Kommissiedrift
48	101820	D2R004Q01	54	Welbedacht Dam on Caledon river: Near Dam Wall
49	101828	D3H013Q01	126	Orange River at Roodepoort
50	101837	D3R003Q01	35	Vanderkloof Dam on Orange River: Near Dam Wall
Lower Orange WMA				
51	101824	D3H008Q01	240	Orange River at Marksdrift
52	101869	D5H021Q01	35	Sak River at De Kruis/Williston
53	101878	D7H008Q01	230	Orange River at Boegoeberg Reserve/Zeekoebaart
54	101884	D7H015Q01	200	South Canal from Orange River at Kakamas/Neusberg
55	101888	D8H003Q01	229	Orange River at Vioolsdrift
56	101893	D8H008Q01	234	Orange River at Pella Mission
Fish to Tsitsikamma WMA				
81	102313	K8H001Q01	31	Kruis River at Farm 508 Pineview
82	102314	K8H002Q01	35	Elands River at Kwaai Brand Forest Reserve/Witelbos
83	102329	L3R001Q01	64	Beervlei Dam at Windheuvel
84	102349	L6H001Q01	31	Heuningklip River at Campherspoort
85	102353	L7H006Q01	139	Groot River at Grootrivierspoort
86	102358	L8H005Q01	81	Kouga River at Stuurmanskraal
87	102386	N1H013Q01	54	Mackiesputs Eye at Graaf-Reinet/Van Reyneveldspas
88	102392	N2H007Q01	59	Sundays River at De Draay
89	102422	N3H002Q01	73	Voël River at Rietvley
90	102425	N4H003Q01	77	Sundays River at Addo Drift East/Addo Bridge
91	102430	P1H003Q01	110	Boesmans River at Donkerhoek/Alicedale
92	102435	P3H001Q01	99	Kariega River at Smithfield/Lower Waterford
93	102438	P4H001Q01	76	Kowie River at Bathurst/Wolfscrag
94	102440	Q1H012Q01	129	Teebus River at Jan Blaauws Kop/Beaconsfield
95	102443	Q1H017Q01	119	Right Canal from Great Fish River at Katkop/Zoutpansdrift
96	102445	Q1H022Q01	105	Grassridge Dam on Great Brak River – Outlet to River
97	102448	Q2H002Q01	173	Great Fish River at Zoutpansdrift
98	102455	Q4H013Q01	133	Tarka River at Bridge Farm/Tarka Bridge (New Weir)
99	102457	Q4R002Q01	58	Kommandodrift Dam on Tarka River at Kommandodrift
100	102463	Q6H003Q01	219	Baviaans River at Botmansgat/De Klerkdal
101	102464	Q7H003Q01	120	Great Fish River at Leeuwe Drift
102	102475	Q8H011Q01	130	Little Fish River at Rietfontein/Junction Drift
103	102478	Q9H001Q01	123	Great Fish River at Fort Brown Peninsula
104	102479	Q9H002Q01	88	Koonap River at Adelaide
105	102487	Q9H018Q01	137	Great Fish River at Matomela's Reserve/Outspan
106	102496	Q9H029Q01	83	Kat River at Fort Beaufort
Gouritz WMA				
68	102123	H8H001Q01	61	Duiwenhoks River at Dassjes Klip
69	102130	H9H005Q01	82	Goukou River at Farm 216 (SWQ 4A-11) D/S River
70	102148	J1H019Q01	83	Groot River at Buffelsfontein/Van Wyksdorp

No.	WMS Code	Sample Site Number	No. of Records	Location of the Site
71	102168	J2H010Q01	89	Gamka River at Huisrivier
72	102173	J2H016Q01	37	Gamkapoort Dam on Gamka River: Down Stream Weir
73	102179	J2R004Q01	48	Gamka Dam on Gamka River: Near Dam Wall
74	102183	J3H011Q01	181	Olifants River at Warm Water
75	102207	K1H005Q01	64	Moordkuil River at Banff
76	102243	K2H004Q01	58	Great Brak River at Vishoek
77	102248	K3H001Q01	67	Kaaimans River at Upper Barbiers Kraal
78	102250	K3H003Q01	62	Maalgate River at Knoetze Kama/Buffelsdrift
79	102283	K4R002Q01	62	Swart Vlei at Ronde Valley/Hoogekraal
80	102312	K7H001Q01	145	Bloukrans River at Lottering Forest Reserve
Olifants/Doorn WMA				
57	101900	E1R001Q01	132	Bulshoek Dam on Olifants River: Near Dam Wall
58	101902	E2H002Q01	54	Doring River at Elands Drift/Aspoort
59	101903	E2H003Q01	165	Doring River at Melkboom
Breede WMA				
63	101998	G4H007Q01	222	Palmiet River at Farm 562- Welgemoed/Kleinmond
64	102088	H4H024Q01	202	Robertson Canal from Bree River at De Goree
65	102099	H5H005Q01	172	Bree River at Wagenboomsheuvel/Drew
66	102107	H6H009Q01	55	Riviersonderend at Reenen
67	102119	H7H006Q01	53	Bree River at Swellendam
Berg WMA				
60	101935	G1H031Q01	215	Berg River at Misverstand/Die Brug
61	101939	G1H036Q01	224	Berg River at Vleesbank/Hermon Bridge
62	101975	G2H015Q01	211	Eerste River at Faure

Map 3 indicates the location of the "hot spot" sites that represent those sites in the individual WMA sample sites sets (a separate but associated study that is also underway) whose median concentrations exceed the *Very Good* and *Good* classes. This is information that is additional to the national assessment sample site set.

Map 3 The location of the “hot spot” sample sites on a national scale

National assessment of water quality

Map 3
Location of "hot spot" sample sites
(at national scale)

- Hotspot: Agriculture (irrigation)
- Hotspot: Domestic (health)
- Hotspot: Domestic (salt)
- River
- Water management area
- Primary drainage region
- Secondary drainage region
- Tertiary drainage region
- Dam, lake
- Urban area

Water management areas

1 - Limpopo
2 - Luvuvhu and Letaba
3 - Crocodile(West) and Marico
4 - Olifants
5 - Inkomati
6 - Usutu to Mhlathuze
7 - Thukela
8 - Upper Vaal
9 - Middle Vaal
10 - Lower Vaal
11 - Mvoti to Umzimkulu
12 - Mzimvubu to Keiskamma
13 - Upper Orange
14 - Lower Orange
15 - Fish to Tsitsikamma
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18 - Breede
19 - Berg

0 100 200 Kilometres

Albers Equal Area projection
Clarke 1880 spheroid
24°E central meridian
18°S 32°S standard parallels

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3.5 Study Period

A study period of 5 years was used for assessing the water inorganic chemical quality status of surface water resources extending from the beginning of 1996 to the end of the year 2000. The median (the most commonly) observed concentration for each variable is used in comparison with the domestic and irrigation use guidelines.

3.6 Presentation of Results

Assessment of the water quality across South Africa is described in terms of fitness-for-use for domestic and irrigated agricultural use, and by means of the trophic status of selected impoundments. The results of the assessment of the water quality are depicted by means of maps and also in a tabular format.

Maps for the depiction of land cover and water quality across South Africa include:

i) The Land Cover of South Africa (after Fairbanks *et al.*, 2000) which was detailed previously (Map 1);
ii) A Maucha diagram map showing the salt balances at each of the national assessment sample sites (Map 4);
iii) The Guideline Compliance Pie Diagrams for South Africa, with the constituent sets outlined in Section 2 above, for the national assessment sample site set (Map 5, 7 and 9); and
iv) The Guideline Compliance Pie Diagrams for South Africa, with the constituent sets outlined in Section 2 above, for the "hot spot" sites (Maps 6, 8 and 10).

The Guideline Compliance Pie Diagrams (Figure 1) illustrate the median concentrations for each of the constituents depicted over the study period. Median constituent concentrations are depicted in a "pie wedge" that only projects beyond the circular "pie" when the concentration falls outside of the *Very Good* range in the case of the domestic use guidelines or the Target Water Quality Range (TWQR) in the case of the agriculture guidelines. If it does project beyond the *Very Good* (or TWQR) range then the colour and extent of the projection indicates the extent of exceedence of the median value.

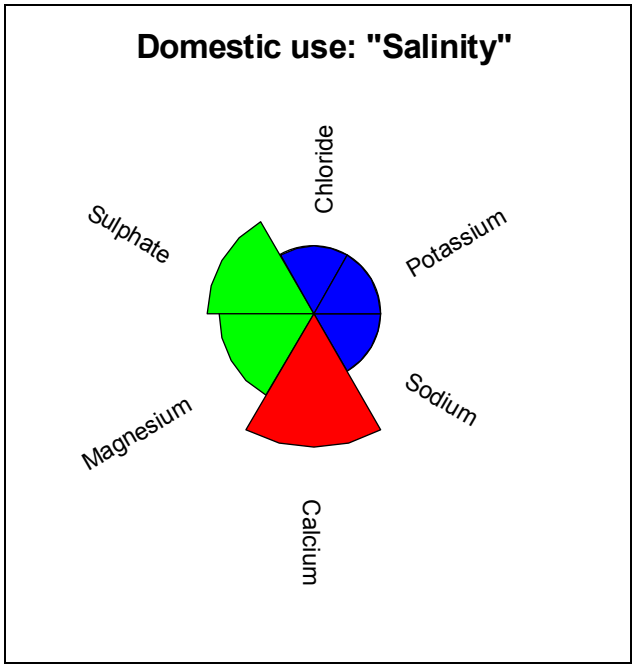


Figure 1 A typical compliance pie diagram for the fitness-for-use class Domestic Use: "Salinity"

Two sets of three Guideline Compliance Pie Diagram maps were produced for South Africa (Maps 5 to 10). The first set of three maps (Map 5, 7 and 9) represent the national assessment sample site set and the second set of three maps (Map 6, 8 and 10) represent the "hot spot" sites that were highlighted during the process of producing the maps for the individual Water Management Areas (WMAs). In order for the maps to be compared between the national assessment sample site and the "hot spots", the latter follow on immediately from the former for each water user class reported. The water quality "hot spots" are those sample sites where water quality median values exceed the *Very Good* and *Good* guideline values for sites that may not be part of the national sample site set, but are on the individual WMA sample site sets.

The first four maps (Map 5 to Map 8) are for the comparison of the median water quality values evident with domestic use guidelines (DWAF, 1996a and WRC, 1998) – of:

- firstly, NO_3+NO_2; NH_4; pH; TDS; and F (the Domestic Use "Health" maps, Maps 5 and 6), and
- secondly, Na; Mg; K; Cl; Ca; and SO_4 (the Domestic Use "Salinity" maps, Maps 7 and 8).

The Domestic Use results were split in to the two sets ("Health" and "Salinity") on a largely arbitrary basis due to the limited space available for variables on the Guideline Compliance Pie Diagrams. All of the desired variables would not have fitted onto one symbol and still been easily legible.

The last two maps, Maps 9 and 10, considered certain constituents important to irrigated agriculture (SAR; Cl; EC; B; and pH) compared with their respective irrigation water use guidelines (DWAF, 1996b).

The assessment results are presented in a series of Maps and Tables. The symbols used in the assessment maps are referred to as Guideline Compliance Pie Diagrams (Figure 1) and illustrate the median concentrations for each of the constituents depicted over the study period. Median constituent concentrations are depicted in a "pie wedge" that only projects beyond the circular "pie" when the concentration falls outside of the *Very Good* range in the case of the domestic use guidelines or the Target Water Quality Range (TWQR) in the case of the agriculture guidelines. If it does project beyond the *Very Good* range, then the colour and extent of the projection indicates the extent of exceedence of the median value.

Information from the Trophic Status Project is also included in the report. The trophic status on a national scale of selected impoundments across South Africa, specifically those impoundments managed by DWAF is reflected in Table 4.7. Information is also given on a priority ranking for the 49 selected impoundments indicating the relative need for eutrophication management (Table 4.8).

4. WATER QUALITY STATUS

4.1 Maucha diagrams

The Maucha Diagram map (Map 4) provides an indication of the salt balances at the various national assessment sample site sets. To a large extent it provides an indication of the salt balances due to natural geology.

It can be seen that the Western Cape, Eastern Cape and KwaZulu Natal coasts are sodium chloride dominant – a legacy of their marine geology and proximity to the ocean. The more inland areas, including the Orange and Vaal WMAs have high alkalinity as represented by the high bicarbonate levels. The water in these regions is typically harder and has a pH above 7. It will not lather as well as water that is softer (for example, mountain water) and may also result in faster scaling of kettles and other water heaters and steam irons.

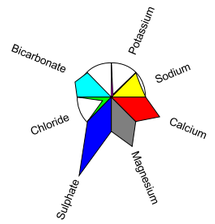
Map 4 Maucha diagram map showing salt balances for the national sample site set

National assessment of water quality

Map4:
Maucha diagrams showing salt balances
(national sample site set)

Sample site
River
Water management area
Primary drainage region
Secondary drainage region
Tertiary drainage region
Dam, lake
Urban area

Maucha ionic-balance diagram



Maucha "TDS" scale

0 100 200 Kilometres

Albers Equal Area projection
Clarke 1880 spheroid
24°E central meridian
18°S 32°S standard parallels
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4.2 Domestic Use

4.2.1 "Health" constituents

The first two of the Guideline Compliance Pie Diagram maps (Map 5 and Map 6) relate to the following constituents: NO_3+NO_2; NH_4; pH; TDS and F. The median water quality at almost all of the sample sites is within the *Very Good* and *Good* water quality ranges for domestic (drinking) water use (DWAF, 1996a and DWAF, DOH and WRC, 1998) when compared to the ranges in Table 3.2, however, at isolated sites median concentrations exceed the *Very Good* and *Good* ranges. The sites in Table 3.6 are included in Map 5.

Table 3.2 (earlier in the document) lists the applicable water quality guideline classifications. Table 4.1 contains a list of sample sites for which certain of the constituents had median concentrations exceeding the *Good* range for domestic (drinking) use (DWAF, DOH and WRC, 1998).

Table 4.1 Sample sites exceeding the *Very Good* and *Good* range for domestic water use for the Domestic Health Water Quality Constituents

Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
Olifants WMA			
B3H021Q01	F	Yellow	Elands River at Scherp Arabie
Upper Vaal WMA			
C2H004Q01	TDS	Yellow	Suikerbosrand River at Uitvlugt
Lower Orange WMA			
D5H021Q01	TDS	Red	Sak River at De Kruis/Williston
Fish to Tsitsikamma WMA			
L6H001Q01	TDS	Red	Heuningklip River at Campherspoort
N1H013Q01	TDS	Purple	Mackiesputs Eye at Graaf-Reinet/Van Reyneveldspas
N2H007Q01	TDS	Yellow	Sundays River at De Draay
N4H003Q01	TDS	Red	Sundays River at Addo Drift East/Addo Bridge
P1H003Q01	TDS	Red	Boesmans River at Donkerhoek/Alicedale
P3H001Q01	TDS	Red	Kariega River at Smithfield/Lower Waterford
P4H001Q01	TDS	Yellow	Kowie River at Bathurst/Wolfscrag
Q4H013Q01	F; TDS	Red; yellow	Tarka River at Bridge Farm/Tarka Bridge (New Weir)
Q8H011Q01	TDS	Yellow	Little Fish River at Rietfontein/Junction Drift
Q9H001Q01	TDS	Yellow	Great Fish River at Fort Brown Peninsula
Q9H018Q01	TDS	Yellow	Great Fish River at Matomela's Reserve/ Outspan
Gouritz WMA			
J1H019Q01	TDS	Purple	Groot River at Buffelsfontein/Van Wyksdorp
J3H011Q01	TDS	Purple	Olifants River at Warm Water
K2H004Q01	TDS	Purple	Great Brak River at Vishoek
K4R002Q01	TDS	Purple	Swart Vlei at Ronde Valley/Hoogekraal

It would appear that Fluoride (F) and Total Dissolved Salts (TDS) are, from a domestic use point of view, the major concerns at certain of the sampling sites (refer to the guideline values in Table 3.2 and Table 4.1 and Map 5 that indicates water quality fitness-for-use for Domestic Use: "Health" and the sites with elevated levels).

Fluoride (F)

On the Elands River at Scherp Arabie (Olifants Water Management Area) and especially at the Tarka River at Bridge Farm/Tarka Bridge (Fish to Tsitsikamma WMA), fluoride levels are elevated. The fluoride levels could result in tooth staining at both sites and also health effects (including skeletal damage) at the latter site (refer to Table 3.2 for the possible effects). Fluorosis is the term given to the disease condition where there is malformation of either the teeth (dental fluorosis) and/or the bony skeleton (skeletal fluorosis), due to chronic exposure to elevated fluoride intake.

Total Dissolved Salts (TDS)

The TDS levels were elevated at many of the sites in Table 4.1 and can be considered to be Poor or Not Acceptable in terms of human health at the Sak River at De Kruis/Williston (Lower Orange WMA), Heuningklip River at Campherspoort, Sundays River at Addo Drift East, Boesmans River at Donkerhoek/Alicedale, Kariega River at Smithfield (all in the Fish to Tsitsikamma WMA), and especially in the Gouritz WMA where it was *Not Acceptable* at the Groot River at Buffelsfontein, Olifants River at Warm Water, Great Brak River at Vishoek and Swart Vlei at Ronde Valley. The health effects range from salt overload in sensitive groups to an increasing risk of dehydration (refer to Table 3.2). It should be noted that the main effect, however, is aesthetic (the water has a salty taste and does not slake thirst at high concentrations).

Link to land cover

Refer to Table 3.5 and Map 1 and the location of the sites above for an explanation.

The elevated fluoride levels evident at the two sites is most probably due to natural geology since the land cover at the Elands River at Scherp Arabie is cultivated land and forest and at the Tarka River at Bridge Farm it is shrub, grass and cultivated land.

The elevated TDS levels would also appear to be a result of natural geology in most cases, with the possible exception of those sites near to where there is cultivated land and/or plantations (Sundays River at Addo Drift East, Boesmans River at Donkerhoek – both in the Fish to Tstitsikamma WMA, Olifants River at Warm Water and Swart Vlei at Ronde Valley – both in the Gouritz WMA) that may be fertilised and thereby contribute to the salt load. It is likely that the Swart Vlei at Ronde Valley site is strongly influenced by seawater intrusion.

Map 5 Water quality fitness for use from a Domestic Use “Health” perspective reported at the national assessment sample sites

National assessment of water quality

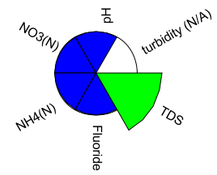
Map 5

Water quality: fitness for use from a domestic perspective (national sample site set)

Sample site
River
Water management area
Primary drainage region
Secondary drainage region
Tertiary drainage region
Dam, lake
Urban area

Pretoria
Johannesburg
Bloemfontein
Durban
Cape Town

Domestic use: "Health"



Colour key for Domestic Health

pH (pH units)
< 3 Acid burns
3 - 4 Severe irritation of mucous membranes
4 - 4.5 Irritation of mucous membranes
4.5 - 5 Mild irritation of mucous membranes
5 - 9.5 No health effects
9.5 - 10 Mild irritation of mucous membranes
10 - 10.5 Irritation of mucous membranes
10.5 - 11 Severe irritation
> 11 Alkali burns

NO3 (mg/L)
< 6 Negligible health effects
6 - 10 Insignificant risk
10 - 20 Slight chronic risk to some babies
20 - 40 Possible chronic risk to some babies
> 40 Increasing acute risk to babies

NH4 (mg/L)
< 1 Negligible health effects
1 - 2 Unknown health effects
2 - 10 Unknown health effects
> 10 Unknown health effects

F (mg/L)
< 0.7 No health effects
0.7-1 Insignificant effects (sensitive groups) & insignificant tooth staining
1 - 1.5 Increasing effects (sensitive groups) & tooth staining
1.5 - 3.5 Possible health effects (all individuals) & marked tooth staining
> 3.5 Increasing risk of health effects & severe tooth staining

TDS (mg/L)
< 450 No health effects
450 - 1000 Insignificant effect on sensitive groups
1000 - 2400 Slight possibility of salt overload in sensitive groups
2400 - 3400 Possible health risk to all individuals
> 3400 Increasing risk of dehydration

Turbidity (NTU)
< 0.1 No health effects
0.1 - 1 Slight risk of potential health effects
1 - 20 Possibility of secondary health effects
20 - 50 Secondary health effects
> 50 Serious health effects common in all users

0 100 200 Kilometres

Albers Equal Area projection
Clarke 1880 spheroid
24°E central meridian
18°S 32°S standard parallels

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"Hot Spot" Information from Additional WMA Sites

The sample sites exceeding the *Very Good* and *Good* categories ("hot spots") are visually located in Map 6 and are presented in Table 4.2. They are the sites from the individual WMAs (and the national assessment sample site set) that exceed the above-mentioned ranges for the selected variables and fitness-for-use class.

Table 4.2 WMA sample sites ("hot spot" sites) exceeding the *Very Good* and *Good* range for domestic water use for the Domestic Use "Health" Water Quality Constituents

WMA Site	Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
Olifants WMA				
95	B1H002Q01	TDS	Yellow	Spook Spruit At Elandspruit
96	B1H004Q01	pH	Red	Klip Spruit At Zaaihoek
125	B3H021Q01	F	Yellow	Elands River At Scherp Arabie
148	B7H019Q01	TDS; F	Yellow; Red	Ga-Selati River At Loole/Foskor
Usutu to Mhlatuze				
671	W3H012Q01	TDS	Yellow	Mzinene River At Cloete
675	W3H023Q01	TDS	Yellow	Nkongolwana River At Veelsgeluk/ Kongolana (Cp5)
686	W3R002Q01	TDS	Purple	Lake St Lucia At Lister's Point
Upper Vaal WMA				
162	C2H004Q01	TDS	Yellow	Suikerbosrand River At Uitvlugt (Rw S2)
179	C2H132Q01	TDS	Yellow	Riet Spruit At Tamboekiesfontein
180	C2H133Q01	TDS	Yellow	Blesbok Spruit At Heidelberg
187	C2H146Q01	TDS	Yellow	Blesbok Spruit At Dagafontein – 2Km D/Stream N17
188	C2H147Q01	TDS	Yellow	Blesbok Spruit At Grootvaly/Betw Mine Bridge And N17
189	C2H149Q01	TDS	Yellow	Blesbok Spruit At Nigel East – R51 Bridge (B8)
200	C2H234Q01	TDS	Yellow	Suikerbosrant River At Badfontein
Middle Vaal WMA				
231	C2H139Q01	TDS	Yellow	Koekemoer Spruit At Buffelsfontein
Lower Orange WMA				
283	D5H017Q01	TDS	Purple	Renoster River At Leeuwenkuil
284	D5H021Q01	TDS	Red	Sak River At De Kruis/Williston
Fish to Tsitsikamma WMA				
444	K8H001Q01	pH	Yellow	Kruis River At Farm 508 Pineview
450	L6H001Q01	TDS	Yellow	Heuningklip River At Campherspoort
452	L7H007Q01	TDS	Purple	Groot River At Sandpoort
459	M1H012Q01	TDS	Yellow	Swartkops River At Uitenhage/Nivens Bridge
461	N1H013Q01	TDS	Purple	Mackiesputs Eye At Graaf-Reinet/ Van Reyneveldspas
463	N2H007Q01	TDS	Yellow	Sundays River At De Draay
466	N3H002Q01	TDS	Yellow	Voël River At Rietvley
468	N4H003Q01	TDS	Red	Sundays River At Addo Drift East/ Addo Bridge
469	N4H005Q01	TDS; F	Purple; yellow	Coerney River At Selborne/Carlton
470	P1H003Q01	TDS	Red	Boesmans River At Donkerhoek/ Alicedale
472	P3H001Q01	TDS	Red	Kariega River At Smithfield/Lower Waterford
475	P4H001Q01	TDS	Yellow	Kowie River At Bathurst/Wolfscrag
481	Q3H004Q01	TDS; F	Yellow; yellow	Pauls River At Coutzenburg
483	Q4H013Q01	TDS; F	Yellow; red	Tarka River At Bridge Farm/Tarka Bridge (New Weir)

WMA Site	Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
488	Q7H005Q01	TDS	Yellow	Great Fish River Atsout Vleij/Sheldon
489	Q8H008Q01	TDS	Yellow	Little Fish River At Doornkraal
491	Q8H011Q01	TDS	Yellow	Little Fish River At Rietfontein/ Junction Drift
493	Q9H001Q01	TDS	Yellow	Great Fish River At Fort Brown Peninsula
495	Q9H012Q01	TDS	Yellow	Great Fish River At Brandtlegte/ Piggot's Bridge
497	Q9H018Q01	TDS	Yellow	Great Fish River At Matomela's Reserve/Outspan
Gouritz WMA				
378	H9H006Q01	pH	Yellow	Canal From Kougou River At Groote Bosch
383	J1H017Q01	TDS	Yellow	Sand River At Buffelsfontein/Van Wyksdorp
384	J1H019Q01	TDS	Purple	Groot River At Buffelsfontein/Van Wyksdorp
387	J1H031Q01	TDS	Yellow	Miertjeskraal Dam On Brak River: Down Stream Weir
388	J1R002Q01	TDS	Yellow	Bellair Dam On Brak River: Near Dam Wall
391	J2H005Q01	TDS	Yellow	Huis River At Zoar
401	J3H011Q01	TDS	Purple	Olifants River At Warm Water
414	K1H009Q01	TDS	Purple	Hartenbos River At Hartenbosch/ Hotel At Estuary
415	K1H013Q01	TDS	Purple	Hartenbos River At Hartenbosch/ Tributary Confluence
421	K2H004Q01	TDS	Purple	Great Brak River At Vishoek
424	K3H002Q01	pH	Salmon	Rooi River At George
431	K3R003Q01	TDS	Purple	Ronde Vlei At Ronde Valley
432	K3R004Q01	TDS	Purple	Upper Lang Vlei At Klein Krantz
433	K3R005Q01	TDS	Purple	Lower Lang Vlei At Klein Krantz (East Shore)
434	K3R006Q01	TDS	Purple	Touws River Estuary At Wilderness
436	K4H002Q01	pH	Yellow	Karatara River At Karatara Forest Reserve
438	K4R001Q01	TDS	Red	Groen Vlei At Ruygte Valley
439	K4R002Q01	TDS	Purple	Swart Vlei At Ronde Valley/ Hoogekraal
441	K5R001Q01	TDS	Purple	Knysna Lagoon At Knysna
443	K7H001Q01	pH	Yellow	Bloukrans River At Lottering Forest Reserve
Olifants/Doorn WMA				
298	G3H001Q01	TDS	Yellow	Kruis River At Tweekuilen/Eendekuil
Breede WMA				
332	G4R003Q01	TDS	Purple	Bot River Vlei On Bot River At Ysterklip/Hermanus
333	G4R004Q01	TDS	Purple	Klein River Vlei On Klein River At Rocklands/Yacht
334	G5H008Q01	TDS	Purple	Sout River At Kykoedy
340	H1H015Q01	TDS	Red	Bree River At Die Nekkies (Onder Brandvlei)
350	H3H011Q01	TDS	Yellow	Kogmanskloof River At Goudmyn
354	H4H018Q01	TDS	Purple	Poesjenels River At La Chasseur
355	H4H019Q01	TDS	Yellow	Vink River At De Gorree
356	H4H020Q01	TDS	Yellow	Nuy River At Doornrivier
369	H7H005Q01	pH	Yellow	Hermitage River At Swellendam Forest Reserve
371	H7H007Q01	pH	Yellow	Grootkloof River At Sparkenbosch
Berg WMA				
302	G1H009Q01	TDS	Yellow	Brakkloof Spruit At Knolvlei Forest Reserve
309	G1H024Q01	TDS	Purple	Berg River At Kliphoek
311	G1H034Q01	TDS	Purple	Moorreesburg Spruit At Holle River
312	G1H035Q01	TDS	Yellow	Matjies River At Matjiesfontein
314	G1H039Q01	TDS; F	Red; yellow	Doring River At Grensplaas/Diepe Gat

WMA Site	Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
315	G1H040Q01	TDS	Yellow	Fish River At La Fonteine
321	G2H012Q01	TDS	Yellow	Diep River At Malmesbury

Map 6 Domestic Use “Health” as represented by the “hot spot” sample site set

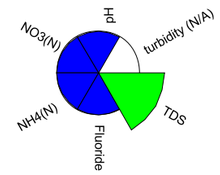
National assessment of water quality

Map 6

Water quality: fitness for use from a domestic perspective ("hot spot" sample site set)

- Sample site
- River
- Water management area
- Primary drainage region
- Secondary drainage region
- Tertiary drainage region
- Dam, lake
- Urban area

Domestic use: "Health"



Colour key for Domestic Health

pH (pH units)
- < 3 Acid burns
- 3 - 4 Severe irritation of mucous membranes
- 4 - 4.5 Irritation of mucous membranes
- 4.5 - 5 Mild irritation of mucous membranes
- 5 - 9.5 No health effects
- 9.5 - 10 Mild irritation of mucous membranes
- 10 - 10.5 Irritation of mucous membranes
- 10.5 - 11 Severe irritation
- > 11 Alkali burns

NO3 (mg/L)
- < 6 Negligible health effects
- 6 - 10 Insignificant risk
- 10 - 20 Slight chronic risk to some babies
- 20 - 40 Possible chronic risk to some babies
- > 40 Increasing acute risk to babies

NH4 (mg/L)
- < 1 Negligible health effects
- 1 - 2 Unknown health effects
- 2 - 10 Unknown health effects
- > 10 Unknown health effects

F (mg/L)
- < 0.7 No health effects
- 0.7-1 Insignificant effects (sensitive groups) & insignificant tooth staining
- 1 - 1.5 Increasing effects (sensitive groups) & tooth staining
- 1.5 - 3.5 Possible health effects (all individuals) & marked tooth staining
- > 3.5 Increasing risk of health effects & severe tooth staining

TDS (mg/L)
- < 450 No health effects
- 450 - 1000 Insignificant effect on sensitive groups
- 1000 - 2400 Slight possibility of salt overload in sensitive groups
- 2400 - 3400 Possible health risk to all individuals
- > 3400 Increasing risk of dehydration

Turbidity (NTU)
- < 0.1 No health effects
- 0.1 - 1 Slight risk of potential health effects
- 1 - 20 Possibility of secondary health effects
- 20 - 50 Secondary health effects
- > 50 Serious health effects common in all users

0 100 200 Kilometres

Albers Equal Area projection
Clarke 1880 spheroid
24°E central meridian
18°S 32°S standard parallels

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4.2.2 "Salinity" constituents

The second set of the Guideline Compliance Pie Diagram maps (Maps 7 and 8) pertain to the following constituents: Sodium (Na); Calcium (Ca); Magnesium (Mg); Sulphate (SO_4); Chloride (Cl) and Potassium (K) and the guidelines depicted in Table 3.3 (earlier in the document). Note that the median water quality for the desired constituent set is less often within the *Very Good* and *Good* water quality range for domestic (drinking) water use (DWAF, DOH and WRC, 1998) than was the case with the previous constituent set. The sites in Table 3.6 are included in Map 7.

From Map 7 and Table 4.3 it can be seen that it is in the Usutu to Mhlatuze, Upper Vaal, Lower Orange, Fish to Tsitsikamma, Gouritz and Breede WMAs that the median concentrations for the constituents reflected in the Domestic Use "Salinity" set are greater than the *Good* range for certain of those constituents. Table 3.3 lists the applicable water quality guideline classifications. Table 4.3 contains a list of sample sites for which certain of the constituents had median concentrations exceeding the *Good* range for domestic use.

Table 4.3 Sample sites exceeding the *Very Good* and *Good* ranges for domestic water use for the Domestic Use "Salinity" Water Quality Constituents

Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
Usutu to Mhlatuze WMA			
W3H015Q01	Cl	Yellow	Hluhluwe River at Valsbaai/St Lucia Inflow
Upper Vaal WMA			
C2H004Q01	SO_4	Yellow	Suikerbosrand River at Uitvlugt (RW S2)
Lower Orange WMA			
D5H021Q01	SO_4; Cl; Na	Red; red; red	Sak River at De Kruis/Williston
Fish to Tsitsikamma WMA			
L6H001Q01	Mg; SO_4; Cl; Na	Yellow; yellow; red; red	Heuningklip River at Campherspoort
N1H013Q01	Ca; Mg; SO_4; Cl; Na	Yellow; yellow; red; red; red	Mackiesputs Eye at Graaf-Reinet/Van Reyneveldspas
N2H007Q01	Cl; Na	Red; yellow	Sundays River at De Draay
N3H002Q01	Cl	Yellow	Voël River at Rietvley
N4H003Q01	Cl; Na	Red; red	Sundays River at Addo Drift East/Addo Bridge
P1H003Q01	Mg; Cl; Na	Yellow; red; red	Boesmans River at Donkerhoek/Alicedale
P3H001Q01	Mg; Na	Yellow; red	Kariega River at Smithfield/Lower Waterford
P4H001Q01	Cl; Na	Red; red	Kowie River at Bathurst/Wolfscrag
Q4H013Q01	Cl; Na	Yellow red	Tarka River at Bridge Farm/Tarka Bridge (New Weir)
Q8H011Q01	Cl; Na	Yellow; yellow	Little Fish River at Rietfontein/Junction Drift
Q9H001Q01	Cl; Na	Yellow; yellow	Great Fish River at Fort Brown Peninsula
Q9H018Q01	Cl; Na	Yellow; yellow	Great Fish River at Matomela's Reserve/ Outspan
Gouritz WMA			
J1H019Q01	Mg; SO_4; Cl; Na	Yellow; yellow; purple; purple	Groot River at Buffelsfontein/Van Wyksdorp
J3H011Q01	Mg; SO_4; Cl; Na	Red; purple; purple; purple	Olifants River at Warm Water
K2H004Q01	Ca; Mg; SO_4; Cl; Na; K	Red; purple; purple; purple; purple; red	Great Brak River at Vishoek
K4R002Q01	Mg; SO_4; Cl; Na; K	Red; yellow; purple; purple; yellow	Swart Vlei at Ronde Valley/Hoogekraal
Breede WMA			
H5H005Q01	Cl	Yellow	Bree River at Wagenboomsheuvel/Drew

From Table 4.3 it can be seen that the median concentrations of Calcium (Ca), Magnesium (Mg), Sulphate (SO_4), Chloride (Cl) and Sodium (Na) were greater than the *Very Good* or *Good* ranges at selected sample sites in the national assessment sample site set.

Calcium (Ca)

The elevated median calcium concentrations would result in hard water and scaling of domestic water pipes and appliances at the site at Mackiesputs Eye at Graaf-Reinet (Fish to Tsitsikamma WMA) and may additionally result in chronic health effects in sensitive groups at the site on the Great Brak River at Vishoek (Gouritz WMA).

Magnesium (Mg)

The elevated median magnesium concentrations could be expected to have a bitter taste and increasing health effects in sensitive individuals at the Groot River at Buffelsfontein (Gouritz WMA), Heuningklip River at Campherspoort, Mackiesputs Eye at Graaf-Reinet, Boesmans River at Donkerhoek and Kariega River at Smithfield (all in the Fish to Tsitsikamma WMA). Potential diarrhoea can result in all individuals using the water for drinking purposes at the site on the Olifants River at Warm Water and at Swart Vlei at Ronde Valley (both in the Gouritz WMA). The Mg levels in the water at the Great Brak River at Vishoek (Gouritz WMA) can be described as Not Acceptable and can be expected to result in diarrhoea in all individuals using it for drinking purposes. Furthermore, magnesium contributes to the total hardness of water.

Sulphate (SO_4)

The median sulphate concentrations could result in a slight chance of diarrhoea in sensitive groups (but disappears with adaptation) at the Suikerbosrand River at Uitvlugt (Upper Vaal WMA), Groot River at Buffelsfontein, Swart Vlei at Ronde Valley (both in the Gouritz WMA) and the Heuningklip River at Campherspoort (Fish to Tsitsikamma WMA). There is a possibility of diarrhoea (with poor adaptation in sensitive individuals) at the Mackiesputs Eye at Graaf-Reinet (Fish to Tsitsikamma WMA). There is a high chance of diarrhoea (with little likelihood of adaptation) at the Olifants River at Warm Water and the Great Brak River at Vishoek (both in the Gouritz WMA).

Chloride (Cl)

The median chloride concentrations could pose increasing health risks to sensitive groups at the Bree River at Wagenboomsheuvel (Breede WMA), Voël River at Rietvley, Tarka River at Bridge Farm, Little Fish River at Rietfontein, Great Fish River at Fort Brown Peninsula, Great Fish River at Matomela's Reserve (all in the Fish to Tsitsikamma WMA) and Hluhluwe River at Valsbaai (Usutu to Mhlatuze WMA). The Cl concentrations could have possible long-term health effects at the Sak River at De Kruis (Lower Orange WMA), Heuningklip River at Campherspoort, Mackiesputs Eye at Graaf-Reinet, Sundays River at De Draay, Boesmans River at Donkerhoek and Kowie River at Bathurst (all in the Fish to Tsitsikamma WMA). The Cl concentrations could result in dehydration in infants, nausea and vomiting at the Groot River at Buffelsfontein, Olifants River at Warm Water, Great Brak River at Vishoek and Swart Vlei at Ronde Valley (all in the Gouritz WMA). The most prominent effect with humans is aesthetic, with a salty taste to the water that does not slake thirst.

Sodium (Na)

The median sodium concentrations could result in a slight health risk to some sensitive groups at the Sundays River at De Draay, Little Fish River at Rietfontein, Great Fish River at Fort Brown Peninsula and Great Fish River at Matomela's Reserve (all in the Fish to Tsitsikamma WMA). The Na concentrations could have a possible health risk, particularly in sensitive groups, at the Sak River at De Kruis (Lower Orange WMA), Heuningklip River at Campherspoort, Mackiesputs Eye at Graaf-Reinet, Sundays River at Addo Drift East, Boesmans River at Donkerhoek, Kariega River at Smithfield, Kowie River at Bathurst and Tarka River at Bridge Farm (all in the Fish to Tsitsikamma WMA). There is a definite Na-related health risk

to using the water at the Groot River at Buffelsfontein, Olifants River at Warm Water, Great Brak River at Vishoek and Swart Vlei at Ronde Valley (all in the Gouritz WMA). The most prominent effect will be aesthetic, with salty tasting water that does not slake thirst.

Potassium (K)

The median potassium concentrations are likely to result in slight risk to some sensitive groups at the Swart Vlei at Ronde Valley (Gouritz WMA). There are possible health effects associated with potassium at this site.

Map 7 “Salinity” effects on the Domestic Use of water reported at the national assessment sample sites

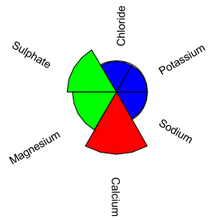
National assessment of water quality

Map 7

Salinity effects on domestic use (national sample site set)

- Sample site
- River
- Water management area
- Primary drainage region
- Secondary drainage region
- Tertiary drainage region
- Dam, lake
- Urban area

Domestic use: "Salinity"



Colour Key for Domestic Salts

Cl (mg/L)
- < 100 No health effects
- 100 - 200 Insignificant health effects
- 200 - 600 Increasing health risk to sensitive groups
- 600 - 1200 Possible long-term health effects
- > 1200 Dehydration in infants, nausea & vomiting

SO4 (mg/L)
- < 200 No health effects
- 200 - 400 Insignificant health effects
- 400-600 Slight chance of diarrhoea (sensitive grps): adaptation
- 600-1000 Diarrhoea possible: poor adaptation (sensitive individu
- > 1000 High chance of diarrhoea - no adaptation

Mg (mg/L)
- < 70 No health effects
- 70 - 100 Insignificant effects in sensitive groups only
- 100 - 200 Potential diarrhoea in all individuals
- 200 - 400 Diarrhoea in all individuals
- > 400

Ca (mg/L)
- < 80 No health effects
- 80 - 150 Insignificant health effects
- 150 - 300 Increased effects in sensitive groups only
- > 300 Chronic health effects in sensitive groups only

Na (mg/L)
- < 100 Negligible health effects
- 100 - 200 Insignificant health effects
- 200 - 400 Slight risk to some sensitive groups
- 400 - 1000 Possible health risk, particularly in sensitive groups
- > 1000

K (mg/L)
- < 25 No health effects
- 25 - 50 Insignificant health effects
- 50 - 100 Slight risk to some sensitive groups
- 100 - 500 Possible health effects
- > 500 Definite health risk to all individuals

0 100 200 Kilometres

Albers Equal Area projection
Clarke 1880 spheroid
24°E central meridian
18°S 32°S standard parallels

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Link to land cover

Refer to Table 3.5 and Map 1 and the location of the sites above for an explanation.

Calcium (Ca)

The elevated calcium levels at the two sites mentioned above are more than likely due to the natural geology in the area. This is probably especially true at the Great Brak River at Vishoek where the land cover is shrub (Table 3.5). The cultivate land and urban land cover at Mackiesputs Eye at Graaf-Reinet may have resulted in an increase in the calcium levels due to disturbance, but the source of calcium is probably still natural.

Magnesium (Mg)

The elevated magnesium concentrations at the sites mentioned above are more than likely due to the natural geology in the area. At some of the sites the levels may be elevated due to the disturbance of the soil surface due to cultivation, forestry and plantations (Table 3.5). The sites that are not largely natural and where water may have a bitter taste include: Mackiesputs Eye at Graaf-Reinet (bush, grass, urban and cultivated land), Boesmans River at Donkerhoek (bush, grass, shrub and cultivated land) and Kariega River at Smithfield (bush, grass and forest). The potential for diarrhoea increases at the Olifants River at Warm Water (shrub, cultivated land and plantation) and at the Swart Vlei at Ronde Valley (bush, plantation and cultivated land). The unacceptably high magnesium levels at the Great Brak River at Vishoek appear to be natural since the land cover is comprised of shrub.

Sulphate (SO_4)

The elevated sulphate concentrations at the sites mentioned previously are most probably due to natural reasons at the Groot River at Buffelsfontein (shrub), and the Great Brak River at Vishoek (shrub). Due to there being some man-modified land cover at the following sites, the elevated sulphate concentrations may be affected by human activities: Suikerbosrand River at Uitvlugt (cultivated land, grass and urban), Swart Vlei at Ronde Valley (bush, plantation and cultivated land), Mackiesputs Eye at Graaf-Reinet (bush, grass, urban and cultivated land) and the Olifants River at Warm Water (shrub, cultivated land and plantation).

Chloride (Cl)

The elevated chloride concentrations would appear to be related to the natural geology in almost all cases. It is only at the Bree River at Wagenboomsheuvel (cultivated land and shrub), Tarka River at Bridge Farm (shrub, grass and cultivated land) Great Fish River at Matomela's Reserve (shrub, bush and cultivated land), Hluhluwe River at Valsbaai (bush, plantation and cultivated land), Mackiesputs Eye at Graaf-Reinet (bush, grass, urban and cultivated land), Boesmans River at Donkerhoek (bush, grass, shrub and cultivated land), Kowie River at Bathurst (bush, grass and cultivated land), Olifants River at Warm Water (shrub, cultivated land and plantation) and the Swart Vlei at Ronde Valley (bush, plant and cultivated land) that there appear to be marked human impacts at a national scale.

Sodium (Na)

The elevated sodium concentrations appear to be related to natural sources. The land cover at the Sundays River at De Draay is shrub, at the Little Fish River at Rietfontein it is shrub and bush, at the Great Fish River at Fort Brown Peninsula it is shrub, bush and cultivated land, at the Great Fish River at Matomela's Reserve it is shrub, bush and cultivated land, at the Sak River at De Kruis it is shrub, at the Heuningklip River at Campherspoort it is shrub and bush, at the Mackiesputs Eye at Graaf-Reinet it is bush, grass, urban and cultivated land, at the Sundays River at Addo Drift East it is bush, shrub and cultivated land, at the Boesmans River at Donkerhoek it is bush, grass, shrub and cultivated land, at the Kariega River it is bush, grass and forest, at the Kowie River at Bathurst it is bush, grass and cultivated land, at the Tarka River at Bridge Farm it is shrub, grass and cultivated land, at the Groot River at Buffelsfontein it is shrub, at the Olifants River at Warm Water it is shrub, cultivated land and plantation, at the Great Brak River at Vishoek it is shrub and at the Swart Vlei at Ronde Valley it is bush, plantation and cultivated land.

"Hot Spot" Information from Additional WMA Sites

Refer to Map 8 and Table 4.4 for the salinity effects based on the "hot-spot" sites. They are the sites from the individual WMAs (and the national assessment sample site set) that exceed the *Very Good* and *Good* classes for the selected variables and fitness-for-use class.

Table 4.4 WMA sample sites ("hot spot" sites) exceeding the *Very Good* and *Good* range for domestic water use for the Domestic Use "Salinity" Water Quality Constituents

WMA Site	Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
Olifants WMA				
95	B1H002Q01	SO_4	Red	Spook Spruit At Elandspruit
96	B1H004Q01	SO_4	Yellow	Klip Spruit At Zaaihoek
104	B1H019Q01	SO_4	Yellow	Noupoort Spruit At Naauwpoort
148	B7H019Q01	SO_4; K; Mg	Red; yellow; yellow	Ga-Selati River At Loole/Foskor
Usutu to Mhlatuze				
671	W3H012Q01	Cl; Na	Yellow; yellow	Mzinene River At Cloete
673	W3H015Q01	Cl	Purple	Hluhluwe River At Valsbaai/St Lucia Inflow
675	W3H023Q01	SO_4; Ca	Red; yellow	Nkongolwana River At Veelsgeluk/ Kongolana (Cp5)
686	W3R002Q01	SO_4; Cl; K; Na; Mg	Red; purple; red; purple; red	Lake St Lucia At Lister's Point
Upper Vaal WMA				
162	C2H004Q01	SO_4	Yellow	Suikerbosrand River At Uitvlugt (Rw S2)
179	C2H132Q01	SO_4; Ca	Yellow; yellow	Riet Spruit At Tamboekiesfontein
180	C2H133Q01	SO_4; Ca	Yellow; yellow	Blesbok Spruit At Heidelberg
189	C2H149Q01	SO_4; Ca	Yellow; yellow	Blesbok Spruit At Nigel East – R51 Bridge (B8)
190	C2H153Q01	SO_4; Ca	Yellow; yellow	Wonderfontein Spruit At Ranfontein Azaadville Bridge
200	C2H234Q01	SO_4	Yellow	Suikerbosrant River At Badfontein
Middle Vaal WMA				
231	C2H139Q01	SO_4	Red	Koekemoer Spruit At Buffelsfontein
Mzimvubu to Keiskamma WMA				
513	R2H016Q01	Cl; Na	Yellow; red	Zwelitsha Spruit At Malakalaka
Lower Orange WMA				
283	D5H017Q01	SO_4; Cl; Na; Mg	Purple; purple; purple; yellow	Renoster River At Leeuwenkuil
284	D5H021Q01	SO_4; Cl; Na	Red; yellow; red	Sak River At De Kruis/Williston
Fish to Tsitsikamma WMA				
450	L6H001Q01	SO_4; Cl; Na; Ca; Mg	Red; purple; red; yellow; yellow	Heuningklip River At Campherspoort
452	L7H007Q01	SO_4; Cl; Na; Ca; Mg	Purple; purple; purple; yellow; red	Groot River At Sandpoort
459	M1H012Q01	Cl; Na	Yellow; yellow	Swartkops River At Uitenhage/Nivens Bridge
461	N1H013Q01	SO_4; Cl; Na; Ca; Mg	Red; red; red; yellow; yellow	Mackiesputs Eye At Graaf-Reinet/ Van Reyneveldspas
463	N2H007Q01	Cl; Na	Red; yellow	Sundays River At De Draay
466	N3H002Q01	Cl	Yellow	Voël River At Rietvley
468	N4H003Q01	Cl; Na	Red; red	Sundays River At Addo Drift East/ Addo Bridge
469	N4H005Q01	SO_4; Cl; Na; Mg	Red; purple; purple; yellow	Coerney River At Selborne/Carlton
472	P3H001Q01	Cl; Na; Ca; Mg	Purple; red; yellow; yellow	Kariega River At Smithfield/Lower Waterford
475	P4H001Q01	Cl; Na	Red; red	Kowie River At Bathurst/Wolfscrag
483	Q4H013Q01	Cl; Na	Yellow; red	Tarka River At Bridge Farm/Tarka Bridge (New Weir)
488	Q7H005Q01	Cl; Na	Yellow; yellow	Great Fish River Atsout Vleij/Sheldon

WMA Site	Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
491	Q8H011Q01	Cl; Na	Yellow; yellow	Little Fish River At Rietfontein/ Junction Drift
493	Q9H001Q01	Cl; Na	Yellow; yellow	Great Fish River At Fort Brown Peninsula
495	Q9H012Q01	Cl; Na	Yellow; yellow	Great Fish River At Brandtlegte/ Piggot's Bridge
497	Q9H018Q01	Cl; Na	Yellow; yellow	Great Fish River At Matomela's Reserve/Outspan
Gouritz WMA				
383	J1H017Q01	Cl; Na	Red; red	Sand River At Buffelsfontein/Van Wyksdorp
384	J1H019Q01	SO_4; Cl; Na; Mg	Yellow; purple; red; yellow	Groot River At Buffelsfontein/Van Wyksdorp
388	J1R002Q01	Cl; Na	Yellow; yellow	Bellair Dam On Brak River: Near Dam Wall
390	J1R004Q01	Cl; Na	Yellow; yellow	Miertjeskraal Dam On Brand River: Near Dam Wall
393	J2H007Q01	Cl	Yellow	Joubert River At Opsoek
401	J3H011Q01	SO_4; Cl; Na; Ca; Mg	Purple; purple; purple; red; red	Olifants River At Warm Water
411	J3R002Q01	Cl	Yellow	Stompdrif Dam On Olifants River: Near Dam Wall
414	K1H009Q01	SO_4; Cl; K; Na; Ca; Mg	Purple; purple; red; purple; red; purple	Hartenbos River At Hartenbosch/Hotel At Estuary
415	K1H013Q01	SO_4; Cl; K; Na; Mg	Yellow; purple; yellow; purple; yellow	Hartenbos River At Hartenbosch/ Tributary Confluence
418	K1R001Q01	Cl	Yellow	Hartebeeskuil Dam On Hartenbos River: Near Dam Wall
421	K2H004Q01	SO_4; Cl; K; Na; Ca; Mg	Purple; purple; red; purple; red; purple	Great Brak River At Vishoek
429	K3H011Q01	Cl	Yellow	Duiwe River At Klein Krantz
431	K3R003Q01	SO_4; Cl; K; Na; Mg	Yellow; purple; yellow; purple; red	Ronde Vlei At Ronde Valley
432	K3R004Q01	Cl; K; Na; Mg	Purple; yellow; purple; yellow	Upper Lang Vlei At Klein Krantz
433	K3R005Q01	Cl; K; Na; Mg	Purple; yellow; purple; yellow	Lower Lang Vlei At Klein Krantz (East Shore)
434	K3R006Q01	SO_4; Cl; K; Na; Mg	Yellow; purple; yellow; purple; red	Touws River Estuary At Wilderness
438	K4R001Q01	Cl; Na	Red; red	Groen Vlei At Ruygte Valley
439	K4R002Q01	SO_4; Cl; K; Na; Mg	Yellow; purple; yellow; purple; red	Swart Vlei At Ronde Valley/ Hoogekraal
441	K5R001Q01	SO_4; Cl; K; Na; Ca; Mg	Purple; purple; red; purple; red; purple	Knysna Lagoon At Knysna
Olifants/Doorn WMA				
298	G3H001Q01	Cl; Na; Mg	Red; red; yellow	Kruis River At Tweekuilen/Eendekuil
Breede WMA				
326	G4H006Q01	Cl	Yellow	Klein River At Can Q5-8/ Wagenboomsdrift
332	G4R003Q01	SO_4; Cl; K; Na; Mg	Red; purple; yellow; purple; red	Bot River Vlei On Bot River At Ysterklip/Hermanus
333	G4R004Q01	SO_4; Cl; K; Na; Ca; Mg	Purple; purple; red; purple; red; purple	Klein River Vlei On Klein Riv At Rocklands/Yacht
334	G5H008Q01	Cl; Na; Mg	Purple; purple; red	Sout River At Kykoedy
340	H1H015Q01	Cl; Na; Mg	Red; red; yellow	Bree River At Die Nekkies (Onder Brandvlei)
350	H3H011Q01	Cl; Na	Red; red	Kogmanskloof River At Goudmyn
352	H4H016Q01	Cl; Na	Yellow; yellow	Keisers River At Mc Gregor Commonage/Vrolykheid
354	H4H018Q01	SO_4; Cl; Na; Ca; Mg	Yellow; purple; red; yellow; yellow	Poesjenels River At La Chasseur
355	H4H019Q01	Cl; Na	Red; yellow	Vink River At De Gorree
356	H4H020Q01	Cl; Na	Yellow; red	Nuy River At Doornrivier
362	H5H004Q01	Cl	Yellow	Bree River At Wolvendrift/Secunda
363	H5H005Q01	Cl	Yellow	Bree River At Wagenboomsheuvel/ Drew
Berg WMA				
302	G1H009Q01	Cl; Na	Red; yellow	Brakkloof Spruit At Knolvlei Forest Reserve
309	G1H024Q01	SO_4; Cl; K; Na; Mg	Yellow; purple; yellow; purple; red	Berg River At Kliphoek
311	G1H034Q01	Cl; Na; Ca; Mg	Purple; purple; yellow; red	Moorreesburg Spruit At Holle River
312	G1H035Q01	Cl; Na	Red; red	Matjies River At Matjiesfontein

WMA Site	Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
314	G1H039Q01	Cl; Na	Purple; red	Doring River At Grensplaas/Diepe Gat
315	G1H040Q01	Cl; Na	Yellow; yellow	Fish River At La Fonteine
321	G2H012Q01	Cl; Na	Yellow; yellow	Diep River At Malmesbury

Map 8 “Salinity” effects on Domestic Use as represented by the “hot spot” sample site set

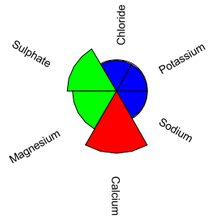
National assessment of water quality

Map 8

Salinity effects on domestic use ("hot spot" sample site set)

- Sample site
- River
- Water management area
- Primary drainage region
- Secondary drainage region
- Tertiary drainage region
- Dam, lake
- Urban area

Domestic use: "Salinity"



Colour Key for Domestic Salts

Cl (mg/L)
- < 100 No health effects
- 100 - 200 Insignificant health effects
- 200 - 600 Increasing health risk to sensitive groups
- 600 - 1200 Possible long-term health effects
- > 1200 Dehydration in infants, nausea & vomiting

SO4 (mg/L)
- < 200 No health effects
- 200 - 400 Insignificant health effects
- 400-600 Slight chance of diarrhoea (sensitive grps): adaptation
- 600-1000 Diarrhoea possible: poor adaptation (sensitive individu
- > 1000 High chance of diarrhoea - no adaptation

Mg (mg/L)
- < 70 No health effects
- 70 - 100 Insignificant effects in sensitive groups only
- 100 - 200 Potential diarrhoea in all individuals
- 200 - 400 Diarrhoea in all individuals
- > 400

Ca (mg/L)
- < 80 No health effects
- 80 - 150 Insignificant health effects
- 150 - 300 Increased effects in sensitive groups only
- > 300 Chronic health effects in sensitive groups only

Na (mg/L)
- < 100 Negligible health effects
- 100 - 200 Insignificant health effects
- 200 - 400 Slight risk to some sensitive groups
- 400 - 1000 Possible health risk, particularly in sensitive groups
- > 1000

K (mg/L)
- < 25 No health effects
- 25 - 50 Insignificant health effects
- 50 - 100 Slight risk to some sensitive groups
- 100 - 500 Possible health effects
- > 500 Definite health risk to all individuals

0 100 200 Kilometres

Albers Equal Area projection
Clarke 1880 spheroid
24°E central meridian
18°S 32°S standard parallels

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4.3 Irrigated Agriculture Use

The third set of the Guideline Compliance Pie Diagram maps (Maps 9 and 10) relate to the following constituents: Sodium Adsorption Ratio (SAR); pH; Boron (B); Conductivity; and Chloride (Cl), that are important for irrigated agriculture (DWAF, 1996b) and the water quality guidelines are depicted in Table 3.4 (earlier in the document). There are isolated sites where median concentrations may be greater than the Target Water Quality Range (TWQR) (DWAF, 1996b). The sites in Table 3.6 are included in Map 9.

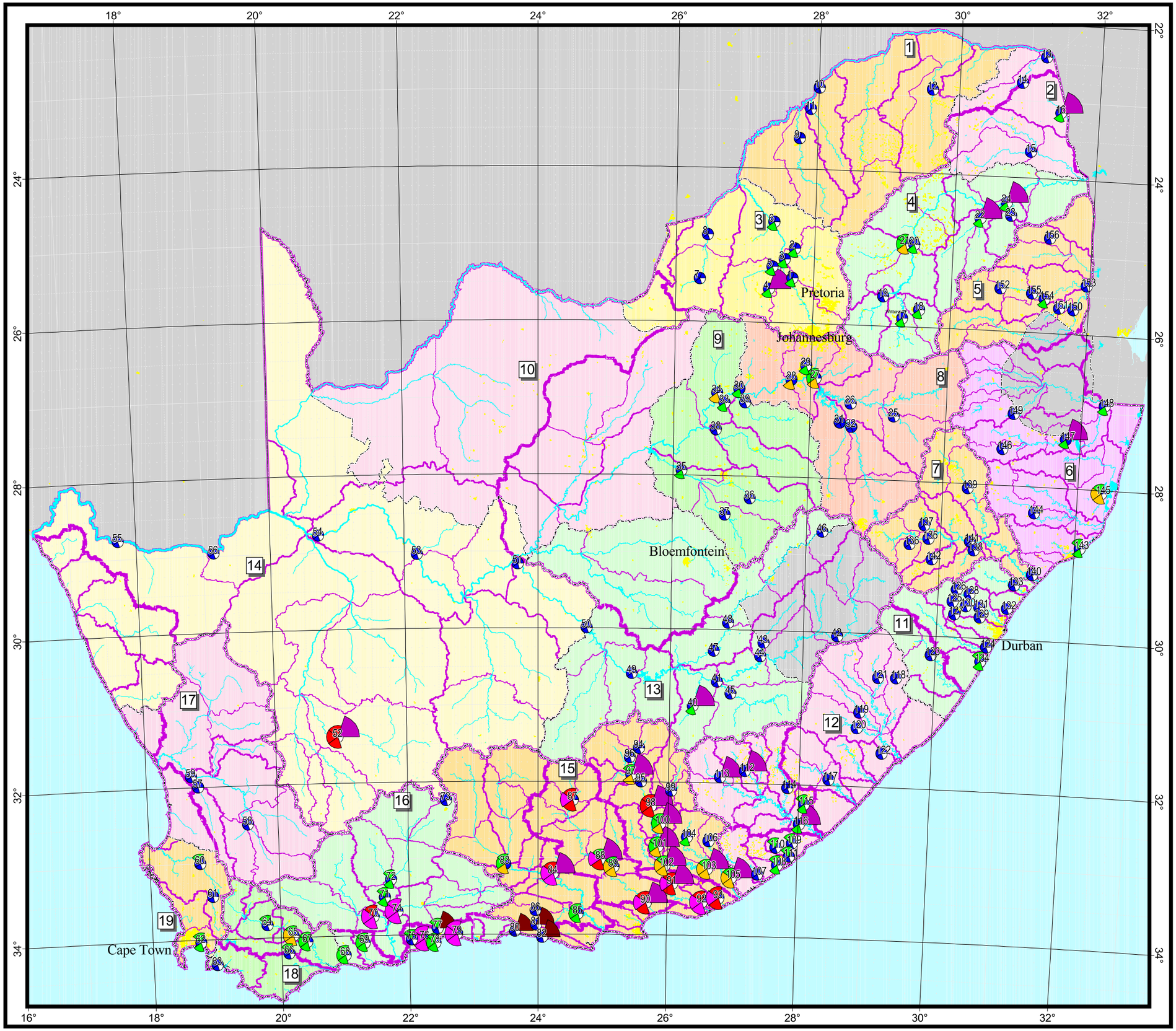
From Map 9 and Table 4.5 it can be seen that it is in the Luvuvhu and Letaba, Crocodile (West) and Marico, Olifants, Usutu to Mhlatuze, Upper Vaal, Mzimvubu to Keiskamma, Upper Orange, Lower Orange, Fish to Tsitsikamma, Gouritz and Breede WMAs that the median concentrations for the constituents reflected in the Irrigated Agriculture constituent set are greater than the TWQR for certain of those constituents at certain sampling sites. Table 3.4 lists the applicable water quality guideline classifications. Table 4.5 contains a list of sample sites for which certain of the constituents had median concentrations that indicate the water as being of *Fair* or *Not Acceptable* quality for irrigation use.

Map 9 Water quality effects on Irrigated Agriculture Use reported at the national assessment sampling sites

National assessment of water quality

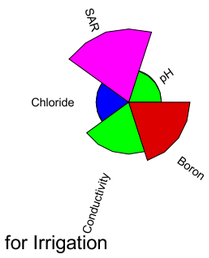
Water quality effects on irrigated agriculture use (national sample site set)

Map 9



- Sample site
- River
- Water management area
- Primary drainage region
- Secondary drainage region
- Tertiary drainage region
- Dam, lake
- Urban area

Agriculture: Irrigation



Key for Irrigation

SAR ((mmol/L)^0.5)

- < 2 Target range for root uptake
- 2 - 8 Toxic sodium uptake by roots in the most sodium-sensitive crops
- 8 - 15 Toxic sodium uptake by roots in sodium-sensitive crops
- > 15 Toxic sodium uptake by roots in all sodium-sensitive crops

Cl (mg/L)

- < 100 Target range
- 100-175 Slight root uptake. Sensitive crops: foliar injury & yield decreases
- 175-350 Some root uptake. Mod. sensitive crops: foliar injury & yield decreas
- 350-700 Root uptake. Mod. tolerant crops: foliar injury & yield decreases
- > 700 Root uptake problems. Tolerant crops: foliar injury & yield decreases

EC (mS/m)

- < 40 Target range
- 40 - 90 Moderately salt-sensitive crops: 95% relative yield
- 90 - 270 Moderately salt-tolerant crops: 90% relative yield
- 270 - 540 Moderately salt-tolerant crops: 80% relative yield
- > 540 Sustainable irrigation unlikely

B (mg/L)

- < 0.5 Target range
- 0.5 - 1 Very sensitive crops: foliar injury & yield decreases
- 1 - 2 Sensitive crops: foliar injury & yield decreases
- 2 - 4 Moderately sensitive crops: foliar injury & yield decreases
- 4 - 6 Moderately tolerant crops: foliar injury & yield decreases
- 6 - 15 Tolerant crops: foliar injury & yield decreases
- > 15 Very tolerant crops: foliar injury & yield decreases

pH (pH units)

- < 6.5 Foliar damage, yield & quality reduction
- 6.5 - 8.4 Target range
- > 8.4 Foliar damage, yield & quality reduction

0 100 200 Kilometres

Albers Equal Area projection
Clarke 1880 spheroid
24°E central meridian
18°S 32°S standard parallels

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Table 4.5 Sample sites exceeding the TWQR for Irrigated Agriculture Water Use for the Irrigated Agriculture Water Quality Constituents

Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
Luvuvhu and Letaba WMA			
B9H003Q01	pH	Purple	Shingwidzi River at Kanniedood Dam/Kruger National Park
Crocodile (West) and Marico WMA			
A2H094Q01	pH	Purple	Bospoort Dam on Hex River: Down Stream Weir
Olifants WMA			
B3H021Q01	EC	Yellow	Elands River at Scherp Arabie
B4H011Q01	pH	Purple	Steelpoort River at Alverton
B7H009Q01	pH	Purple	Olifants River at Finale/Liverpool
Usutu to Mhlatuze WMA			
W3H015Q01	EC; Cl	Yellow; yellow	Hluhluwe River at Valsbaai/St Lucia Inflow
W4H006Q01	pH	Purple	Phongolo River at Ndume Game Reserve
Upper Vaal WMA			
C2H004Q01	EC	Yellow	Suikerbosrand River at Uitvlugt (RW S2)
C2H005Q01	EC	Yellow	Riet Spruit at Kaal Plaats (RW RV2)
Mzimvubu to Keiskamma WMA			
S3H006Q01	pH	Purple	Klaas Smits River at Weltevreden/Queenstown
Upper Orange WMA			
D1H001Q01	pH	Purple	Wonderboom/Stormboom Spruit at Diepkloof/ Burgersdorp
Lower Orange WMA			
D5H021Q01	SAR; EC; pH; Cl	Yellow; red; purple; red	Sak River at De Kruis/Williston
Fish to Tsitsikamma WMA			
K8H001Q01	pH	Red	Kruis River at Farm 508 Pineview
K8H002Q01	pH	Red	Elands River at Kwaai Brand Forest Reserve/ Witelbos
L3R001Q01	EC	Yellow	Beervlei Dam at Windheuvel
L6H001Q01	SAR; EC; Cl	Yellow; red; purple	Heuningklip River at Campherspoort
L7H006Q01	Cl	Yellow	Groot River at Grootrivierspoort
N1H013Q01	SAR; EC; Cl	Yellow; red; purple	Mackiesputs Eye at Graaf-Reinet/Van Reyneveldspas
N2H007Q01	EC; Cl	Red; red	Sundays River at De Draay
N3H002Q01	EC; Cl	Yellow; yellow	Voël River at Rietvley
N4H003Q01	SAR; EC; Cl	Yellow; red; purple	Sundays River at Addo Drift East/Addo Bridge
P1H003Q01	SAR; EC; pH; Cl	Yellow; red; purple; purple	Boesmans River at Donkerhoek/Alicedale
P3H001Q01	SAR; EC; Cl	Yellow; purple; purple	Kariega River at Smithfield/Lower Waterford
P4H001Q01	SAR; EC; Cl	Yellow; red; purple	Kowie River at Bathurst/Wolfscrag
Q2H002Q01	EC; pH	Yellow; purple	Great Fish River at Zoutpansdrift
Q4H013Q01	SAR; EC; pH; Cl	Yellow; red; purple; red	Tarka River at Bridge Farm/Tarka Bridge (New Weir)
Q6H003Q01	EC; pH	Yellow; purple	Baviaans River at Botmansgat/De Klerkdal
Q7H003Q01	EC; pH	Yellow; purple	Great Fish River at Leeuwe Drift
Q8H011Q01	EC; pH; Cl	Yellow; purple; yellow	Little Fish River at Rietfontein/Junction Drift
Q9H001Q01	EC; pH; Cl	Yellow; purple; yellow	Great Fish River at Fort Brown Peninsula
Q9H018Q01	EC; pH; Cl	Yellow; purple; yellow	Great Fish River at Matomela's Reserve/Outspan
Gouritz WMA			
J1H019Q01	SAR; EC; Cl	Yellow; purple; purple	Groot River at Buffelsfontein/Van Wyksdorp
J3H011Q01	SAR; EC; Cl	Red; purple; purple	Olifants River at Warm Water
K2H004Q01	SAR; EC; Cl	Red; purple; purple	Great Brak River at Vishoek
K3H001Q01	pH	Red	Kaaimans River at Upper Barbiers Kraal
K4R002Q01	SAR; EC; Cl	Red; purple; purple	Swart Vlei at Ronde Valley
K7H001Q01	pH	Red	Bloukrans River at Lottering Forest Reserve
Breede WMA			
H5H005Q01	EC; Cl	Yellow; yellow	Bree River at Wagenboomsheuvel/Drew

It would appear that there are sampling sites with constituents of real concern from the constituent set (Table 3.4) from an irrigated agriculture use point of view, especially those sites indicated in Table 4.5.

Sodium Adsorption Ratio (SAR)

Sodium-sensitive crops can be expected to absorb toxic levels of sodium through the roots at the median SAR values at the Sak River at De Kruis (Lower Orange WMA), Groot River at Buffelsfontein (Gouritz WMA), Heuningklip River at Campherspoort, Mackiesputs Eye at Graaf-Reinet, Sundays River at Addo Drift East, Boesmans River at Donkerhoek, Kariega River at Smithfield, Kowie River at Bathurst and Tarka River at Bridge Farm (all in the Fish to Tsitsikamma WMA).

All sodium-sensitive crops absorb toxic levels of sodium through root uptake (while a number of economically important crops can be irrigated without sodium toxicity developing) at the Olifants River at Warm Water, Great Brak River at Vishoek and Swart Vlei at Ronde Valley (all in the Gouritz WMA).

Electrical Conductivity (EC)

According to median electrical conductivity values, a 90 % relative yield of moderately salt-tolerant crops can be maintained by using a low frequency irrigation system at the Elands River at Scherp Arabie (Olifants WMA), Suikerbosrand River at Uitvlugt, Riet Spruit at Kaal Plaats (both in the Upper Vaal WMA), Bree River at Wagenboomsheuvel (Breede WMA), Beervlei Dam at Windheuvel, Groot River at Grootrivierspoort, Voël River at Rietvley, Great Fish River at Zoutpansdrift, Baviaans River at Botmansgat, Great Fish River at Leeuwe Drift, Little Fish River at Rietfontein, Great Fish River at Fort Brown Peninsula, Great Fish River at Matomela's Reserve (all in the Fish to Tsitsikamma WMA) and Hluhluwe River at Valsbaai (Usutu to Mhlatuze WMA).

An 80 % relative yield of moderately salt-tolerant crops can be maintained by using a low frequency irrigation system at the Sak River at De Kruis (Lower Orange WMA), Heuningklip River at Campherspoort, Mackiesputs Eye at Graaf-Reinet, Sundays River at De Draay, Sundays River at Addo Drift East, Boesmans River at Donkerhoek, Kowie River at Bathurst and Tarka River at Bridge Farm (all in the Fish to Tsitsikamma WMA).

The water with median electrical conductivity values recorded at the following sites can still be used for irrigation of selected crops provided that sound irrigation management is practised and yield decreases are acceptable: the Groot River at Buffelsfontein, Olifants River at Warm Water, Great Brak River at Vishoek, Swart Vlei at Ronde Valley (all in the Gouritz WMA) and Kariega River at Smithfield (Fish to Tsitsikamma WMA).

pH

Due to the nature of the pH range, an undesirable value can be one that is lower or higher than the *Very Good* range.

The median pH was not *Very Good* (too acid) and results in increasing problems of foliar damage at the Kaaimans River at Upper Barbiers Kraal, Bloukrans River at Lottering Forest Reserve (both in the Gouritz WMA), Kruis River at Farm 508 Pineview and Elands River at Kwaai Brand Forest Reserve (both in the Fish to Tsitsikamma WMA).

The median pH was not *Very Good* (too alkaline) and also results in increasing problems with foliar damage at the Bospoort Dam on Hex River (Crocodile West and Marico WMA), Steelpoort River at Alverton, Olifants River at Finale (both in the Olifants WMA), Shingwidzi River at Kanniedood Dam (Luvuvhu and Letaba WMA), Wonderboom/ Stormboom Spruit at Diepkloof (Upper Orange WMA), Sak River at De Kruis (Lower Orange WMA), Boesmans River at Donkerhoek, Great Fish River at Zoutpansdrift, Tarka River at Bridge Farm, Baviaans River at Botmansgat, Great Fish River at Leeuwe Drift, Little Fish River at Rietfontein, Great

Fish River at Fort Brown Peninsula, Great Fish River at Matomela's Reserve (all in the Fish to Tsitsikamma WMA), Klaas Smits River at Weltevreden (Mzimvubu to Keiskamma WMA) and Phongolo River at Ndume Game Reserve (Usutu to Mhlatuze WMA).

Chloride (Cl)

According to median chloride concentrations, crops moderately sensitive to foliar absorption accumulate toxic levels of chloride when foliage is wetted at the Bree River at Wagenboomsheuvel (Breede WMA), Groot River at Grootrivierspoort, Voël River at Rietvley, Little Fish River at Rietfontein, Great Fish River at Fort Brown Peninsula, Great Fish River at Matomela's Reserve (all in the Fish to Tsitsikamma WMA) and Hluhluwe River at Valsbaai (Usutu to Mhlatuze WMA).

Crops moderately sensitive to foliar absorption increasingly accumulate toxic levels of chloride when foliage is wetted at the Sak River at De Kruis (Lower Orange WMA) and Tarka River at Bridge Farm (Fish to Tsitsikamma WMA).

Crops tolerant to foliar absorption increasingly accumulate toxic levels of chloride when foliage is wetted at the Groot River at Buffelsfontein, Olifants River at Warm Water, Great Brak River at Vishoek, Swart Vlei at Ronde Valley (all in the Gouritz WMA), Heuningklip River at Campherspoort, Mackiesputs Eye at Graaf-Reinet, Sundays River at Addo Drift East, Boesmans River at Donkerhoek, Kariega River at Smithfield and Kowie River at Bathurst (all in the Fish to Tsitsikamma WMA).

Boron (B)

No sites had elevated boron levels, but it must be said that boron was sampled at very few sites and this, therefore, does not indicate that there are no locations were boron was elevated.

Link to land cover

Refer to Table 3.5 and Map 1 and the location of the sites above for an explanation.

Sodium Adsorption Ratio (SAR)

The land cover at the sites with elevated sodium adsorption ratio values is as follows: shrub at the Sak River at De Kruis; shrub at the Groot River at Buffelsfontein; shrub and bush at the Heuningklip River at Campherspoort; bush, grass, urban and cultivated land at the Mackiesputs Eye at Graaf-Reinet; bush, shrub and cultivated land at the Sundays River at Addo Drift East; bush, grass, shrub and cultivated land at the Boesmans River at Donkerhoek; bush, grass and forest at the Kariega River at Smithfield; bush, grass and cultivated land at the Kowie River at Bathurst; and shrub, grass and cultivated land at the Tarka River at Bridge Farm.

The land cover at the sites with more elevated sodium adsorption ratio values is as follows: shrub, cultivated land and plantation at the Olifants River at Warm Water; and bush, plantation and cultivated land at the Swart Vlei at Ronde Valley.

Electrical Conductivity (EC)

The land cover at the sites with elevated electrical conductivity values resulting in a 90 % relative yield of moderately salt tolerant crops is as follows: cultivated land at the Elands River at Scherp Arabie; cultivated land, grass and urban at the Suikerbosrand River at Uitvlugt; cultivated land, urban and grass at the Riet Spruit at Kaal Plaats; cultivated land and shrub at the Bree River at Wagenboomsheuvel; shrub and degraded land at the Beervlei Dam at Windheuvel; shrub, bush and cultivated land at the Groot River at Grootrivierspoort; shrub and bush at the Voël River at Rietvley; shrub and cultivated land at the Great Fish River at Zoutpansdrift; shrub, bush and cultivated land at the Baviaans River at Botmansgat; shrub, cultivated land and forest at the Great Fish River at Leeuwe Drift; shrub and bush at the Little Fish River at Rietfontein; bush and shrub at the Great Fish River at Fort Brown Peninsula; shrub, bush and cultivated land at the Great Fish River at Matomela's Reserve; and bush, plantation and cultivated land at the Hluhluwe River at Valsbaai.

The land cover at the sites with elevated electrical conductivity values resulting in an 80 % relative yield of moderately salt tolerant crops is as follows: shrub at the Sak River at De Kruis; shrub and bush at the Heuningklip River at Campherspoort; bush, grass, urban and cultivated land at the Mackiesputs Eye at Graaf-Reinet; shrub at the Sundays River at De Draay; bush, shrub and cultivated land at the Sundays River at Addo Drift East; bush, grass, shrub and cultivated land at the Boesmans River at Donkerhoek; bush, grass and cultivated land at the Kowie River at Bathurst; and shrub, grass and cultivated land at the Tarka River at Bridge Farm.

The land cover at the sites with even more elevated electrical conductivity values is as follows: shrub at the Groot River at Buffelsfontein; shrub, cultivated land and plantation at the Olifants River at Warm Water; shrub at the Great Brak River at Vishoek; bush, plantation and cultivated land at the Swart Vlei at Ronde Valley; and bush, grass and forest at the Kariega River at Smithfield.

The range of land cover types seen in each class indicates that there is not a strong correlation between land cover and the electrical conductivity value.

pH

Land cover types where the water was too acid: bush and plantation at the Kaaimans River at Upper Barbiers Kraal; forest, plantation and bush at the Bloukrans River at Lottering Forest Reserve; cultivated land and bush at the Kruis River at Farm 508 Pineview; and cultivated land, bush and urban at the Kwaai Brand Forest Reserve.

Land cover types where the water was too alkaline: bush at the Bospoort Dam on the Hex River; bush and cultivated land at the Steelpoort River at Alverton; cultivated land, degraded land and bush at the Olifants River at Finale; bush at the Shingwidzi River at Kanniedood Dam; shrub and bush at the Wonderboom/Stormboom Spruit at Diepkloof; shrub at the Sak River at De Kruis; bush, grass, shrub and cultivated land at the Boesmans River at Donkerhoek; shrub and cultivated land at the Great Fish River at Zoutpansdrift; shrub, grass and cultivated land at the Tarka River at Bridge Farm; shrub, bush and cultivated land at the Baviaans River at Botmansgat; shrub, cultivated land and forest at the Great Fish River at Leeuwe Drift; shrub and bush at the Little Fish River at Rietfontein; bush and shrub at the Great Fish River at Fort Brown Peninsula; shrub, bush and cultivated land at the Great Fish River at Matomela's Reserve; grass, bush and degraded land at the Klaas Smits River at Weltevreden; and forest, bush and cultivated land at the Phongolo River at Ndume Game Reserve.

Chloride (Cl)

The land cover at sites where crops moderately sensitive to foliar absorption accumulate toxic levels of chloride when foliage is wetted are as follows: cultivated land and shrub at the Bree River at Wagenboomsheuvel; shrub, bush and cultivated land at the Groot River at Grootrivierspoort; shrub and bush at the Voël River at Rietvley; shrub and bush at the Little Fish River at Rietfontein; bush and shrub at the Great Fish River at Fort Brown Peninsula; shrub, bush and cultivated land at the Great Fish River at Matomela's Reserve; bush, plantation and cultivated land at the Hluhluwe River at Valsbaai.

The land cover at sites where crops moderately sensitive to foliar absorption increasingly accumulate toxic levels of chloride when foliage is wetted are as follows: shrub at the Sak River at De Kruis; and shrub, bush and cultivated land at the Tarka River at Bridge Farm.

The land cover at sites where crops tolerant to foliar absorption increasingly accumulate toxic levels of chloride when foliage is wetted are as follows: shrub at the Groot River at Buffelsfontein; shrub, cultivated land and plantation at the Olifants River at Warm Water; shrub at the Great Brak River at Vishoek; bush, plantation and cultivated land at the Swart Vlei at Ronde Valley; shrub and bush at the Heuningklip River at Campherspoort; bush, grass, urban and cultivated land at the Mackiesput Eye at Graaf-Reinet; bush, shrub and cultivated land at the Sundays River at Addo Drift East; bush, grass, shrub and cultivated land at the Boesmans River at Donkerhoek; bush, grass and forest at the Kariega River at Smithfield; and bush, grass and cultivated land at the Kowie River at Bathurst.

"Hot Spot" Information from Additional WMA Sites

Refer to Map 10 and Table 4.6 for the location of the "hot spots" as they relate to irrigated agriculture. They are the sites from the individual WMAs (and the national assessment sample site set) that exceed the Target Water Quality Range for the selected variables and fitness-for-use for irrigated agriculture.

Map 10 Water quality effects on Irrigated Agriculture Use reported at the “hot spot” sample sites

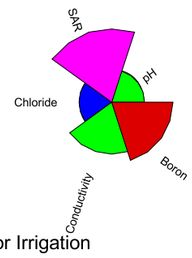
National assessment of water quality

Water quality effects on irrigated agriculture use ("hot spot" sample site set)

Map 10

- Sample site
- River
- Water management area
- Primary drainage region
- Secondary drainage region
- Tertiary drainage region
- Dam, lake
- Urban area

Agriculture: Irrigation



Key for Irrigation

SAR ((mmol/L)^0.5)

- < 2 Target range for root uptake
- 2 - 8 Toxic sodium uptake by roots in the most sodium-sensitive crops
- 8 - 15 Toxic sodium uptake by roots in sodium-sensitive crops
- > 15 Toxic sodium uptake by roots in all sodium-sensitive crops

Cl (mg/L)

- < 100 Target range
- 100-175 Slight root uptake. Sensitive crops: foliar injury & yield decreases
- 175-350 Some root uptake. Mod. sensitive crops: foliar injury & yield decreas
- 350-700 Root uptake. Mod. tolerant crops: foliar injury & yield decreases
- > 700 Root uptake problems. Tolerant crops: foliar injury & yield decreases

EC (mS/m)

- < 40 Target range
- 40 - 90 Moderately salt-sensitive crops: 95% relative yield
- 90 - 270 Moderately salt-tolerant crops: 90% relative yield
- 270 - 540 Moderately salt-tolerant crops: 80% relative yield
- > 540 Sustainable irrigation unlikely

B (mg/L)

- < 0.5 Target range
- 0.5 - 1 Very sensitive crops: foliar injury & yield decreases
- 1 - 2 Sensitive crops: foliar injury & yield decreases
- 2 - 4 Moderately sensitive crops: foliar injury & yield decreases
- 4 - 6 Moderately tolerant crops: foliar injury & yield decreases
- 6 - 15 Tolerant crops: foliar injury & yield decreases
- > 15 Very tolerant crops: foliar injury & yield decreases

pH (pH units)

- < 6.5 Foliar damage, yield & quality reduction
- 6.5 - 8.4 Target range
- > 8.4 Foliar damage, yield & quality reduction

0 100 200 Kilometres

Albers Equal Area projection
Clarke 1880 spheroid
24°E central meridian
18°S 32°S standard parallels

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Table 4.6 WMA sample sites ("hot spot" sites) exceeding the TWQR for Irrigated Agriculture Water Use for the Irrigated Agriculture Water Quality Constituents

WMA Site	Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
Luvuvhu and Letaba WMA				
94	B9H003Q01	pH	Purple	Shingwidzi River At Kanniedood Dam/ Kruger National Park
Crocodile (West) and Marico WMA				
11	A2H033Q01	pH	Purple	Nouklip Eye At Hartbeeshoek
26	A2H094Q01	pH	Purple	Bospoort Dam On Hex River: Down Stream Weir
39	A2R012Q01	pH	Purple	Klipvoor Dam On Pienaars River: Near Dam Wall
41	A2R016Q01	pH	Purple	Leeukraal Dam On Apies River: Near Dam Wall
Olifants WMA				
95	B1H002Q01	EC	Yellow	Spook Spruit At Elandspruit
96	B1H004Q01	pH; EC	Red; yellow	Klip Spruit At Zaaihoek
104	B1H019Q01	EC	Yellow	Noupoort Spruit At Naauwpoort
105	B1H020Q01	EC	Yellow	Koring Spruit At Vaalkranz
125	B3H021Q01	EC	Yellow	Elands River At Scherp Arabie
132	B4H011Q01	pH	Purple	Steelpoort River At Alverton
145	B7H009Q01	pH	Purple	Olifants River At Finale/Liverpool
147	B7H015Q01	pH	Purple	Olifants River At Mamba/Kruger National Park
148	B7H019Q01	EC; Cl	Yellow; yellow	Ga-Selati River At Loole/Foskor
Usutu to Mhlatuze WMA				
669	W3H008Q01	pH	Purple	Mkuze River At Doornhoek
671	W3H012Q01	EC; Cl	Yellow; red	Mzinene River At Cloete
673	W3H015Q01	EC; Cl	Yellow; yellow	Hluhluwe River At Valsbaai/St Lucia Inflow
675	W3H023Q01	EC	Yellow	Nkongolwana River At Veelsgeluk/ Kongolana (Cp5)
686	W3R002Q01	SAR; pH; EC; Cl	Purple; purple; purple; purple	Lake St Lucia At Lister's Point
688	W4H006Q01	pH	Purple	Phongolo River At M'Hlati
Thukela WMA				
611	V1H009Q01	pH	Purple	Bloukrans River At Frere
638	V6H003Q01	pH	Purple	Wasbank River At Kuikvlei
642	V6H011Q01	pH	Purple	Wasbank River At Uithoek
643	V6H013Q01	pH	Purple	Wasbank River At Wasbank
644	V6H016Q01	pH	Purple	Mkomazana River At Wasbank
645	V6H017Q01	pH	Purple	Blinkwater River At Lynwood
646	V6H018Q01	pH	Purple	Tholeni River At Vaalkop
647	V6H019Q01	pH	Purple	Wasbank River At Vaalkop
648	V6H020Q01	pH	Purple	Wasbank River At Asynkraal
Upper Vaal WMA				
162	C2H004Q01	EC	Yellow	Suikerbosrand River At Uitvlugt (Rw S2)
163	C2H005Q01	EC	Yellow	Riet Spruit At Kaal Plaats (Rw Rv2)
166	C2H013Q01	EC	Yellow	Upper Turffontein Eye At Turffontein
173	C2H069Q01	EC	Yellow	Mooirivierloop (River) At Blaaubank
179	C2H132Q01	EC	Yellow	Riet Spruit At Tamboekiesfontein
180	C2H133Q01	EC	Yellow	Blesbok Spruit At Heidelberg
181	C2H134Q01	EC	Yellow	Cowles Dam Outflow At Springs
182	C2H135Q01	EC	Yellow	Natal Spruit At Rietfontein
183	C2H136Q01	EC	Yellow	Riet Spruit At Waterval

WMA Site	Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
187	C2H146Q01	EC	Yellow	Blesbok Spruit At Dagafontein – 2Km D/Stream N17
189	C2H149Q01	EC	Yellow	Blesbok Spruit At Nigel East – R51 Bridge (B8)
190	C2H153Q01	EC	Yellow	Wonderfontein Spruit At Randfontein Azaadville Bridge
191	C2H154Q01	EC	Yellow	Wonderfontein Spruit At Bridge On The Doornkop
193	C2H161Q01	EC	Yellow	Wonderfontein Spruit On Gravel Road Bridge
200	C2H234Q01	EC	Yellow	Suikerbosrant River At Badfontein
201	C2R001Q01	pH	Purple	Boskop Dam On Mooi River: Near Dam Wall
202	C2R003Q01	pH	Purple	Klerkskraal Dam On Mooi River: Near Dam Wall
203	C2R004Q01	pH	Purple	Potchefstroom Dam On Mooi River: Near Dam Wall
Middle Vaal WMA				
230	C2H073Q01	EC	Yellow	Skoon Spruit At Goedgenoeg/Orkney Bridge
231	C2H139Q01	EC	Yellow	Koekemoer Spruit At Buffelsfontein
232	C2R002Q01	pH	Purple	Johan Nesser Dam On Skoon Spruit: Near Dam Wall
234	C4H016Q01	EC; Cl	Yellow; yellow	Sand River At Bloudrif
235	C4H017Q01	EC; Cl	Yellow; yellow	Sand River At Doring River/Bloudrif
244	C7R001Q01	pH	Purple	Koppies Dam On Renoster River: Near Dam Wall
Mvoti to Umzimkulu WMA				
600	U6H005Q01	SAR; EC	Red; yellow	Sterk Spruit At Zigzag/Claires Est/ Shongweni Dam-
Mzimvubu to Keiskamma WMA				
510	R2H009Q01	pH	Purple	Ngqokweni River At Sheshegu 5/ Mgqokweni 19
512	R2H015Q01	pH; EC; Cl	Purple; yellow; yellow	Yellowwoods River At Fort Murray Outspan
513	R2H016Q01	SAR; pH; EC; Cl	Red; purple; red; red	Zwelitsha Spruit At Malakalaka
522	S1R001Q01	pH	Purple	Xonxa Dam On White Kei River: Near Dam Wall
525	S3H004Q01	pH	Purple	Black Kei River At Cathcarts Gift/ Endwell
526	S3H005Q01	pH	Purple	Oskraal River At Whittlesea
527	S3H006Q01	pH	Purple	Klaas Smits River At Weltevreden/ Queenstown
539	S7H004Q01	pH	Purple	Great Kei River At Area 8 Sprigs B/ Transkei Border
Upper Orange WMA				
261	D1H001Q01	pH	Purple	Wonderboom/Stormb. Spruit At Diepkloof/Burgersdorp
Lower Orange WMA				
283	D5H017Q01	SAR; EC; Cl	Red; purple; purple	Renoster River At Leeuwenkuil
284	D5H021Q01	SAR; pH; EC; Cl	Red; purple; red; red	Sak River At De Kruis/Williston
285	D5R001Q01	pH	Purple	Rooiberg Dam On Hartbees River: Near Dam Wall
Fish to Tsitsikamma WMA				
444	K8H001Q01	pH	Red	Kruis River At Farm 508 Pineview
445	K8H002Q01	pH	Red	Elands River At Kwaai Brand Forest Reserve/Witelsbos
449	L3R001Q01	EC	Yellow	Beervlei Dam At Windheuvel
450	L6H001Q01	SAR; pH; EC; Cl	Red; purple; purple; purple	Heuningklip River At Campherspoort
452	L7H007Q01	SAR; EC; Cl	Purple; purple; purple	Groot River At Sandpoort
453	L8H001Q01	pH	Red	Wabooms River At Diepkloof
459	M1H012Q01	EC; Cl	Yellow; red	Swartkops River At Uitenhage/Nivens Bridge
461	N1H013Q01	SAR; EC; Cl	Red; red; purple	Mackiesputs Eye At Graaf-Reinet/ Van Reyneveldspas
462	N1R001Q01	SAR; EC; Cl	Red; red; purple	Van Reyneveldspas Dam On Sundays River
463	N2H007Q01	pH; EC; Cl	Purple; red; purple	Sundays River At De Draay
464	N2H009Q01	pH; EC	Purple; yellow	Volkers River At Volkersrivier
465	N2R001Q01	pH	Purple	Darlington Dam On Sundays River At Dwaas

WMA Site	Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
466	N3H002Q01	EC; Cl	Yellow; yellow	Voël River At Rietvley
467	N4H001Q01	pH; EC	Purple; yellow	Sundays River At Korhaanspoort/ Couransdrift
468	N4H003Q01	SAR; pH; EC; Cl	Red; purple; red; purple	Sundays River At Addo Drift East/ Addo Bridge
469	N4H005Q01	SAR; EC; Cl	Purple; purple; purple	Coerney River At Selborne/Carlton
470	P1H003Q01	SAR; pH; EC; Cl	Red; purple; red; purple	Boesmans River At Donkerhoek/ Alicedale
471	P1R003Q01	SAR; pH; EC; Cl	Red; purple; red; purple	Nuwejaars Dam On Nuwejaars Spruit At Nuwejaars Drift West
472	P3H001Q01	SAR; EC; Cl	Red; purple; purple	Kariega River At Smithfield/Lower Waterford
475	P4H001Q01	SAR; EC; Cl	Red; red; purple	Kowie River At Bathurst/Wolfscrag
480	Q2H002Q01	pH; EC	Purple; yellow	Great Fish River At Zoutpansdrift
481	Q3H004Q01	pH; EC	Purple; yellow	Pauls River At Coutzenburg
483	Q4H013Q01	SAR; pH; EC; Cl	Red; purple; red; red	Tarka River At Bridge Farm/Tarka Bridge (New Weir)
485	Q5H005Q01	SAR; pH; EC; Cl	Red; purple; red; red	Great Fish River At Van Stadens Dam/Mortimer Weir
486	Q6H003Q01	pH; EC	Purple; yellow	Baviaans River At Botmansgat/De Klerkdal
487	Q7H003Q01	pH; EC	Purple; yellow	Great Fish River At Leeuwe Drift
488	Q7H005Q01	pH; EC; Cl	Purple; yellow; yellow	Great Fish River Atsout Vlei/Sheldon
489	Q8H008Q01	pH; EC	Purple; yellow	Little Fish River At Doornkraal
490	Q8H010Q01	pH; EC	Purple; yellow	Little Fish River At Grootvlakte
491	Q8H011Q01	pH; EC; Cl	Purple; yellow; yellow	Little Fish River At Rietfontein/Junction Drift
492	Q8R001Q01	pH	Purple	De Mist Kraal Dam On Little Fish River
493	Q9H001Q01	SAR;	Purple; yellow; yellow	Great Fish River At Fort Brown Peninsula
495	Q9H012Q01	pH; EC; Cl	Purple; yellow; yellow	Great Fish River At Brandtlegte/ Piggot's Bridge
496	Q9H017Q01	pH	Purple	Blinkwater River At Blinkwater
497	Q9H018Q01	SAR;	Purple; yellow; yellow	Great Fish River At Matomela's Reserve/Outspan
Gouritz WMA				
374	H8H003Q01	pH	Red	Duiwenhoks Dam On Duiwenhoks River: Down Stream Weir
375	H9H002Q01	pH	Red	Vet River At The Camp
376	H9H004Q01	pH	Red	Kruis River At Aan De Kruisrivier/Swq 3-44
378	H9H006Q01	pH	Red	Canal From Goukoul River At Groote Bosch
379	H9H010Q01	pH	Red	Korinte-Vet Dam On Korinte River: Down Stream Weir
380	H9R001Q01	pH	Red	Korinte-Vet Dam On Korinte River: Near Dam Wall
383	J1H017Q01	SAR; EC; Cl	Red; red; purple	Sand River At Buffelsfontein/Van Wyksdorp
384	J1H019Q01	SAR; EC; Cl	Red; purple; purple	Groot River At Buffelsfontein/Van Wyksdorp
388	J1R002Q01	pH; EC; Cl	Purple; yellow; red	Bellair Dam On Brak River: Near Dam Wall
390	J1R004Q01	EC; Cl	Yellow; red	Miertjeskraal Dam On Brand River: Near Dam Wall
391	J2H005Q01	EC; Cl	Yellow; yellow	Huis River At Zoar
401	J3H011Q01	SAR; EC; Cl	Purple; purple; purple	Olifants River At Warm Water
411	J3R002Q01	EC; Cl	Yellow; yellow	Stompdrif Dam On Olifants River: Near Dam Wall
416	K1H017Q01	EC; Cl	Yellow; yellow	Hartebeeskuil Dam On Hartenbos River: Down Stream
417	K1H021Q01	EC; Cl	Yellow; red	Hartenbos River At Hartenbosch
418	K1R001Q01	EC; Cl	Yellow; yellow	Hartebeeskuil Dam On Hartenbos River: Near Dam Wall
423	K3H001Q01	pH	Red	Kaaimans River At Upper Barbiers Kraal
426	K3H004Q01	pH	Red	Malgas River At Blanco
427	K3H005Q01	pH	Red	Touws River At Farm 162/Geo.F.12-8
430	K3R002Q01	pH	Red	Garden Route Dam On Swart River: Near Dam Wall

WMA Site	Sample Site	Constituent/s Exceeding Good Range	Extent of Exceedence	Location of Site
434	K3R006Q01	SAR; EC; Cl	Purple; purple; purple	Touws River Estuary At Wilderness
435	K4H001Q01	pH	Red	Hoekraal River At Eastbrook
436	K4H002Q01	pH	Red	Karatara River At Karatara Forest Reserve
438	K4R001Q01	SAR; pH; EC; Cl	Purple; purple; red; purple	Groen Vlei At Ruygte Valley
439	K4R002Q01	SAR; EC; Cl	Purple; purple; purple	Swart Vlei At Ronde Valley/ Hoogekraal
440	K5H002Q01	pH	Red	Knysna River At Milwood Forest Reserve
441	K5R001Q01	SAR; EC; Cl	Purple; purple; purple	Knysna Lagoon At Knysna
Olifants/Doorn WMA				
298	G3H001Q01	SAR; EC; Cl	Red; red; purple	Kruis River At Tweekuilen/Eendekuil
Breede WMA				
326	G4H006Q01	EC; Cl	Yellow; yellow	Klein River At Can Q5-8/ Wagenboomsdrift
330	G4R001Q01	pH	Red	Steenbras Dam On Steenbras River: Near Dam Wall
331	G4R002Q01	pH	Red	Eikenhof Dam On Palmiet River: Near Dam Wall
332	G4R003Q01	SAR; EC; Cl	Purple; purple; purple	Bot River Vlei On Bot River At Ysterklip/Hermanus
333	G4R004Q01	SAR; EC; Cl	Purple; purple; purple	Klein River Vlei On Klein Riv At Rocklands/Yacht
334	G5H008Q01	SAR; EC; Cl	Purple; purple; purple	Sout River At Kykoedy
337	H1H007Q01	pH	Red	Wit River At Drosterskloof
338	H1H009Q01	pH	Red	Holsloot River At Boontjiesrivier
341	H1H018Q01	pH	Red	Molenaars River At Hawequas Forest Reserve
342	H1H033Q01	pH	Red	Elands River At Hawequas Forest Reserve
347	H2H010Q01	EC; Cl	Red; red	Hex River At Worcester/Drie Riviere (Bridge)
350	H3H011Q01	SAR; EC; Cl	Red; red; purple	Kogmanskloof River At Goudmyn
352	H4H016Q01	EC; Cl	Yellow; yellow	Keisers River At Mc Gregor Commonage/Vrolykheid
354	H4H018Q01	SAR; EC; Cl	Red; purple; purple	Poesjenels River At La Chasseur
355	H4H019Q01	EC; Cl	Red; red	Vink River At De Gorree
356	H4H020Q01	EC; Cl	Red; purple	Nuy River At Doornrivier
360	H4R003Q01	pH	Red	Klipberg Dam On Konings River: Near Dam Wall
362	H5H004Q01	EC; Cl	Yellow; yellow	Bree River At Wolvendrift/Secunda
363	H5H005Q01	EC; Cl	Yellow; yellow	Bree River At Wagenboomsheuvel/ Drew
364	H6H005Q01	pH	Red	Baviaans River At Genadendal Mission Station
369	H7H005Q01	pH	Red	Hermitage River At Swellendam Forest Reserve
371	H7H007Q01	pH	Red	Grootkloof River At Sparkenbosch
Berg WMA				
302	G1H009Q01	EC; Cl	Yellow; red	Brakkloof Spruit At Knolvlei Forest Reserve
303	G1H012Q01	pH	Red	Watervals River At Watervalsberge/ Lower Watervals
309	G1H024Q01	SAR; EC; Cl	Purple; purple; purple	Berg River At Kliphoek
311	G1H034Q01	SAR; EC; Cl	Purple; purple; purple	Moorreesburg Spruit At Holle River
312	G1H035Q01	SAR; EC; Cl	Red; red; purple	Matjies River At Matjiesfontein
314	G1H039Q01	SAR; EC; Cl	Red; red; purple	Doring River At Grensplaas/Diepe Gat
315	G1H040Q01	EC; Cl	Yellow; red	Fish River At La Fonteine
317	G1H064Q01	PH	Purple; red	Banghoek River At Bosmanshoek (Compensation Water)
321	G2H012Q01	EC; Cl	Yellow; red	Diep River At Malmesbury

4.4 Trophic Status

The trophic status of each of the previously mentioned impoundments is reflected in Table 4.7.

Table 4.7 The Trophic Status of Selected Impoundments (after van Ginkel *et al.,* 2001)

Water Management Area	Impoundment	Trophic Status
Luvuvhu and Letaba	Ebenezer Dam	Oligotrophic
	Magoebaskloof Dam	Oligotrophic to mesotrophic
	Tzaneen Dam	Oligotrophic
Crocodile (West) and Marico	Bon Accord Dam	Eutrophic to hypereutrophic
	Buffelspoort Dam	Not sampled
	Hartbeespoort Dam	Eutrophic to hypereutrophic
	Klipvoor Dam	Hypereutrophic
	Kosterrivier Dam	Eutrophic
	Lindleyspoort Dam	Eutrophic
	Rietvlei Dam	Hypereutrophic
	Roodekopjes Dam	Oligotrophic to mesotrophic
	Roodeplaat Dam	Hypereutrophic
	Vaalkop Dam	Mesotrophic to Eutrophic
Olifants	Bronkhorstspruit Dam	Oligotrophic
	Witbank Dam	Mesotrophic
	Middelburg Dam	Oligotrophic
	Loskop Dam	Mesotrophic
Usutu to Mhlatuze	Klipfontein Dam	Hypereutrophic to eutrophic
Upper, Middle and Lower Vaal	Allemanskraal Dam	Hypereutrophic
	Bloemhof Dam	Eutrophic to hypereutrophic
	Boskop Dam	Mesotrophic
	Erfenis Dam	Hypereutrophic
	Grootdraai Dam	Eutrophic
	Koppies Dam	Eutrophic
	Sterkfontein Dam	Mesotrophic
	Vaal Dam	Eutrophic to hypereutrophic
Mvoti to Umzimkulu	Albert Falls Dam	Mesotrophic to eutrophic
	Inanda Dam	Mesotrophic
	Midmar Dam	Mesotrophic
	Nagle Dam	Mesotrophic (towards Eutrophic)
	Hazelmere Dam	Mesotrophic (towards Eutrophic)
	Shongweni Dam	Hypereutrophic
Mzimvubu to Keiskamma	Bridledrift Dam	Eutrophic to hypereutrophic
	Laing Dam	Eutrophic to hypereutrophic
Upper and Lower Orange	Gariep Dam	Eutrophic
	Cook's Lake	Hypereutrophic
	Disaneng Dam	Mesotrophic
	Lotlamoreng Dam	Hypereutrophic to eutrophic
	Setumo (Modimola) Dam	Eutrophic
Fish to Tsitsikamma	Bo-Lang Vlei	Eutrophic
	Groen Vlei	Mesotrophic
	Onder-Lang Vlei	Mesotrophic
	Ronde Vlei	Eutrophic
	Sedgefield Lagoon	Oligotrophic
	Swart Vlei	Oligotrophic
	Wilderness Lagoon	Mesotrophic
Berg	Misverstand Dam	Eutrophic to hypereutrophic
	Voëlvlei Dam	Mesotrophic
	Wemmershoek Dam	Mesotrophic to Oligotrophic

It is rather disturbing to note the number of impoundments listed in Table 4.7 that have a trophic status in the eutrophic to hypereutrophic classes. The list of impoundments that are classified by van Ginkel *et al*. (2001) as oligotrophic or mesotrophic is shorter: the Roodekopjes Dam; Bronkhorstspruit Dam, Witbank Dam; Middelburg Dam; Loskop Dam; Ebenezer Dam; Magoebaskloof Dam; Tzaneen Dam; Boskop Dam; Sterkfontein Dam; Disaneng Dam; Voëlvlei Dam; Wemmershoek Dam; Groen Vlei; Onder-Land Vlei; Sedgefield Lagoon; Swart Vlei; Wilderness Lagoon; Inanda Dam and Midmar Dam.

The impoundments are ranked according to the greatest need to undertake eutrophication management (van Ginkel *et al.*, 2001) in Table 4.8.

Table 4.8 The priority ranking of selected impoundments throughout South Africa out of 49 impoundments included in the study of van Ginkel *et al.* (2001) indicating the relative need for eutrophication management

Water Management Area	Impoundment	Priority ranking
Crocodile (West) and Marico	Rietvlei Dam	1
Crocodile (West) and Marico	Klipvoor Dam	2
Upper and Lower Orange	Cooke's Lake	3
Crocodile (West) and Marico	Roodeplaat Dam	4
Crocodile (West) and Marico	Bon Accord Dam	5
Crocodile (West) and Marico	Hartbeespoort Dam	6
Upper, Middle and Lower Vaal	Erfenis Dam	7
Upper and Lower Orange	Lotlamoreng Dam	8
Upper, Middle and Lower Vaal	Bloemhof Dam	9
Mvoti to Umzimkulu	Shongweni Dam	10
Mzimvubu to Keiskamma	Bridledrift Dam	11
Upper, Middle and Lower Vaal	Koppies Dam	12
Mzimvubu to Keiskamma	Laing Dam	13
Berg	Misverstand Dam	14
Upper, Middle and Lower Vaal	Allemanskraal Dam	15
Upper and Lower Orange	Gariep Dam	16
Upper, Middle and Lower Vaal	Vaal Dam	17
Crocodile (West) and Marico	Kosterrivier Dam	18
Crocodile (West) and Marico	Lindleyspoort Dam	19
Upper and Lower Orange	Setumo Dam	20
Upper, Middle and Lower Vaal	Grootdraai Dam	21
Fish to Tsitsikamma	Bo-Lang Vlei	22
Usutu to Mhlatuze	Klipfontein Dam	23
Fish to Tsitsikamma	Ronde Vlei	24
Crocodile (West) and Marico	Vaalkop Dam	25
Mvoti to Umzimkulu	Inanda Dam	26
Olifants	Bronkhorstspruit Dam	27
Crocodile (West) and Marico	Roodekopjes Dam	28
Mvoti to Umzimkulu	Albert Falls Dam	29
Mvoti to Umzimkulu	Hazelmere Dam	30
Olifants	Witbank Dam	31
Mvoti to Umzimkulu	Nagle Dam	32
Olifants	Middelburg Dam	33
Fish to Tsitsikamma	Onder-Lang Vlei	34
Luvuvhu and Letaba	Magoebaskloof Dam	35
Mvoti to Umzimkulu	Midmar Dam	36
Upper, Middle and Lower Vaal	Sterkfontein Dam	37
Upper and Lower Orange	Disaneng Dam	38
Luvuvhu and Letaba	Tzaneen Dam	39
Berg	Voël Vlei	40
Olifants	Loskop Dam	41
Luvuvhu and Letaba	Ebenezer Dam	42
Upper, Middle and Lower Vaal	Boskop Dam	43
Fish to Tsitsikamma	Groen Vlei	44
Berg	Wemmershoek Dam	45
Fish to Tsitsikamma	Wilderness Lagoon	46
Fish to Tsitsikamma	Sedgefield Lagoon	47
Fish to Tsitsikamma	Swart Vlei	48
Crocodile (West) and Marico	Buffelspoort Dam (not sampled)	49

According to Table 4.8, the impoundments most in need of eutrophication management are situated in the Crocodile (West) Marico WMA, with five out of the top ten priority impoundments being situated in this WMA.

5. CONCLUSIONS

5.1 Domestic Use

The main water quality problems throughout the country for domestic use relate to the widespread elevated salt levels (high TDS values) and elevated fluoride levels in certain locations.

Water with elevated TDS levels tastes salty and does not slake thirst. The elevated salt levels (as expressed by TDS concentrations) also decrease the aesthetic value of water. Consumption of the water may not produce adverse health effects in the short-term, but there is a slight possibility of salt overload in sensitive individuals in the long term. TDS levels were especially elevated in the Lower Orange, Fish to Tsitsikamma and Gouritz WMAs. It would appear that these elevated levels are due to natural reasons. The Breede and Berg WMAs have elevated TDS levels when considering the individual WMA sample sites.

High fluoride (F) levels were evident in the lower Olifants WMA. Health effects and tooth staining can be expected at the concentrations evident at selected sample sites.

At a WMA scale, pH values were also seen to deviate in various parts of the country. The pH was low in the Klip Spruit (of the Olifants WMA) and would likely result in irritation of the mucous membranes of water users in this area. It is likely that the source of the low pH is the acid mine drainage from the coalmines and mine dumps in the area. A notable effect of the low pH would be "burning eyes" with the use of the water for recreational purposes.

Magnesium (Mg), sulphate (SO_4), chloride (Cl), sodium (Na) and potassium (K) were also elevated in various parts of the country.

5.2 Irrigation Use

From an irrigated agriculture use perspective, the sodium adsorption ratio (SAR), electrical conductivity (EC), pH and chloride (Cl) were elevated in various regions of the country.

There were high pH levels in the Luvuvhu and Letaba, Crocodile (West) and Marico, Olifants, Usutu to Mhlatuze, Mzimvubu to Keiskamma, Upper Orange and Lower Orange WMAs.

The Fish to Tsitsikamma and Gouritz WMAs had low pH values and high sodium adsorption ratio, electrical conductivity and chloride values; making irrigated agriculture in these WMAs more challenging, and limiting crop selection to more salt tolerant crops.

The Thukela WMA had high pH values, with the Upper and Middle Vaal WMAs having high electrical conductivity values.

The South Western Cape (Breede and Berg WMAs) had low pH values evident in some cases and elevated sodium adsorption ratio, electrical conductivity and chloride values, again limiting the potential for growing salt sensitive crops.

5.3 Trophic Status of Selected Impoundments

South Africa has disturbing levels of nutrient enrichment at many of its impoundments. This is something that requires urgent attention. The most enriched impoundments are often those that have the greatest concentration of humans in their catchment areas. The top ten impoundments in need of nutrient management are:

- Rietvlei Dam (in the Crocodile (West) and Marico WMA),
- Klipvoor Dam (in the Crocodile (West) and Marico WMA),
- Cooke's Lake (in the Upper and Lower Orange WMAs),
- Roodeplaat Dam (in the Crocodile (West) and Marico WMA),
- Bon Accord Dam (in the Crocodile (West) and Marico WMA),
- Hartbeespoort Dam (in the Crocodile (West) and Marico WMA),
- Erfenis Dam (in the Upper, Middle and Lower Vaal WMAs),
- Lotlamoreng Dam (in the Upper and Lower Orange WMAs),
- Bloemhof Dam (in the Upper, Middle and Lower Vaal WMAs), and
- Shongweni Dam (in the Mvoti to Umzimkulu WMA).

Apart from the aesthetic aspects of water with a "pea-soup" appearance, eutrophication leads to the frequent occurrence of toxic algal blooms, with the danger of fish and cattle deaths, and the induction of gastro-enteritis in humans.

6. RECOMMENDATIONS

The following recommendations are proposed:

- Revision of the existing monitoring network is necessary to terminate sampling at unnecessary sites and expand the network to cover more adequately the sensitive problem areas or those areas with insufficient sampling sites.

- Role players must be informed of the impact of land uses that result in deterioration in the water quality. This is especially important for mining and agriculture.

- Ways to improve the water quality at those negatively impacted sites must be investigated.

- Water users at sites where there is water that could be detrimental to their health should be informed to take appropriate precautions. Safe water should be provided to those domestic users who have no access to a safe and healthy water supply.

- Water resources should be protected, in particular the more pristine water sources, in order that their quality does not deteriorate as a result of a change in land use or management practice.

- The trophic status monitoring and assessment programme should be expanded to include more of the impoundments throughout the country and appropriate land-use management practises should be encouraged to prevent or minimise large nutrient loads entering the aquatic environment.

7. REFERENCES

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8. APPENDICES

8.1 Appendix A: Basic Statistics for the National Sampling Site Set

8.2 Appendix B: Land cover types and extent of areal cover across South Africa per WMA (after Fairbanks *et al.*, 2000)

8.3 Appendix C: Barcode Graphs for the National Sampling Sites that Exceed the *Very Good* and *Good* (or TWQR) Categories

8.1 Appendix A: Basic Statistics for the National Sampling Site Set

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
90167	A2H019Q01	Number of Elements	145	145	145	145	145	145	145	145	145	145	145	145	143	130
90167	A2H019Q01	Median	8.26	0.594	0.17	0.37	46.8	24.37	71	57.9	6.43	38	61.4	429.3	1.456	1
90167	A2H019Q01	95% Percentile	8.494	2.036	0.4048	0.48	60.98	29.94	88.12	74.13	7.649	46.98	71.88	495	1.809	9.924
90168	A2H021Q01	Number of Elements	145	145	145	145	145	145	145	145	145	145	145	145	140	128
90168	A2H021Q01	Median	8.31	0.3	0.051	0.45	50.3	17.87	51.1	48.6	8.58	35.5	56.2	420	1.7	2
90168	A2H021Q01	95% Percentile	8.94	0.8738	0.2874	0.538	71.18	22.18	66.46	67.28	10.57	41.28	70.46	511.8	2.443	13.95
90203	A2H059Q01	Number of Elements	279	279	279	279	279	279	279	279	279	279	279	279	271	
90203	A2H059Q01	Median	8.283	0.74	0.035	0.42	54.3	27	76.9	69.1	6.04	43.3	68.1	481	1.61	
90203	A2H059Q01	95% Percentile	8.496	1.826	0.0931	0.551	79.01	35.22	100.4	112.4	7.261	54.99	89.16	618.1	2.07	
90220	A2H094Q01	Number of Elements	46	46	46	46	46	46	46	46	46	46	46	46	46	
90220	A2H094Q01	Median	8.42	0.152	0.02	0.169	39.05	22.15	76.1	65.05	6.4	45.35	61.3	414.5	1.2	
90220	A2H094Q01	95% Percentile	8.835	1.861	0.2413	0.2053	48.55	31.65	94.08	95.42	8.698	57.35	77.68	531.6	1.505	
90230	A2H111Q01	Number of Elements	138	138	138	138	138	138	138	138	138	138	138	138	137	135
90230	A2H111Q01	Median	8.33	0.098	0.06	0.469	28.8	16.85	43.57	34.25	4.657	28.4	43.65	302.5	1.049	1
90230	A2H111Q01	95% Percentile	8.594	0.7838	0.1378	0.5904	39.6	21.64	56.68	53.1	6.227	33.87	54.75	365.6	1.347	27.3
90233	A2H116Q01	Number of Elements	139	139	139	139	139	139	139	139	139	139	139	139	133	
90233	A2H116Q01	Median	8.353	0.523	0.034	0.46	57	26.6	73	70.5	6.917	45.5	69.7	497	1.68	
90233	A2H116Q01	95% Percentile	8.64	1.472	0.0771	0.55	81.44	38.42	103	115.4	8.47	60.17	92.97	667.1	2.191	
90325	A3R003Q01	Number of Elements	37	37	37	37	37	37	37	37	37	37	37	37	36	
90325	A3R003Q01	Median	8.117	0.137	0.031	0.26	5.4	7.1	13.6	5	2.346	14.81	17.4	126.6	0.28	
90325	A3R003Q01	95% Percentile	8.34	0.4828	0.1036	0.3632	7.13	9.807	18.75	6.14	3.086	20.03	22.26	159.6	0.445	

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
90326	A3R003Q01	Number of Elements	55	55	55	55	55	55	55	55	55	55	55	55	53	
90326	A3R003Q01	Median	8.29	0.092	0.024	0.26	5.9	13.35	8.9	4.9	4.183	16.3	23.1	179	0.27	
90326	A3R003Q01	95% Percentile	8.5	0.2327	0.0657	0.34	8.284	18.36	16.05	5.5	4.823	24.99	31.41	234.1	0.344	
90334	A4H013Q01	Number of Elements	98	98	98	98	98	98	98	98	98	98	98	98	95	61
90334	A4H013Q01	Median	7.45	0.022	0.02	0.128	6.4	2.4	4.353	7	0.855	4.5	8.09	56	0.59	3.25
90334	A4H013Q01	95% Percentile	7.732	0.08315	0.0782	0.1781	8.303	3.071	9.26	11.68	2.561	6.845	10.3	74.15	0.7825	52
90340	A5H006Q01	Number of Elements	50	50	50	50	50	50	50	50	50	50	50	50	50	10
90340	A5H006Q01	Median	8.19	0.081	0.02	0.304	22.9	10.95	27.41	29.08	4.35	20.35	33.45	215.1	1.015	15.35
90340	A5H006Q01	95% Percentile	8.627	0.5817	0.0682	0.4355	50.87	26.42	67.78	70.75	6.803	40.25	61.23	438.5	1.586	106.8
90341	A5H008Q01	Number of Elements	67	67	67	67	67	67	67	67	67	67	67	67	66	33
90341	A5H008Q01	Median	7.75	0.178	0.02	0.16	8.3	2.812	7.2	10.9	1.04	7.2	11	74	0.675	2
90341	A5H008Q01	75% Percentile	7.971	0.3735	0.029	0.194	15.68	5.306	10.4	20.95	1.398	10.4	19.7	115.7	1.014	12
90370	A7H001Q01	Number of Elements	61	61	61	61	61	61	61	61	61	61	61	61	57	
90370	A7H001Q01	Median	7.88	0.131	0.029	0.12	5.3	4.6	5.6	8.2	0.98	10.2	12.5	91	0.39	
90370	A7H001Q01	95% Percentile	8.491	0.762	0.064	0.21	63.84	22.25	33.9	119.1	4.25	31.77	70.8	437.5	2.108	
90398	A9H011Q01	Number of Elements	109	109	109	109	109	109	109	109	109	109	109	109	109	63
90398	A9H011Q01	Median	7.94	0.085	0.02	0.125	9.4	5.6	5.9	11.7	0.78	7.445	14.3	101.2	0.62	6
90398	A9H011Q01	95% Percentile	8.234	0.5334	0.063	0.302	40.73	16.23	12.3	48.91	2.348	14.16	41.06	278.4	1.729	111.8
90399	A9H012Q01	Number of Elements	139	139	139	139	139	139	139	139	139	139	139	139	138	5
90399	A9H012Q01	Median	7.95	0.258	0.029	0.11	7.2	5.2	4.788	6.8	0.78	8.4	12.7	95.25	0.47	6.46
90399	A9H012Q01	95% Percentile	8.201	0.6501	0.0701	0.1664	8.807	7.182	10.91	11.58	1.316	11.5	16.43	118.4	0.54	39.22
90412	B1H010Q01	Number of Elements	267	267	267	267	267	267	267	267	267	267	267	267	266	
90412	B1H010Q01	Median	8.27	0.06	0.024	0.4	26.2	25	155.8	14.94	5.728	40.4	55.3	378	0.81	

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
90412	B1H010Q01	95% Percentile	8.985	0.4874	0.0747	0.4697	34.07	37.77	265	22.26	6.739	66.2	72.1	509.7	1.019	
90414	B1H015Q01	Number of Elements	265	265	265	265	265	265	265	265	265	265	265	265	264	
90414	B1H015Q01	Median	8.023	0.083	0.02	0.316	19.7	22	133.3	14.02	6.58	33.6	46.2	314.2	0.629	
90414	B1H015Q01	95% Percentile	8.25	0.3824	0.0626	0.39	23.24	29.58	190.6	17.63	7.898	44.74	57.06	389.8	0.7487	
90442	B2H015Q01	Number of Elements	221	221	221	221	221	221	220	221	221	221	221	221	214	121
90442	B2H015Q01	Median	7.956	0.111	0.026	0.23	10	8	38.8	7.4	2.85	18.2	23.2	158	0.479	1.04
90442	B2H015Q01	95% Percentile	8.23	0.313	0.075	0.31	13.73	10.9	88.15	11.8	4.13	35.47	32.4	215	0.6422	16
90444	B3H001Q01	Number of Elements	214	214	214	214	214	214	214	214	214	214	214	214	205	150
90444	B3H001Q01	Median	8.218	0.4165	0.03	0.5	37.55	17.5	101.5	25.15	4.689	30.7	47.85	334	1.32	1
90444	B3H001Q01	95% Percentile	8.551	1.03	0.0784	1.207	140.2	36.92	175.1	139.3	6.308	48.71	109.5	820.7	3.654	14.55
90458	B3H021Q01	Number of Elements	135	135	135	135	135	135	135	135	135	135	135	135	127	136
90458	B3H021Q01	Median	8.298	0.467	0.024	1.27	106.5	32.8	126	144.6	7.95	54.48	100.4	682.7	2.741	2.945
90458	B3H021Q01	95% Percentile	8.656	1.357	0.076	1.733	192.8	58.51	193.7	255.1	9.941	74.78	166.8	1071	3.9	29.5
90473	B4H011Q01	Number of Elements	95	95	95	95	95	95	95	95	95	95	95	95	95	69
90473	B4H011Q01	Median	8.55	1.153	0.03	0.16	31.4	26.2	27.1	25.8	1.13	30.9	48.8	370	1.02	7
90473	B4H011Q01	95% Percentile	8.83	2.317	0.0665	0.273	88.57	72.68	81.19	86.05	1.761	39.85	108.7	874.7	2.019	168.8
90491	B6H004Q01	Number of Elements	134	134	134	134	134	134	134	134	134	134	134	134	134	71
90491	B6H004Q01	Median	8.1	0.169	0.0215	0.12	4.5	8.461	10.37	4.6	0.515	14.6	17.15	127.5	0.23	0.5
90491	B6H004Q01	95% Percentile	8.417	0.3284	0.0574	0.1987	6.135	11.74	14.94	5.735	1.677	19.59	22.34	168.7	0.2835	2.06
90506	B7H009Q01	Number of Elements	98	98	98	98	98	98	98	98	98	98	98	98	97	29
90506	B7H009Q01	Median	8.52	0.3095	0.0255	0.33	37.95	22.65	52.75	40.4	3.095	32.7	51.5	366	1.22	1
90506	B7H009Q01	95% Percentile	8.732	0.6291	0.057	0.4115	65.65	39.23	92.83	91.29	4.565	40.01	76.49	533.4	1.824	611

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
90524	B8H008Q01	Number of Elements	120	120	120	120	120	120	119	120	120	120	120	120	118	44
90524	B8H008Q01	Median	8.125	0.1155	0.029	0.184	24.3	9.25	10.9	28.95	2.265	15.4	28.45	194.5	1.21	1
90524	B8H008Q01	95% Percentile	8.415	0.4997	0.0643	0.273	55.88	17.21	25.83	74.62	3.595	27.31	54.08	366.7	1.947	31.75
90583	B9H003Q01	Number of Elements	113	113	113	113	113	113	113	113	113	113	113	113	108	38
90583	B9H003Q01	Median	8.44	0.097	0.042	0.21	35.7	17.6	10.4	19.1	5.692	31.4	44	379	1.28	9
90583	B9H003Q01	95% Percentile	8.762	2.954	0.9248	0.28	207.3	55.23	50.2	252.2	17.57	46.52	160.4	1105	5.048	235.9
90585	C1H002Q01	Number of Elements	277	277	277	277	277	277	277	277	277	277	277	277	265	
90585	C1H002Q01	Median	8.21	0.048	0.021	0.21	15.8	13.27	18.34	8.7	1.873	24.12	30.2	235.9	0.64	
90585	C1H002Q01	95% Percentile	8.492	0.167	0.0732	0.29	26.84	22.62	30.76	14.9	3.508	36.82	46.9	377.2	0.87	
90597	C1H017Q01	Number of Elements	277	277	277	277	277	277	277	277	277	277	277	277	265	
90597	C1H017Q01	Median	8.271	0.113	0.026	0.24	20.2	14.25	29.1	13.55	3.073	23.43	33.4	255	0.809	
90597	C1H017Q01	95% Percentile	8.64	0.787	0.0944	0.34	39.12	27	45.37	28.54	4.301	41.36	55.12	444	1.226	
90615	C2H004Q01	Number of Elements	369	359	361	361	354	353	354	359	354	353	1374	322	350	96
90615	C2H004Q01	Median	8.2	0.257	0.025	0.26	119.7	49.9	447.2	110	10.44	130	140	1052	2.205	2
90615	C2H004Q01	95% Percentile	8.536	0.9697	0.26	0.34	226.6	91.88	1061	199.4	18.85	267.2	263.3	2015	3.19	19
90616	C2H005Q01	Number of Elements	337	322	327	329	320	320	316	326	320	320	1255	283	316	115
90616	C2H005Q01	Median	7.89	4.707	1	0.59	58.4	25.6	214.2	94	11	90.45	98.3	641.2	1.382	4
90616	C2H005Q01	95% Percentile	8.28	9.58	7.923	0.956	82.14	31.02	287.1	150	18.85	110	120	815.2	1.848	21.9
90618	C2H007Q01	Number of Elements	265	265	265	265	265	265	265	265	265	265	265	265	261	117
90618	C2H007Q01	Median	8.33	0.494	0.02	0.288	42.9	22.16	141.8	43.4	7.55	50.8	66.3	451	1.28	7
90618	C2H007Q01	95% Percentile	9.078	1.589	0.089	0.3956	81.85	34.78	248.5	86.34	12.69	82.71	101.6	716.7	2.01	60
90654	C2H071Q01	Number of Elements	319	309	311	311	303	302	304	310	304	302	1325	273	288	87
90654	C2H071Q01	Median	7.98	4.868	0.151	0.28	64.15	25	177.4	68.85	13.9	64.05	87	589	1.63	4

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
90654	C2H071Q01	95% Percentile	8.341	7.209	0.999	0.34	77	33	256.1	87	18	86.79	105	703.2	2.206	15.7
90656	C2H073Q01	Number of Elements	267	267	267	267	267	267	267	267	267	267	288	267	260	128
90656	C2H073Q01	Median	8.1	3.062	0.336	0.274	57.09	37	147.4	71.13	10.39	68.06	88.15	644.2	1.37	1.1
90656	C2H073Q01	95% Percentile	8.563	13.49	8.533	0.37	130.5	55.57	347.7	165	23.11	110.9	164.6	1129	2.621	12.13
90668	C2H085Q01	Number of Elements	1047	312	312	312	312	312	312	312	312	312	1706	312	305	120
90668	C2H085Q01	Median	8.32	0.549	0.022	0.24	35.36	43.25	101.3	38	5.12	55.58	73.85	574.3	0.85	1
90668	C2H085Q01	95% Percentile	8.67	1.6	0.2558	0.4036	53.07	52.65	126.6	61.75	8.537	66.24	89.43	691.3	1.246	7.145
90795	C4H004Q01	Number of Elements	145	148	148	148	148	148	148	148	148	148	148	148	145	62
90795	C4H004Q01	Median	8.3	0.036	0.0205	0.28	54	15.97	52.85	70.77	6.805	35.15	60.7	407	1.809	31
90795	C4H004Q01	95% Percentile	8.689	0.8733	0.08	0.3347	106.3	32.83	125.1	173.9	8.976	60.67	105	707.6	2.778	214.5
90809	C4R001Q01	Number of Elements	72	72	72	72	72	72	72	72	72	72	72	72	72	
90809	C4R001Q01	Median	8.18	0.3775	0.035	0.295	15.2	5.1	16.2	7.1	5.11	11.85	18.6	155	0.94	
90809	C4R001Q01	95% Percentile	8.365	0.7326	0.1349	0.3727	18.7	6.39	34.41	10.47	5.685	15.59	23.15	191.6	1.106	
90810	C4R002Q01	Number of Elements	93	93	93	93	93	93	93	93	93	93	93	93	90	
90810	C4R002Q01	Median	8.183	0.236	0.022	0.27	13.6	6.5	15.15	7.1	4.799	14.7	21.4	165	0.7545	
90810	C4R002Q01	95% Percentile	8.359	0.4806	0.111	0.3564	23.53	18.87	22.93	10.69	5.896	39.4	46.34	370.2	0.96	
90847	C6H003Q01	Number of Elements	159	159	159	159	159	159	159	159	159	159	159	159	157	108
90847	C6H003Q01	Median	8.33	0.191	0.02	0.252	29.6	12.77	31.43	18.4	5.941	28.14	38.7	296	1.19	9
90847	C6H003Q01	95% Percentile	9.055	1.39	0.9846	0.3355	72.11	29.34	79.8	62.66	8.853	45.15	74.03	577.1	2.108	157.2
90853	C7H006Q01	Number of Elements	415	275	275	275	275	275	275	275	275	275	474	275	263	75
90853	C7H006Q01	Median	8.24	0.051	0.024	0.24	28	12.45	27.9	20.6	5.54	25.1	36.55	277.5	1.12	18.6
90853	C7H006Q01	95% Percentile	8.63	0.3791	0.0879	0.31	36.43	17.13	39.66	30.63	6.541	34.3	46.47	356.3	1.468	122.4

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
90859	C8H001Q01	Number of Elements	281	281	281	281	281	281	281	281	281	281	281	281	271	
90859	C8H001Q01	Median	8.088	0.236	0.038	0.171	10.2	6.1	15.3	5.6	2.27	15.7	18.6	144	0.57	
90859	C8H001Q01	95% Percentile	8.38	0.506	0.094	0.25	23.9	16.3	25.04	14.2	4.111	32.1	40	315	0.955	
90884	C8H027Q01	Number of Elements	276	276	276	276	276	276	275	276	276	276	276	276	274	123
90884	C8H027Q01	Median	8.238	0.1895	0.02	0.2	16.54	9.35	18.4	8.8	2.653	21.1	26.45	202.5	0.77	10
90884	C8H027Q01	95% Percentile	8.534	0.465	0.0735	0.2833	28.82	19.97	25.14	16.63	4.126	34.92	46.03	357.4	1.07	157.7
101788	D1H001Q01	Number of Elements	155	155	155	155	155	155	155	155	155	155	155	155	145	1
101788	D1H001Q01	Median	8.42	0.783	0.026	0.34	51.6	28	44.2	30.1	5.17	48	66.5	517	1.41	857
101788	D1H001Q01	95% Percentile	9.022	9.193	0.2289	0.4206	93.37	45.32	90.03	89.31	11.21	69.38	98.96	795.9	2.486	857
101789	D1H003Q01	Number of Elements	253	253	253	253	253	253	253	253	253	253	253	253	249	102
101789	D1H003Q01	Median	8.11	0.187	0.026	0.14	4.9	6.556	9.5	3.9	0.81	19	17.4	140	0.24	32
101789	D1H003Q01	95% Percentile	8.406	0.5082	0.0604	0.2094	7.279	11.1	14.94	5.3	2.104	28.74	26.74	207	0.376	355
101790	D1H005Q01	Number of Elements	17	17	17	17	17	17	17	17	17	17	17	17	17	1
101790	D1H005Q01	Median	8.079	0.334	0.02	0.11	4.3	6.61	9	3.9	0.58	19.1	17.5	138	0.2	119
101790	D1H005Q01	95% Percentile	8.474	0.85	0.0358	0.2216	14.13	11.3	25.48	14.12	0.9516	28.88	29.94	219.4	0.702	119
101791	D1H006Q01	Number of Elements	147	147	147	147	147	147	147	147	147	147	147	147	139	131
101791	D1H006Q01	Median	8.1	0.234	0.022	0.14	5.6	6.6	11.07	4.2	0.95	20.4	18.5	148	0.27	19.1
101791	D1H006Q01	95% Percentile	8.377	0.7821	0.0754	0.2463	8.077	9.9	16.25	5	2.165	27.64	26.06	201	0.392	914.5
101793	D1H009Q01	Number of Elements	148	148	148	148	148	148	148	148	148	148	148	148	144	129
101793	D1H009Q01	Median	8.05	0.2065	0.02	0.1325	4.428	5.898	8.679	3.8	0.754	17.62	15.9	128	0.2275	11.35
101793	D1H009Q01	95% Percentile	8.366	0.5508	0.0607	0.19	6.056	9.93	14.19	5	1.86	27.17	24.69	191	0.34	693.4
101795	D1H011Q01	Number of Elements	120	120	120	120	120	120	120	120	120	120	120	120	116	102
101795	D1H011Q01	Median	8.24	0.0315	0.022	0.13	6.128	9.45	9.6	4.2	0.866	24.6	22.55	181.5	0.26	4.065

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
101795	D1H011Q01	95% Percentile	8.441	0.1192	0.0492	0.1962	8.729	16.77	14.71	5.9	1.981	36.26	35.03	272.4	0.354	133.8
101808	D2H012Q01	Number of Elements	65	63	65	63	63	63	63	63	63	63	65	63	62	7
101808	D2H012Q01	Median	8.314	0.053	0.02	0.15	10.7	13	14.9	5	1.41	33.4	32.1	256	0.395	5.04
101808	D2H012Q01	95% Percentile	8.514	0.181	0.065	0.21	16.57	20.3	20.57	9.09	3.135	47.61	42.76	370.9	0.5296	90.54
101816	D2H036Q01	Number of Elements	112	112	112	112	112	112	111	112	112	112	112	112	104	95
101816	D2H036Q01	Median	8.074	0.386	0.028	0.21	8.29	6.118	13	5	1.812	17.62	19.05	145.7	0.43	140
101816	D2H036Q01	95% Percentile	8.451	0.8933	0.0854	0.33	13.46	12.85	23.11	7.045	3.05	32.97	31.88	257.8	0.5785	1823
101820	D2R004Q01	Number of Elements	61	61	61	61	61	61	61	61	61	61	61	61	60	15
101820	D2R004Q01	Median	8.104	0.402	0.045	0.21	8.093	6	12.6	5	1.76	16.7	18.5	142	0.418	11.1
101820	D2R004Q01	95% Percentile	8.46	0.831	0.103	0.27	15	15.6	29.5	9.4	3.21	37.2	38.5	302	0.5806	436
101824	D3H008Q01	Number of Elements	265	265	265	265	265	265	265	265	265	265	265	265	257	116
101824	D3H008Q01	Median	8.18	0.48	0.03	0.17	7.712	7	12.09	5.1	1.337	19.57	20	151.1	0.38	7
101824	D3H008Q01	95% Percentile	8.361	0.7918	0.073	0.22	11.26	8.2	16.64	9.78	2.848	22.48	23.88	174	0.5272	51.5
101828	D3H013Q01	Number of Elements	147	147	147	147	147	147	147	147	147	147	147	147	141	123
101828	D3H013Q01	Median	8.122	0.494	0.036	0.16	5.2	5.8	9.5	4.1	1.15	16.79	16.1	129	0.276	17.9
101828	D3H013Q01	95% Percentile	8.394	0.8415	0.0924	0.22	7.139	6.594	13.65	5	2.695	19.15	18.4	141.8	0.4	100.9
101837	D3R003Q01	Number of Elements	37	36	37	36	36	36	36	36	36	36	37	36	36	
101837	D3R003Q01	Median	8.17	0.509	0.03	0.157	5.15	6	9.35	3.85	1.305	17.1	17	130	0.27	
101837	D3R003Q01	95% Percentile	8.366	0.781	0.0674	0.2118	6.725	7.1	13.43	5.025	2.805	19.67	19.32	147.3	0.3375	
101869	D5H021Q01	Number of Elements	35	35	35	35	35	35	35	35	35	35	35	35	34	
101869	D5H021Q01	Median	8.63	0.031	0.031	0.79	692.3	88.4	624.1	588	5.93	52.8	371	2660	12.89	
101869	D5H021Q01	95% Percentile	8.773	0.1047	0.1237	1.073	1110	164.4	1097	1090	12.01	68.46	568.5	4130	18.24	

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
101878	D7H008Q01	Number of Elements	239	239	239	239	239	239	239	239	239	239	239	239	235	2
101878	D7H008Q01	Median	8.268	0.347	0.036	0.19	14.2	9.1	22.8	13.14	2.218	23.4	27.1	194	0.64	28.25
101878	D7H008Q01	95% Percentile	8.561	0.7073	0.0943	0.28	31.29	15.71	69.91	33.37	5.367	34.2	45.43	314.7	1.186	38.11
101884	D7H015Q01	Number of Elements	216	216	216	216	216	216	216	216	216	216	216	216	204	
101884	D7H015Q01	Median	8.29	0.076	0.02	0.23	19.55	11.65	28.55	16.26	2.17	26.95	33.55	240	0.8	
101884	D7H015Q01	95% Percentile	8.484	0.566	0.0613	0.3048	37.2	16.7	72.13	36.65	5.411	35.43	50.93	338	1.319	
101888	D8H003Q01	Number of Elements	244	244	244	244	244	244	244	244	244	244	244	244	239	12
101888	D8H003Q01	Median	8.368	0.0255	0.02	0.27	25.05	12.9	33.85	20.85	2.9	30.7	38.6	279.2	0.955	27
101888	D8H003Q01	95% Percentile	8.569	0.4788	0.0627	0.36	40.28	18.3	77.34	39.1	5.509	37.55	52.55	374.8	1.361	101.8
101893	D8H008Q01	Number of Elements	254	254	254	254	254	254	254	254	254	254	254	254	250	
101893	D8H008Q01	Median	8.362	0.042	0.023	0.26	23.85	12.49	31.55	19.35	2.649	28.88	36.9	265.3	0.922	
101893	D8H008Q01	95% Percentile	8.54	0.5767	0.0747	0.34	38.78	17.34	67.87	39.34	5.476	36.81	50.5	360.1	1.383	
101900	E1R001Q01	Number of Elements	154	154	154	154	154	154	154	154	154	154	154	154	154	
101900	E1R001Q01	Median	7.09	0.1245	0.02	0.1	14.42	3	8.05	27.71	0.9225	3.2	14	68.26	1.367	
101900	E1R001Q01	95% Percentile	7.44	0.3842	0.0791	0.1304	29.57	5.318	14.92	55.24	1.528	5.542	25.84	120.6	2.217	
101902	E2H002Q01	Number of Elements	56	56	56	56	56	56	56	56	56	56	56	56	55	
101902	E2H002Q01	Median	7.094	0.025	0.02	0.109	8.841	2.25	7.273	16.07	0.827	3.159	9.25	51	0.94	
101902	E2H002Q01	95% Percentile	7.635	0.1753	0.0508	0.1483	22.02	5.082	14.8	43.57	2.705	9.8	23.73	128.1	1.516	
101903	E2H003Q01	Number of Elements	172	172	172	172	172	172	172	172	172	172	172	172	163	
101903	E2H003Q01	Median	7.62	0.034	0.02	0.13	34.13	7.05	20.4	62.85	1.79	10.33	31.95	173.1	2.06	
101903	E2H003Q01	95% Percentile	8.115	0.3632	0.0585	0.24	168.4	19.55	89.8	271.7	5.375	36.11	119.9	723.9	5.83	
101935	G1H031Q01	Number of Elements	221	221	221	221	221	221	221	221	221	221	221	221	217	
101935	G1H031Q01	Median	7.67	0.402	0.026	0.139	33.4	6.7	16.1	57.7	2.5	8.2	30.1	164	2.13	

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
101935	G1H031Q01	95% Percentile	7.95	1.69	0.125	0.24	87.7	14.5	40.4	151.6	5.41	14.2	65.9	381	3.96	
101939	G1H036Q01	Number of Elements	231	231	231	231	231	231	231	231	231	231	231	231	227	
101939	G1H036Q01	Median	7.53	0.942	0.025	0.12	23.3	3.4	12.1	29.3	2.94	7.2	20.5	124.4	1.72	
101939	G1H036Q01	95% Percentile	7.885	2.487	0.119	0.1645	36.95	5.6	17.65	49.45	5.785	10.9	30.95	191	2.467	
101975	G2H015Q01	Number of Elements	220	220	220	220	220	220	220	220	220	220	220	220	212	
101975	G2H015Q01	Median	7.7	2.294	0.0315	0.207	55.7	8.064	20.8	86.87	8.035	16.6	47.65	285.5	2.782	
101975	G2H015Q01	95% Percentile	8.012	5.783	0.4104	0.2801	90.2	10.61	29	126	15.54	22.64	67.42	424.1	4.039	
101998	G4H007Q01	Number of Elements	230	230	230	230	230	230	230	230	230	230	230	230	224	
101998	G4H007Q01	Median	6.83	0.285	0.02	0.09	14.52	2.7	14.63	25.75	0.98	3.6	13.55	77.96	1.422	
101998	G4H007Q01	95% Percentile	7.276	0.7769	0.0804	0.14	23.9	4.855	25.08	45.26	2.617	5.813	21.71	121.1	1.958	
102088	H4H024Q01	Number of Elements	210	210	210	210	210	210	210	210	210	210	210	210	204	
102088	H4H024Q01	Median	7.53	0.223	0.024	0.13	32.04	6.2	19.3	54.22	1.41	7	27.25	151	2.108	
102088	H4H024Q01	95% Percentile	7.83	1.118	0.0657	0.1896	58.21	11.96	38.21	97.11	3.21	12.33	48.87	271.6	3.006	
102099	H5H005Q01	Number of Elements	181	181	181	181	181	181	181	181	181	181	181	181	178	
102099	H5H005Q01	Median	8.07	0.107	0.022	0.26	144	23.6	63	220	3.72	21.1	98.7	596	4.96	
102099	H5H005Q01	95% Percentile	8.55	0.993	0.081	0.46	277.2	49.79	121.5	430	6.27	37.63	198	1134	7.112	
102107	H6H009Q01	Number of Elements	57	57	57	57	57	57	57	57	57	57	57	57	54	
102107	H6H009Q01	Median	7.16	0.136	0.02	0.11	29	4.4	15.8	50.5	1.15	3.7	23.9	127	2.449	
102107	H6H009Q01	95% Percentile	7.59	0.3428	0.0728	0.1552	120.2	14.76	39.34	197.1	2.904	8.52	72.3	448.2	5.326	
102119	H7H006Q01	Number of Elements	55	55	55	55	55	55	55	55	55	55	55	55	53	
102119	H7H006Q01	Median	7.74	0.143	0.02	0.16	78.8	12.7	37.2	128.9	2.61	12.5	58.5	336	3.829	
102119	H7H006Q01	95% Percentile	8.161	0.7368	0.0652	0.3192	189.7	31.57	73.42	287.6	4.353	23.11	125.5	747.7	6.023	

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
102123	H8H001Q01	Number of Elements	64	64	64	64	64	64	64	64	64	64	64	64	62	1
102123	H8H001Q01	Median	7.36	0.179	0.0265	0.1275	59.7	8.435	37.3	98.35	1.55	5.9	42.05	254	3.645	4
102123	H8H001Q01	95% Percentile	7.916	0.4929	0.0766	0.17	145.4	21.69	61.97	236.7	3.269	13.44	93.23	561.4	5.785	4
102130	H9H005Q01	Number of Elements	87	87	87	87	87	87	87	87	87	87	87	87	84	
102130	H9H005Q01	Median	7.47	0.022	0.02	0.15	80.1	11.5	28.5	137.6	1.86	7.8	54.8	311	4.58	
102130	H9H005Q01	95% Percentile	8.394	0.1357	0.0658	0.6996	565.4	51.35	139	796.2	13.25	34.35	329.2	1981	14.09	
102148	J1H019Q01	Number of Elements	88	88	88	88	88	88	88	88	88	88	88	88	87	
102148	J1H019Q01	Median	8.213	0.0205	0.033	0.5355	1002	146.9	566.3	1541	9.785	142.3	610	3916	14.24	
102148	J1H019Q01	95% Percentile	8.474	0.1538	0.0737	0.6665	2212	346.5	1401	3530	34.37	261.9	1217	8461	21.9	
102168	J2H010Q01	Number of Elements	95	95	95	95	95	95	95	95	95	95	95	95	94	
102168	J2H010Q01	Median	8.36	0.029	0.02	0.36	87	22.4	64.6	108.3	5.19	53.4	86.6	599	2.576	
102168	J2H010Q01	95% Percentile	8.592	0.4773	0.0718	0.4291	368.3	52.07	341.8	562.9	10.29	112.4	269.6	1658	7.098	
102173	J2H016Q01	Number of Elements	37	37	37	37	37	37	37	37	37	37	37	37	34	
102173	J2H016Q01	Median	8.37	0.505	0.035	0.29	60.4	9.5	53.7	64	6.03	35.71	57.9	396	2.345	
102173	J2H016Q01	95% Percentile	8.754	0.757	0.1426	0.384	77.56	13.74	68.24	85.22	7.092	44.6	67.9	475.6	2.71	
102179	J2R004Q01	Number of Elements	53	53	53	53	53	53	53	53	53	53	53	53	51	
102179	J2R004Q01	Median	8.19	0.032	0.02	0.23	15.3	10.04	21.93	9.7	1.742	28.2	30.3	226	0.634	
102179	J2R004Q01	95% Percentile	8.81	0.2004	0.236	0.294	19.26	14.14	29.46	15.01	3.2	35.63	37.04	283.3	0.74	
102183	J3H011Q01	Number of Elements	190	190	190	190	190	190	190	190	190	190	190	190	187	
102183	J3H011Q01	Median	8.15	0.024	0.047	0.48	2423	249.2	1841	3612	10.91	422.6	1282	9059	22.88	
102183	J3H011Q01	95% Percentile	8.348	0.1343	0.1147	0.61	3795	353.9	2834	6073	60.26	716.8	1931	1.40E+04	29.83	
102207	K1H005Q01	Number of Elements	70	70	70	70	70	70	70	70	70	70	70	70	68	
102207	K1H005Q01	Median	7.285	0.043	0.02	0.14	43.35	5.7	16.7	72.3	0.9065	5.211	31.45	173.3	3.107	

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
102207	K1H005Q01	95% Percentile	7.712	0.2075	0.1036	0.19	65.71	8.155	34.88	110.9	2.367	7.855	47.96	260.4	4.024	
102243	K2H004Q01	Number of Elements	62	62	62	62	62	62	62	62	62	62	62	62	61	
102243	K2H004Q01	Median	7.985	0.0365	0.0505	0.44	8353	969.6	2057	1.47E+04	298.4	329.4	3575	2.69E+04	52.48	
102243	K2H004Q01	95% Percentile	8.339	0.1536	0.2449	0.5709	1.08E+04	1257	2623	1.90E+04	386.9	417.2	4490	3.45E+04	60.01	
102248	K3H001Q01	Number of Elements	73	73	73	73	73	73	73	73	73	73	73	73	73	
102248	K3H001Q01	Median	5.58	0.054	0.022	0.09	20.4	3.1	16.37	38.2	0.84	2.476	16.8	96	2.041	
102248	K3H001Q01	95% Percentile	7.374	0.2008	0.0826	0.144	38.3	6.6	36.46	67.68	2.984	10.26	32	183.8	2.736	
102250	K3H003Q01	Number of Elements	66	66	66	66	66	66	66	66	66	66	66	66	64	
102250	K3H003Q01	Median	6.74	0.109	0.027	0.12	66.6	7.691	29.31	129.2	1.56	7.55	47.45	274.5	4.05	
102250	K3H003Q01	95% Percentile	7.72	0.3505	0.1288	0.18	203.1	23.98	63.7	375.6	3.808	23.25	142.5	684.3	7.272	
102283	K4R002Q01	Number of Elements	67	67	67	67	67	67	67	67	67	67	67	67	67	
102283	K4R002Q01	Median	7.79	0.024	0.042	0.24	2633	286.5	583.5	4674	91.42	134.2	1340	8522	28.76	
102283	K4R002Q01	95% Percentile	8.205	0.1205	0.1547	0.28	3685	423.9	903.2	6715	144.8	175.2	1856	1.21E+04	34.99	
102312	K7H001Q01	Number of Elements	152	152	152	152	152	152	152	152	152	152	152	152	145	14
102312	K7H001Q01	Median	4.73	0.031	0.0255	0.07	9.6	1.8	14.95	16.4	0.41	1.7	9	53.86	1.24	3
102312	K7H001Q01	95% Percentile	6.164	0.07245	0.0585	0.1345	13.09	2.367	29.72	22.39	1.556	3.145	11.54	71.9	1.624	17.9
102313	K8H001Q01	Number of Elements	31	31	31	31	31	31	31	31	31	31	31	31	29	17
102313	K8H001Q01	Median	4.81	0.029	0.02	0.1	8.4	1.7	13.9	14.1	0.79	1.8	7.7	52	1.08	3
102313	K8H001Q01	95% Percentile	6.57	0.0885	0.0615	0.145	16.55	3.1	39.85	24.15	2.58	3.55	12	80.5	1.798	23.2
102314	K8H002Q01	Number of Elements	35	35	35	35	35	35	35	35	35	35	35	35	33	16
102314	K8H002Q01	Median	5.07	0.03	0.011	0.09	11.2	2	10.8	19.3	0.64	1.5	10	54	1.39	3.5
102314	K8H002Q01	95% Percentile	6.563	0.0842	0.0462	0.123	17.37	2.9	19.21	28.73	2.462	2.59	14.33	75.4	1.958	7.25

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
102329	L3R001Q01	Number of Elements	71	71	71	71	71	71	71	71	71	71	71	71	71	
102329	L3R001Q01	Median	8.23	0.071	0.035	0.26	109	17.2	91.7	149	8.731	39	91	574	3.55	
102329	L3R001Q01	95% Percentile	8.78	0.5985	0.35	0.465	505.5	76.05	461.6	801.1	13.16	134.6	356	2128	8.52	
102349	L6H001Q01	Number of Elements	34	34	34	34	34	34	34	34	34	34	34	34	34	26
102349	L6H001Q01	Median	8.385	0.035	0.0315	0.425	611.9	118.2	527.4	939.8	15.04	123.7	422.5	2728	9.876	1.015
102349	L6H001Q01	95% Percentile	8.849	0.7242	0.1007	0.527	1227	257	1182	2043	24.24	234.1	776.1	5216	13.37	51.75
102353	L7H006Q01	Number of Elements	158	158	158	158	158	158	158	158	158	158	158	158	152	29
102353	L7H006Q01	Median	8.005	0.02	0.02	0.194	112.2	19.75	68.39	177.9	3.435	26.28	85.85	492.1	4.135	4
102353	L7H006Q01	95% Percentile	8.315	0.1351	0.0682	0.3412	974.1	189.1	631.8	1670	12.2	149.3	614.9	3805	12.32	210.6
102358	L8H005Q01	Number of Elements	88	88	88	88	88	88	88	88	88	88	88	88	83	18
102358	L8H005Q01	Median	7.33	0.034	0.02	0.11	18.85	3.2	8.5	31.46	0.95	3.9	16.15	86.39	1.663	6
102358	L8H005Q01	95% Percentile	7.632	0.2714	0.0592	0.183	24.82	4.365	16.13	39.86	2.467	5.525	19.6	113	2.097	55.55
102386	N1H013Q01	Number of Elements	61	61	61	61	61	61	61	61	61	61	61	61	60	
102386	N1H013Q01	Median	8.069	0.086	0.094	0.703	775.4	134.3	634.1	909.2	4.989	171.6	485	3490	10.73	
102386	N1H013Q01	95% Percentile	8.232	0.333	0.178	0.786	819	149.5	693.9	973.5	16.58	187.3	519	3646	12.25	
102392	N2H007Q01	Number of Elements	64	64	64	64	64	64	64	64	64	64	64	64	64	18
102392	N2H007Q01	Median	8.314	0.035	0.0255	0.3515	369.7	70.22	258.7	659.1	9.047	108.8	291	1678	6.28	1
102392	N2H007Q01	95% Percentile	8.686	0.588	0.185	0.517	692.9	153.6	544.1	1357	14.32	230	495.9	3223	9.248	147.1
102422	N3H002Q01	Number of Elements	78	78	78	78	78	78	78	78	78	78	78	78	72	19
102422	N3H002Q01	Median	8.31	0.0445	0.0295	0.52	181.1	39.2	86.15	289.5	5.83	70.75	155.3	983	4.15	15
102422	N3H002Q01	95% Percentile	8.583	1.019	0.1201	0.7215	279.5	65.59	142.1	545.5	8.586	117.7	245.8	1467	5.203	1201
102425	N4H003Q01	Number of Elements	77	77	77	77	77	77	77	77	77	77	77	77	72	21
102425	N4H003Q01	Median	8.39	1.004	0.041	0.77	747.2	89.1	368.1	872.9	7.31	71.2	416	2844	13.66	9

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
102425	N4H003Q01	95% Percentile	8.61	2.332	0.32	1.02	3113	349.8	1369	4713	19.36	186.4	1522	1.05E+04	31.77	52
102430	P1H003Q01	Number of Elements	116	116	116	116	116	116	116	116	116	116	116	116	110	20
102430	P1H003Q01	Median	8.529	0.0475	0.0255	0.781	664.6	108.3	216.6	1018	5.99	55.47	396.5	2580	11.29	5
102430	P1H003Q01	95% Percentile	8.758	0.776	0.1125	0.952	906.6	159	333.7	1396	14.21	76.66	529.8	3487	14.88	20.35
102435	P3H001Q01	Number of Elements	105	105	105	105	105	105	105	105	105	105	105	105	102	14
102435	P3H001Q01	Median	8.146	0.045	0.033	0.23	790.8	141.9	126.7	1649	9.01	149.7	559	3260	11.14	5
102435	P3H001Q01	95% Percentile	8.418	0.3968	0.2064	0.2948	1099	195.6	192.1	2291	24.99	206.1	724.8	4298	13.71	15.9
102438	P4H001Q01	Number of Elements	83	83	83	83	83	83	83	83	83	83	83	83	83	3
102438	P4H001Q01	Median	8.36	0.035	0.02	0.29	474.9	80.6	103.9	867.6	7.22	69	328	1896	9	3
102438	P4H001Q01	95% Percentile	8.623	1.565	0.1219	0.3594	780	142.3	173.3	1553	12.63	109.7	522.5	3042	11.8	15.6
102440	Q1H012Q01	Number of Elements	140	140	140	140	140	140	140	140	140	140	140	140	133	21
102440	Q1H012Q01	Median	8.185	0.5055	0.034	0.188	9.175	7.041	13.7	6	1.257	18.2	20.15	153	0.47	114
102440	Q1H012Q01	95% Percentile	8.411	0.7852	0.1131	0.331	37.03	14.7	35.36	29.57	2.739	23.8	51.47	290.5	1.631	389
102443	Q1H017Q01	Number of Elements	129	129	129	129	129	129	129	129	129	129	129	129	125	
102443	Q1H017Q01	Median	8.28	0.473	0.034	0.22	18	8.9	18.2	10.3	1.438	20.71	27	202	0.854	
102443	Q1H017Q01	95% Percentile	8.561	1.563	0.1182	0.699	130.7	26.6	38.8	38.18	2.738	39.77	84.54	732.5	4.031	
102445	Q1H022Q01	Number of Elements	114	114	114	114	114	114	114	114	114	114	114	114	112	
102445	Q1H022Q01	Median	8.27	0.428	0.036	0.201	13.25	8.15	16.05	8	1.35	19.9	23.7	178	0.635	
102445	Q1H022Q01	95% Percentile	8.461	0.7354	0.0994	0.2992	25.18	12.14	25.87	16.59	2.675	23.02	32	243.7	1.103	
102448	Q2H002Q01	Number of Elements	193	193	193	193	193	193	193	193	193	193	193	193	188	41
102448	Q2H002Q01	Median	8.516	1.601	0.05	0.9	178.9	30.99	39.11	29	1.78	40.1	106.9	968.5	5.101	3.22
102448	Q2H002Q01	95% Percentile	8.7	2.917	0.1468	1.051	197	35.84	50.04	39.19	3.347	48.06	115.2	1040	5.716	42.1

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
102455	Q4H013Q01	Number of Elements	143	143	143	143	143	143	143	143	143	143	143	143	141	
102455	Q4H013Q01	Median	8.45	3.112	0.042	1.79	498.6	65.3	335.1	362.8	3.031	58	284	2112	10.57	
102455	Q4H013Q01	95% Percentile	8.637	3.839	0.1077	2.019	561.7	76.7	383.5	409.9	9.36	65.92	310.9	2298	11.88	
102457	Q4R002Q01	Number of Elements	62	62	62	62	62	62	62	62	62	62	62	62	57	
102457	Q4R002Q01	Median	8.389	0.1135	0.0435	0.3675	27.2	11.8	17.25	16.66	4.464	26.68	36.45	283.4	1.15	
102457	Q4R002Q01	95% Percentile	8.72	0.5977	0.1766	0.5475	67.61	24.55	30.76	47.39	6.202	34.9	66.58	514.5	2.134	
102463	Q6H003Q01	Number of Elements	239	239	239	239	239	239	239	239	239	239	239	239	235	22
102463	Q6H003Q01	Median	8.52	0.045	0.023	0.46	120.7	31.9	26.5	103.1	3.12	46.7	97	745.4	2.972	9.5
102463	Q6H003Q01	95% Percentile	8.873	0.4692	0.0952	0.6	166.4	43.12	40.45	154.2	4.276	71.4	123.7	962.9	4.54	163.6
102464	Q7H003Q01	Number of Elements	131	131	131	131	131	131	131	131	131	131	131	131	130	
102464	Q7H003Q01	Median	8.527	1.167	0.023	0.654	162.2	30.2	103	118.9	2.28	37.87	108.2	815	4.787	
102464	Q7H003Q01	95% Percentile	8.769	1.904	0.1	1.123	289.7	48.81	172.5	246.3	3.85	58.8	190.5	1334	7.136	
102475	Q8H011Q01	Number of Elements	143	143	143	143	142	143	143	143	143	143	143	143	138	
102475	Q8H011Q01	Median	8.523	0.668	0.037	0.852	246	34.5	138	227.3	3.856	43.8	162	1090	6.649	
102475	Q8H011Q01	95% Percentile	8.74	1.082	0.1853	1.497	562.5	58.41	278.4	607.7	12.47	70.19	323.5	2127	12.54	
102478	Q9H001Q01	Number of Elements	136	136	136	136	136	136	136	136	136	136	136	136	134	
102478	Q9H001Q01	Median	8.68	0.569	0.0265	0.817	285.5	41.98	163.9	250.4	3.788	36.82	179.5	1246	7.395	
102478	Q9H001Q01	95% Percentile	8.923	1.614	0.1945	1.136	419.9	57.3	234.7	405.6	6.16	55.75	240	1632	10.3	
102479	Q9H002Q01	Number of Elements	101	101	101	101	101	101	101	101	101	101	101	101	96	19
102479	Q9H002Q01	Median	8.3	0.035	0.021	0.327	57.2	19.8	16.9	47.96	2.333	36.8	59.3	454.2	1.79	6
102479	Q9H002Q01	95% Percentile	8.56	0.2	0.1	0.55	118.8	37	33	117.5	3.56	59.1	100.9	807	3.012	237.1
102487	Q9H018Q01	Number of Elements	149	149	149	149	149	149	149	149	149	149	149	149	144	26
102487	Q9H018Q01	Median	8.68	0.307	0.027	0.763	250.3	38.1	142.6	249.7	3.72	35.5	166	1112	6.83	64

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
102487	Q9H018Q01	95% Percentile	8.882	1.321	0.1818	1.05	426.8	58.28	235.3	397.9	5.26	50.98	242.8	1686	9.948	282
102496	Q9H029Q01	Number of Elements	96	96	96	96	96	96	96	96	96	96	96	96	95	10
102496	Q9H029Q01	Median	8.15	0.6155	0.0425	0.26	37.26	10.35	18.5	37.9	2.043	20.48	37.75	260.5	1.63	33
102496	Q9H029Q01	95% Percentile	8.444	1.563	0.2243	0.5175	84.53	24.15	36.93	117.7	3.403	41.06	79.95	552.7	2.728	152.8
102504	R1H015Q01	Number of Elements	84	84	84	84	84	84	84	84	84	84	84	84	82	20
102504	R1H015Q01	Median	8.173	0.217	0.028	0.23	35.94	9.6	15	45.87	2.15	17.1	36.65	236	1.744	54
102504	R1H015Q01	95% Percentile	8.402	0.7952	0.0899	0.3471	69.53	17.79	26.37	102.8	3.252	29.76	64.12	416.8	2.435	526.8
102525	R2R003Q01	Number of Elements	75	75	75	75	75	75	75	75	75	75	75	75	75	
102525	R2R003Q01	Median	8.13	0.669	0.032	0.2	53	10.1	21.4	68.5	3.36	15	42.8	276	2.57	
102525	R2R003Q01	95% Percentile	8.406	1.69	0.1186	0.289	59.32	11	26.19	73.93	4.239	17.4	46.33	303.3	2.788	
102526	R3H001Q01	Number of Elements	39	39	39	39	39	39	39	39	39	39	39	39	39	23
102526	R3H001Q01	Median	8.1	0.141	0.025	0.2	43.9	10.17	16.35	55.5	2.639	16.6	38.7	267	2.092	24
102526	R3H001Q01	95% Percentile	8.292	0.4605	0.1056	0.251	82.09	18.06	50.21	113.3	3.759	28.7	67.39	456.1	2.779	72.7
102527	R3H003Q01	Number of Elements	28	28	28	28	28	28	28	28	28	28	28	28	28	14
102527	R3H003Q01	Median	8.026	0.3345	0.021	0.22	45.75	8.286	19.15	59.2	2.697	13.03	37.35	241.6	2.398	58
102527	R3H003Q01	95% Percentile	8.262	0.557	0.1105	0.24	55.67	10.87	30.18	74.42	3.79	17.18	46.52	291.2	2.627	107.8
102528	R3H004Q01	Number of Elements	53	53	53	53	53	53	53	53	53	53	53	53	52	
102528	R3H004Q01	Median	8.04	0.499	0.032	0.23	43.3	7.9	15.5	55.2	3.21	12.3	35.9	233	2.365	
102528	R3H004Q01	95% Percentile	8.21	0.6314	0.092	0.2752	50.62	9.14	34.15	62.82	4.02	15.34	41.9	255.6	2.6	
102534	S1R001Q01	Number of Elements	17	17	17	17	17	17	17	17	17	17	17	17	16	
102534	S1R001Q01	Median	8.4	0.146	0.035	0.48	19.1	13	8.3	11.4	1.52	24.2	32.6	247	0.785	
102534	S1R001Q01	95% Percentile	8.644	0.3172	0.061	0.5552	27.42	14.04	16.7	22.21	1.915	25.52	37.1	279.6	1.198	

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
102545	S3H006Q01	Number of Elements	61	61	61	61	61	61	61	61	61	61	61	61	61	
102545	S3H006Q01	Median	8.46	0.068	0.02	0.348	31.7	19	19.89	22.53	3.02	29.2	44.5	348	1.18	
102545	S3H006Q01	95% Percentile	8.69	0.7	0.271	0.57	69.08	50.36	47.3	61.57	4.768	51.48	83	643.5	1.705	
102553	S5H002Q01	Number of Elements	57	57	57	57	57	57	57	57	57	57	57	57	54	
102553	S5H002Q01	Median	8.21	0.386	0.033	0.17	17.3	8.3	9	15.3	1.11	15.4	24.3	172	0.96	
102553	S5H002Q01	95% Percentile	8.468	0.6794	0.1078	0.24	28.65	12.33	16.96	25.76	1.714	21.77	35.24	253.1	1.248	
102565	S7H001Q01	Number of Elements	48	48	48	48	48	48	48	48	48	48	48	48	48	
102565	S7H001Q01	Median	8.349	0.9295	0.0265	0.25	63.67	19.5	19.63	75.55	1.849	32.22	62.15	439	2.26	
102565	S7H001Q01	95% Percentile	8.73	5.632	0.1101	0.2865	107.3	35.61	27.88	135.2	3.377	49.65	95.76	691.7	2.914	
102568	S7H004Q01	Number of Elements	64	64	64	64	64	64	64	64	64	64	64	64	62	12
102568	S7H004Q01	Median	8.385	0.14	0.0205	0.28	34.79	13.91	12.51	35.73	1.959	23.25	40.05	289.1	1.382	28
102568	S7H004Q01	95% Percentile	8.739	0.4932	0.09	0.437	82.33	31.53	21.35	87.22	2.917	30.59	75.3	541.7	2.492	225.5
102573	T1H004Q01	Number of Elements	35	35	35	35	35	35	35	35	35	35	35	35	34	
102573	T1H004Q01	Median	8.08	0.262	0.038	0.154	11.1	5.7	8.825	11	1.13	10.2	16.5	121	0.77	
102573	T1H004Q01	95% Percentile	8.366	0.4831	0.0788	0.2729	21.2	9.766	14.62	22.66	1.442	16.2	27.29	190.2	1.071	
102586	T3H004Q01	Number of Elements	63	63	63	63	63	63	63	63	63	63	63	63	62	
102586	T3H004Q01	Median	8.078	0.099	0.026	0.135	7.7	5.3	5.8	5.3	1.32	9.904	14.1	108	0.4785	
102586	T3H004Q01	95% Percentile	8.289	0.1913	0.0883	0.189	12.22	9.28	11.59	8.87	3.193	18.16	22.7	176	0.6095	
102587	T3H005Q01	Number of Elements	49	49	49	49	49	49	49	49	49	49	49	49	48	
102587	T3H005Q01	Median	7.99	0.344	0.027	0.14	6.6	4.4	5.2	5	0.89	9.861	12.14	98.79	0.46	
102587	T3H005Q01	95% Percentile	8.35	0.5236	0.0752	0.1812	9.4	7.36	12.34	6.26	1.786	15.21	18.5	142.7	0.5565	
102588	T3H006Q01	Number of Elements	50	50	50	50	50	50	50	50	50	50	50	50	47	
102588	T3H006Q01	Median	7.906	0.2005	0.0205	0.13	8.005	3.925	5.85	5.15	0.9955	8.15	11.55	90.11	0.578	

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
102588	T3H006Q01	95% Percentile	8.368	0.4539	0.1043	0.1822	14.28	9.621	10.65	12.76	1.59	18.67	26.37	189.8	0.7922	
102590	T3H008Q01	Number of Elements	66	66	66	66	66	66	66	66	66	66	66	66	63	1
102590	T3H008Q01	Median	7.984	0.055	0.0215	0.148	7.7	5.1	6.408	5	1.473	10.7	14.55	115.5	0.5	62.3
102590	T3H008Q01	95% Percentile	8.315	0.1953	0.123	0.1995	12.87	9.915	15.5	7.25	3.458	20.57	25.58	198.7	0.749	62.3
102606	T5H007Q01	Number of Elements	41	41	41	41	41	41	41	41	41	41	41	41	39	
102606	T5H007Q01	Median	7.92	0.216	0.024	0.136	7.002	3.502	6.607	5	0.75	6.896	10.65	84	0.52	
102606	T5H007Q01	95% Percentile	8.23	0.393	0.066	0.18	15.1	6.1	11.2	9.2	1.469	11	18.7	135	0.9713	
102615	T7H001Q01	Number of Elements	43	43	43	43	43	43	43	43	43	43	43	43	42	
102615	T7H001Q01	Median	8.236	0.412	0.027	0.16	22.9	9.7	7.2	22.9	1.072	13.6	25.4	187.5	1.2	
102615	T7H001Q01	95% Percentile	8.575	0.8895	0.0789	0.2189	31.31	13.88	29.8	35.01	1.891	19.74	35.97	250.5	1.359	
102620	U1H006Q01	Number of Elements	58	58	58	58	58	58	58	58	58	58	58	58	57	
102620	U1H006Q01	Median	7.935	0.1705	0.027	0.15	12.49	4.25	9.65	10.95	0.817	9	15.2	103.2	0.86	
102620	U1H006Q01	95% Percentile	8.255	0.4284	0.0762	0.2109	28.5	8.16	20.52	31.27	1.546	16.55	31	197.3	1.442	
102679	U4H008Q01	Number of Elements	208	208	208	208	208	208	208	208	208	208	208	208	203	
102679	U4H008Q01	Median	7.995	0.4905	0.022	0.2	25.1	6.3	10.6	26.2	1.89	9.6	23.6	154	1.57	
102679	U4H008Q01	95% Percentile	8.31	0.8893	0.0677	0.2979	44.8	9.61	19.33	49.4	3.196	14.23	39.7	250.7	2.35	
102693	U8H003Q01	Number of Elements	64	64	64	64	64	64	64	64	64	64	64	64	64	2
102693	U8H003Q01	Median	8.365	0.546	0.0225	0.459	77.03	14.55	22.17	92.72	2.123	20.34	58.55	389.7	3.165	20.5
102693	U8H003Q01	95% Percentile	8.666	1.085	0.0936	0.58	110.8	19.52	32.19	157.3	3.381	27.11	85	534.2	4.049	20.95
102695	V1H001Q01	Number of Elements	90	90	90	90	90	90	90	90	90	90	90	90	88	
102695	V1H001Q01	Median	7.96	0.2345	0.034	0.13	5.6	3.7	8.05	4.35	1.031	8.969	10.5	87.5	0.39	
102695	V1H001Q01	95% Percentile	8.253	0.4119	0.0727	0.1855	9.71	6.965	14.02	6.155	1.724	15.21	18.87	144.9	0.5795	

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
102704	V1H010Q01	Number of Elements	63	63	63	63	63	63	63	63	63	63	63	63	61	
102704	V1H010Q01	Median	7.82	0.214	0.055	0.121	4.269	3	5.348	4.9	0.79	8.7	9.43	80	0.31	
102704	V1H010Q01	95% Percentile	8.199	0.5148	0.1657	0.1696	6.67	5.3	11.25	5.38	2.453	13.77	15.59	119	0.465	
102718	V1H038Q01	Number of Elements	78	78	78	78	78	78	78	78	78	78	78	78	78	2
102718	V1H038Q01	Median	8.137	0.0735	0.02	0.19	7.714	5.71	9.942	5	1.48	13.38	16.15	131	0.4535	152.8
102718	V1H038Q01	95% Percentile	8.499	0.2926	0.0813	0.2645	14.19	12.93	18.55	7.115	2.875	26.87	30.02	234	0.649	289.8
102740	V2H008Q01	Number of Elements	68	68	68	68	68	68	68	68	68	68	68	68	66	
102740	V2H008Q01	Median	8.03	0.1845	0.0205	0.16	9.8	6.591	8.7	6.95	1.325	11.38	17.15	131.5	0.58	
102740	V2H008Q01	95% Percentile	8.636	0.4199	0.0656	0.3734	34.49	21.1	16.38	20.16	2.623	29.74	46.06	355.7	1.212	
102755	V3H010Q01	Number of Elements	205	205	205	205	205	205	205	205	205	205	205	205	197	
102755	V3H010Q01	Median	8.17	0.855	0.024	0.19	19.6	11.2	43.5	9.4	3.12	20.9	30.4	218	0.9	
102755	V3H010Q01	95% Percentile	8.908	3.11	0.0868	0.3	54.3	19.2	114.3	29.4	5.744	35.38	59.2	409.5	1.902	
102779	V5H002Q01	Number of Elements	85	85	85	85	85	85	85	85	85	85	85	85	82	2
102779	V5H002Q01	Median	8.17	0.11	0.021	0.21	15.3	7.8	16	9.5	1.81	17.8	24	172	0.7675	12.75
102779	V5H002Q01	95% Percentile	8.54	0.484	0.0954	0.332	35.13	15.7	31.01	25.53	2.928	25.4	40.54	293.4	1.4	13.79
102781	V6H002Q01	Number of Elements	78	78	78	78	78	78	78	78	78	78	78	78	75	
102781	V6H002Q01	Median	8.155	0.314	0.0215	0.22	18.55	7.85	15.75	9.75	1.511	17.3	25.4	188	0.91	
102781	V6H002Q01	95% Percentile	8.512	0.7806	0.0806	0.292	40.41	15.82	29.38	25.16	2.954	25.73	41.85	316.2	1.583	
102797	V7H012Q01	Number of Elements	62	62	62	62	62	62	62	62	62	62	62	62	62	
102797	V7H012Q01	Median	7.882	0.5055	0.039	0.15	9.65	5.496	11.6	5.8	1.685	12.8	17.05	130.5	0.5505	
102797	V7H012Q01	95% Percentile	8.209	1.227	0.225	0.19	17.69	8.731	20.05	12.58	3.016	20.24	26.1	205.3	0.9672	
102832	W1R004Q01	Number of Elements	68	68	68	68	68	68	68	68	68	68	68	68	66	
102832	W1R004Q01	Median	7.795	0.038	0.031	0.282	48.65	10.1	39.3	82.55	2.205	24.75	47.85	277.5	2.08	

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
102832	W1R004Q01	95% Percentile	8.116	0.1203	0.0896	0.3486	59.17	13.55	71.18	99.02	3.58	31.89	57.92	348	2.278	
102834	W2H005Q01	Number of Elements	186	186	186	186	186	186	186	186	186	186	186	186	183	
102834	W2H005Q01	Median	8.371	0.109	0.025	0.31	24.9	13.9	21.65	14.8	1.59	20	32.6	246	1.03	
102834	W2H005Q01	95% Percentile	8.578	0.291	0.0665	0.41	36.2	20.8	39.78	24.19	2.758	27.6	45.58	342.5	1.32	
102871	W3H015Q01	Number of Elements	156	156	156	156	156	156	156	156	156	156	156	156	151	
102871	W3H015Q01	Median	8.218	0.1215	0.031	0.33	198.3	40.45	31.05	297.5	3.274	52.3	146	959	4.96	
102871	W3H015Q01	95% Percentile	8.633	0.6245	0.068	0.4	303.9	54.32	46.05	484.4	4.342	67.95	219	1342	6.338	
102897	W4H004Q01	Number of Elements	60	60	60	60	60	60	60	60	60	60	60	60	60	
102897	W4H004Q01	Median	7.76	0.2815	0.0235	0.113	4.65	3.557	8.331	5	0.844	6.5	9.55	71.2	0.365	
102897	W4H004Q01	95% Percentile	8.056	0.5648	0.0811	0.1751	7.027	5.215	13.42	5.305	2.02	9.943	13.71	99.82	0.493	
102898	W4H006Q01	Number of Elements	55	55	55	55	55	55	55	55	55	55	55	55	54	1
102898	W4H006Q01	Median	8.403	0.702	0.023	0.296	55.9	20.28	19.7	41.6	1.25	22	51.7	371.1	2.1	52
102898	W4H006Q01	95% Percentile	8.795	1.213	0.142	0.6709	163.8	42.71	38.02	95.46	2.49	31.5	110.7	903.9	4.54	52
102901	W4H009Q01	Number of Elements	30	30	30	30	30	30	30	30	30	30	30	30	30	
102901	W4H009Q01	Median	8.151	0.2445	0.0405	0.26	46.7	14.7	19.75	57.75	2.055	23.55	44.2	305.5	1.955	
102901	W4H009Q01	95% Percentile	8.336	0.5787	0.0868	0.3283	68.29	19.45	25.23	100.9	3.181	29.39	65.18	418.7	2.413	
102914	W5H022Q01	Number of Elements	99	99	99	99	99	99	99	99	99	99	99	99	94	20
102914	W5H022Q01	Median	7.88	0.184	0.026	0.13	6.739	4.6	9.4	5	1.59	9.1	12.7	94	0.4885	4
102914	W5H022Q01	95% Percentile	8.13	0.45	0.1272	0.1702	13.02	6.21	14.34	9.63	3.295	11.71	18.19	135	0.8	25.15
102933	X1H003Q01	Number of Elements	237	237	237	237	237	237	237	237	237	237	237	237	232	
102933	X1H003Q01	Median	8.09	0.175	0.023	0.18	16.3	8.206	8.4	15.6	1.183	9.8	20.7	144.9	0.9455	
102933	X1H003Q01	95% Percentile	8.452	0.5504	0.0714	0.28	66.42	20.22	16.62	81.16	2.952	21.98	56.8	373.5	2.612	

WMS No.	Feature Name	Type of Statistics	pH	NO_3+NO_2-N	NH_4-N	F	Na	Mg	SO_4	Cl	K	Ca	EC	DMS	SAR	TURB (NTU)
102935	X1H014Q01	Number of Elements	90	90	90	90	90	90	90	90	90	90	90	90	89	
102935	X1H014Q01	Median	7.803	0.324	0.0405	0.122	7.016	4.6	6.233	6.4	0.9785	6.764	11.44	82.72	0.52	
102935	X1H014Q01	95% Percentile	8.115	1.025	0.0766	0.1711	15.16	10.36	12.36	21.54	2.053	13.71	24.32	168	0.788	
102958	X2H013Q01	Number of Elements	106	106	106	106	106	106	106	106	106	106	106	106	105	72
102958	X2H013Q01	Median	7.972	0.0915	0.0205	0.1325	3.9	6.876	5	5	0.773	8.652	12.27	98	0.24	1
102958	X2H013Q01	95% Percentile	8.252	0.1965	0.0665	0.1875	4.851	8.4	8.5	5.6	1.515	10.55	14.68	117	0.3124	13.85
102963	X2H016Q01	Number of Elements	319	319	319	319	319	319	319	319	319	319	319	319	308	101
102963	X2H016Q01	Median	8.209	0.52	0.02	0.23	28.29	17.8	25.1	22.7	1.406	20.5	37.8	279	1.09	2.2
102963	X2H016Q01	95% Percentile	8.53	0.9227	0.0811	0.34	52.96	29.01	36.82	43.81	2.887	31.46	60.44	453.4	1.63	22
102965	X2H022Q01	Number of Elements	103	103	103	103	103	103	102	103	103	103	103	103	101	1
102965	X2H022Q01	Median	8.32	0.541	0.02	0.24	26.66	25.76	40.59	16.5	1.13	25.3	44.8	338.4	0.87	4
102965	X2H022Q01	95% Percentile	8.587	1.008	0.0842	0.4616	70.5	49.25	77.74	35.99	3.127	39.02	77.61	646	1.84	4
102975	X2H032Q01	Number of Elements	205	205	205	205	205	205	205	205	205	205	205	205	198	71
102975	X2H032Q01	Median	7.86	0.489	0.028	0.15	8.665	7.875	14.09	11	1.102	12.82	18.7	132	0.481	2
102975	X2H032Q01	95% Percentile	8.145	1.092	0.0938	0.2196	12.48	10.5	25.61	18.31	2.728	17.94	24.68	166.8	0.6016	32
103014	X3H008Q01	Number of Elements	49	49	49	49	49	49	49	49	49	49	49	49	49	34
103014	X3H008Q01	Median	7.65	0.04	0.02	0.16	15	3.272	6.635	11.81	1.12	6.6	14.5	104.4	1.2	2
103014	X3H008Q01	95% Percentile	8.047	0.2232	0.0654	0.22	20.8	4.7	13.48	17.67	2.66	9.395	20.26	137.2	1.522	16.8

8.2 Appendix B: Land cover types and extent of areal cover across South Africa per WMA (after Fairbanks *et al.,* 2000)

WMA	Total surface area (km^2)	1st Largest Areal Cover Type Extent (and %)	2nd Largest Areal Cover Type Extent (and %)	3rd Largest Areal Cover Type Extent (and %)	4th Largest Areal Cover Type Extent (and %)
Limpopo	60 390	Thicket; Bushland; Bush clumps; High Fynbos 31 274 (52 %)	Forest and Woodland (Woodland and Wooded Grassland) 15 005 (25 %)	Degraded land (Thicket; Bushland; Bush clumps; High Fynbos) 4 428 (7 %)	Cultivated land (temp crops commercial dryland) 2 980 (5 %)
Luvuvhu and Letaba	25 014	Forest and Woodland (Woodland and Wooded Grassland) 11 426 (46 %)	Thicket; Bushland; Bush clumps; High Fynbos 6 609 (26 %)	Cultivated land (temp crops commercial dryland) 3 457 (14 %)	Forest Plantations (Exotic) 778 (3 %)
Crocodile (West) and Marico	47 517	Thicket; Bushland; Bush clumps; High Fynbos 18 819 (40 %)	Forest and Woodland (Woodland and Wooded Grassland) 10 791 (23 %)	Unimproved Grassland 4 308 (9 %)	Cultivated land (temp crops commercial dryland) 3 499 (7 %)
Olifants	54 504	Forest and Woodland (Woodland and Wooded Grassland) 14 186 (26 %)	Unimproved Grassland 12 109 (22 %)	Thicket; Bushland; Bush clumps; High Fynbos 8 998 (17 %)	Cultivated land (temp crops commercial dryland) 8121 (15 %)
Inkomati	28 670	Forest and Woodland (Woodland and Wooded Grassland) 9 233 (32 %)	Unimproved Grassland 6 440 (22 %)	Thicket; Bushland; Bush clumps; High Fynbos 4 783 (17 %)	Forest Plantations (Exotic) 3 776 (13 %)
Usutu to Mhlatuze	45 055	Unimproved Grassland 15 804 (35 %)	Thicket; Bushland; Bush clumps; High Fynbos 6 164 (14 %)	Forest and Woodland (Woodland and Wooded Grassland) 5 865 (13 %)	Forest Plantations (Exotic) 5 001 (11 %)
Thukela	29 035	Unimproved Grassland 15 405 (53 %)	Thicket; Bushland; Bush clumps; High Fynbos 5 698 (20 %)	Cultivated land (temporary subsistence dryland) 2 064 (7 %)	Degraded land (Unimproved Grassland) 1 365 (5 %)
Upper Vaal	55 463	Unimproved Grassland 33 231	Cultivated land (temp crops commercial dryland) 17 650	Urban/ Built up land 1 086	Thicket; Bushland; Bush clumps; High Fynbos 651

WMA	Total surface area (km^2)	1st Largest Areal Cover Type Extent (and %)	2nd Largest Areal Cover Type Extent (and %)	3rd Largest Areal Cover Type Extent (and %)	4th Largest Areal Cover Type Extent (and %)
		(60 %)	(32 %)	(2 %)	(1 %)
Middle Vaal	52 549	Unimproved Grassland 26 043 (50 %)	Cultivated land (temp crops commercial dryland) 22 212 (42 %)	Thicket; Bushland; Bush clumps; High Fynbos 2 139 (4 %)	Wetlands 435 (1 %)
Lower Vaal	134 543	Thicket; Bushland; Bush clumps; High Fynbos 71 387 (53 %)	Unimproved Grassland 25 700 (19 %)	Degraded land (Thicket; Bushland; Bush clumps; High Fynbos) 11 433 (8 %)	Cultivated land (temp crops commercial dryland) 10 359 (8 %)
Mvoti to Umzimkulu	27 221	Unimproved Grassland 8 815 (32 %)	Thicket; Bushland; Bush clumps; High Fynbos 4 649 (17 %)	Forest Plantations (Exotic) 3 425 (13 %)	Cultivated land (permanent commercial sugar cane) 2 902 (11 %)
Mzimvubu to Keiskamma	66 182	Unimproved Grassland 29 804 (45 %)	Degraded land (Unimproved Grassland) 11 150 (17 %)	Thicket; Bushland; Bush clumps; High Fynbos 9 585 (14 %)	Cultivated land (temporary subsistence dryland) 8 001 (12 %)
Upper Orange	94 014	Unimproved Grassland 41 990 (45 %)	Shrubland and Low Fynbos 32 037 (34 %)	Cultivated land (temp crops commercial dryland) 8 050 (9 %)	Thicket; Bushland; Bush clumps; High Fynbos 7 331 (8 %)
Lower Orange	260 917	Shrubland and Low Fynbos 208 975 (80 %)	Unimproved Grassland 28 500 (11 %)	Thicket; Bushland; Bush clumps; High Fynbos 12 805 (5 %)	Wetlands 2 695 (1 %)
Fish to Tsitsikamma	96 950	Shrubland and Low Fynbos 61 766 (64 %)	Thicket; Bushland; Bush clumps; High Fynbos 17 156 (18 %)	Unimproved Grassland 8 348 (9 %)	Degraded lands (Shrubland and Low Fynbos) 3 193 (3 %)
Gouritz	52 590	Shrubland and Low Fynbos 44 004 (84 %)	Cultivated land (temp crops commercial dryland) 2 655 (5 %)	Thicket; Bushland; Bush clumps; High Fynbos 2 109 (4 %)	Degraded lands (Shrubland and Low Fynbos) 724 (1 %)
Olifants/Doorn	56 748	Shrubland and Low Fynbos	Cultivated land (temp crops commercial dryland)	Thicket; Bushland; Bush clumps; High Fynbos	Unimproved Grassland

WMA	Total surface area (km^2)	1st Largest Areal Cover Type Extent (and %)	2nd Largest Areal Cover Type Extent (and %)	3rd Largest Areal Cover Type Extent (and %)	4th Largest Areal Cover Type Extent (and %)
		45 735 (81 %)	3499 (6 %)	3 400 (6 %)	1 489 (3 %)
Breede	19 663	Shrubland and Low Fynbos 10 571 (54 %)	Cultivated land (temp crops commercial dryland) 5 565 (28 %)	Cultivated land (permanent crops commercial irrigated) 1 265 (6 %)	Thicket; Bushland; Bush clumps; High Fynbos 695 (1 %)
Berg	13 296	Cultivated land (temp crops commercial dryland) 5 995 (45 %)	Shrubland and Low Fynbos 3 552 (25 %)	Cultivated land (permanent crops commercial irrigated) 1 043 (8 %)	Thicket; Bushland; Bush clumps; High Fynbos 695 (5 %)

8.3 Appendix C: Barcode Graphs for the National Sampling Sites that Exceed the *Very Good* and *Good* (or TWQR) Categories