

# The Diatoms of the Western Cape and their use in Monitoring Wetland Water Quality

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**Psalm 24:1-2:** The earth is the Lord's, and all its fullness, the world, and they that dwell therein. For He hath founded it upon the seas, and established it upon the waters (KJV).

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## **ABSTRACT**

### **The Diatoms of the Western Cape and their use in Monitoring Wetland Water Quality**

South Africa's water resources are limited and, in global terms, scarce. The demand for water is, however, growing continuously due to population growth, a developing economy, global warming, the spreading of alien plant species and the urgent need to supply water services to millions of people. In the past wetlands were perceived as having no value; they were dammed, overgrazed, mined for their soils, polluted with chemicals and litter, or drained for agriculture/housing development. Wetlands have also been converted for other land-use purposes, with more than 50% of the country's wetlands already lost, thus monitoring of wetland water quality is needed in order to make sound management decisions. Wetlands are very important ecosystems; they prevent flooding, they filter and purify surface water, and are important in providing habitats for various animals and plants. Diatoms, which form part of the group of protists known as algae, are good environmental indicators and are one of the key groups of organisms that can reflect ecological status.

Diatoms form an important part of the ecosystem as they, along with other algal groups, are primary producers and form the base of aquatic food webs. Diatoms are also excellent water quality indicators, they respond to climatic and chemical influences and their siliceous frustules preserve well over long periods of time in sediments. For all of these reasons, diatom analysis of wetlands can reveal much about environmental change at various timescales and can also be used to determine historical environmental conditions. Moreover, they can be used to monitor ongoing water quality in a given wetland and act as an early warning signal should human impacts intensify. Although diatoms are used regularly as indicators in rivers both internationally and in South Africa, less is known about diatom communities in wetland systems in South Africa. Several diatom indices have been successfully applied in South African rivers and in addition the same indices in a preliminary study on wetlands in the Western Cape. The study indicated that diatoms can be used for inferring aspects of the water quality of wetlands since changes in physico-chemical quality correlate well with the diatom index scores.

The main aim of the present project was to contribute information about the distribution and environmental preferences of diatoms in wetlands in the Western Cape. During the 1980s wetlands were investigated in the Cape Floristic Region and re-examined in the present study. A part of this study was to determine whether diatoms can be used to monitor the water quality of the wetlands in the Western Cape. A total number of 28 wetlands with different types of

hydrogeographical (HGM) characteristics were investigated during the study. A total of 324 diatom species belonging to 60 genera were found in samples collected for the present study. Species sensitive towards pollution were observed during the study namely; *Eunotia genuflexa*, *Eunotia flexuosa*, *Eunotia* sp., *Rhopalodia gibberula*, *Navicula reichardtiana*, *Achnantheidium crassum*, *Brachysira brebissonii* and *Tabellaria flocculosa*.

Information pertaining to ecological tolerances of the species was obtained using statistical analysis, in particular, Canonical Correspondence Analysis (CCA). Species typically considered to be from Europe were identified in this and responded in a similar way to water quality variables found in Europe, suggesting that they are sub-cosmopolitan.

In particular, significant correlations existed between the Specific Pollution sensitivity Index (SPI) and certain water quality variables, such as dissolved oxygen, electrical conductivity, pH, temperature, orthophosphate and turbidity, but no correlations existed between nitrate, nitrite and ammonium. Despite the once-off sampling regime and the little studied diatom flora of the south-western Cape wetlands, these wetlands could be separated into water quality classes based on an analysis using diatom indices. Bio-assessment using diatoms, therefore represents a potential tool for assessing the ecological condition of wetlands of the south-western Cape of South Africa. The feasibility of using diatoms as a national tool for monitoring wetland water quality needs to be investigated objectively in conjunction with other potential biotic indicators. The SPI showed potential for describing water quality in freshwater wetlands but caution should be used in interpreting results for naturally occurring saline pans. A new indicator system may need to be developed for these systems. While diatom samples from different substrata gave similar results, further investigations are needed into the effect of substratum on the 'ecological condition' or water quality classes identified from diatom analyses. The preliminary data set herein illustrated the potential of the use of these benthic diatoms as bio-indicators in wetlands.

**Key words:** Wetlands; diatoms; species list; water quality; Canonical Correspondence Analysis; Western Cape; substrates; monitoring

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## LIST OF ABBREVIATIONS

BDI	Biological Diatom Index
CCA	Canonical Correspondence Analysis
Chl a	Chlorophyll a
DO	Dissolved oxygen
EC	Electrical Conductivity
GDI	Generic Diatom Index
HGM	Hydrogeomorphological
NEMA	National Environmental Management Act
NFEPAs	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PES	Present Ecological State
PTVs	Pollution-Tolerant Valve
SA	South Africa
SADI	South African Diatom Index
SANBI	South African National biodiversity Institute
SEM	Scanning Electron Microscope
SPI	Specific Pollution sensitivity Index
Temp	Temperature
Turb	Turbidity
WQ	Water quality
WRC	Water Research commission

## CHAPTER 1: INTRODUCTION

When the well is dry, we learn the worth of water."

Benjamin Franklin

### 1.1 General information and background

During the 1980s around 100 wetlands were studied in the Western Cape by Drs King and Silberbauer to determine the wetlands' environmental conditions. Their study focused on the general drainage patterns, disturbances, topography, conservation status, geographical details and the extent of land use. They took fauna, flora, water chemistry parameters and invertebrate samples (not published), but no diatom samples were collected (King & Silberbauer, 1991a; King & Silberbauer, 1991b). The main aim of their study was to classify the wetlands of the Western Cape, using invertebrate species, wetland plants and water chemistry (King & Silberbauer 1991a). In 2012, a new study, funded by the Water Research Commission (WRC) and titled K5/2183: The Trajectories of Change in Wetlands of the Fynbos Biome was initiated and aimed to revisit the same wetlands to determine the pressures to which these wetlands have been exposed over the past 25 years, and it was decided to add diatoms as a new component within the project to determine whether diatoms of the Western Cape can be used in monitoring wetland water quality.

Some of the types of material of diatom taxa described by B.J. Chohnoky, and in particular, many from the Western Cape have been lost over the last 60 years, without these types diatom names cannot be linked to a taxon with confidence. There is thus an urgent need to document the flora of the Western Cape again, in order to develop reliable indicators of water quality and to re-sample the flora in terms of diversity. There is in addition a gap in research on diatoms in the Western Cape with most of the recent work taking place in the Highveld region and thus this present study makes an important contribution to the study of diatoms from this region.

### 1.2 Water as a limited resource in South Africa

South Africa is recognised as a water-scarce country; due to its unpredictable rainfall and high evaporation rates water resources are limited (Davies & Day, 1998; Karr & Chu, 1999). South Africa has an average rainfall of around 450 mm per year (mm/a), which is well below the world average of 860 mm/a (Davies & Day, 1998; NWRS, 2004). South Africa receives water in three ways: too much (floods), too little (droughts) and too dirty (pollution) (Davies & Day, 1998; NWRS, 2004). The main water resources on which South Africa depends are surface waters, return flows (the part of artificially supplied water that is not consumed by evapotranspiration and that either drains to the water table or runs off to a surface-water body), and groundwater (NWRS, 2004). Water is necessary for the development and nourishment of

life. Although a significant resource for all aspects of human life in South Africa, many challenges exist in providing people access to significant quality and quantities of water. South Africa's already limited fresh water is decreasing in quality due to an increase in pollution and population (NWRS & DWAF, 2004). Although South Africa doesn't have much fresh water, we lean so heavily on it: it is the lifeblood for our agriculture and forestry, it helps power the electricity grid, and drives the economy and industry. People need clean water in their homes so as to be able to live a healthy life.

One of the biggest threats to a sustainable water supply is contamination of available resources through pollution. Polluted water has a deleterious effect on the quantity, quality and economical value of water, because more pollution means higher treatment costs and less water availability (Turton *et al.*, 2002). Human health can also be affected by poor water quality since it can give rise to waterborne diseases (WHO, 2004). The unfortunate effect of these anthropogenic activities is the degradation of the integrity of aquatic ecosystems. Therefore, sound management of water resources becomes a critical aspect of sustainable development.

### **1.3 Freshwater resources and ecosystems in South Africa**



South Africa is well-known for having different types of freshwater resources such as rivers, wetlands, aquifers, streams, lakes and estuaries. These freshwater resources have been mapped and classified into National Freshwater Ecosystem Priority Areas (NFEPAs). This work (SANBI, 2012) showed that 23% of South African river ecosystems are critically endangered and 60% of river ecosystems are threatened. The situation for wetlands is even worse: 65% of wetland types are threatened, and 48% of the threatened wetland types are critically endangered. It is important to fully recognise the value of wetlands as water resources (Dini, 2004).




Mitsch and Gosselink (2000) stated that, in the past, globally wetlands were generally perceived as having no value; being overgrazed, mined for their soils, polluted with chemicals and litter, drained for agriculture/housing development and building dams. The majority of South Africa's major rivers have been dammed to provide water for the increasing population. Likewise, wetlands have been converted for other land-use purposes, with more than 50% of the country's wetlands already lost (Dini, 2004; Vlok *et al.*, 2006). Wetlands play important roles not only in the environment but also offer services and goods for humans and animals (Ewel, 1990).

## 1.4 What is a wetland?

It is extremely challenging to characterise wetlands because of their internal spatial heterogeneity and the large variations in wetland types (Wu *et al.*, 2003). Because of the variations in wetland types, a classification system (for wetlands in South Africa) was proposed by Ollis *et al.* (2013) in order to determine management and conservation strategies for each wetland type. The type of wetland is classified according to their hydrogeomorphological (HGM) characteristics, where hydrology is the movement of water and geomorphology is the landform characteristics. The seven inland HGM categories (essentially different wetland types) are defined in Ollis *et al.* (2013) as described below in Table 1.1.

**Table 1.1:** The seven inland HGM categories defined by Ollis *et al.*, 2013 and images providing examples of some of the different wetland types that were observed throughout the study

<u>Photos:</u>	<u>Wetland type: Definition</u>	<u>Wetland name, area and GPS coordinates:</u>
	<p><b>Depressions</b> are wetlands with closed or partly closed elevation contours that increase in depth towards the centre. Flat-bottomed depressions are typically referred to as pans. Depressions may have inlets, outlets, a combination of the two, or neither. (Ollis <i>et al.</i>, 2013).</p>	<ul style="list-style-type: none"> <li>❖ Rondeberg</li> <li>❖ Darling area (Western Cape)</li> <li>❖ -34.645037 S 20.021475 E</li> </ul>
	<p><b>Saltpan (Depressions)</b> Flatbottomed depressions are typically referred to as pans. Depressions may have inlets, outlets, a combination of the two, or neither. (Ollis <i>et al.</i>, 2013).</p>	<ul style="list-style-type: none"> <li>❖ Koekiespan</li> <li>❖ Darling area (Western Cape)</li> <li>❖ -33.263346 S 18.343378 E</li> </ul>

	<p><b>Channelled valley-bottom wetlands</b> are located along a valley floor with a distinctive river channel running through. (Ollis <i>et al.</i>, 2013).</p>	<ul style="list-style-type: none"> <li>❖ Driehoek</li> <li>❖ Cederberg (Western Cape)</li> <li>❖ -32.431429 S</li> </ul> <p>19.148417 E</p>
	<p><b>Seeps</b> are located on gently to steeply sloping valley slopes, with the gravity-driven unidirectional movement of water and sediment downslope. (Ollis <i>et al.</i>, 2013).</p>	<ul style="list-style-type: none"> <li>❖ Hoogvertoon</li> <li>❖ Cederberg</li> <li>❖ -32° 28' 21.77"S</li> </ul> <p>19° 09' 51.94"E</p>
	<p><b>Unchannelled valley-bottom wetlands</b> are located along a valley floor but without a distinctive channel. (Ollis <i>et al.</i>, 2013).</p>	<ul style="list-style-type: none"> <li>❖ Wagenboomsriver</li> <li>❖ Cederberg</li> <li>❖ -32° 28' 21.77"S</li> </ul> <p>19° 09' 51.94"E</p>
<p>Not available</p>	<p><b>Wetland flats</b> are situated on a plain or a bench and are associated with weak multidirectional movement of water, due to the lack of change in gradient. (Ollis <i>et al.</i>, 2013).</p>	<p>Not sampled in the study</p>
<p>Not available</p>	<p><b>Rivers</b> are linear landforms with distinctive bed and banks carrying the concentrated flow of water permanently or periodically. Both the active channel and the riparian zone are included in the unit. (Ollis <i>et al.</i>, 2013).</p>	<p>Not sampled in the study</p>

\*Photos taken by Malan H. & Ramjukadh, C., 2012

One of the most widely accepted definitions of a wetland is that of the Ramsar Convention whereby wetlands are defined as:

*“areas of marsh, fen, peatland or water (whether natural, artificial, permanent or temporary) with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters. (Davis, 1994; Phillips & Madlokazi; 2011; Ramsar Convention Secretariat, 2011).”*

The definition used for this project is based on the definition of the South African National Water Act 36 of 1998 where wetlands are defined and recognised as:

*“land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.”*

A lot of questions have been raised over the years regarding wetlands. Why are wetlands so important? Why does one benefit from wetlands? Why should so much attention be paid to them? What roles do they play in nature? Can they add to economical values? The section below will describe the overall values of wetlands and the services they provide.

## **1.5 The importance of wetlands for humans, animals and the environment**

The importance of wetlands for human society and the environment was globally recognised in the 1960s, before which they were viewed as boggy pieces of ground that served as a breeding ground for hosts of diseases (Cowan, 1995; Ramsar, 2002; Phillips & Madlokazi, 2011). Although South African wetlands suffered degradation and loss due to poor management and conservation, the vital importance of these water bodies has finally been recognised during the past years. Phillips and Madlokazi (2011) revealed that between 2002 and 2010, the WRC had invested nearly R50 million in 67 research projects containing a wetland objective. Approximately 10% of this investment was co-funded by other benefactors, further emphasising the awareness of the importance of wetlands. Wetlands support agriculture, filter pollution from water, trickle-feed water into rivers even in the dry seasons, and ameliorate flooding. Wetlands are important in biogeochemical cycling and are highly productive ecosystems that support terrestrial and aquatic food webs (Westlake & Kvét *et al.*, 1998; Millennium Ecosystem Assessment, 2005; Reddy & DeLaune, 2008). Wetlands are known as the ‘kidneys’ of nature because they play a crucial role in purifying water by trapping pollutants, bacteria and viruses that cause diseases such as diarrhoea and dysentery (Cowan, 1995). Water treatment systems are very expensive to build, therefore alternative options, such as constructed wetlands, are being explored (EPA, 2004; Kadlec & Wallace, 2008). An

example of economic benefits supplied by wetlands is that of the Congaree Bottomland Hardwood Swamp in South Carolina, which removes quantities of pollutants equivalent to that which would be removed by a treatment system costing US\$ 5 million (EPA, 2004). Since wetlands act as natural filters, they have been constructed and used for water treatment purposes worldwide (Wyatt, 1995; Kotze, 1996; Kadlec & Wallace, 2008). Wetlands play a vital role in purifying water; however, it is important to note that even though they are efficient in doing so, they are still highly dependent on the quality of influent waters. Influent waters have a great effect on the functionality of the wetland; the more polluted the water, the less functional the wetland (Kadlec & Wallace, 2008; Wang *et al.*, 2012). Wetlands act as sponges in the landscape, preventing fast evaporation during summertime and slowly releasing water back in winter (except winter rainfall areas), thus making wetlands crucially important in an arid to a semi-arid country like South Africa (Sánchez-Carrilo *et al.*, 2010). Wetlands are “nurseries for life” because they provide habitats for thousands of species of aquatic and terrestrial plants and animals (EPA, 2004). Wetlands are also used for recreational purposes, as they are great attractions for birdwatching, hiking, fishing, photography and hunting (Constanza *et al.*, 1997).

According to De Groot (1994) wetlands are important in terms of the following functions:

- Regulation functions – ecosystems regulate ecological processes that contribute to a healthy environment;
- Carrier functions – ecosystems provide space for activities;
- Production function – ecosystems provide resources for humans;
- Information function – ecosystems contribute to mental health by providing scientific, aesthetic, and spatial information (as summarised in Table 1.2 below).

**Table 1.2:** Regulation, carrier, production and information functions of wetlands which demonstrate their overall value

Function Type	Wetland Goods, Service or Attribute	Function Type	Wetland Goods, Service or Attribute
<b>Regulation Functions</b>	Storage and recycling of surface waters	<b>Carrier Functions</b>	Agriculture
	Storage and recycling of nutrients		Stock farming (grazing)
	Storage and recycling of organic waste		Wildlife cropping/resources
	Groundwater recharge & discharge		Energy production/conversion
	Natural flood control and flow regulation		Transport
	Erosion control		Tourism and recreation
	Salinity control		Human habitation and settlements
	Water treatment		<b>Production Functions</b>
	Climatic stabilisation	Food	
	Maintenance of migration and nursery habitats	Fuel wood	
	Maintenance of ecosystem stability	Medicinal resources	
	Maintenance of integrity of other ecosystems	Raw materials for building, construction and industrial use	
	Maintenance of biological and genetic diversity	<b>Information Functions</b>	
			Uniqueness, rarity or naturalness and role in cultural heritage

Sources: (De Groot, 1994; Rogerri, 1995; Lemly *et al.*, 2000; Schuyt, 2005; Millennium Ecosystem Assessment, 2005).

Wetlands protect South Africa's scarcest resource, namely water, therefore it is very important to protect and manage these systems correctly. Bad management, such as drainage of wetlands for crops, overgrazing, incorrect burning management, pollution and mining, all lead to the destruction of wetlands. Continued wetland destruction will lead to less pure water, less reliable water supplies, increased flooding and lower agricultural productivity. The National Water Act of 1998 (NWA) and National Environmental Management Act of 1998 (NEMA) both call for an integrated approach to resource management to protect the ecological reserve (the amount of water that needs to stay in the natural environment in order for an aquatic ecosystem to remain in a good condition) of all aquatic resources, including wetlands, classifying water resources and maintaining the water quality (Eekhout *et al.*, 1996). The challenge remains in implementing the legal requirements and to ensure the right science is available to protect wetlands and make the most prudent choices between development and loss of ecological infrastructure.

### 1.6 Assessment of wetlands using the WET-Health technique

The WET-Health assessment technique formed part of a nine-year WRC wetland management programme initiated in 2003 in order to create a WET-management series as follows:

- WET-Roadmap
- WET-origins
- WET-outcomeEvaluate
- WET-ManagementReview
- WET-RehabPlan
- WET-Prioritise
- WET-Legal
- WET-EcoService
- WET-EffectiveManage
- WET-RehabMethods, and □ WET-RehabEvaluate.

This section however will only focus on the WET-Health series because it formed part of the aforementioned WRC project titled K5/2183: The Trajectories of Change in Wetlands of the Fynbos Biome mentioned (Malan, *et al.*, 2014) in Section 1.1 and will be used to compare the Present Ecological State (PES) of the WET-Health contrary to the PES of the diatom results (the main focus of the study).

### **1.6.1 What is WET-Health?**

Wet-health is a tool designed to determine the health, or ecological integrity of wetlands. Before the wetlands are assessed they are categorised into different hydrogeomorphic (HGM) units and their associated catchments.

This method evaluates the ecological condition of the geomorphology, hydrology and vegetation using three distinct modules:

- i) Hydrology – distribution and movement of water through a wetland and its soil.
- ii) Geomorphology – distribution and holding patterns of sediment within the wetland.
- iii) Vegetation – the vegetation structural and compositional state.

Based on the intensity and magnitude of impact (human activities: agricultural, flood control, pollution etc.) analyses are separately performed on the geomorphological, hydrological and vegetation health, this is then turned into a health score. Present State health categories, on an impact score scale of 1–6 (or health category A–F), are as follows: natural, moderately altered, mainly natural, largely modified, broadly modified, and critically modified. The five groups of likely change are: large improvement, slight improvement, remains the same, slight decline and rapid decline. The overall health of the wetland is then presented for each module by equally representing the PES (Macfarlane *et al.*, 2007).

## 1.6.2 Terminology used to describe wetland health

When referring to wetland health it is important to know what is precisely meant by the terminology, some important terms will be discussed below:

The term wetland health is important to clarify. "WET-Health" outlines wetland health as "a measure of the similarity of a wetland to a natural reference condition" (Macfarlane *et al.*, 2008). Wetlands differ in their natural condition due to human impacts. Human impacts are usually associated with wetland drainage, urban developments and mining sectors (causing pollution). Wetlands can also be influenced by natural conditions such as flooding events, seasonal changes and storm events. It is thus important to determine how and to what degree/class a wetland is modified from its natural condition caused by human disturbances; this can be expressed as the Present Ecological State(PES). The PES describes an aquatic system according to ecological status or health compared to natural conditions. the ecological status is usually described in terms of ecological categories, such as A–F, where A is near natural, and F is seriously modified (Kleynhans & Louw, 2007). There are three main indicators of health in aquatic systems:

- i) Stressors (such as anthropogenic activities, large scale influences);
- ii) Exposure indicators (such as habitat degradation, whole effluent toxicity and sediment contamination); and
- iii) Response indicators (such as biomonitoring: relationship between stressors and biological communities e.g. diatoms, fish and macroinvertebrates). (i) ii) Kleynhans & Louw, 2007;iii) Novotny *et al.*, 2005 & Yoder *et al.*, 2000).

## 1.7 What is biomonitoring?

Traditionally, water quality monitoring actions have focused on physical and chemical measurements. It is widely recognised that the use of other indicators (diatoms, fish and macroinvertebrates), in addition and complementary to traditional chemical and physical water quality monitoring techniques, can greatly enhance the assessment and management of aquatic ecosystems (Cairns & Pratt, 1993). In this regard biomonitoring can play a crucial role as explained below.

Biological monitoring, or biomonitoring, is the use of biological responses to assess changes in the environment (Harding & Taylor, 2011). The presence or absence of the indicator (or of an indicator species or indicator community) reflects environmental conditions. Biological monitoring, or biomonitoring, is an important tool in assessing the condition of aquatic ecosystems. Information and understanding of environmental change is necessary to allow for the protection and remediation of ecosystems (Rosenberg & Resh, 1993). Diatoms can

form part of biomonitoring programmes to assess the ecological and water quality status of the environment.

### **1.8 Historical research on diatoms in South Africa**

South Africa has a long history of diatom research and possesses one of the most comprehensive collections of diatoms. The collection consists of slides, unprocessed sample materials and documents. The material in the collection dates as far back as the 1950s which is very important because these samples hold information for many South African rivers prior to weir and dam construction (Harding & Taylor, 2011) and other impacts. Dr B.J. Chohnoky made the most significant contribution to date to the study and collection of diatoms in South Africa (Chohnoky, 1968). He carried out intensive and extensive taxonomic and ecological studies on diatoms that helped build up the national diatom collection (Harding *et al.*, 2004).

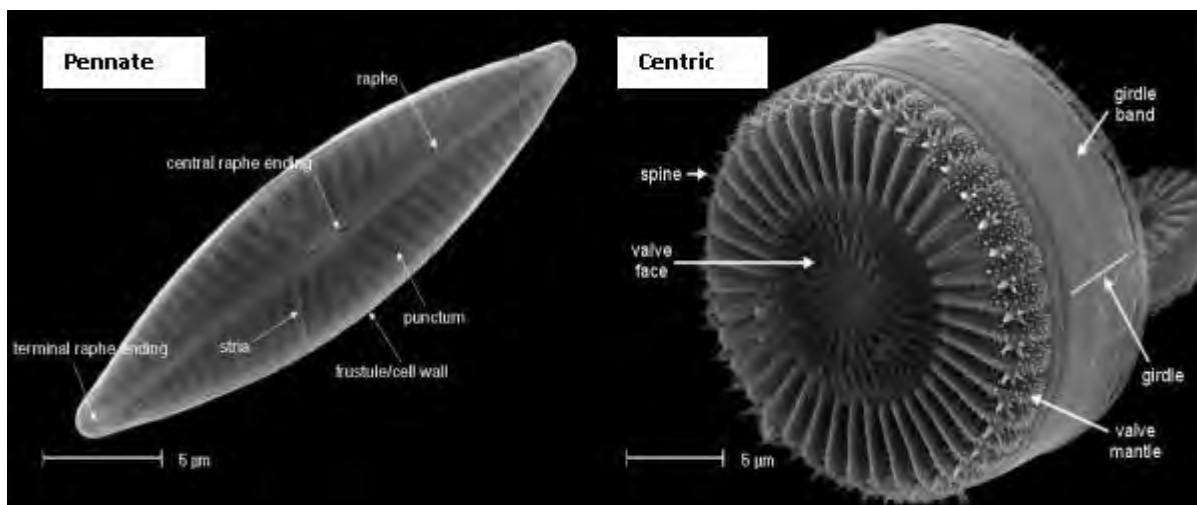
The investigation of African inland diatoms had already started in the 19th century. Later, B.J. Chohnoky described many new taxa and depicted his findings by line drawings. His diatom investigations focused on two aspects: the taxonomy of the diatoms, and their species-specific autecology. Some of the type material of taxa that were described by B.J. Chohnoky—and in particular, many from the Western Cape—have been lost over the intervening years and thus there is an urgent need to document the flora of the Western Cape again in order to develop reliable indicators of water quality and document diatom biodiversity (Harding *et al.*, 2004). It is important that there is a sound understanding of the taxonomy of diatoms in this country, and in order to study taxonomy, representative samples of diatoms from the entire country are required. According to the curator of the South African diatom collection (Dr J Taylor *pers. comm.* February 2012), large gaps exist in both taxonomic and ecological data for diatoms, especially for the Western Cape. Currently, there are not enough samples from this region to be able to meaningfully assign tolerance and indicator values to diatom taxa. Therefore, it is important to collect samples and compose species lists to document the diatom flora of the Western Cape and to have a better understanding of how the diatoms respond to local water quality conditions and what taxa are present in this unique region of the country. The Western Cape is well-known for its high level of endemism in terrestrial plants, fynbos and naturally occurring acidic water (Brown & Magoba, 2009) and this endemism is also found in diatom communities.

### **1.9 What are diatoms and why should they be considered to be used as tools to infer wetland water quality?**

Diatoms are microscopic organisms living in water and moist soils and are distributed worldwide. They belong to the algal class *Bacillariophyceae* and occur as single cells or in

colonies. A golden-brown mucilaginous film on the surface of a substratum indicates the presence of benthic diatoms, while planktonic diatoms occur in the water columns of rivers and dams. More than 100 000 species of diatoms are thought to exist (Mann & Droop, 1996) and they often form the main component of phytoplanktonic and phytobenthic communities in shallow waters.

The most obvious morphological characteristic of diatoms is the siliceous cell wall or frustule, which consists of two almost identical halves or valves. The taxonomy of diatoms is based on the ornamented structure of the valves, which are identified and enumerated in ecological studies of diatom communities (Barber & Hayworth, 1981). Diatoms can be placed loosely into two morphological groups, centric and pennate (as illustrated in Figure 1.1 below). Centric diatoms are non-motile and radially symmetrical, while pennate diatoms are often motile and are commonly bilaterally symmetrical. Centric diatoms usually form part of the phytoplankton, and species of genera such as *Cyclotella* may have chitinous extrusions from the mantle that aid in flotation (Barber & Hayworth, 1981; Saros & Fritz, 2000). Pennate diatoms are predominantly attached to hard substrata and often produce mucilaginous stalks or pads that keep the cells in contact with the substratum in flowing waters (Anderson & Cabana 2007).



**Figure 1.1:** Scanning Electron Microscope (SEM) of a pennate and centric diatom (Taylor et al., 2007b)

Diatoms have been used internationally and locally to infer water quality (WQ) for a number of reasons:

- Diatoms are found in almost all aquatic habitats (Gell *et al.*, 2005).
- Software has been developed for the calculation of diatom indices (OMNIDIA) Lecointe *et al.*, 1993; Smol & Stoermer, 2010).

- The combined costs of sampling and sample assay are relatively low when compared to some other biomonitoring techniques (Yallop *et al.*, 2006) and they are relatively easy to sample (King *et al.*, 2000) compared to some other biota (e.g. fish).
- The taxonomy of the diatoms is well documented (Krammer & Lange-Bertalot, 2000; Lavoie *et al.*, 2008).
- As primary producers, they are affected by nutrients and other components of water quality (Round *et al.*, 1990).
- They respond sensitively to differences in pH, conductivity, sediments, pesticides and many other contaminants (Adamus *et al.*, 2001), and individual species have specific requirements with regard to water chemistry and habitat (Tilman, 1977; Sebatier, 1988; Salomoni *et al.*, 2006).
- Due to the siliceous nature of their cell walls, diatoms are usually well preserved in sediments and can, therefore, be used to infer past environmental conditions (Deny, 2004; Taylor *et al.*, 2007a).
- Diatoms can be found on different substrata even when dry, so they can often be sampled throughout the year (Cremer *et al.*, 2004).
- Samples can easily be archived for future analysis and long-term records (Round, 1993; Johnson *et al.*, 2006).
- Diatom assemblages are species-rich and so provide redundancy of data (Dixit *et al.*, 1992).

In summary, the biological characteristics of diatoms render them useful indicators of water quality, but despite their ecological importance, the knowledge of lentic diatom communities is less comprehensive than the knowledge of lotic communities, and diatom identification requires taxonomic expertise and training. The diatoms are also not restricted to a certain 'type' of wetland because they occur in almost any area that is moist. Diatom assemblages can be found on the following substrates: epipsammon (assemblages on sand), epiphytes on macro algae, epilithon (assemblages on rock) and macrophytes, epidendron (assemblages on wood), epipelon (assemblages on mud), and bacterial slime.

Understanding the degree of endemism of individual diatom species is important when indices developed in one part of the world are used in another. The assumption that individuals of similar morphology are in fact the same species throughout the world, and, therefore, have the same tolerance ranges, has to be tested for each region, despite the argument that diatoms are sub-cosmopolitan. The designation 'sub-cosmopolitan' infers that the specific

environmental variables at a site—and not the genetic makeup of individual diatoms—determine their distribution patterns (Kelly *et al.*, 1998).

### **1.10 The application and testing of diatom indices in South Africa**

A biomonitoring index is a scale for showing the quality of an environment by indicating the type of organisms present in it (e.g. fish, diatoms or macroinvertebrates). It is often used to assess the quality of aquatic environments (e.g. rivers and wetlands). Diatom-based indices are used in ecological assessments and can be translated into information that is useful for management purposes (Karthick *et al.*, 2013). Diatom indices can infer environmental conditions in an ecosystem by using their ecological preferences, the relative abundance of species in assemblages, and sensitivities or tolerances values. The sensitivity and tolerances among diatom species differ towards eutrophication, heavy metals, pH, salinity and organic pollution (Descy, 1979; Palmer, 1969; Stevenson, 1996). The specific water quality tolerances of diatoms have been resolved into different diatom-based water quality indices used around the world. Most indices are based on a weighted average equation (Zelinka & Marvan, 1961). In general, each diatom species used in the calculation of the index is assigned two values: the first value (*s value*), reflects the tolerance or affinity of the particular diatom species to a certain water quality (good or bad). The second value (*v value*), indicates how strong (or weak) the relationship is (Taylor, 2004). These values are then weighted by the abundance of the particular diatom species in the sample (Lavoie *et al.*, 2006; Taylor, 2004; Besse, 2007) and calculated via a software programme OMNIDIA (Lecoite *et al.*, 1993).

The majority of diatom research conducted in South Africa has been based on riverine ecosystems, and the efficacy of diatoms as indicators of environmental conditions in wetland ecosystems has not been formally documented in South Africa. Diatom-based water quality indices have recently been evaluated and implemented in South Africa for riverine ecosystems (Taylor, 2004; RHP, 2005). De la Rey (2007) and Taylor (2004) showed that diatom-based pollution indices may be good bio-indicators of water quality in rivers in South Africa by demonstrating significant relationships between variables such as pH, electrical conductivity, phosphorus and nitrogen concentrations, and the structure of diatom communities as reflected by diatom index scores. These authors concluded that the European indices are suitable for monitoring South African rivers. The Trophic Diatom Index (TDI) (Kelly and Whitton, 1995), Biological Diatom Index (BDI) (Leoir & Coste, 1996), Generic Diatom Index (GDI) (Coste & Ayphassoro, 1991), and SPI (Coste in Cemagref, 1982) indices have been successfully applied in South African rivers by Taylor (2004), as well as in a preliminary study conducted on wetlands in the Western Cape by Matlala *et al.* (2011). Matlala's study indicated that

diatoms can be used for inferring aspects of the water quality of wetlands since the actual physico-chemical measurements correlated with the diatom index scores generated. The result of both studies by Taylor (2004) and Matlala *et al.* (2011), indicated that the %PTV, BDI, GDI and SPI indices correlated best with environmental variables (pH, Electrical conductivity, orthophosphates and nitrates, etc.), and it was decided to use the same indices in the current project to see if the indices correlated with the environmental variables that were measured during the study (this will be discussed in Section 3.2). A South African Diatom Index (SADI) is being developed and is currently based on the analysis of 768 individual samples, together with their water quality information. The SADI is based on the same principles as most of the European indices but is yet to be completed, further data being required, especially for the Western Cape region to include endemic species (Harding & Taylor, 2011). Water bodies (particularly rivers and wetlands) in the Western Cape differ considerably from water bodies in the rest of the country, since the Western Cape fynbos vegetation causes these water bodies to be naturally acidic (DWAF, 1996). The final and important role of biotic indices is to answer questions frequently asked about, for instance, is the index score affected by natural causes (in the case of wetlands: seasonal changes and natural saline conditions), or are there external factors affecting the score, such as human activities (agricultural, industrial or municipal waste). It is therefore essential to interpret the index correctly and gather as much information as possible when monitoring a specific site.

As already mentioned, wetlands are complex systems and differ according to hydro geomorphological type, which makes it difficult to choose a substrate type that is always present in all wetland types in comparison to riverine systems, where stones are found to be the best substrate of interest (Taylor, 2007). Studies have been conducted to determine whether diatom communities differ according to microhabitat types, and interestingly the studies contradicted each other; some of the studies concluded that similar diatom communities can be found in different microhabitat types (Winter & Duthie, 2000; Rothfritz *et al.*, 1997), while others suggest that these microhabitats are unique (Reavie & Smol, 1997; Hashim & Stevenson, 1989).

### **1.11 Differences between river and wetland systems that may influence diatom communities and diatom indices**

As noted in section 1.1, diatoms as indicators of environmental conditions in wetland ecosystems have not been formally documented in South Africa. It is possible that indices suitable for rivers may not provide accurate results for wetlands, because of the very different physical and chemical conditions in standing and running waters. The amount of rainfall, evaporation rates and groundwater level are the most important features influencing the water

regime and inundation period of isolated wetlands. Salinity can also change markedly during the year, especially in salt pans (depressions, see definition in Section 1.3) depending on inundation period and wetland size; turbidity depends on pan depth, vegetation cover and wind action; and pH varies with conductivity and rate of photosynthesis (Seaman & Kok, 1987, in Allan *et al.*, 1995). Since water level, hydrological variability, habitat availability and spatial heterogeneity affect the distribution of diatoms (Gaiser *et al.*, 1998; Weilhoefer & Pan, 2007) diatom indices are likely to provide different results in standing compared to running waters. Since water level, hydrological variability, habitat availability and spatial heterogeneity affect the distribution of diatoms (Gaiser *et al.*, 1998; Weilhoefer & Pan, 2007) diatom indices are likely to provide different results in standing and running waters. In addition, in rivers diatoms prefer rocky substrata whereas wetland systems may have a variety of substrata. It is thus necessary to also investigate the most suitable substrata to sample in wetlands.

### **1.12 Aims and objectives**

The present study aimed to contribute information on the distribution and environmental preferences of diatoms in wetlands in the Western Cape, by:

- Documenting the diatom flora of the Western Cape, by composing species lists for the wetlands studied.
- Ascertaining the relationship between aspects of water quality and diatom community composition in the wetlands studied.
- Investigating the effect of different substrates and their resultant index scores.
- Testing the applicability of diatom indices for monitoring water quality in wetlands.

### **1.13 Hypothesis**

In order to achieve the aim and objectives, the following hypotheses were developed:

- Diatom flora of the Western Cape will be listed according to the wetlands studied
- Relationships between aspects of water quality and diatom communities will be found
- Different substrates will affect resultant index scores
- Diatom indices will result in a tool to monitor water quality in wetlands

## CHAPTER 2: MATERIAL AND METHODS

### 2.1 Study area

As already mentioned in Section 1.1, the sites chosen for this particular project were based on a previous survey conducted by Drs King and Silberbauer in the 1980s. Different types of wetlands as well as different types of substrate were sampled during the period 2012–2013 in the Western Cape Province. The majority of the wetlands were sampled during the winter months in 2013 and were visited only once. In Figure 2.1 the location/geographical distribution of each wetland is given. The main sampling took place in the following areas: Cederberg, West Coast, Greater Cape Town, Tulbagh/Worcester, Bettys Bay, Vermont, Agulhas Plain and Riversdal/Mosselbay.

### 2.2 Field procedures

Wetlands are typically characterised as lentic water bodies where rocks and boulders are not usually found, however when present, diatoms were sampled from these too. Benthic diatoms growing on rocks and other hard, submerged surfaces are favoured when sampling riverine waters (Eloranta & Soininen, 2002). Substrata such as macrophytes, sediment and other solid substrata were selected as the best alternative diatom sampling surfaces. Due to budget constraints, it was not possible for the researcher to do all the sampling and it was decided to summarise a sampling strategy (described below), from Taylor *et al.* (2007) before the sampling commenced (sampling strategy described in Section 2.4-2.9).

### 2.3 Environmental variables

Physical and chemical variables were measured in the field at each sampling occasion: pH, temperature (°C), dissolved oxygen (%), electrical-conductivity (mS/m), and turbidity (NTU), and nutrients including phosphate (mg/L), nitrite (mg/L), nitrate (mg/L) and ammonium (mg/L) were tested. The electrical-conductivity (EC) was measured with a Crison CM 35 meter and the pH was measured using either a Crison pH 25, or Orbeco Hellige Series 150 multimeter. The meters were calibrated for pH 4 and pH 7 in order to ensure accurate measurements (Dr H. Malan, 2013, *pers. comm.*, 6 June). Water samples (+/- 250mL) preserved with mercuric chloride were also collected for chemical analysis and analysed by the Department of Water Affairs and Sanitation (South African National Department of Water Affairs) (Dr H. Malan, *pers. comm.*, 2012).

## 2.4 Materials required to sample diatoms from wetlands

The following apparatus was used when sampling:

- New toothbrush (scrub diatom from substratum)
- Spoon (collecting sediment)
- Knife (to cut macrophyte stems)
- Ethanol 100% (preserve sample 20% by volume of the final sample)
- Shallow tray / 2 litre ice cream tub / similar dish (rinse and scrub substrata)
- Ziplock bags (medium size)
- Sample bottles – ‘medical flats’ (available from pharmacies and can be posted without risk of damage; round bottles are often crushed)
- Gumboots/waders
- Marking pen

At each site samples were taken from all available substrata, and preserved separately. When collecting diatoms, it is important to look (for brown mucilage) or feel (a slimy substance) in order to check for the presence of diatom growth on the plant surface before collecting. Samples were taken within a 10-meter radius from the sampling point.

## 2.5 Different aquatic vegetation types

**(a) Free-floating** – Plants unattached and floating on the surface of the water body (e.g. *Salvinia molesta*: Henderson, 2001).

When sampling free-floating plants the area of interest would be below the water line i.e. the roots and the undersides of leaves in contact with the surface of the water.

**(b) Floating-leaved attached** – Plants rooted in the substrate with mature leaves floating on the surface of the water.

When sampling floating-leaved attached substrata the area of interest would be below the water surface and include both the stems of leaves and flowers and the underside of floating leaves. Care should be taken not to get sediment in the sample.

**(c) Emergent-broad leaved** – Plants are rooted in the substrate with stems and flowers and most mature leaves are floating above the water surface.

Only sample if the plant is submerged. When sampling emergent-broad leaved plants the area of interest is the stems just below the water line, where there is a brown film or a slimy feel.

**(d) Emergent, narrow leaved** – Plants are rooted in the substrate with modified leaves

and are reed-like.

When sampling emergent plants the area of interest would be the stems below the water surface, covered with a well-developed biofilm.

**(e) Submerged** – Plants rooted in the substrate. Leaves can be feathery or linear and are mostly submerged.

When sampling a submerged plant the whole plant is of interest except the roots to avoid contaminating the sample with sediment. Only sample if submerged. When sampling emergent broad-leaved plants the area of interest would be the stems just below the water line, where there is a brown film or a slimy feel.

## **2.6 Sampling from aquatic vegetation**

The aquatic vegetation types identified above (a–e) was sampled as follow, while keeping the area of interest in mind (as described above). After observing or feeling the presence of diatoms on the submerged surface, the surface of the substrate was scrubbed with a toothbrush in order to obtain a diatom sample in order to avoid contamination between sites, both the toothbrush and the plastic tray was rinsed before taking the diatom sample. A minimum of five substrates were collected for each type of aquatic vegetation.

### **2.6.1 Sampling from emergent aquatic macrophytes**

This includes aquatic vegetation types a–d, such as *Typha* spp. and *Phragmites* spp.

**i)** Cut emergent macrophyte stems with a knife slightly above the point where it emerges from the sediment. This procedure needs to be repeated until AT LEAST five stems have been collected.

**Note:** Take care not to avoid disturbing the biofilm as it is often only loosely attached.

**ii)** Scrub and remove diatom communities from macrophyte stem.

- Place in a sampling tray, together with approximately 10–20 ml of water from the water body.
- Remove diatoms by vigorously scrubbing the surface of the substratum with a small brush (e.g. clean toothbrush) to dislodge the diatom community.

**Note:** The substrata can also be scraped with a knife or a spoon as these implements are easier to clean and reduce the possibility of contamination between sites.

- iii) Mix the sample from the five stems well and pour into a labelled sampling bottle and preserve with ethanol (20% volume ethanol per volume sample).

### 2.6.2 Sampling from submerged aquatic macrophytes

This includes aquatic vegetation type (e), for example *Potamogeton* spp., *Ceratophyllum* spp., etc.

- i) Select replicates from five plants (if available) growing in the sampling area.
  - Each replicate consists of a single stem plus associated branches from the lowest healthy leaves to the tip.

**Note:** Diatoms should be visible as a golden-brown film associated with the macrophytes.

- ii) Place in a plastic bag together with 10-20 ml of water from the water body.
  - Shake vigorously and agitate the plant in the Ziploc bag (Taylor *et al.*, 2007b).
- iii) Pour the resulting brown suspension into a labelled sampling bottle and preserve with ethanol (20% volume ethanol per volume sample).

### 2.7 Alternative sampling substrates

Alternative substrate diatom communities can be sampled from the following:

- Manmade objects (bricks, pieces of concrete, bridge supports, canal walls, etc.)
- logs or branches,
- plastic bags, and
- pebbles or cobbles.

### 2.8 Sampling diatoms from solid substrata

- i) Five to ten cobbles or other solid substrata of similar proportions should be collected from a span of at least 10m in the sampling area.
- ii) Place the substrata in a sampling tray on the bank, together with approximately 10–20 ml of water from the water body.
  - Vigorously scrub the **upper surface** of the substratum with a small brush (e.g. clean toothbrush) to dislodge the diatom community.

**Note:** Only the upper side (the side most exposed to water) should be scrubbed to avoid contamination with sediment that might be present on the undersides of the substrate.

The substrata can also be scraped with a knife or a spoon, as these implements are easier to clean and reduce the possibility of contamination between sites.

- iii) Pour the resulting diatom suspension into a labelled wide-mouth plastic sampling bottle of 50–100 ml capacity or greater, and preserve with ethanol (20% volume ethanol per volume sample).

## **2.9 Sampling diatoms from sediment**

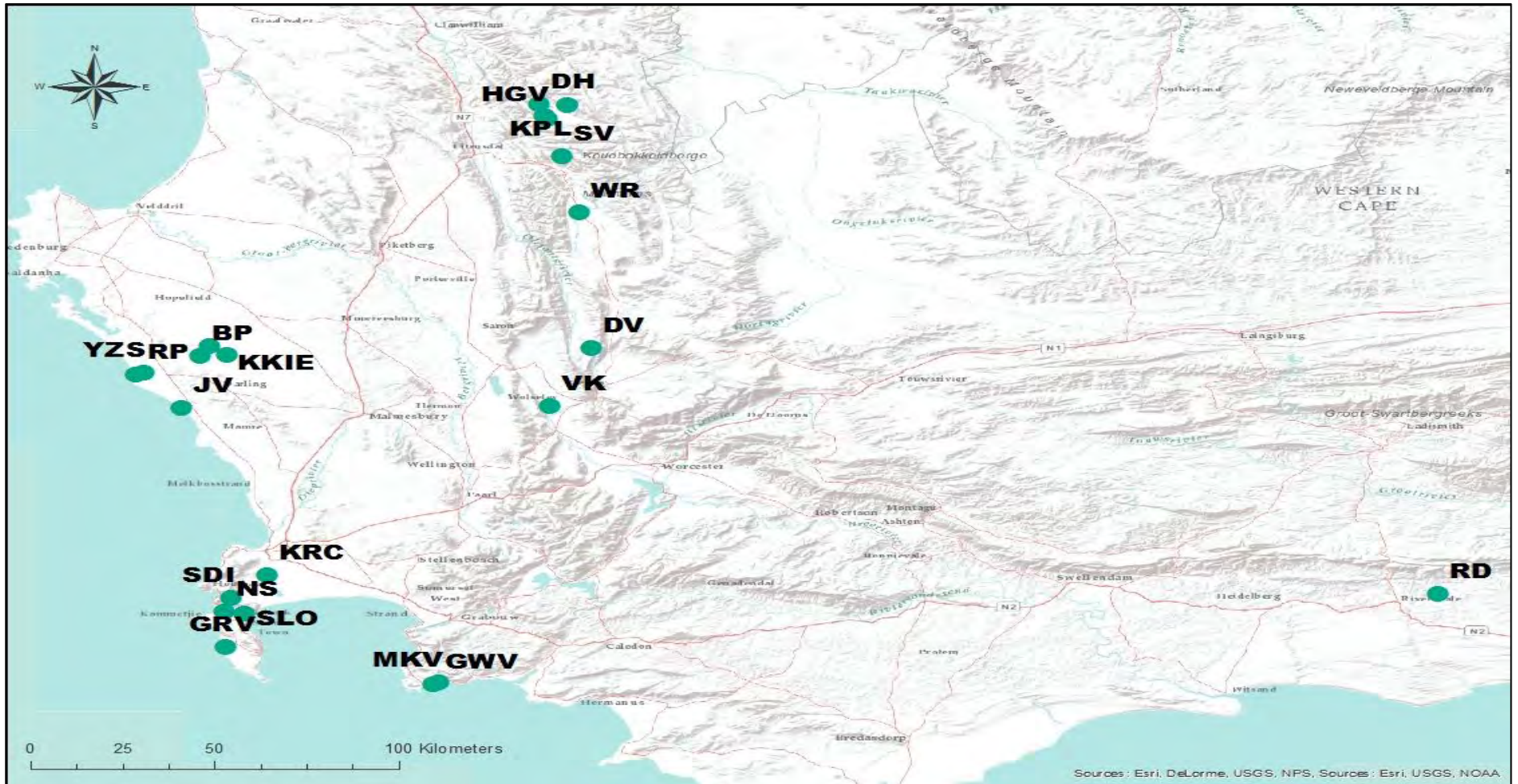
- i) Diatoms are visible as a golden-brown film on top of the sediment; a spoon can be used to gently remove the top 2–3 mm of sediment.

- Avoid collecting any sediment without signs of growth.

Note: The mucilage produced by the diatoms binds the sediment together; this thin layer which often remains intact can be gently 'floated' off by carefully sliding the spoon underneath the biofilm.

- ii) Take 4–5 samples within an area of five square meters.
- iii) Put sample into the sample container and preserve with ethanol (20% volume ethanol per volume sample).

During this study 40 samples were taken from 24 wetlands. Wetland habitats differed from each other in terms of available sampling substrates as indicated in Table 2.1 (page 22 below). Figure 2.1 below indicates the location of the wetlands that were sampled during the study period.



**KKIE:** Kiekoesvlei, **JV:** Jakkalsvlei, **YZS;** Yzerfontein soutpan, **RP;** Rooipan, **KRC;** Kennilworth Racecourse, **NS;** Noordhoek Soutpan, **SDI:** Silwer dam inflow, **SLO;** Silwer dam lower, **GR;** Groot Rondevlei, **MKV;** Malkopsvlei, **GWV;** Groot witvlei, **VK;** Verrekker, **DV;** Die vlakte, **WR;** Wagenboomsrivier, **SV;** Suurvlakte, **KPL;** Kleinplaats, **HGV;** Hoogvertoon, **DH;** Driehoek, **BP;** Burgerspan

**Figure 2.1:** ArcGIS image showing the geographical distribution of the wetlands sampled during the study period (ESRI, 2014. ArcGIS Desktop v.10.2. Redlands, CA: Environmental System Research Institute)

## **2.10 Lab procedures**

After following the sampling strategy described in Section 2.3–2.9, different type of wetlands and different type of substrates were sampled and can be observed in Table 2.1 below. The diatoms were preserved with ethanol (to a final concentration of 20% by volume). Diatoms were then processed using the hot hydrochloric acid (HCl) and potassium permanganate (KMnO<sub>4</sub>) method summarised by Taylor *et al.* (2007) & Hasle (1978).

### **2.10.1 Hot HCl and KMnO<sub>4</sub> method**

This method was recommended by Round *et al.* (1990) and was used because it has yielded good results in the past. This method was performed within a fume cabinet. After the raw diatom samples settled for 24 hours, allowing the diatoms to settle out of suspension, the top layer was decanted. The sample was then homogenised and ±5 ml poured into clearly labelled test tubes. The same volume of KMnO<sub>4</sub> was added to each test tube and allowed to stand for a further 24 hours. A small volume (± 2ml) of concentrated HCl (32%) was added to each test tube. The test tubes were placed in a large beaker containing one-third water; the beaker was then heated on a stove plate (±90°C) for 1–2 hours. While being heated more concentrated HCl (32%) was added in intervals until a clear yellowish solution was observed. Next, one drop of hydrogen peroxide was added to see if the oxidation process was complete. The oxidised samples were then poured (after vigorous swirling) into 10 ml centrifuge tubes and were rinsed at 2,500 rpm for 10 mins, after which the supernatant was poured off and the remaining pellet was re-suspended with distilled water; this process was repeated four times. After centrifuging the samples the concentrated diatom material was placed into glass bottles for future reference. It is important to store the diatom samples in glass bottles as opposed to plastic bottles, as glass releases silica, which counters the dissolution of diatom valves. These samples were then stored in labelled boxes (Taylor *et al.*, 2007a).

### **2.10.2 Diatom slide preparation**

Diatom slides should meet the following criteria (Taylor *et al.*, 2007 a):

- The mountant should be spread evenly right to the edge of the cover slip with no air bubbles.
- Ideally there should be 1–15 valves per microscope field, under a 1,000x magnification (no more than 25 valves per field).
- The valves should be distributed evenly over the whole area of the coverslip and not too dense.

In order to meet the criteria set out for the slides, the following method was implemented. After oxidising the sample using the hot HCl and  $\text{KMnO}_4$  method, an aliquot of each cleaned sample was dripped onto a cover slip to air dry. Using a pipette, a portion of the clean diatom material was drawn from the glass vials that were used to store the cleaned diatom material; there is no absolute amount used to obtain the correct dilution, the material is diluted until it appears only slightly cloudy to the naked eye. A drop of ammonium chloride ( $\text{NH}_4\text{Cl}$ ; 10% solution) was added to neutralise electrostatic charges and then 0.5 mL of the suspension was placed on a dry, cleaned cover slip and left to air dry. After the cover slips had dried they were placed on a hotplate to sublimate the residual ammonium chloride and to drive off any excess moisture. After the cover slips had cooled, one or two drops (depending on the temperature and quality of the mountant) of Pleurax (Taylor *et al.*, 2007 b) (phenol-sulphur resin) was dripped onto the cover slip. The mountant was not heated for too long in order to prevent it from turning too dark (burning). As the mountant remains viscous and after heating for a few minutes the slide was taken off the hot plate and was placed onto a cooler area on the workbench. After the slide was thoroughly cooled, the mountant was hard and brittle capable of chipping off when using a scalpel. The slides were then ready for microscopic examination.

**Table 2.1:** Study sites with their names, substrates sampled, HGM type, longitude and latitude

Wetland name	Substrata sampled	HGM Type (Ollis <i>et al.</i> , 2103)	Latitude	Longitude	Wetland name	Substrata sampled	HGM Type (Ollis <i>et al.</i> , 2013)	Latitude	Longitude
Die Vlakte	Emergent vegetation	Channelled valley-bottom	33°14'35.12"S	19°16'33.99"E	Groot Witvlei	Emergent vegetation	Depression	34°21'45.81"S	18°53'29.04"E
Wagenbooms River	Emergent vegetation	Unchannelled valley-bottom	32°47'33.53"S	19°14'49.69"E	Groot Rondevlei	Emergent vegetation	Depression	34°21'44.67"S	18°52'48.22"E
Sneeuberg Hut Stream	Sediment	Mountain seep	32°28'48.00"S	19°10'4.90"E	Silvermine Dam inflow	Emergent vegetation	Channelled valleybottom	34° 4'26.83"S	18°23'44.01"E
Driehoek	Sediment	Channelled valley-bottom	32°25'52.66"S	19° 8'54.66"E	Silvermine lower	Emergent vegetation	Floodplain	34° 7'43.83"S	18°25'50.05"E
Suurvlakte	Sediment	Channel valleybottom	32°36'15.35"S	19°12'13.31"E	Kiekoesvlei	Emergent vegetation	Depression	33°15'57.20"S	18°23'10.80"E
Blomfontein	Sediment	Mountain seep	32°26'7.36"S	19°13'7.03"E	Rooipan	Sediment	Saline depression	33°19'51.50"S	18° 9'49.10"E
Malkopsvlei	Emergent vegetation	Depression	34°21'22.76"S	18°54'20.83"E	Koekiespan	Emergent vegetation	Depression	33°14'13.60"S	18°20'39.10"E
Riversdale	Sediment	River	34° 3'40.77"S	21°20'49.28"E		Hoogvertoon	Sediment	Mountain seep	32°28'21.77"S
Verrekijker	Emergent vegetation	Channelled valley-bottom	33°26'10.93"S	19°10'33.21"E	Januariesvlei	Emergent vegetation	Depression	33°26'32.30"S	18°16'26.30"E
	Floating vegetation								
Kleinplaats	Emergent vegetation	Mountain seep	28°59'59.97"S	23°59'59.94"E	Yzerfontein Soutpan	Sediment	Saline depression	33°19'28.20"S	18°11'3.00"E
Kenilworth Racecourse	Emergent vegetation Sediment	Depression	33°59'55.60"S	18°29'1.00"E					
Noordhoek Soutpan (Lake Michelle)	Emergent vegetation	Perennial depression	34° 7'12.50"S	18°22'53.90"E	Burgers Pan	Emergent vegetation	Depression	33°16'8.48"S	18°19'20.10"E
					Riversdale	Sediment	River	34° 3'40.77"S	21°20'49.28"E

## 2.11 Diatom analysis

Three to four hundred diatom valves were counted per slide (Prygiel *et al.* 2002), using a high-resolution Nikon 80i microscope equipped with differential interference contrast (DIC) optics, a 100×1.4 N.A oil immersion objective, and a Digital Sight DS-U2 5MB camera. Diatoms were counted along a horizontal traverse and each whole frustule (i.e. not broken or damaged) observed in the field of view was counted and identified (CEN, 2004).

Sources, such as Krammer and Lange-Bertalot (1976–2002), Schoeman and Archibald (1976–1980), Round *et al.* (1990), Hartley (1996), Prygiel and Coste (2000), Kellog and Kellog (2002), Krammer (2002), and Taylor *et al.* (2007) were used to identify the diatoms to the lowest taxonomic level possible (usually species), and to review the nomenclature.

After the enumeration of all the diatom slides, the species and environmental data were entered into an Excel spreadsheet to determine the relative abundance of each diatom species according to Equation 2.1.

**Equation 2.1:** Formula used to calculate the relative abundance of diatom species encountered

$$\text{Relative abundance} = \frac{\text{Number of individual species present in each sample}}{\text{Number of species found within the sample}} \times 100 \% \quad \dots(2.1)$$

## 2.12 Diatom indices and calculations

The relative abundance was determined for each species to determine how common or rare a species was relative to other species in a given location or community. OMNIDIA Version 5.3 (Lecointe *et al.*, 1993) was then used to calculate the different diatom indices, the majority of which are based on Equation 2.2 below (developed by Zelinka & Marvan, 1961).

**Equation 2.2:** Zelinka and Marvan equation which calculates diatom index scores in order to determine water quality classes

Where:		$\sum_{j=1}^n a_j s_j v_j$
$a_j$ = abundance (proportion) of species j in sample	Index=	-----
$s_j$ = pollution sensitivity of species		$\sum_{j=1}^n a_j v_j$
indicator value.		$\dots(2.2)$

Diatom index scores range between 0–20 (presented in Table 2.2 below), where a decreasing score will typically represent an increasing level of pollution and a higher score will indicate decreasing levels of pollution. Diatom indices, used in the present study, function in the

following manner: Diatom taxa will be most abundant in a sample taken from a water body that is closely related to the particular water quality determinant (Harding & Taylor, 2011). The taxon that is found more recurrently within a sample has more influence on the water quality index score than taxa that is found less. The particular diatom species used in the equation are assigned two values as follows:

- i) Sensitivity (s) values ranging from 1 (very tolerant species) to 5 (very sensitive species); and
- ii) Indicator (v) values ranging from 1 (for species which are not very specific for their class of tolerance) to 3 (for species which are very good indicators (Harding & Taylor, 2011).

The sensitivity value reflects the attraction or tolerance of the diatom towards a certain water quality (good or bad), while the indicator value indicates how strong (or weak) the relationship is. In addition, these values are then weighted by the abundance of the diatom in the sample (the amount of a certain diatom that occurs in the sample in relation to the total number counted) (Kelly, 1998). For instance, if the diatom species *Nitzschia palea* was dominant at a site it would typically represent an increasing level of pollution with a lower index score. *Nitzschia palea* is assigned a pollution sensitivity score of 1 (very tolerant species) and an indicator value of 3 (species which are good indicator species). The assessment of the water quality for all samples was carried out through the OMNIDIA programme (Version3.1) (Lecointe *et al.*, 1993).

The class limits in Table 2.2 were first set by Prygiel and Coste (2002) and will be used to categorise each wetland investigated in this study into a water quality class and ecological category. This will be described in Section 4.1.

**Table 2.2:** Interpretation of index scores generated by the indices used throughout the study to describe the water quality classes and Ecological Categories (from Harding & Taylor, 2011)

Interpretation of index scores		
Ecological Category (EC)	Water quality Class	Index Score
A	High quality	18 - 20
A/B		17 - 18
B	Good quality	15 - 17
B/C		14 - 15
C	Moderate quality	12 - 14
C/D		10 - 12
D	Poor quality	8 - 10
D/E		6 - 8
E	Bad quality	5 - 6
E/F		4 - 5
F		<4

The above indices form the foundation for developing computer software to estimate biological water quality using diatoms. OMNIDIA (Lecointe *et al.*, 1993) is one such software package. It has been approved by the European Union, is used with increasing frequency in Europe and will be used for this study. The programme is a taxonomic and ecological database of 7,500 diatom species, and contains indicator values and degrees of sensitivity for given species (e.g. as described for the species *N.palea* above). It permits the user to perform rapid calculations of indices of general pollution, saprobity (the occurrence of decomposed organic matter in an aquatic system) and trophic state, and indices of species diversity, as well as of ecological systems (Szczepocka, 2007). The main difference between indices is in the indicator sets (number of indicators and list of taxa) used in calculations (Eloranta & Soininen, 2002). The Specific Pollution sensitivity Index (SPI) has been used in places such as France, correlated with parameters related to organic pollution, ionic strength, and eutrophication, and provides a complex estimation of water quality. The SPI was developed in the early 1980s based on 189 surveys and has been updated since 1982 to add in any changes resulting from new knowledge of diatom taxonomy or diatom ecology (Coste in Cemagref, 1982). The Generic Diatom Index(GDI) works on the same basis as the SPI, although the GDI offers the advantage that diatoms need only be identified to genus level and not species level (Coste & Ayphassoro, 1991). The Biological diatom Index (BDI) is used for the biological assessment of water quality. This index is based on a list of 209 key species showing different pollution sensitivities. The pollution sensitivity, or 'ecological profile', is determined through the species presence. The results from the TDI (Kelly & Whitton, 1995) were also taken into account as this index provides the percentage pollution-tolerant diatom valves (PTVs) in a sample, and was developed for monitoring sewage outfall (orthophosphate-phosphorus concentrations), and not general stream quality. The presence of more than 20% PTVs shows significant organic impact. The diatom indices can be arranged according to their objective:

- a) Trophic indices for evaluating nutrient levels in watercourses, e.g. TDI.
- b) Pollution indices based on the sensitivity and amplitude of diatoms towards pollution considered as a simple factor, e.g. SPI, GDI and BDI.

The indices mentioned below were used to describe the biological water qualities for each of the wetlands. As these indices had been tested by Taylor *et al.* (2004) for use in South Africa (in rivers) they were also used in a previous study on the wetlands in the Western Cape by Matlala (2010) as described in Chapter 1, Section 1.9.

**%PTV** = Pollution-tolerant valves % (Kelly & Whitton, 1995) indicates whether pollution is present in a given sample by reflecting the percentage of pollution-tolerant taxa present within a given sample, if over 20% it may indicate the presence of organic pollution.

**GDI** = Generic diatom Index: (Coste & Ayphassoro, 1991). This index offers the advantage that diatoms need to be identified only to the genus level. It uses every freshwater genus in the database. This index uses five sensitivity classes. Sensitivity (s) values vary from 5 (very sensitive) to 1 (very tolerant), and indicator values (v) vary from 1–3 ((s) value and (v) value – refer to Zelinka & Marvan equation).

**SPI** = Specific Pollution sensitivity Index (Coste in Cemagref, 1982), is correlated with parameters related to organic pollution, ionic strength, and eutrophication, and gives a complex estimation of water quality. It utilises all the identified to species level taxa. It is one of the most precise indexes commonly used for calibration and estimation of other indexes. The scale runs from 1 (worst) to 5 (best) water quality. It is based on the same principle as the GDI but works at the level of species rather than genus.

**BDI** = Biological diatom Index (Lenoir & Coste, 1996). The BDI is used for the biological assessment of water quality. This index is based on a list of 209 key species showing different pollution sensitivities. The pollution sensitivity, or ‘ecological profile’, is determined through the species presence.

### **2.13 Multivariate analysis**

CCA is a multivariate gradient analysis technique used extensively in the environmental sciences (Line *et al.*, 1994). The technique perceives the patterns of variation in diatom community composition, and attempts to explain it according to the environmental variables provided (Ter Braak & Verdonschot, 1995). In order to determine the relationship between the environmental variables such as pH, dissolved oxygen (%) and electro-conductivity (mS/m) and diatom assemblages, CCA biplots were drawn using CANOCO Version 4.5 (Ter Braak & Smilauer, 1998). In summary, CCA is a method that can help aquatic ecologists unravel how an assembly of species concurrently respond to external factors, such as pollutants, environmental variables and management regime, using data either from observational studies or from designed experiments (Birks *et al.*, 1990). Only diatom taxa occurring in at least one sample with a relative abundance of more than 10%, were included in drawing up the biplots. The relationships between water quality variables and the calculated index scores were determined with Pearson’s correlation coefficient, carried out in STATISTICA 11 (Statsoft, 2011). The Pearson coefficient determined how closely different variables were related to one another. The chemical data, excluding pH (already in log form) were Log<sub>10</sub>-transformed to normalise the data.

## CHAPTER 3: Results and discussions

### DIATOM AND WATER QUALITY VARIABLES

#### 3.1 Diatom taxa and environmental variables data

The following section will describe the dominant taxa that occurred at each wetland studied, and full species lists are provided in Appendix 1 (species are arranged according to order of high dominance (top) towards lower dominance (bottom)). The relative abundance of species can be found in Appendix 1.

The list of dominant species (abundance  $\geq 10\%$ ), together with the substrate that was sampled are given in Table 3.1 below, the *s* and *v* values accorded by OMNIDIA Version 5.3 (Lecointe *et al.* 1993) are also provided. Sensitivity (*s*) values range from 1 (very tolerant species) to 5 (very sensitive species). Indicator (*v*) values range from 1 (for species which are not very specific for their class of tolerance) to 3 (for species which are very good indicators) as described in Section 1.10.

During the course of the study 324 species belonging to 60 genera were found, distributed among the families *Achnanthidiaceae*, *Achnanthaceae*, *Bacillariaceae*, *Eunotiaceae*, *Cymbellaceae*, *Gomphonemataceae*, *Fragilariaceae*, *Melosiraceae*, *Naviculaceae*, *Rhoicospheniaceae*, *Rhopalodiaceae* and *Surirellaceae*. Most species observed throughout the study were cosmopolitan species (commonly occurring throughout the world) and well documented in the literature. Some members of the genus *Eunotia* were not identified to species due to the complexity of the genus (some of the species described in this section are illustrated in Appendix 2).

The most widespread and abundant taxa were *Achnanthidium* spp., *Cyclotella meneghiniana*, *Eunotia bilunaris*, *Gomphonema parvulum*, *Eunotia incisa*, *Staurosira elliptica*, *Fragilaria bicapitata*, *Cocconeis pediculus*, *Pinnularia intermedia*, *Brachysira brebissonii*, *Eunotia* spp., *Gomphonema* spp., *Amphora coffeaeformis*, *Amphora veneta*, *Planothidium engelbrechtii*, *Aulacoseira ambigua*, *Eunotia genuflexa*, *Nitzschia frustulum*, *Melosira nummuloides* and *Nitzschia palea*, species that are also commonly found in rivers.

*Eunotia* spp. are sensitive towards pollution and are good indicator species, occurring in acidic flowing or standing water with low electrolyte content (Taylor *et al.*, 2007b). *Nitzschia littoralis*, *Melosira nummuloides* and *Planothidium engelbrechtii* are all indicators of salinity. Species indicative of organic pollution include *Amphora veneta* and *Nitzschia palea*.

Individuals in a community have specific requirements or optimum conditions in which they can survive, and as in any community, should there be a disturbance in the natural living conditions, the sensitive individuals or species are the first ones to die, whereas the more resistant species would proliferate and become dominant as there would be less competition for resources (Wu *et al.*, 2011). Sensitive species were observed during the course of the study. As presented in Table 3.1 below, each species was given a pollution sensitivity value and indicator value. Despite the once-off sampling regime and the almost complete lack of knowledge of the diatom flora of the south-western Cape wetlands, a number of useful groups emerged from the analysis. The following species (Table 3.1), *Eunotia genuflexa*, *Eunotia flexuosa*, *Eunotia* sp., *Rhopalodia gibberula*, *Navicula reichardtiana*, *Achnantheidium crassum*, *Brachysira brebissonii*, *Tabellaria flocculosa*, are known as sensitive species (Karthick, et al., 2013 & Taylor 2007b), which means that should there be any disturbances where these species are dominant, they will be the first ones to die off if changes occur within the wetland. LangeBertalot (1978) stated that a species is indicative of the upper limits of pollution that they can tolerate and not the lower limit. Thus, species that develop well in polluted zones (e.g. *Gomphonema parvulum*, *Nitzschia palea*, *Lemnicola hungarica* and *Navicula recens*. in this case) may also occur in fairly clean water. Their value as an indicator is their presence in polluted water. Three endemic species (native to South Africa) were observed, all at abundance values of <5%. They are *Cocconeis engelbrechtii*, *Navicula dutoitana* and *Achnantheidium standerii*.

The ecological preferences of these endemic species are as follows and images can be observed in Appendix 2: *Cocconeis engelbrechtii*. This endemic South African species occurs in alkaline inland and coastal waters with highly elevated electrolyte concentrations (i.e. brackish waters) (Taylor *et al*, 2007a). *Navicula dutoitana*, until now has only been recorded in South Africa, and the autecology is still unknown (Taylor *et al*, 2007 a). *Achnantheidium standerii*. This species is endemic to South Africa and is found in acidic, oligotrophic, well-oxygenated water (Taylor *et al.*, 2007a).

The rest of the species that were encountered in this study are cosmopolitan species that are well-documented in the literature e.g. Krammer and Lange-Bertalot (2000–2008), Schoeman and Archibald (1976–1980), Round *et al.* (1990), Hartley (1996), Prygiel and Coste (2000), Krammer (2002), Taylor *et al.* (2007), and Kellog and Kellog (2002).

**Table 3.1:** The dominant species found during the course of the study, the pollution sensitivity value and indicator value of each species (Lecoite et al., 1993)

Wetland name	Substrate sampled at each wetland	Dominant species found at each site	Sensitivity value (s)	Indicator value (v)	Wetland name	Substrate sampled at each wetland	Dominant species found at each site	Sensitivity value (s)	Indicator value (v)
Die Vlakte	Emergent vegetation	<i>Achnanthydium saprophilum</i> Kobayasi & Mayama	1	3	Groot Witvlei	Emergent vegetation	<i>Staurosira elliptica</i> (Schumann) Williams & Round	3	1
		<i>Gomphonema lagenula</i> Kützing	2	3			<i>Cocconeis placentula</i> Ehrenberg	4	1
		<i>Eunotia</i> sp. 1 C.G. Ehrenberg	5	2			<i>Staurosira construens</i> (Ehrenberg) Hustedt	4	1
Wagenbooms River	Emergent vegetation	<i>Achnanthes</i> sp. J.B.M. Bory de St. Vincent	5	2	Groot Rondevlei	Emergent vegetation	<i>Navicula</i> sp. J.B.M. Bory de St. Vincent	3	1
		<i>Tabellaria flocculosa</i> (Roth) Kützing	5	1			<i>Tabellaria flocculosa</i> (Roth) Kützing	5	1
		<i>Rhoicosphenia abbreviata</i> (Agardh) Lange-Bertalot	4	1			<i>Eunotia porcellus</i> Cholnoky	5	2
Sneeuberg Hut Stream	Sediment	<i>Eunotia</i> sp. C.G. Ehrenberg	5	2	Silvermine Dam inflow	Emergent vegetation	<i>Planothidium engelbrechtii</i> (Cholnoky) Round & Bukhtiyarova	3	2
		<i>Psammothidium</i> sp. Bukhtiyarova & Round	5	2			<i>Gomphonema parvulum</i> (Kützing) Kützing	2	1
		<i>Eunotia</i> sp 5 C.G. Ehrenberg	5	2			<i>Nitzschia</i> sp. 11 A.H. Hassall	1	2
Driehoek	Sediment	<i>Craticula molestiformis</i> (Hustedt) Lange-Bertalot	4	3	Silvermine lower	Emergent vegetation	<i>Fragilaria bicapitata</i> A. Mayer	5	2
		<i>Eunotia</i> sp.5 C.G. Ehrenberg	5	2			<i>Hippodonta capitata</i> Ehrenberg Lange-Bertalot	4	1
		<i>Eunotia</i> sp. 1 C.G. Ehrenberg	5	2			<i>Gomphonema parvulum</i> (Kützing) Kützing	2	1
Suurvlakte	Sediment	<i>Eunotia flexuosa</i> (Brébisson) Kützing	5	2	Kiekoesvlei	Emergent vegetation	<i>Nitzschia palea</i> (Kützing) W. Smith	1	3
		<i>Eunotia incisa</i> Gregory	5	1			<i>Nitzschia</i> sp.2 A.H. Hassall	1	2
		<i>Frustulia rostrata</i> Hustedt	5	2			<i>Navicula</i> sp.3 J.B.M. Bory de St. Vincent	3	2

Wetland name	Substrate sampled at each wetland	Dominant species found at each site	Sensitivity value (s)	Indicator value (v)	Wetland name	Substrate sampled at each wetland	Dominant species found at each site	Sensitivity value (s)	Indicator value (v)
Blomfontein	Sediment	<i>Nitzschia palea</i> (Kützing) W. Smith	1	3	Rooipan	Sediment	<i>Amphora coffeaeformis</i> (Agardh) Kützing	2	3
		<i>Amphora</i> sp. C.G. Ehrenberg ex Kützing	3	2			<i>Navicula pusilla</i> W. Smith	5	3
		<i>Frustulia rostrata</i> Hustedt	5	2			<i>Achnanthes</i> sp. 3 J.B.M. Bory de St. Vincent	5	2
Malkopsvlei	Emergent vegetation	<i>Aulacoseira ambigua</i> (Grunow) Simonsen	3	1	Koekiespan	Emergent vegetation	<i>Amphora coffeaeformis</i> (Kützing) Archibald & Schoeman	2	3
		<i>Tabellaria flocculosa</i> (Roth) Kützing	5	1			<i>Nitzschia communis</i> Rabenhorst	1	3
		<i>Rhopalodia gibberula</i> (Ehrenberg) O. Muller	5	3			<i>Navicula</i> sp. J.B.M. Bory de St. Vincent	3	2
Riversdale	Emergent vegetation	<i>Eunotia</i> sp.5. C.G. Ehrenberg	5	2	Hoogvertoon	Sediment	<i>Pinnularia intermedia</i> (Lagerstedt) Cleve	5	2
		<i>Nitzschia linearis</i> (Agardh) W.M. Smith	3	2			<i>Pinnularia borealis</i> Ehrenberg	5	3
		<i>Eunotia bilunaris</i> (Ehrenberg) Mills	5	2			<i>Pinnularia divergens</i> W.M. Smith	5	2
Verrekyker	Emergent vegetation	<i>Fragilaria ulna</i> var. <i>biceps</i> (Kützing) Lange-Bertalot	3	1	Januariesvlei	Emergent vegetation	<i>Planothidium engelbrechtii</i> Cholnoky Round & Bukhtiyarova	2	3
		<i>Cocconeis placentula</i> Ehrenberg	4	1			<i>Gomphonema pumilum</i> (Grunow) Reichardt & Lange-Bertalot	5	1
		<i>Navicula recens</i> (Lange-Bertalot) Lange-Bertalot	3	2			<i>Nitzschia microcephala</i> - Grunow in Cleve & Moller	1	3
Kleinplaats	Emergent vegetation	<i>Cyclotella meneghiniana</i> Kützing	2	1	Yzerfontein Soutpan	Sediment	<i>Nitzschia littoralis</i> Grunow in Cl. & Grunow.	2	2
		<i>Navicula disjuncta</i> Hustedt	4	3			<i>Nitzschia</i> sp A.H. Hassall	1	2
		<i>Eunotia</i> sp. C.G. Ehrenberg	5	2			<i>Eunotia</i> sp. C.G. Ehrenberg	5	2
Kenilworth Racecourse	Emergent vegetation	<i>Eunotia bilunaris</i> (Ehrenberg) Mills	5	2	Burgers Pan	Sediment	<i>Nitzschia littoralis</i> Grunow	2	2
		<i>Eunotia formica</i> Ehrenberg	5	1			<i>Eunotia</i> sp C.G. Ehrenberg	5	2
		<i>Gomphonema gracile</i> Ehrenberg	4	1			<i>Amphora coffeaeformis</i> (Agardh) Kützing	2	3
Noordhoek Soutpan (Lake Michelle)	Emergent vegetation	<i>Staurosira elliptica</i> Ehrenberg	3	1	Khayalitsha pool	Emergent vegetation	<i>Gomphonema parvulum</i> (Kützing) Kützing	2	1
		<i>Epithemia adnata</i> (Kützing) Brébisson	4	3			<i>Nitzschia amphibia</i> Grunow	2	2
		<i>Nitzschia microcephala</i> Grunow in Cleve & Moller	1	3			<i>Nitzschia desertorum</i> Hustedt	1	2

### 3.2 An overview of the water quality variables taken throughout the study

The following section will only give an overview of the different water quality parameters (observed in Table 3.2) that were measured by the Department of Water Affairs and Sanitation (as described in section 2.3). The water quality values will also be used for further discussion in section 3.3, to determine the relationship between diatom communities and environmental variables.

**Water quality** refers to:

*...the chemical, physical and biological characteristics of water. It is a measure of the condition of water relative to the waters' physical chemistry, requirements of one or more biotic species and to any human need or purpose (Johnson et al., 1997; Diersing, 2009).*

**Table 3.2:** The environmental variable conditions at the time of sampling for each wetland

Wetland name	EC (mS/m)	pH	Dissolved oxygen (%)	Phosphate (mg/L)	Total Inorganic Nitrogen (mg/L)
Noordhoek Soutpan	227	7.24	50	0.021	0.006
Kenilworth Racecourse	31.2	6.7	13	0.02	0.006
Rooipan	4440	9.45	116	0.139	0.006
Yzerfontein Soutpan	12500	7.95	101	0.135	0.046
Burgers Pan	13260	7.77	98.7	0.111	1.099
Kiekoesvlei	49.5	7.4	82	1.166	0.0067
Koekiespan	18300	7.76	97.5	0.204	1.326
Januarievlei	322	7.43	101	0.585	0.173
Modderrivier	466	7.56	88	0.022	0.021
Witsand Aquifer Recharge	55.9	8.06	97	0.743	1.064
Silvermine Dam inflow	1.58	4.04	89	0.022	0.017
Silvermine lower	3.96	7.67	76	0.032	0.804
Malkopsvlei	23	6.3	9.9	0.001	0.083
Groot Rondevlei	39.2	6.05	9.5	0.065	0.105
Groot Witvlei	78.7	7.97	9.9	0.062	0.118
Riversdale	24	6.3	3	0.004	0.072
Blomfontein	4.63	4.63	13	0.004	0.145
Driehoeks	1.88	7.55	13.2	0	0.077
Sneeuberg Hut	3.9	4.77	9.3	0	3.096
Hoogvertoon	2.94	5.7	9.4	0.05	0.162
Middleberg Wes	2.04	4.9	13	0.072	0.061
Suurvlakte	5	4.1	9.6	0.006	0.091
Wagenbooms River	18	6.1	14.4	0.016	0.451
Die Vlake	36	6.2	8	0.047	0.848
Verrekyker	32	6.24	4.2	0.098	0.125
Khayelitsha Pool	96	6.92	11.1	0.643	0.899

### 3.2.1 Electrical conductivity

Many of the wetlands that were classified as freshwater systems had low electrical conductivity measurements; these included wetlands that were situated in and near the Cederberg (Blomfontein, Suurvlakte, Sneeuberg hut and Driehoek). The electrical conductivity across all samples varied roughly between 3.00–18300 mS/m; Blomfontein represented the lowest, and Koekiespan the highest EC values. Low EC values were recorded for the following wetlands: Die Vlake, Verrekyker, Blomfontein, Suurvlakte, Hoogvertoon and Middelburg Wes. Higher EC values were recorded for wetlands that were classified as depression pans, such as Burgerspan, Yzerfontein soutpan, Koekiespan and Rooipan, where the highest EC value was recorded for Koekiespan 18300 mS/m, and the second highest value of 13260 mS/m was recorded at Burgerspan, which was expected within these naturally saline systems. Agricultural land uses were present around these pans, which may have led to higher EC values. The wetlands that were classified as pans were expected to have higher values as these systems are naturally more saline (Malan & Day, 2005). The highest value recorded was for Koekiespan; historically salt was obtained from the pan and evidence of excavations to form shallow evaporation pans was seen during the sampling trip, which explains the high salinity values obtained. Burgerspan (also naturally saline) which had the second highest value of 13 260 mS/m was situated largely within agricultural land which could explain the high salinity values and might have been due to agricultural runoff, it can also be associated with natural geology conditions or evaporation, exacerbated by agricultural return flows (Malan *et al.*, 2014).

### 3.2.2 pH

The pH values that were recorded for the wetlands roughly ranged between 4–10. The majority of the wetlands that were sampled fell within a circum-neutral range (pH6-8), including Noordhoek soutpan, Yzerfontein, Burgerspan and Koekiesvlei, etc. (as presented in Table 3.2.) Wetlands in Table 3.2 have acidic conditions which can be explained as a natural condition, since it is a well-known phenomenon that waters in the south-western and southern Cape tend to be naturally acidic, caused by tannins in fynbos vegetation (DWAF, 1996; Waterman & Mole, 1994). Only two wetlands were recorded as alkaline, namely Witsand aquifer (8.06), and Rooipan (9.45). Witsand aquifer is not naturally alkaline as it is fed by effluent water which could explain the high pH value. Januarievlei displayed different results to those expected; the wetland is situated in a natural fynbos area where the pH was recorded at a value of 7.43, contrary to the expectation that the system would be more acidic as it is within a natural fynbos area (Malan *et al.*, 2014).

### 3.2.3 Dissolved oxygen

The Dissolved Oxygen (DO%) displayed interesting results, as according to Dallas and Day (2004), low salinity levels should lead to higher oxygen levels, whereas in this case the water quality indicated otherwise. The wetlands Rooipan, Yzerfontein, Burgerpan and Koekiespan all had high salinity levels with high dissolved oxygen levels, whereas high salinity levels should lead to lower oxygen levels; this might be due to high diffusion rates between the water and the atmosphere, or high photosynthesis taking place within the system. Low dissolved oxygen was recorded for the mountain seep wetlands located in the Cederberg. Again according to Dallas & Day (2004) it was expected that these low temperature water bodies would have high dissolved oxygen levels, but low levels of oxygen were detected, and this might be explained by the fact that these mountain wetlands are fed by anoxic groundwater. Sneeuberg Hut Stream, Driehoek and Blomfontein were located at high altitudes, which could also explain the low oxygen levels as the atmospheric pressure differs with altitude. Dissolved oxygen (DO) can also be affected by the movement of water; rivers are capable of exchanging more oxygen with the atmosphere because water flows fast and rapidly, whereas wetlands usually have stagnant waters which could lead to lower rates of diffusion and thus lower DO measurements. Mitsch (1989) explained that oxygen criteria developed for other aquatic habitats may not be appropriate for wetlands, which can either be naturally low in DO, or experience DO depletion on a daily basis. The majority of the wetlands had low levels of oxygen that might be explained as naturally occurring conditions as described by Mitsch (1989).

### 3.2.4 Phosphate (PO<sub>4</sub>-P)

The highest levels of phosphate were recorded for the following wetlands (Table 3.2): Koekiespan (agricultural impacts), Khayelitsha (urban development), and Witsand Aquifer Recharge (storm water). These results were expected because these wetlands occur in areas that experience daily impacts from human activity. Interestingly the highest phosphorus levels were recorded at many of the saline depressions (e.g. Yzerfontein Salt Pan, Rooipan and Burgers pan). The lowest levels of phosphates were recorded at Blomfontein, Driehoek, Hoogvertoon and Sneeuberg Hut; low levels were expected at these sites as they are located in regions (Appendix 5) with little to no human impact. Januarievlei (Rondeberg) displayed an unexpectedly high level of 0.580 mg PO<sub>4</sub>/L (Malan *et al.*, 2014). Januarievlei is situated in the least impacted area (can be observed in Appendix 5), the high value recorded for this wetland might be natural, as there was no visible human impact present during the sampling period (Malan *et al.*, 2014).

### **3.2.5 Total inorganic nitrogen**

Total inorganic nitrogen refers to the sum of nitrite, nitrate and ammonium in a sample (DWAF,1996). The highest values recorded were at the following sites: Burgerspan, Koekiespan, Witsand aquifer and Khayelitsha as was expected, since, these wetlands are located in impacted areas (Appendix 5). Burgerspan and Koekiespan are situated in agricultural areas, which could explain the nutrient enrichment (via agricultural runoff) which can lead to algal biomass production. The mountain seep (Sneeuberg Hut) also had high nitrogen values, but in this case, it is naturally occurring instead of being related to human impact. Sneeuberg Hut is located (Appendix 5) in the Cederburg mountains where low or no impacts were visible. High nitrate levels were recorded for Khayalitsha pool; this wetland is situated in an area that is associated with a high impact area due to urban development around it, which could explain the high values of nitrogen that were recorded (0.728mg/L). Koekiespan also had high values of nitrogen, this wetland was also associated with a high impact area due to agricultural activities in the surrounding area. Januarievlei had higher values of nitrogen than expected (0.173mg/L); it would be interesting to further investigate this wetland in depth, as there were no visual surrounding impacts (Malan et al., 2014).

The following section will focus on how the diatom communities mentioned in Section 3.1 responded to each of the above-mentioned environmental variables via statistical analyses.

### **3.3 Diatom community composition in relation to measured environmental variables**

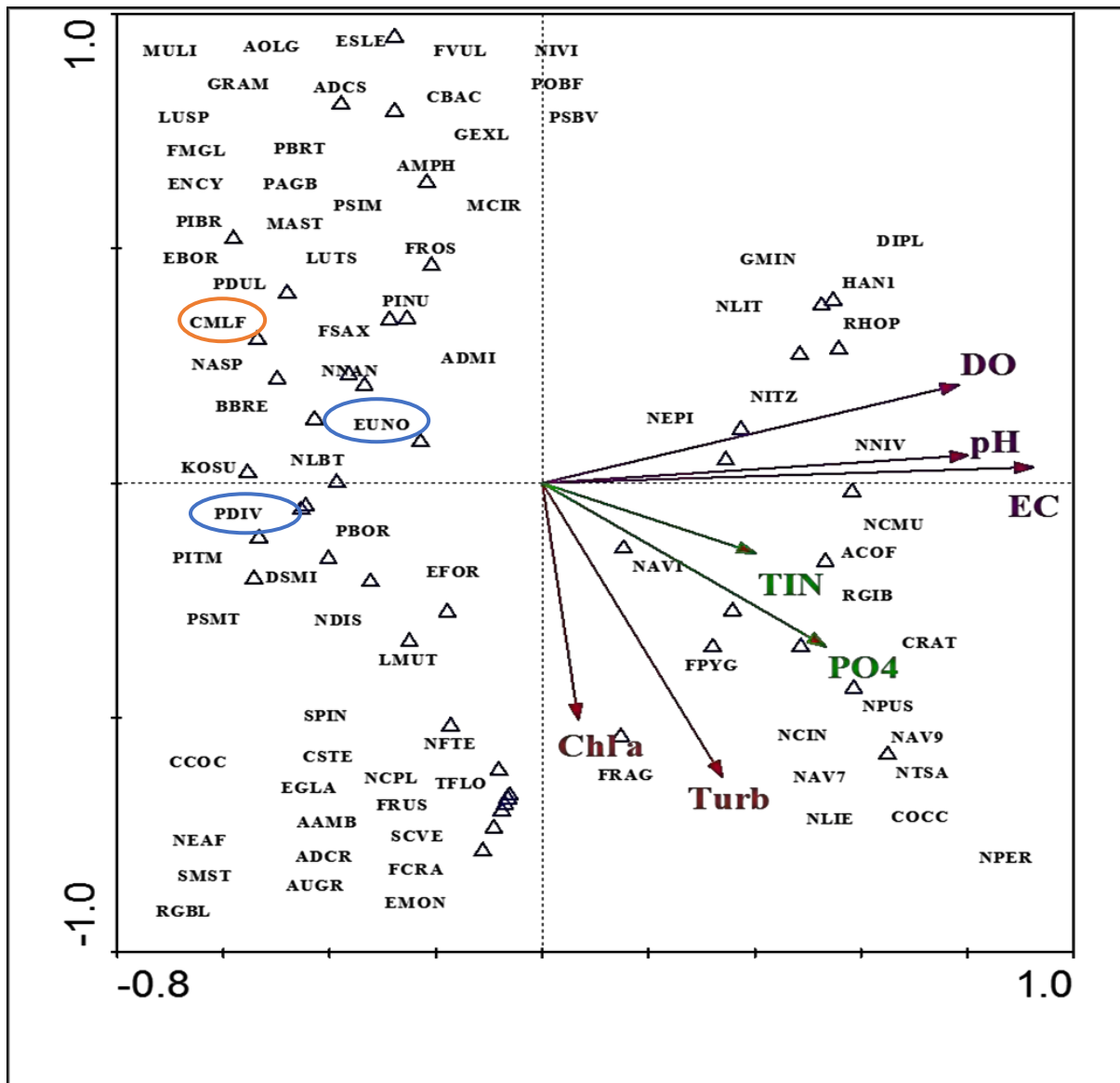
It is necessary to determine how human activities (agricultural, informal settlements, industrial and mining, etc.) affect water quality and biological communities. The study of the algal group known as diatoms (Bacillariophyta) provides a valuable tool for assessing the quality of natural and polluted waters (Karthick *et al.*, 2013). Diatoms are an integral constituent of the aquatic biota and the association of species living at any time in a given locality is the result of the physico-chemical conditions of the surrounding waters over a period of time. Each species in an association has its own particular ecological requirements. It is the knowledge of these specific requirements that enables the diatomist to draw conclusions concerning the composition or quality of the water (U.S. EPA, 2002; Christie & Smol, 1993; McCormick & O'Dell, 1996). Canonical Correspondence Analysis (CCA) is a multivariate gradient analysis technique used extensively in environmental science. The technique perceives the patterns of variation in diatom community composition and explains it best according to the environmental variables (ter Braak & Verdonschot, 1995).

In this section, the relationship between diatom communities and the following environmental variables, pH, electrical conductivity (EC), Dissolved Oxygen (DO), nitrite (NO<sub>2</sub>-N) + nitrate (NO<sub>3</sub>-N) + ammonium (NH<sub>4</sub>-N) = Total Inorganic Nitrogen (TIN), phosphate (PO<sub>4</sub>-P), Turbidity (Turb), and chlorophyll a (Chl a) was explored using CCA. As mentioned in Section 2.13 the data was log transformed (except pH) in order to normalise the data. The normalised data and the acronyms used on the CCA biplot can be found in Appendix 3.

The Eigen values given in Table 3.3 are a measure of the extent of variance represented by each axis. The sum of the canonical eigenvalues is the sum of those axes that represent a function of the environment. The first three axes account for 52.3% of the effect (termed the species-environment relation) that the supplied environmental variables had on species' composition (Figure 3.1). Figure 3.1 shows the relationship that diatom species have with the environmental variables.

**Table 3.3:** Summary of the CCA analysis on diatom community composition and measured environmental variables (n=28)

Axes	1	2	3	4	Total inertia
Eigenvalues	0.67	0.552	0.542	0.501	14.803
Species-environment correlations	0.966	0.949	0.952	0.947	
Cumulative percentage variance					
of species data	4.5	8.3	11.9	15.3	
of species-environment relation:	19.9	36.2	52.3	67.2	
Sum of all eigenvalues					14.803
Sum of all canonical eigenvalues					3.374



**Figure 3.1:** CCA biplot for the wetlands showing the relationship between dominant diatom species (>10% relative abundance) and environmental variables. n=28

In Figure 3.1, the distances between the environmental variables indicate the degree of similarity in species composition of the samples. Distances between positions of species along the plot indicate how similar/different they are in their distribution along gradients. Species close together are likely to respond similarly to the environmental variables measured. Long arrows indicate a large and important effect of that environmental variable on the distribution of species in the plot and the angle between an arrow and an axis indicates the correlation of that variable to that axis—if the angle is small then the variable is strongly correlated with that axis. Species positions can also be projected at 90 degrees onto environmental variables. If they project towards the middle (origin) of the arrow, then they occur at average conditions for that variable, but if they project towards the head of the arrow they are most abundant at

above-average values for the variable, and if they project towards the tail they are most abundant at below-average values (Ter braak, 1998).

In this ordination EC, DO, phosphate (PO<sub>4</sub>-P), Turbidity (Turb) and pH are most strongly correlated with the distribution of the taxa in multidimensional space, Total Inorganic Nitrogen (TIN) and, to a lesser extent, chlorophyll *a*. Species that seem to cluster at the lowest EC, pH and DO values (towards the projected tails of their arrows) are PDIV (*Pinnularia divergens*), KOSU (*Kobayasiella subtilissima*), PITM (*Pinnularia intermedia*), and DSMI (*Diploneis smithii*). Species clustering at higher EC, pH and DO values (towards the direction of the arrow) are NNIV (*Navicula nivalis*), NCMU (*Nitzschia commutatoides*), RGIB (*Rhopalodia gibba*), GMIN (*Gomphonema minutum*), and NLIT (*Nitzschia littoralis*).

Species close to lowest values for TIN and phosphate are EUNO (*Eunotia* spp.), BBRE (*Brachysira brebissonii*) and NNAN (*Nitzschia nana*). The species present in large numbers at the highest TIN and phosphate values are NAVI (*Navicula* spp.), FPYG (*Fallacia pygmaea*) and NPUS (*Navicula pusilla*).

Species clustering closest to high and moderate chlorophyll *a* and turbidity are FRAG (*Fragilaria* spp.), FPYG (*Fragilaria pygmaea*), AAMB (*Aulacoseira ambigua*) and AUGR (*Aulacoseira granulata*) and species closest to lower chlorophyll *a* and turbidity values are MUELI (*Muelleria linearis*), FMGL (*Frustulia magaliesmontana*) and GRAM (*Grammatophora* spp.).

With one exception (encircled in orange), species included in the CCA ordinated as would be expected for samples from local rivers and from the international literature. The exception is the species CMLF (*Craticula molestiformis*), which is reported to occur in relatively saline, often heavily polluted water, including sewage effluent (e.g. Levkov *et al.*, 2016; Taylor *et al.*, 2007a; and Krammer & Lange-Bertalot, 1986–91). In the biplot (Figure 3.1), however, in this study, CMLF seems to prefer electrolyte-poor waters with low nutrients. The rest of the species ordinate as expected according to literature (Cholnky 1968; Teply and Bahls, 2006, Luís *et al.*, 2008) Two examples of these relationships will suffice to explain this (blue circles in Figure 3.1). *Eunotia* sp. occurs in waters relatively poor in nutrients and with moderate electrical conductivity. *Pinnularia divergens* (PDIV), a montane species, occurs in acidic, oligotrophic, electrolyte-poor water (50-100 µS cm<sup>-1</sup>), optimally at pH 5.8 - 6.1 (Cholnoky, 1968; Taylor *et al.*, 2007).

The CCA shows that in general, diatom species react to change in water quality in an expected manner, showing that for the wetlands in question the diatom indices can be used outside their continent of derivation and might be helpful tools in indicating wetland water quality. It seems

that the species identified in this study as ‘European’ do respond in the same way to water quality variables, suggesting that they are cosmopolitan.

In the section below the hypotheses about these indices being helpful tools in the inference of wetland water quality will be tested via Pearson correlation, which will indicate if diatom indices correlate with trends in environmental variables.

### 3.4 Correlations between environmental variables and diatom index scores

Pearson’s correlation was used to ascertain the relationship between the diatom index scores and the environmental variables measured during this study as presented in Table 3.4 below.

As noted in Section 1.9 the diatom indices used for the correlation measurements were %PTV (Pollution-Tolerant Valves %), GDI = Generic Diatom Index: (Coste & Ayphassoro, 1991), SPI = Specific Pollution sensitivity Index (Coste in Cemagref, 1982), and BDI = Biological Diatom Index (Lenoir & Coste, 1996) because they have been tested and proved useful for monitoring South Africa’s rivers and wetlands by Taylor (2004) and Matlala *et al.* (2011).

**Table 3.4:** Pearson Correlation coefficients between measured environmental variables and diatom index scores. Significant correlations at  $p < 0.05$ ,  $n = 28$ . Non-significant correlations deleted (.....)

	EC (mS /m)	pH	Temperature (°C)	Dissolved oxygen (%)	Ammonium (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Turbidity (NTU)
GDI	.....	.....	.....	.....	.....	.....	.....	.....	.....
SPI	<b>-0.4308</b> <b>p=0.022</b>	<b>-0.4173</b> <b>p=0.02</b>	<b>-0.4106</b> <b>p=0.030</b>	<b>-0.5511</b> <b>p=0.002</b>	.....	.....	.....	<b>-0.5419</b> <b>p=0.003</b>	<b>-0.4951</b> <b>p=0.007</b>
BDI	<b>-0.6363</b> <b>p=0.000</b>	<b>-0.4884</b> <b>p=0.008</b>	<b>-0.4665</b> <b>p=0.012</b>	<b>-0.5651</b> <b>p=0.002</b>	.....	.....	.....	<b>-0.4226</b> <b>p=0.025</b>	.....
%PTV	.....	.....	.....	.....	.....	.....	.....	.....	.....

As observed in Table 3.4 the SPI and the BDI showed significant correlations with environmental variables, such as electrical conductivity, pH, temperature (°C), dissolved oxygen (%), phosphate (mg l<sup>-1</sup>) and turbidity (NTU). The percentage pollution-tolerant valves %PTV and the GDI showed no correlation with the environmental variables electrical conductivity, pH, temperature (°C), dissolved oxygen (%), phosphate (mg l<sup>-1</sup>), turbidity (NTU), ammonium (mg/L), nitrite (mg/L), and nitrate (mg/L). The SPI showed the strongest correlation

with the environmental variables; it correlated significantly with electrical conductivity, pH, temperature (°C), dissolved oxygen (%), phosphate (mg/L) and turbidity (NTU), but did not correlate with environmental variables such as ammonium (mg/L), nitrite (mg/L) and nitrate (mg/L). The BDI correlated well with the environmental variables such as EC, pH, temperature, dissolved oxygen and phosphate, but did not correlate significantly with environmental variables such as turbidity (NTU), ammonium (mg/L), nitrate (mg/L) and nitrite (mg/L).

The SPI correlated negatively with most environmental variables, which means that as the concentrations of the variable in question rises the SPI score will decrease, while conversely as the SPI score increases the variables value would decrease.

The BDI correlated negatively with the environmental variables, which shows that as the EC, pH, temperature, etc. values rise the BDI score will decrease, and as the BDI score increases the EC values would decrease as discussed above (see Table 3.4).

The SPI correlated best with the environmental variables, as it correlated significantly with the majority of the environmental variables that were tested. This indicated that the SPI will provide the most accurate water quality score generated for each wetland and was thus used in further analyses linking diatom results with the environmental condition of each wetland, as described in the next chapter.

## CHAPTER 4: THE USE OF DIATOM COMMUNITIES AS INDICATORS OF WETLAND BIOLOGICAL INTEGRITY

### 4.1 Diatom-based indices of water quality

In Section 3.3 the SPI index correlated best with the environmental variables measured in the study wetlands and was thus used further in an attempt to describe the water quality class of each wetland sampled in this project and it was decided to exclude the BDI, GDI and %PTV from this chapter. The rest of the results for the indices (BDI, GDI and PTV %) are given in Appendix 4. As discussed in Section 1.1, diatoms were not collected in the survey conducted in the 1980s by King and Silberbauer (1991), so it was decided to compare the diatoms with the WET- Health tool that formed part of the WRC K5/2183 funded project in order to have a reference. Tables 4.1 and 4.2 give the SPI score and the corresponding Ecological Category and Water Quality class for each wetland according to the criteria listed, calculated using OMNIDIA 5.3 (Lecointe *et al.*, 1993) as described in Chapter Two (section 2.12).

The SPI index indicates the ecological integrity of an ecosystem and provides information about whether a system is polluted, pristine or in between these categories (Acs *et al.*, 2004). The five following conditions will affect and determine the condition of aquatic biota: energy sources, habitat, flow regime, biotic interactions and water quality. If any of these factors experience integrated impacts of various stressors, a change will take place in the biotic index score and will show the extent of change and alteration that has been caused on the biota of the system (Karr *et al.*, 1986).

As was discussed in Section 1.3, wetlands are complex systems, so one standard substrate could not be selected (unlike rivers where stones are the main substrate, Taylor *et al.*, 2007b), so it was decided to sample all available substrates at each wetland and compare the SPI scores generated via OMNIDIA 5.3 (Lecointe *et al.*, 1993) for each substrate that was sampled during the study period. At some of the wetlands only one substrate was available for sampling and these results are presented in Table 4.1, while Table 4.2 presents sites where more than one substrate was sampled.

The SPI index (in Table 4.1 below) identified four wetlands as being in an 'A category' putting these wetlands in a high water quality class (Hoogvertoon, Suurvlake, Kenilworth Racecourse and Silvermine inflow), suggesting that these wetlands were in pristine condition with no human impact present, and that the water quality should be adequate to sustain a healthy aquatic ecosystem. Two wetlands were classified in the 'very poor' F category (Koekiespan and Kiekoesvlei), indicating that these systems have undergone pressures from human activities such as agricultural runoff observed during the sampling period; site descriptions can

be found in Appendix 5. The water quality data generated for these two wetlands suggests that the prevailing water quality can be seen as very poor and could be a limiting factor to biotic integrity and not ideal for the sustainability of the aquatic ecosystem.

The following wetlands (Table 4.1) (Wagenbooms river, Sneeuberg Hut Stream, Riversdale, Groot Rondevlei and Januarievlei) were placed in the “B” category indicating that the biological water quality was good at the time of sampling. The good water quality means that these systems should be more than appropriate to sustain a healthy ecosystem.

The rest of the wetlands (in Table 4.1) had moderate biological water quality, suggesting that these aquatic ecosystems have been exposed to some form of pollution by human activities that could possibly contribute to a fair amount of degradation of biotic integrity at these sites.

**Table 4.1:** Diatom-derived index scores (SPI) for water quality class and ecological category of each wetland with only a single substrate sampled

Wetland name	Ecological Category	Class	SPI score	Substratum
Die Vlakte	C	Moderate quality	13	Vegetation
Wagenbooms River	B	Good quality	15.6	Vegetation
Sneeuberg Hut Stream	B	Good quality	16.9	Sediment
Driehoek	A/B	High quality	17.2	Sediment
Suurvlakte	A	High quality	18.7	Sediment
Blomfontein	C/D	Moderate quality	11.8	Sediment
Malkopsvlei	B/C	Good quality	14.6	Vegetation
Riversdale	B	Good quality	16,5	Sediment
Groot witvlei	C/D	Moderate quality	11,3	vegetation
Silver dam inflow	A	High quality	19.9	<i>Phragmites</i> Sp.
Kiekoesvlei	F	Very poor quality	2.4	Sediment
Koekiespan	E	Very poor quality	6	Vegetation
Rooipan	C/D	Moderate quality	11.3	Sediment

**Class Modification:** A- Natural, unmodified, B- Largely natural with few modifications, C- Moderately modified, D -Largely modified Seriously modified F- Critically modified (almost complete loss of biota and habitat).

## 4.2 The influence of substrate on diatom index scores

The dominant diatom taxa from wetlands in which more than one type of substratum was sampled are listed in Table 4.2 below. The diatom index scores differed to some extent according to the substrates that were sampled, and would mostly vary in one class variance but not more than two classes (Table 4.2); for example, Januarievlei had two discreet scores, a good water quality score from samples collected from emergent vegetation, and a moderate water quality score from submerged vegetation. Table 4.2 shows that only three of the wetlands (Verrekyker, Januarievlei and Silwerdam lower) had different water quality classes (where different substrates were sampled), the remainder of the wetlands in Table 4.2 reflected the same water quality classes even though different substrates were sampled.

The amount of light and nature of the substrate affect the growth and abundance of certain diatom communities (Potapova & Charles, 2002). Diatom communities differed in composition from substratum to substratum, but although they differed, the communities (Appendix 1-A Relative Abundance) reflected more or less the same water quality status (Table 4.2). As wetland habitats differ greatly from riverine systems, one particular substrate cannot be chosen because individual wetland habitats may present different substrates. It is, however, concluded that vegetation and sediment samples are the best substrates to reflect the water quality status of a wetland as they were the dominant substrates present at each sampling site and yielded good results. Table 4.3 (see below) was added in order to present the dominant taxa for each wetland and to illustrate how they differentiated according to substrates. The majority of the samples had the same dominant taxa, despite the differing substrates that were sampled. Of the twelve wetlands examined in this way, the dominant taxa differed in six (indicated in Table 4.3, highlighted in orange). Witsand aquifer, Kennilworth Racecourse, Kleinplaats, Burgerspan, Modder River and Yzerfontein soutpan all had the same dominant taxa although different substrates were sampled. Hoogvertoon had dominant taxa that also differed according to the substrate, but still had the same genera and only differed at species level. In Januarievlei, submerged and emergent vegetation were sampled and the dominant taxa differed completely—interestingly the same substrates were sampled for Witsand aquifer and the different substrates had the same dominant taxa, again emphasising that wetlands, diatoms and the relationships between substrates are important to investigate in order to find out what drives and changes certain diatom communities within these complex systems. The wetlands were only sampled once, thus no in-depth conclusions could be drawn in terms of spatial differences, temporal trends and seasonal changes to see how these communities differ from one another. Therefore, in the next section (4.3) the diatom-derived ecological score was compared to an independent study (WET-Health, described in Chapter One) conducted

as part of the WRC K5/2183 project on these wetlands, in order to provide some comparison with how the diatoms compared to other techniques in terms of placing sites in a particular ecological category.

**Table 4.2:** Diatom-derived index scores for water quality class and ecological category of each wetland where different substrates were sampled

Wetland name	Ecological Category	Class	SPI score	Substratum
Hoogvertoon	A/B	High quality	17.8	Sediment
Hoogvertoon	A	High quality	18.8	Vegetation
Verrekyker	C/D	Moderate quality	10.9	Vegetation
Verrekyker	D/E	Poor quality	6.3	Floating vegetation
Verrekyker	D/E	Poor quality	7.4	Vegetation (grass)
Verrekyker	D	Poor quality	8.4	Floating vegetation
Kleinplaats	C	Moderate quality	12,3	Vegetation
Kleinplaats	C/D	Moderate quality	11,1	Sediment
Groot Rondevlei	B/C	Good quality	14,3	Sediment
Groot Rondevlei	B	Good quality	15,1	Vegetation
Kenilworth Racecourse	A	High quality	19.7	Sediment
Kenilworth Racecourse	A/B	High quality	17.5	Vegetation
Silver dam lower	C/D	Moderate quality	11.2	Reeds
Silver dam lower	D	Poor quality	10	Palriet
Lake Michelle	C	Moderate quality	10.4	Vegetation
Lake Michelle	C	Moderate quality	13.5	Reeds
Januariesvlei	C/D	Moderate quality	10.1	Emergent vegetation
Januariesvlei	B	Good quality	15.5	Submerged vegetation
Modder River	D	Poor quality	9.7	Vegetation
Modder River	D	Poor quality	9	Stones
Yzerfontein Soutpan A	D/E	Poor quality	6.6	Plastic pipe
Yzerfontein Soutpan B	D/E	Poor quality	7.5	Submerged vegetation
Yzerfontein Soutpan B	D	Poor quality	9.3	Plastic pipe
Yzerfontein Soutpan A	D/E	Poor quality	7.4	Sediment
Burgerspan	C/D	Moderate quality	10.4	Wooden crate
Burgerspan	C/D	Moderate quality	10.9	Juncus Sp.
Burgerspan	C/D	Moderate quality	11	Sediment

**Class Modification:** A- Natural, unmodified, B- Largely natural with few modifications, C- Moderately modified, D -Largely modified Seriously modified F- Critically modified (almost complete loss of biota and habitat).

**Table 4.3:** Dominant diatom taxa from wetlands in which more than one type of substratum was sampled. Dominant taxa that differ on different substrates in a single wetland are indicated by bold typeface and highlighted in orange

Wetland name	Dominant taxon	Substrate
Kenilworth Racecourse	<i>Eunotia bilunaris</i>	sediment
Kenilworth Racecourse	<i>Eunotia bilunaris</i>	vegetation
<b>Silver dam lower</b>	<b><i>Fragilaria ulna</i></b>	<b>reeds</b>
<b>Silver dam lower</b>	<b><i>Planothidium engelbrechtii</i></b>	<b>palmiet</b>
Witsand aquifer recharge	<i>Cocconeis placentula</i>	emergent vegetation
Witsand aquifer recharge	<i>Cocconeis placentula</i>	submerged vegetation
<b>Hoogvertoon</b>	<b><i>Pinnularia intermedia</i></b>	<b>sediment</b>
<b>Hoogvertoon</b>	<b><i>Pinnularia borealis</i></b>	<b>vegetation</b>
<b>Verrekyker</b>	<b><i>Nitzschia palea</i></b>	<b>submerged vegetation</b>
<b>Verrekyker</b>	<b><i>Cyclotella meneghiniana</i></b>	<b>floating vegetation</b>
<b>Verrekyker</b>	<b><i>Fragilaria ulna</i></b>	<b>emergent vegetation</b>
<b>Verrekyker</b>	<b><i>Nitzschia palea</i></b>	<b>macrophytes</b>
Kleinplaats	<i>Cyclotella meneghiniana</i>	vegetation
Kleinplaats	<i>Cyclotella meneghiniana</i>	sediment
<b>Groot Rondevlei</b>	<b><i>Staurosira construens</i></b>	<b>sediment</b>
<b>Groot Rondevlei</b>	<b><i>Tabellaria flocculosa</i></b>	<b>vegetation</b>
<b>Januariesvlei</b>	<b><i>Planothidium engelbrechtii</i></b>	<b>emergent vegetation</b>
<b>Januariesvlei</b>	<b><i>Gomphonema gracile</i></b>	<b>submerged vegetation</b>
Modderrivier	<i>Planothidium engelbrechtii</i>	vegetation
Modderrivier	<i>Planothidium engelbrechtii</i>	stones
<b>Lake Michelle</b>	<b><i>Sellaphora pupula</i></b>	<b>vegetation</b>
<b>Lake Michelle</b>	<b><i>Planothidium engelbrechtii</i></b>	<b>reeds</b>
Yzerfontein Soutpan	<i>Nitzschia littoralis</i>	plastic pipe
Yzerfontein Soutpan	<i>Nitzschia littoralis</i>	vegetation
Yzerfontein Soutpan	<i>Nitzschia littoralis</i>	sediment
Yzerfontein Soutpan	<i>Nitzschia littoralis</i>	sediment
Burgerspan	<i>Nitzschia littoralis</i>	wooden crate
Burgerspan	<i>Nitzschia littoralis</i>	<i>Juncus</i> sp.
Burgerspan	<i>Nitzschia littoralis</i>	sediment

According to the literature (Winter & Duthie, 2000; and Rothfritz *et al*, 1997) some studies concluded that different habitats have similar diatom communities, while other studies (Reavie

& Smol, 1997; and Hashim & Stevenson, 1989) indicated otherwise (that habitats are unique), thus since the studies are contradictory, including the present study, it would be sensible in future to sample one substrate in a water quality assessment study.

### **4.3 Comparison of ecological categories defined by the SPI and WET-Health**

As mentioned in Section 1.1, WET-Health is a tool designed to determine the health and ecological integrity of wetlands and this was used to compare the ecological category generated by the diatoms (SPI) and the Ecological category generated by the Wet-health assessment (Table 4.4).

Ten of the wetlands (indicated in yellow) were placed in the same or adjacent categories as observed in Table 4.4; two were placed one or two categories higher by the SPI calculated from the diatoms (indicated in blue); twelve were placed one or two categories higher by WET-Health (indicated in green). Two artificial systems (indicated in purple) were not categorised by WET-Health. When referred to as a category higher than WET-Health it means that the WET-Health rated the wetland in a 'better' ecological state than the diatoms and vice versa. The differences in ecological categories might be explained by the fact that WET-Health looks at integrated perspectives (metrics addressed are vegetation, hydrology and geomorphology) whereas diatoms look at pure water quality. Diatoms are also fully submerged in the water column and thus are constantly exposed to stressors (compared to rooted and shore line plants and changes that occur in hydrology and geomorphology). In cases where the diatoms were placed in a higher ecological category, this could be explained by the fact that the aquatic system has undergone some extent of restoration (if previously disturbed). Overall the diatoms showed promising results for wetland health and should also be noted that the diatoms are related very strongly to water quality and that a variety of other factors may influence aquatic or semi-aquatic macrophytes and thus a difference in classification is to be expected.

**Table 4.4:** Comparison of categories assessed by the SPI diatom index and WET-Health

Wetland name	Ecological Category from the SPI scores generated by the diatoms	Wet-Health Ecological Category scores given based on the geomorphological, hydrological and vegetation health	Which tool indicated a higher class in the ecological category: Diatom (D) or WET-Health (W) category?
Die Vlakte	C	C/D	
Wagenbooms River	B	C	D
Hoogvertoon	A - A/B	A	
Sneeuberg Hut Stream	B	A	W
Driehoek	A/B	B	
Suurvlakte	A	C	D
Verrekker	C/D to D/E	C	W
Blomfontein	C/D	A	W
Malkopsvlei	B/C	B	
Riversdale	B	B/C	
Kleinplaats	C - C/D	A	W
Groot Rondevlei	B - B/C	B	
Groot Witvlei	C/D	B	W
Kenilworth Racecourse	A - A/B	A	
Silvermine dam inflow	A	A	
Silvermine dam lower	C/D - D	C	
Witsand aquifer	C - D	ARTIFICIAL	
Kiekoesvlei	F	D	W
Lake Michelle	C	TRANSFORMED	
Januariesvlei	B - C/D	A	W
Modder River	D	C	W
Yzerfontein Soutpan A	D/E	B	W
Yzerfontein Soutpan B	D - D/E	B	W
Koekiespan	E	D	W
Rooipan	C/D	C	

## CHAPTER 5: CONCLUSIONS

South Africa is a water-scarce country and there is a need for the development of biomonitoring tools to aid in the protection and management of water resources (as described in Chapter One). Holistic management of ecosystems is impossible without adequate monitoring. The degradation of wetlands and loss of their associated ecosystem services is widely recognised in South Africa. However, at present there is no standardised tool for assessing the water quality of wetlands in South Africa (Bowd *et al.*, 2006).

Despite the once-off sampling regime and the almost complete lack of knowledge of diatom flora in the south-western Cape wetlands, several useful results emerged from the present study. The taxa *Eunotia genuflexa*, *Eunotia flexuosa*, *Eunotia sp.*, *Eunotia incisa*, *Pinnularia intermedia*, *Pinnularia borealis*, *Pinnularia divergens*, *Psammothidium sp.* and *Tabellaria flocculosa* are confirmed as being sensitive species, meaning that these species would be the first to die off if a wetland became degraded (Section 3.1, Table 3.1). Diatom species are useful indicators of the upper limits of pollution which can be tolerated and not the lower limit. Thus, species such as *Gomphonema parvulum*, *Nitzschia palea*, *Lemnicola hungarica* and *Navicula recens*, which tolerate pollution, may also occur in fairly clean water. During the course of the study three endemic species were observed and it is recommended that after the appropriate study of their environmental preferences, these be included in the OMNIDIA database (as they can cause discrepancies in the diatom indices when abundant).

The relationship between diatom communities and some environmental variables as determined using CCA (Figure 3.1) showed that in general, local diatom communities respond in a similar manner as their riverine counterparts to key environmental variables. Interestingly, the biplot (Figure 3.1) shows that in this analysis *Craticula molestiformis* is most likely to be found in electrolyte-poor waters with low nutrients, whereas in previous studies (Taylor, 2007a) it was found in electrolyte-rich and often heavily polluted water, including sewage effluents. The most likely explanation for this discrepancy is that this is an example of sibling species, with apparently identical morphology but different levels of tolerance to pollutants, one preferring wetlands and the other preferring rivers, or one being an endemic with different tolerance limits. This phenomenon is important for index derivation and needs further investigation. Taxa that are tolerant of changes in electrolyte concentration (i.e. osmotic stress) may also be tolerant of fluctuations in water level and rapid shifts in electrical conductivity which may also explain the presence of this species in wetlands.

Water quality in rivers is usually related to longitudinal position in the river, and to levels of pollution—both natural and of human origin (Eckhardt *et al.*, 1995). Natural water quality in wetlands is far more variable than in rivers, both from site to site and over time (Allan *et*

*al.*, 1995; and CEN, 2003). For example, Yzerfontein Soutpan and Rooipan, which are naturally saline systems, were assigned low SPI scores of 6.6 and 11.3, indicating poor to moderate water quality, although according to the PTV% scores, there was no indication of organic pollution (Appendix 4). Blomfontein, located in the Cederberg Mountains, is virtually pristine and yet the SPI score for this wetland indicated only moderately good water quality, placing it in the C/D class, although it should be in an 'A' class because of its natural, almost unimpacted, condition. Furthermore, low pH values are normal in many south-western Cape wetlands, while intermediate pH values are the norm in most systems elsewhere. Other systems are naturally extremely turbid (and still pristine), while many wetlands are naturally virtually anoxic or highly saline. These features are seldom encountered in rivers and can lead to misinterpretation of results of indices such as the SPI.

Naturally saline or acidic systems are therefore special cases that cannot be adequately assessed using the unmodified SPI. In cases like these, where indices can be misinterpreted, it is important to compare results with other sources such as chemical analysis or assessment methods for wetland ecological conditions such as the WET-health, diversity of diatoms and elements of the higher plant flora. Caution needs to be exercised in deciding what 'good' water quality means: for whom is it 'good'? Pans are entirely dependent on the water regime and inundation duration which is affected by rainfall intensity, evaporation rate and groundwater level, and as these features vary seasonally and geographically, inundation periods are highly variable, even between pans in close proximity (Allan *et al.*, 1995). The abiotic features of pans also change markedly during various seasons. Due to the high unpredictability of seasonal changes in the water regime, some pans can vary from freshwater systems in the wet season, to saline systems during the dry season as salinity intensifies. Inundation also results in considerable changes in other physical and chemical properties of pans (Allan *et al.*, 1995). Seaman and Kok (1987) in Allan *et al.* (1995) state that there is instability of the physical and chemical parameters in relation to the different environmental variables. Conductivity varies in relation to inundation period and pan size. Turbidity values depend on pan depth (shallowness) vegetation cover and wind action, while pH also varies widely, especially in less saline pans and increase with increased conductivity (Allan *et al.*, 1995).

Ultimately if diatoms are to be used routinely in the bio-assessment of water quality in wetlands, it will probably be necessary to develop new indices based on an understanding of what is naturally 'good' water quality in systems whose water chemistry is very different from that of rivers. It is likely that in several cases the differences in categories derived from the SPI and WET-Health can be explained by differences in natural water quality. During this study the application of the SPI to derive biological water quality scores in wetlands showed promise

(Section 4.3, Table 4.4). A study is in progress to further refine the application of diatoms as water quality bio-indicators in wetland systems, specifically endorheic and exorheic pan systems (Koekemoer, in progress).

Although the application of diatom-based water quality indices in wetland ecosystems is still being refined, recent studies indicate that diatoms show potential to be reliable indicators of specific water quality problems, such as organic pollution, eutrophication, acidification and metal pollution, however the reliability of various diatom indices still needs to be tested. Therefore, within the scope of this assessment emphasis should preferably be on pollution levels and type of pollution input rather than defining the water quality of water body based on index scores.

In a similar vein, the lack of correlation between the indices and nitrogen (Table 3.3), needs to be investigated. This project (Chapter Three) has shown that levels of nitrate in southwestern Cape wetlands which have not showed any impact can be very low and fairly variable. A lack of correlation between nitrogen and indicators is not necessarily problematic but the phenomenon does need explanation. Correlations did exist, however, between the diatom indices and phosphate (Table 3.3), electrical conductivity, pH, temperature, dissolved oxygen, phosphate and turbidity.

In general, diatom communities from different substrata in the same wetland reflected more or less the same water quality status (Table 4.2). Of the thirteen sites for which more than one substratum was sampled though, the dominant species of diatom were the same in only six (Section 4.2, Table 4.2). Generally, rocks are the best substrates for sampling (Round, 1991), but they are not always available in wetlands. It seems that vegetation and sediment samples are the best substrates to reflect the water quality status of a wetland since they are the dominant substrates present at most sampling sites and yielded good results. Studies by Porter *et al.* (1993), Lowe and Pan (1996), Kelly *et al.* (1998), and Eloranta and Soininen (2004), have shown that consensus has yet to be reached concerning the assessment of benthic diatom community structure based on epiphytic and epilithic communities. To obtain consistent results it will be necessary to investigate the issue of substrates further. It may be that the diatom assemblages are sufficiently species-rich that substratum is not important, but in other cases it may even be necessary to consider the use of artificial substrates

## CHAPTER 6: SUMMARY AND RECOMMENDATIONS

- Despite the once-off sampling regime and the almost complete lack of knowledge of the diatom flora of the south-western Cape wetlands, the wetlands could be separated into 'condition' or water quality classes based on an analysis of their diatom floras. Bio-assessment using diatoms is therefore a potential tool for assessing the condition of wetlands of the south-western Cape of South Africa.
- While diatom samples from different substrates gave similar results, further investigations are needed into the effect of substrates on the ecological 'condition' or water quality classes identified by diatom analysis.
- It seems that the species identified in this study are cosmopolitan as they respond in the same way to water quality variables, as in the rest of the world.
- The SPI (Sensitivity Pollution sensitivity Index) showed potential for describing water quality in freshwater wetlands but caution should be used in interpreting results for naturally occurring saline systems and systems that are naturally acidic in fynbos areas.
- Strong correlations exist between certain, but not all, water quality variables and the indices calculated during this study.

Currently there are not enough diatom samples from the Western Cape region to be able to meaningfully assign tolerance and indicator values to all the diatom taxa encountered during the present study. Therefore, it is recommended that diatom sampling is repeated and species lists are compiled together with prevailing environmental conditions, in order to build a robust indicator set for the Western Cape. Further documentation and taxonomic study of the diatom flora of the Western Cape is recommended in order to have a better understanding of how the diatoms respond to local water quality conditions and what taxa are present in this unique region of the country. During the course of the study three endemic species were observed and it is recommended that after the appropriate study of their environmental preferences, these are included in the OMNIDIA programme.

It is recommended that further studies be conducted on wetlands in the Western Cape and that a specific diatom index is created for South African wetlands which includes endemic species. It is also recommended that the chemical and physical water quality variables should be assessed at each wetland monthly or seasonally, as only once-off sampling was undertaken for each wetland. This will allow for more accurate assignment of tolerance values to diatom species.

## **6.1 Summary of achievements that were met during the course of the study**

The present study aimed to contribute information on the distribution and environmental preferences of diatoms in wetlands in the Western Cape, by:

- Documenting the diatom flora of the Western Cape by composing species lists for the wetlands studied (Section 3.1) and despite the once-off sampling, good indicator species (confirmed as being sensitive species) were observed throughout the study, which can be deemed as important when monitoring these wetlands, as these sensitive species will be the first species to die off if any disturbances or human activities should affect the system.
- Ascertaining the relationship between aspects of water quality and diatom community composition in the wetlands studied. The results indicated that there were relationships between the selected environmental variables and diatom communities (Chapter Three).
- Demonstrating the correlation between water quality variables and results for diatom indices calculated during the study- The Pearson correlation in Section 3.3 indicated significant correlations between the SPI index and measured environmental variables.
- Demonstrating how different substrates affected diatom index scores: Chapter Four gave a general overview on how different substrates affected diatom indices, and conclusions could be drawn not only that one substrate should be sampled, but that sediment and vegetation were deemed as the best choice for sampling the different types of HGM type wetlands.

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## **APPENDICES**

**7.1 APPENDIX 1: Diatom taxa- relative abundance and compiled species lists for each wetland**

**7.2 APPENDIX 2: Diatom plates- species observed during the study**

**7.3 APPENDIX 3: Canonical Correspondence Analysis**

**7.4 APPENDIX 4: BDI, GDI and %PTV scores**

**7.5 APPENDIX 5: Wetland descriptions**

## Appendix 1

**Table 1:** Relative abundance of diatom species encountered in the Western Cape.

Species list	Acronyms	Kenilworth Racecourse-sediment	Kenilworth Racecourse-vegetation	Lake Michelle-vegetation	Lake Michelle-vegetation	Rooipan-sediment	Burgerspan-wooden crate	Burgerspan-vegetation	Burgerspan-sediment	Kikoesvlei-sediment
<i>Achnanthes</i> J. B. M. Bory de St. Vincent	ACHN	0,752	....	....	....	12,581	21,981	....	....	....
<i>Achnanthes crassa</i> Hustedt	ACRA	....	....	....	....	....	3,715	....	....	....
<i>Achnanthes duthii</i> Sreenivasa	ADUT	....	....	....	....	....	....	....	....	....
<i>Achnanthes linearis</i> (W. Sm.) Grunow	ALIN	....	1,656	....	....	....	....	....	....	....
<i>Achnanthes minutissima</i> Kützing	AMIN	....	....	....	....	....	....	....	....	....
<i>Achnanthes minutissima</i> var. <i>saprophila</i> Kobayasi et Mayama	AMSA	....	....	....	....	....	....	....	....	....
<i>Achnanthes oblongella</i> Oestrup	AOBG	....	....	....	....	....	....	....	....	....
<i>Achnantheidium</i> F. T. Kützing	ACHD	....	....	....	....	....	....	....	....	....
<i>Achnantheidium affine</i> (Grunow) Czarnecki	ACAF	....	....	....	....	....	....	....	....	....
<i>Achnantheidium crassum</i> (Hustedt) Potapova & Ponader	ADCR	....	....	....	....	....	....	....	....	....
<i>Achnantheidium deflexum</i> (Reimer) Kingston	ACDF	....	....	....	....	....	....	....	....	....
<i>Achnantheidium saprophilum</i> (Kobayasi et Mayama) Round & Bukhtiyarova	ADMI	....	....	....	....	....	....	....	....	....
<i>Achnantheidium rivulare</i> Potapova & Ponader	ADRT	....	....	....	....	....	....	....	....	....
<i>Achnantheidium standerii</i> (Cholnoky) Taylor, Morales & Ector	ACHS	....	....	....	....	....	....	....	....	....
<i>Achnantheidium</i> sp.	ADCS	....	....	....	....	....	....	....	....	....
<i>Actinocyclus subtilis</i> (Gregory) Ralfs in Pritchard	ASUB	....	....	....	....	....	....	....	....	....
<i>Amphora</i> C. G. Ehrenberg ex F. T. Kützing	AMPH	....	....	0,946	....	....	....	....	....	....
<i>Amphora coffeaeformis</i> (Agardh) Kützing	ACOF	....	....	0,315	....	26,774	3,406	1,303	12,149	3,205
<i>Amphora coffeaeformis</i> var. <i>aponina</i> (Kützing) Archibald & Schoeman	ACFA	....	....	....	....	....	....	....	....	....
<i>Amphora fontinalis</i> Hustedt	AFON	....	....	1,893	1,202	....	....	....	....	....
<i>Amphora granulata</i> Gregory	AMGN	....	....	0,946	....	....	....	....	....	....
<i>Amphora hybrida</i> Grunow in Van Heurck	AHYB	....	....	....	....	....	....	....	....	....
<i>Amphora oligotrappenta</i> Lange-Bertalot	AOLG	....	....	....	....	....	....	....	....	....
<i>Amphora ovalis</i> (Kützing) Kützing	AOVA	....	....	0,946	....	....	....	....	....	....
<i>Amphora pseudoholsatica</i> Nagumo & Kobayasi	APHO	....	....	....	....	....	....	....	....	....
<i>Amphora sabiniana</i> Reimer	ASAB	....	....	....	....	....	....	....	....	....
<i>Amphora veneta</i> Kützing	AVEN	....	....	....	0,481	....	....	....	....	....

Species list	Acronyms	Kenilwort Racecourse-	Kenilwort Racecourse-	Lake Michelle-	Lake Michelle-	Rooipan-sediment	Burgerspan-wooden	Burgerspan- vegetation	Burgerspan-sediment	Kikoosvlei-sediment
		sediment	vegetation	vegetation	vegetation		crate			
<i>Anomoeoneis serians</i> var. <i>apiculata</i> Boyer	ASAP	...	...	...	...	...	...	...	...	...
<i>Asterionella gracillima</i> (Hantzsch.) Heiberg	AGRA	...	...	...	0,962	...	...	...	...	...
<i>Aulacoseira</i> G. H. K. Thwaites	AULA	...	...	...	...	...	...	...	...	...
<i>Aulacoseira ambigua</i> (Grunow) Simonsen	AAMB	...	...	...	...	...	...	...	...	...
<i>Aulacoseira granulata</i> (Ehrenberg) Simonsen	AUGR	...	...	...	...	...	...	...	...	...
<i>Aulacoseira granulata</i> var. <i>angustissima</i> Simonsen	AUGA	...	...	...	...	...	...	...	...	...
<i>Bacillaria paradoxa</i> Gmelin	BPAR	...	...	...	...	...	...	...	...	...
<i>Brachysira brébissonii</i> Ross in Hartley	BBRE	...	...	...	...	...	...	...	...	...
<i>Caloneis bacillum</i> (Grunow) Cleve	CBAC	...	...	...	...	...	...	...	...	...
<i>Caloneis</i> Cleve	CALO	...	...	...	...	...	...	...	...	...
<i>Caloneis molaris</i> (Grunow) Krammer	CMOL	...	...	...	...	...	...	...	...	0,641
<i>Caloneis patagonica</i> var. <i>alaskaensis</i> Manguin ex Kociolek & Reviere	CPAL	...	...	...	...	...	...	...	...	...
<i>Caloneis permagna</i> (J. W. Bailey) Cleve	CPRM	...	...	...	...	...	...	...	...	...
<i>Cavinula cocconeiformis</i> (Gregory ex Greville) Mann & Stickle	CCOC	...	...	...	...	...	...	...	...	...
<i>Cocconeis costata</i> Gregory	COCC	...	...	...	...	0,968	...	...	...	...
<i>Cocconeis engelbrechtii</i> Cholnoky	CENG	...	...	0,946	...	...	...	...	...	...
<i>Cocconeis placentula</i> Ehrenberg	CPLA	...	...	...	...	...	...	...	...	...
<i>Cocconeis scutellum</i> Ehrenberg	CSCU	...	...	...	...	...	...	...	...	...
<i>Cosmioneis pusilla</i> (W. Smith) Mann & Stickle	COPU	...	...	...	...	...	...	...	...	...
<i>Craticula</i> A. Grunow	CRAT	...	...	1,893	...	4,839	0,311	...	1,246	...
<i>Craticula halophila</i> (Grunow ex Van Heurck) Mann	CHAL	...	...	...	...	...	...	...	...	1,603
<i>Craticula molestiformis</i> (Hustedt) Lange-Bertalot	CMLF	...	...	...	...	...	...	...	...	...
<i>Craticula vixnegligenda</i> Lange-Bertalot	CVIX	...	...	...	...	...	...	...	...	...
<i>Cyclotella meneghiniana</i> Kützing	CMEN	...	...	5,363	3,125	...	...	...	...	...
<i>Cyclotella stelligera</i> Cleve et Grun (in Van Heurck)	CSTE	...	...	...	...	...	...	...	...	...
<i>Cymatopleura brunii</i> Petit ex Brun	CBRU	...	...	...	...	...	...	...	...	...
<i>Cymbella aspera</i> (Ehrenberg) H. Peragallo	CASP	...	...	...	...	...	...	...	...	...
<i>Cymbella helvetica</i> Kützing	CHEL	...	...	...	...	...	...	...	...	...

<i>Cymbella lanceolata</i> Agardh	CLTA	...	...	...	...	...	...	...	...	...
<i>Cymbella sinuata</i> Gregory	CSIN	...	...	...	...	...	...	...	...	...
<i>Cymbella</i> sp. 1	CYM1	...	...	1,577	...	...	...	...	...	...

Species list	Acronyms	Kenilwort Racecourse-sediment	Kenilwort Racecourse-vegetation	Lake Michelle-vegetation	Lake Michelle-vegetation	Rooipan-sediment	Burgerspan-wooden crate	Burgerspan-vegetation	Burgerspan-sediment	Kikoesvlei-sediment
<i>Cymbella</i> sp. 2	CYM2	...	...	0,691	...	...	...	...	...	...
<i>Cymbella turgidula</i> Grunow 1875 in A. Schmidt & al.	CTGL	...	...	...	...	...	...	...	...	...
<i>Cymbopleura</i> (Krammer) Krammer	CBPL	...	...	...	4,086	...	...	...	...	...
<i>Delicata krammeri</i> Metzeltin, Lange-Bertalot & Garcia-Rodriguez	DKRM	...	...	...	...	...	...	...	...	...
<i>Diadesmis confervacea</i> Kützing	DCON	...	...	0,631	0,721	...	...	...	...	...
<i>Diadesmis</i> F.T. Kützing	DDSP	...	...	...	...	...	...	...	...	...
<i>Diploneis</i> C. G. Ehrenberg ex P. T. Cleve	DIPL	...	...	...	...	...	...	...	...	...
<i>Diploneis smithii</i> (Brébisson) Cleve	DSMI	...	...	...	...	...	...	...	...	...
<i>Diploneis smithii</i> var. <i>chilensis</i> Hustedt	DSCH	...	...	...	...	...	...	...	...	...
<i>Diploneis stroemi</i> Hustedt	DSTR	...	...	...	...	...	...	...	...	...
<i>Encyonema caespitosum</i> Kützing	ECAE	...	...	...	...	...	...	...	...	...
<i>Encyonema</i> F. T. Kützing	ENCY	...	...	...	...	...	...	...	...	...
<i>Encyonema mesianum</i> (Cholnoky) D. G. Mann	ENME	...	...	...	...	...	...	...	...	...
<i>Encyonema silesiacum</i> (Bleisch in Rabenhorst) D. G. Mann	ESLE	...	...	...	...	...	...	...	...	...
<i>Encyonema silesiacum</i> var. <i>latarea</i> Krammer	ESLT	0,752	...	...	...	...	...	...	...	...
<i>Encyonopsis minuta</i> Krammer & Reichardt	ECPM	...	...	...	...	...	...	...	...	...
<i>Entomoneis paludosa</i> (W. Smith) Reimer	EPAL	...	...	...	...	...	...	...	...	...
<i>Epithemia adnata</i> (Kützing) Brébisson	EADN	...	...	9,148	19,952	...	...	...	...	...
<i>Eunotia bilunaris</i> (Ehrenberg) Mills	EBIL	26,445	63,245	0,949	...	...	...	...	...	...
<i>Eunotia boreoalpina</i> Lange-Bertalot & Nörpel-Schempp	EUBO	...	...	...	...	...	...	...	...	...
<i>Eunotia boreotenuis</i> Norpel-Schempp & Lange-Bertalot	EBOR	...	...	...	...	...	...	...	...	...
<i>Eunotia flexuosa</i> (Brébisson) Kützing	EFLE	0,644	...	...	...	...	...	...	...	...
<i>Eunotia formica</i> Ehrenberg	EFOR	1,612	2,649	...	...	...	...	...	...	...
<i>Eunotia glacialis</i> Meister	EGLA	...	...	...	...	...	...	...	...	...

<i>Eunotia incisa</i> Gregory	EINC	...	...	...	...	...	...	...	...	...
<i>Eunotia minor</i> (Kützing) Grunow in Van Heurck	EMIN	0,215	...	...	...	...	...	...	...	...
<i>Eunotia monodon</i> Ehrenberg	EMON	...	...	...	...	...	...	...	...	...
<i>Eunotia pectinalis</i> (Dyllwyn) Rabenhorst	EPEC	...	...	...	...	...	...	...	...	...
<i>Eunotia silvahercynia</i> Nörpel Van Sull & Lange-Bertalot	ESIL	...	...	...	...	...	...	...	...	...
<i>Eunotia sudetica</i> var. <i>incisa</i> (Gregory) Manguin	ESIN	0,215	...	...	...	...	...	...	...	...

Species list	Acronyms	Kenilwort Racecourse-sediment	Kenilwort Racecourse-vegetation	Lake Michelle-vegetation	Lake Michelle-vegetation	Roopian-sediment	Burgerspan-wooden crate	Burgerspan- vegetation	Burgerspan-sediment	Kikoesvlei-sediment
<i>Eunotia tenella</i> (Grunow) Hustedt	EUNO	...	1,324	...	...	0,968	5,573	12,377	24,299	...
<i>Eunotia veneris</i> (Kützing) De Toni	EVEN	0,215	...	...	...	...	...	...	...	...
<i>Eunotogramma</i> Weisse	EUTO	...	...	...	...	...	...	...	...	...
<i>Fallacia</i> A. J. Stickle & D. G. Mann	FALL	...	...	...	...	...	...	...	...	...
<i>Fallacia pygmaea</i> (Kützing) Stickle & Mann	FPYG	...	...	...	...	...	...	...	0,623	...
<i>Fistulifera saprophila</i> (Lange-Bertalot & Bonik) Lange-Bertalot	FSAP	...	...	...	...	...	...	...	...	...
<i>Fragilaria</i> H. C. Lyngbye	FRAG	...	...	...	...	...	...	...	...	...
<i>Fragilaria bicapitata</i> A. Mayer	FBIC	...	...	1,893	3,365	...	...	...	...	...
<i>Fragilaria biceps</i> (Kützing) Lange-Bertalot	FBCP	...	...	...	...	...	...	...	...	...
<i>Fragilaria brevistriata</i> Grunow (Pseudostaurosira)	FBRE	...	...	...	...	...	...	...	...	...
<i>Fragilaria capucina</i> Desmazieres	FCAP	...	1,324	...	...	...	...	...	...	...
<i>Fragilaria capucina</i> var. <i>radians</i> (Kützing) Lange-Bertalot	FCRA	...	...	...	...	...	...	...	...	...
<i>Fragilaria capucina</i> var. <i>rumpens</i> (Kützing) Lange-Bertalot.	FCRP	...	...	...	...	...	...	...	...	...
<i>Fragilaria construens</i> (Ehrenberg) Grunow	FCON	...	...	...	...	...	...	...	...	...
<i>Fragilaria construens</i> fo. <i>venter</i> (Ehrenberg) Hustedt	FCVE	...	...	...	...	...	...	...	...	...
<i>Fragilaria crotonensis</i> Kitton	FCRO	...	1,655	...	...	...	...	...	...	...
<i>Fragilaria fasciculata</i> (C. A. Agardh) Lange-Bertalot sensu lato	FFAS	...	...	...	...	...	...	...	...	...
<i>Fragilaria pulchella</i> (Ralfs ex Kützing) Lange-Bertalot (Ctenophora)	FPUL	...	...	...	...	...	...	...	...	...
<i>Fragilaria striatula</i> Lyngbye	FSTR	...	...	...	...	...	...	...	...	...
<i>Fragilaria tenera</i> (W. Smith) Lange-Bertalot	FTEN	...	...	1,893	...	...	...	...	...	...
<i>Fragilaria ulna</i> (Nitzsch.) Lange-Bertalot	FULN	...	...	...	...	...	...	...	...	...

<i>Fragilaria ulna</i> var. <i>biceps</i> (Kützing) Lange-Bertalot	FUBI	...	...	...	...	...	...	...	...	...
<i>Frustulia</i> L. Rabenhorst	FRUS	...	...	...	...	...	...	...	...	...
<i>Frustulia crassinervia</i> (Brébisson) Lange-Bertalot et Krammer	FCRS	...	...	...	...	...	...	...	...	...
<i>Frustulia magaliesmontana</i> Cholnoky	FMGL	...	...	...	...	...	...	...	...	...
<i>Frustulia rostrata</i> Hustedt	FROS	...	...	...	...	...	...	...	...	...
<i>Frustulia saxonica</i> Rabenhorst	FSAX	...	...	...	...	...	...	...	...	...
<i>Frustulia vulgaris</i> (Thwaites) De Toni	FVUL	...	...	...	...	...	...	...	...	...
<i>Gomphonema</i> C. G. Ehrenberg	GOMP	...	...	...	...	...	...	23,127	...	...
<i>Gomphonema affine</i> Kützing	GAFF	0,430	...	...	...	...	...	...	...	...
<i>Gomphonema angustatum</i> (Kützing) Rabenhorst	GANG	...	...	...	...	...	...	17,263	11,838	...
<i>Gomphonema clavatum</i> Ehrenberg	GCLA	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Kenilwort Racecourse-sediment	Kenilwort Racecourse-vegetation	Lake Michelle-vegetation	Lake Michelle-vegetation	Rooipan-sediment	Burgerspan-wooden crate	Burgerspan-vegetation	Burgerspan-sediment	Kikoosvlei-sediment
<i>Gomphonema exilissimum</i> (Grunow) Lange-Bertalot & Reichardt	GEXL	...	...	...	...	...	...	...	...	...
<i>Gomphonema gracile</i> Ehrenberg	GGRA	0,859	13,245	...	...	1,290	...	...	...	...
<i>Gomphonema lagenula</i> Kützing	GLGN	...	...	...	...	...	...	...	...	...
<i>Gomphonema laticollum</i> Reichardt	GLTC	...	...	...	...	...	...	...	...	...
<i>Gomphonema minutum</i> (Agardh) Agardh	GMIN	0,322	...	...	...	...	...	...	...	...
<i>Gomphonema parvulum</i> (Kützing) Kützing	GPAR	...	...	...	2,163	...	...	...	...	...
<i>Gomphonema parvulum</i> var. <i>subellipticum</i> Cleve	GPSE	...	...	...	...	...	...	...	...	...
<i>Gomphonema pseudoaugur</i> Lange-Bertalot	GPSA	...	...	...	...	...	...	...	...	...
<i>Gomphonema pumilum</i> (Grunow) Reichardt & Lange-Bertalot	GPUM	...	...	...	...	...	3,401	...	...	...
<i>Gomphonema pumilum</i> var. <i>rigidum</i> Reichardt & Lange-Bertalot	GPRI	...	...	...	...	...	...	...	...	...
<i>Gomposphenia oahuensis</i> (Hustedt) Lange-Bertalot	GOAH	...	...	...	...	...	...	...	...	...
<i>Grammatophora</i> C. G. Ehrenberg	GRAM	...	...	...	...	...	...	...	...	...
<i>Halamphora eunotia</i> (Cleve) Levkov (Cleve) Levkov	HEUN	...	...	...	...	...	...	...	...	...
<i>Halamphora paraveneta</i> Lange-Bertalot. Cavacini. Tagliaventi & Alfinito	HPAR	...	...	...	...	...	...	...	...	...
<i>Halamphora robusta</i> Gregory	HROB	...	...	...	...	...	...	...	...	...
<i>Halamphora veneta</i> (Kützing) Levkov	HVEN	...	...	...	...	...	...	...	...	...

<i>Halampora dominici</i> Ács & Levkov	HDOM	....	....	....	....	....	....	....	....	....
<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow in Cleve et Grunow 1880	HAMP	....	....	....	....	2,581	....	....	....	2,884
<i>Hantzschia</i> sp. 1	HAN1	....	....	....	....	....	....	....	....	....
<i>Haslea spicula</i> (Hickie) Bukhtiyarova	HSPC	....	....	....	....	....	....	....	....	....
<i>Hippodonta capitata</i> (Ehrenberg) Lange-Bert. Metzeltin & Witkowski	HCAP	....	....	....	....	....	....	....	....	....
<i>Hippodonta hungarica</i> (Grunow) Lange-Bertalot Metzeltin & Witkowski	HHUN	....	....	....	....	....	....	....	....	....
<i>Hippodonta</i> Lange-Bertalot. Metzeltin & Witkowski	HIPO	....	....	....	....	....	....	....	....	....
<i>Kobayasia subtilissima</i> (Cleve) Lange-Bertalot	KSUB	....	....	....	....	....	....	....	....	....
<i>Kobayasiella subtilissima</i> (Cleve) Lange-Bertalot	KOSU	....	....	....	....	....	....	....	....	....
<i>Lemnicola hungarica</i> (Grunow) Round & Basson	LHUN	....	....	....	....	....	....	....	....	....
<i>Lemnicola</i> Round & Basson	LEMN	....	....	0,946	....	....	....	....	....	....
<i>Luticola</i> D. G. Mann	LUTI	....	....	....	....	....	....	....	....	....
<i>Luticola acidoclinata</i> Lange-Bertalot	LACD	....	....	....	....	....	....	....	....	....
<i>Luticola goeppertiana</i> (Bleich in Rabenhorst) D. G. Mann	LGOT	....	....	....	....	....	....	....	....	....
<i>Luticola goeppertiana</i> (Bleich in Rabenhorst) D. G. Mann abnormal form	LGOE	....	....	....	....	....	....	....	....	....

Species list	Acronyms	Kenilwort Racecourse-sediment	Kenilwort Racecourse-vegetation	Lake Michelle-vegetation	Lake Michelle-vegetation	Rooipan-sediment	Burgerspan-wooden crate	Burgerspan- vegetation	Burgerspan-sediment	Kikoesvlei-sediment
		....	....	....	....	....	....	....	....	....
<i>Luticola mutica</i> (Kützing) D. G. Mann	LMUT	....	....	....	....	....	....	....	....	....
<i>Luticola</i> sp.	LUSP	....	....	....	....	....	....	....	....	....
<i>Luticola</i> sp. (aff. <i>mutica</i> )	LUTS	....	....	....	....	....	....	....	....	....
<i>Martyana atomus</i> (Hustedt) Snoeijs	MATO	....	....	....	....	....	....	....	....	0,641
<i>Mastogloia</i> G. H. K. Thwaites ex W. Smith 1856	MAST	....	....	....	....	....	....	....	....	....
<i>Mastogloia braunii</i> Grunow	MBRA	....	....	....	....	....	....	....	....	....
<i>Mastogloia elliptica</i> (C. A. Agardh) Cleve	MELL	....	....	....	....	....	....	....	....	....
<i>Mastogloia pusilla</i> (Grunow) Cleve	MPUS	....	....	....	....	....	....	....	....	....
<i>Mayamaea atomus</i> (Kützing) Lange-Bertalot	MAAT	....	....	....	....	....	....	....	....	....
<i>Melosira nummuloides</i> var. <i>alata</i> Jurilj	MNAL	....	....	....	....	....	....	....	....	....
<i>Melosira varians</i> Agardh	MVAR	....	....	....	....	....	....	....	....	....
<i>Meridion circulare</i> (Greville) C. A. Agardh	MCIR	....	....	....	....	....	....	....	....	....

<i>Microcostatus</i> sp. Johansen & Sray	MCCT	...	...	...	...	...	...	...	...	...
<i>Muelleria linearis</i> (O. Muller) Frenguelli	MULI	...	...	...	...	...	...	...	...	...
<i>Navicula</i> J. B. M. Bory de St. Vincent	NAVI	...	...	1,893	...	8,387	14,861	5,863	8,411	5,128
<i>Navicula arvensis</i> Hustedt	NARV	...	...	...	...	...	...	...	...	...
<i>Navicula capitatoradiata</i> Germain	NCPG	...	...	...	...	...	...	...	...	...
<i>Navicula cincta</i> (Ehrenberg) Ralfs in Pritchard	NCIN	...	...	...	...	0,645	...	...	...	...
<i>Navicula clementis</i> Grunow	NCLE	...	...	...	...	...	...	...	...	...
<i>Navicula cryptocephala</i> Kützing	NCRY	...	...	...	...	...	...	...	...	...
<i>Navicula cryptotenella</i> - type in Kelly	NCTY	...	...	...	...	...	...	...	...	...
<i>Navicula disjuncta</i> Hustedt	NDSJ	...	...	...	...	...	...	...	...	...
<i>Navicula erifuga</i> Lange-Bertalot	NERI	...	...	...	...	...	...	...	...	...
<i>Navicula frugalis</i> Hustedt	NFRU	...	...	...	5,048	1,612	...	...	...	...
<i>Navicula humerosa</i> Brébisson ex W. Smith	NHUM	...	...	...	...	...	...	...	...	...
<i>Navicula lanceolata</i> (Agardh) Ehrenberg	NLAN	...	...	...	0,961	...	...	...	...	...
<i>Navicula libonensis</i> Schoeman	NLIB	...	...	...	...	...	...	...	...	...
<i>Navicula microcari</i> Lange-Bertalot	NMCA	...	...	...	...	...	...	...	...	...
<i>Navicula modica</i> Hustedt	NMOD	...	...	...	...	...	...	...	...	...
<i>Navicula nivalis</i> Ehrenberg	NNIV	...	...	...	...	...	...	...	...	2,243
<i>Navicula parasubtilissima</i> Kobayasi & Nagumo	NPSU	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Kenilwort Racecourse- sediment	Kenilwort Racecourse- vegetation	Lake Michelle- vegetation	Lake Michelle- vegetation	Rooipan-sediment	Burgerspan-wooden crate	Burgerspan- vegetation	Burgerspan-sediment	Kikoesvlei-sediment
		...	...	...	...	...	...	...	...	...
<i>Navicula peregrina</i> (Ehrenberg) Kützing	NPRG	...	...	...	...	...	...	...	...	...
<i>Navicula permitis</i> Hustedt	NPER	...	...	...	...	1,935	...	...	...	...
<i>Navicula phylleptosoma</i> Lange-Bertalot	NPHP	...	...	...	...	...	...	...	...	...
<i>Navicula placenta</i> Ehrenberg	NPLT	...	...	...	...	...	...	...	...	...
<i>Navicula pseudosalinarioides</i> Giffen	NWPS	...	...	...	...	...	...	...	...	...
<i>Navicula pupula</i> fo. <i>rostrata</i> (Hustedt) Hustedt	NPUR	...	...	...	...	...	...	...	...	...
<i>Navicula pusilla</i> W. Smith	NPUS	...	...	0,631	...	15,161	...	0,977	1,869	...
<i>Navicula ranomafanensis</i> (Manguin) Metzeltin & Lange-Bertalot	NRAN	...	...	...	...	...	...	...	...	...

<i>Navicula recens</i> (Lange-Bertalot) Lange-Bertalot	NRCS	...	...	...	...	...	...	...	...	...
<i>Navicula rhynchocephala</i> Kützing	NRHY	...	...	...	...	...	...	...	...	...
<i>Navicula riediana</i> Lange-Bertalot & Rumrich	NRIE	...	...	...	...	...	...	...	...	...
<i>Navicula rostellata</i> Kützing	NROS	...	...	...	...	...	...	...	...	...
<i>Navicula salinarum</i> Grunow in Cleve et Grunow	NSAL	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 1	NAV1	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 2	NAV2	...	...	...	...	...	...	...	0,935	...
<i>Navicula</i> sp. 3	NAV3	...	...	...	...	1,612	...	...	...	...
<i>Navicula</i> sp. 4	NAV4	...	...	...	...	0,645	...	...	...	...
<i>Navicula supergregaria</i> Lange-Bertalot & Rumrich	NSGG	...	...	...	...	...	...	...	...	...
<i>Navicula testa</i> Carter & Bailey-Watts	NTSA	...	...	...	...	2,581	...	...	...	...
<i>Navicula tripunctata</i> (O. F. M.) Bory forme teratogene	NTTT	...	...	...	...	...	...	...	...	...
<i>Navicula veneta</i> Kützing	NVEN	...	...	2,839	...	...	3,095	0,651	...	...
<i>Navicula vitrea</i> (Oestrup) Hustedt	NVIT	...	...	...	...	...	...	...	0,623	...
<i>Navicula wasmundii</i> Witkowski Metzeltin & Lange-Bertalot	NWAS	...	...	...	...	...	...	...	...	...
<i>Navicula zanoni</i> Hustedt	NZAN	...	...	...	...	...	...	...	...	...
<i>Neidium affine</i> (Ehrenberg) Pfitzer	NEAF	...	...	...	...	...	...	...	...	...
<i>Neidium productum</i> (W. M. Smith) Cleve	NEPR	...	...	...	...	...	...	...	...	...
<i>Nitzschia</i> A. H. Hassall	NITZ	0,107	...	3,155	...	5,161	13,932	1,302	...	17,628
<i>Nitzschia acicularis</i> (Kützing) W. M. Smith	NACI	...	...	0,315	...	...	...	...	...	...
<i>Nitzschia amphibia</i> Grunow	NAMP	...	...	...	...	...	...	...	...	...
<i>Nitzschia calida</i> Grunow in Cleve & Grunow	NICA	...	...	...	...	...	...	...	...	...
<i>Nitzschia capitellata</i> Hustedt in A. Schmidt & al.	NCPL	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Habitats								
		Kenilwort Racecourse-sediment	Kenilwort Racecourse-vegetation	Lake Michelle-vegetation	Lake Michelle-vegetation	Rooppan-sediment	Burgerspan-wooden crate	Burgerspan-vegetation	Burgerspan-sediment	Kikoevlei-sediment
<i>Nitzschia communis</i> Rabenhorst	NCOM	...	...	...	...	...	...	...	...	...
<i>Nitzschia commutata</i> Grunow in Cleve et Grunow	NICO	...	...	...	...	...	...	...	...	...
<i>Nitzschia commutatoides</i> Lange-Bertalot	NCMU	...	...	...	...	...	...	...	...	0,641
<i>Nitzschia desertorum</i> Hustedt	NDES	...	...	...	...	...	...	...	...	...

<i>Nitzschia dissipata</i> (Kützing) Grunow	NDIS	...	1,324	...	...	...	...	...	...	...
<i>Nitzschia draveillensis</i> Coste & Ricard	NDRA	...	1,324	...	...	...	...	...	...	...
<i>Nitzschia epiphytica</i> O. Muller	NEPI	...	...	...	...	...	9,598	7,818	8,099	...
<i>Nitzschia filiformis</i> (W. M. Smith) Van Heurck	NFIL	...	...	...	1,682	...	...	...	...	...
<i>Nitzschia fonticola</i> Grunow in Cleve et Möller	NFON	...	...	...	...	...	...	...	...	...
<i>Nitzschia frustulum</i> (Kützing) Grunow	NFTE	...	...	...	...	...	...	...	...	...
<i>Nitzschia frustulum</i> var. <i>bulnheimiana</i> (Rabenhorst) Grunow	NFBU	...	...	5,678	...	...	...	...	...	...
<i>Nitzschia fusiformis</i> Grunow	NFUS	...	...	...	...	...	...	...	...	...
<i>Nitzschia gracilis</i> Hantzsch	NIGR	...	...	...	...	...	...	...	...	...
<i>Nitzschia hantzschiana</i> Rabenhorst	NHAN	...	...	...	...	...	...	...	...	...
<i>Nitzschia intermedia</i> Hantzsch ex Cleve & Grunow	NINT	...	2,980	...	...	...	...	...	...	...
<i>Nitzschia liebetruthii</i> Rabenhorst	NLBT	...	...	...	...	4,194	...	...	...	...
<i>Nitzschia linearis</i> (Agardh) W. M. Smith	NLIN	...	...	...	0,962	...	...	...	...	...
<i>Nitzschia littoralis</i> Grunow in Cleve & Grunow	NLIT	...	...	...	...	...	20,123	28,990	29,283	...
<i>Nitzschia microcephala</i> Grunow in Cleve & Moller	NMIC	...	2,317	7,571	3,365	...	...	0,325	...	...
<i>Nitzschia nana</i> Grunow in Van Heurck	NNAN	...	1,987	...	...	...	...	...	...	...
<i>Nitzschia obtusa</i> var. <i>nana</i> Grunow	NOBN	...	...	...	...	...	...	...	...	...
<i>Nitzschia obtusa</i> var. <i>scalpelliformis</i> Grunow	NOBS	...	...	...	...	...	...	...	...	...
<i>Nitzschia ovalis</i> Arnott ex Grunow in Cleve & Grunow	NOVA	...	...	...	...	...	...	...	...	...
<i>Nitzschia palea</i> (Kützing) W. Smith	NPAL	...	...	...	2,644	...	...	...	...	64,423
<i>Nitzschia palea</i> var. <i>debilis</i> (Kützing) Grunow in Cleve & Grun	NPAD	...	...	...	...	...	...	...	...	...
<i>Nitzschia pura</i> Hustedt	NIPR	...	...	...	...	...	...	...	...	...
<i>Nitzschia recta</i> Hantzsch in Rabenhorst	NREC	...	...	...	...	...	...	...	...	...
<i>Nitzschia rhopalodioides</i> Hustedt	NIRH	...	...	...	...	...	...	...	...	...
<i>Nitzschia vitrea</i> Norman var. <i>tenuistriata</i> Manguin ex Kociolek & Reviere	NVTE	...	...	...	...	...	...	...	...	...
<i>Nitzschia vitrea</i> Norman	NIVI	...	...	...	...	...	...	...	...	...
<i>Nupela</i> W. Vyverman & P. Compere	NUPE	...	...	...	...	...	...	...	...	...

<b>Species list</b>	<b>Acronyms</b>									
		Kenilwort Racecourse-sediment	Kenilwort Racecourse-vegetation	Lake Michelle-vegetation	Lake Michelle-vegetation	Rooipan-sediment	Burgerspan-wooden crate	Burgerspan-vegetation	Burgerspan-sediment	Kikoosvlei-sediment
<i>Parlibellus</i> E. J. Cox	PARL	...	...	...	...	...	...	...	...	...

<i>Pinnularia</i> C. G. Ehrenberg	PINU	....	....	....	....	....	....	....	....	....
<i>Pinnularia acoricola</i> Hustedt	PACO	....	....	....	....	....	....	....	....	....
<i>Pinnularia acrosphaeria</i> var. <i>undulata</i> (Cleve) Hustedt	PAUN	....	....	....	....	....	....	....	....	....
<i>Pinnularia acrosphaeria</i> W. Smith	PACR	....	....	....	....	....	....	....	....	....
<i>Pinnularia angustiborealis</i> Krammer & Lange-Bertalot	PAGB	....	....	....	....	....	....	....	....	....
<i>Pinnularia borealis</i> Ehrenberg	PBOR	....	....	....	....	....	....	....	....	....
<i>Pinnularia borealis</i> Ehrenberg fo. <i>rectangularis</i> Carlson	PBRT	....	....	....	....	....	....	....	....	....
<i>Pinnularia brébissonii</i> (Kützing) Rabenhorst morphotyp. 1	PBMU	....	....	....	....	....	....	....	....	....
<i>Pinnularia divergens</i> W. Smith	PDIV	....	....	....	....	....	....	....	....	....
<i>Pinnularia dulcicola</i> (Maguin) Van de Vijver & Le Cohu	PDUL	....	....	....	....	....	....	....	....	....
<i>Pinnularia gibba</i> Ehrenberg	PGIB	....	....	....	....	....	....	....	....	....
<i>Pinnularia intermedia</i> (L) Cleve	PITM	....	....	....	....	....	....	....	....	....
<i>Pinnularia intermedia</i> (Lagerstedt) Cleve v. <i>bryophila</i> Manguin ex Kociolek. & Reviere	PIBR	....	....	....	....	....	....	....	....	....
<i>Pinnularia microstauron</i> var. <i>brébissonii</i> (Kützing) Mayer	PMBR	....	....	....	....	....	....	....	....	....
<i>Pinnularia microstauron</i> var. <i>rostrata</i> Krammer	PMRO	....	....	....	....	....	....	....	....	....
<i>Pinnularia obscura</i> Krasske	POBS	....	....	....	....	....	....	....	....	....
<i>Pinnularia obscuriformis</i> Krammer	POBF	....	....	....	....	....	....	....	....	....
<i>Pinnularia pulchella</i> (Boyer) Krammer	PPLL	....	....	....	....	....	....	....	....	....
<i>Pinnularia similiformis</i> Krammer	PSIF	....	....	....	....	....	....	....	....	....
<i>Pinnularia similis</i> Hustedt	PSIM	....	....	....	....	....	....	....	....	....
<i>Pinnularia</i> sp. 1	PIN1	....	....	....	....	....	....	....	0,623	....
<i>Pinnularia</i> sp. 2	PIN2	....	0,993	....	....	....	....	....	....	....
<i>Pinnularia subbrevistriata</i> Krammer	PSBV	....	....	....	....	....	....	....	....	....
<i>Pinnularia subcapitata</i> fo. <i>divergens</i> Hustedt	PSCD	0,215	....	....	....	....	....	....	....	....
<i>Pinnularia subcapitata</i> Gregory	PSCA	....	....	....	....	....	....	....	....	....
<i>Pinnularia subcapitata</i> var. <i>elongata</i> Krammer	PSEL	....	....	....	....	....	....	....	....	....
<i>Pinnularia superdivergentissima</i> Germain et Chaumont	PSPD	....	....	....	....	....	....	....	....	....
<i>Pinnularia viridiformis</i> var. <i>minor</i> Krammer	PVFM	....	....	....	....	....	....	....	....	....
<i>Pinnularia viridis</i> var. <i>minor</i> Cleve	PVMI	....	....	....	....	....	....	....	....	....
<i>Placoneis placentula</i> fo. <i>lanceolata</i> (Grunow in Cleve & Grunow) Bukhtiyarova	PLPL	....	....	....	....	....	....	....	....	....

Species list	Acronyms	Kenilwort Racecourse- sediment	Kenilwort Racecourse- vegetation	Lake Michelle- vegetation	Lake Michelle- vegetation	Rooipan-sediment	Burgerspan-wooden crate	Burgerspan- vegetation	Burgerspan-sediment	Kikoosvlei-sediment
<i>Planothidium</i> sp. Round & Bukhtiyarova	PLTD	...	...	...	...	...	...	...	...	...
<i>Planothidium delicatulum</i> (Kützing) Round & Bukhtiyarova	PTDE	...	...	...	...	...	...	...	...	...
<i>Planothidium engelbrechtii</i> (Cholnoky) Round & Bukhtiyarova	PLEN	...	2,317	...	27,163	1,613	...	...	...	0,962
<i>Planothidium lanceolatum</i> (Brebisson ex Kützing) Lange-Bertalot	PFMA	...	...	...	...	...	...	...	...	...
<i>Pleurosigma salinarum</i> (Grunow) Cleve & Grunow	PSAL	...	...	...	0,962	...	...	...	...	...
<i>Psammothidium</i> Bukhtiyarova & Round	PSMT	...	...	...	...	...	...	...	...	...
<i>Psammothidium altaicum</i> Bukhtiyarova	PALT	...	...	...	...	...	...	...	...	...
<i>Psammothidium chlidanos</i> (Hohn & Hellerman) Lange-Bertalot	PCHL	...	...	...	...	...	...	...	...	...
<i>Reimeria sinuata</i> (Gregory) Kociolek & Stoermer	RSIN	...	...	...	...	...	...	...	...	...
<i>Rhoicosphenia abbreviata</i> (C. Agardh) Lange-Bertalot	RABB	...	...	...	...	...	...	...	...	...
<i>Rhopalodia</i> sp. O Müller	RHOP	...	...	...	...	1,935	...	...	...	...
<i>Rhopalodia brébissonii</i> Krammer	RBRE	...	...	...	...	...	...	...	...	...
<i>Rhopalodia gibba</i> (Ehrenberg) O. Muller	RGIB	...	...	...	2,163	1,290	...	...	...	...
<i>Rhopalodia gibberula</i> (Ehrenberg) O. Muller	RGBL	...	...	...	...	...	...	...	...	...
<i>Rhopalodia gibberula</i> var. <i>vanheurckii</i> O. Muller	RGBB	...	...	...	3,365	...	...	...	...	...
<i>Rhopalodia musculus</i> (Kützing) O. Muller	RMUS	...	...	...	...	...	...	...	...	...
<i>Rhopalodia operculata</i> (Agardh) Hakansson	ROPE	...	...	6,309	9,135	3,225	...	...	...	...
<i>Sellaphora</i> sp. C. Mereschkowsky	SELL	...	...	...	...	...	...	...	...	...
<i>Sellaphora pupula</i> (Kützing) Mereschkowsky	SPUP	...	...	...	...	...	...	...	...	...
<i>Seminavis strigosa</i> (Hustedt) Danieledis & Economou-Amilli	SMST	...	...	...	...	...	...	...	...	...
<i>Stauroneis acidoclinata</i> Lange-Bertalot & Werum	SADC	...	...	...	...	...	...	...	...	...
<i>Stauroneis gracilior</i> (Rabenhorst) Reichardt	SGRL	...	...	...	...	...	...	...	...	...
<i>Stauroneis heinii</i> Lange-Bertalot & Krammer	SHEI	...	...	...	...	...	...	...	...	...
<i>Stauroneis pseudosuboptusoides</i> Germain	STPO	...	...	...	...	...	...	...	...	...
<i>Staurosira construens</i> var. <i>venter</i> (Ehrenberg) Hamilton	SCVE	...	...	...	...	...	...	...	...	...
<i>Staurosira elliptica</i> (Schumann) Williams & Round	SELI	...	...	40,379	6,493	...	...	...	...	...
<i>Staurosirella pinnata</i> (Ehrenberg) Williams & Round	SPIN	...	...	...	...	...	...	...	...	...
<i>Surirella angusta</i> Kützing	SANG	...	...	...	...	...	...	...	...	...
<i>Surirella brébissonii</i> Krammer & Lange-Bertalot	SBRE	...	...	0,315	...	...	...	...	...	...

<i>Surirella</i> P. J. F. Turpin	SURI	...	...	...	...	...	...	...	...	...
<i>Surirella</i> sp. 1	SUR1	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Kenilwort Racecourse-sediment	Kenilwort Racecourse-vegetation	Lake Michelle-vegetation	Lake Michelle-vegetation	Rooipan-sediment	Burgerspan-wooden crate	Burgerspan-vegetation	Burgerspan-sediment	Kikoesvlei-sediment
<i>Surirella striatula</i> Turpin sensu Schmidt	SSTR	...	...	...	...	...	...	...	...	...
<i>Synedra commutata</i> Grunow in Cleve & Grunow	SYCO	...	...	...	...	...	...	...	...	...
<i>Tabellaria flocculosa</i> (Roth) Kützing	TFLO	...	...	...	...	...	...	...	...	...
<i>Tabularia affinis</i> (Kützing) Snoeijs	TFLA	...	1,656	...	...	...	...	...	...	...
<i>Tabularia fasciculata</i> (Agardh) Williams et Round	TFAS	...	...	...	...	...	...	...	...	...
<i>Thalassiosira weissflogii</i> (Grunow) Fryxell & Hasle	TWEI	...	...	...	...	...	...	...	...	...
<i>Tryblionella angustata</i> Wm Smith	TANG	...	...	...	...	...	...	...	...	...
<i>Tryblionella apiculata</i> Gregory	TAPI	...	...	...	...	...	...	...	...	...
<i>Ulnaria ulna</i> (Nitzsch.) Compère	UULN	...	...	...	...	...	...	...	...	...
Unknown sp.	UNKN	...	...	...	...	...	...	...	...	...
Species list	Acronyms	Januariesvlei-vegetation	Januariesvlei-vegetation	Silwer dam inflow-vegetation	Silwer dam lower-vegetation	Silwer dam-vegetation	Witsand aquifer recharge-vegetation	Witsand aquifer recharge-vegetation	Yzerfontein Soutpan-pipe	Yzerfontein Soutpan-stones
<i>Achnanthes</i> J. B. M. Bory de St. Vincent	ACHN	...	...	...	...	...	...	...	...	12,500
<i>Achnanthes crassa</i> Hustedt	ACRA	...	...	...	...	...	...	...	...	...
<i>Achnanthes duthii</i> Sreenivasa	ADUT	...	...	...	...	...	...	...	...	...
<i>Achnanthes linearis</i> (W. Sm.) Grunow	ALIN	...	...	...	...	...	...	...	...	...
<i>Achnanthes minutissima</i> Kützing	AMIN	...	...	...	...	1,980	...	...	...	...
<i>Achnanthes minutissima</i> var. <i>saprophila</i> Kobayasi et Mayama	AMSA	...	...	...	...	...	...	...	...	...
<i>Achnanthes oblongella</i> Oestrup	AOBG	...	...	...	...	...	...	...	...	...
<i>Achnantheidium</i> F. T. Kützing	ACHD	...	...	...	...	...	...	...	...	...
<i>Achnantheidium affine</i> (Grunow) Czarnecki	ACAF	...	...	...	...	...	...	...	...	...
<i>Achnantheidium crassum</i> (Hustedt) Potapova & Ponader	ADCR	...	...	...	...	...	...	...	...	...
<i>Achnantheidium deflexum</i> (Reimer) Kingston	ACDF	...	...	...	...	...	...	...	...	...

<i>Achnanthydium saprophilum</i> (Kobayasi et Mayama) Round & Bukhtiyarova	ADMI	...	...	...	...	...	...	...	...	...
<i>Achnanthydium rivulare</i> Potapova & Ponader	ADRT	...	...	...	...	...	...	...	...	...
<i>Achnanthydium standerii</i> (Cholnoky) Taylor, Morales & Ector	ACHS	...	...	...	...	...	...	...	...	...
<i>Achnanthydium</i> sp.	ADCS	...	...	...	...	...	...	...	...	...
<i>Actinocyclus subtilis</i> (Gregory) Ralfs in Pritchard	ASUB	...	...	...	...	2,640	...	...	...	...
<i>Amphora</i> C. G. Ehrenberg ex F. T. Kützing	AMPH	...	...	...	3,630	2,310	...	...	...	...

Species list	Acronyms	Januaries/lel-vegetation	Januaries/lel-vegetation	Silwer dam inflow-vegetation	Silwer dam lower-vegetation	Silwer dam-vegetation	Witsand aquifer recharge-vegetation	Witsand aquifer recharge-vegetation	Yzerfontein Soutpan-pipe	Yzerfontein Soutpan-stones
<i>Amphora coffeaeformis</i> (Agardh) Kützing	ACOF	0,993	...	...	...	...	...	...	...	9,936
<i>Amphora coffeaeformis</i> var. <i>aponina</i> (Kützing) Archibald & Schoeman	ACFA	...	...	...	...	...	...	...	...	...
<i>Amphora fontinalis</i> Hustedt	AFON	...	...	...	...	...	...	...	...	...
<i>Amphora granulata</i> Gregory	AMGN	...	...	...	...	...	...	...	...	...
<i>Amphora hybrida</i> Grunow in Van Heurck	AHYB	...	...	...	...	...	...	...	...	...
<i>Amphora oligotrappenta</i> Lange-Bertalot	AOLG	...	...	...	...	...	...	...	...	...
<i>Amphora ovalis</i> (Kützing) Kützing	AOVA	...	...	...	...	...	...	...	...	...
<i>Amphora pseudoholsatica</i> Nagumo & Kobayasi	APHO	...	...	...	...	...	...	...	...	...
<i>Amphora sabiniana</i> Reimer	ASAB	...	...	...	...	...	...	...	...	...
<i>Amphora veneta</i> Kützing	AVEN	...	...	...	...	...	6,149	0,645	...	...
<i>Anomoeoneis serians</i> var. <i>apiculata</i> Boyer	ASAP	3,642	...	...	...	...	...	...	...	...
<i>Asterionella gracillima</i> (Hantzsch.) Heiberg	AGRA	...	...	...	...	...	...	...	...	...
<i>Aulacoseira</i> G. H. K. Thwaites	AULA	1,324	...	...	...	...	...	...	...	...
<i>Aulacoseira ambigua</i> (Grunow) Simonsen	AAMB	...	...	...	...	...	...	...	...	...
<i>Aulacoseira granulata</i> (Ehrenberg) Simonsen	AUGR	...	...	...	...	...	...	...	...	...
<i>Aulacoseira granulata</i> var. <i>angustissima</i> Simonsen	AUGA	...	...	...	...	...	...	...	...	...
<i>Bacillaria paradoxa</i> Gmelin	BPAR	...	...	...	...	...	...	...	...	...
<i>Brachysira brébissonii</i> Ross in Hartley	BBRE	...	...	...	...	...	...	...	...	...
<i>Caloneis bacillum</i> (Grunow) Cleve	CBAC	...	...	...	...	...	...	...	...	...
<i>Caloneis</i> Cleve	CALO	...	...	...	...	...	...	...	...	...
<i>Caloneis molaris</i> (Grunow) Krammer	CMOL	...	...	...	...	...	...	...	...	...
<i>Caloneis patagonica</i> var. <i>alaskaensis</i> Manguin ex Kociolek & Reviere	CPAL	...	...	...	...	...	...	...	...	...
<i>Caloneis permagna</i> (J. W. Bailey) Cleve	CPRM	...	...	...	...	...	...	...	...	...
<i>Cavinula cocconeiformis</i> (Gregory ex Greville) Mann & Stickle	CCOC	...	...	...	...	...	...	...	...	...
<i>Cocconeis costata</i> Gregory	COCC	...	...	...	...	...	...	...	...	...

<i>Cocconeis engelbrechtii</i> Cholnoky	CENG	...	...	...	...	...	...	...	...	...	...
<i>Cocconeis placentula</i> Ehrenberg	CPLA	...	...	...	...	...	29,773	71,935	...	...	...
<i>Cocconeis scutellum</i> Ehrenberg	CSCU	...	...	...	...	...	...	...	...	...	...
<i>Cosmioneis pusilla</i> (W. Smith) Mann & Stickle	COPU	...	...	...	...	...	...	...	...	...	...
<i>Craticula</i> A. Grunow	CRAT	...	...	...	...	...	...	...	...	...	...
<i>Craticula halophila</i> (Grunow ex Van Heurck) Mann	CHAL	...	...	...	1,320	...	...	...	...	...	...
<i>Craticula molestiformis</i> (Hustedt) Lange-Bertalot	CMLF	...	...	...	...	...	...	...	...	...	...
<i>Craticula vixnegligenda</i> Lange-Bertalot	CVIX	...	...	...	...	...	...	...	...	...	...
<i>Cyclotella meneghiniana</i> Kützing	CMEN	...	...	...	0,990	2,640	1,618	...	...	...	...
<i>Cyclotella stelligera</i> Cleve et Grun (in Van Heurck)	CSTE	...	...	...	...	...	...	...	...	...	...
<i>Cymatopleura brunii</i> Petit ex Brun	CBRU	...	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Januarieslei-vegetation	Januarieslei-vegetation	Silwer dam inflow-vegetation	Silwer dam lower-vegetation	Silwer dam-vegetation	Witsand aquifer recharge-vegetation	Witsand aquifer recharge-vegetation	Yzerfontein Soutpan-pipe	Yzerfontein Soutpan-stones
<i>Cymbella aspera</i> (Ehrenberg) H. Peragallo	CASP	...	...	...	...	...	...	...	...	...
<i>Cymbella helvetica</i> Kützing	CHEL	...	...	...	...	...	...	...	...	...
<i>Cymbella lanceolata</i> Agardh	CLTA	...	...	...	...	...	...	...	...	...
<i>Cymbella sinuata</i> Gregory	CSIN	0,662	...	...	...	...	...	...	...	...
<i>Cymbella</i> sp. 1	CYM1	...	...	...	...	...	...	...	...	...
<i>Cymbella</i> sp. 2	CYM2	...	...	...	...	...	...	...	...	...
<i>Cymbella turgidula</i> Grunow 1875 in A. Schmidt & al.	CTGL	...	...	...	...	...	...	...	...	...
<i>Cymbopleura</i> (Krammer) Krammer	CBPL	...	...	...	...	...	...	...	...	...
<i>Delicata krammeri</i> Metzeltin, Lange-Bertalot & Garcia-Rodriguez	DKRM	...	...	...	...	...	...	...	...	...
<i>Diadesmis confervacea</i> Kützing	DCON	...	...	...	...	1,320	...	...	...	...
<i>Diadesmis</i> F.T. Kützing	DDSP	...	...	...	...	...	...	...	...	...
<i>Diploneis</i> C. G. Ehrenberg ex P. T. Cleve	DIPL	...	...	...	...	...	...	...	0,327	...
<i>Diploneis smithii</i> (Brébisson) Cleve	DSMI	...	...	...	...	...	...	...	...	...
<i>Diploneis smithii</i> var. chilensis Hustedt	DSCH	...	...	...	...	...	...	...	...	...
<i>Diploneis stroemi</i> Hustedt	DSTR	...	...	...	...	...	...	...	...	...
<i>Encyonema caespitosum</i> Kützing	ECAE	...	...	...	...	...	...	...	...	...
<i>Encyonema</i> F. T. Kützing	ENCY	...	...	...	...	...	...	...	...	...
<i>Encyonema mesianum</i> (Cholnoky) D. G. Mann	ENME	...	...	...	...	...	...	...	...	...
<i>Encyonema silesiacum</i> (Bleisch in Rabenhorst) D. G. Mann	ESLE	...	...	...	...	...	...	...	...	...
<i>Encyonema silesiacum</i> var. <i>latarea</i> Krammer	ESLT	...	...	...	...	...	...	...	...	...

<i>Encyonopsis minuta</i> Krammer & Reichardt	ECPM	...	...	...	...	...	...	...	...	...
<i>Entomoneis paludosa</i> (W. Smith) Reimer	EPAL	...	...	...	...	...	...	...	...	...
<i>Epithemia adnata</i> (Kützing) Brébisson	EADN	...	...	...	...	...	...	...	...	...
<i>Eunotia bilunaris</i> (Ehrenberg) Mills	EBIL	...	...	...	...	1,320	...	...	1,639	...
<i>Eunotia boreoalpina</i> Lange-Bertalot & Nörpel-Schempp	EUBO	...	...	...	...	...	...	...	...	...
<i>Eunotia boreotenuis</i> Nörpel-Schempp & Lange-Bertalot	EBOR	...	...	...	...	...	...	...	...	...
<i>Eunotia flexuosa</i> (Brébisson) Kützing	EFLE	...	...	...	...	...	...	...	...	...
<i>Eunotia formica</i> Ehrenberg	EFOR	...	...	...	...	3,960	...	...	...	...
<i>Eunotia glacialis</i> Meister	EGLA	...	...	...	...	...	...	...	...	...
<i>Eunotia incisa</i> Gregory	EINC	...	...	15,789	...	...	...	...	...	...
<i>Eunotia minor</i> (Kützing) Grunow in Van Heurck	EMIN	...	...	...	...	1,650	...	...	...	...
<i>Eunotia monodon</i> Ehrenberg	EMON	...	...	...	...	...	...	...	...	...
<i>Eunotia pectinalis</i> (Dyllwyn) Rabenhorst	EPEC	...	...	...	...	...	...	...	...	...
<i>Eunotia silvahercynia</i> Nörpel Van Sull & Lange-Bertalot	ESIL	3,311	...	...	...	...	...	...	...	...
<i>Eunotia sudetica</i> var. <i>incisa</i> (Gregory) Manguin	ESIN	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Januariesvlei-vegetation	Januariesvlei-vegetation	Silwer dam inflow-vegetation	Silwer dam lower-vegetation	Silwer dam-vegetation	Witsand aquifer recharge-vegetation	Witsand aquifer recharge-vegetation	Yzerfontein Soutpan-pipe	Yzerfontein Soutpan-stones
<i>Eunotia tenella</i> (Grunow) Hustedt	EUNO	...	...	9,868	...	...	...	...	...	...
<i>Eunotia veneris</i> (Kützing) De Toni	EVEN	...	...	71,052	...	...	...	...	...	...
<i>Eunotogramma</i> Weisse	EUTO	...	...	...	...	...	...	...	...	...
<i>Fallacia</i> A. J. Stickle & D. G. Mann	FALL	...	...	...	...	...	...	...	...	...
<i>Fallacia pygmaea</i> (Kützing) Stickle & Mann	FPYG	...	...	...	...	...	...	...	...	...
<i>Fistulifera saprophila</i> (Lange-Bertalot & Bonik) Lange-Bertalot	FSAP	...	...	...	...	...	...	...	...	...
<i>Fragilaria</i> H. C. Lyngbye	FRAG	3,973	...	...	...	...	...	...	...	...
<i>Fragilaria bicapitata</i> A. Mayer	FBIC	2,318	10,423	...	27,062	5,611	6,472	0,645	...	...
<i>Fragilaria biceps</i> (Kützing) Lange-Bertalot	FBCP	...	...	...	...	...	...	...	...	...
<i>Fragilaria brevistriata</i> Grunow (Pseudostaurosira)	FBRE	...	...	...	...	...	...	...	...	...
<i>Fragilaria capucina</i> Desmazieres	FCAP	0,993	...	...	3,303	3,303	8,414	8,387	...	...
<i>Fragilaria capucina</i> var. <i>radians</i> (Kützing) Lange-Bertalot	FCRA	...	...	...	...	...	...	...	...	...
<i>Fragilaria capucina</i> var. <i>rumpens</i> (Kützing) Lange-Bertalot.	FCRP	...	...	...	...	...	...	...	...	...
<i>Fragilaria construens</i> (Ehrenberg) Grunow	FCON	...	...	...	...	...	...	2,903	...	...
<i>Fragilaria construens</i> fo. <i>venter</i> (Ehrenberg) Hustedt	FCVE	...	...	...	...	...	...	...	...	...
<i>Fragilaria crotonensis</i> Kitton	FCRO	...	...	...	...	...	...	...	...	...

<i>Fragilaria fasciculata</i> (C. A. Agardh) Lange-Bertalot sensu lato	FFAS	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria pulchella</i> (Ralfs ex Kützing) Lange-Bertalot (Ctenophora)	FPUL	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria striatula</i> Lyngbye	FSTR	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria tenera</i> (W. Smith) Lange-Bertalot	FTEN	...	...	...	3,303	4,290	2,913	...	...	...	...
<i>Fragilaria ulna</i> (Nitzsch.) Lange-Bertalot	FULN	...	...	...	8,251	...	...	...	...	...	...
<i>Fragilaria ulna</i> var. <i>biceps</i> (Kützing) Lange-Bertalot	FUBI	...	...	...	...	...	...	...	...	...	...
<i>Frustulia</i> L. Rabenhorst	FRUS	...	...	...	...	...	...	...	...	...	...
<i>Frustulia crassinervia</i> (Brébisson) Lange-Bertalot et Krammer	FCRS	...	...	...	...	...	...	...	...	...	...
<i>Frustulia magaliesmontana</i> Cholnoky	FMGL	...	...	...	...	...	...	...	...	...	...
<i>Frustulia rostrata</i> Hustedt	FROS	...	...	...	...	...	...	...	...	...	...
<i>Frustulia saxonica</i> Rabenhorst	FSAX	...	...	0,657	...	...	...	...	...	...	...
<i>Frustulia vulgaris</i> (Thwaites) De Toni	FVUL	...	...	...	...	...	...	...	...	...	...
<i>Gomphonema</i> C. G. Ehrenberg	GOMP	...	...	...	...	...	...	...	...	9,180	...
<i>Gomphonema affine</i> Kützing	GAFF	...	...	...	...	...	...	...	...	...	...
<i>Gomphonema angustatum</i> (Kützing) Rabenhorst	GANG	...	...	...	...	...	...	...	...	...	...
<i>Gomphonema clavatum</i> Ehrenberg	GCLA	0,662	...	...	...	...	...	...	...	...	...
<i>Gomphonema exilissimum</i> (Grunow) Lange-Bertalot & Reichardt	GEXL	...	...	...	...	...	...	...	...	...	...
<i>Gomphonema gracile</i> Ehrenberg	GGRA	4,636	81,107	...	...	3,303	...	0,322	...	...	...
<i>Gomphonema lagenula</i> Kützing	GLGN	...	...	...	...	...	...	...	...	...	...
<i>Gomphonema laticollum</i> Reichardt	GLTC	...	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Januarisvei-vegetation	Januarisvei-vegetation	Silwer dam inflow-vegetation	Silwer dam lower-vegetation	Silwer dam-vegetation	Witsand aquifer recharge-vegetation	Witsand aquifer recharge-vegetation	Yzerfontein Soutpan-pipe	Yzerfontein Soutpan-stones
<i>Gomphonema minutum</i> (Agardh) Agardh	GMIN	...	...	...	...	...	...	...	...	...
<i>Gomphonema parvulum</i> (Kützing) Kützing	GPAR	...	...	...	10,231	7,590	1,294	...	...	...
<i>Gomphonema parvulum</i> var. <i>subellipticum</i> Cleve	GPSE	...	...	...	1,320	...	...	...	...	...
<i>Gomphonema pseudoaugur</i> Lange-Bertalot	GPSA	...	...	...	...	...	...	...	...	...
<i>Gomphonema pumilum</i> (Grunow) Reichardt & Lange-Bertalot	GPUM	20,529	...	...	...	...	...	...	...	...
<i>Gomphonema pumilum</i> var. <i>rigidum</i> Reichardt & Lange-Bertalot	GPRI	...	...	...	...	...	...	...	...	...
<i>Gomphosphenia oahuensis</i> (Hustedt) Lange-Bertalot	GOAH	...	...	...	...	...	...	...	...	...
<i>Grammatophora</i> C. G. Ehrenberg	GRAM	...	...	...	...	...	...	...	...	...
<i>Halamphora eunotia</i> (Cleve) Levkov	HEUN	...	...	...	...	...	...	...	...	...
<i>Halamphora paraveneta</i> Lange-Bertalot. Cavacini. Tagliaventi & Alfinito	HPAR	...	...	...	...	...	...	...	...	...
<i>Halamphora robusta</i> Gregory	HROB	...	...	...	...	...	...	...	...	...

<i>Halampora veneta</i> (Kützing) Levkov	HVEN	...	...	...	...	...	...	...	...	...	...
<i>Halampora dominici</i> Ács & Levkov	HDOM	...	...	...	...	...	...	...	...	...	...
<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow in Cleve et Grunow 1880	HAMP	...	...	...	...	...	...	...	...	...	...
<i>Hantzschia</i> sp. 1	HAN1	...	...	...	...	...	...	...	...	...	...
<i>Haslea spicula</i> (Hickie) Bukhtiyarova	HSPC	...	...	...	...	...	...	...	...	...	...
<i>Hippodonta capitata</i> (Ehrenberg) Lange-Bert. Metzeltin & Witkowski	HCAP	...	...	...	15,182	...	...	...	...	...	...
<i>Hippodonta hungarica</i> (Grunow) Lange-Bertalot Metzeltin & Witkowski	HHUN	...	...	...	...	...	...	...	...	...	...
<i>Hippodonta</i> Lange-Bertalot. Metzeltin & Witkowski	HIPO	...	...	...	...	...	...	...	...	...	...
<i>Kobayasia subtilissima</i> (Cleve) Lange-Bertalot	KSUB	...	...	...	...	...	...	...	...	...	...
<i>Kobayasiella subtilissima</i> (Cleve) Lange-Bertalot	KOSU	...	...	...	...	...	...	...	...	...	...
<i>Lemnicola hungarica</i> (Grunow) Round & Basson	LHUN	...	...	...	...	...	16,828	4,838	...	...	...
<i>Lemnicola</i> Round & Basson	LEMN	...	...	...	...	...	...	...	...	...	...
<i>Luticola</i> D. G. Mann	LUTI	...	...	...	...	...	...	...	...	...	...
<i>Luticola acidoclinata</i> Lange-Bertalot	LACD	...	...	...	...	...	...	...	...	...	...
<i>Luticola goeppertiana</i> (Bleisch in Rabenhorst) D. G. Mann	LGOT	...	...	...	...	...	...	...	...	...	...
<i>Luticola goeppertiana</i> (Bleisch in Rabenhorst) D. G. Mann abnormal form	LGOE	...	...	...	...	...	...	...	...	...	...
<i>Luticola mutica</i> (Kützing) D. G. Mann	LMUT	...	...	...	...	...	...	...	...	...	...
<i>Luticola</i> sp.	LUSP	...	...	...	...	...	...	...	...	...	...
<i>Luticola</i> sp. (aff. mutica)	LUTS	...	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Januariesvei-vegetation	Januariesvei-vegetation	Silwer dam inflow-vegetation	Silwer dam lower-vegetation	Silwer dam-vegetation	Witsand aquifer recharge-vegetation	Witsand aquifer recharge-vegetation	Yzerfontein Soutpan-pipe	Yzerfontein Soutpan-stones
<i>Martyana atomus</i> (Hustedt) Snoeijs	MATO	...	...	...	...	...	0,971	...	...	...
<i>Mastogloia</i> G. H. K. Thwaites ex W. Smith 1856	MAST	...	...	...	...	...	...	...	...	...
<i>Mastogloia braunii</i> Grunow	MBRA	...	...	...	...	...	...	...	...	...
<i>Mastogloia elliptica</i> (C. A. Agardh) Cleve	MELL	...	...	...	...	...	...	...	...	...
<i>Mastogloia pusilla</i> (Grunow) Cleve	MPUS	...	...	...	...	...	...	...	...	...
<i>Mayamaea atomus</i> (Kützing) Lange-Bertalot	MAAT	...	...	...	...	...	...	...	...	...
<i>Melosira nummuloides</i> var. alata Jurilj	MNAL	...	...	...	...	...	...	...	...	...
<i>Melosira varians</i> Agardh	MVAR	...	...	...	...	...	1,294	...	...	...
<i>Meridion circulare</i> (Greville) C. A. Agardh	MCIR	...	...	...	...	...	...	...	...	...
<i>Microcostatus</i> sp. Johansen & Sray	MCCT	...	...	...	...	...	...	...	...	...
<i>Muelleria linearis</i> (O. Muller) Frenguelli	MULI	...	...	...	...	...	...	...	...	...
<i>Navicula</i> J. B. M. Bory de St. Vincent	NAVI	...	...	...	...	3,630	3,559	...	...	...

<i>Navicula arvensis</i> Hustedt	NARV	...	...	...	...	...	...	...	...	...	...
<i>Navicula capitatoradiata</i> Germain	NCPG	...	...	...	...	...	...	...	...	...	...
<i>Navicula cincta</i> (Ehrenberg) Ralfs in Pritchard	NCIN	...	...	...	...	...	...	...	...	...	...
<i>Navicula clementis</i> Grunow	NCLE	...	...	...	...	...	...	...	...	...	1,282
<i>Navicula cryptocephala</i> Kützing	NCRY	...	...	...	...	...	0,971	...	...	...	...
<i>Navicula cryptotenella</i> - type in Kelly	NCTY	...	...	...	...	...	...	...	...	...	...
<i>Navicula disjuncta</i> Hustedt	NDSJ	...	...	...	...	...	...	...	...	...	...
<i>Navicula erifuga</i> Lange-Bertalot	NERI	...	...	...	1,320	...	...	...	...	...	...
<i>Navicula frugalis</i> Hustedt	NFRU	...	...	...	...	...	...	...	...	...	...
<i>Navicula humerosa</i> Brébisson ex W. Smith	NHUM	...	...	...	...	...	...	...	...	...	...
<i>Navicula lanceolata</i> (Agardh) Ehrenberg	NLAN	...	...	...	...	...	...	0,323	...	...	...
<i>Navicula libonensis</i> Schoeman	NLIB	...	...	...	...	...	...	...	...	...	...
<i>Navicula microcari</i> Lange-Bertalot	NMCA	...	...	...	...	...	...	...	...	...	...
<i>Navicula modica</i> Hustedt	NMOD	...	...	...	...	...	...	...	...	...	...
<i>Navicula nivalis</i> Ehrenberg	NNIV	...	...	...	...	...	...	...	...	...	...
<i>Navicula parasubtilissima</i> Kobayasi & Nagumo	NPSU	...	...	...	...	...	...	...	...	...	...
<i>Navicula peregrina</i> (Ehrenberg) Kützing	NPRG	...	...	...	...	...	...	...	...	...	...
<i>Navicula permitis</i> Hustedt	NPER	...	...	...	...	...	...	...	...	...	...
<i>Navicula phylleptosoma</i> Lange-Bertalot	NPHP	...	...	...	...	...	...	...	...	...	...
<i>Navicula placenta</i> Ehrenberg	NPLT	...	...	...	...	...	...	...	...	...	...
<i>Navicula pseudosalinarioides</i> Giffen	NWPS	...	...	...	...	...	...	...	...	...	...
<i>Navicula pupula</i> fo. <i>rostrata</i> (Hustedt) Hustedt	NPUR	...	...	...	...	1,980	4,530	...	...	...	...
<i>Navicula pusilla</i> W. Smith	NPUS	...	...	...	...	...	...	...	...	...	0,641
<i>Navicula ranomafanensis</i> (Manguin) Metzeltin & Lange-Bertalot	NRAN	...	...	...	...	...	...	...	...	...	...

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<i>Navicula recens</i> (Lange-Bertalot) Lange-Bertalot	NRCS	...	...	...	...	...	...	...	...	...
<i>Navicula rhynchocephala</i> Kützing	NRHY	...	...	...	...	5,610	...	...	...	...
<i>Navicula riediana</i> Lange-Bertalot & Rumrich	NRIE	...	...	...	...	...	...	...	...	...
<i>Navicula rostellata</i> Kützing	NROS	...	...	...	...	...	...	...	...	...
<i>Navicula salinarum</i> Grunow in Cleve et Grunow	NSAL	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 1	NAV1	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 2	NAV2	...	...	...	...	...	...	...	...	...

<i>Navicula</i> sp. 3	NAV3	...	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 4	NAV4	...	...	...	...	...	...	...	...	...	...
<i>Navicula supergregaria</i> Lange-Bertalot & Rumrich	NSGG	...	...	...	...	...	...	...	...	...	...
<i>Navicula testa</i> Carter & Bailey-Watts	NTSA	...	...	...	...	...	...	...	...	...	...
<i>Navicula tripunctata</i> (O. F. M.) Bory forme teratogene	NTTT	...	...	...	...	...	...	...	...	...	...
<i>Navicula veneta</i> Kützing	NVEN	1,325	...	...	3,630	2,310	...	...	...	...	0,321
<i>Navicula vitrea</i> (Oestrup) Hustedt	NVIT	...	...	...	...	...	...	...	...	...	...
<i>Navicula wasmundii</i> Witkowski Metzeltin & Lange-Bertalot	NWAS	...	...	...	...	...	...	...	...	...	...
<i>Navicula zaroni</i> Hustedt	NZAN	...	...	...	...	...	...	...	...	...	...
<i>Neidium affine</i> (Ehrenberg) Pfitzer	NEAF	...	...	...	...	...	...	...	...	...	...
<i>Neidium productum</i> (W. M. Smith) Cleve	NEPR	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia</i> A. H. Hassall	NITZ	...	...	...	4,290	14,851	...	0,645	11,803	16,025	...
<i>Nitzschia acicularis</i> (Kützing) W. M. Smith	NACI	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia amphibia</i> Grunow	NAMP	...	...	...	0,991	...	2,589	...	...	...	...
<i>Nitzschia calida</i> Grunow in Cleve & Grunow	NICA	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia capitellata</i> Hustedt in A. Schmidt & al.	NCPL	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia communis</i> Rabenhorst	NCOM	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia commutata</i> Grunow in Cleve et Grunow	NICO	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia commutatoides</i> Lange-Bertalot	NCMU	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia desertorum</i> Hustedt	NDES	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia dissipata</i> (Kützing) Grunow	NDIS	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia draveillensis</i> Coste & Ricard	NDRA	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia epiphytica</i> O. Muller	NEPI	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia filiformis</i> (W. M. Smith) Van Heurck	NFIL	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia fonticola</i> Grunow in Cleve et Möller	NFON	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia frustulum</i> (Kützing) Grunow	NFTE	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia frustulum</i> var. <i>bulnheimiana</i> (Rabenhorst) Grunow	NFBU	...	...	...	...	...	...	...	...	...	...
<i>Nitzschia fusiformis</i> Grunow	NFUS	...	...	...	...	1,650	...	...	...	...	...
<i>Nitzschia gracilis</i> Hantzsch	NIGR	...	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Januaries/leiv-vegetation	Januaries/leiv-vegetation	Silwer dam inflow-vegetation	Silwer dam lower-vegetation	Silwer dam-vegetation	Witsand aquifer recharge-vegetation	Witsand aquifer recharge-vegetation	Yzerfontein Soutpan-pipe	Yzerfontein Soutpan-stones
<i>Nitzschia hantzschiana</i> Rabenhorst	NHAN	...	...	...	...	...	...	...	...	...
<i>Nitzschia intermedia</i> Hantzsch ex Cleve & Grunow	NINT	...	...	...	...	...	...	...	...	...

<i>Nitzschia liebetruthii</i> Rabenhorst	NLBT	....	....	....	....	....	....	....	....	....
<i>Nitzschia linearis</i> (Agardh) W. M. Smith	NLIN	....	....	....	....	2,640	....	....	....	....
<i>Nitzschia littoralis</i> Grunow in Cleve & Grunow	NLIT	0,662	....	....	....	....	....	1,612	73,443	52,243
<i>Nitzschia microcephala</i> Grunow in Cleve & Moller	NMIC	8,940	....	....	....	....	....	....	....	....
<i>Nitzschia nana</i> Grunow in Van Heurck	NNAN	....	....	....	....	....	....	....	....	....
<i>Nitzschia obtusa</i> var. <i>nana</i> Grunow	NOBN	....	....	....	....	....	....	....	....	....
<i>Nitzschia obtusa</i> var. <i>scalpelliformis</i> Grunow	NOBS	....	....	....	....	....	....	....	....	....
<i>Nitzschia ovalis</i> Amott ex Grunow in Cleve & Grunow	NOVA	....	....	....	....	....	....	....	....	....
<i>Nitzschia palea</i> (Kützing) W. Smith	NPAL	0,662	....	....	6,601	2,970	1,618	....	....	....
<i>Nitzschia palea</i> var. <i>debilis</i> (Kützing) Grunow in Cleve & Grun	NPAD	....	....	....	....	....	....	....	....	....
<i>Nitzschia pura</i> Hustedt	NIPR	....	....	....	....	....	....	....	....	....
<i>Nitzschia recta</i> Hantzsch in Rabenhorst	NREC	4,636	....	....	....	....	....	....	....	1,282
<i>Nitzschia rhopalodioides</i> Hustedt	NIRH	....	....	....	....	....	....	....	....	....
<i>Nitzschia vitrea</i> Norman var. <i>tenuistriata</i> Manguin ex Kociolek & Reviere	NVTE	....	....	....	....	....	....	....	....	....
<i>Nitzschia vitrea</i> Norman	NIVI	....	....	....	....	....	....	....	....	....
<i>Nupela</i> W. Vyverman & P. Compere	NUPE	....	....	....	....	....	....	....	....	....
<i>Parlibellus</i> E. J. Cox	PARL	....	....	....	....	....	....	....	....	....
<i>Pinnularia</i> C. G. Ehrenberg	PINU	....	....	1,316	....	5,280	....	....	....	....
<i>Pinnularia acorica</i> Hustedt	PACO	....	....	....	....	....	....	....	....	....
<i>Pinnularia acrosphaeria</i> var. <i>undulata</i> (Cleve) Hustedt	PAUN	....	....	....	....	....	....	....	....	....
<i>Pinnularia acrosphaeria</i> W. Smith	PACR	....	....	....	....	....	....	....	....	....
<i>Pinnularia angustiborealis</i> Krammer & Lange-Bertalot	PAGB	....	....	....	....	....	....	....	....	....
<i>Pinnularia borealis</i> Ehrenberg	PBOR	....	....	....	....	....	....	....	....	....
<i>Pinnularia borealis</i> Ehrenberg fo. <i>rectangularis</i> Carlson	PBRT	....	....	....	....	....	....	....	....	....
<i>Pinnularia brébissonii</i> (Kützing) Rabenhorst morphotyp. 1	PBMU	....	....	....	....	....	....	....	....	....
<i>Pinnularia divergens</i> W. Smith	PDIV	....	....	....	....	....	....	....	....	....
<i>Pinnularia dulcicola</i> (Maguin) Van de Vijver & Le Cohu	PDUL	....	....	....	....	....	....	....	....	....
<i>Pinnularia gibba</i> Ehrenberg	PGIB	....	....	....	....	....	0,971	....	....	....
<i>Pinnularia intermedia</i> (L) Cleve	PITM	....	....	....	....	....	....	....	....	....
<i>Pinnularia intermedia</i> (Lagerstedt) Cleve v. <i>bryophila</i> Manguin ex Kociolek & Reviere	PIBR	....	....	....	....	....	....	....	....	....
<i>Pinnularia microstauron</i> var. <i>brébissonii</i> (Kützing) Mayer	PMBR	....	....	....	....	....	....	....	....	....
<i>Pinnularia microstauron</i> var. <i>rostrata</i> Krammer	PMRO	....	....	....	....	....	....	....	....	....
<i>Pinnularia obscura</i> Krasske	POBS	....	....	....	....	....	....	....	....	....
<i>Pinnularia obscuriformis</i> Krammer	POBF	....	....	....	....	....	....	....	....	....

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<i>Pinnularia pulchella</i> (Boyer) Krammer	PPLL	...	...	...	...	...	...	...	...	...
<i>Pinnularia similiformis</i> Krammer	PSIF	...	...	...	...	...	...	...	...	...
<i>Pinnularia similis</i> Hustedt	PSIM	...	...	...	...	...	...	...	...	...
<i>Pinnularia</i> sp. 1	PIN1	0,662	...	...	...	...	...	...	...	...
<i>Pinnularia</i> sp. 2	PIN2	...	...	...	...	...	...	...	...	...
<i>Pinnularia subbrevistriata</i> Krammer	PSBV	...	...	...	...	...	...	...	...	...
<i>Pinnularia subcapitata</i> fo. <i>divergens</i> Hustedt	PSCD	...	...	1,320	...	3,300	...	...	...	...
<i>Pinnularia subcapitata</i> Gregory	PSCA	...	...	...	...	...	...	...	...	...
<i>Pinnularia subcapitata</i> var. <i>elongata</i> Krammer	PSEL	...	...	...	...	...	...	...	...	...
<i>Pinnularia superdivergentissima</i> Germain et Chaumont	PSPD	...	...	...	...	...	...	...	...	...
<i>Pinnularia viridiformis</i> var. <i>minor</i> Krammer	PVFM	...	...	...	...	...	...	...	...	...
<i>Pinnularia viridis</i> var. <i>minor</i> Cleve	PVMI	...	...	...	...	...	...	...	...	...
<i>Placoneis placentula</i> fo. <i>lanceolata</i> (Grunow in Cleve & Grunow) Bukhtiyarova	PLPL	...	...	...	...	...	...	...	...	...
<i>Planothidium</i> sp. Round & Bukhtiyarova	PLTD	...	...	...	...	...	...	...	...	...
<i>Planothidium delicatulum</i> (Kützing) Round & Bukhtiyarova	PTDE	...	...	...	...	...	...	...	...	...
<i>Planothidium engelbrechtii</i> (Cholnoky) Round & Bukhtiyarova	PLEN	36,093	10,749	...	2,640	11,221	5,825	2,258	...	...
<i>Planothidium lanceolatum</i> (Brebisson ex Kützing) Lange-Bertalot	PFMA	...	...	...	...	...	...	...	...	...
<i>Pleurosigma salinarum</i> (Grunow) Cleve & Grunow	PSAL	...	...	...	...	...	...	...	...	...
<i>Psammothidium</i> Bukhtiyarova & Round	PSMT	...	...	...	...	...	...	...	...	...
<i>Psammothidium altaicum</i> Bukhtiyarova	PALT	...	...	...	...	...	...	...	...	...
<i>Psammothidium chlidanos</i> (Hohn & Hellerman) Lange-Bertalot	PCHL	...	...	...	...	...	...	...	...	...
<i>Reimeria sinuata</i> (Gregory) Kocielek & Stoermer	RSIN	...	...	...	...	...	...	...	...	...
<i>Rhoicosphenia abbreviata</i> (C. Agardh) Lange-Bertalot	RABB	...	...	...	...	...	...	...	...	...
<i>Rhopalodia</i> sp. O Müller	RHOP	...	...	...	...	...	...	...	3,606	5,769
<i>Rhopalodia brébissonii</i> Krammer	RBRE	...	...	...	...	...	...	...	...	...
<i>Rhopalodia gibba</i> (Ehrenberg) O. Muller	RGIB	...	...	...	...	...	...	...	...	...
<i>Rhopalodia gibberula</i> (Ehrenberg) O. Muller	RGBL	...	...	...	...	...	...	...	...	...
<i>Rhopalodia gibberula</i> var. <i>vanheurckii</i> O. Muller	RGBB	...	...	...	...	...	...	...	...	...
<i>Rhopalodia musculus</i> (Kützing) O. Muller	RMUS	...	...	...	...	...	...	...	...	...
<i>Rhopalodia operculata</i> (Agardh) Hakansson	ROPE	...	...	...	...	...	...	...	...	...
<i>Sellaphora</i> sp. C. Mereschowsky	SELL	...	...	...	...	...	...	...	...	...
<i>Sellaphora pupula</i> (Kützing) Mereschowsky	SPUP	...	...	...	1,980	...	...	...	...	...

<i>Seminavis strigosa</i> (Hustedt) Danieledis & Economou-Amilli	SMST	...	...	...	...	...	...	...	...	...
<i>Stauroneis acidoclinata</i> Lange-Bertalot & Werum	SADC	...	...	...	...	...	...	...	...	...
<i>Stauroneis gracilior</i> (Rabenhorst) Reichardt	SGRL	...	...	...	...	...	...	...	...	...
<i>Stauroneis heinii</i> Lange-Bertalot & Krammer	SHEI	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Januariesvlei-vegetation	Januariesvlei-vegetation	Silwer dam inflow-vegetation	Silwer dam lower-vegetation	Silwer dam-vegetation	Witsand aquifer recharge-vegetation	Witsand aquifer recharge-vegetation	Yzerfontein Soutpan-pipe	Yzerfontein Soutpan-stones
<i>Stauroneis pseudosuboptusoides</i> Germain	STPO	...	...	...	...	...	...	...	...	...
<i>Stausosira construens</i> var <i>venter</i> (Ehrenberg) Hamilton	SCVE	...	...	...	...	...	...	...	...	...
<i>Stausosira elliptica</i> (Schumann) Williams & Round	SELI	...	...	...	...	...	...	...	...	...
<i>Stausosirella pinnata</i> (Ehrenberg) Williams & Round	SPIN	...	...	...	...	...	...	...	...	...
<i>Surirella angusta</i> Kützing	SANG	...	...	...	...	...	...	...	...	...
<i>Surirella brébissonii</i> Krammer & Lange-Bertalot	SBRE	...	...	...	...	...	...	...	...	...
<i>Surirella</i> P. J. F. Turpin	SURI	...	...	...	...	...	...	...	...	...
<i>Surirella</i> sp. 1	SUR1	...	...	...	...	...	...	...	...	...
<i>Surirella striatula</i> Turpin sensu Schmidt	SSTR	...	...	...	...	...	...	...	...	...
<i>Synedra commutata</i> Grunow in Cleve & Grunow	SYCO	...	...	...	...	...	...	...	...	...
<i>Tabellaria flocculosa</i> (Roth) Kützing	TFLO	...	...	...	...	...	...	...	...	...
<i>Tabularia affinis</i> (Kützing) Snoeijs	TFLA	...	...	...	...	...	...	...	...	...
<i>Tabularia fasciculata</i> (Agardh) Williams et Round	TFAS	3,974	0,977	...	3,960	2,640	4,207	5,483	...	...
<i>Thalassiosira weissflogii</i> (Grunow) Fryxell & Hasle	TWEI	...	...	...	...	...	...	...	...	...
<i>Tryblionella angustata</i> Wm Smith	TANG	...	...	...	...	...	...	...	...	...
<i>Tryblionella apiculata</i> Gregory	TAPI	...	...	...	...	...	...	...	...	...
<i>Ulnaria ulna</i> (Nitzsch.) Compère	UULN	...	...	...	...	...	...	...	...	...
Unknown sp.	UNKN	...	...	...	...	...	...	...	...	...
Species list	Acronyms	Yzerfontein Soutpan-sediment disturbed	Yzerfontein Soutpan-sediment undisturbed	Koekiespan-vegetation	Modderrivier-vegetation	Modderrivier-stones	Die vlakke-vegetation	Wagensboomrivier-vegetation	Hoogvertoon-sediment	Hoogvertoon-vegetation
<i>Achnanthes crassa</i> Hustedt	ACRA	...	...	...	...	...	...	...	...	...
<i>Achnanthes duthii</i> Sreenivasa	ADUT	...	...	...	...	...	...	...	...	...

<i>Achnanthes</i> J. B. M. Bory de St. Vincent	ACHN	10,749	7,566	...	1,333	1,333	...	49,000	...	...
<i>Achnanthes linearis</i> (W. Sm.) Grunow	ALIN	...	...	...	...	...	...	...	...	...
<i>Achnanthes minutissima</i> Kützing	AMIN	...	...	...	...	...	...	...	...	...
<i>Achnanthes minutissima</i> var. <i>saprophila</i> Kobayasi et Mayama	AMSA	...	...	...	...	...	24,667	...	...	...
<i>Achnanthes oblongella</i> Oestrup	AOBG	...	...	...	...	...	...	...	...	...
<i>Achnantheidium</i> F. T. Kützing	ACHD	...	...	...	...	...	...	...	...	...
<i>Achnantheidium affine</i> (Grunow) Czarnecki	ACAF	...	...	...	...	...	...	...	...	...
<i>Achnantheidium crassum</i> (Hustedt) Potapova & Ponader	ADCR	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Yzerfontein Soutpan-sediment disturbed	Yzerfontein Soutpan-sediment undisturbed	Koekiespan-vegetation	Modderrivier-vegetation	Modderrivier-stones	Die vlakte-vegetation	Wagensboomrivier-vegetation	Hoogvertoon-sediment	Hoogvertoon-vegetation
<i>Achnantheidium deflexum</i> (Reimer) Kingston	ACDF	...	...	...	...	...	...	...	...	...
<i>Achnantheidium saprophilum</i> (Kobayasi et Mayama) Round & Bukhtiyarova	ADMI	...	...	...	...	...	...	...	...	...
<i>Achnantheidium rivulare</i> Potapova & Ponader	ADRT	...	...	...	...	...	...	...	...	...
<i>Achnantheidium standerii</i> (Cholnoky) Taylor, Morales & Ector	ACHS	...	...	...	...	...	...	...	...	...
<i>Achnantheidium</i> sp.	ADCS	...	...	...	...	...	...	...	...	...
<i>Actinocyclus subtilis</i> (Gregory) Ralfs in Pritchard	ASUB	...	...	...	...	...	...	...	...	...
<i>Amphora</i> C. G. Ehrenberg ex F. T. Kützing	AMPH	...	...	...	...	...	...	...	...	...
<i>Amphora coffeaeformis</i> (Agardh) Kützing	ACOF	2,280	0,659	...	...	...	...	...	...	...
<i>Amphora coffeaeformis</i> var. <i>aponina</i> (Kützing) Archibald & Schoeman	ACFA	...	...	11,221	...	...	...	...	...	...
<i>Amphora fontinalis</i> Hustedt	AFON	...	...	...	...	...	...	...	...	...
<i>Amphora granulata</i> Gregory	AMGN	...	...	...	...	...	...	...	...	...
<i>Amphora hybrida</i> Grunow in Van Heurck	AHYB	...	...	...	...	...	...	...	...	...
<i>Amphora oligotrappenta</i> Lange-Bertalot	AOLG	...	...	...	...	...	...	...	...	...
<i>Amphora ovalis</i> (Kützing) Kützing	AOVA	...	...	...	...	...	...	...	...	...
<i>Amphora pseudoholsatica</i> Nagumo & Kobayasi	APHO	...	...	...	...	...	...	...	...	...
<i>Amphora sabiniana</i> Reimer	ASAB	...	...	...	...	...	...	...	...	...
<i>Amphora veneta</i> Kützing	AVEN	...	...	...	...	...	...	...	...	...
<i>Anomoeoneis seriens</i> var. <i>apiculata</i> Boyer	ASAP	...	...	...	...	...	...	...	...	...
<i>Asterionella gracillima</i> (Hantzsch.) Heiberg	AGRA	...	...	...	...	...	...	...	...	...
<i>Aulacoseira</i> G. H. K. Thwaites	AULA	...	...	...	...	...	...	...	...	...
<i>Aulacoseira ambigua</i> (Grunow) Simonsen	AAMB	...	...	...	...	...	...	...	...	...

<i>Aulacoseira granulata</i> (Ehrenberg) Simonsen	AUGR	...	...	...	...	...	...	...	...	...
<i>Aulacoseira granulata</i> var. <i>angustissima</i> Simonsen	AUGA	...	...	...	...	...	...	...	...	...
<i>Bacillaria paradoxa</i> Gmelin	BPAR	...	...	...	...	...	...	...	...	...
<i>Brachysira brébissonii</i> Ross in Hartley	BBRE	...	...	...	...	...	...	...	...	...
<i>Caloneis bacillum</i> (Grunow) Cleve	CBAC	...	...	...	...	...	...	...	...	...
<i>Caloneis</i> Cleve	CALO	...	...	...	...	...	...	...	...	...
<i>Caloneis molaris</i> (Grunow) Krammer	CMOL	...	...	...	...	...	...	...	...	...
<i>Caloneis patagonica</i> var. <i>alaskaensis</i> Manguin ex Kociolek & Reviere	CPAL	...	...	...	...	...	...	...	...	...
<i>Caloneis permagna</i> (J. W. Bailey) Cleve	CPRM	...	...	...	...	...	...	...	...	...
<i>Cavinula cocconeiformis</i> (Gregory ex Greville) Mann & Stickle	CCOC	...	...	...	...	...	...	...	...	...
<i>Cocconeis costata</i> Gregory	COCC	...	...	...	...	...	...	...	...	...
<i>Cocconeis engelbrechtii</i> Cholnoky	CENG	...	...	...	...	...	...	...	...	...
<i>Cocconeis placentula</i> Ehrenberg	CPLA	...	...	...	...	...	...	3,000	...	...
<i>Cocconeis scutellum</i> Ehrenberg	CSCU	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Vegetation types								
		Yzerfontein Soutpan-sediment disturbed	Yzerfontein Soutpan-sediment undisturbed	Koekiespan-vegetation	Modderrivier-vegetation	Modderrivier-stones	Die vlakte-vegetation	Wagensboomrivier-vegetation	Hoogvertoon-sediment	Hoogvertoon-vegetation
<i>Cosmioneis pusilla</i> (W. Smith) Mann & Stickle	COPU	...	...	...	...	...	...	...	1,667	...
<i>Craticula</i> A. Grunow	CRAT	...	...	...	...	...	...	...	...	...
<i>Craticula halophila</i> (Grunow ex Van Heurck) Mann	CHAL	...	...	...	...	...	...	...	...	...
<i>Craticula molestiformis</i> (Hustedt) Lange-Bertalot	CMLF	...	...	...	...	...	...	1,333	0,667	...
<i>Craticula vixnegligenda</i> Lange-Bertalot	CVIX	...	...	...	1,000	...	...	...	...	...
<i>Cyclotella meneghiniana</i> Kützing	CMEN	...	...	...	0,667	...	2,667	2,667	...	...
<i>Cyclotella stelligera</i> Cleve et Grun (in Van Heurck)	CSTE	...	...	...	...	...	...	...	...	...
<i>Cymatopleura brunii</i> Petit ex Brun	CBRU	...	...	...	0,667	...	...	...	...	...
<i>Cymbella aspera</i> (Ehrenberg) H. Peragallo	CASP	...	...	...	...	...	...	...	...	...
<i>Cymbella helvetica</i> Kützing	CHEL	...	...	...	...	...	...	1,000	...	...
<i>Cymbella lanceolata</i> Agardh	CLTA	...	...	...	...	...	...	...	...	...
<i>Cymbella sinuata</i> Gregory	CSIN	...	...	...	...	...	...	...	...	...
<i>Cymbella</i> sp. 1	CYM1	...	...	...	...	...	...	...	...	...
<i>Cymbella</i> sp. 2	CYM2	...	...	...	...	...	...	...	...	...

<i>Cymbella turgidula</i> Grunow 1875 in A. Schmidt & al.	CTGL	...	...	...	...	...	...	...	...	...
<i>Cymboppleura</i> (Krammer) Krammer	CBPL	...	...	...	...	...	...	...	...	...
<i>Delicata krammeri</i> Metzeltin, Lange-Bertalot & Garcia-Rodriguez	DKRM	...	...	...	...	...	...	2,333	...	...
<i>Diadesmis confervacea</i> Kützing	DCON	...	...	...	...	...	...	...	...	...
<i>Diadesmis</i> F. T. Kützing	DDSP	...	...	...	...	...	...	...	...	...
<i>Diploneis</i> C. G. Ehrenberg ex P. T. Cleve	DIPL	0,977	1,316	...	...	...	...	...	...	...
<i>Diploneis smithii</i> (Brébisson) Cleve	DSMI	...	...	...	...	...	...	...	...	...
<i>Diploneis smithii</i> var. <i>chilensis</i> Hustedt	DSCH	...	...	...	...	0,667	...	...	...	...
<i>Diploneis stroemi</i> Hustedt	DSTR	...	...	...	...	...	...	...	...	...
<i>Encyonema caespitosum</i> Kützing	ECAE	...	...	...	...	...	...	...	...	...
<i>Encyonema</i> F. T. Kützing	ENCY	...	...	...	...	...	...	...	...	...
<i>Encyonema mesianum</i> (Cholnoky) D. G. Mann	ENME	...	...	...	...	...	...	...	...	...
<i>Encyonema silesiacum</i> (Bleisch in Rabenhorst) D. G. Mann	ESLE	...	...	...	...	...	...	...	...	...
<i>Encyonema silesiacum</i> var. <i>latarea</i> Krammer	ESLT	...	...	...	...	...	...	...	...	...
<i>Encyonopsis minuta</i> Krammer & Reichardt	ECPM	...	...	...	...	...	...	...	...	...
<i>Entomoneis paludosa</i> (W. Smith) Reimer	EPAL	...	...	...	1,333	0,667	...	...	...	...
<i>Epithemia adnata</i> (Kützing) Brébisson	EADN	...	...	...	...	...	...	...	...	...
<i>Eunotia bilunaris</i> (Ehrenberg) Mills	EBIL	...	...	...	...	...	...	1,333	...	...
<i>Eunotia boreoalpina</i> Lange-Bertalot & Nörpel-Schempp	EUBO	...	...	...	...	...	...	...	...	...
<i>Eunotia boreotenuis</i> Norpel-Schempp & Lange-Bertalot	EBOR	...	...	...	...	...	...	...	...	47,667

Species list	Acronyms	Yzerfontein Soutpan-sediment disturbed	Yzerfontein Soutpan-sediment undisturbed	Koekiespan-vegetation	Modderrivier-vegetation	Modderrivier-stones	Die vlakte-vegetation	Wagensboomrivier-vegetation	Hoogvertoon-sediment	Hoogvertoon-vegetation
<i>Eunotia flexuosa</i> (Brébisson) Kützing	EFLE	...	...	...	...	...	7,667	...	...	...
<i>Eunotia formica</i> Ehrenberg	EFOR	...	...	...	...	...	...	...	...	...
<i>Eunotia glacialis</i> Meister	EGLA	...	...	...	...	...	...	...	...	...
<i>Eunotia incisa</i> Gregory	EINC	...	...	...	...	...	...	...	...	...
<i>Eunotia minor</i> (Kützing) Grunow in Van Heurck	EMIN	...	...	...	...	...	...	...	...	...
<i>Eunotia monodon</i> Ehrenberg	EMON	...	...	...	...	...	...	...	...	...
<i>Eunotia pectinalis</i> (Dyllwyn) Rabenhorst	EPEC	...	...	...	...	...	...	...	...	...
<i>Eunotia silvahercynia</i> Nörpel Van Sull & Lange-Bertalot	ESIL	...	...	...	...	...	...	...	...	...

<i>Eunotia sudetica</i> var. <i>incisa</i> (Gregory) Manguin	ESIN	...	...	...	...	...	...	...	...	...
<i>Eunotia tenella</i> (Grunow) Hustedt	EUNO	16,938	...	...	...	...	17,333	3,000	13,667	36,000
<i>Eunotia veneris</i> (Kützing) De Toni	EVEN	...	...	...	...	...	...	...	...	...
<i>Eunotogramma</i> Weisse	EUTO	...	...	...	...	...	...	...	...	...
<i>Fallacia</i> A. J. Stickle & D. G. Mann	FALL	...	...	...	...	...	...	...	...	...
<i>Fallacia pygmaea</i> (Kützing) Stickle & Mann	FPYG	...	...	2,310	...	...	...	...	...	...
<i>Fistulifera saprophila</i> (Lange-Bertalot & Bonik) Lange-Bertalot	FSAP	...	...	...	...	...	...	...	...	...
<i>Fragilaria</i> H. C. Lyngbye	FRAG	...	...	...	...	...	...	...	...	...
<i>Fragilaria bicapitata</i> A. Mayer	FBIC	...	...	...	...	...	...	...	...	...
<i>Fragilaria biceps</i> (Kützing) Lange-Bertalot	FBCP	...	...	...	...	...	...	...	...	...
<i>Fragilaria brevistriata</i> Grunow (Pseudostaurosira)	FBRE	...	...	...	...	...	...	...	...	...
<i>Fragilaria capucina</i> Desmazieres	FCAP	...	...	...	...	...	...	...	...	...
<i>Fragilaria capucina</i> var. <i>radians</i> (Kützing) Lange-Bertalot	FCRA	...	...	...	...	...	...	...	...	...
<i>Fragilaria capucina</i> var. <i>rumpens</i> (Kützing) Lange-Bertalot.	FCRP	...	...	...	...	...	3,667	...	...	...
<i>Fragilaria construens</i> (Ehrenberg) Grunow	FCON	...	...	...	...	...	...	...	...	...
<i>Fragilaria construens</i> fo. <i>venter</i> (Ehrenberg) Hustedt	FCVE	...	...	...	...	...	...	...	...	...
<i>Fragilaria crotonensis</i> Kitton	FCRO	...	...	...	...	...	...	...	...	...
<i>Fragilaria fasciculata</i> (C. A. Agardh) Lange-Bertalot sensu lato	FFAS	...	...	...	2,667	...	...	...	...	...
<i>Fragilaria pulchella</i> (Ralfs ex Kützing) Lange-Bertalot (Ctenophora)	FPUL	...	...	...	...	...	...	...	...	...
<i>Fragilaria striatula</i> Lyngbye	FSTR	...	...	...	...	...	...	...	4,667	...
<i>Fragilaria tenera</i> (W. Smith) Lange-Bertalot	FTEN	...	...	...	...	...	...	3,667	...	...
<i>Fragilaria ulna</i> (Nitzsch.) Lange-Bertalot	FULN	...	...	...	...	...	...	...	...	...
<i>Fragilaria ulna</i> var. <i>biceps</i> (Kützing) Lange-Bertalot	FUBI	...	...	...	...	...	2,333	...	...	...
<i>Frustulia</i> L. Rabenhorst	FRUS	...	...	...	...	...	...	...	...	...
<i>Frustulia crassinervia</i> (Brébisson) Lange-Bertalot et Krammer	FCRS	...	...	...	...	...	...	...	...	...
<i>Frustulia magaliesmontana</i> Cholnoky	FMGL	...	...	...	...	...	...	...	...	...
<i>Frustulia rostrata</i> Hustedt	FROS	...	...	...	...	...	...	...	...	...

<b>Species list</b>	<b>Acronyms</b>	Yzerfontein Soutpan-sediment disturbed	Yzerfontein Soutpan-sediment undisturbed	Koekiespan-vegetation	Modderrivier-vegetation	Modderrivier-stones	Die vlakke-vegetation	Wagensboomrivier-vegetation	Hoogvertoon-sediment	Hoogvertoon-vegetation
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<i>Frustulia saxonica</i> Rabenhorst	FSAX	...	...	...	...	...	...	...	...	...
<i>Frustulia vulgaris</i> (Thwaites) De Toni	FVUL	...	...	...	...	...	...	...	...	...
<i>Gomphonema</i> C. G. Ehrenberg	GOMP	...	...	...	...	...	...	...	...	...
<i>Gomphonema affine</i> Kützing	GAFF	...	...	...	...	...	...	...	...	...
<i>Gomphonema angustatum</i> (Kützing) Rabenhorst	GANG	...	0,986	...	...	...	...	...	...	...
<i>Gomphonema clavatum</i> Ehrenberg	GCLA	...	...	...	...	...	...	...	...	...
<i>Gomphonema exilissimum</i> (Grunow) Lange-Bertalot & Reichardt	GEXL	...	...	...	...	...	...	...	...	...
<i>Gomphonema gracile</i> Ehrenberg	GGRA	...	...	...	...	...	...	0,333	...	...
<i>Gomphonema lagenula</i> Kützing	GLGN	...	...	...	...	...	12,667	...	...	...
<i>Gomphonema laticollum</i> Reichardt	GLTC	...	...	...	...	...	1,000	...	...	...
<i>Gomphonema minutum</i> (Agardh) Agardh	GMIN	8,143	3,289	...	...	...	...	...	...	...
<i>Gomphonema parvulum</i> (Kützing) Kützing	GPAR	...	...	...	...	...	5,667	...	...	...
<i>Gomphonema parvulum</i> var. <i>subellipticum</i> Cleve	GPSE	...	...	...	...	...	...	...	...	...
<i>Gomphonema pseudoaugur</i> Lange-Bertalot	GPSA	...	...	...	...	...	...	...	...	...
<i>Gomphonema pumilum</i> (Grunow) Reichardt & Lange-Bertalot	GPUM	...	...	...	...	...	...	...	...	...
<i>Gomphonema pumilum</i> var. <i>rigidum</i> Reichardt & Lange-Bertalot	GPRI	...	...	...	...	...	...	1,333	...	...
<i>Gomphosphenia oahuensis</i> (Hustedt) Lange-Bertalot	GOAH	...	...	...	...	...	...	...	...	...
<i>Grammatophora</i> C. G. Ehrenberg	GRAM	...	...	...	...	...	...	...	...	...
<i>Halamphora eunotia</i> (Cleve) Levkov	HEUN	...	...	...	...	3,333	...	...	...	...
<i>Halamphora paraveneta</i> Lange-Bertalot. Cavacini. Tagliaventi & Alfinito	HPAR	...	...	...	...	0,333	...	...	...	...
<i>Halamphora robusta</i> Gregory	HROB	...	...	...	1,667	...	...	...	...	...
<i>Halamphora veneta</i> (Kützing) Levkov	HVEN	...	...	...	...	3,333	...	...	...	...
<i>Halamphora dominici</i> Ács & Levkov	HDOM	...	...	...	...	1,333	...	...	...	...
<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow in Cleve et Grunow 1880	HAMP	...	...	...	...	...	...	1,333	2,667	1,000
<i>Hantzschia</i> sp. 1	HAN1	3,257	...	...	...	...	...	...	...	...
<i>Haslea spicula</i> (Hickie) Bukhtiyarova	HSPC	...	...	...	...	...	...	...	...	...
<i>Hippodonta capitata</i> (Ehrenberg) Lange-Bert. Metzeltin & Witkowski	HCAP	...	...	...	...	...	...	...	...	...
<i>Hippodonta hungarica</i> (Grunow) Lange-Bertalot Metzeltin & Witkowski	HHUN	...	...	...	...	...	...	...	...	...
<i>Hippodonta</i> Lange-Bertalot. Metzeltin & Witkowski	HIPO	...	...	...	...	...	...	...	...	...
<i>Kobayasia subtilissima</i> (Cleve) Lange-Bertalot	KSUB	...	...	...	...	...	...	...	...	...
<i>Kobayasiella subtilissima</i> (Cleve) Lange-Bertalot	KOSU	...	...	...	...	...	...	...	...	...
<i>Lemnicola hungarica</i> (Grunow) Round & Basson	LHUN	...	...	...	...	...	...	...	...	...
<i>Lemnicola</i> Round & Basson	LEMN	...	...	...	...	...	...	...	...	...
<i>Luticola</i> D. G. Mann	LUTI	...	...	...	...	...	...	...	0,667	...
<i>Luticola acidoclinata</i> Lange-Bertalot	LACD	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Yzerfontein Soutpan-sediment disturbed	Yzerfontein Soutpan-sediment undisturbed	Koekiespan-vegetation	Modderrivier-vegetation	Modderrivier-stones	Die vlakke-vegetation	Wagensboomrivier-vegetation	Hoogvertoon-sediment	Hoogvertoon-vegetation
<i>Luticola goeppertiana</i> (Bleisch in Rabenhorst) D. G. Mann	LGOT	...	...	...	...	...	...	...	...	...
<i>Luticola goeppertiana</i> (Bleisch in Rabenhorst) D. G. Mann abnormal form	LGOE	...	...	...	...	...	0,667	...	...	...
<i>Luticola mutica</i> (Kützing) D. G. Mann	LMUT	...	...	...	...	...	...	...	...	1,000
<i>Luticola</i> sp.	LUSP	...	...	...	...	...	...	...	...	...
<i>Luticola</i> sp. (aff. <i>mutica</i> )	LUTS	...	...	...	...	...	...	...	...	1,333
<i>Martyana atomus</i> (Hustedt) Snoeijs	MATO	...	...	...	...	...	...	...	...	...
<i>Mastogloia</i> G. H. K. Thwaites ex W. Smith 1856	MAST	...	...	...	...	...	...	...	...	...
<i>Mastogloia braunii</i> Grunow	MBRA	...	...	...	...	...	...	...	...	...
<i>Mastogloia elliptica</i> (C. A. Agardh) Cleve	MELL	...	...	...	...	...	...	...	...	...
<i>Mastogloia pusilla</i> (Grunow) Cleve	MPUS	...	...	...	...	...	...	...	...	...
<i>Mayamaea atomus</i> (Kützing) Lange-Bertalot	MAAT	...	...	...	...	...	...	1,000	...	...
<i>Melosira nummuloides</i> var. <i>alata</i> Jurilj	MNAL	...	...	...	...	...	...	...	...	...
<i>Melosira varians</i> Agardh	MVAR	...	...	...	...	0,667	...	...	...	...
<i>Meridion circulare</i> (Greville) C. A. Agardh	MCIR	...	...	...	...	...	...	...	...	...
<i>Microcostatus</i> sp. Johansen & Sray	MCCT	...	...	...	...	...	...	...	...	...
<i>Muelleria linearis</i> (O. Muller) Frenguelli	MULI	...	...	...	...	...	...	...	...	...
<i>Navicula</i> J. B. M. Bory de St. Vincent	NAVI	...	8,882	14,851	...	1,667	...	...	10,667	...
<i>Navicula arvensis</i> Hustedt	NARV	...	...	...	...	...	...	...	...	...
<i>Navicula capitatoradiata</i> Germain	NCPG	...	...	...	...	...	...	...	...	...
<i>Navicula cincta</i> (Ehrenberg) Ralfs in Pritchard	NCIN	...	...	...	...	...	...	...	...	...
<i>Navicula clementis</i> Grunow	NCLE	...	...	...	...	...	...	...	...	...
<i>Navicula cryptocephala</i> Kützing	NCRY	...	...	...	...	...	...	...	...	...
<i>Navicula cryptotenella</i> - type in Kelly	NCTY	...	...	...	...	0,667	...	...	...	...
<i>Navicula disjuncta</i> Hustedt	NDSJ	...	...	...	...	...	...	...	...	...
<i>Navicula erifuga</i> Lange-Bertalot	NERI	...	...	...	...	...	...	...	...	...
<i>Navicula frugalis</i> Hustedt	NFRU	...	...	...	...	...	...	...	...	...
<i>Navicula humerosa</i> Brébisson ex W. Smith	NHUM	...	...	...	...	...	...	...	...	...
<i>Navicula lanceolata</i> (Agardh) Ehrenberg	NLAN	...	...	...	...	...	...	...	...	...

<i>Navicula libonensis</i> Schoeman	NLIB	...	...	...	...	...	...	...	...	...
<i>Navicula microcari</i> Lange-Bertalot	NMCA	...	...	...	3,667	...	...	...	...	...
<i>Navicula modica</i> Hustedt	NMOD	...	...	...	8,667	...	...	...	...	...
<i>Navicula nivalis</i> Ehrenberg	NNIV	...	...	...	...	...	...	...	...	...
<i>Navicula parasubtilissima</i> Kobayasi & Nagumo	NPSU	...	...	...	...	...	...	...	6,667	...
<i>Navicula peregrina</i> (Ehrenberg) Kützing	NPRG	...	...	...	...	...	...	...	...	...
<i>Navicula permitis</i> Hustedt	NPER	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Yzerfontein Soutpan-sediment disturbed	Yzerfontein Soutpan-sediment undisturbed	Koekiespan-vegetation	Modderrivier-vegetation	Modderrivier-stones	Die vlakke-vegetation	Wagensboomrivier-vegetation	Hoogvertoon-sediment	Hoogvertoon-vegetation
<i>Navicula phylleptosoma</i> Lange-Bertalot	NPHP	...	...	...	1,333	1,333	...	...	...	...
<i>Navicula placenta</i> Ehrenberg	NPLT	...	...	...	...	...	...	...	...	...
<i>Navicula pseudosalinarioides</i> Giffen	NWPS	...	...	0,661	...	...	...	...	...	...
<i>Navicula pupula</i> fo. <i>rostrata</i> (Hustedt) Hustedt	NPUR	...	...	...	...	...	...	...	...	...
<i>Navicula pusilla</i> W. Smith	NPUS	...	...	...	...	...	...	...	...	...
<i>Navicula ranomafanensis</i> (Manguin) Metzeltin & Lange-Bertalot	NRAN	...	...	...	...	...	...	...	...	...
<i>Navicula recens</i> (Lange-Bertalot) Lange-Bertalot	NRCS	...	...	...	...	2,667	...	...	...	...
<i>Navicula rhynchocephala</i> Kützing	NRHY	...	...	...	...	...	...	...	...	...
<i>Navicula riediana</i> Lange-Bertalot & Rumrich	NRIE	...	...	...	...	...	...	...	...	...
<i>Navicula rostellata</i> Kützing	NROS	...	...	...	...	0,667	...	...	...	...
<i>Navicula salinarum</i> Grunow in Cleve et Grunow	NSAL	...	...	...	1,333	...	...	...	...	...
<i>Navicula</i> sp. 1	NAV1	...	...	...	...	...	...	...	1,000	2,333
<i>Navicula</i> sp. 2	NAV2	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 3	NAV3	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 4	NAV4	...	...	...	...	...	...	...	...	...
<i>Navicula supergregaria</i> Lange-Bertalot & Rumrich	NSGG	...	...	...	...	2,000	...	...	...	...
<i>Navicula testa</i> Carter & Bailey-Watts	NTSA	...	...	...	...	...	...	...	...	...
<i>Navicula tripunctata</i> (O. F. M.) Bory forme teratogene	NTTT	...	...	...	...	0,333	...	...	...	...
<i>Navicula veneta</i> Kützing	NVEN	0,651	...	...	1,667	...	...	...	...	...
<i>Navicula vitrea</i> (Oestrup) Hustedt	NVIT	...	...	...	...	...	...	...	...	...
<i>Navicula wasmundii</i> Witkowski Metzeltin & Lange-Bertalot	NWAS	...	...	35,974	...	...	...	...	...	...

<i>Navicula zanoni</i> Hustedt	NZAN	...	...	...	...	...	0,667	...	...	...
<i>Neidium affine</i> (Ehrenberg) Pfitzer	NEAF	...	...	...	...	...	...	...	...	...
<i>Neidium productum</i> (W. M. Smith) Cleve	NEPR	...	...	...	...	...	...	...	...	...
<i>Nitzschia</i> A. H. Hassall	NITZ	29,640	4,934	4,620	1,333	...	...	...	...	0,667
<i>Nitzschia acicularis</i> (Kützing) W. M. Smith	NACI	...	...	...	...	...	...	...	...	...
<i>Nitzschia amphibia</i> Grunow	NAMP	...	...	...	...	...	...	...	...	...
<i>Nitzschia calida</i> Grunow in Cleve & Grunow	NICA	...	...	1,650	...	...	...	...	...	...
<i>Nitzschia capitellata</i> Hustedt in A. Schmidt & al.	NCPL	...	...	...	...	...	...	...	...	...
<i>Nitzschia communis</i> Rabenhorst	NCOM	...	...	10,231	...	...	...	...	...	...
<i>Nitzschia commutata</i> Grunow in Cleve et Grunow	NICO	...	...	...	0,667	...	...	...	...	...
<i>Nitzschia commutatoides</i> Lange-Bertalot	NCMU	...	...	...	...	...	...	...	...	...
<i>Nitzschia desertorum</i> Hustedt	NDES	...	...	...	...	...	...	...	...	...
<i>Nitzschia dissipata</i> (Kützing) Grunow	NDIS	...	...	...	...	...	...	1,333	...	...
<i>Nitzschia draveillensis</i> Coste & Ricard	NDRA	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Vegetation types								
		Yzerfontein Soutpan-sediment disturbed	Yzerfontein Soutpan-sediment undisturbed	Koekiespan-vegetation	Modderrivier-vegetation	Modderrivier-stones	Die vlakke-vegetation	Wagensboomrivier-vegetation	Hoogvertoon-sediment	Hoogvertoon-vegetation
<i>Nitzschia epiphytica</i> O. Muller	NEPI	...	...	...	...	...	...	...	...	...
<i>Nitzschia filiformis</i> (W. M. Smith) Van Heurck	NFIL	...	...	...	...	...	...	...	...	...
<i>Nitzschia fonticola</i> Grunow in Cleve et Möller	NFON	...	...	...	...	...	...	...	...	...
<i>Nitzschia frustulum</i> (Kützing) Grunow	NFTE	...	...	...	...	...	...	...	...	...
<i>Nitzschia frustulum</i> var. <i>bulnheimiana</i> (Rabenhorst) Grunow	NFBU	...	...	...	...	33,667	...	...	...	...
<i>Nitzschia fusiformis</i> Grunow	NFUS	...	...	...	...	...	...	...	...	...
<i>Nitzschia gracilis</i> Hantzsch	NIGR	...	...	...	...	...	...	...	...	...
<i>Nitzschia hantzschiana</i> Rabenhorst	NHAN	...	...	...	...	...	2,667	0,667	...	...
<i>Nitzschia intermedia</i> Hantzsch ex Cleve & Grunow	NINT	...	...	...	...	...	...	1,000	...	...
<i>Nitzschia liebetruthii</i> Rabenhorst	NLBT	...	...	...	...	...	...	...	...	...
<i>Nitzschia linearis</i> (Agardh) W. M. Smith	NLIN	...	...	...	...	...	...	1,000	...	...
<i>Nitzschia littoralis</i> Grunow in Cleve & Grunow	NLIT	20,846	71,711	8,581	...	...	...	...	...	...
<i>Nitzschia microcephala</i> Grunow in Cleve & Moller	NMIC	0,325	...	...	...	...	...	...	...	...
<i>Nitzschia nana</i> Grunow in Van Heurck	NNAN	...	...	...	...	...	...	...	...	...

<i>Nitzschia obtusa</i> var. <i>nana</i> Grunow	NOBN	...	...	...	...	...	1,667	...	...	...
<i>Nitzschia obtusa</i> var. <i>scalpelliformis</i> Grunow	NOBS	...	...	...	...	...	...	1,000	...	...
<i>Nitzschia ovalis</i> Arnott ex Grunow in Cleve & Grunow	NOVA	...	...	3,303	...	...	...	...	...	...
<i>Nitzschia palea</i> (Kützing) W. Smith	NPAL	...	...	...	...	...	1,000	3,667	...	...
<i>Nitzschia palea</i> var. <i>debilis</i> (Kützing) Grunow in Cleve & Grun	NPAD	...	...	...	...	...	...	...	...	...
<i>Nitzschia pura</i> Hustedt	NIPR	...	...	...	...	...	1,000	2,333	...	...
<i>Nitzschia recta</i> Hantzsch in Rabenhorst	NREC	...	...	...	...	...	...	...	...	...
<i>Nitzschia rhopalodioides</i> Hustedt	NIRH	...	...	1,650	...	...	...	...	...	...
<i>Nitzschia vitrea</i> Norman var. <i>tenuistriata</i> Manguin ex Kociolek & Reviers	NVTE	...	...	...	0,667	...	...	...	...	...
<i>Nitzschia vitrea</i> Norman	NIVI	...	...	...	...	...	...	...	...	...
<i>Nupela</i> W. Vyverman & P. Compere	NUPE	...	...	...	...	...	...	...	1,000	...
<i>Parlibellus</i> E. J. Cox	PARL	...	...	1,650	...	...	...	...	...	...
<i>Pinnularia</i> C. G. Ehrenberg	PINU	...	...	...	...	...	...	...	...	2,000
<i>Pinnularia acoricola</i> Hustedt	PACO	...	...	...	...	...	2,000	...	...	...
<i>Pinnularia acrosphaeria</i> var. <i>undulata</i> (Cleve) Hustedt	PAUN	...	...	...	...	...	...	...	...	...
<i>Pinnularia acrosphaeria</i> W. Smith	PACR	...	...	...	...	...	...	...	...	...
<i>Pinnularia angustiborealis</i> Krammer & Lange-Bertalot	PAGB	...	...	...	...	...	...	...	...	...
<i>Pinnularia borealis</i> Ehrenberg	PBOR	...	...	...	...	...	...	...	...	...
<i>Pinnularia borealis</i> Ehrenberg fo. <i>rectangularis</i> Carlson	PBRT	...	...	...	...	...	...	1,667	14,000	3,000
<i>Pinnularia brébissonii</i> (Kützing) Rabenhorst morphotyp. 1	PBMU	...	...	...	...	...	...	...	...	...
<i>Pinnularia divergens</i> W. Smith	PDIV	...	...	...	...	...	...	...	8,000	...

Species list	Acronyms	Yzerfontein Soutpan-sediment disturbed	Yzerfontein Soutpan-sediment undisturbed	Koekiespan-vegetation	Modderrivier-vegetation	Modderrivier-stones	Die vlakte-vegetation	Wagensboomrivier-vegetation	Hoogvertoon-sediment	Hoogvertoon-vegetation
<i>Pinnularia dulcicola</i> (Maguin) Van de Vijver & Le Cohu	PDUL	...	...	...	...	...	...	...	...	1,333
<i>Pinnularia gibba</i> Ehrenberg	PGIB	...	...	...	...	...	...	...	...	...
<i>Pinnularia intermedia</i> (L) Cleve	PITM	...	...	...	...	...	...	...	20,667	3,667
<i>Pinnularia intermedia</i> (Lagerstedt) Cleve v. bryophila Manguin ex Kociolek. & Reviers	PIBR	...	...	...	...	...	...	...	...	...
<i>Pinnularia microstauron</i> var. <i>brébissonii</i> (Kützing) Mayer	PMBR	...	...	...	...	...	...	...	...	...
<i>Pinnularia microstauron</i> var. <i>rostrata</i> Krammer	PMRO	...	...	...	...	...	...	...	...	...
<i>Pinnularia obscura</i> Krasske	POBS	...	...	...	...	...	...	1,000	...	...

<i>Pinnularia obscuriformis</i> Krammer	POBF	...	...	...	...	...	...	...	...	...
<i>Pinnularia pulchella</i> (Boyer) Krammer	PPLL	...	...	...	...	...	...	...	...	...
<i>Pinnularia similiformis</i> Krammer	PSIF	...	...	...	...	...	0,667	...	...	...
<i>Pinnularia similis</i> Hustedt	PSIM	...	...	...	...	...	...	...	...	...
<i>Pinnularia</i> sp. 1	PIN1	...	...	...	...	...	...	...	...	...
<i>Pinnularia</i> sp. 2	PIN2	...	...	...	...	...	...	...	...	...
<i>Pinnularia subbrevistriata</i> Krammer	PSBV	...	...	...	...	...	...	...	...	...
<i>Pinnularia subcapitata</i> fo. <i>divergens</i> Hustedt	PSCD	...	...	...	...	...	...	...	...	...
<i>Pinnularia subcapitata</i> Gregory	PSCA	...	...	...	...	...	...	...	...	...
<i>Pinnularia subcapitata</i> var. <i>elongata</i> Krammer	PSEL	...	...	...	...	...	...	...	...	...
<i>Pinnularia superdivergentissima</i> Germain et Chaumont	PSPD	...	...	...	...	...	...	...	2,000	...
<i>Pinnularia viridiformis</i> var. <i>minor</i> Krammer	PVFM	...	...	...	...	...	1,333	...	...	...
<i>Pinnularia viridis</i> var. <i>minor</i> Cleve	PVMI	...	...	...	...	...	...	...	...	...
<i>Placoneis placentula</i> fo. <i>lanceolata</i> (Grunow in Cleve & Grunow) Bukhtiyarova	PLPL	...	...	...	...	...	...	...	...	...
<i>Planothidium</i> sp. Round & Bukhtiyarova	PLTD	...	...	...	...	...	...	...	...	...
<i>Planothidium delicatulum</i> (Kützing) Round & Bukhtiyarova	PTDE	...	...	...	...	...	...	...	...	...
<i>Planothidium engelbrechtii</i> (Cholnoky) Round & Bukhtiyarova	PLEN	...	...	...	62,000	41,000	5,000	2,000	...	...
<i>Planothidium lanceolatum</i> (Brebisson ex Kützing) Lange-Bertalot	PFMA	...	...	...	...	...	...	...	...	...
<i>Pleurosigma salinarum</i> (Grunow) Cleve & Grunow	PSAL	...	...	...	...	...	...	...	...	...
<i>Psammothidium</i> Bukhtiyarova & Round	PSMT	...	...	...	...	...	...	...	7,000	...
<i>Psammothidium altaicum</i> Bukhtiyarova	PALT	...	...	...	...	...	...	...	1,000	...
<i>Psammothidium chlidanos</i> (Hohn & Hellerman) Lange-Bertalot	PCHL	...	...	...	...	...	...	...	...	...
<i>Reimeria sinuata</i> (Gregory) Kociolek & Stoermer	RSIN	...	...	...	...	...	...	1,000	...	...
<i>Rhoicosphenia abbreviata</i> (C. Agardh) Lange-Bertalot	RABB	...	...	...	...	...	...	4,000	...	...
<i>Rhopalodia</i> sp. O Müller	RHOP	6,188	0,657	...	...	...	...	...	...	...
<i>Rhopalodia brébissonii</i> Krammer	RBRE	...	...	...	...	0,667	...	...	...	...
<i>Rhopalodia gibba</i> (Ehrenberg) O. Muller	RGIB	...	...	...	...	...	...	...	...	...
<i>Rhopalodia gibberula</i> (Ehrenberg) O. Muller	RGBL	...	...	...	...	...	...	...	...	...

<b>Species list</b>	<b>Acronyms</b>	Yzerfontein Soutpan-sediment disturbed	Yzerfontein Soutpan-sediment undisturbed	Koekiespan-vegetation	Modderrivier-vegetation	Modderrivier-stones	Die vlakke-vegetation	Wagensboornivier-vegetation	Hoogvertoon-sediment	Hoogvertoon-vegetation

<i>Rhopalodia gibberula</i> var. <i>vanheurckii</i> O. Muller	RGBB	...	...	...	...	...	...	...	...	...
<i>Rhopalodia musculus</i> (Kützing) O. Muller	RMUS	...	...	3,303	...	...	...	...	...	...
<i>Rhopalodia operculata</i> (Agardh) Hakansson	ROPE	...	...	...	...	...	...	...	...	...
<i>Sellaphora</i> sp. <i>C. Mereschkowsky</i>	SELL	...	...	...	...	...	...	...	3,333	...
<i>Sellaphora pupula</i> (Kützing) Mereschkowksy	SPUP	...	...	...	...	...	...	...	...	...
<i>Seminavis strigosa</i> (Hustedt) Danieledis & Economou-Amilli	SMST	...	...	...	...	...	...	...	...	...
<i>Stauroneis acidoclinata</i> Lange-Bertalot & Werum	SADC	...	...	...	...	...	...	...	0,667	...
<i>Stauroneis gracilior</i> (Rabenhorst) Reichardt	SGRL	...	...	...	...	...	...	3,333	...	...
<i>Stauroneis heinii</i> Lange-Bertalot & Krammer	SHEI	...	...	...	...	...	...	...	...	...
<i>Stauroneis pseudosuboptusoides</i> Germain	STPO	...	...	...	...	...	...	...	...	...
<i>Staurosira construens</i> var. <i>venter</i> (Ehrenberg) Hamilton	SCVE	...	...	...	...	...	...	...	...	...
<i>Staurosira elliptica</i> (Schumann) Williams & Round	SELI	...	...	...	...	...	...	...	...	...
<i>Staurosirella pinnata</i> (Ehrenberg) Williams & Round	SPIN	...	...	...	...	...	...	...	...	...
<i>Surirella angusta</i> Kützing	SANG	...	...	...	...	...	...	...	...	...
<i>Surirella brébissonii</i> Krammer & Lange-Bertalot	SBRE	...	...	...	...	...	...	...	...	...
<i>Surirella</i> P. J. F. Turpin	SURI	...	...	...	1,000	...	...	...	...	...
<i>Surirella</i> sp. 1	SUR1	...	...	...	...	...	1,667	...	...	...
<i>Surirella striatula</i> Turpin sensu Schmidt	SSTR	...	...	...	...	...	...	...	...	...
<i>Synedra commutata</i> Grunow in Cleve & Grunow	SYCO	...	...	...	1,667	...	...	...	...	...
<i>Tabellaria flocculosa</i> (Roth) Kützing	TFLO	...	...	...	...	...	3,000	4,667	...	...
<i>Tabularia affinis</i> (Kützing) Snoeijs	TFLA	...	...	...	...	...	...	...	...	...
<i>Tabularia fasciculata</i> (Agardh) Williams et Round	TFAS	...	...	...	6,667	3,667	...	...	...	...
<i>Thalassiosira weissflogii</i> (Grunow) Fryxell & Hasle	TWEI	...	...	...	...	...	...	...	...	...
<i>Tryblionella angustata</i> Wm Smith	TANG	...	...	...	...	...	...	...	...	...
<i>Tryblionella apiculata</i> Gregory	TAPI	...	...	...	...	...	...	...	...	...
<i>Ulnaria ulna</i> (Nitzsch.) Compère	UULN	...	...	...	...	...	1,000	...	...	...
Unknown sp.	UNKN	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Sneeuberg Hut	Driehoek-	Suurvlakte-	Verrekyker-	Verrekykerfloating-	Verrekyker-	Verrekyker-	Blomfontein-	Malkopsvlei-
		stream-Sediment	sediment	sediment	vegetation	vegetation	vegetation	sediment	vegetation	
<i>Achnanthes</i> J. B. M. Bory de St. Vincent	ACHN	...	...	...	...	...	...	...	...	...
<i>Achnanthes crassa</i> Hustedt	ACRA	...	...	...	...	...	...	...	...	...

<i>Achnanthes duthii</i> Sreenivasa	ADUT	....	....	....	....	....	....	....	....	....
<i>Achnanthes linearis</i> (W. Sm.) Grunow	ALIN	....	....	....	....	....	....	....	....	....
<i>Achnanthes minutissima</i> Kützing	AMIN	....	....	....	....	....	....	....	....	....
<i>Achnanthes minutissima</i> var. <i>saprophila</i> Kobayasi et Mayama	AMSA	....	....	....	....	....	....	....	....	....
<i>Achnanthes oblongella</i> Oestrup	AOBG	....	....	....	....	....	....	....	....	....
<i>Achnantheidium</i> F. T. Kützing	ACHD	....	....	....	1,000	....	3,333	3,667	....	....
<i>Achnantheidium affine</i> (Grunow) Czarnecki	ACAF	1,667	....	....	....	....	....	1,667	....	....
<i>Achnantheidium crassum</i> (Hustedt) Potapova & Ponader	ADCR	....	....	....	....	....	....	....	....	1,000
<i>Achnantheidium deflexum</i> (Reimer) Kingston	ACDF	....	1,000	....	....	....	3,333	....	....	....
<i>Achnantheidium saprophilum</i> (Kobayasi et Mayama) Round & Bukhtiyarova	ADMI	....	....	....	....	....	3,333	....	2,667	....
<i>Achnantheidium rivulare</i> Potapova & Ponader	ADRT	....	....	....	....	....	....	....	....	....
<i>Achnantheidium standerii</i> (Cholnoky) Taylor, Morales & Ector	ACHS	....	....	....	....	....	....	....	....	....
<i>Achnantheidium</i> sp.	ADCS	....	1,333	....	....	....	....	....	2,667	....
<i>Actinocyclus subtilis</i> (Gregory) Ralfs in Pritchard	ASUB	....	....	....	....	....	....	....	....	....
<i>Amphora</i> C. G. Ehrenberg ex F. T. Kützing	AMPH	....	....	....	....	....	....	....	13,667	....
<i>Amphora coffeaeformis</i> (Agardh) Kützing	ACOF	....	....	....	....	....	....	....	....	....
<i>Amphora coffeaeformis</i> var. <i>aponina</i> (Kützing) Archibald & Schoeman	ACFA	....	....	....	....	....	....	....	....	....
<i>Amphora fontinalis</i> Hustedt	AFON	....	....	....	....	....	....	....	....	....
<i>Amphora granulata</i> Gregory	AMGN	....	....	....	....	....	....	....	....	....
<i>Amphora hybrida</i> Grunow in Van Heurck	AHYB	....	....	....	....	....	....	....	....	....
<i>Amphora oligotraphenta</i> Lange-Bertalot	AOLG	....	....	....	....	....	....	....	5,333	....
<i>Amphora ovalis</i> (Kützing) Kützing	AOVA	....	....	....	....	....	....	....	....	....
<i>Amphora pseudoholsatica</i> Nagumo & Kobayasi	APHO	....	....	....	....	....	....	....	....	....
<i>Amphora sabiniana</i> Reimer	ASAB	....	....	....	....	....	....	....	....	....
<i>Amphora veneta</i> Kützing	AVEN	....	....	....	....	....	....	....	....	....
<i>Anomoeoneis serians</i> var. <i>apiculata</i> Boyer	ASAP	....	....	....	....	....	....	....	....	....
<i>Asterionella gracillima</i> (Hantzsch.) Heiberg	AGRA	....	....	....	....	....	....	....	....	....
<i>Aulacoseira</i> G. H. K. Thwaites	AULA	....	....	....	....	....	....	....	....	....
<i>Aulacoseira ambigua</i> (Grunow) Simonsen	AAMB	....	....	....	....	....	....	1,333	....	42,667
<i>Aulacoseira granulata</i> (Ehrenberg) Simonsen	AUGR	....	....	....	....	....	....	....	....	7,667
<i>Aulacoseira granulata</i> var. <i>angustissima</i> Simonsen	AUGA	....	....	....	....	....	....	....	....	....
<i>Bacillaria paradoxa</i> Gmelin	BPAR	....	....	....	....	....	....	....	....	....
<i>Brachysira brébissonii</i> Ross in Hartley	BBRE	3,000	7,000	3,000	....	....	....	....	....	2,000
<i>Caloneis bacillum</i> (Grunow) Cleve	CBAC	....	....	....	1,000	....	....	1,000	5,333	....

Species list	Acronyms	Sneeuberg Hut stream-Sediment	Driehoek-sediment	Suurvlakte-sediment	Verrekyker-vegetation	Verrekykerfloating-vegetation	Verrekyker-vegetaion	Verrekyker-vegetation	Blomfontein-sediment	Malkopsvlei-vegetation
<i>Caloneis</i> Cleve	CALO	...	...	...	...	...	...	...	...	...
<i>Caloneis molaris</i> (Grunow) Krammer	CMOL	...	...	...	...	...	1,000	...	...	...
<i>Caloneis patagonica</i> var. <i>alaskaensis</i> Manguin ex Kociolek & Reviere	CPAL	...	...	...	...	...	...	...	...	...
<i>Caloneis permagna</i> (J. W. Bailey) Cleve	CPRM	...	...	...	...	...	...	...	...	...
<i>Cavinula cocconeiformis</i> (Gregory ex Greville) Mann & Stickle	CCOC	...	...	...	...	...	...	...	...	...
<i>Cocconeis costata</i> Gregory	COCC	...	...	...	...	...	...	...	...	...
<i>Cocconeis engelbrechtii</i> Cholnokoy	CENG	...	...	...	...	...	...	...	...	...
<i>Cocconeis placentula</i> Ehrenberg	CPLA	...	...	...	9,333	...	...	3,000	...	...
<i>Cocconeis scutellum</i> Ehrenberg	CSCU	...	...	...	...	...	...	...	...	...
<i>Cosmioneis pusilla</i> (W. Smith) Mann & Stickle	COPU	...	...	...	...	...	...	...	...	...
<i>Craticula</i> A. Grunow	CRAT	...	...	...	...	...	...	...	...	...
<i>Craticula halophila</i> (Grunow ex Van Heurck) Mann	CHAL	...	...	...	...	...	...	1,333	...	...
<i>Craticula molestiformis</i> (Hustedt) Lange-Bertalot	CMLF	3,000	13,333	...	...	...	...	...	...	...
<i>Craticula vixnegligenda</i> Lange-Bertalot	CVIX	...	...	...	...	...	...	...	...	...
<i>Cyclotella meneghiniana</i> Kützing	CMEN	...	...	...	5,667	42,333	3,333	4,667	...	0,333
<i>Cyclotella stelligera</i> Cleve et Grun (in Van Heurck)	CSTE	...	...	...	...	...	...	...	...	...
<i>Cymatopleura brunii</i> Petit ex Brun	CBRU	...	...	...	...	...	...	...	...	...
<i>Cymbella aspera</i> (Ehrenberg) H. Peragallo	CASP	...	...	...	...	...	...	0,667	...	...
<i>Cymbella helvetica</i> Kützing	CHEL	...	...	...	...	...	...	...	...	...
<i>Cymbella lanceolata</i> Agardh	CLTA	...	...	...	...	...	0,333	...	...	...
<i>Cymbella sinuata</i> Gregory	CSIN	...	...	...	...	...	...	...	...	...
<i>Cymbella</i> sp. 1	CYM1	...	...	...	...	...	...	...	...	...
<i>Cymbella</i> sp. 2	CYM2	...	...	...	...	...	...	...	...	...
<i>Cymbella turgidula</i> Grunow 1875 in A. Schmidt & al.	CTGL	...	...	...	...	0,667	...	...	...	...
<i>Cymbopleura</i> (Krammer) Krammer	CBPL	...	...	...	...	...	...	...	...	...
<i>Delicata krammeri</i> Metzeltin, Lange-Bertalot & Garcia-Rodriguez	DKRM	...	...	...	...	...	...	...	...	...
<i>Diadesmis confervacea</i> Kützing	DCON	...	...	...	...	...	...	5,333	...	...

<i>Diademsis</i> F. T. Kützing	DDSP	...	...	0,667	...	...	...	...	...	...
<i>Diploneis</i> C. G. Ehrenberg ex P. T. Cleve	DIPL	...	...	...	...	...	...	...	...	...
<i>Diploneis smithii</i> (Brébisson) Cleve	DSMI	...	...	...	...	...	...	...	...	...
<i>Diploneis smithii</i> var. <i>chilensis</i> Hustedt	DSCH	...	...	...	...	...	...	...	...	...
<i>Diploneis stroemi</i> Hustedt	DSTR	...	...	...	...	...	...	...	...	...
<i>Encyonema caespitosum</i> Kützing	ECAE	...	...	0,667	...	...	...	...	...	...
<i>Encyonema</i> F. T. Kützing	ENCY	...	1,000	...	...	...	...	...	...	...
<i>Encyonema mesianum</i> (Cholnoky) D. G. Mann	ENME	...	...	...	...	...	...	...	...	...
<i>Encyonema silesiacum</i> (Bleisch in Rabenhorst) D. G. Mann	ESLE	...	...	...	...	...	...	...	2,000	...

Species list	Acronyms	Vegetation types								
		Sneeuberg Hut stream-Sediment	Driehoek-sediment	Suurvlakte-sediment	Verrekyker-vegetation	Verrekykerfloating-vegetation	Verrekyker-vegetation	Verrekyker-vegetation	Blomfontein-sediment	Malkopslei-vegetation
<i>Encyonema silesiacum</i> var. <i>latarea</i> Krammer	ESLT	...	...	...	...	...	...	...	...	...
<i>Encyonopsis minuta</i> Krammer & Reichardt	ECPM	...	...	...	...	...	...	1,000	...	...
<i>Entomoneis paludosa</i> (W. Smith) Reimer	EPAL	...	...	...	...	...	...	...	...	...
<i>Epithemia adnata</i> (Kützing) Brébisson	EADN	...	...	...	...	...	...	...	...	...
<i>Eunotia bilunaris</i> (Ehrenberg) Mills	EBIL	...	3,667	1,333	...	0,667	5,667	6,667	...	...
<i>Eunotia boreoalpina</i> Lange-Bertalot & Nörpel-Schempp	EUBO	...	...	...	...	...	...	1,000	...	...
<i>Eunotia boreotenuis</i> Norpel-Schempp & Lange-Bertalot	EBOR	...	...	...	...	...	...	...	...	...
<i>Eunotia flexuosa</i> (Brébisson) Kützing	EFLE	4,667	5,000	21,333	...	...	...	...	...	...
<i>Eunotia formica</i> Ehrenberg	EFOR	...	...	...	...	...	...	...	...	1,000
<i>Eunotia glacialis</i> Meister	EGLA	...	...	...	...	...	...	...	...	...
<i>Eunotia incisa</i> Gregory	EINC	...	...	20,333	...	...	...	...	...	...
<i>Eunotia minor</i> (Kützing) Grunow in Van Heurck	EMIN	...	...	...	...	...	...	...	...	...
<i>Eunotia monodon</i> Ehrenberg	EMON	...	...	...	...	...	...	...	...	...
<i>Eunotia pectinalis</i> (Dyllwyn) Rabenhorst	EPEC	...	...	...	...	...	...	2,333	...	...
<i>Eunotia silvahercynia</i> Nörpel Van Sull & Lange-Bertalot	ESIL	...	...	...	...	...	...	...	...	...
<i>Eunotia sudetica</i> var. <i>incisa</i> (Gregory) Manguin	ESIN	...	...	...	...	...	...	...	...	...
<i>Eunotia tenella</i> (Grunow) Hustedt	EUNO	16,938	...	...	...	...	17,333	3,000	13,667	36,000
<i>Eunotia veneris</i> (Kützing) De Toni	EVEN	...	...	...	...	...	...	...	...	...

<i>Eunotogramma</i> Weisse	EUTO	...	...	...	...	...	...	...	...	...	...
<i>Fallacia</i> A. J. Stickle & D. G. Mann	FALL	...	...	...	...	...	...	...	...	...	...
<i>Fallacia pygmaea</i> (Kützing) Stickle & Mann	FPYG	...	...	...	...	...	...	...	...	...	...
<i>Fistulifera saprophila</i> (Lange-Bertalot & Bonik) Lange-Bertalot	FSAP	...	...	...	...	...	1,667	...	...	...	...
<i>Fragilaria</i> H. C. Lyngbye	FRAG	...	...	...	...	...	...	...	...	...	1,667
<i>Fragilaria bicapitata</i> A. Mayer	FBIC	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria biceps</i> (Kützing) Lange-Bertalot	FBCP	...	...	...	...	...	1,667	...	...	...	...
<i>Fragilaria brevistriata</i> Grunow (Pseudostaurosira)	FBRE	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria capucina</i> Desmazieres	FCAP	...	...	...	...	...	...	2,000	...	...	...
<i>Fragilaria capucina</i> var. <i>radians</i> (Kützing) Lange-Bertalot	FCRA	...	...	...	...	...	...	...	...	...	2,667
<i>Fragilaria capucina</i> var. <i>rumpens</i> (Kützing) Lange-Bertalot.	FCRP	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria construens</i> (Ehrenberg) Grunow	FCON	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria construens</i> fo. <i>venter</i> (Ehrenberg) Hustedt	FCVE	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria crotonensis</i> Kitton	FCRO	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria fasciculata</i> (C. A. Agardh) Lange-Bertalot sensu lato	FFAS	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria pulchella</i> (Ralfs ex Kützing) Lange-Bertalot (Ctenophora)	FPUL	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria striatula</i> Lyngbye	FSTR	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria tenera</i> (W. Smith) Lange-Bertalot	FTEN	...	...	...	...	3,000	...	2,333	...	...	...

Species list	Acronyms	Vegetation types									
		Sneeuberg Hut stream-Sediment	Driehoek-sediment	Suurvlakte-sediment	Verrekyker-vegetation	Verrekykerfloating-vegetation	Verrekyker-vegetation	Verrekyker-vegetation	Blomfontein-sediment	Malkopslei-vegetation	
<i>Fragilaria ulna</i> (Nitzsch.) Lange-Bertalot	FULN	...	...	...	...	...	...	...	...	...	...
<i>Fragilaria ulna</i> var. <i>biceps</i> (Kützing) Lange-Bertalot	FUBI	...	...	...	33,333	5,667	...	...	...	...	...
<i>Frustulia</i> L. Rabenhorst	FRUS	...	...	...	...	...	...	...	...	...	...
<i>Frustulia crassinervia</i> (Brébisson) Lange-Bertalot et Krammer	FCRS	...	...	...	...	...	...	...	...	...	...
<i>Frustulia magaliesmontana</i> Chohnoky	FMGL	...	2,333	...	...	...	...	...	...	...	...
<i>Frustulia rostrata</i> Hustedt	FROS	...	...	17,333	...	...	...	...	9,667	...	...
<i>Frustulia saxonica</i> Rabenhorst	FSAX	1,333	2,000	4,667	...	...	...	...	...	...	...
<i>Frustulia vulgaris</i> (Thwaites) De Toni	FVUL	...	...	...	...	...	...	...	2,667	...	...
<i>Gomphonema</i> C. G. Ehrenberg	GOMP	...	...	...	0,667	...	...	...	...	...	...

<i>Gomphonema affine</i> Kützing	GAFF	...	...	...	...	...	...	...	...	...
<i>Gomphonema angustatum</i> (Kützing) Rabenhorst	GANG	...	...	...	...	...	...	...	...	...
<i>Gomphonema clavatum</i> Ehrenberg	GCLA	...	...	...	...	...	...	...	...	...
<i>Gomphonema exilissimum</i> (Grunow) Lange-Bertalot & Reichardt	GEXL	...	...	...	...	...	...	...	2,000	...
<i>Gomphonema gracile</i> Ehrenberg	GGRA	...	...	...	1,667	9,000	8,000	7,333	...	0,667
<i>Gomphonema lagenula</i> Kützing	GLGN	...	...	...	...	...	...	...	...	...
<i>Gomphonema laticollum</i> Reichardt	GLTC	...	...	...	...	...	...	...	...	...
<i>Gomphonema minutum</i> (Agardh) Agardh	GMIN	...	...	...	...	...	...	...	...	...
<i>Gomphonema parvulum</i> (Kützing) Kützing	GPAR	...	...	...	6,667	5,667	...	1,333	...	...
<i>Gomphonema parvulum</i> var. <i>subellipticum</i> Cleve	GPSE	...	...	...	...	...	...	...	...	...
<i>Gomphonema pseudoaugur</i> Lange-Bertalot	GPSA	...	...	...	1,333	...	...	...	...	...
<i>Gomphonema pumilum</i> (Grunow) Reichardt & Lange-Bertalot	GPUM	...	...	...	...	...	...	...	...	...
<i>Gomphonema pumilum</i> var. <i>rigidum</i> Reichardt & Lange-Bertalot	GPRI	...	...	...	...	...	...	...	...	...
<i>Gomphosphenia oahuensis</i> (Hustedt) Lange-Bertalot	GOAH	...	...	...	...	...	...	...	...	...
<i>Grammatophora</i> C. G. Ehrenberg	GRAM	...	...	...	...	...	...	...	1,667	...
<i>Halamphora eunotia</i> (Cleve) Levkov	HEUN	...	...	...	...	...	...	...	...	...
<i>Halamphora paraveneta</i> Lange-Bertalot. Cavacini. Tagliaventi & Alfinito	HPAR	...	...	...	...	...	...	...	...	...
<i>Halamphora robusta</i> Gregory	HROB	...	...	...	...	...	...	...	...	...
<i>Halamphora veneta</i> (Kützing) Levkov	HVEN	...	...	...	...	...	...	...	...	...
<i>Halampora dominici</i> Ács & Levkov	HDOM	...	...	...	...	...	...	...	...	...
<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow in Cleve et Grunow 1880	HAMP	0,667	4,000	...	...	...	...	1,667	0,667	...
<i>Hantzschia</i> sp. 1	HAN1	...	...	...	...	...	...	...	...	...
<i>Haslea spicula</i> (Hickie) Bukhtiyarova	HSPC	...	...	...	...	...	...	...	...	...
<i>Hippodonta capitata</i> (Ehrenberg) Lange-Bert. Metzeltin & Witkowski	HCAP	...	...	...	2,333	...	...	...	...	...
<i>Hippodonta hungarica</i> (Grunow) Lange-Bertalot Metzeltin & Witkowski	HHUN	...	...	...	...	...	1,667	...	...	...
<i>Hippodonta</i> Lange-Bertalot. Metzeltin & Witkowski	HIPO	...	...	...	...	...	...	...	...	...
<i>Kobayasia subtilissima</i> (Cleve) Lange-Bertalot	KSUB	...	...	1,333	...	...	...	...	...	...

<b>Species list</b>	<b>Acronyms</b>	Sneeuberg Hut stream-Sediment	Driehoek-sediment	Suurvlakte-sediment	Verrekyker-vegetation	Verrekykerfloating-vegetation	Verrekyker-vegetation	Verrekyker-vegetation	Blomfontein-sediment	Malkopsvlei-vegetation

<i>Kobayasiella subtilissima</i> (Cleve) Lange-Bertalot	KOSU	7,333	3,333	....	....	....	....	....	....	....
<i>Lemnicola hungarica</i> (Grunow) Round & Basson	LHUN	....	....	....	1,667	....	....	3,333	....	....
<i>Lemnicola</i> Round & Basson	LEMN	....	....	....	....	....	....	....	....	....
<i>Luticola</i> D. G. Mann	LUTI	....	....	....	....	....	....	....	....	....
<i>Luticola acidoclinata</i> Lange-Bertalot	LACD	....	....	....	0,333	....	....	....	....	....
<i>Luticola goeppertiana</i> (Bleisch in Rabenhorst) D. G. Mann	LGOT	....	....	....	....	....	....	....	....	....
<i>Luticola goeppertiana</i> (Bleisch in Rabenhorst) D. G. Mann abnormal form	LGOE	....	....	....	....	....	....	....	....	....
<i>Luticola mutica</i> (Kützing) D. G. Mann	LMUT	....	....	....	....	....	....	....	....	....
<i>Luticola</i> sp.	LUSP	....	2,333	....	....	....	....	....	....	....
<i>Luticola</i> sp. (aff. mutica)	LUTS	....	....	....	....	....	....	....	....	....
<i>Martyana atomus</i> (Hustedt) Snoeijs	MATO	....	....	....	....	....	....	....	....	....
<i>Mastogloia</i> G. H. K. Thwaites ex W. Smith 1856	MAST	....	0,667	....	....	....	....	....	....	....
<i>Mastogloia braunii</i> Grunow	MBRA	....	....	....	....	....	....	....	....	....
<i>Mastogloia elliptica</i> (C. A. Agardh) Cleve	MELL	....	....	....	....	....	....	....	....	....
<i>Mastogloia pusilla</i> (Grunow) Cleve	MPUS	....	....	....	....	....	....	....	....	....
<i>Mayamaea atomus</i> (Kützing) Lange-Bertalot	MAAT	....	....	....	....	....	....	....	....	....
<i>Melosira nummuloides</i> var. alata Jurilj	MNAL	....	....	....	....	....	....	....	....	....
<i>Melosira varians</i> Agardh	MVAR	....	....	....	....	....	....	....	....	....
<i>Meridion circulare</i> (Greville) C. A. Agardh	MCIR	....	....	....	....	....	....	....	1,667	....
<i>Microcostatus</i> sp. Johansen & Sray	MCCT	....	....	2,000	....	....	....	....	....	....
<i>Muelleria linearis</i> (O. Muller) Frenguelli	MULI	....	....	....	....	....	....	....	3,667	....
<i>Navicula</i> J. B. M. Bory de St. Vincent	NAVI	....	2,333	....	....	....	....	....	4,667	....
<i>Navicula arvensis</i> Hustedt	NARV	1,667	....	....	....	....	....	....	....	....
<i>Navicula capitatoradiata</i> Germain	NCPG	....	....	....	....	1,000	....	....	....	....
<i>Navicula cincta</i> (Ehrenberg) Ralfs in Pritchard	NCIN	....	....	....	....	....	....	....	....	....
<i>Navicula clementis</i> Grunow	NCLE	....	....	....	....	....	....	....	....	....
<i>Navicula cryptocephala</i> Kützing	NCRY	....	....	....	....	....	....	....	....	....
<i>Navicula cryptotenella</i> - type in Kelly	NCTY	....	....	....	....	....	....	....	....	0,667
<i>Navicula disjuncta</i> Hustedt	NDSJ	....	....	....	....	....	....	....	....	....
<i>Navicula erifuga</i> Lange-Bertalot	NERI	....	....	....	....	....	....	....	....	....
<i>Navicula frugalis</i> Hustedt	NFRU	....	....	....	....	....	....	....	....	....
<i>Navicula humerosa</i> Brébisson ex W. Smith	NHUM	....	....	....	....	....	....	....	....	....
<i>Navicula lanceolata</i> (Agardh) Ehrenberg	NLAN	....	....	....	....	....	....	....	....	....
<i>Navicula libonensis</i> Schoeman	NLIB	....	....	....	....	....	....	0,667	....	....

<i>Navicula microcari</i> Lange-Bertalot	NMCA	...	...	...	...	...	...	...	...	...
<i>Navicula modica</i> Hustedt	NMOD	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Sneeuberg Hut	Driehoek-	Suurvlakte-	Verrekyker-	Verrekykerfloating-	Verrekyker-	Verrekyker-	Blomfontein-	Malkopsvlei-
		stream-Sediment	sediment	sediment	vegetation	vegetation	vegetation	sediment	vegetation	
<i>Navicula nivalis</i> Ehrenberg	NNIV	...	...	...	...	...	...	...	...	...
<i>Navicula parasubtilissima</i> Kobayasi & Nagumo	NPSU	...	...	...	...	...	...	...	...	...
<i>Navicula peregrina</i> (Ehrenberg) Kützing	NPRG	...	...	...	...	...	...	...	...	...
<i>Navicula permitis</i> Hustedt	NPER	...	...	...	...	...	...	...	...	...
<i>Navicula phylleptosoma</i> Lange-Bertalot	NPHP	...	...	...	...	...	...	...	...	...
<i>Navicula placenta</i> Ehrenberg	NPLT	...	...	...	...	...	...	...	...	...
<i>Navicula pseudosalinarioides</i> Giffen	NWPS	...	...	...	...	...	...	...	...	...
<i>Navicula pupula</i> fo. <i>rostrata</i> (Hustedt) Hustedt	NPUR	...	...	...	...	...	...	...	...	...
<i>Navicula pusilla</i> W. Smith	NPUS	...	...	...	...	...	...	...	...	...
<i>Navicula ranomafanensis</i> (Manguin) Metzeltin & Lange-Bertalot	NRAN	...	...	...	...	...	...	...	...	...
<i>Navicula recens</i> (Lange-Bertalot) Lange-Bertalot	NRCS	...	...	...	7,000	...	2,000	1,000	...	...
<i>Navicula rhyngocephala</i> Kützing	NRHY	...	...	...	...	...	...	...	...	...
<i>Navicula riediana</i> Lange-Bertalot & Rumrich	NRIE	...	...	...	...	5,667	3,333	...	...	...
<i>Navicula rostellata</i> Kützing	NROS	...	...	...	...	...	...	...	...	...
<i>Navicula salinarum</i> Grunow in Cleve et Grunow	NSAL	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 1	NAV1	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 2	NAV2	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 3	NAV3	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 4	NAV4	...	...	...	...	...	...	...	...	...
<i>Navicula supergregaria</i> Lange-Bertalot & Rumrich	NSGG	...	...	...	...	...	...	...	...	...
<i>Navicula testa</i> Carter & Bailey-Watts	NTSA	...	...	...	...	...	...	...	...	...
<i>Navicula tripunctata</i> (O. F. M.) Bory forme teratogene	NTTT	...	...	...	...	...	...	...	...	...
<i>Navicula veneta</i> Kützing	NVEN	...	...	...	...	...	...	2,333	...	...
<i>Navicula vitrea</i> (Oestrup) Hustedt	NVIT	...	...	...	...	...	...	...	...	...
<i>Navicula wasmundii</i> Witkowski Metzeltin & Lange-Bertalot	NWAS	...	...	...	...	...	...	...	...	...

<i>Navicula zanoni</i> Hustedt	NZAN	....	....	....	....	3,667	7,333	1,000	....	....
<i>Neidium affine</i> (Ehrenberg) Pfitzer	NEAF	....	....	....	....	....	....	....	....	....
<i>Neidium productum</i> (W. M. Smith) Cleve	NEPR	....	....	....	....	....	....	1,000	....	....
<i>Nitzschia</i> A. H. Hassall	NITZ	2,000	....	....	1,000	....	....	....	....	....
<i>Nitzschia acicularis</i> (Kützing) W. M. Smith	NACI	....	....	....	....	....	....	....	....	....
<i>Nitzschia amphibia</i> Grunow	NAMP	6,333	....	....	....	....	....	....	....	....
<i>Nitzschia calida</i> Grunow in Cleve & Grunow	NICA	....	....	....	....	....	....	....	....	....
<i>Nitzschia capitellata</i> Hustedt in A. Schmidt & al.	NCPL	....	....	....	....	....	....	....	....	....
<i>Nitzschia communis</i> Rabenhorst	NCOM	....	....	....	....	....	....	....	....	....
<i>Nitzschia commutata</i> Grunow in Cleve et Grunow	NICO	....	....	....	....	....	....	....	....	....
<i>Nitzschia commutatoides</i> Lange-Bertalot	NCMU	....	....	....	....	....	....	....	....	....

Species list	Acronyms	Sneeuberg Hut	Driehoek-	Suurvlakte-	Verrekyker-	Verrekykerfloating-	Verrekyker-	Verrekyker-	Blomfontein-	Malkopsvlei-
		stream-Sediment	sediment	sediment	vegetation	vegetation	vegetation	vegetation	sediment	vegetation
<i>Nitzschia desertorum</i> Hustedt	NDES	....	....	....	....	....	....	....	....	....
<i>Nitzschia dissipata</i> (Kützing) Grunow	NDIS	2,000	....	....	....	....	....	....	....	....
<i>Nitzschia draveillensis</i> Coste & Ricard	NDRA	....	....	....	....	....	....	....	....	....
<i>Nitzschia epiphytica</i> O. Muller	NEPI	....	....	....	....	....	....	....	....	....
<i>Nitzschia filiformis</i> (W. M. Smith) Van Heurck	NFIL	....	....	....	....	....	2,000	....	1,667	....
<i>Nitzschia fonticola</i> Grunow in Cleve et Möller	NFON	....	....	....	1,000	....	....	....	....	....
<i>Nitzschia frustulum</i> (Kützing) Grunow	NFTE	....	....	....	....	....	1,333	....	....	2,333
<i>Nitzschia frustulum</i> var. <i>bulnheimiana</i> (Rabenhorst) Grunow	NFBU	....	....	....	....	....	....	....	....	....
<i>Nitzschia fusiformis</i> Grunow	NFUS	....	....	....	....	....	....	....	....	....
<i>Nitzschia gracilis</i> Hantzsch	NIGR	....	....	....	....	....	....	1,000	....	....
<i>Nitzschia hantzschiana</i> Rabenhorst	NHAN	....	....	....	....	1,000	....	....	....	....
<i>Nitzschia intermedia</i> Hantzsch ex Cleve & Grunow	NINT	....	....	....	....	....	5,000	....	....	....
<i>Nitzschia liebetruthii</i> Rabenhorst	NLBT	....	....	....	0,667	....	2,667	2,333	....	....
<i>Nitzschia linearis</i> (Agardh) W. M. Smith	NLIN	....	....	....	....	....	....	2,667	....	....
<i>Nitzschia littoralis</i> Grunow in Cleve & Grunow	NLIT	....	....	....	....	....	....	....	....	....
<i>Nitzschia microcephala</i> Grunow in Cleve & Moller	NMIC	....	....	....	....	....	....	....	....	....
<i>Nitzschia nana</i> Grunow in Van Heurck	NNAN	....	....	....	....	1,333	2,000	....	4,000	0,667

<i>Nitzschia obtusa</i> var. <i>nana</i> Grunow	NOBN	...	...	...	...	...	...	...	...	...
<i>Nitzschia obtusa</i> var. <i>scalpelliformis</i> Grunow	NOBS	...	...	...	...	...	...	...	...	...
<i>Nitzschia ovalis</i> Arnott ex Grunow in Cleve & Grunow	NOVA	...	...	...	...	...	...	...	...	...
<i>Nitzschia palea</i> (Kützing) W. Smith	NPAL	...	...	1,667	...	17,000	26,000	18,000	12,333	1,333
<i>Nitzschia palea</i> var. <i>debilis</i> (Kützing) Grunow in Cleve & Grun	NPAD	8,333	...	...	...	...	...	...	...	...
<i>Nitzschia pura</i> Hustedt	NIPR	...	...	...	...	...	...	...	...	...
<i>Nitzschia recta</i> Hantzsch in Rabenhorst	NREC	...	...	...	...	...	...	...	...	...
<i>Nitzschia rhopalodioides</i> Hustedt	NIRH	...	...	...	...	...	...	...	...	...
<i>Nitzschia vitrea</i> Norman var. <i>tenuistriata</i> Manguin ex Kociolek & Reviere	NVTE	...	...	...	...	...	...	...	...	...
<i>Nitzschia vitrea</i> Norman	NIVI	...	...	...	...	...	...	...	4,667	...
<i>Nupela</i> W. Vyverman & P. Compere	NUPE	...	...	...	...	...	...	...	...	...
<i>Parlibellus</i> E. J. Cox	PARL	...	...	...	...	...	...	...	...	...
<i>Pinnularia</i> C. G. Ehrenberg	PINU	...	...	...	...	...	...	...	5,000	...
<i>Pinnularia acoricola</i> Hustedt	PACO	...	...	...	...	...	...	...	...	...
<i>Pinnularia acrosphaeria</i> var. <i>undulata</i> (Cleve) Hustedt	PAUN	...	...	...	...	...	...	1,000	...	...
<i>Pinnularia acrosphaeria</i> W. Smith	PACR	...	...	...	...	1,333	...	...	...	...
<i>Pinnularia angustiborealis</i> Krammer & Lange-Bertalot	PAGB	...	6,667	...	...	...	...	...	...	...
<i>Pinnularia borealis</i> Ehrenberg	PBOR	...	4,667	...	...	...	...	...	...	...
<i>Pinnularia borealis</i> Ehrenberg fo. <i>rectangularis</i> Carlson	PBRT	1,667	...	3,000	...	...	...	...	1,000	...

Species list	Acronyms	Sneeuberg Hut	Driehoek-	Suurvlakte-	Verrekyker-	Verrekykerfloating-	Verrekyker-	Verrekyker-	Blomfontein-	Malkopsvlei-
		stream-Sediment	sediment	sediment	vegetation	vegetation	vegetation	vegetation	sediment	vegetation
<i>Pinnularia brébissonii</i> (Kützing) Rabenhorst morphotyp. 1	PBMU	...	...	...	1,333	...	...	...	...	...
<i>Pinnularia divergens</i> W. Smith	PDIV	2,333	1,333	3,000	...	...	1,333	...	...	...
<i>Pinnularia dulcicola</i> (Maguin) Van de Vijver & Le Cohu	PDUL	...	...	...	...	...	...	...	...	...
<i>Pinnularia gibba</i> Ehrenberg	PGIB	...	...	...	...	...	1,000	...	...	...
<i>Pinnularia intermedia</i> (L) Cleve	PITM	1,333	...	...	...	...	...	...	...	...
<i>Pinnularia intermedia</i> (Lagerstedt) Cleve v. <i>bryophila</i> Manguin ex Kociolek. & Reviere	PIBR	...	5,667	...	...	...	...	...	...	...
<i>Pinnularia microstauron</i> var. <i>brébissonii</i> (Kützing) Mayer	PMBR	1,667	...	...	...	...	...	...	...	...
<i>Pinnularia microstauron</i> var. <i>rostrata</i> Krammer	PMRO	7,000	...	...	...	...	...	...	...	...
<i>Pinnularia obscura</i> Krasske	POBS	...	...	10,333	...	...	1,667	...	...	...

<i>Pinnularia obscuriformis</i> Krammer	POBF	...	...	...	...	...	...	...	4,000	...
<i>Pinnularia pulchella</i> (Boyer) Krammer	PPLL	...	...	...	...	...	0,667	...	...	...
<i>Pinnularia similiformis</i> Krammer	PSIF	...	...	2,667	...	...	...	...	...	...
<i>Pinnularia similis</i> Hustedt	PSIM	...	...	...	...	...	...	...	1,333	...
<i>Pinnularia</i> sp. 1	PIN1	...	...	...	...	...	...	...	...	...
<i>Pinnularia</i> sp. 2	PIN2	...	...	...	...	...	...	...	...	...
<i>Pinnularia subbrevistriata</i> Krammer	PSBV	...	...	...	...	...	...	1,000	4,000	...
<i>Pinnularia subcapitata</i> fo. <i>divergens</i> Hustedt	PSCD	...	1,667	...	4,333	...	...	...	...	...
<i>Pinnularia subcapitata</i> Gregory	PSCA	2,333	...	...	...	...	...	...	...	...
<i>Pinnularia subcapitata</i> var. <i>elongata</i> Krammer	PSEL	...	...	...	...	...	3,333	...	...	0,667
<i>Pinnularia superdivergentissima</i> Germain et Chaumont	PSPD	...	...	...	...	...	...	...	...	...
<i>Pinnularia viridiformis</i> var. <i>minor</i> Krammer	PVFM	...	...	...	...	...	...	2,000	...	...
<i>Pinnularia viridis</i> var. <i>minor</i> Cleve	PVMI	...	...	...	1,333	...	...	3,667	...	...
<i>Placoneis placentula</i> fo. <i>lanceolata</i> (Grunow in Cleve & Grunow) Bukhtiyarova	PLPL	...	...	...	2,667	...	...	...	...	...
<i>Planothidium</i> sp. Round & Bukhtiyarova	PLTD	...	...	...	...	...	...	...	...	...
<i>Planothidium delicatulum</i> (Kützing) Round & Bukhtiyarova	PTDE	...	...	...	...	...	...	...	...	...
<i>Planothidium engelbrechtii</i> (Cholnoky) Round & Bukhtiyarova	PLEN	...	...	...	6,667	2,000	4,000	...	...	...
<i>Planothidium lanceolatum</i> (Brebisson ex Kützing) Lange-Bertalot	PFMA	...	...	...	1,667	...	...	1,333	...	...
<i>Pleurosigma salinarum</i> (Grunow) Cleve & Grunow	PSAL	...	...	...	...	...	...	...	...	...
<i>Psammothidium</i> Bukhtiyarova & Round	PSMT	14,333	...	...	...	...	...	...	...	...
<i>Psammothidium altaicum</i> Bukhtiyarova	PALT	...	...	...	...	...	...	...	...	...
<i>Psammothidium chlidanos</i> (Hohn & Hellerman) Lange-Bertalot	PCHL	...	...	...	1,333	...	...	...	...	...
<i>Reimeria sinuata</i> (Gregory) Kociolek & Stoermer	RSIN	...	...	...	...	...	...	...	...	...
<i>Rhoicosphenia abbreviata</i> (C. Agardh) Lange-Bertalot	RABB	...	...	...	...	...	...	...	...	...
<i>Rhopalodia</i> sp. O Müller	RHOP	...	...	...	...	...	...	...	...	...
<i>Rhopalodia brébissonii</i> Krammer	RBRE	...	...	...	...	...	...	...	...	...
<i>Rhopalodia gibba</i> (Ehrenberg) O. Muller	RGIB	...	...	...	...	...	...	0,667	...	...

Species list	Acronyms	Vegetation types									
		Sneeuberg Hut stream-Sediment	Driehoek-sediment	Suurvlakte-sediment	Verrekyker-vegetation	Verrekykerfloating-vegetation	Verrekyker-vegetation	Verrekyker-vegetation	Blomfontein-sediment	Malkopsvei-vegetation	
<i>Rhopalodia gibberula</i> (Ehrenberg) O. Muller	RGBL	...	...	...	...	...	...	...	...	...	11,333

<i>Rhopalodia gibberula</i> var. <i>vanheurckii</i> O. Muller	RGBB	...	...	...	...	...	...	...	...	...
<i>Rhopalodia musculus</i> (Kützing) O. Muller	RMUS	...	...	...	...	...	...	...	...	...
<i>Rhopalodia operculata</i> (Agardh) Hakansson	ROPE	...	...	...	...	...	...	...	...	...
<i>Sellaphora</i> sp. <i>C. Mereschowsky</i>	SELL	...	...	...	...	...	...	...	...	...
<i>Sellaphora pupula</i> (Kützing) Mereschowksy	SPUP	...	...	...	1,667	...	1,667	...	...	...
<i>Seminavis strigosa</i> (Hustedt) Danieledis & Economou-Amilli	SMST	...	...	...	...	...	...	...	...	...
<i>Stauroneis acidoclinata</i> Lange-Bertalot & Werum	SADC	...	...	...	...	...	...	...	...	...
<i>Stauroneis gracilior</i> (Rabenhorst) Reichardt	SGRL	...	...	...	...	...	...	1,000	...	...
<i>Stauroneis heinii</i> Lange-Bertalot & Krammer	SHEI	...	...	...	1,667	...	...	...	...	...
<i>Stauroneis pseudosuboptusoides</i> Germain	STPO	1,667	...	...	...	...	...	...	...	...
<i>Stausosira construens</i> var. <i>venter</i> (Ehrenberg) Hamilton	SCVE	...	...	...	...	...	...	2,333	...	...
<i>Stausosira elliptica</i> (Schumann) Williams & Round	SELI	...	...	...	...	...	...	...	...	...
<i>Stausosirella pinnata</i> (Ehrenberg) Williams & Round	SPIN	...	...	...	...	...	...	...	...	...
<i>Surirella angusta</i> Kützing	SANG	...	...	...	0,667	...	...	...	...	...
<i>Surirella brébissonii</i> Krammer & Lange-Bertalot	SBRE	...	...	...	...	...	...	...	...	...
<i>Surirella</i> P. J. F. Turpin	SURI	...	...	...	...	...	...	...	...	...
<i>Surirella</i> sp. 1	SUR1	...	...	...	...	...	...	...	...	...
<i>Surirella striatula</i> Turpin sensu Schmidt	SSTR	...	...	...	...	...	...	...	...	...
<i>Synedra commutata</i> Grunow in Cleve & Grunow	SYCO	...	...	...	...	...	...	...	...	...
<i>Tabellaria flocculosa</i> (Roth) Kützing	TFLO	...	...	0,667	...	...	...	...	...	20,333
<i>Tabularia affinis</i> (Kützing) Snoeijs	TFLA	...	...	...	...	...	...	...	...	...
<i>Tabularia fasciculata</i> (Agardh) Williams et Round	TFAS	...	...	...	...	...	...	...	...	...
<i>Thalassiosira weissflogii</i> (Grunow) Fryxell & Hasle	TWEI	...	...	...	...	...	...	...	...	...
<i>Tryblionella angustata</i> Wm Smith	TANG	...	...	...	...	...	...	...	...	...
<i>Tryblionella apiculata</i> Gregory	TAPI	...	...	...	...	...	...	...	...	...
<i>Ulnaria ulna</i> (Nitzsch.) Compère	UULN	...	...	...	...	...	...	5,333	...	...
Unknown sp.	UNKN	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Riversdale-sediment	Blinde River Eustary	Blinde River upper	Blinde River 2	Kleinplaats-vegetation	Kleinplaats-sediment	Groot Rondevlei-sediment	Groot Rondevlei-vegetation	Groot witvlei
<i>Achnanthes</i> J. B. M. Bory de St. Vincent	ACHN	5,435	...	...	...	1,000	...	1,000	2,667	...

<i>Achnanthes crassa</i> Hustedt	ACRA	....	....	....	....	....	....	....	....	....
<i>Achnanthes duthii</i> Sreenivasa	ADUT	....	....	....	12,667	....	....	....	....	....
<i>Achnanthes linearis</i> (W. Sm.) Grunow	ALIN	....	....	....	....	....	....	....	....	....
<i>Achnanthes minutissima</i> Kützing	AMIN	....	....	....	....	....	....	....	....	....
<i>Achnanthes minutissima</i> var. <i>saprophila</i> Kobayasi et Mayama	AMSA	....	....	....	....	....	....	....	....	....
<i>Achnanthes oblongella</i> Oestrup	AOBG	3,623	....	....	....	....	....	....	....	....
<i>Achnantheidium</i> F. T. Kützing	ACHD	....	....	....	....	....	....	....	....	....
<i>Achnantheidium affine</i> (Grunow) Czarnecki	ACAF	....	....	....	....	....	0,333	....	....	....
<i>Achnantheidium crassum</i> (Hustedt) Potapova & Ponader	ADCR	....	....	....	....	....	....	....	....	....
<i>Achnantheidium deflexum</i> (Reimer) Kingston	ACDF	....	....	....	....	....	....	....	....	....
<i>Achnantheidium saprophilum</i> (Kobayasi et Mayama) Round & Bukhtiyarova	ADMI	....	....	0,667	....	....	....	....	....	0,667
<i>Achnantheidium rivulare</i> Potapova & Ponader	ADRT	....	....	....	....	....	0,333	....	....	....
<i>Achnantheidium standerii</i> (Cholnoky) Taylor, Morales & Ector	ACHS	....	....	0,333	....	....	....	....	....	....
<i>Achnantheidium</i> sp.	ADCS	....	....	....	....	....	....	....	....	....
<i>Actinocyclus subtilis</i> (Gregory) Ralfs in Pritchard	ASUB	....	....	....	....	....	....	....	....	....
<i>Amphora</i> C. G. Ehrenberg ex F. T. Kützing	AMPH	....	3,667	6,667	....	....	....	....	....	....
<i>Amphora coffeaeformis</i> (Agardh) Kützing	ACOF	....	....	....	....	....	....	....	....	....
<i>Amphora coffeaeformis</i> var. <i>aponina</i> (Kützing) Archibald & Schoeman	ACFA	....	....	....	....	....	....	....	....	....
<i>Amphora fontinalis</i> Hustedt	AFON	....	....	....	....	....	....	....	....	....
<i>Amphora granulata</i> Gregory	AMGN	....	....	....	....	....	....	....	....	....
<i>Amphora hybrida</i> Grunow in Van Heurck	AHYB	....	2,333	....	....	....	....	....	....	....
<i>Amphora oligotraphenta</i> Lange-Bertalot	AOLG	....	....	....	....	....	....	....	....	....
<i>Amphora ovalis</i> (Kützing) Kützing	AOVA	....	....	....	....	....	....	....	....	....
<i>Amphora pseudoholsatica</i> Nagumo & Kobayasi	APHO	....	13,333	....	....	....	....	....	....	....
<i>Amphora sabiniana</i> Reimer	ASAB	....	....	1,333	....	....	....	....	....	....
<i>Amphora veneta</i> Kützing	AVEN	....	....	....	....	....	....	....	....	1,667
<i>Anomoeoneis serians</i> var. <i>apiculata</i> Boyer	ASAP	....	....	....	....	....	....	....	....	....
<i>Asterionella gracillima</i> (Hantzsch.) Heiberg	AGRA	....	....	....	....	....	....	....	....	....
<i>Aulacoseira</i> G. H. K. Thwaites	AULA	....	....	....	....	....	....	....	....	....
<i>Aulacoseira ambigua</i> (Grunow) Simonsen	AAMB	....	....	....	....	....	1,667	....	....	....
<i>Aulacoseira granulata</i> (Ehrenberg) Simonsen	AUGR	....	....	....	....	3,667	3,333	3,667	2,333	....
<i>Aulacoseira granulata</i> var. <i>angustissima</i> Simonsen	AUGA	....	....	....	....	....	....	....	....	3,333
<i>Bacillaria paradoxa</i> Gmelin	BPAR	....	....	1,667	....	....	....	....	....	....
<i>Brachysira brébissonii</i> Ross in Hartley	BBRE	....	....	....	....	....	....	....	....	....
<i>Caloneis bacillum</i> (Grunow) Cleve	CBAC	....	....	....	....	1,000	....	....	....	....
<i>Caloneis</i> Cleve	CALO	....	....	....	....	....	1,667	....	....	0,333

Species list	Acronyms	Riversdale-sediment	Blinde River Eustary	Blinde River upper	Blinde River 2	Kleinplaats-vegetation	Kleinplaats-sediment	Groot Rondevlei-sediment	Groot Rondevlei-vegetation	Groot witvlei
<i>Caloneis molaris</i> (Grunow) Krammer	CMOL	...	...	...	...	...	...	...	...	...
<i>Caloneis patagonica</i> var. <i>alaskaensis</i> Manguin ex Kociolek & Reviere	CPAL	...	...	2,000	...	...	...	...	...	...
<i>Caloneis permagna</i> (J. W. Bailey) Cleve	CPRM	...	3,333	...	0,333	...	...	...	...	...
<i>Cavinula cocconeiformis</i> (Gregory ex Greville) Mann & Stickle	CCOC	...	...	...	...	...	...	3,333	2,333	...
<i>Cocconeis costata</i> Gregory	COCC	...	...	...	...	...	...	...	...	...
<i>Cocconeis engelbrechtii</i> Cholnoky	CENG	...	...	...	...	...	...	...	...	...
<i>Cocconeis placentula</i> Ehrenberg	CPLA	...	6,000	...	7,667	...	...	1,333	...	17,333
<i>Cocconeis scutellum</i> Ehrenberg	CSCU	...	1,667	...	...	...	...	...	...	...
<i>Cosmioneis pusilla</i> (W. Smith) Mann & Stickle	COPU	...	...	...	...	...	...	...	...	...
<i>Craticula</i> A. Grunow	CRAT	...	0,333	...	...	...	...	...	...	...
<i>Craticula halophila</i> (Grunow ex Van Heurck) Mann	CHAL	...	2,333	...	...	...	...	...	...	...
<i>Craticula molestiformis</i> (Hustedt) Lange-Bertalot	CMLF	...	...	...	...	...	...	...	...	...
<i>Craticula vixnegligenda</i> Lange-Bertalot	CVIX	...	...	...	...	...	...	...	...	...
<i>Cyclotella meneghiniana</i> Kützing	CMEN	2,899	...	10,000	...	52,000	52,333	1,333	1,000	0,667
<i>Cyclotella stelligera</i> Cleve et Grun (in Van Heurck)	CSTE	...	...	...	...	...	...	7,667	4,000	...
<i>Cymatopleura brunii</i> Petit ex Brun	CBRU	...	...	...	...	...	...	...	...	...
<i>Cymbella aspera</i> (Ehrenberg) H. Peragallo	CASP	...	...	...	...	...	...	...	...	...
<i>Cymbella helvetica</i> Kützing	CHEL	...	...	...	...	...	...	...	...	...
<i>Cymbella lanceolata</i> Agardh	CLTA	...	...	...	...	...	...	...	...	...
<i>Cymbella sinuata</i> Gregory	CSIN	...	...	...	...	...	...	...	...	...
<i>Cymbella</i> sp. 1	CYM1	...	...	...	...	...	...	...	...	...
<i>Cymbella</i> sp. 2	CYM2	...	...	...	...	...	...	...	...	...
<i>Cymbella turgidula</i> Grunow 1875 in A. Schmidt & al.	CTGL	...	...	...	...	...	...	...	...	...
<i>Cymbopleura</i> (Krammer) Krammer	CBPL	...	...	...	...	...	...	...	...	...
<i>Delicata krammeri</i> Metzeltin, Lange-Bertalot & Garcia-Rodriguez	DKRM	...	...	...	...	...	...	...	...	...
<i>Diadesmis confervacea</i> Kützing	DCON	...	...	...	...	...	...	...	...	...
<i>Diadesmis</i> F.T. Kützing	DDSP	...	...	...	...	...	...	...	...	...
<i>Diploneis</i> C. G. Ehrenberg ex P. T. Cleve	DIPL	...	...	...	...	...	...	...	...	...
<i>Diploneis smithii</i> (Brébisson) Cleve	DSMI	2,899	3,667	...	...	...	...	1,333	...	1,333

<i>Diploneis smithii</i> var. <i>chilensis</i> Hustedt	DSCH	...	...	...	...	...	...	...	...	...
<i>Diploneis stroemi</i> Hustedt	DSTR	...	2,667	...	...	...	...	...	...	...
<i>Encyonema caespitosum</i> Kützing	ECAE	...	...	...	...	...	...	...	...	...
<i>Encyonema</i> F. T. Kützing	ENCY	...	...	...	...	...	...	...	...	...
<i>Encyonema mesianum</i> (Cholnoky) D. G. Mann	ENME	1,087	...	...	...	...	...	...	...	...
<i>Encyonema silesiacum</i> (Bleisch in Rabenhorst) D. G. Mann	ESLE	...	...	...	...	...	...	...	...	...
<i>Encyonema silesiacum</i> var. <i>latarea</i> Krammer	ESLT	...	...	...	...	...	...	...	...	...
<i>Encyonopsis minuta</i> Krammer & Reichardt	ECPM	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Riversdale-sediment	Blinde River Eustary	Blinde River upper	Blinde River 2	Kleinplaats-vegetation	Kleinplaats-sediment	Groot Rondevlei-sediment	Groot Rondevlei-vegetation	Groot witvlei
<i>Entomoneis paludosa</i> (W. Smith) Reimer	EPAL	...	...	...	...	...	...	...	...	...
<i>Epithemia adnata</i> (Kützing) Brébisson	EADN	...	...	...	...	...	...	...	...	...
<i>Eunotia bilunaris</i> (Ehrenberg) Mills	EBIL	10,870	...	...	...	...	...	...	3,333	...
<i>Eunotia boreoalpina</i> Lange-Bertalot & Nörpel-Schempp	EUBO	...	...	...	...	...	...	...	...	...
<i>Eunotia boreotenuis</i> Norpel-Schempp & Lange-Bertalot	EBOR	...	...	...	...	...	...	...	...	...
<i>Eunotia flexuosa</i> (Brébisson) Kützing	EFLE	...	...	...	...	...	...	...	...	...
<i>Eunotia formica</i> Ehrenberg	EFOR	...	...	...	...	...	...	1,667	...	...
<i>Eunotia glacialis</i> Meister	EGLA	...	...	...	...	...	...	2,667	...	...
<i>Eunotia incisa</i> Gregory	EINC	...	...	...	...	...	...	...	...	...
<i>Eunotia minor</i> (Kützing) Grunow in Van Heurck	EMIN	...	...	...	...	...	2,000	...	...	...
<i>Eunotia monodon</i> Ehrenberg	EMON	...	...	...	...	...	...	1,667	...	...
<i>Eunotia pectinalis</i> (Dyllwyn) Rabenhorst	EPEC	...	...	...	...	...	...	...	...	...
<i>Eunotia silvahercynia</i> Nörpel Van Sull & Lange-Bertalot	ESIL	...	...	...	...	...	...	...	...	...
<i>Eunotia sudetica</i> var. <i>incisa</i> (Gregory) Manguin	ESIN	...	...	...	...	...	...	...	...	...
<i>Eunotia tenella</i> (Grunow) Hustedt	EUNO	16,938	...	...	...	...	17,333	3,000	13,667	36,000
<i>Eunotia veneris</i> (Kützing) De Toni	EVEN	...	...	...	...	...	...	...	...	...
<i>Eunotogramma</i> Weisse	EUTO	1,870	...	...	...	...	...	...	...	...
<i>Fallacia</i> A. J. Stickle & D. G. Mann	FALL	...	3,333	...	...	...	...	...	...	...
<i>Fallacia pygmaea</i> (Kützing) Stickle & Mann	FPYG	...	...	1,667	...	...	...	...	...	...
<i>Fistulifera saprophila</i> (Lange-Bertalot & Bonik) Lange-Bertalot	FSAP	...	...	...	...	...	1,333	...	...	...
<i>Fragilaria</i> H. C. Lyngbye	FRAG	...	...	...	...	...	...	...	1,667	...

<i>Fragilaria bicapitata</i> A. Mayer	FBIC	...	...	...	...	...	...	...	...	...
<i>Fragilaria biceps</i> (Kützing) Lange-Bertalot	FBCP	...	...	...	...	...	...	...	...	...
<i>Fragilaria brevistriata</i> Grunow (Pseudostaurosira)	FBRE	...	...	...	...	...	...	...	0,667	...
<i>Fragilaria capucina</i> Desmazieres	FCAP	...	...	...	...	...	...	...	2,000	...
<i>Fragilaria capucina</i> var. <i>radians</i> (Kützing) Lange-Bertalot	FCRA	...	...	...	...	...	...	...	...	...
<i>Fragilaria capucina</i> var. <i>rumpens</i> (Kützing) Lange-Bertalot.	FCRP	...	...	...	...	...	...	...	...	...
<i>Fragilaria construens</i> (Ehrenberg) Grunow	FCON	...	...	...	...	...	...	...	...	...
<i>Fragilaria construens</i> fo. <i>venter</i> (Ehrenberg) Hustedt	FCVE	...	...	...	...	...	...	...	...	15,333
<i>Fragilaria crotonensis</i> Kitton	FCRO	...	...	...	...	...	...	...	...	...
<i>Fragilaria fasciculata</i> (C. A. Agardh) Lange-Bertalot sensu lato	FFAS	...	...	...	...	...	...	...	...	...
<i>Fragilaria pulchella</i> (Ralfs ex Kützing) Lange-Bertalot (Ctenophora)	FPUL	...	...	...	...	...	...	...	...	0,667
<i>Fragilaria striatula</i> Lyngbye	FSTR	...	...	...	...	...	...	...	...	...
<i>Fragilaria tenera</i> (W. Smith) Lange-Bertalot	FTEN	...	...	...	...	...	...	...	...	...
<i>Fragilaria ulna</i> (Nitzsch.) Lange-Bertalot	FULN	...	...	...	...	...	...	...	...	...
<i>Fragilaria ulna</i> var. <i>biceps</i> (Kützing) Lange-Bertalot	FUBI	...	...	...	...	...	...	...	...	...
<i>Frustulia</i> L. Rabenhorst	FRUS	...	...	...	...	...	...	1,667	...	...

Species list	Acronyms	Riversdale-sediment	Blinde River Eustary	Blinde River upper	Blinde River 2	Kleinplaats-vegetation	Kleinplaats-sediment	Groot Rondevlei-sediment	Groot Rondevlei-vegetation	Groot witvlei
<i>Frustulia crassinervia</i> (Brébisson) Lange-Bertalot et Krammer	FCRS	10,145	...	...	...	...	...	0,667	3,333	...
<i>Frustulia magaliesmontana</i> Cholnoky	FMGL	...	...	...	...	...	...	...	...	...
<i>Frustulia rostrata</i> Hustedt	FROS	...	...	...	...	...	...	...	...	...
<i>Frustulia saxonica</i> Rabenhorst	FSAX	...	...	...	...	...	...	...	...	...
<i>Frustulia vulgaris</i> (Thwaites) De Toni	FVUL	...	...	...	...	...	...	...	...	...
<i>Gomphonema</i> C. G. Ehrenberg	GOMP	1,449	...	...	...	...	...	...	...	...
<i>Gomphonema affine</i> Kützing	GAFF	...	...	...	...	...	...	...	...	...
<i>Gomphonema angustatum</i> (Kützing) Rabenhorst	GANG	...	...	...	...	...	...	...	...	...
<i>Gomphonema clavatum</i> Ehrenberg	GCLA	...	...	...	...	...	...	...	...	...
<i>Gomphonema exilissimum</i> (Grunow) Lange-Bertalot & Reichardt	GEXL	...	...	...	...	...	...	...	...	...
<i>Gomphonema gracile</i> Ehrenberg	GGRA	0,725	...	...	...	...	1,333	...	...	...
<i>Gomphonema lagenula</i> Kützing	GLGN	...	...	...	...	...	...	...	...	...
<i>Gomphonema laticollum</i> Reichardt	GLTC	...	...	...	...	...	...	...	...	...

<i>Gomphonema minutum</i> (Agardh) Agardh	GMIN	...	...	...	...	...	...	...	...	...
<i>Gomphonema parvulum</i> (Kützing) Kützing	GPAR	...	...	0,667	...	...	...	0,667	...	...
<i>Gomphonema parvulum</i> var. <i>subellipticum</i> Cleve	GPSE	...	...	...	...	...	...	...	...	...
<i>Gomphonema pseudoaugur</i> Lange-Bertalot	GPSE	...	...	...	...	...	...	...	...	...
<i>Gomphonema pumilum</i> (Grunow) Reichardt & Lange-Bertalot	GPUM	...	...	...	...	...	...	...	...	...
<i>Gomphonema pumilum</i> var. <i>rigidum</i> Reichardt & Lange-Bertalot	GPRI	...	...	...	...	...	...	...	...	...
<i>Gomphosphenia oahuensis</i> (Hustedt) Lange-Bertalot	GOAH	...	8,333	0,667	8,667	...	...	...	...	...
<i>Grammatophora</i> C. G. Ehrenberg	GRAM	...	...	...	...	...	...	...	...	...
<i>Halamphora eunotia</i> (Cleve) Levkov	HEUN	...	...	...	...	...	...	...	...	...
<i>Halamphora paraveneta</i> Lange-Bertalot. Cavacini. Tagliaventi & Alfinito	HPAR	...	...	...	...	...	...	...	...	...
<i>Halamphora robusta</i> Gregory	HROB	...	...	...	...	...	...	...	...	...
<i>Halamphora veneta</i> (Kützing) Levkov	HVEN	...	...	...	...	...	...	...	...	...
<i>Halampora dominici</i> Ács & Levkov	HDOM	...	...	...	...	...	...	...	...	...
<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow in Cleve et Grunow 1880	HAMP	1,087	...	...	...	...	...	...	...	...
<i>Hantzschia</i> sp. 1	HAN1	...	...	...	...	...	...	...	...	...
<i>Haslea spicula</i> (Hickie) Bukhtiyarova	HSPC	...	...	2,000	...	...	...	...	...	...
<i>Hippodonta capitata</i> (Ehrenberg) Lange-Bert. Metzeltin & Witkowski	HCAP	...	...	...	...	...	...	...	...	...
<i>Hippodonta hungarica</i> (Grunow) Lange-Bertalot Metzeltin & Witkowski	HHUN	...	...	...	...	4,667	2,000	...	1,667	...
<i>Hippodonta</i> Lange-Bertalot. Metzeltin & Witkowski	HIPO	...	...	...	...	...	...	...	...	1,333
<i>Kobayasia subtilissima</i> (Cleve) Lange-Bertalot	KSUB	...	...	...	...	...	...	...	...	...
<i>Kobayasiella subtilissima</i> (Cleve) Lange-Bertalot	KOSU	...	...	...	...	...	...	...	...	...
<i>Lemnicola hungarica</i> (Grunow) Round & Basson	LHUN	...	...	...	...	...	...	...	...	...
<i>Lemnicola</i> Round & Basson	LEMN	...	...	...	...	...	...	...	...	...
<i>Luticola</i> D. G. Mann	LUTI	...	...	...	...	...	...	...	...	...

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<i>Luticola acidoclinata</i> Lange-Bertalot	LACD	...	...	...	...	...	...	...	...	...
<i>Luticola goeppertiana</i> (Bleisch in Rabenhorst) D. G. Mann	LGOT	1,812	...	...	...	...	...	...	...	...
<i>Luticola goeppertiana</i> (Bleisch in Rabenhorst) D. G. Mann abnormal form	LGOE	...	...	...	...	...	...	...	...	...
<i>Luticola mutica</i> (Kützing) D. G. Mann	LMUT	...	...	...	...	...	...	1,667	...	...
<i>Luticola</i> sp.	LUSP	...	...	...	...	...	...	...	...	...

<i>Luticola</i> sp. (aff. <i>mutica</i> )	LUTS	....	....	....	....	....	....	....	....	....
<i>Martyana atomus</i> (Hustedt) Snoeijs	MATO	....	....	....	....	....	....	....	....	....
<i>Mastogloia</i> G. H. K. Thwaites ex W. Smith 1856	MAST	....	....	....	....	....	....	....	....	....
<i>Mastogloia braunii</i> Grunow	MBRA	....	2,667	....	....	....	....	....	....	....
<i>Mastogloia elliptica</i> (C. A. Agardh) Cleve	MELL	....	3,333	....	....	....	....	....	....	....
<i>Mastogloia pusilla</i> (Grunow) Cleve	MPUS	....	5,667	....	....	....	....	....	....	....
<i>Mayamaea atomus</i> (Kützing) Lange-Bertalot	MAAT	....	....	....	....	....	2,333	....	....	....
<i>Melosira nummuloides</i> var. <i>alata</i> Jurilj	MNAL	....	....	....	65,667	....	....	....	....	....
<i>Melosira varians</i> Agardh	MVAR	....	1,333	....	....	....	....	....	....	....
<i>Meridion circulare</i> (Greville) C. A. Agardh	MCIR	....	....	....	....	....	....	....	....	....
<i>Microcostatus</i> sp. Johansen & Sray	MCCT	....	....	....	....	....	....	....	....	....
<i>Muelleria linearis</i> (O. Muller) Frenguelli	MULI	....	....	....	....	....	....	....	....	....
<i>Navicula</i> J. B. M. Bory de St. Vincent	NAVI	....	13,000	3,667	....	3,333	1,333	6,667	16,000	1,000
<i>Navicula arvensis</i> Hustedt	NARV	....	....	....	....	....	....	....	....	....
<i>Navicula capitatoradiata</i> Germain	NCPG	....	....	....	....	....	....	....	....	....
<i>Navicula cincta</i> (Ehrenberg) Ralfs in Pritchard	NCIN	....	....	....	....	....	....	....	....	....
<i>Navicula clementis</i> Grunow	NCLE	....	....	....	....	....	....	0,667	....	....
<i>Navicula cryptocephala</i> Kützing	NCRY	....	....	....	....	....	....	....	....	....
<i>Navicula cryptotenella</i> - type in Kelly	NCTY	....	....	....	....	....	....	....	....	....
<i>Navicula disjuncta</i> Hustedt	NDSJ	....	....	....	....	6,333	9,333	....	....	....
<i>Navicula erifuga</i> Lange-Bertalot	NERI	....	....	0,333	....	....	....	....	....	....
<i>Navicula frugalis</i> Hustedt	NFRU	....	....	....	....	....	....	....	....	....
<i>Navicula humerosa</i> Brébisson ex W. Smith	NHUM	....	....	....	0,333	....	....	....	....	....
<i>Navicula lanceolata</i> (Agardh) Ehrenberg	NLAN	....	....	....	....	....	....	....	....	....
<i>Navicula libonensis</i> Schoeman	NLIB	....	....	....	....	....	....	....	....	....
<i>Navicula microcari</i> Lange-Bertalot	NMCA	....	2,667	....	....	....	1,333	....	....	....
<i>Navicula modica</i> Hustedt	NMOD	....	....	....	....	....	....	....	....	....
<i>Navicula nivalis</i> Ehrenberg	NNIV	....	....	....	....	....	....	....	....	....
<i>Navicula parasubtilissima</i> Kobayasi & Nagumo	NPSU	....	....	....	....	....	....	....	....	....
<i>Navicula peregrina</i> (Ehrenberg) Kützing	NPRG	....	....	....	....	....	....	....	....	2,667
<i>Navicula permitis</i> Hustedt	NPER	....	....	....	....	....	....	....	....	....
<i>Navicula phylleptosoma</i> Lange-Bertalot	NPHP	....	....	....	....	....	....	....	....	....

Species list	Acronyms	Riversdale-sediment	Blinde River Eustary	Blinde River upper	Blinde River 2	Kleinplaats-vegetation	Kleinplaats-sediment	Groot Rondevlei-sediment	Groot Rondevlei-vegetation	Groot witvlei
<i>Navicula placenta</i> Ehrenberg	NPLT	...	...	...	...	...	0,667	...	...	...
<i>Navicula pseudosalinarioides</i> Giffen	NWPS	...	...	...	...	...	...	...	...	...
<i>Navicula pupula</i> fo. <i>rostrata</i> (Hustedt) Hustedt	NPUR	...	...	...	...	...	...	...	...	...
<i>Navicula pusilla</i> W. Smith	NPUS	...	...	...	...	...	...	...	...	...
<i>Navicula ranomafanensis</i> (Manguin) Metzeltin & Lange-Bertalot	NRAN	...	...	...	0,333	...	...	...	...	...
<i>Navicula recens</i> (Lange-Bertalot) Lange-Bertalot	NRCS	...	...	...	...	...	...	...	...	...
<i>Navicula rhyngocephala</i> Kützing	NRHY	...	...	...	...	...	...	...	...	...
<i>Navicula riediana</i> Lange-Bertalot & Rumrich	NRIE	...	...	...	...	...	...	...	...	...
<i>Navicula rostellata</i> Kützing	NROS	...	...	...	...	...	...	...	...	...
<i>Navicula salinarum</i> Grunow in Cleve et Grunow	NSAL	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 1	NAV1	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 2	NAV2	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 3	NAV3	...	...	...	...	...	...	...	...	...
<i>Navicula</i> sp. 4	NAV4	...	...	...	...	...	...	...	...	...
<i>Navicula supergregaria</i> Lange-Bertalot & Rumrich	NSGG	...	...	...	...	...	...	...	...	...
<i>Navicula testa</i> Carter & Bailey-Watts	NTSA	...	...	...	...	...	...	...	...	...
<i>Navicula tripunctata</i> (O. F. M.) Bory forme teratogene	NTTT	...	...	...	...	...	...	...	...	...
<i>Navicula veneta</i> Kützing	NVEN	...	...	0,333	...	...	...	...	...	...
<i>Navicula vitrea</i> (Oestrup) Hustedt	NVIT	...	...	...	...	...	...	...	...	...
<i>Navicula wasmundii</i> Witkowski Metzeltin & Lange-Bertalot	NWAS	...	...	...	...	...	...	...	...	...
<i>Navicula zanoi</i> Hustedt	NZAN	...	...	...	...	...	...	...	...	...
<i>Neidium affine</i> (Ehrenberg) Pfitzer	NEAF	...	...	...	...	...	...	0,667	...	...
<i>Neidium productum</i> (W. M. Smith) Cleve	NEPR	...	...	...	...	...	...	...	...	...
<i>Nitzschia</i> A. H. Hassall	NITZ	...	3,333	2,667	...	...	...	...	2,667	...
<i>Nitzschia acicularis</i> (Kützing) W. M. Smith	NACI	...	...	...	...	...	...	...	...	...
<i>Nitzschia amphibia</i> Grunow	NAMP	...	7,000	...	...	...	...	...	...	...
<i>Nitzschia calida</i> Grunow in Cleve & Grunow	NICA	...	...	...	...	...	...	...	...	...
<i>Nitzschia capitellata</i> Hustedt in A. Schmidt & al.	NCPL	...	...	...	...	...	...	2,333	...	...
<i>Nitzschia communis</i> Rabenhorst	NCOM	...	...	...	...	...	...	...	...	...
<i>Nitzschia commutata</i> Grunow in Cleve et Grunow	NICO	...	...	...	...	...	...	...	...	...

<i>Nitzschia commutatooides</i> Lange-Bertalot	NCMU	...	...	...	...	...	...	...	...	...
<i>Nitzschia desertorum</i> Hustedt	NDES	...	...	...	...	1,667	1,333	...	...	...
<i>Nitzschia dissipata</i> (Kützing) Grunow	NDIS	...	...	...	...	...	...	...	...	...
<i>Nitzschia draveillensis</i> Coste & Ricard	NDRA	...	...	...	...	...	...	...	...	...
<i>Nitzschia epiphytica</i> O. Muller	NEPI	...	...	...	...	...	...	...	...	...
<i>Nitzschia filiformis</i> (W. M. Smith) Van Heurck	NFIL	...	...	...	...	3,000	...	1,333	...	...
<i>Nitzschia fonticola</i> Grunow in Cleve et Möller	NFON	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Riversdale- sediment	Blinde River Eustary	Blinde River upper	Blinde River 2	Kleinplaats- vegetation	Kleinplaats- sediment	Groot Rondevlei- sediment	Groot Rondevlei- vegetation	Groot witvlei
<i>Nitzschia frustulum</i> (Kützing) Grunow	NFTE	...	...	3,000	...	...	...	...	...	...
<i>Nitzschia frustulum</i> var. <i>bulnheimiana</i> (Rabenhorst) Grunow	NFBU	...	...	...	1,667	...	...	...	...	...
<i>Nitzschia fusiformis</i> Grunow	NFUS	...	...	...	...	...	...	...	...	...
<i>Nitzschia gracilis</i> Hantzsch	NIGR	...	...	...	...	...	...	...	...	...
<i>Nitzschia hantzschiana</i> Rabenhorst	NHAN	...	...	...	...	...	...	...	...	...
<i>Nitzschia intermedia</i> Hantzsch ex Cleve & Grunow	NINT	...	...	...	...	...	...	...	...	...
<i>Nitzschia liebetruthii</i> Rabenhorst	NLBT	2,174	...	...	2,000	...	...	...	...	...
<i>Nitzschia linearis</i> (Agardh) W. M. Smith	NLIN	18,478	...	...	...	...	...	...	...	...
<i>Nitzschia littoralis</i> Grunow in Cleve & Grunow	NLIT	...	...	...	...	...	...	...	...	...
<i>Nitzschia microcephala</i> Grunow in Cleve & Moller	NMIC	...	...	...	...	...	...	...	...	...
<i>Nitzschia nana</i> Grunow in Van Heurck	NNAN	5,435	...	...	...	1,000	0,667	...	...	...
<i>Nitzschia obtusa</i> var. <i>nana</i> Grunow	NOBN	...	...	...	...	...	...	...	...	...
<i>Nitzschia obtusa</i> var. <i>scalpelliformis</i> Grunow	NOBS	...	...	...	...	...	...	...	...	...
<i>Nitzschia ovalis</i> Arnott ex Grunow in Cleve & Grunow	NOVA	...	...	...	...	...	...	...	...	...
<i>Nitzschia palea</i> (Kützing) W. Smith	NPAL	...	...	...	...	...	1,667	...	2,000	5,333
<i>Nitzschia palea</i> var. <i>debilis</i> (Kützing) Grunow in Cleve & Grun	NPAD	...	...	...	...	...	...	...	...	...
<i>Nitzschia pura</i> Hustedt	NIPR	...	...	...	...	...	2,333	...	...	...
<i>Nitzschia recta</i> Hantzsch in Rabenhorst	NREC	...	...	...	...	...	...	...	...	...
<i>Nitzschia rhopalodioides</i> Hustedt	NIRH	...	...	...	...	...	...	...	...	...
<i>Nitzschia vitrea</i> Norman var. <i>tenuistriata</i> Manguin ex Kociolek & Reviers	NVTE	...	...	...	...	...	...	...	...	...
<i>Nitzschia vitrea</i> Norman	NIVI	...	...	...	...	...	...	...	...	...
<i>Nupela</i> W. Vyverman & P. Compere	NUPE	...	...	...	...	...	...	...	...	...
<i>Parlibellus</i> E. J. Cox	PARL	...	...	...	...	...	...	...	...	...

<i>Pinnularia</i> C. G. Ehrenberg	PINU	...	...	...	...	4,667	4,667	...	...	...
<i>Pinnularia acoricola</i> Hustedt	PACO	...	...	...	...	...	...	...	...	...
<i>Pinnularia acrosphaeria</i> var. <i>undulata</i> (Cleve) Hustedt	PAUN	...	...	...	...	...	...	...	...	...
<i>Pinnularia acrosphaeria</i> W. Smith	PACR	...	...	...	...	...	...	...	...	...
<i>Pinnularia angustiborealis</i> Krammer & Lange-Bertalot	PAGB	...	...	...	...	...	...	...	...	...
<i>Pinnularia borealis</i> Ehrenberg	PBOR	...	...	...	...	...	...	...	...	...
<i>Pinnularia borealis</i> Ehrenberg fo. <i>rectangularis</i> Carlson	PBRT	...	...	...	...	...	...	...	...	...
<i>Pinnularia brébissonii</i> (Kützing) Rabenhorst morphotyp. 1	PBMU	...	...	...	...	...	...	...	...	...
<i>Pinnularia divergens</i> W. Smith	PDIV	...	...	...	...	1,667	...	...	...	...
<i>Pinnularia dulcicola</i> (Maguin) Van de Vijver & Le Cohu	PDUL	...	...	...	...	...	...	...	...	...
<i>Pinnularia gibba</i> Ehrenberg	PGIB	...	...	...	...	...	...	...	...	...
<i>Pinnularia intermedia</i> (L) Cleve	PITM	...	...	...	...	...	...	...	...	...
<i>Pinnularia intermedia</i> (Lagerstedt) Cleve v. <i>bryophila</i> Manguin ex Kociolek. & Reviers	PIBR	...	...	...	...	...	...	...	...	...
<i>Pinnularia microstauron</i> var. <i>brébissonii</i> (Kützing) Mayer	PMBR	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Riversdale-sediment	Blinde River Eustary	Blinde River upper	Blinde River 2	Kleinplaats-vegetation	Kleinplaats-sediment	Groot Rondevlei-sediment	Groot Rondevlei-vegetation	Groot witvlei
<i>Pinnularia microstauron</i> var. <i>rostrata</i> Krammer	PMRO	...	...	...	...	...	...	...	...	...
<i>Pinnularia obscura</i> Krasske	POBS	...	...	...	...	...	...	...	...	...
<i>Pinnularia obscuriformis</i> Krammer	POBF	...	...	...	...	...	...	...	...	...
<i>Pinnularia pulchella</i> (Boyer) Krammer	PPLL	...	...	...	...	...	...	...	...	...
<i>Pinnularia similiformis</i> Krammer	PSIF	...	...	...	...	...	...	...	...	...
<i>Pinnularia similis</i> Hustedt	PSIM	...	...	...	...	...	...	...	...	...
<i>Pinnularia</i> sp. 1	PIN1	...	...	...	...	...	...	...	...	...
<i>Pinnularia</i> sp. 2	PIN2	...	...	...	...	...	...	...	...	...
<i>Pinnularia subbrevistriata</i> Krammer	PSBV	...	...	...	...	...	...	...	...	...
<i>Pinnularia subcapitata</i> fo. <i>divergens</i> Hustedt	PSCD	...	...	...	...	...	...	...	...	...
<i>Pinnularia subcapitata</i> Gregory	PSCA	...	...	...	...	...	...	0,667	...	...
<i>Pinnularia subcapitata</i> var. <i>elongata</i> Krammer	PSEL	...	...	...	...	...	...	...	...	...
<i>Pinnularia superdivergentissima</i> Germain et Chaumont	PSPD	...	...	...	...	...	...	...	...	...
<i>Pinnularia viridiformis</i> var. <i>minor</i> Krammer	PVFM	...	...	...	...	...	...	...	...	...
<i>Pinnularia viridis</i> var. <i>minor</i> Cleve	PVMI	...	...	...	...	...	...	...	...	...
<i>Placoneis placentula</i> fo. <i>lanceolata</i> (Grunow in Cleve & Grunow) Bukhtiyarova	PLPL	...	...	...	...	...	...	...	...	...

<i>Planothidium</i> sp. Round & Bukhtiyarova	PLTD	...	...	...	0,667	...	...	...	...	12,000
<i>Planothidium delicatulum</i> (Kützing) Round & Bukhtiyarova	PTDE	...	2,667	...	...	...	...	...	...	...
<i>Planothidium engelbrechtii</i> (Cholnoky) Round & Bukhtiyarova	PLEN	...	1,667	...	...	...	...	...	...	...
<i>Planothidium lanceolatum</i> (Brebisson ex Kützing) Lange-Bertalot	PFMA	...	...	...	...	...	...	...	...	...
<i>Pleurosigma salinarum</i> (Grunow) Cleve & Grunow	PSAL	...	2,000	7,333	...	...	...	...	...	...
<i>Psammothidium</i> Bukhtiyarova & Round	PSMT	...	...	...	...	...	...	...	...	...
<i>Psammothidium altaicum</i> Bukhtiyarova	PALT	...	...	...	...	...	...	...	...	...
<i>Psammothidium chlidanos</i> (Hohn & Hellerman) Lange-Bertalot	PCHL	...	...	...	...	...	...	...	...	...
<i>Reimeria sinuata</i> (Gregory) Kociolek & Stoermer	RSIN	...	...	...	...	...	...	...	...	...
<i>Rhoicosphenia abbreviata</i> (C. Agardh) Lange-Bertalot	RABB	...	...	...	...	...	...	...	...	...
<i>Rhopalodia</i> sp. O Müller	RHOP	...	...	...	...	...	...	...	...	...
<i>Rhopalodia brébissonii</i> Krammer	RBRE	...	...	...	...	...	...	...	...	...
<i>Rhopalodia gibba</i> (Ehrenberg) O. Muller	RGIB	...	...	...	...	...	...	...	...	...
<i>Rhopalodia gibberula</i> (Ehrenberg) O. Muller	RGBL	...	...	...	...	...	...	...	...	...
<i>Rhopalodia gibberula</i> var. <i>vanheurckii</i> O. Muller	RGBB	...	...	...	...	...	...	...	...	...
<i>Rhopalodia musculus</i> (Kützing) O. Muller	RMUS	...	...	...	...	...	...	...	...	...
<i>Rhopalodia operculata</i> (Agardh) Hakansson	ROPE	...	...	...	...	...	...	...	...	...
<i>Sellaphora</i> sp. C. Mereschkowsky	SELL	...	3,667	...	...	...	...	...	...	...
<i>Sellaphora pupula</i> (Kützing) Mereschkowsky	SPUP	...	...	...	...	...	...	...	...	...
<i>Seminavis strigosa</i> (Hustedt) Danieledis & Economou-Amilli	SMST	...	...	...	...	...	...	1,333	...	...
<i>Stauroneis acidoclinata</i> Lange-Bertalot & Werum	SADC	...	...	...	...	...	...	...	...	...

Species list	Acronyms	Riversdale-sediment	Blinde River Eustary	Blinde River upper	Blinde River 2	Kleinplaats-vegetation	Kleinplaats-sediment	Groot Rondevlei-sediment	Groot Rondevlei-vegetation	Groot witvlei
<i>Stauroneis gracilior</i> (Rabenhorst) Reichardt	SGRL	...	...	...	...	...	...	...	...	...
<i>Stauroneis heinii</i> Lange-Bertalot & Krammer	SHEI	...	...	...	...	...	...	...	...	...
<i>Stauroneis pseudosuboptusoides</i> Germain	STPO	...	...	...	...	...	...	...	...	...
<i>Stausira construens</i> var. <i>venter</i> (Ehrenberg) Hamilton	SCVE	...	...	...	...	...	...	24,000	10,000	...
<i>Stausira elliptica</i> (Schumann) Williams & Round	SELI	...	...	...	...	...	...	17,333	6,000	34,333
<i>Stausosirella pinnata</i> (Ehrenberg) Williams & Round	SPIN	...	...	...	...	...	...	2,667	1,667	...
<i>Surirella angusta</i> Kützing	SANG	...	...	...	...	...	...	...	...	...
<i>Surirella brébissonii</i> Krammer & Lange-Bertalot	SBRE	...	...	...	...	...	...	...	...	...
<i>Surirella</i> P. J. F. Turpin	SURI	...	...	...	...	...	...	...	...	...

<i>Surirella</i> sp. 1	SUR1	....	....	....	....	....	....	....	....	....
<i>Surirella striatula</i> Turpin sensu Schmidt	SSTR	....	....	0,333	....	....	....	....	....	....
<i>Synedra commutata</i> Grunow in Cleve & Grunow	SYCO	....	....	....	....	....	....	....	....	....
<i>Tabellaria flocculosa</i> (Roth) Kützing	TFLO	....	....	....	....	3,667	2,000	8,000	15,667	....
<i>Tabularia affinis</i> (Kützing) Snoeijs	TFLA	....	....	....	....	....	....	....	....	....
<i>Tabularia fasciculata</i> (Agardh) Williams et Round	TFAS	....	....	31,333	....	....	....	....	....	....
<i>Thalassiosira weissflogii</i> (Grunow) Fryxell & Hasle	TWEI	....	....	18,667	....	....	....	....	....	....
<i>Tryblionella angustata</i> Wm Smith	TANG	....	....	1,667	....	....	....	....	....	....
<i>Tryblionella apiculata</i> Gregory	TAPI	....	....	3,000	....	....	....	....	....	....
<i>Ulnaria ulna</i> (Nitzsch.) Compère	UULN	....	....	....	....	....	....	....	5,333	....
Unknown sp.	UNKN	....	....	....	....	....	....	0,667	....	....

Compiled species lists for each wetland:

**Table 1:** Species list from Januarievlei arranged in order of dominance

Species list
<i>Planothidium engelbrechtii</i> Cholnoky Round & Bukhtiyarova
<i>Gomphonema pumilum</i> (Grunow) Reichardt & Lange-Bertalot
<i>Nitzschia microcephala</i> - Grunow in Cleve & Moller
<i>Nitzschia recta</i> - Hantzsch in Rabenhorst
<i>Gomphonema gracile</i> - Ehrenberg
<i>Tabularia fasciculata</i> - (Agardh) Williams & Round
<i>Fragilaria</i> sp. H.C. Lyngbye
<i>Anomoeoneis serians</i> var. <i>apiculata</i> Boyer
<i>Eunotia silvahercynia</i> Nörpel, Van Sull & Lange-Bertalot
<i>Fragilaria bicapitata</i> A.Mayer
<i>Navicula veneta</i> Kützing
<i>Aulacoseira</i> sp. A.G.H.K. Thwaites
<i>Fragilaria capucina</i> Desmazieres
<i>Amphora coffeaeformis</i> (Agardh) Kützing.
<i>Nitzschia littoralis</i> Grunow in Cl. & Grunow.
<i>Gomphonema clavatum</i> Ehrenberg.
<i>Nitzschia palea</i> (Kützing) W.Smith
<i>Cymbella sinuata</i> Gregory
<i>Pinnularia</i> sp. C.G. Ehrenberg

**Table2:** Species list from Die Vlakte arranged in order of dominance

Species list:
<i>Achnanthydium saprophilum</i> (Kobayasi & Mayama) Round & Bukhtiyarova
<i>Gomphonema lagenula</i> Kützing
<i>Eunotia</i> sp. 1 C.G. Ehrenberg
<i>Eunotia flexuosa</i> (Brébisson) Kützing
<i>Eunotia</i> sp. 2. C.G. Ehrenberg
<i>Gomphonema parvulum</i> (Kützing) Kützing
<i>Planothydium engelbrechtii</i> (Cholnoky) Round & Bukhtiyarova
<i>Fragilaria capucina</i> ssp. <i>rumpens</i> (Kützing) Lange-Bertalot ex Bukhtiyarova
<i>Tabellaria flocculosa</i> (Roth) Kützing
<i>Cyclotella meneghiniana</i> Kützing
<i>Nitzschia hantzschiana</i> Rabenhorst
<i>Fragilaria ulna</i> var. <i>biceps</i> (Kützing) Lange-Bertalot
<i>Pinnularia acorica</i> Hustedt
<i>Surirella</i> sp.1
<i>Nitzschia obtusa</i> var. <i>nana</i> Grunow
<i>Pinnularia viridiformis</i> var. <i>minor</i> Krammer
<i>Nitzschia palea</i> (Kützing) W.Smith
<i>Nitzschia pura</i> Hustedt
<i>Ulnaria ulna</i> (Nitzsch) Compère
<i>Gomphonema laticollum</i> Reichardt
<i>Pinnularia similiformis</i> Krammer
<i>Navicula zanoni</i> Hustedt
<i>Luticola goeppertiana</i> (Bleisch in Rabenhorst) D.G. Mann

**Table 3:** Species list from Wagenbooms River arranged in order of dominance

Species list:
<i>Achnanthes</i> sp. J.B.M. Bory de St. Vincent
<i>Tabellaria flocculosa</i> (Roth) Kützing
<i>Rhoicosphenia abbreviata</i> (Agardh) Lange-Bertalot
<i>Nitzschia palea</i> (Kützing) W.Smith
<i>Fragilaria tenera</i> (W.Smith) Lange-Bertalot
<i>Stauroneis gracilior</i> (Rabenhorst) Reichardt
<i>Cocconeis placentula</i> Ehrenberg
<i>Cyclotella meneghiniana</i> Kützing
<i>Delicata krammeri</i> Metzeltin, Lange-Bertalot & Garcia-Rodriguez
<i>Nitzschia pura</i> Hustedt
<i>Planothidium engelbrechtii</i> (Cholnoky) Round & Bukhtiyarova
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Pinnularia borealis</i> Ehrenberg
<i>Nitzschia dissipata</i> (Kützing) Grunow
<i>Craticula molestiformis</i> (Hustedt) Lange-Bertalot
<i>Eunotia bilunaris</i> (Ehrenberg) Mills
<i>Gomphonema pumilum</i> var. <i>rigidum</i> Reichardt & Lange-Bertalot
<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow in Cleve et Grunow
<i>Nitzschia linearis</i> (Agardh) W.M.Smith
<i>Nitzschia obtusa</i> var. <i>scalpelliformis</i> Grunow
<i>Nitzschia intermedia</i> Hantzsch ex Cleve & Grunow
<i>Eunotia</i> sp. 4 C.G. Ehrenberg
<i>Pinnularia obscura</i> Krasske
<i>Reimeria sinuata</i> (Gregory) Kociolek & Stoermer
<i>Mayamaea atomus</i> (Kützing) Lange-Bertalot
<i>Cymbella helvetica</i> Kützing
<i>Nitzschia hantzschiana</i> Rabenhorst
<i>Gomphonema gracile</i> Ehrenberg

**Table4:** Species list from Hoogvertoon arranged in order of dominance

Species list:
<i>Pinnularia intermedia</i> (Lagerstedt) Cleve
<i>Pinnularia borealis</i> Ehrenberg
<i>Pinnularia divergens</i> W.M. Smith
<i>Psammothidium</i> sp. Bukhtiyarova & Round
<i>Navicula</i> sp. J.B.M. Bory de St. Vincent
<i>Navicula parasubtilissima</i> Kobayasi & Nagumo
<i>Eunotia</i> sp. 1 C.G. Ehrenberg
<i>Fragilaria striatula</i> Lyngbye
<i>Eunotia</i> sp. 3 C.G. Ehrenberg
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Navicula</i> sp. J.B.M. Bory de St. Vincent
<i>Sellaphora</i> sp. C. Mereschkowsky
<i>Hantzschia amphioxys</i> (Ehrenberg.) Grunow in Cleve et Grunow
<i>Pinnularia superdivergentissima</i> Germain et Chaumont
<i>Cosmioneis pusilla</i> (W. Smith) Mann & Stickle
<i>Psammothidium altaicum</i> Bukhtiyarova
<i>Nupela</i> sp.
<i>Navicula</i> sp.
<i>Craticula molestiformis</i> (Hustedt) Lange-Bertalot
<i>Stauroneis acidoclinata</i> Lange-Bertalot & Werum
<i>Luticola</i> sp. D.G. Mann

**Table 5:** Species list from Sneeuberg Hut Stream arranged in order of dominance

Species list:
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Psammothidium</i> sp. Bukhtiyarova & Round
<i>Eunotia</i> sp 5 C.G. Ehrenberg
<i>Nitzschia palea</i> var. <i>debilis</i> (Kützing) Grunow in Cleve & Grunow
<i>Kobayasiella subtilissima</i> (Cleve) Lange-Bertalot
<i>Pinnularia microstauron</i> var. <i>rostrata</i> Krammer
<i>Nitzschia amphibia</i> Grunow
<i>Eunotia flexuosa</i> (Brébisson) Kützing
<i>Brachysira brebissonii</i> Ross in Hartley
<i>Pinnularia divergens</i> W.M. Smith
<i>Pinnularia subcapitata</i> var. <i>elongata</i> Krammer
<i>Nitzschia dissipata</i> (Kützing) Grunow
<i>Nitzschia</i> sp. A.H. Hassall
<i>Stauroneis pseudosuboptusoides</i> Germain
<i>Achnanthydium affine</i> (Grunow) Czarnecki
<i>Pinnularia microstauron</i> var. <i>brebissonii</i> (Kützing) Mayer
<i>Pinnularia borealis</i> Ehrenberg
<i>Navicula arvensis</i> Hustedt
<i>Pinnularia intermedia</i> (Lagerstedt) Cleve
<i>Frustulia saxonica</i> Rabenhorst
<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow in Cleve et Grunow
<i>Craticula molestiformis</i> (Hustedt) Lange-Bertalot

**Table 6:** Species list from Driehoek arranged in order of dominance

Species list:
<i>Craticula molestiformis</i> (Hustedt) Lange-Bertalot
<i>Eunotia</i> sp.5 C.G. Ehrenberg
<i>Eunotia</i> sp. 1 C.G. Ehrenberg
<i>Eunotia</i> sp. 3 C.G. Ehrenberg
<i>Brachysira brebissonii</i> Ross
<i>Pinnularia angustiborealis</i> Krammer & Lange-Bertalot
<i>Pinnularia intermedia</i> var. <i>bryophila</i> Manguin ex Kociolek & Reviere
<i>Eunotia flexuosa</i> (Brébisson) Kützing
<i>Pinnularia borealis</i> Ehrenberg
<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow in Cleve et Grunow
<i>Eunotia bilunaris</i> (Ehrenberg) Mills
<i>Kobayasiella subtilissima</i> (Cleve) Lange-Bertalot
<i>Navicula</i> sp. 5 J.B.M. Bory de St. Vincent
<i>Luticola</i> sp.
<i>Frustulia magaliesmontana</i> Cholnoky
<i>Frustulia saxonica</i> Rabenhorst
<i>Pinnularia subcapitata</i> f. <i>divergens</i> Hustedt
<i>Achnanthis</i> sp.
<i>Pinnularia divergens</i> W.M. Smith
<i>Encyonema</i> sp. F.T. Kützing
<i>Achnanthis deflexum</i> (Reimer) Kingston
<i>Mastogloia</i> sp. G.H.K. Thwaites ex Smith

**Table 7:** Species list from Suurvlaakte arranged in order of dominance

Species list:
<i>Eunotia flexuosa</i> (Brébisson) Kützing
<i>Eunotia incisa</i> Gregory
<i>Frustulia rostrata</i> Hustedt
<i>Pinnularia obscura</i> Krasske
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Frustulia saxonica</i> Rabenhorst
<i>Brachysira brebissonii</i> Ross
<i>Pinnularia divergens</i> W.M. Smith
<i>Pinnularia borealis</i> Ehrenberg
<i>Pinnularia similiformis</i> Krammer
<i>Microcostatus</i> sp. Johansen & Sray
<i>Nitzschia palea</i> (Kützing) W. Smith
<i>Kobayasia subtilissima</i> (Cleve) Lange-Bertalot
<i>Eunotia bilunaris</i> Ehrenberg Mills
<i>Diadesmis</i> sp.
<i>Encyonema caespitosum</i> Kützing
<i>Tabellaria flocculosa</i> (Roth) Kützing

**Table 8:** Species list from Verrekker/Skilpadsgat arranged in order of dominance

Species list:
<i>Fragilaria ulna</i> var. <i>biceps</i> (Kützing) Lange-Bertalot
<i>Cocconeis placentula</i> Ehrenberg
<i>Navicula recens</i> (Lange-Bertalot) Lange-Bertalot
<i>Planothidium engelbrechtii</i> (Cholnoky) Round & Bukhtiyarova
<i>Gomphonema parvulum</i> (Kützing) Kützing
<i>Cyclotella meneghiniana</i> Kützing
<i>Pinnularia subcapitata</i> f. <i>divergens</i> Hustedt
<i>Placoneis placentula</i> f. <i>lanceolata</i> (Grunow) Bukhtiyarova
<i>Hippodonta capitata</i> (Ehrenberg) Lange-Bert. Metzeltin & Witkowski
<i>Eunotia</i> sp. 5 C.G. Ehrenberg
<i>Stauroneis heinii</i> Lange-Bertalot & Krammer
<i>Planothidium lanceolatum</i> (Brébisson ex Kützing) Lange-Bertalot
<i>Sellaphora pupula</i> (Kützing) Mereschkowsky
<i>Gomphonema gracile</i> Ehrenberg
<i>Lemnicola hungarica</i> (Grunow) Round & Basson
<i>Pinnularia brebissonii</i> (Kützing) Rabenhorst morphotype.
<i>Psammothidium chlidanos</i> (Hohn & Hellerman) Lange-Bertalot
<i>Gomphonema pseudoaugur</i> Lange-Bertalot
<i>Pinnularia viridis</i> (Nitzsch) Ehrenberg
<i>Achnantheidium</i> sp. Kützing
<i>Nitzschia</i> sp. 10 Hassall
<i>Caloneis bacillum</i> (Grunow) Cleve
<i>Nitzschia fonticola</i> Grunow in Cleve et Möller
<i>Surirella angusta</i> Kützing
<i>Gomphonema</i> sp. C.G. Ehrenberg
<i>Nitzschia liebetruthii</i> Rabenhorst
<i>Luticola acidoclinata</i> Lange-Bertalot

**Table 9:** Species list from Blomfontein arranged in order of dominance

Species list:
<i>Nitzschia palea</i> (Kützing) W. Smith
<i>Amphora</i> sp. C.G. Ehrenberg ex Kützing
<i>Frustulia rostrata</i> Hustedt
<i>Caloneis bacillum</i> (Grunow) Cleve
<i>Amphora oligotraphenta</i> Lange-Bertalot
<i>Pinnularia</i> sp. C.G. Ehrenberg
<i>Nitzschia vitrea</i> Norman
<i>Pinnularia subbrevistriata</i> Krammer
<i>Pinnularia obscuriformis</i> Krammer
<i>Nitzschia nana</i> Grunow in Van Heurck
<i>Eunotia</i> sp. 5 C.G. Ehrenberg
<i>Muelleria linearis</i> (O. Muller) Frenguelli
<i>Achnantheidium</i> sp.
<i>Frustulia vulgaris</i> (Thwaites) De Toni
<i>Achnantheidium minutissimum</i> (Kützing) Czarnecki
<i>Navicula</i> sp. 4J.B.M. Bory de St. Vincent
<i>Navicula</i> sp. 3 J.B.M. Bory de St. Vincent
<i>Gomphonema exilissimum</i> (Grunow) Lange-Bertalot & Reichardt
<i>Encyonema silesiacum</i> (Bleisch in Rabenhorst.) D.G. Mann
<i>Nitzschia filiformis</i> (W.M. Smith) Van Heurck
<i>Meridion circulare</i> (Greville) C.A. Agardh
<i>Grammatophora</i> sp. C.G. Ehrenberg
<i>Amphora</i> sp. C.G. Ehrenberg ex F.T. Kützing
<i>Pinnularia similis</i> Hustedt
<i>Pinnularia borealis</i> Ehrenberg
<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow in Cleve et Grunow

**Table 10:** Species list from Malkopsvlei arranged in order of dominance

Species list :
<i>Aulacoseira ambigua</i> (Grunow) Simonsen
<i>Tabellaria flocculosa</i> (Roth) Kützing
<i>Rhopalodia gibberula</i> (Ehrenberg) O. Muller
<i>Aulacoseira granulata</i> (Ehrenberg) Simonsen
<i>Eunotia</i> sp. 5 C.G. Ehrenberg
<i>Fragilaria capucina</i> var. <i>radians</i> (Kützing) Lange-Bertalot
<i>Nitzschia frustulum</i> (Kützing) Grunow.
<i>Brachysira brebissonii</i> Ross
<i>Fragilaria</i> sp. H.C. Lyngbye
<i>Nitzschia palea</i> (Kützing) W. Smith
<i>Eunotia formica</i> Ehrenberg
<i>Achnantheidium crassum</i> (Hustedt) Potapova & Ponader
<i>Pinnularia subcapitata</i> Gregory
<i>Nitzschia nana</i> Grunow in Van Heurck
<i>Navicula cryptotenella</i> - type in Kelly
<i>Gomphonema gracile</i> Ehrenberg
<i>Cyclotella meneghiniana</i> Kützing

**Table 11:** Species list from Riversdale wetland arranged in order of dominance

Species list:
<i>Eunotia</i> sp.5. C.G. Ehrenberg
<i>Nitzschia linearis</i> (Agardh) W.M. Smith
<i>Eunotia bilunaris</i> (Ehrenberg) Mills
<i>Frustulia crassinervia</i> Lange-Bertalot et Krammer
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Nitzschia nana</i> Grunow in Van Heurck
<i>Achnanthes</i> sp. J.B.M. Bory de St. Vincent
<i>Achnanthes oblongella</i> Oestrup
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Diploneis smithii</i> (Brébisson) Cleve
<i>Cyclotella meneghiniana</i> Kützing
<i>Nitzschia liebetruthii</i> Rabenhorst
<i>Luticola goeppertiana</i> (Bleisch in Rabenhorst) D.G. Mann
<i>Gomphonema</i> sp. C.G. Ehrenberg
<i>Eunotia Gramma</i> Weisse
<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow in Cleve et Grunow
<i>Eunotia</i> sp. 1 C.G. Ehrenberg
<i>Eunotis</i> sp. 2 C.G. Ehrenberg
<i>Encyonema mesianum</i> (Cholnoky) D.G. Mann
<i>Achnanthes</i> sp. J.B.M. Bory de St. Vincent
<i>Gomphonema gracile</i> Ehrenberg

**Table 12:** Species list from Blinde River arranged in order of dominance

Species list:
<i>Melosira nummuloides</i> (Dillwyn) Agardh
<i>Achnanthes duthii</i> Sreenivasa
<i>Gomphosphenia oahuensis</i> (Hustedt) Lange-Bertalot
<i>Cocconeis placentula</i> Ehrenberg
<i>Nitzschia liebetruthii</i> Rabenhorst
<i>Nitzschia frustulum</i> var. <i>bulnheimiana</i> (Rabenhorst) Grunow
<i>Planothidium</i> sp. Round & Bukhtiyarova
<i>Caloneis permagna</i> (J.W.Bailey) Cleve
<i>Navicula humerosa</i> Brébisson ex W. Smith
<i>Navicula ranomafanensis</i> (Manguin) Metzeltin & Lange-Bertalot

**Table 13:** Species list from Kleinplaats arranged in order of dominance

Species list:
<i>Cyclotella meneghiniana</i> Kützing
<i>Navicula disjuncta</i> Hustedt
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Pinnularia</i> sp. C.G. Ehrenberg
<i>Hippodonta hungarica</i> (Grunow) Lange-Bertalot Metzeltin & Witkowski
<i>Aulacoseira granulata</i> (Ehrenberg) Simonsen
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Nitzschia filiformis</i> (W.M. Smith) Van Heurck
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Tabellaria flocculosa</i> (Roth) Kützing
<i>Navicula</i> sp. J.B.M. Bory de St. Vincent
<i>Nitzschia desertorum</i> Hustedt
<i>Pinnularia divergens</i> W.M. Smith
<i>Navicula</i> sp. J.B.M. Bory de St. Vincent
<i>Caloneis bacillum</i> (Grunow) Cleve
<i>Nitzschia nana</i> Grunow in Van Heurck
<i>Achnanthes</i> sp. J.B.M. Bory de St. Vincent
<i>Tabellaria flocculosa</i> (Roth) Kützing

**Table 14:** Species list from Groot Rondevlei arranged in order of dominance

Species list:
<i>Navicula</i> sp. J.B.M. Bory de St. Vincent
<i>Tabellaria flocculosa</i> (Roth) Kützing
<i>Eunotia porcellus</i> Cholnoky
<i>Stausosira construens</i> var <i>venter</i> Ehrenberg Hamilton
<i>Stausosira elliptica</i> (Schumann) Williams & Round
<i>Ulnaria ulna</i> (Nitzsch.) Compère
<i>Cyclotella stelligera</i> Cleve et Grun (in Van Heurck)
<i>Eunotia bilunaris</i> Ehrenberg Mills
<i>Frustulia crassinervia</i> Lange-Bertalot et Krammer
<i>Nitzschia</i> sp. A.H. Hassall
<i>Aulacoseira granulata</i> Ehrenberg Simonsen
<i>Cavinula cocconeiformis</i> (Gregory ex Greville) Mann & Stickle
<i>Fragilaria capucina</i> Desmazieres
<i>Achnanthes</i> sp. J.B.M. Bory de St. Vincent
<i>Nitzschia palea</i> (Kützing) W. Smith
<i>Stausosirella pinnata</i> Ehrenberg Williams & Round
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Hippodonta hungarica</i> (Grunow) Lange-Bertalot Metzeltin & Witkowski
<i>Fragilaria</i> sp. H.C. Lyngbye
<i>Cyclotella meneghiniana</i> Kützing
<i>Fragilaria brevistriata</i> Grunow (Pseudostaurosira)
<i>Achnanthes</i> sp. J.B.M. Bory de St. Vincent

**Table 15:** Species list from Groot Witvlei arranged in order of dominance

Species list:
<i>Staurosira elliptica</i> (Schumann) Williams & Round
<i>Cocconeis placentula</i> Ehrenberg
<i>Fragilaria construens</i> f.venter Ehrenberg Hustedt
<i>Planothidium</i> sp. Round & Bukhtiyarova
<i>Nitzschia palea</i> (Kützing) W. Smith
<i>Aulacoseira granulata</i> var. <i>angustissima</i> (O.M.) Simonsen
<i>Navicula peregrina</i> Ehrenberg Kützing
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Amphora veneta</i> Kützing
<i>Diploneis smithii</i> (Brébisson) Cleve
<i>Hippodonta</i> sp. Lange-Bertalot. Metzeltin & Witkowski
<i>Navicula</i> sp. J.B.M. Bory de St. Vincent
<i>Fragilaria pulchella</i> Kützing Lange-Bertalot (Ctenophora)
<i>Cyclotella meneghiniana</i> Kützing
<i>Achnanthydium minutissimum</i> (Kützing) Czarnecki
<i>Caloneis</i> sp. Cleve

**Table 16:** Species list from Kenilworth racecourse arranged in order of dominance

Species list:
<i>Eunotia bilunaris</i> Ehrenberg Mills
<i>Eunotia formica</i> Ehrenberg
<i>Gomphonema gracile</i> Ehrenberg
<i>Encyonema silesiacum</i> Nörpel Van Sull & Lange-Bertalot
<i>Achnanthes</i> sp. J.B.M. Bory de St. Vincent
<i>Eunotia flexuosa</i> (Brébisson) Kützing
<i>Gomphonema affine</i> Kützing
<i>Gomphonema minutum</i> Agardh
<i>Eunotia minor</i> (Kützing) Grunow in Van Heurck
<i>Eunotia sudetica</i> var. <i>incisa</i> (Gregory) Manguin
<i>Eunotia veneris</i> (Kützing) De Toni
<i>Pinnularia subcapitata</i> fo. <i>divergens</i> Hustedt
<i>Nitzschia</i> sp A.H. Hassall

**Table 17:** Species list from Kiekoesvlei arranged in order of dominance

Species list:
<i>Nitzschia palea</i> (Kützing) W. Smith
<i>Nitzschia</i> sp.2 A.H. Hassall
<i>Navicula</i> sp.3 J.B.M. Bory de St. Vincent
<i>Amphora coffeaeformis</i> (Agardh) Kützing
<i>Hantzschia amphioxys</i> Ehrenberg Grunow in Cleve et Grunow
<i>Navicula nivalis</i> Ehrenberg
<i>Craticula halophila</i> (Grunow ex Van Heurck) Mann
<i>Planothidium engelbrechtii</i> Cholnoky Round & Bukhtiyarova
<i>Nitzschia commutatooides</i> Lange-Bertalot
<i>Mayamaea atomus</i> (Hustedt) Snoeijs
<i>Craticula molestiformis</i> (Grunow) Krammer

**Table 18:** Species list from Koekies pan arranged in order of dominance

Species list:
<i>Amphora coffeaeformis</i> var. <i>aponina</i> (Kützing) Archibald & Schoeman
<i>Nitzschia communis</i> Rabenhorst
<i>Navicula</i> sp. J.B.M. Bory de St. Vincent
<i>Nitzschia littoralis</i> Grunow in Cl. & Grun.
<i>Navicula</i> sp. 2 J.B.M. Bory de St. Vincent
<i>Nitzschia</i> sp. A.H. Hassall
<i>Rhopalodia musculus</i> (Kützing) O. Muller
<i>Nitzschia ovalis</i> Arnott ex Grunow in Cl. & Grun.
<i>Fallacia pygmaea</i> Lange-Bertalot
<i>Nitzschia rhopalodioides</i> Hustedt
<i>Nitzschia calida</i> Grunow in Cl. & Grunow
<i>Parlibellus</i> sp. E.J. Cox
<i>Navicula pseudosalinarioides</i> Giffen
<i>Navicula wasmundii</i> Witkowski Metzeltin & Lange-Bertalot

**Table 19:** Species list from Noordhoek soutpan/ Lake Michelle arranged in order of dominance

Species list:
<i>Staurosira elliptica</i> (Schumann) Williams & Round
<i>Epithemia adnata</i> (Kützing) Brébisson
<i>Nitzschia microcephala</i> Grunow in Cleve & Moller
<i>Rhopalodia operculata</i> (Agardh) Hakansson
<i>Navicula frugalis</i> Hustedt
<i>Cyclotella meneghiniana</i> Kützing
<i>Nitzschia</i> sp. A.H. Hassall
<i>Navicula veneta</i> Kützing
<i>Craticula</i> sp. A. Grunow
<i>Amphora fontinalis</i> Hustedt
<i>Fragilaria bicapitata</i> A. Mayer
<i>Fragilaria tenera</i> (W. Smith) Lange-Bertalot
<i>Cymbella</i> sp. C. Agardh
<i>Navicula peregrina</i> J.B.M. Bory de St. Vincent
<i>Lemnicola</i> sp. Round & Basson
<i>Eunotia bilunaris</i> Ehrenberg Mills
<i>Asterionella gracillima</i> (Hantzsch.) Heiberg
<i>Amphora</i> sp. C.G. Ehrenberg ex F.T. Kützing
<i>Amphora ovalis</i> (Kützing) Kützing
<i>Cocconeis engelbrechtii</i> Cholnoky
<i>Navicula pusilla</i> W. Smith
<i>Cymbella</i> sp. C. Agardh
<i>Diadesmis confervacea</i> Kützing
<i>Navicula</i> sp. 3 J.B.M. Bory de St. Vincent
<i>Nitzschia acicularis</i> (Kützing) W.M. Smith
<i>Surirella brebissonii</i> Krammer & Lange-Bertalot
<i>Amphora coffeaeformis</i> (Agardh) Kützing

**Table 20:** Species list from Rooi Pan arranged in order of dominance

Species list:
<i>Amphora coffeaeformis</i> (Agardh) Kützing
<i>Navicula pusilla</i> W. Smith
<i>Achnanthes</i> sp. 3 J.B.M. Bory de St. Vincent
<i>Achnanthes</i> sp 2 J.B.M. Bory de St. Vincent
<i>Nitzschia liebetruthii</i> Rabenhorst
<i>Navicula</i> sp. J.B.M. Bory de St. Vincent
<i>Achnanthes</i> sp 4 J.B.M. Bory de St. Vincent
<i>Rhopalodia operculata</i> (Agardh) Hakansson
<i>Nitzschia</i> sp A.H. Hassall
<i>Navicula</i> sp. 2 J.B.M. Bory de St. Vincent
<i>Hantzschia amphioxys</i> Ehrenberg Grunow in Cleve et Grunow
<i>Navicula testa</i> Carter & Bailey-Watts
<i>Craticula</i> sp 1 A. Grunow
<i>Craticula</i> sp 2 A. Grunow
<i>Navicula permitis</i> Hustedt
<i>Navicula</i> sp. J.B.M. Bory de St. Vincent
<i>Planothidium engelbrechtii</i> Cholnoky Round & Bukhtiyarova
<i>Navicula</i> sp 4 J.B.M. Bory de St. Vincent
<i>Navicula frugalis</i> Hustedt
<i>Nitzschia</i> sp. 11 A.H. Hassall
<i>Gomphonema gracile</i> Ehrenberg
<i>Rhopalodia gibba</i> Ehrenberg O. Muller
<i>Rhopalodia</i> sp. O. Muller
<i>Nitzschia</i> sp. A.H. Hassall
<i>Cocconeis costata</i> Gregory
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Navicula cincta</i> Ehrenberg Ralfs in Pritchard
<i>Navicula</i> sp. J.B.M. Bory de St. Vincent

**Table 21:** Species list from upper Silvermine River Wetland arranged in order of dominance

Species list:
<i>Planothidium engelbrechtii</i> (Cholnoky) Round & Bukhtiyarova
<i>Gomphonema parvulum</i> (Kützing) Kützing
<i>Nitzschia</i> sp. 11 A.H. Hassall
<i>Navicula rhynchocephala</i> Kützing
<i>Fragilaria bicapitata</i> A. Mayer
<i>Nitzschia</i> girdle A.H. Hassall
<i>Pinnularia</i> sp 3 C.G. Ehrenberg
<i>Fragilaria tenera</i> (W. Smith) Lange-Bertalot
<i>Eunotia formica</i> Ehrenberg
<i>Gomphonema gracile</i> Ehrenberg
<i>Fragilaria capucina</i> Desmazieres
<i>Pinnularia subcapitata</i> var. <i>elliptica</i> Krasske
<i>Nitzschia palea</i> (Kützing) W. Smith
<i>Nitzschia</i> sp. 10 A.H. Hassall
<i>Nitzschia linearis</i> (Agardh) W.M. Smith
<i>Actinocyclus subtilis</i> (Gregory) Ralfs in Pritchard
<i>Cyclotella meneghiniana</i> Kützing
<i>Tabularia fasciculata</i> (Agardh) Williams et Round
<i>Navicula veneta</i> Kützing
<i>Amphora</i> sp C.G. Ehrenberg ex F.T. Kützing
<i>Navicula</i> sp J.B.M. Bory de St. Vincent
<i>Navicula pupula</i> fo. <i>rostrata</i> Hustedt Hustedt
<i>Achnanthydium saprophilum</i> (Kobayasi & Mayama) Round & Bukhtiyarova
<i>Nitzschia fusiformis</i> Grunow
<i>Eunotia minor</i> (Kützing) Grunow in Van Heurck
<i>Navicula</i> sp 5 J.B.M. Bory de St. Vincent
<i>Eunotia bilunaris</i> Ehrenberg Mills
<i>Diploneis constricta</i> (Grunow) Cleve
<i>Pinnularia</i> sp 5 C.G. Ehrenberg

**Table 22:** Species list from lower Silvermine River wetland arranged in order of dominance

Species list:
<i>Fragilaria bicapitata</i> A. Mayer
<i>Hippodonta capitata</i> Ehrenberg Lange-Bertalot
<i>Gomphonema parvulum</i> (Kützing) Kützing
<i>Fragilaria ulna</i> (Nitzsch.) Lange-Bertalot
<i>Nitzschia palea</i> (Kützing) W. Smith
<i>Nitzschia</i> sp 11 A.H. Hassall
<i>Tabularia fasciculata</i> (Agardh) Williams et Round
<i>Amphora</i> sp. C.G. Ehrenberg ex F.T. Kützing
<i>Navicula veneta</i> Kützing
<i>Fragilaria tenera</i> (W. Smith) Lange-Bertalot
<i>Fragilaria capucina</i> Desmazieres
<i>Planothidium engelbrechtii</i> Cholnoky Round & Bukhtiyarova
<i>Sellaphora pupula</i> (Kützing) Mereschkowsky
<i>Gomphonema parvulum</i> var. <i>subellipticum</i> Cleve
<i>Navicula erifuga</i> (O.F. Müller) Bory
<i>Craticula halophila</i> (Grunow ex Van Heurck) Mann
<i>Nitzschia amphibia</i> Grunow
<i>Cyclotella meneghiniana</i> Kützing

**Table23:** Species list from Burgerspan arranged in order of dominance

Species list:
<i>Nitzschia littoralis</i> Grunow in Cl. & Grunow
<i>Eunotia</i> sp C.G. Ehrenberg
<i>Amphora coffeaeformis</i> (Agardh) Kützing
<i>Gomphonema angustatum</i> (Kützing) Rabenhorst
<i>Navicula</i> sp. J.B.M. Bory de St. Vincent
<i>Nitzschia epiphytica</i> O. Muller
<i>Navicula pusilla</i> W. Smith
<i>Craticula</i> sp A. Grunow
<i>Navicula</i> sp2. J.B.M. Bory de St. Vincent
<i>Fallacia pygmaea</i> Lange-Bertalot
<i>Navicula vitrea</i> (Oestrup) Hustedt
<i>Pinnularia</i> sp C.G. Ehrenberg

**Table 24:** Species list of Witsand pond 7 arranged in order of dominance

Species list:
<i>Cocconeis pediculus</i> Ehrenberg
<i>Lemnicola hungarica</i> (Grunow) Round & Basson
<i>Fragilaria capucina</i> var. <i>capucina</i> Desmazieres
<i>Fragilaria bicapitata</i> A. Mayer
<i>Amphora veneta</i> Kützing
<i>Planothidium engelbrechtii</i> Cholnoky Round & Bukhtiyarova
<i>Navicula pupula</i> Hustedt
<i>Tabularia fasciculata</i> (Agardh) Williams et Round
<i>Fragilaria tenera</i> (W. Smith) Lange-Bertalot
<i>Nitzschia amphibia</i> Grunow
<i>Navicula</i> sp 10. J.B.M. Bory de St. Vincent
<i>Cyclotella meneghiniana</i> Kützing
<i>Nitzschia palea</i> (Kützing) W. Smith
<i>Navicula</i> sp 3 J.B.M. Bory de St. Vincent
<i>Melosira varians</i> Agardh
<i>Gomphonema parvulum</i> (Kützing) Kützing
<i>Navicula cryptocephala</i> Kützing
<i>Martyana atomus</i> (Hustedt) Snoeijs
<i>Pinnularia gibba</i> Ehrenberg

**Table 25:** Species list from Yzerfontein arranged in order of dominance

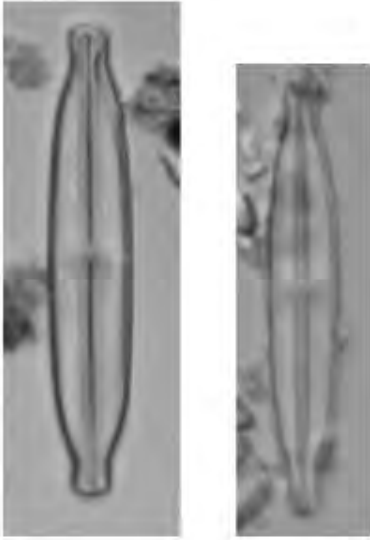
Species list:
<i>Nitzschia littoralis</i> Grunow in Cl. & Grunown.
<i>Nitzschia</i> sp A.H. Hassall
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Achnanthes</i> sp J.B.M. Bory de St. Vincent
<i>Gomphonema minutum</i> Agardh
<i>Rhopalodia</i> sp O. Müller
<i>Nitzschia frustulum</i> A.H. Hassall
<i>Nitzschia</i> sp. A.H. Hassall
<i>Eunotia</i> sp. C.G. Ehrenberg
<i>Hantzschia</i> sp. A. Grunow
<i>Nitzschia</i> sp 5. A.H. Hassall
<i>Amphora coffeaeformis</i> (Agardh) Kützing
<i>Diploneis</i> sp. C.G. Ehrenberg ex P.T. Cleve
<i>Navicula veneta</i> Kützing
<i>Nitzschia microcephala</i> Grunow in Cleve & Moller

**Table26:** Species list from Modder River arranged in order of dominance

Species list:
<i>Planothidium engelbrechtii</i> Cholnoky, Round & Bukhtiyarova
<i>Navicula modica</i> Hustedt
<i>Tabularia fasciculata</i> (Agardh) Williams et Round
<i>Navicula microcari</i> Lange-Bertalot
<i>Fragilaria fasciculata</i> (Agardh) Lange-Bertalot
<i>Synedra commutata</i> Grunow in Cleve & Grunow
<i>Navicula veneta</i> Kützing
<i>Amphora robusta</i> Gregory
<i>Navicula salinarum</i> Grunow in Cleve et Grunow
<i>Navicula phylleptosoma</i> Lange-Bertalot
<i>Nitzschia</i> sp. 4 A.H. Hassall
<i>Entomoneis paludosa</i> (W. Smith) Reimer
<i>Achnanthes</i> sp. J.B.M. Bory de St. Vincent
<i>Craticula vixnegligenda</i> Lange-Bertalot
<i>Suirella</i> sp. P.J.F. Turpin
<i>Nitzschia commutata</i> Grunow in Cleve et Grunow
<i>Nitzschia vitraea</i> var. <i>tenuistriata</i> Manguin ex Kociolek & Reiers
<i>Cyclotella meneghiniana</i> Kützing
<i>Cymatopleura brunii</i> Petit ex Brun

## Appendix 2

## Endemic diatom species of South Africa encountered



1 Figure 1: *Navicula dutoitana* Cholnoky



Figure 2: *Cocconeis engelbrechtii* Cholnoky

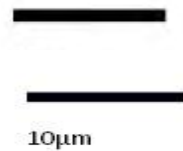
2



Figure 3-4: *Achnanthisdium standerii* (Cholnoky) Taylor, Morales & Ector

3

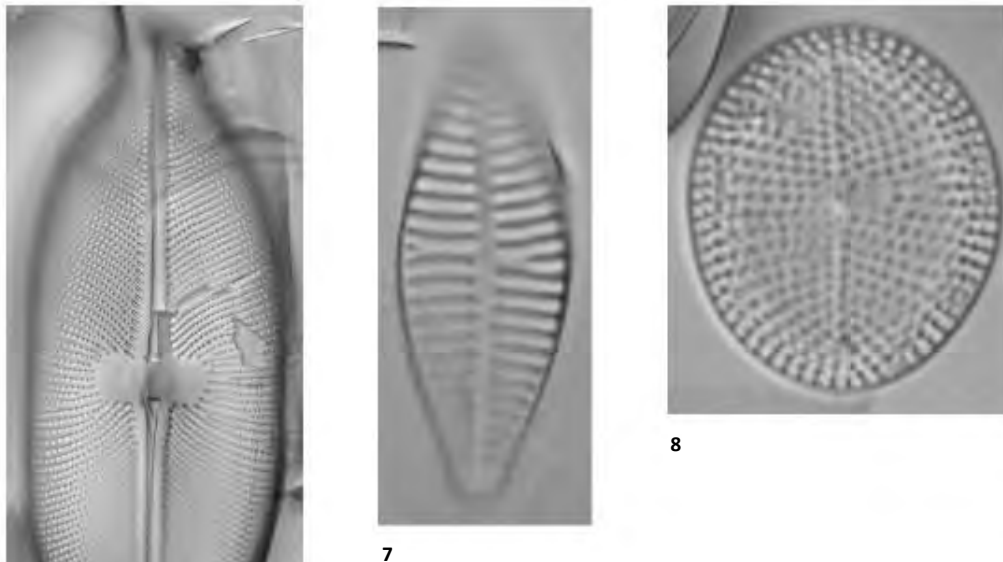
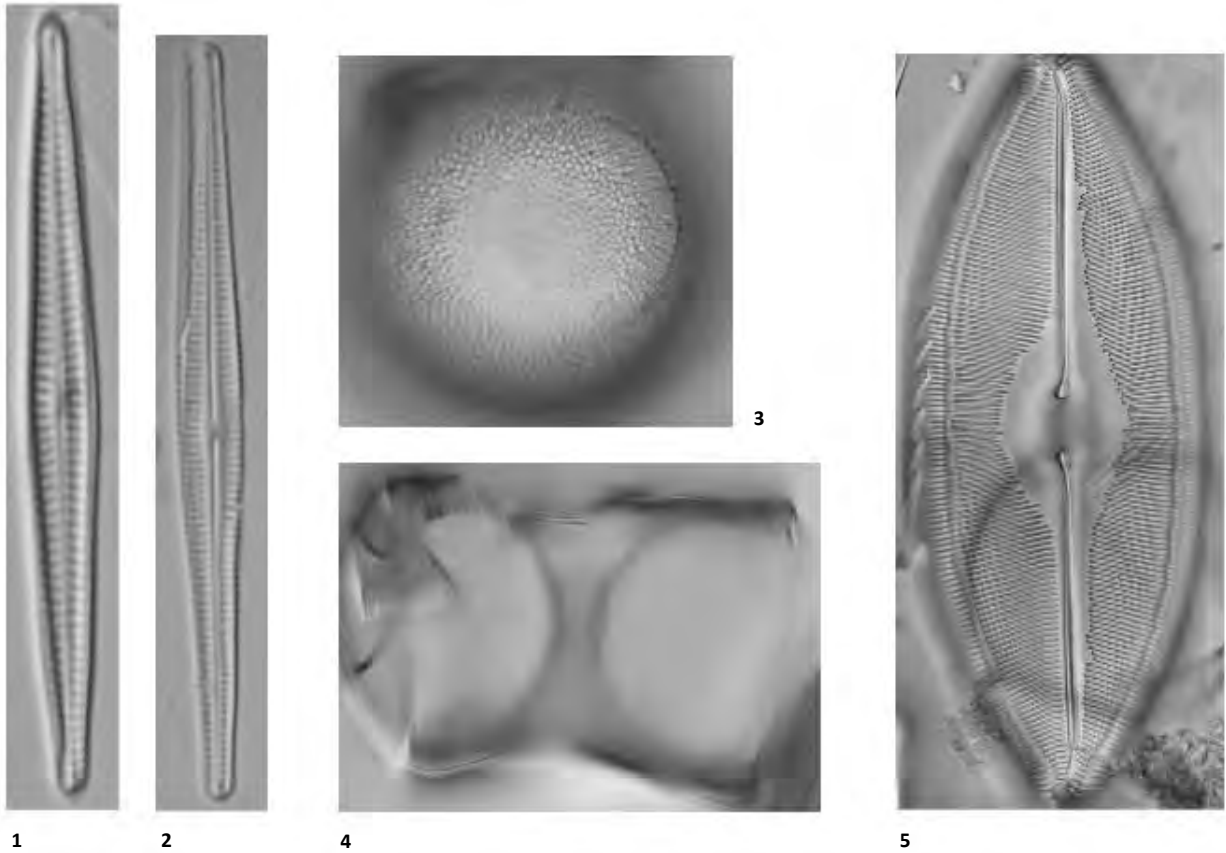
4



10µm

Plate 1

## Diatoms observed in the Western Cape



6

Figure 1-2: *Gomphosphenia oahuensis* (Hustedt) Lange-Bertalot

Figure 3-4: *Melosira nummuloides* (Dilwyn) Agardh

Figure 5: *Caloneis permagna* (Bailey) Cleve

Figure 6: *Navicula humerosa* Brébisson ex W. Smith

Figure 7: *Planothidium* sp. Round & Bukhtiyarova

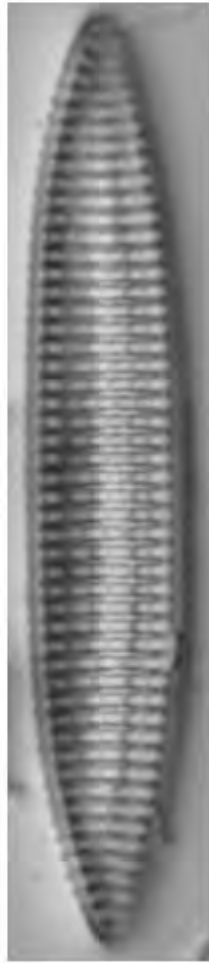
Figure 8: *Cocconeis scutellum* Ehrenberg

10µm

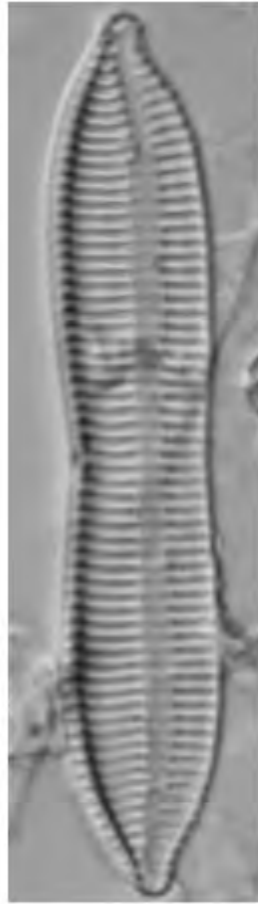
## Diatoms observed in the Western Cape



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3



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6



7

Figure 1: *Haslæ spiculata* (Hickie) Lange-Bertalot

Figure 2: *Tryblionella angustata* Wm. Smith

Figure 3: *Tryblionella apiculata* Gregory

Figure 4: *Bacillaria paradoxa* Gmelin

Figure 5: *Nitzschia* sp. 2

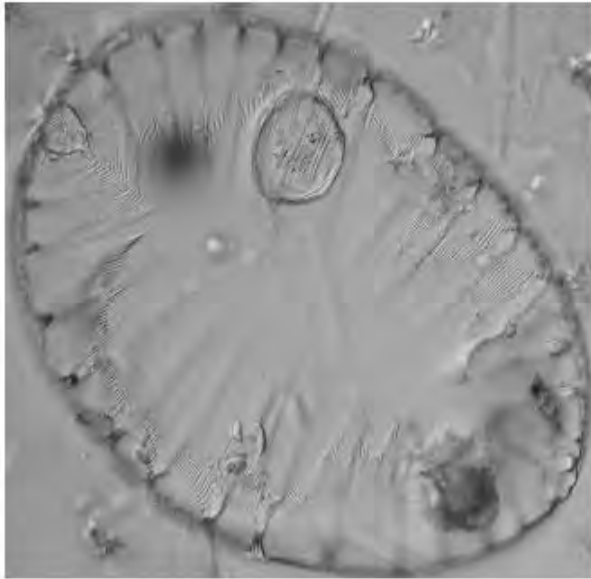
Figure 6: *Nitzschia* sp. 1

Figure 7: *Nitzschia frustulum* (Kützing) Grunow



10µm

## Diatoms observed in the Western Cape



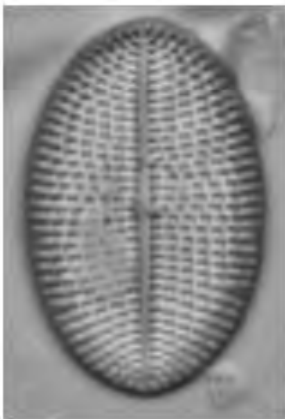
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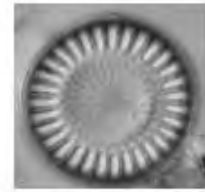
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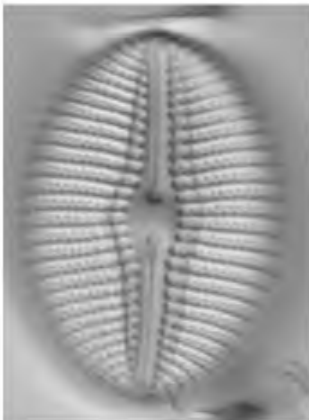
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7



8

Figure 1: *Surirella striatula* Turpin sensu Schmidt

Figure 2: *Surirella* sp. 1

Figure 3: *Planothidium engelbrechtii* (Cholnoky) Round & Bukhtiyarova

Figure 4-5: *Cocconeis placentula* Ehrenberg

Figure 6: *Thalassiosira weissflogii* (Grunow) Fryxell & Hasle

Figure 7: *Cyclotella meneghiniana* Kützing

Figure 8: *Diploneis smithii* (Brébisson) Cleve



10µm

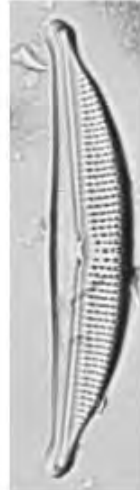
## Diatoms observed in the Western Cape



1



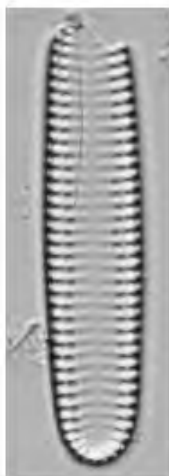
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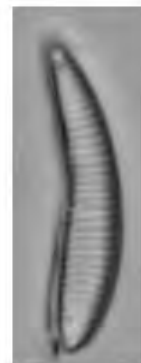
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Figure 1: *Entomoneis paludosa* (W. Smith) Reimer

Figure 2: *Craticula buderi* (Hustedt) Lange-Bertalot


Figure 3: *Amphora coffaeiformis* (Kützing) Cleve

Figure 4: *Rhopalodia gibberula* (Ehrenberg) O. Müller

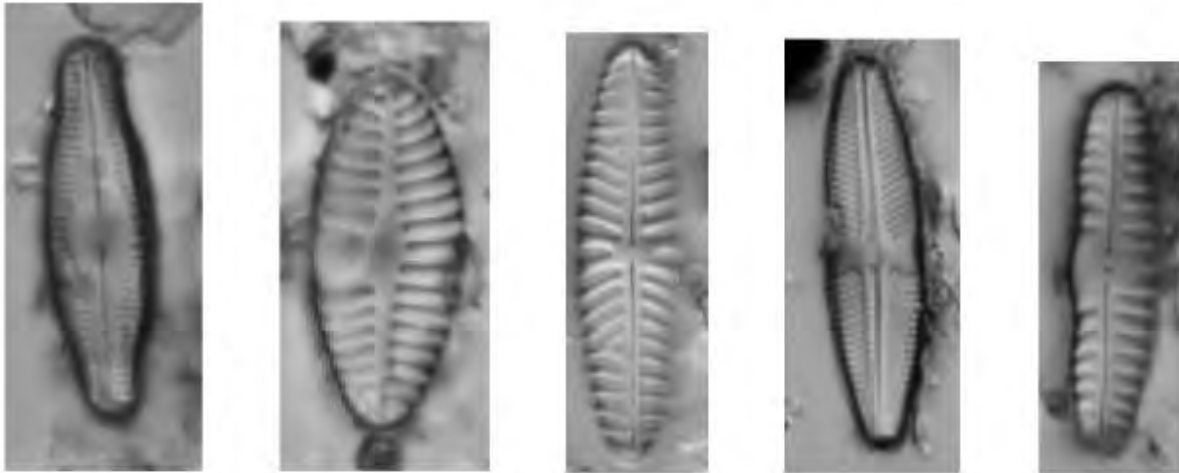
Figure 5-6: Unknown sp.

Figure 7-8: *Aulacoseira granulata* (Ehrenberg) Simonsen

Figure 9-10: *Eunotia tenella* (Grunow) Hustedt

  
 10µm

## Diatoms observed in the Western Cape



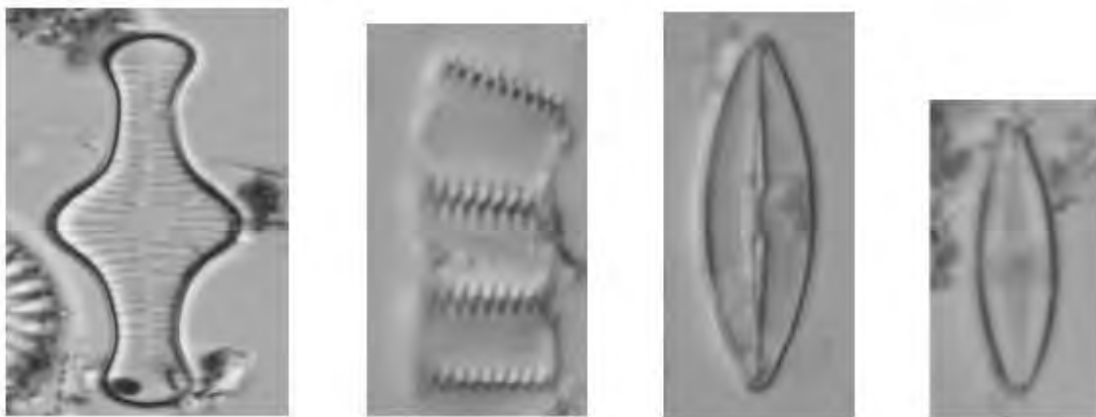
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Figure 1: *Psammothidium altaicum* Bukhtiyarova

Figure 2: *Planothidium lanceolatum* (Brebisson ex Kützing) Lange-Bertalot

Figure 3: *Hippodonta* sp. Lange-Bertalot

Figure 4: *Stauroneis acidocilinata* Lange-Bertalot & Werum

Figure 5: *Reimera sinuate* (Gregory) Kociolek & Stoermer

Figure 6: *Tabellaria flocculosa* (Roth) Kützing

Figure 7: *Staurosira elliptica* (Schumann) Williams & Round

Figure 8: *Microcostatus* sp. Johansen & Sray

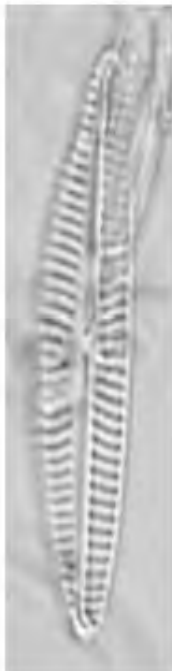
Figure 9: *Microsfissurata* sp.



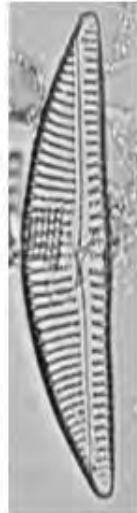
10µm

Plate 6

## Diatoms observed in the Western Cape



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2



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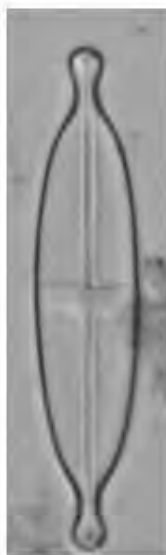
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8



9

Figure 1: *Navicymbula pusilla* Krammer

Figure 2: *Encyonema* sp. F.T. Kützing

Figure 3: *Hantzschia amphioxys* (Ehrenberg) Grunow fo. *capitata* O. Müller

Figure 4: *Amphora commutata* Grunow

Figure 5: *Nitzschia epithemoides* Grunow in Cleve

Figure 6: *Nitzschia littoralis* Grunow in Cleve

Figure 7: *Stauroneis gracilior* (Rabenhorst) Reichardt

Figure 8: *Brachysira brebissonii* Ross in Hartley

Figure 9: *Navicula nivalis* Ehrenberg



10µm

## APPENDIX 3

Table 1: Acronyms for the diatom species illustrated in the Canonical Correspondence Analysis

Species list	Acronyms	Species list	Acronyms
<i>Aulacoseira ambigua</i> (Grunow) Simonsen	AAMB	<i>Luticola goeppertiana</i> (Bleisch in Rabenhorst) D. G. Mann	LGOE
<i>Achnantheidium affine</i> (Grun) Czarnocki	ACAF	<i>Lemnicola hungarica</i> (Grunow) Round & Basson	LHUN
<i>Achnantheidium deflexum</i> (Reimer) Kingston	ACDF	<i>Luticola mutica</i> (Kützing) D. G. Mann	LMUT
<i>Achnantheidium</i> sp. F. T. Kützing	ACHD	<i>Luticola</i> sp. D.G. Mann	LUSP
<i>Achnantheidium standerii</i> (Cholnoky) Taylor	ACHN	<i>Luticola</i> sp (aff. <i>mutica</i> )	LUTS
<i>Amphora coffeaeformis</i> (Agardh) Kützing	ACOF	<i>Mayamaea atomus</i> (Kützing) Lange-Bertalot	MAAT
<i>Achnantheidium crassum</i> (Hustedt) Potapova & Ponader	ADCR	<i>Mastogloia</i> sp. G. H. K. Thwaites ex W. Smith 1856	MAST
<i>Achnantheidium</i> sp. 1	ADCS	<i>Martyana atomus</i> (Hustedt) Snoeijs	MATO
<i>Achnantheidium saphophilum</i> (Kobayasi et Mayama) Round & Bukhtiyarova	ADMI	<i>Microcostatus</i> sp. Johansen & Sray	MCCT
<i>Achnanthes minutissima</i> Kützing	AMIN	<i>Meridion circulare</i> (Greville) C. A. Agardh var. <i>circulare</i>	MCIR
<i>Amphora</i> sp. C. G. Ehrenberg ex F. T. Kützing	AMPH	<i>Muelleria linearis</i> (O. Muller) Frenguelli	MULI
<i>Achnanthes oblongella</i> Oestrup	AOBG	<i>Melosira varians</i> Agardh	MVAR
<i>Amphora oligotrachenta</i> Lange-Bertalot	AOLG	<i>Nitzschia amphibia</i> Grunow	NAMP
<i>Actinocyclus subtilis</i> (Gregory) Ralfs in Pritchard	ASUB	<i>Navicula arvensis</i> Hustedt	NARV
<i>Aulacoseira granulata</i> var. <i>angustissima</i> (O. M.) Sim	AUGA	<i>Navicula</i> sp. 1 J.B.M. Bory de St. Vincent	NASP
<i>Aulacoseira granulata</i> (Ehrenberg) Simonsen	AUGR	<i>Navicula</i> sp. J. B. M. Bory de St. Vincent	NAVI
<i>Amphora veneta</i> Kützing	AVEN	<i>Nitzschia commutatoides</i> Lange-Bertalot	NCMU
<i>Brachysira brébissonii</i> Ross in Hartley	BBRE	<i>Navicula cryptocephala</i> Kützing	NCRY
<i>Caloneis</i> sp. Cleve	CALO	<i>Navicula cryptotenella</i> - type in Kelly	NCTY
<i>Cymbella aspera</i> (Ehrenberg) H. Peragallo	CASP	<i>Nitzschia dissipata</i> (Kützing) Grunow	NDIS
<i>Caloneis bacillum</i> (Grunow) Cleve	CBAC	<i>Neidium productum</i> (W. M. Smith) Cleve	NEPR
<i>Cavinula cocconeiformis</i> (Gregory ex Greville) Mann & Stickle	CCOC	<i>Nitzschia frustulum</i> var. <i>bulnheimiana</i> (Rabenhorst) Grunow	NFBU
<i>Craticula halophila</i> (Grunow ex Van Heurck) Mann	CHAL	<i>Nitzschia filiformis</i> (W. M. Smith) Van Heurck	NFIL
<i>Cymbella helvetica</i> Kützing	CHEL	<i>Nitzschia frustulum</i> (Kützing) Grunow abnormal fo.	NFTE
<i>Cyclotella meneghiniana</i> Kützing	CMEN	<i>Nitzschia fusiformis</i> Grunow	NFUS
<i>Craticula molestiformis</i> (Hustedt) Lange-Bertalot	CMLF	<i>Nitzschia hantzschiana</i> Rabenhorst	NHAN
<i>Caloneis molaris</i> (Grunow) Krammer	CMOL	<i>Nitzschia gracilis</i> Hantzsch	NIGR
<i>Cocconeis placentula</i> Ehrenberg	CPLA	<i>Nitzschia intermedia</i> Hantzsch ex Cleve & Grunow	NINT
<i>Cyclotella stelligera</i> Cleve et Grun (in Van Heurck)	CSTE	<i>Nitzschia pura</i> Hustedt	NIPR
<i>Diadesmis confervacea</i> Kützing	DCOF	<i>Nitzschia</i> sp. A. H. Hassall	NITZ
<i>Diadesmis</i> sp. F.T. Kützing	DDSP	<i>Nitzschia vitrea</i> Norman	NIVI
<i>Delicata krammeri</i> Metzeltin, Lange-Bertalot & Garcia-Rodriguez	DKRM	<i>Nitzschia liebetruthii</i> Rabenhorst	NLBT
<i>Diploneis smithii</i> var. <i>chilensis</i> Hustedt	DSCH	<i>Navicula libonensis</i> Schoeman	NLIB
<i>Diploneis smithii</i> (Brébisson) Cleve	DSMI	<i>Nitzschia linearis</i> (Agardh) W. M. Smith	NLIN
<i>Eunotia bilunaris</i> (Ehrenberg) Mills	EBIL	<i>Nitzschia nana</i> Grunow in Van Heurck	NNAN
<i>Eunotia boreotenuis</i> Norpel-Schempp&Lange-Bertalot	EBOR	<i>Navicula nivalis</i> Ehrenberg	NNIV
<i>Encyonema caespitosum</i> Kützing	ECAE	<i>Nitzschia obtusa</i> W. M. Smith var. Grunow	NOBS
<i>Encyonopsis minuta</i> Krammer & Reichardt	ECPM	<i>Nitzschia palea</i> var. <i>debilis</i> (Kützing) Grunow in	NPAD
<i>Eunotia flexuosa</i> (Brébisson) Kützing	EFLE	<i>Nitzschia palea</i> (Kützing) W. Smith	NPAL
<i>Navicula peregrina</i> (Ehrenberg) Kützing	NPRG	<i>Navicula phylleptosoma</i> Lange-Bertalot	NPHP
<i>Navicula pupula</i> fo. <i>rostrata</i> (Hust.) Hustedt	NPUR		

Table 1: Acronyms for the diatom species illustrated in the Canonical Correspondence Analysis

Species list	Acronyms	Species list	Acronyms
<i>Navicula recens</i> (Lange-Bertalot) Lange-Bertalot	NRCS	<i>Eunotia formica</i> Ehrenberg	EFOR
<i>Navicula rhynchocephala</i> Kützing	NRHY	<i>Eunotia incisa</i> Gregory	EINC
<i>Navicula rostellata</i> Kützing	NROS	<i>Eunotia minor</i> (Kützing) Grunow in Van Heurck	EMIN
<i>Navicula supergregaria</i> Lange-Bertalot & Rumrich	NSGG	<i>Encyonema</i> sp. F. T. Kützing	ENCY
<i>Navicula tripunctata</i> (O. F. M.) Bory	NTTT	<i>Encyonema mesianum</i> (Cholnoky) D. G. Mann	ENME
<i>Navicula veneta</i> Kützing	NVEN	<i>Entomoneis paludosa</i> (W. Smith) Reimer	EPAL
<i>Navicula zanoni</i> Hustedt	NZAN	<i>Eunotia pectinalis</i> (Dyllwyn) Rabenhorst	EPEC
<i>Pinnularia angustiborealis</i> Krammer & Lange-Bertalot	PAGB	<i>Eunotia sudetica</i> var. <i>incisa</i> (Gregory) Manguin	ESIN
<i>Pinnularia acrosphaeria</i> var. <i>undulata</i> (Cleve) Hu	PAUN	<i>Encyonema silesiacum</i> (Bleisch in Rabenhorst) D. G. Mann	ESLE
<i>Pinnularia borealis</i> Ehrenberg	PBOR	<i>Encyonema silesiacum</i> var. <i>latarea</i> Krammer	ESLT
<i>Pinnularia borealis</i> Ehrenberg fo. <i>rectangularis</i> Carlson	PBRT	<i>Eunotia</i> sp. C. G. Ehrenberg	EUNO
<i>Pinnularia divergens</i> W. M. Smith	PDIV	<i>Eunotogramma</i> sp. Weisse	EUTO
<i>Pinnularia dulcicola</i> (Maguin) Van de Vijver & Le Cohu	PDUL	<i>Fragilaria bicapitata</i> A. Mayer	FBIC
<i>Planothidium frequentissimum</i> var. <i>magnum</i> (Straub) Lange-Bertalot	PFMA	<i>Fragilaria brevistriata</i> Grunow (Pseudostaurosira)	FBRE
<i>Pinnularia gibba</i> Ehrenberg	PGIB	<i>Fragilaria capucina</i> Desmazieres	FCAP
<i>Pinnularia intermedia</i> (Lagardh) Cleve var. <i>bryophila</i> Manguin ex Kociolek	PIBR	<i>Fragilaria capucina</i> var. <i>radians</i> (Kützing) Lange-Bertalot	FCRA
<i>Pinnularia</i> sp. C. G. Ehrenberg	PINU	<i>Frustulia crassinervia</i> (Brébisson) Lange-Bertalot et Krammer	FCRS
<i>Pinnularia intermedia</i> (Lagerstedt) Cleve	PITM	<i>Fragilaria construens</i> fo. <i>venter</i> (Ehrenberg) Hustedt	FCVE
<i>Planothidium engelbrechtii</i> (Cholnoky) Round & Bukhtiyarova	PLEN	<i>Frustulia magaliesmontana</i> Cholnoky	FMGL
<i>Planothidium</i> sp. Round & Bukhtiyarova	PLTD	<i>Fragilaria pulchella</i> (Ralfs ex Kützing) Lange-Bertalot (Ctenophora)	FPUL
<i>Pinnularia microstauron</i> var. <i>brébissonii</i> (Kützing) M	PMBR	<i>Fragilaria</i> sp. H. C. Lyngbye	FRAG
<i>Pinnularia microstauron</i> var. <i>rostrata</i> Krammer	PMRO	<i>Frustulia rostrata</i> Hustedt	FROS
<i>Pinnularia obscuriformis</i> Krammer	POBF	<i>Frustulia saxonica</i> Rabenhorst	FSAX
<i>Pinnularia obscura</i> Krasske	POBS	<i>Fragilaria tenera</i> (W. Smith) Lange-Bertalot	FTEN
<i>Pinnularia subbrevistriata</i> Krammer	PSBV	<i>Fragilaria ulna</i> (Nitzsch.) Lange-Bertalot	FULN
<i>Pinnularia subcapitata</i> Gregory	PSCA	<i>Frustulia vulgaris</i> (Thwaites) De Toni	FVUL
<i>Pinnularia subcapitata</i> fo. <i>divergens</i> Hustedt	PSCD	<i>Gomphonema affine</i> Kützing	GAFF
<i>Pinnularia subcapitata</i> var. <i>elongata</i> Krammer	PSEL	<i>Gomphonema exilissimum</i> (Grunow) Lange-Bertalot & Reichardt	GEXL
<i>Pinnularia similiformis</i> Krammer	PSIF	<i>Gomphonema gracile</i> Ehrenberg	GGRA
<i>Pinnularia similis</i> Hustedt	PSIM	<i>Gomphonema minutum</i> (Agardh) Agardh	GMIN
<i>Psammothidium</i> sp. Bukhtiyarova & Round	PSMT	<i>Gomphonema</i> sp. C. G. Ehrenberg	GOMP
<i>Pinnularia viridiformis</i> var. <i>minor</i> Krammer	PVFM	<i>Gomphonema parvulum</i> (Kützing) Kützing	GPAR
<i>Pinnularia viridis</i> var. <i>minor</i> Cleve	PVMI	<i>Gomphonema pumilum</i> var. <i>rigidum</i> Reichardt & Lange-Bertalot	GPRI
<i>Rhoicosphenia abbreviata</i> (C. Agardh) Lange-Bertalot	RABB	<i>Gomphonema parvulum</i> var. <i>subellipticum</i> Cleve	GPSE
<i>Rhopalodia brébissonii</i> Krammer	RBRE	<i>Grammatophora</i> sp. C. G. Ehrenberg	GRAM
<i>Rhopalodia gibberula</i> (Ehrenberg) O. Muller	RGBL	<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow in Cleve et Grunow 1880	HAMP
<i>Rhopalodia gibba</i> (Ehrenberg) O. Muller	RGIB	<i>Hippodonta capitata</i> (Ehrenberg) Lange-Bert. Metzeltin & Witkowski	HICA
<i>Reimeria sinuata</i> (Gregory) Kociolek & Stoermer	RSIN	<i>Hippodonta hungarica</i> (Grunow) Lange-Bertalot Metzeltin & Witkowski	HHUN
<i>Staurosira construens</i> var. <i>venter</i> (Ehrenberg) Hamilton	SCVE	<i>Hippodonta</i> sp. Lange-Bertalot. Metzeltin & Witkowski	HIPO
<i>Staurosira elliptica</i> (Schumann) Williams & Round	SELI	<i>Kobayasiella subtilissima</i> (Cleve) Lange-Bertalot	KOSU
<i>Stauroneis gracillior</i> (Rabenhorst) Reichardt	SGRL	<i>Kobayasiella subtilissima</i> (Cleve) Lange-Bertalot	KSUB
<i>Stauroneis pinnata</i> (Ehrenberg) Williams & Round	SPIN	<i>Stauroneis pseudosuboptusoides</i> Germain	STPO
<i>Sellaphora pupula</i> (Kützing) Mereschkowsky	SPUP	<i>Tabularia fasciculata</i> (Agardh) Williams et Round	TFAS
<i>Ulnaria ulna</i> (Nitzsch.) Compère	UULN	<i>Tabellaria flocculosa</i> (Roth) Kützing	TFLO

**Table 1: Logged environmental data used during the Canonical Correspondence Analysis (CCA)**

Wetland name	EC (mS/m)	pH	Temperature (°C)	Dissolved oxygen (%)	Ammonium (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Turbidity (NTU)
Noordhoek Soutpan	2,356025857	7,24	0,859738566	1,698970004	-1,15490196	-3,826930336	-2,227242413	-1,675698555	0,727541257
Kenilworth Racecourse	1,494154594	6,7	0,826074803	1,113943352	-1,15490196	-2,204525977	-3,15490196	-1,705177345	0,176091259
Rooipan	3,64738297	9,45	0,975431809	2,064457989	-1,15490196	-2,202416723	-3,15490196	-0,857596433	1,386677284
Yzerfontein Soutpan	4,096910013	7,95	0,900367129	2,004321374	-1,15490196	-1,338465958	-3,15490196	-0,870792795	0,718501689
Burgers Pan	4,122543524	7,77	0,890421019	1,994317153	-0,063437995	-1,488229971	-0,692321664	-0,954248628	0,555094449
Kiekoesvlei	1,694605199	7,4	0,86923172	1,913813852	-1,15490196	-2,231119294	-3,15490196	0,066805643	1,976349979
Koekiespan	4,26245109	7,76	0,889861721	1,989004616	-0,281643214	-0,536859365	-0,290246584	-0,690609048	1,58410497
Januariesvlei	2,507855872	7,43	0,870988814	2,004321374	-0,788938235	-1,999007469	-3,331566272	-0,233071825	1,155336037
Modderrivier	2,668385917	7,56	0,878521796	1,944482672	-1,707354024	-3,15490196	-3,15490196	-1,648094154	0,294466226
Witsand Aquifer Rechar	1,747411808	8,06	0,906335042	1,986771734	-1,897588407	-1,153382852	-0,008546171	-0,129271575	0,075546961
Silvermine Dam inflow	0,198657087	4,04	0,606381365	1,949390007	-2,137717923	-2,013199612	-3,15490196	-1,648094154	0,292256071
Silvermine lower	0,597695186	7,67	0,884795364	1,880813592	-1,417046637	-2,288982809	-0,118749474	-1,492428711	0,307496038
Malkopsvlei	1,361727836	6,3	0,799340549	0,995635195	-1,460998048	-3,15490196	-1,322020954	-2,849266059	0,865103975
Groot Rondevlei	1,593286067	6,05	0,781755375	0,977723605	-1,068249868	-1,695475654	-3,15490196	-1,185113955	1,360214613
Groot Witvlei	1,895974732	7,97	0,901458321	0,995635195	-1,046848953	-1,550964648	-3,15490196	-1,210047195	1,197556213
Riversdale	1,380211242	6,3	0,799340549	0,477121255	-1,734824711	-3,15490196	-1,269168647	-2,397940009	0,541579244
Blomfontein	-1,334419009	4,63	0,665580991	1,113943352	-1,616389094	-3,15490196	-0,91900142	-2,397940009	0,745074792

Driehoeks	0,274157849	7,55	0,877946952	1,120573931	-1,627093429	-3,15490196	-1,278312026	-3,444891941	-0,008773924
Sneeuberg Hut	0,591064607	4,77	0,678518379	0,968482949	0,484995014	-3,15490196	-1,38811702	-3,444891941	0,825426118
Hoogvertoon	0,46834733	5,7	0,755874856	0,973127854	-0,974767994	-1,255403709	-2,15490196	-1,297197371	0,079181246
Middleberg Wes	0,309630167	4,9	0,69019608	1,113943352	-1,75520936	-3,15490196	-1,364949155	-1,141695883	-0,22184875
Suurvlakte	0,698970004	4,1	0,612783857	0,982271233	-1,427438564	-3,15490196	-1,268039142	-2,248829601	0,11058971
Wagenbooms River	1,255272505	6,1	0,785329835	1,158362492	-1,489645238	-3,068598884	-0,378862077	-1,790545498	0,77524626
Die Vlakte	1,556302501	6,2	0,792391689	0,903089987	-0,991629201	-1,518581507	-0,145135421	-1,329575169	1,788380515
Verrekker	1,505149978	6,24	0,79518459	0,62324929	-1,628446276	-3,15490196	-0,995564607	-1,010980987	0,838849091
Khayelitsha Pool	1,982271233	6,92	0,840106094	1,045322979	-0,581010463	-0,89033092	-0,29425529	-0,191511169	0,198657087

## Appendix 4

Table 1: Wetland names, substrata and different diatom index scores reflecting the water quality scores of each wetland sampled

Wetland names and substrata	GDI	BDI	%PTV
Die Vlake vegetation	15.6	13.1	10.3
Wagenbooms River vegetation	14.9	15.3	10.7
Hoogvertoon sediment	16.6	15.5	0
Hoogvertoon vegetation	18.3	9.6	0
Sneeuberg Hut Stream sediment	15.2	16	10
Driehoek sediment	15.8	17.6	0
Suurvlakte sediment	18.7	20	2.3
Verrekyker vegetation	13.7	12.5	8.3
Verrekyker floating vegetation	10.7	9.3	25
Verrekyker vegetation (grass)	9.2	11.3	39.3
Verrekyker vegetation (aquatic macrophytes)	10.9	11.6	30.7
Blomfontein sediment	11.8	11.6	18
Malkopsvlei vegetation	15.7	14.3	2
Riversdale sediment	13.5	18,1	26,1
Kleinplaats vegetation	14,3	9,4	5,7
Kleinplaats sediment	13,6	9,8	9,7
Groot Rondevlei sediment	15,1	13,2	4,3
Groot Rondevlei vegetation	15,8	17,4	2
Groot witvlei vegetation	12,9	10,5	5,3
Kenilworth Racecourse sediment	18.7	20	0
Kenilworth Racecourse vegetation	16.5	20	8.6
Silver dam inflow <i>Phragmites</i> sp.	19	20	0
Silver dam lower reeds	10.9	11.8	16.8
Silver dam lower Pariet	9.9	13.3	13.2
Witsand aquifer recharge emergent vegetation.	11.1	11.3	2.9
Witsand aquifer recharge submerged vegetation	11.8	13.9	0.3
Kiekoesvlei sediment	2.3	5.1	65.1
Lake Michelle vegetation	11.5	8.8	13.2
Lake Michelle reeds	14	11.1	11.8
Januariesvlei emergent vegetation	11	13.2	14.2
Januariesvlei submerged vegetation	13.3	15.7	0
Modder River vegetation	12.1	10.2	0.7
Modder River stones	7.1	9.6	33.7
Yzerfontein Soutpan plastic pipe (disturbed site where gypsum occurred)	3	3.5	0
Yzerfontein Soutpan undisturbed site (no mining currently taking place) submerged vegeta	5	3.3	1.3
Yzerfontein Soutpan undisturbed site sediment	8.1	5.9	0.3
Yzerfontein Soutpan sediment disturbed site	3.9	3.6	0
Koekiespan vegetation	8.2	2.2	13.5
Rooipan sediment	11	5.4	0
Burgerspan wooden crate	8.7	7	0
Burgerspan <i>Juncus</i> sp.	8.8	6.8	0.3
Burgerspan sediment	9.2	5.1	0

## Appendix 5

## APPENDIX 5

### Location and description of each wetland

#### Burgers Pan

**Geographic coordinates:** 33° 16' 18.49''S; 18° 19' 27.47''E

**Region:** Darling area, Western Cape.

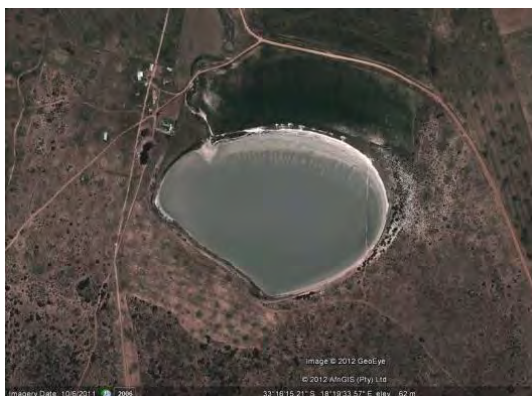
**Date sampled:** 28/8/2012

The descriptions for the following wetland are taken from Malan *et al.*, 2014.

Burgers Pan is an isolated saline depression with a small inflow channel that has been modified due to infilling and excavation. It is situated considerably close to agricultural lands, with approximately 30% of the perimeter of the pan being occupied by cultivated land and the rest by natural veldt.



**Figure 2. 1:** Photos of sampling site at Burgers Pan (left) and visible cultivated fields at the pan (right)  
Photos by Malan H. & Ramukadh, C. (2012).



**Figure 2.2:** Google earth image (2011) of Burgers Pan wetland in the Darling area, Western Cape.

### Januariesvlei (Rondeberg wetland)

**Geographic coordinates:** 33° 26' 33.14"S; 18° 16' 28.58"E

**Region:** West Coast, Western Cape.

**Datesampled:** 29/8/2012

The descriptions for the following wetland are taken from Malan

Januariesvlei is a small permanent open water body which is located very close to sea, with just a dune that separates the wetland from the sea (clearly visible in Google earth image). According to Silberbauer and King (1991), it is part of a linear seepage area that has formed between the coastal dunes and a ridge of ironstone parallel to the shore. There is no inflow or outflow channel and the wetland is most likely fed by inland seepage. The water is dark in colour (tannin-stained) and the water body is surrounded by undisturbed fynbos vegetation.



**Figure 2. 3:** Photos of sampling site Januariesvlei and the visible coastal dune that separates the wetland from the sea. Photos by Malan H. & Ramukadh, C. (2012).



**Figure 2. 4:** Google earth image (2009) of Januariesvlei on the West coast of Western Cape.

## Kenilworth Wetland

**Geographic coordinates:** 33° 59' 54.70"S; 18° 29' 00.10"E

**Region:** Cape Town, Western Cape.

**Date sampled:** 25/07/2012

The descriptions for the following wetland are taken from Malan

This wetland is one of several wetlands (both seasonal and permanent) located within the Kenilworth Racecourse/Youngsfield Military Base area. This wetland is a permanent isolated depression located in the Cape Flats Sand Fynbos vegetation, which is an extremely rare vegetation type. Only ± 70 ha remain globally, with all remnants located within the urban areas of Cape Town (<1% of the original extent is conserved). The area is significant due to the rare flora and endangered amphibian species inhabiting this area.



**Figure 2.5:** Photos of wetland sampled in the Kenilworth site. Photos by Malan H. & Ramukadh, C. (2012).



**Figure 2.6:** Google earth image of Kenilworth racecourse (2011) in Cape Town.

## Kiekoesvlei

**Geographic coordinates:** 33° 15' 45.38"S; 18° 23' 21.62"E

**Region:** Darling area, Western Cape.

**Date sampled:** 28/8/2012

The descriptions for the following wetland are taken from Malan

Kiekoesvlei is an isolated endorheic (inwardly draining) depression located in an agricultural area, near to the town of Darling. There is no obvious inflow channel. This water body is ringed by loamy sand in the terrestrial areas and has clay substrate. It is seasonally inundated (with some years being completely dry) and is dominated by aquatic vegetation.



**Figure 2.7:** Photos of Kiekoesvlei. Photos by Malan H. & Ramukadh, C. (2012).



**Figure 2.8:** Google earth image (2011) of Kiekoesvlei in the Darling area, Western Cape.

## Koekies Pan

**Geographic coordinates:** 33° 14' 09.11"S; 18° 20' 36.55"E

**Region:** Darling area, Western Cape.

**Date sampled:** 28/8/2012

The descriptions for the following wetland are taken from Malan

Koekies Pan is a highly saline, endorheic (inwardly-draining) depression with a single, short drainage line flowing into the system. The drainage line appears to have been separated from the pan by a berm, forming a dammed area. Although several houses, roads and agricultural buildings are present in this zone, there is a narrow buffer of disturbed land between the pan and the cultivated fields. Cultivated lands are immediately adjacent to the channel and the water in the channel (although not sampled) appears to be eutrophic (bright green in colour). Historically, salt was obtained from the pan and evidence of excavations to form shallow pans can be seen. According to the land owner salt is not currently being mined.



**Figure 2.9:** Photos of Koekies Pan. Photos by Malan H. & Ramukadh, C. (2012).



**Figure 2. 10:** Google earth image (2011) Koekeis Pan situated in the Darling area, Western Cape.

## Lake Michelle (“Noordhoek Salt Pan”)

**Geographic coordinates:** 34° 07' 12”S; 18° 22' 41”E

**Region:** Noordhoek, Cape Peninsula.

**Date sampled:** 27/6/2012

The descriptions for the following wetland are taken from Malan

This wetland is part of a larger wetland complex that includes the two open water bodies of Wildevoelwei and the Noordhoek Wetland (Papkuilsvlei). The various wetland areas are interconnected due to the high water table. Lake Michelle is a highly modified permanently inundated depression. The inflow point is east of the Lekkerwater/Pick n’ Pay wetland complex and the outflow to the west into the Noordhoek wetland complex.



**Figure 2.11:** Photos of sampling site 1 (boat house) and site 2 (at the inflow). Photos by Malan H. & Ramukadh, C. (2012).



**Figure 2.12:** Aerial photograph of the Noordhoek wetland and surrounding area (Malan, 2013).

## Rooi Pan

**Geographic coordinates:** 33° 19' 49.88"S; 18° 09' 47.71"E

**Region:** West Coast area, Western Cape.

**Date sampled:** 28/8/2012

The descriptions for the following wetland are taken from Malan

Rooi Pan consists of three isolated shallow saline depressions, aligned linearly from north to south (Figure 2. 14). The pans are in close proximity to the coast ( $\pm 100\text{m}$ ), separated by coastal dunes and no inflow channel is present. The pans are seasonally inundated, although in wet years water does persist in the deepest areas throughout the summer months.



**Figure 2.13:** Photos of Rooi Pan. Photos by Malan H. & Ramukadh, C. (2012).



**Figure 2.14:** Aerial photo of Rooi Pan and Yzerfontein Salt Pan 2010. The town of Yzerfontein is shown in pink (Malan et al in prep).

## Upper Silvermine River

**Geographic coordinates:** 34° 04' 26.13"S; 18° 23' 45.73"E

**Region:** Cape Town, Western Cape.

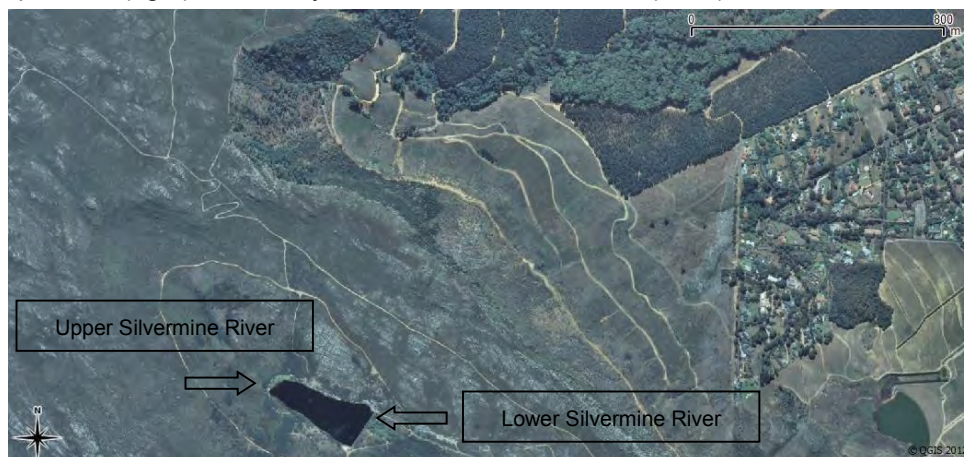
**Dates sampled:** 26/9/2012

The descriptions for the following wetland are taken from Malan

This wetland is a channelled valley bottom wetland and forms part of the Silvermine River, which rises in the mountains of the Cape peninsula and flows to the sea at Fishoek. The wetland is located just above the Silvermine dam. This wetland along with its upper catchment area is situated within the Table Mountain National Park.



**Figure 2.15:** Photos of Silvermine Dam inflow just above the dam (left) and the wetland further upstream (right). Photos by Malan H. & Ramukadh, C. (2012).



**Figure 2.16:** Aerial photos of the Silvermine Dam (2010) in the Western Cape (Malan et al.,2013).

## Lower Silvermine River Wetland

**Geographic coordinates:** 34° 07' 43.89"S; 18° 25' 50.87"E

**Region:** Cape Town, Western Cape.

**Date sampled:** 26/9/2012

The descriptions for the following wetland are taken from Malan

The lower Silvermine River Wetland is upstream of the river mouth at Fishoek. It is an unchannelled valley bottom wetland, the lower part of which has been modified and reconstructed. The assumed (no precise geographical coordinates) sampling site of Silberbauer and King (1991) was about 100m upstream from the bridge, that demarcates the reconstructed site. The stretch of wetland sampled by Silberbauer and King (1991) is now dominated by dense *Phragmites* (reed) stands and free-flowing water could not be accessed in order to take water quality or invertebrate samples. Thus a new sample site was chosen a few meters downstream, just within the rehabilitation area. This area has a pedestrian footbridge over the wetland and is surrounded by houses on either side.



**Figure 2.17:** Photos of the Lower Silvermine River wetland area in the Western Cape.

## Witzand Aquifer Recharge Area

**Geographic coordinates:** 33° 37' 44.72"S; 18° 26' 45.81"E

**Region:** Cape Town, Western Cape.

**Dates sampled:** 29/8/2012

The descriptions for the following wetland are taken from Malan

This permanent man-made wetland (Pond 7), in the Witzand Aquifer Recharge area, is open and collects treated storm-water and domestic effluent from the town of Atlantis. The wetland acts as a collecting point for the water which then seeps into the underlying sand of the Witzand Aquifer. Groundwater is pumped out of this aquifer at several boreholes and is the main supply of water for domestic purposes in Atlantis. The area is recognised as a water catchment area and forms part of the Witzands Aquifer Nature Reserve under the management of the City of Cape Town.



**Figure 2.18:** Photos of Witzand Aquifer Recharge area 2012. Photos by Malan H. & Ramukadh, C. (2012).



**Figure 2.19:** Google earth image (2011) of Pond 7 Witzand Aquifer Recharge area.

## Yzerfontein Salt Pan

**Geographic coordinates:** 33° 19' 01.15"S; 18°11'07.09"E

**Region:** West Coast area, Western Cape.

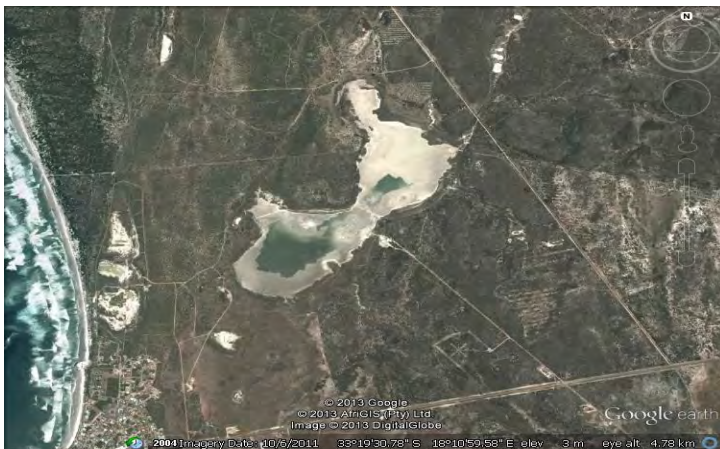
**Dates sampled:** 27/8/2012

The descriptions for the following wetland are taken from Malan

Yzerfontein Salt Pan is a saline depression (part of the paleo-channel of the Berg River), with two seasonal inflows and one outflow. The pan is seasonally to semi-permanently inundated and has sparse patches of vegetation around the edge.



**Figure 2.20:** Photos of Yzerfontein Salt Pan (2012). Photos by Malan H. & Ramukadh, C (2012).



**Figure 2.21:** Google earth image (2011) of the Yzerfontein salt pan and inflow channel, Western Cape.

## Modder River

**Geographic coordinates:** 33° 28' 25.49"S; 18° 22' 29.10"E

**Region:** West Coast area, Western Cape.

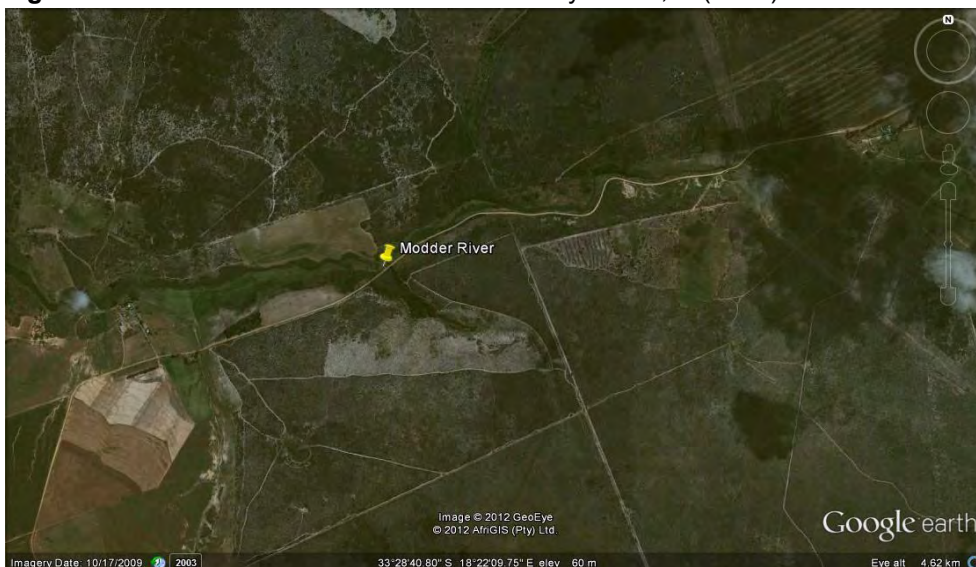
**Dates sampled:** 28/8/2012

The descriptions for the following wetland are taken from Malan

The main-stream Modder River wetland is a channelled, valley bottom wetland. The sampling site is located at the confluence with a second wetland, which is an un-channelled, *Phragmites*-dominated valley bottom wetland. A road crosses the wetland at the point of confluence of the two wetlands. The 1:50 000 map shows the Modder River to be nonperennial. A rocky sill which forms a small waterfall was observed and it appears that the banks of the wetland at the sampling site might have been modified by excavating, although this was difficult to confirm.



**Figure 2. 22:** Photos of Modder River. Photos by Malan, H (2012).



**Figure 2.23:** Google earth image (2009) of the Modder River wetland in the Western Cape.

## Sneeuberg Hut Stream

**Geographic coordinates:** 32° 28' 48.00"S; 19° 10' 04.9"E

**Region:** Cedarberg area, Western Cape.

**Dates sampled:** 6/5/2013

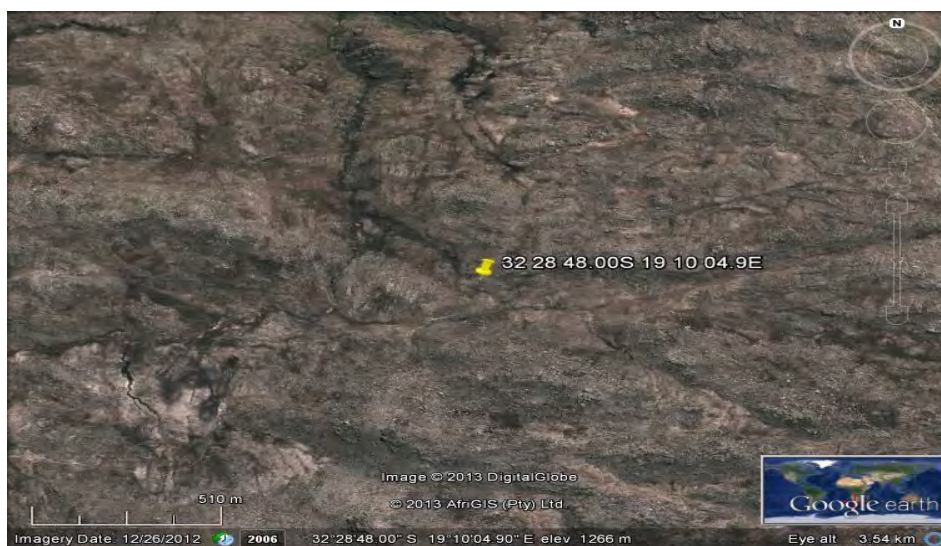
Self-observations were made for this Wetland:

The Sneeuberg Hut stream is located in the Cedarberg. Water seeps from the mountains into the stream. This site did not appear to have been impacted by human activities. The surroundings however indicated that there was a fire earlier that year, since the majority of the vegetation was burnt. The stream was fast flowing with exceptionally clear water. The sample was taken just beside the car trail, beneath a cement bridge.



**Figure 2.24:** Photos of the Sneeuberg Hut Stream in the Cedarberg area, Western Cape

Photos by Malan H. & Ramukadh, C (2013).



**Figure 2.25:** Google earth image (2012) of the Sneeuberg Hut Stream in the Sanddrift area, Western Cape.

## Die Vlakte

**Geographic coordinates:** 33° 14' 35.12"S; 19° 16' 33.99"E

**Region:** Situated +/- 7.1 km from the Witzenberg turnoff towards Tulbach, Western Cape.

**Date sampled:** 6/7/2013

Self-observations were made for this Wetland:

This water body runs along agricultural fields and irrigation takes place. The wetland runs underneath a bridge with a road crossing. Human impacts on this wetland were visible, as it appeared polluted and ill managed.



**Figure 2.26:** Photos of Die Vlakte wetland in, Western Cape. Photos by Malan ,H. (2013).



**Figure 2.27:** Google earth image (2010) of Die Vlakte wetland in the Sanddrif area, Western Cape.

## Wagenbooms River

**Geographic coordinates:** 32° 47' 33.53"S; 19° 14' 49.69"E

**Region:** nearby the Citrusdal area on the R303, Western Cape.

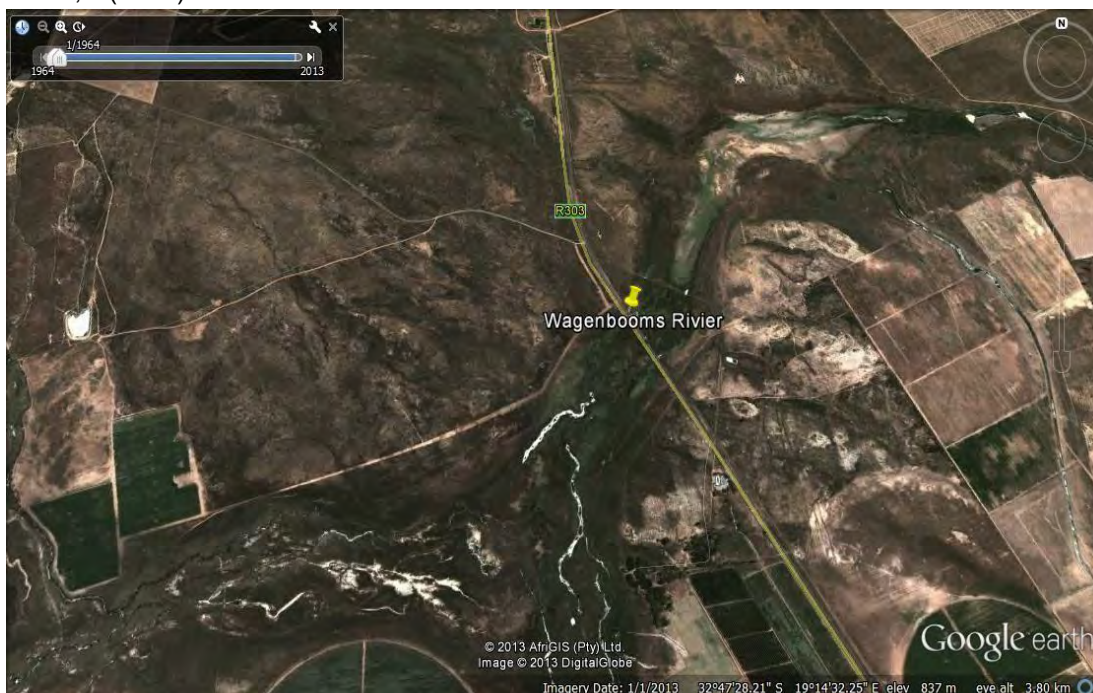
**Dates sampled:** 6/7/2013

Self-observations were made for this Wetland:

This wetland is situated right next to a road. Cow manure was present and indicated that grazing took place.



**Figure 2.28:** Photos of Wagenbooms River in the Western Cape. Photos by Malan, H (2013).



**Figure 2.29:** Google earth image (2013) of Wagensboom River in the Western Cape.

## Verrekyker

**Geographic coordinates:** 33° 26' 10.93"S; 19° 10' 33.21"E

**Region:** Wolseley, Western Cape.

**Date sampled:** 6/8/2013

Self-observations were made for this Wetland:

Verrekyker is situated in the Wolseley area. The water body was mostly dominated by water hyacinths and there were irrigation visible in nearby surrounding areas.



**Figure 2.30:** Photos of Verrekyker in Wolseley area, Western Cape. Photos by Malan, H (2013).



**Figure 2.31:** Google earth image (2013) of Verrekyker wetland in the Wolseley area, Western Cape.

## Kleinplaats

**Geographic coordinates:** 34° 10' 17.32"S; 18° 22' 56.79"E

**Region:** West Coast area, Western Cape.

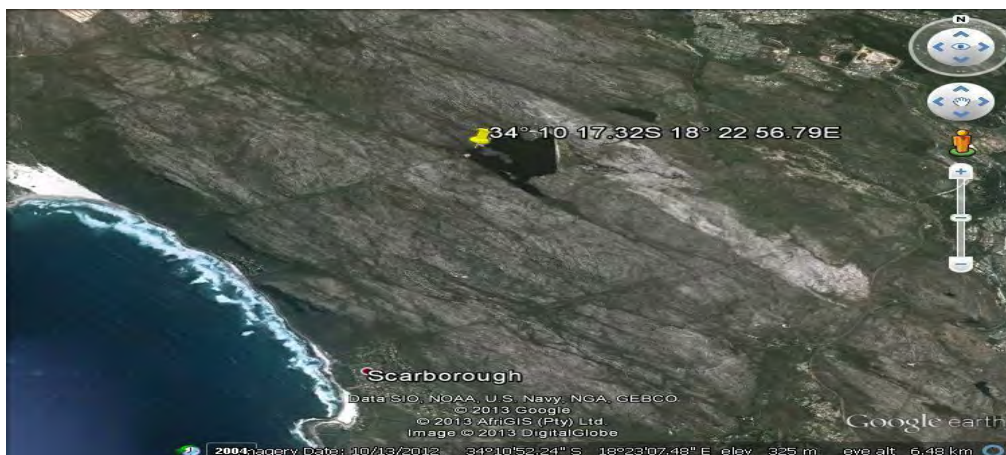
**Dates sampled:** 4/18/2013

The descriptions for the following wetland are taken from Malan *et al.*,2014.

This wetland forms part of The Table Mountain Peninsula National Park and is located just above Simons Town. The mountain seeps flow from the west to the east and a dam was positioned across the seepage area, from which drinking water is abstracted to provide surrounding areas with water. No visual impact of pollution was present, however the surrounding vegetation indicated that there was a fire in this area.



**Figure 2.32:** Photos of Kleinplaats wetland in the Table Mountain peninsula. Photos by Malan, H (2013).



**Figure 2.33:** Google earth image (2012). of sampling site near the Kleinplaats Dam in the Western Cape.

## Blomfontein

**Geographic coordinates:** 32° 26' 07.36"S; 19° 13' 07.03"E

**Region:** Cedarberg, Western Cape.

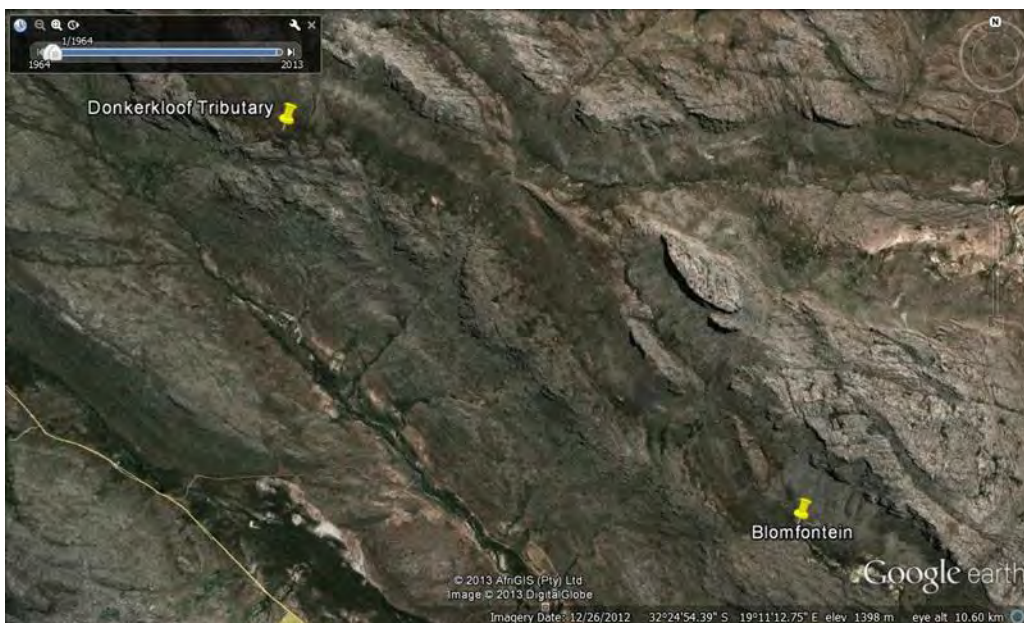
**Date sampled:** 6/4/2013

Self-observations were made for this Wetland:

Blomfontein is located in the Cedarberg. The wetland receives seepage from the Cedarberg Mountains and no human impacts were visible. Water was very clear and snowfalls were recorded on the mountains while sampling.



**Figure 2.34:** Photos of Blomfontein wetland in Cedarberg, Western Cape. Photos by Malan, H (2013).



**Figure 2.35:** Google earth image (2013) of Blomfontein wetland in Cedarberg, Western Cape.

## Driehoek

**Geographic coordinates:** 32° 25' 52.665"S: 19°08'54.66"E

**Region:** Cedarberg, Western Cape.

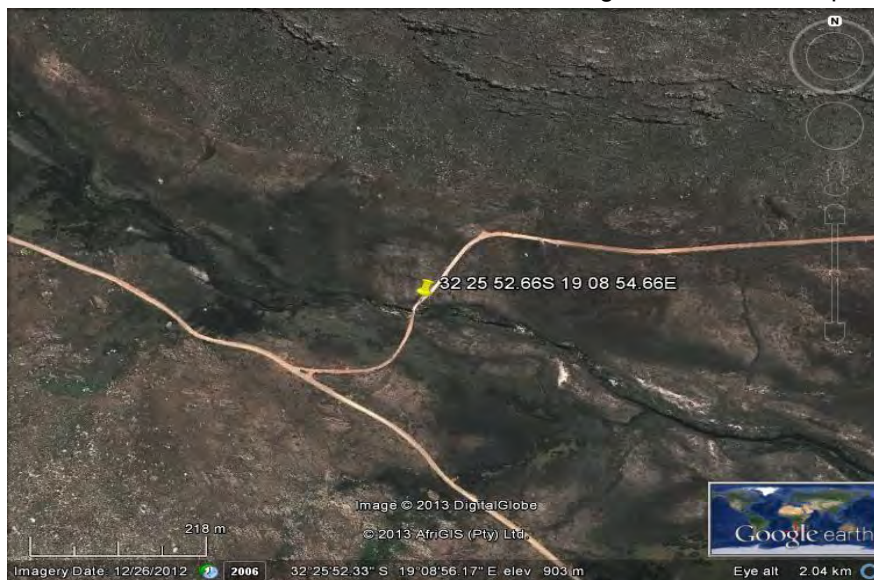
**Date sampled:** 6/4/2013

Self-observations were made for this Wetland:

This wetland is also situated in the Cedarberg; the water is very clear and had a relatively strong flow. The area was mostly dominated with *Isolepis* plants and the stream receives the majority of its water from the mountains. No human impacts were observed at this wetland.



**Figure 2.36:** Photos of Driehoek wetland in the Cedarberg area, Western Cape. Photos by Malan, H. 2013



**Figure 2.37:** Google earth image (2006) of Driehoek wetland in the Sanddrift area, Western Cape.

## Riversdale

**Geographic coordinates:** 34° 3' 40.76"S; 21° 20' 49.28"E

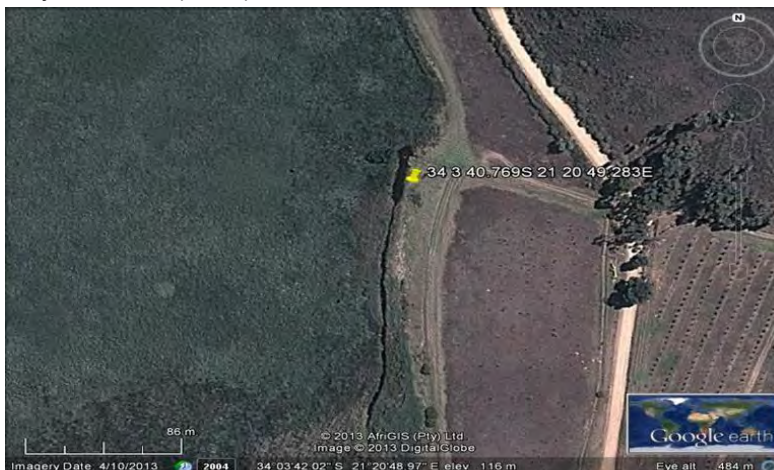
**Region:** Riversdale, Western Cape.

**Date sampled:** 4/29/2013

Riversdale is a very big system that consists of channelled valley- and un-channelled valleybottom wetlands. Samples were taken in a waterhole where the animals usually drink. The vegetation surrounding the wetland included large quantities of grass (*pers.com.* Malan, H., 2013).



**Figure 2.38:** Photos of the sampling sites in the Riversdale wetland system, Western Cape. Photos by Malan, H (2013).



**Figure 2.39:** Google earth image (2013) of Riversdale wetland system, Western Cape.

## Hoogvertoon

**Geographic coordinates:** 32° 28' 21.77"S; 19° 09' 51.94"E

**Region:** Cedarberg, Western Cape.

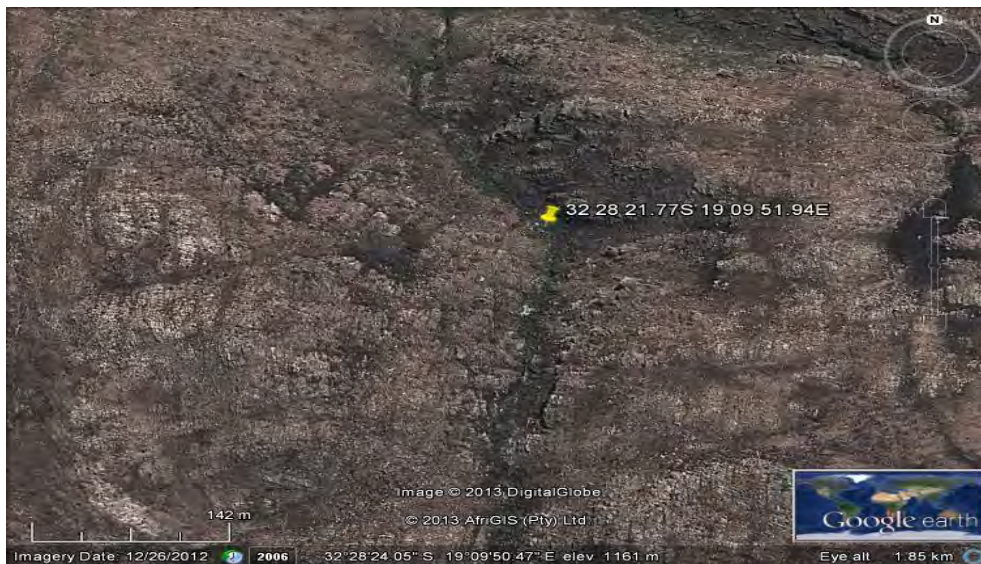
**Date sampled:** 6/5/2013

Self-observations were made for this Wetland:

Hoogvertoon wetland is situated in the Cedarberg. The wetland receives water mainly from mountain seepages. The Hoogvertoon wetland had exceptionally clear water and no human impacts were observed.



**Figure 2.40:** Photos of Hoogvertoon wetland in the Cedarberg area, Western Cape. Photos by Malan, H (2013).



**Figure 2.41:** Google earth image (2012) of Hoogvertoon (2006) wetland in the Sanddrift area, Western Cape.

## Middelburg Wes

**Geographic coordinates:** 32° 21' 10.44"S; 19° 04' 57.38"E

**Region:** Cedarberg area, Western Cape.

**Date sampled:** 6/6/2013

Self-observations were made for this Wetland:

Middelburg Wes is situated in the Cedarberg. The wetland is on top of the mountain ±600m above sea level. The water very clear and direct human consumption of raw water from the streams was possible. The majority of the surrounding vegetation consisted of various grass types. This water body also received mountain seepage.



**Figure 2.42:** Photos of Middelburg Wes wetland in the Cedarberg, Western Cape. Photos by Malan, H (2013).



**Figure 2.43:** Google image of Middelburg Wes (2012) wetland in the Cedarberg, Western Cape.

## Suurvlakte

**Geographic coordinates:** 32° 36' 15.35"S; 19° 12' 13.31"E

**Region:** Situated near the Citrusdal area on the R303 road, Western Cape.

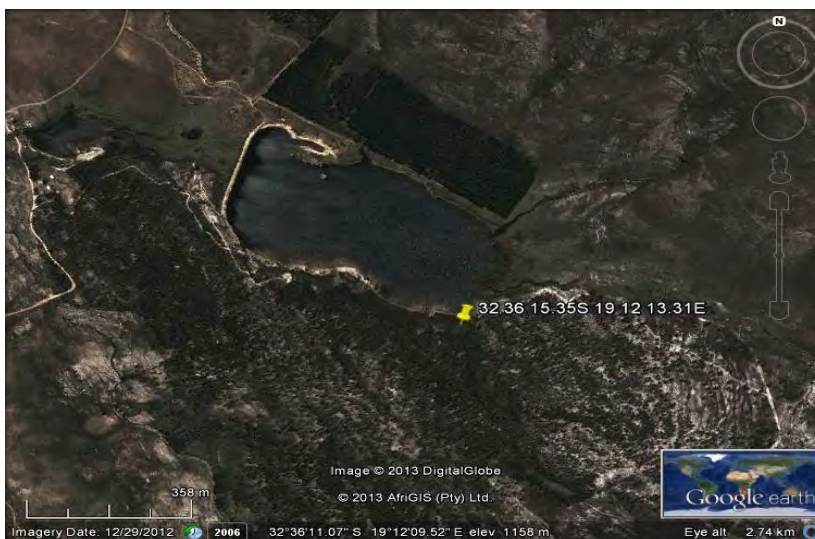
**Date sampled:** 6/7/2013

Self-observations were made for this Wetland:

The Suurvlakte wetland has been developed into a dam. The wetland was surrounded by Pine trees and fynbos which might explain the presence of tannins in the water. Surrounding vegetation for the larger part of the wetland consisted mainly of various grass types.



**Figure 2.44:** Photos of Suurvlakte and the surrounding vegetation. Photos by Malan, H (2013).



**Figure 2.45:** Google earth image (2012) of Suurvlakte dam in the Western Cape.

## Malkopsvlei

**Geographic coordinates:** 34° 21' 22.76"S; 18° 54' 20.83"E

**Region:** Betty's bay area, Western Cape.

**Date sampled:** 4/11/2013

Seepage feeding this wetland comes mostly from mountains in the surrounding areas. The wetland had thick grass growing along the one side. Settlements were recorded around the wetland and algal blooms in the wetland have been previously recorded by house owners within the area (*pers.com. Malan, H.,2013*).



**Figure 2.46:** Photos of Malkopsvlei wetland in the Betty's bay area, Western Cape. Photos by Malan, H. (2013).



**Figure 2.47:** Google earth image (2005) of Malkopsvlei wetland in the Betty's bay area, Western Cape.

## Groot Rondevlei

**Geographic coordinates:** 34° 21' 44.67"S; 18° 52' 48.22"E

**Region:** Betty's bay area, Western Cape.

**Date sampled:** 4/11/2013

This water body receives water from mountain seepages. The majority of vegetation that surrounded the wetland was consists of *Phragmites* species. (*pers.com.* Malan, H.,2013).



**Figure 2.48:** Photos of Groot Rondevlei wetland in the Betty's bay area, Western Cape

Photos by Malan, H (2013).



**Figure 2.49:** Google earth image (2005) of Groot Rondevlei wetland in the Betty's bay area, Western Cape.

## Groot Witvlei

**Geographic coordinates:** 34° 21' 45.81"S; 18° 53' 29.04"E

**Region:** Betty's bay area, Western Cape.

**Date sampled:** 4/11/2013

Groot Witvlei is a shallow depression which is located in the Betty's bay area and receives mountain seepage. A diverse range of vegetation grows around the wetland creating a buffer zone. Groot Rondevlei and Groot Witvlei are in close proximity of each other, yet there was a considerable difference in pH between these sites (*pers.com*. Malan, H,2013).



**Figure 2.50:** Photos of Groot Witvlei wetland in the Betty's bay area, Western Cape. Photos by Malan,H (2013).



**Figure 2.51:** Google earth image (2005) of Groot Witvlei wetland in the Betty's bay area, Western Cape.