C.A.P.E. fine-scale planning project:
AQUATIC ECOSYSTEMS OF THE SANDVELD-SALDANHA PLANNING DOMAIN

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1.0 INTRODUCTION

1.1 Overview

This study forms part of the broader C.A.P.E. Fine-Scale Biodiversity Planning Project, which aims to provide Critical Biodiversity Area Maps and guidelines to inform land-use planning and decision-making by a range of organizations, including the Western Cape Department of Environment Affairs and Development Planning, the Department of Agriculture, and municipalities. The fine-scale biodiversity planning approach adopted for this study is based on systematic conservation planning principles and methods (Margules and Pressey 2000; Roux *et al.* 2006).

An associated report *CAPE Fine-Scale Planning Project: Surface Freshwater Ecosystems Methodology Report* (Snaddon *et al.* 2008) describes in more detail the underlying methodology applied for this study.

A biodiversity assessment was conducted in the Sandveld-Saldanha planning domain (Figure 1) to identify spatial priorities for aquatic ecosystems, namely, rivers, inland wetlands and estuaries. This report presents the biodiversity assessment results. The focus of the fine-scale biodiversity assessment was to identify aquatic priority areas. These priority areas aim to be representative of the freshwater biodiversity of the area and the associated ecosystem processes, with a focus on biodiversity of regional significance.

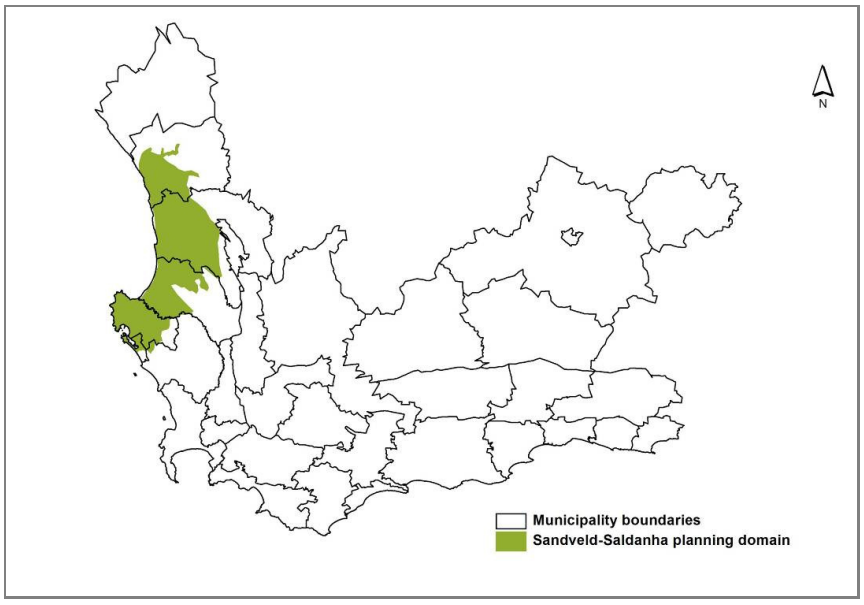

Figure 1 Study area.

1.2 Catchment approach

For management purposes and for the purposes of this report, all wetlands and rivers in the Sandveld-Saldanha planning domain can be grouped firstly by Water Management Area (WMA) (Figure 2), then by quaternary catchment groups.

It is useful to know the WMA within which a site or aquatic system falls, as the Department of Water and Forestry (DWAF) arranges water quality monitoring and water licensing within, and has staff and managers allocated according to WMAs.

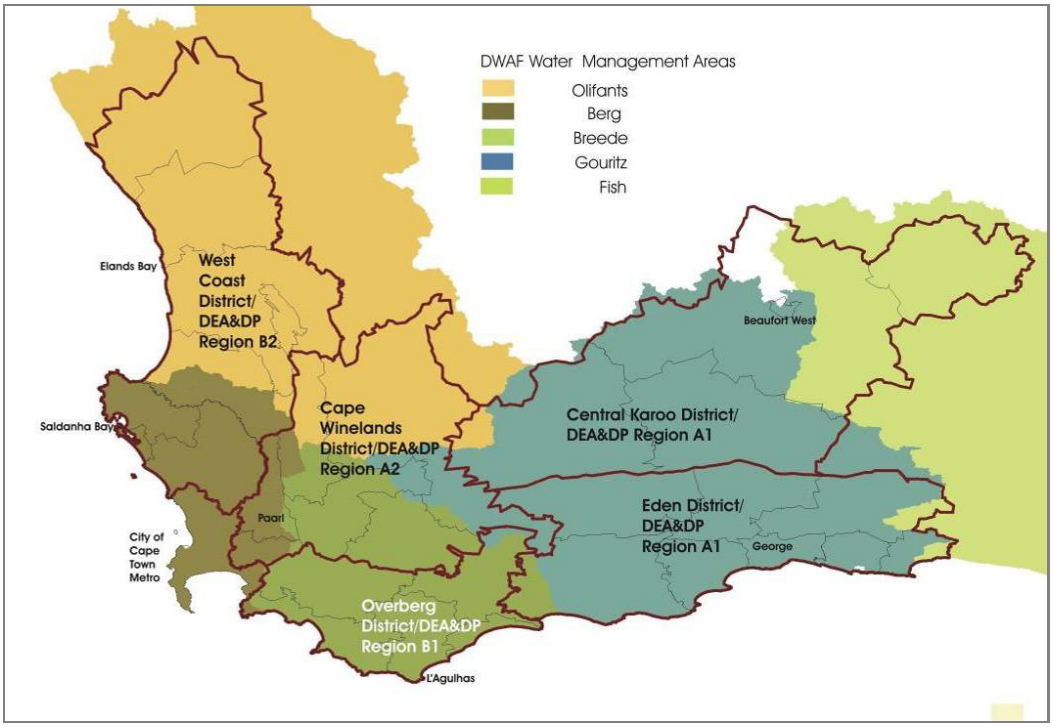

Figure 2 DWAF Water Management Areas and DEA&DP Regions of the Western Cape.

The Sandveld-Saldanha planning domain falls within two WMAs:

- the **Olifants / Doorn WMA**, which includes the
    - Knersvlakte catchments (Figure 3);
    - Sandveld Coast catchments (Rocher Pan, Verlorevlei, Langvlei and Jakkalsvlei) (Figure 4);
    - Olifants River catchments (Figure 5), and

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- Doring River catchments (Figure 6).

- the **Berg River WMA**, which includes the
  - Berg River catchments (Figure 7).

Stakeholders, including conservation agencies, are all urged to develop a catchment planning approach for their implementation strategy. In Figures 3-7 below, quaternary catchments are grouped logically together around major river systems of the region, and broadly follow the groupings used by the River Health Programme. As the "isolated" ecosystems within a catchment may also influence non-isolated systems, either by intercepting overland water runoff (after rain) or via subsurface (groundwater) connections, it makes sense to consider land-use decisions within this grouped quaternary catchment context. Furthermore, this is a useful framework towards holistic management.

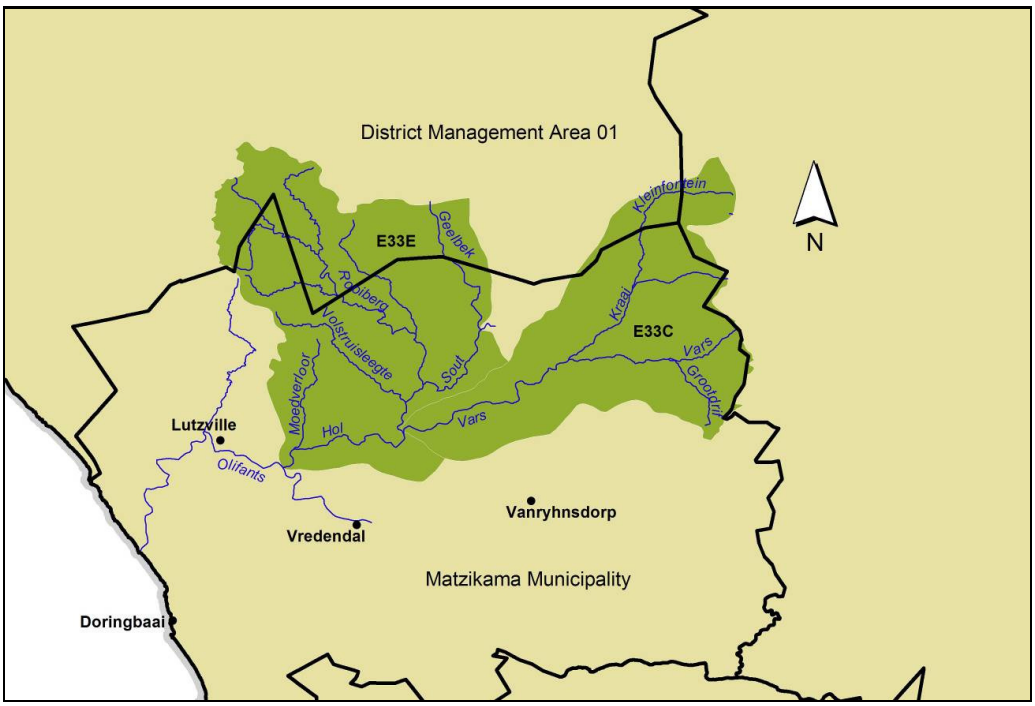

Figure 3 Knersvlakte catchments (Olifants-Doring WMA).

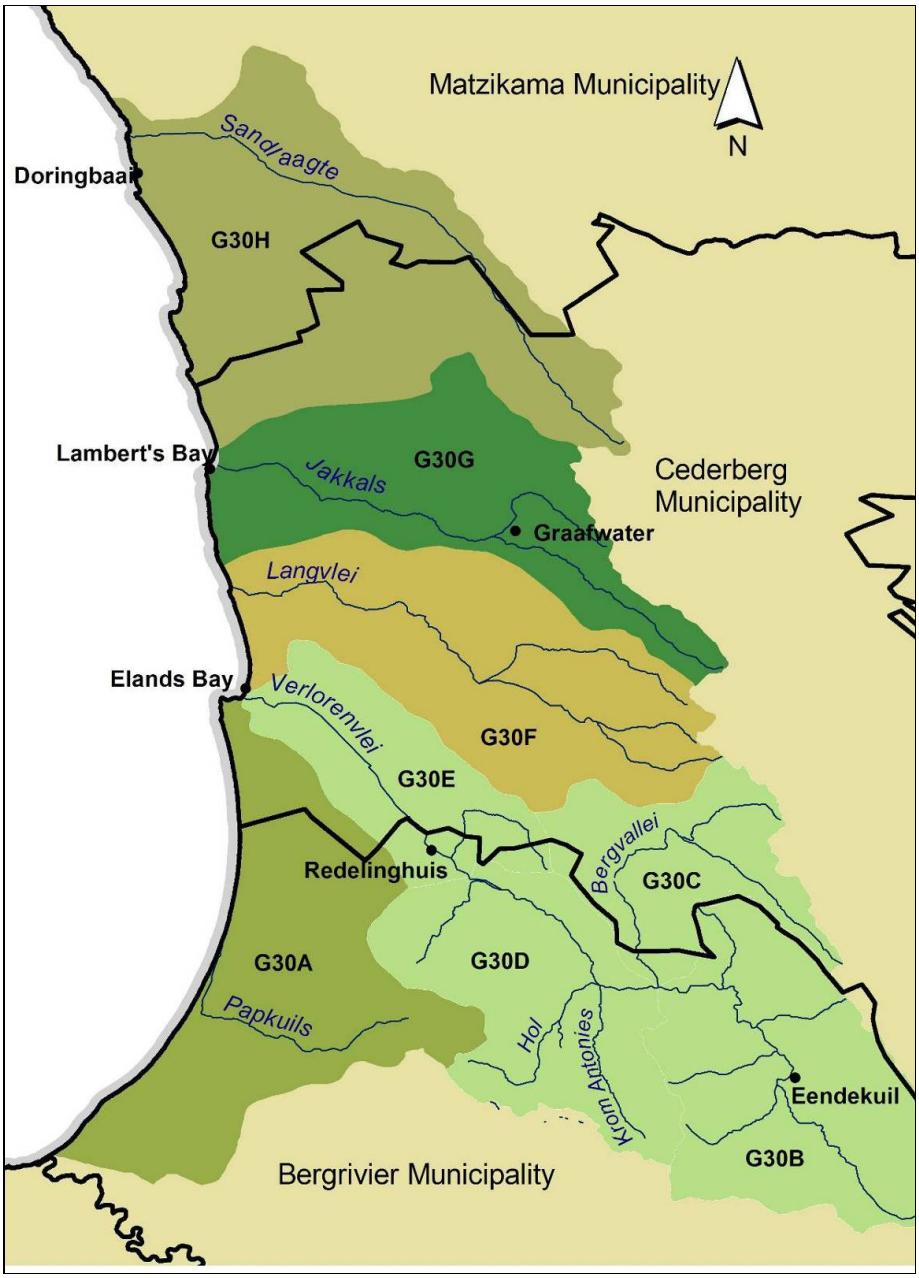

Figure 4 Coastal catchments (Olifants-Doring WMA).

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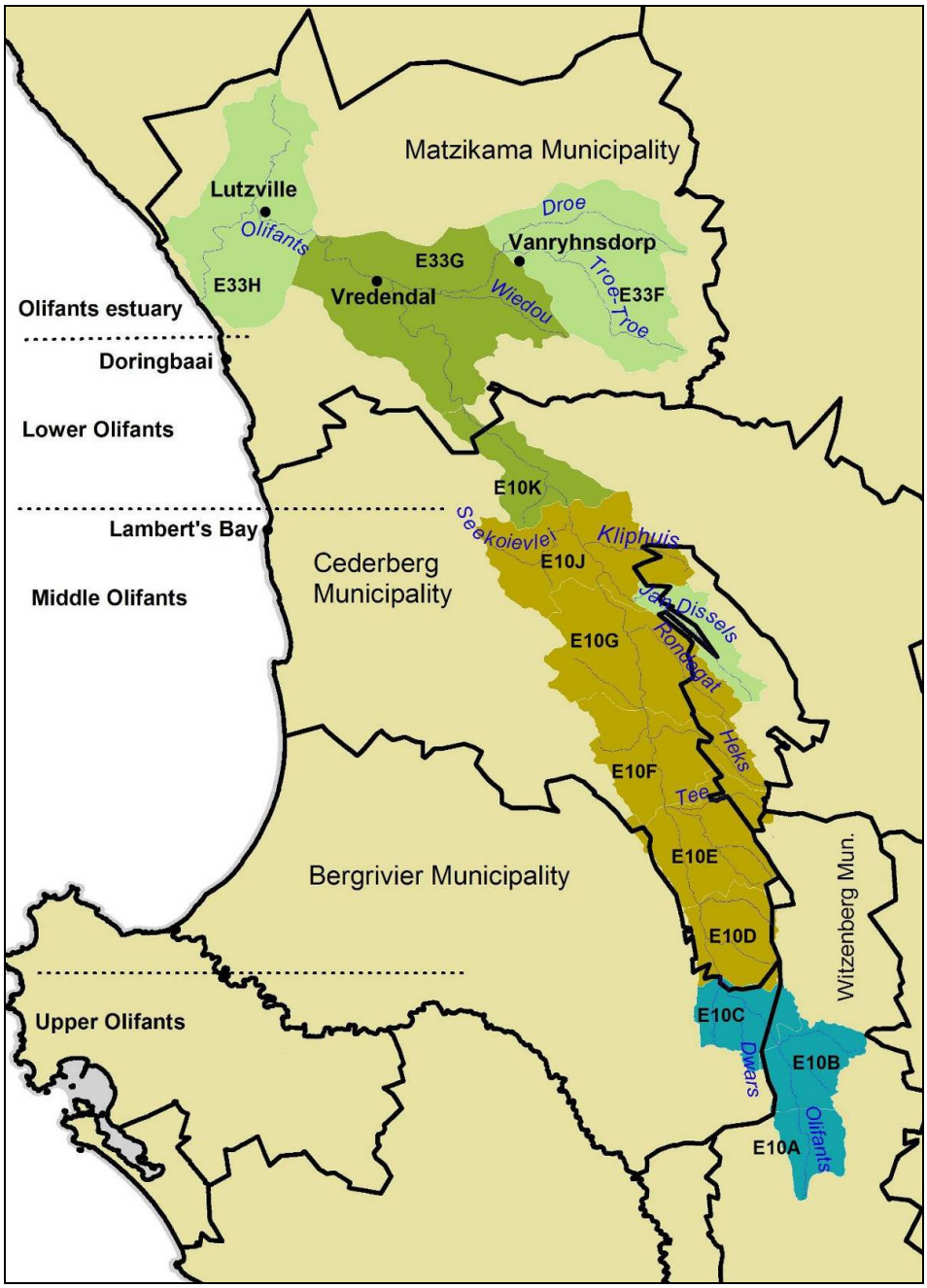

Figure 5 Olifants River catchments (Olifants-Doring WMA).

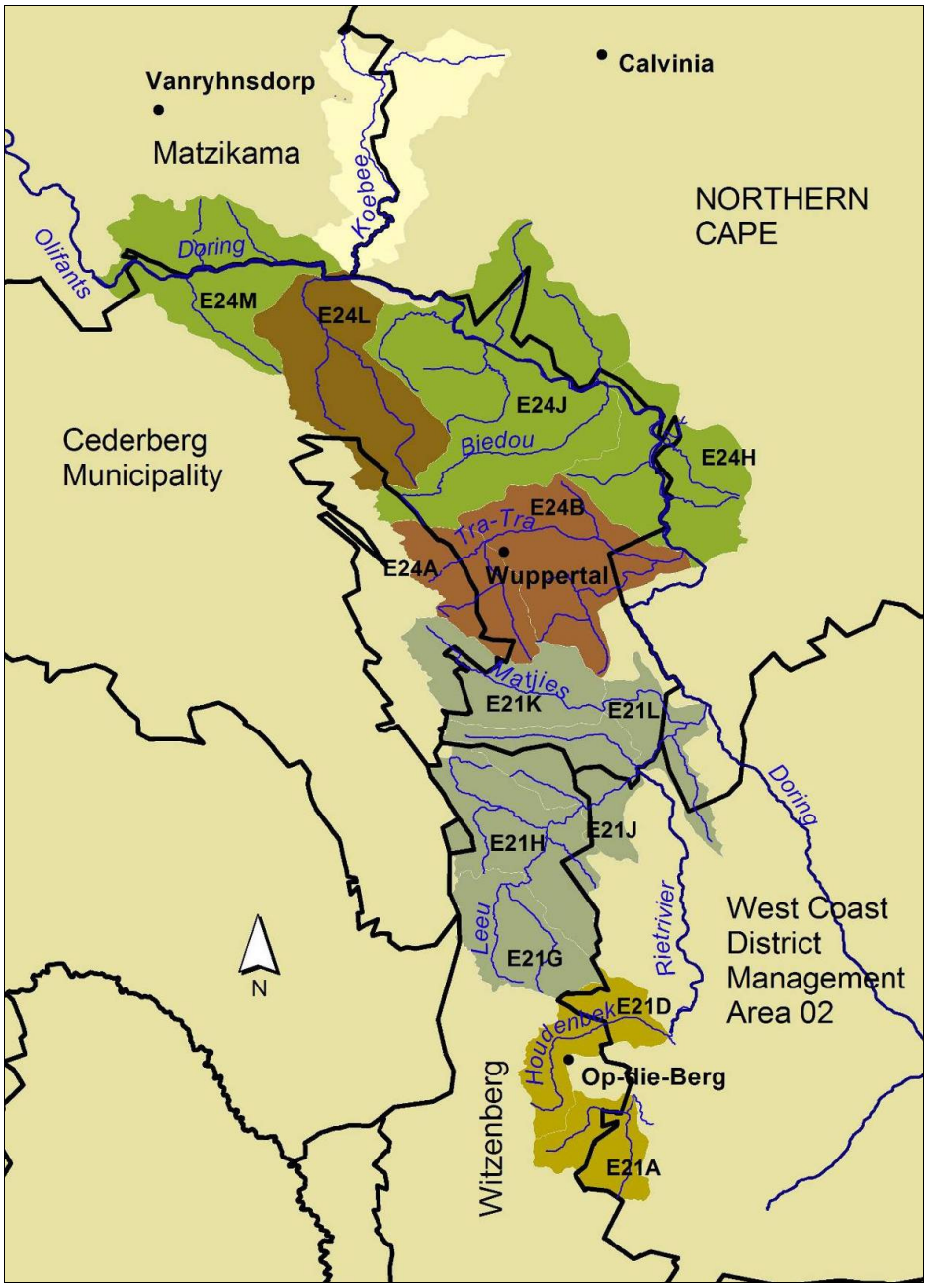

Figure 6 Doring River catchments within the Sandveld-Saldanha planning domain (Olifants-Doring WMA).

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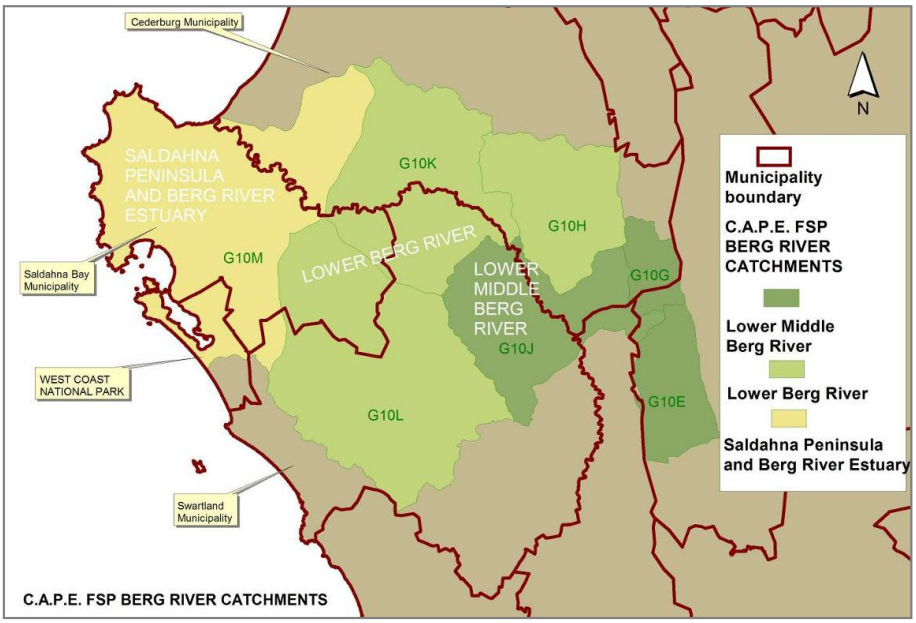

Figure 7 Berg River catchments (Berg River WMA).

A set of smaller sub-catchments has also been mapped for this project, and priority sub-catchments supporting CBA rivers and wetlands have been identified. These are described in Section 2 of this report.

1.3 Categories of aquatic type and importance

All aquatic ecosystems within the study area have been assigned an **ecosystem type** and a **biodiversity priority category**.

1.3.1 Aquatic ecosystem type

The following aquatic ecosystem types, based on function and position in the landscape were identified:

AQUATIC ECOSYSTEM TYPES:
1. FLOODPLAIN WETLANDS
2. VALLEY BOTTOM WETLANDS
3. SEEPS

4. DEPRESSIONAL WETLANDS
5. ESTUARIES
6. MOUNTAIN STREAMS
7. FOOTHILL RIVERS
8. LOWLAND RIVERS
"MANAGEMENT ZONES"
9. WETLAND CLUSTERS
10. SUB-CATCHMENTS

The aquatic ecosystem types were further sub-divided within the above broad types and are described in further detail in Sections 2.3, 3.3 and 4.3 of this report.

The importance of managing aquatic ecosystems within a context of the surrounding contributing and downstream receiving catchments has been emphasised in Section 1.2 above. Two further important management zones (subcatchments and wetland clusters) have been defined and described in this study, in Sections 2.5 and 4.4 of this report. Buffer management zones have also been recommended and have been assigned according to the biodiversity priority category to which the ecosystem has been assigned.

Decisions regarding application of buffer recommendations should include an assessment of the impacts to the ecosystem of the existing and proposed adjacent land use. They should incorporate an understanding of the condition of the aquatic ecosystem and existing and proposed buffers, as well as the role of the system in the broader ecological and human landscape.

In order to apply buffer recommendations in practice (on the ground) and enforce recommendations to keep development outside of wetland or river ecosystems, a wetland delineation/top of river bank determination is required, to determine the boundary of the ecosystem.

1.3.2 Biodiversity priority categories

Biodiversity priority categories were assigned to each aquatic ecosystem and management zone. The priority categories are described below.

Critical Biodiversity Areas (CBAs) are terrestrial and aquatic features in the landscape that are critical for conserving biodiversity and maintaining ecosystem functioning in the long term, particularly in the face of climate change. In terms of surface freshwater ecosystems, aquatic CBAs include the irreplaceable, in terms of meeting biodiversity pattern targets, and best condition wetlands, estuaries and river reaches, representative of the full set of types in the region. These also include sub-catchments, considered to be critical for achieving river or wetland type targets, or containing rivers important as fish sanctuaries. To a certain extent, CBAs also include some ecosystems required for the persistence of species, e.g. fish spawning areas.

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Wetlands were categorised as CBAs if they are:

- Required to meet the wetland conservation threshold of 24% for all wetland types;
- A significant wetland cluster (see Section 4.4);
- An estuary;
- Known habitat for Red Data Book listed hydrophytic plant species, or
- Known habitat for focal amphibian species.

River reaches were categorised as CBAs if they are:

- Required to meet target of 20% of each river type;
- Rivers of high integrity (A, AB and B classes) (i.e. considered irreplaceable), or
- Considered to be an important fish sanctuary.

Sub-catchments were selected as CBA or priority sub-catchments if they are:

- Required for achieving river or wetland type conservation targets, or
- Include rivers considered to be important fish sanctuaries.

Critical Ecological Support Areas (CESAs) are supporting areas required for preventing degradation of CBAs and protected areas. These are freshwater ecosystems required in order to meet ecological process targets, or which are required in order to meet persistence objectives. Importantly, these include all buffer areas around CBAs, required for the protection of the aquatic CBAs.

Wetlands were categorised as CESAs if they are:

- The remaining (non-CBA) significant wetland clusters;
- Supporting a CBA river, wetland or estuary, or
- Good condition wetlands in CBA or CESA sub-catchments.

River reaches were categorised as CESAs if they:

- Are important for connectivity between CBA river reaches;
- Are major rivers that support a CBA river segment or wetland, or
- Are minor rivers that are situated within a CBA or priority sub-catchment.

Sub-catchments were categorised as CESAs if they support a CBA river or wetland or contain CESA river reaches.

Other Ecological Support Areas (OESAs) include all remaining (i.e. non-CBA and non-CESA) wetlands and rivers. These are essentially supporting areas required for preventing the degradation of CBAs and CESAs, or those ecosystems requiring at most moderate protection (based on its low to moderate functional importance and sensitivity).

Also included as OESAs are sub-catchments that are:

- Significant groundwater recharge and discharge sites;
- Upstream management zones, or
- Required for connecting sub-catchments for fish movement / refuge.

A major value of systematic assessments lies not only in the identification of priority areas, but also in the mechanism they provide for stakeholder collaboration around conservation action. Providing such a mechanism for collaboration is immensely important in conserving freshwater ecosystems, which can be considered one of the greatest governance challenges faced by modern societies, since water affects every activity of human society and everyone needs to be part of the solutions for conserving freshwater ecosystems (Nel *et al.* 2006).

The areas identified as aquatic CBAs and CESAs are mostly not intended as formal protected areas. Rather, they reflect areas that need to be managed appropriately to conserve the full spectrum of freshwater biodiversity for both present and future generations. Identification of these areas alone is not enough to catalyse conservation action. Spatial priorities need to be coupled to an implementation strategy developed in collaboration with the key stakeholders in the area (Driver *et al.* 2003, Knight *et al.* 2006, Nel *et al.* 2006). Stakeholders, including conservation agencies, are all urged to develop a catchment planning approach for their implementation strategy.

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2.0 BIODIVERSITY ASSESSMENT RESULTS - RIVERS

2.1 Overview

The main river systems of the Sandveld-Saldanha planning domain include:

- The Berg River and tributaries,
- The Olifants River and tributaries,
- The lower Doring River and tributaries (the Doring River is also a major tributary to the Olifants River), and
- Several coastal rivers of the Sandveld, namely the Papkuils River (ends in Rocher Pan), Verlorenvlei River and tributaries, Langvlei River (ends in Wadrif Pan) and the Jakkals River and tributaries.

2.2 Base data for river conservation assessment

The biodiversity assessment of rivers for this project was undertaken using the 1:500 000 rivers DWAF GIS layer.

This GIS layer was supplemented with 15 additional rivers in the Sandveld-Saldanha planning domain, added from the 1:50 000 rivers GIS layer. These finer-scale rivers were added mainly to increase the options of representing certain river types in intact smaller river systems, particularly where larger rivers are heavily utilized and largely degraded.

An associated report *CAPE Fine-Scale Planning Project: Surface Freshwater Ecosystems Methodology Report* (Snaddon *et al.* 2008) describes in more detail the underlying methodology of preparing the base data for this study.

2.3 River (channel) types

Rivers of the Sandveld-Saldanha planning domain were classified according to:

- Flow variability (permanent or non-permanent flow),
- Level 2 ecoregion (after Kleynhans *et al.*, 2005), and
- Geomorphological zone according to Rowntree and Wadeson (1999), which were subsequently lumped into four classes:
    - mountain streams (mountain headwater streams and mountain stream);
    - upper foothills (transitional zones and upper foothills);
    - lower foothills; and
    - lowland rivers.

Flow variability

An indication of the permanence of each river system was derived from the 1:50,000 Surveyor General maps. "Perennial" tends to describe both permanently and seasonally flowing rivers (e.g. the Olifants and Doring rivers respectively), whereas "Non-perennial" tends to describe those systems with flashy flow regimes (i.e. flow during, and for a short while after, storm events) (e.g. tributaries of the Berg River).

Ecoregions

Four of the 31 Level 1 ecoregions in South Africa occur in the Sandveld-Saldanha domain, and these are further divided into 13 Level 2 ecoregions (Table 1, Figure 8), which have yet to be described.

Table 1 Descriptions of the Level 1 and 2 ecoregions that occur in the Sandveld – Saldanha planning domain (after Kleynhans *et al.*, 2005).

Name	Level 1 ecoregion	Level 2 ecoregions	Description
Great Karoo	21	21.1, 21.2	Characterised by plains with low to moderate relief, although significant areas contain closed hills and mountains with moderate to high relief. Vegetation consists of a diversity of Nama Karoo, Succulent Karoo, Renosterveld and thicket types, but the dominant types are Central Nama Karoo and Great Nama Karoo. • Mean annual precipitation: Arid to low • Coefficient of variation of annual precipitation: High but very high in areas • Drainage density: Varies from low to medium to high • Stream frequency: Low/medium, medium/high to high • Slopes <5%: Varies from <20% to >80% • Median annual simulated runoff: Very low to low • Mean annual temperature: Moderate to moderately high
Western Folded Mountains	23	23.1, 23.2, 23.3, 23.4	Closed hills and mountains with moderate to high relief are distinctive in this area, although tablelands and plains are present. Prominent escarpments occur along the east and north west of the region. Mountain fynbos is the dominant vegetation type. The Olifants and Breede rivers both have their source in this region. • Mean annual precipitation: Varies from moderate/high in the south to low in the north • Coefficient of variation of annual precipitation: Mostly high • Drainage density: Low to medium • Stream frequency: Mostly medium/high but low/medium in patches • Slopes <5%: <20% but >80% in limited areas • Median annual simulated runoff: Very high in the south to moderate/low in the north • Mean annual temperature: Moderate/low to moderate high
South Western Coastal Belt	24	24.1, 24.2, 24.3, 24.4, 24.5	Plains with a moderate to low relief are characteristic of the region, with altitude varying from sea level to 900 mAMSL. The dominant vegetation type is West Coast Renosterveld, although significant areas of fynbos, succulent Karoo and thicket are also found in this region. The Berg River flows through this region. • Mean annual precipitation: Moderate in a limited area in the south, decreasing to low in the north. • Coefficient of variation of annual precipitation: Moderate/high in the north with a restricted area being low in the south. • Drainage density: Low. • Stream frequency: Low/medium. • Slopes <5%: Predominantly >80%.

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Name	Level 1 ecoregion	Level 2 ecoregions	Description
			• Median annual simulated runoff: Very low in the north to moderate/high in the south. • Mean annual temperature: Moderate/high.
Western Coastal Belt	25	25.1, 25.2	Plains with low and moderate relief are typical of this region, with altitude varying from sea level to 700 mAMSL. Vegetation types consist of succulent Karoo types. The lower Olifants River, and the Doring and Sout rivers traverse this region. • Mean annual precipitation: Very low/arid. • Coefficient of variation of annual precipitation: High to very high. • Drainage density: Low. • Stream frequency: Low/medium. • Slopes <5%: >80%. • Median annual simulated runoff: Very low. • Mean annual temperature: Moderate/high.

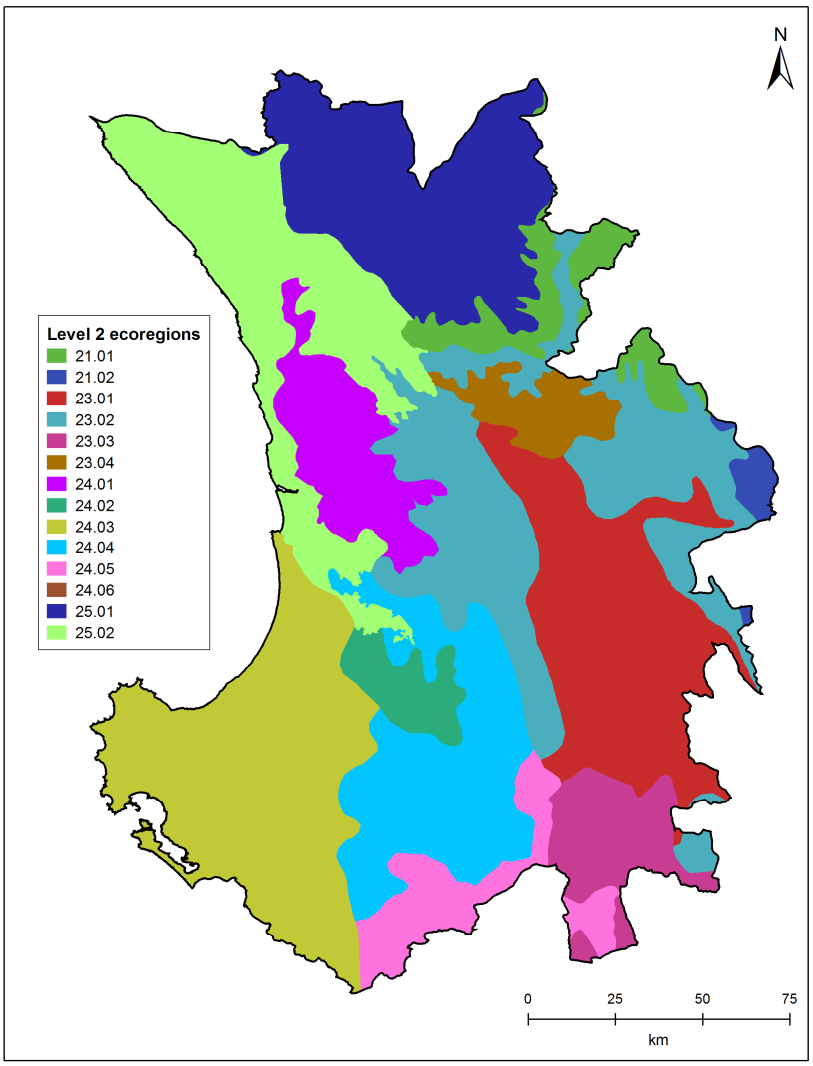

Figure 8 Level 2 ecoregions for the Sandveld-Saldanha planning domain.

Geomorphological zone

River reaches were divided into geomorphological zones using slope gradients recommended by Rowntree and Wadeson (1999):

Longitudinal Zone	Characteristic Channel Types	Slope
Source zone	Low gradient, upland plateau or upland basin able to store water. Spongy or peaty hydromorphic soils.	Not specified
Mountain Headwater	A very steep gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order.	> 0.1

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Longitudinal Zone	Characteristic Channel Types	Slope
stream	Reach types include bedrock fall and cascades.	
Mountain stream	Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock fall, step-pool. Approximate equal distribution of 'vertical' and 'horizontal' flow components.	0.04 - 0.99
Transitional	Moderately steep stream dominated by bedrock or boulder. Reach types include plain-bed, pool rapid or pool riffle. Confined or semi-confined valley floor with limited flood plain development.	0.02 - 0.039
Upper Foothills	Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow flood plain of sand, gravel or cobble often present.	0.005 - 0.019
Lower Foothills	Lower gradient mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Reach types typically include pool- riffle or pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Flood plain often present.	0.001 - 0.005
Lowland river	Low gradient alluvial fine bed channel, typically regime reach type. May be confined, but fully developed meandering pattern within a distinct flood plain develops in unconfined reaches where there is an increased silt content in bed or banks.	0.0001- 0.001

The above geomorphological zones were subsequently lumped into four classes:

- mountain streams (mountain headwater streams and mountain stream);
- upper foothills (transitional zones and upper foothills);
- lower foothills; and
- lowland rivers.

Results

Combining the above descriptions for each river resulted in the description of 78 river types in the Sandveld – Saldanha planning domain (Figure 9), with each river type representing a group with broadly similar flow, similar surrounding landscape characteristics, similar sediment transport characteristics and supporting broadly similar biota.

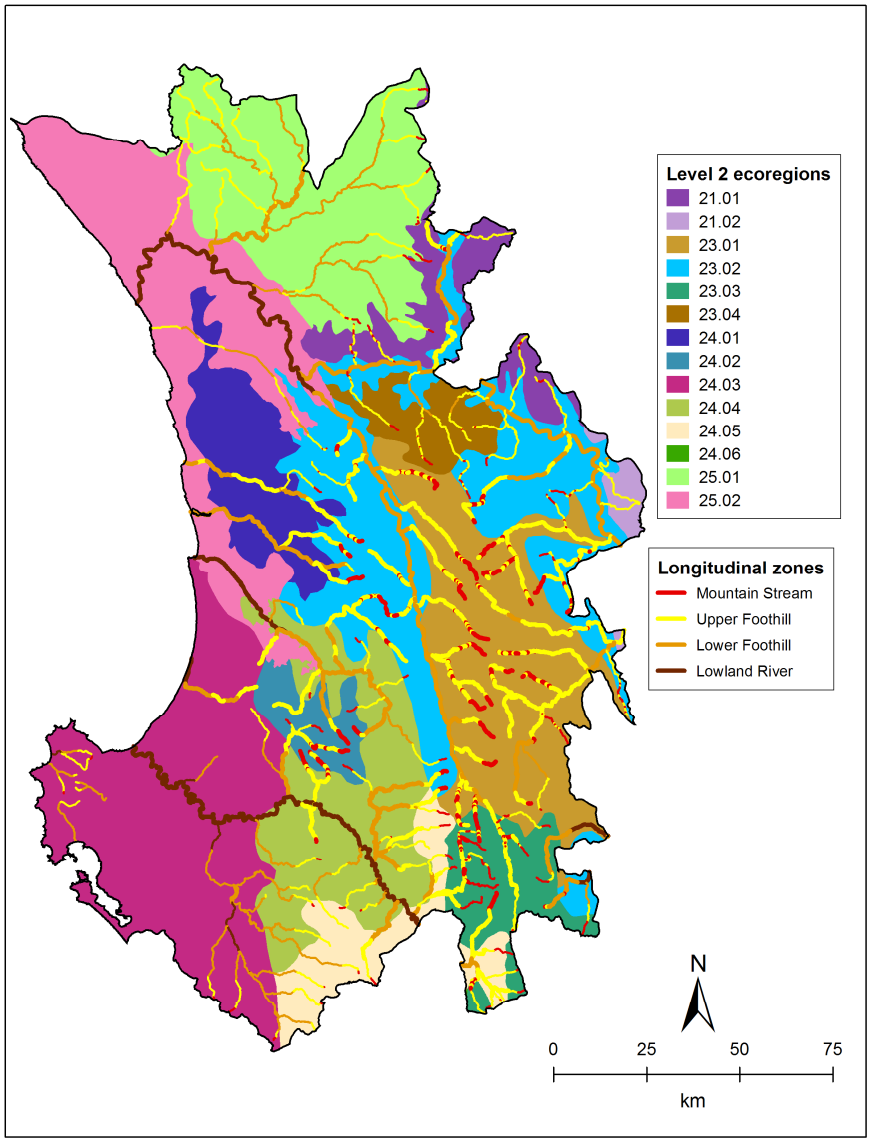

Figure 9 River types of the Sandveld-Saldanha domain. Line thickness indicates flow variability (thick lines represent permanent rivers and thinner lines represent non-permanent rivers). Shaded areas represent Level 2 ecoregions used to characterise the landscape through which the river flows. The Level 2 river types were classified further at the level of individual streams using longitudinal zones, as depicted by the line colours.

2.4 River integrity

The majority of main rivers in the Sandveld - Saldanha planning domain are moderately modified, i.e. in a "C" ecological integrity category (Figure 10). This is similar to the status of rivers nationally (Nel *et al.*, 2007). Main rivers in South Africa are heavily utilised and regulated

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to improve water security for socio-economic use, and there are widespread water transfer schemes across the country to cater for areas where water requirements exceed the natural water availability (Braune, 1985; O'Keeffe, 1989). Smaller tributaries are often less regulated and therefore are frequently in a better condition than main rivers. Thus, tributaries have a crucial role to play in meeting conservation targets, and are important to include in the assessment.

2.4.1 Expert review of changes to ecological integrity

The map showing the combination of main river integrity based on existing data and modelled tributary integrity was reviewed by regional river experts. Based on their experience, the following changes were made:

- Lower portion of the Doring River was changed from the PES C-category to a B–category. The rationale for this is that the effects of the C-category are localised around a waste-water treatment plant, and taken at the landscape level, the river is a majority B-category.
- Jan Dissels River was changed from it PES D-category to a C-category following the more recent 5 km aerial habitat integrity surveys.
- Changed the reaches of the Olifants River just below the gorge (in quaternary catchments E10E and E10D) from a PES D-category to a C-category based on the more recent 5 km aerial habitat integrity surveys.
- Extended the intact PES category of the Olifants gorge further upstream (was a C previously), based on expert knowledge of the area.
- Changed the modelled integrity of an unnamed tributary of the Olifants River (in quaternary catchment E10D) from "not intact" to "intact" based on River Health site survey data.
- Changed the modelled integrity of the upper Plattekloof River from "not intact" to "intact" based on expert knowledge of the area.
- Changed the modelled integrity of the lower portion of the Plattekloof River from "not intact" to a C-category, based on expert knowledge of the area.
- Based on expert knowledge of the area, changed the upper Boesmans River to a C-category where modelled integrity had assigned it "not intact", and left the "intact" reaches the same. Left lower Boesmans River as "not intact".
- Changed Groen/Sout tributary of Berg River from a PES D-category to a C-category, based on expert knowledge of the area.

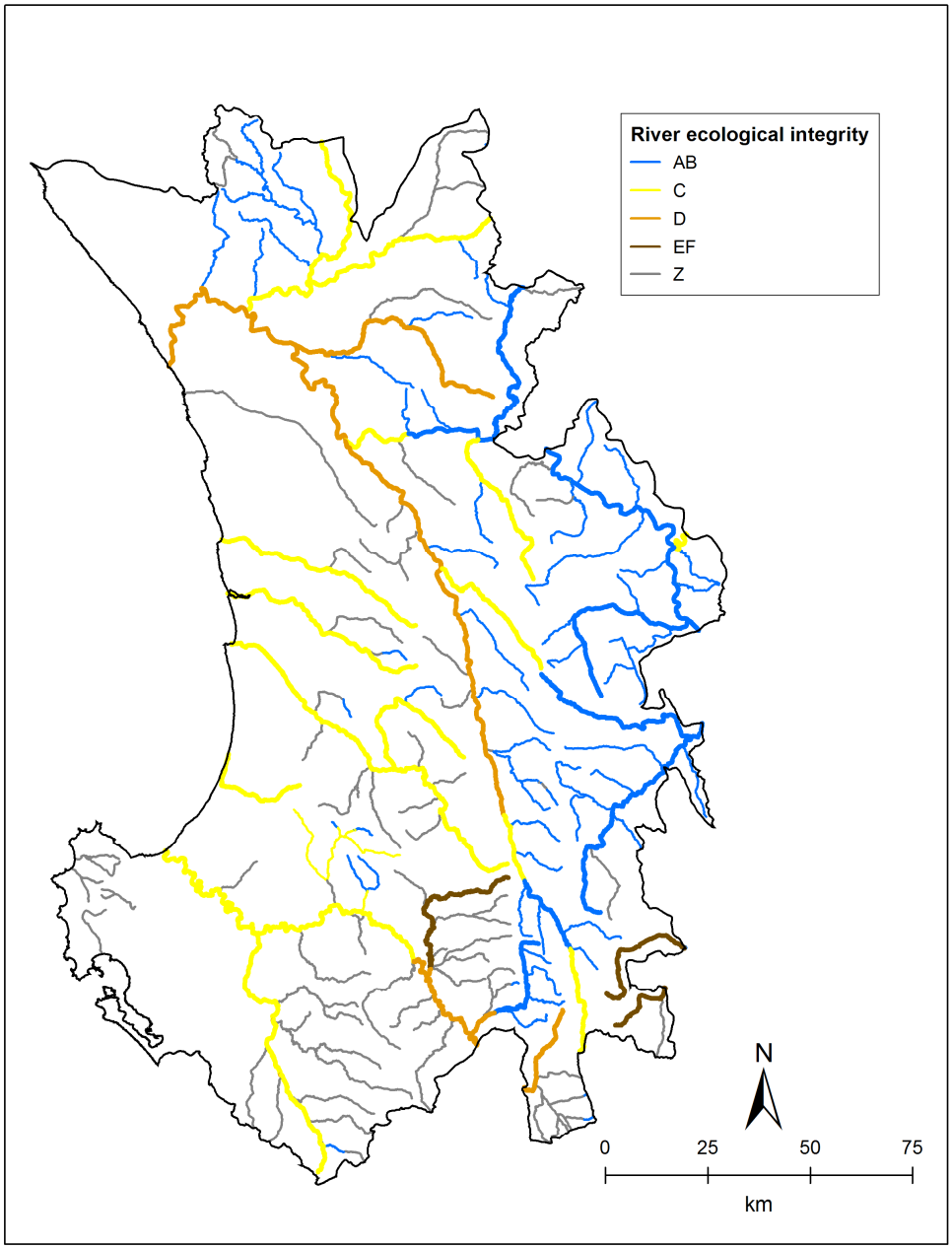

Figure 10. River ecological integrity in Sandveld-Saldanha. Thicker lines represent main rivers, for which Present Ecological State data were used (Kleynhans 2000). Thinner lines represent tributaries, where integrity was modelled based on percentage of natural landcover in the sub-catchment and riparian buffer zones.

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2.5 Priority sub-catchments

Sub-catchments for the Sandveld-Saldanha domain were modelled using a combination of digital elevation data (US SRTM 90m)[1] and the DWAF 1:500 000 rivers[2] GIS layer. This resulted in 533 sub-catchments. The size of the sub-quaternary catchments is variable, ranging from 20 - 287km^2, with an average size of 49km^2.

To derive initial river priorities, the 533 modelled sub-quaternary catchments were used as the units of assessment and selection, or the planning units.

In selecting priority sub-catchments (and thus, priority river segments) for the Sandveld-Saldanha planning domain, the following multiple criteria were considered:

- Complementarity and efficiency in achieving river type conservation targets;
- Where there were choices between sub-quaternary catchments with similar biodiversity features, the following sub- catchments were chosen:
    - those containing the highest proportion of intact natural vegetation, or
    - those identified as a river priority by the conservation plan for the Olifants/Doorn Water Management Area, which partially overlaps with the Sandveld-Saldanha planning domain.

Using MARXAN/CLUZ conservation planning decision support software we derived the minimum set of sub-catchments required to achieve river type conservation targets in intact river systems. These conservation targets were set as 20% of the total length of each river type. This initial step in the prioritisation process identified Critical Biodiversity Areas for rivers. Critical Ecological Support Areas required to support these Critical Biodiversity Areas were also identified.

Sub-catchments chosen as Critical Biodiversity Areas were used to drive the first selections in the subsequent integrated terrestrial and freshwater conservation plan for the region. This was achieved by earmarking all terrestrial planning units that intersected with the river reaches and their associated riparian buffer within each of the selected sub-catchments.

2.6 Fish sanctuaries

2.6.1 Endemic and endangered fish species

The Olifants-Doring primary catchment is a southern African endemic hotspot for freshwater fish species, containing the highest number of endemic freshwater fishes, which are all threatened by invasive alien fish species, unsustainable water abstraction and habitat degradation. The Olifants River catchment is fully contained within the Sandveld-Saldanha planning domain; whilst the Doring River catchment is partially encompassed within the planning domain.

There are nine endemic fish species (Table 2), of which at least two – the Verlorenvlei redfin (*Pseudobarbus burgi* sp.) and the Fiery redfin (*Pseudobarbus phlegethon*) – appear to be taxonomically distinct species. An additional three indigenous fish species also occur in the planning domain, of which at least two – Cape galaxias (*Galaxias zebratus*) and Cape kurper

[1] available from the website: http://www.personal.psu.edu/users/j/z/jzs169/Project3.htm
[2] available on DWAF website: http://www.dwaf.gov.za/iwqs/gis_data/river/All.htm

(*Sandelia capensis*) - may well be split into several distinct species. One indigenous species (the Berg-Breede whitefish, *Barbus andrewi*) is now extinct in the Berg River, and its conservation is dependent upon conserving populations in the Breede River.

Table 2 Freshwater fishes in the Sandveld - Saldanha planning domain. The IUCN conservation status reflects the 2006 updates.

Common name	Scientific name	Endemic/ Indigenous	IUCN Conservation status
Verlorevlei/BergRiver redfin	*Pseudobarbus burgi* sp.	endemic	Endangered
Fiery redfin	*Pseudobarbus phlegethon*	endemic	Critically endangered
Clanwilliam redfin	*Barbus calidus*	endemic	Vulnerable
Twee River redfin	*Barbus erubescens*	endemic	Critically endangered
Clanwilliam sawfin	*Barbus serra*	endemic	Endangered
Clanwilliam yellowfish	*Labeobarbus capensis*	endemic	Vulnerable
Clanwilliam sandfish	*Labeo seeberi*	endemic	Endangered
Spotted rock catfish	*Austroglanis barnardi*	endemic	Endangered
Clanwilliam rock catfish	*Austroglanis gilli*	endemic	Vulnerable
Chubbyhead barb	*Barbus anoplus*	indigenous	Data deficient
Cape galaxias	*Galaxias zebratus*	indigenous	Data deficient
Cape kurper	*Sandelia capensis*	indigenous	Data deficient

2.6.2 Fish sanctuaries

A previous conservation planning exercise for the Olifants/Doorn Water Management Area identified fish sanctuaries for the conservation of this globally important area. These fish sanctuaries were based on meeting the following systematic criteria:

- Explicit and quantitative conservation targets were set for all twelve indigenous freshwater fish species. No explicit conservation targets were set for estuarine fish species, but the estuary itself was selected as an important conservation feature.
- For the nine endemic freshwater fish species, a target was set to select a "viable" population *at least twice*, preferably in different secondary catchments (which translate roughly to different sub-areas). For example, select one population in the Olifants and one in the Doring; or one in the Olifants and one in the Sandveld. "Viable" was defined broadly to mean a self-maintaining, recruiting population of fish. "Species" were defined as evolutionary significant units (*sensu* Moritz 1994) – thus, in cases where recent taxonomic studies suggest a genetic separation between populations, these populations were treated as distinct units. For the remaining indigenous freshwater fish species that are not endemic to the area, only one viable population was selected.
- Additional considerations included habitat requirements for individual species. For example, explicit linkages were established for migratory species which require a combination of tributary habitat, and habitat in the mainstem rivers of the Olifants and Doring rivers. The rationale for this is that many tributaries provide refugia free of alien fish, so that smaller fish can escape predation;

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whilst mainstem rivers provide critical habitat for larger adult fish, because the rivers support greater numbers of larger fish, being more productive and offer more living space.

- In the few instances where options existed for placement of sanctuaries (i.e. where several viable populations could be chosen to satisfy conservation targets), factors such as existing conservation initiatives, land use and complementarity were taken into account.

The same fish sanctuaries identified in the conservation plan for the Olifants-Doorn Water Management Area were used for the Sandveld - Saldanha fish sanctuaries, but were supplemented with additional fish sanctuaries in areas outside the Olifants-Doorn domain (Figure 11). These additional areas included:

- Selection of the sub-quaternary catchment of the upper Twenty-Fours River to capture the montane evolutionary significant unit of the Cape kurper (*Sandelia capensis*);
- Establishing linkages between the Verlorenvlei fish sanctuary and the Kruismans River, to link metapopulations of the lowland evolutionary significant unit of the Cape kurper (*Sandelia capensis*);
- Selection of the sub-quaternary catchments containing the Sout River (tributary of the Berg River) to capture the lowland Berg River evolutionary significant unit for the Cape galaxias (*Galaxias zebratus*);
- Selection of the sub-quaternary catchments containing the upper Plattekloof River to capture the mountainous Berg River evolutionary significant unit for the Cape galaxias (*Galaxias zebratus*), and
- Selection of the sub-quaternary catchments containing the upper Plattekloof River to capture the Berg River redfin (*Pseudobarbus burgi* sp.).

Fish sanctuaries were combined to provide a summary of all fish sanctuaries required to achieve conservation targets for the freshwater fish of the Sandveld - Saldanha planning domain (Figure 11). A total of 69 sub- catchments were selected as fish sanctuary areas, which should be managed to maintain at least a B-category river ecological integrity. A critical requirement is not allowing abstraction from rivers during the dry summer months (November to March). This is when fish recruitment takes place, which coincides with the period of lowest flows.

An additional 26 sub-catchments, were selected for maintaining longitudinal connectivity between tributaries and the mainstems of the Olifants, Doring and Verlorenvlei rivers. Some of these "connecting" rivers may be able to withstand moderate impacts, but should be managed in at least a C-category ecological integrity. For some species, maintaining this longitudinal connectivity is important for allowing re-colonization events and genetic exchange between tributaries, and providing sufficient habitat for recruitment and spawning. However, maintaining longitudinal connectivity is not always desirable between tributary and mainstem populations where this will facilitate invasion or re-invasion by alien species; this was taken into account in designating connecting rivers.

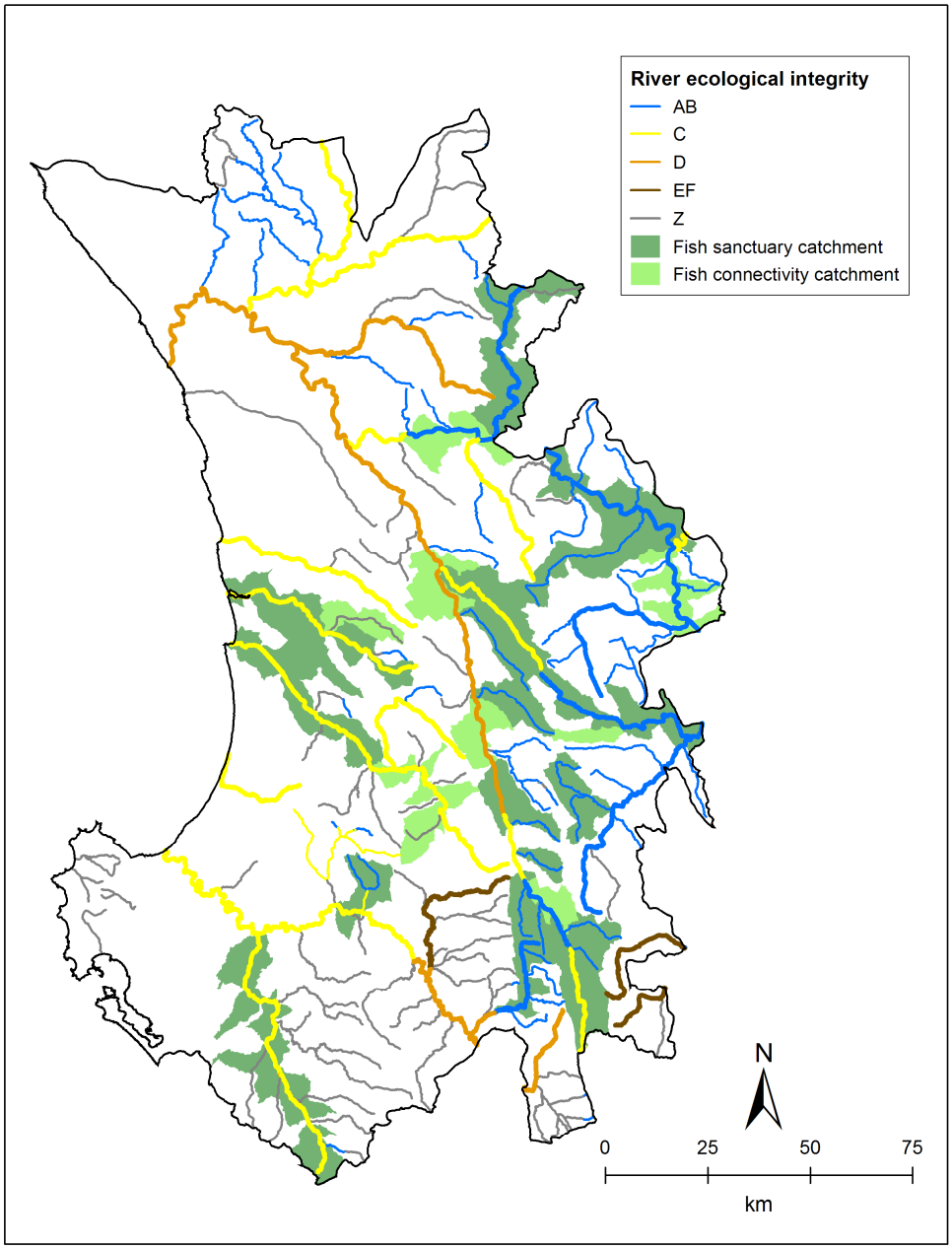

Figure 11. Combined map of fish sanctuaries for the indigenous freshwater fish species of the Sandveld-Saldanha planning domain.

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3.0 BIODIVERSITY ASSESSMENT RESULTS - ESTUARIES

3.1 Overview

Summary descriptions of the estuaries of the Sandveld-Saldanha planning domain are provided in Table 3, and the location of the estuaries shown in Figure 12.

Table 3 Summary of estuaries of the Sandveld - Saldanha planning domain.

Estuary	Municipal jurisdiction	Approx. size (ha)	Protection status	Priority rank in SA	Recommded status*	Averaged integrity
Olifants River estuary	Matzikamma	1 992	None / Ramsar site	4th	Partial EPA	0.7
Jakkalsvlei estuary	Cederberg	78	None	Not ranked	EMA	0.9
Langvlei estuary	Cederberg	287	None	Not ranked	EMA	0.9
Verlorenvlei	Cederberg	1 667	None / Ramsar site		Partial EPA	0.9
Berg River estuary	Berg River / Saldanha Bay	7 770	None / Ramsar site	3rd	Partial EPA	0.5
Langebaan lagoon	Saldanha Bay	1 770+	West Coast National Park	Not ranked	Existing PA	0.9

*PA = Protected Area, EPA = Estuarine Protected Area, EMA = Estuarine Management Area

Currently all estuaries are considered to be CBAs.

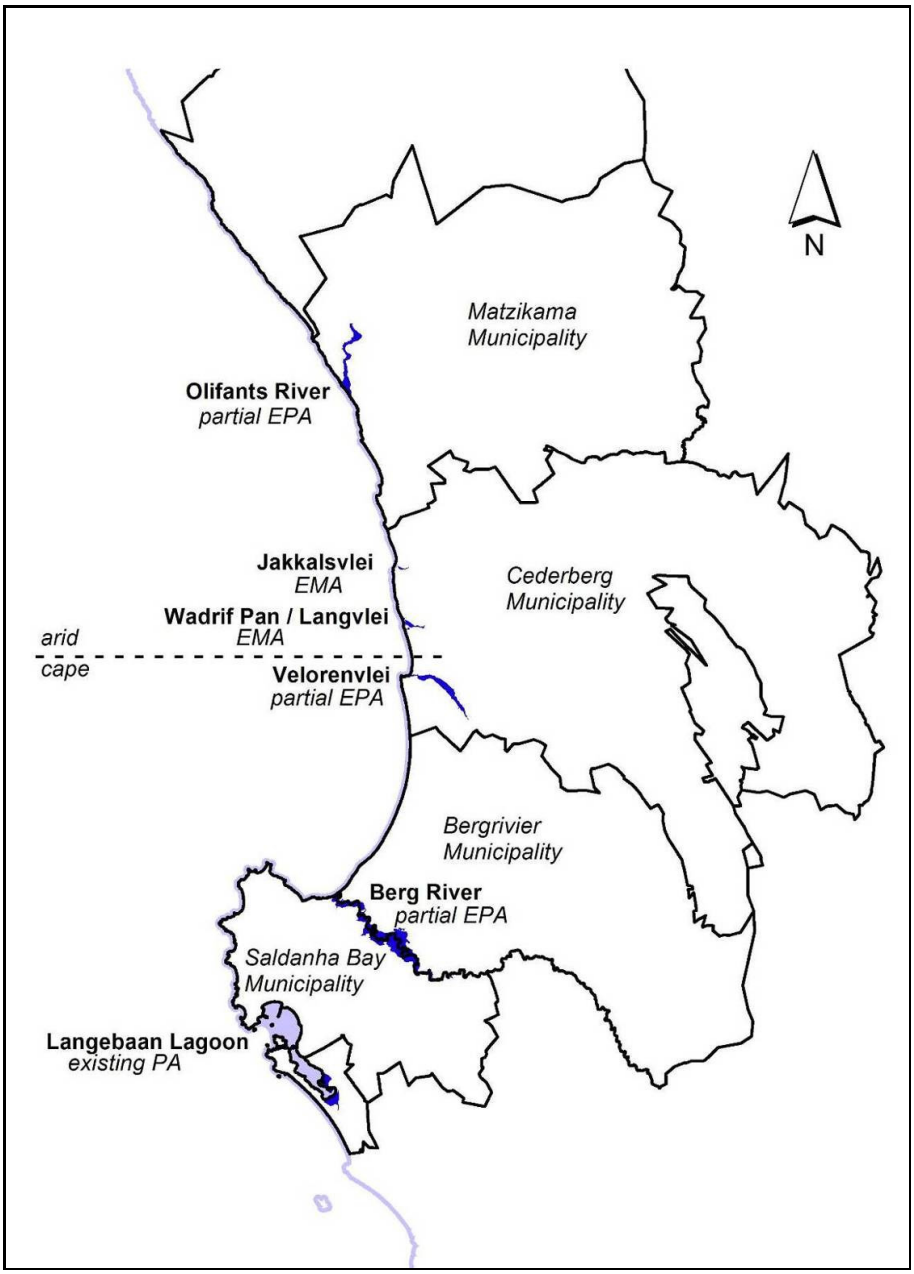

Figure 12 Estuaries of the Sandveld-Saldanha planning domain.

Appendix A includes useful site specific and management information for each estuary, compiled from available literature.

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3.2 Base data for estuarine conservation assessment

Estuarine upstream extent was derived from the SA VEGMAP and spatial extent was derived from SPOT and DWAF aerial imagery interpretation. No assessment of estuarine integrity was undertaken by this project, as the C.A.P.E. estuaries conservation plan (Turpie and Clark, 2007) was also in progress during the course of this project.

3.3 Estuarine types

According to the National Wetland Inventory Classification System (NWICS), estuaries are defined as "…partially enclosed ecosystems that are permanently or periodically connected to the ocean, which are influenced by tidal fluctuations and within which ocean water is at least occasionally diluted by fresh water derived from surface or subsurface land drainage."

Estuarine longitudinal and lateral extent was derived from the Reserve Determination Methods for estuaries (under the National Water Act 36 of 1998), which define the geographical boundaries of an estuary as:

- *Downstream boundary*: the estuary mouth.
- *Upstream boundary*: the extent of tidal influence; i.e., the point up to where tidal variation in water levels can still be detected or the extent of saline intrusion, whichever is furthest upstream.
- *Lateral boundaries*: the 5m Above Mean Seal Level (AMSL) contour along each bank has been recommended as a useful preliminary management boundary to define the whole estuary, including its upstream extent, particularly where data on saline extent are limited (Lara van Niekerk, CSIR, pers.comm.). In the present study, estuarine lateral extent was been mapped based on extant plant communities, with the 5m contour being represented as far as these data allow as a planning / conservation tool and to assist in setting ecological setbacks from estuaries.

All of the estuaries that lie within the Sandveld-Saldanha planning domain are classified as cool temperate systems. Taking this classification further, we have adopted the approach used for the SA vegetation map (Mucina and Rutherford, 2006), where estuaries of the Western Cape are divided, more or less at Lamberts Bay, into Cape Estuarine Saltmarsh, and, in the north, Arid Estuarine Saltmarsh. In addition to this Cape / Arid split, we have added the NWICS estuarine types. Thus, there are three broad categories of estuarine types found in the Saldanha/Sandveld planning domain:

- Arid estuarine channels and depressions;
- Cape estuarine channels and depressions, and
- Cape estuarine bays.

All of the Cape estuaries are permanently open systems, while the Arid estuaries are either permanently open or temporarily (or artificially) closed systems.

3.3.1 Arid estuarine channels and depressions

These include the estuaries north of Elands Bay, the major characteristics of which have been summarised in Table 3. They are:

- Wadrif Soutpan/Langvlei estuary,
- Jakkalsrivier estuary at Lambert's Bay, and the
- Olifants river estuary.

These ecosystems occur in an area characterised by a cool temperate climatic regime, with very low and erratic mean annual precipitation (MAP) ranging from 45 – 150 mm (Mucina and Rutherford, 2006). The dominant vegetation type is Arid Estuarine Saltmarsh, which comprises mainly low succulent dwarf shrubs that form a mosaic with patches of grass and, in places, reedbeds. This vegetation type is characterised by the presence of seawater and thus, salinities are high. Gradients are generally shallow, with supratidal saltmarshes forming on elevated silty alluvial terraces. These estuarine channels and depressions are generally vegetated, but barren areas with silt/mud substrata are a common sight along the west coast (Figure 13).

These estuaries tend to be less botanically diverse than Cape estuarine depressions and channels.

Figure 13 Jakkalsvlei vegetation.

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Typical plant species: *Chenolea diffusa, Atriplex prostrata, Sarcocornia natalanesis, Salicornia meyeriana, Psilocaulon dinteri, Triglochin striata, Triglochin bulbosa, Plantago crassifolia, Spergularia media, Juncus kraussii, Juncus acutus, Sporobolus virginicus, Odyssea paucinervis, Salsola zeyheri, Suaeda fruticosa, Phragmites australis, Cotula coronopifolia, Limonium equisetinum, Schoenoplectus scirpoideus, Samolus porosus.* On drier edges *Lycium ferocissimum, L. cinereum*, *L. decumbens, Malephora lutea*, and *Exomis microphylla* may be prominent.

Special plant species: None known; not noted for rares or endemics in this region.

Major threats and impacts: Major impacts include salt mining, water abstraction (e.g. for potato farming in the Sandveld), urban and rural development, fragmentation and other impacts resulting from road and rail infrastructure, diamond mining (Olifants River estuary), agricultural activities in the surrounding catchment. The Jakkals River estuary has been artificially closed with a berm, while the Wadrift Soutpan (Langvlei estuary, Figure 14) is now mostly a dry pan, with limited connectivity to the sea. Perceived threats include rising sea levels, an increase in road infrastructure, further water abstraction from upstream surface water (e.g. raising of the Clanwilliam Dam, damming of the Doring River) and localised groundwater abstraction; urban encroachment; escalating degradation of land and vegetation cover, as a result of grazing, infilling and clearing of land for agriculture and rural settlement; manipulation of flows / water levels for irrigation purposes.

Figure 14 Flamingoes at Wadrif Pan.

C.A.P.E. estuaries programme conservation planning context: The C.A.P.E. estuaries conservation plan (Turpie and Clark, 2007) recognises that all estuaries are sufficiently valuable to warrant the maintenance of their health. At the same time, the necessity to protect a core set

of estuaries in a highly natural state, to the level where freshwater and other protection requirements may limit or alter certain human activities is emphasised. Three broad types of estuary protection are considered – Estuarine Protected Areas, Estuarine Conservation Areas and Estuarine Management Areas – the last type should be applicable to all estuaries (Turpie, 2004). The C.A.P.E. estuaries conservation plan addresses only the selection of Estuarine Protected Areas (EPAs), and looks at whole or partial estuarine conservation within each EPA. Of the arid estuaries within the Sandveld-Saldanha planning domain, the **Olifants** was selected for partial EPA status. This means that at least one side of the system should be managed as a sanctuary, receiving protection from all consumptive use. It is noted that none of the remaining arid estuaries that lie within the Sandveld-Saldanha planning domain (i.e. the Wadrif Soutpan/Langvlei estuary and the Jakkals River estuary) were included in Turpie and Clark's (2007) conservation plan. Dr L. van Niekerk (CSIR, pers. comm.) has noted that of these, the Jakkals River still affords sporadic nursery habitat to marine fish, which is not the case in the more hydrologically impacted Wadrift Pan. The latter has however been recognised for its importance as a bird habitat of importance, as an example of an increasingly rare wetland habitat type. Thus, management at least as Estuarine Conservation Areas should be assumed and the generic recommended 5m AMSL contour buffer applied regarding further development, including agriculture, within and around these systems.

3.3.2 Cape estuarine channels, bays and depressions

These include the estuaries south of Elands Bay:

- Verlorenvlei estuary at Elands Bay (Figure 15);
- Berg River estuary (Figure 16), and
- Langebaan lagoon

These systems are defined by the presence of seawater, and hence have a very high salinity.

Most of Verlorenvlei is classified as an estuarine depression, with a lower portion of estuarine channel, while the Berg River estuary comprises a mix of estuarine channel and estuarine depression wetlands. Langebaan Lagoon has been classified for the purposes of this programme as an estuarine bay - note however that it is a problematic system, and arguably falls should be classified as a marine embayment. Given its importance within the context of management of wetland systems within this region, it has however been included as an estuarine type.

Typical plant species: *Zostera capensis* (aquatic), *Chenolea diffusa, Sarcocornia perennis, S. pillansii, S. capensis, Salicornia meyeriana, Triglochin striata, Triglochin bulbosa, Plantago crassifolia, Ruppia cirrhosa, R. maritima, Spergularia media, Juncus kraussii, Sporobolus virginicus, Cotula coronopifolia, Cotula filifolia, Limonium equisetinum, L.decumbens, Samolus porosus*, and Puccinellia *angusta*. On drier edges *Lycium ferocissimum, Lycium cinereum*, and *Exomis microphylla* may be prominent.

Special plant species: None known; not noted for rares or endemics in this region.

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Major threats and impacts: Although some of these estuaries are protected (Langebaan Lagoon in the West Coast National Park) they are vulnerable to impacts of groundwater abstraction. This is particularly true of the Berg River estuary. Other impacts include salt mining and processing plants, urban development and encroachment of cultivated fields. These estuaries occupy land that is very valuable in terms of resort, housing estate, and golf course development and, although their presence and good condition inflate land prices and aesthetic value, these systems are threatened by the encroachment of these developments. Estuaries are vulnerable to rising sea levels, and sedimentation from upstream erosion.

Figure 15 Upper Verlorenvlei estuary.

C.A.P.E. estuaries programme conservation planning context: The C.A.P.E. estuaries conservation plan (Turpie and Clark, 2007) recognises that all estuaries are sufficiently valuable to warrant the maintenance of their health. At the same time, the necessity to protect a core set of estuaries in a highly natural state, to the level where freshwater and other protection requirements may limit or alter certain human activities is emphasised. Three broad types of estuary protection are considered – Estuarine Protected Areas, Estuarine Conservation Areas and Estuarine Management Areas – the last type should be applicable to all estuaries (Turpie, 2004). The C.A.P.E. estuaries conservation plan addresses only the selection of Estuarine Protected

Areas (EPAs), and looks at whole or partial estuarine conservation within each EPA. The Verlorenvlei and Berg River estuaries were selected for partial EPA status. This means that at least one side of each system should be managed as a sanctuary, receiving protection from all consumptive use.

Langebaan lagoon was not assessed by Turpie and Clark (2007). The Ramsar Status of this site should afford it at least equal conservation status with the selected EPAs – again, the 5m contour setback should also applied in terms of future development within and around this estuarine system.

Figure 16 Berg River estuary.

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4.0 BIODIVERSITY ASSESSMENT RESULTS - INLAND WETLANDS

4.1 Overview

Inland wetlands can be divided into isolated and non-isolated systems, depending on their connection or proximity to a riverine system. These wetlands can then further be subdivided into the following functional types (definitions taken from NWICS (Ewart-Smith *et al.* 2006)) (see Snaddon *et al*. (2008) for more detail on typing):

- ***Floodplain:*** a valley bottom area with a well-defined, gently sloped, stream channel characterised by alluvial transport and deposition of sediment, usually leading to a net accumulation of sediment. Water enters from the main channel when the channel banks overspill. Always non-isolated.
- ***Valley bottom:*** a low-lying, gently-sloped area that receives water from an upstream channel and/or form adjacent hillslopes, not subject to periodic over-bank flooding by a river channel. Always non-isolated.
- ***Seep:*** concave or convex area that is permanently or periodically saturated, usually on a slope, where groundwater or interflow meets the surface. Isolated or non-isolated.
- ***Depression:*** a basin-shaped area increasing in depth from the perimeter to a central area of greatest depth. Isolated or non-isolated.

These main types have been further divided into a total of 22[3] wetland groups within the Sandveld – Saldanha planning domain (see Figures 17 – 20), which are described in this section. These wetland types are a combination of functional type (according to the NWICS) and the dominant vegetation group, derived from either the Mucina and Rutherford (2006) vegetation type map for South Africa, or another appropriate descriptor based on CAPE fine-scale vegetation mapping (Helme 2007a and 2007b).

Table 4 below provides a summary. Figures 17 – 20 show the location of the broad wetland types within the Sandveld-Saldanha domain.

Table 4 Summary of inland wetlands of the Sandveld - Saldanha planning domain.

System	Subsystem	Wetland Group	Total #	Total area (ha)	>80% intact (#)	>80% intact (ha)	>80% intact (% area)	>75% intact (#)	>75% intact (ha)	>75% intact (% area)
FLOODPLAIN WETLANDS	**Total # 73 (13 904 ha) 80 %>80**						**CBA TARGET 24% per group**			

[3] Twenty six (26) have been described but basin seep and hillslope seep have been grouped together, in anticipation of this proposed change in the NWICS.

inland	**non-isolated**	**arid floodplain**	**3**	**1 321.129**	**3**	**1 321**	**100**
inland	**non-isolated**	**alluvial floodplain**	**59**	**10 169.36**	**19**	**5 086**	**50**
inland	**non-isolated**	**sandveld floodplain**	**11**	**2 414.033**	**5**	**2 192**	**90**
VALLEY BOTTOM WETLANDS		**Total # 325 (11 867 ha) 58% >80**			**CBA TARGET 24% per group**		
inland	**non-isolated**	**alluvial valley bottom**	**3**	**56.389**	**no data**	**no data**	**no data**
inland	**non-isolated**	**arid valley bottom**	**57**	**1668.867**	**26**	**259**	**15**
inland	**non-isolated**	**renosterveld valley bottom**	**4**	**151.377**	**no data**	**no data**	**no data**
inland	**non-isolated**	**sandstone fynbos valley bottom**	**125**	**6563.989**	**52**	**1 908**	**29**
inland	**non-isolated**	**shale valley bottom**	**6**	**112**	**no data**	**no data**	**no data**
inland	**non-isolated**	**strandveld valley bottom**	**115**	**1948.686**	**11**	**6 48**	
inland	**non-isolated**	**sandveld valley bottom**	**15**	**1365.646**	**6**	**998**	**73**
SEEP WETLANDS		**Total # 728 (5 460 ha) 71%>80**			**CBA TARGET 24% per group**		
inland	**non-isolated**	**arid seep**	**32**	**294.764**	**28**	**140**	**48**
inland	**non-isolated**	**alluvial seep**	**3**	**32.298**	**no data**	**no data**	**no data**
inland	**non-isolated**	**sandstone fynbos seep**	**395**	**3045.693**	**299**	**1774**	**58**
inland	**non-isolated**	**sand fynbos seep**	**124**	**928.049**	**18**	**142**	**15**
inland	**non-isolated**	**renosterveld seep**	**99**	**936.865**	**43**	**113**	**12**
inland	**non-isolated**	**strandveld seep**	**75**	**468.152**	**8**	**150**	**32**
DEPRESSIONAL WETLANDS		**Total # 1183 (6 970 ha) 30%>80**			**CBA TARGET 24% per group**		
inland	**isolated**	**arid depression**	**243**	**2012.87**	**3**	**13**	**0.6**
inland	**isolated / non-isolated**	**sandstone fynbos depression**	**78**	**280.408**	**12**	**19**	**6**
inland	**isolated**	**sand fynbos depression**	**152**	**316.184**	**21**	**135**	**42**
inland	**isolated / non-isolated**	**shale fynbos depression**	**13**	**93.015**	**no data**	**no data**	**no data**
inland	**isolated**	**renosterveld depression**	**525**	**1233.997**	**1**	**0.4**	**0.03**
inland	**isolated**	**strandveld depression**	**172**	**3034.326**	**31**	**419**	**14**
TOTAL WETLAND AREA 38 201 ha (~1.5 % of planning domain)							

* no data refers to wetlands within non-priority area where integrity was not calculated

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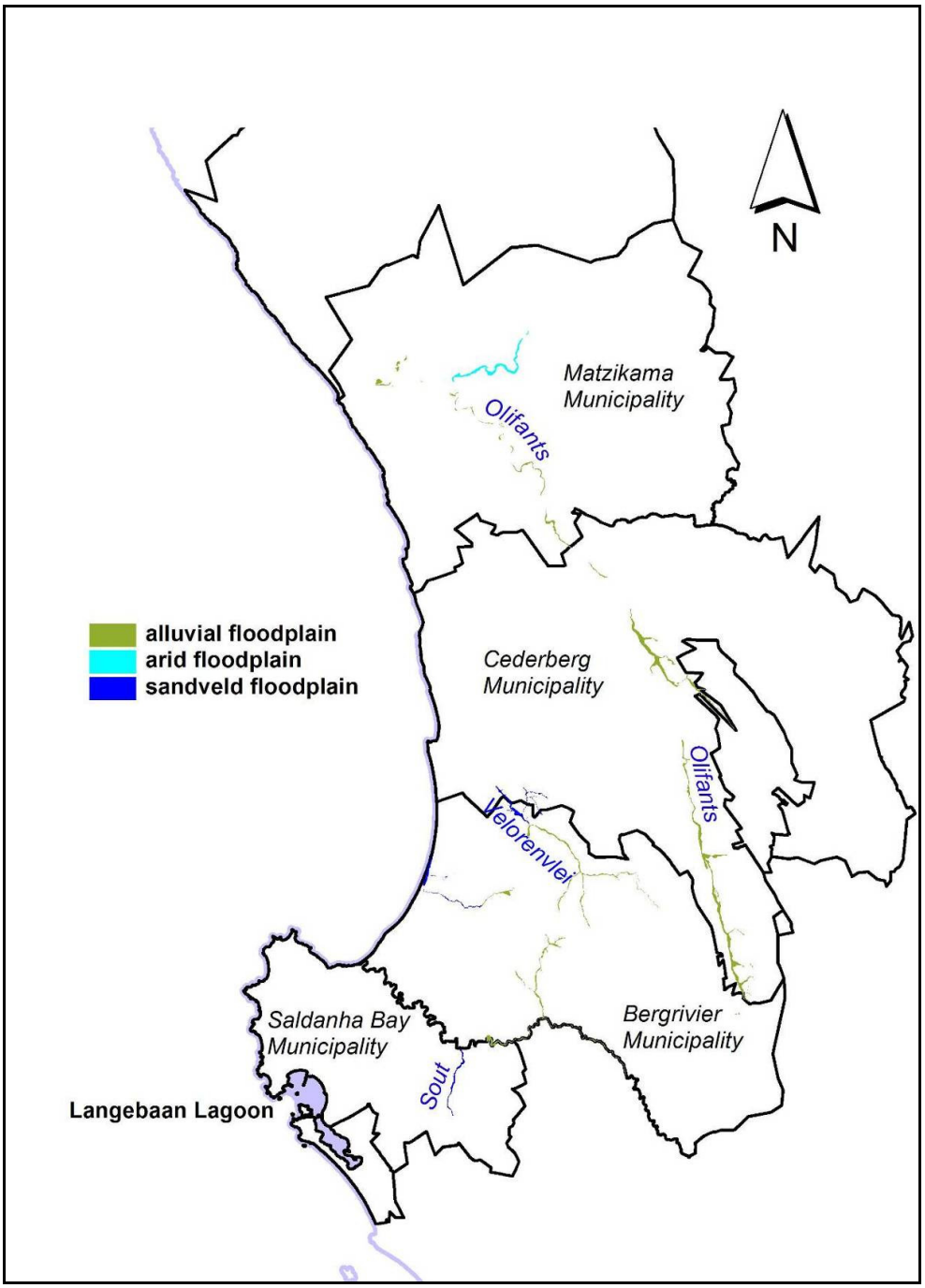

Figure 17 Floodplain wetlands of the Sandveld-Saldanha planning domain (73 / 13 904 ha).

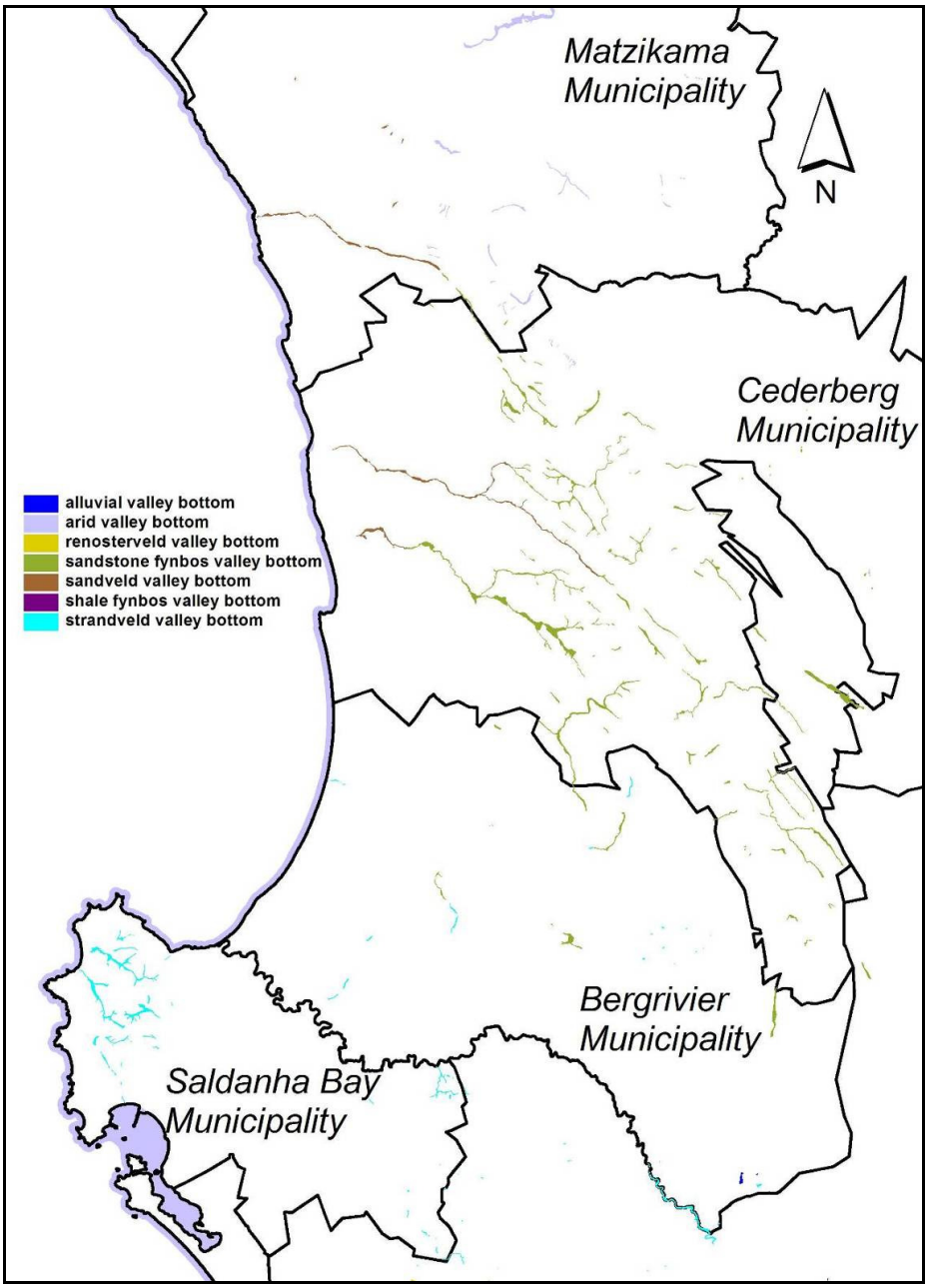

Figure 18 Valley bottom wetlands of the Sandveld-Saldanha planning domain (325 / 11 867 ha).

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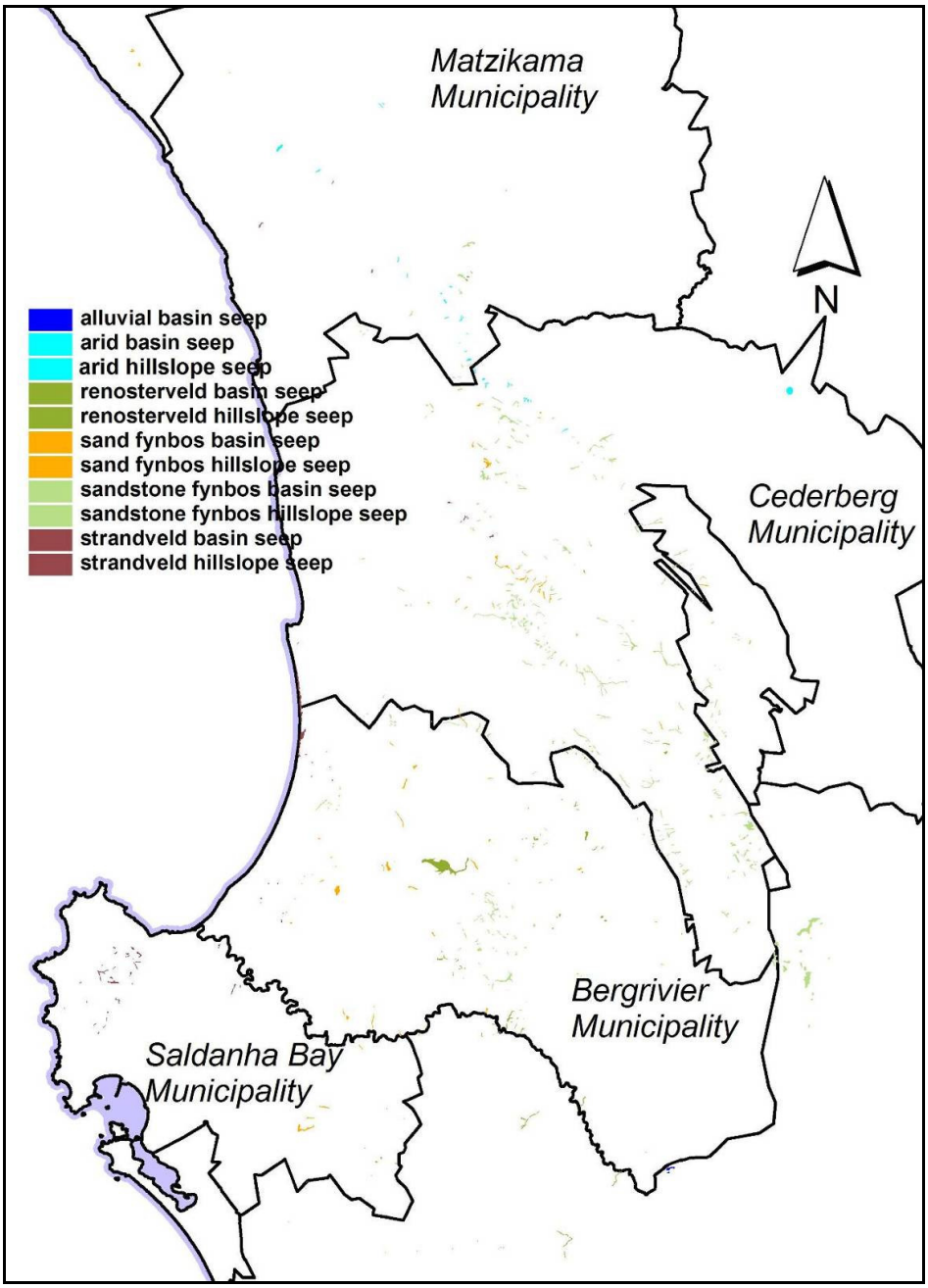

Figure 19 Seep wetlands of the Sandveld-Saldanha planning domain (728 / 5 460 ha).

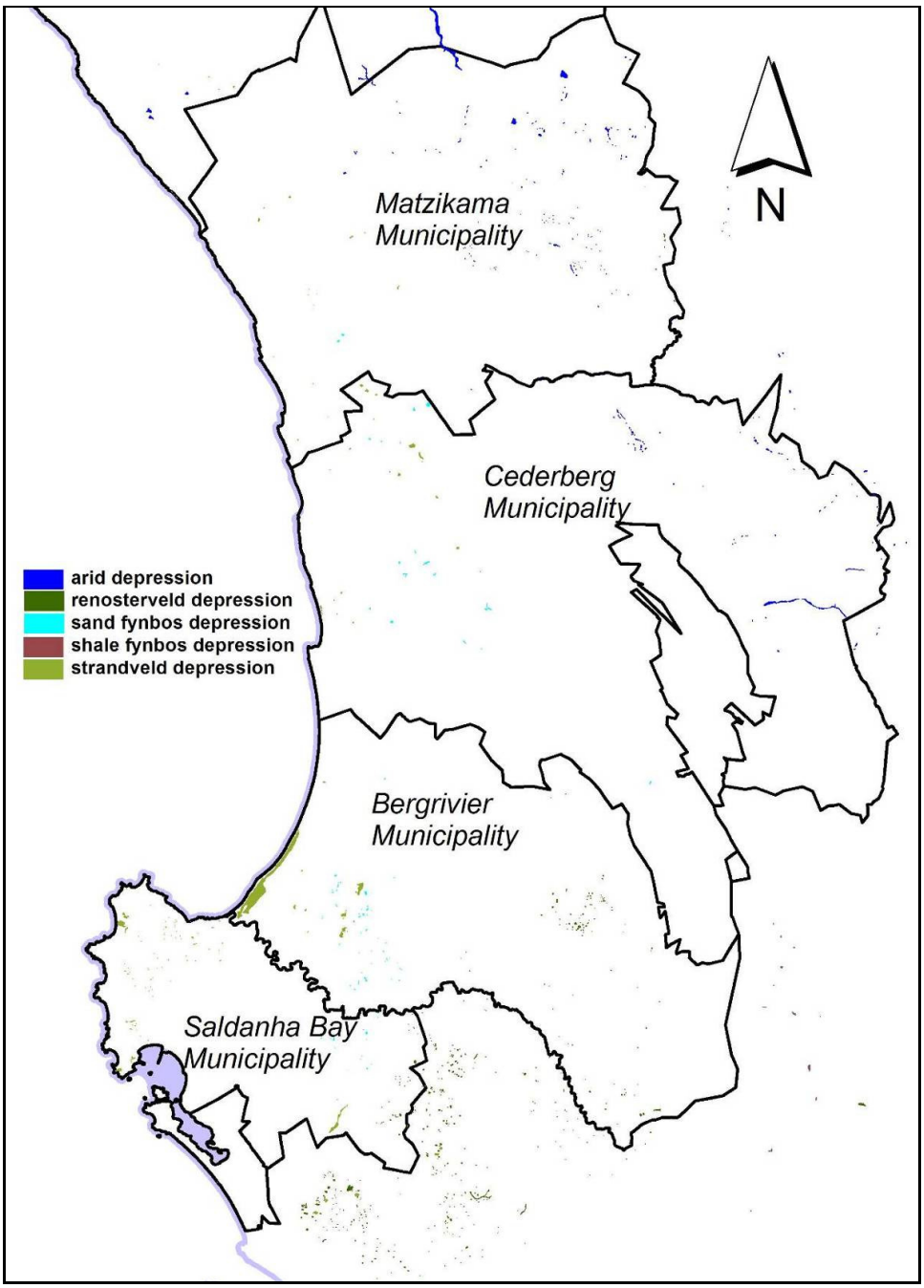

Figure 20 Depressional wetlands of the Sandveld-Saldanha planning domain (1 183 / 6 970 ha).

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4.2 Base data for inland wetland conservation assessment

A wetland layer was created for this project, using existing spatial information as an informative layer, then digitising "new" wetlands using the GIS software ArcView 3.2/3, or ArcMap 9.1.

An associated report, *CAPE Fine-Scale Planning Project: Surface Freshwater Ecosystems Methodology Report* (Snaddon *et al.* 2008), describes in more detail the underlying methodology of preparing the base data for this study.

4.3 Inland wetland types

The descriptions of wetland types are largely based on the information provided by the fine-scale vegetation assessments commissioned for the North-West Sandveld and Saldanha Peninsula planning domains (Helme 2007a and 2007b).

4.3.1 Floodplain Wetlands

Arid floodplain

The arid floodplains within the Sandveld – Saldanha planning domain include one of the major tributaries to the lower Olifants River, the Sout / Hol river system, which flows out of the Knersvlakte, joining the Olifants River near Vredendal. These riverine systems tend to be dry most of the year, with intermittent flow only after good rains. The climate is arid and seasonal, with a MAP around 150mm, most of which occurs between June and August.

Arid floodplains typically occupy broad river valleys, with alluvial sandy soils with some clayey depressions. Sandstone, granite or shale bedrock is observed within riverbeds. These systems may be slightly saline in places – a salt crust may develop in the riverbed over dry periods. The dominant vegetation type is Namaqualand Riviere, which is characterised by a mixture of succulent shrubs and patches of grasses in riverbeds and on banks. Arid floodplains typically have a narrow band of medium to tall trees – usually *Acacia karoo* or *Tamarix usneoides* – marking the edge of the active, although sometimes ill-defined riverbed.

Figure 21 Hol River below confluence with Sout River.

Typical plant species: Trees include *Tamarix usneoides* and *Acacia karroo*. Alien trees include *Acacia saligna*, and *A. longifolia*, with *Prosopis* invading drier areas. Alien shrubs include *Ricinis communis, Nerium oleander, Nicotiana glauca*, and *Polygonum lapathifolium*. Indigenous grasses, shrubs and succulents *include Lycium ferocissimum, L. horridum, Salsola tuberculata, Limonium dregeanum, Sarcocornia terminalis, Suaeda fruticosa, Galenia africana, Viscum capense, Rhus burchellii, Melianthus pectinatus, Zygophyllum retrofractum, Didelta carnosa, Tetragonia fruticosa, Ehrhrarta longiflora, Odyssea paucinervis, Cynodon dactylon, Exomis microphylla, Malephora framesii, M. lutea, Mesembryanthemum guerichianum, Psilocaulon* sp., and *Phragmites australis*.

Special plant species: Very few special plant species occur in this unit. *Sarcocornia terminalis* is endemic to the floodplains and valley bottoms in the Knersvlakte.

Major threats and impacts: Arid floodplains are particularly threatened by water abstraction – largely groundwater - which will lead to further drying of these systems. Irrigation return flows tend to elevate the natural salinity of these floodplains. Ephemeral nature of these systems means that they area particularly vulnerable to changes in water quantity and quality. Other impacts include sand mining, roads and railway networks, and alien (e.g. *Prosopis* sp.) and indigenous (e.g. *Galenia africana*) invasives. In some places, such as the Knersvlakte, arid floodplains are protected to some extent by the aridity of the environment which is unsuitable for large-scale agriculture and development. However, they have little or no formal protection.

Alluvial floodplain

Alluvial floodplains occur throughout the planning domain – the largest being the Olifants River floodplain. Other alluvial floodplain wetlands can be found along the following rivers:

- Jan Dissels
- Verlorenvlei and its major tributaries – Kruismans, Krom Antonies, Hol
- Papkuils (feeds Rocher Pan)
- Berg River and its tributary – Boesmans

The climate where these systems are found is variable, but more mesic than for arid floodplains. The rivers flowing through alluvial floodplain wetlands are both permanent and non-permanent systems. These floodplains are characterised by wide river valleys, where periodic inundation of the floodplain sustains wetland habitat. They tend to occur on acid sands, which can be deep in places. Sandstone and shale bedrock outcroppings are observed within river channels. The river channel itself is often braided, with secondary and tertiary channels meandering across the wide floodplain.

The vegetation context for this wetland group is mixed – incorporating Namaqualand Riviere (as for arid floodplains and found along the Olifants River below Bulshoek Dam), Olifants Alluvium

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(along the Olifants River, above Bulshoek Dam), Cape Lowland Freshwater Wetlands and Lowland Acid Sand Wetlands.

Generally, alluvial floodplains are vegetated, with the vegetation being structurally diverse, including a band of perennial trees (often alien) and tall shrubs that occurs on the wet river bank, with swathes of varying width of reeds, sedges and palmiet (e.g. along the Olifants River) extending on either side of the riparian tree band. Other plant groups include restios, seasonal aquatics, annuals and bulbs (after floodwaters subside).

Typical plant species: Trees and large shrubs include *Rhus angustifolia, Brabejum stellatifolium, Brachylaena neriifolia, Prionum serratum, Metrosideros excelsa, Freylinia lanceolata, Diospyros glabra, Erica caffra, Platycaulos compressus, Rhus lucida, Salix mucronata, , Cliffortia strobilifera*, and *Podocarpus elongatus*. Smaller shrubs include *Willdenowia incurvata, Cliffortia ferruginea, Arctotis revoluta, Melianthus major, Erica parviflora, Conyza scabrida*, and *Calopsis paniculata*. Sedges and restios are numerous and include *Elegia recta, Restio tetragonus, Fuirena* spp*., Cyperus* spp*., Juncus* spp*., and Isolepis* spp*.* *Laurembergia repens* is a common herb, and grasses include *Pennisetum macrourum, Cynodon dactylon* and *Merxmuellera cincta*. Annuals may be common and include *Ursinia* spp., *Dimorpotheca pluvialis, Osteospermum* spp., *Senecio* spp., *Gorteria personata, Tripteris sinuata*, etc.

Special plant species: Many of the species recorded here have never been recorded this far north, and thus are of major biogeographic interest, and ecological value. At least two new plant species are largely restricted to these systems (*Psoralea* sp. nov, and *Limonium* sp. nov.). *Salix mucronata* ssp. *mucronata* (indigenous willow) is one of the few special species in this habitat, where it is common, and it is possibly endemic to the Olifants catchment. *Babiana scabrifolia* is endemic to sands in the Olifants river valley and may occur in drier parts of this habitat. *Geissorhiza louisabolusiae* is restricted to vleis and marshy areas in the Clanwilliam region, and is now certainly very rare. *Oxalis laxiuscula* is a poorly known species from sands in the Olifants river valley, and *Oxalis uliginosa* is known only from marshy areas near Clanwilliam.

Figure 22 Olifants River between Citrusdal and Clanwilliam.

Major threats and impacts: The Olifants River floodplain has been severely reduced in extent, due to the encroachment of agricultural activities – primarily the cultivation of vines and tomatoes, and potato farming – close to, and sometimes right up to, the edge of the river itself. The floodplain has been extensively filled in order to create cultivated fields. Indigenous vegetation has been burnt and removed, to make way for crops. All of the alluvial floodplains in the planning domain are highly threatened by water abstraction – both surface (the many dams on the Olifants) and groundwater, especially for potato farming. This is threatening the seasonal inundation of the floodplain, and so the persistence of floodplain vegetation and wetlands.

There is also extensive invasion by alien vegetation, with roads and railways, irrigation canals, urban and rural development comprising lesser threats.

Sandveld floodplain

Sandveld floodplain wetlands occur along the following river systems:

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- Verlorenvlei
- Jakkals
- Sout River (tributary to the south of the Berg River)
- Rocher Pan system

The climate in these areas is low rainfall (MAP less than 300mm), which occurs in winter. With the exception of Verlorenvlei, all of these rivers are seasonal in nature. Sandveld floodplains occur on alkaline to neutral silts and sands, which can be deep in places, and which can lie over calcretes and clays (water tends to be more permanent in these areas). These systems tend to be saline, and have a high dependence on groundwater – surface water flow is replenished by the occurrence of springs and seeps. Much of the water flow in these floodplains can occur as subsurface flow. Sandveld floodplains are often wide, sandy systems with braided channels within the wider floodplain.

The wetland type occurring on sandveld floodplains is classified as Cape Inland Salt Pans / Marsh. This vegetation type is dominated by small succulent shrubs, such as *Sarcocornia* spp., and rushes, *Juncus kraussii*. Trees, annuals, bulbs and grasses (with the exception of *Cynodon dactylon*) are rare. The botanical diversity is low.

Typical plant species: Bolboschoenus *maritimus, Carpha glomerata, Chondropetalum tectorum, Cliffortia strobilifera, Cyperus longus, C.thunbergii, Leucadendron brunioides, Monopsis* spp., *Pennisetum macrourum, Phragmites australis, Psoralea filifolia, Pycreus polystachyus, Romulea leipoldtii, Scirpoides thunbergii, Typha capensis and Zantedeschia aethiopica, Zostera capensis* (aquatic), *Chenolea diffusa, Sarcocornia* spp., *Salicornia meyeriana, Salsola aphylla, Triglochin striata, Triglochin bulbosa, Plantago crassifolia, Ruppia* spp., *Psilocaulon dinteri, Drosanthemum sp., Disphyma crassifolium, Spergularia media, Juncus kraussii, J. acutus, Sporobolus virginicus, Cotula coronopifolia, Cotula filifolia, Limonium equisetinum*, and *Puccinellia angusta*. On drier edges *Lycium ferocissimum, Lycium cinereum*, and *Exomis microphylla* may be prominent. The shallow, seasonal freshwater elements associated with some of these systems (eg. Sout River) introduce a different suite of species such as *Elegia recta, Dimorpotheca pluvialis, Dorotheanthus bellidiformis, Dorotheanthus clavatus, Senecio* cf. *burchellii, Oxalis pes caprae, Asparagus capensis*, and *Cotula* sp. Alien grasses may be common on the fringes of the fresher systems (eg. *Lolium, Avena*).

Special plant species: Three vygie species have specialised in this habitat in the region: *Drosanthemum salicola* is known from saltmarshes from Nuwerus to Langebaan. *Lampranthus salicola* is known from this habitat in the Sandveld and Saldanha regions, and *Dorotheanthus clavatus* occurs in the greater Hopefield district. All three species are poorly known, and possibly threatened. The Verlorenvlei floodplain wetlands support an undescribed three meter tall species of *Psoralea* that is endemic to the Sandveld, and is Red Data listed as Endangered.

Major threats and impacts: Like the other floodplain types, sandveld floodplains are threatened by infilling, in order to reclaim land for agriculture, development and roads. Salt mining is a major threat, due to the natural salinity of these systems. Water abstraction – especially groundwater – is predominant in these catchments, and could lead to the drying out of these floodplain wetlands.

Figure 23 Verlorenvlei River.

4.3.2 Valley Bottom Wetlands

Arid valley bottom

Arid valley bottom wetlands are associated with rivers located in the north of the Sandveld-Saldanha planning domain – these include the Klein / Troe-Troe river system (major tributary of the Olifants River), a short, confined section of the middle Olifants River itself, the lower Doring River (as it joins the Olifants) and a number of small streams that enter the middle Olifants. The climate is semi-arid, and the underlying soils and geology are variable, ranging from acid through to alkaline shale-derived soils, with intrusions of quartz, dolomite and sandstone. These riverine systems tend to have a well-defined channel, and are found associated with lower foothill or lowland rivers.

Arid valley bottoms are vegetated, usually with reeds and sedges along the water's edge, but often invaded by reeds, Phragmites australis, where water is now more permanent as a result of disturbance. The river channels themselves tend to be of a sandy / silty substratum which is mostly unvegetated. Trees can occur in the riparian belt, but are more often alien than indigenous. Acacia karoo could be expected to naturally occur in valley bottom wetlands. This

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valley bottom type is defined more by the climate than the vegetation or underlying geology, and so a variety of vegetation types surround arid valley bottoms, including Doring River Quartzite Karoo, Knersvlakte Quartz Vygieveld and Knersvlakte Dolomite Shrubland, Klawer Sandy Shrubland and Vanrhynsdorp Gannabosveld. The wet vegetation type for arid valley bottoms is Namaqualand Riviere.

Figure 24 Doring River.

Typical plant species: Trees include *Tamarix usneoides* and *Acacia karroo*. Alien trees include *Acacia saligna*, and *A. longifolia*, with *Prosopis* invading drier areas. Alien shrubs include *Ricinis communis, Nerium oleander, Nicotiana glauca*, and *Polygonum lapathifolium*. Indigenous grasses, shrubs and succulents include *Lycium ferocissimum, L. horridum, Salsola tuberculata, Limonium dregeanum, Sarcocornia terminalis, Suaeda fruticosa, Galenia africana, Viscum capense, Rhus burchellii, Melianthus pectinatus, Zygophyllum retrofractum, Didelta carnosa, Tetragonia fruticosa, Ehrhrarta longiflora*, *Ischyrolepis rotboellioides, Odyssea paucinervis, Cynodon dactylon, Exomis microphylla, Malephora framesii, M. lutea, Mesembryanthemum guerichianum, Psilocaulon* sp., and *Phragmites australis*.

Special plant species: Very few special plant species occur. *Sarcocornia terminalis* is endemic to the floodplains and valley bottoms in the Knersvlakte.

Major threats and impacts: Arid valley bottoms are particularly threatened by water abstraction – largely groundwater - which will lead to the drying of these systems. Impoundment is also a major threat, especially on the Doring River. Irrigation return flows tend to elevate the natural salinity of these floodplains, and tend to lead to more permanent water being present in the river channel and so a change in the nature of the system. The ephemeral nature of these systems means that they area particularly vulnerable to changes in water quantity and quality. Other impacts include sand mining, roads and railway networks, and alien (e.g. *Prosopis* sp.) and indigenous (e.g. *Galenia africana*) invasives.

Sandstone fynbos valley bottom

Sandstone fynbos valley bottom wetlands are scattered throughout the planning domain. They are located in the lowlands and the more mountainous areas, wherever sandstone fynbos vegetation types are found. Typically, these systems are fed by hillslope seeps situated on higher-lying ground, and are themselves comprised of a generally well-defined channel with riparian wetland of varying width, that is fed by water seeping from the surrounding mountain slopes and from springsor from upstream. These valley bottom wetlands are typically associated with upper and lower foothill river systems, which can be permanent or seasonal, depending on location and aspect. Floating aquatics can occur in more permanent pools.

The underlying soils are derived from sandstones, and are acid. The dominant vegetation is a mix of low to medium height herbaceous species – reeds, restios, grasses, sedges – and scrub-shrub type vegetation – small trees and proteoid and ericoid fynbos species.

The azonal wet vegetation type is Cape Lowland Freshwater Wetland.

Typical plant species: *Athanasia crithmifolia, Bolboschoenus maritimus, Salix mucronata, Cliffortia strobilifera, Conyza scabrida, Morella integra, Eleocharis limosa, Paspalum vaginatum, Panicum schinzii, Cyperus sphaerospermus, Rhus rehmanniana, R. angustifolia, R. lucida, Romulea multisulcata, R. schlechteri, Carpha glomerata, Metrosideros angustifolia, Podocarpus elongatus, Melianthus major, Leucodendron pubescens, Elegia capensis*, and *Olea europaea* ssp. *africana*. *Phragmites australis* (reeds) and *Typha capensis* (bulrush) common in deeper waters. Floating aquatics include *Aponogeton distachyos* (waterblommetjie) and *Spiloxene aquatica*. *Sarcocornia* sp., *Juncus rigidus*, and *Polypogon monspeliensis* may be present in slightly more saline areas. Numerous alien invasive species are a feature, including *Eucalyptus cladocalyx* (red river gum), *Acacia saligna* (Port Jackson), *Acacia longifolia, Sesbania punicea, Polygonum lapathifolium* and *Eichornia crassipes* (water hyacinth).

Special plant species: The level of endemism in Cederberg Sandstone Fynbos is high, and includes the following wetland species: *Leucospermum reflexum, Erica cernua, Disa cederbergensis, Geissorhiza minuta*.

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Figure 25 Boontjies River.

Major threats and impacts: The clearing of land for cultivation of potatoes and rooibos in sandstone fynbos has led to the loss or reduction the extent of sandstone fynbos valley bottom wetlands. Associated with rooibos cultivation, and other crops, is the use of chemicals and fertilizers which tend to alter the water chemistry in wetlands – these acid systems are particularly vulnerable to a change in pH. These wetlands are threatened by fragmentation, as a result of roads crossing wetlands, rural development and draining of wetlands. All of these activities can lead to erosion within seeps. Sandstone fynbos is fire-driven vegetation and so alterations to the fire regime would lead to loss of species diversity.

Strandveld valley bottom

These systems are located almost exclusively on the Saldanha Peninsula. They are seasonal wetlands associated with lower foothill and lowland rivers. These strandveld valley bottoms are generally fed by hillslope seeps lying on higher ground and are not particularly groundwater-dependent. Most of these valley bottoms have a well-defined channel, but it is likely that historically they lacked a channel and water flowed as diffuse flow through marshy areas. Strandveld valley bottoms tend to be quite wide in places, where the ground flattens out on the

Peninsula. These systems are seasonal, tend to be saline, and occur on neutral to alkaline sands or granite-derived soils.

The dominant vegetation is a mix of restios, grasses (usually *Cynodon dactylon*), *Sarcocornia* spp. and the rush, *Juncus kraussi*. The surrounding vegetation types all belong to the western strandveld vegetation group, while the wet vegetation type is Cape Inland Salt Pan / Marsh.

Figure 26 Valley bottom wetland on the Saldanha Peninsula.

Typical plant species: Restios, *Juncus kraussi, Cynodon dactylon, Melianthus major, Typha capensis, Phragmites australis, Exomis microphylla, Sarcocornia* spp., *Drosanthemum* sp., *Lycium cinereum, Atriplex* spp., *Chenolea diffusa*, and *Disphyma crassifolia*.

Special plant species: None noted in the strandveld wetlands.

Major threats and impacts: Strandveld valley bottom wetlands have been severely impacted by agricultural activities near the coast. Cultivated fields have encroached severely into these riverine corridors, with physical modifications also resulting from impoundment, roads and railways and urban development. Livestock are often allowed to roam through these riverine wetlands, in order to make use of the superior grazing in these wetter areas. Due to their location near the coast, these systems are also particularly threatened by resort, housing, and urban

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development. Stormwater and sewage disposal are of particular concern. As seasonal systems, strandveld valley bottom wetlands are particularly threatened by changes to the flow regime, as a result of water abstraction or augmentation. Alien tree invasion is a problem – the main culprits are Acacia saligna and A. cyclops. Alien grasses are also a problem.

Sandveld valley bottom

Sandveld valley bottom wetlands are found associated with the lower foothill and lowland river reaches of the Sandlaagte, Jakkals and Langvlei rivers, along the west coast. These wetlands are mostly seasonal, fed by groundwater discharge and upstream surface water flow. They lie on acid to alkaline sands, and tend to be saline to brackish systems.

The vegetation comprised grasses and reeds, small succulent shrubs, such as *Sarcocornia* spp., and rushes, *Juncus kraussii*. Trees, annuals, bulbs and grasses (with the exception of Cynodon dactylon) are rare. Floating aquatics can occur in more permanent pools. The botanical diversity is low. The surrounding vegetation types are strandveld types – Namaqualand and Graafwater Flats Strandveld – or sand fynbos – Leipoldtville Sand Fynbos and Namaqualand Sand Fynbos. The wet vegetation type equivalent is Cape Inland Salt Pan / Marsh.

Figure 27 Valley bottom wetland in the upper Jakkalsvlei catchment.

Typical plant species: *Bolboschoenus maritimus, Carpha glomerata, Chondropetalum tectorum, Cliffortia strobilifera, Cyperus longus, C.thunbergii, Leucadendron brunioides, Monopsis spp., Pennisetum macrourum, Phragmites australis, Psoralea filifolia, Pycreus polystachyus, Romulea leipoldtii, Scirpoides thunbergii, Typha capensis*, *Zantedeschia aethiopica, Zostera capensis* (aquatic), *Chenolea diffusa, Sarcocornia spp., Salicornia meyeriana, Salsola aphylla, Triglochin striata, Triglochin bulbosa, Plantago crassifolia, Ruppia* spp., *Psilocaulon dinteri, Drosanthemum sp., Disphyma crassifolium, Polypogon monspeliensis, Spergularia media, Juncus kraussii, Juncus rigidus, J. acutus, Sporobolus virginicus, Cotula coronopifolia, Cotula filifolia, Limonium equisetinum*, and *Puccinellia angusta*. On drier edges *Lycium ferocissimum, Lycium cinereum*, and *Exomis microphylla* may be prominent. Alien grasses may be common on the fringes of the fresher systems (eg. Lolium, Avena).

Special plant species: Three vygie species have specialised in this habitat in the region: *Drosanthemum salicola* is known from saltmarshes from Nuwerus to Langebaan; *Lampranthus salicola* is known from this habitat in the Sandveld and Saldanha regions, and *Dorotheanthus clavatus* occurs in the greater Hopefield district. All three species are poorly known, and possibly threatened.

Major threats and impacts: Sandveld valley bottom wetlands are threatened by infilling, in order to reclaim land for agriculture, development and roads. Salt mining is a major threat, due to the natural salinity of these systems. Water abstraction – especially groundwater – is predominant in these catchments, and could lead to the drying out of these wetlands.

4.3.3 Seep Wetlands

Both hillslope and basin seeps were scattered throughout the planning domain, being both isolated and non-isolated systems. Basin seeps tend to be isolated systems, whereas hillslope seeps tend to be non-isolated systems. The seeps have been grouped primarily according to the vegetation type in which they are found:

Arid seep

Arid seeps are located in association with the lower Olifants and its smaller tributaries. These seeps are defined more by the climate than the underlying geology or soils. The climate in this area is semi-arid – MAP ranges between 100 and 250mm – with erratic rainfall falling between June and August. The arid seeps – all hillslope seeps with one exception – are short systems, often on fairly steep ground, located in the hills (altitude less than 500m) to the west of the Olifants River and feeding into the Olifants River floodplain. The single arid basin seep is situated on the Olifants River floodplain (now cultivated) around the lower Olifants, near Ebenhezer.

There are two main types of arid seep. Those occurring in the southern portion of the arid seep distribution, located in the Doringrivier Quartzite Karoo vegetation type, are dominated by sedges and grasses, and lie on a mix of acid to alkaline shale- and sandstone-derived soils. The azonal wet vegetation type equivalent of these seeps is Cape Lowland Freshwater Wetland. The

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seeps further north tend to be more arid with reeds where there is more permanent water, and riparian trees such as *Acacia karoo* and *Prosopis*. These seeps occur in Knersvlakte Quartz Vygieveld (neutral shale-derived soils, with quartz), Namaqualand Spinescent Grassland (neutral sands), Vanrhynsdorp Gannabosveld (neutral to alkaline shale-derived soils) and Klawer Sandy Shrubland (acid sands and sandstone-derived soils). The closest equivalent azonal wet vegetation type is Namaqualand Riviere.

Arid seeps are fed primarily by precipitation and upstream surface flow, and are not considered to be particularly important for groundwater recharge.

Typical plant species: Trees include *Acacia karoo* and the alien *Prosopis sp; Phragmites australis*, various sedges and grasses (indigenous and alien), *Ischyrolepis rotboellioides*.

Special plant species: The vegetation is poorly known, but *Oxalis simplex* may be endemic to this unit, in seasonally wet areas.

Major threats and impacts: The seeps associated with the lower Olifants River have been severely impacted by cultivation of vines, tomatoes and other fruits. Those that lie in the hills are fairly protected, while those on the floodplain have been completely transformed into more perennial, reed-infested systems. The irrigation canal and roads that run adjacent to the middle and lower Olifants River have led to a loss of connectivity within seeps, and only impacted fragments remain below the roads and canal. In the more arid areas, e.g. the Knersvlakte, overgrazing can lead to a loss of the grasses and sedges that should occur in the seeps, and erosion. Alien grass and tree invasion are not as problematic as in the more mesic areas further south of the domain, but Prosopis can be fairly common.

Sandstone fynbos seep

Sandstone fynbos seeps tend to be mountainous systems, located in the mountain ranges on either side of the Olifants River – the Western Cederberg, Kouebokkeveld mountains, and the mountains around Heerenlogenment. These seeps are important areas for water supply, located as they are towards the source of rivers and streams, and for groundwater recharge. Sandstone fynbos seeps are both permanent and non-permanent, depending on location and slope, but are usually drier in summer (although soils can remain wet) and inundated in winter. These seeps occur on sandstone-derived acid sands. The seeps in the north of the domain (those located in Graafwater and Bokkeveld Sandstone Fynbos) are more arid – MAP of between 200 and 500mm - than those further south, where the MAP can reach 700mm.

Basin seeps are depression-like or concave, with water gathering at a distinct low point. Sandstone fynbos basin seeps are associated with the upper reaches of the Peddies River (tributary of the Jakkals River) and the Lambertshoek River (tributary of the Langvlei system). Hillslope seeps tend to occur on slight slopes, and may be very rich in organic deposits. Sandstone fynbos hillslope seeps are scattered throughout the mountainous parts of the planning domain.

The seeps are fairly densely vegetated, and tend to be dominated by restioid (where sands are deeper) and proteoid fynbos and indigenous grasses, but can be invaded by reeds, such as *Phragmites australis*, and bulrush, *Typha capensis*, where disturbed or where water is more

permanent. The vegetation type surrounding these seeps are all sandstone fynbos types, primarily Bokkeveld, Graafwater, Olifants and Cederberg Sandstone Fynbos that occur around the middle and upper Olifants River and, further south, Piketberg Sandstone Fynbos. The equivalent azonal wet vegetation type is Cape Lowlands Freshwater Wetlands.

Typical plant species: *Athanasia crithmifolia, Salix mucronata, Cliffortia strobilifera, Conyza scabrida, Morella integra, Eleocharis limosa, Panicum schinzii, Rhus rehmanniana, R. angustifolia, R. lucida, Romulea multisulcata, R. schlechteri, Carpha glomerata, Metrosideros angustifolia, Podocarpus elongatus, Melianthus major, Leucodendron pubescens, Elegia capensis*, and *Olea europaea ssp. africana*. Wetland aliens include *Acacia mearnsii, A. longifolia, Polygonum lapathifolium*, and *Paraserianthes lophantha*.

Special plant species: The level of endemism in Cederberg Sandstone Fynbos is high, and includes the following wetland species: *Leucospermum reflexum, Erica cernua, Disa cederbergensis, Geissorhiza minuta*.

Figure 28 Seeps evident on sandstone hillslopes.

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Major threats and impacts: The last two decades or so have seen substantial clearing of dry and wet areas in sandstone fynbos for the cultivation of rooibos. These fields are often placed in wetter, seep areas. This leads to the almost total loss of wetland vegetation in and around these seeps, and so a radical deterioration in the quality of wetland habitat. Associated with rooibos cultivation, and other crops, is the use of chemicals and fertilizers which tend to alter the water chemistry in wetlands – these acid seeps are particularly vulnerable to a change in pH. Hillslope and basin seeps are threatened by fragmentation, as a result of roads crossing wetlands, rural development and draining of wetlands. All of these activities can lead to erosion within seeps. Sandstone fynbos is fire-driven vegetation and so alterations to the fire regime would lead to loss of species diversity.

Sand fynbos seep

Sand fynbos basin seeps occur on fairly low-lying, flat ground, predominantly around the southern Sout River (tributary of the Berg River) and inland of the Rocher Pan system. These all occur in the vegetation type classified as Bergriver Sand Fynbos – Flats Strandveld Mosaic, and Hopefield Sand Fynbos. A few basin seeps are located in the upper Sandlaagte River catchment, and in the middle Langvlei catchment. The hillslope seeps are located on slightly higher ground, also in the upper catchments of the Sandlaagte, Jakkals, Langvlei and Verlorenvlei rivers in Leipoldtville Sand Fynbos, with a smaller group of hillslope seeps in the Bergriver Sand Fynbos – Flats Strandveld Mosaic vegetation type further south. These seeps all occur on acid sands, which are generally deep, and which are low altitude (less than 150m).

The seeps essentially occupy coastal sand flats. The northern Leipoldtville Sand Fynbos, Hopefield Sand Fynbos and Bergriver Sand Fynbos – Flats Strandveld Mosaic vegetation types are characterised by patches of medium to tall shrubs, which are separated by fairly dense restiolands. The seeps are generally vegetated, dominated by restios and the rush, *Juncus kraussii*, but can be invaded by reeds, such as *Phragmites australis*, and the bulrush, *Typha capensis*, where disturbed. *Sarcocornia natalensis*, which required seasonal freshwater flooding, can occur in sand fynbos seeps. The equivalent azonal wet vegetation type is Cape Lowlands Freshwater Wetlands.

Typical plant species: The wetland areas may feature *Berzelia lanuginosa, Orphium frutescens, Restio tetragona, Elegia fistulosa, Elegia tectorum, Elegia recta, Platycaulos compressus, Cliffortia ferruginea, C. strobilifera, Merxmuellera cincta, Typha capensis, Phragmites australis*, *Plantago crassifolia, Cynodon dactylon, Sarcocornia natalensis, Nidorella foetida, Schoenus nigricans, Limonium sp. nov., Psoralea sp. nov., Erica parviflora, Morella quercifolia, Imperata cylindrica, Senecio halimifolius*, and *Athanasia crithmifolia*.

Special plant species: The sand fynbos seeps on peaty acid sands within the Leipoldtville Sand Fynbos are a special habitat, regarded as rare and extremely important. The northernmost records of several wetland species are recorded here.

Major threats and impacts: Same as for sandstone fynbos seeps. Potato and rooibos farming in the north, and wheat in the south, are having a significant impact on both wet and dry habitats in the sand fynbos vegetation types. Wetlands, in particular seeps, are being drained and filled in to provide fields for cultivation. This represents large-scale loss of wetland habitat. Where non-

isolated seeps are destroyed, the consequences for the downstream catchments will be severe, leading to a loss of surface water in an area where irrigation resources are poor. Groundwater abstraction is having a serious impact on seeps.

Renosterveld hillslope seep

Renosterveld hillslope seeps (there are no basin seeps) occur on alkaline shale-derived clays. These seeps are all non-isolated, and mostly located in the southern half of the domain, around the middle Berg River, the Boesmans River (major tributary of the Berg River) and the upper reaches of tributaries of Verlorenvlei. Many of the renosterveld hillslope seeps are situated in groundwater discharge areas – however, their location on clays means that they are probably perched wetlands. They tend to lie at fairly low altitudes, on gentle slopes.

The surrounding vegetation types are all of the Shale Renosterveld group – most of them lie in the south of the domain in Swartland Shale Renosterveld (MAP 270 – 670mm), while the few remaining, more northerly renosterveld hillslope seeps lie in Graafwater, Vanrhynsdorp and Citrusdal Shale Renosterveld (MAP < 450mm). These seeps are dominated by sedges and grasses, but are often impacted and so are invaded by kikuyu grass, Typha capensis and Phragmites australis.

Typical plant species: Restios, grasses, sedges.

Special plant species: Not many specials known in wetlands, but Swartland Shale Renosterveld has a high occurrence of special species. *Geissorhiza imbricata subsp. bicolor* (geophyte) is listed as important in Swartland Shale Renosterveld by Mucina and Rutherford (2006).

Major threats and impacts: The Swartland Shale Renosterveld has been severely transformed – 90% has been totally transformed – and remaining 10% lies in fragments across the landscape. The wetlands lying within this vegetation type have similarly been affected, largely by cultivation and livestock grazing. Many of these renosterveld hillslope seeps lie on the lowlands, which are ideal for agriculture, and so these habitats are highly threatened.

Strandveld seep

Strandveld basin seeps are all coastal systems, occurring on neutral to alkaline deep sands. In the south of the domain, basin seeps are found around the lower Berg River and on the coast just north of Rocher Pan, with one basin seep lying in up in the north, near the Olifants River mouth. These are mostly isolated systems, fed seasonally by precipitation. They tend to be saline, especially closer to the coast. Most of the strandveld hillslope seeps occur on the Saldanha Peninsula, on neutral granite-derived soils. A few are located further north, with several isolated seeps around the upper reaches of the Jakkals River and its tributaries, and one isolated hillslope seep north of the Sandlaagte. These northern seeps occur on neutral to alkaline sands. None of the strandveld seeps appear to be particularly important for groundwater recharge, and are not situated in groundwater discharge areas. All of the strandveld seeps lie in the lowlands, in areas with a low rainfall – MAP ranging from 250 – 350mm in the south of the domain to 125 - 200mm in the north.

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The Saldanha hillslope seeps lie within the Saldanha Granite Strandveld. These seeps are dominated by a restio - *Juncus kraussii* mix, with some grasses, such as *Cynodon dactylon*. The scattered northern hillslope seeps are located within Graafwater Flats Strandveld and Namaqualand Strandveld. The coastal basin seeps north of Rocher Pan are situated in Langebaan Dune Strandveld, and are essentially dune slack wetlands dominated by *Juncus kraussi*. The northern isolated basin seep near the Olifants River mouth is located in Namaqualand Strandveld. The azonal wet vegetation type equivalent is Cape Inland Salt Pan / Marsh.

Typical plant species: Restios, *Juncus kraussi, Cynodon dactylon, Melianthus major, Typha capensis, Phragmites australis, Exomis microphylla, Sarcocornia spp., Drosanthemum sp., Lycium cinereum, Atriplex* spp., *Chenolea diffusa*, and *Disphyma crassifolia*.

Special plant species: None noted in the strandveld wetlands.

Major threats and impacts: Although there are some protected areas within the strandveld, the strandveld seeps have been severely impacted by agricultural activities near the coast. Many seeps have been ploughed up, especially the basin seeps, or drained to provide fields for cultivation. Livestock are often allowed to roam through seeps, in order to make use of the superior grazing in these wetter areas. Due to their location near the coast, these systems are also particularly threatened by resort, housing, and urban development, especially in the southern portion of the domain. Road and railways tend to fragment hillslope seeps, separating them from their downstream catchment. Alien tree invasion is more of a problem towards the south of the domain – the main culprits are *Acacia saligna* and *A. cyclops*. Alien grasses are also a problem.

4.3.4 Depressional Wetlands

Sandstone fynbos depression

A mix of isolated and non-isolated sandstone fynbos depressions occur in the upper Jakkals River and Boesmans River (tributary of the Berg River) catchments. These are all inland systems, lying above 200m altitude, on gently sloped terrain. The depressions occur on acid sandstone-derived soils, and are all seasonal, shallow (littoral) systems. Some are situated in groundwater recharge areas, and all are fed predominantly by precipitation.

The depressions are vegetated (although sometimes sparsely so), with the plant species dominating the depressions similar to that found in the sandstone fynbos seeps – they tend to be dominated by restioid (where sands are deeper) and proteoid fynbos, indigenous grasses and sedges, but can be invaded by reeds, such as *Phragmites australis*, and bulrush, *Typha capensis*, where disturbed or where water is more permanent. The vegetation type surrounding the majority of these depressions is Piketberg Sandstone Fynbos, and the remainders are within Graafwater, Olifants and Cederberg Sandstone Fynbos.

The azonal wet vegetation equivalent is Cape Lowland Freshwater Wetland.

Typical plant species: *Athanasia crithmifolia, Salix mucronata, Cliffortia strobilifera, Conyza scabrida, Morella integra, Eleocharis limosa, Panicum schinzii, Rhus rehmanniana, R. angustifolia, R. lucida, Romulea multisulcata, R. schlechteri, Carpha glomerata, Metrosideros*

angustifolia, Podocarpus elongatus, Melianthus major, Leucodendron pubescens, Elegia capensis, and *Olea europaea* ssp. *africana*. Wetland aliens include *Acacia mearnsii, A. longifolia, Polygonum lapathifolium*, and *Paraserianthes lophantha*.

Special plant species: The level of endemism in Cederberg Sandstone Fynbos is high, and includes the following wetland species: *Leucospermum reflexum, Erica cernua, Disa cederbergensis, Geissorhiza minuta*.

Major threats and impacts: The sandstone fynbos depressions are mostly impacted by the cultivation of crops – mostly wheat in the Piketberg area. These seasonal systems are vulnerable to changes in hydrology – such as the result of ground- or surface water abstraction.

Sand fynbos depression

There are many sand fynbos depressions, most of which lie on either side of the lower Berg River. These depressions in the south of the planning domain are found in Bergriver Sand Fynbos – Flats Strandveld Mosaic and Hopefield Sand Fynbos. The remaining sand fynbos depressions lie inland, in the west coast catchments of the Sandlaagte, Jakkals, Langvlei and Verlorenvlei rivers. The more northern sand fynbos depressions lie in Leipoldtville Sand Fynbos and Namaqualand Sand Fynbos. All the sand fynbos depressional wetlands are found on acid deep sands, and tend to be fed by groundwater.

The majority of these depressional wetlands are isolated, shallow and seasonally inundated. They are predominantly unvegetated, with a silt and mud substratum. Where vegetated, the vegetation is dominated by restios and the rush Juncus kraussi. The azonal wet vegetation equivalent is Cape Lowland Freshwater Wetland.

Typical plant species: The wetlands may feature *Berzelia lanuginosa, Orphium frutescens, Restio tetragona, Elegia fistulosa, Elegia tectorum, Elegia recta, Platycaulos compressus, Cliffortia ferruginea, C. strobilifera, Merxmuellera cincta, Typha capensis, Phragmites australis, Plantago crassifolia, Cynodon dactylon, Nidorella foetida, Schoenus nigricans, Limonium* sp. nov., *Psoralea* sp. nov., *Erica parviflora, Morella quercifolia, Imperata cylindrica, Senecio halimifolius*, and *Athanasia crithmifolia*.

Special plant species: None noted.

Major threats and impacts: Sand fynbos depressions are highly threatened by cultivation of crops such as wheat, especially in the Hopefield area. These wetlands are often ploughed up for the creation of fields. Livestock graze and trample the depressions. These wetlands are also frequently fragmented by road and rail networks.

Renosterveld depression

The renosterveld depressions are all isolated, shallow systems, most of which are vegetated. These depressions are located to in the lowlands to the east of the middle Berg River and in the catchment of the Boesmans River. They lie on alkaline shale-derived clays, and are probably fed predominantly be precipitation, becoming inundated in the wet winter months.

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Most of the depressions lie in Swartland Shale Renosterveld, with one lying further north in Graafwater Shale Renosterveld. The equivalent azonal wet vegetation type is Cape Lowlands Freshwater Wetlands.

Typical plant species: Restios, grasses, sedges.

Special plant species: Not many specials known in wetlands, but Swartland Shale Renosterveld has a high occurrence of special species. *Geissorhiza imbricata* subsp. *bicolor* (geophyte) is listed as important in Swartland Shale Renosterveld by Mucina and Rutherford (2006).

Major threats and impacts: The Swartland Shale Renosterveld has been severely transformed – 90% has been totally transformed – and remaining 10% lies in fragments across the landscape. The wetlands lying within this vegetation type have similarly been affected, largely by cultivation and livestock grazing. All of the renosterveld depressional wetlands lie on the lowlands, which are ideal for agriculture, and so these habitats are highly threatened.

Strandveld depression

There are numerous strandveld depressions, located primarily on the Saldanha Peninsula and just north of the lower Berg River. These are mostly isolated, shallow, seasonally inundated depressions, lying on neutral sands or granite-derived soils, reliant mostly on precipitation rather than groundwater or surface flow. The depressions north of the Berg River are within a groundwater discharge area, so probably are also filled when the water table rises. Further north, there are a smaller number of depressional wetlands situated around the lower Langvlei system, and then some in the Sandlaagte catchment, although far from the river system itself. A few are scattered around the lower and middle Olifants River. Strandveld depressions tend to be saline.

Figure 29 Heerenlogenment pan near Graafwater.

The strandveld depressions are a mixture of vegetated and unvegetated wetlands. Those that are vegetated are dominated by grasses (such as *Cynodon dactylon*), *Sarcocornia* spp., and various restios, rushed and sedges. The wetlands in the south of the domain lie within the Saldanha Flats Strandveld, Saldanha Granite Strandveld and Bergriver Sand Fynbos – Flats Strandveld Mosaic vegetation types. Those further north are surrounded predominantly by Lamberts Bay Strandveld, Leipoldtville Flats Strandveld, Graafwater Flats Strandveld and Namaqualand Strandveld.

The wet vegetation type equivalent is Cape Estuarine Saltmarsh for those depressional wetlands lying on the coastline, while the remaining wetlands are Cape Inland Salt Pan / Marsh. One exception is a strandveld depression in Namaqualand Strandveld, which lies close to the middle Olifants River and which has been classified as Namaqualand Riviere in the botanical report.

Typical plant species: Restios, *Juncus kraussi, Cynodon dactylon, Melianthus major, Typha capensis, Phragmites australis, Exomis microphylla, Sarcocornia spp., Drosanthemum sp., Lycium cinereum, Atriplex spp., Chenolea diffusa*, and *Disphyma crassifolia*.

Special plant species: None noted in the strandveld wetlands.

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Figure 30 This pan on the Saldanha Peninsula is used for recreational biking and has been impacted through fill, vegetation clearing and encroaching development.

Major threats and impacts: Although there are some protected areas within the strandveld, the strandveld depressions have been severely impacted by agricultural activities near the coast. Many isolated depressions have been ploughed up, or drained to provide fields for cultivation. Salt-mining, on a small or large scale has led to physical modification of depressional wetlands. Due to their location near the coast, these systems are also particularly threatened by resort, housing, and urban development, especially in the southern portion of the domain. Alien invasion, apart from grass species, is not a major problem in strandveld depressions.

Figure 31 Strandveld depression surrounded by wheatfields.

Arid depression

Three arid depressions are located in the Sandveld-Saldanha planning domain – one isolated depression is located close to Sout River in the Knersvlakte, another non-isolated depression is located alongside the Moedverloor River (a tributary of the Hol / Sout) and a third isolated depression is situated close to the middle Olifants River at its confluence with the Doring River. All of the arid depressions are ephemeral systems, which are only inundated after good rains (in winter). They are unvegetated, with silt / mud substrata. The underlying geology and soils are not characteristic, and vary from acid through to alkaline sands, sandstone- or shale-derived soils.

The northern arid depressions tend to be fairly saline, and are characterised as Namaqualand Riviere, while the southern isolated depression is a Cape Lowland Freshwater Wetland.

Typical or Special plant species: Tend not to be vegetated.

Major threats and impacts: The major obvious impact on arid depressions is trampling by livestock. When these systems are filled with water, they are visited by livestock that tend to trample the edges of the depressions. Threats include water abstraction and physical modification in order to improve their accessibility for livestock watering.

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4.4 Significant wetland clusters

Wetlands form stepping-stones for many taxa, including birds, reptiles, invertebrates and amphibians, as they move about the landscape. The functioning of these wetlands as stepping-stones is dependent on the permeability of the surrounding landscape matrix, which generally decreases as the landscape becomes degraded.

Wetland clusters that serve potentially as ecologically viable stepping-stones were identified as follows:

- All seeps and depressions were buffered by 750 m. This buffer distance is half of the maximum viable distance between wetlands that would allow the movement of amphibian species characteristic of this planning domain across the landscape (i.e. a maximum of 1.5 km).
- The proportion of natural vegetation within these wetland clusters was calculated using the National Land Cover 2000.
- Any wetland cluster greater than 500 ha in size AND with ≥ 80% natural vegetation cover was considered a significant wetland cluster.

The significant wetland clusters that best aligned with terrestrial goals and focal amphibian point localities were subsequently selected in the integrated conservation plan.

5.0 RESULTS PER MUNICIPALITY

Table 5. Summary of inland wetlands occurring within each municipality of the Sandveld-Saldanha planning domain.

System	Subsystem	Wetland type	Total #	Total area (ha)	> 75% intact(#/ha)	CBA area (#/ha)	Protected wetlands (#/ha)	CBA# area protected
SALDANHA **BAY MUNICIPALITY**			**269**	**13406**	**56/9632**	**103/1248**	**7/1902**	**7/1902**
estuarine			2	9620				
inland	non-isolated	floodplain	3	1680				
inland	non-isolated	valley bottom	56	1267				
inland	non-isolated	seep	48	269				
inland	isolated / non-isolated	depression	160	558				
CEDERBERG MUNICIPALITY			**633**	**18868**	**339/1075**	**398/1251**	**159/5336**	**148/5090**
estuarine			3	2083				
inland	non-isolated	floodplain	22	5732				
inland	non-isolated	valley bottom	127	6858				
inland	non-isolated	seep	329	2532				
inland	isolated / non-isolated	depression	152	1140				
BERG RIVER MUNICIPALITY			**534**	**19453**	**125/1137**	**219/1644**	**64/3340**	**58/2838**
estuarine			1	6987				
inland	non-isolated	floodplain	26	6455				
inland	non-isolated	valley bottom	40	1674				
inland	non-isolated	seep	224	1761				
inland	isolated / non-isolated	depression	243	2574				
MATZIKAMMA MUNICIPALITY			**299**	**8429**	**62/4274**	**90/4503**	**4/9**	**4/9**
estuarine			1	19				
inland	non-isolated	floodplain	27	2564				
inland	non-isolated	valley bottom	52	2271				
inland	non-isolated	seep	34	252				
inland	Isolated / non-isolated	depression	184	1349				

5.1 Saldanha Bay municipality

The CBAs wetlands and sub-catchments of the Saldanha Bay municipality are shown in Figures 32 and 33.

Estuaries

The **Berg River estuary** comprises a mix of estuarine channel and estuarine depression wetlands. **Langebaan Lagoon** has been classified for the purposes of this project as an estuarine bay. Given its importance within the context of management of wetland systems within this region, it has been included as an estuarine type although it could arguably be classified as a marine embayment.

Turpie and Clark (2007) ranked the Berg River estuary as the 3rd most important South African wetland system, according it very high scores (100%) in terms of size, habitat

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importance and zonal type rarity and a high score (90%) in terms of biodiversity importance. Prochazka *et al.* (2002) noted the importance of the Berg River estuary for fish (as a nursery / refuge area) and as a feeding / over-wintering / breeding area for birds The C.A.P.E. estuaries conservation plan (Turpie and Clark, 2007) selected for the Berg River estuary for partial EPA status. This means that at least one side of the system should be managed as a sanctuary, receiving protection from all consumptive use. Langebaan lagoon was not assessed by Turpie and Clark (2007). However, the Ramsar Status of this site should afford it at least equal conservation status with the selected EPAs, and it does fall within a Protected Area, West Coast National Park.

The Berg River estuary and Langebaan lagoon systems are both vulnerable to impacts of groundwater abstraction. Other impacts include salt mining and processing plants, urban development and encroachment of cultivated fields. RHP (2006) also cited alien vegetation, overexploitation of fish, increased siltation from erosion in the catchment and, importantly, a reduction in freshwater inflows into the estuary as impacts affecting this estuary. Estuaries are vulnerable to rising sea levels, and sedimentation from upstream erosion.

Wetlands

Saldanha Bay municipality has more than 200 mapped wetlands. This is expected to be a more accurate depiction than has ever been available before, however, some wetlands were missed and all wetlands need ground-truthing to ascertain their extent and current condition.

Rivers

Rivers within the municipality have lost much of their diversity to human modification of their banks, invasive alien plant species, and invasive alien fish species.

The Saldanha Bay municipality falls within the Berg River Water Management Area. It encompasses most of quaternary catchment G10M, which includes the lower Berg River and several short coastal drainages on the Saldanha Peninsula, such as the Bok River which flows from Vredenburg to Langebaan lagoon. The Berg River rises near Franschhoek and the Drakenstein mountains, and receives water from Drakenstein, Witzenberg, Swartland and Cederburg municipalities before reaching Saldanha Bay municipality.

The Sout River is an important tributary to the Berg River within the municipality, and it has been highlighted for conservation. The Sout River is considered a unique river type. It is a saline system which likely supports a unique fish species of Cape galaxid, endemic to the area.

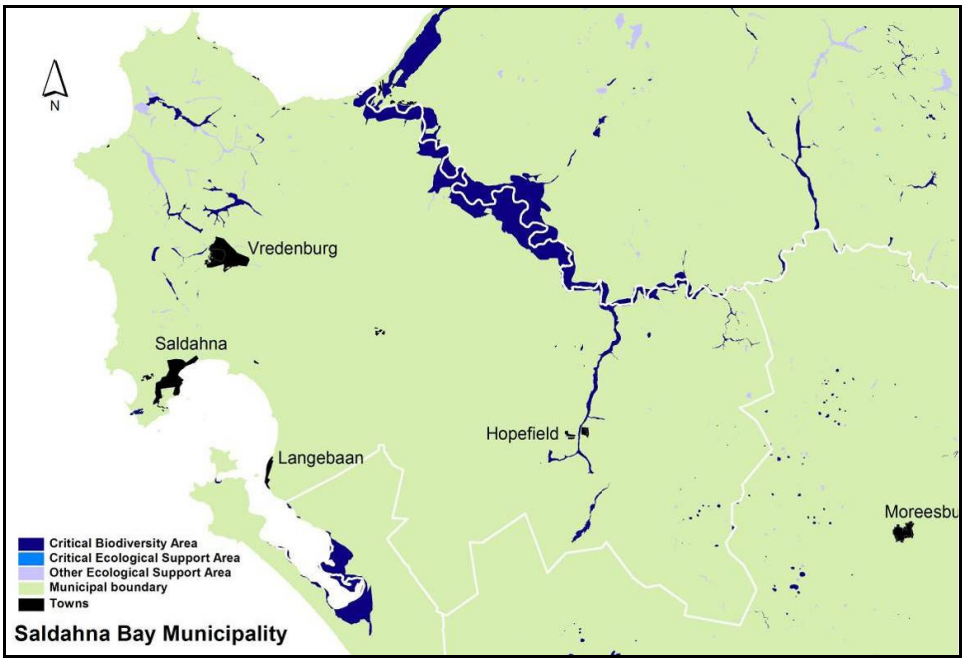

Figure 32 Wetland Critical Biodiversity Areas within Saldanha Bay municipality.

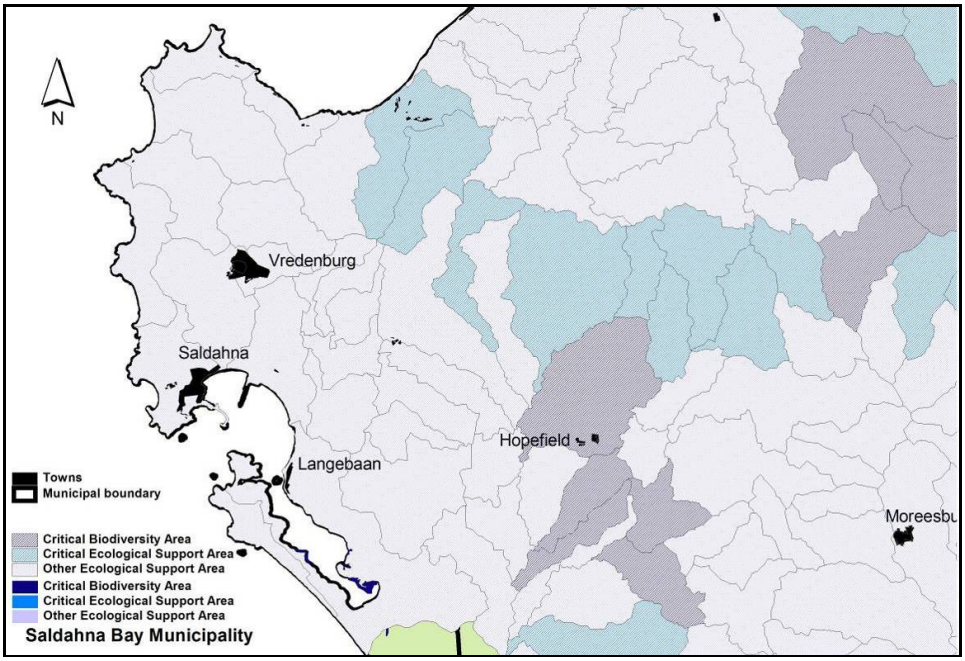

Figure 33 Critical Biodiversity Area sub-catchments within Saldanha Bay municipality.

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5.2 Berg River municipality

The CBAs wetlands and sub-catchments of the Berg River municipality are shown in Figures 34 and 35.

Estuaries

The **Berg River estuary** comprises a mix of estuarine channel and estuarine depression wetlands. Turpie and Clark (2007) ranked the Berg River estuary as the 3rd most important South African wetland system, according it very high scores (100%) in terms of size, habitat importance and zonal type rarity and a high score (90%) in terms of biodiversity importance. Prochazka *et al.* (2002) noted the importance of the Berg River estuary for fish (as a nursery / refuge area) and as a feeding / over-wintering / breeding area for birds The C.A.P.E. estuaries conservation plan (Turpie and Clark, 2007) selected for the Berg River estuary for partial EPA status. This means that at least one side of the system should be managed as a sanctuary, receiving protection from all consumptive use.

The Berg River estuary is vulnerable to impacts of groundwater abstraction. Other impacts include salt mining and processing plants, urban development and encroachment of cultivated fields. RHP (2006) also cited alien vegetation, overexploitation of fish, increased siltation from erosion in the catchment and, importantly, a reduction in freshwater inflows into the estuary as impacts affecting this estuary. Estuaries are vulnerable to rising sea levels, and sedimentation from upstream erosion.

Wetlands

The municipality supports 19 453 ha of mapped wetlands. These are mostly floodplain (6 455 ha) and valley bottom (1 674 ha) wetlands, although depression (2 574) and seep (1 761 ha) wetlands are also present.

Rivers

Rivers within the municipality have lost much of their diversity to human modification of their banks, invasive alien plant species, and invasive alien fish species.

The Berg River municipality falls within the Olifants / Doorn Water Management Area.

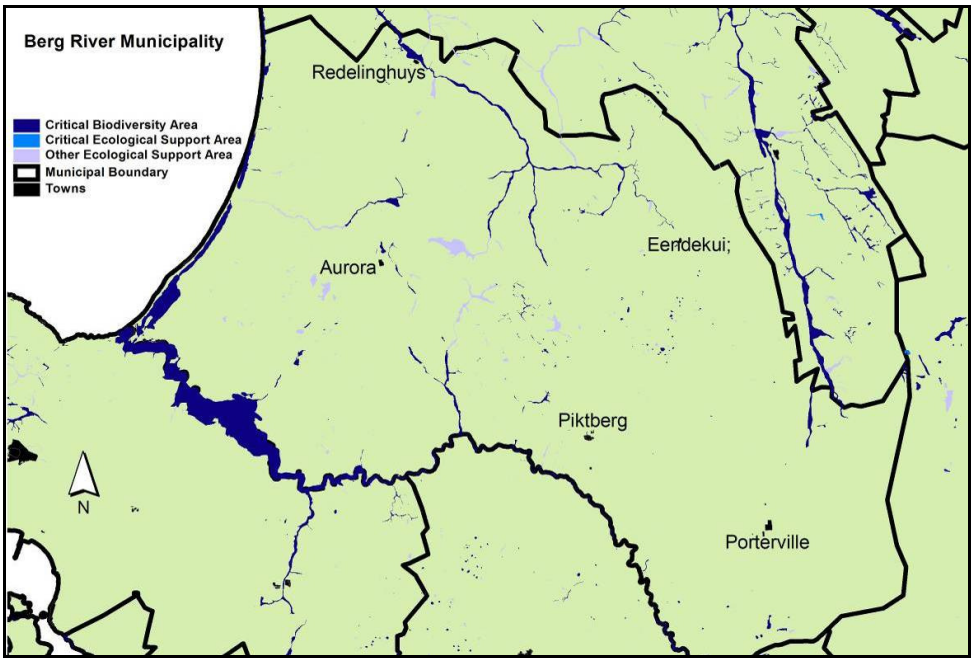

Figure 34 Wetland Critical Biodiversity Areas within Berg River municipality.

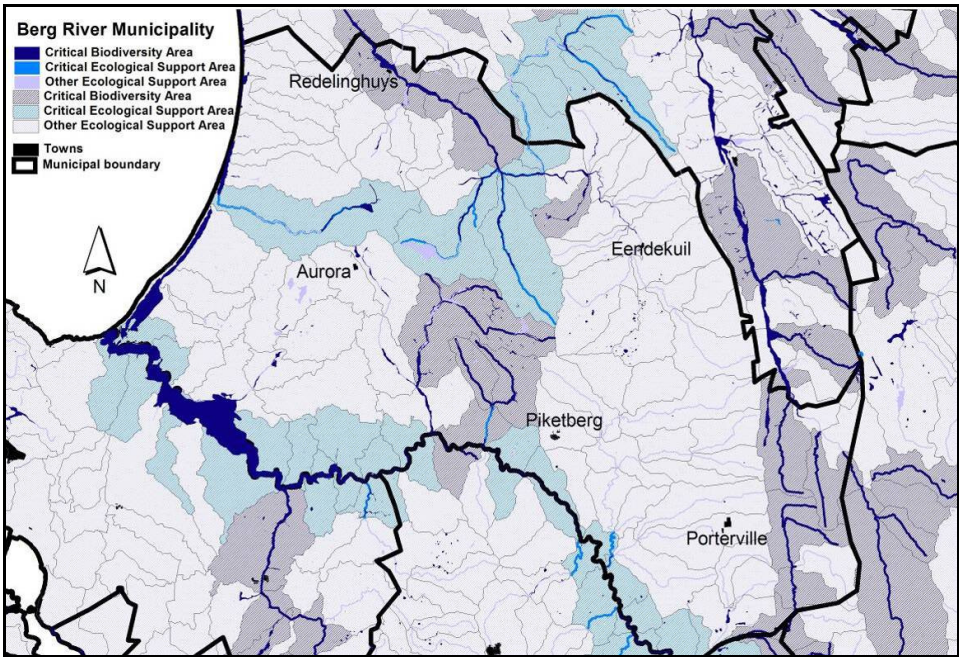

Figure 35 Critical Biodiversity Area sub-catchments within Berg River municipality.

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5.3 Cederberg municipality

The CBAs wetlands and sub-catchments of the Cederberg municipality are shown in Figures 36 and 37.

Estuaries

Velorenvlei estuary comprises a mix of estuarine channel and estuarine depression wetlands. **Langvlei** and **Jakkalsvlei** comprise….

Major impacts include salt mining, water abstraction (e.g. for potato farming in the Sandveld), urban and rural development, fragmentation and other impacts resulting from road and rail infrastructure, agricultural activities in the surrounding catchment. The Jakkals River estuary has been artificially closed with a berm, while the Wadrift Soutpan (Langvlei estuary) has been bisected by a road and railway line severely limiting connectivity to the sea. Perceived threats include rising sea levels, an increase in road infrastructure, further water abstraction from upstream surface water and localised groundwater abstraction; urban encroachment; escalating degradation of land and vegetation cover, as a result of grazing, infilling and clearing of land for agriculture and rural settlement; manipulation of flows / water levels for irrigation purposes.

Wetlands

The municipality supports 18 868 ha of mapped wetlands. These are mostly floodplain (5 732 ha) and valley bottom (6 858 ha) wetlands, although depression (1 140) and seep (2 532 ha) wetlands are also present.

Rivers

Rivers within the municipality have lost much of their diversity to human modification of their banks, invasive alien plant species, and invasive alien fish species.

Important rivers include the Olifants River and tributaries and the Velorenvlei River and tributaries.

The Cederberg municipality falls within the Olifants / Doorn Water Management Area.

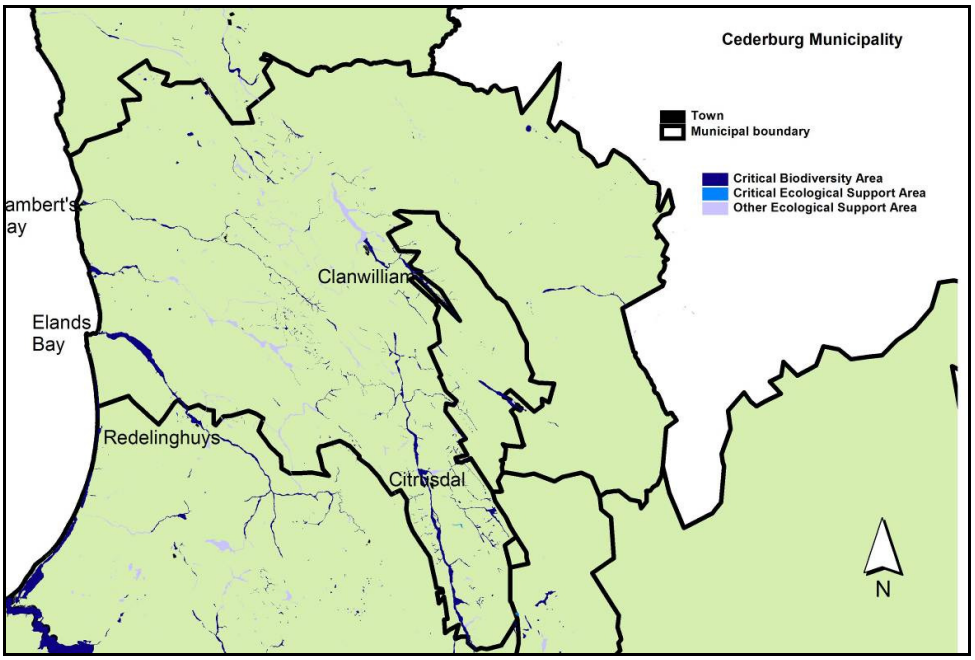

Figure 36 Wetland Critical Biodiversity Areas within Cederberg municipality.

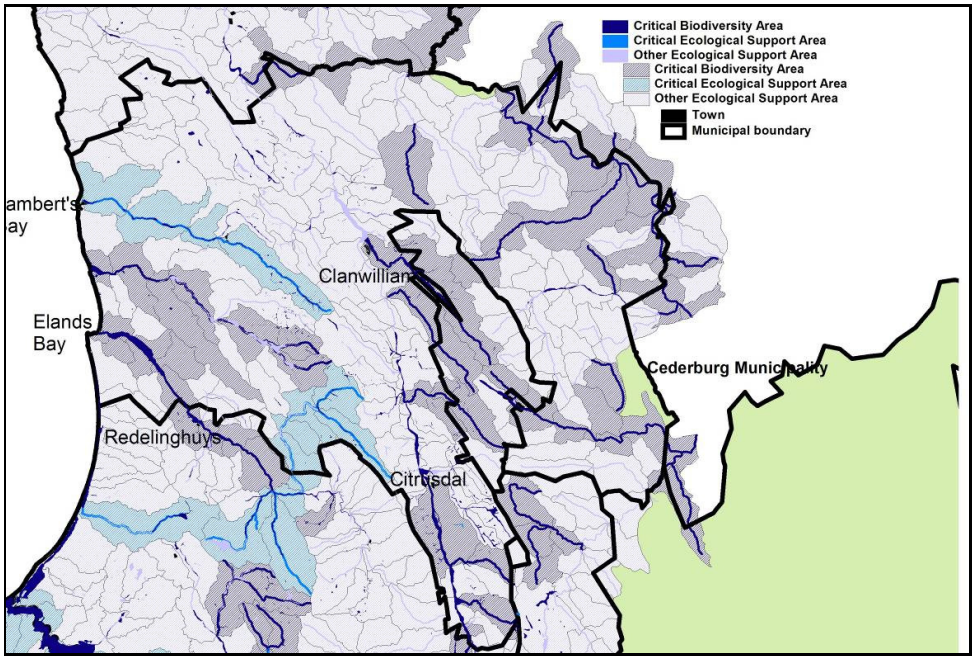

Figure 37 Critical Biodiversity Area sub-catchments within Cederberg municipality.

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5.4 Matzikamma municipality

The CBAs wetlands and sub-catchments of the Matzikamma municipality are shown in Figures 38 and 39.

Estuaries

The **Olifants River estuary** comprises a mix of estuarine channel and estuarine depression wetlands.

Major impacts include salt mining, water abstraction, urban and rural development, fragmentation and other impacts resulting from road and rail infrastructure, diamond mining, agricultural activities in the surrounding catchment. Perceived threats include rising sea levels, an increase in road infrastructure, further water abstraction from upstream surface water (e.g. raising of the Clanwilliam Dam, damming of the Doring River) and localised groundwater abstraction; urban encroachment; escalating degradation of land and vegetation cover, as a result of grazing, infilling and clearing of land for agriculture and rural settlement; manipulation of flows / water levels for irrigation purposes.

Wetlands

The municipality supports 8 429 ha of mapped wetlands. These are mostly floodplain (2 564 ha) and valley bottom (2 271 ha) wetlands, although depression (1 349) and seep (252 ha) wetlands are also present.

Rivers

Rivers within the municipality have lost much of their diversity to human modification of their banks, invasive alien plant species, and invasive alien fish species.

Important rivers include the Olifants and Doring Rivers.

The Matzikamma municipality falls within the Olifants / Doorn Water Management Area.

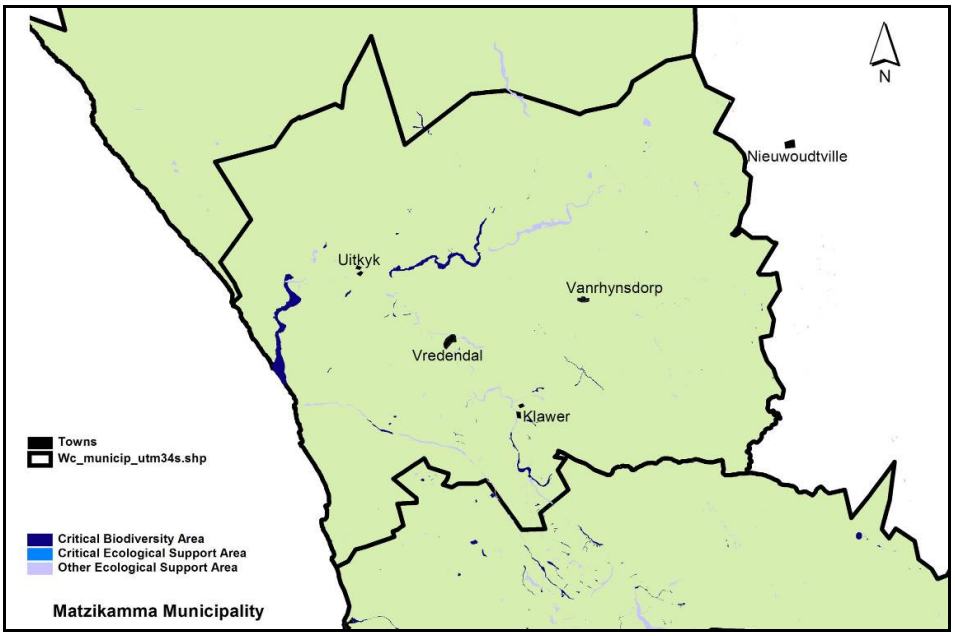

Figure 38 Wetland Critical Biodiversity Areas within Matzikamma municipality.

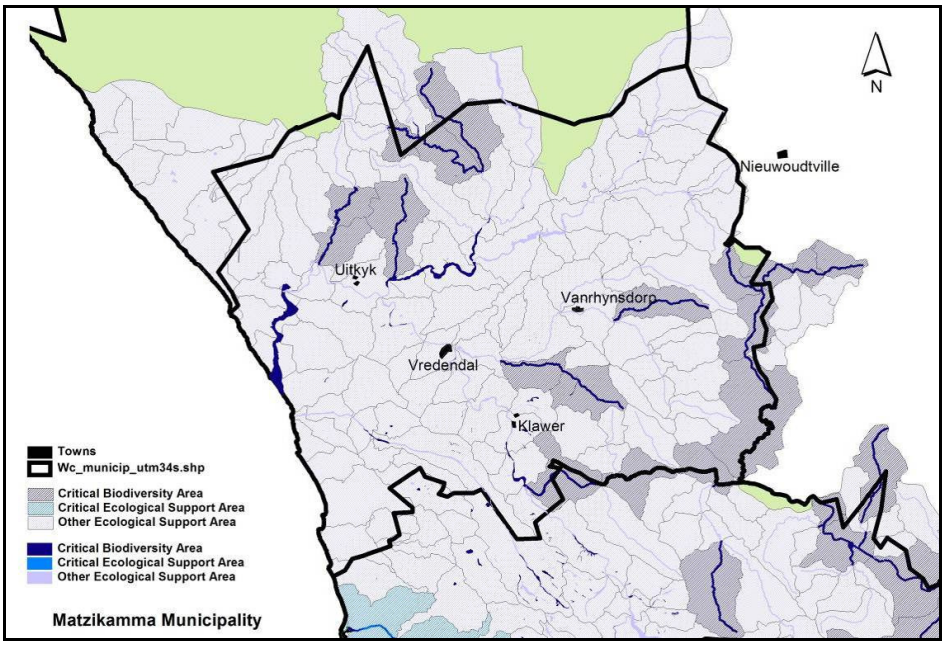

Figure 39 Critical Biodiversity Area sub-catchments within Matzikamma municipality**.**

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6.0 MANAGEMENT GUIDELINES

The development of a set of environmental management guidelines, aimed at informing decision-makers and guiding practitioners working in the study area, was undertaken as a separate exercise, in close consultation with key stakeholders, including, but not necessarily limited to, CapeNature, Department of Environmental Affaris and Development Planing, Department of Agriculture, Department of Water Affairs and Forestry, and aquatic specialists. The guidelines are presented in the Appendix C, according to the ecosystem types and management zones listed in Section 1.3.1.

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APPENDIX A: ESTUARIES

SUMMARISED SITE-SPECIFIC INFORMATION

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Estuary name[4]	**Olifants River Estuary**
Current Protected status	RAMSAR site and recognised Important Bird Area (IBA)
Hydrological connectivity	Permanently open
Ecological significance:	The mouth of the Olifants River is permanently open, with a tidal influence up to 36 km upstream during spring tides CSIR 1998). It is one of only three permanently open estuaries on the west coast of South Africa, the others being the Berg and the Orange River estuaries. It therefore represents a critical habitat to many estuarine-associated fish species, providing a warm-water refuge during the summer upwelling season (RHP 2006). The estuary includes has a high diversity of habitat (Turpie and Clark 2007) including the largest area of salt marsh in South Africa, located in the middle and lower reaches of the estuary. The upper reaches of the estuary are fringed by *Phragmites australis* reedbeds. Submerged macrophytes (dominated by *Potamogeton pectinatus*) provide an important water column habitat and refugia. Thirty eight fish species from 30 families have been recorded in the Olifants River estuary, 12 of which are endemic to South Africa (RHP 2006). Six of these are entirely estuarine-dependent to complete their lifecycle; eight breed in estuaries and four depend on estuaries as nursery areas (RHP 2006), giving the estuary the highest percentage of estuarine-dependent or partially-dependent fish species in the country (CSIR 1998). This means that degradation of the estuary may have a significant impact on west coast fish. Seasonal extremes in salinity mean that the benthic invertebrate species diversity is relatively low, with only 45 species recorded. The estuary supports at least 86 species of estuarine waterbirds.
Socio / economic l significance	The Olifants River Estuary is vital to inshore fisheries and moreover supports the important West Coast marine fisheries Tourism is increasing in the area (RHP 2006)
Conservation importance	Turpie and Clark (2007) classified the estuary as the fourth most important South African estuary in terms of overall estuarine importance, with high habitat importance, zonal type rarity and biodiversity scores. It is one of only two permanently open estuaries on the West Coast and the largest estuary in the country, and one of the top ten estuaries in the country for the conservation of avifauna (CSIR 1998).
Major threats and current impacts	Major threats to the Olifants River Estuary include: water abstraction at a catchment level (the Olifants / Doring River systems have high levels of present and even higher planned future levels of abstraction); impacts to water quality associated with agricultural return flows; over-exploitation of fish, including gill-netting in nursery areas which affects recruitment into the fishery. RHP (2006) assigned overall estuarine habitat and biotic health ratings of "Fair" to the system – estuarine health indices showed "good" health in terms of hydrological and physical habitat; "fair" health in terms of water quality, microalgae, macrophyte and invertebrate health indices, "poor" health in terms of fish and "natural" health in terms of avifauna.

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Estuary name[4]	**Olifants River Estuary**
	These data contrast with Whitfield's (2000) overall health rating of the estuary as "Good", used in Turpie and Clark (2007). The latter did not recommend the estuary for rehabilitation – however, ensuring adequate management of freshwater inputs and estuarine resources is assumed to be implicit in all future estuarine management recommendations.

Estuary name	**Jakkals River Estuary**
Current Protected status	None
Hydrological connectivity	Partially closed by a berm and intermittently connected to sea – affected by catchment-level abstraction
Ecological significance:	The Jakkals River has been severely affected by surface and groundwater abstraction, which is exacerbated as the lower system lacks the inflows from localised seepage areas characteristic of the nearby Verlorenvlei. RHP (2006) notes the seeming disappearance of Cape galaxies fish from the system, attributed to lack of freshwater flows and habitat destruction. RHP (2006) assigned the following scores to the Jakkals River upstream of the estuary: "Fair" in terms of all categories except for fish health ("poor") and riparian condition ("good"). The health of the estuary was not assessed, and the system was excluded from analysis by both Turpie and Clark (2007) and Prochazka *et al.* (2000), as a result of the extent of reduction in estuarine function.
Socio / economic l significance	
Conservation importance	Not included in Turpie and Clark (2007) importance rating and conservation plan. RHP (2006) notes however that Wadrif Pan, Jakkalsvlei and Verlorenvlei have complementary attributes in terms of habitat provision for pan-coastal migrant birds needing to build up energy reserves before migrating to the inland pans of northern South Africa.
Major threats and current impacts	

Estuary name	**Wadrif Pan (Langvlei Estuary)**
Current Protected status	None – and lack of formal conservation makes this site in-eligible for RAMSAR status
Hydrological connectivity	Naturally temporarily open – a railway causeway now effectively isolates Wadrif from the sea and it no longer functions as an estuary (Prochazka *et al.* 2002).
Ecological significance	Wadrif Pan – the estuary of the Langvlei River – is a brackish to saline pan that usually fill in late winter. During summer, shallow exposed mudflats support a number of bird species, including lesser and greater flamingo, Cape shoveller, black oyster catcher and chestnut banded plover (RHP2006). The pan has been identified as of particular importance, in conjunction with adjacent Jakkalsvlei and Verlorenvlei in supporting populations of pan -coastal migrant birds.
Socio / economic significance	
Conservation importance	Not included in Turpie and Clark (2007) importance rating and conservation plan but considered as of high importance

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Estuary name	**Wadrif Pan (Langvlei Estuary)**
	by Cape Nature as a bird habitat. In this regard, Wadrif Pan, Jakkalsvlei and Verlorenvlei have complementary attributes in terms of habitat provision for pan-coastal migrant birds needing to build up energy reserves before migrating to the inland pans of northern South Africa. From this perspective the importance of the Wadrif Pan is rated higher than Verlorenvlei (RHP 2 006).
Major threats and current impacts	Mouth altered and/or artificially controlled. A railway causeway has effectively isolated Wadrif from the sea. It no longer functions as an estuary and rehabilitation is not considered a realistic option. It was not considered in Turpie and Clark (2007) as an estuary, for this reason. Stocks of fish and bait organisms were described by Prochazka *et al.* (2002) as entirely destroyed Unsustainable over-abstraction of groundwater is currently taking place, which threatens the upstream Wadrif wetlands and the long-term health of the pan itself.

Estuary name[5]	**Verlorenvlei**
Current Protected status	RAMSAR site
Hydrological connectivity	Perennial
Ecological significance	Verlorenvlei is among the largest natural estuarine depressions along the west coast of South Africa. Large masses of filamentous green algae, including *Chaetomorpha* and *Cladophora*, are common in the estuarine channel, particularly between the railway bridge and the lower causeway, where the water is often stagnant and hypersaline. Extensive beds of emergent aquatic macrophytes occur along the margins of the estuarine depression, with *Phragmites australis*, *Typha latifolia* and sedges being dominant Dense reedbeds are present in the upper part of the estuary depression / lake. *Myriophyllum spicatum*, a submerged macrophyte, dominates large areas of the lake where the water is about 2m deep. *Nymphaea capensis* (waterlily), a species which is becoming rare in South Africa due to destruction of wetlands, occurs in small numbers. Many researchers have noted the botanical importance of the vlei and its environs, because of its position at the transition between the karroid and fynbos vegetation types. The region therefore, has a high diversity typical of an ecotone area. Several rare bird species occur in the system. These include the white pelican, which breeds at only two sites (on Dassenberg along the West coast and Lake St Lucia along the East coast), the African fish eagle *haliaetus vocifer*, greater flamingo *Phoenicopterus ruber*, lesser flamingo *P. minor*, Caspian tern *Hydroprogne caspia*, little bittern *Ixobrychus minutus* and the great crested grebe *Podiceps cristatus*. Spoonbills *Platalea alba* and glossy ibises *Plegadis falcinellus*, which are uncommon in the southwestern Cape, may also be found in the area. Overall, the system supports at least 189 bird species, two of which are nationally threatened, 3 globally threatened and 6 nationally near threatened. Endangered mammals such as Grant's Golden Mole, De Winton's Golden Mole and Van Zyl's Golden Mole occupy the

[5] Information adapted largely from RAMSAR data sheets

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Estuary name[5]	**Verlorenvlei**
	broader wetland area as do feline predators such as the Leopard, Caracal and African Wildcat (Barnes 1998). The rare minnow *Barbus burgi* has also been recorded in the Verlorenvlei River. In the past estuarine fish entered Verlorenvlei regularly viz. *Lithognathus lithognanthus*, *Liza richardsonii* and *Mugil cephalus* (mullet) and these species still exist at the site. Another estuarine species, *Gilchristella aestuarius* also breeds in openwater areas, and the importance of the estuary as a nursery area for fish is emphasised in wet years when the estuary mouth is breached for long periods, allowing the movement of fish into the estuary. The only indigenous freshwater species are *Galaxias zebratus* and the minnow *Barbus burgi*. In recent years the system has been colonised by the introduced exotic (to this estuary) species *Cyprinus carpio* (carp), *Oreochromis mossambicus* (tilapia), *Tinca tinca* and *Tilapia sparrmanii*. RHP (2006) notes that Cape Nature has identified the Verlorenvlei River as a priority for freshwater fish conservation, stating "This river is critically important for freshwater fish conservation due to the ecological collapse of the nearby Langvlei river."
Socio / economic l significance	Visitor pressure is seasonal, and the numbers of visitors are currently relatively low due to the poor condition of the roads in the area (these are currently being upgraded). The deeper, *Myriophyllum* free areas are suitable for sailing, although these areas are very small. The varying depth of the vlei throughout the year also places a large restriction on sailing. Motor boats above 5 horsepower are not permitted. Angling is permitted provided an inland water fishing license is obtained. Only riparian landowners have permits for fishing using nets. The vlei and environs provide good bird-watching conditions, and many routes are possible for hiking including along the water edge and to places of historical interest such as archaeological sites. Marshland along the edges of the lake and along the Verlorenvlei River is used for cattle grazing (when reeds have been cut) and *Myriophyllum* in the vlei is grazed by cattle
Conservation importance	The site is one of the ten most important wetlands for wading birds in the southwestern Cape, providing feeding, nesting and resting facilities to a large variety of birds. It is an important moulting area for Egyptian geese *Alopochen aegyptiacus*. There are around 200 species of birds in the surrounding area, and Verlorenvlei is of particular importance as a feeding area for the white pelican. Turpie and Clark (2007) ranked the estuary 58th in importance, out of a total of 256 assessed South African estuaries. Conversations with Dr L. van Niekerk (CSIR) suggest that the estuary should be considered of high conservation importance in terms of its role as a fish nursery, at least during periods of connectivity with the marine environment, and noting that the present impacts that most plague estuarine ecosystem health (primarily surface and groundwater abstraction) are potentially reversible with stringent management in the future
Major threats and current impacts	Extensive groundwater abstraction; urban and agricultural encroachment; escalating degradation of land and vegetation cover, as a result of grazing and clearing of land for agriculture and rural settlement; manipulation of flows / water levels for irrigation purposes; fragmentation as a result of road crossings Verlorenvlei and the adjacent Wadrif and Jakkalsvlei estuaries are interdependent in terms of in supporting populations of pan -coastal migrant birds. Both the latter systems are presently highly threatened.

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Estuary name[6]	**Berg River Estuary**
Current Protected status	RAMSAR site and IBA
Hydrological connectivity	Perennial – the river mouth has been altered (canalised) and is maintained as a permanently open system.
Ecological significance	The Berg River estuary is one of only three permanently open estuaries on the west coast of South Africa, the others being the Olifants and the Orange River estuaries. It therefore represents a critical habitat to many estuarine-associated fish species, providing a warm-water refuge during the summer upwelling season (RHP 2006). The estuary is one of the few suitable habitats along the west coast suitable for migratory birds. Migratory waders on the East Atlantic, Mediterranean and Middle East flyways use the estuary as a feeding ground. IN addition the estuary supports some 250 resident bird species, representing 50% of the birds on the south western Cape in the area (RHP 2006). Bird fauna is supported by an extremely high abundance of invertebrates (RHP 2006). The system is associated with extensive areas of estuarine wetland habitat, including the third largest saltmarsh in the Western Cape. Wetland habitat diversity, as described by Boucher and Jones (2007), comprises: • **Inundated Mudflats -** supporting aquatic species such as *Eichhornia crassipes* (water hyacinth), *Potamogeton pectinatus* (fountain grass) and *Zostera capensis* (sea grass). Increased salinities through increased water abstraction imply displacement of *Potamogeton* by *Zostera*. These perennial wetlands include occasionally exposed mud flats and natural pools on the river's edge. Exposure relates mainly to tidal influence. • **Normal Reed Marsh**, - Consists of virtually monospecific stands of *Phragmites australis* (fluitjiesriet) from two to four metres in height. Reed Marsh is found mainly on depositional, saturated silt-rich soils on inner riverine bends. • **Short Reed Marsh – short reed stands** (virtually monospecific) consist mainly of *Schoenoplectus triqueter;* stands of medium height reeds such as *Schoenoplectus scirpoideus* and *Cyperus textilis* (matjiesgoed) are also to be found less frequently in zones subject to greater fresh water influences • **Open Pan** wetlands represent a saltpan community, dominated by *Triglochin striata* - *Salicornia meyeriana* Dwarf Shrubland. • **Sedge Pan** habitat has characteristic monospecific stands of *Juncus maritimus* (sareegras) in summer while *Aponogeton distachyos* (waterblommetjie) is conspicuous when in flower in late winter (after the rains) • **Estuarine saltmarsh**

[6] Information adapted largely from RAMSAR data sheets

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Estuary name[6]	**Berg River Estuary**
	Halophytic Saltmarsh: This low-growing community, less than 0.5 metres in height, includes an estuarine community of mainly fleshy-leaved salt-tolerant species **Sedge Marsh:** characterized by *Juncus kraussii* (biesie) with other species, including, *Sarcocornia pillansii* (brakbos), *Samolus porosus*, *Nidorella foetida* and *Sporobolus virginicus* (brakgras). This community includes several sedge species and is exemplified by the invariable presence of *Juncus kraussii* (biesie). Smaller sedge species occur in a varied mosaic, which often include nonsedge species - especially *Sarcocomia perennis* (brakbos) as well as *Samolus porous* (samolus), *Nidorella foetida* (nidorella) and *Sporobolus virginicus* (brakgras). Typical saltmarsh species are a minor element. Regular estuarine submersion ameliorated by freshwater drainage and river flooding. Increased salinities would have an adverse effect on this community. **Blind Lagoon:** The marshes in this area probably consisted of disjunctive patches with some submerged macrophytes (probably *Zostera capensis*), which were greatly reduced by 1960 with no evidence of submerged macrophytes (possibly related to extensive dredging activities). By 1971 the new mouth had been open for five years, the old mouth had closed (forming the Blind Lagoon), with much sediment deposition, especially along the northern shores, and development of patches of salt marsh. Continued sediment deposition visible in 1977. Photographs from 1981 showed increased sedimentation and increased development of salt marshes Berg River estuarine health was assessed as "fair" by Turpie and Clark (2007), but no rehabilitation measures were recommended.
Socio / economic l significance	The Olifants River Estuary is vital to inshore fisheries and moreover supports the important West Coast marine fisheries Tourism is increasing in the area (RHP 2006)
Conservation importance	Turpie and Clark (2007) ranked the Berg River estuary as the 3rd most important South African wetland system, according it very high scores (100%) in terms of size, habitat importance and zonal type rarity and a high score (90%) in terms of biodiversity importance. Prochazka *et al.* (2002) noted the importance of the Berg River estuary for fish (as a nursery / refuge area) and as a feeding / over-wintering / breeding area for birds
Major threats and current impacts	Boucher and Jones (2006) noted that estuarine areas have been significantly transformed and threatened by anthropogenic disturbance (urban development e.g. Laaipiek, Velddrif and Port Owen, and water storage). The lands adjacent to the upper estuary and river have long been used for agricultural purposes. Over 250 ha of the upper marsh areas on the southern banks are now occupied by evaporation pans from the salt works and the only upper marsh remaining in this region is an approximately 10 ha above Carinus Bridge (also severely disturbed by trampling and grazing). The mouth of the river was artificially stabilized in 1966 to facilitate the passage of fishingtrawlers. RHP (2006) also cited alien vegetation, overexploitation of fish, increased siltation from erosion in the catchment and, importantly, a reduction in freshwater inflows into the estuary as impacts affecting this estuary.

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APPENDIX B: INLAND WETLANDS

SUMMARY TABLES FOR WETLAND GROUPS

Each wetland group corresponds with a "wet" vegetation type (generally, these are azonal vegetation types) on the SA vegetation map (Mucina and Rutherford, 2006).

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Table B.1. Floodplain wetlands

Name	Corresponding "wet" vegetation type (from SA vegetation map)	Surrounding vegetation type	Brief description
arid floodplain	**Namaqualand Riviere**	Vanrhynsdorp Gannabosveld Knersvlakte Quartz Vygieveld	Neutral to alkaline shale and quartz. Largely silted floodplains, in very arid areas e.g. Hol / Vars Rivers
alluvial floodplain	**Olifants Alluvium Fynbos** **Namaqualand Riviere** **Cape Lowland Freshwater Wetlands** **Lowland Acid Sand wetlands**	Hopefield Sand Fynbos Leipoldtville Sand Fynbos Graafwater Sandstone Fynbos Cape Lowland Freshwater Wetlands Olifants Alluvium Fynbos Olifants Sandstone Fynbos Klawer Sandy Shrubland Namaqualand Riviere Piketberg Sandstone Fynbos Bergriver Sand Fynbos - Flats Strandveld Mosaic	Acid sands. Floodplain vegetated, should be sedges, palmiet, but more often invaded by reeds, bulrush, blue gums and black wattle. e.g. Olifants River upstream of the estuary; Berg River upstream of estuary; Boesmans River
sandveld floodplain	**Cape Inland Salt Pan / Marsh**	Saldanha Flats Strandveld Langebaan Dune Strandveld	Alkaline to neutral sands. Saltmarsh-dominated. e.g. Langvlei, Verlorenvlei, Jakkals, Sout River; Rocher Pan system

Table B.2. Valley bottom wetlands

Name	Corresponding "wet" vegetation type (from SA vegetation map)	Surrounding vegetation type	Description
arid valley bottom	**Namaqualand Riviere**	Knersvlakte Quartz Vygieveld Knersvlakte Dolomite Vygieveld Vanrhynsdorp Gannabosveld Klawer Sandy Shrubland Doringrivier Quartzite Karoo	Mix of acid through to alkaline, on shales and some sandstone or quartz or dolomite. Generally narrow band of riparian trees, with reeds where there's perennial water. Some of these are just dry river beds – sand/silt. e.g. Hol / Vars Rivers; Klein River (tributary of Olifants), Doring River
sandstone fynbos valley bottom	**Cape Lowland Freshwater Wetlands**	Piketberg Sandstone Fynbos Graafwater Sandstone Fynbos Olifants Sandstone Fynbos Olifants Alluvium Fynbos Cederberg Sandstone Fynbos	Acid sandstones and sands. Scrubby, shrubby fynbos riparian belt, with restios, varying in width – wider the higher up the mountains. This riparian veg is often removed through agriculture. More herbaceous elements such as reeds, sedges and grasses can occur in wetter ground.

		Leipoldtville Sand Fynbos Klawer Sandy Shrubland	Tributaries of the Olifants
strandveld valley bottom	**Cape Inland Salt Pan / Marsh**	Saldanha Granite Strandveld Hopefield Sand Fynbos Leipoldtville Sand Fynbos Langebaan Dune Strandveld Saldanha Flats Strandveld Swartland Shale Renosterveld Cape Inland Salt Pan / Marsh	Mix of neutral to alkaline sand, or shale or granite. River channels are dominated by Juncus kraussi and restios in the upper reaches (upper/lower foothills) and become more saltmarshy as they become lowland river – Sarcocornia. Often start as hillslope seeps Can have depressional wetlands associated with them Saldanha Peninsula valley bottoms, plus northern Sout River (G10M_3c; 3d)
sandveld valley bottom	**Cape Inland Salt Pan / Marsh**	Namaqualand Strandveld Namaqualand Sand Fynbos	Acid through to alkaline sands. Jakkals, Langvlei, Verlorenvlei

Table B.3. Seeps

Name	Corresponding "wet" veg type (from SA veg map)	Veg type context (FSP, or SA if FSP not done)	Description
sandstone fynbos hillslope or basin seeps	**Cape Lowland Freshwater Wetlands**	Piketberg Sandstone Fynbos Northern Shale Band Vegetation Cederberg Sandstone Fynbos Bokkeveld Sandstone Fynbos Graafwater Sandstone Fynbos Olifants Sandstone Fynbos	Acid sandstones.
sand fynbos hillslope or basin seeps	**Cape Lowland Freshwater Wetlands**	Hopefield Sand Fynbos Leipoldtville Sand Fynbos Breede Alluvium Fynbos Bergriver Sand Fynbos - Flats Strandveld Mosaic Namaqualand Sand fynbos	Acid sands.
renosterveld hillslope seeps	**Cape Lowland Freshwater Wetlands**	Swartland Shale Renosterveld Graafwater Shale Renosterveld Citrusdal Shale Renosterveld Vanrhynsdorp Shale Renosterveld	Alkaline shales (with some silcrete in places)
strandveld hillslope or basin seeps	**Cape Inland Salt Pan / Marsh**	Saldanha Flats Strandveld Saldanha Granite Strandveld Saldanha Limestone Strandveld Varkvlei Shale Strandveld	Mix of neutral to alkaline sand, or shale or granite.

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		Namaqualand Strandveld Leipoldtville Flats Strandveld Graafwater Flats Strandveld Lamberts Bay Strandveld	
arid hillslope or basin seeps	**Namaqualand Riviere** **Cape Lowland Freshwater Wetland**	Doringrivier Quartzite Karoo Namaqualand Spinescent Grassland Knersvlakte Quartz Vygieveld Vanrhynsdorp Gannabosveld	Neutral to alkaline sands and shales.

Table B.4. Depressions

Name	Corresponding "wet" vegetation type (from SA vegetation map)	Surrounding vegetation type	Brief description
sandstone fynbos depression	**Cape Lowland Freshwater Wetlands**	Piketberg Sandstone Fynbos Northern Shale Band Vegetation Cederberg Sandstone Fynbos Bokkeveld Sandstone Fynbos Graafwater Sandstone Fynbos Olifants Sandstone Fynbos	Acid sandstones.
sand fynbos depression	**Cape Lowland Freshwater Wetlands**	Hopefield Sand Fynbos Leipoldtville Sand Fynbos Breede Alluvium Fynbos Sand Fynbos - Flats Strandveld Mosaic Namaqualand Sand fynbos	Acid sands.
renosterveld depression	**Cape Lowland Freshwater Wetlands**	Breede Shale Renosterveld Swartland Shale Renosterveld Swartland Silcrete Renosterveld Citrusdal Shale Renosterveld Vanrhynsdorp Shale Renosterveld	Alkaline shales (with some silcrete in places)
strandveld depression	**Cape Inland Salt Pan / Marsh**	Saldanha Flats Strandveld Saldanha Granite Strandveld Saldanha Limestone Strandveld Varkvlei Shale Strandveld Namaqualand Strandveld Leipoldtville Flats Strandveld Graafwater Flats Strandveld	Mix of neutral to alkaline sand, or shale or granite.

		Lamberts Bay Strandveld	
arid depression	**Namaqualand Riviere**	Namaqualand Spinescent Grassland Knersvlakter Quarts Vygieveld	Neutral to alkaline sands and shales.

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APPENDIX C: MANAGEMENT GUIDELINES

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CRITICAL BIODIVERSITY AREAS

Rivers

MOUNTAIN STREAM		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• Maintain mean annual run-off as close to natural or near natural as possible, in terms of magnitude and variability (desired Eco-status or Ecological Management Class of A: Natural or B: Largely Natural) e.g. water quantity component of Ecological Reserve of > 80% of Mean Annual Runoff (MAR). • Where abstraction is absolutely necessary, off-channel dam construction or run-of-river abstraction only, with the highest Ecological Reserve possible (see above), and closely monitored for compliance. • Intact tributaries into major rivers cannot be impounded, even if off-channel. • Improve regulation of abstractions from these rivers and encourage efficient water use (i.e. demand control, recycling, use of grey water, rainwater tanks). • No stormwater to be discharged into mountain streams. • Irrigation return flows should be directed away from mountain streams. • There should be no change in the hydrology of the system, e.g. from ephemeral to seasonal, or seasonal to perennial.	• No hard development within the riparian buffer. • No stormwater to be conveyed into a riparian buffer. • No irrigation return flows to be discharged directly into a riparian buffer. • Clear water using alien invading plants.
Environmental flow requirements (surface):	• Dry season base flows can not be abstracted or regulated. The maintenance of dry season pools in the river is essential for many fish species. • Maintain flow regime (i.e. the magnitude, frequency, and variability of flow) as close to natural as possible. • Licensed abstractions and river regulation should be assessed in terms of the Ecological Reserve, which should be seen as a	• n/a

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MOUNTAIN STREAM		
	AQUATIC FEATURE	**BUFFER**
	high-priority user.. • Compliance with and effectiveness of the required releases of water from impoundments in rivers must be monitored and enforced. This is particularly so for dry season, low-flow releases, but also important for freshes and floods. • Optimal use should be made of existing abstractions through water demand management measures. There should be a halt to further abstractions within catchments that are particularly water stressed, e.g. the Verlorenvlei River catchment.	
Groundwater:	• No groundwater abstraction that would impact on the supply of water to groundwater-fed mountain streams, i.e. those situated in groundwater recharge areas.	• No groundwater abstraction within the riparian buffer.
Water quality:	• Water quality should be maintained as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B). • No waste (including treated waste) or water containing waste to be dicharged into CBA mountain streams. • DWAF's National Water Resource Classification process is the vehicle through which the Resource Water Quality Objectives (RWQO's) are set, and through which the water quality component of the Ecological Reserve is determined. This must be strictly applied for all CBA rivers. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	• Enforce the riparian buffer zone. Natural vegetation cover must be maintained, or rehabilitated, in order to ensure filtering of surface runoff before it enters the river. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas should be closely monitored for the use of pesticides, herbicides and fertilizers. • Access areas for livestock should be limited and demarcated. • No hard development within the buffer. • No stormwater to be conveyed into a buffer. • No irrigation return flows to be discharged into buffer.
Sedimentation and erosion:	• Prohibit modifications to bed and banks of the river. • Limit livestock access to river – the bed and banks of mountain streams are particularly sensitive to trampling which causes major erosion and sedimentation.	• No grazing, ploughing or cultivation of riparian buffer zone. • Access areas for livestock should be limited and demarcated. • Clear all alien plants, and maintain indigenous plant cover.

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MOUNTAIN STREAM		
	AQUATIC FEATURE	**BUFFER**
Connectivity:	• No obstructions to flow (e.g. fences, walls) permissable within the river channel. • No canalisation or channelisation of river banks or river bed. • The construction of roads through or over CBA rivers should not be permitted, unless necessary (e.g. for safety or fire management) Construction of roads and bridges must be strictly controlled, and must go through the full EIA process. • Intact tributaries into major rivers cannot be impounded, even if off-channel.	• No fragmentation of the riparian zone. • No disconnection of the riparian zone from the river. • Buffer width to be consistent along the length of the associated river reach (i.e. should not be allowed to diminish in width to accommodate other land-uses). • The construction of roads (this includes tracks, e.g. for 4x4 routes) through riparian buffers should not be permitted. • Where a road or other water channeling structure runs close to a riparian buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the riparian zone, at ground level. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the riparian zone, or lead to separation of the riparian buffer from the river.
Flora and fauna:	• CapeNature / SANParks (or other relevant conservation body) to investigate the establishment of fish sanctuary areas and aquatic reserves. • No further building of instream dams and weirs in fish sanctuary areas, as these restrict the movement of fish. • Dry season base flows can not be abstracted or regulated. The maintenance of dry season pools in the river is essential for many fish species. • Maintain adequate flow velocities in fish spawning months. • Prohibit the stocking of farm dams (even off-stream dams) and rivers with alien fish, especially in sanctuary areas. • Investigate the possibility of the eradication and control of alien fish populations.	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a riparian buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora.

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MOUNTAIN STREAM		
	AQUATIC FEATURE	**BUFFER**
	• Clear infestations of alien invasive plants within the river system.	
CBA-specific management:	• No decline in Ecological Management Class. • Conservation of biodiversity to be considered a high priority user, in terms of the Ecological Reserve. • DWAF and DEAT to monitor resource quality status in order to ascertain whether management actions are adequate to achieve compliance with the requirements of DWAF's National Water Resource Classification System[7] (i.e. the desired Ecological Management Class), the Ecological Reserve and DWAF Resource Quality Objectives. • A management plan will need to be developed for each biodiversity feature or site, for example – red data species, specific river reach habitat. • These management plans should outline the most appropriate strategies to employ for each selected area, depending on criteria such as the characteristics of the biodiversity features requiring conservation, the main land use pressures and threats in the area, the socio-economic opportunities and constraints, and specific financial and institutional arrangements. • Users of the water resource to monitor abstraction and discharge to ensure maintenance of natural level of ecological functioning (e.g. water quality amelioration; infiltration; floodwater retention; provision of low flows to downstream systems).	• Maintain or restore to a natural or near natural state.
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

FOOTHILL RIVERS

[7] The National Water Resource Classification System is used as part of a consultative process to classify water resources to help facilitate a balance between protection and use of the nation's water resources.

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	AQUATIC FEATURE	BUFFER
Water Quantity:	• Maintain mean annual run-off as close to natural or near natural as possible, in terms of magnitude and variability (desired Eco-status or Ecological Management Class of A: Natural or B: Largely Natural) e.g. water quantity component of Ecological Reserve of > 70% of Mean Annual Runoff (MAR). • Where abstraction is absolutely necessary, off-channel dam construction or run-of-river abstraction only, with the highest Ecological Reserve possible (see above), and closely monitored for compliance. • Intact tributaries into major rivers cannot be impounded, even if off-channel. • Improve regulation of abstractions from these rivers and encourage efficient water use (i.e. demand control, recycling, use of grey water, rainwater tanks). • No stormwater to be discharged into foothill rivers. • Irrigation return flows should be directed away from foothill rivers. • There should be no change in the hydrology of the system, e.g. from ephemeral to seasonal, or seasonal to perennial.	• No hard development within the riparian buffer. • No stormwater to be conveyed into a riparian buffer. • No irrigation return flows to be discharged directly into a riparian buffer.
Environmental flow requirements (surface):	• Dry season base flows can not be abstracted or regulated. The maintenance of dry season pools in the river is essential for many fish species. • Maintain flow regime (i.e. the magnitude, frequency, and variability of flow) as close to natural as possible. • Licensed abstractions and river regulation should be assessed in terms of the Ecological Reserve, which should be seen as the highest priority user. • Compliance with and effectiveness of the required releases of water from impoundments in rivers must be monitored and enforced. This is particularly so for dry season, low-flow releases, but also important for freshes and floods. • Optimal use should be made of existing abstractions through	• n/a

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	AQUATIC FEATURE	**BUFFER**
	water demand management measures. There should be a halt to further abstractions within catchments that are particularly water stressed, e.g. the Verlorenvlei River catchment.	
Groundwater:	• n/a	• No groundwater abstraction within the riparian buffer.
Water quality:	• Water quality should be maintained as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B). • No waste (including treated waste) or water containing waste to be dicharged into CBA foothill rivers. • DWAF's National Water Resource Classification process is the vehicle through which the Resource Water Quality Objectives (RWQO's) are set, and through which the water quality component of the Ecological Reserve is determined. This must be strictly applied for all CBA rivers. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	• Enforce the riparian buffer zone. Natural vegetation cover must be maintained, or rehabilitated, in order to ensure filtering of surface runoff before it enters the river. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas should be closely monitored for the use of pesticides, herbicides and fertilizers. • Access areas for livestock should be limited and demarcated. • No hard development within the buffer. • No stormwater to be conveyed into a buffer. • No irrigation return flows to be discharged into buffer.
Sedimentation and erosion:	• Prohibit modifications to bed and banks of the river. • Limit livestock access to river – the bed and banks of foothill rivers are particularly sensitive to trampling which causes major erosion and sedimentation.	• No grazing, ploughing or cultivation of riparian buffer zone. • Access areas for livestock should be limited and demarcated. • Clear all alien plants, and maintain indigenous plant cover.
Connectivity:	• No obstructions to flow (e.g. fences, walls) permissable within the river channel. • No canalisation or channelisation of river banks or river bed. • The construction of roads through or over CBA rivers should not be permitted, unless necessary (e.g. for safety or fire management) Construction of roads and bridges must be strictly controlled, and must go through the full EIA process. • Intact tributaries into major rivers cannot be impounded, even if	• No fragmentation of the riparian zone. • No disconnection of the riparian zone from the river. • Buffer width to be consistent along the length of the associated river reach (i.e. should not be allowed to diminish in width to accommodate other land-uses). • The construction of roads (this includes tracks, e.g. for 4x4 routes) through riparian buffers should not be permitted.

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	AQUATIC FEATURE	**BUFFER**
	off-channel.	• Where a road or other water channeling structure runs close to a riparian buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the riparian zone, at ground level. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the riparian zone, or lead to separation of the riparian buffer from the river.
Flora and fauna:	• CapeNature / SANParks (or other relevant conservation body) to investigate the establishment of fish sanctuary areas and aquatic reserves. • No further building of instream dams and weirs in fish sanctuary areas, as these restrict the movement of fish. • Dry season base flows can not be abstracted or regulated. The maintenance of dry season pools in the river is essential for many fish species. • Prohibit the stocking of farm dams (even off-stream dams) and rivers with alien fish, especially in sanctuary areas. • Investigate the possibility of the eradication and control of alien fish populations. • Clear infestations of alien invasive plants within the river system.	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a riparian buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora.
CBA-specific management:	• No decline in Ecological Management Class. • Conservation of biodiversity to be considered the highest priority user, in terms of the Ecological Reserve. • DWAF and DEAT to monitor resource quality status in order to ascertain whether management actions are adequate to achieve	• Maintain or restore to a natural or near natural state.

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	AQUATIC FEATURE	**BUFFER**
	compliance with the requirements of DWAF's National Water Resource Classification System[8] (i.e. the desired Ecological Management Class), the Ecological Reserve and DWAF Resource Quality Objectives. • A management plan will need to be developed for each biodiversity feature or site, for example – red data species, specific river reach habitat. • These management plans should outline the most appropriate strategies to employ for each selected area, depending on criteria such as the characteristics of the biodiversity features requiring conservation, the main land use pressures and threats in the area, the socio-economic opportunities and constraints, and specific financial and institutional arrangements. • Users of the water resource to monitor abstraction and discharge to ensure maintenance of natural level of ecological functioning (e.g. water quality amelioration; infiltration; floodwater retention; provision of low flows to downstream systems).	
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

LOWLAND RIVERS		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• Maintain mean annual run-off as close to natural or near natural as possible, in terms of magnitude and variability (desired Eco-status or Ecological Management Class of A: Natural or B: Largely Natural) e.g. water quantity component of Ecological Reserve of > 70% of Mean Annual Runoff (MAR).	• No hard development within the riparian buffer. • No stormwater to be conveyed into a riparian buffer. • No irrigation return flows to be discharged directly into a riparian buffer.

[8] The National Water Resource Classification System is used as part of a consultative process to classify water resources to help facilitate a balance between protection and use of the nation's water resources.

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LOWLAND RIVERS		
	AQUATIC FEATURE	**BUFFER**
	• Where abstraction is absolutely necessary, off-channel dam construction or run-of-river abstraction only, with the highest Ecological Reserve possible (see above), and closely monitored for compliance. • Intact tributaries into major rivers cannot be impounded, even if off-channel. • Improve regulation of abstractions from these rivers and encourage efficient water use (i.e. demand control, recycling, use of grey water, rainwater tanks). • No stormwater to be discharged into mountain streams. • Irrigation return flows should be directed away from mountain streams. • There should be no change in the hydrology of the system, e.g. from ephemeral to seasonal, or seasonal to perennial.	
Environmental flow requirements (surface):	• Dry season base flows can not be abstracted or regulated. • Maintain flow regime (i.e. the magnitude, frequency, and variability of flow) as close to natural as possible. Seasonal inundation of lowland river floodplains is essential. • Licensed abstractions and river regulation should be assessed in terms of the Ecological Reserve, which should be seen as the highest priority user. • Compliance with and effectiveness of the required releases of water from impoundments in rivers must be monitored and enforced. This is particularly so for dry season, low-flow releases, but also important for freshes and floods. • Optimal use should be made of existing abstractions through water demand management measures. There should be a halt to further abstractions within catchments that are particularly water stressed, e.g. the Verlorenvlei River catchment.	• n/a

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LOWLAND RIVERS		
	AQUATIC FEATURE	**BUFFER**
Groundwater:	• n/a	• No groundwater abstraction within the riparian buffer.
Water quality:	• Water quality should be maintained as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B). • No waste (including treated waste) or water containing waste to be dicharged into CBA lowland rivers. • DWAF's National Water Resource Classification process is the vehicle through which the Resource Water Quality Objectives (RWQO's) are set, and through which the water quality component of the Ecological Reserve is determined. This must be strictly applied for all CBA rivers. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	• Enforce the riparian buffer zone. Natural vegetation cover must be maintained, or rehabilitated, in order to ensure filtering of surface runoff before it enters the river. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas should be closely monitored for the use of pesticides, herbicides and fertilizers. • Access areas for livestock should be limited and demarcated. • No hard development within the buffer. • No stormwater to be conveyed into a buffer. • No irrigation return flows to be discharged into buffer.
Connectivity:	• Prohibit modifications to bed and banks of the river. • Limit livestock access to river – trampling causes major erosion and sedimentation.	• No grazing, ploughing or cultivation of riparian buffer zone. • Access areas for livestock should be limited and demarcated. • Clear all alien plants, and maintain indigenous plant cover.
Sedimentation and erosion:	• No obstructions to flow (e.g. fences, walls) permissable within the river channel. • No canalisation or channelisation of river banks or river bed. • The construction of roads through or over CBA rivers should not be permitted, unless necessary (e.g. for safety or fire management) Construction of roads and bridges must be strictly controlled, and must go through the full EIA process. • Intact tributaries into major rivers cannot be impounded, even if off-channel.	• No fragmentation of the riparian zone. • No disconnection of the riparian zone from the river. • Buffer width to be consistent along the length of the associated river reach (i.e. should not be allowed to diminish in width to accommodate other land-uses). • The construction of roads (this includes tracks, e.g. for 4x4 routes) through riparian buffers should not be permitted. • Where a road or other water channeling structure runs close to a riparian buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity

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LOWLAND RIVERS		
	AQUATIC FEATURE	**BUFFER**
		structures. They must preferably discharge into vegetated areas outside of the riparian zone, at ground level. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the riparian zone, or lead to separation of the riparian buffer from the river.
Flora and fauna:	• CapeNature / SANParks (or other relevant conservation body) to investigate the establishment of fish sanctuary areas and aquatic reserves. • No further building of instream dams and weirs in fish sanctuary areas, as these restrict the movement of fish. • Prohibit the stocking of farm dams (even off-stream dams) and rivers with alien fish, especially in sanctuary areas. • Investigate the possibility of the eradication and control of alien fish populations. • Clear infestations of alien invasive plants within the river system.	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a riparian buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora.
CBA-specific management:	• No decline in Ecological Management Class. • Conservation of biodiversity to be considered the highest priority user, in terms of the Ecological Reserve. • DWAF and DEAT to monitor resource quality status in order to ascertain whether management actions are adequate to achieve compliance with the requirements of DWAF's National Water Resource Classification System[9] (i.e. the desired Ecological Management Class), the Ecological Reserve and DWAF Resource Quality Objectives. • A management plan will need to be developed for each biodiversity feature or site, for example – red data species, specific river reach habitat.	• Maintain or restore to a natural or near natural state.

9 The National Water Resource Classification System is used as part of a consultative process to classify water resources to help facilitate a balance between protection and use of the nation's water resources.

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LOWLAND RIVERS		
	AQUATIC FEATURE	**BUFFER**
	• These management plans should outline the most appropriate strategies to employ for each selected area, depending on criteria such as the characteristics of the biodiversity features requiring conservation, the main land use pressures and threats in the area, the socio-economic opportunities and constraints, and specific financial and institutional arrangements. • Users of the water resource to monitor abstraction and discharge to ensure maintenance of natural level of ecological functioning (e.g. water quality amelioration; infiltration; floodwater retention; provision of low flows to downstream systems).	
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

PRIORITY SUB-CATCHMENTS	
Water Quantity:	• Surface water abstraction and use in the catchment must be monitored – e.g. existing abstractions should be checked against permitted water use – and managed so that river integrity is not adversely affected. • No further abstraction in water-stressed catchments (e.g. all Berg River sub-catchments). • In water stressed sub-catchments, no further licenses for additional extensive agriculture should be granted. • The Ecological Reserve must be determined for all rivers in the sub-catchment. • Intact tributaries into major rivers cannot be impounded, even if off-channel. • Abstraction from impoundments and from run-of-river can only occur during the high flow months. • No further construction of in-channel impoundments.
Environmental flow requirements (surface):	• The Ecological Reserve must be determined for all rivers in the sub-catchment. • The effectiveness of and compliance with required environmental flow releases from any impoundments in the catchment must be monitored. • Intact tributaries into major rivers cannot be impounded, even if off-channel.

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PRIORITY SUB-CATCHMENTS	
Groundwater:	• Groundwater abstractions should be assessed, monitored and controlled, particularly in groundwater-dependent sub-catchments and areas, such as the Sandveld and Koue Bokkeveld areas. Rivers in the South-Western and Western Coastal Belt ecoregions are highly sensitive to groundwater abstraction. Rivers in the Cederberg and Groot Winterhoek mountain ranges, in the Western Folded Mountains ecoregion are thought to sustain the aquifers in the Sandveld area. Groundwater abstraction in these areas therefore needs to be closely monitored and managed. • The groundwater Reserve must be determined (preferably as a Comprehensive Reserve), implemented, monitored and enforced. • Management activities include assessing current levels of abstraction (e.g. number of boreholes, current rates and volumes of abstraction), and controlling, or preventing further groundwater abstraction, maintaining natural vegetation cover, and clearing alien invasive plants in the catchment. • Groundwater-fed seeps, springs, rivers and areas of hydraulically conductive fault zones must be protected from groundwater abstraction of any volume – in the case of groundwater recharge areas (generally mountainous areas) the buffer should be at least 100m, whereas in groundwater discharge areas, this buffer should be extended to at least 250m. • Aquifer-dependent ecosystems must be protected from groundwater abstraction by a buffer of at least 250m.
Water quality:	• In water stressed sub-catchments, no further licenses for additional extensive agriculture should be granted. • Herbicides and pesticides should not be used within 500m of rivers, wetlands *or their buffers*.
Sedimentation and erosion:	• The construction of roads across rivers or through wetlands or buffers must be assessed according to the EIA regulations. Such crossings must be minimised, as these create points where erosion is more likely to occur.
Connectivity:	• Rivers and their buffers (see relevant sections for recommended riverine buffers) must be protected and maintained as natural ecological corridors within a landscape that accommodates other land-uses.
Flora and fauna:	• CapeNature / SANParks (or other relevant conservation body) to investigate the establishment of fish sanctuary areas and aquatic reserves. • No further building of instream dams and weirs in fish sanctuary areas, as these restrict the movement of fish. • Prohibit the stocking of farm dams (even off-stream dams) and rivers with alien fish, especially in sanctuary areas. • Investigate the possibility of the eradication and control of alien fish populations. • Clear infestations of alien invasive plants within the catchment. • Where the construction of fences is necessary (e.g. around reserves), this should be done ensuring that fences / walls does not obstruct the movement of fauna and flora.
CBA-specific management:	• A catchment management strategy must be developed for the sub-catchment. This is the vehicle through which the Resource Quality Objectives (RQOs) can be determined and achieved. • All new urban or rural developments, change in land-use, or increases / changes in extensive and intensive agricultural activities within priority

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PRIORITY SUB-CATCHMENTS		
	sub-catchments must be assessed according to the EIA regulations, to ensure that impacts associated with the construction and operation of developments or changes in land-use do not lead to the loss or deterioration of aquatic ecosystems.	
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	Clear all ali plant cov

Wetlands

FLOODPLAIN WETLANDS		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• There should be no changes in flood frequency and magnitude as this would modify the extent and duration of floodplain inundation - decreases in duration and frequency of inundation may also have implications for the value of certain floodplain habitats as breeding sites for wetland fauna, may result in shrinkage of floodplain wetland vegetation, leading to loss of wetland function (e.g. erosion protection, sediment trapping and flood detention) during extreme high flow events. This is important in the context of climate change – models predict an increase in unexpected storm events in the study region. • There should be no change in the natural hydrology of the wetland– e.g. from seasonal to perennial, or from ephemeral to seasonal. • No stormwater or irrigation return flows shall be conveyed directly into a CBA floodplain wetland. This runoff should be directed elsewhere or treated outside of the wetland, such that it is dissipated to a degree where it has no impact on wetland water quality or hydrology. • CBA floodplain wetlands shall not be drained or infilled. • If the condition or function of a CBA floodplain wetland is impacted or threatened by water abstraction, the current condition of the wetland should be determined using a preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the rapid Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quantity component of the Ecological Reserve for the wetland.	• No hard development within the wetland buffer. • No stormwater to be conveyed into a wetland buffer. No irrigation return flows to be discharged directly into a wetland buffer. This runoff should be stored outside of the buffer, and allowed to evaporate or be directed elsewhere.

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FLOODPLAIN WETLANDS		
	AQUATIC FEATURE	**BUFFER**
	• No abstraction that results in a change in Ecological Management Class shall take place and CBA wetlands should be managed as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B).	
Groundwater:	• Floodplain wetlands can be critical for groundwater recharge in the lower catchment. Thus, inundation of the floodplain must be allowed to occur – refer to "water quantity" guidelines. • Floodplain wetlands may also rely on groundwater in groundwater discharge areas, thus there should be no abstraction of groundwater allowed within the wetland.	• No groundwater abstraction within wetland buffer – the buffer should be at least 100m in groundwater recharge areas and 250m in groundwater discharge areas.
Water quality:	• No increases in salinity and/or nutrients in floodwaters as this will affect wetland habitat quality – increased nutrients might result in the creation of eutrophic and potentially oxygen depleted habitats; increased salinity above key threshold levels might result in changes in plant zonation and community structure and a proliferation of weedy elements. • If a wetland is threatened by activities that will / could impact on water quality, the condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quality component of the Ecological Reserve for the wetland. • Water quality should be maintained as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B). • No waste (including treated waste) or water containing waste to be discharged into CBA floodplain wetlands. • DWAF's National Water Resource Classification process is the vehicle through which the Resource Water Quality Objectives (RWQO's) are set, and through which the water quality component of the Ecological Reserve is determined. This must be strictly applied for all CBA wetlands. For floodplain wetlands, the RWQO's set for the associated river can be used.	• Enforce the wetland buffer zone. Natural vegetation cover must be maintained, or rehabilitated, to promote buffer function. Alien vegetation should be removed. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas surrounding the wetland and buffer should be closely monitored for the use of pesticides, herbicides and fertilizers. Where the use of these substances is likely, consideration should be given to widening the buffer. • Livestock should not have access to the buffer area. • No hard development within the buffer. • No stormwater to be conveyed into a wetland buffer. No irrigation return flows to be discharged directly into a wetland buffer. This runoff should be stored outside of the buffer, and allowed to evaporate or be directed elsewhere.

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FLOODPLAIN WETLANDS		
	AQUATIC FEATURE	**BUFFER**
	• A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	
Sedimentation and erosion:	• Prohibit modifications to bed and banks of the wetland. No excavation and / or removal of soil / sand or cobbles allowed. • No livestock access to wetland. • Water flow through the wetland shall not be constricted through channels, culverts or pipes, for any reason. This leads to erosion.	• No grazing, ploughing or cultivation of wetland buffer. • Livestock should not have access to the buffer area. • Clear all alien plants, and maintain indigenous plant cover.
Connectivity:	• Floodplain wetlands are influenced by riverine processes, as they are all associated with rivers (generally lowland rivers). Thus, they are sensitive to upstream activities and activities in the catchment as a whole. The user should refer to the management guidelines for lowland rivers. • The extent of floodplain wetlands is not always readily discernible (because the extent of inundation of these systems fluctuates widely) so they are vulnerable to constriction and encroachment by agricultural activities, roads, urban development. • Floodplain wetlands are often closely associated with estuarine systems. Thus, activities occurring on and around floodplains must take into account that these may impact on the downstream estuary. • Floodplain wetlands shall not be impounded. Flood control berms should not be placed in or close to CBA floodplain wetlands. • No roads shall be constructed through a floodplain wetland. Construction of bridges over wetlands must be strictly controlled, and must go through the full EIA process. Bridges should span the entire wetland area • Water flow through the wetland shall not be constricted through culverts or pipes, for any reason. There should be no canalisation or channelisation of flow into, through or out of the wetland.	• There should be no fragmentation of the wetland buffer, e.g. through road construction (this includes tracks, e.g. for 4x4 routes) or the erection of fences or walls. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the wetland buffer, or lead to separation of the buffer from the wetland. • Water flow through the wetland buffer shall not be constricted through culverts or pipes, for any reason. • There shall be no disconnection of the wetland buffer from the wetland • Buffer width to be consistent around the entire wetland (i.e. should not be allowed to diminish in width to accommodate other land-uses) but could increase to attenuate additional impacts. • Where a road or other water channeling structure runs close to a wetland buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the buffer, at ground level and their locations should correspond to natural drainage lines.
Flora and fauna:	• CapeNature / SANParks (or other relevant conservation body) to	• Clear all alien plants, and maintain indigenous plant cover.

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FLOODPLAIN WETLANDS		
	AQUATIC FEATURE	**BUFFER**
	investigate the establishment of fish, amphibian and invertebrate sanctuary areas and aquatic reserves. • There shall be no impoundment of floodplain wetlands, as these structures restrict the movement of fish and invertebrates and alter floodplain characteristics (flood duration etc). • Prohibit the stocking of CBA wetlands with alien fish (and any other fauna), especially in sanctuary areas. • Investigate the possibility of the eradication and control of alien fish populations. • Clear infestations of alien invasive plants within and around the wetland. • Fences should not be erected around or through floodplain wetlands	• Where the construction of fences is necessary within a buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora.
Management:	• No decline in Ecological Management Class should take place and the wetland should be actively rehabilitated to Class A or B if currently assessed as being lower than Class B. • Conservation of biodiversity to be considered the highest priority user, in terms of the Ecological Reserve. • CBA floodplain wetlands must be accurately delineated, using the DWAF delineation protocol (DWAF, 2005). • The condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quantity and water quality components of the Ecological Reserve for the wetland. • Resource Quality Objectives (RQOs) to be set for CBA floodplain wetlands.	• Maintain or restore to a natural or near natural state (Ecological Management Class of A or B).
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

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VALLEY BOTTOM WETLANDS (channeled and unchanneled)		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• Valley bottom wetlands are driven by both riverine processes and processes occurring on the surrounding slopes. • There should be no changes in riverine flood frequency and magnitude as this would modify the extent of valley bottom inundation – reduction in riverine discharge could reduce scour, leading to encroachment by aquatic and marginal vegetation, and channel narrowing – this would increase the likelihood of down-cutting and erosion after flood events. • There should be no change in the natural hydrology of the valley bottom wetland system – e.g. from seasonal to perennial, or from ephemeral to seasonal. In the case of naturally ephemeral systems, decreases in flow could result in their alteration to mainly terrestrial systems, characterised by weedy vegetation, with a loss of wetland function. Increases in surface and/or groundwater inflows could lead to changes in plant structure, e.g. an increase in hardy sedges and reeds or bulrushes, and a decrease in seasonal wetland vegetation communities. There may be changes in plant zonation e.g. increased width of wet bank *versus* dry bank vegetation, or a loss of important seasonally inundated breeding areas (e.g. inundated sedge habitat used by larvae of many invertebrate taxa). • No stormwater or irrigation return flows from the surrounding slopes shall be conveyed directly into a valley bottom wetland. This runoff should be stored outside of the wetland, and allowed to evaporate or be directed elsewhere, or attenuated in appropriately sized and s\designed buffer area. • CBA valley bottom wetlands shall not be drained or infilled. • If a wetland is threatened by water abstraction, the current condition of the wetland should be determined using a preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the rapid Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which	• No hard development within the wetland buffer. • No stormwater to be conveyed into a wetland buffer. No irrigation return flows to be discharged directly into a wetland buffer. This runoff should be stored outside of the buffer, and allowed to evaporate or be directed elsewhere.

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VALLEY BOTTOM WETLANDS (channeled and unchanneled)		
	AQUATIC FEATURE	**BUFFER**
	is required for the calculation of the water quantity component of the Ecological Reserve for the wetland. • No abstraction that results in a change in Ecological Management Class shall take place and CBA wetlands should be managed as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B).	
Groundwater:	• No abstraction of groundwater allowed within the wetland.	• No groundwater abstraction within wetland buffer – the buffer should be at least 100m from the edge of wetlands in groundwater recharge areas and 250m from the edge of wetlands in groundwater discharge areas.
Water quality:	• No increases in salinity and/or nutrients in runoff entering the valley bottom, as this will affect wetland habitat quality – increased nutrients might result in the creation of eutrophic and potentially oxygen depleted habitats; increased salinity above key threshold levels, might result in changes in plant zonation and community structure and a proliferation of weedy elements. • If a wetland is threatened by activities that will / could impact on water quality, the condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quality component of the Ecological Reserve for the wetland. • Water quality should be maintained as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B). • No waste (including treated waste) or water containing waste to be discharged into CBA valley bottom wetlands. • DWAF's National Water Resource Classification process is the vehicle through which the Resource Water Quality Objectives (RWQO's) are set, and through which the water quality component of the Ecological Reserve is determined. This must	• Enforce the wetland buffer zone. Natural vegetation cover must be maintained, or rehabilitated, in order to ensure filtering of runoff from surrounding catchment before it enters the wetland. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas surrounding the wetland and buffer should be closely monitored for the use of pesticides, herbicides and fertilizers. • Livestock should not be permitted into buffer areas. • No hard development within the buffer. • No stormwater to be conveyed into a wetland buffer. No irrigation return flows to be discharged directly into a wetland buffer. This runoff should be stored outside of the buffer, and allowed to evaporate or be directed elsewhere.

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VALLEY BOTTOM WETLANDS (channeled and unchanneled)		
	AQUATIC FEATURE	**BUFFER**
	be strictly applied for all CBA wetlands. For valley bottom wetlands, the RWQO's set for the associated river can be used. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	
Sedimentation and erosion:	• Prohibit modifications to bed and banks of the wetland. No excavation and / or removal of soil / sand allowed. • No livestock access to wetland. • Water flow through the wetland shall not be constricted through culverts or pipes, for any reason. This leads to erosion through the creation of nick points. This is particularly so for unchanneled valley bottom wetlands.	• No grazing, ploughing or cultivation of wetland buffer. • Livestock should not be permitted into buffer areas. • Clear all alien plants, and maintain indigenous plant cover.
Connectivity:	• Valley bottom wetlands are influenced by riverine processes, as they are all associated with rivers (generally mountain stream and upper foothill rivers). Thus, they are sensitive to upstream activities and activities in the catchment as a whole. The user should refer to the management guidelines for mountain stream and foothill rivers. • The extent of valley bottom wetlands is not always readily discernible (because the extent of inundation and / or saturation of these systems fluctuates widely, depending on riverine discharge and runoff from the surrounding catchment) so they are vulnerable to constriction and encroachment by agricultural activities, roads, urban development. • Valley bottom wetlands shall not be fragmented or reduced in extent. These wetlands can perform an important function as natural ecological corridors, allowing movement of fauna and flora within the landscape, as well as providing many other goods and services (such as flood attenuation, erosion control). • Valley bottom wetlands shall not be impounded (this is so for both	• There should be no fragmentation of the wetland buffer, e.g. through road construction (this includes tracks, e.g. for 4x4 routes) or the erection of fences or walls. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the wetland buffer, or lead to separation of the buffer from the wetland. • Water flow through the wetland buffer shall not be constricted through culverts or pipes, for any reason. • There shall be no disconnection of the wetland buffer from the wetland • Buffer width to be consistent around the entire wetland (i.e. should not be allowed to diminish in width to accommodate other land-uses), but could be increased to attenuate additional impacts. • Where a road or other water channeling structure runs close to a wetland buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside

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VALLEY BOTTOM WETLANDS (channeled and unchanneled)		
	AQUATIC FEATURE	**BUFFER**
	channeled and unchanneled valley bottom wetlands). Flood control berms should not be placed in or close to CBA valley bottom wetlands. • No roads shall be constructed through a valley bottom wetland. Construction of bridges over these CBA wetlands must be strictly controlled, and must go through the full EIA process. • Water flow through the wetland shall not be constricted through culverts or pipes, for any reason. There should be no canalisation or channelisation of flow into, through or out of the wetland.	of the buffer, at ground level.
Flora and fauna:	• CapeNature / SANParks (or other relevant conservation body) to investigate the establishment of fish, amphibian and invertebrate sanctuary areas and aquatic reserves. • There shall be no impoundment of valley bottom wetlands, as these structures restrict the movement of fish and invertebrates. • Prohibit the stocking of wetlands with alien fish (and any other fauna), especially in sanctuary areas. • Investigate the possibility of the eradication and control of alien fish populations. • Clear infestations of alien invasive plants within and around the wetland. • Fences should not be erected around or through valley bottom wetlands	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora.
Management:	• No decline in Ecological Management Class, and restore to Class A or B if currently assessed as being lower than Class B. • Conservation of biodiversity to be considered the highest priority user, in terms of the Ecological Reserve. • CBA valley bottom wetlands must be accurately delineated, using the DWAF delineation protocol (DWAF, 2005).	• Maintain or restore to a natural or near natural state (Ecological Management Class of A or B).

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VALLEY BOTTOM WETLANDS (channeled and unchanneled)		
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	• The condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quantity and water quality components of the Ecological Reserve for the wetland. • Resource Quality Objectives (RQOs) to be set for CBA valley bottom wetlands.	
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

SEEPS (isolated and non-isolated hillslope and basin seeps)		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• Seep wetlands may be connected to a riverine system, but tend not to be fed by a river. Generally, seeps are groundwater-fed, but are also influenced by runoff from the surrounding catchment. • Seeps are particularly sensitive to changes in hydrology. • There should be no change in the natural hydrology of the seep system – e.g. from seasonal to perennial, or from ephemeral to seasonal. Increases in surface and/or groundwater inflows could lead to changes in plant structure, e.g. an increase in hardy sedges and reeds or bulrushes, and a decrease in seasonal wetland vegetation communities. There may be changes in plant zonation, or a loss of important seasonally inundated breeding areas (e.g. inundated sedge habitat used by larvae of many invertebrate taxa). • No stormwater or irrigation return flows from the surrounding slopes shall be conveyed directly into a seep. This runoff should be stored outside of the wetland and its buffer, and allowed to	• No hard development within the wetland buffer. • No stormwater to be conveyed into a wetland buffer. No irrigation return flows to be discharged directly into a wetland buffer. This runoff should be stored outside of the buffer, and allowed to evaporate or be directed elsewhere.

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SEEPS (isolated and non-isolated hillslope and basin seeps)		
	AQUATIC FEATURE	**BUFFER**
	evaporate or be directed elsewhere. • CBA seeps shall not be drained, channelised or infilled. • If a wetland is threatened by water abstraction, the current condition of the wetland should be determined using a preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quantity component of the Ecological Reserve for the wetland. • No abstraction that results in a change in Ecological Management Class shall take place and CBA wetlands should be managed as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B).	
Groundwater:	• No abstraction of groundwater (e.g. well points) allowed within the wetland or such that it is likely to affect flows into the wetland – note that groundwater-fed wetlands may be influenced by groundwater abstraction or diversion far from the wetland itself.	• No groundwater abstraction within wetland buffer – the buffer should be at least 100m in groundwater recharge areas and 250m in groundwater discharge areas.
Water quality:	• Seeps are particularly sensitive to changes in water quality. • There shall be no changes in pH, or increases in salinity and/or nutrients in runoff entering a seep, as this will affect wetland habitat quality – increased nutrients might result in the creation of eutrophic and potentially oxygen depleted habitats; increased salinity above key threshold levels, might result in changes in plant zonation and community structure and a proliferation of weedy elements. • If a wetland is threatened by activities that will / could impact on water quality, the condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quality component of the Ecological	• Enforce the wetland buffer zone. Natural vegetation cover must be maintained, or rehabilitated, in order to ensure filtering of runoff from surrounding catchment before it enters the wetland. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas surrounding the wetland and buffer should be closely monitored for the use of pesticides, herbicides and fertilizers. Where the use of these substances is likely, consideration should be given to widening the buffer. • Livestock should not be permitted into buffer areas. • No hard development within the buffer. • No stormwater to be conveyed into a buffer. • No irrigation return flows to be discharged into buffer.

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SEEPS (isolated and non-isolated hillslope and basin seeps)		
	AQUATIC FEATURE	**BUFFER**
	Reserve for the wetland. • Water quality should be maintained as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B). • No waste (including treated waste) or water containing waste to be discharged into CBA seeps. • DWAF's National Water Resource Classification process is the vehicle through which the Resource Water Quality Objectives (RWQO's) are set, and through which the water quality component of the Ecological Reserve is determined. This must be strictly applied for all CBA wetlands. For seeps, the RWQO's set for the associated river can be used. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	
Sedimentation and erosion:	• Seeps are particularly vulnerable to erosion of the surrounding catchment. Refer to guidelines for terrestrial CBAs. • Prohibit modifications to bed and banks of the wetland. No excavation and / or removal of soil / sand allowed. • No livestock access to CBA seeps. • Water flow through the wetland shall not be constricted through culverts or pipes, for any reason. This leads to erosion through the creation of nick points. . • CBA seeps should be protected from concentration of flows as a result of bridges, pipes or culverts. These should not cross seeps, but where crossings are in existence they must allow for adequate spread of flows through multiple surface and subsurface pipes and culverts across the full width of the wetland.	• No grazing, ploughing or cultivation of wetland buffer. • Livestock should not be permitted into buffer areas. • Clear all alien plants, and maintain indigenous plant cover.
Connectivity:	• CBA seeps shall not be impounded. This could lead to	• There should be no fragmentation of the wetland buffer, e.g. through road

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SEEPS (isolated and non-isolated hillslope and basin seeps)		
	AQUATIC FEATURE	**BUFFER**
	deepening of these shallow (often just saturated to the surface, and not inundated) systems, and so a change in the natural character of the seep, with consequent changes in the fauna and flora inhabiting the seep. • No roads shall be constructed through a seep. Construction of bridges over these CBA wetlands must be strictly controlled, and must go through the full EIA process. • Water flow through the wetland shall not be constricted through culverts or pipes, for any reason. There should be no canalisation or channelisation of flow into, through or out of the wetland. • Where a road or other water channeling structure must run close to a seep, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the wetland and its buffer, at ground level.	construction (this includes tracks, e.g. for 4x4 routes) or the erection of fences or walls. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the wetland buffer, or lead to separation of the buffer from the wetland. • Water flow through the wetland buffer shall not be constricted through culverts or pipes, for any reason. • There shall be no disconnection of the wetland buffer from the wetland • Buffer width to be consistent around the entire wetland (i.e. should not be allowed to diminish in width to accommodate other land-uses), but could be increased to attenuate additional impacts. • Where a road or other water channeling structure runs close to a wetland buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the buffer, at ground level.
Flora and fauna:	• CapeNature / SANParks (or other relevant conservation body) to investigate the establishment of amphibian and invertebrate sanctuary areas and aquatic reserves. • There shall be no impoundment of seeps, as these structures restrict the movement of aquatic fauna. • Clear infestations of alien invasive plants within and around the wetland. • Fences should not be erected around or through seep wetlands.	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora.
Management:	• No decline in Ecological Management Class, and restore to Class A or B if currently assessed as being lower than Class B. • Conservation of biodiversity to be considered the highest priority user, in terms of the Ecological Reserve.	• Maintain or restore to a natural or near natural state (Ecological Management Class of A or B).

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SEEPS (isolated and non-isolated hillslope and basin seeps)		
	AQUATIC FEATURE	**BUFFER**
	• CBA seeps must be accurately delineated, using the DWAF delineation protocol (DWAF, 2005). • The condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quantity and water quality components of the Ecological Reserve for the wetland. • Resource Quality Objectives (RQOs) to be set for CBA seeps.	
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

DEPRESSIONAL WETLANDS (isolated and non-isolated)		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• Depressional wetlands may be connected to a riverine system, but may be isolated from any surface water system, and so groundwater-fed or filled through direct precipitation. • Seasonally saturated or inundated depressional wetlands are particularly sensitive to changes in hydrology. Invertebrate taxa are often highly sensitive to changes in inundation period – where naturally seasonal wetlands are saturated or inundated throughout the year, loss of key taxa can occur. • There should be no change in the natural hydrology of the depressional wetland system – e.g. from seasonal to perennial, or from ephemeral to seasonal. Increases in surface and/or groundwater inflows could lead to changes in plant structure, e.g. an increase in hardy sedges and reeds or bulrushes, and a decrease in seasonal wetland vegetation communities. There may be changes in plant zonation or a loss of important	• No hard development within the wetland buffer. • No stormwater to be conveyed into a wetland buffer. No irrigation return flows to be discharged directly into a wetland buffer. This runoff should be stored outside of the buffer, and allowed to evaporate or be directed elsewhere.

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DEPRESSIONAL WETLANDS (isolated and non-isolated)		
	AQUATIC FEATURE	**BUFFER**
	seasonally inundated breeding areas (e.g. inundated sedge or reed habitat used by larvae of many invertebrate taxa). • No stormwater or irrigation return flows from the surrounding slopes shall be conveyed directly into a depressional wetland. This runoff should be stored outside of the wetland and its buffer, and allowed to evaporate or be directed elsewhere. • CBA depressions shall not be drained or infilled. • If a wetland is threatened by water abstraction, the current condition of the wetland should be determined using a preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quantity component of the Ecological Reserve for the wetland. • No abstraction that results in a change in Ecological Management Class shall take place and CBA wetlands should be managed as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B).	
Groundwater:	• No abstraction of groundwater (e.g. well points) allowed within the wetland, or such that it is likely to affect flows into the wetland – note that groundwater fed wetlands may be influenced by groundwater abstraction or diversion far from the wetland itself	• No groundwater abstraction within wetland buffer – the buffer should be at least 100m in groundwater recharge areas and 250m in groundwater discharge areas.
Water quality:	• Seasonal depressional wetlands often undergo a range of natural water quality during a single season, and their faunal and floral communities in some cases are attuned to this natural variability. They are sensitive to changes in natural water quality regime. • There shall be no alteration in pH, or increases in salinity and/or nutrients in runoff entering the depression beyond natural levels and cycles, as this will affect wetland habitat quality – increased nutrients might result in the creation of eutrophic and potentially oxygen depleted habitats (especially in isolated systems that are not regularly flushed); increased salinity above key threshold	• Enforce the wetland buffer zone. Natural vegetation cover must be maintained, or rehabilitated, in order to ensure filtering of runoff from surrounding catchment before it enters the wetland. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas surrounding the wetland and buffer should be closely monitored for the use of pesticides, herbicides and fertilizers. • Livestock should not be permitted into buffer areas. • No hard development within the buffer.

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DEPRESSIONAL WETLANDS (isolated and non-isolated)		
	AQUATIC FEATURE	**BUFFER**
	levels, might result in changes in plant zonation and community structure and a proliferation of weedy elements. • If a wetland is threatened by activities that will / could impact on water quality, the condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quality component of the Ecological Reserve for the wetland. • Water quality should be maintained as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B). • No waste (including treated waste) or water containing waste to be discharged into CBA depressional wetlands. • DWAF's National Water Resource Classification process is the vehicle through which the Resource Water Quality Objectives (RWQO's) are set, and through which the water quality component of the Ecological Reserve is determined. This must be strictly applied for all CBA wetlands. For depressional wetlands, the RWQO's set for the associated river can be used. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	• No stormwater to be conveyed into a buffer. • No irrigation return flows to be discharged into buffer.
Sedimentation and erosion:	• Prohibit modifications to bed and banks of the wetland. No excavation and / or removal of soil / sand allowed. • No livestock access to CBA depressional wetlands. • Water flow through the wetland shall not be constricted through culverts or pipes, for any reason. This leads to erosion through the creation of nick points.	• No grazing, ploughing or cultivation of wetland buffer. • Livestock should not be permitted into buffer areas. • Clear all alien plants, and maintain indigenous plant cover.

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DEPRESSIONAL WETLANDS (isolated and non-isolated)		
	AQUATIC FEATURE	**BUFFER**
	• Isolated depressions are particulary sensitive to the accumulation of sediments (e.g. as a result of agricultural activities), so there can only be limited agricultural activities near (i.e. within 200m) these systems.	
Connectivity:	• Depressional wetlands shall not be impounded. This could lead to deepening of the wetland, and so a change in the natural character of the depressional wetland, with consequent changes in the fauna and flora inhabiting the wetland. • No roads shall be constructed through a depressional wetland. Construction of bridges over these CBA wetlands must be strictly controlled, and must go through the full EIA process. • Water flow through the wetland shall not be constricted through culverts or pipes, for any reason. There should be no canalisation or channelisation of flow into, through or out of the wetland. • Where a road or other water channeling structure must run close to a depression, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the wetland and its buffer, at ground level.	• There should be no fragmentation of the wetland buffer, e.g. through road construction (this includes tracks, e.g. for 4x4 routes) or the erection of fences or walls. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the wetland buffer, or lead to separation of the buffer from the wetland. • Water flow through the wetland buffer shall not be constricted through culverts or pipes, for any reason. • There shall be no disconnection of the wetland buffer from the wetland • Buffer width to be consistent around the entire wetland (i.e. should not be allowed to diminish in width to accommodate other land-uses), but could be increased to accommodate additional impacts. • Where a road or other water channeling structure runs close to a wetland buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the buffer, at ground level.
Flora and fauna:	• CapeNature / SANParks (or other relevant conservation body) to investigate the establishment of amphibian and invertebrate sanctuary areas and aquatic reserves. • There shall be no impoundment of depressional wetlands, as these structures restrict the movement of aquatic fauna and alter habitat quality for natural faunal and floral communities. • Clear infestations of alien invasive plants within and around the wetland.	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora.

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DEPRESSIONAL WETLANDS (isolated and non-isolated)		
	AQUATIC FEATURE	**BUFFER**
	• Fences should not be erected around or through depressional wetlands.	
Management:	• No decline in Ecological Management Class, and restore to Class A or B if currently assessed as being lower than Class B. • Conservation of biodiversity to be considered the highest priority user, in terms of the Ecological Reserve. • CBA depressional wetlands must be accurately delineated, using the DWAF delineation protocol (DWAF, 2005). • The condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quantity and water quality components of the Ecological Reserve for the wetland. • Resource Quality Objectives (RQOs) to be set for CBA depressional wetlands.	• Maintain or restore to a natural or near natural state (Ecological Management Class of A or B).
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

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WETLAND CLUSTERS		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• Wetlands within a wetland cluster may be connected to a riverine system, but may be isolated from any surface water system, and so groundwater-fed or filled through direct precipitation. • Seasonally saturated or inundated wetlands are particularly sensitive to changes in hydrology. Invertebrate taxa are often highly sensitive to changes in inundation period – where naturally seasonal wetlands are saturated or inundated throughout the year, loss of key taxa can occur. • There should be no change in the natural hydrology of the wetlands within the cluster – e.g. from seasonal to perennial, or from ephemeral to seasonal. Increases in surface and/or groundwater inflows could lead to changes in plant structure, e.g. an increase in hardy sedges and reeds or bulrushes, and a decrease in seasonal wetland vegetation communities. There may be changes in plant zonation or a loss of important seasonally inundated breeding areas (e.g. inundated sedge or reed habitat used by larvae of many invertebrate taxa). • No stormwater or irrigation return flows from the surrounding slopes shall be conveyed directly into a wetland cluster. This runoff should be stored outside of the cluster and its buffer, and allowed to evaporate or be directed elsewhere. • Wetlands within CBA clusters shall not be drained or infilled. • If a wetland within a cluster is threatened by water abstraction, the current condition of the wetland should be determined using a preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quantity component of the Ecological Reserve for the wetland. • No abstraction that results in a change in Ecological Management	• No hard development within the buffer surrounding a wetland cluster. • No stormwater to be conveyed into a buffer for a wetland cluster. No irrigation return flows to be discharged directly into a wetland buffer. This runoff should be stored outside of the buffer, and allowed to evaporate or be directed elsewhere.

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WETLAND CLUSTERS		
	AQUATIC FEATURE	**BUFFER**
	Class shall take place, and the wetlands within a CBA cluster should be managed as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B).	
Groundwater:	• No abstraction of groundwater (e.g. well points) allowed within the wetlands, or such that it is likely to affect flows into the wetlands – note that groundwater fed wetlands may be influenced by groundwater abstraction or diversion far from the wetland itself	• No groundwater abstraction within wetland buffer – the buffer should be at least 100m in groundwater recharge areas and 250m in groundwater discharge areas.
Water quality:	• Seasonal wetlands often undergo a range of natural water quality during a single season, and their faunal and floral communities in some cases are attuned to this natural variability. They are sensitive to changes in natural water quality regime. • There shall be no alteration in pH, or increases in salinity and/or nutrients in runoff entering the depression beyond natural levels and cycles, as this will affect wetland habitat quality – increased nutrients might result in the creation of eutrophic and potentially oxygen depleted habitats (especially in isolated systems that are not regularly flushed); increased salinity above key threshold levels, might result in changes in plant zonation and community structure and a proliferation of weedy elements. • If a wetland is threatened by activities that will / could impact on water quality, the condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quality component of the Ecological Reserve for the wetland. • Water quality should be maintained as close to **natural or near natural** as possible (Eco-status / Ecological Management Class A or B). • No waste (including treated waste) or water containing waste to be discharged into CBA depressional wetlands.	• Enforce the appropriate wetland buffer zone. Natural vegetation cover must be maintained, or rehabilitated, in order to ensure filtering of runoff from surrounding catchment before it enters the wetlands in the cluster. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas surrounding the wetland cluster and buffer should be closely monitored for the use of pesticides, herbicides and fertilizers. • Livestock should not be permitted into buffer areas. • No hard development within the buffer. • No stormwater to be conveyed into a buffer. • No irrigation return flows to be discharged into a buffer.

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WETLAND CLUSTERS		
	AQUATIC FEATURE	**BUFFER**
	• DWAF's National Water Resource Classification process is the vehicle through which the Resource Water Quality Objectives (RWQO's) are set, and through which the water quality component of the Ecological Reserve is determined. This must be strictly applied for all CBA wetlands. For depressional wetlands, the RWQO's set for the associated river can be used. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	
Sedimentation and erosion:	• Prohibit modifications to bed and banks of the wetland. No excavation and / or removal of soil / sand allowed. • No livestock access to CBA depressional wetlands. • Water flow through the wetland shall not be constricted through culverts or pipes, for any reason. This leads to erosion through the creation of nick points. • Isolated depressions are particulary sensitive to the accumulation of sediments (e.g. as a result of agricultural activities), so there can only be limited agricultural activities near (i.e. within 200m) these systems.	• No grazing, ploughing or cultivation of the wetland buffer. • Livestock should not be permitted into buffer areas. • Clear all alien plants, and maintain indigenous plant cover.
Connectivity:	• Connectivity within a wetland cluster is critical – no activities that impact on flow (e.g. impoundment, construction of a road) or movement of fauna and flora (e.g. fences, roads, canals) between wetlands within a cluster shall be permitted. • Wetlands within clusters shall not be impounded. This could lead to deepening of wetlands, and so a change in the natural character of the wetland, with consequent changes in the fauna and flora inhabiting the system. • No roads shall be constructed through or between cluster wetlands. Construction of bridges over these CBA wetlands must be strictly controlled, and must go through the full EIA process.	• There should be no fragmentation of the wetland buffer, e.g. through road construction (this includes tracks, e.g. for 4x4 routes) or the erection of fences or walls. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the wetland buffer or the wetland cluster, or lead to separation of the buffer from the wetlands. • Water flow through the wetland buffer shall not be constricted through culverts or pipes, for any reason. • There shall be no disconnection of the wetland buffer from the wetlands.

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WETLAND CLUSTERS		
	AQUATIC FEATURE	**BUFFER**
	• Water flow through and between the wetlands shall not be constricted through culverts or pipes, for any reason. There should be no canalisation or channelisation of flow into, through or out of the wetland. • Where a road or other water channeling structure must run close to a wetland within a cluster, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the wetland cluster and its buffer, at ground level.	• Buffer width to be consistent around the entire cluster (i.e. should not be allowed to diminish in width to accommodate other land-uses), but it could be increased to accommodate additional impacts. • Where a road or other water channeling structure runs close to a wetland buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the buffer, at ground level.
Flora and fauna:	• CapeNature / SANParks (or other relevant conservation body) to investigate the establishment of amphibian and invertebrate sanctuary areas and aquatic reserves. • There shall be no impoundment of cluster wetlands, as these structures restrict the movement of aquatic fauna and alter habitat quality for natural faunal and floral communities. • Infestations of alien invasive plants shall be cleared within and around the wetlands.	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora into and through the cluster.
Management:	• No decline in Ecological Management Class, and restore to Class A or B if currently assessed as being lower than Class B. • Conservation of biodiversity to be considered the highest priority user, in terms of the Ecological Reserve. • All wetlands within a wetland cluster must be accurately delineated, using the DWAF delineation protocol (DWAF, 2005). • The condition of the wetland within a cluster should be determined using the current preferred method of assessment – currently, this is WET-Health, WET-EcoServices and/or WETLAND-IHI. This assessment will feed into the determination of the appropriate Ecological Management Class for each wetland, which is required for the calculation of the water quantity	• Maintain or restore to a natural or near natural state (Ecological Management Class of A or B).

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WETLAND CLUSTERS		
	AQUATIC FEATURE	**BUFFER**
	and water quality components of the Ecological Reserve for each wetland separately, and together as a cluster. • Resource Quality Objectives (RQOs) to be set for the wetland cluster as an entity.	
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

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ECOLOGICAL SUPPORT AREAS (AQUATIC – CRITICAL AND OTHER)

Rivers

MOUNTAIN STREAM		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• Where abstraction is necessary, off-channel dam construction or run-of-river abstraction is preferable, with the highest Ecological Reserve possible, and monitored for compliance. • Improve regulation of abstractions from these rivers and encourage efficient water use (i.e. demand control, recycling, use of grey water, rainwater tanks). • No stormwater to be discharged into mountain streams. • Irrigation return flows should be directed away from mountain streams. • There should be no change in the hydrology of the system, e.g. from ephemeral to seasonal, or seasonal to perennial.	• No hard development within the riparian buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it, upstream of the wetland. Thus where stormwater and irrigation return flows pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality. • Clear water using alien invading plants.
Environmental flow requirements (surface):	• Maintain flow regime (i.e. the magnitude, frequency, and variability of flow) as close to natural as possible. • Licensed abstractions and river regulation should be assessed in terms of the Ecological Reserve. • Compliance with and effectiveness of the required releases of water from impoundments in rivers must be monitored and enforced. This is particularly so for dry season, low-flow releases, but also important for freshes and floods. • Optimal use should be made of existing abstractions through water demand management measures. There should be a halt to further abstractions within catchments that are particularly water stressed.	• n/a
Groundwater:	• No groundwater abstraction that would impact on the supply of water to groundwater-fed mountain streams, i.e. those situated in groundwater recharge areas.	• No groundwater abstraction within the riparian buffer.

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MOUNTAIN STREAM		
	AQUATIC FEATURE	**BUFFER**
Water quality:	• Changes in salinity and/or nutrient concentrations in mountain streams should be minimised, and should not exceed natural fluctuations by more than 15%. • An application must be submitted to the relevant government departments – i.e. DEADP and DWAF – before any waste (including treated waste) or water containing waste can be discharged directly into a mountain stream. Water quality should be maintained so that there is no deterioration in the Ecological Management Class to which the stream is currently assigned. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	• Enforce the wetland buffer zone. Natural vegetation cover must be maintained, or rehabilitated, to promote buffer function. Alien vegetation should be removed. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas surrounding the stream and buffer should be closely monitored for the use of pesticides, herbicides and fertilizers. Where the use of these substances is likely, consideration should be given to widening the buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • No hard development within the buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it. Thus, where stormwater and irrigation return flows pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality.
Sedimentation and erosion:	• Anymodifications to the bed and banks of the river shall be subject to an environmental impact assessment, according to the EIA regulations (2006). • Limit livestock access to river – the bed and banks of mountain streams are particularly sensitive to trampling which causes major erosion and sedimentation.	• No grazing, ploughing or cultivation of buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • Clear all alien plants, and maintain indigenous plant cover.
Connectivity:	• Obstructions to flow (e.g. fences, walls) within the river channel shall be minimised. • No canalisation or channelisation of river banks or river bed. • The construction of roads through or over mountain streams should be minimised. Construction of roads and bridges must be strictly controlled, and must go through the full EIA process.	• No fragmentation of the riparian zone. • No disconnection of the riparian zone from the river. • Buffer width to be consistent along the length of the associated river reach (i.e. should not be allowed to diminish in width to accommodate other land-uses). • The construction of roads (this includes tracks, e.g. for 4x4 routes) through riparian buffers should not be permitted.

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MOUNTAIN STREAM		
	AQUATIC FEATURE	**BUFFER**
		• Where a road or other water channeling structure runs close to a riparian buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the riparian zone, at ground level. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the riparian zone, or lead to separation of the riparian buffer from the river.
Flora and fauna:	• No further building of instream dams and weirs in fish sanctuary areas, as these restrict the movement of fish. • Maintain adequate flow velocities in fish spawning months. • Prohibit the stocking of farm dams (even off-stream dams) and rivers with alien fish, especially in sanctuary areas. • Clear infestations of alien invasive plants within the river system.	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a riparian buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora.
Management:	• No decline in Ecological Management Class. • DWAF and DEAT to monitor resource quality status in order to ascertain whether management actions are adequate to achieve compliance with the requirements of DWAF's National Water Resource Classification System[10] (i.e. the desired Ecological Management Class), the Ecological Reserve and DWAF Resource Quality Objectives. • Users of the water resource to monitor abstraction and discharge to ensure maintenance of natural level of ecological functioning (e.g. water quality amelioration; infiltration; floodwater retention; provision of low flows to downstream systems).	• The maintenance of ecological functioning of the riparian buffer shall be considered the main management objective.
Rehabilitation	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

[10] The National Water Resource Classification System is used as part of a consultative process to classify water resources to help facilitate a balance between protection and use of the nation's water resources.

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MOUNTAIN STREAM		
	AQUATIC FEATURE	**BUFFER**
guidelines		

FOOTHILL RIVER		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• Where abstraction is necessary, off-channel dam construction or run-of-river abstraction is preferable, with the highest Ecological Reserve possible, and monitored for compliance. • Improve regulation of abstractions from these rivers and encourage efficient water use (i.e. demand control, recycling, use of grey water, rainwater tanks). • No stormwater to be discharged into foothill rivers. • Irrigation return flows should be directed away from foothill rivers. • There should be no change in the hydrology of the system, e.g. from ephemeral to seasonal, or seasonal to perennial.	• No hard development within the riparian buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it, upstream of the wetland. Thus where stormwater and irrigation return flows pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality. • Clear water using alien invading plants.
Environmental flow requirements (surface):	• Maintain flow regime (i.e. the magnitude, frequency, and variability of flow) as close to natural as possible. • Licensed abstractions and river regulation should be assessed in terms of the Ecological Reserve. • Compliance with and effectiveness of the required releases of water from impoundments in rivers must be monitored and enforced. This is particularly so for dry season, low-flow releases, but also important for freshes and floods. • Optimal use should be made of existing abstractions through water demand management measures. There should be a halt to further abstractions within catchments that are particularly water stressed.	• n/a
Groundwater:	• No groundwater abstraction that would impact on the supply of water to groundwater-fed foothill rivers, i.e. those situated in	• No groundwater abstraction within the riparian buffer.

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FOOTHILL RIVER		
	AQUATIC FEATURE	**BUFFER**
	groundwater recharge areas.	
Water quality:	• Changes in salinity and/or nutrient concentrations in foothill rivers should be minimised, and should not exceed natural fluctuations by more than 15%. • An application must be submitted to the relevant government departments – i.e. DEADP and DWAF – before any waste (including treated waste) or water containing waste can be discharged directly into a foothill river. Water quality should be maintained so that there is no deterioration in the Ecological Management Class to which the stream is currently assigned. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	• Enforce the wetland buffer zone. Natural vegetation cover must be maintained, or rehabilitated, to promote buffer function. Alien vegetation should be removed. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas surrounding the stream and buffer should be closely monitored for the use of pesticides, herbicides and fertilizers. Where the use of these substances is likely, consideration should be given to widening the buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • No hard development within the buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it. Thus, where stormwater and irrigation return flows pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality.
Sedimentation and erosion:	• Any modifications to the bed and banks of the river shall be subject to an environmental impact assessment, according to the EIA regulations (2006). • Limit livestock access to river – the bed and banks of foothill rivers are particularly sensitive to trampling which causes major erosion and sedimentation.	• No grazing, ploughing or cultivation of buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • Clear all alien plants, and maintain indigenous plant cover.
Connectivity:	• Obstructions to flow (e.g. fences, walls) within the river channel shall be minimised. • No canalisation or channelisation of river banks or river bed. • The construction of roads through or over foothill rivers should be minimised. Construction of roads and bridges must be strictly controlled, and must go through the full EIA process.	• No fragmentation of the riparian zone. • No disconnection of the riparian zone from the river. • Buffer width to be consistent along the length of the associated river reach (i.e. should not be allowed to diminish in width to accommodate other land-uses). • The construction of roads (this includes tracks, e.g. for 4x4 routes)

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FOOTHILL RIVER		
	AQUATIC FEATURE	**BUFFER**
		through riparian buffers should not be permitted. • Where a road or other water channeling structure runs close to a riparian buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the riparian zone, at ground level. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the riparian zone, or lead to separation of the riparian buffer from the river.
Flora and fauna:	• No further building of instream dams and weirs in fish sanctuary areas, as these restrict the movement of fish. • Maintain adequate flow velocities in fish spawning months. • Prohibit the stocking of farm dams (even off-stream dams) and rivers with alien fish, especially in sanctuary areas. • Clear infestations of alien invasive plants within the river system.	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a riparian buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora.
Management:	• No decline in Ecological Management Class. • DWAF and DEAT to monitor resource quality status in order to ascertain whether management actions are adequate to achieve compliance with the requirements of DWAF's National Water Resource Classification System[11] (i.e. the desired Ecological Management Class), the Ecological Reserve and DWAF Resource Quality Objectives. • Users of the water resource to monitor abstraction and discharge to ensure maintenance of natural level of ecological functioning (e.g. water quality amelioration; infiltration; floodwater retention; provision of low flows to downstream systems).	• The maintenance of ecological functioning of the riparian buffer shall be considered the main management objective.

[11] The National Water Resource Classification System is used as part of a consultative process to classify water resources to help facilitate a balance between protection and use of the nation's water resources.

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FOOTHILL RIVER		
	AQUATIC FEATURE	**BUFFER**
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

LOWLAND RIVER		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• Where abstraction is necessary, off-channel dam construction or run-of-river abstraction is preferable, with the highest Ecological Reserve possible, and monitored for compliance. • Improve regulation of abstractions from these rivers and encourage efficient water use (i.e. demand control, recycling, use of grey water, rainwater tanks). • No stormwater to be discharged into lowland rivers. • Irrigation return flows should be directed away from lowland rivers. • There should be no change in the hydrology of the system, e.g. from ephemeral to seasonal, or seasonal to perennial.	• No hard development within the riparian buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it, upstream of the wetland. Thus where stormwater and irrigation return flows pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality. • Clear water using alien invading plants.
Environmental flow requirements (surface):	• Maintain flow regime (i.e. the magnitude, frequency, and variability of flow) as close to natural as possible. • Licensed abstractions and river regulation should be assessed in terms of the Ecological Reserve. • Compliance with and effectiveness of the required releases of water from impoundments in rivers must be monitored and enforced. This is particularly so for dry season, low-flow releases, but also important for freshes and floods. • Optimal use should be made of existing abstractions through water demand management measures. There should be a halt to further abstractions within catchments that are particularly water stressed.	• n/a

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LOWLAND RIVER		
	AQUATIC FEATURE	**BUFFER**
Groundwater:	• No groundwater abstraction that would impact on the supply of water to groundwater-fed lowland rivers, i.e. those situated in groundwater recharge areas.	• No groundwater abstraction within the riparian buffer.
Water quality:	• Changes in salinity and/or nutrient concentrations in lowland rivers should be minimised, and should not exceed natural fluctuations by more than 15%. • An application must be submitted to the relevant government departments – i.e. DEADP and DWAF – before any waste (including treated waste) or water containing waste can be discharged directly into a lowland river. Water quality should be maintained so that there is no deterioration in the Ecological Management Class to which the stream is currently assigned. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	• Enforce the wetland buffer zone. Natural vegetation cover must be maintained, or rehabilitated, to promote buffer function. Alien vegetation should be removed. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas surrounding the stream and buffer should be closely monitored for the use of pesticides, herbicides and fertilizers. Where the use of these substances is likely, consideration should be given to widening the buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • No hard development within the buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it. Thus, where stormwater and irrigation return flows pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality.
Sedimentation and erosion:	• Anymodifications to the bed and banks of the river shall be subject to an environmental impact assessment, according to the EIA regulations (2006). • Limit livestock access to river – the bed and banks of lowland rivers are particularly sensitive to trampling which causes major erosion and sedimentation.	• No grazing, ploughing or cultivation of buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • Clear all alien plants, and maintain indigenous plant cover.
Connectivity:	• Obstructions to flow (e.g. fences, walls) within the river channel shall be minimised. • No canalisation or channelisation of river banks or river bed. • The construction of roads through or over lowland rivers should be minimised. Construction of roads and bridges must be strictly	• No fragmentation of the riparian zone. • No disconnection of the riparian zone from the river. • Buffer width to be consistent along the length of the associated river reach (i.e. should not be allowed to diminish in width to accommodate

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LOWLAND RIVER		
	AQUATIC FEATURE	**BUFFER**
	controlled, and must go through the full EIA process.	other land-uses). • The construction of roads (this includes tracks, e.g. for 4x4 routes) through riparian buffers should not be permitted. • Where a road or other water channeling structure runs close to a riparian buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the riparian zone, at ground level. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the riparian zone, or lead to separation of the riparian buffer from the river.
Flora and fauna:	• No further building of instream dams and weirs in fish sanctuary areas, as these restrict the movement of fish. • Maintain adequate flow velocities in fish spawning months. • Prohibit the stocking of farm dams (even off-stream dams) and rivers with alien fish, especially in sanctuary areas. • Clear infestations of alien invasive plants within the river system.	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a riparian buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora.
Management:	• No decline in Ecological Management Class. • DWAF and DEAT to monitor resource quality status in order to ascertain whether management actions are adequate to achieve compliance with the requirements of DWAF's National Water Resource Classification System[12] (i.e. the desired Ecological Management Class), the Ecological Reserve and DWAF Resource Quality Objectives. • Users of the water resource to monitor abstraction and discharge to ensure maintenance of natural level of ecological functioning	• The maintenance of ecological functioning of the riparian buffer shall be considered the main management objective.

[12] The National Water Resource Classification System is used as part of a consultative process to classify water resources to help facilitate a balance between protection and use of the nation's water resources.

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LOWLAND RIVER		
	AQUATIC FEATURE	**BUFFER**
	(e.g. water quality amelioration; infiltration; floodwater retention; provision of low flows to downstream systems).	
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

SUB-CATCHMENTS	
Water Quantity:	• Surface water abstraction and use in the catchment must be monitored – e.g. existing abstractions should be checked against permitted water use – and managed so that river integrity is not adversely affected. • No further abstraction in water-stressed catchments (e.g. all Berg River sub-catchments). • In water stressed sub-catchments, no further licenses for additional extensive agriculture should be granted. • The Ecological Reserve must be determined for all rivers in the sub-catchment that are threatened by abstraction. • Intact tributaries into major rivers cannot be impounded, even if off-channel. • Abstraction from impoundments and from run-of-river to be governed by the Ecological Reserve.
Environmental flow requirements (surface):	• The Ecological Reserve must be determined for all rivers in the sub-catchment that are threatened by abstraction. • The effectiveness of and compliance with required environmental flow releases from any impoundments in the catchment must be monitored. • Intact tributaries into major rivers cannot be impounded, even if off-channel.
Groundwater:	• Groundwater abstractions should be assessed, monitored and controlled, particularly in groundwater-dependent sub-catchments and areas, such as the Sandveld and Koue Bokkeveld areas. Rivers in the South-Western and Western Coastal Belt ecoregions are highly sensitive to groundwater abstraction. Rivers in the Cederberg and Groot Winterhoek mountain ranges, in the Western Folded Mountains ecoregion are thought to sustain the aquifers in the Sandveld area. Groundwater abstraction in these areas therefore needs to be closely monitored and managed. • The groundwater Reserve must be determined in catchments that are stressed by groundwater abstraction. • Management activities include assessing current levels of abstraction (e.g. number of boreholes, current rates and volumes of abstraction), and controlling, or preventing further groundwater abstraction, maintaining natural vegetation cover, and clearing alien invasive plants in the

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SUB-CATCHMENTS	
	catchment. • Groundwater-fed seeps, springs, rivers and areas of hydraulically conductive fault zones must be protected from groundwater abstraction of any volume – in the case of groundwater recharge areas (generally mountainous areas) the buffer should be at least 100m, whereas in groundwater discharge areas, this buffer should be extended to at least 250m. • Aquifer-dependent ecosystems must be protected from groundwater abstraction by a buffer of at least 250m.
Water quality:	• In water stressed sub-catchments, no further licenses for additional extensive agriculture should be granted. • Herbicides and pesticides should not be used within 500m of rivers, wetlands *or their buffers*.
Sedimentation and erosion:	• The construction of roads across rivers or through wetlands or buffers must be assessed according to the EIA regulations. Such crossings must be minimised, as these create points where erosion is more likely to occur.
Connectivity:	• Rivers and their buffers (see relevant sections for recommended riverine buffers) must be protected and maintained as natural ecological corridors within a landscape that accommodates other land-uses.
Flora and fauna:	• No further building of instream dams and weirs in fish sanctuary areas, as these restrict the movement of fish. • Prohibit the stocking of farm dams (even off-stream dams) and rivers with alien fish, especially in sanctuary areas. • Investigate the possibility of the eradication and control of alien fish populations. • Clear infestations of alien invasive plants within the catchment. • Where the construction of fences is necessary (e.g. around reserves), this should be done ensuring that fences / walls do not obstruct the movement of fauna and flora.
CBA-specific management:	• A catchment management strategy must be developed for the sub-catchment. This is the vehicle through which the Resource Quality Objectives (RQOs) can be determined and achieved. • All new urban or rural developments, change in land-use, or increases / changes in extensive and intensive agricultural activities within priority sub-catchments must be assessed according to the EIA regulations, to ensure that impacts associated with the construction and operation of developments or changes in land-use do not lead to the loss or deterioration of aquatic ecosystems.
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.

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Wetlands

FLOODPLAIN WETLANDS		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• There should be no changes in flood frequency and magnitude as this would modify the extent and duration of floodplain inundation - decreases in duration and frequency of inundation may also have implications for the value of certain floodplain habitats as breeding sites for wetland fauna, may result in shrinkage of floodplain wetland vegetation, leading to loss of wetland function (e.g. erosion protection, sediment trapping and flood detention) during extreme high flow events. This is important in the context of climate change – models predict an increase in unexpected storm events in the study region. • There should be no change in the natural hydrology of the wetland system – e.g. from seasonal to perennial, or from ephemeral to seasonal. • Stormwater or irrigation return flows shall not be conveyed directly into a floodplain wetland, but should rather be conveyed over land, such that it is dissipated to a degree where it has no impact on wetland water quality or hydrology – see buffer guidelines • Floodplain wetlands shall not be drained or infilled. • If the ecological functioning or overall condition of a floodplain wetland, or its provision of goods and services, is impacted or threatened by water abstraction, the current condition of the wetland should be determined using a preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices, or the rapid Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland. It follows then that no abstraction that results in a deterioration in Ecological Management Class shall take place.	• No hard development within the wetland buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it, upstream of the wetland. Thus where stormwater and irrigation return flows pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality.
Groundwater:	• Floodplain wetlands can be critical for groundwater recharge in the lower catchment. Thus, inundation of the floodplain must be	• No groundwater abstraction within wetland buffer – the buffer should be at least 100m in groundwater recharge areas and 250m in groundwater

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FLOODPLAIN WETLANDS		
	AQUATIC FEATURE	**BUFFER**
	allowed to occur – refer to "water quantity" guidelines. • Floodplain wetlands may also rely on groundwater in groundwater discharge areas, thus there should be no abstraction of groundwater allowed within the wetland.	discharge areas.
Water quality:	• Changes in salinity and/or nutrient concentrations in floodplain wetlands should be minimised, and should not exceed natural fluctuations by more than 15%. Increased nutrients might result in the creation of eutrophic and potentially oxygen depleted habitats; increased salinity above key threshold levels might result in changes in plant zonation and community structure and a proliferation of weedy elements. • If the wetland is threatened by activities that will / could impact on water quality, the condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland. Water quality should be maintained so that there is no deterioration in the Ecological Management Class to which the wetland is currently assigned. • An application must be submitted to the relevant government departments – i.e. DEADP and DWAF – before any waste (including treated waste) or water containing waste can be discharged directly into a floodplain wetland. This process will require an assessment of the condition of the wetland before permission is granted for waste disposal. Water quality should be maintained so that there is no deterioration in the Ecological Management Class to which the wetland is currently assigned. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	• Enforce the wetland buffer zone. Natural vegetation cover must be maintained, or rehabilitated, to promote buffer function. Alien vegetation should be removed. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas surrounding the wetland and buffer should be closely monitored for the use of pesticides, herbicides and fertilizers. Where the use of these substances is likely, consideration should be given to widening the buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • No hard development within the buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it, upstream of the wetland. Thus where stormwater and irrigation return flows pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality.

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FLOODPLAIN WETLANDS		
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Sedimentation and erosion:	• Modifications to the bed and banks of the floodplain wetland should be minimised. The excavation and / or removal of soil / sand or cobbles should not exceed $5m^3$, but if it must exceed this amount, then at least a basic assessment, as stipulated in the EIA regulations (2006) must be done. • No livestock access to wetland. • Water flow through the wetland shall not be constricted through channels, culverts or pipes. This leads to erosion.	• No grazing, ploughing or cultivation of wetland buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • Clear all alien plants, and maintain indigenous plant cover.
Connectivity:	• All floodplain wetlands must be managed in such a manner as to at least maintain the ecosystem services provided by the wetland, and to maintain the biodiversity supported by that wetland. • Floodplain wetlands are influenced by riverine processes, as they are all associated with rivers (generally lowland rivers). Thus, they are sensitive to upstream activities and activities in the catchment as a whole. • The user should refer to the management guidelines for lowland rivers. • Floodplain wetlands are often closely associated with estuarine systems. Thus, activities occurring on and around floodplains must take into account that these may impact on the downstream estuary. • Floodplain wetlands shall not be impounded. Flood control berms should not be placed in floodplain wetlands. • The extent of floodplain wetlands is not always readily discernible (because the extent of inundation of these systems fluctuates widely) so they are vulnerable to constriction and encroachment by agricultural activities, roads, urban development. No roads shall be constructed through a floodplain wetland. Construction of bridges over wetlands must be strictly controlled, and must go through the full EIA process. • Water flow through the wetland shall not be constricted through	• There should be no fragmentation of the wetland buffer, e.g. through road construction (this includes tracks, e.g. for 4x4 routes) or the erection of fences or walls. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the wetland buffer, or lead to separation of the buffer from the wetland. • Water flow through the wetland buffer shall not be constricted through culverts or pipes, for any reason. • There shall be no disconnection of the wetland buffer from the wetland • Buffer width to be consistent around the entire wetland (i.e. should not be allowed to diminish in width to accommodate other land-uses) but could increase to attenuate additional impacts. • Where a road or other water channeling structure runs close to a wetland buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the buffer, at ground level and their locations should correspond to natural drainage lines.

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FLOODPLAIN WETLANDS		
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	culverts or pipes.	
Flora and fauna:	• All floodplain wetlands must be managed in such a manner as to at least maintain the ecosystem services provided by the wetland, and to maintain the biodiversity supported by that wetland. • There shall be no impoundment of floodplain wetlands, as these structures restrict the movement of fish and invertebrates and alter floodplain characteristics (flood duration etc). • The stocking of floodplain wetlands with alien fish (and any other fauna) shall be prohibited. • Clear infestations of alien invasive plants within and around the wetland. • Fences should not be erected around or through floodplain wetlands	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a buffer, this should be done to ensure that this does not obstruct the movement of fauna and flora.
Management:	• The maintenance of ecological functioning of the floodplain wetland shall be considered the main management objective. • Floodplain wetlands that are threatened by development, or any other activities that would impact significantly on the wetlands, should be accurately delineated, using the DWAF delineation protocol (DWAF, 2005) before any such activities commence. At least a basic assessment of impacts must be completed with regards to the wetlands, as required by the EIA regulations (2006). • The condition of floodplain wetlands that are threatened by development, or any other activities that would impact significantly on the wetlands, should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland. No decline in Ecological Management Class should occur.	• The maintenance of ecological functioning of the wetland buffer shall be considered the main management objective.
Rehabilitation	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

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FLOODPLAIN WETLANDS		
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VALLEY BOTTOM WETLANDS (channeled and unchanneled)		
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Water Quantity:	• Valley bottom wetlands are driven by both riverine processes and processes occurring on the surrounding slopes. • There should be no changes in riverine flood frequency and magnitude as this would modify the extent of valley bottom inundation – reduction in riverine discharge could reduce scour, leading to encroachment by aquatic and marginal vegetation, and channel narrowing – this would increase the likelihood of downcutting and erosion after flood events. • There should be no change in the natural hydrology of the valley bottom wetland system – e.g. from seasonal to perennial, or from ephemeral to seasonal. In the case of naturally ephemeral systems, decreases in flow could result in their alteration to mainly terrestrial systems, characterised by weedy vegetation, with a loss of wetland function. Increases in surface and/or groundwater inflows could lead to changes in plant structure, e.g. an increase in hardy sedges and reeds or bulrushes, and a decrease in seasonal wetland vegetation communities. There may be changes in plant zonation e.g. increased width of wet bank *versus* dry bank vegetation, or a loss of important seasonally inundated breeding areas (e.g. inundated sedge habitat used by larvae of many invertebrate taxa). • Stormwater or irrigation return flows shall not be conveyed directly into a floodplain wetland, but should rather be conveyed over land, such that it is dissipated to a degree where it has no impact on wetland water quality or hydrology – see buffer guidelines	• No hard development within the wetland buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it, upstream of the wetland. Thus where stormwater and irrigation return flows must pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality.

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VALLEY BOTTOM WETLANDS (channeled and unchanneled)		
	AQUATIC FEATURE	**BUFFER**
	• Valley bottom wetlands shall not be drained or infilled. • If the ecological functioning or overall condition of a valley bottom wetland, or its provision of goods and services, is impacted or threatened by water abstraction, the current condition of the wetland should be determined using a preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices, or the rapid Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland. It follows then that no abstraction that results in a deterioration in Ecological Management Class shall take place.	
Groundwater:	• No abstraction of groundwater allowed within the wetland.	• No groundwater abstraction within wetland buffer – the buffer should be at least 100m from the edge of wetlands in groundwater recharge areas and 250m from the edge of wetlands in groundwater discharge areas.
Water quality:	• Changes in salinity and/or nutrient concentrations in valley bottom wetlands should be minimised, and should not exceed natural fluctuations by more than 15%. Increased nutrients might result in the creation of eutrophic and potentially oxygen depleted habitats; increased salinity above key threshold levels might result in changes in plant zonation and community structure and a proliferation of weedy elements. • If the wetland is threatened by activities that will / could impact on water quality, the condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland. Water quality should be maintained so that there is no deterioration in the Ecological Management Class to which the wetland is currently assigned. • An application must be submitted to the relevant government departments – i.e. DEADP and DWAF – before any waste (including treated waste) or water containing waste can be	• Enforce the wetland buffer zone. Natural vegetation cover must be maintained, or rehabilitated, to promote buffer function. Alien vegetation should be removed. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas surrounding the wetland and buffer should be closely monitored for the use of pesticides, herbicides and fertilizers. Where the use of these substances is likely, consideration should be given to widening the buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • No hard development within the buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it, upstream of the wetland. Thus where stormwater and irrigation return flows pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality.

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VALLEY BOTTOM WETLANDS (channeled and unchanneled)		
	AQUATIC FEATURE	**BUFFER**
	discharged directly into a valley bottom wetland. This process will require an assessment of the condition of the wetland before permission is granted for waste disposal. Water quality should be maintained so that there is no deterioration in the Ecological Management Class to which the wetland is currently assigned. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	
Sedimentation and erosion:	• Modifications to the bed and banks of the valley bottom wetland should be minimised. The excavation and / or removal of soil / sand or cobbles should not exceed $5m^3$, but if it must exceed this amount, then at least a basic assessment, as stipulated in the EIA regulations (2006) must be done. • No livestock access to wetland. • Water flow through the wetland shall not be constricted through channels, culverts or pipes. This leads to erosion.	• No grazing, ploughing or cultivation of wetland buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • Clear all alien plants, and maintain indigenous plant cover.
Connectivity:	• Valley bottom wetlands are influenced by riverine processes, as they are all associated with rivers (generally mountain stream and upper foothill rivers). Thus, they are sensitive to upstream activities and activities in the catchment as a whole. The user should refer to the management guidelines for mountain stream and foothill rivers. • The extent of valley bottom wetlands is not always readily discernible (because the extent of inundation and / or saturation of these systems fluctuates widely, depending on riverine discharge and runoff from the surrounding catchment) so they are vulnerable to constriction and encroachment by agricultural activities, roads, urban development. • Valley bottom wetlands shall not be fragmented or reduced in extent. These wetlands can perform an important function as natural ecological corridors, allowing movement of fauna and flora	• There should be no fragmentation of the wetland buffer, e.g. through road construction (this includes tracks, e.g. for 4x4 routes) or the erection of fences or walls. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the wetland buffer, or lead to separation of the buffer from the wetland. • Water flow through the wetland buffer shall not be constricted through culverts or pipes, for any reason. • There shall be no disconnection of the wetland buffer from the wetland • Buffer width to be consistent around the entire wetland (i.e. should not be allowed to diminish in width to accommodate other land-uses), but could be increased to attenuate additional impacts. • Where a road or other water channeling structure runs close to a wetland

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VALLEY BOTTOM WETLANDS (channeled and unchanneled)		
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	within the landscape, as well as providing many other goods and services (such as flood attenuation, erosion control). • All valley bottom wetlands must be managed in such a manner as to at least maintain the ecosystem services provided by the wetland, and to maintain the biodiversity supported by that wetland. • Valley bottom wetlands shall not be impounded (this is so for both channeled and unchanneled valley bottom wetlands). Flood control berms should not be placed in valley bottom wetlands. • No roads shall be constructed through a valley bottom wetland. Construction of bridges over these wetlands must be strictly controlled, and must go through the full EIA process. • Water flow through the wetland shall not be constricted through culverts or pipes.	buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the buffer, at ground level.
Flora and fauna:	• All valley bottom wetlands must be managed in such a manner as to at least maintain the ecosystem services provided by the wetland, and to maintain the biodiversity supported by that wetland. • There shall be no impoundment of valley bottom wetlands, as these structures restrict the movement of fish and invertebrates. • The stocking of wetlands with alien fish (and any other fauna), should be prohibited. • Clear infestations of alien invasive plants within and around the wetland.	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a buffer, this should be done to ensure that the fences do not obstruct the movement of fauna and flora.
Management:	• The maintenance of ecological functioning of the valley bottom wetland shall be considered the main management objective. • Valley bottom wetlands that are threatened by development, or any other activities that would impact significantly on the wetlands, should be accurately delineated, using the DWAF delineation protocol (DWAF, 2005) before any such activities	• The maintenance of ecological functioning of the wetland buffer shall be considered the main management objective.

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VALLEY BOTTOM WETLANDS (channeled and unchanneled)		
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	commence. At least a basic assessment of impacts must be completed with regards to the wetlands, as required by the EIA regulations (2006). • The condition of valley bottom wetlands that are threatened by development, or any other activities that would impact significantly on the wetlands, should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland. No decline in Ecological Management Class should occur.	
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

SEEPS (isolated and non-isolated hillslope and basin seeps)		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• Seep wetlands may be connected to a riverine system, but tend not to be fed by a river. Generally, seeps are groundwater-fed, but are also influenced by runoff from the surrounding catchment. Seeps are particularly sensitive to changes in hydrology. • There should be no increases in surface and/or groundwater inflows into a seep wetland, as these could lead to changes in plant structure, e.g. an increase in hardy sedges and reeds or bulrushes, and a decrease in seasonal wetland vegetation communities. There may be changes in plant zonation, or a loss of important seasonally inundated breeding areas (e.g. inundated sedge habitat used by larvae of many invertebrate taxa). • No stormwater or irrigation return flows from the surrounding slopes shall be conveyed directly into a seep. This runoff should be stored outside of the wetland and its buffer, and allowed to evaporate or be directed elsewhere.	• No hard development within the wetland buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it, upstream of the wetland. Thus where stormwater and irrigation return flows must pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality.

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SEEPS (isolated and non-isolated hillslope and basin seeps)		
	AQUATIC FEATURE	**BUFFER**
	• There should be no change in the natural hydrology of the seep system – e.g. from seasonal to perennial, or from ephemeral to seasonal. • Seep wetlands shall not be drained, channelised or infilled. • If the ecological functioning or overall condition of a valley bottom wetland, or its provision of goods and services, is impacted or threatened by water abstraction, the current condition of the wetland should be determined using a preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices, or the rapid Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland. It follows then that no abstraction that results in a deterioration in Ecological Management Class shall take place.	
Groundwater:	• No abstraction of groundwater (e.g. well points) allowed within the wetland or such that it is likely to affect flows into the wetland – note that groundwater fed wetlands may be influenced by groundwater abstraction or diversion far from the wetland itself	• No groundwater abstraction within wetland buffer – the buffer should be at least 100m from the edge of wetlands in groundwater recharge areas and 250m from the edge of wetlands in groundwater discharge areas.
Water quality:	• Changes in salinity and/or nutrient concentrations in seep wetlands should be minimised, and should not exceed natural fluctuations by more than 15%. Increased nutrients might result in the creation of eutrophic and potentially oxygen depleted habitats; increased salinity above key threshold levels might result in changes in plant zonation and community structure and a proliferation of weedy elements. • If the wetland is threatened by activities that will / could impact on water quality, the condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland. Water quality should be maintained so that there is no deterioration in the Ecological Management Class to which	• Enforce the wetland buffer zone. Natural vegetation cover must be maintained, or rehabilitated, to promote buffer function. Alien vegetation should be removed. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas surrounding the wetland and buffer should be closely monitored for the use of pesticides, herbicides and fertilizers. Where the use of these substances is likely, consideration should be given to widening the buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • No hard development within the buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it, upstream of the wetland. Thus where stormwater and irrigation return flows pass through the buffer,

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SEEPS (isolated and non-isolated hillslope and basin seeps)		
	AQUATIC FEATURE	**BUFFER**
	the wetland is currently assigned. • An application must be submitted to the relevant government departments – i.e. DEADP and DWAF – before any waste (including treated waste) or water containing waste can be discharged directly into a seep wetland. This process will require an assessment of the condition of the wetland before permission is granted for waste disposal. Water quality should be maintained so that there is no deterioration in the Ecological Management Class to which the wetland is currently assigned. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	adequately sized artificial treatment wetlands should be provided to address stormwater quality.
Sedimentation and erosion:	• Modifications to the bed and banks of the seep wetland should be minimised. The excavation and / or removal of soil / sand or cobbles should not exceed $5m^3$, but if it must exceed this amount, then at least a basic assessment, as stipulated in the EIA regulations (2006) must be done. • No livestock access to seeps. • Water flow through the wetland shall not be constricted through culverts or pipes, for any reason. This leads to erosion through the creation of nick points. . • Seeps should be protected from concentration of flows as a result of bridges, pipes or culverts. These should preferably not cross seeps, but where crossings are in existence they must allow for adequate spread of flows through multiple surface and subsurface pipes and culverts across the full width of the wetland.	• No grazing, ploughing or cultivation of wetland buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • Clear all alien plants, and maintain indigenous plant cover.
Connectivity:	• All seep wetlands must be managed in such a manner as to at least maintain the ecosystem services provided by the wetland, and to maintain the biodiversity supported by that wetland. • Seeps shall not be impounded. This could lead to deepening of	• There should be no fragmentation of the wetland buffer, e.g. through road construction (this includes tracks, e.g. for 4x4 routes) or the erection of fences or walls. • Where the construction of fences is necessary (e.g. around reserves), this

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SEEPS (isolated and non-isolated hillslope and basin seeps)		
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	these shallow (often just saturated to the surface, and not inundated) systems, and so a change in the natural character of the seep, with consequent changes in the fauna and flora inhabiting the seep. • A road shall preferably not be constructed through a seep. Construction of bridges over seep wetlands must be strictly controlled, and must go through the full EIA process. • Water flow through the wetland should not be constricted through culverts or pipes. There should be no canalisation or channelisation of flow into, through or out of the wetland. • Where a road or other water channeling structure must run close to a seep, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the wetland and its buffer, at ground level.	should be done to ensure that this does not fragment the wetland buffer, or lead to separation of the buffer from the wetland. • Water flow through the wetland buffer shall not be constricted through culverts or pipes. • There shall be no disconnection of the wetland buffer from the wetland • Buffer width should be consistent around the entire wetland (i.e. should not be allowed to diminish in width to accommodate other land-uses), but could be increased to attenuate additional impacts. • Where a road or other water channeling structure runs close to a wetland buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the buffer, at ground level.
Flora and fauna:	• There shall be no impoundment of seeps, as these structures restrict the movement of aquatic fauna. • Clear infestations of alien invasive plants within and around the wetland.	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora.
Management:	• The maintenance of ecological functioning of the seep wetland shall be considered the main management objective. • Seep wetlands that are threatened by development, or any other activities that would impact significantly on the wetlands, should be accurately delineated, using the DWAF delineation protocol (DWAF, 2005) before any such activities commence. At least a basic assessment of impacts must be completed with regards to the wetlands, as required by the EIA regulations (2006). • The condition of seep wetlands that are threatened by development, or any other activities that would impact significantly on the wetlands, should be determined using the	• The maintenance of ecological functioning of the wetland buffer shall be considered the main management objective.

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SEEPS (isolated and non-isolated hillslope and basin seeps)		
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	current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland. No decline in Ecological Management Class should occur.	
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

DEPRESSIONAL WETLANDS (isolated and non-isolated)		
	AQUATIC FEATURE	**BUFFER**
Water Quantity:	• Depressional wetlands may be connected to a riverine system, but may be isolated from any surface water system, and so groundwater-fed or filled through direct precipitation. • There should be no increases in surface and/or groundwater inflows into a depressional wetland, as these could lead to changes in plant structure, e.g. an increase in hardy sedges and reeds or bulrushes, and a decrease in seasonal wetland vegetation communities. There may be changes in plant zonation, or a loss of important seasonally inundated breeding areas (e.g. inundated sedge habitat used by larvae of many invertebrate taxa). • No stormwater or irrigation return flows from the surrounding slopes shall be conveyed directly into a depression. This runoff should be stored outside of the wetland and its buffer, and allowed to evaporate or be directed elsewhere. • There should be no change in the natural hydrology of the depressional system – e.g. from seasonal to perennial, or from ephemeral to seasonal. • Depressional wetlands shall not be drained, channelised or infilled.	• No hard development within the wetland buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it, upstream of the wetland. Thus where stormwater and irrigation return flows must pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality.

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DEPRESSIONAL WETLANDS (isolated and non-isolated)		
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	• If the ecological functioning or overall condition of a depressional wetland, or its provision of goods and services, is impacted or threatened by water abstraction, the current condition of the wetland should be determined using a preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices, or the rapid Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland. It follows then that no abstraction that results in a deterioration in Ecological Management Class shall take place.	
Groundwater:	• No abstraction of groundwater (e.g. well points) allowed within the wetland or such that it is likely to affect flows into the wetland – note that groundwater fed wetlands may be influenced by groundwater abstraction or diversion far from the wetland itself	• No groundwater abstraction within wetland buffer – the buffer should be at least 100m from the edge of wetlands in groundwater recharge areas and 250m from the edge of wetlands in groundwater discharge areas.
Water quality:	• Changes in salinity and/or nutrient concentrations in depressional wetlands should be minimised, and should not exceed natural fluctuations by more than 15%. Increased nutrients might result in the creation of eutrophic and potentially oxygen depleted habitats; increased salinity above key threshold levels might result in changes in plant zonation and community structure and a proliferation of weedy elements. • If the wetland is threatened by activities that will / could impact on water quality, the condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the Wetland Index of Habitat Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland. Water quality should be maintained so that there is no deterioration in the Ecological Management Class to which the wetland is currently assigned. • An application must be submitted to the relevant government departments – i.e. DEADP and DWAF – before any waste (including treated waste) or water containing waste can be	• Enforce the wetland buffer zone. Natural vegetation cover must be maintained, or rehabilitated, to promote buffer function. Alien vegetation should be removed. • No cultivation of the buffer zone shall be permissible. Existing cultivated areas surrounding the wetland and buffer should be closely monitored for the use of pesticides, herbicides and fertilizers. Where the use of these substances is likely, consideration should be given to widening the buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • No hard development within the buffer. • The buffer should be sized and designed so as to provide effective management of any runoff passing into it, upstream of the wetland. Thus where stormwater and irrigation return flows pass through the buffer, adequately sized artificial treatment wetlands should be provided to address stormwater quality.

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DEPRESSIONAL WETLANDS (isolated and non-isolated)		
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	discharged directly into a depressional wetland. This process will require an assessment of the condition of the wetland before permission is granted for waste disposal. Water quality should be maintained so that there is no deterioration in the Ecological Management Class to which the wetland is currently assigned. • A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise potential risks of undesirable impacts on the environment.	
Sedimentation and erosion:	• Modifications to the bed and banks of the depressional wetland should be minimised. The excavation and / or removal of soil / sand or cobbles should not exceed $5m^3$, but if it must exceed this amount, then at least a basic assessment, as stipulated in the EIA regulations (2006) must be done. • No livestock access to depressions. • Water flow through the wetland shall not be constricted through culverts or pipes, for any reason. This leads to erosion through the creation of nick points. . • Depressional wetlands should be protected from concentration of flows as a result of bridges, pipes or culverts. These should preferably not cross depressions, but where crossings are in existence they must allow for adequate spread of flows through multiple surface and subsurface pipes and culverts across the full width of the wetland.	• No grazing, ploughing or cultivation of wetland buffer. • Livestock access to the buffer area should be limited to less than 10% of the total buffer area. • Clear all alien plants, and maintain indigenous plant cover.
Connectivity:	• All depressional wetlands must be managed in such a manner as to at least maintain the ecosystem services provided by the wetland, and to maintain the biodiversity supported by that wetland. • Depressional wetlands shall not be impounded. This could lead to deepening of these shallow (often just saturated to the surface, and not inundated) systems, and so a change in the natural character of the depression, with consequent changes in the	• There should be no fragmentation of the wetland buffer, e.g. through road construction (this includes tracks, e.g. for 4x4 routes) or the erection of fences or walls. • Where the construction of fences is necessary (e.g. around reserves), this should be done to ensure that this does not fragment the wetland buffer, or lead to separation of the buffer from the wetland. • Water flow through the wetland buffer shall not be constricted through

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DEPRESSIONAL WETLANDS (isolated and non-isolated)		
	AQUATIC FEATURE	**BUFFER**
	fauna and flora inhabiting the depression. • A road shall preferably not be constructed through a depression. Construction of bridges over depressional wetlands must be strictly controlled, and must go through the full EIA process. • Water flow through the wetland should not be constricted through culverts or pipes. There should be no canalisation or channelisation of flow into, through or out of the wetland. • Where a road or other water channeling structure must run close to a depression, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the wetland and its buffer, at ground level.	culverts or pipes. • There shall be no disconnection of the wetland buffer from the wetland • Buffer width should be consistent around the entire wetland (i.e. should not be allowed to diminish in width to accommodate other land-uses), but could be increased to attenuate additional impacts. • Where a road or other water channeling structure runs close to a wetland buffer and / or directs water into it, such water should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the buffer, at ground level.
Flora and fauna:	• There shall be no impoundment of depressional wetlands, as these structures restrict the movement of aquatic fauna. • Clear infestations of alien invasive plants within and around the wetland.	• Clear all alien plants, and maintain indigenous plant cover. • Where the construction of fences is necessary within a buffer (e.g. around reserves), this should be done to ensure that this does not obstruct the movement of fauna and flora.
Management:	• The maintenance of ecological functioning of the depressional wetland shall be considered the main management objective. • Depressional wetlands that are threatened by development, or any other activities that would impact significantly on the wetlands, should be accurately delineated, using the DWAF delineation protocol (DWAF, 2005) before any such activities commence. At least a basic assessment of impacts must be completed with regards to the wetlands, as required by the EIA regulations (2006). • The condition of depressional wetlands that are threatened by development, or any other activities that would impact significantly on the wetlands, should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the Wetland Index of Habitat	• The maintenance of ecological functioning of the wetland buffer shall be considered the main management objective.

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DEPRESSIONAL WETLANDS (isolated and non-isolated)		
	AQUATIC FEATURE	**BUFFER**
	Integrity. This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland. No decline in Ecological Management Class should occur.	
Rehabilitation guidelines	• Clear all alien plants, and maintain indigenous plant cover.	• Clear all alien plants, and maintain indigenous plant cover.

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