FISH TO SUNDAYS INTERNAL STRATEGIC PERSPECTIVE

APPENDICES

APPENDIX 1

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APPENDIX 2

Groundwater overview

FISH TO SUNDAYS ISP: GROUNDWATER OVERVIEW

1. INTRODUCTION

The Fish to Tsitsikamma Water Management Area (WMA) has, for ISP purposes, been divided into western and eastern ISPs areas. The eastern (**Fish-Sundays**) area incorporates three sub-areas, which are:

- **Fish**, which corresponds to the catchment of the Great Fish River (Drainage Region Q) with 71 quaternary catchments (30 300 km^2);
- **Sundays**, the catchment of the Sundays River (Drainage Region N) with 36 quaternary catchments (21 200 km^2),
- **Albany Coast**, consisting of the coastal catchments between the Fish and Sundays Rivers (Drainage Region P) with 16 quaternary catchments (5 300 km^2).

Within the whole Fish-Sundays ISP area the drainage basins of the Great Fish and Sundays Rivers comprise 85% of the quaternary catchments. Most of the Sundays sub-area is situated in the Great Karoo. The upper basin of the Great Fish sub-area is also situated in an arid area. The Albany Coast sub-area consists of steep, bush covered hills with deeply incised river valleys. The ISP sub-areas are shown in **Figure 2.1**.

2. WMA CONTEXT AND ISSUES

The Fish-Sundays ISP area is located in the transition between the arid to semi-arid western part of South Africa (longitude < 26°E), where mean annual precipitation (MAP) is generally less than 400 mm, and the relatively well-watered eastern part (longitude > 27°E), where MAP, mostly as summer rainfall, is generally in excess of 600 mm. The highest annual rainfall (800-1 000 mm) occurs in a narrow belt along the crest of the Winterberg-Katberg ranges (Q94A quaternary), and to a lesser degree (700-800 mm) in the southernmost part of the Albany Coast (P20A quaternary).

Because of the comparatively poor endowment of surface water over much of this area, groundwater is well established as a water resource for the Great Karoo towns (notably Graaff-Reinet and Middelburg), at a number of smaller towns and many rural villages and settlements as well as for stock farming (see **Table 1**). The Fish and Sundays sub-areas form part of the Orange-Fish-Sundays Water Supply System, which supplies Orange River water to the Great Fish River Valley and thence to the Sundays River Valley, to supplement local, mainly agricultural water supply. Water is also transferred to the Nelson Mandela Metropolitan Municipality via this system.

There is a lack of sound scientific understanding of the mechanism of groundwater occurrence and flow, compounded by a lack of good quality information (see the following Section 2.2).

2.1 GUIDING PRINCIPLES

Under the National Water Act (NWA, 1998), that gives equal weight to groundwater and surface water, the four guiding principles of an Integrated Water Resources Management (IWRM) strategy are:

- Groundwater resources are integral to water resource development planning, to the extent that groundwater is a preferred source where additional resources are required. It is only where groundwater is proven to be inadequate that surface water will normally be considered;
- The optimal use of available resources is promoted through conjunctive use of surface and groundwater, where feasible;
- Water demands must be optimally reconciled with all available resources;
- All water use must follow the principles of sustainability, equity and efficiency.

2.2 AVAILABILITY OF INFORMATION

Information about the volume of the available groundwater resource, depth, the distance between a suitable source and its intended use, quality, and its reliability (assuming proactive, appropriate aquifer management) needs to be conveniently available to planners and engineers in a readily understandable format. General background information is published in map form at 1:2 500 000 scale on the poster sheet “Groundwater Resources of the Republic of South Africa” (Vegter, 1995), and regional information appears at 1:500 000 scale on the set of The Department of Water Affairs and Forestry hydrogeological maps.

However, these graphic information sources are too generalised and at too small a scale to be practically useful for aquifer exploration, development and management. There is a growing national consensus emerging from the ISP process that graphic information (hydrogeological maps) at a minimum scale of 1:50 000 is needed, and that a complementary geographic information systems (GIS)-based or “geoinformatics” approach to hydrogeological data management and information dissemination is also required.

The major hindrance to the optimal development of groundwater resources is the lack of and/or inaccessibility of area and aquifer-specific data at the scale of a quaternary catchment, or group of related quaternary catchments. In the Limpopo WMA and in other WMAs of the Eastern Cape, GRIP envisages 1:50 000 scale hydrogeological maps, beginning with the most stressed and ecologically sensitive catchments, depicting the groundwater resources, groundwater quality and exploration/ development potential, based upon the needs of the end user.

2.3 GROUNDWATER RESOURCES IN THE FISH-SUNDAYS

As in other WMAs around South Africa, groundwater use can be distinguished in five general categories:

- **Rural Domestic**: ranges from individual boreholes for primary water supply to rural

landowners, villages, schools clinics, hospitals, through small-scale reticulation over short distances (2-5 km), to larger schemes based on several boreholes;
- **Livestock/agricultural**: individual boreholes for stock watering, vegetable gardening etc.;
- **Irrigation**: larger schemes requiring well-developed groundwater resources;
- **Bulk water supply**: wellfields consisting of several high-yielding boreholes in large or extensive aquifer systems;
- **Industrial (including mining)**: medium to large-sized reticulation schemes based on several boreholes or a wellfield.

Table 1 summarises the usage of groundwater in the above categories as estimated on a quaternary catchment basis.

Table 1: Groundwater use in the Fish to Sundays ISP area

Use	Annual volume (million m^3/a)	% of total use
Irrigation	16.7	70
Agricultural/Livestock	4.5	17.5
Rural domestic	0 (1)	0 (1)
Municipal (bulk water)	3.5	12.5
Industrial/Mining	0	0
Total	**24.7**	**100**

1) The zero usage of groundwater for rural supply is questionable and should be addressed.

It is stated in the Fish to Tsitsikamma WMA Water Resources Situation Assessment Report that the groundwater is considered to be under-utilised in the Albany Coast sub-area, heavily to over-utilised in many parts of the Upper and Middle Fish zones of the Great Fish sub-area and moderately to heavily utilised in the middle parts of the Sundays sub-area. This requires verification, as do the usage figures.

The under-developed groundwater potential in the Fish-Sundays ISP area is contained in the fractured rock aquifers of the Katberg and Witteberg Formations (middle to lower reaches of the Great Fish sub-area and the Albany Coast sub-area). It is suggested that improved borehole siting and wellfield management would significantly increase both the yield and the reliability of the groundwater resource in the upper and middle reaches of the Great Fish sub-area. These areas are currently thought to be heavily over-utilised, but in reality there may be quite a bit more water still available.

A purposeful exploration strategy is required to quantify and realise the groundwater usage and resource in this ISP area. In areas where the groundwater yield is low and/or the aquifers are vulnerable to mismanagement and are generally recharged in the extreme precipitation events it is imperative that the groundwater usage values are correct and up to date. If not, planning is impacted upon and areas in which there appears to be available resource could in fact be stressed and *vice versa*.

2.4 GROUNDWATER QUALITY

Groundwater quality is one of the main factors affecting the development of available groundwater resources. The majority of serious water quality problems are related to total dissolved solids (TDS), nitrates (NO_3) and fluorides (F) and toxic trace elements arising from both natural and anthropogenic sources. In the absence of chemical analyses, TDS may be roughly estimated from electrical conductivity (EC) measurements (1 mS/m ≅ 6.5 mg/l). **Figure 3.5** is a map of groundwater quality.

2.4.1 Natural

Groundwater quality is generally controlled by the lithology and geochemistry of aquifer host-rocks. In the Fish-Sundays ISP area, the higher part of the Karoo sedimentary sequence presents no real problem to groundwater quality. However, weathering of shale formations in the Dwyka and Ecca Group, and in the lower Beaufort Group (Adelaide Subgroup), may adversely affect groundwaters. Consequently, base flow in the arid, poorly recharged Sundays River basin where these formations are dominant in the regolith aquifer, is heavily mineralised. Sulphide-mineralised zones within some Karoo dolerite intrusions may locally be associated with undesirable trace-element hydrochemistry of through-flowing groundwaters.

2.4.2 Pollution

Refer to **Figure 6**. The threat of groundwater pollution increases with population growth and development, and can result from:

- Domestic use in centres of concentrated human settlement;
- Agriculture;
- Industrial and mining activity;
- Waste disposal;
- Poor sanitation; and
- Mismanagement of wastewater treatment works (WWTWs).

All sewerage works pose a threat to the groundwater quality in these areas if they are inadequately maintained or managed. This is because discharged wastewater flows directly into the surface water streams and pollutes surface water directly and indirectly via recharge to the groundwater. In general these rivers are located along zones of weakness related to lithological and structural controls, making them more accessible to groundwater pollution.

2.5 MANAGEMENT AND MONITORING REQUIREMENTS

The protection of the groundwater resource, and its long-term sustainability of supply, requires effective monitoring and “adaptive“ management. In this region, however, the monitoring undertaken is very restricted spatially and temporally. Thus it is not always possible to timeously identify areas of over-abstraction, nor is it possible to prioritise areas where determination of ecological flow requirements or compulsory licensing is required, from a groundwater perspective. **Figure 5** contains a map of NGDB boreholes and DWAF monitoring sites.

The hydrological data collected by the King William's Town office is not being populated in the NGDB on a regular basis. The flow of hydrogeological data from projects implemented by DWAF or other agents (who may or may not use consultants) is irregular at best. Furthermore, the data is not being interpreted and translated into useful accessible information either for intra or extra-governmental users. It is necessary that the NGDB is kept up-to-date through systematic input of relevant data, that data verification and validation is undertaken and that an audit trail be available. Data must be interpreted and used.

At present the data, information and knowledge base is distributed among diverse persons, institutions, sources and modes, still requiring to be cohered into a readily accessible, useful and understandable format for different users.

Groundwater monitoring programmes must involve regular measurements of:

- water levels;
- water quality (macro and trace elements and biological indicators);
- abstraction volumes;
- climatic variables - rainfall, temperature, evaporation, and snowfall; and
- hydrologic variables – spring flow (altitude, volume, water quality, seasonal and/or climate event- related variation), baseflow in rivers.

There is an imperative need for a strategic, regional monitoring network and strategically placed *observation boreholes* exclusively dedicated to groundwater monitoring in locations distant from production wellfields. Even one suitably located monitoring borehole, preferably placed furthest from outflow boundaries to surface waters and/or away from sites that are likely to be affected significantly by surface abstraction or by local (artificial) recharge from surface irrigation, can provide substantial information about the overall state of the resource. This is because the dynamic variability of groundwater levels throughout an aquifer has some components that are common to all wells in that aquifer.

Dynamic behaviour as a leaky storage for natural recharge is the defining characteristic of an aquifer as a groundwater resource (Bidwell, 2003). Most of the temporal variation in piezometric levels is caused by temporal variations in land-surface recharge, together with the effects of pumped abstraction. Due to the common dynamic components related to the seasonal variability of recharge, the value of groundwater level observations increases more with length of record than with the number of observation sites. It is particularly important in a fractured rock environment that the observation wells are correctly sited and intersect preferred flow paths, and that others are drilled into the matrix of the aquifer.

The amount of groundwater stored in an aquifer at any instant in time is governed by dynamic relationships between recharge inflows through the overlying land surface and from rivers, and outflows to surface waters and pumped abstraction. Aquifer storage acts as a buffer between highly variable, climatically driven inflow processes and the less variable outflow that supports surface water ecosystems. Because abstractions of groundwater for human use, and also land-use changes of certain kinds, alter this dynamic balance between recharge and the state of surface waters, the objective of groundwater resource management is "to determine the regime of abstraction that results in acceptable environmental effects" (Bidwell, 2003).

The strategy of "adaptive management", sometimes described as a process of "learning by doing" (Lowry & Bright, 2002), entails the development of policies as "experiments that test the responses of ecosystems to changes in people's behaviour", and is also conceived as "managing the people who interact with the ecosystem, not the management of the ecosystem itself" (Lowry and Bright, quoted in Bidwell, 2003). An adaptive approach to groundwater management necessarily requires appropriate analytical tools or models to support it, which are (op. cit):

- conceptually presentable and plausible to stakeholders, and expressive of a collective understanding of participants;
- physical operation of the groundwater system;
- assessment of uncertainties;
- prediction of the effects of various management actions;
- capable of implementation in "real-time" mode consistent with the time scale of adaptive decision-making;
- suitable for use with (often sparse) available data.

At present there is very limited data collection in the Fish-Sundays. The regional Hydrology Section takes surface water, and some borehole and spring water quality samples which are sent to Pretoria. Results are input into the WSM system but there is no feedback to hydrogeology staff. There is limited to no data validation, contract information is not routinely put into the regional data system, and no coliform testing at springs or routine trace element or biological sampling is undertaken. The lack of access and staff make data collection for monitoring and operations difficult to maintain and it would not be possible to establish detailed models.

Land degradation arising from overgrazing and/or inappropriate land use leads to reduced infiltration and increased overland flow, turbidity and siltation. Less infiltration means less soil water and reduced recharge to aquifers. The loss of soil, wetlands and riparian areas, especially through gully and riverbank erosion, means that there is less to hold and store rainwater, and therefore less opportunity for this to percolate into the groundwater zone. In general reduced recharge results in an induced soil drought and reduced spring flow, with obvious consequences to water supply and society. This is a cross cutting issue that is noted here given that the use of remote sensing provides an effective early warning as well as a monitoring method for management.

A Knowledge Management Strategy is required, that:

- includes proactive engagement with new telemetric and teledetection technologies potentially suitable for upgrading approaches to groundwater monitoring in this challenging environment, and for obtaining regional and aquifer-specific information;
- understands how best to use information and communication technology to access knowledge, insight and local understanding, both within and outside of DWAF, to both mentor and network with personnel as well as the greater scientific community;
- establishes and maintains communication and data exchange with local service providers, consultants, the research community, other government departments, and also between divisions within DWAF, in particular Water Quality Management and Water Resources Management; and
- initiates a remote sensing-based programme for the monitoring of spring flow, vegetation change, land use impact, wetland status and health, and (de)forestation effects, all in the wider context of quantifying groundwater/surface water interaction.

2.6 POVERTY ERADICATION

Groundwater development impacts positively on poverty eradication and general quality of life through:

- supply of more and/or cleaner water;
- saving of time on water collection, particularly affecting women, which could otherwise be given to small-scale economic activities (vegetable gardening, stock rearing, etc.) that require ready access to water;
- improvement of health (clean water and food production);
- Time and energy available to contribute to community life and decision making (notably allowing women to become more involved);
- Time and energy available for education of children and women; and
- Time and energy to develop the social resilience and coherence needed in these times of change.

The potential of groundwater to contribute to poverty eradication and empowerment of small-scale and resource-poor farmers is very significant in this ISP area. Groundwater development is incremental and acquiring skills is also an incremental process. Paradoxically the poor perception of groundwater is an education opportunity and a necessity that will allow and facilitate a holistic approach to water resource development operations and maintenance.

It is strongly recommended that a holistic enviro-socio-economic approach to services (sanitation and water supply in particular) upgrade, economic empowerment, land-use practise, health and hygiene education (arising from cholera outbreaks and HIV interventions) and skills transfer in the beneficiation of water is mapped out and undertaken. The socio-economic benefits of additional water supply and or the socio-economic costs of limited supply must be factored into the cost equation when making decisions regarding cost effectiveness of a water supply.

Groundwater development is not very capital intensive, although depth and yields do greatly affect local costs, and the real and perceived risks are accordingly reduced. The chances of successful groundwater development are increased if the wellfield supply is co-ordinated with education and support for beneficiation activities, improved infrastructure and ongoing support to master the operations and maintenance of supply.

Because poverty eradication is a multidisciplinary activity it is necessary to map those areas with the most overlap of groundwater potential, soils, and positive social factors, and then to stimulate/catalyse these ingredients with education (e.g. trench gardening and health and hygiene) and other support programmes. This will require co-ordination of initiatives by different government departments and DWAF directorates. It is recommended that a *Participatory Rural Appraisal Approach* be considered in this effort. See Chambers (1983) and DWAF (2002) for more information on participatory methodologies.

Awareness at community level is necessary to achieve consensus and to obtain commitment from communities to engage in a programme of change. There can be controversial choices and/or possible political consequences, such as the re-allocation of funds from visible development projects to projects that will limit or eliminate the impact of a medium to longer-term threat of the failure of a groundwater supply. It is a challenge to persuade people to invest time and money to prevent something happening that most do not believe will ever happen or do not see as their responsibility (implementing operations and maintenance rules in a wellfield or at a borehole). The achievement of such objectives will require a public education process to increase awareness about the causes and consequences of hazards.

3. OVERVIEW OF GROUNDWATER BY ISP SUB-AREA

The hydrogeological provinces outlined in **Table 2** on the following page differ from the three sub-areas used in this ISP. The table summarises the catchments and stratigraphic formations that fall within the Hydrogeological or “Hydrogeotectonic” provinces that are proposed for IWRM strategic purposes within this ISP area (see **Figure 3.4**). For consistency this text uses the ISP sub-areas as defined for surface water.

Table 2: Hydrogeological divisions of the Fish to Sundays ISP area

Hydrogeological Province (Subprovince)	Tertiary/ Quat. Catchments	Geology/ Hydrogeology	Preferred Groundwater Targets
Algoa-Albany Basin-and-Range			
Algoa Basin	N40B-F, S part of P10E, P20A-B	Algoa Group Uitenhage Group Suurberg Group Witteberg Group Bokkeveld Group Table Mountain Group (Nardouw Subgroup)	Primary aquifers in Algoa Group and parts of Uitenhage Group; Witteberg fractured-rock along basin border faults TMG (sub)outcrop in basin floor
Albany Coastal Range	N40A, N parts of N40B-D, P10, P30, P40, Q93D	Dwyka Formation (outlier synclines) Witteberg Group Bokkeveld Group (inlier anticlines)	Fractured quartzite of Witpoort Formation (Witteberg Gp)
Southern Karoo Foreland	N24, N22, N23, N30B-C, Q80E-G, Q70, Q91, Q92E-G, Q93A-C, Q94F	Karoo dolerite (local dykes) Beaufort Group (Adelaide Sgp) Ecca Group Dwyka Formation	WNW/ESE dykes; Regolith aquifers overlying Ecca and Adelaide aquicludes
Sundays-Great Fish Uplands			
Camdeboo-Winterberg Escarpment	N14, N13, N12, N21, N30A, Q21A, Q30A-B, Q30D-E, Q44A&C, Q50, Q60, Q92A-D, Q94A-E	Karoo dolerite (sills & dykes) [Katberg Formation (outliers)] Adelaide Subgroup (Balfour Formation Middleton Formation)	Karoo sill and dyke structures in conjunction with minor sandstone units within Middleton and Balfour formations
Upper Great Fish Basin	Q14, Q11, Q12, Q13, Q30C, Q44B, Q43, Q42, Q41	Tertiary-Quaternary alluvials Karoo dolerites Molteno Formation Burgersdorp Formation Katberg Formation [Balfour Formation]	Karoo dyke and ring (sill) structures; Fractured Katberg sandstone

The current groundwater usage documented for each ISP sub-area is taken from the WRSAS Report and the available unexploited groundwater is based on 50% (in high recharge, moderate to high storage potential areas) and 20% (in low recharge, low storage and flood hydrology dominated areas) of the difference between recharge (Vegter, 1995; Umvoto, 2004) and baseflow estimates (Vegter, 1995), less current usage. This value implicitly takes into account aquifer storage and accessibility as well as groundwater contribution to the Reserve.

The ***Algoa-Albany Basin-and-Range*** province incorporates Groundwater Regions 50 (very minor), 64 and 52, but has also been extended to the "Southern Karoo Foreland" subprovince (southern parts of Groundwater Regions 42 and 43), where topography and drainage is structurally controlled by fold and fracture structures in lower Karoo strata. The northern parts of Groundwater Regions 42 and 43 are incorporated into the ***Sundays-Great Fish Uplands*** province, divided into generally E/W-trending escarpment zone and an upland area consisting of the Great Fish headwaters (Q1 and Q4 secondary catchments). The base of the Katberg Formation sandstone is the main geological factor controlling this subdivision (see **Figure 3.4**).

There are some area-specific issues which are addressed per sub-area. The generic issues have been addressed in the groundwater strategy.

3.1 ALBANY COAST

The Albany Coast consists of the Bushmans-Kowie/Kariega (P1, P2, P3 & P4) catchments. A separate report detailing groundwater supply options for this sub-area has been submitted to DWAF. The summary results are included in this section.

Folded sedimentary rocks of the ***Cape Supergroup*** (***Bokkeveld*** and ***Witteberg Groups***) and ***lower Karoo Supergroup*** (***Dwyka, Ecca Group***) are the dominant bedrock units in the southern coastal belt, which constitutes the eastern part of "*Groundwater Region No. 52*" (Grootrivier-Klein Winterhoek-Suur-Kaprivier Ranges) as defined by J.R. Vegter ("Groundwater Development in South Africa and an Introduction to the Hydrogeology of Groundwater Regions", WRC Report No. TT 134/00, 2001).

The ***Algoa Basin subprovince*** is a major fault-bounded basin on the Sundays River coastal plain (N4 & P1 / P2 secondary catchments), which constitutes *Groundwater Region No. 64* (Algoa Basin; Vegter, 2001). This subprovince has the highest rainfall and, although dominated by a mixture of Karroid vegetation and Coastal Tropical Forest which could reduce infiltration through interception and evapotranspiration, a favourable recharge. The groundwater potential here is therefore good, with the fractured Witteberg Aquifers and primary Algoa Aquifer showing the highest groundwater potential in the coastal belt.

The Algoa Basin subprovince contains subordinate ***Suurberg Group*** volcanics and volcaniclastic sediments overlain by generally shaley sediments of the Uitenhage Group. Coarse conglomerate and grit of the Enon Formation (***Uitenhage Group***) occurs in the hanging wall of the major E-W border fault stretching from Paterson in the East to south of Wolwefontein in the west. Unconsolidated to semi-consolidated, palaeo-coastal calcareous sand and conglomerate deposits of the younger ***Algoa Group*** occur within the eastern portion of the Algoa Basin and the Bushmans coastal plain.

Algoa beds are overlain by Quaternary alluvium in much of the Sundays River valley south of Kirkwood. Recent and reworked coastal sands occur within a narrow dune zone between Cannonvale and Port Alfred.

The ***Albany Coastal Range subprovince*** south and east of Grahamstown exhibits an elevated borehole concentration, consistent with high groundwater usage in this arid coastal belt. In this area there is a relatively strong correlation between the borehole distribution and the aquifer type, with most boreholes situated in the fractured Witteberg Aquifer, and to a lesser degree, within the primary intergranular Algoa Aquifer and coastal dune belt.

The Witpoort Formation secondary fractured rock aquifer of the Witteberg Group, which outcrops extensively within the Albany Coast Basin and Range, is considered to represent an under-utilised hydrogeological resource with **capability to produce significant, sustainable yields of high quality groundwater**. It is recommended that this aquifer be explored and developed on a regional scale rather than in a piecemeal fashion. A regional cross section below illustrates the regional extent and depth of this aquifer that also receives a significant percentage of the rain in this sub-area.

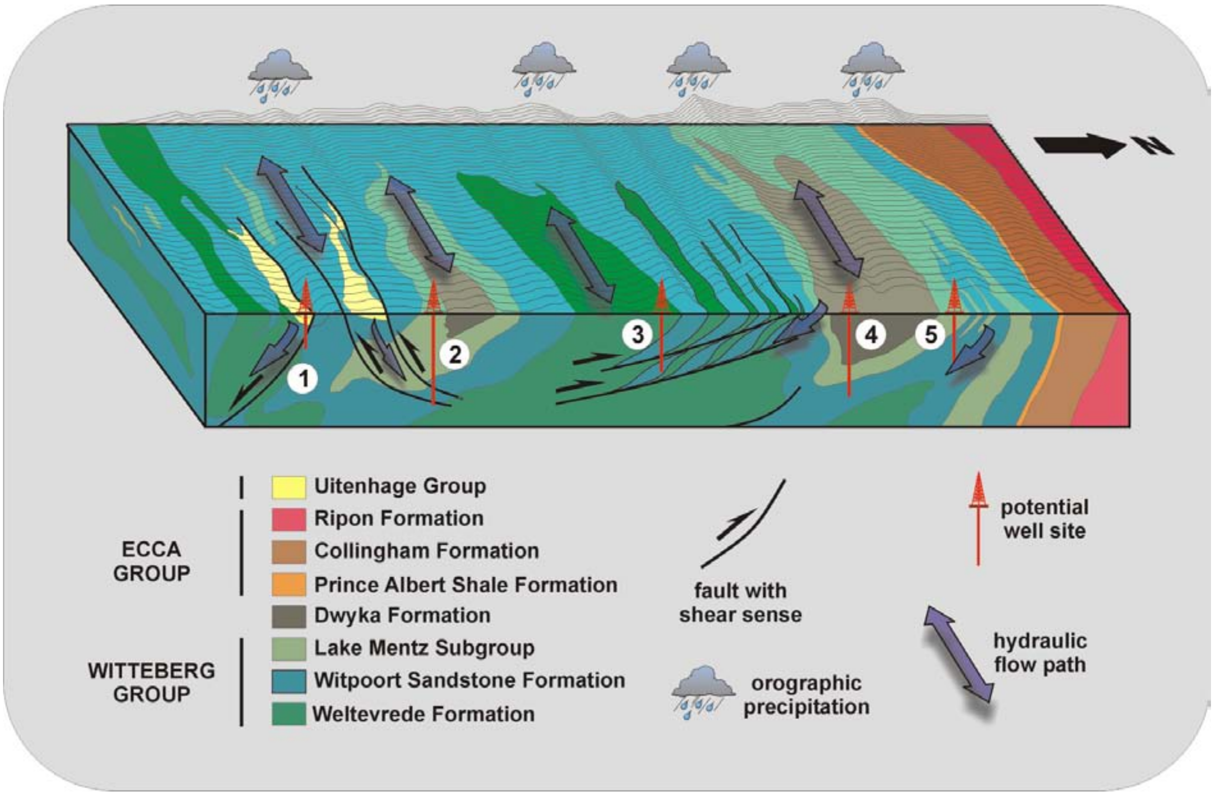

Figure 1: Hydrogeological model for the Witteberg Aquifer System

Significant hydrogeological research effort is required to evaluate the recharge / discharge balance, storage capacity and other hydraulic parameters to determine sustainable abstractability limits of the Witteberg secondary aquifer system. Both regional and focused structural geological mapping carried out in concert with exploratory core drilling, will be required to improve our understanding of the three-dimensional geometry, internal tectonic character and hydraulic parameters of the Witteberg Formation secondary aquifer. These data are essential to define the hydraulic parameters. At present the development of sophisticated structural geological models in support of regional groundwater exploration strategies is frustrated by the lack of fundamental data in the area. It is recommended that pilot studies be initiated to identify high yield structures and to derive empirical data by which the groundwater potential of the Witteberg Aquifer can be reliably evaluated.

The primary intergranular Algoa Aquifer and coastal dune belt is reportedly among the world's largest and will become part of the Addo Elephant National Park. The wellfield at Alexandria supports a groundwater-dependent community. Additionally, the springs in the Albany Coast sub-area are thought to be supplied from the Cenozoic Alexandria Formation conglomerate and equivalent palaeo-coastal deposits of the Algoa Group.

In the Albany Coastal Range groundwater of poor quality (TDS >2000 mg/l) is associated with outcrops of the Bokkeveld Group and the Dwyka-basal Ecca formations.

A revised average annual vertical (or surface) recharge estimate of 251 million m^3/a is obtained for this sub-area (See **Table 3**), compared with earlier estimates in the range of 215 to 255 million m^3/a. Of this total, 118 million m^3 annually recharges the exposed portions of the Witteberg (Witpoort) fractured-rock aquifer, and 39 million m^3/a recharges the shallow intergranular-and fractured zone overlying surrounding rock units. About 94 million m^3/a enters the primary aquifer.

The average depth in the primary aquifers is less than 50 m and yields vary between 2 and 20 l/s. In the fractured or weathered aquifers the average depth is less than 100 m and the average yield is less than 5 l/s. From a groundwater development perspective, recent work has suggested that the yields in the fractured rock aquifers can be much higher. In the true fractured rock aquifers the boreholes should be about 300 m deep with potential yields of 20 l/s.

Total annual groundwater use in this sub-area was estimated at 1.6 million m^3/a by NWRS and 4.8 million m^3/a in 2000 (DWAF, 2002), but could be higher. For the purposes of this report the figure of 4.8 million m^3 is used.

The annually available unexploited groundwater is estimated to be 119 million m^3/a *in the "best case" and 45* million m^3/a *in the "base case".* As explained in **Table 5** and recommended, the 'base case' is calculated as 20% of (recharge – baseflow) less usage, while the 'best case' assumes that 50% of (recharge – baseflow) is available. The narrow bounds to the estimates of unused groundwater potential in this sub-area suggest with some certainty that groundwater could contribute to widespread provision of water for basic human needs, allocations for food gardening or small scale agriculture, as well as water for small town supply.

Issues

Desalination of groundwater, abstracted along the Bushmans River Estuary, through reverse osmosis (for purification) is too costly for resource-poor farmer schemes coming on line at

Bushmans River and DWAF is currently exploring the Witteberg quartzites as an alternative regional source. Results suggest improved yields (blow yield of 20 l/s) and suitable water quality from the Witteberg quartzites.

The groundwater table at the Kenton-on-Sea scheme is reported to be dropping. Problems of failure have also been experienced in the Alexandria dunefields.

Licence conditions should always require that abstraction be within the limits of sustainable yield, but district and local municipalities are not addressing issues of sustainability in the planning stages of water supply schemes.

Routine monitoring, operations and maintenance, and interpretation of the data to adjust pumping regimes on supply wellfields are not being undertaken.

3.2 FISH

The Fish ISP sub-area is divided, geomorphologically and geologically, into three zones.

The southern zone, ***Southern Karoo Foreland subprovince***, consists of the main stem of the Lower Fish River (Q91-Q93), and the lower portions of the Little Fish (Q80E-G), Middle Fish (Q70A-C), Koonap (Q92E-G), and Kat (Q94F) tributaries. These rivers flow generally ESE to SE in deeply incised meanders, below a post-African land surface on the northern foreland of the Cape Fold Belt, underlain mainly by Dwyka tillite and Ecca shales.

The middle zone, ***Camdeboo-Winterberg Escarpment subprovince***, consists of the catchments of the upper Kat (Q94AA-E), upper Koonap (Q92A-D), upper Middle Fish (Q50A-C, Q60A-C), and the upper Little Fish (Q80A-D). These catchments drain the steeper topography of an escarpment zone between the dissected post-African plain and interior mountain areas (e.g., Winterberg-Amatolas in the east) that rise above the older African land surface, and are the type area of the lower Beaufort Group (Adelaide Subgroup, after the town of Adelaide in the Q92D catchment).

The northern zone, ***Upper Great Fish Basin subprovince***, consists of the Groot Brak (Q1-Q3) and Tarka (Q4) headwaters of the Great Fish basin. These catchments drain a high amphitheatre of False Karoo veld, enclosed on its southern side by ridges underlain by the fractured-rock aquifer of the Katberg sandstone and associated Karoo dolerite sills, with Pure Grassveld vegetation. To the northeast the Burgersdorp Formation underlies the smaller remainder of the sub-area, to a steep escarpment zone along its northern margin, underlain by Molteno sandstones and Karoo dolerite sills.

Groundwater quality is generally good (TDS < 450 mg/l) in the more elevated parts of the Upper Great Fish area. Areas of good quality groundwater occur also in the northeastern part of the middle zone, below the Winterberg Range, most likely supplied by overflow or "rejected recharge" from the Katberg fractured-rock aquifer. Groundwater quality is, however, generally brackish (450 to 2 000 mg/l) to poor in parts of the Southern Karoo Foreland subprovince with EC values > 2 000 mg/l over wide areas in the south.

A revised average groundwater recharge estimate of 626 million m^3/a is obtained for this sub-area (**Table 3 –** Recharge and baseflow), compared with earlier estimates in the range 677 to 765 million m^3/a. Of this total, 74 million m^3/a recharges the exposed portions of the Katberg fractured-rock aquifer, and 490 million m^3/a recharges the shallow intergranular-and fractured zone above surrounding (lower and higher) Karoo rock units. About 60 million m^3/a enters the fractured Karoo dolerites. Recharge to the primary or intergranular aquifers amounts to only 360 million m^3/a.

Total annual groundwater use in this sub-area was estimated at 18 million m^3/a in 2000 (DWAF, 2002) and 6.3 million m^3/a by the NWRS. A total of 18 million m^3/a is recommended in this report.

Of the recharge of approximately 800 million *m^3/a the annually available unexploited groundwater is estimated to be 115* million *m^3a /in the "best case" and 105* million *m^3 in the "base case".* Groundwater could significantly contribute to the betterment of socio-economic conditions in this ISP area and the rural provision of the basic human Reserve as well as additional allocation for food support.

Issues

The groundwater tables are reported to be dropping at many schemes. Middelburg and Graaff-Reinet are reported to be in difficulties with wellfield supply, with Middelburg being granted a R2m drought relief fund.

The RDM office is responsible for determining the Groundwater Reserve (i.e. the contribution of groundwater to the Surface Water Reserve).

Licence conditions should always require that abstraction be within the limits of sustainable yield, but district and local municipalities are not addressing issues of sustainability in the planning stages of water supply schemes.

Numerous small towns and rural settlements are solely or partially reliant on groundwater. Despite this, routine monitoring operations, and maintenance and interpretation of the data to adjust pumping regimes on supply wellfields is not being undertaken

3.3 SUNDAYS

The Sundays ISP sub-area is also divided into three parts, the two northern zones of which are western extensions of the two southern zones of the adjacent Fish sub-area. The Katberg sandstone, which is the southern boundary unit of the Upper Great Fish Basin subprovince (**Table 2**), does not extend into the Sundays basin, only as outliers along the northern Sundays-Fish divide. The Upper Sundays (N14, N13, N12, N21, N30A catchments) falls within the western ***Camdeboo-Winterberg subprovince***, underlain by lower Beaufort (Adelaide Subgroup) strata and intrusive Karoo dolerites. The Middle Sundays (N24, N22, N23, N30B-C catchments) lies within the ***Southern Karoo foreland subprovince***, in which structural control of drainage by WNW/ESE tectonic trends of the Cape Fold Belt (CFB) is evident in the western and eastern tributaries of the incised main river channel. The Lower Sundays catchments (N40) are divided between the ***Albany Coastal Range and Algoa Basin subprovinces***, mainly the latter.

A revised average annual groundwater recharge estimate of 352 million m^3 is obtained for this sub-area (**Table 3** – Recharge and baseflow), compared with earlier estimates in the range 307 to 367 million m^3/a. Of this total, 28 million m^3/a recharges the CFB fractured-rock aquifers (Witteberg in the Albany Coastal Range and Table Mountain Group in the southwestern corner of the Algoa Basin) in the south, and 284 million m^3/a recharges the shallow intergranular-and fractured zone units. About 18 million m^3/a enters fractured Karoo dolerites, mostly in the Upper Sundays area. Recharge to the alluvial and coastal primary aquifers in the south amounts to 22 million m^3/a.

Groundwater quality in the higher catchments of the Upper Sundays, e.g., around Nieu Bethesda, is locally good (EC < 450 mg/l), but is otherwise brackish (TDS 450 to 2 000 mg/l) even in this zone, with a belt of poor quality (2 000-6 500 mg/l) between Aberdeen and Graaff-Reinet. In the Middle and Lower Sundays, the groundwater quality is rarely good, and belts of poor quality (2 000-6 500 mg/l) are widespread, generally related to Bokkeveld, Dwyka-Ecca and Uitenhage Group strata.

Total annual groundwater use in this sub-area was estimated at 30 million m^3 in 2000 (DWAF, 2002) and 15.6 million m^3 by the NWRS. A total of 30 million m^3/a is recommended in this report.

The annually available unexploited groundwater is estimated to be 54 million m^3 *in the "best case" and 39* million m^3 *in the "base case".* Groundwater quality, rather than quantity, may be the greater limitation to "best case" levels of aquifer development.

It is suggested that it would be appropriate strategy to consider rainfall harvesting, i.e. the improving of recharge into the groundwater aquifers.

Issues

Groundwater usage in this area is considered to be moderately to heavily utilised in the middle Sundays area. This is both for rural settlement and agricultural supply. Despite this, and reports that the groundwater tables on many schemes are reported to be dropping, routine monitoring operations and maintenance and interpretation of the data to adjust pumping regimes on supply well-fields is not undertaken.

Licence conditions should always require that abstraction be within the limits of sustainable yield, but district and local municipalities do not address issues of sustainability in the planning stages of water supply schemes.

There are no licence applications at present waiting for attention; there is one disputed licence application near the hamlet of Sundays River. This involves the Paterson Municipality which has drilled on a private landowner's land without knowledge and permission. This is a co-operative governance affair and requires confirmation that there is no alternative source.

4. GROUNDWATER/SURFACE WATER LINKAGE

There is little to no quantitative knowledge of surface/ groundwater interaction in the Fish-Sundays. However the environmental and tourist importance of the estuaries, the goods and services that the wetlands/vleis deliver in the high-lying areas and the implementation of the Reserve, are factors contributing to the importance of managing the groundwater contribution at low-flow times.

Estimates of baseflow contribution by different researchers vary significantly for the Fish-Sundays area. It is important that the evaluation of the baseflow contribution is realistic, particularly in the Albany Coast sub-area and in the lower Fish sub-area because, this being an area of relatively high dependency on groundwater, good estimates could mean the difference between there being some spare groundwater potential in certain areas, or over-exploitation. Preliminary assessment of spring distribution patterns in this ISP area suggests that the surface-groundwater interaction is geologically controlled, i.e. situated at lithological and/or structural (therefore also geomorphologically) defined regions.

Baseflow is negligible to low in the regolith and flood hydrology dominated sub-areas of the upper and middle Fish and Sundays sub-areas, indicating a very low to negligible impact on surface water or ecosystems other than at site specific springs and seep zones associated with the dolerite dyke and sill systems. Most of the streams and rivers in the upper regions and the relatively dry areas of the WMA are considered *detached* (piezometric level at all times below streambed and no discharge to surface water), *intermittent* (piezometric level slopes towards the stream and recharge occurs at intervals or occasionally) or *famished* (piezometric level slopes towards the stream, but groundwater does not reach due to evapotranspiration (definitions by Vegter and Pitman, 1996).

The bigger seasonally effluent reaches of rivers with riparian zones, constituting the alluvial aquifers, are located in climatic regions of low rainfall and high evaporation. These aquifers are not considered relevant for water resource development in this ISP area. Rivers normally do not act as source for groundwater recharge. However, in the event of floods or large-scale transfers the river becomes influent and recharges the groundwater, if the storage capacity is sufficient. The primary consideration in this ISP area is the pollution threat to the fractured rock aquifers arising from this recharging.

Relevant surface/ groundwater interaction is therefore largely limited to perennial springs (see above) and very occasionally rivers embedded in alluvial aquifers. Alluvial aquifers are not of much significance in this area, and primary aquifers are concentrated along the coast and arise from wind action, not fluvial action.

The springs and seep zones discharging from the Katberg Formation, the Witteberg formation and the dolerite dykes and sills support perennial reaches of river, vleis and wetlands (see **Figure 1**). Interaction between surface and groundwater in the river courses is likely limited to these few areas.

The springs in this area need to be thoroughly mapped and monitored. The relationship of spring and seep discharge to river flow needs to be established and groundwater contribution to baseflow needs to be verified. This is particularly important since the aquifers in this area generally have a low storage capacity and many people depend on run-of-river and or groundwater for supply.

Recognising this, it does not mean that a spring flow cannot be replaced by groundwater pumped out of a borehole. In many instances groundwater discharge can be better managed in a wellfield context than in a natural context by supplementing the decrease in spring flow from managed wellfields.

In the fractured rock dominated areas of the WMA (where the Witteberg outcrops in the Albany Coast sub-area and where aquifers behind dolerite dykes and sills have been developed in the other sub-areas), elevation and depth of boreholes is a more critical factor to consider than distance from a river in regulating groundwater abstraction with regards to impact on baseflow.

A strategy of purposeful and managed drawdown of the groundwater table in summer in order to enhance recharge in the winter and optimise the evaporation-free storage can be adopted in the management of the storage available in the Katberg and Witteberg Aquifers.

Table 3: Recharge and baseflow

ISP Sub-area	Recharge (Umvoto model)	Recharge (Vegter)	Baseflow (Pitman)	Baseflow (Hughes)
Great Fish	626	728	21	114.6
Albany Coast	251	155	3	29.2
Sundays	352	409	2.5	45.2
Total	**1 230**	**1292**	**26**	**189**

NOTE: The baseflow of Pitman is ~14% of that of Hughes; the baseflow of Hughes is up to 19% of recharge.

Table 4: Groundwater usage

ISP Sub-area	Usage (NWRS)	Usage (Baron and Seward 2000)	Usage (based on NGDB and WRC Yield map) [1]	Usage (ISP)	Comment
Great Fish	6.3	18	111	18	To be conservative the Baron & Seward estimate is preferred
Albany Coast	1.6	4.8	26	4.8	
Sundays	15.6	30	69	30	
Total	**23.5**	**53**	**206**	**52.8**	

(1) The method used to estimate usage would significantly over-estimate for the Karoo-dominated sub-areas due to high percentage of dry boreholes and assumed pumping regime in model.

Table 5: Groundwater available for development[1]

Sub-area	Recharge (Umvoto)	Baseflow (Pitman)	Usage (ISP)	Groundwater Available for Development	Comment
Great Fish	626	21	18	103	NWRS usage figures would increase available groundwater
Albany Coast	251	3	4.8	45	
Sundays	352	2.5	30	40	
Total	**1 230**	**26**	**52.8**	**188**	

(1) 20% of (Recharge – Baseflow) less usage/ supply = Groundwater Available for Development. The amount could be as low as 10% or as much as 80% - but additional information is required to improve on the current estimate. The Potential for Development in the Albany Coast sub-area is estimated very conservatively given that the exploration of the Witpoort Formation has only been initiated recently.

Table 6: Comparison of Values for 'Groundwater Available for Development'

Sub-area	Harvest Potential	Exploitation Potential (WSM 2000)	NWRS	ISP	Comment
Great Fish	824	455	95.7	105	
Albany Coast	325	154	25.6	48	Witteberg aquifer not emphasised in NWRS
Sundays	385	223	67.8	54	
Total	**1 534**	**206**	**189.1**	**217**	

NOTE: The Groundwater Potential estimated in this study is considered to be very conservative for reasons discussed in text and table notes. *We recommend that the NWRS numbers be revised accordingly (see Table 7 below).* The total Groundwater Potential for development would be 217 million m^3/a. In the event that the Baron and Seward (2000) usage figures are used, the NWRS and ISP values are very comparable.

Table 7: Summary table of potential and current supply

Item	Groundwater available for exploitation/ development	Current groundwater supply
Unit	Million m^3/a	Million m^3/a
Ref	ISP	NWRS
Formula	Recharge – baseflow/2 or 5 less supply	
Great Fish	115	6.3
Albany Coast	48	1.6
Sundays	54	15.6
Total	**217**	**23.5**

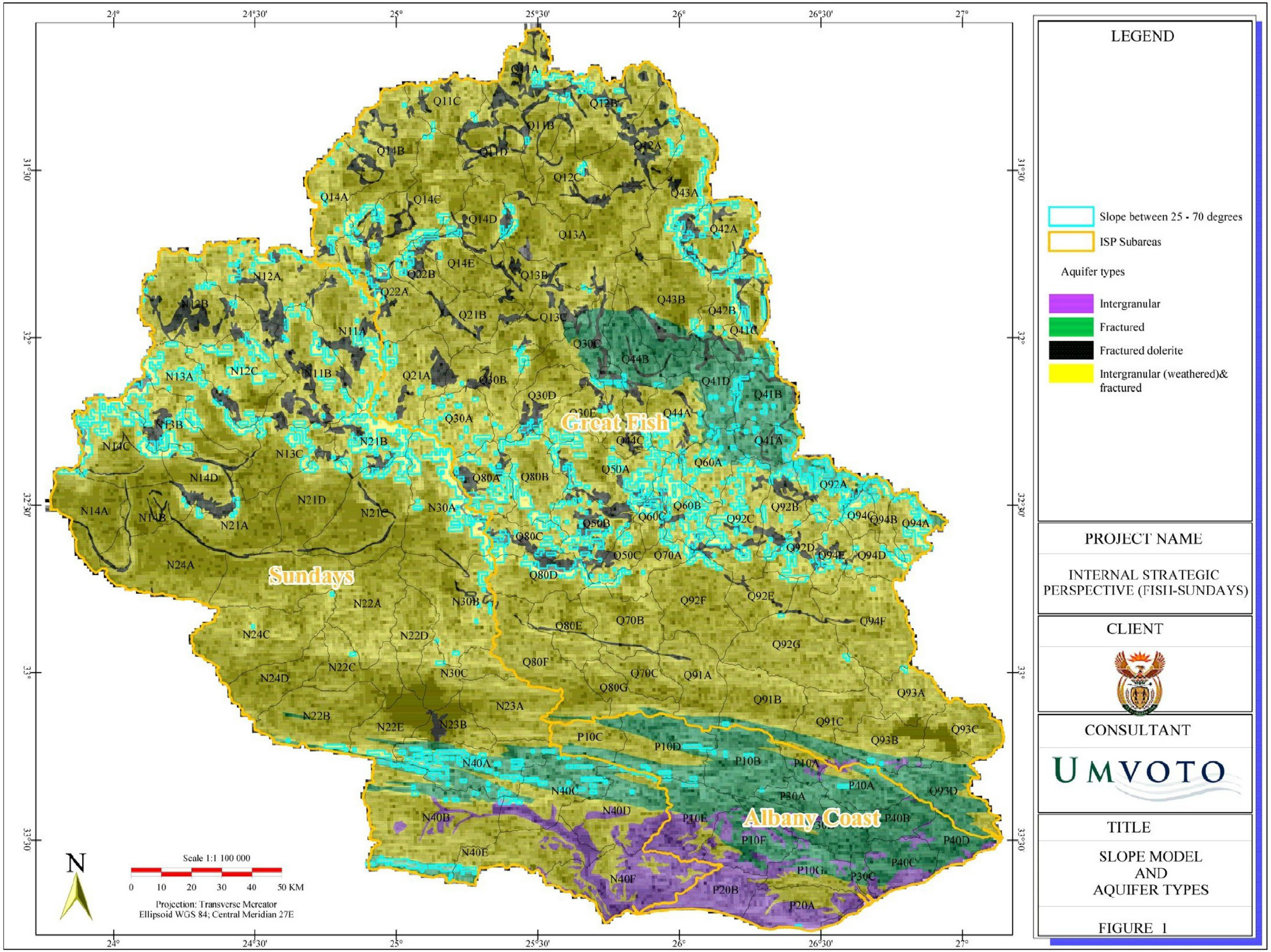

Figure 2: Slope model and aquifer types

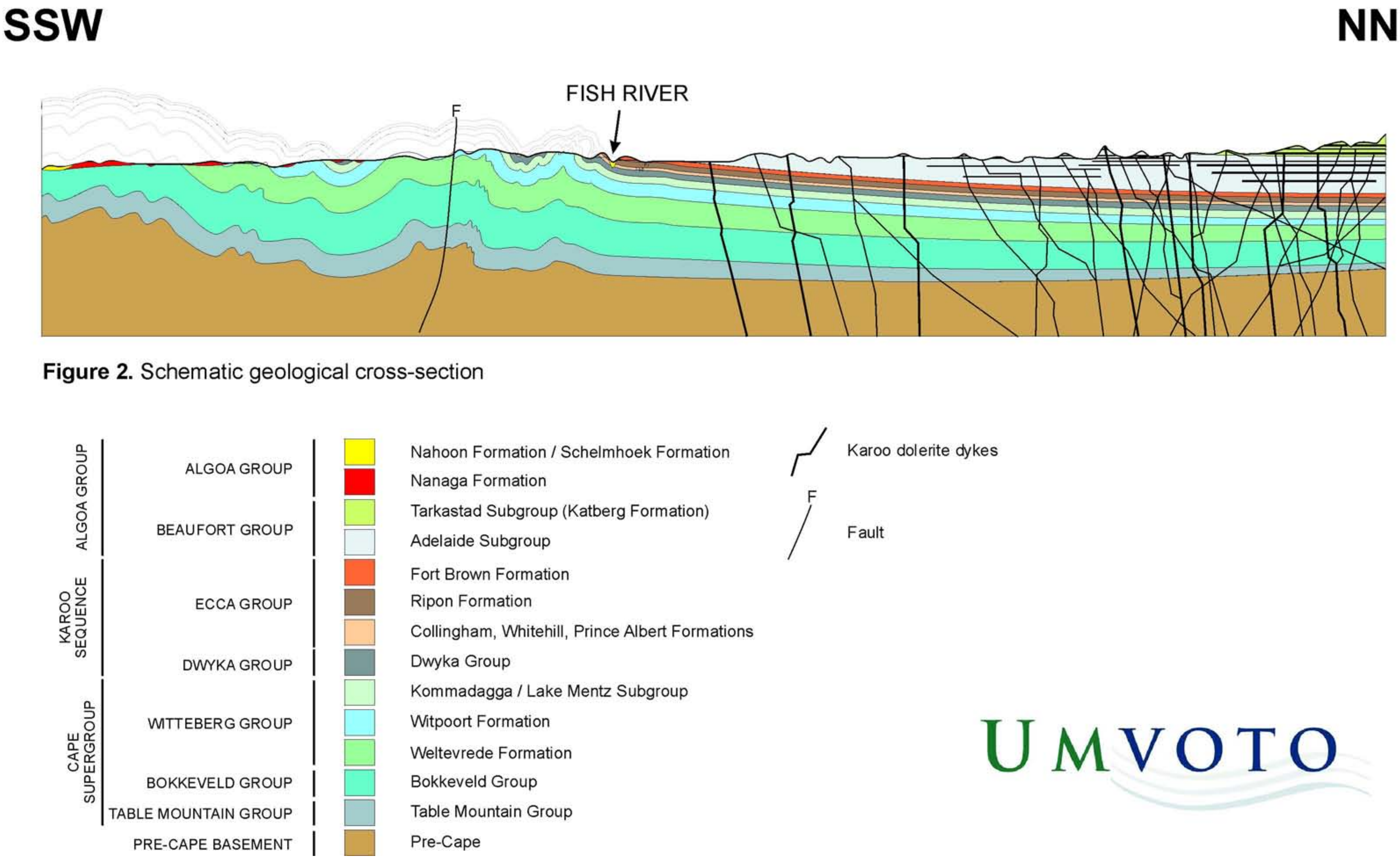

Figure 3: N-S Geological cross-section

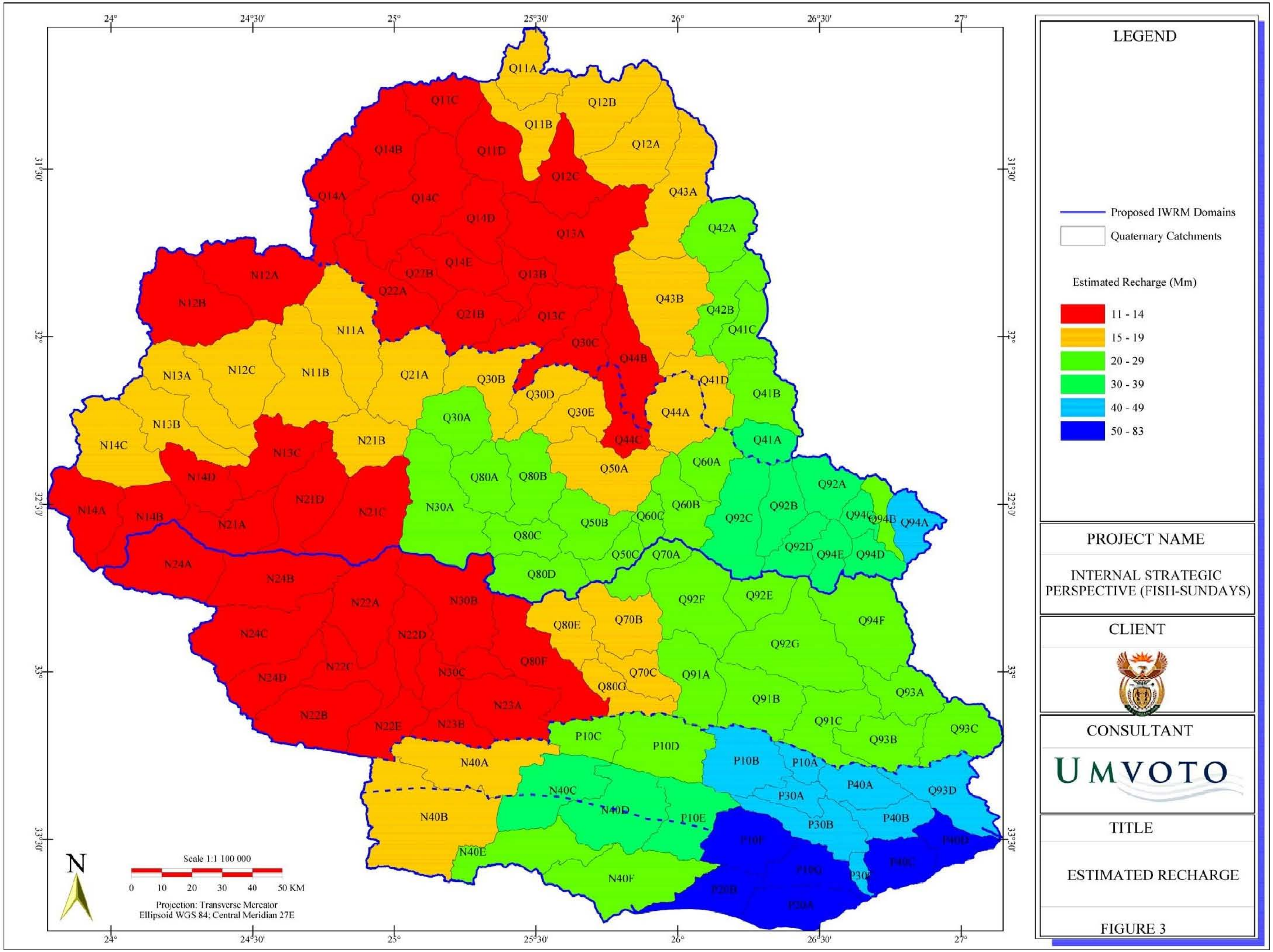

Figure 4: Estimated recharge

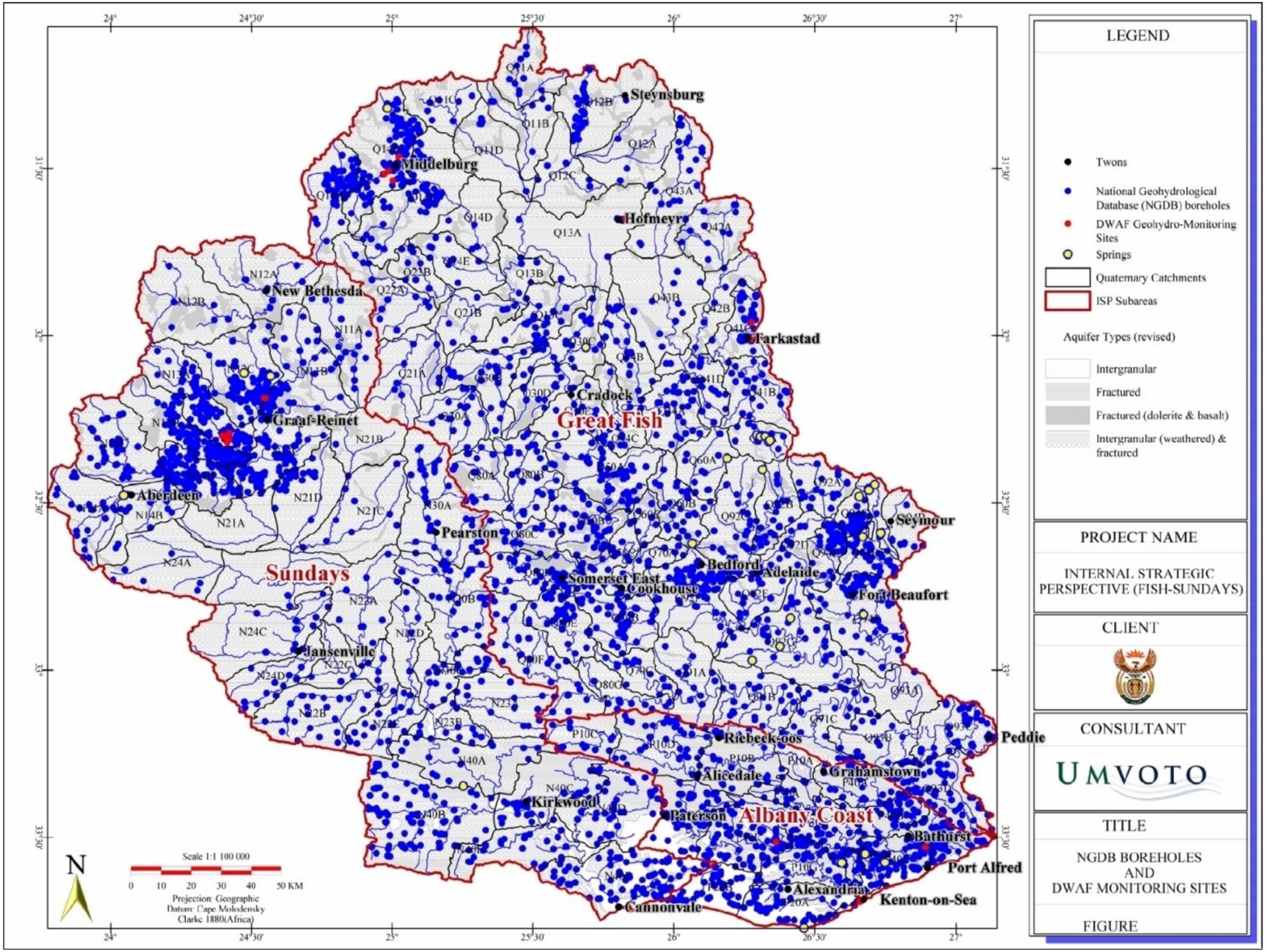

Figure 5: NGDB boreholes and DWAF monitoring sites

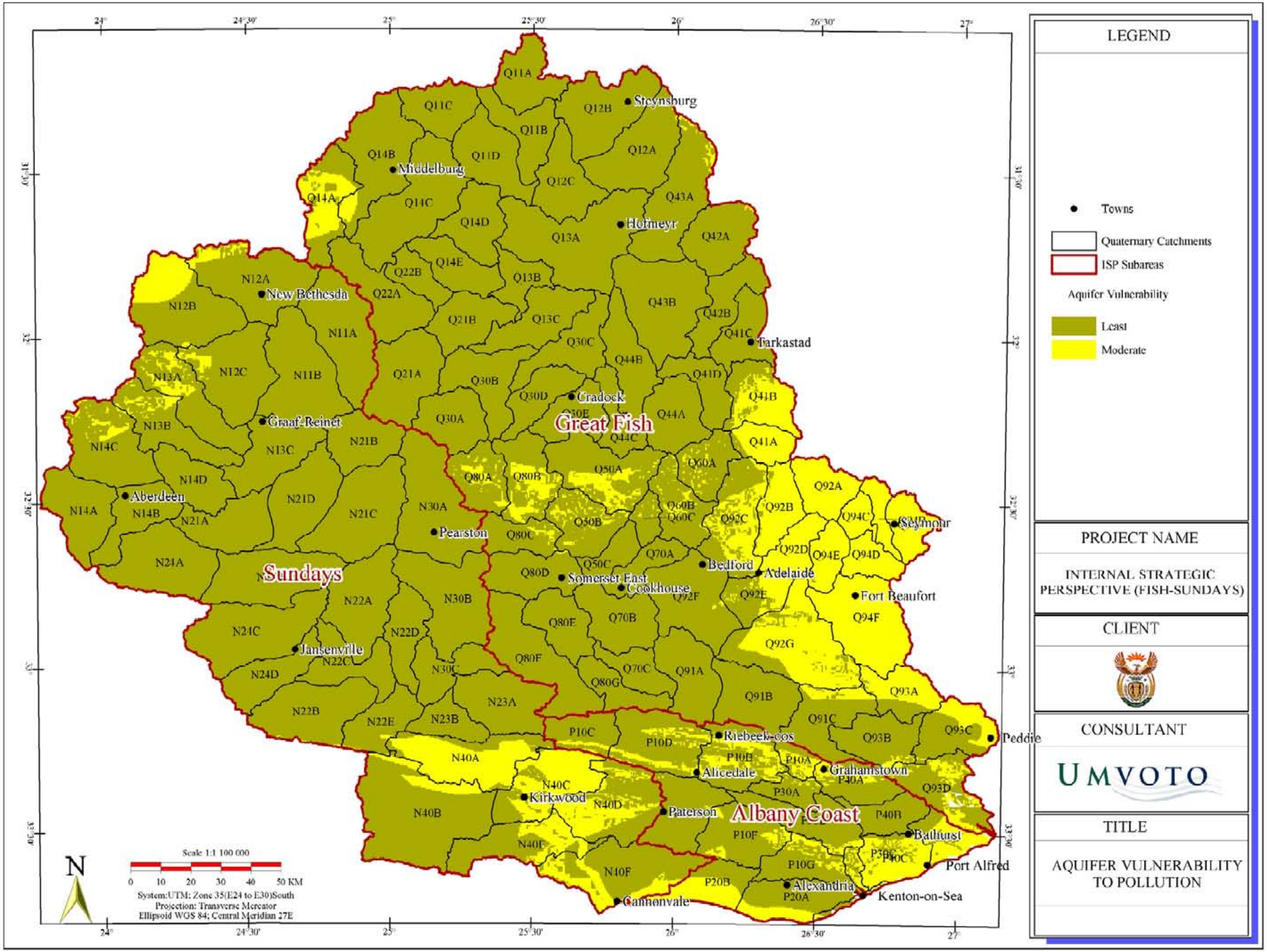

Figure 6: Aquifer vulnerability to pollution

APPENDIX 3

Municipalities in the ISP area

MUNICIPALITIES IN THE ISP AREA

District/Metropolitan Municipality	Local Municipality	Town
Central Karoo District (DC5)	(Very small area)	None
Cacadu District (DC10)	Blue Crane Route Municipality	Cookhouse, Somerset East, Pearston
	Camdeboo Municipality	Graaff-Reinet, Nieu-Bethesda, Aberdeen
	Ikwezi Municipality	Jansenville
	Makana Municipality	Alicedale, Grahamstown, Riebeeck-East
	Ndlambe Municipality	Alexandria, Bathurst, Kenton-on-Sea, Port Alfred, Bushmans River Mouth, Cannon Rocks, Boknes, Kleinemonde
	Sunday's River Valley Municipality	Kirkwood, Sunland, Addo, Bontrug, Enon
Amatole District (DC12)	Ngqushwa Municipality	Peddie
	Nkonkobe Municipality	Alice, Fort Beaufort, Middledrift, Seymour, Hogsback
	Nxuba Municipality	Adelaide, Bedford
Chris Hani District (DC13)	Inxuba Yethemba Municipality	Cradock, Middelburg
	Tsolwana Municipality	Hofmeyr, Tarkastad
Ukhahlamba District (DC14)	Gariep Municipality	Steynsburg
Nelson Mandela Metropolitan	N/a	Colchester, Cannonvale

APPENDIX 4

Rivers and towns

RIVERS AND TOWNS

Quaternaries	Rivers / river reaches	Towns / suburbs
Sundays		
N11A	Sundays River	
N11B	Sundays River	
N12A	Gats River	Nieu Bethesda
N12B	Bloukrans River	
N12C	Gats River, Pienaars River	
N13A	Moordenaars River, Droë River	
N13B	Swart River	
N13C	Sundays River, Swart River	Graaff-Reinet
N14A	Kraai River	
N14B	Kraai River	Aberdeen
N14C	Kamdeboo River	
N14D	Kamdeboo River	
N21A	Sundays River, Karee River	
N21B	Melk River	
N21C	Melk River	
N21D	Klip River	
N22A	Lootskloof River	
N22B	Driekop River	
N22C	Sundays River	
N22D	Riet River	
N22E	Wortelkuil River	
N23A	Schoenmakers River	
N23B	Volkers River	
N24A	Bul River	
N24B	Bul River, Sundays River	
N24C	Brak River, Sundays River	Jansenville
N24D	Delport River	
N30A	Voël River	Pearston
N30B	Voël River	
N30C	Voël River	
N40A	Sundays River, Kruis River	
N40B	Kariega River, Sundays River	
N40C	Wit River	Bontrug, Enon, Kirkwood
N40D	Krom River	Paterson
N40E	Sundays River	
N40F	Sundays River	Cannonvale

Albany Coast		
P10A	New Years River	
P10B	New Years River	Riebeeck-East
P10C	Bushmans River	
P10D	Bushmans River	Alicedale

Quaternaries	Rivers / river reaches	Towns / suburbs
P10E	Bushmans River	Paterson
P10F	Bushmans River	
P10G	Bega River, Bushmans River	
P20A	Boknes River	Alexandria, Cannon Rocks, Boknes
P20B	Bega River	
P30A	Kariega River	
P30B	Assegaai River, Kariega River	
P30C	Kariega River	
P40A	Bloukrans River, Kowie River, Kafferkraal River	Grahamstown
P40B	Kowie River	
P40C	Kowie River	Bathurst, Port Alfred
P40D	Riet River	
Fish		
Q11A	Great Brak River	
Q11B	Great Brak River	
Q11C	Oorlogspoort River	
Q11D	Oorlogspoort River	
Q12A	Strydpoort River	
Q12B	Teebus Spruit	Steynsburg
Q12C	Teebus Spruit	
Q13A	Great Brak River, Kwaai River	Hofmeyr
Q13B	Great Fish River, Great Brak River	
Q13C	Great Fish River	
Q14A	Little Brak River	
Q14B	Little Brak River	Middelburg
Q14C	Little Brak River	
Q14D	Little Brak River	
Q14E	Great Fish River	
Q21A	Willem Burgers River	
Q21B	Willem Burgers River	
Q22A	Elandskloof River	
Q22B	Small Seekoei River	
Q30A	Pauls River	
Q30B	Kareebos River, Pauls River	
Q30C	Great Fish River	
Q30D	Wilgebooms River	
Q30E	Great Fish River	Cradock
Q41A	Tarka River	
Q41B	Tarka River	
Q41C	Tarka River	Tarkastad
Q41D	Poort River	
Q42A	Elands River	
Q42B	Elands River	
Q43A	Vlekpoort River	
Q43B	Vlekpoort River	
Q44A	Tarka River	
Q44B	Gunstelingstroom River	

Quaternaries	Rivers / river reaches	Towns / suburbs
Q44C	Golden Glade River	
Q50A	Riet River	
Q50B	Great Fish River	
Q50C	Great Fish River	
Q60A	Poort River	
Q60B	Poort River	
Q60C	Baviaans River	
Q70A	Great Fish River, Droë River	Cookhouse
Q70B	Great Fish River	Uitkeer
Q70C	Great Fish River	Sheldon
Q80A	Great Blyde River	
Q80B	Little Fish River	
Q80C	Little Fish River	
Q80D	Little Fish River, Naude's River	Somerset East
Q80E	Little Fish River	
Q80F	Brak River	
Q80G	Small Fish River	
Q91A	Great Fish River	
Q91B	Great Fish River	
Q91C	Bothas River, Great Fish River	
Q92A	Koonap River	
Q92B	Braambos River, Koonap River, Tarka River	
Q92C	Koonap River	Adelaide
Q92D	Kaalhoek River	
Q92E	Koonap River	
Q92F	Kat River	Bedford
Q92G	Koonap River	
Q93A	Great Fish River	
Q93B	Brak River	
Q93C	Blue River, Paradise River	Peddie
Q93D	Great Fish River, Rufane River	
Q94A	Esk River	Seymour
Q94B	Kat River	
Q94C	Kat River	
Q94D	Kat River	
Q94E	Blinkwater River	
Q94F	Kat River	Fort Beaufort

APPENDIX 5

Wastewater treatment works

WASTEWATER TREATMENT WORKS

Quats	Controlling authority	Name	Capacity	Disposal
Fish sub-area				
Q12B	Gariep Municipality	Steynsburg Oxidation Ponds	200 m^3/d	Irrigate
Q13A	Tsolwana Municipality	Hofmeyr Sewage Treatment Works	Small < 1 000 m^3/d	Pond System
Q14B	Inxuba Yethemba Municipality	Grootfontein Agri College Sewage Treatment Works	Small < 1 000 m^3/d	Irrigation
Q14B	Inxuba Yethemba Municipality	Middelburg Sewage Treatment Works	1 000 m^3/d	Discharge & irrigate
Q30E	Inxuba Yethemba Municipality	Cradock Sewage Treatment Works	4 000 m^3/d	Great Fish River
Q41C	Tsolwana Municipality	Tarkastad Sewage Treatment Works	Small < 1 000 m^3/d	No irrigation
Q70A	Blue Crane Route Municipality	Cookhouse Sewage Treatment works	Small < 1 000 m^3/d	Evaporate / pond system
Q80D	Blue Crane Route Municipality	Somerset East Sewage Treatment works	Small < 1 000 m^3/d	Irrigate
Q91C	Makana Municipality	Rini STW		Irrigate
Q92C	Nxuba Municipality	Adelaide Sewage Treatment works	Small < 1000 m^3/d	Koonap River
Q92F	Nxuba Municipality	Bedford sewage Treatment works	Small < 1 000 m^3/d	Koonap River
Q92F	Bedford Hospital	Bedford Hospital Sewage treatment Works		Irrigation
Q93C	Ngqushwa Municipality	Peddie Sewage Treatment works	Small < 1 000 m^3/d	Paradise (Ngqushwa River)
Q94A	Nkonkobe Municipality	Seymour Sewage Treatment Works	250 m^3/d	Irrigation
Q94F	Nkonkobe Municipality	Fort Beaufort Sewage Treatment Works	2 000 m^3/d	Irrigation / pond
Albany Coast sub-area				
P10D	Makana Municipality	Alicedale Sewage Treatment Works	Small < 1 000 m^3/d	Evaporate / Irrigate
P10E	Sundays River Valley Municipality	Paterson Oxidation Ponds	Influent received is 230 m^3/d	Evaporate
P10G	Ndlambe municipality	Bushmans River Mouth Sewage Treatment Works	Small < 1 000 m^3/d	Bushmans River
P10G	Ndlambe municipality	Kenton-on- Sea		Kariega River

Quats	Controlling authority	Name	Capacity	Disposal
		Sewage Treatment Works		
P20A	Ndlambe municipality	Alexandria Sewage Treatment Works	Small < 1 000 m^3/d	Irrigate
Q93B	Makana Municipality	Glen Melville Sewage Treatment Works (Grahamstown)		
P40A	Makana Municipality	Grahamstown Sewage Treatment Works	4 000 m^3/d	Blaauwkrantz River
P40C	Ndlambe Municipality	Bathurst Sewage Treatment Works	Small < 1 000 m^3/d	Evaporate / Irrigate
P40C	Ndlambe Municipality	Port Alfred Sewage Treatment Works	1 000 m^3/d	Irrigate
Sundays sub-area				
N13C	Camdeboo Municipality	Graaff-Reinet Sewage Treatment Works	3 000 m^3/d	Discharge / Pond System
N14B	Camdeboo Municipality	Aberdeen Sewage Treatment Works	Small < 1 000 m^3/d	Evaporate
N14B	Camdeboo Municipality	Tembelesiswe Oxidation ponds (Aberdeen)	Small < 1 000 m^3/d	Irrigation
N24C	Ikwezi Municipality	Jansenville oxidation ponds		Evaporate
N30A	Blue Crane Route Municipality	Pearston oxidation ponds		Discharge
N40C	Cacadu District Municipality (DC10)	Enon oxidation ponds	153 m^3/d	Evaporate / Irrigate
N40C	Sunday's River Valley Municipality	Kirkwood Sewage Treatment works	Small < 1 000 m^3/d Influent received is 1 197 m^3/a	Discharge
N40C	Kirkwood Prison	Kirkwood Prison Sewage Treatment Works	Small < 1 000 m^3/d	Discharge
N40E	S A National Parks	Addo Elephant National Park oxidation ponds	40 m^3/d	Soak away
N40E	Addo Research Station	Addo Research Station Sewage Treatment Works	Small < 1 000 m^3/d	Pond System
N40E	Sunday's River Valley Municipality	Addo Town Sewage Treatment Works	Small < 1 000 m^3/d Influent received is 553 m^3/d	Irrigation / pond

APPENDIX 6

Solid waste disposal sites

SOLID WASTE DISPOSAL SITES

Quaternary catchment	Area	Local authority	District Municipality	Type of site
Fish sub-area				
Q12B	Steynsburg	Gariep	Ukhahlamba (DC14)	Class C
Q13A	Hofmeyr	Tsolwana	Chris Hani (DC13)	Class C
Q14B	Middelburg	Inxuba Yethemba	Chris Hani (DC13)	Class S
Q30E	Cradock	Inxuba Yethemba	Chris Hani (DC13)	Class M
Q41C	Tarkastad	Tsolwana	Chris Hani (DC13)	Existing: Class C New: Class C
Q70A	Cookhouse	Blue Crane Route	Cacadu	C: G: B-
Q70B	Uitkeer	DWAF		C: G: B-
Q80D	Somerset East	Blue Crane Route	Cacadu (DC10)	Class S – Class 2 site
Q92C	Adelaide	Nxuba	Amatole (DC12)	Class S
Q92F	Bedford	Nxuba	Amatole (DC12)	Existing: Class C New: Class S
Q94A	Hogsback	Nkonkobe	Amatole (DC12)	Class CSAFCOL Class C
Q94F	Fort Beaufort	Nkonkobe	Amatole (DC12)	Class S (Closed) New Class C (No official facility)
Sundays sub-area				
N12A	Nieu Bethesda	Camdeboo	Cacadu (DC10)	Proposed A and an existing Class C site
N13C	Graaff-Reinet	Camdeboo	Cacadu (DC10)	Class S
N14B	Aberdeen	Camdeboo	Cacadu (DC10)	Old Class C (closed) + New Class C
N24C	Jansenville	Ikwezi	Cacadu (DC10)	Class C
N30A	Pearston	Blue Crane Route	Cacadu (DC10)	Class C
N40B N40C	Kirkwood Corr. Services Kirkwood	Public Works Sundays River Valley	Cacadu (DC10)	Class C – Class 2 site Class C – Class 2 site
N40E	Addo Langbos	Sundays River Valley	Cacadu (DC10)	Class C
N40E	Addo (Mistkraal)	Sundays River Valley	Cacadu (DC10)	Class C – Class 2 site
N40F	Cannonvale/Colchester Caravan Park (C. Botha)	Sundays River Valley	Cacadu (DC10)	Class C Class C - Private
Albany Coast sub-area				
P20A	Cannon Rocks	Ndlambe	Cacadu (DC10)	Class C Domestic Class C Garden

Quaternary catchment	Area	Local authority	District Municipality	Type of site
P10A	Grahamstown	Makana	Cacadu (DC10)	Class M G: M: B +
P40C	Bathurst	Ndlambe	Cacadu (DC10)	Class C
P40C	Port Alfred	Ndlambe	Cacadu (DC10)	Class S – Class 2 site
P10B	Riebeeck-East	Makana	Cacadu (DC10)	Class C – Class 2 site
P40D	Kleinemonde	Ndlambe		C: G: B+
P40D	Riet River Mouth	Ndlambe		C: G: B+
P30B	Salem	Ndlambe		C: G: B-
P30C	Kenton-on-Sea	Ndlambe		C: G: B+
P10D	Alicedale	Makana	Cacadu (DC10)	Class C
P10E	Paterson	Sundays River Valley	Cacadu (DC10)	Class C G: S: B
P10G	Bushmans River Mouth	Ndlambe	Cacadu (DC10)	Old: Class C Class 2 New: Class C
P20A	Alexandria	Ndlambe	Cacadu (DC10)	Class S
P20A	Boknes	Ndlambe	Cacadu (DC10)	Class C Rural

APPENDIX 7

General authorisations tables

GENERAL AUTHORISATIONS

GAZETTE NO 26187

GOVERNMENT NOTICE

DEPARTMENT OF WATER AFFAIRS AND FORESTRY

NO. 399 **26 March 2004**

REVISION OF GENERAL AUTHORISATIONS IN TERMS OF SECTION 39 OF THE NATIONAL WATER ACT, 1998 (ACT NO. 36 OF 1998)

SCHEDULE

1. THE TAKING OF WATER FROM A WATER RESOURCE AND STORAGE OF WATER

[Sections 21(a) and (b)]

TABLE 1.1 Areas excluded from General Authorisation for the taking of surface water

Primary drainage region	Secondary/Tertiary/Quaternary drainage region and excluded resources	Description of main river in drainage region for information purposes
N	N11, N12	Sundays River upstream of Nqweba Dam
P	P10 P30 P40	Bushmans River Kowie River Kariega River
Q	Q41A, Q41B, Q41C, Q41D, Q44A, Q44B Q42A & B Q43A & B Q92 Q94	Tarka River Elands River Vlekpoort River Koonap River Kat River

Table 1.2 Groundwater Taking Zones: Quaternary Drainage Regions

The Table refers to the size of the property on which the General Authorisation is applicable

Zone A **NO WATER MAY BE TAKEN FROM THESE DRAINAGE REGIONS EXCEPT AS SET OUT UNDER SCHEDULE 1 AND FOR SMALL INDUSTRIAL USERS.**	**Zone B** **45 M^3 PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND FOR SMALL INDUSTRIAL USERS.**	**Zone C** **75 M^3 PER HECTARE PER ANNUM MAY BE TAKEN -FROM THESE DRAINAGE REGIONS AND FOR SMALL INDUSTRIAL USERS.**	**Zone D** **150 M^3 PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND FOR SMALL INDUSTRIAL USERS.**	**Zone E** **400 M^3 PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND FOR SMALL INDUSTRIAL USERS.**
N14B-D	N12C	N11A, B	N40F	P20B
N21A	N13A-C	N12A, B	P20A	
N22A, E	N14A	N21B, D		
N23B	N21C	N40A, B, D, E		
N24B-D	N22B-D	P10A, B, D-G		
N30A-C	N23A	P30A-C		
N40C	N24A	P40A-D		
Q12C	P10C	Q11A-D		
Q13B, C	Q13A	Q12A, B		
Q14A-C, E	Q22A	Q14D		
Q21B	Q30A	Q21A		
Q22B	Q43A, B	Q41A-D		
Q30B-E	Q50C	Q42A, B		
Q44A-C	Q60A, B	Q91C		
Q50A, B	Q70A-C	Q92A, B, D, E, G		
Q60C	Q80D, E, G	Q93A-D		
Q80A-C, F	Q91A, B	Q94A-F		
	Q92C, F			

TABLE 1.3 (a) Areas excluded from General Authorisation for any storage of water

Primary drainage region	Secondary/Tertiary/Quaternary drainage region	Description of main river in drainage region for information purposes
None	None	None

TABLE 1.3 (b) Areas excluded from General Authorisation for storage of water in excess of 10 000 cubic metres and falling outside government control areas proclaimed under the Water Act No 54 of 1956.

Primary drainage region	Secondary/Tertiary/Quaternary drainage region	Description of main river in drainage region for information purposes
None	None	None

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2. ENGAGING IN A CONTROLLED ACTIVITY, IDENTIFIED AS SUCH IN SECTION 37(1): IRRIGATION OF ANY LAND WITH WASTE OR WATER CONTAINING WASTE GENERATED THROUGH ANY INDUSTRIAL ACTIVITY OR BY A WATERWORK

[Section 21(e)]

3. DISCHARGE OF WASTE OR WATER CONTAINING WASTE INTO A WATER RESOURCE THROUGH A PIPE, CANAL, SEWER OR OTHER CONDUIT; AND DISPOSING IN ANY MANNER OF WATER WHICH CONTAINS WASTE FROM, OR WHICH HAS BEEN HEATED IN, ANY INDUSTRIAL OR POWER GENERATION PROCESS

[Sections 21(f) and (h)]

TABLE 3.3: Listed Water Resources

	WATER RESOURCE		
	Great Brak River		
	LISTED WATER RESOURCES WHERE SPECIAL LIMIT FOR ORTHO-PHOSPHATE AS PHOSPHOROUS IS APPLICABLE (Crocodile (West) Marico Water Management Area)		
	None		
	RAMSAR LISTED WETLANDS:	**PROVINCE**	**LOCATION**
	None	None	None

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4 DISPOSING OF WASTE IN A MANNER WHICH MAY DETRIMENTALLY IMPACT ON A WATER RESOURCE

[Section 21(g)]

TABLE 4.1 Subterranean government water control areas excluded from General Authorisation for disposal of waste

Primary drainage region	Tertiary/ Quaternary drainage region	Description of subterranean government water control area	Government Notice No.	Government Gazette Date
None	None	None	None	None

APPENDIX 8

Resource-poor farmers schemes

RESOURCE- POOR FARMER IRRIGATION SCHEMES

Scheme/Area	Implementing authority / Comment
Fish sub-area	
Tyhefu: (380 ha)	Bulk supply rehabilitation for Phases I and II are in place, as well as in-field works for Phase I (380 ha). DWAF and DLA will only become involved with further capital development once there are significant production from Phase I and II. No definite implementing authority has been identified for the additional potential 860 ha, which would form part of Phase III of the project. Total envisaged eventual irrigation is about 1 400 ha, which includes the additional 860 ha.
Cradock (18 ha)	This has already been fully developed with help from DLA and Inxuba Yethemba Municipality, and is mainly small commercial cash crop plots just downstream of Cradock.
Masipatisane (20 ha)	No development yet of this potential irrigation scheme, and no plans for development known at present.
Kwa Nojoli (84 ha)	No development yet of this potential irrigation scheme, and no plans for development known at present
The proposed sugar beet project is a possible user that may use part, or whole of the allocation for resource-poor farmers.	Sugar Beet S.A. would be the implementing agent if such a scheme was implemented. A Strategic Environmental Assessment is proposed for this project. Note that the use of water for this project would preclude the implementation of some of the other listed proposals, which already total more than 5 000 ha.
Albany Coast sub-area	
No identified schemes for resource-poor farmers.	
Sundays sub-area	
Barkley Bridge: The ORRS Study identified 3 000 ha in the Barkley Bridge area.	DWAF originally indicated that they will only become involved when there is a definite demand from the end users for development, which there is not at present. The Sunday River WUA (SRWUA) is very keen to have the area developed for empowerment and other purposes, and may look for willing partners to aid in development. DWAF is currently reconsidering undertaking a study of the possible development of the area, as part of a greater resource-poor farmer planning study.
Enon Mission (296 ha)	No development as yet. The SRWUA feels that some body (e.g. DLA) needs to take the responsibility to get aspirant resource-poor farmers together, to create a need for development, and find willing development partners. The SRWUA has informed the EC MEC for Agriculture as such.
Vaalhoedskraal (188 ha)	An application for a licence for resource-poor farmers has been made to DWAF, for development just downstream of Vaalhoedskraal. The Implementing Authority is the Provincial Department of Agriculture. Any future proposed development (in excess of 188 ha) would have to form part of the identified 4 000 ha if the licence application is successful.
Addo (690 ha)	No development as yet. SRWUA feels that some body (e.g. DLA) needs to take the responsibility to get aspirant resource-poor farmers together, to create a need for development, and find willing development partners. The SRWUA has informed the EC MEC for Agriculture as such.

APPENDIX 9

Land reform (redistribution) schemes

LAND REFORM (REDISTRIBUTION) SCHEMES

Farm /Scheme	Water Source	Scheduled Area (ha)	Region	Comment
Bedrog CPA	ORP	122.7	Klipfontein, near Cookhouse	After unsuccessful attempts to retain resource-poor farmers on property, it was sold early 2004. Back in hands of commercial farmer.
Masizame Trust	ORP	50	Somerset-East	Infrastructure vandalised and fallen into disrepair. Used as communal grazing area at present.
Sonder Trust	ORP	?	Klipfontein, near Cookhouse	
Masizakhe Trust	ORP	4	Lower Sundays River	Handed over to lawyers to claim owed water bills. Seems as if farm will be sold in total.
Nomzamo Stock Farmers Trust	ORP	29	Kirkwood, under SRWUA	About to sell out altogether to cover all debts, including ± R60 000 owed to SRWUA.
Masiphathisane Trust	ORP	5	Lower Sundays River	Handed over to lawyers to claim outstanding amounts. Total sale of property imminent.
Dept of Agriculture Project	ORP	?	Addo	Handed over to lawyers to claim outstanding debts to SRWUA.
Perks Hoek	ORP	?	Tyhefu area, Lower Fish River	Infrastructure fallen into disrepair, or sold to bring income to community.
Glenmore	ORP	93 ha, but rising to 160 ha when rehabilitated scheme in full production	Tyhefu, Lower Fish Area	Recently rehabilitated by DWAF and Dept Agriculture. Community (through a Project Steering Committee) to find donors/ developers to start production.

APPENDIX 10

Irrigation schemes

UPDATED INFORMATION ON SCHEDULED IRRIGATION AREAS AND WATER DEMANDS: November 2004

Because some of this information still requires clarification, much private irrigation has not yet been included and the breakdown between hydrological sub-divisions has not been fully clarified, this information was not used in the hydrological calculations. The RO is busy refining these values.

Quaternaries	Irrigation Board / Irrigator	Water Source/River	Scheduled Irrigation area (ha)	Water rights not scheduled (ha)	Water quota (m3/ha/a)	Scheduled water demand (Mm3/a)	Actual average water use (Mm3/a)	ISP hydro sub-division
Q12B	Teebus	Orange River water via Teebus tunnel – Teebus Spruit (Canals)	1 246.8		13 500	16.83	Unknown	Groot Brak
Q12C, Q13A	Upper Grassridge	Orange River water via Teebus Tunnel – Teebus Spruit (Canals)	3 069.1		13 500	41.43	Unknown	Groot Brak
SUB-TOTAL		**Groot Brak River (Teebus-Grassridge)**	**4 315.9**		**13 500**	**58.26**	**Unknown**	**Groot Brak**
Q13B	Brak River	Brak River	875.1		13 500	11.81	Unknown	Upper Fish
Q13C	Knutsford	Great Fish River	3 387.8		13 500	45.74	Unknown	Upper Fish
Q13C	Baroda	Great Fish River	1 857.9		13 500	25.08	Unknown	Upper Fish
Q30D	Marlow	Great Fish River	1 944.7		13 500	26.25	Unknown	Upper Fish
Q30E	Scanlen	Great Fish River	1 749.2		13 500	23.61	Unknown	Upper Fish
Q30E	Tarka	Great Fish River	1 743.2		13 500	23.53	Unknown	Upper Fish
Q50A	Mortimer	Great Fish River	1 391.2		13 500	18.78	Unknown	Upper Fish
Q13 &Q30, Q50?	Upper and Middle Great Fish River (Private)	Great Fish River	1 212.8		13 500	16.37	Unknown	Upper/Middle Fish?
SUB-TOTAL		**Great Fish River (Grassridge-Elandsdrift)**	**14 161.9**		**13 500**	**191.17**	**Unknown**	
Q50C	Renfield	Great Fish River	1 447.3		12 500	18.09	Unknown	Middle Fish
Q70A	Hougham Abrahamson	Great Fish River	2 901.4		12 500	36.27	Unknown	Middle Fish
Q70B	Middleton	Great Fish River	2 171.0		12 500	27.14	Unknown	Middle Fish

Quaternaries	Irrigation Board / Irrigator	Water Source/River	Scheduled Irrigation area (ha)	Water rights not scheduled (ha)	Water quota (m3/ha/a)	Scheduled water demand (Mm3/a)	Actual average water use (Mm3/a)	ISP hydro sub-division
Q50? & Q70	Lower Great Fish River (Private)	Great Fish River	459.6	0	12 500	5.75	Unknown	Middle Fish?
Q70C	Sheldon	Great Fish	40.0	0	12 500	0.50	Unknown	Middle Fish
SUB-TOTAL		**Great Fish River (Elandsdrift-Junction Drift)**	**7 035.5**	**0**	**12 500**	**87.75**	**Unknown**	
Q50B	Klipfontein	Fish/Sundays Canal	2 281.3	0	12 500	28.52	Unknown	Middle Fish
Q50B	Boschberg	Fish/Sundays Canal	617.7	0	12 500	7.72	Unknown	Middle Fish
Q50B	Somerset East	Fish Sundays Canal	1 281.1	0	12 500	16.01	Unknown	Middle Fish
Q80E	Sheldon	Little Fish (Rockcliffe Canal)	70.2	0	12 500	0.88	Unknown	Upper Little Fish
Q80E	Upper Little Fish (Private)	Little Fish	720.4	0	12 500	9.01	Unknown	Upper Little Fish
SUB-TOTAL		**Fish-Sundays Canal and Little Fish (Elandsdrift–De Mistkraal)**	**4 970.7**	**0**	**12 500**	**62.14**	**Unknown**	
Q80G	Sheldon	Little Fish (Canal)	807.6	0	12 500	10.10	Unknown	Middle Fish
Q80E	Sheldon	Little Fish (Fish-Sundays Canal)	256.7	0	12 500	3.21	Unknown	Upper Little Fish
Q80G	Lower Little Fish (Private)	Little Fish	432.7	0	12 500	5.41	Unknown	Middle Fish
SUB-TOTAL		**Little Fish River (De Mistkraal-Junction Drift)**	**1 497.0**	**0**	**12 500**	**18.72**	**Unknown**	
Q70C, Q91 *	Pumps (25 ha permit area)	Great Fish River		647.2	9 000	5.82	Unknown	Middle/Lower Fish
Q93B	Glenn Melville	Glenn Melville Dam	394.4	0	12 500	4.93	Unknown	Lower Fish
SUB-TOTAL		**Lower Fish (Junction Drift-Hermanuskraal)**	**394.4**	**647.2**	**Various**	**10.75**	**Unknown**	

Quaternaries	Irrigation Board / Irrigator	Water Source/River	Scheduled Irrigation area (ha)	Water rights not scheduled (ha)	Water quota (m3/ha/a)	Scheduled water demand (Mm3/a)	Actual average water use (Mm3/a)	ISP hydro sub-division
Q44A, Q44B,Q44C	Commando Drift	Tarka River (Commando Drift Dam and Lake Arthur)	920.7	0	13 500	12.43	Unknown	Tarka
SUB-TOTAL		**Tarka River**	**920.7**	**0**	**13 500**	**12.43**	**Unknown**	**Tarka**
Q92	Private	Koonap river	Unknown	0		19.6	Unknown	Koonap
SUB-TOTAL		**Koonap**	**Unknown**	**0**		**19.6**	**Unknown**	**Koonap**
Q94B, C, D, F	Kat River	Kat River Dam	1 599.2	0	10 900	17.43	Unknown	Kat
SUB-TOTAL		**Kat**	**1 599.2**	**0**	**10 900**	**17.43**	**Unknown**	**Kat**
TOTAL		**FISH SUB-AREA**	**34 895.3**	**647.2**	**Various**	**478.25**	**Unknown**	**FISH TOTAL**
	Private	Bushmans, Kowie/Kariega	0	0	Unknown	11.0	Unknown	Albany Coast
TOTAL		**ALBANY COAST SUB-AREA**	**0**	**0**	**Unknown**	**11.0**	**Unknown**	**Albany Coast**
N11, N12	Private	Above Nqweba Dam	0	0		9.8	Unknown	Upper Sundays
SUB-TOTAL		**Upper Sundays**	**0**	**0**		**9.8**	**Unknown**	**Upper Sundays**
N23A, B	Schoenmakers	Schoenmakers	287.8	0	12 500	3.60	Unknown	Middle Sundays
N30A,B	Blyde River	Blyde River Dam (not GWS)	86.3	0	10 900	0.94	Unknown	Middle Sundays
SUB-TOTAL		**Middle Sundays**	**374.1**	**0**	**Various**	**4.54**	**Unknown**	**Middle Sundays**
N40B, C, E	Lower Sundays River	Orange River water from Korhaansdrift Weir	16 644.4	0	9 000	149.80	Unknown	Lower Sundays
SUB-TOTAL		**Lower Sundays**	**16 644.4**	**0**	**9 000**	**149.80**	**Unknown**	**Lower Sundays**
TOTAL		**SUNDAYS SUB-AREA**	**17 018.5**	**0**	**Various**	**164.14**	**Unknown**	**SUNDAYS**
GRAND TOTAL		**ISP AREA**	**51 913.8**	**647.2**	**Various**	**653.39**	**Unknown**	**ISP AREA**

APPENDIX 11

Irrigation schemes in disrepair

IRRIGATION SCHEMES IN DISREPAIR

Quats	Irrigation scheme	Location	Water Source/River	Areas Covered/ Owner	Total area (ha)	Food plots (ha)	Commercial farmers (ha)	Description	Comments
Q94D, F	Kat River, (Mpofu) Tyume and Ripplemead Schemes	N/A	N/A	N/A	N/A	N/A	N/A	Kat River Scheme: These schemes (except the ex-RSA portion of Kat River) are in disrepair due to lack of maintenance. Payment problems are experienced	Widespread bankruptcies are common. These high-investment farms have fallen into a state of disrepair. Ex-RSA section of Kat River scheme is functioning well.
Q93A, B, C	Tyhefu Irrigation Scheme	Tyhefu, Lower Fish Area	Fish River, Orange River Scheme (ORP)	Kalileni, Pikoli, Ndlambe, Ndwayana, Glenmore, Committees	Kalileni -145 ha Pikoli -13 ha Ndlambe-151 ha Ndwayana-60 ha Glenmore-160 ha Committees-55 ha	1 646 food-plots (0.2 ha - 0.5 ha)	33 small commercial farmers (4 ha each)	Condition of the scheme is good in some areas but none of the schemes are properly functioning.	Ex-Ciskei schemes are being refurbished. ± 160 ha at Glenmore and ± 60 ha at Ndwayana. Ndwayana Phase 2: 1.2 m diameter pipeline was lengthened to Ndlambe Dam at a cost of R38 million. Future phases 3 and 4 are envisaged in co-operation with Dept. of Agriculture.
N40	Lower Sundays	The farm borders on the Valencia Township near Addo	ORP	DLA Project	N/A	N/A	N/A	No activity on this property at present.	

Sources:

- Report on investigations into ways of rehabilitating the water supply aspects of certain irrigation schemes in former Transkei and Ciskei, drawn up by the DLA/DWAF scheme-rehabilitation task team for presentation to provincial and national ministries, August 1997.
- DWAF, Division of Advisory Services Cradock, "*Update on the creation of new WUAs and the transformation of irrigation boards to WUAs*", compiled by T. Sombeselele and S. Mullineux, October 2003.

APPENDIX 12

Flow gauging stations

FLOW GAUGING STATIONS

Station No	Place or description	River / Pipeline	Latitude	Longitude	Catchment Area	Record Period of Primary Data	
					km^2	From	To
Sundays							
N1H001	Graaff-Reinet	Sundays River	32 : 14 : 15	24 : 31 : 48	3681	11/1921	02/1932
N1H002	Bloemskraal	Gats River	32 : 09 : 40	24 : 32 : 56	1787	03/1927	07/1947
N1H003	Klipdrift	Swart River	32 : 23 : 18	24 : 28 : 10	1040	03/1927	02/1932
N1H004	Broederstroom	Broederstroom	32 : 12 : 52	24 : 34 : 43	134	11/1927	02/1932
N1H005	Roodebloem	Sundays River	32 : 10 : 26	24 : 35 : 21	1265	11/1927	03/1932
N1H006	Buffelshoek	Pienaars River	32 : 10 : 52	24 : 25 : 29	196	03/1927	07/1948
N1H007	Groote Vlakte	Kamdeboo River	32 : 25 : 31	24 : 17 : 29	1669	11/1927	06/1947
N1H008	Aberdeen	Kraai River	32 : 29 : 47	24 : 03 : 00	490	11/1927	06/1947
N1H009	Sevenfontein	Koloniesplaas-Eye	31 : 59 : 36	24 : 48 : 44		06/1963	04/1974
N1H010	Grasrand	Moordenaars River	32 : 19 : 13	24 : 27 : 29		06/1961	12/1971
N1H011	Onbedacht	Toorberg Spruit No 1	32 : 10 : 08	24 : 04 : 35	14	05/1957	11/1991
N1H012	Lange Fontein	Toorberg Spruit	32 : 09 ; 39	24 : 07 : 35	0.6	06/1961	11/1991
N1H013	Graaff-Reinet	Mackies Puts-Eye	32 : 14 : 05	24 : 31 : 45		01/1925	09/2002
N1H014	Bloemhof	Bloemhof-Eye	32 : 02 : 08	24 : 40 : 23		05/1961	11/1991
N1H015	Onbedacht	Toorberg Spruit 1	32 : 10 : 08	24 : 04 : 35		07/1961	11/1991
N1H016	Lange Fontein	Toorberg Spruit 2	32 :0 9 : 39	24 : 07 : 35		07/1961	11/1991
N1H017	Sevenfontein	Canal from Kolonies-Plaas-Eye	31 : 59 : 35	24 : 48 : 44		06/1963	03/1974
N1H018	Sevenfontein	Canal from Kolonies-Plaas-Eye	31 : 59 : 35	24 : 48 : 44		06/1963	03/1963
N1H019	Graaff-Reinet	V. Ryneveldspas Dam	32 : 14 : 05	24 : 31 : 45		01/1925	11/2003
N1H020	Graaff-Reinet	V. Ryneveldspas Dam	32 : 14 : 05	24 : 31 : 45		01/1925	11/2003
N1H021	Graaff-Reinet	V. Ryneveldspas Dam	32 : 14 : 05	24 : 31 : 45		01/1925	11/2003
N1H022	Graaff-Reinet	V. Ryneveldspas	32 : 14 : 33	24 : 31 : 54		12/2001	08/2002
N1R001	Graaff-Reinet	Sundays River	32 : 14 : 06	24 : 31 : 44	368	01/1925	11/2003
N2E001	Darlington	Dwaas	33 : 12 : 37	25 : 08 : 34		10/1925	10/2003
N2E002	Jansenville		32 : 56 : 00	24 : 40 : 00		06/1957	10/1980
N2H001	Riet River	Sundays River	33 : 07 : 00	25 : 07 : 30	16047	01/1918	01/1922
N2H002	Jansenville	Sundays River	32 : 57 : 00	24 : 40 : 08	11395	10/1923	12/1992
N2H003	Blaauwkrans	Sundays River	32 : 48 : 31	24 : 40 : 00	10620	09/1928	09/1947
N2H004	Schoemans Vlakte	Melk River	32 : 37 : 53	24 : 40 : 46	1128	03/1927	01/1932
N2H005	Waterford	Sundays River	33 : 04 : 32	25 : 00 : 56	13419	09/1928	09/1947
N2H006	Brand Kraal	Sundays River	32 : 29 : 53	24 : 28 : 17	7124	12/1933	05/1934
N2H007	De Draay	Sundays River	33 : 06 : 02	25 : 00 : 44	13428	09/1974	01/2004
N2H008	Groene Leegte	Riet River	33 : 04 : 49	25 : 04 : 41	341	09/1974	11/2003
N2H009	Volkers River	Volkers River	33 : 06 : 28	25 : 13 : 43	536	09/1978	02/1989
N2H010	Dwaas	Left Canal from Dam	33 : 12 : 26	25 : 09 : 00		01/1923	11/2003
N2h011	Dwaas	Left Canal from Dam	33 : 12 : 27	25 : 08 : 59		10/1986	11/2003
N2R001	Dwaas	Sundays River	33 : 12 : 22	25 : 08 : 50	16826	01/1923	11/2003
N3H001	Riet River	Voel River	32 : 58 : 47	25 : 11 : 25	1597	09/1928	07/1948
N3H002	Riet Vley	Voel River	33 : 00 : 06	25 : 09 : 41	1744	06/1978	04/1992
N4E001	Addo		33 : 34 : 06	25 : 41 : 32		01/1960	09/2002
N4H001	Korhaanspoort	Sundays River	33 : 22 : 43	25 : 21 : 17	17485	11/1914	12/2003
N4H002	Strathsomers Estate	Sundays River	33 : 25 : 05	25 : 28 : 56	18909	03/1917	05/1921
N4H003	Addo Drift East	Sundays River	33 : 34 : 53	25 : 40 :28	20460	10/1984	05/1997
N4H004	Landrost Veeplaats	Sundays River	33 : 27 : 46	25 : 32 : 29	18952	03/1986	
N4H005	Selborne	Coerney River	33 : 30 : 43	25 : 38 : 52	590	03/1986	12/2003

Station No	Place or description	River / Pipeline	Latitude	Longitude	Catchment Area	Record Period of Primary Data	
					km^2	From	To
N4H006	Korhaanspoort	Sundays River	33 : 22 : 47	25 : 21 : 14		11/1914	12/2003
N4H007	Strathsomers Estate	Left Canal from Sundays River	33 : 25 : 05	25 : 28 : 56		02/1919	05/1921
N4H008	Slagboom	Wit River	33 : 22 : 11	25 : 40 : 00	196	02/1955	07/1974
N4H009	Slagboom	Pipeline from Slagboom Dam	33 : 22 : 11	25 : 40 : 00		02/1955	07/1974
N4R001	Slagboom	Wit River	33 : 22 : 11	25 : 40 : 00	196	02/1955	06/1980
Albany Coast							
P1H001	Thornkloof	Gaitu River	33 : 15 : 18	26 : 18 : 41	158	12/1948	10/1950
P1H002	Hilton	New Years River	33 : 14 : 49	26 : 21 : 41	124	12/1948	10/1953
P1H003	Donker Hoek	Boesmans River	33 : 19 : 48	26 : 04 : 40	1479	02/1957	12/2003
P1H004	New Years Drift West	Pipeline from Nuwejaars Dam	33 : 19 : 05	26 : 04 : 51		06/1978	08/2002
P1R003	New Years Drift West	Nuwejaars Spruit	33 : 18 : 13	26 : 06 : 44	408	04/1978	12/2003
P3E001	Howinsonspoort Dam	Thomas Baines Natres	33 : 23 : 15	26: 29 : 15		01/1963	10/1983
P3H001	Smithfield	Kariega River	33 : 33 : 08	26 : 36 : 07	588	07/1969	12/2003
P3R001	Palmiet River	Palmiet River	33 : 23 : 16	26 : 26 : 15	33	12/1966	12/1982
P3R002	Newingreen	Kariega River	33 : 24 : 44	26 : 30 : 33	176	12/1966	12/1982
P4H001	Bathurst	Kowie River	33 : 30 : 24	26 : 44 : 40	576	07/1969	12/2003
Great Fish							
Q1E001	Grassridge Dam	Klipheuvel	31 : 45 : 30	25 : 28 : 00		01/1926	11/2003
Q1E002	Grootfontein College		31 : 29 : 00	25 : 02 : 00		06/1935	03/1995
Q1E003	Middelburg		31 : 30 : 30	25 : 04 : 00		01/1954	05/1959
Q1H001	Katkop	Great Fish River	31 : 54 : 11	25 : 28 : 56	9091	03/1918	02/1993
Q1H002	Klipheuvel	Great Brak River	31 : 46 : 55	25 : 27 : 10	4385	10/1920	10/1923
Q1H003	Connay Farm	Little Brak River	31 : 44 : 11	25 : 20 : 00	2412	01/1926	07/1947
Q1H004	Kwaayaplaats	Kwaai River	31 : 56 : 53	25 : 33 : 12	141	01/1927	07/1947
Q1H005	Weltevreden	Hongerskloof River	31 : 28 : 00	25 : 41 : 00	449	03/1927	03/1942
Q1H006	Jan Blaauws Kop	Teebus River	31 : 34 :42	25 : 32 : 21	1577	03/1927	05/1948
Q1H007	The Kuur	Great Brak River	31 : 36 : 00	25 : 29 : 37	3296	01/197	10/1932
Q1H008	Brakke Kuilen	Little Brak River	31 : 33 : 05	25 : 10 : 00	1870	01/1927	06/1947
Q1H009	Buffels Valey	Little Brak River	31 : 31 : 58	25 : 04 : 29	1211	02/1959	02/1974
Q1H010	Tafelburg	Little Brak River	31 : 36 : 37	25 : 14 : 39	2046	02/1959	03/1974
Q1H011	Rietfontein	Little Brak River	31 : 32 : 21	24 : 54 : 36	492	02/1959	03/1974
Q1H012	Jan Blaauws Kop	Teebus River	31 : 34 : 04	25 : 32 : 37	1567	07/1977	01/2004
Q1H013	Zeeven Fontein	Little Brak River	31 : 46 : 40	25 : 19 : 06	2445	07/1982	01/2004
Q1H014	Brakleegte	Teebus Canal from Ovis Tunnel	31 : 25 : 12	25 : 38 : 14		10/1976	01/2004
Q1H015	Brakleegte	Irrigation Canal from Ovis Tunnel	31 : 25 : 12	25 : 38 : 14		11/1985	01/2004
Q1H016	Katkop	Left Canal from Great Fish River	31 : 54 : 4	25 : 28 : 58		03/1918	03/1993
Q1H017	Zoutpansdrift	Right Canal from Great Fish River	31 : 54 : 11	25 : 28 : 56		03/1918	03/1993
Q1H018	Teebus	Irrigation Pipe from Ovis Tunnel	31 : 25 : 12	25 : 38 : 14		05/1988	09/2002
Q1H019	Klipheuvel	Left Canal from Grassridge Dam	31 : 46 : 05	25 : 28 : 00		05/1985	01/2004
Q1H020	Klipheuvel	Right Canal from Grassridge Dam	31 : 46 : 05	25 : 28 : 00		01/1924	01/2004

Station No	Place or description	River / Pipeline	Latitude	Longitude	Catchment Area	Record Period of Primary Data	
					km^2	From	To
Q1H021	Klipheuvel	Left Canal from Grassridge Dam	31 : 46 : 05	25 : 28 : 00		05/1985	01/2004
Q1H022	Klipheuvel	Outlet to Great Brak River	31 : 46 : 05	25 : 28 : 00		06/1985	08/1990
Q1H023	Klipheuvel	Great Brak River	31 : 46 : 05	25 : 28 : 00	4325	09/1925	01/1934
Q1R001	Klipheuvel	Great Brak River	31 : 46 : 05	25 : 28 : 00	4325	02/1924	11/2003
Q2H001	Zoutpansdrift	Great Fish River	31 : 54 : 50	25 : 25 : 09	1702	12/1926	07/1948
Q2H002	Zoutpansdrift	Great Fish River	31 : 54 : 18	25 : 25 : 48	1713	07/1973	11/2003
Q3E001	Hales Owen	Halesvlakte	32 : 13 : 16	25 : 41 : 24		06/1959	08/2002
Q3H001	Doorn River	Pauls River	32 : 02 : 31	25 : 30 : 13	867	12/1926	04/1948
Q3H002	Rietfontein	Jenkins Spruit	32 : 04 : 53	25 : 35 : 09	289	10/1930	02/1937
Q3H003	Cradock	Great Fish River	32 : 11 : 37	25 : 39 : 15	11282	01/1934	12/1938
Q3H004	Coutzenburg	Pauls River	32 : 02 : 00	25 : 31 : 15	872	10/1973	11/2003
Q3H005	Rietfontein	Great Fish River	32 : 05 : 18	25 : 34 : 34	10830	04/1977	11/2003
Q3H006	Cradock	Great Fish River	32 : 10 : 05	25 : 36 : 45	8498	03/1986	
Q4E001	Lake Arthur Dam	Vrischgewaagd	32 : 13 : 30	25 : 49 : 15		01/1926	11/1996
Q4E002	Commando Drift	Almondsfontein	32 : 16 : 30	26 : 02 : 30		11/1978	10/2003
Q4H001	Teeken Fontein	Tarka River	32 : 14 : 13	25 : 48 : 15	4508	01/1914	10/1931
Q4H002	Roberts Kraal	Vlekpoort River	31 : 57 : 44	26 : 00 : 00	1273	11/1959	12/1964
Q4H003	Roberts Kraal	Vlekpoort River	31 : 58 : 06	26 : 00 : 06	1300	12/1964	12/1992
Q4H004	Beestekraal	Tarka River	32 : 04 : 57	26 : 11 : 22	671	09/1966	06/1987
Q4H005	Bridge Farm	Tarka River	32 : 18 : 50	25 : 44 : 29	4742	07/1973	07/1980
Q4H006	Vrischgewaagd	Canal from Lake Arthur	32 : 13 : 32	25 : 49 : 06		08/1959	11/1996
Q4H007	Vrischgewaagd	Right Canal from Lake Arthur	32 : 13 : 32	25 : 49 : 06		08/1959	11/1996
Q4H008	Vrischgewaagd	Tarka River	32 : 13 : 32	25 : 49 : 06		04/1925	11/1996
Q4H009	Commando Drift	Main Canal from Commando Drift Dam	32 : 06 : 39	26 : 02 : 27		01/1956	12/2003
Q4H010	Commando Drift	Return Flow Canal to River	32 : 06 : 39	26 : 02 : 27		12/1979	12/2003
Q4H011	Commando Drift	Irrigation Canal	32 : 06 : 40	26 : 02 : 27		04/195	12/2003
Q4H012	Teeken Fontein	Tarka River	32 : 14 : 13	25 : 48 : 15	4508	01/1914	03/1930
Q4H013	Bridge Farm	Tarka River	32 : 18 : 50	25 : 44 : 29	4742	07/1980	01/2004
Q4R001	Vrischgewaagd	Tarka River	32 : 13 : 32	25 : 49 : 06	4497	02/1925	04/1997
Q4R002	Commando Drift	Tarka River	32 : 06 : 36	26 : 02 : 41	3632	03/1956	12/2003
Q5E001	Elandsdrift Dam	Elandsdrift	32 : 31 : 45	25: 45 : 00		08/1977	11/2003
Q5H001	Vader Landsche Wilge	Kromspruit	32 : 29 : 16	25 : 48 : 12	52	01/1927	06/1947
Q5H002	Vrischgewaagd	Rietspruit	32 : 25 : 24	25 : 46 : 37	158	02/1927	12/1940
Q5H003	Elandsdrift	Sluice to River	32 : 31 : 49	25 : 45 : 15		01/1977	01/1993
Q5H004	Fonteins Hoek	Great Fish River	32 : 38 : 23	25 : 45 : 15	17260	07/1977	07/1983
Q5H005	Van Stadens Dam	Great Fish River	32 : 20 : 10	25 : 43 : 21	1003	03/1987	
Q5H006	Elandsdrift	Left Canal from Dam	32 : 31 : 49	25 : 45 : 15		01/1977	12/2003
Q5R001	Elandsdrift	Great Fish River	32 : 31 : 45	25 : 45 : 10	16864	08/1976	01/1993
Q6H001	Belvedere	Baviaans River	32 : 34 : 00	25 : 56 : 50	694	10/1918	12/1937
Q6H002	Melrose	Baviaans River	32 : 37 : 44	25 : 53 : 0	819	09/1973	08/1980
Q6H003	Botmansgat	Baviaans River	32 : 36 : 21	25 : 53 : 05	814	09/1980	10/2003
Q6H004	Botmansgat	Left Canal from Baviaans River	32 : 36 : 19	25 : 53 : 06		09/1980	06/1990
Q7E001	Golden Valley	Altona	32 : 49 : 00	25 : 47 : 00		03/1973	11/1979
Q7E002	Middelton	Voorspoed	32 : 59 : 00	25 : 50 : 00		12/1979	07/1995
Q7H001	Moordenaars Drift	Great Fish River	32 : 57 : 16	25 : 48 : 56	18989	01/1906	11/1928

Station No	Place or description	River / Pipeline	Latitude	Longitude	Catchment Area	Record Period of Primary Data	
					km^2	From	To
Q7H002	Doringdraai	Great Fish River	32 : 43 : 11	25 : 50 : 33	18452	08/1922	10/1948
Q7H003	Leeuwe Drift	Great Fish River	32 : 46 : 42	25 : 50 : 23	18534	11/1928	10/1948
Q7H004	Cookhouse	Great Fish River	32 : 44 : 34	25 : 48 : 41	18485	11/1948	10/1973
Q7H005	Sout Vleij	Great Fish River	33 : 01 : 40	25 : 53 : 37	19134	06/1972	12/2003
Q7H006	Cookhouse	Great Fish River	32 : 44 : 34	25 : 48 : 41	18485	11/1948	10/1973
Q8E001	Power Station	Somerset-East	32 : 44 : 00	25 : 35 : 00		12/1960	10/1980
Q8E002	De Mist Kraal Dam	Mist Kraal	32 : 58 : 10	25 : 40 : 25		10/1987	10/2003
Q8H001	Buffelfontein	Little Fish River	32 : 38 : 36	25 : 26 : 29	980	07/1922	10/1947
Q8H002	Somerset-East	Little Fish River	32 : 44 : 21	25 : 34 : 17	1369	12/1930	12/1963
Q8H003	Farm 370 Glen Evon	Naude's River	32 : 43 : 00	25 : 39 : 00	54	03/1955	03/1965
Q8H004	Grootvlakte	Little Fish River	32 : 33 : 49	25 : 26 : 44	810	03/1957	02/1987
Q8H005	Luns Klip	Little Fish River	32 : 37 : 28	25 : 27 : 21	917	03/1957	06/1981
Q8H006	Wellington-Grove	Little Fish River	32 : 59 : 11	25 : 41 : 08	1879	01/1960	
Q8H007	Nieuwe Grond	Little Fish River	32 : 49 : 58	25 : 39 : 21		08/1978	12/2003
Q8H008	Doorn Kraal	Little Fish River	32 : 47 : 10	25 : 36 : 54	1512	01/1979	11/2003
Q8H009	Wellington-Grove	Little Fish River	32 : 59 : 18	25 : 41 : 10		06/1979	
Q8H010	Grootvlakte	Little Fish River	32 : 33 : 39	25 : 26 : 44	808	09/1986	11/2003
Q8H011	Rietfontein Junction Drift	Little Fish River	33 : 5 : 29	25 : 57 : 14	22	05/1987	
Q8H012	Luns Klip	Left Canal from Little Fish River	32 : 37 : 28	25 : 27 : 21		03/1957	05/1981
Q8H013	Mist Kraal	Left Canal from Dam	32 : 58 : 05	25 : 40 : 19		09/1987	112/2003
Q8H014	Somerset-East	Canal from Little Fish River	32 : 44 : 21	25 : 34 : 17		05/1958	12/1963
Q8R001	Mist Kraal	Little Fish River	32 : 58 : 05	25 : 40 : 19	1873	10/1987	10/2003
Q9E001	Kat River Dam	Weltevreden	32 : 34 : 21	26 : 45 : 13		02/1968	09/2002
Q9H001	Fort Brown Peninsula	Great Fish River	33 : 08 : 21	26 : 36 : 20	23582	01/1913	
Q9H002	Adelaide	Knoonap River	32 : 42 : 50	26 : 17 : 48	1245	09/1926	12/2003
Q9H003	Koesters Drift	Great Fish River	33 : 07 : 10	26 : 30 : 21	23465	10/1926	11/1935
Q9H004	Fort Armstrong	Kat River	32 : 33 : 37	26 : 41 : 36	404	10/1926	05/1964
Q9H005	Linton	Mankazana River	32 : 331 : 00	26 : 15 :13	231	08/1926	12/1931
Q9H006	Committees Drift	Great Fish River	33 : 09 : 32	26 : 50 : 19	28937	09/1928	05/1975
Q9H007	Mesopotamia	Balfour River	32 : 33 : 28	26 : 40 : 19	82	05/1928	03/1943
Q9H008	Heald Town Fingo	Kat River	32 : 42 : 40	26 : 34 : 43	748	12/1921	09/1971
Q9H009	Drumbae	Mankazana River	32 : 39 : 13	26 : 41 : 35	78	09/1928	09/1938
Q9H010	Blaauw	Great Fish River	33 : 12 : 31	26 : 51 : 58	29328	06/1930	03/1956
Q9H011	Harringay	Kat River	32 : 34 : 05	26 : 41 : 03	539	03/1931	10/1960
Q9H012	Brandt Legte	Great Fish River	33 : 05 : 53	26 : 26 : 41	223067	10/11935	10/2003
Q9H013	Kat River	Kat River Mountains	33 : 21 : 19	26 : 51 : 43	46	01/1963	01/1993
Q9H014	Frisch Gewaagd	Koonap River	32 : 27 : 53	26 : 30 : 39	246	01/1964	04/1986
Q9H015	Spioenkop	Koonap River	32 : 29 : 15	26 : 26 : 54	321	01/1964	07/1965
Q9H016	Schurftekop	Koonap River	32 : 29 : 57	26 : 21 : 56	489	09/1966	03/1993
Q9H017	Blinkwater	Blinkwater River	32 : 42 : 29	26 : 34 : 43	226	06/1965	11/2003

APPENDIX 13

Major dams

MAJOR DAMS

Quat	Dam name	Live storage (million m^3)	YIELD (million m^3/a)				Owner	Assurance of supply
			Domestic supplies	Irrigation	Other	Total		
Fish sub-area								
Q13A.	Grassridge	49.60	0	Balancing dam	0	0	DWAF	
Q14C	Kelly Patterson						Private farmer	
Q14D	Biggs							
Q41D	Commando Drift	55.7	0	7	0	7	DWAF	
Q44B	Lake Arthur	10.95	0	Negligible	0	0	Great Fish River WUA	
Q94A	Kat River	24.8	1.68	11	0	12.68	DWAF	1:10
Q50B	Elandsdrift Weir	7 (1994)	0	Diversion weir	0	0	DWAF	
Q80E	De Mistkraal Weir	3.1	0	Diversion weir	0	0	DWAF	
Q91C	Hermanuskraal Weir	1.2	0	Diversion weir	0	0	DWAF	
Q93B	Glen Melville	6.13	Balancing dam	0	0	0	DWAF	
Q93B	Glen Boyd	0.15	Balancing dam	400 ha at present, but can rise to ± 3000 ha. Glen Boyd supplies water for irrigation to Tyhefu and Lower Fish	0	0	DWAF	
Sundays sub-area								
N12C	Nqweba	47	4.5	0	0	4.5	Graaff - Reinet	1:50
N14D	De Hoop	16	0	Negligible	0	0	Private	
N23B	Darlington	187	0	28.3 when operated to FSL - Reduced yield due to problem with gates is unknown	0	28.3	DWAF	
N40A	Korhaansdrift Weir		0	Diversion weir	0	0	DWAF	
N40D	Scheepersvlakte	1.5	Balancing dam				DWAF	
Albany Coast sub-area								
P10B	New Years	4.5	3.3	0	0	3.3	Makana Municipality	
P30A P30B	Howiesons Poort Settlers	0.8 5.57	2.2	0.9	0	3.1	Makana/Ndlambe Municipality	
P40B	Sarel Hayward Mansfield	2.5 0.2	1.6	0	0	1.6	Ndlambe Municipality	

APPENDIX 14

Major infrastructure and transfer schemes

MAJOR INFRASTRUCTURE AND TRANSFER SCHEMES

PURIFICATION PLANTS

Quats	Name	Owner	Capacity (Ml/d)	Raw water source			
				Name	Urban yield		Yield allocated to other users ($10^6m^3/a$)
					$10^6m^3/a$	Ml/d	
Fish							
Q92C	Adelaide	Nxuba Municipality	0.4 (est)	Koonap River	0.4		
Q92F	Bedford	Nxuba Municipality	2	Small dam, boreholes, Orange River	0.4 0.5	1.1 1.3	
Q30E	Cradock	Inxuba Yethemba Municipality	19	Orange River	6.6	18	
Q70A	Cookhouse	Blue Crane Municipality		Existing WTW to be decommissioned			
Q70A	Cookhouse	Blue Crane Municipality	1.4 (new)	Orange River.	0.4	1.1	
Q93C	Peddie	Ngqushwa Municipality	0.3	Khewekazi Dam	0.11		
Q80E	Somerset East	Blue Crane Municipality	1.5	Orange River/ J. van der Walt/ Lake Bertie dams	0.8	2.2	
Q80E	Besterhoek Somerset East	Blue Crane Municipality	1	Bosberg/ Besterhoek dams			
Q92F	Bedford	Nxuba Municipality					
Q94A	Kat River Dam	Nkonkobe Municipality					
Q94F	Fort Beaufort	Nkonkobe Municipality	4.5	Kat River Dam	1.36		
Q94A	Seymour	Nkonkobe Municipality	0.74	Kat River Dam	0.22		
Q93B	Glen Boyd Dam	Makana Municipality					
Q93B	Glen Melville Dam	Makana Municipality					
Sundays							
N40E	Addo	Sundays River Valley Municipality	1.8	Orange River	0.1	0.27	
N40C	Enon	Sundays River Valley Municipality	0.6	Orange River	0.1	0.27	
N13B	Graaff-Reinet	Camdeboo Municipality	7	Nqweba Dam Mimosa Wellfield Graaff-Reinet Aquifer	3.3 0.3 2.2	9 0.8 6	
N40C	Kirkwood	Sundays River Valley Municipality	2.3	Orange River	0.9	2.5	
N40E	Nooitgedacht	NMMM	70	Orange River	207	567	
N23B	Darlington Dam	Blue Crane Municipality					
N24C	Jansenville	Ikwezi Municipality					
Albany Coast							
P10B.	Alicedale	Makana Municipality	1.2	Nuwejaars Dam	3.3	9	
P10G.	Bushmans River Desalination Plant	Albany Coast Water Board	0.4	Bushmans River Mouth wellfield			
P40A	Grahamstown	Makana Municipality	11	Orange River Glen Melville, Settlers, Milner, Howiespoort, Jameson dams	0.8 ~ ~ 2.2 ~	8	
P20A	Kenton-on-Sea	Ndlambe Municipality					
P40C	Port Alfred	Ndlambe Municipality	6	Mansfield and Sarel Hayward dams Coastal Dunes	1.6 1.73	4.7	

PIPELINES

Description	Approximate Length (km)	Capacity (Ml/d)	Diameter (cm)
Source to supply end: main pipeline to Port Elizabeth			
Scheepersvlakte – Nooitgedacht Water Treatment works		105	
Nooitgedacht WTW -Grassridge reservoir - Motherwell Reservoir		105	
Other pipelines			
Somerset East - Cookhouse			
Somerset East – Q80C			
Sarel Hayward Dam – Port Alfred			
Coastal Wellfields - Alexandria			
Settlers Dam - Grahamstown			
Glen Boyd Dam – Peddie (regional water supply)			

CANALS

Quaternaries	Description
Fish	
Q12B, Q12A	Canal from Orange/Fish Tunnel to Teebus Spruit
Q50B, Q50C	Fish- Sundays Canal from Elandsdrift Weir to Cookhouse Tunnel
Q70B, Q80E	Fish-Sundays Canal Cookhouse Tunnel to Little Fish
Q80G, N23A.	De Mistkraal Weir (Little Fish) to Schoenmakers canal – Schoenmakers River
Q93B, Q93B	Ecca Canal from Glen Melville Dam to Glen Boyd Dam
Sundays	
N40B, N40C, N40D	Hesses Corner Canal from Korhaansdrift Weir to Scheepersvlakte Balancing Dam

TUNNELS

Quaternaries	Description
Fish	
D35H, D35G, D35D, Q12B.	Orange Fish River Tunnel from Gariep Dam to Teebus River Canal
Q50C, Q70B.	Cookhouse Tunnel from Fish-Sundays Canal to Fish-Sundays Canal
Q91C, Q93B	Fish-Ecca Tunnel from Hermanuskraal Weir to Glen Melville Dam
	Heatleys Krantz tunnels – Lower Sundays River Canals

TRANSFER SCHEMES

From	To	Component
D35H	Q12B	Orange Fish-Tunnel, Length: 82.9 km, Original capacity was 54 m^3/s and has since decreased by about 10%. Testing has shown that the transfer capacity improves when very large volumes are transferred.
Q12	Q12A	Canal from Orange-Fish Tunnel to Teebus Spruit
Q50B	Q50C	Fish-Sundays Canal (section 1) from Elandsdrift Weir to Cookhouse Tunnel, 158 Mm^3/a
Q50C	Q70B	Cookhouse Tunnel from Fish-Sundays Canal (section 1) to Fish-Sundays Canal (section 2), 158 Mm^3/a
Q70B	Q80E	Fish-Sundays Canal (section 2) Cookhouse Tunnel to Little Fish, 158 Mm^3/a
Q80G	N23A	Fish-Sundays Canal (section 3) from De Mistkraal Weir to Schoenmakers River, Length 26.5 km Capacity: 22.1 m^3/s, 117 Mm^3/a
N40A	N40D	Hesses Corner Canal from Korhaansdrift Weir to Scheepersvlakte Balancing Dam, Capacity: 16.5 m^3/s. Supply from Orange/Sundays River to Port Elizabeth 11 Mm^3/a
Q91C	Q93B	Fish-Ecca Tunnel From Hermanuskraal Weir Glen Melville Dam, Length: 5km, Capacity: 16.6 m^3/s or 6 Mm^3/a
Q93B	Q93B	Ecca Canal from Glen Melville Dam to Glen Boyd Dam, Length: 11.5 km, Capacity: 1.7 m^3/s

HYDROPOWER

600 kVA Francis Turbine driven alternator driven by water discharged by Orange-Fish tunnel outlet at Teebus (unused).

URBAN BOREHOLE SUPPLY

Quatenary	Town supplied
Fish	
Q13A	Hofmeyr
Q14B	Middelburg (adequate to 2010)
Q12B	Steynsburg
Q41C	Tarkastad
Q80D	Somerset East
Sundays	
N14B	Aberdeen
N13C	Graaff-Reinet
N24C	Jansenville
N12A	Nieu Bethesda
N40D	Paterson
N30A	Pearston
Albany Coast	
P10B	Riebeeck East
P10E	Paterson
P10G	Bushmans River Mouth Kenton-on-Sea (Yield 1.1 Mm^3/a)
P20A	Alexandria
P20A	Cannon Rocks, Boknes
P20A	Kenton-on-Sea
P40C	Port Alfred