CHAPTER 3 – WATER RESOURCES PERSPECTIVE OF THE ISP AREA

This chapter presents a perspective of the water availability in the ISP area, water requirements of the various water use sectors and the yield balance and reconciliation options. Supplies and demands in the ISP area are currently practically in balance. Only enough water is transferred from the Orange River into the Fish River to meet the requirements for abstraction and to provide freshening flows.

Surplus flows observed or recorded in the lower Fish and Sundays Rivers are as a result of freshening releases, unused releases for irrigation use, or return flows downstream of the last point of abstraction. Salinity may be too high in these river stretches for direct beneficial use without further blending or treatment. This water is therefore not readily available for use, but for a large part of the year provides flows that are beneficial for the functioning of the estuary.

As will become clear in this Chapter, only limited additional amounts (over and above current transfer volumes) of Orange River water will in future be transferred to this ISP area via the Orange-Fish-Sundays Water Supply System. Water for future allocation and transfers has only been reserved for the establishment of 4 000 ha of resource-poor farmer irrigation schemes in the Fish and Sundays catchments and for full use of its allocation by the NMMM. Further transfer to meet the growing urban demand in the Port Elizabeth/Uitenhage/Despatch urban areas, now unified under the Nelson Mandela Metropolitan Municipality (NMMM), and the Coega Industrial Development Zone, which is currently under development, is however a possibility.

Although only three sub-areas have been demarcated for this ISP area, twelve hydrological sub-divisions (river stretches, rivers or grouped rivers) have been identified for hydrological calculations, so as to present a more detailed picture of the water balance in the ISP area. These hydrological sub-divisions are shown in **Table 3.1** and are graphically depicted in **Figure 3.1**.

3.1 WATER RESOURCES AVAILABILITY

The transfer of Orange River water dominates the availability of water. Local catchment yields (Fish and Sundays) are relatively small and highly variable. Information on water resources availability has been drawn from the NWRS, and approximately the same format of presentation has been followed.

3.1.1 Surface water availability

The water resources are not evenly distributed across the catchment, with natural runoff greater towards the coast and in a small area along the western boundary, where higher rainfalls occur. The natural mean annual runoff (MAR) of 972 million m^3/a has been reduced by changes in land use, soil conservation measures, abstractions and other consumptive uses,

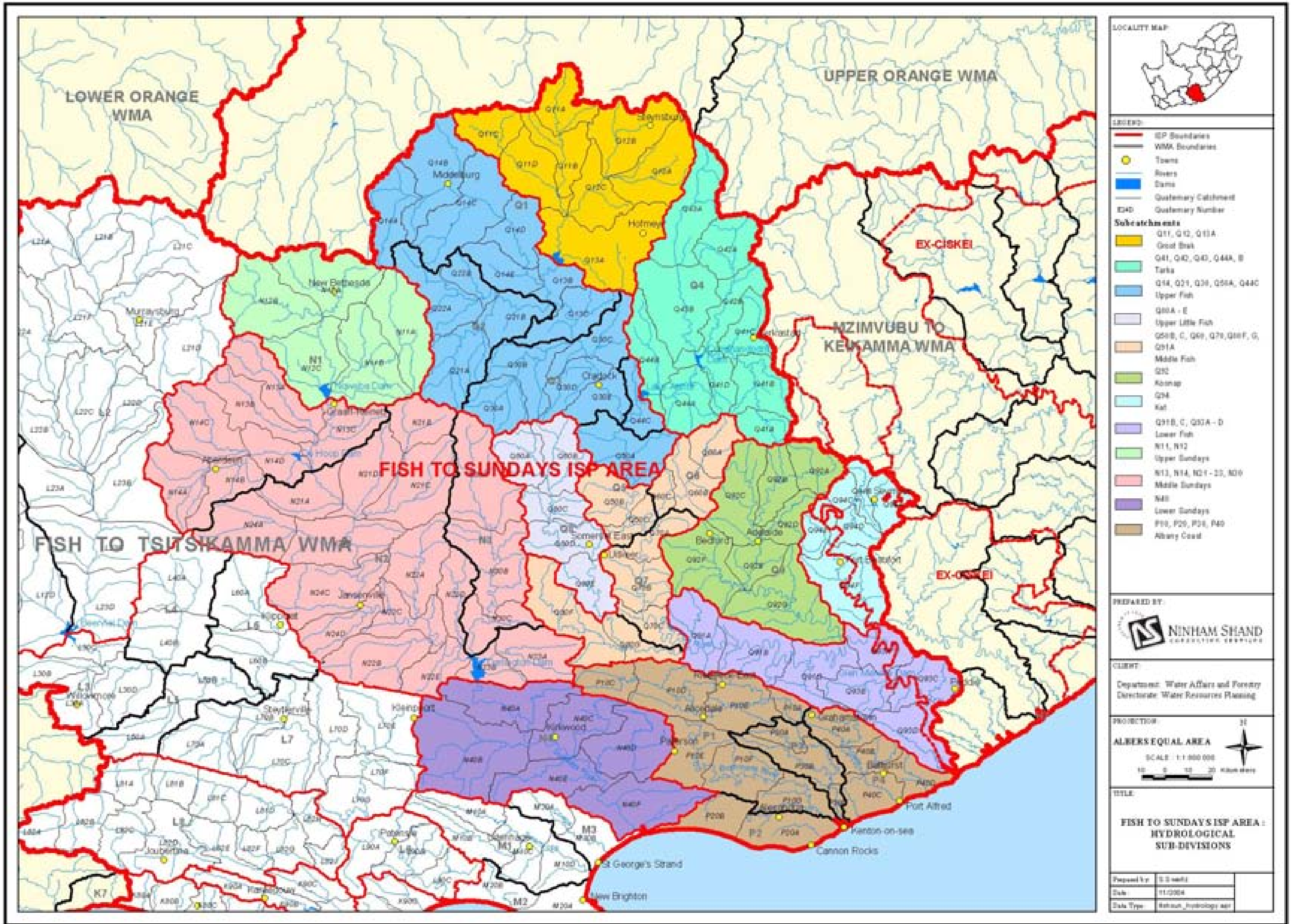

Figure 3.1 Hydrological sub-divisions of the ISP area

but has been substantially augmented through transfers from the Orange River for irrigation, urban use and freshening releases. There are no natural lakes or large wetlands in the ISP area, although there are many small wetlands. There is uncertainty about the estimates of the Reserve and how these may change in future. The Great Fish estuary is ranked among the top fifteen estuaries in South Africa in terms of conservation importance [19].

Table 3.1: ISP sub-areas and hydrological sub-divisions

ISP Sub-area	Hydrological sub-division / River	Reason for selection	Secondary catchment	Tertiary / quaternary catchment
Fish	Groot Brak	Catchment of Grassridge Dam	Q1 (part)	Q11, Q12, Q13A
	Tarka	Catchment of Lake Arthur	Q4	Q41, Q42 Q43 Q44A, B
	Upper Fish	Incremental catchment of Elandsdrift Weir	Q1 (part) Q2 to 4 Q5 (part)	Q13B, C Q14, Q21 Q22, Q30 Q50A Q44C
	Upper Little Fish	Catchment of De Mistkraal Weir	Q8 (part)	Q80A to E
	Middle Fish	Part of Fish River Irrigation Scheme area	Q5 - Q9 (part)	Q50B, C, Q60, Q70 Q80F, G
	Koonap	Koonap River Catchment	Q9 (part)	Q92
	Kat	Kat River Catchment	Q9 (part)	Q94
	Lower Fish	Main stem of lower Fish River	Q9 (part)	Q91 A, B, C Q93A to D
Albany Coast	Bushmans	Catchment of Bushmans River	P1, P2	P10, P20
	Kowie/Kariega	Catchments of Kowie and Kariega Rivers	P3, P4	P30, P40
Sundays	Upper Sundays	Catchment of Nqweba Dam	N1 (part)	N11, N12
	Middle Sundays	Incremental catchment of Darlington Dam	N1 (part), N2, N3	N13, N14 N21 - 23 N30
	Lower Sundays	Lower Sundays Irrigation Scheme area	N4	N40

More detail on the estimation of the Reserve is discussed in **Addendum 3 of the NWRS First Edition, 2004**. Only estimates of the Reserve for the ecological water requirements of the rivers were available. Estimates of the requirements of the estuaries still need to be made and incorporated into the figures.

A summary of the natural runoff, together with the estimated ecological flow requirements (EFR), is given in **Table 3.2**. An *incremental value* refers to the flow in the main stem river at the outlet of an individual hydrological sub-division, relating only to that area, while a cumulative value (MAR or EFR) indicates the cumulative flow in the main stem of a river at the outlet of the hydrological sub-division, and includes the flows originating from upstream river reaches and tributary rivers.

Table 3.2: Natural MAR and estimated EFR (million m³/a)

Hydrological sub-division	Natural MAR	Incremental natural MAR (1)	EFR	Incremental EFR (1)
Groot Brak	60.5	60.5	4.5	4.5
Tarka	65.9	65.9	4.6	4.6
Upper Fish	215.6 (2)	89.2	15.5 (2)	6.4
Upper Little Fish	38.8	38.8	4.2	4.2
Middle Fish	310.0 (2)	55.6	23.2 (2)	3.5
Koonap	76.4	76.4	9.6	9.6
Kat	70.0	70.0	7.1	7.1
Lower Fish	518.5 (2)	62.1	46.8 (2)	6.9
Fish Total	**518.5**	**518.5**	**46.8**	**46.8**
Bushmans, Kowie/Kariega	173.6	173.6	15.3	15.3
Albany Coast Total	**173.6**	**173.6**	**15.3**	**15.3**
Upper Sundays	43.7	43.7	3.0	3.0
Middle Sundays	217.6 (2)	173.9	13.1 (2)	10.1
Lower Sundays	279.9 (2)	62.3	19.8 (2)	6.7
Sundays Total	**279.9**	**279.9**	**19.8**	**19.8**
Total for ISP area	**972**	**972**	**81.9**	**81.9**

1) Quantities given are incremental, and refer to the sub-area under consideration only. This is the total volume, based on preliminary estimates. Impact on yield will be a portion of this.
2) The value indicates the cumulative flow in the main stem of the river, at the outlet of the hydrological sub-division, and includes the flows from upstream river reaches and of rivers flowing into the hydrological sub-division's main stem river.

The **available yield** is the amount of water that can be expected to be "available" for commercial use (for 98% of the time in this case), either from dams, directly from rivers, or from groundwater - during any one year. The available yield in the ISP area is a combination of the yields obtainable from local catchments through existing infrastructure supplying surface water, groundwater and usable return flows, as well as transfers into the ISP area.

Figure 3.2: Sundays River Estuary

Figure 3.3: Great Fish River Estuary

Table 3.3 shows the calculation for the determination of the surface water yields for the various hydrological sub-divisions, the sub-area totals and the ISP area totals. It is important to note that under 1:50 year drought conditions, the Grassridge and Darlington dams operate purely as balancing dams for transferred water, and their yields are negligible. In the case of Darlington Dam, this is because the dam is not operated anywhere near its full capacity, because of problems with the gates [27]. The yield of the dam when operated to its full capacity was determined to be 28 million m³/a.

Owing to the aridity of the area, the estimated impacts of the ecological flows on the available surface water yields are very small. Invasive alien plants have an even lesser impact. Concern have been expressed that the yields from minor dams and run-of-river abstraction seem too high, but the values from the NWRS, determined through modelling, have been retained because information at an improved confidence is not available.

Table 3.3: Surface water yield in the year 2000 (million m³/a) at 1:50 year assurance

Hydrological sub-division	Yields from major dams (a)	Yields from minor dams & run-of-river (b)	Surface water yield before reductions (c = a+b)	Reduction in yield: Reserve (d)	Reduction in yield: Alien plants (e)	Surface water yield (c-d-e)
Groot Brak	0.0 [1]	2.0	**2.0**	0.0	0.0	2.0
Tarka	7.0	2.0	**9.0**	1.3	0.0	7.7
Upper Fish	0.0	2.0	**2.0**	0.0	0.0	2.0
Upper Little Fish	0.0	20.0	**20.0**	0.0	0.0	20.0
Middle Fish	0.0	5.7	**5.7**	0.0	0.0	5.7
Koonap	0.0	20.0	**20.0**	0.0	0.0	20.0
Kat	12.7	10.3	**23.0**	1.3	1.2	20.5
Lower Fish	0.0	13.0	**13.0**	0.0	0.0	13.0
Fish Total	**19.7**	**75.0**	**94.7**	**2.6**	**1.2**	**90.9**
Bushmans, Kowie/Kariega	6.8	10.3	17.1	0.0	2.3	14.8
Albany Coast Total	**6.8**	**10.3**	**17.1**	**0.0**	**2.3**	**14.8**
Upper Sundays	4.5	10.0	**14.5**	1.1	0.0	13.4
Middle Sundays	0 [1]	27.7	**27.7**	0.0	0.3	27.4
Lower Sundays	0.0	14.0	**14.0**	0.0	0.0	14.0
Sundays Total	**4.5**	**51.7**	**56.2**	**1.1**	**0.3**	**54.8**
Total for ISP area	**31.0**	**137.0**	**168.0**	**3.7**	**3.8**	**160.5**

1) At 1:50 year assurance, the yields of both Grassridge and Darlington dams are negligible, and these dams act only as balancing dams.

The reduction in yield due to the Reserve was set to zero for both the Groot Brak and Lower Sundays hydrological sub-divisions, whereas in the NWRS the reduction in yield due to the Reserve for the Groot Brak was 1.2 million m^3/a and for the Lower Sundays 3.7 million m^3/a. These changes were made because the yields from large dams in these hydrological sub-divisions for the 1:50 year situation are negligible. The reduction in yield due to the Reserve would therefore also be negligible in such circumstances.

3.1.2 Water availability

Table 3.4 shows the yields per ISP sub-area and per hydrological sub-divisions. Return flows resulting from irrigation with Orange River water is strictly speaking not part of the local yield, but has been included here, in a similar fashion as in the NWRS. Values under the "*Transfer in*" column refer to impacts that transferred flows have on the yields of the receiving catchments under 1:50 year drought conditions, determined through modelling.

Table 3.4: Available yield in the year 2000 (million m^3/a) at 1:50 year assurance

Hydrological sub-division	Natural resource		Usable return flow			Total local yield (1)	Transfers in (2)	River losses (3)	Grand Total (1)+(2)+(3)
	Surface water	Ground-water	Irriga-tion	Urban	Mining and bulk				
Groot Brak	2	0	0	0	0	2	575	-6	**571**
Tarka	8	2	0	0	0	10	0	0	**10**
Upper Fish	2	2	39	3	0	46	512	-20	**538**
Upper Little Fish	20	1	11	0	0	32	163	0	**195**
Middle Fish	6	1	25	0	0	32	220	-33	**219**
Koonap	20	0	1	1	0	22	0	0	**22**
Kat	20	0	1	1	0	22	0	0	**22**
Lower Fish	13	0	0	0	0	13	110	-35	**88**
Fish Total	**91**	**6**	**77**	**5**	**0**	**179**	**575**	**-94**	**660**
Bushmans, Kowie/Kariega	15	2	0	4	0	21	1	0	**22**
Albany Coast Total	**15**	**2**	**0**	**4**	**0**	**21**	**1**	**0**	**22**
Upper Sundays	13	1	0	0	0	14	0	0	**14**
Middle Sundays	27	13	12	1	0	53	128	0	**181**
Lower Sundays	14	2	10	1	0	27	115	-18	**124**
Sundays Total	**54**	**16**	**22**	**2**	**0**	**94**	**123**	**-18**	**199**
Total for ISP area	**160**	**24**	**99**	**11**	**0**	**294**	**575**	**-112**	**757**

1) After allowance for the impacts on the yield of the ecological component of the Reserve, river losses, invasive alien plants, dry land agriculture and urban runoff.
2) Transfers into and out of hydrological sub-divisions or sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers therefore does not necessarily correspond to the total transfers into and out of the WMA.
3) River losses as calculated for the Orange River Replanning Study (ORRS) and used in the NWRS.

Transferred water from the Orange River accounts for the majority of all available yield in the ISP area. Significant river losses (as calculated in the ORRS study) due to the large volumes of transferred water have also been taken into account in the calculations of total available yields. The total year 2000 *available surface water yield* from the ISP area at a 1:50 year assurance is 160 million m^3/a. Groundwater yield, which reflects the year 2000 use, is 24 million m^3/a.

Return flows along those parts of the Fish and Sundays Rivers that receive water transferred from the Orange River are high because the substantial seepage losses from distribution canals, as well as the seepage from irrigated lands, which contribute to the totals. Elsewhere they are low to negligible because much of the irrigation occurs in areas in which there is little or no flowing surface water during the summer months. Irrigation return flow of 99 million m^3/a has been included as part of the local area yield, although it must be borne in mind that such return flows only exist because of irrigation with Orange River water.

There is some uncertainty about the 4.5 million m^3/a 1:50 year yield of Nqweba Dam on the Upper Sundays River (which supplies Graaff-Reinet) as previously determined. This must be verified.

The *major* differences between the available yields as determined in the ISP and the NWRS yields are the following:

- Available yield in the ISP area was determined as 757 million m^3/a compared to 786 million m^3/a in the NWRS;
- Sub-area available yields (according to the NWRS sub-areas) were determined as:
    - 660 million m^3/a in the Fish sub-area which is virtually the same as the 659 million m^3/a of the NWRS;
    - 22 million m^3/a in the Albany Coast sub-area which is the same as the 22 million m^3/a of the NWRS;
    - 199 million m^3/a in the Sundays sub-area compared to the 217 million m^3/a of the NWRS;
- The yields of Grassridge and Darlington dams, which is reflected in the surface water yields, have been adjusted, because under 1:50 year drought conditions, these dams operate purely as balancing dams for transferred water, and their yields become negligible. The reduction in yield due to the Reserve, for the hydrological sub-divisions in which these dams fall, were consequently also adjusted;
- The impact on yield of the transfer from the Fish to the Sundays sub-area was increased from 116 million m^3/a in the NWRS to 123 million m^3/a, to reflect a situation where just enough water is transferred to ensure a balanced situation.

3.1.3 Groundwater

Refer to **Appendix 2,** *Groundwater overview* for a more detailed groundwater resources perspective.

Groundwater use is shown by catchment in **Table 3.4,** and by sector in **Table 3.5**. These are the values given in the NWRS and this use is considered to be equivalent to the current available yield from groundwater sources. Groundwater is often the only source of water for rural domestic use and stock watering, whilst several towns also obtain a large proportion or all of their water from underground sources. Groundwater is also used for urban supply by coastal towns, but cannot always support growing demands and peak seasonal uses.

Actual groundwater use, especially for irrigation, is likely to be significantly higher than has been reflected in the NWRS and these numbers require verification. In general over the ISP area the potential for groundwater use is under-developed.

Table 3.5: Groundwater use in the ISP area

Use	Annual volume (million m^3/yr)	% of total use
Irrigation	17	70
Agricultural /livestock	4	17
Rural domestic	0 (1)	0 (1)
Municipal (bulk water)	3	13
Industrial /mining	0	0
Total	**24** (1)	**100**

1) The zero usage of groundwater for rural supply is questionable. It is possible that this sector has been included under municipal use, but this is not clear – also see **Appendix 2**.

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 areas of the Great Fish sub-area, and moderately to heavily utilised in the middle parts of the Sundays sub-area. This too requires verification.

The under-developed groundwater potential in the 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.

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 resources could in fact be stressed and *vice versa*.

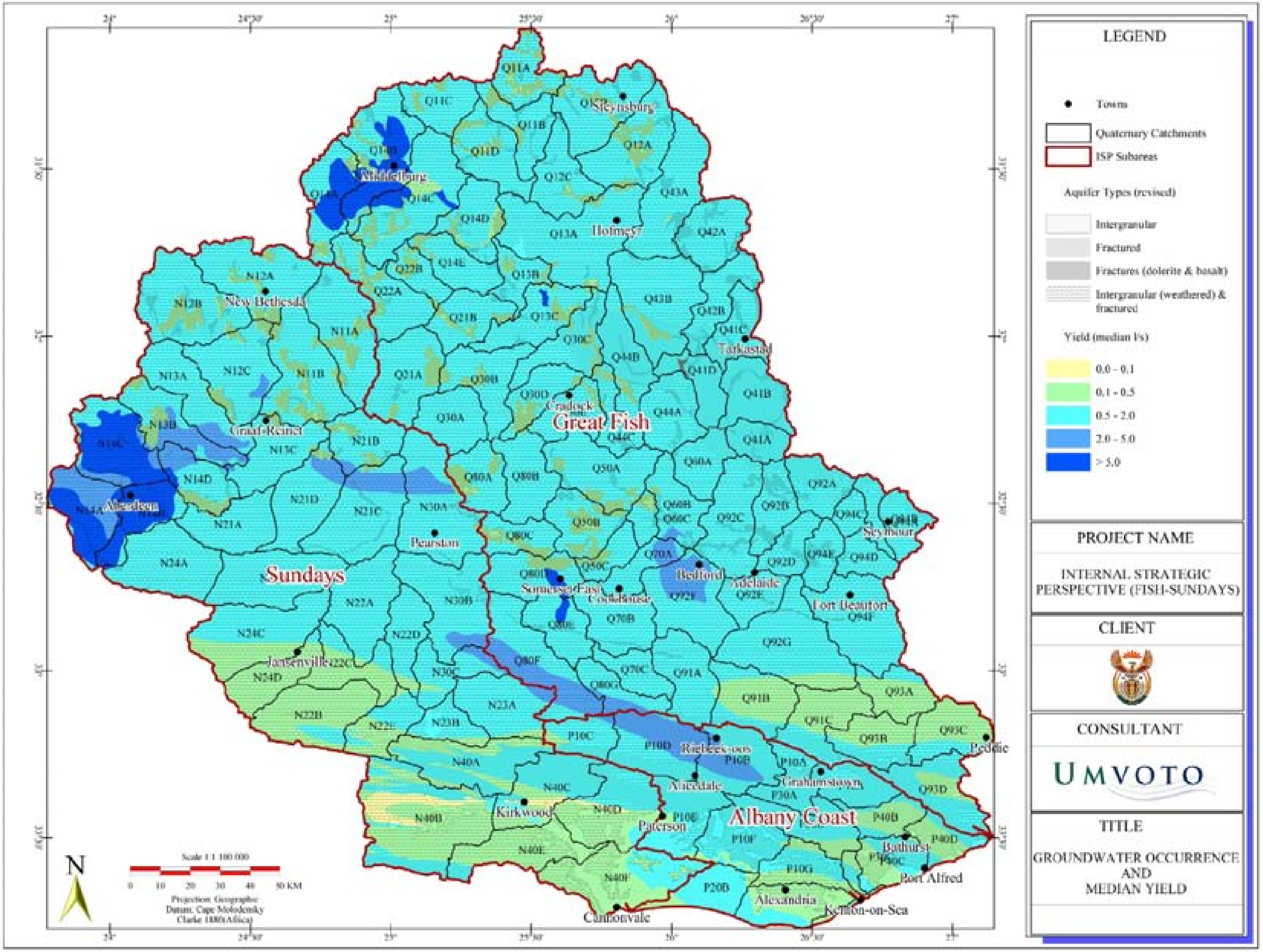

Figure 3.4: Groundwater occurrence and median yield

There are four main aquifer systems in this ISP area (see **Figure 1** in **Appendix 2**). These are:

- the Katberg Sandstones - a fractured rock aquifer;
- the Witteberg Quartzites - a fractured rock aquifer;
- the Intergranular Coastal Aquifers - primary aquifers of marine, fluvial and Aeolian origin; and
- the Dolerite Dyke system - a fractured rock aquifer. This can be considered as a strategic resource since it delivers reliable yields and acceptable water quality in the sub-areas, which are otherwise dominated by regolith aquifers of very poor water quality and yield.

The Katberg and Witteberg aquifers are relatively unexploited and yield good quality groundwater, being fractured sandstone aquifers. Borehole yields from these aquifers are expected to be in the moderate to good range (5 – 20 l/s) and, being in the highest rainfall areas and receiving good recharge. These aquifers would be best exploited if they were explored and developed on a regional scale and if production boreholes were drilled to depths of no less than 300 m.

The coastal aquifers are currently exploited for use in coastal towns but are not necessarily well managed. The groundwater quality varies from good to very poor, depending upon the position and recharge patterns. Boreholes are generally shallow (less than 100 m) or the groundwater is extracted using well points.

The dolerite dyke and sill system extends throughout the Fish and Sundays sub-areas. Small and large Karoo towns use groundwater from this aquifer system. Understanding of the aquifer is improving and significantly increased yields have been realised with improved siting techniques. Monitoring on a regional and a wellfield scale is required to upgrade the management of the wellfields and to improve assurance of supply. The aquifer system could strategically be further developed if location boreholes depths vary between 100 to 300 m.

a. Aquifer recharge and borehole yields

The shallow "regolith" (intergranular/weathered-and-fractured) Karoo Aquifer centred on the towns of Aberdeen, Middelburg and Somerset East (**Figure 4** in **Appendix 2**) provides the highest median borehole yields (>5 l/s) within the Fish-Sundays ISP area. Intermediate to high median yields (2 to 5 l/s) are obtained from the same aquifer within a discontinuous axis stretching from Aberdeen/ Graaff-Reinet in the west through to Bedford in the east. This axis coincides with the transition from the Ciskeian Coastal Foreland to the Middleveld/Eastern Karoo Escarpment and marks the southern limit of the extensive dolerite sheets.

Rates of recharge to groundwater are also somewhat higher along this axis (**Figure 4 in Appendix 2**), but in contrast the area of highest recharge around Seymour produces only low to moderate (0.5 to 2 l/s) median borehole yields from the same aquifer type. Further south, intermediate to high yields are obtained within an elongated WNW-ESE trending zone with its eastward termination in the area between Alicedale, Riebeeck East and Grahamstown. This linear belt of relatively high median yields shows no apparent correlation with aquifer type (fractured Witteberg vs. Intergranular/weathered-and-fractured Adelaide Sub-group) or documented recharge-to-groundwater rate, but appears to coincide closely with an orographically induced zone of higher (400 to 800 mm) mean annual rainfall.

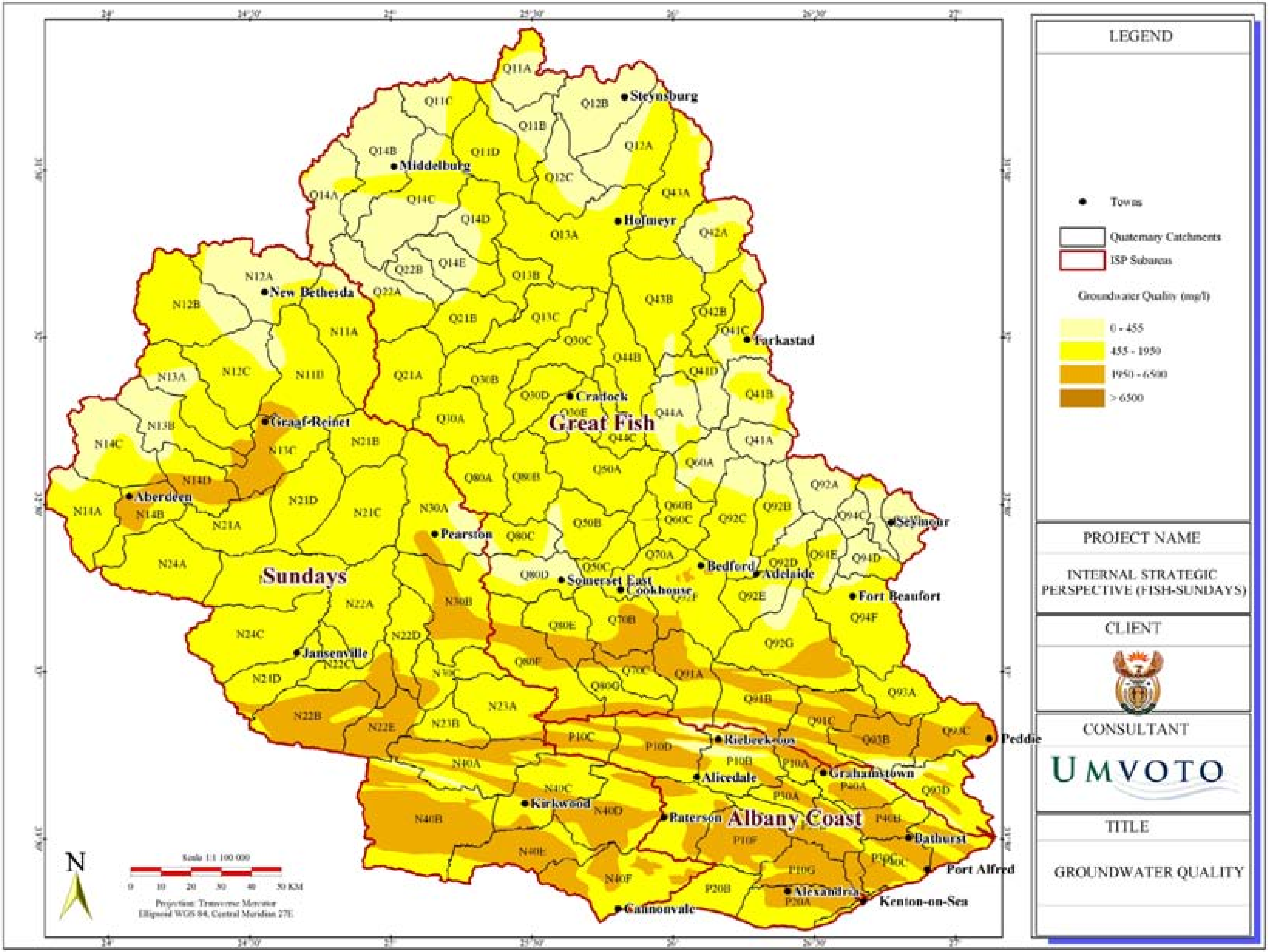

Figure 3.5: Groundwater quality

Low to moderate (0.5 to 2 l/s) median borehole yields are characteristic of the WMA as a whole, with low median yields (0.1 to 0.5 l/s) being obtained in the low lying, middle and lower Sundays (secondary catchments N2 and N4), Lower Fish and Kariega-Kowie/Kariega catchments. In general, the median yield in the southern half of the WMA may be broadly correlated with orographically induced rainfall patterns and to a lesser degree with the aquifer type, with the fractured Peninsula and Witteberg Aquifers and primary Algoa Aquifer showing the highest groundwater potential in the coastal belt.
Rain-shadow areas on the northern side of the Groot Winterhoek Mountains, Klein Winterhoek Mountains and Grootrivier mountains are characterised by mean annual rainfall of 100 to 300 mm and typically have low median borehole yields (0.1 to 0.5 l/s).

b. Vulnerability to pollution

Mapping of aquifer vulnerability (**Figure 6** in **Appendix 2**) indicates that most of the aquifers are in the "least vulnerable" category. There are small areas in the east-central, southern, and north-western parts that are mapped as moderately vulnerable. These areas cannot be correlated with either geology or the nature of the aquifer. The primary and fractured rock aquifers (purple and green areas, respectively, on **Figure 2.5**) may perhaps be considered as more vulnerable units, while the shallow regolith aquifers are in general only moderately vulnerable.

3.1.4 Water quality

The relatively flat topography, low MAR, high evaporation and underlying mudstones generally give rise to saline groundwater and resulting saline base flows in the Fish and Sundays rivers, irrespective of water transferred in from the Orange or irrigation return flows. It is not known what natural water quality without development would be, but it is likely that natural surface water would often be unusable if not diluted with transferred water. The ‘natural quality’ in an undisturbed system would be an important quantity in assessing quality requirements from a Reserve perspective

a. Groundwater quality

Groundwater quality, shown in **Figure 3.5**, is controlled by the aquifer lithology and geochemistry. In the Albany Coastal Range groundwater of poor quality (TDS > 2 000 mg/l) is associated with outcrops of the Bokkeveld Group and the Dwyka-basal Ecca formations. Areas of low slope (see **Figure 2.2**) in the Ecca and lower Beaufort (Adelaide Sub-group) between the coastal ranges and the Middle Veld escarpment also show a higher electrical conductivity, probably reflecting higher residence times of groundwater under conditions of low hydraulic gradient and low transmissivity of the shallow regolith aquifer.

In the south, the best quality groundwater (TDS < 500 mg/l) is associated with the limited areas of the Witpoort aquifer in the Albany Coastal Range. In the north, good quality groundwater is generally associated with the Katberg sandstone aquifer in the Winterberg Range between Seymour and Cradock, and along the Great Fish and Sundays headwater divides near Nieu Bethesda, Middelburg and Steynsburg.

b. Surface water quality

Water quality in the upper reaches of the Fish River is generally good at 50-100 mg/l [17]. TDS where the Orange River water enters the system. The quality however decreases in a downstream direction, and in the middle reaches of the Fish it is marginal to poor. Sources of salinity in the middle and lower reaches are the geology of the river valley as well as irrigation return flows. Above Elandsdrift Weir water quality is generally of an acceptable standard. Below Elandsdrift Weir the water quality deteriorates downstream and is often not usable, but not much is needed. At Middleton/Sheldon on the Fish River water quality is approximately 800 mg/l and at Committees Drift in the lower Fish River the quality is approximately 2 000 to 3 000 mg/l. Water quality in the lower Fish River can at times be in excess of 6 000 mg/l [25].

Sources of salinity in the middle and lower reaches are the geology of the river valley as well as irrigation return flows. Water quality in the Fish River is controlled to the point where the Middleton WUA abstracts, approximately at the confluence with the Little Fish River. Riparian irrigation below that point are not scheduled to receive Orange River water and no water will be let down for freshening purposes.

The lower Fish River operates as a drain for discharging highly saline irrigation return flows and catchment runoff to the sea. Salinity impacts due to irrigation return flows are the main concern in these catchments. There is however a commitment to supply relatively good quality water to the Lower Fish River Scheme at points of use, i.e. at less than 650 mg/l TDS. Releases to the lower Fish River is therefore made with the aim of achieving a water quality of between 300 to 400 mg/l at Hermanuskraal Weir, where water is diverted to Glenn Mellville Dam, for eventual use by Grahamstown and all scheduled irrigation along the Lower Fish River (Lower Fish River GWS irrigators). Releases of slugs of good quality water is discharged from Elandsdrift Weir and/or De Mistkraal Weir, in the Little Fish River, two or three times a year to fill the Glen Melville Dam. Releases of slugs of such good quality water show "slug flow" behaviour with intermittent periods of good quality (transfer water) and poor quality (natural base flows).

Water quality in the Sundays River is poor in the upper reaches. Darlington Dam has somewhat better water quality because of the introduction of Orange River water. Quality deteriorates to very poor again in the lower reaches of the Sundays River, primarily as a result of irrigation return flows, where the river acts as a collector drain for such flows.

When the Gariep and Van der Kloof dams spill, significant additional volumes can be transferred to the Fish/Sundays rivers to freshen the system.

A gradual increase in salinity in the Fish/Sundays Rivers over the medium term has been observed. **Figure 3.6**, as measured in 1999, and possibly still valid, provides a picture of how water quality decreases as it flows or is transferred through the Orange-Fish-Sundays Water Supply System. The lower Fish River would show a similar (even more pronounced) worsening of quality.

In the Scheepersvlakte Dam from which Port Elizabeth draws some of its raw water, problems have been experienced with corrosion of pumping equipment, taste and odours in treated water and trihalomethane compounds which have formed during the treatment process. Some of the problems are related to elevated levels of dissolved oxygen content [18].

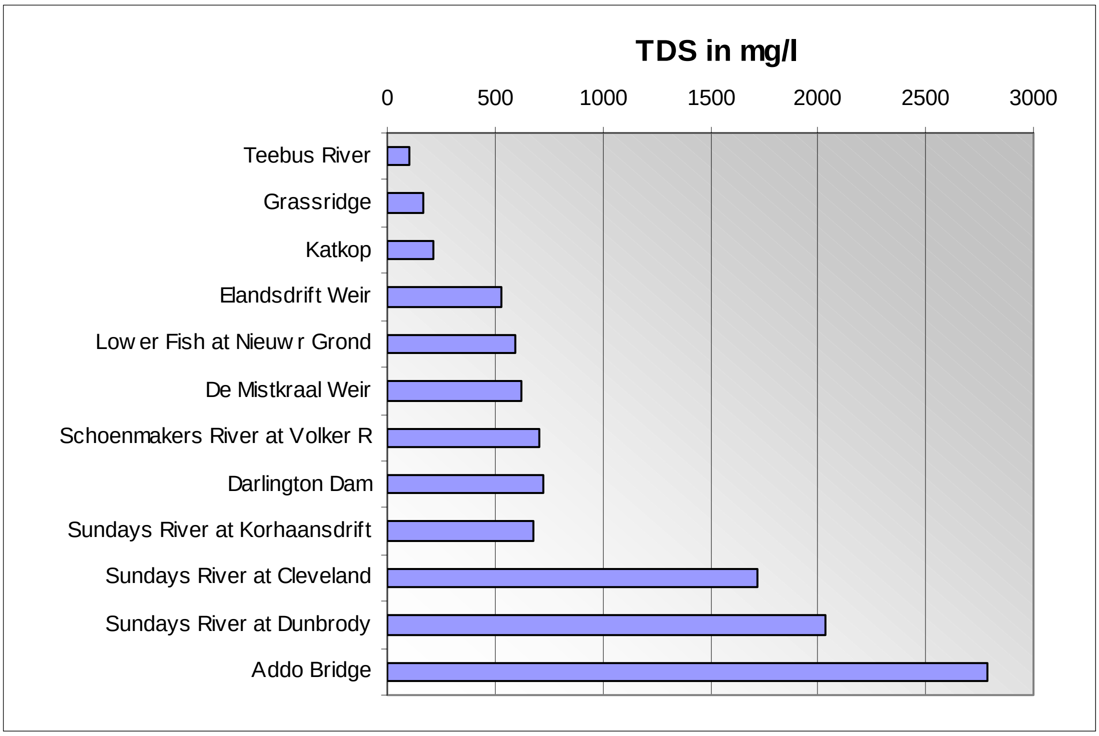

Figure 3.6: Median TDS values of transferred Orange/Fish water (from Herold 1999)

High salinity is the main concern in the Bushmans, Kariega and Kowie River catchments. The Bushmans River water quality is mostly unacceptable. Water quality in the Kowie River is poor and in the Kariega River the water quality is completely unacceptable. The geology of the Bushmans, Kariega and Kowie River catchments results in highly saline base flow which explains the poor water quality in the area.

3.2 WATER TRANSFERS

Table 3.6 and **Figure 3.7** show the various transfers taking place. Large volumes are annually transferred into the ISP area, mainly for irrigation use but also for some use by small towns and further transfer on to the NMMM. Large volumes of freshening flows are also currently transferred in (apparently up to 200 million m^3/a in some years). These transfers also allow for river losses and canal transportation losses. The total impact of transferred Orange River water from the Upper Orange WMA into the Fish to Sundays ISP area on the yield of the ISP area is 575 million m^3/a, of which freshening flows contribute 32 million m^3/a, by making poor quality water usable. A total of 11 million m^3/a of this is transferred further to the Tsitsikamma to Coega ISP area for use in the NMMM. See the Upper Orange ISP [31], Report P WMA 13/000/00/0304 for the corresponding description of transfers to this ISP area. Significant volumes flow to the sea through the estuaries of the Great Fish and Sundays Rivers.

Table 3.6: Transfers within the ISP area (million m^3/a) at 1:50 year assurance

Hydrological sub-division	Transfer from upstream	Freshening transfer from upstream	Other transfers in	Total transfer in	Notes on transfer in	Transfer out d'nstream	Freshening transfer out d'nstream	Other transfer out	Total transfer out	Notes on transfers out
Groot Brak	0	32	543	**575**	Transfer in from Upper Orange WMA	478	32	0	**510**	To Upper Fish, including freshening release flows
Tarka	0	0	0	**0**	No transfer in	2	0	0	**2**	To irrigators below Lake Arthur (in Upper Fish)
Upper Fish	478	32	2	**512**	From Groot Brak and Tarka	150	45	163	**358**	Transfer to Upper Little Fish and d/s to Middle Fish, including freshening releases
Upper Little Fish	0	0	163	**163**	From Upper Fish	0	25	123	**148**	Transfer to Middle Sundays and freshening release to Lower Fish
Middle Fish	150	70	0	**220**	From Upper Fish and Upper Little Fish, including freshening releases	40	70	0	**110**	To Lower Fish
Koonap	0	0	0	**0**	No transfer in	0	0	0	**0**	No flows under 1:50 year conditions
Kat	0	0	0	**0**	No transfer in	0	0	0	**0**	No flows under 1:50 year conditions
Lower Fish	40	70	0	**110**	From Middle Fish	0	70	1	**71** [1]	To Albany Coast and flows to sea
Fish Total	0	**32**	**543**	**575**	From Upper Orange WMA	0	**70** [1,2]	**123**	**193** [1]	To Sundays River and flows to sea
Bushmans, Kowie/Kariega	0	0	1	**1**	From Lower Fish	0	0	0	**0**	No transfer out
Albany Coast Total	0	**0**	**1**	**1**	From Lower Fish	0	**0**	**0**	**0**	No transfer out
Upper Sundays	0	0	0	**0**	No transfer in	5	0	0	**5**	To middle Sundays
Middle Sundays	5	0	123	**128**	From Upper Little Fish	115	0	0	**115**	To Lower Sundays
Lower Sundays	115	0	0	**115**	From Middle Sundays	0	7 [3]	11	**18**	To NMMM and flows to sea
Sundays Total	0	**0**	**123**	**123**	From Upper Little Fish	0	**7** [3]	**11**	**18**	To NMMM and flows to sea
Total for ISP area	0	**32**	**543**	**575**	From Upper Orange WMA	0	**77** [1,2]	**11**	**88** [1]	To NMMM and flows to sea

1) Includes freshening flows/ return flows of 70 million m^3/a to sea from the Fish River.

2) Irrigation return flows of 7 million m^3/a to sea from the Sundays River.

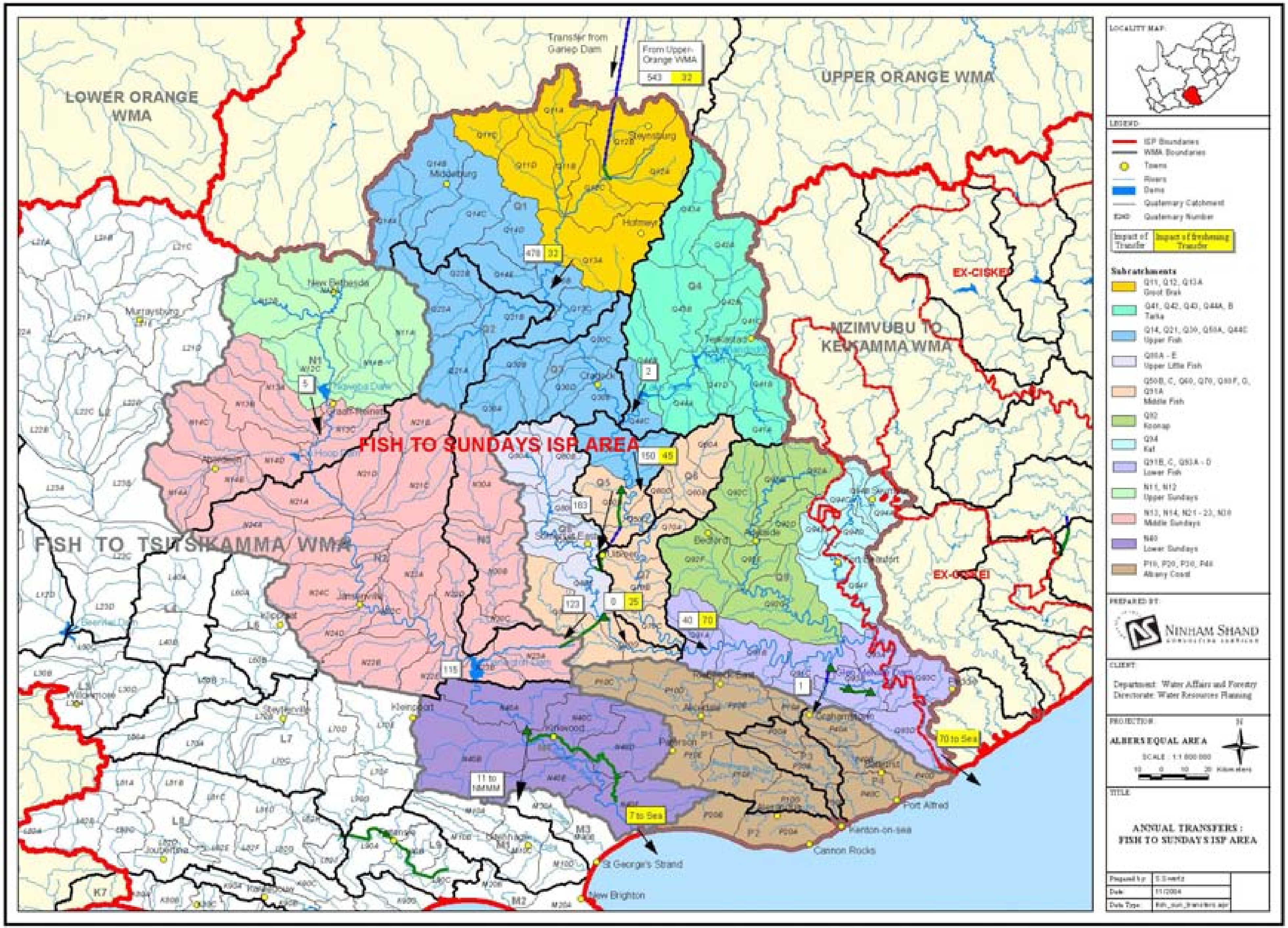

Figure 3.7: Annual transfers

Distinction is made between flows to river reaches of downstream hydrological sub-divisions, transfers to other sub-divisions and freshening releases, which are shown separately as downstream transfers in **Table 3.6**. Freshening flows are specifically released into the Great Fish River, in addition to irrigation requirements, to control the salinity of the water abstracted for irrigation. In addition, freshening releases from Elandsdrift Weir, at the outlet of the Upper Fish sub-division, account for 1:50 year yields of 45 million m^3/a, and 25 million m^3/a from De Mistkraal Weir, at the outlet of the Upper Little Fish sub-division. Part of this water released for freshening originates from return flows.

It has been assumed that areas receiving Orange River water transfer just enough water (including freshening flow requirements) to satisfy the demands, i.e., they are in balance. Transfer amounts from the NWRS were used to determine the water balance, as a starting point. Because of the assumption that all the hydrological sub-divisions are practically in balance, such transfers were then slightly modified, so that areas receiving Orange River water were in balance. The impact on yield (116 million m^3/a) of the transfer from the Fish to the Sundays sub-area in the NWRS was subsequently increased to 123 million m^3/a.

3.3 WATER USE

Figure 3.8: Port Alfred – an important urban user

There can be large differences in the assurance of supply at which various users receive their water. It is therefore necessary to convert actual water allocations to the same assurance of supply, in order to determine a meaningful yield balance at that particular assurance.

There are large uncertainties associated with irrigation water use in this ISP area. Allocations from Government Water Schemes have been partially updated by DWAF Regional Office Staff as part of the preparation of this ISP and the information has been included in **Appendix 10**. Use estimates are however not based on these allocations. Irrigation use outside of the Government Water Schemes is not readily available and will have to be sourced from allocations registered on the WARMS database. These will need verification. Additional water use surveys may also prove necessary. Improved estimates of actual irrigation requirements should also be obtained so that allocations can better be matched to requirements. Record keeping is poor in terms of releases, freshening releases, and actual use, and requires urgent attention. The *Reliability of the Yield Balance Strategy*, Strategy 5.1, provides a more detailed evaluation of the uncertainties associated with water use in the ISP area.

Information on water use has been drawn from the NWRS, and approximately the same format of presentation has been followed. Available updated information has been included and obvious errors have been corrected. The assurance level chosen for comparison purposes is 1:50 year failure or 98% assurance of supply. Water requirements, as shown in **Table 3.7**, are standardised at a 98% assurance of supply.

The differences between the water requirements as determined in the ISP and the NWRS water requirements are the following:

- The irrigation requirement in the Fish sub-area was corrected to 447 million m^3/a, compared to 453 million m^3/a for the NWRS. This as a result of:
  - the Kat River use that was changed to 17 million m^3/a, in line with allocations, compared to 14 million m^3/a;
  - a reduction in the irrigation water requirement from the Commando Drift Dam, which should not include the irrigation below Lake Arthur in the Tarka River catchment (as it does in the NWRS), as this (except for 180 ha) receives transferred Orange River water via the Fish River;
- The transfer into the Tsitsikamma to Coega ISP area from this ISP area, for use by the NMMM, was corrected to 11 million m^3/a, compared to 31 million m^3/a of the NWRS.
- A major difference between the ISP and NWRS is the presentation of flows to sea, which have been included in the ISP as downstream transfers out of the lowest sub-divisions, sub-areas and the ISP area. This was done to be able to show more realistic water balances, as this water is not used because of its very poor water quality. *An assumption is being made that the impact on these most downstream areas is equal to the flow out of the area, which of course is strictly speaking not necessarily so. These values likely do not correctly represent actual flows under 1:50 year drought conditions nor flows in average years, and should not be interpreted as that. For the purpose of this report they will be further reported on as transferred flows, simply to produce an improved yield balance with existing information;*
- These changes then lead to the following differences:
  - Total requirements in the Fish sub-area is 660 million m^3/a compared to 590 million m^3/a of the NWRS;
  - Water requirements in the Sundays sub-area is 200 million m^3/a compared to 213 million m^3/a of the NWRS;
  - Local requirements of the ISP area were determined as 671 million m^3/a compared to 677 million m^3/a for the NWRS;
  - Total requirements in the ISP area, is 759 million m^3/a, which includes transfers out of the area of 88 million m^3/a (most of which is due to freshening releases that flows to the sea), compared to 825 million m^3/a for the NWRS.

Table 3.7 also includes a column to illustrate the average irrigation use, while the 1:50 year irrigation water requirement, which is used to determine the yield balance, shows the requirement during a 1:50 year drought situation. At 94%, irrigation currently constitutes by far the largest user of water in the ISP area. The water is mainly used to grow vegetables, deciduous fruit, citrus, lucerne and maize, and for the irrigation of pastures. There is believed to be significant scope for more efficient use.

Table 3.7: Water requirements for the year 2000 (million m³/a)

Hydrological sub-division	Average	1:50 year assurance								
	Average irrigation use (1)	Irrigation (2)	Urban (3)	Rural (3)	Mining and bulk industrial (4)	Power generation (5)	Affore-station (5)	Total local require-ments	Transfers out	Grand Total
Groot Brak	67	59	1	0	0	0	0	**60**	510	**570**
Tarka	14	12	0	1	0	0	0	**13**	2	**15**
Upper Fish	196	171	7	1	0	0	0	**179**	358	**537**
Upper Little Fish	52	45	1	0	0	0	0	**46**	148	**194**
Middle Fish	125	108	0	1	0	0	0	**109**	110	**219**
Koonap	23	20	1	1	0	0	0	**22**	0	**22**
Kat	17	16	2	1	0	0	2	**21**	0	**21**
Lower Fish	19	16	0	1	0	0	0	**17**	71 (6)	**88**
Fish Total	**513**	**447**	**12**	**6**	**0**	**0**	**2**	**467**	**193 (6)**	**660**
Bushmans, Kowie/Kariega	13	11	9	2	0	0	0	**22**	0	**22**
Albany Coast Total	**13**	**11**	**9**	**2**	**0**	**0**	**0**	**22**	**0**	**22**
Upper Sundays	12	10	0	0	0	0	0	**10**	5	**15**
Middle Sundays	74	60	4	2	0	0	0	**66**	115	**181**
Lower Sundays	130	104	1	1	0	0	0	**106**	18 (6)	**124**
Sundays Total	**217**	**174**	**5**	**3**	**0**	**0**	**0**	**182**	**18 (6)**	**200**
Total for ISP area	**743**	**632**	**26**	**11**	**0**	**0**	**2**	**671**	**88 (6)**	**759**

1) Actual average irrigation use has only been included here to show the comparison with the 1:50 year requirement, and has not been included in the total requirement.
2) Irrigation requirements allows for canal losses.
3) Includes component of Reserve for basic human needs at 25 l/c/d.
4) Mining and bulk industrial water uses, which are not part of urban systems.
5) Quantities given refer to impact on yield only.
6) 70 Million m^3/a water flows to sea from the Fish River and 7 million m^3/a from the Sundays River, while 11 million m^3/a is transferred on from the Sundays sub-area to NMMM.

The urban requirements are spread throughout the area, with few large towns. Groundwater is mainly used to supply small towns and for rural water supply.

Water losses through urban distribution systems and inefficiencies in irrigated agriculture are significant. Sufficient information about irrigation water losses is not generally available.

It is very strongly recommended that more accurate water use values be generated, due to the large uncertainty associated with irrigation water use in this ISP area. Water allocations from government water schemes were checked and updated by DWAF Regional Office staff during this ISP process, and the partially updated information has been included in **Appendix 10**. There is however still significant uncertainty about the water allocations outside GWSs and especially about water use. Refer to the *Reliability of the yield balance Strategy*, Strategy 5.1 for a more detailed evaluation of the uncertainties associated with water use in the ISP area.

Table 3.8 shows a calculation of the maximum Orange River water requirements of the ISP area. This shows a calculated maximum average allocated volume of 773 million m^3/a for transfer from the Orange River. A conversion to 1:50 year use (using the same factor as used in **Table 3.7**) indicates a maximum allocated quantity of 658 million m^3/a. Annual average transfers should therefore not exceed 773 million m^3/a. This transfer volume differs from the value in the Upper Orange ISP, where a 1:50 year annual transfer value of 575 million m^3/a have been used. Flows to sea at 1:50 year assurance are calculated as 70 million m^3/a from the Fish River and 7 million m^3/a from the Sundays River.

Table 3.8: Maximum Orange River requirements for the O-F-S Transfer Scheme (million m³/a)

Description	Allocated quantity (million m^3/a)
Irrigation allocation of areas supplied with Orange River water in the Fish and Sundays (from Appendix 10)	582
Allocation for urban supply with Orange River water	9
Supply to Port Elizabeth (year 2000)	11
Total allocations	**602**
Canal losses allowed:	
25% of 18 478 ha @ 13 500 m^3/ha/a (1) =	62
25% of 14 185 ha @ 12 500 m^3/ha/a (2) =	44
15% of 16 644 ha @ 9 000 m^3/ha/a (3) =	23
Total canal losses	**129**
Allocation + canal losses	**731**
+ River losses (4)	112
+ Freshening releases average impact (5)	32
Gross allocated quantity	**875**
Less return flows in areas supplied with Orange River water (4)	102
Average maximum net allocated quantity	**773**
Maximum net allocated quantity at 1:50 year assurance	**658**

1) Upstream of Elandsdrift Weir (from Appendix 10).
2) Fish-Sundays Canal and Great Fish River (from Appendix 10).
3) Lower Sundays River.
4) From Table 3.4
5) From Table 3.5

The implications of this difference of 83 million m^3/a at 1:50 year assurance of supply, is that farmers could potentially use more water than have been allocated for transfer from the Upper Orange WMA. It is necessary to urgently address this difference in Strategy 5.1, *Reliability of the yield balance* and Strategy 5.5, *Reconciliation*, to ensure that the allocation of Orange River water to this ISP area and the licensed quantity, to use the transferred water, are the same.

The average use of Orange River water in the ISP area, from **Table 3.7**, that includes allowance for canal losses, are (664 +11) = 675 million m^3/a, for areas supplied with Orange River water (calculated by subtracting irrigation use in the Tarka, Koonap, Kat, Upper Sundays and Albany Coast areas from the total irrigation use and adding requirements of towns/NMMM supplied with Orange River water). The comparable maximum average requirement for Orange River water, from **Table 3.8,** is 731 million m^3/a. Use of Orange River water at a 1:50 year assurance of supply, from **Table 3.6,** is (563 + 9) = 572 million m^3/a (the difference with 575 million m^3/a is likely due to simplification), while the comparable maximum 1:50 year requirement for Orange River water, from **Table 3.8** (using the same factor as used in **Table 3.7**)**,** is 622 million m^3/a. This indicates that the allocation for transfer from the Upper Orange WMA is in line with actual water use, and do not reflect allocations, which is a concern.

3.4 YIELD BALANCE

3.4.1 Current situation

Table 3.9 shows the yield balance. The **yield balance** is: the *total available water* (the sum of the available local resources and the transfers into the area) compared or reconciled with *the total requirements* (the sum of the various water requirements and losses and the transfers out of the area).

The entire ISP area is practically in balance, mainly because transfers are sufficient to satisfy the demand. The Tarka catchment is stressed. There are unused and under-utilised water allocations in the Kat River. These unused allocations must be addressed, as well as the unlawful use of these current unused allocations. The big question is how the system is operated / managed, and how that operation can be improved or even optimised.

The surplus flows at the bottom end of the Fish River (71 million m^3/a) includes freshening releases made, unused irrigation releases, and return flows downstream of the last point of abstraction. The salinity of such flows may be too high for direct beneficial use without blending or treatment. This water is therefore generally not available for use. A total of 7 million m^3/a flows to sea from the Sundays River. Because the quality of the lower river is generally poor, there are no abstractions for use from that part of the river.

Freshening releases are normally made from Elandsdrift Weir and De Mistkraal Weir. The release in 2003 was 59 million m^3 from Elandsdrift Weir and 42 million m^3 from De Mistkraal Weir, i.e. a total of 101 million m^3/a (or >3 m^3/s). Further information on these releases was not available. A DWAF view is that between 3 and 5 m^3/s typically runs down to the Fish River estuary and typically 2 to 4 m^3/s to the Sunday's River estuary. This perception that river flows in the lower parts of the Fish and Sundays rivers are higher than the water balance shows, could be due to the following reasons:

- The 1:50 year evaluation presents a serious drought situation – not an average situation;
- Releases for irrigation are requested by farmers but are not always fully used;
- Irrigation return flows may be more than modelled; and
- Operational losses may be more than modelled.

Table 3.9: ISP reconciliation of water requirements and availability for the year 2000 at 1:50 year assurance (million m³/a)

Hydrological sub-division	Available yield				Water requirements			Balance (1)
	Local yield	Transfers in (2)	River Losses (3)	Total	Local require-ments	Transfers out (2)	Total	
Groot Brak	2	575	-6	571	60	510	570	**1**
Tarka	10	0	0	10	13	2	15	**-5**
Upper Fish	46	512	-20	538	179	358	537	**1**
Upper Little Fish	32	163	0	195	46	148	194	**1**
Middle Fish	32	220	-33	219	109	110	219	**0**
Koonap	22	0	0	22	22	0	22	**0**
Kat	22	0	0	22	21	0	21	**1**
Lower Fish	13	110	-35	88	17	71 (4)	88	**0**
Fish Total	**179**	**575**	**-94**	**660**	**467**	**193 (4)**	**660**	**0**
Bushmans, Kowie/Kariega	21	1	0	22	22	0	22	**0**
Albany Coast Total	**21**	**1**	**0**	**22**	**22**	**0**	**22**	**0**
Upper Sundays	14	0	0	14	10	5	15	**-1**
Middle Sundays	53	128	0	181	66	115	181	**0**
Lower Sundays	27	115	-18	124	106	18 (4)	124	**0**
Sundays Total	**94**	**123**	**-18**	**199**	**182**	**18 (4)**	**200**	**-1**
Total for ISP area	**294**	**575**	**-112**	**757**	**671**	**88 (4)**	**759**	**-2**

1) Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.
3) The river losses resulting from evaporation and seepage for the transferred volumes have been included here. This was a best estimate from the ORRS modeling [16].
4) 70 Million m^3/a flows to sea from the Fish River and 7 million m^3/a from the Sundays River, while 11 million m^3/a is transferred on from the Sundays sub-area to NMMM.

3.4.2 Projected 2025 yield balance

a. Projected 2025 water requirements at 1:50 year assurance of supply

The Tsitsikamma to Coega ISP addresses the water requirements of the NMMM through the *NMMM future augmentation strategy*. In 2000, 11 million m^3/a was transferred from the Orange River via the Fish/Sundays system to Port Elizabeth. The Sundays River Scheme can potentially supply 25.6 million m^3/a Orange River water to Port Elizabeth if operated at full capacity throughout the year and if some additional treatment capacity is added to the current capacity of 20 million m^3/a.

Water for significant new envisaged resource - poor farmer developments (4 000 ha), involving a total estimated water requirement of about 38 million m^3/a of Orange River water to alleviate poverty, have been reserved for future transfers to this ISP area from the Upper Orange WMA. Refer to the Upper Orange WMA ISP Report No P WMA 13/000/00/0304 for more information.

Significant growth in urban water use in the Albany Coast sub-area is expected.

ISP area: Irrigation grows by 38 million m^3/a for resource-poor farmer schemes. It has been assumed that approximately 30% (11 million m^3/a) of this development will take place in the Fish River catchment and 70% (27 million m^3/a) in the Lower Sundays River catchment, approximately along the lines of recommendations made in the ORRS study. Requirement for transfer to the Tsitsikamma-Coega ISP area (NMMM) increases by 10 million m^3/a (to 21 million m^3/a), in accordance with the recommendations made in the Algoa Pre-Feasibility Study. Urban use grows by 11 million m^3/a.

Fish: Irrigation grows by 11 million m^3/a and urban use grows by 3 million m^3/a.

Albany Coast: Urban use grows by 7 million m^3/a, due to significant projected growth of especially coastal towns.

Sundays: Irrigation grows by 27 million m^3/a and urban use grows by 1 million m^3/a. Transfer out to the Tsitsikamma to Coega ISP area of the NMMM's requirement increases by 10 million m^3/a.

Table 3.10 on the following page shows the water requirements in 2025, in comparison to the year 2000 availability, as an indication of the expected shortfall that will need to be met with increased yield. The possibility that the requirement for transfers to the NMMM could increase significantly, in addition to the 10 million m^3/a that have been allowed for, should be borne in mind, taking the current spate of growth into account.

Table 3.10: ISP year 2025 water requirements and availability for 1:50 year assurance (million m³/a)

ISP sub-area	Available year 2000 yield				Water requirements in 2025			Balance
	Local yield	Transfers in (1)	River Losses (2)	Total	Local require-ments	Transfers out (1)	Total	
Fish	179	575	-94	660	481	193 (3)	674	-14
Albany Coast	21	1	0	22	29	0	29	-7
Sundays	94	123	-18	199	210	28 (3)	238	-39
Total for ISP area	**294**	**575**	**-112**	**757**	**720**	**98 (3)**	**818**	**-58**

1) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.
2) The river losses resulting from evaporation and seepage for the transferred volumes, which is a best estimate from the ORRS modeling, have been included here.
3) 71 Million m^3/a flows to sea from the Fish River and 7 million m^3/a from the Sundays River.

b. Projected 2025 water requirements according to the NWRS (Version 1) at 1:50 year assurance of supply

In the NWRS, provision was made for growth in irrigation use, through the development of an additional 4 000 ha under irrigation, for the establishment of new resource-poor farmers as a means of poverty eradication. Substantial growth in the urban water use of the NMMM was also allowed for, meeting their needs with increased transfers of Orange River water. The forecast was for significant growth in urban use in the Albany Coast sub-area, part of which would be associated with an increase in the standard of living. Little change in the requirements for water was foreseen for the inland and rural parts of the ISP area, where irrigation is dominant. Limited economic growth together with no or negative population growth was forecast.

A notable difference between the projected water requirements of the ISP, compared with that of the NWRS, is that most of the new resource-poor farmer development has been assumed to be in the lower Sundays River, in line with the ORRS study recommendations, whereas the NWRS assumed that all such development would be in the Fish River. The NWRS made greater provision for the transfer of Orange River water to the NMMM (an additional 28 million m^3/a), and significantly so in the high growth scenario (an additional 78 million m^3/a), whereas the ISP is in accordance with the recommendations made in the Algoa Pre-Feasibility Study (an additional 10 million m^3/a). There is however the concern that the need for increased transfers to the NMMM could indeed increase significantly.

c. Projected 2025 ISP water balance at 1:50 year assurance of supply

An additional quantity of 2 million m^3/a (for increased use of Orange River water by small Eastern Cape towns) has been included in the Upper-Orange ISP for future use. Together with the 38 million m^3/a reserved for future use by resource-poor farmers, a total of 40 million m^3/a has been reserved for future transfer from the Upper Orange WMA to this ISP area.

In a 1:50 year drought situation in the OFSWSS, freshening releases will depend on the availability of "surplus" water in the Upper Orange WMA, which is only available when Gariep and Van der Kloof dams are spilling. The water resource in that WMA is currently close to a balanced situation, and is expected to move to a situation where demand exceeds available resources. Availability of "surplus" water from the Upper Orange WMA is therefore likely to diminish, when compared with previous years, which may also influence the long term future availability of water to the NMMM. **Table 3.11** shows the ISP 2025 reconciliation of water requirements and availability at 1:50 year assurance.

It is envisaged that the increase in requirements will be met through the following interventions:

ISP area: As transfers for resource-poor farmers increase, irrigation return flows and river losses will increase accordingly. Provision must me made in the transfer volumes for losses as water is transferred through the system. The growing urban requirement is met by increased groundwater use and by a very limited increase in the supply of Orange River water. A possible requirement for increased freshening releases has not been allowed for. The overall balance and that of the sub-areas remain the same as in 2000.

Fish: Local yield (groundwater use) should increase by 2 million m^3/a. Transfer in of Orange River water increases by 55 million m^3/a, and onwards transfer from the Fish to the Sundays will be 40 million m^3/a. River losses accordingly increase by 5 million m^3/a and irrigation return flow by 2 million m^3/a.

Albany Coast: Local yield increases by 7 million m^3/a.

Sundays: Local yield (groundwater use) increases by 1 million m^3/a to meet increased urban needs. Transfer in of Orange River water from the Fish sub-area increases by 40 million m^3/a and transfers out to the NMMM increase by 10 million m^3/a. River losses increase by 3 million m^3/a. There will be no usable return flows.

Table 3.11: ISP year 2025 reconciliation of water requirements and availability at 1:50 year assurance (million m³/a)

ISP sub-area	Available yield				Water requirements			Balance (1)
	Local yield	Transfers in (2)	River Losses (3)	Total	Local require-ments	Transfers out (2)	Total	
Fish	183	630	-99	714	481	233 (4)	714	0
Albany Coast	28	1	0	29	29	0	29	0
Sundays	95	163	-21	237	210	28 (4)	238	-1
Total for ISP area	**306**	**630**	**-120**	**816**	**720**	**98** (4)	**818**	**-2**

1) Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.
3) The river losses resulting from evaporation and seepage for the transferred volumes, which is a best estimate from the ORRS modeling, have been included here.
4) 70 Million m^3/a flows to sea in the Fish River and 7 million m^3/a in the Sundays River.

3.4.3 Approach to future reconciliation

a. Systems approach

Eventually, when all allocations have been taken up, the Orange System will be in balance and the Eastern Cape will have to make do with its allocation for long periods of time. The use of additional transfers, which may be available from time to time for further Fish-Sundays salinity reduction, will have to be weighed up against the cost of other lost opportunities (like power generation). The overall system will be very complex and good operation will be essential. At the moment there is still temporary operational latitude due to allocations not being fully utilised.

There are large uncertainties with regard to actual irrigation water use, which need to be accurately determined, to prepare an updated water balance that provides a more reliable picture of actual use vs. scheduled water use. This is addressed through the *Reliability of the yield balance Strategy*, Strategy 5.1.

Management of salinity in the OFSWSS will determine when and how freshening releases should be made and could influence where new development would be allowed. This should also be evaluated through the OFSWSS Management Strategy.

The future focus on water use in the ISP area will be to ensure optimal utilisation of the irrigation water allocation, improving efficiency of urban water use, and ensuring that water is made available to uplift the poor.

b. Intervention measures

With the entire ISP area as well as all the sub-areas approximately in balance, any further demands for commercial water use should preferably be addressed either through the trading of unused or under-utilised water use authorisations, or through increased efficiency. Unused or underdeveloped allocations, notably in the Kat River catchment, which is close to full allocation, but where there is a big demand from irrigators without allocations, needs to be resolved through trading, delisting or possibly reallocation, or a pricing system. Less could possibly be paid for water of poorer quality, or for water with a lower assurance of availability.

Water saved through WC&DM measures, such as e.g. the lining of earth canals, could make water available for development, although it would also mean that there would be less return flows. Many existing irrigators may also be in a position to use such “freed” water. This scenario needs to be carefully evaluated through the OFSWSS Management Strategy, Strategy 12.1.

c. Development options

Very limited potential for the development of new dams and other local water resource developments remains. Feasible dams development have however been identified and studied in the Kat River (Baddaford Dam) and Koonap River (Foxwood Dam). Groundwater also holds some real possibilities for development, specifically for urban water supply.

There have been recent proposals for further irrigation development in the lower Sundays and Fish Rivers. These proposals will have to be considered in the light of the Eastern Cape Provincial Growth and Development Strategy [34]. The use of water such schemes, if approved, should benefit resource-poor farmers and it should form part of the 4 000 ha allocation for new resource-poor farmer schemes.

d. Supply of Orange River water to NMMM

It is envisaged that additional Orange River water could also be transferred in future for industrial and urban use of the NMMM. This would depend on the balance of the Orange River System at the time, and more likely involve the development of additional storage infrastructure in the Orange River catchment (e.g. Boskraai Dam) to meet this and other needs. An allowance has been made in the Upper Orange ISP water balance, for use by the NMMM of 26 million m^3/a (of which 11 million m^3/a was used in 2000 and 17 million m^3/a in 2004). This will be reviewed in future water balances.

Although the current supply system from the Sundays River canals has spare capacity, the disadvantage is that that water needs to undergo additional treatment, which is costly. There is also some resistance by users. The Algoa Pre-feasibility Study concluded that the NMMM did not need to develop a new scheme / increase their current use of Orange River water until 2020. The current growth in the NMMM’s water requirements is however very rapid, which could change the conclusions of the Algoa Pre-feasibility Study.