National Accounts

Environmental Economic Accounts

Water Management Areas in South Africa

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List of abbreviations and acronyms

AIDS	Acquired immune deficiency syndrome
C	Celsius
°	Degrees
DWA	Department of Water Affairs (Department of Water Affairs and Forestry prior to July 2009, President's Minute No. 690)
EEA	Environmental Economic Accounts
Eskom	Electricity Supply Commission of South Africa
GDP	Gross domestic product
HIV	Human immunodeficiency virus
km	Kilometres
km^2	Square kilometres
M^3	Cubic metres
MAR	Mean annual runoff
mm	Millimetres
NEPAD	New Partnership for Africa's Development
NWRS	National Water Resource Strategy
SADC	Southern African Development Community
SASQAF	South African Statistical Quality Assessment Framework
SEEA-W	System of Integrated Environmental and Economic Accounts for Water
SIC	Standard Industrial Classification of all Economic Activities
Stats SA	Statistics South Africa
UNSD	United Nations Statistics Division
WMA/(s)	Water Management Area/(s)
WMO	World Meteorological Organization

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1. Introduction

This discussion document on water management areas (WMAs) in South Africa is a first attempt by Statistics South Africa (Stats SA) to bridge the information contained in the National Water Resources Strategy (NWRS) – a major data source from the Department of Water Affairs (DWA), with official social and economic statistics to facilitate the future development of the Water Accounts for South Africa. The water accounts rely on physical data with regard to quantity and these physical tables form the core of the water accounts. Future work will include quality and monetary data to expand the Water Accounts for South Africa further according to the System of Integrated Economic and Environmental Accounts for Water (SEEA-W) developed by the United Nations Statistics Division (UNSD). At this stage insufficient information is available to disaggregate the economy to WMA levels.

One of the key constraints to the development of environmental economic accounts (EEA) in South Africa is the reliance on other government departments and statutory bodies as primary sources of EEA data. This reliance has limited Stats SA in the development of EEA in the following ways:

- It has required the use of data that do not necessarily qualify as official statistics as defined according to the South African Statistical Quality Assessment Framework (SASQAF).
- It has limited Stats SA to the compilation of physical water accounts as the data provided by line departments and statutory bodies are expressed in physical units only.
- Data from line departments and statutory bodies are not classified according to the Standard Industrial Classification of all Economic Activities (SIC) in all cases.
- The time series of data is not comparable to official statistics produced by Stats SA.

The above constraints have prevented Stats SA from publishing regular updates with regard to Water Accounts for South Africa as well as making the accounts official reports.

This discussion document is aimed at the assessment of the potential of integration from:

- Extracting existing incidental environmental data from Stats SA data bases.
- Adapting Stats SA census and survey questionnaires to collect additional environmental data in future.
- Linking Stats SA data to the DWA water data, which is the main source of obtaining physical quantities of water resources in South Africa.

2. South Africa's population estimates

Table 1 below shows 2009 mid-year population estimates for South Africa grouped according to gender and population group, and Table 2 gives a breakdown of the population estimates by province.[1]

Table 1: Mid-year population estimates for South Africa by population group and gender, 2009[1]

	Male		Female		Total	
Population group	Number	Percentage of total population	Number	Percentage of total population	Number	Percentage of total population
African	18 901 000	79,2%	20 235 200	79,5%	39 136 200	79,4%
Coloured	2 137 300	9,0%	2 295 800	9,0%	4 433 100	9,0%
Indian/Asian	635 700	2,7%	643 400	2,5%	1 279 100	2,6%
White	2 194 700	9,2%	2 277 400	8,9%	4 472 100	9,1%
Total[i]	23 868 700	100,0%	25 451 800	100,0%	49 320 500	100,0%

Table 2: Mid-year population estimates by province, 2009[1]

Province	Population estimate	Percentage share of the total population
Eastern Cape	6 648 600	13,5%
Free State	2 902 400	5,9%
Gauteng	10 531 300	21,4%
KwaZulu-Natal	10 449 300	21,2%
Limpopo	5 227 200	10,6%
Mpumalanga	3 606 800	7,3%
North West	1 147 600	2,3%
Northern Cape	3 450 400	7,0%
Western Cape	5 356 900	10,9%
Total[i]	49 320 500	100,0%

[i] Where figures have been rounded, discrepancies may occur with totals.

3. South Africa's economy

Table 3 below shows the contribution by the various industries to South Africa's economy in 2009 at current prices. The highest contributions to the gross domestic product (GDP) were finance, real estate and business services (21,7%), general government services (15,5%) and manufacturing (15,1%). The lowest contributions to GDP were agriculture, forestry and fishing (3,0%), and electricity, gas and water (2,4%).

Table 3: Contributions to South Africa's economy by industry in 2009 at current prices (Rand million)[2a]

Industry	Rand (million)	Percentage contribution
Agriculture, forestry and fishing	66 049	3,0%
Mining and quarrying	212 469	9,7%
Manufacturing	329 166	15,1%
Electricity, gas and water	53 133	2,4%
Construction	84 450	3,9%
Wholesale, retail, motor trade and accommodation	290 957	13,3%
Transport, storage and communication	206 271	9,5%
Finance, real estate and business services	473 720	21,7%
General government services	337 236	15,5%
Personal services	128 603	5,9%
Total value added at basic prices	2 182 054	100,0%

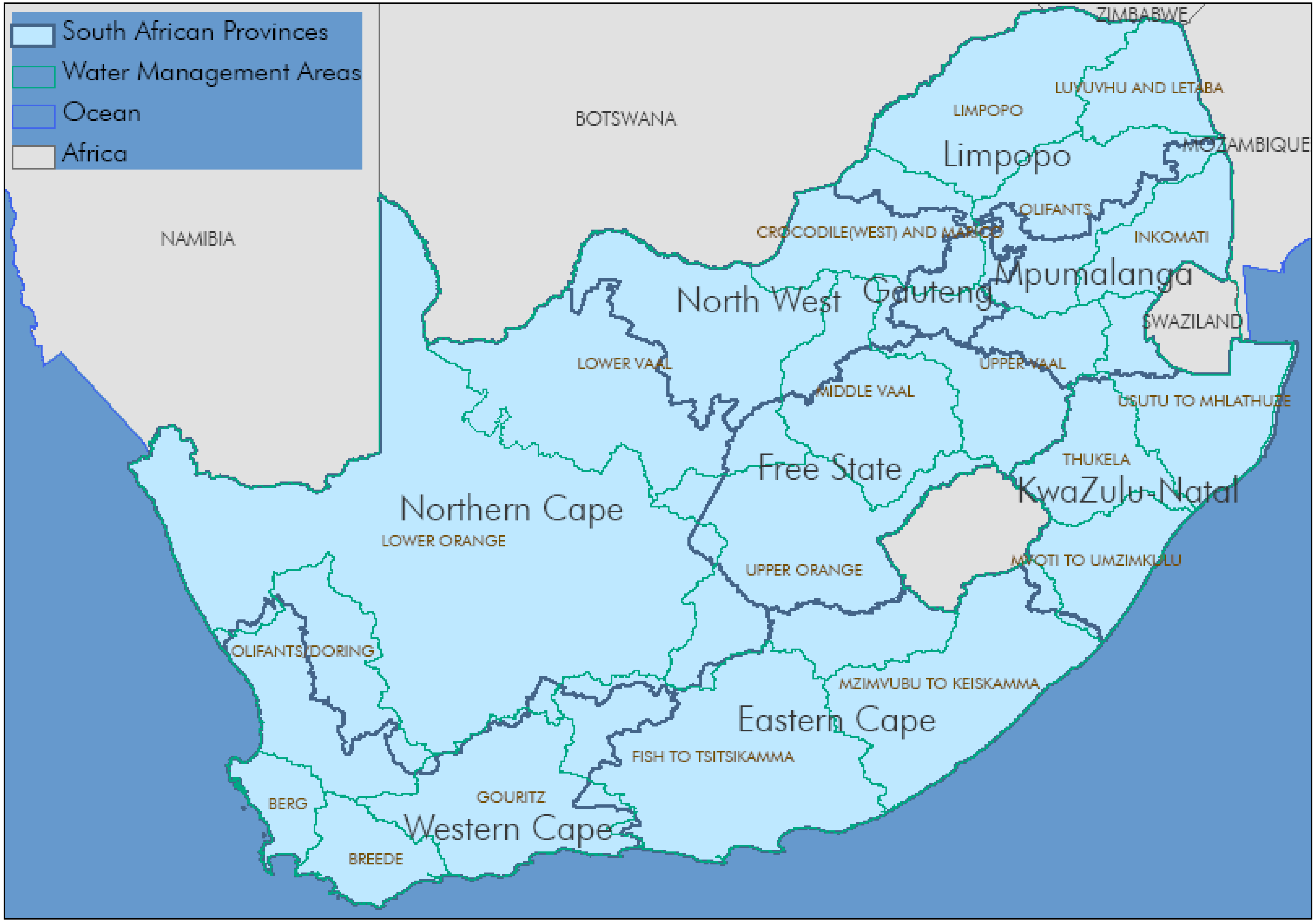
3. South Africa's economy (continued)

Table 4 describes the proportional regional distribution of economic activity across the nine provinces. Given the dominance of Gauteng in the economy, all industry groups are found to be concentrated there, except for the agriculture, forestry and fishing industry and the mining industry. The bulk of the value added by the agriculture, forestry and fishing industry in South Africa stems from KwaZulu-Natal (28,3%) and the Western Cape (23,9%). The mining industry is predominantly in Limpopo (23,3%), Mpumalanga (22,9%) and North-West (21,4%). In Map 1 the location of each of the 19 WMAs are given. The WMAs span more than one province, except for the Breede and Berg WMAs that are entirely within the Western Cape.

Table 4: Proportional regional distribution of economic activity at current prices, 2008[2b]

Industry	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	North West	Western Cape
Agriculture, forestry and fishing	5,1%	8,2%	5,6%	28,3%	7,3%	8,8%	6,4%	6,4%	23,9%
Mining and quarrying	0,3%	7,1%	9,8%	7,1%	23,3%	22,9%	6,9%	21,4%	1,0%
Manufacturing	7,8%	4,0%	40,3%	21,4%	1,4%	7,5%	0,4%	2,6%	14,6%
Electricity, gas and water	4,4%	7,3%	32,5%	17,1%	8,4%	14,9%	2,1%	3,0%	10,3%
Construction	5,3%	3,0%	41,4%	14,6%	4,6%	5,6%	1,2%	5,2%	19,2%
Wholesale, retail, motor trade and accommodation	7,8%	4,8%	34,4%	16,5%	6,0%	5,6%	2,2%	5,6%	17,1%
Transport, storage and communication	7,3%	4,7%	31,6%	21,8%	5,8%	6,1%	2,0%	5,7%	15,0%
Finance, real estate and business services	7,6%	4,1%	39,2%	14,0%	5,3%	4,1%	1,5%	4,0%	20,1%
General government services	13,0%	10,3%	24,2%	16,7%	5,5%	6,1%	3,1%	8,7%	12,4%
Personal services	10,9%	5,3%	39,2%	14,6%	8,4%	4,8%	2,0%	5,4%	9,5%

Map 1: Location of water management areas within provincial boundaries[9]



4. South Africa's geography and climate

South Africa occupies the southernmost part of the African continent. Its surface area is 1 219 090 square kilometres (km^2) and has an extensive coastline of approximately 3 200 kilometres (km) constituting the western, southern and eastern boundaries of the country. The northern boundary runs along the Orange, Molopo and Limpopo rivers, with deviations along the Lebombo Mountains in the north-east and a meridian or line of longitude, 20 degrees (°) east in the north-west. South Africa is divided into nine provinces, comprising groupings of magisterial districts. Some of the boundaries follow rivers or other geographic features, but the most suitable boundary delineation from an environmental point of view, is the watershed boundary, also known as catchment boundary. The reason for this is that environmental resources such as water and pollution control can be more effectively managed within a single catchment.[3]

South Africa is a dry country with pronounced spatial and temporal variability, and an east-west rainfall gradient ranging from more than 1 000 millimetres (mm) per year to less than 250 mm/annum. Rainfall generally occurs during summer from November through to March. In the south-west, around Cape Town rainfall occurs in winter from June to August. In the north-west, annual rainfall often remains below 200 mm. Much of the eastern Highveld, in contrast, receives 500 to 900 mm of rainfall per year. Occasionally, rainfall on the eastern Highveld exceeds 2 000 mm/annum. A large area of the central country is semi-arid and receives about 400 mm of rain on average, and there are wide variations closer to the coast. The 400 mm 'rainfall line' has been significant because land east of the rainfall line is generally suitable for growing crops, and land west of the rainfall line, only for livestock grazing or crop cultivation on irrigated land, also known as dryland farming.[4]

Temperature and rainfall patterns vary in response to the movement of a high pressure belt that circles the globe between 25 and 30° south latitude during the winter and low-pressure systems that occur during summer. There is very little difference in average temperatures from south to north, however, in part because the inland plateau rises slightly in the north-east. For example, the average annual temperature in Cape Town and Pretoria is 17° Celsius (C), although these cities are separated by almost ten degrees of latitude. Maximum temperatures often exceed 32° C in the summer, and reach 38° C in some areas of the far north. The country's highest recorded temperatures, close to 48° C, have occurred in both the Northern Cape and Mpumalanga.[4]

Climatic conditions vary noticeably between east and west, largely in response to the warm Agulhas ocean current, which sweeps southward along the Indian Ocean coastline in the east for several months of the year, and the cold Benguela current, which sweeps northward along the Atlantic Ocean coastline in the west. Air temperatures in Durban, on the Indian Ocean, average nearly 6° C warmer than temperatures at the same latitude on the Atlantic Ocean coast. The effects of these two currents can be seen even at the narrow peninsula of the Cape of Good Hope, where water temperatures average 4° C higher on the east side than on the west.[4]

5. South Africa's water situation

5.1 Overview

Fresh water is vital on a daily basis to sustain all living matter, including humans. Water is at risk against over-exploitation and pollution, and requires careful management to protect the resource. South Africa's water resources are stressed[a], bordering on water scarce, with a water availability of 1 100 cubic metres (m^3) per person per annum.

Most fresh water resources in Southern Africa are located in transboundary watercourse systems and shared river basins. Management and protection of these shared basins is required through a strong commitment to regional collaboration within the Southern African Development Community (SADC). In the same way, the environmental initiatives of the New Partnership for Africa's Development (NEPAD) include a framework for regional cooperation on water resources, as well as processes for the restoration of degraded ecosystems (including wetlands), the combating of desertification, drought relief, sustainable agricultural production, and biodiversity conservation. NEPAD's framework therefore provides a key initiative for improving water resource management for social, economic, and environmental security in Africa.[5]

Besides the direct use of water, the way in which land is used, as well as uncontrolled pollution from various sources could have a negative impact on aquatic resources. The use of water resources affects the functioning of estuaries and coastal waters. The predictions on climate change are that of changing the amount and distribution of rainfall as well as evaporation rates. All of these complex interactions has to be considered when implementing South Africa's water resource policy and requires an integrated approach to water management. Sustainable aquatic ecosystems rely on the availability of water of adequate quantity and quality. The ecosystem, as well as the various water-users, needs to be considered when assessing the water requirements of South Africa and its neighbouring territories.[5]

The nation's water resources are under the custody of the DWA who manages these resources in order to promote equity, sustainability, and efficiency. The NWRS sets out the Department's plans with regard to the strategic management of South Africa's water resources.[5]

The quantity of water available for direct human use or to support aquatic ecosystems depends on the availability and sustainability of the resource. Rainfall, surface flows, and groundwater recharge are intimately linked in the hydrological cycle and need to be managed accordingly. One of principal objectives of the NWRS 'is to ensure an adequate supply of water to underpin the prosperity of the country and the well-being of its population'.[5]

[a] According to the United Nations water availability of less than 1 700 m^3 per person per annum constitutes water stress, with values below 1 000 m^3 per person per annum classified as water scarce.

5. South Africa's water situation (continued)

5.2 Access to water

From the 2007 Community Survey that includes the 2001 Census tables, an overview is provided of households with access to clean water per province.

Table 5: Households with access to clean water per province[6]

	Census 2001				
	Piped water inside dwelling	Piped water inside yard	Piped tap water to community stand: distance < 200 m from dwelling	Piped tap water to community stand: distance > 200 m from dwelling	Total piped water
Eastern Cape	18,3%	19,5%	13,5%	11,9%	63,2%
Free State	22,8%	47,7%	13,7%	11,4%	95,7%
Gauteng	46,4%	36,4%	7,0%	7,3%	97,1%
KwaZulu-Natal	29,1%	19,6%	10,5%	13,3%	72,5%
Limpopo	9,7%	29,2%	16,1%	23,1%	78,1%
Mpumalanga	19,8%	36,7%	12,8%	16,4%	85,7%
North West	18,7%	35,5%	16,0%	16,4%	86,6%
Northern Cape	34,3%	37,7%	10,9%	11,1%	94,0%
Western Cape	67,5%	17,7%	6,3%	6,8%	98,3%

	Community Survey 2007			
	Piped water inside dwelling	Piped water inside yard	Piped water from access point outside the yard	Total piped water
Eastern Cape	29,9%	13,9%	27,1%	70,9%
Free State	46,2%	40,6%	10,5%	97,3%
Gauteng	66,2%	20,8%	10,9%	97,9%
KwaZulu-Natal	39,4%	19,1%	20,8%	79,3%
Limpopo	18,0%	25,5%	40,1%	83,6%
Mpumalanga	34,9%	33,4%	22,7%	91,0%
North West	32,6%	31,7%	25,6%	89,9%
Northern Cape	50,0%	30,3%	14,1%	94,4%
Western Cape	79,5%	11,7%	7,8%	98,9%

5. South Africa's water situation (continued)

5.3 Water supply to municipalities per water management area

The table below indicates water supplied by WMA in 2006. Municipalities obtained their water from Water Boards with the balance obtained from other service providers and own sources.

Table 6: Water supply to municipalities by water management area, 2006 (m^3)[8]

	Water management areas	Water Boards	Other service providers	Own sources	Total
			m^3		
1	Limpopo	26 322 247	4 705 623	31 344 392	62 372 262
2	Luvuvhu to Letaba	10 902 316	1 949 005	12 982 420	25 833 741
3	Crocodile West and Marico	392 234 981	11 566 596	134 106 019	537 907 597
4	Olifants	190 627 310	3 475 378	100 181 685	294 284 373
5	Inkomati	13 736 244	722 943	33 814 494	48 273 681
6	Usutu to Mhlatuze	150 165 752	12 088 650	50 925 712	213 180 114
7	Thukela	116 827 475	9 530 970	32 292 657	158 651 103
8	Upper Vaal	540 727 755	8 617 318	363 713 368	913 058 441
9	Middle Vaal	39 080 216	9 372 272	265 191 098	313 643 586
10	Lower Vaal	38 860 355	20 623 786	79 424 358	138 908 499
11	Mvoti to Umzimkulu	97 860 301	8 213 045	30 023 826	136 097 171
12	Mzimvubu to Keiskamma	28 027 501	6 594 882	73 001 481	107 623 864
13	Upper Orange	51 929 457	9 834 714	391 184 335	452 948 507
14	Lower Orange	18 555 884	4 097 529	63 781 214	86 434 627
15	Fish to Tsitsikamma	17 304 026	9 963 440	129 264 131	156 531 596
16	Gouritz	4 493 851	11 788 270	154 105 766	170 387 888
17	Olifants/Doring	4 201 484	7 570 627	99 015 998	110 788 109
18	Breede	1 606 176	4 614 544	60 333 394	66 554 114
19	Berg	1 086 832	3 122 467	40 825 063	45 034 362
	Total[i]	1 744 550 163	148 452 059	2 145 511 412	4 038 513 634

[i] Where figures have been rounded, discrepancies may occur with totals.

5. South Africa's water situation (continued)

5.4 Water distribution by municipalities per water management area

The table below indicates water distribution by municipalities per water management area in 2006. Municipalities play a key role in the treatment and supply of water to industry and households.

Table 7: Water distribution by municipalities per water management area, 2006 (m^3)[8]

	Water management areas	Water lost	Water sold	Free basic water supplied	Water for own use	Total
				m^3		
1	Limpopo	7 734 991	35 474 535	11 509 527	1 086 835	55 805 888
2	Luvuvhu to Letaba	3 203 728	14 693 069	4 767 089	450 152	23 114 038
3	Crocodile West and Marico	112 968 291	287 330 515	51 740 622	1 032 333	453 071 761
4	Olifants	60 437 111	149 969 594	32 156 042	1 049 740	243 612 487
5	Inkomati	10 464 287	25 338 514	7 741 002	508 117	44 051 921
6	Usutu to Mhlatuze	70 489 284	121 195 834	18 762 523	434 838	210 882 480
7	Thukela	53 736 005	90 657 902	13 080 574	225 551	157 700 032
8	Upper Vaal	157 369 290	377 187 254	68 188 262	2 658 536	605 403 342
9	Middle Vaal	14 489 542	44 424 974	5 774 727	3 028 689	67 717 932
10	Lower Vaal	19 435 094	85 081 853	14 248 049	2 140 968	120 905 964
11	Mvoti to Umzimkulu	45 534 712	77 954 910	11 617 250	248 441	135 355 313
12	Mzimvubu to Keiskamma	23 692 131	63 096 775	16 925 618	1 307 664	105 022 188
13	Upper Orange	22 581 484	61 781 298	11 081 901	4 428 550	99 873 233
14	Lower Orange	13 280 720	41 351 049	12 723 192	2 026 197	69 381 158
15	Fish to Tsitsikamma	29 289 929	97 206 939	24 425 872	2 990 178	153 912 917
16	Gouritz	30 297 264	119 348 879	18 156 591	5 071 966	172 874 700
17	Olifants/Doring	19 689 276	76 822 936	12 186 466	3 299 605	111 998 283
18	Breede	11 820 715	46 750 441	7 011 650	1 996 803	67 579 609
19	Berg	7 998 579	31 634 052	4 744 488	1 351 153	45 728 271
	Total[i]	714 512 435	1 847 301 323	346 841 443	35 336 316	2 943 991 517

[i] Where figures have been rounded, discrepancies may occur with totals.

5. South Africa's water situation (continued)

5.5 Water purchases and sales by municipalities per water management area

Total purchases of water by municipalities amounted to approximately R6 million and total sales by municipalities amounted to approximately R10 million in 2006.

Table 8: Municipal purchases and sales of water, and purchase and selling unit costs per water management area, 2006[8]

	Water management areas	Water purchases	Water sales	Purchase price	Selling price
		Value (Rands)		Price (Rands)	
1	Limpopo	49 344	114 742	0,79	3,23
2	Luvuvhu to Letaba	20 438	47 525	0,79	3,23
3	Crocodile West and Marico	1 232 414	2 160 670	2,29	7,52
4	Olifants	600 689	1 070 460	2,04	7,14
5	Inkomati	59 895	113 927	1,24	4,50
6	Usutu to Mhlatuze	408 847	617 005	1,92	5,09
7	Thukela	311 950	464 823	1,97	5,13
8	Upper Vaal	1 699 304	2 853 104	1,86	7,56
9	Middle Vaal	126 988	42 777	0,40	0,96
10	Lower Vaal	149 093	240 864	1,07	2,83
11	Mvoti to Umzimkulu	266 573	386 243	1,96	4,95
12	Mzimvubu to Keiskamma	180 300	62 618	1,68	0,99
13	Upper Orange	193 640	9 084	0,43	0,15
14	Lower Orange	44 433	163 636	0,51	3,96
15	Fish to Tsitsikamma	203 949	147 254	1,30	1,51
16	Gouritz	96 389	555 172	0,57	4,65
17	Olifants/Doring	60 941	359 588	0,55	4,68
18	Breede	36 598	220 293	0,55	4,71
19	Berg	24 764	149 063	0,55	4,71
	Total[i]	5 766 547	9 778 848		

[i] Where figures have been rounded, discrepancies may occur with totals.

5. South Africa's water situation (continued)

5.6 Water resources

The average rainfall in South Africa is about 450 mm/annum, that is, about half the world average of 860 mm/annum. South Africa's rainfall has a water supply potential per capita of just over 1 100 cubic metres (m^3) per annum. The geographical distribution of rainfall, and subsequent availability for water supply, is highly variable, with the eastern and southern part of the country receiving significantly more rain than the northern and western regions. South Africa's inland water resources are the rivers, dams, lakes, wetlands, and subsurface aquifers, which together with natural processes (such as rainfall and evaporation) and anthropogenic influences (such as human-originated abstraction and discharges), form the hydrological cycle (see Figure 1) that controls the quality and quantity of our inland waters. Within the cycle, there are complex interactions between surface and ground water and between the water and the sediments, stream banks, animals, plants, and microbes in rivers, dams, and wetlands. These interactions have to be taken into account in water management. The chemical characteristics of water depend on the source of water, the local geology, local ecology, and the impact of local human activity.[5]

5.7 Agricultural production

The total area under dryland crops in South Africa was just over 3 million ha and dryland production totalled over 16 million tons in 2002. Of the total agricultural production of R23 119 million in 2002, irrigation agriculture produced 55% of agricultural produce by value, making this water use of key importance to South Africa.

Table 9: Summary of agricultural production for South Africa, 2002[8]

Crops	Dryland area ha	Dryland production tons	Irrigated area ha	Irrigated production tons	Dryland production (Rands)	Irrigated production (Rands)	Total production (Rands)
Field crops	3 159 670	14 995 096	471 262	6 050 873	8 803 400 205	3 136 438 795	11 939 839 000
Horticultural crops	109 576	1 401 291	291 417	6 024 464	1 570 311 153	9 608 364 447	11 178 675 600
Total[i]	3 269 246	16 396 387	762 679	12 075 336	10 373 711 358	12 744 803 242	23 118 514 600

[i] Where figures have been rounded, discrepancies may occur with totals.

5. South Africa's water situation (continued)

The Olifants/Doring WMA had the highest total production for horticultural crops of approximately R2 179 million for 2002. The Olifants/Doring WMA also had the largest irrigated area of about 0,058 million ha which in turn gave it the highest irrigated production of approximately 1 million tons to the value of just over R2 006 million.

Table 10: Summary of horticultural crop production for South Africa, 2002 by water management area[8]

Water management areas	Dryland area ha	Dryland production tons	Irrigated area ha	Irrigated production tons	Dryland production Rands	Irrigated production Rands	Total production Rands
1 Limpopo	336	2 167	7 866	168 421	3 401 782	198 896 018	202 297 800
2 Luvuvhu to Letaba	4 879	38 887	8 110	116 278	66 477 802	183 657 498	250 135 300
3 Crocodile West and Marico	1 023	26 823	5 952	120 436	26 934 091	191 108 409	218 042 500
4 Olifants	12 875	137 175	49 045	997 626	262 157 402	1 692 734 698	1 954 892 100
5 Inkomati	2 248	15 887	18 517	406 815	36 026 596	610 283 504	646 310 100
6 Usutu to Mhlatuze	4 239	14 298	5 221	126 303	27 018 930	150 592 670	177 611 600
7 Thukela	925	11 264	1 732	43 106	12 245 767	55 825 133	68 070 900
8 Upper Vaal	10 523	550 522	14 127	316 473	190 402 250	482 957 150	673 359 400
9 Middle Vaal	2 429	34 949	2 050	39 150	46 130 340	51 878 060	98 008 400
10 Lower Vaal	1 860	17 925	16 869	385 662	38 805 232	701 034 468	739 839 700
11 Mvoti to Umzimkulu	1 452	28 028	4 078	75 370	25 095 121	117 481 479	142 576 600
12 Mzimvubu to Keiskamma	2 699	46 394	2 167	56 641	72 344 289	81 321 211	153 665 500
13 Upper Orange	4 453	87 228	5 795	227 354	75 690 672	182 638 228	258 328 900
14 Lower Orange	1 004	1 730	2 973	31 591	5 689 118	74 883 382	80 572 500
15 Fish to Tsitsikamma	6 076	91 122	14 966	298 738	75 466 889	349 203 211	424 670 100
16 Gouritz	7 847	52 031	17 788	319 872	77 384 800	510 507 700	587 892 500
17 Olifants/Doring	19 435	107 044	57 901	1 331 445	172 678 229	2 006 153 071	2 178 831 300
18 Breede	18 710	91 832	47 678	808 996	220 963 409	1 709 261 391	1 930 224 800
19 Berg	6 563	45 988	8 585	154 186	135 398 432	257 947 168	393 345 600
Total[i]	109 576	1 401 291	291 417	6 024 464	1 570 311 153	9 608 364 447	11 178 675 600

[i] Where figures have been rounded, discrepancies may occur with totals.

5. South Africa's water situation (continued)

For field crops, the Upper Vaal WMA had the highest total production of approximately R2 669 million for 2002. The Upper Vaal WMA also had the largest dryland area of about 0,867 million ha. The Upper Vaal WMA had the second highest dry land production of approximately 3 million tons to the value of just over R2 408 million.

Table 11: Summary of field crop production for South Africa, 2002 by water management area[8]

		Dryland area	Dryland production	Irrigated area	Irrigated production	Dryland production	Irrigated production	Total production
Water management areas		ha	tons	ha	tons		Rands	
1	Limpopo	12 020	23 427	13 959	65 675	38 911 224	113 476 076	152 387 300
2	Luvuvhu to Letaba	1 291	3 512	848	10 915	1 789 987	3 980 213	5 770 200
3	Crocodile West and Marico	4 718	10 144	15 239	71 292	11 153 292	126 073 208	137 226 500
4	Olifants	192 896	468 296	62 418	323 340	500 510 821	573 482 979	1 073 993 800
5	Inkomati	1 376	45 286	17 237	1 295 050	8 233 096	252 775 104	261 008 200
6	Usutu to Mhlatuze	127 889	1 984 646	36 752	1 100 309	538 349 716	254 866 284	793 216 000
7	Thukela	57 219	1 517 093	16 077	504 871	290 247 974	109 828 226	400 076 200
8	Upper Vaal	866 917	2 520 092	49 096	255 583	2 408 057 767	260 897 433	2 668 955 200
9	Middle Vaal	740 394	1 830 119	24 648	128 313	2 043 345 425	160 910 375	2 204 255 800
10	Lower Vaal	143 991	327 411	39 983	242 077	341 596 409	242 163 191	583 759 600
11	Mvoti to Umzimkulu	110 204	4 056 273	12 662	503 519	754 541 888	88 535 912	843 077 800
12	Mzimvubu to Keiskamma	23 160	263 431	7 216	154 202	59 794 738	35 058 762	94 853 500
13	Upper Orange	378 899	921 359	77 681	419 067	787 206 120	481 849 180	1 269 055 300
14	Lower Orange	10 049	27 966	23 835	158 983	31 819 189	195 911 711	227 730 900
15	Fish to Tsitsikamma	15 206	40 273	13 244	74 662	21 532 479	41 766 321	63 298 800
16	Gouritz	69 311	130 161	25 911	75 424	79 078 304	29 277 396	108 355 700
17	Olifants/Doring	158 580	296 662	22 090	633 209	303 295 294	135 617 506	438 912 800
18	Breede	101 395	231 464	3 953	13 712	223 077 047	8 712 353	231 789 400
19	Berg	144 155	297 483	8 414	20 671	360 859 437	21 256 563	382 116 000
	Total[i]	3 159 670	14 995 096	471 262	6 050 873	8 803 400 205	3 136 438 795	11 939 839 000

[i] Where figures have been rounded, discrepancies may occur with totals.

5. South Africa's water situation (continued)

The Upper Vaal WMA had the highest total production for all crops amounting to approximately R3 342 million. Total production for all nineteen WMAs amounted to over R23 119 million, with dryland production totalling over R10 374 million and irrigated production totalling over R12 745 million.

Table 12: Summary of all crop production for South Africa, 2002 by water management area[8]

		Dryland area	Dryland production	Irrigated area	Irrigated production	Dryland production	Irrigated production	Total production
Water management areas		ha	tons	ha	tons		Rands	
1	Limpopo	12 355	25 594	21 825	234 096	42 313 007	312 372 093	354 685 100
2	Luvuvhu and Letaba	6 170	42 399	8 958	127 193	68 267 789	187 637 711	255 905 500
3	Crocodile West and Marico	5 741	36 967	21 191	191 728	38 087 383	317 181 617	355 269 000
4	Olifants	205 771	605 471	111 463	1 320 967	762 668 223	2 266 217 677	3 028 885 900
5	Inkomati	3 624	61 172	35 753	1 701 865	44 259 691	863 058 609	907 318 300
6	Usutu to Mhlatuze	132 128	1 998 945	41 973	1 226 611	565 368 646	405 458 954	970 827 600
7	Thukela	58 145	1 528 357	17 809	547 976	302 493 741	165 653 359	468 147 100
8	Upper Vaal	877 440	3 070 614	63 223	572 056	2 598 460 018	743 854 582	3 342 314 600
9	Middle Vaal	742 823	1 865 067	26 697	167 462	2 089 475 765	212 788 435	2 302 264 200
10	Lower Vaal	145 850	345 336	56 852	627 739	380 401 641	943 197 659	1 323 599 300
11	Mvoti to Umzimkulu	111 657	4 084 300	16 740	578 889	779 637 009	206 017 391	985 654 400
12	Mzimvubu to Keiskamma	25 859	309 825	9 383	210 843	132 139 027	116 379 973	248 519 000
13	Upper Orange	383 351	1 008 587	83 476	646 421	862 896 792	664 487 408	1 527 384 200
14	Lower Orange	11 053	29 696	26 808	190 574	37 508 307	270 795 093	308 303 400
15	Fish to Tsitsikamma	21 282	131 395	28 210	373 400	96 999 368	390 969 532	487 968 900
16	Gouritz	77 158	182 192	43 699	395 296	156 463 104	539 785 096	696 248 200
17	Olifants/Doring	178 015	403 706	79 991	1 964 655	475 973 523	2 141 770 577	2 617 744 100
18	Breede	120 105	323 295	51 631	822 708	444 040 456	1 717 973 744	2 162 014 200
19	Berg	150 719	343 471	16 999	174 857	496 257 869	279 203 731	775 461 600
	Total[i]	3 269 246	16 396 387	762 679	12 075 336	10 373 711 358	12 744 803 242	23 118 514 600

[i] Where figures have been rounded, discrepancies may occur with totals.

5. South Africa's water situation (continued)

Water use by irrigation in the agriculture sector was approximately 6 907 million m^3 in 2002. This was 87% of the total irrigation water allocation of 7 920 million m^3 reported by the DWA in its NWRS. Irrigation water payments varied between 0,60 cents per m^3 water in the Luvuvhu to Letaba WMA to 6,90 cents per m^3 water in the Breede WMA. Irrigation production per water use was R1,80 per m^3 for the country as a whole and varied from a low of R0,90 per m^3 in the Usutu to Mhlatuze WMA to R4,60 per m^3 in the Breede WMA.

Table 13: Summary of irrigation water use for all crops per water management area for 2002[8]

	Water management areas	Weighted average irrigation allocation	Estimated irrigation water use	Irrigation water purchased	Cost of irrigation water	Irrigated production per water use
		m^3/ha	m^3	Rands	cents/m^3	Rands per m^3
1	Limpopo	7 725	168 602 202	1 819 400	1,1	1,90
2	Luvuvhu to Letaba	9 622	86 190 884	528 900	0,6	2,20
3	Crocodile West and Marico	6 977	147 858 418	5 932 700	4,0	2,10
4	Olifants	8 300	925 196 793	17 034 400	1,8	2,40
5	Inkomati	10 064	359 810 260	5 381 600	1,5	2,40
6	Usutu to Mhlatuze	11 150	468 008 927	7 883 800	1,7	0,90
7	Thukela	7 700	137 126 990	1 193 000	0,9	1,20
8	Upper Vaal	7 211	455 888 149	8 009 900	1,8	1,60
9	Middle Vaal	6 762	180 540 943	5 026 000	2,8	1,20
10	Lower Vaal	9 111	517 983 239	23 137 500	4,5	1,80
11	Mvoti to Umzimkulu	4 600	77 002 620	2 558 100	3,3	2,70
12	Mzimvubu to Keiskamma	7 642	71 706 660	761 300	1,1	1,60
13	Upper Orange	9 975	832 631 624	19 595 000	2,4	0,80
14	Lower Orange	14 347	384 614 358	4 809 600	1,3	0,70
15	Fish to Tsitsikamma	11 651	328 673 347	11 031 600	3,4	1,20
16	Gouritz	6 987	305 340 806	9 444 000	3,1	1,80
17	Olifants/Doring	12 000	959 890 800	26 451 300	2,8	2,20
18	Breede	7 223	372 918 774	25 685 500	6,9	4,60
19	Berg	7 467	126 921 070	5 517 300	4,3	2,20
	Total[i]		6 906 906 864	181 800 900		

[i] Where figures have been rounded, discrepancies may occur with totals.

5. South Africa's water situation (continued)

5.8 Mining sector

Total water use by the mining sector was valued at approximately R340 million in 2004. The average price paid for water by the mining sector was estimated at approximately 8,77 cents per m^3. The largest water users were gold and uranium, chrome, manganese and other metal ores, the platinum group metals, and iron ore and coal.

Table 14: Water use by value and volume in the mining sector, 2004[8]

Mining Sector	Water use Rand (million)	Estimated price cents per m^3	Water use million m^3
Gold and uranium	185,45	8,77	211,51
Chrome, manganese and other metal ores	52,99	8,77	60,43
Platinum Group Metals	43,72	8,77	49,86
Iron ore	24,57	8,77	28,02
Coal	23,51	8,77	26,82
Stone quarrying, clay and sandpits	2,89	8,77	3,30
Diamonds	1,40	8,77	1,59
Phosphate and other chemicals	1,19	8,77	1,36
Limestone	0,86	8,77	0,99
Dimension stone	0,42	8,77	0,48
Other mining	3,19	8,77	3,64
Total[i]	340,20		388,00

[i] Where figures have been rounded, discrepancies may occur with totals.

5. South Africa's water situation (continued)

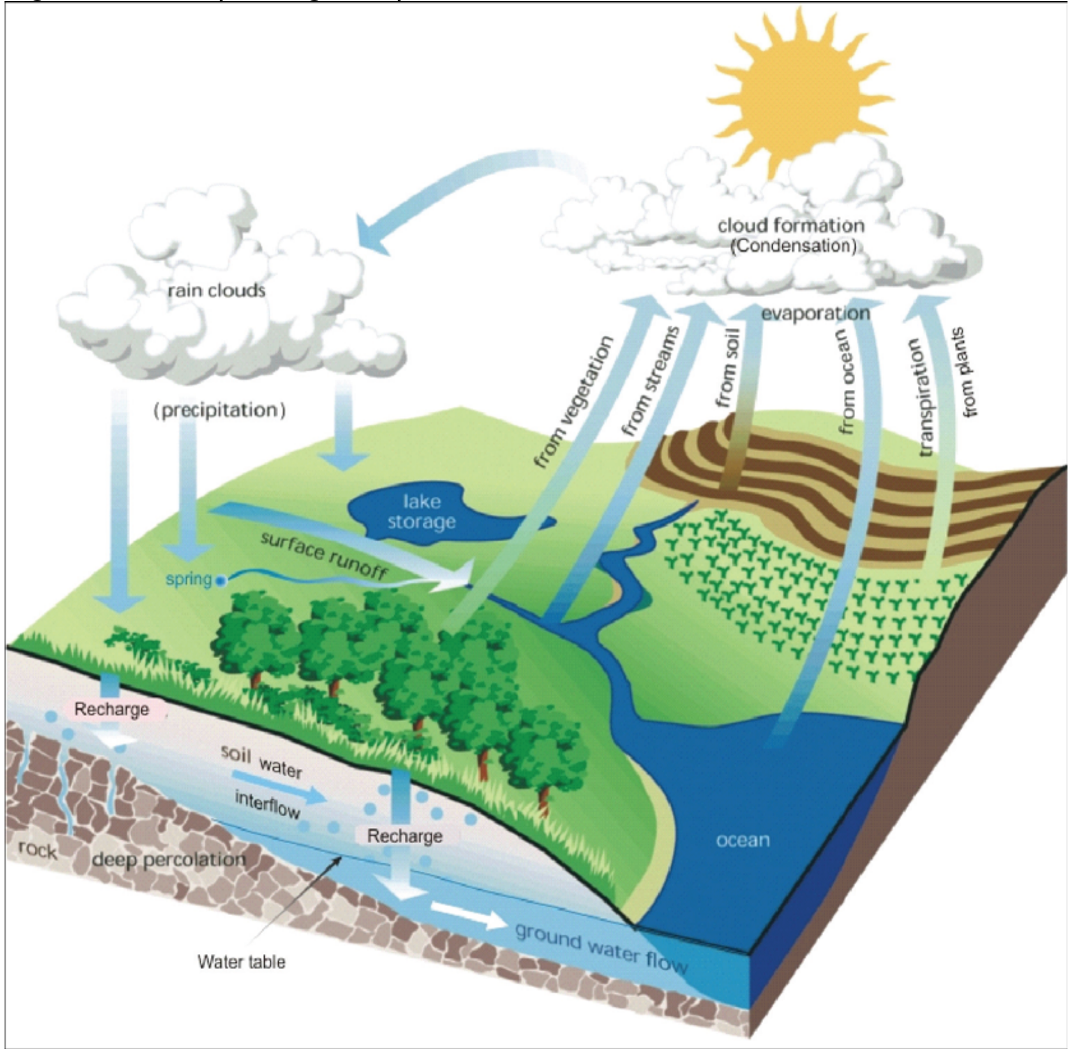
5.9 Business services, construction, personal services, and accommodation sectors

The business sector consumed water to the value of approximately R323 million in 2006 at an estimated price of R5,29 per m^3 with a total volume of about 61 million m^3. The construction sector is a relatively small water user that consumed water to the value of approximately R21 million in 2004 at an estimated water price of R5,29 per m^3 with a total volume of about 4 million m^3. The personal services sector consumed water to the value of approximately R144 million in 2004 at an estimated price of R5,29 per m^3 with a total volume of about 27 million m^3. The accommodation sector is also a relatively small water user that consumed water to the value of approximately R6 million in 2004 at an estimated price of R5,29 per m^3 with a total volume of about 1 million m^3.

Table 15: Water use by value and volume in the construction, business and personal services, and accommodation sectors, 2004 and 2006[8]

Sector	Year	Water use Rand (million)	Water price Rand per m^3	Water volume million m^3
Business	2006	322,82	5,29	61,02
Construction	2004	21,07	5,29	3,98
Personal Service	2004	144,24	5,29	27,27
Accommodation	2004	5,81	5,29	1,10

Figure 1: The hydrological cycle[5]



6. Overview of the 19 water management areas in South Africa

South Africa's water resources are currently allocated to 19 WMAs covering the country, and because of the uneven distribution of water resources, a significant amount of water transfer needs to take place between WMAs, both nationally and internationally (Map 2). Substantial transfers take place from the Upper Orange to the Lower Orange (1 886 million m^3/annum), the Upper Vaal to the Middle Vaal (790 million m^3/annum), and from Lesotho into the Upper Vaal (600 million m^3/annum) (see Table 18 for details of total transfers).[5]

Most of South Africa's water requirements are provided by surface water supplies from rivers and dams. Generally, these surface water resources are highly developed over the country, with about 320 major dams having a total capacity of more than 32 400 million m^3, which is some 66% of the total mean annual runoff (MAR) of about 49 000 m^3/annum. This includes about 4 800 million m^3/annum draining from Lesotho into South Africa and a further 500 million m^3/annum draining from Swaziland to South Africa. A portion of this runoff (typically about 20%) needs to remain in rivers and estuaries to support the ecological component of the Reserve[b]. Only part of the remainder can be harnessed effectively as a usable yield[c]. The usable yield may be further constrained by sources of pollution, such as irrigation return flows, urban drainage, and industrial and mining activities.[5]

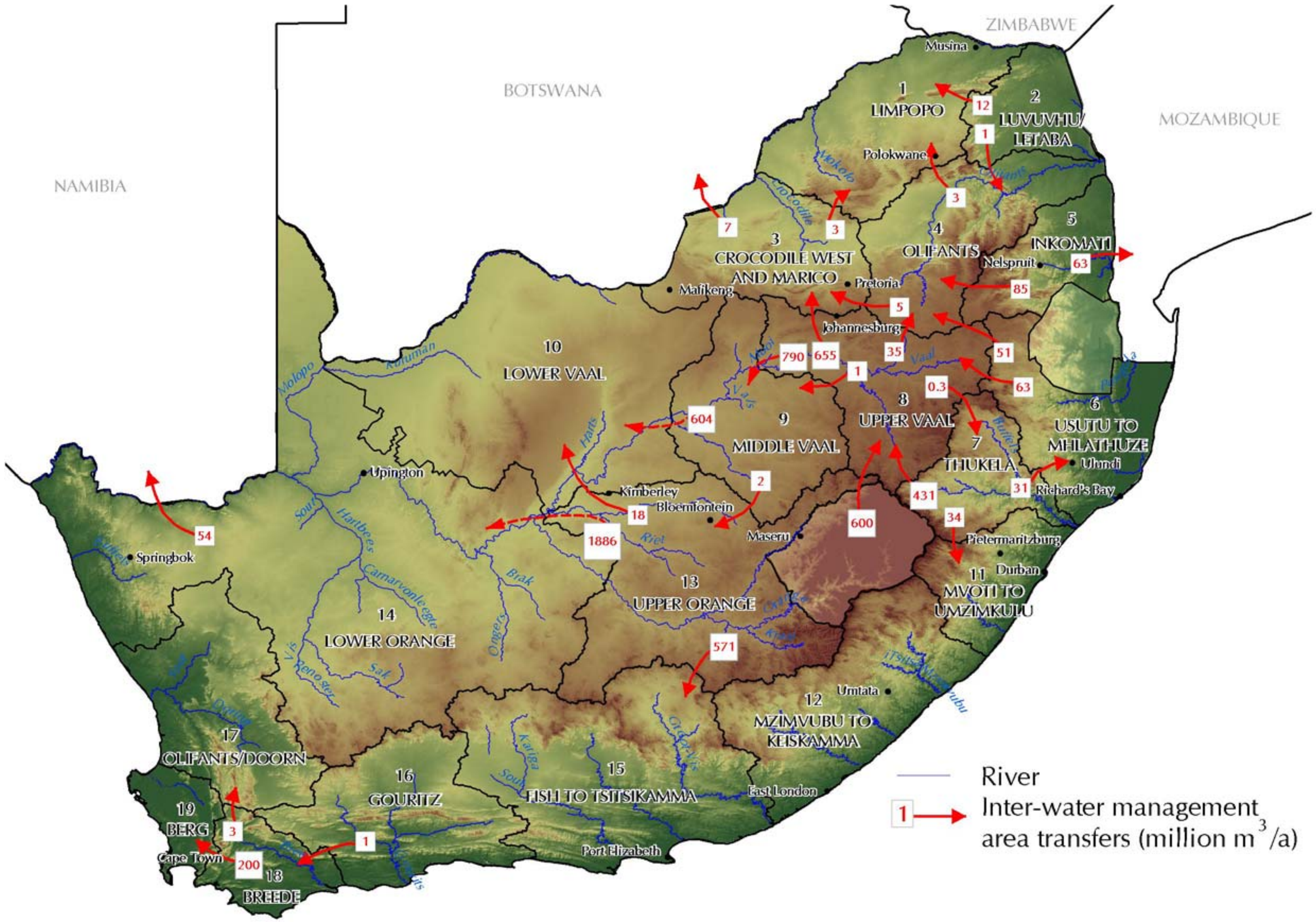
Table 16 indicates the relevant contributions of different water components (surface water, groundwater, and return flows) to the available yield in each of the WMAs. The local yield is calculated from the contribution of both natural resources and usable return flows (irrigation, urban, and mining/industrial). It should be noted that substantial volumes of water are returned to streams after use; the water is then available for re-use, provided that the quality of the return flows satisfy the relevant user requirements. The total usable return flows are close to twice the current yield from groundwater sources. The deficit in yields over time from surface water in the Middle Vaal, Lower Vaal, and Lower Orange WMAs indicate that river losses due to evaporation and seepage are greater than the additional yield contributed by local runoff in these areas.[7]

Although the yield indicated in Table 16 takes account of the estimated allowance for protecting aquatic ecosystems (that is, the ecological Reserve), insufficient knowledge of the functioning and habitat requirements of these systems exist. Catchments have different characteristics, and the estimates of requirements needed to sustain each aquatic ecosystem component of a Reserve vary from 12 to 30% of the total river flow in drier parts of the country. Estuarine requirements are difficult to estimate and not understood very well.[5, 7]

Appendix A provides more detail on the characteristics, uses, reconciliations, key requirements and inter-water management area transfers of each of the 19 WMAs.

[b] The Reserve is the volume and quality of water required for satisfying basic human needs and for maintaining aquatic ecosystems.
[c] The yield is the volume of water that can be abstracted at a certain rate over a specified period of time for supply purposes.

Map 2: Water management areas and inter-basin transfers[5, 7]



7. Water requirements

An appropriate understanding of water use requirements is essential for managing water resources judiciously. What complicates this understanding is the large variation in water requirements across the country, as different sectors have different needs in terms of quantity, quality, temporal distribution, and assurance of supply. Factors to be taken into account are the divergent social and economic values associated with water, the ability to pay, and priorities with regard to the provision of water.[5]

7.1 Current water requirements

Estimated water requirements for the year 2000 for the different water use sectors are shown in Table 17. For ease of comparison with Table 16, the quantities are standardised at a 98% assurance of supply[d].

Comparison of the requirements (in Table 17) with return flows (in Table 16) shows that much of the water is used consumptively. Agricultural irrigation accounts for about 62% of South Africa's total water requirement, with urban requirements needing about 23%. The remaining 15% is shared by the other four sectors, namely rural users, mining and bulk industrial, power generation and afforestation. Only part of the water used non-consumptively becomes available for re-use, with large quantities of effluent return flows being discharged to the ocean, particularly from urban and bulk industrial users in coastal areas. Water use in the rural areas, as well as for irrigation and thermal power generation, is predominantly consumptive.

Although irrigation activities uses the major share of water in South Africa, its economic impact per unit of water used, seems to be substantially lower than in other sectors. In other words, its economic contribution is small in relation to the quantity of water used. A similar situation exists in mining.[5]

Groundwater use has increased dramatically, from approximately 684 million m^3 in 1950 to 1 770 million m^3 in 2004, mainly due to increased irrigation. Nationally, irrigation comprises over 64% of groundwater use, while mining and domestic consumption in urban and rural areas, each use 8%. Groundwater is used for different purposes in various parts of the country, according to patterns of land use. Irrigation is the largest user in many of the WMAs, but groundwater is used for mining in the Highveld, while domestic use in rural areas occurs in KwaZulu-Natal, the Eastern Cape, Mpumalanga, and Limpopo (see Map 3).[5]

[d]The amount of water that can be abstracted for 98 out of 100 years on average is referred to as 'the yield at a 98 percent assurance of supply'.

Table 16: Available yield in 2000 (million m^3/annum)[5, 7]

Water management areas		Natural Resource		Usable return flow			
		Surface water[i]	Ground water[ii]	Irrigation	Urban	Mining and bulk industrial	Total local yield
				million m^3			
1	Limpopo	160	98	8	15	0	281
2	Luvuvhu and Letaba	244	43	19	4	0	310
3	Crocodile West and Marico	203	146	44	282	41	716
4	Olifants	410	99	44	42	14	609
5	Inkomati	816	9	53	8	11	897
6	Usutu to Mhlatuze	1 019	39	42	9	1	1 110
7	Thukela	666	15	23	24	9	737
8	Upper Vaal	598	32	11	343	146	1 130
9	Middle Vaal	-67	54	16	29	18	50
10	Lower Vaal[iii]	-54	126	52	0	2	126
11	Mvoti to Umzimkulu	433	6	21	57	6	523
12	Mzimvubu to Keiskamma	777	21	17	39	0	854
13	Upper Orange	4 311	65	34	37	0	4 447
14	Lower Orange[iii]	-1 083	24	96	1	0	-962
15	Fish to Tsitsikamma	260	36	103	19	0	418
16	Gouritz	191	64	8	6	6	275
17	Olifants/Doring	266	45	22	2	0	335
18	Breede	687	109	54	16	0	866
19	Berg	403	57	11	37	0	508
	Total for South Africa	10 240	1 088	678	970	254	13 230

Notes:

Transfers into and out of water management areas are not included above but are covered in Table 18.

[i] Yield from run-of-river and existing storage, after allowance for the impacts on yield of the ecological component of the Reserve, river losses, alien vegetation, rain-fed sugar cane, and urban run-off.

[ii] Estimated use from existing boreholes and springs. Total groundwater use may exceed this estimate as a result of development of groundwater for irrigation since the compilation of the database for the NWRS. Increase is due mainly to growth in irrigation water requirements, and therefore does not impact significantly on the overall water balances given in the NWRS.

[iii] Negative figures under surface water arising from river losses being larger than the incremental runoff from within the water management area.

Table 17: Water requirements for the year 2000 (million m^3/annum)[5, 7]

	Water management areas	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
					million m^3			
1	Limpopo	238	34	28	14	7	1	322
2	Luvuvhu and Letaba	248	10	31	1	0	43	333
3	Crocodile West and Marico	445	547	37	127	28	0	1 184
4	Olifants	557	88	44	94	181	3	967
5	Inkomati	593	63	26	24	0	138	844
6	Usutu to Mhlatuze	432	50	40	91	0	104	717
7	Thukela	204	52	31	46	1	0	334
8	Upper Vaal	114	635	43	173	80	0	1 045
9	Middle Vaal	159	93	32	85	0	0	369
10	Lower Vaal	525	68	44	6	0	0	643
11	Mvoti to Umzimkulu	207	408	44	74	0	65	798
12	Mzimvubu to Keiskamma	190	99	39	0	0	46	374
13	Upper Orange	780	126	60	2	0	0	968
14	Lower Orange	977	25	17	9	0	0	1 028
15	Fish to Tsitsikamma	763	112	16	0	0	7	898
16	Gouritz	254	52	11	6	0	14	337
17	Olifants/Doring	356	7	6	3	0	1	373
18	Breede	577	39	11	0	0	6	633
19	Berg	301	389	14	0	0	0	704
	Total for South Africa	7 920	2 897	574	755	297	428	12 871
		62%	23%	4%	6%	2%	3%	100%

Notes:

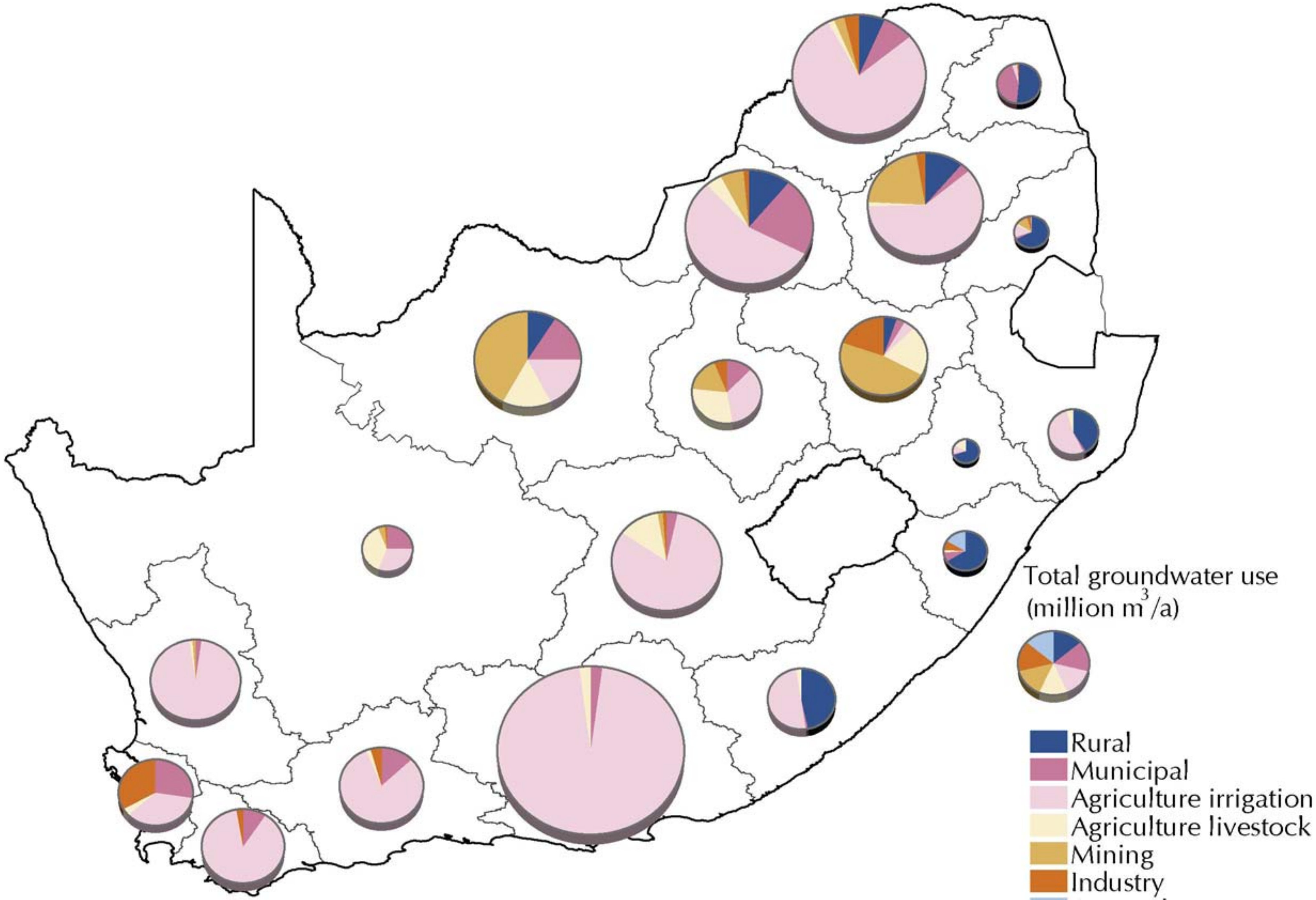
[i] Includes the component of the Reserve for basic human needs at 25 litres/person/day.

[ii] Mining and bulk industrial that are not part of urban systems.

[iii] Includes water for thermal power generation only, since water used for hydropower, which represents only a small portion of power generation in South Africa, remains available, unchanged, for further use. For ease of direct comparison with Eskom data, these numbers have not been adjusted for assurance of supply. The quantitative impact is not large.

[iv] Quantities given refer to impact on yield only. The incremental water use in excess of that of natural vegetation is estimated at 1 460 million m^3/annum.

Map 3: Sectoral groundwater use (million m³/annum) per water management area[5]



7. Water requirements (continued)

7.1 Current water requirements (continued)

Table 18 provides a reconciliation of available water and total requirements for the year 2000, including transfers between WMAs and to neighbouring countries. Deficits exist in more than half of the WMAs, but there is a surplus for the country as a whole. This situation highlights the regional differences in the country and reveals the potential risks of generalisation. Similarly, a surplus or a deficit shown in a specific WMA is unlikely to be representative of the entire area, and anomalies are most likely to occur in some catchments or smaller areas within a larger WMA. Furthermore, the water availability and water balance figures are related to current water use patterns and the existing geographic occurrence of resources, abstractions, and return flows. Often it is not practical or economically feasible for water to be transferred from areas of surplus to areas of deficit. Imbalances within WMAs will be handled according to catchment management strategies to be formulated by the relevant catchment management agencies.[5, 7]

In many cases, the deficits shown do not necessarily imply that water use exceeds the amount that is available, but rather that the allowances made for implementing the ecological component of the Reserve cannot fully be met at current levels of use. The requirements for the Reserve are estimates at present, and further research is needed to understand the ecosystem requirements sufficiently. The Reserve has not yet been implemented. The planned approach is to phase it in, so as to diminish the likelihood of adverse effects on existing users. Nevertheless, in many areas, current levels of use make no allowance for the need to sustain the ecological viability of the resource, and substantial changes will be needed when the Reserve is implemented.[5, 7]

In summary, approximately 9 500 million m^3/annum of the total requirements for water of 12 871 million m^3/annum is abstracted from surface water resources. The remainder comes from groundwater, the re-use of return flows, and the interception of water by afforestation. Total requirements, therefore, represent approximately 20% of the total MAR of 49 040 million m^3/annum. A further 8% is lost by evaporation from storage and conveyance along rivers, and 6% through land use. Country-wide, approximately 66% of the natural river flow (MAR) remains in the rivers. Typically, the temporal flow distribution of this remaining water has been significantly altered as a result of upstream regulation and use, and it no longer reflects the characteristics of the natural stream flow. It does however meet substantial requirements of the Reserve and fulfils downstream international commitments. Potential also exists for part of the remaining water to be abstracted for allocation to users, provided that sufficient infrastructure exists, or can be developed. Should the surface resources be developed to their full, but feasible potential, more than 50% of the MAR can still remain in the rivers. Serious questions that require attention include the consideration of what likely future escalation in water requirements should be provided for, and what strategies need to be developed to ensure that these future requirements can be met.[5, 7]

Table 18: Reconciliation of the requirements for and availability of water for year 2000 (million m^3/annum)[5, 7]

	Water management areas	Reliable local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i, ii]
				million m^3		
1	Limpopo	281	18	322	0	-23
2	Luvuvhu and Letaba	310	0	333	13	-36
3	Crocodile West and Marico	716	519	1 184	10	41
4	Olifants	609	172	967	8	-194
5	Inkomati	897	0	844	311	-258
6	Usutu to Mhlatuze	1 110	40	717	114	319
7	Thukela	737	0	334	506	-103
8	Upper Vaal	1 130	1 311	1 045	1 379	17
9	Middle Vaal	50	829	369	502	8
10	Lower Vaal	126	548	643	0	31
11	Mvoti to Umzimkulu	523	34	798	0	-241
12	Mzimvubu to Keiskamma	854	0	374	0	480
13	Upper Orange	4 447	2	968	3 149	332
14	Lower Orange	-962	2 035	1 028	54	-9
15	Fish to Tsitsikamma	418	575	898	0	95
16	Gouritz	275	0	337	1	-63
17	Olifants/Doring	335	3	373	0	-35
18	Breede	866	1	633	196	38
19	Berg	505	194	704	0	-5
South Africa[ii]		13 227	0	12 871	170	186

Notes:

[i] Surpluses in the Vaal and Orange Water Management Areas are shown in the most upstream water management area where they become available (namely, the Upper Vaal and Upper Orange Water Management Areas).

[ii] Transfers into and out of water management areas may include transfers between water management areas as well as to or from neighbouring countries. Yields transferred from one water management area to another may also not be numerically equivalent in the source and recipient water management area. For this reason, the total of transfers into and out of water management areas does not necessarily correspond to the country total. The transfer of water from Lesotho to South Africa is reflected in the tables as being from the Upper Orange Water Management Area (Appendix D13 of NWRS).

7. Water requirements (continued)

7.2 Future water requirements

Many factors, including climate, the nature of the economy, and standards of living, will influence South Africa's future water requirements. Changes in population and economic growth are regarded as the primary determinants of future water requirements.

Changes in national policies since 1994, and the influence of global economic trends on South Africa, have led to population migration into some areas and population loss from others. Urbanisation and the adverse effects of the human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS) are recognized as strong contributory factors. Scenarios developed for population growth up to 2025 have indicated a decline in general population growth towards the end of this period, with small to negative growth in the rural population. Similar scenarios have been developed for economic growth and its influence on future water requirements. Economic growth (and the growth in water requirements) is, not surprisingly, expected to be substantially higher in the larger urban and industrialized areas than in the rural areas. An upper scenario of average real growth in GDP of 4,0% per year has been seen as a conservative indicator, to forestall any likelihood of unexpected water shortages. This compares with a low growth scenario of about 1,5% per year. Both these scenarios have been used in the NWRS for developing strategies to balance future water supply and demand.[5, 7]

Future growth in water demand is expected to occur in the economically more favourably located urban areas, given the general trends towards urbanisation and continued economic growth. Relatively strong growth is expected in the mining sector, with water demand for mineral exploitation concentrated in South Africa's northern regions. The base scenario[e] comprises the high scenario of population growth, together with higher average levels of urban domestic water requirements (this occurs because demand and consumption increase as people become better off through more equitable distribution of wealth). The ratio of domestic to commercial, communal, and industrial water use in urban centres in the year 2000 is maintained in this scenario. The upper limit scenario is based on the same assumption of high population growth and the high standard of service provision that arises from rapid socio-economic development. These are combined with strong economic growth in which commercial, communal, and industrial water use increases in direct proportion to growth in GDP. The upper scenario serves as a conservative indicator, factoring in possible unexpected water shortages.[5, 7]

[e]The Base Scenario is a scenario used in the National Water Resources Strategy to estimate the most likely future water requirements.

8. Strategies to balance supply and demand

Tables 19 and 20 show the reconciliation of requirements and availability of water for the year 2025 for the base scenario (1,5% GDP growth rate per year) and high scenario (4,0% GDP growth rate per year). These scenarios provide for known and anticipated future developments in irrigation, mining, and bulk use, as well as projections from the Electricity Supply Commission of South Africa (Eskom) of future water requirements for power generation.

The base scenario, which is regarded as the more probable, does not show a pronounced deviation from the situation in the year 2000. Deficits will increase under both scenarios, while surpluses will diminish. Total deficits in water resources range between 234 million m^3/annum for the base scenario and 2 044 million m^3/annum for the high scenario. It is expected that future growth in water requirements will be largely in the main metropolitan centres. Apart from catchments already under stress, particular attention will therefore have to be given to ensuring adequate future water supplies to these areas, as well as ensuring equitable access to existing supplies.

Water that is potentially identified as available for supply (primarily through the construction of new storage dams and the use of groundwater) amounts to 5 410 million m^3/annum. Water is thus not currently regarded as a limiting factor to economic growth. Nonetheless, the discussed deficits could increase, taking account of the potential effects of climate change, and allowing for the fact that allocations for the ecological Reserve have not yet been fully implemented. In addition, it is questionable whether or not the further development of water resources will address imbalances, given unequal geographic distribution of water resources, the relevant technological requirements that are necessary for corrections, and the capacity constraints of the DWA. Such development will need to be carefully managed to ensure protection of aquatic ecosystems and other habitats. Issues to be considered include: the implications of transferring water between areas and across catchments (for example, changes in flows, transfer of species, varying chemistry); variable rainfall across the country and over time; loss of land with agricultural potential; loss of areas of high biodiversity including aquatic systems; and climate change, which could exacerbate potential problems.[5, 7]

Table 19: Reconciliation of requirements for and availability of water for the year 2025 base scenario (million m³/annum)[5, 7]

	Water management areas	Reliable local yield[i]	Transfers in[iv]	Local requirements[ii]	Transfers out[iv]	Balance[iv]	Potential for development[iii]
				million m³			
1	Limpopo	281	18	347	0	-48	8
2	Luvuvhu and Letaba	404	0	349	13	42	102
3	Crocodile West and Marico	846	727	1 438	10	125	0
4	Olifants	630	210	1 075	7	-242	239
5	Inkomati	1 028	0	914	311	-197	104
6	Usutu to Mhlatuze	1 113	40	728	114	311	110
7	Thukela	742	0	347	506	-111	598
8	Upper Vaal	1 229	1 630	1 269	1 632	-42	50
9	Middle Vaal	55	838	381	503	9	0
10	Lower Vaal	127	571	641	0	57	0
11	Mvoti to Umzimkulu	555	34	1 012	0	-423	1 018
12	Mzimvubu to Keiskamma	872	0	413	0	459	1 500
13	Upper Orange	4 734	2	1 059	3 589	88	900
14	Lower Orange	-956	2 082	1 079	54	-7	150
15	Fish to Tsitsikamma	456	603	988	0	71	85
16	Gouritz	278	0	353	1	-76	110
17	Olifants/Doring	335	3	370	0	-32	185
18	Breede	869	1	638	196	36	124
19	Berg	568	194	829	0	-67	127
South Africa[iv]		14 166	0	14 230	170	-234	5 410

Notes:

[i] Based on infrastructure in existence, and under construction, in the year 2000. Return flows resulting from a growth in requirements are included.

[ii] The assumed growth in urban and rural water requirements results from the anticipated high population growth and current ratios of domestic to public and business water use. Allowance has been made for known developments in urban, industrial, and mining sectors only, with no general increase in irrigation.

[iii] For more detail for each water management area, refer to the corresponding tables in Appendix A of this document and Appendix D of the NWRS.

[iv] Transfers into and out of water management areas may include transfers between water management areas as well as to or from neighbouring countries. Yields transferred from one water management area to another may also not be numerically equivalent in the source and recipient water management area. For this reason, the total of transfers into and out of water management areas does not necessarily correspond to the country total. The transfer of water from Lesotho to South Africa is reflected in the tables as being from the Upper Orange Water Management Area (Appendix D13 of NWRS).

Table 20: Reconciliation of requirements for and availability of water for the year 2025 high scenario (million m^3/annum)[5, 7]

Water management areas		Reliable local yield[i]	Transfers in[iv]	Local requirements[ii]	Transfers out[iv]	Balance[iv]	Potential for development[iii]
				million m^3			
1	Limpopo	295	23	379	0	-61	8
2	Luvuvhu and Letaba	405	0	351	13	41	102
3	Crocodile West and Marico	1 084	1 159	1 898	10	335	0
4	Olifants	665	210	1 143	13	-281	239
5	Inkomati	1 036	0	957	311	-232	104
6	Usutu to Mhlatuze	1 124	40	812	114	238	110
7	Thukela	776	0	420	506	-150	598
8	Upper Vaal	1 486	1 630	1 742	2 138	-764	50
9	Middle Vaal	67	911	415	557	6	0
10	Lower Vaal	127	646	703	0	70	0
11	Mvoti to Umzimkulu	614	34	1 436	0	-788	1 018
12	Mzimvubu to Keiskamma	886	0	449	0	437	1 500
13	Upper Orange	4 755	2	1 122	3 678	-43	900
14	Lower Orange	-956	2 100	1 102	54	-12	150
15	Fish to Tsitsikamma	452	653	1 053	0	52	85
16	Gouritz	288	0	444	1	-157	110
17	Olifants/Doring	337	3	380	0	-40	185
18	Breede	897	1	704	196	-2	124
19	Berg	602	194	1 304	0	-508	127
South Africa[iv]		14 940	0	16 814	170	-2 044	5 410

Notes:

[i] Based on infrastructure in existence and under construction in the year 2000. Also includes return flows resulting from a growth in requirements.

[ii] Urban and rural requirements based on high growth in water requirements as a result of population growth and the high impact of economic development. Allowance has been made for known developments in urban, industrial, and mining sectors only, with no general increase in irrigation.

[iii] For more detail for each water management area, refer to the corresponding tables in Appendix A of this document and Appendix D of NWRS.

[iv] Transfers into and out of water management areas may include transfers between water management areas as well as to or from neighbouring countries. Yields transferred from one water management area to another may also not be numerically equivalent in the source and recipient water management area. For this reason, the total of transfers into and out of water management areas does not necessarily correspond to the country total. The transfer of water from Lesotho to South Africa is reflected in the tables as being from the Upper Orange water management area (Appendix D13 of NWRS).

9. Reconciliation interventions

The main interventions for balancing the requirements and availability of water are summarised below. In practice, varying combinations of the intervention options outlined here may be employed, depending on suitability for each WMA.[5, 7]

- Control of invasive alien vegetation. Provisional estimates quoted in the NWRS indicate that about 1 400 million m^3/annum of surface runoff (about 3% of the national MAR) is intercepted by invasive alien vegetation. Without effective control, this impact is likely to increase. Typical catchment management strategies include the clearing of alien vegetation as part of the Working for Water Programme.

- Demand management. This is a response to a situation in which the demand for water exceeds supply. Investment is made in resource development, often with increasing cost implications and environmental impacts. An effective alternative is the management of water demand, this having been applied with notable success to some users, particularly in selected areas of industry and agriculture. Compared with supply-side management, the management of water demand in South Africa is relatively unexploited. Investment in improving practices, technology, and capacity in water demand management is now a NWRS priority.

- Development of surface water resources. Significant opportunities still exist in many parts of the country for developing surface water resources further. These would typically be capital-intensive projects, however, tending to have a long pay-back period that could diminish the economical viability of such an investment. In many cases, it may be more economically attractive to induce changes in water-use patterns and to re-allocate water among users.

- Environmental considerations. As concerns water quality, all interventions on behalf of reconciliation need to take account of the potential impacts on the social and natural environment, and need to be assessed together with the technical and economic factors.

- Inter-catchment transfers. The country's geographical imbalances in water availability and requirements make inter-catchment transfer necessary in South Africa. More than half of the WMAs listed in Table 18 relies on inter-catchment transfers to avoid deficits in water supply. More water will inevitably need to be transferred in future.

- Managing groundwater resources. Under previous legislation, groundwater was deemed to be private water. Consequently, there has been limited investment in the assessment and management of this resource. Recent investigation reveals the considerable potential for developing small-localised supplies of groundwater in most parts of South Africa, to assist in reconciling future demand and supply imbalances. These systems are often particularly attractive, because of a minimal investment requirement for developing and treating this supply.

9. Reconciliation interventions (continued)

- **Re-allocation of water.** Water should ideally be exploited to best advantage to achieve the greatest overall benefit for the country, from a social, economic, and environmental perspective. Re-allocation of water can be effective in achieving these aims. It includes the option of moving water from lower to high benefit uses through trading water use authorisations, while preserving priorities such as the maintenance of food security. Managing the process effectively is critically important but reallocation may not be practicable in certain locations. A major consideration is the quantity and quality of the return flow, which may render the source unfit for other legitimate uses.

- **Re-use of water.** Approximately 50% of urban and industrial drainage is returned for re-use in urban and industrial areas such as Pretoria and Johannesburg. Coastal cities such as Cape Town and Durban re-use only 5 to 15% of urban and industrial drainage. Opportunities may be available for increasing the source of water substantially through additional re-use, provided appropriate treatment technology and quality control is are applied.

- **Water resource management.** Water resource deficits in more than half the WMAs in South Africa have made it necessary to develop more sophisticated systems of reservoir management and to use inter-catchment transfer to reduce risks of failure in supply. Scope now exists to improve the management of many of the smaller water resource systems; to revise operating strategies for the larger water resource systems to improve effectiveness; and to respond more constructively to any change.

- **Water-quality considerations.** Water quality is a fundamental consideration for all options, although it is not in itself an intervention that reconciles the imbalances between water supply and requirements. It is essential for water to be of appropriate quality for the uses intended as well as for the ecological Reserve. All interventions affect the water quality in some way and, in some cases, the blending of resources may be needed to maintain the quality that is fit for the intended use.

10. Other factors affecting availability and requirements

10.1 Land use

Changing patterns of land use affect water flows and water availability in the following ways:

- Urbanisation results in an increase in inflexible surfaces. These augment the volume of runoff entering surface waters and reduce the volume that recharges groundwater. Such runoff constitutes a new source of recharge, with further contributions from leaking water pipes or underground storage tanks, as well as from the over-irrigation of gardens and parks.
- The hydrological patterns (flow rate and volume) are significantly altered by human activities including the construction of dams, weirs, and bridges; canalisation or diversion of watercourses; and mining within watercourses.
- The misuse of land (including overgrazing) results in erosion, with increased sediment loads entering watercourses. The material tends to settle where water flows slowly, such as at dams and in wide river sections, thereby degrading ecosystems through silting, reducing the storage capacity of these facilities, and changing the flow dynamics of rivers.
- Alien vegetation in South Africa tends to consume greater volumes of water than indigenous vegetation, creating the risk of reduced yields in affected areas. Alien vegetation in some areas has been estimated to reduce stream flows by up to 10%. Alien vegetation removal in North West and Limpopo has resulted in a 20 m rise in the water table over a thirty-year period.[5]

10.2 Policy and regulation

Some of the structures and devices required to regulate South Africa's water resources are in place, through the terms of the National Water Policy 1997, the National Water Act No. 36 of 1998, and the Water Services Act No. 108 of 1997, amongst others. Historical lack of capacity and financial resources within the regulating bodies, however, has led to inconsistent management and a lack of widespread enforcement. Water-supply organisations should strive to supply water efficiently and effectively, minimise water losses (from reticulation leakage, for example) and promote water conservation and water demand management among their consumers.[5]

The National Water Act provides a key step in assisting the DWA to identify and control water abstraction. All existing water users are required to be registered. The time-period for registration has lapsed, so all users that are not covered by Schedule 1 of the Act, or by a General Authorization, or by a DWA registration/licence, are drawing water illegally. The DWA is in the process of issuing all the registered users with a water-use licence, based on the priority of the water-stressed nature of the WMAs, which stipulates the volumes to be abstracted and the conditions that apply to the abstractor. Allocation of water not already in use, as well as re-allocation of water to achieve equity and beneficial use, will form part of the licensing process. Guidelines have been drawn up to facilitate the equitable allocation and re-allocation of water. It is imperative for DWA to take strong action against illegal abstractors.[5]

10. Other factors affecting availability and requirements (continued)

10.3 Climate change

Climate change has the potential to make a significant impact on both the availability of and requirements for water in South Africa. The 2003 South African study on water resource management and climate change indicates that climate change is expected to alter hydrological systems and water resources in Southern Africa and reduce the availability of water.[5]

Rising temperatures and increasing variability of rainfall will generally affect surface waters, increasing drought in some regions and causing floods in others, as well as influencing groundwater recharge. There is likely to be a general decrease of 5 to 10% of present rainfall, with longer dry spells in the interior and north-eastern areas of the country coupled with more frequent and severe flood events. The probable effect is greater evapo-transpiration and more stress on arid and marginal zones.[5]

Recent models, using a local scale response to climate change, indicate more rainfall in the east than other global models[5]. Wetter conditions are generally expected over the eastern half of the country, particularly in the east coast regions, where topography plays a significant role. Portions of the Eastern Cape interior may experience increased late summer rainfall. Dryer conditions are expected in the west of the country, particularly around the Western Cape, which seems to be facing a shorter rainfall season, and in the far northern area of the country in Limpopo.[5]

Runoff is highly dependent upon changes in rainfall, and groundwater recharge even more so. Parts of South Africa could experience reductions in runoff and/or stream flow of up to 10%, which could be evident in the western parts of the country in as soon as 2015. The decrease in runoff would move progressively from west to east, and could be expected to reach the east coast by 2060. Even if the average rainfall were to remain the same, increased variability of stream flow would result in reduced natural yields and reliability, and an increase in the unit cost of water from dams. Should warmer climatic conditions prevail, the water requirements of plants, and therefore irrigation requirements, would also increase. A decrease in water availability will also affect water quality, further limiting the extent to which water may be used and developed.[5]

Interaction is needed among all water-dependent sectors to ensure that all available measures are considered, so as to adapt to changing circumstances and reduce vulnerability. No development or investment decisions should be made that neglect to take into account the actual or potential effects of climate change on water resources.[5]

10. Other factors affecting availability and requirements (continued)

10.4 Impacts of water resources management

Reductions in flow that arise from some of the pressures indicated above can result in increasingly variable availability of water, reducing assurance of supply, and increasing cost of water to downstream users. The demand for scarce resources can lead to conflicts among different users. The various users in the Mpumalanga Olifants River WMA are an example, with a deficit of 194 million m^3/annum (see Table 18) covering plantations, irrigated farmlands, domestic use, and mining. The consequence is a significant stream-flow reduction. This has had negative affects on downstream aquatic ecosystems (many of which are found in conservation areas such as the Kruger National Park and neighbouring countries of Mozambique and Swaziland).[5]

Over-abstraction of groundwater (where abstraction exceeds recharge) by particular users, especially where recharge rates are low, such as in the North West, can lower the groundwater to a point that renders it unavailable to other users. Even if over-abstraction is curtailed, it can take many years to re-establish natural levels.[5]

Infrequent severe events, such as prolonged droughts and heavy floods, can reduce the availability of clean water, cause significant damage to infrastructure (for example bridges, weirs, and dams) and lead to a loss of crops and livestock. The effects of these major events often last for several years, increasing the risk of people moving away from their traditional homes. Climate change is likely to increase the risk of such severe events.[5]

Further development of currently under-developed water resources for water supply (for example in the Mvoti to Umzimkulu WMA, Mzimvubu to Keiskamma WMA, and Upper Orange WMA) could result in the future availability of about 5 410 million m^3/annum. The implications are significant: they include economic implications (dams and pipelines are capital expensive), social implications (in terms of loss of land and livelihoods), and environmental implications (such as loss of habitat and changes to aquatic ecosystems). Each option will need to be investigated intensively, with environmental impact and socio-economic assessments being conducted to ensure long-term benefits to all stakeholders. This kind of investigation is currently under way for the Olifants River Water Resources Development Project, which includes upgrades to the Flag Boshielo Dam and the proposed construction of the De Hoop Dam.[5, 7]

10. Other factors affecting availability and requirements (continued)

10.5 Data and information availability

The availability of reliable data and information is critical for planning purposes. Monitoring and information systems that are in place, or have been proposed, include the following:

- Flow monitoring at 800 stations: this translates into one station per 1 500 km^2. Some of them are combined with off-takes or outlets, reservoir water level recording, and meteorological stations. The target that has been set by the World Meteorological Organization (WMO) is one station per 1 000 km^2. The DWA, in response, is planning for another 500 to 1 000 stations to be developed over the next 20 to 25 years.
- Surface water quality, with additional emphasis on microbial, toxicological, and radioactivity monitoring (physico-chemical, biological, and estuary monitoring, including eutrophication) are fairly well established.
- Groundwater monitoring. Because of groundwater's historical 'private' status, past monitoring has been incomplete. Plans now include the monitoring of water levels, as well as the water's physical, chemical, and biological characteristics. Initially, only physical and chemical data will be collected, but eventual monitoring will expand to include microbial, toxicological, and radioactivity data.
- Preparations of a national scale map, indicating river reaches that depend on groundwater recharge. The quantification of groundwater use has also been recommended.
- Water-use registration and authorisations to control the registration/application process and invoicing, and the links to other databases.[5, 7]

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12. Glossary of terms

Alien vegetation	Plants not indigenous to (not naturally found) South Africa.
Aquifer	A stratum or zone below the surface of the earth capable of producing water.
Basin	The area of land that is drained by a large river, or river system.
Catchments	The area of land drained by a river. The term can be applied to a stream, a tributary of a larger river or a whole river system.
Dam	The wall across a valley that retains water, but also used in the colloquial sense to denote the lake behind the wall.
Dolomitic wetland or 'eye' system	Dolomitic eyes are water bodies fed by groundwater originating from fractures in the underlying dolomite. The fractures and intrusions of geological formations impenetrable to water in the dolomite form aquifers, dolomite compartments and dolomitic eyes. Aquifers are subterranean waterways/tunnels and reservoirs from which water is forced above ground through openings (fractures), which are called dolomitic eyes or springs.
Drainage region	A single or large river basin or groups of contagious catchments or smaller catchments with similar hydrological characteristics. They follow the division of the country into the drainage regions as used by the Department of Water Affairs.
DWA/DWAF	Department of Water Affairs (Department of Water Affairs and Forestry prior to July 2009, President's Minute No. 690). The DWA is the national custodian of South Africa's water resources, and is primarily responsible for the formulation and implementation of policy governing the sector.
Ecological Reserve	The quantity and quality of water required (a) to satisfy basic human needs, (b) to protect aquatic ecosystems in order to secure ecologically sustainable development. The Reserve is the volume and quality of water required for satisfying basic human needs and for maintaining aquatic ecosystems.
Effluent	Effluent is a liquid waste product (whether treated or untreated) discharged from an industrial process or human activity that is discharged into the environment.
Groundwater	Water in the subsurface that is beneath the water table, and thus present within the saturated zone. In contrast, to water present in the unsaturated or vadose zone (underground water in the zone above the water table), which is referred to as soil moisture.
Inter-basin transfer	Water transferred from one water management area to another.
Mean annual runoff	Abbreviated as MAR, this is a long term mean annual flow calculated for a specific period of time, at a particular point along a river and for a particular and catchment development condition.
Precipitation	Any form of water, such as rain, snow, sleet, or hail that falls to the earth's surface. The quantity of such water falling in a specific area within a specific period.
Reservoir	A reservoir is a lake-like area where water is kept until it is needed. They come in all shapes and sizes, and are owned by a water company or authority.
Sub-area	The sub-divisions used as management regions for this document.

12. Glossary of terms (continued)

Surface water	Bodies of water, snow, or ice on the surface of the earth, such as lakes, streams, ponds, wetlands, etc.
Surplus	Describes the situation where the availability of water at a particular assurance of supply is more than the unrestricted water requirements.
Vlei/(s)	In the geography of South Africa a 'vlei' is a shallow seasonal or intermittent lake. The word is of Dutch/Afrikaans origin meaning 'pond' or 'marsh', and is pronounced as 'flay'. 'Vleis' vary in their extent according to the fall of rain or dryness of the season.
Water transfers	Water transferred from one drainage basin or secondary sub-catchment to another. Transfers are synonymous with water imports.
Yield	The maximum quantity of water obtainable on a sustainable basis from a dam in any hydrological year in a sequence of year and under specific conditions of catchment development and dam operation.

Appendix A: Water Management Areas

1 Limpopo Water Management Area[7]

The Limpopo WMA is the northern-most WMA in the country and represents part of the South African portion of the Limpopo Basin, which is also shared by Botswana, Zimbabwe and Mozambique. The Limpopo WMA borders on Botswana and Zimbabwe, where the Limpopo River demarcates the entire length of the international boundaries before flowing into Mozambique. The region is semi-arid and the mean annual rainfall ranges from 300 to 700 mm over most of the WMA.

Economic activity is mainly centred on game, livestock and irrigation farming, while mining activity is increasing. Approximately 200 rural villages are scattered throughout the area, with little local economic activity to support these population concentrations.

Due to the aridity and flatness of the terrain few sites are available for the construction of major dams and the surface water potential has largely been fully developed. Relatively favourable formations for groundwater are found in the area and groundwater is therefore used extensively. Overexploitation of water resources occurs in localised areas. Several inter-water management area water transfers exist, all of which bring water into the Limpopo WMA. Demographic scenarios indicate a small growth in population until 2005 and little change thereafter.

Significant growth in water requirements is expected from mining developments in the mineral-rich Bushveld Igneous Complex, which extends across the south-eastern part of the area, while the further exploitation of coal reserves near Ellisras could also increase water requirements. Further growth in economic activity is likely at established urban centres.

Map A1: Location of the Limpopo Water Management Area[9]

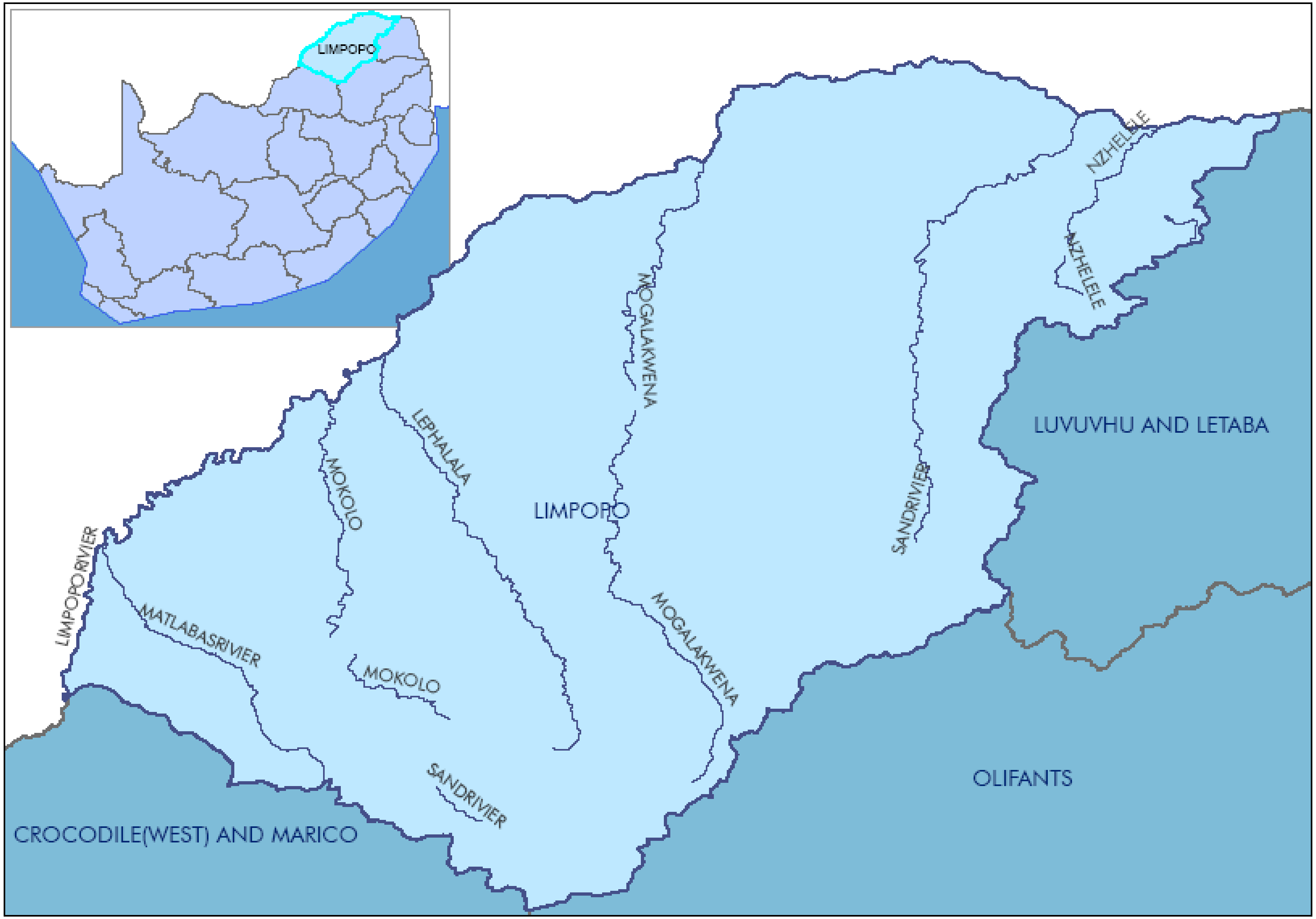

Table A1.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Matlabas/Mokolo	382	76
Lephalala	150	17
Mogalakwena	269	41
Sand	72	10
Nzhelele/Nwanedzi	113	12
Total for Limpopo WMA[iii]	986	156

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.
[iii] Total for South African tributaries to the Limpopo only, excluding the main stream.

Table A1.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m^3/annum					
Matlabas/Mokolo	35	7	3	1	0	46
Lephalala	38	4	0	0	0	42
Mogalakwena	50	15	3	4	0	72
Sand	10	71	0	10	0	91
Nzhelele/Nwanedzi	27	1	2	0	0	30
Total for Limpopo WMA	160	98	8	15	0	281

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A1.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Matlabas/Mokolo	48	2	2	4	7	0	63
Lephalala	39	0	3	0	0	0	42
Mogalakwena	56	8	9	6	0	0	79
Sand	69	24	9	4	0	0	106
Nzhelele/Nwanedzi	26	0	5	0	0	1	32
Total for Limpopo WMA	238	34	28	14	7	1	322

Notes:

[ii] Includes component of Reserve for basic human needs at 25 litres per person per day.

[iii] Mining and bulk industrial water uses that are not part of urban systems.

[iv] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).

[v] Quantities refer to the impact on yield only.

Table A1.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Matlabas/Mokolo	46	0	63	0	-17
Lephalala	42	0	42	0	0
Mogalakwena	72	3	79	0	-4
Sand	91	15	106	0	0
Nzhelele/Nwanedzi	30	0	32	0	-2
Total for Limpopo WMA	281	18	322	0	-23

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.

[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A1.5 and A1.6.

Table A1.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Matlabas/Mokolo	45	0	62	0	-17	0
Lephalala	42	0	43	0	-1	0
Mogalakwena	73	3	101	0	-25	7
Sand	92	15	107	0	0	0
Nzhelele/Nwanedzi	29	0	33	0	-4	1
Total for Limpopo WMA	281	18	346	0	-47	8

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation. A provisional allowance of 20 million m^3/annum has been made for mining in the Mogalakwena catchment.

[iii] Shows negative balances.

[iv] Based on raising the Glen Alpine and Mutshedzi Dams and construction of the Groenvlei Dam.

Table A1.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Matlabas/Mokolo	46	0	64	0	-18	0
Lephalala	42	0	43	0	-1	0
Mogalakwena	76	3	108	0	-29	7
Sand	102	20	130	0	-8	0
Nzhelele/Nwanedzi	29	0	33	0	-4	1
Total for Limpopo WMA	295	23	378	0	-60	8

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on a high growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation. A provisional allowance of 20 million m^3/annum has been made for mining in the Mogalakwena catchment.

[iii] Shows negative balances.

[iv] Based on raising the Glen Alpine and Mutshedzi Dams and construction of the Groenvlei Dam.

To ensure sufficient future availability of water for mining development and urban/industrial growth, the following water quantities must be held in reserve for transfer from other WMAs to the Limpopo WMA:

- Water from the Olifants River (Olifantspoort Weir) for transfer to Polokwane, up to the full capacity of the existing pipeline of 5 million m^3/annum – reserved in the Olifants WMA.

- The existing transfer of 19 million m^3/annum maximum capacity to Polokwane from the Ebenezer and Dap Naude Dams in the Luvuvhu and Letaba WMAs – reserved in the Luvuvhu and Letaba WMAs.

- The existing transfer of 2 million m^3/annum from the Albasini Dam in the Luvuvhu and Letaba WMA to Makhado, supplemented by an additional 5 million m^3/annum from the Luvuvhu River – reserved in the Luvuvhu and Letaba WMA.

- About 45 million m^3/annum (assumed at half of Sasol II's (South Africa's coal and oil company) requirements) of the growth in effluent return flows to the Crocodile River may be required for the development of coal reserves in the Lephalale area. Since considerable uncertainty still surrounds this possibility, this requirement is not included in the tables of the NWRS – reserved in the Crocodile West and Marico WMAs.

- Water from the development of the Rooipoort Dam on the Olifants River mainly to supply possible new mining-related developments in the Olifants WMA and the Mogoto to Mokopane area as well as for Polokwane. Other developments that could have a negative on the Rooipoort development will not be allowed – reserved in the Olifants WMA.

- The development of new dams or large water resource projects will be subject to national authorisation because of their possible impact on neighbouring countries – reservation with respect to the Limpopo WMA.

- Small transfer from the Crocodile West and Marico WMA to Modimolle in the Limpopo WMA – reserved in the Crocodile West and Marico WMA.

2 Luvuvhu and Letaba Water Management Area[7]

The Luvuvhu and Letaba WMA lies entirely within Limpopo and borders on Zimbabwe and Mozambique. It forms part of the Limpopo Basin, which is shared by South Africa, Botswana, Zimbabwe and Mozambique. While the Luvuvhu River is a direct tributary of the Limpopo River, the Shingwedzi River and Letaba River flow into the Olifants River, which is a tributary of the Limpopo. A unique feature of this WMA is the Kruger National Park along its eastern boundary, which occupies approximately 35% of the area and through which all the main rivers flow into Mozambique. Due to the topography, rainfall varies from well over 1 000 mm/annum to less than 300 mm/annum.

Economic activity is characterised by irrigation, afforestation, tourism and informal farming. Over 90% of the area's population live in rural communities.

Surface water mainly originates in the mountainous areas and is regulated by several dams in the upper and middle reaches of the rivers. The Nandoni Dam is under construction on the Luvuvhu River and other sites have been identified as being feasible for the construction of dams in the future. Groundwater is utilised extensively and limited potential remains for further development. Significant over-exploitation of groundwater occurs in parts of the Luvuvhu and Letaba WMA, particularly near Albasini Dam and in the vicinity of Thohoyandou. Water transfers occur from the Luvuvhu and Letaba WMA to both neighbouring WMAs and some inter-catchment transfers within the WMA also take place.

Current expectations are that population growth in the area will be moderate, probably at less than 1% per annum. New mining developments are foreseen in the Tzaneen/Gravelotte area and coal mining could possibly commence near Tshikondeni. A water allocation has been reserved from Nandoni Dam for the irrigation of 1 100 ha of farmland to be set aside for the purposes of rural development and poverty relief. It is doubtful whether any further expansion of irrigation will be economically viable. No dramatic growth in future water requirements is therefore expected, with the possible exception of developments related to mining.

Map A2: Location of the Luvuvhu and Letaba Water Management Area[9]

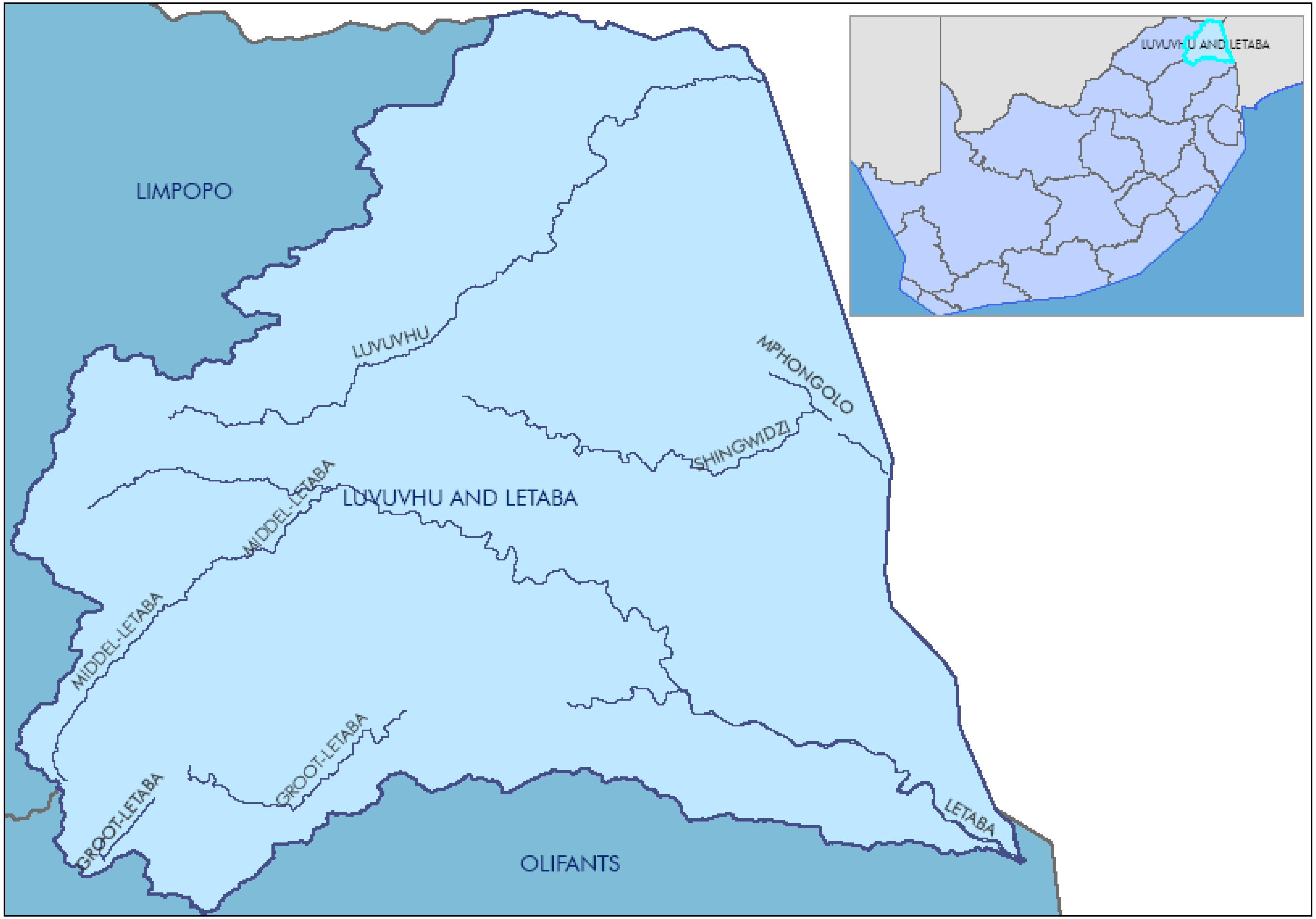

Table A2.1: Natural mean annual runoff and ecological Reserve (million m³/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m³/annum	
Luvuvhu/Mutale	520	105
Shingwedzi	90	14
Groot Letaba	382	72
Klein Letaba	151	20
Lower Letaba	42	13
Total for Luvuvhu/Letaba WMA	1 185	224

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A2.2: Available yield in the year 2000 (million m³/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m³/annum					
Luvuvhu/Mutale	88	20	5	2	0	115
Shingwedzi	1	2	0	0	0	3
Groot Letaba	133	12	13	1	0	159
Klein Letaba	21	9	1	1	0	32
Lower Letaba	1	0	0	0	0	1
Total for Luvuvhu/Letaba WMA	244	43	19	4	0	310

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A2.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
				million m^3/annum			
Luvuvhu/Mutale	97	4	10	1	0	7	119
Shingwedzi	0	0	3	0	0	0	3
Groot Letaba	126	3	10	0	0	35	174
Klein Letaba	25	3	8	0	0	1	37
Lower Letaba	0	0	0	0	0	0	0
Total for Luvuvhu/Letaba WMA	248	10	31	1	0	43	333

Notes:

[ii] Includes component of Reserve for basic human needs at 25 litres per person per day.
[iii] Mining and bulk industrial water uses that are not part of urban systems.
[iv] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).
[v] Quantities refer to the impact on yield only.

Table A2.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
			million m^3/annum		
Luvuvhu/Mutale	115	0	119	2	-6
Shingwedzi	3	0	3	0	0
Groot Letaba	159	0	174	11	-26
Klein Letaba	32	0	37	0	-5
Lower Letaba	1	0	0	0	1
Total for Luvuvhu/Letaba WMA	310	0	333	13	-36

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A2.5 and A2.6.

Table A2.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
			million m^3/annum			
Luvuvhu/Mutale	208	0	129	2	77	60
Shingwedzi	3	0	3	0	0	0
Groot Letaba	160	0	177	11	-28	42
Klein Letaba	32	0	39	0	-7	0
Lower Letaba	1	0	0	0	1	0
Total for Luvuvhu/Letaba WMA	404	0	348	13	43	102

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000 (Nandoni Dam). Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Irrigation of an additional 1 100 ha from the Nandoni Dam has been allowed for in the Luvuvhu/Mutale sub-area.

[iii] Shows negative balances.

[iv] Based on raising the Tzaneen Dam, construction of the Nwamitwa Dam and the possible construction of a dam on the Mutale River.

Table A2.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
			million m^3/annum			
Luvuvhu/Mutale	208	0	129	2	77	60
Shingwedzi	3	0	3	0	0	0
Groot Letaba	161	0	179	11	-29	42
Klein Letaba	33	0	39	0	-6	0
Lower Letaba	1	0	0	0	1	0
Total for Luvuvhu/Letaba WMA	406	0	350	13	43	102

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000 (Nandoni Dam). Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Irrigation of an additional 1 100 ha from the Nandoni Dam has been allowed for in the Luvuvhu/Mutale sub-area.

[iii] Shows negative balances.

[iv] Based on raising the Tzaneen Dam, construction of the Nwamitwa Dam and the possible construction of a dam on the Mutale River.

The following reservations with respect to developments and water resources will apply to the Luvuvhu and Letaba WMA:

- Development of all new dams or large water resource projects will be subject to national authorisation because of possible impacts on Mozambique.
- Water reserved in the Luvuvhu and Letaba WMA for transfer to users in neighbouring WMAs:
  - The existing transfer of 2 million m^3/annum from the Albasini Dam to Makhado in the Limpopo WMA.
  - An additional 5 million m^3/annum to be reserved from either the Albasini Dam or the Nandoni Dam for possible transfer to Makhado in the Limpopo WMA.
  - A maximum of 19 million m^3/annum per year to be available from the Ebenezer Dam and Dap Naude Dam for transfer to Polokwane in the Limpopo WMA.
  - Existing transfers of just under 1 million m^3/annum from the Groot Letaba River to Gravelotte and other users in the Olifants WMA.

3 Crocodile West and Marico Water Management Area[7]

The Crocodile West and Marico WMA borders on Botswana to the north-west. Its main rivers, the Crocodile and Marico Rivers, give rise to the Limpopo River at their confluence. The climate is generally semi-arid, with the mean annual rainfall ranging from 400 to 800 mm. Extensive irrigation development occurs along the main rivers, with grain, livestock and game farming in other parts.

Economic activity in the Crocodile West and Marico WMA is dominated by the urban and industrial complexes of northern Johannesburg and Pretoria and platinum mining north-east of Rustenburg. It is the second most populous WMA in the country and has the largest proportionate contribution to the national economy.

Development and utilisation of surface water occurring naturally in the Crocodile West and Marico WMA has reached its full potential. Large dolomitic groundwater aquifers occur along the southern part of the area, which is the reason for part of the Upper Molopo River catchment being incorporated into the area. The aquifers are utilised extensively for urban and irrigation purposes. Localised over-exploitation of groundwater occurs in the Molopo area. Some aquifers also underlie the border with Botswana and are shared with that country. A substantial portion of the water used in the WMA is transferred from the Vaal River and further afield. Small transfers out of the Crocodile West and Marico WMA are to Gabarone in Botswana and to Modimolle in the Limpopo WMA.

Increasing quantities of effluent return flow from urban and industrial areas offer considerable potential for re-use, but the effluent is at the same time a major cause of pollution in some rivers.

Population and economic growth, around Johannesburg and Pretoria, and mining developments, are expected to continue strongly in this area. Little change is foreseen in population and economic development in rural areas.

Map A3: Location of the Crocodile West and Marico Water Management Area[9]

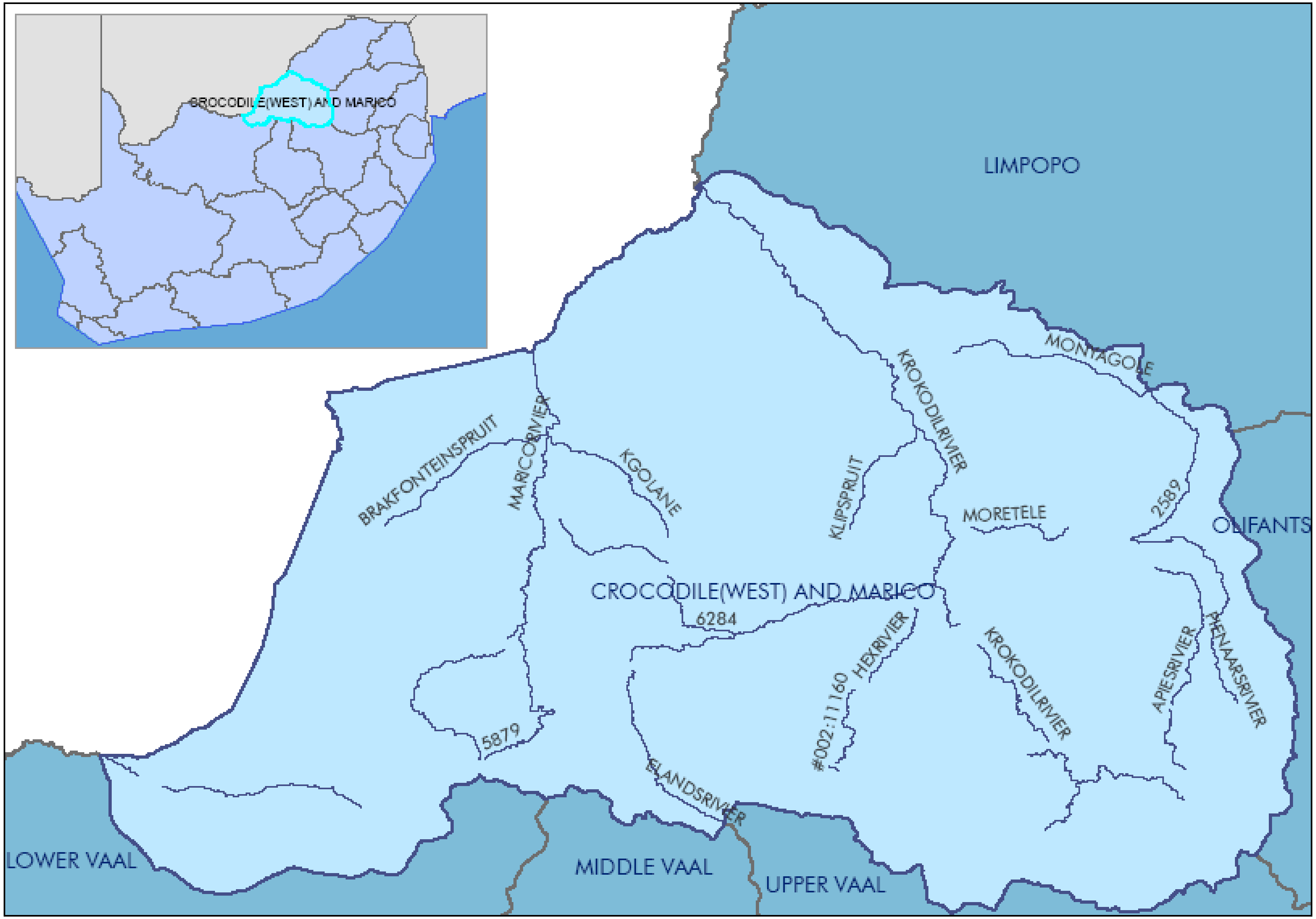

Table A3.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Apies/Pienaars	142	34
Upper Crocodile	253	57
Elands	113	15
Lower Crocodile	138	25
Marico	172	29
Upper Molopo	37	4
Total for Crocodile West/Marico WMA	855	164

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A3.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m^3/annum					
Apies/Pienaars	38	36	4	106	2	186
Upper Crocodile	111	31	21	158	15	336
Elands	30	29	3	10	14	86
Lower Crocodile	7	29	14	1	8	59
Marico	14	12	2	3	1	32
Upper Molopo	3	9	0	5	2	19
Total for Crocodile West/Marico WMA	203	146	44	283	42	718

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A3.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Apies/Pienaars	41	211	7	6	15	0	280
Upper Crocodile	208	292	5	38	13	0	556
Elands	32	23	10	48	0	0	113
Lower Crocodile	137	3	3	28	0	0	171
Marico	24	5	9	2	0	0	40
Upper Molopo	3	13	3	5	0	0	24
Total for Crocodile West/Marico WMA	445	547	37	127	28	0	1 184

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.

[ii] Mining and bulk industrial water uses that are not part of urban systems.

[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).

[iv] Quantities refer to the impact on yield only.

Table A3.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Apies/Pienaars	186	182	280	87	1
Upper Crocodile	336	279	556	17	42
Elands	86	71	113	24	20
Lower Crocodile	59	112	171	0	0
Marico	32	0	40	7	-15
Upper Molopo	19	0	24	0	-5
Total for Crocodile West/Marico WMA	718	644	1 184	135	43

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.

[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A3.5 and A3.6.

Table A3.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Apies/Pienaars	244	287	399	92	40	0
Upper Crocodile	399	382	673	13	95	0
Elands	90	71	124	24	13	0
Lower Crocodile	59	113	173	0	-1	0
Marico	32	0	40	7	-15	0
Upper Molopo	22	0	29	0	-7	0
Total for Crocodile West/Marico WMA	846	853	1 438	136	125	0

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements. It is assumed that water will be transferred into the Apies/Pienaars and Upper Crocodile sub-areas from the Upper Vaal WMA to meet growth requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] No significant potential for the further development of local resources.

Table A3.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Apies/Pienaars	360	517	630	95	152	0
Upper Crocodile	511	584	880	13	202	0
Elands	97	71	141	24	3	0
Lower Crocodile	62	116	179	0	-1	0
Marico	33	0	42	7	-16	0
Upper Molopo	21	0	27	0	-6	0
Total for Crocodile West/Marico WMA	1 084	1 288	1 899	139	334	0

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements. It is assumed that water will be transferred into the Apies/Pienaars and Upper Crocodile sub-areas from the Upper Vaal WMA to meet growth requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] No significant potential for the further development of local resources.

The following reservations will apply with respect to the Crocodile West and Marico WMA:

- An additional 220 million m^3/annum will have to be transferred from the Upper Vaal WMA and WMAs beyond to the Johannesburg and Pretoria areas in future. As an upper high-growth scenario, up to 750 million m^3/annum may be required – reserved in the Upper Vaal WMA.

- Surplus effluent return flows that become available are to be reserved in the Crocodile West and Marico WMA for the following priorities:

  – Re-use for urban, industrial and mining purposes where this will feasibly contribute to reducing transfers into the WMA.

  – About 45 million m^3/annum may be required for developments in the Lephalale area in the Limpopo WMA. This quantity is not included in the tables of the NWRS.

  – Small quantities may be required to augment supplies in the Limpopo and Olifants WMAs.

- The transfer of about 7 million m^3/annum from the Molatedi Dam to Gabarone in Botswana – reserved in the Crocodile West and Marico WMA.

- Continuation of small transfers from the Olifants WMA to the Crocodile West and Marico WMA, as well as from the Crocodile West and Marico WMA to the Limpopo WMA – reserved in the Olifants WMA, and Crocodile West and Marico WMA.

- Water resource developments that may negatively influence the flow of water towards neighbouring countries will be subject to national authorisation – reservation with respect to Crocodile West and Marico WMA.

4 Olifants Water Management Area[7]

The Olifants River originates to the east of Johannesburg and initially flows northwards before gently curving eastwards towards the Kruger National Park, where it is joined by the Letaba River before flowing into Mozambique. The Olifants WMA corresponds with the South African portion of the Olifants River catchment, excluding the Letaba River catchment, which is a tributary catchment to the Limpopo Basin shared by South Africa, Botswana, Zimbabwe and Mozambique. Distinct differences in climate occur, from cool Highveld in the south to subtropical east of the escarpment. Mean annual rainfall is in the range of 500 to 800 mm over most of the Olifants WMA.

Economic activity is highly diverse and ranges from mining and metallurgic industries to irrigation, dryland and subsistence agriculture, and ecotourism. With one of the main rivers, the Olifants River, flowing through the Kruger National Park, which is located at the downstream extremity of the Olifants WMA, the provision of water to meet ecological requirements is one of the controlling factors in the management of water resources throughout the WMA.

Most surface runoff originates from the higher rainfall in the southern and mountainous areas and is controlled by several large dams. The most promising options identified for the further development of surface water resources are the raising of Flag Boshielo Dam, the construction of a new dam at Rooipoort on the middle Olifants River and a dam on the Steelpoort River.

Large quantities of groundwater are abstracted for irrigation in the north-west of the Olifants WMA, as well as for rural water supplies throughout most of the area. Potential for increased groundwater utilisation has been identified on the Nebo Plateau north-east of Groblersdal. Substantial amounts of water are transferred into the Olifants WMA as cooling water for power generation, while smaller transfers are made to neighbouring WMAs.

Map A4: Location of the Olifants Water Management Area[9]

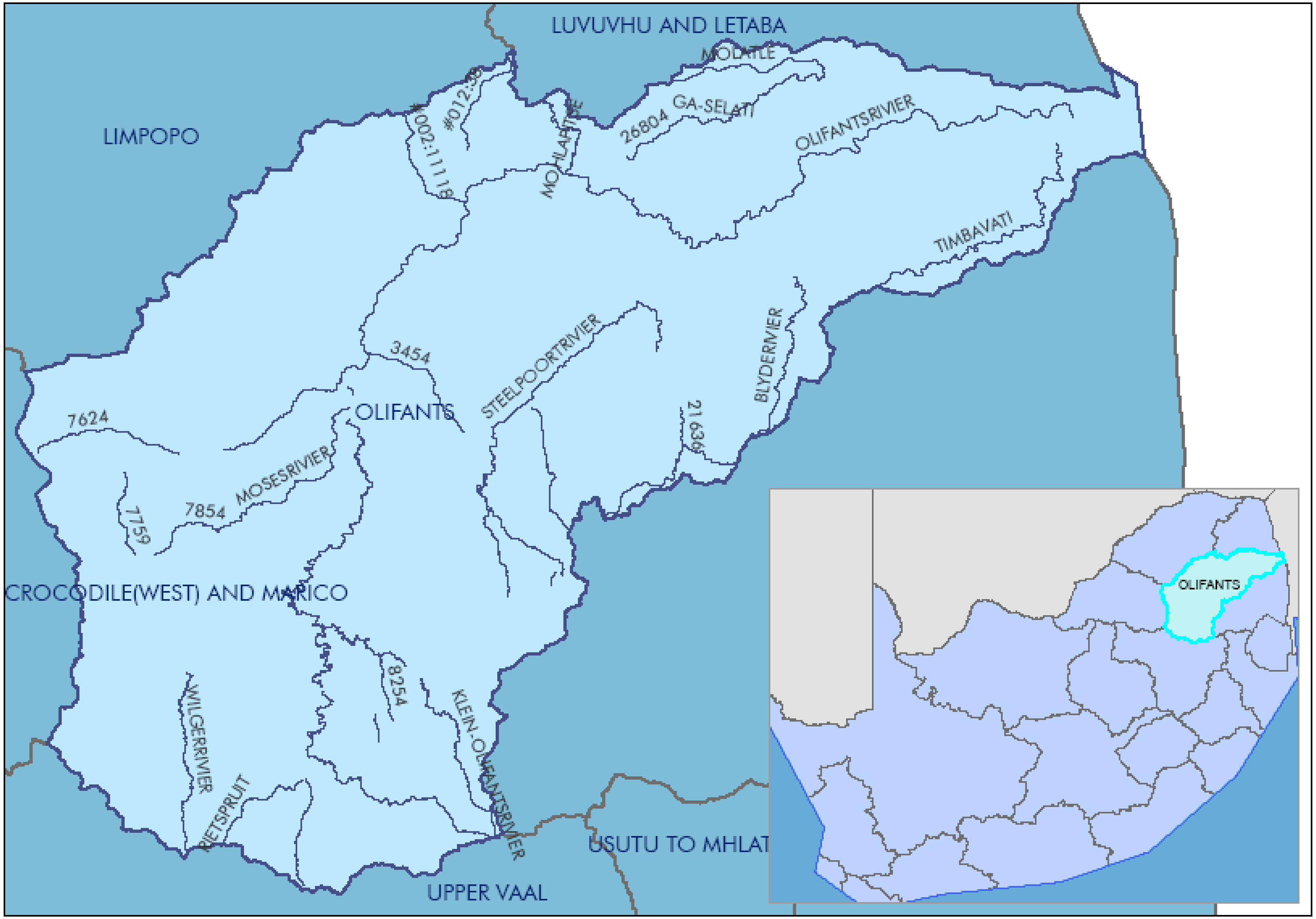

Table A4.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Upper Olifants	465	83
Middle Olifants	481	69
Steelpoort	396	94
Lower Olifants	698	214
Total for Olifants WMA	2 040	460

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A4.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m^3/annum					
Upper Olifants	194	4	2	34	4	238
Middle Olifants	100	70	34	5	1	210
Steelpoort	42	14	3	1	1	61
Lower Olifants	74	11	5	2	8	100
Total for Olifants WMA	410	99	44	42	14	609

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A4.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
			million m^3/annum				
Upper Olifants	44	62	6	20	181	1	314
Middle Olifants	336	15	28	13	0	0	392
Steelpoort	69	3	5	17	0	1	95
Lower Olifants	108	7	5	43	0	1	164
Total for Olifants WMA	557	87	44	93	181	3	965

Notes:

[ii] Includes component of Reserve for basic human needs at 25 litres per person per day.
[iii] Mining and bulk industrial water uses that are not part of urban systems.
[iv] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).
[v] Quantities refer to the impact on yield only.

Table A4.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
			million m^3/annum		
Upper Olifants	238	171	314	96	-1
Middle Olifants	210	91	392	3	-94
Steelpoort	61	0	95	0	-34
Lower Olifants	100	1	164	0	-63
Total for Olifants WMA	609	263	965	99	-192

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A4.5 and A4.6.

Table A4.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Upper Olifants	256	209	383	82	0	0
Middle Olifants	212	77	430	2	-143	152
Steelpoort	62	0	96	0	-34	87
Lower Olifants	100	1	165	0	-64	0
Total for Olifants WMA	630	287	1 074	84	-241	239

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements. It is assumed that water will be transferred into the Apies/Pienaars and Upper Crocodile sub-areas from the Upper Vaal WMA to meet growth requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development, including an additional 25 million m^3/annum required for mining in the Middle Olifants sub-area. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] Based on the raising of the Flag Boshielo Dam and construction of the Rooipoort and De Hoop Dams.

Table A4.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Upper Olifants	287	209	439	57	0	0
Middle Olifants	213	52	433	8	-176	152
Steelpoort	63	0	98	0	-35	87
Lower Olifants	102	1	171	0	-68	0
Total for Olifants WMA	665	262	1 141	65	-279	239

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements. It is assumed that water will be transferred into the Apies/Pienaars and Upper Crocodile sub-areas from the Upper Vaal WMA to meet growth requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development, including an additional 25 million m^3/annum required for mining in the Middle Olifants sub-area. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] Based on the raising of the Flag Boshielo Dam and construction of the Rooipoort and De Hoop Dams.

With due consideration of the options available for reconciling the requirements for and the availability of water, the following reservations will apply with respect to the Olifants WMA:

- Water from the Rooipoort Dam to be developed in the main stem of the Olifants River is to be reserved in the Olifants WMA primarily for supplying future mining developments within the Olifants WMA and for possible transfers to Polokwane and Mokopane in the Limpopo WMA. Water resource developments elsewhere in the catchment that could have a significant negative impact on this will not be permitted.

- Similar reservation will apply with regard to a large dam to be constructed on the Steelpoort River, possibly at De Hoop, in the Olifants WMA.

- Currently, 172 million m^3/annum of water is transferred from the Inkomati, Usutu to Mhlatuze and Upper Vaal WMAs to the Olifants WMA for strategic use in power generation. A further 38 million m^3/annum is to be reserved in the Upper Vaal WMA for this purpose. The Upper Vaal WMA will in turn source this water from other WMAs.

- The transfer of water from the Olifantspoort Weir to Polokwane in the Limpopo WMA at the maximum pipeline capacity of 5 million m^3/annum – reserved in the Olifants WMA.

- The existing water transfer from the Wilge tributary of the Olifants River to Cullinan and Premier Diamond Mine in the Crocodile West and Marico WMA – reserved in the Olifants WMA.

- The existing water transfer from the Letaba River in the Luvuvhu and Letaba WMA to users in the Olifants WMA – reserved in the Luvuvhu and Letaba WMA.

- All water resource developments that could have a possible impact on Mozambique will be subject to national authorisation – reservation applicable to Olifants WMA.

5 Inkomati Water Management Area[7]

The Inkomati WMA is situated in the north-eastern part of South Africa and borders on Mozambique and Swaziland. All the rivers from this area flow through Mozambique to the Indian Ocean. The Komati River flows into Swaziland and re-enters South Africa before flowing into Mozambique. Topographically the WMA is divided by the escarpment into a plateau in the west and a subtropical Lowveld in the east. Annual rainfall varies from close to 1 500 mm in the mountains to 400 mm in the lower-lying areas.

Economic activity is mainly centred on irrigation and afforestation, with related industries and commerce, and a strong ecotourism industry. A key feature of the Inkomati WMA is the renowned Kruger National Park. The Sabie River, which flows through the park, is ecologically one of the most important rivers in South Africa, while the Crocodile River forms the park's southern boundary.

Dams have been constructed on all the main rivers or their tributaries, and surface water resources in the Inkomati WMA are generally well regulated. An important feature is the joint management by South Africa and Swaziland of part of the water resources of the Komati River by the Komati Basin Water Authority. Potential for further water resource development exists in the Kaap tributary of the Crocodile River, the Komati River and the Sand tributary of the Sabie River, although such development will probably only be feasible for domestic and high value uses. Because of the well-watered nature of most of the area, groundwater utilisation is relatively small. Most of the present yield from the Komati River west of Swaziland is transferred to the Olifants WMA for power generation.

Future population growth in the area is expected to be moderate and to be concentrated in the urbanised areas. In some rural areas the population could decline. With about 90% of total water requirements within the Inkomati WMA area being utilised by the irrigation and forestry sectors, only a small natural growth in overall water requirements is foreseen.

Map A5: Location of the Inkomati Water Management Area[9]

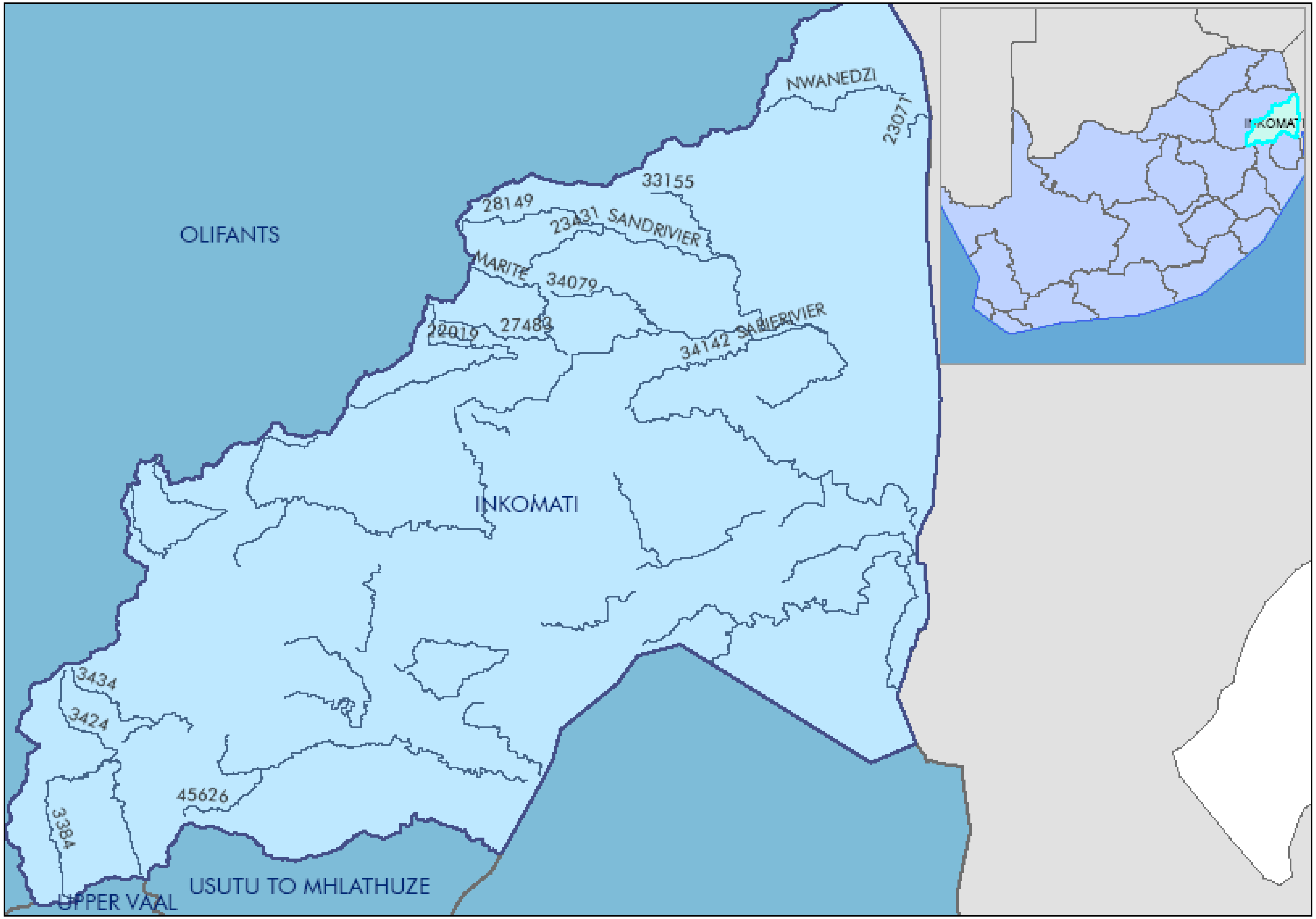

Table A5.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Komati (West Swazi)	749	239
Swaziland[iii]	517	100
Komati (North Swazi)	130	25
Crocodile	1 277	328
Sabie[iv]	866	316
Total for Inkomati WMA	3 539	1 008

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.
[iii] Includes the Komati and Lomati catchments in Swaziland.
[iv] Includes the Uanetse and Mássintonto catchments in South Africa.

Table A5.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	
			million m^3/annum			
Komati (West Swazi)	116	1	0	1	0	118
Swaziland	183	1	1	0	0	185
Komati (North Swazi)	228	2	21	0	1	252
Crocodile	202	2	26	6	10	246
Sabie	87	3	5	0	0	95
Total for Inkomati WMA	816	9	53	7	11	896

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff. Includes Driekoppies Dam, but not the Maguga Dam under construction.

Table A5.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Komati (West Swazi)	21	2	4	0	0	38	65
Swaziland	35	1	6	0	0	25	67
Komati (North Swazi)	215	3	6	1	0	7	232
Crocodile	257	35	7	23	0	42	364
Sabie	65	22	4	0	0	26	117
Total for Inkomati WMA	593	63	27	24	0	138	845

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.
[ii] Mining and bulk industrial water uses that are not part of urban systems.
[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).
[iv] Quantities refer to the impact on yield only.

Table A5.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Komati (West Swazi)	118	0	65	97	-44
Swaziland	185	0	67	117	1
Komati (North Swazi)	252	0	232	60	-40
Crocodile	246	12	364	49	-155
Sabie	95	0	117	0	-22
Total for Inkomati WMA	896	12	845	323	-260

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A5.5 and A5.6.

Table A5.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m³/annum					
Komati (West Swazi)	118	0	64	97	-43	40
Swaziland	250	0	95	156	-1	0
Komati (North Swazi)	252	39	233	60	-2	0
Crocodile	249	12	381	49	-169	64
Sabie	159	0	141	0	18	0
Total for Inkomati WMA	1 028	51	914	362	-197	104

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000, including the Maguga and Inyaka Dams. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] Based on the construction of the Boekenhout and Mountain View Dams.

Table A5.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m³/annum					
Komati (West Swazi)	119	0	67	97	-45	40
Swaziland	250	0	95	156	-1	0
Komati (North Swazi)	252	39	233	60	-2	0
Crocodile	256	12	423	49	-204	64
Sabie	159	0	139	0	20	0
Total for Inkomati WMA	1 036	51	957	362	-232	104

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000, including the Maguga and Inyaka Dams. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] Based on the construction of the Boekenhout and Mountain View Dams.

The following reservations and national authorisations apply to the Inkomati WMA:

- The transfer of water to the Olifants WMA for power generation at the current capacity of approximately 100 million m^3/annum. The treaty between South Africa and Swaziland accommodates a transfer of 132 million m^3/annum out of the catchment, which must be reserved in the Inkomati WMA.

- Water supplied to South Africa by the Komati Basin Water Authority, which includes releases for environmental purposes – reserved by international agreement for use in the Inkomati WMA.

- Water to be released to Mozambique to honour international commitments. This currently amounts to 109 million m^3/annum – reserved in the Inkomati WMA.

- All water resource developments that may impact on neighbouring countries will be subject to national authorisation – reservation applies to the Inkomati WMA.

6 Usutu to Mhlatuze Water Management Area[7]

The Usutu to Mhlatuze WMA falls predominantly within northern KwaZulu-Natal with a part in Mpumalanga, and bordering on Swaziland and Mozambique. Two rivers are shared with these countries, namely the Usutu River has its headwaters in South Africa and flows into Swaziland, while part of the Pongola River Catchment lies in Swaziland. The two rivers flow together in South Africa just before entering Mozambique as the Maputo River. Climate in the region can be described as sub-humid to humid, but varies considerably. Mean annual rainfall ranges between 600 mm and 1 500 mm.

Economic activity is diverse and includes rain fed and subsistence farming, irrigation, afforestation, ecotourism, and heavy industries in the Richards Bay/Empangeni area. Water resources in the Upper Usutu, Mkuze and Mhlatuze catchments have been well developed, while undeveloped potential exists in the Pongola and Mfolozi catchments. Ground water utilisation in most parts of the Usutu to Mhlatuze WMA is relatively small, and can thus be developed further.

Strong interdependencies between surface and groundwater occur in many areas, with groundwater levels together with surface flows, being particularly important to water balances in the ecologically sensitive coastal lakes and wetlands, some of which are internationally recognised conservation areas. Large quantities of water are transferred from the Upper Usutu to the Upper Vaal and Upper Olifants WMAs, and transfers are also made from the Thukela WMA to the Mhlatuze sub-area.

The expectations are that little change will occur in the overall population in the Usutu to Mhlatuze WMA. A decline in rural population will likely be balanced by a growth in urbanisation in the Richards Bay/Empangeni area. Growth in water requirements will be dictated by the level of industrial activity in the Richards Bay area, which is difficult to estimate.

Map A6: Location of the Usutu to Mhlatuze Water Management Area[9]

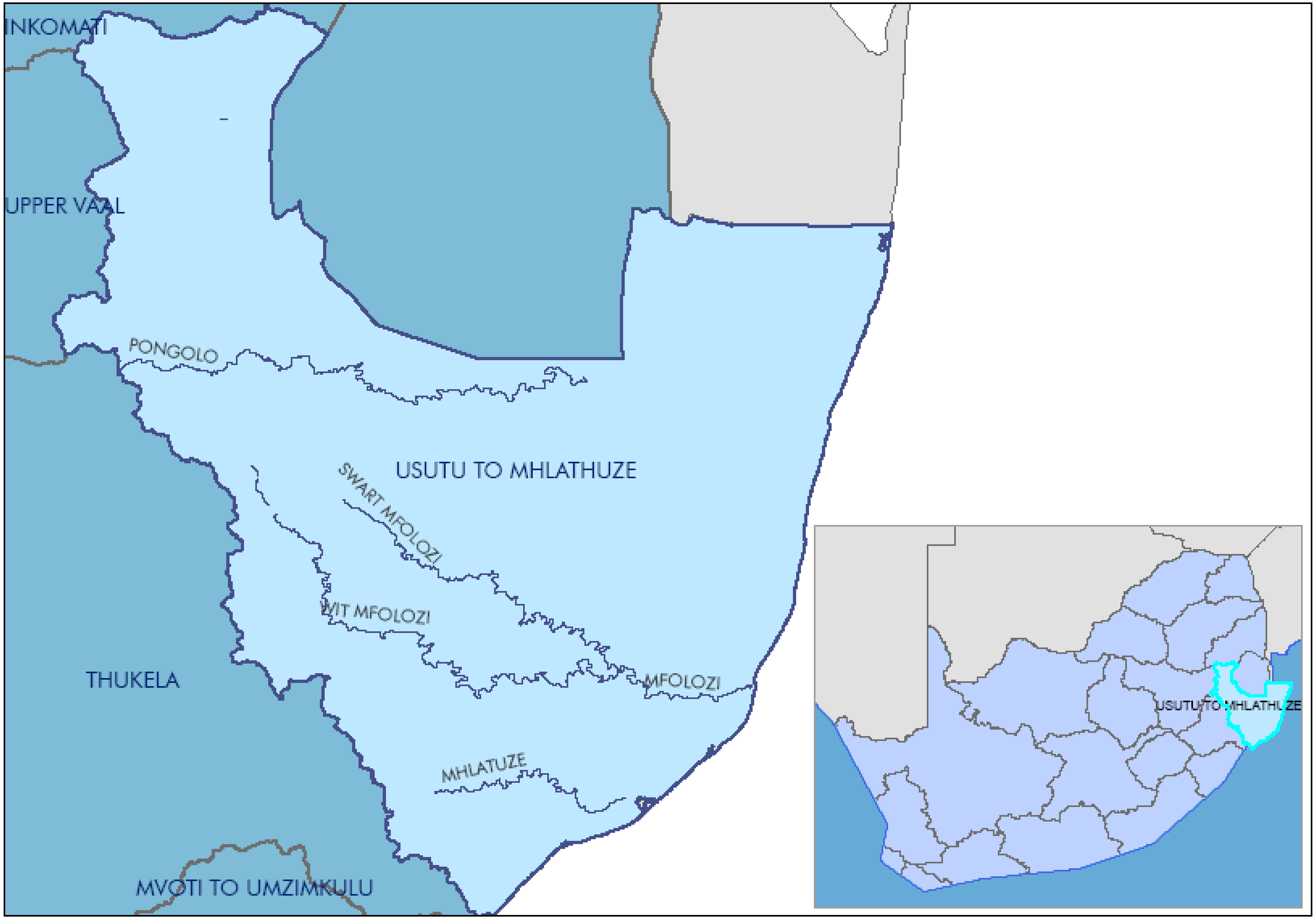

Table A6.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Upper Usutu[iii]	901	328
Pongola[iv]	1 344	200
Mkuze	635	218
Mfolozi	962	275
Mhlatuze	938	171
Total for Usutu to Mhlatuze WMA	4 780	1 192

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.
[iii] Excludes the Usutu River in Swaziland (MAR = 1 320 million m^3/annum).
[iv] Includes the Pongola and Ngwavuma Rivers in Swaziland (MAR = 213 million m^3/annum).

Table A6.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m^3/annum					
Upper Usutu	196	2	1	3	0	202
Pongola	616	8	21	0	0	645
Mkuze	15	12	6	0	0	33
Mfolozi	36	5	5	4	1	51
Mhlatuze	156	12	9	2	0	179
Total for Usutu to Mhlatuze WMA	1 019	39	42	9	1	1 110

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A6.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Upper Usutu	13	8	5	0	0	43	69
Pongola	213	1	6	1	0	34	255
Mkuze	61	1	10	0	0	6	78
Mfolozi	51	12	11	4	0	2	80
Mhlatuze	94	28	8	86	0	19	235
Total for Usutu to Mhlatuze WMA	432	50	40	91	0	104	717

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.
[ii] Mining and bulk industrial water uses that are not part of urban systems.
[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).
[iv] Quantities refer to the impact on yield only.

Table A6.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Upper Usutu	202	0	69	114	19
Pongola	645	0	255	30	360
Mkuze	33	30	78	0	-15
Mfolozi	51	0	80	18	-47
Mhlatuze	179	58	235	0	2
Total for Usutu to Mhlatuze WMA	1 110	88	717	162	319

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A6.5 and A6.6.

Table A6.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
			million m^3/annum			
Upper Usutu	203	0	74	114	15	0
Pongola	646	0	257	30	359	95
Mkuze	33	30	77	0	-14	0
Mfolozi	51	0	79	18	-46	15
Mhlatuze	180	58	241	0	-3	0
Total for Usutu to Mhlatuze WMA	1 113	88	728	162	311	110

Notes:
[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
[iii] Shows negative balances.
[iv] Based on the construction of the Embiane and Vaderland Dams. Additional potential may also be developed in the Upper Usutu catchment.

Table A6.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
			million m^3/annum			
Upper Usutu	205	0	79	114	12	0
Pongola	646	0	257	30	359	95
Mkuze	34	30	78	0	-14	0
Mfolozi	54	0	86	18	-50	15
Mhlatuze	185	58	312	0	-69	0
Total for Usutu to Mhlatuze WMA	1 124	88	812	162	238	110

Notes:
[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
[iii] Shows negative balances.
[iv] Based on the construction of the Embiane and Vaderland Dams. Additional potential may also be developed in the Upper Usutu catchment.

The following reservations will apply with respect to the Usutu to Mhlatuze WMA:

- Existing transfers from the Upper Usutu catchment to the Upper Vaal and Olifants WMAs up to the installed capacity of 114 million m^3/annum – reserved in the Usutu to Mhlatuze WMA.

- Current transfers from the Thukela River into the Mhlatuze sub-area of 40 million m^3/annum may be increased to a maximum of 94 million m^3/annum – reserved in the Thukela WMA.

- Provisional planning has been completed for increasing water transfers from the Thukela to the Mhlatuze sub-area to about 252 million m^3/annum, which would be dependent on the construction of additional storage in the Thukela River. No reservation is required at this stage.

- The construction of new dams in the Pongola River catchment, as well as developments in the Upper Usutu catchment, which may negatively impact on possible further transfers of water to the Upper Vaal WMA and beyond, will be subject to approval at national level – reservations applicable to the Usutu to Mhlathuze WMA.

- Water resource developments that may impact on neighbouring countries will be subject to national authorisation – reservation applies to Usutu to Mhlathuze WMA.

7 Thukela Water Management Area[7]

The Thukela WMA corresponds fully to the catchment area of the Thukela River and lies predominantly in KwaZulu-Natal. It is a funnel-shaped catchment, with several tributaries draining from the Drakensberg escarpment towards the Indian Ocean. Parts of the Thukela WMA enjoy a high ecological status. It is characterised by mountain streams in the upper reaches, where several parks and conservation areas are located, as well as a number of important wetlands and 'vleis'[f]. Rainfall is highest near the mountains and along the coast, and the mean annual precipitation is in the range from 600 to 1 500 mm.

The Thukela WMA is predominantly rural in character with forestry, agriculture and ecotourism as primary activities. Newcastle is the major industrial centre and the only other significant industrial activity at present is a large paper mill near Mandini.

Because of the high mean annual runoff and favourable topography, the Thukela basin offers some of the best opportunities for water resources development in South Africa. Although several large dams have already been constructed in the upper reaches of the Thukela River and on the main tributaries, substantial undeveloped resource potential remains. One of the largest inter-catchment transfer schemes in the country conveys water from the Upper Thukela River to the Upper Vaal WMA. Other water transfers are from the Mooi River to the Mgeni River in the Mvoti to Umzimkulu WMA, from the Buffalo River to the Upper Vaal WMA, and from the lower Thukela River to the Usutu to Mhlutuze WMA. Owing to the relatively well-watered nature of the catchment, only a small proportion of the water requirements are supplied from groundwater.

Expectations are that the area's population will remain relatively stable over the period of projection, with small growth or declines in localised areas. There are no major economic centres or stimuli in the Thukela WMA.

[f] In the geography of South Africa a 'vlei' is a shallow seasonal or intermittent lake. The word is of Dutch/Afrikaans origin meaning 'pond' or 'marsh', and is pronounced as "flay". Vleis vary in their extent according to the fall of rain or dryness of the season.

Map A7: Location of the Usutu to Mhlatuze Water Management Area[9]

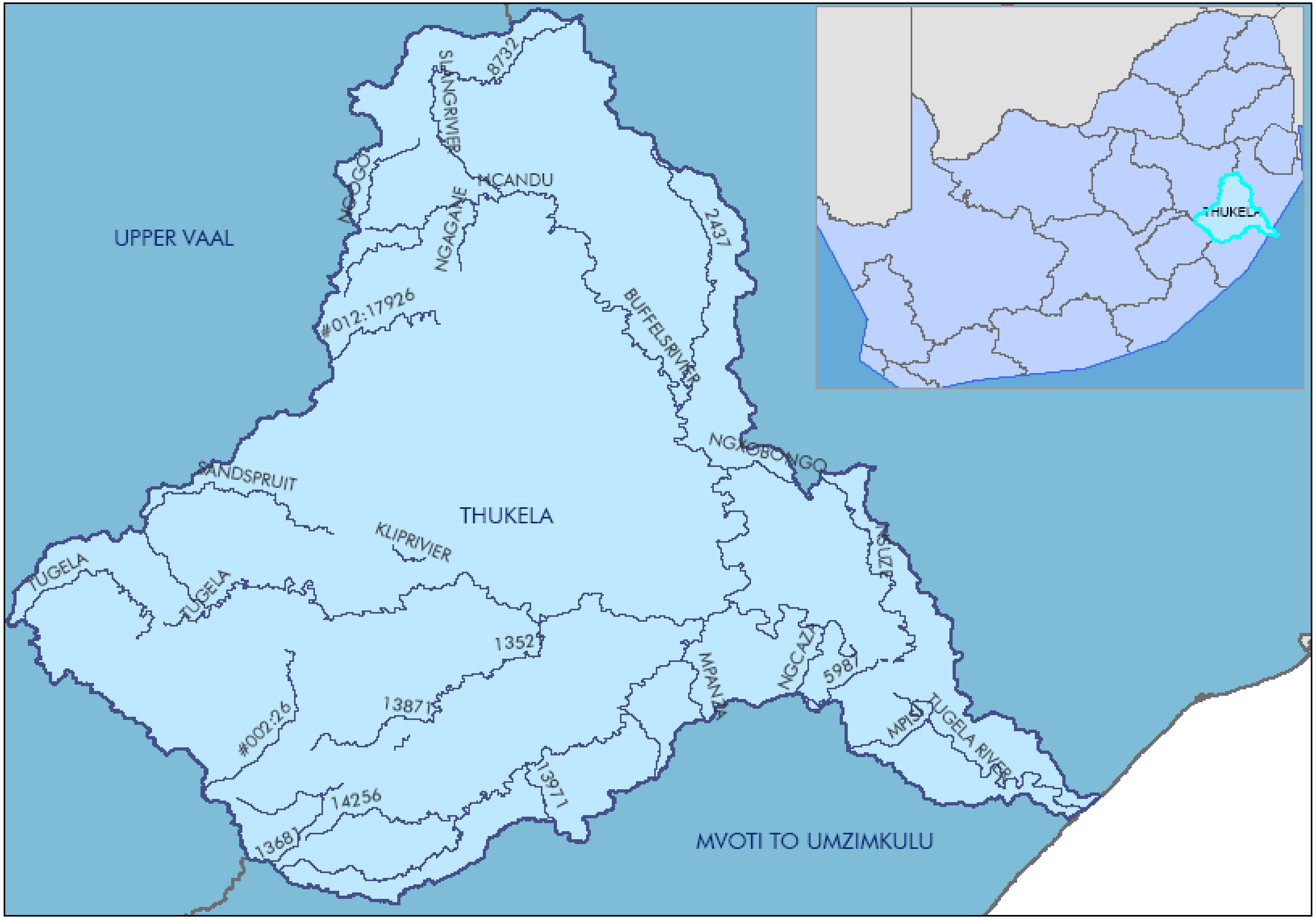

Table A7.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Upper Thukela	1 502	392
Mooi/Sundays	992	213
Buffalo	941	182
Lower Thukela	364	72
Total for Thukela WMA	3 799	859

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A7.2: Available yield in the year 2000 (million m^3/annum)

	Natural resource		Usable return flow			
Sector/sub-area	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
			million m^3/annum			
Upper Thukela	376	5	8	5	0	394
Mooi/Sundays	110	3	8	6	1	128
Buffalo	107	6	5	13	5	136
Lower Thukela	73	1	2	0	3	79
Total for Thukela WMA	666	15	23	24	9	737

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A7.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
				million m^3/annum			
Upper Thukela	71	11	6	0	0	0	88
Mooi/Sundays	76	13	9	4	0	0	102
Buffalo	38	27	11	14	1	0	91
Lower Thukela	19	1	5	28	0	0	53
Total for Thukela WMA	204	52	31	46	1	0	334

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.
[ii] Mining and bulk industrial water uses that are not part of urban systems.
[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).
[iv] Quantities refer to the impact on yield only.

Table A7.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
			million m^3/annum		
Upper Thukela	394	0	88	377	-71
Mooi/Sundays	128	0	102	34	-8
Buffalo	136	0	91	55	-10
Lower Thukela	79	0	53	40	-14
Total for Thukela WMA	737	0	334	506	-103

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A7.5 and A7.6.

Table A7.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Upper Thukela	396	0	94	377	-75	380
Mooi/Sundays	131	0	107	34	-10	218
Buffalo	136	0	92	55	-11	0
Lower Thukela	79	0	54	40	-15	0
Total for Thukela WMA	742	0	347	506	-111	598

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] Based on the construction of the Jana, Mielietuin and Springgrove Dams.

Table A7.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Upper Thukela	401	0	104	377	-80	380
Mooi/Sundays	140	0	129	34	-23	218
Buffalo	155	0	133	55	-33	0
Lower Thukela	80	0	54	40	-14	0
Total for Thukela WMA	776	0	420	506	-150	598

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] Based on the construction of the Jana, Mielietuin and Springgrove Dams.

A substantial portion of the water resources of the Thukela basin will be required for existing and future transfers to other WMAs. Reservations in the Thukela WMA for this purpose are:

- The transfer of a maximum of 630 million m^3/annum from the Upper Thukela River to the Upper Vaal WMA (equal to the current capacity). The average quantity transferred is about 530 million m^3/annum.

- The transfer of up to 55 million m^3/annum (current capacity) from the Assegaai tributary of the Buffalo River to the Upper Vaal WMA.

- The transfer from the Mooi River to the Mgeni River in the Mvoti to Umzimkulu WMA up to the current installed capacity of 100 million m^3/annum and up to 136 million m^3/annum with the addition of new infrastructure.

- The current transfer of 40 million m^3/annum to the Usutu to Mhlatuze WMA, which may be increased to a maximum of 94 million m^3/annum.

8 Upper Vaal Water Management Area[7]

The Upper Vaal WMA lies in the eastern interior of South Africa. From a water resources management perspective it is a pivotal WMA in the country. Large quantities of water are transferred into the area from two neighbouring areas, as well as water sourced from the Upper Orange River via Lesotho. Similarly, large quantities of water are transferred out to three other WMAs, which are dependent on water from the Upper Vaal WMA to meet much of their requirements. The impacts of these transfers extend well beyond the four adjoining WMAs and eventually involve a total of ten WMAs and all the neighbouring countries of South Africa. Climate over the Upper Vaal WMA is fairly uniform and the average rainfall varies between 600 mm and 800 mm per year.

Extensive urbanisation and mining and industrial activity, which relate to the rich gold and coal deposits in the area, occur in the northern part of the Upper Vaal WMA. Economic activity in the remainder of the Upper Vaal WMA mainly relates to livestock farming and rain fed cultivation.

Because of the high level of urbanisation and economic activity in the area and its pivotal role as a water transfer point to other WMAs, water resources in the area are highly developed and regulated, and only marginal potential for further development remains. The total yield transferred into the catchment is in excess of 120% of the yield from local surface resources, while virtually the same quantity of water that is again transferred out of the area. Groundwater is mainly used for rural domestic needs and for stock watering, while a substantial quantity of water is also abstracted from dolomitic aquifers for urban use.

Projections show that population and economic growth will remain strong in the urban and industrialised parts of the water management area. A significant decline in population is, however, foreseen in the Qwa Qwa region in the southern extremity of the Upper Vaal WMA.

Map A8: Location of the Upper Vaal Water Management Area[9]

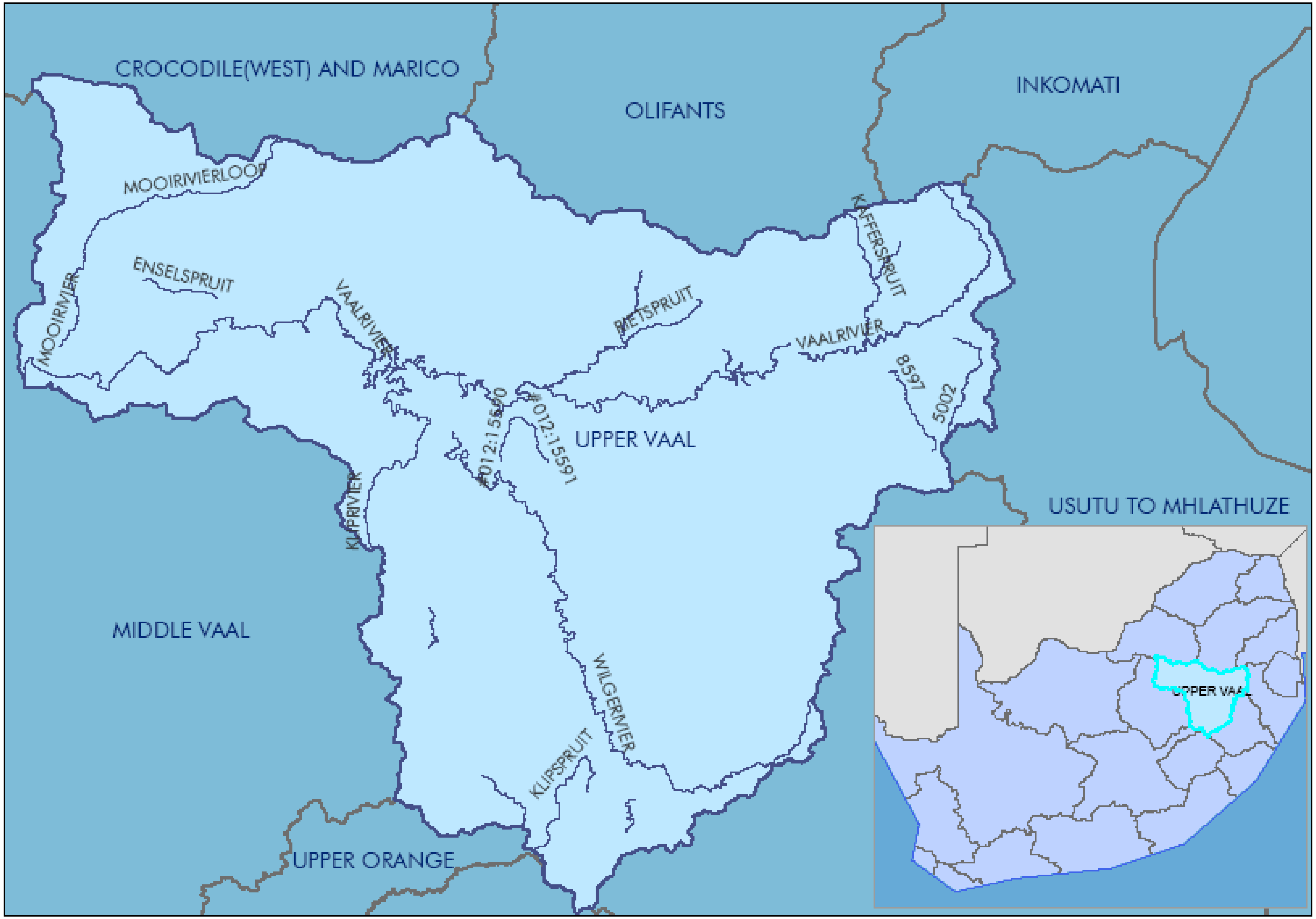

Table A8.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Wilge	868	116
Vaal Dam - upstream	1 109	126
Vaal Dam - downstream	446	57
Total for the Upper Vaal WMA	2 423	299

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A8.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m^3/annum					
Wilge	46	4	2	7	0	59
Vaal Dam - upstream	154	8	3	11	8	184
Vaal Dam - downstream	399	20	7	325	138	889
Total for the Upper Vaal WMA	599	32	12	343	146	1 132

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A8.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Wilge	18	27	15	0	0	0	60
Vaal Dam - upstream	29	32	17	99	39	0	216
Vaal Dam - downstream	67	576	11	74	41	0	769
Total for the Upper Vaal WMA	114	635	43	173	80	0	1 045

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.
[ii] Mining and bulk industrial water uses that are not part of urban systems.
[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).
[iv] Quantities refer to the impact on yield only.

Table A8.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Wilge	59	0	60	0	-1
Vaal Dam - upstream	184	118	216	67	19
Vaal Dam - downstream	889	1 224	769	1 343	1
Total for the Upper Vaal WMA	1 132	1 342	1 045	1 410	19

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A8.5 and A8.6.

Table A8.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Wilge	58	0	56	0	2	0
Vaal Dam - upstream	184	118	256	74	-28	50
Vaal Dam - downstream	987	1 513	957	1 561	-18	0
Total for the Upper Vaal WMA	1 229	1 631	1 269	1 635	-44	50

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
[iii] Shows negative balances.
[iv] Based on the construction of the Klip River Dam.

Table A8.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Wilge	64	0	78	0	-14	0
Vaal Dam - upstream	190	118	272	74	-38	50
Vaal Dam - downstream	1 232	1 513	1 391	2 067	-713	0
Total for the Upper Vaal WMA	1 486	1 631	1 741	2 141	-765	50

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
[iii] Shows negative balances.
[iv] Based on the construction of the Klip River Dam.

The following reservations apply with respect to the transfer of water into and out of the Upper Vaal WMA, and the provision of water for future growth:

- The existing transfer of 491 million m^3/annum from Lesotho, which is to be increased to 835 million m^3/annum after the commissioning of Mohale Dam in Lesotho – reserved by international agreement for use in and transfer from the Upper Vaal WMA.

- Existing transfers from the Thukela WMA up to the installed capacity of 630 million m^3/annum. The yield benefit in the Vaal System is 736 million m^3/annum – reserved in the Thukela WMA.

- Future large-scale water resources development on the Thukela River is reserved mainly for transfer to the Upper Vaal WMA. Current planning allows for an additional transfer of 475 million m^3/annum – reserved in the Thukela WMA.

- Existing transfer of 55 million m^3/annum from the Buffalo River in the Thukela WMA to the Upper Vaal WMA – reserved in the Thukela WMA.

- Transfers from the Usutu to Mhlatuze WMA at the current capacity of 63 million m^3/annum – reserved in the Usutu to Mhlatuze WMA.

- Existing transfers from the Upper Vaal WMA to the Olifants WMA of 36 million m^3/annum for power generation, plus an allowance of 38 million m^3/annum for future growth – reserved in the Upper Vaal WMA.

- Transfers from the Upper Vaal WMA through the Rand Water distribution system to meet requirements in the Crocodile West and Marico WMA, which are in excess of the capacity of the local resources in the Crocodile West and Marico WMA. Currently this amounts to 514 million m^3/annum and is projected to increase to 723 million m^3/annum. As an upper high growth scenario, transfers may need to increase to 1 125 million m^3/annum – reserved in the Upper Vaal WMA.

- Releases from the Upper Vaal WMA along the Vaal River to users in the Middle Vaal and Lower Vaal WMAs to meet their realistic needs that cannot be supplied from own resources. Little change is expected from the current transfer of 828 million m^3/annum, although it may increase to about 910 million m^3/annum in 2025 under the high growth scenario – reserved in the Upper Vaal WMA.

- Current surplus transfer capacity into the Upper Vaal WMA is to be reserved for growth in urban, industrial and mining water requirements in the Upper Vaal and Crocodile West and Marico WMAs, and is not to be used for commercial irrigation.

- The allocation of surplus yield in the Upper Vaal WMA will be subject to national authorisation as it can be allocated to users in the Upper, Middle, Lower Vaal as well as Crocodile West and Marico and Olifants WMAs.

- The Upper Vaal WMA forms the central component of the Vaal River System, which extends over several WMAs. As water resources management in the Vaal River System impacts to some degree on the water quantity and quality in all the interlinked WMAs, management of the Vaal River System is to be controlled at a national level.

9 Middle Vaal Water Management Area[7]

The Middle Vaal WMA is situated in the Free State and North West in the central part of South Africa. It covers the middle reaches of the Vaal River, between the Upper Vaal and Lower Vaal WMAs. Rainfall is relatively low and ranges from 400 to 700 mm per year, while evaporation can be as high as 1 900 mm per year.

There are no distinct geographic or topographic features and surface runoff is low. Activity in the Middle Vaal WMA is typically extensive livestock farming and rain fed cultivation, with some irrigation farming. Economic activity is dominated by gold mining in the vicinity of Klerksdorp and Welkom.

Dams have been constructed on all the main tributaries of the Vaal River. Any unregulated runoff is controlled by the Bloemhof Dam on the Vaal River in the Lower Vaal WMA immediately after the river exits the Middle Vaal WMA. No realistic potential for further development of surface water exists. Extensive use of groundwater for rural domestic and village supplies is made throughout the Middle Vaal WMA. Large dolomitic aquifers are found in the northern part of the Middle Vaal WMA, which extend into the adjoining WMAs and support large areas under irrigation.

Water along the Vaal River is highly saline and generally of poor quality as a result of the large quantities of effluent and urban runoff that is discharged into the river in the Upper Vaal WMA. Water quality is carefully managed by blending fresh water with the effluent.

Because of a decline in gold mining activity, a small decrease in population is projected for the area, with associated effects on economic activity. Little change in water requirements is therefore expected.

Map A9: Location of the Middle Vaal Water Management Area[9]

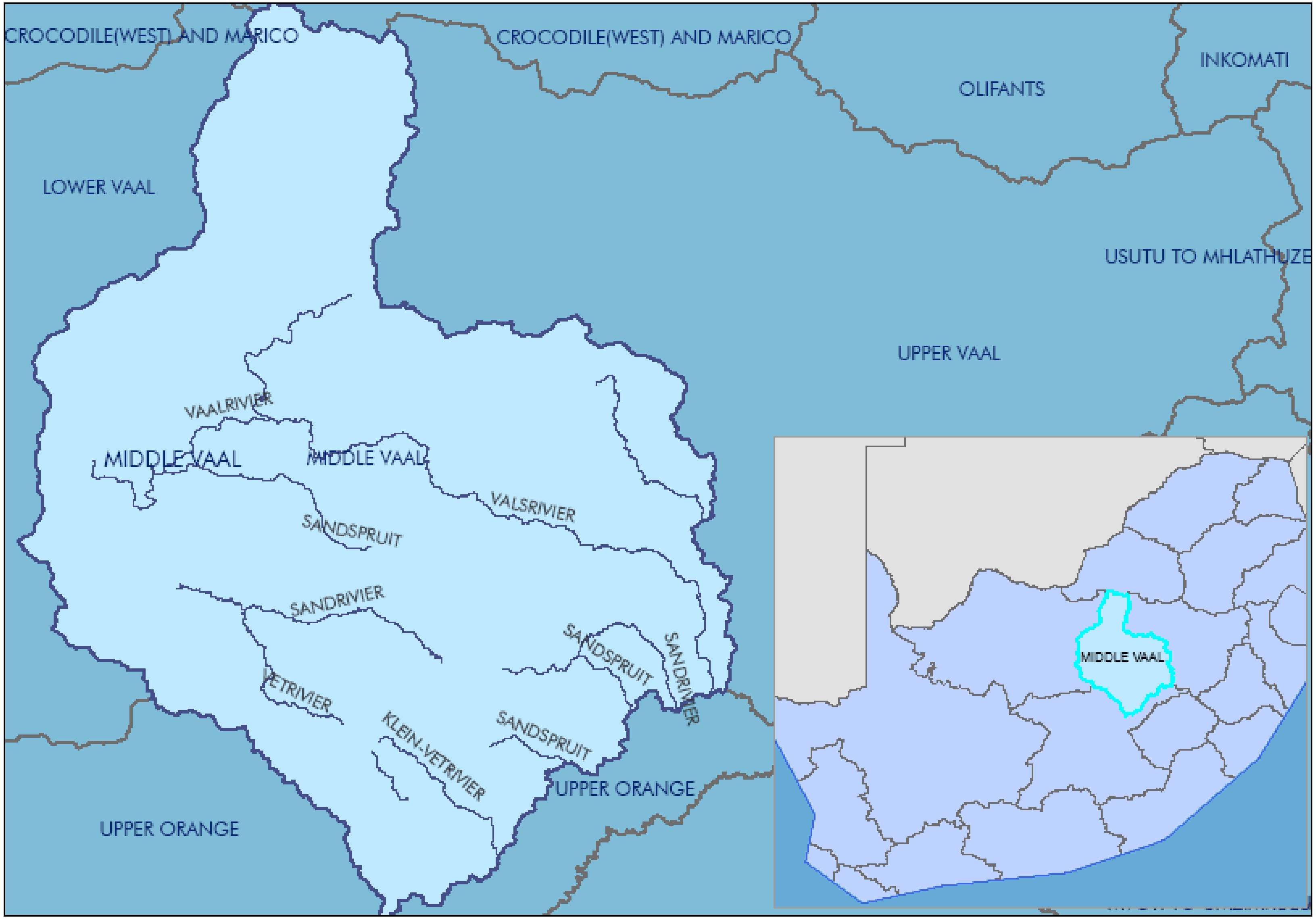

Table A9.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Rhenoster/Vals	295	35
Middle Vaal	170	29
Sand/Vet	423	45
Total for the Middle Vaal WMA	888	109

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A9.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m^3/annum					
Rhenoster/Vals	22	12	3	7	0	44
Middle Vaal	-201	25	3	15	16	-142
Sand/Vet	112	17	10	7	1	147
Total for the Middle Vaal WMA	-67	54	16	29	17	49

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A9.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Rhenoster/Vals	26	20	8	0	0	0	54
Middle Vaal	33	35	13	48	0	0	129
Sand/Vet	100	38	11	38	0	0	187
Total for the Middle Vaal WMA	159	93	32	86	0	0	370

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.
[ii] Mining and bulk industrial water uses that are not part of urban systems.
[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).
[iv] Quantities refer to the impact on yield only.

Table A9.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Rhenoster/Vals	44	1	54	0	-9
Middle Vaal	-142	828	129	559	-2
Sand/Vet	147	59	187	2	17
Total for the Middle Vaal WMA	49	888	370	561	6

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A9.5 and A9.6.

Table A9.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development
	million m^3/annum					
Rhenoster/Vals	44	1	53	0	-8	0
Middle Vaal	-136	837	142	560	-1	0
Sand/Vet	147	59	187	2	17	0
Total for the Middle Vaal WMA	55	897	382	562	8	0

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
[iii] Shows negative balances.

Table A9.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development
	million m^3/annum					
Rhenoster/Vals	49	2	65	0	-14	0
Middle Vaal	-131	910	152	628	-1	0
Sand/Vet	149	72	200	2	19	0
Total for the Middle Vaal WMA	67	984	417	630	4	0

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
[iii] Shows negative balances.

The following quantities of water need to be reserved for transfers in to and out of the Middle Vaal WMA:

- Transfers from the Upper Vaal WMA for use in the Middle Vaal and Lower Vaal WMAs. Currently this amounts to 828 million m^3/annum and may under a high growth scenario increase to 910 million m^3/annum – reserved in the Upper Vaal WMA.

- Transfers from the Middle Vaal WMA to the Lower Vaal WMA.

- The current volume is 500 million m^3/annum, which under a high growth scenario may increase to about 555 million m^3/annum – reserved in the Middle Vaal WMA.

- Small existing transfers for domestic use from Vaal Dam in the Upper Vaal WMA to Heilbron in the Middle Vaal WMA – reserved in the Upper Vaal WMA.

- Small existing transfers for domestic use from the Erfenis Dam in the Middle Vaal WMA to users in the Upper Orange WMA – reserved in the Middle Vaal WMA.

10 Lower Vaal Water Management Area

The Lower Vaal WMA lies in the north-western part of South Africa and borders on Botswana in the north. Climate in the region is semi-arid to arid, with rainfall ranging from 500 mm to as low as 100 mm per year and evaporation reaching 2 800 mm per year towards the west. Streamflow characteristics are distinctly different for the three sub-areas. Flow in the Vaal River is perennial, fed by high rainfall and regulation upstream, the Harts River is characterised by highly intermittent runoff, and the Molopo and Kuruman Rivers are endorheic[9] and typically cease to flow after some distance due to infiltration into the river bed and evaporation.

Iron ore, diamonds and manganese are mined in the Lower Vaal WMA. Farming activity ranges from extensive livestock production and rain fed cultivation to intensive irrigation enterprises at Vaalharts. Kimberley, which straddles the divide between the Lower Vaal and Upper Orange WMAs, is the largest urban centre in the area.

Utilisable surface water resources in the Lower Vaal WMA are limited to those supplied by the Vaal and Harts Rivers, both of which are fully regulated. Barberspan, an off-channel pan in the upper reaches of the Harts River, is a Ramsar wetland site. More than 50% of the yield from natural water resources in the tributary catchments within the Lower Vaal WMA is supplied from groundwater. At Sishen, groundwater abstracted in the process of de-watering the mine is also used for water supply, although it is recognised as being controlled mining of groundwater. Localised over-exploitation of groundwater occurs in some areas. Water quality is of special concern in the lower reaches of the Harts and the Vaal Rivers because of the high salinity of leach water from the Vaalharts irrigation scheme. To counter this problem, better quality water is transferred from the Orange River to the Douglas Weir in the lower reaches of the Vaal River for blending purposes.

There is limited potential for strong economic development in the region and future population projections show little change in the demographics of the Lower Vaal WMA. Little change in water requirements is therefore foreseen.

[9] Endorheic lakes/rivers are bodies of water that do not flow into the sea. Most of the water falling on earth finds its way to the oceans through a network of rivers, lakes and wetlands. However, there is a class of water bodies that are located in closed or endorheic watersheds where the topography prevents their drainage to the oceans. These endorheic watersheds (containing water in rivers or lakes that form a balance of surface inflows, evaporation and seepage) are often called terminal lakes or sink lakes.

Map A10: Location of the Lower Vaal Water Management Area[9]

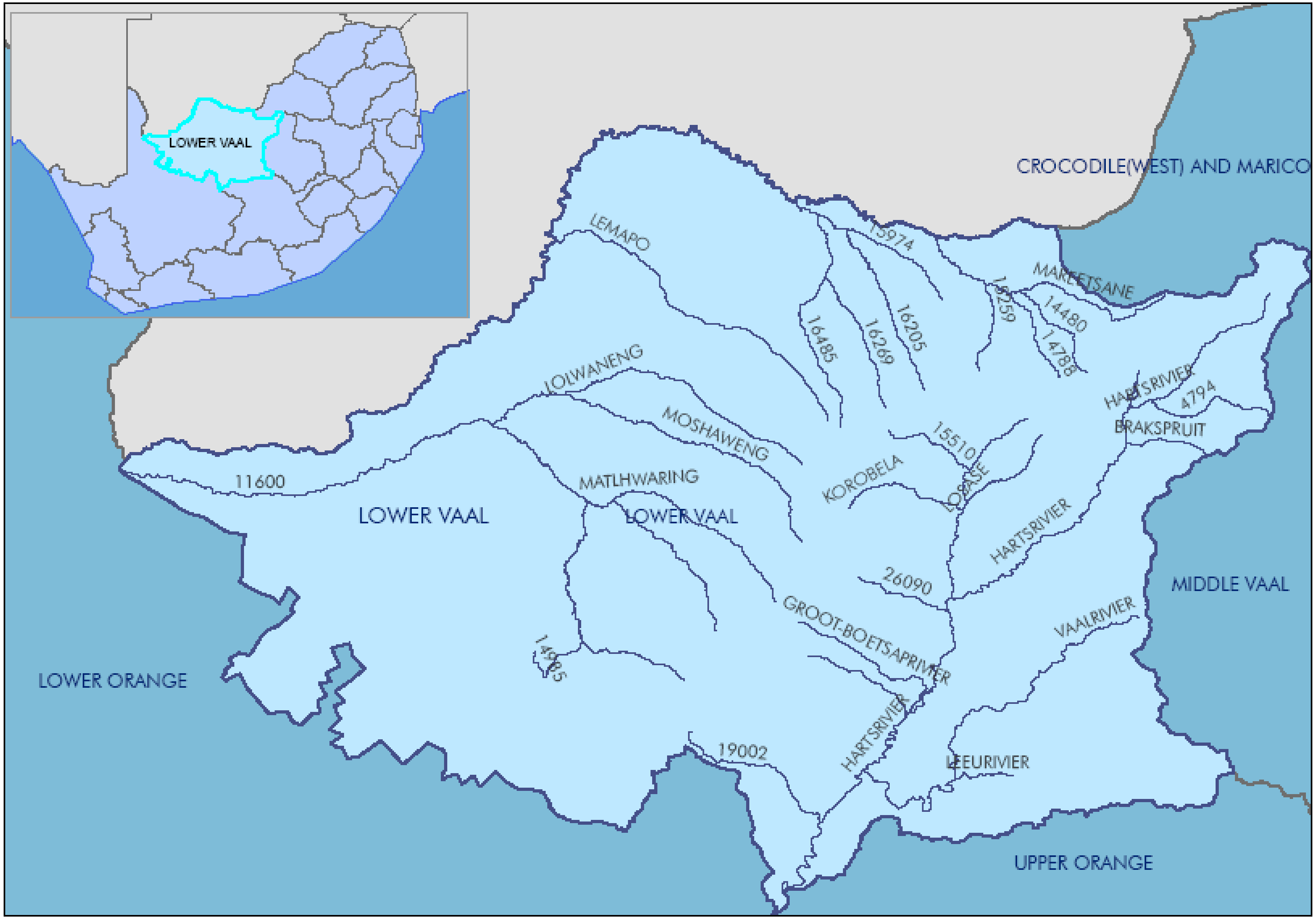

Table A10.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Harts	138	15
Vaal d/s Bloemhof[iii]	43	5
Molopo	197[iv]	29
Total for the Lower Vaal WMA	181	49

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.
[iii] d/s Bloemhof = downstream of the Bloemhof Dam.
[iv] Estimated runoff from catchment (lost through evaporation and infiltration before reaching Orange River). This runoff therefore does not add to the total for the Lower Vaal WMA.

Table A10.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	
			million m^3/annum			
Harts	51	40	45	0	0	136
Vaal d/s Bloemhof[ii]	-107	54	7	0	0	-46
Molopo	2	31	0	0	2	35
Total for the Lower Vaal WMA	-54	125	52	0	2	125

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.
[ii] d/s Bloemhof = downstream of the Bloemhof Dam.

Table A10.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Harts	452	23	19	0	0	0	494
Vaal d/s Bloemhof[v]	73	32	8	0	0	0	113
Molopo	0	13	17	6	0	0	36
Total for the Lower Vaal WMA	525	68	44	6	0	0	643

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.
[ii] Mining and bulk industrial water uses that are not part of urban systems.
[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).
[iv] Quantities refer to the impact on yield only.
[v] d/s Bloemhof = downstream of the Bloemhof Dam.

Table A10.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Harts	136	419	494	62	-1
Vaal d/s Bloemhof[iii]	-46	609	113	422	28
Molopo	35	4	36	0	3
Total for the Lower Vaal WMA	125	1 032	643	484	30

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A10.5 and A10.6.
[iii] d/s Bloemhof = downstream of the Bloemhof Dam.

Table A10.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development
			million m^3/annum			
Harts	137	419	496	60	0	0
Vaal d/s Bloemhof[iv]	-45	631	112	422	52	0
Molopo	35	4	34	0	5	0
Total for the Lower Vaal WMA	127	1 054	642	482	57	0

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
[iii] Shows negative balances.
[iv] d/s Bloemhof = downstream of the Bloemhof Dam.

Table A10.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development
			million m^3/annum			
Harts	137	419	504	52	0	0
Vaal d/s Bloemhof[iv]	-45	697	158	422	72	0
Molopo	35	4	41	0	-2	0
Total for the Lower Vaal WMA	127	1 120	703	474	70	0

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
[iii] Shows negative balances.
[iv] d/s Bloemhof = downstream of the Bloemhof Dam.

The key issues with regard to water resources management in the Lower Vaal WMA are the following:

- The Lower Vaal WMA forms part of the Vaal River System, which extends over several WMAs. As water resources management in this system impacts to some degree on water quantity and quality in all the interlinked WMAs, management of water resources in the Vaal River System is to be controlled at a national level.

- Operational management of water abstractions from the Vaal River is handled in close co-operation with the Middle Vaal and Upper Vaal Catchment Management Agencies to ensure the efficient overall management of the Vaal River System and efficient flood control in the Orange-Vaal system.

- Management of water quality in the Vaal and Harts Rivers.

- Management of groundwater, both from an abstraction and a recharge perspective, to ensure sustainability of use.

Due consideration is also to be given to the implementation of appropriate demand management measures and to ensuring the most beneficial use of water. Reservations will apply in respect of water transfers into and out of the Lower Vaal WMA.

- Currently 500 million m^3/annum is transferred from the Middle Vaal WMA to the Lower Vaal WMA and may as an upper scenario increase to about 555 million m^3/annum – reserved in the Middle Vaal WMA.

- A reservation also applies to the transfer of 18 million m^3/annum from the Upper Orange WMA to the Douglas Weir in the Lower Vaal WMA – reserved in the Upper Orange WMA.

11 Mvoti to Umzimkulu Water Management Area[7]

The Mvoti to Umzimkulu WMA lies along the eastern coast of South Africa, predominantly within KwaZulu-Natal, and borders on Lesotho to the west. It is situated in a humid part of the country with a mean annual precipitation of 800 to 1 500 mm. The terrain is rolling, with the Drakensberg escarpment as the main topographic feature. Several parallel rivers drain the Mvoti to Umzimkulu WMA, two of which originate in the Drakensberg Mountains at the border with Lesotho. Small coastal streams also abound. Many of the estuaries are still in a relatively natural state.

Economic activity in the Mvoti to Umzimkulu WMA is diverse. The rural areas are characterised by both subsistence and commercial farming, with extensive cultivation of sugar cane along the coast and commercial forests in the higher rainfall areas. The Durban metropolitan area is the second largest commercial and industrial nucleus in the country, and is surrounded by satellite developments along the coast and inland towards Pietermaritzburg.

Large differences are noticeable in the degree to which water resources have been developed in the Mvoti to Umzimkulu WMA. The Mgeni River, which is the main source of water for the Durban/Pietermaritzburg area, is fully regulated by several large dams in the catchment and is augmented with transfers from the Thukela WMA. In contrast, the potential of the Mkomazi and Umzimkulu Rivers remains largely undeveloped and various degrees of development apply to the remainder of the surface resources in the Mvoti to Umzimkulu WMA. Because of the perennial nature of streamflow in the Mvoti to Umzimkulu WMA, surface water, which includes springflow is generally used for rural water supplies and there is only minimal abstraction of groundwater.

Strong population growth is projected for the Mgeni sub-area, commensurate with the expected economic growth in the Durban/Pietermaritzburg area as well as a general tendency towards urbanisation. It is anticipated that population in the rural areas will remain relatively unchanged, although there could be localised decreases.

Map A11: Location of the Mvoti to Umzimkulu Water Management Area[9]

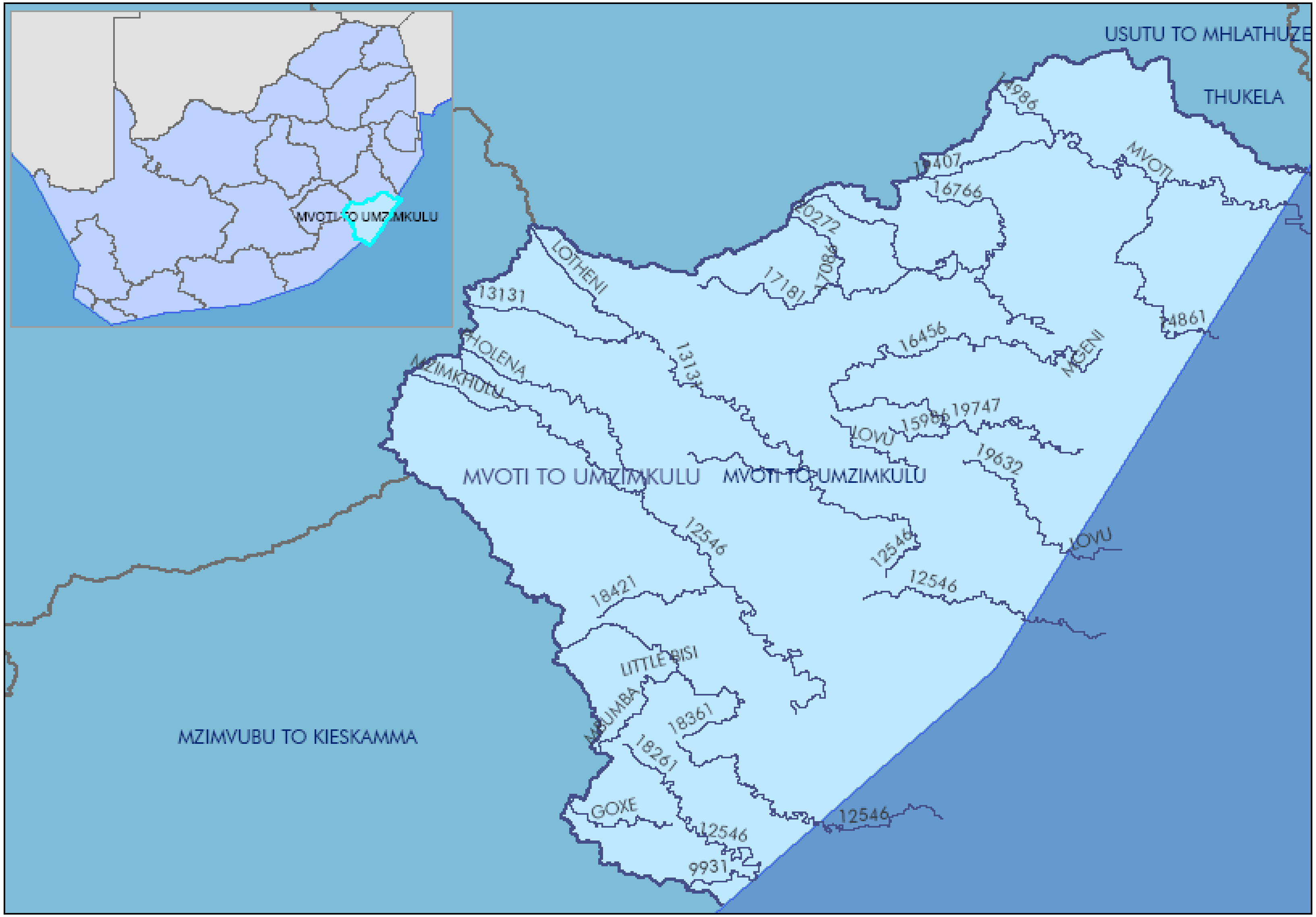

Table A11.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Mvoti	595	150
Mgeni	992	187
Mkomazi	1 080	295
Coastal	758	211
Umzimkulu	1 373	317
Total for Mvoti to Umzimkulu WMA	4 798	1 160

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A11.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m^3/annum					
Mvoti	68	1	8	5	4	86
Mgeni	316	1	6	52	1	376
Mkomazi	27	1	3	0	0	31
Coastal	11	2	1	0	0	14
Umzimkulu	11	1	3	0	1	16
Total for Mvoti to Umzimkulu WMA	433	6	21	57	6	523

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A11.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Mvoti	76	9	10	11	0	8	114
Mgeni	63	378	12	4	0	47	504
Mkomazi	33	1	5	53	0	6	98
Coastal	10	19	10	1	0	1	41
Umzimkulu	25	1	7	4	0	3	40
Total for Mvoti to Umzimkulu WMA	207	408	44	73	0	65	797

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.
[ii] Mining and bulk industrial water uses that are not part of urban systems.
[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).
[iv] Quantities refer to the impact on yield only.

Table A11.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Mvoti	86	0	114	4	-32
Mgeni	376	38	504	0	-90
Mkomazi	31	0	98	1	-68
Coastal	14	11	41	0	-16
Umzimkulu	16	0	40	10	-34
Total for Mvoti to Umzimkulu WMA	523	49	797	15	-240

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A11.5 and A11.6.

Table A11.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Mvoti	90	0	122	4	-36	47
Mgeni	404	38	705	0	-263	90
Mkomazi	31	0	99	1	-69	481
Coastal	14	11	45	0	-20	0
Umzimkulu	16	0	40	10	-34	400
Total for Mvoti to Umzimkulu WMA	555	49	1 011	15	-422	1 018

Notes:
[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
[iii] Shows negative balances.
[iv] Based on the raising of the Hazelmere and Midmar Dams, and construction of the Impendle, Smithfield and iSitungo Dams.

Table A11.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Mvoti	94	0	131	4	-41	47
Mgeni	459	38	1 103	0	-606	90
Mkomazi	31	0	100	1	-70	481
Coastal	14	11	62	0	-37	0
Umzimkulu	16	0	41	10	-35	400
Total for Mvoti to Umzimkulu WMA	614	49	1 437	15	-789	1 018

Notes:
[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
[iii] Shows negative balances.
[iv] Based on the raising of the Hazelmere and Midmar Dams, and construction of the Impendle, Smithfield and iSitungo Dams.

The following options are of specific relevance to the Mvoti to Mzimkulu WMA:

- Additional transfers of water from the Mooi River in the Thukela WMA. Plans have already been developed to increase the transfer capacity from the existing 100 million m^3/annum to 136 million m^3/annum by constructing the Springgrove Dam on the Mooi River and increasing the pumping capacity.

- Increased re-use of return flows from the Durban metropolitan area. Although about 15% of the return flows are currently re-used, some indirectly or for environmental purposes, the bulk is still discharged to the ocean.

- The transfer of water from the Mkomazi River to the Mgeni River within the Mvoti to Umzimkulu WMA. As a future option water may also be transferred from the Umzimkulu River.

In support of the first option a volume of 135 million m^3/annum is reserved for transfer from the Mooi River in the Thukela WMA to the Mgeni River in the Mvoti to Umzimkulu WMA. The Springgrove Dam to be constructed on the Mooi River for the purpose of transferring water to the Mgeni River will therefore fall under national control – reserved in the Thukela WMA.

The Mkomazi River has been identified by planning studies as the most feasible next option for augmenting water supplies for the Durban/Pietermaritzburg area, and development of this river needs to be reserved for that purpose – reservation to apply within the Mvoti to Umzimkulu WMA.

12 Mzimvubu to Keiskamma Water Management Area[7]

The Mzimvubu to Keiskamma WMA lies predominantly within the Eastern Cape and borders on Lesotho to the north. Climate over most of the area can be classified as sub-humid to humid, with rainfall in the range from 700 mm/annum to nearly 1 500 mm/annum, but reducing to as low as 400 mm/annum in the west. The topography is rolling, with the highest points on the border with Lesotho, which also forms the divide with the Orange River catchment. Three main rivers flow from the inland divide to the coast, while smaller rivers and coastal streams abound. Many of the estuaries are still in a relatively natural state. The Mzimvubu River is the largest undeveloped river in South Africa.

Land use in the Mzimvubu to Keiskamma WMA is predominantly for livestock farming and subsistence agriculture. There are several irrigation developments, some of which are only partly operational, and timber is grown commercially in the higher rainfall areas. Economic activity is dominated by industrial development in the East London area, which is known for its automotive and textile industries.

The degree of water resources development in the Mzimvubu to Keiskamma WMA varies considerably. No noteworthy dams have been constructed in the Mzimvubu River catchment, where significant potential for water resource development remains. Development potential also exists in the Mbashe River. The Mtata River is well regulated by the Mtata Dam, while several dams have been constructed in the upper reaches of the Kei catchment and on the Buffalo River. Three small hydro-electric developments are in operation on the Mbashe and Mtata Rivers. Although inter-catchment transfers of water take place within the Mzimvubu to Keiskamma WMA, there are no inter-water management area transfers.

A moderate growth in population is expected for the East London/Bisho region (Amatola sub-area), while the area's rural population is projected to decline after the year 2005. Little change in the total population of the Mzimvubu to Keiskamma WMA is thus foreseen. Potential for economic development exists mainly in the East London/Bisho industrial zone, with tourism and commercial forestry as possible additional stimulants.

Map A12: Location of the Mzimvubu to Keiskamma Water Management Area[9]

Table A12.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Mzimvubu	2 897	338
Mtata	836	163
Mbashe	1 126	203
Kei	1 027	154
Amatola	559	116
Wild Coast	796	148
Total for Mzimvubu to Keiskamma WMA	7 241	1 122

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A12.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m^3/annum					
Mzimvubu	84	3	2	2	0	91
Mtata	129	1	0	6	0	136
Mbashe	112	1	0	1	0	114
Kei	325	14	14	6	0	359
Amatola	122	1	2	24	0	149
Wild Coast	4	1	0	0	0	5
Total for Mzimvubu to Keiskamma WMA	776	21	18	39	0	854

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A12.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Mzimvubu	15	6	9	0	0	3	33
Mtata	4	15	5	0	0	29	53
Mbashe	3	2	6	0	0	0	11
Kei	135	18	10	0	0	11	174
Amatola	33	57	5	0	0	4	99
Wild Coast	0	1	3	0	0	0	4
Total for Mzimvubu to Keiskamma WMA	190	99	38	0	0	47	374

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.

[ii] Mining and bulk industrial water uses that are not part of urban systems.

[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).

[iv] Quantities refer to the impact on yield only.

Table A12.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Mzimvubu	91	0	33	0	58
Mtata	136	0	53	0	83
Mbashe	114	85	11	0	188
Kei	359	0	174	85	100
Amatola	149	0	99	0	50
Wild Coast	5	0	4	0	1
Total for Mzimvubu to Keiskamma WMA	854	85	374	85	480

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.

[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A12.5 and A12.6.

Table A12.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
			million m^3/annum			
Mzimvubu	91	0	34	0	57	1 200
Mtata	141	0	61	0	80	45
Mbashe	115	85	10	0	190	65
Kei	360	0	179	85	96	135
Amatola	159	0	125	0	34	55
Wild Coast	5	0	4	0	1	0
Total for Mzimvubu to Keiskamma WMA	871	85	413	85	458	1 500

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] Based on the construction of a number of dams within the Mzimvubu to Keiskamma WMA.

Table A12.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
			million m^3/annum			
Mzimvubu	92	0	35	0	57	1 200
Mtata	138	0	54	0	84	45
Mbashe	115	85	10	0	190	65
Kei	362	0	185	85	92	135
Amatola	174	0	161	0	13	55
Wild Coast	5	0	4	0	1	0
Total for Mzimvubu to Keiskamma WMA	886	85	449	85	437	1 500

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] Based on the construction of a number of dams within the Mzimvubu to Keiskamma WMA.

Other issues that should receive specific consideration within the Mzimvubu to Keiskamma WMA are:

- Refurbishment and improved utilisation of irrigation schemes that have fallen into disrepair.

- The position with respect to insufficient streamflow measurement in many parts of the Mzimvubu to Keiskamma WMA.

In view of the fact that the Mzimvubu River is the largest undeveloped water resource in the country, the benefits to be derived from the development of this river will potentially be of national importance. It is prudent, therefore, for large-scale development of the Mzimvubu River to be made subject to authorisation at national level. With appropriate planning, new dams for hydropower generation and irrigation, for example, can be located and designed in such a way as to permit the abstraction of water for transfer to other WMAs. The possibility of such future developments of national importance should not be jeopardised unduly by other developments in the interim – reservation with respect to large-scale development of the Mzimvubu River therefore applies to the Mzimvubu to Keiskamma WMA.

13 Upper Orange Water Management Area[7]

The Upper Orange WMA lies in the centre of South Africa and extends over the southern Free State and parts of the Eastern and Northern Cape. It borders on Lesotho to the east, where the Orange River originates as the Senqu River. Draining the Highlands of Lesotho, the Senqu River contributes close to 60% of the surface water associated with the Upper Orange WMA. The climate varies considerably over the region and rainfall ranges from over 1 000 mm/annum in the foothills of the mountains to 200 mm/annum in the west. Vegetation is mainly grassland. Extensive sheep and cattle farming is characteristic throughout the area. Some dryland cultivation occurs where the rainfall and soils are favourable, but sizeable areas are under irrigation below the main storage dams. Bloemfontein, as an administrative and commercial centre, is the only large urban development in the Upper Orange WMA.

Water resources management in the area mainly revolves around the Orange River. Two of the highest dams in Africa have been constructed in the Orange (Senqu) catchment in Lesotho for the purpose of transferring water to the Upper Vaal WMA. The Gariep and Vanderkloof Dams in the Upper Orange WMA, where the two largest conventional hydropower installations in the country are located, also command the two largest storage reservoirs in South Africa. From the Gariep Dam a major inter-water management area transfer occurs via the 80 km long Orange-Fish Tunnel to the Fish to Tsitsikamma WMA. A significant portion of the yield of the Orange River is also released down the river for use in the Lower Orange WMA and by Namibia. In total, close to 70% of the yield realised in the Upper Orange WMA and in Lesotho is used in other WMAs. Even so, potential still exists for further large-scale development of the Orange River, with the most attractive sites for new dams being at the confluence of the Orange and Kraai Rivers, and at Mashai in Lesotho. The Modder and Riet tributaries have been fully developed.

Significant quantities of groundwater are used in parts of the Upper Orange WMA. Demographic projections show a small decline in rural population. As the expectations are that this will be balanced by population growth in the Bloemfontein area, little change in the total population of the Upper Orange WMA is anticipated within the period of projection. There are no strong stimulants for economic growth in the area.

Map A13: Location of the Upper Orange Water Management Area[9]

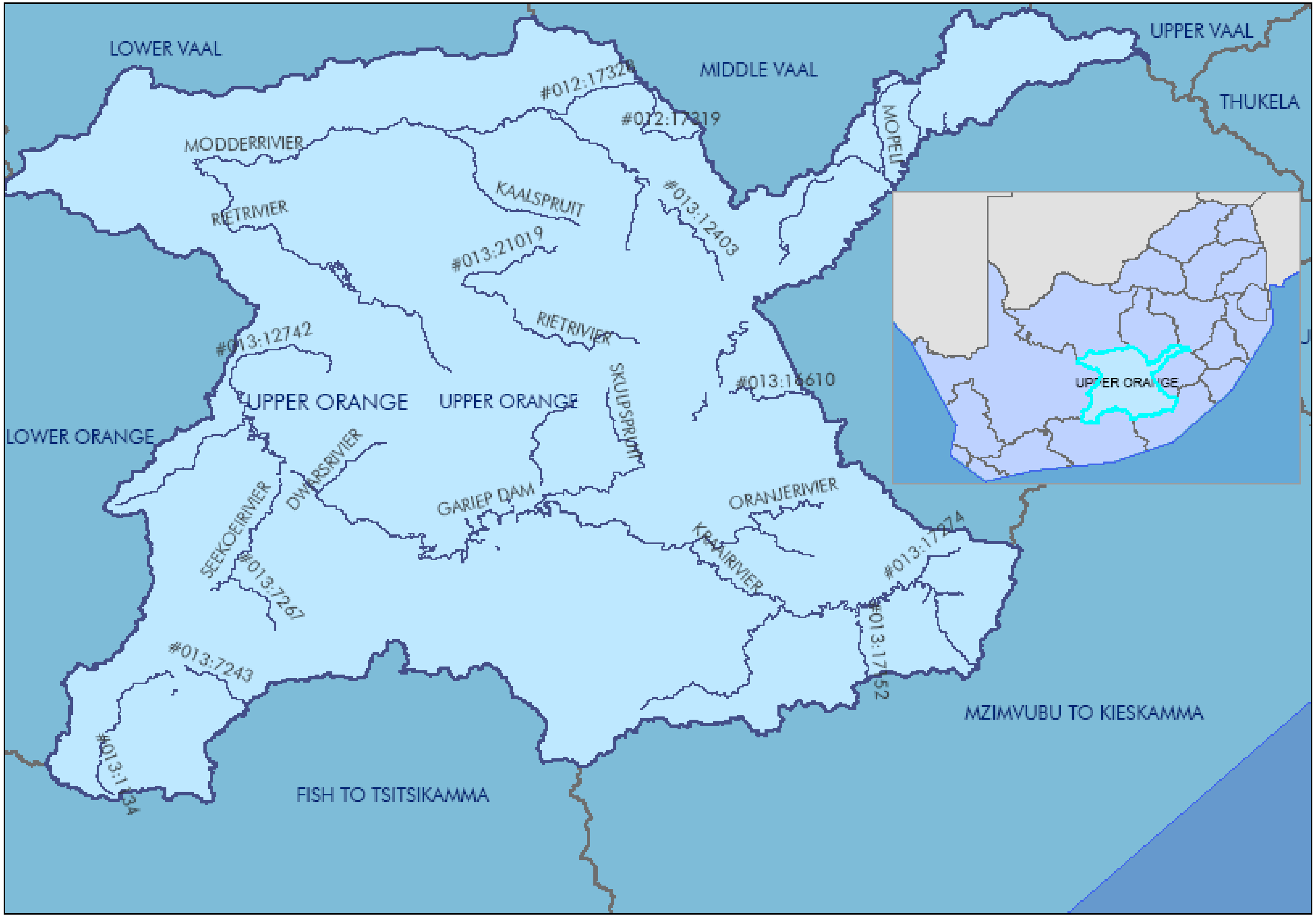

Table A13.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Senqu Lesotho	4 012	933
Caledon Lesotho	753	92
Caledon RSA	650	90
Kraai	956	158
Riet/Modder	407	45
Vanderkloof	203	31
Total for Upper Orange WMA	6 981	1 349

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A13.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m^3/annum					
Senqu Lesotho	523	0	0	0	0	523
Caledon Lesotho	28	1	0	2	0	31
Caledon RSA	167	5	4	2	0	178
Kraai	34	10	0	0	0	44
Riet/Modder	85	6	13	33	0	137
Vanderkloof	3 474	43	17	0	0	3 534
Total for Upper Orange WMA	4 311	65	34	37	0	4 447

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A13.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Senqu Lesotho	8	2	13	0	0	0	23
Caledon Lesotho	12	22	6	0	0	0	40
Caledon RSA	88	4	13	0	0	0	105
Kraai	84	6	13	0	0	0	103
Riet/Modder	252	87	10	2	0	0	351
Vanderkloof	336	5	5	0	0	0	346
Total for Upper Orange WMA	780	126	60	2	0	0	968

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.

[ii] Mining and bulk industrial water uses that are not part of urban systems.

[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).

[iv] Quantities refer to the impact on yield only.

Table A13.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Senqu Lesotho	523	0	23	491	9
Caledon Lesotho	31	0	40	0	-9
Caledon RSA	178	0	105	59	14
Kraai[iii]	44	0	103	0	-59
Riet/Modder	137	242	351	29	-1
Vanderkloof	3 534	0	346	2 809	379
Total for Upper Orange WMA	4 447	242	968	3 388	333

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.

[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A13.5 and A13.6.

[iii] The negative balance for the Kraai sub-area is as a result of irrigation requirements that are not fully supplied from run-of-river.

Table A13.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Senqu Lesotho	867	0	23	835	9	300
Caledon Lesotho	30	0	40	0	-10	0
Caledon RSA	273	0	104	118	51	0
Kraai[iii]	45	0	138	0	-93	0
Riet/Modder	160	301	410	52	-1	0
Vanderkloof	3 359	0	347	2 883	129	600
Total for Upper Orange WMA	4 734	301	1 062	3 888	85	900

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Water for 5 000 ha expansion in irrigation farming the Fish to Tsitsikamma WMA and an expansion of 4 000 ha each in the Upper and Lower Orange WMAs is to be sourced from the Upper Orange WMA. The water requirements of 36 million m^3/annum and 54 million m^3/annum for the Upper and Lower Orange WMAs respectively are provisionally allowed for under the Kraai sub-area and as a transfer from the Vanderkloof sub-area.

[iii] Shows negative balances.

[iv] The potential of 900 million m3/annum could be realised by constructing the Mashai Dam in Lesotho in conjunction with the Boskraai Dam at the confluence of the Orange and Kraai Rivers, or by constructing a larger Boskraai Dam on its own.

Table A13.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
			million m^3/annum			
Senqu Lesotho	867	0	23	835	9	300
Caledon Lesotho	30	0	40	0	-10	0
Caledon RSA	274	0	106	171	-3	0
Kraai[iii]	45	0	141	0	-96	0
Riet/Modder	180	354	463	72	-1	0
Vanderkloof	3 359	0	351	2 952	56	600
Total for Upper Orange WMA	4 755	354	1 124	4 030	-45	900

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Water for 5 000 ha expansion in irrigation farming the Fish to Tsitsikamma WMA and an expansion of 4 000 ha each in the Upper and Lower Orange WMAs is to be sourced from the Upper Orange WMA. The water requirements of 36 million m^3/annum and 54 million m^3/annum for the Upper and Lower Orange WMAs respectively are provisionally allowed for under the Kraai sub-area and as a transfer from the Vanderkloof sub-area.

[iii] Shows negative balances.

[iv] The potential of 900 million m^3/annum could be realised by constructing the Mashai Dam in Lesotho in conjunction with the Boskraai Dam at the confluence of the Orange and Kraai Rivers, or by constructing a larger Boskraai Dam on its own.

Because of the Upper Orange WMA central location and its linkages to other WMAs, much of the area's water resources are used in other WMAs. Accordingly specific reservations with regard to the use of water from the Upper Orange WMA are:

- The current transfer of 491 million m^3/annum from the Senqu River in Lesotho to the Upper Vaal WMA is to be increased to 835 million m^3/annum when the Mohale Dam in Lesotho comes into operation by the year 2004 – reserved through a treaty with Lesotho. In view of the reduced projections of water requirements from the Lesotho Highlands Water Project, it is imperative that the minimum quantity of water to be delivered, as specified in Annexure 2 of the Treaty on the Lesotho Highlands Water Project, is revised.

- The transfer of water to the Fish to Tsitsikamma WMA, up to the maximum capacity of the transfer tunnel of approximately 600 million m^3/annum, to serve current users as well as requirements for growth in the Port Elizabeth area – reserved in Upper Orange WMA.

- The transfer of 18 million m^3/annum from Marksdrift to Douglas Weir in the Lower Vaal WMA for water quality purposes – reserved in Upper Orange WMA.

- The release of water down the Orange River, currently about 2 035 million m^3/annum, to meet requirements in the Lower Orange WMA and for use by Namibia. A further 54 million m^3/annum for a possible 4 000 ha new irrigation project in the Lower Orange WMA must also be allowed for – reserved in Upper Orange WMA.

- The agreement with Eskom in respect of water for hydropower generation must be honoured. Revisions to the agreement are, however, required to address the impact of hydropower generation on the flow regime in the river and the impact of further resource developments on power generation more adequately – agreement at national level with Eskom imposes reservation on Upper Orange WMA.

- Large-scale water resource developments on the Orange River as well as on the Caledon and Kraai tributaries, that may impact on the above or on neighbouring countries (including the Senqu in Lesotho), will be subject to authorisation at national level – reservation applies to Upper Orange WMA.

- The allocation of all surplus water in the Upper Orange WMA will resort under national control as this water may be allocated to users in the Upper Orange or other WMAs.

14 Lower Orange Water Management Area[7]

The geographic extent of the Lower Orange WMA largely corresponds to that of the Northern Cape. It is situated in the western extremity of South Africa and borders on Botswana, Namibia and the Atlantic Ocean. Climate over the region is harsh semi-desert to desert. Rainfall is minimal, ranging from 400 mm/annum to a low of 20 mm/annum and is characterised by prolonged droughts. With the exception of sparse and highly intermittent runoff from local tributaries and occasional inflows from the Fish River in Namibia, the Lower Orange WMA is totally dependent on flow in the Orange River from upstream WMAs. Because of the low rainfall, groundwater resources are limited, although this source is well used for rural water supplies.

Important conservation areas in the Lower Orange WMA include the Kgalagadi Transfrontier National Park, the Augrabies National Park, the Richtersveld National Park and a transboundary Ramsar wetland site at the Orange River mouth.

The largest contributions to the region's economy are made by mining and irrigated agriculture. Mining activities consist mainly of the extraction of alluvial diamonds and a variety of other mineral resources from locations both inland and along the coast. Extensive irrigation occurs along the Orange River, where the tendency is increasingly towards the growing of high-value orchard crops. Namibia also abstracts water from the river for domestic, mining and irrigation purposes. Sheep and other livestock farming is practised where the climate is favourable.

Water resources in the Lower Orange WMA are fully developed. Owing to the fact that water has to travel a distance of 1 400 km from the point of release at Vanderkloof Dam to the most downstream point of use, large operational and transmission losses are incurred in the process of ensuring that the requirements of users are met. Opportunity exists for this situation to be improved by constructing a new dam in the Lower Orange River for the purpose of providing de-regulation storage. Such a dam could serve a secondary function of regulating spills from dams in upstream WMAs. An unique development in the southern tributary catchments is the use of soil embankments that retain runoff from the land, as a means of rainfall harvesting.

Map A14: Location of the Lower Orange Water Management Area[9]

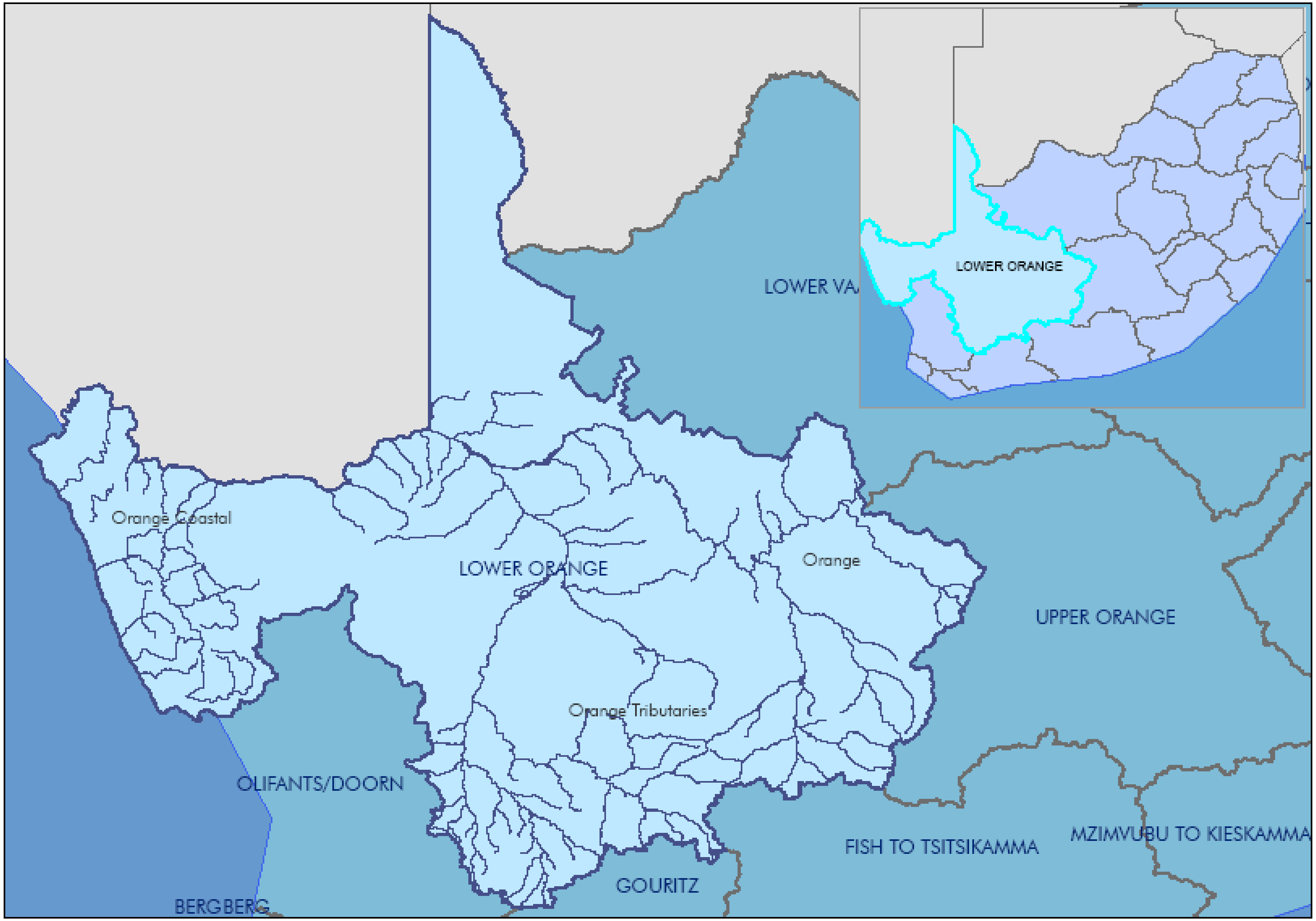

Table A14.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Orange[iii]	198	32
Orange Tributaries	280	35
Orange Coastal	24	2
Total for the Lower Orange WMA	502	69

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.
[iii] Does not include the MAR of 466 million m^3/annum of the Fish River in Namibia.

Table A14.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m^3/annum					
Orange	-1 092	9	96	1	0	-986
Orange Tributaries	9	13	0	0	0	22
Orange Coastal	0	3	0	0	0	3
Total for the Lower Orange WMA	-1 083	25	96	1	0	-961

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A14.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Orange	961	12	9	7	0	0	989
Orange Tributaries	16	8	7	0	0	0	31
Orange Coastal	0	5	1	2	0	0	8
Total for the Lower Orange WMA	977	25	17	9	0	0	1 028

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.
[ii] Mining and bulk industrial water uses that are not part of urban systems.
[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).
[iv] Quantities refer to the impact on yield only.

Table A14.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Orange	-986	2 035	989	60	0
Orange Tributaries	22	0	31	0	-9
Orange Coastal	3	6	8	0	1
Total for the Lower Orange WMA	-961	2 041	1 028	60	-8

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A14.5 and A14.6.

Table A14.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Orange	-981	2 082	1 042	60	-1	150
Orange Tributaries	22	0	29	0	-7	0
Orange Coastal	2	6	8	0	0	0
Total for the Lower Orange WMA	-957	2 088	1 079	60	-8	150

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Includes a 4 000 ha increase in irrigated farming land in the Orange sub-area, which will require 54 million m^3/annum.

[iii] Shows negative balances.

[iv] Based on construction of the Vioolsdrift Dam.

Table A14.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Orange	-980	2 100	1 056	65	-1	150
Orange Tributaries	22	0	33	0	-11	0
Orange Coastal	2	11	13	0	0	0
Total for the Lower Orange WMA	-956	2 111	1 102	65	-12	150

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Includes a 4 000 ha increase in irrigated farming land in the Orange sub-area, which will require 54 million m^3/annum.

[iii] Shows negative balances.

[iv] Based on construction of the Vioolsdrift Dam.

The following reservations apply with regard to the management of the Lower Orange WMA:

- The transfer of water from the Upper Orange WMA, which currently amounts to about 2 035 million m^3/annum. The water requirement of 54 million m^3/annum for 4 000 ha of new irrigation development – reserved in Upper Orange WMA.

- The abstraction of water by Namibia and all water-related negotiations and agreements with Namibia are subject to national authorisation. The arrangement was for Namibia to abstract a firm 50 million m^3/annum, plus an additional maximum quantity of 60 million m^3/annum under a temporary arrangement valid until 31 December 2007. However, in the year 2000 only a small portion of the additional allowance was abstracted – international agreement with Namibia imposes reservation on Lower Orange WMA.

- Flood management in the Orange/Vaal catchment will resort under national control because of the interdependence of the Orange/Vaal WMAs in this respect.

- Any new control infrastructure on the Orange River is subject to national authorisation because of its potential impact on Namibia and the requirements for managing the Orange River mouth. Apart from this, new infrastructure across much of the lower Orange River will involve Namibian territory – reservation applies to the Lower Orange WMA.

15 Fish to Tsitsikamma Water Management Area[7]

The Fish to Tsitsikamma WMA is situated in the south-eastern part of South Africa, mainly within the Eastern Cape. The south-western part of the area is characterised by several mountain ranges lying parallel to the coast, with undulating terrain and localised massives inland. Climate over the Fish to Tsitsikamma WMA is strongly influenced by its location and topography. Typical arid Karoo climate prevails over most of the interior, where annual rainfall ranges from 600 mm to less than 200 mm. Small areas along the coast experience rainfall in excess of 1 000 mm/annum. Several national parks and conservation areas are found in the Fish to Tsitsikamma WMA.

Sheep and mohair farming is the main land use, although intensive cultivation of irrigated land occurs along the main rivers. Subsistence farming is practised in the former Ciskei region and timber plantations occupy the high rainfall areas. The economy of the region is dominated by industrial activities in Port Elizabeth and Uitenhage.

Several dams have been constructed in the Fish to Tsitsikamma WMA, but because of the natural poor quality of water draining from the inland areas there is only limited potential for further water resources development. The waters of the Fish and Sundays Rivers are of natural high salinity, and because of this large quantities of good quality water are transferred from the Orange River in the Upper Orange WMA for blending with local resources. Irrigation return flows reaching the main streams contribute to further deterioration of water quality. Groundwater is utilised extensively to supply towns and rural areas and over-exploitation occurs on a localised basis.

Economic growth in the Fish to Tsitsikamma WMA will for the foreseeable future be concentrated in the Port Elizabeth/Uitenhage area (the Algoa sub-area), although an increase in tourism is anticipated along the coast. A strong growth in population is projected for the industrial hub. Economic activity in the inland areas is expected to remain largely unchanged and a small decline in population is projected for these parts.

Map A15: Location of the Fish to Tsitsikamma Water Management Area[9]

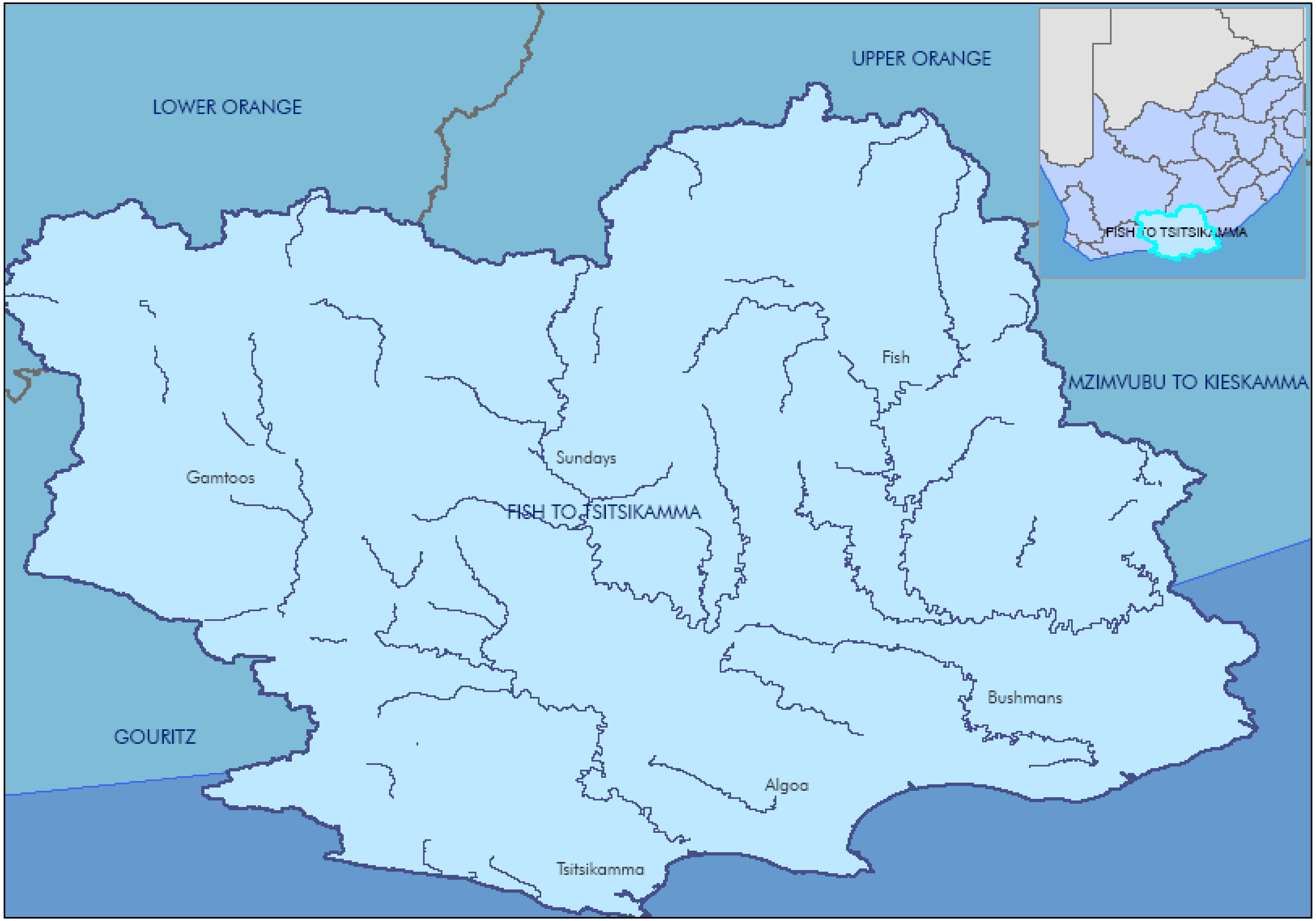

Table A15.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Fish	518	47
Bushmans	174	15
Sundays	280	20
Gamtoos	491	39
Algoa	147	15
Tsitsikamma	544	107
Total for Fish to Tsitsikamma WMA	2 154	243

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A15.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
			million m^3/annum			
Fish	-4	6	77	5	0	84
Bushmans	15	2	0	4	0	21
Sundays	61	16	22	2	0	101
Gamtoos	137	5	2	1	0	145
Algoa	10	6	1	6	0	23
Tsitsikamma	41	6	1	1	0	49
Total for Fish to Tsitsikamma WMA	260	41	103	19	0	423

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A15.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Fish	453	12	6	0	0	2	473
Bushmans	11	9	2	0	0	0	22
Sundays	174	5	3	0	0	0	182
Gamtoos	104	3	3	0	0	1	111
Algoa	12	78	1	0	0	0	91
Tsitsikamma	11	5	1	0	0	5	22
Total for Fish to Tsitsikamma WMA	765	112	16	0	0	8	901

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.

[ii] Mining and bulk industrial water uses that are not part of urban systems.

[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).

[iv] Quantities refer to the impact on yield only.

Table A15.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Fish	84	575	473	117	69
Bushmans	21	1	22	0	0
Sundays	101	117	182	31	5
Gamtoos	145	0	111	12	22
Algoa	23	64	91	0	-4
Tsitsikamma	49	0	22	22	5
Total for Fish to Tsitsikamma WMA	423	757	901	182	97

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.

[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A15.5 and A15.6.

Table A15.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Fish	95	603	525	145	28	25
Bushmans	25	1	29	0	-3	0
Sundays	102	145	184	59	4	0
Gamtoos	146	0	112	12	22	60
Algoa	36	92	118	0	10	0
Tsitsikamma	52	0	24	22	6	0
Total for Fish to Tsitsikamma WMA	456	841	992	238	67	85

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Includes a provision of 50 million m^3/annum for a 5 000 ha increase in irrigated farming land in the Fish sub-area, which may have to be sourced from the Upper Orange WMA.

[iii] Shows negative balances.

[iv] Based on construction of the Foxwood and Guerna Dams. Unquantified potential also exists in the Tsitsikamma sub-areas.

Table A15.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
			million m^3/annum			
Fish	97	653	530	195	25	25
Bushmans	25	1	33	0	-7	0
Sundays	102	195	185	109	3	0
Gamtoos	146	0	113	12	21	60
Algoa	28	142	169	0	1	0
Tsitsikamma	52	0	27	22	3	0
Total for Fish to Tsitsikamma WMA	450	991	1 057	338	46	85

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Includes a provision of 50 million m^3/annum for a 5 000 ha increase in irrigated farming land in the Fish sub-area, which may have to be sourced from the Upper Orange WMA.

[iii] Shows negative balances.

[iv] Based on construction of the Foxwood and Guerna Dams. Unquantified potential also exists in the Tsitsikamma sub-areas.

Key elements in respect of the management of water resources in the Fish to Tsitsikamma WMA relate to:

- The efficient use of transferred water and the proper management of water quality.
- The achievement of improved irrigation efficiencies and the maximisation of the benefits derived.
- Ensuring sufficient future water supplies to the Port Elizabeth area.

A reservation will apply to the Upper Orange WMA with regard to the transfer of up to a maximum of 600 million m^3/annum of water from the Upper Orange WMA to serve current allocations in the Fish to Tsitsikamma WMA. Additional water from the Orange River will be subject to national authorisation. A reservation is also placed on the Fish to Tsitsikamma WMA with respect to the construction of the proposed Guerna Dam, which will be subject to national authorisation because of its inter-dependence with transfers from the Orange River.

16 Gouritz Water Management Area[7]

The Gouritz WMA is situated along the southern coast of South Africa and extends inland across the Little Karoo and into the Great Karoo. The area has two primary climatic regions that display distinctly different characteristics, namely the large arid inland Karoo area drained by the Gouritz River and the smaller humid strip of land along the coastal belt to the south of the Outeniqua Mountains, which is drained by several small rivers. Rainfall ranges from less than 200 mm/annum to over 1 000 mm/annum.

Economic activity is centred on sheep and ostrich farming in the arid areas, with extensive irrigation farming of lucerne, grapes and deciduous fruit in the Little Karoo, and on forestry, tourism and petrochemical industries in the coastal region. Indigenous forests, wetlands and estuaries of high conservation status are found in the humid areas. The water in the arid areas is naturally of high salinity as a result of the geology and climate.

Several dams control the Gouritz River and its tributaries. Dams have also been constructed on some of the coastal rivers, where potential for further regulation remains. A substantial proportion of the yield is from groundwater and there is strong interdependence between surface water and groundwater in the Olifants River valley. The potential of utilising the deep groundwater from the Table Mountain Group aquifers is being investigated. A small quantity of water of less than 1 million m^3/annum is transferred to the Breede WMA for rural water supply.

A decline in population is foreseen in the inland areas, with little change in the requirements for water. A strong potential for growth, related to tourism, ecotourism and possible further petrochemical developments based on offshore gas-field exploration exists in the coastal area.

Map A16: Location of the Gouritz Water Management Area[9]

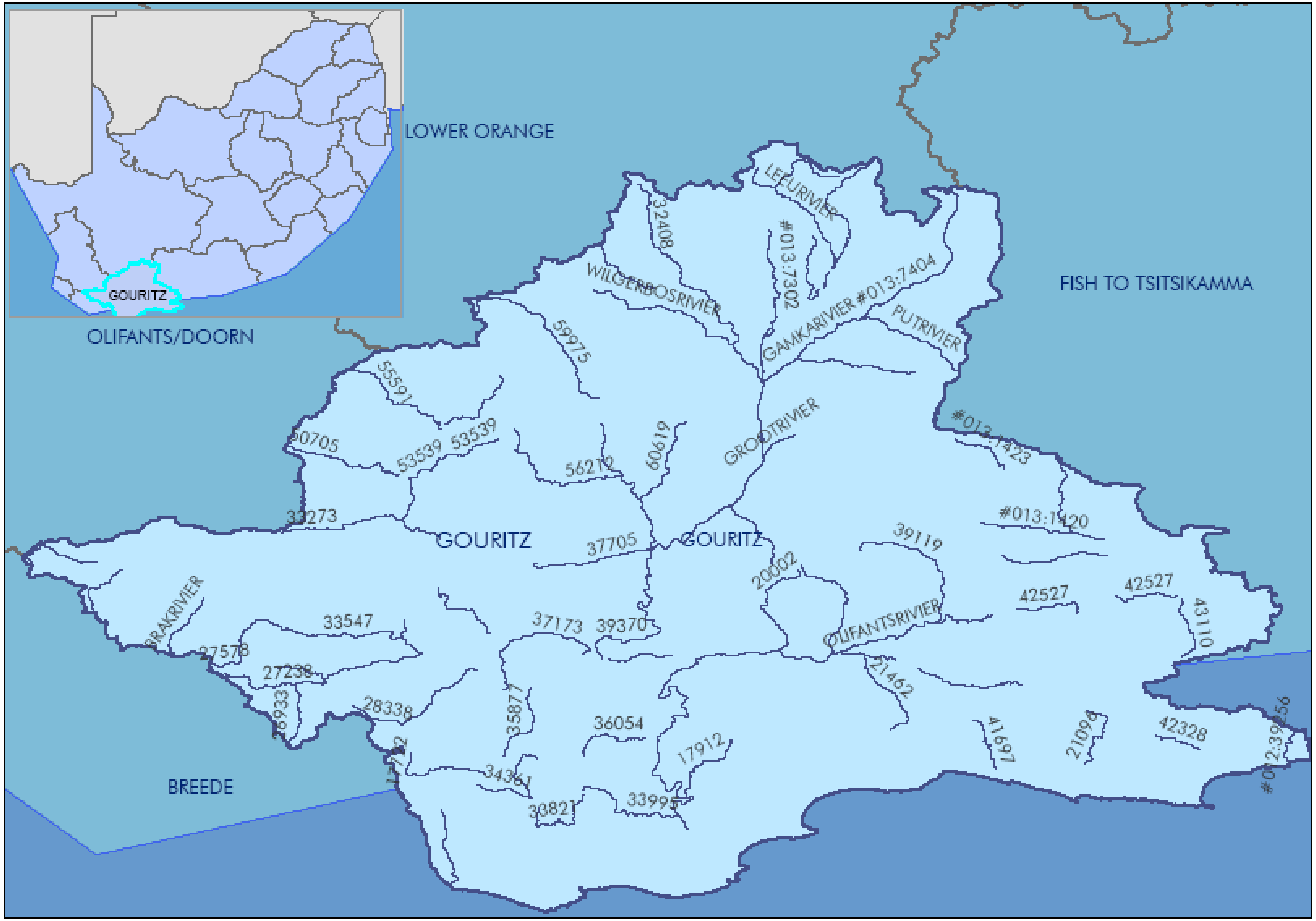

Table A16.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Gamka	227	19
Groot	105	5
Olifants	229	17
Gouritz	347	56
Coastal	771	228
Total for the Gouritz WMA	1 679	325

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A16.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
			million m^3/annum			
Gamka	24	24	0	0	0	48
Groot	19	23	0	0	0	42
Olifants	49	15	3	4	0	71
Gouritz	54	1	3	1	0	59
Coastal	45	1	2	1	6	55
Total for the Gouritz WMA	191	64	8	6	6	275

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A16.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Gamka	49	5	1	0	0	0	55
Groot	49	2	2	0	0	0	53
Olifants	62	10	2	0	0	0	74
Gouritz	51	3	3	0	0	1	58
Coastal	43	32	3	6	0	14	98
Total for the Gouritz WMA	254	52	11	6	0	15	338

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.

[ii] Mining and bulk industrial water uses that are not part of urban systems.

[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).

[iv] Quantities refer to the impact on yield only.

Table A16.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Gamka	48	0	55	0	-7
Groot	42	0	53	0	-11
Olifants	71	0	74	0	-3
Gouritz	59	0	58	1	0
Coastal	55	0	98	0	-43
Total for the Gouritz WMA	275	0	338	1	-64

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.

[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A16.5 and A16.6.

Table A16.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Gamka	48	0	55	0	-7	0
Groot	43	0	52	0	-9	0
Olifants	71	0	75	0	-4	0
Gouritz	60	0	58	1	1	10
Coastal	56	0	116	0	-60	100
Total for the Gouritz WMA	278	0	356	1	-79	110

Notes:
[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
[iii] Shows negative balances.
[iv] Provisional estimates, subject to detailed investigations of environmental impacts and feasibility of developments.

Table A16.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Gamka	48	0	60	0	-12	0
Groot	43	0	53	0	-10	0
Olifants	78	0	90	0	-12	0
Gouritz	61	0	61	1	-1	10
Coastal	58	0	181	0	-123	100
Total for the Gouritz WMA	288	0	445	1	-158	110

Notes:
[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
[iii] Shows negative balances.
[iv] Provisional estimates, subject to detailed investigations of environmental impacts and feasibility of developments.

At current levels of development, deficits occur in all the sub-areas with the exception of the lower Gouritz River. The deficits are mainly the result of irrigation requirements that are in excess of the available water, but where farming practices have been adapted accordingly. Particularly in the dry inland areas irrigation is at a very low assurance of supply and large areas are only cultivated in years when water is available. The deficit reflected for the coastal region is mostly attributable to the provision made for implementation of the Reserve. Under current conditions, without formal provision for the full Reserve, all urban/industrial uses can be fully supplied. However, the total irrigation requirements cannot always be supplied from run-of-river. Careful assessment of Reserve requirements and proper implementation planning is therefore necessary.

With future growth expected to be concentrated along the coastal belt, a strong growth in water requirements could be experienced in this region. Although significant potential exists for the further development of surface resources, the occurrence of the resources in an area that is very important environmentally and ecologically sensitive is likely to be a limiting factor. Apart from the general options for reconciling water requirements and availability, the utilisation of groundwater from the Table Mountain Group aquifers, which currently spills directly into the ocean, may hold good promise and should be investigated further.

It is essential for the proper management of water resources in the Gouritz WMA that the surface water/groundwater interrelationship in the Olifants River valley is clearly understood and quantified. Priority should be afforded to research in this area.

A reservation will apply to the Gouritz WMA with respect to the transfer of less than 1 million m^3/annum of water to the Breede WMA.

17 Olifants/Doring Water Management Area[7]

The Olifants/Doring WMA lies on the west coast of South Africa along the Atlantic Ocean and is shared by the Western Cape and Northern Cape. It is one of the most diverse WMAs in the country with respect to its natural characteristics and water resources. Prominent topographic features are the Cederberg range and the narrow Olifants River valley. Rainfall varies from over 1 000 mm/annum in the extreme south to less than 100 mm/annum in the north, and a harsh and arid climate prevails over most of the Olifants/Doring WMA. Virtually all the surface flow originates from the small, high-rainfall area around the Cederberg and is carried to the ocean by the Olifants River and its main tributary, the Doring River. A unique flow and water quality regime is created by the natural characteristics of the region, which provides a habitat for aquatic species of high conservation importance.

Economic activity in the Olifants/Doring WMA is centred on irrigated agriculture and 95% of total water use is for irrigation. Intensive production of deciduous fruits, citrus and grapes occurs in the Koue Bokkeveld and along the Olifants River. The arid areas remote from the rivers are sparsely populated, with sheep and goat farming as the main activity. There are no large towns or urban areas in the Olifants/Doring WMA.

Surface water in the Olifants River is regulated by the Clanwilliam Dam and the Bulshoek Barrage. There are no large dams on the Doring River, although a large number of farm dams have been constructed on the upper tributaries. Significant potential for further water resource development exists, mainly on the Doring River, but is tempered by serious concerns about the potential impacts of such development on the sensitive ecosystems. Groundwater is used extensively in the Olifants/Doring WMA. In particular large quantities are abstracted for irrigation in the Sandveld area. The potential has also been identified for the possible abstraction of sizeable quantities of water from the deep Table Mountain Group aquifers.

Demographic projections show a future population decline in the Olifants/Doring WMA. Economic development is likely to be modest and will depend mainly on further irrigation development and the development of tourism.

Map A17: Location of the Olifants/Doring Water Management Area[9]

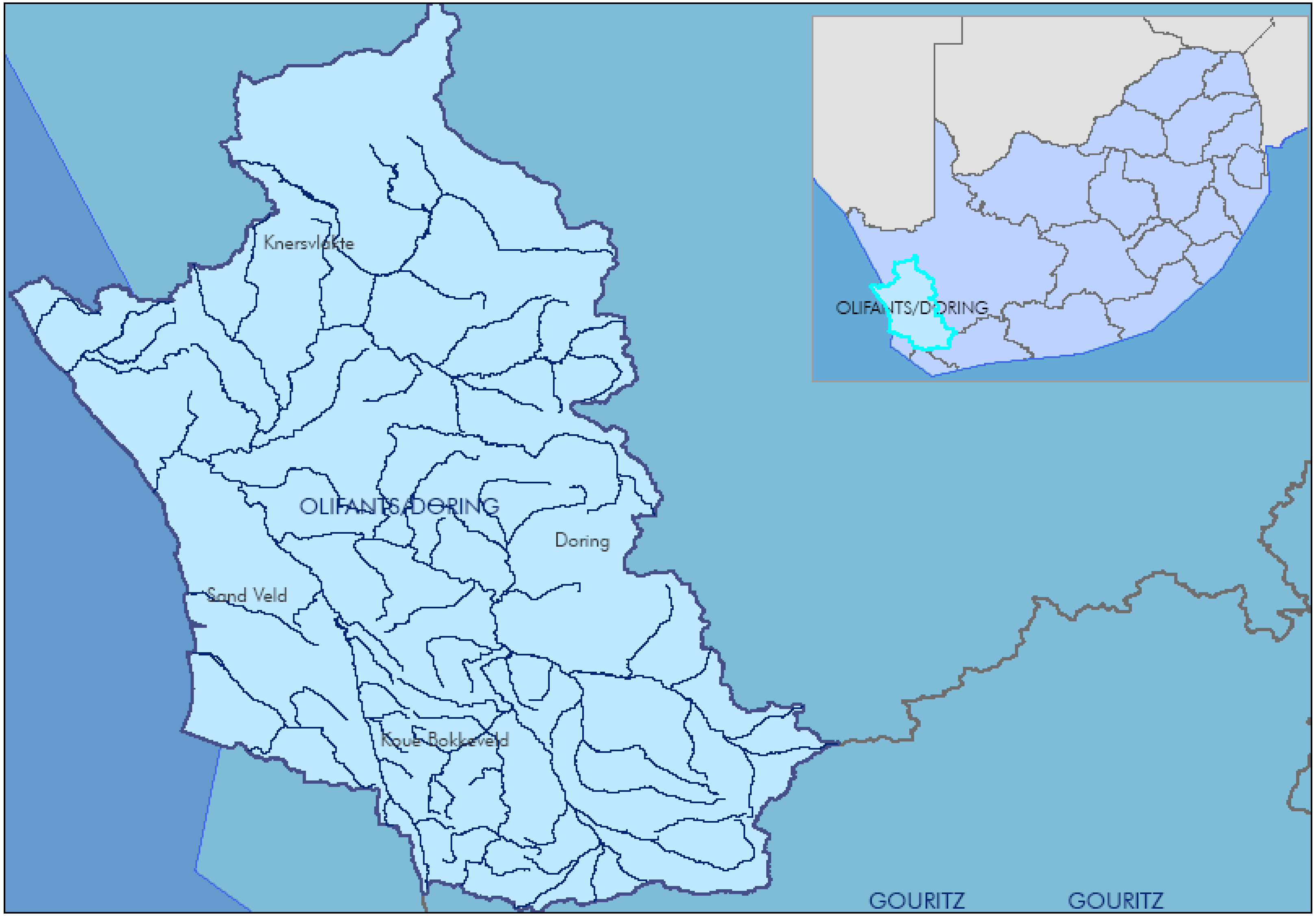

Table A17.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Koue Bokkeveld	279	29
Sandveld	60	8
Olifants	514	77
Knersvlakte	27	3
Doring	228	39
Total for Olifants/Doring WMA	1 108	156

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A17.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m^3/annum					
Koue Bokkeveld	59	5	3	0	0	67
Sandveld	2	30	0	0	0	32
Olifants	196	4	19	2	0	221
Knersvlakte	1	3	0	0	0	4
Doring	8	3	0	0	0	11
Total for Olifants/Doring WMA	266	45	22	2	0	335

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A17.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Koue Bokkeveld	65	0	1	0	0	0	66
Sandveld	35	2	1	0	0	0	38
Olifants	240	4	2	0	0	1	247
Knersvlakte	3	0	1	3	0	0	7
Doring	13	1	1	0	0	0	15
Total for Olifants/Doring WMA	356	7	6	3	0	1	373

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.
[ii] Mining and bulk industrial water uses that are not part of urban systems.
[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).
[iv] Quantities refer to the impact on yield only.

Table A17.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Koue Bokkeveld	67	0	66	0	1
Sandveld	32	0	38	0	-6
Olifants	221	0	247	3	-29
Knersvlakte	4	3	7	0	0
Doring	11	3	15	0	-1
Total for Olifants/Doring WMA	335	6	373	3	-35

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A17.5 and A17.6.

Table A17.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Koue Bokkeveld	67	0	66	0	1	0
Sandveld	32	0	38	0	-6	0
Olifants	221	0	247	3	-29	10
Knersvlakte	4	3	7	0	0	0
Doring	11	3	15	0	-1	175
Total for Olifants/Doring WMA	335	6	373	3	-35	185

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] Based on the raising of the Clanwilliam Dam and construction of the Melkboom Dam.

Table A17.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Koue Bokkeveld	67	0	65	0	2	0
Sandveld	32	0	42	0	-10	0
Olifants	223	0	251	3	-31	10
Knersvlakte	4	3	7	0	0	0
Doring	11	3	15	0	-1	175
Total for Olifants/Doring WMA	337	6	380	3	-40	185

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] Based on the raising of the Clanwilliam Dam and construction of the Melkboom Dam.

The following key aspects need to be considered in the management of the Olifants/Doring WMA:

- The unique seasonal salinity regime of the Olifants/Doring River system and its importance to riverine species and fish breeding in the estuary. Much of the Doring River is still in a relatively pristine state and specific caution is warranted.

- Further research needs to be undertaken of the characteristics of the Sandveld aquifers to facilitate their proper management and to ensure that future priority requirements for water can be met.

- The deep Table Mountain Group aquifers may hold good potential for the abstraction of large quantities of groundwater. Many unknowns still exist, however, and these need to be clarified before any large-scale development can be embarked upon.

- Water needs to be reserved in the Breede WMA with respect to the existing inter-water management area transfer to the Olifants/Doring WMA. Currently this involves the transfer of approximately 3 million m^3/annum to the Inverdoorn canal for irrigation purposes – reserved in the Breede WMA.

Considering the possible implications of climate change, and indications that its impacts may be manifest first in the south-western parts of the country, it is important that the hydrological parameters in the Berg and Breede WMAs are monitored closely. No development or investment decisions should be made that neglect to take into account the actual or potential affects of climatic change on water resources.

18 Breede Water Management Area[7]

The Breede WMA is the southern-most WMA in South Africa and lies entirely in the Western Cape. The climate in the area varies considerably. In the western mountainous regions rainfall can exceed 1 500 mm/annum, while in the lower eastern parts of the area the rainfall decreases to about 300 mm/annum. Rainfall occurs during the winter. The greater part of the Breede WMA is drained by the Breede River and its main tributary, the Riviersonderend River. Several small coastal rivers drain the southern part of the Breede WMA, while 'vleis' with no outflow to the sea are found in the south-east. The lower Palmiet River and the 'vlei' areas are of high conservation importance.

The economy of the region is mainly agriculture-based, with tourism at resort towns along the coast. Extensive vineyards and fruit orchards are grown under irrigation, fed by water from mountain streams, the Breede River and groundwater. Dryland wheat is cultivated between the Riversonderend River and the coastal mountains, while livestock farming is practised throughout the region.

Several large dams, some of which are off-channel, and many farm dams have been constructed in the Breede WMA. A unique feature is the operation of the Theewaterskloof Dam. Water is transferred into the dam from the Berg WMA for seasonal storage and is then transferred back to that area during the dry season together with a larger quantity of additional water from the Breede WMA. Water is also transferred from the Palmiet River to the Berg WMA via the Palmiet Pumped Storage Scheme. Water in the lower Breede River is highly saline. This is attributable to natural mineralisation because of the geology of the region and irrigation return flows, which renders the water unfit for further irrigation use. Strong inter-dependence exists between groundwater and surface water in parts of the Breede WMA. A sizeable potential for resource development remains in the area.

Demographic projections indicate population growth in the coastal areas, but a decline in inland areas, as a result of which the total population is anticipated to remain relatively constant. Because of the poor performance of the region's agricultural sector in recent times, no significant economic growth is foreseen over the short term, but this may change.

Map A18: Location of the Breede Water Management Area[9]

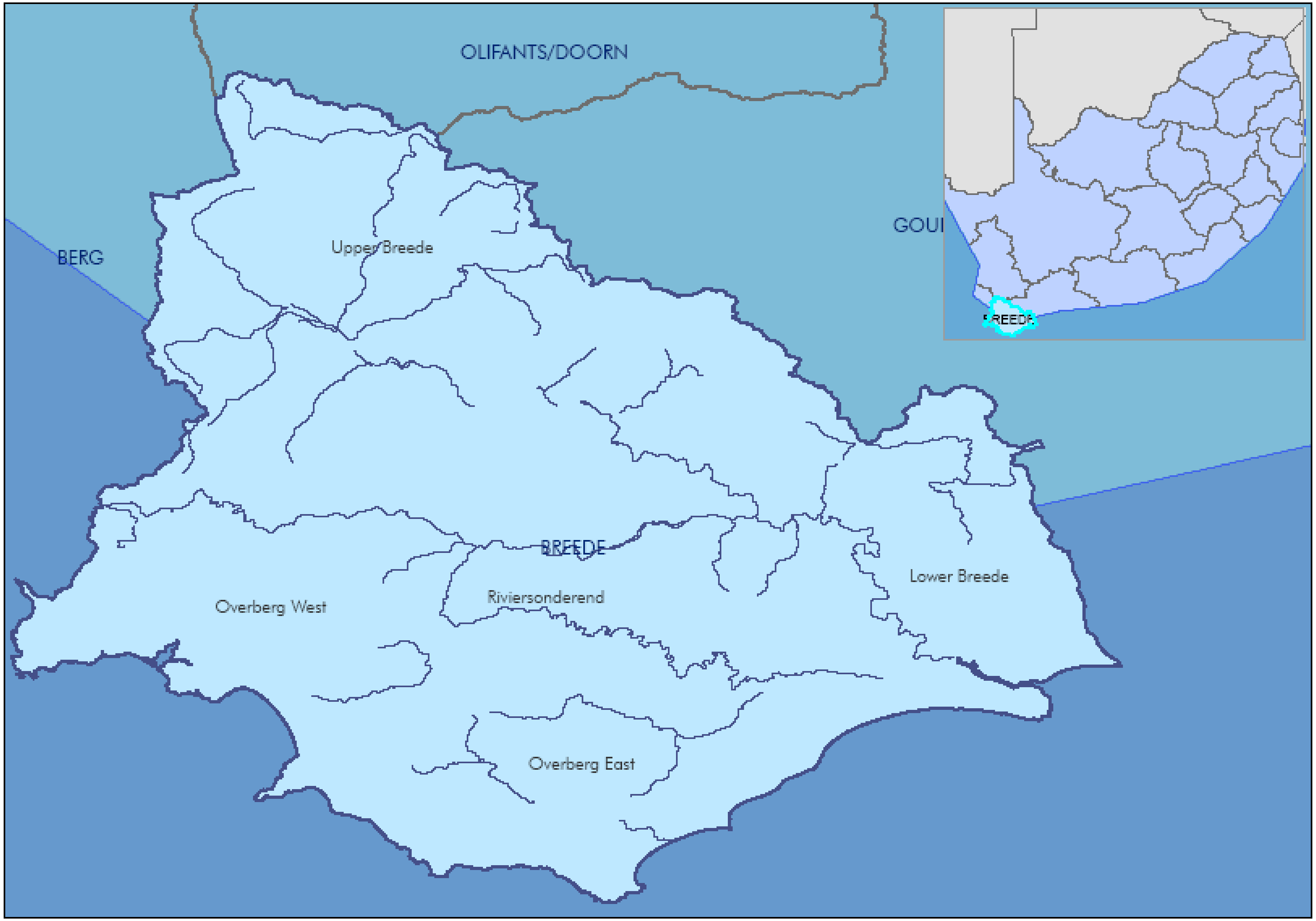

Table A18.1: Natural mean annual runoff and ecological Reserve (million m³/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m³/annum	
Upper Breede	1 212	178
Riversonderend	460	65
Lower Breede	210	34
Overberg East	110	13
Overberg West	480	94
Total for Breede WMA	2 472	384

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table A18.2: Available yield in the year 2000 (million m³/annum)

	Natural resource		Usable return flow			
Sector/sub-area	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
			million m³/annum			
Upper Breede	348	97	44	12	0	501
Riversonderend	220	4	2	0	0	226
Lower Breede	30	4	1	1	0	36
Overberg East	1	1	0	0	0	2
Overberg West	88	3	6	2	0	99
Total for Breede WMA	687	109	53	15	0	864

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A18.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Upper Breede	435	26	4	0	0	0	465
Riversonderend	49	1	2	0	0	1	53
Lower Breede	28	2	1	0	0	0	31
Overberg East	0	2	2	0	0	0	4
Overberg West	64	8	2	0	0	5	79
Total for Breede WMA	576	39	11	0	0	6	632

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.

[ii] Mining and bulk industrial water uses that are not part of urban systems.

[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).

[iv] Quantities refer to the impact on yield only.

Table A18.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Upper Breede	501	0	465	35	1
Riversonderend	226	0	53	174	-1
Lower Breede	36	33	31	0	38
Overberg East	2	2	4	0	0
Overberg West	99	2	79	23	-1
Total for Breede WMA	864	37	632	232	37

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.

[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A18.5 and A18.6.

Table A18.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Upper Breede	503	0	467	35	1	79
Riversonderend	227	0	52	174	1	24
Lower Breede	36	33	31	0	38	12
Overberg East	3	2	3	0	2	0
Overberg West	100	2	83	23	-4	9
Total for Breede WMA	869	37	636	232	38	124

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] Based on the construction of various schemes in the Breede WMA.

Table A17.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Upper Breede	525	0	513	11	1	79
Riversonderend	228	0	54	173	1	24
Lower Breede	38	8	34	0	12	12
Overberg East	3	2	7	0	-2	0
Overberg West	103	2	95	23	-13	9
Total for Breede WMA	897	12	703	207	-1	124

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes return flows resulting from a growth in requirements.

[ii] Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.

[iii] Shows negative balances.

[iv] Based on the construction of various schemes in the Breede WMA.

Priority considerations in respect of water resources management in the Breede WMA include:

- Improvement of irrigation efficiencies.
- The management of salinity levels in the Breede River.
- The improved management of groundwater abstraction. Greater knowledge is needed of aquifer and recharge characteristics, and in particular the interdependencies between groundwater and surface water.
- Additional transfers are likely to be required in future, possibly even within the period under consideration, to serve the greater Cape Town area in the Berg WMA. Although water does not specifically need to be reserved for this purpose at this stage, it would be prudent not to forfeit this option unintentionally by the development of less beneficial projects. Care must therefore be taken that the construction of any new large infrastructure does not prejudice future water transfer options to the Berg WMA.
- No further afforestation should be allowed without the impacts on the ecological component of the Reserve, groundwater recharge and the sensitive salinity balance having been determined and found acceptable.

Water that has to be reserved in the Breede WMA for transfers include the following:

- The transfer of water between the Breede and Berg WMAs via the Riviersonderend/Berg River Scheme. This involves a net transfer of 162 million m^3/annum to the Berg WMA.
- The transfer of a maximum of 50 million m^3/annum from the Palmiet River to the Berg WMA. The average transfer is about 23 million m^3/annum.
- Smaller transfers to the Berg WMA amounting to 9 million m^3/annum.
- The transfer of a maximum of approximately 3 million m^3/a to the Olifants/Doring WMA through the Inverdoorn Canal.
- A maximum of 2 million m^3/annum is reserved in the Gouritz WMA for transfer to the Breede WMA area for rural water supply.
- A reservation also applies to the Breede WMA with respect to any new large scale water resource developments which may impact on future transfers to the Berg WMA.
- Considering the possible implications of climate change, and indications that its impacts may manifest first in the south-western parts of the country, it is important that the hydrological parameters in the Berg and Breede WMAs are monitored closely. No development or investment decisions should be made that neglect to take into account the actual or potential affects of climatic change on water resources.

19 Berg Water Management Area[7]

The Berg WMA commands the south-western corner of South Africa. The Berg River is the only major river in the Berg WMA, although there are several smaller rivers and streams draining to the ocean. High mountain ranges characterise the east and south-east of the Berg WMA, from where most of the runoff originates, the most well-known being Table Mountain and the Cape Peninsula mountains in the south-west. Sandy lowlands, with minimal runoff, extend across the central and western part of the Berg WMA. Rainfall occurs in winter and is highly varied, ranging from a high of over 3 000 mm/annum in the mountains to less than 300 mm/annum in the northwest. The Cape Fynbos represents a unique floral kingdom of World Heritage status.

A strong and diversified economy exists in the Berg WMA, which is dominated by industrial and other activities in the Cape Town metropolitan area. A close interdependency, particularly with respect to tourism and agriculture, exists with the economic activities of the surrounding area and further inland.

Intensive viticulture and fruit farming, under sophisticated irrigation, are found in the valleys and foothills of the mountains. This changes to extensive rain fed wheat cultivation in the central regions.

Several large dams and numerous farm dams regulate the surface runoff from the Berg WMA. Regulation will be increased by the addition of the new dam on the Berg River near Franschoek (the Berg Water Project), which has been approved for construction. Significant quantities of groundwater are also abstracted, mainly in the central and western parts of the Berg WMA, with small-scale artificial recharge of groundwater being practised in the vicinity of Atlantis. Large quantities of water are transferred into the area from the Breede WMA via the Riviersonderend/Berg River Scheme and the Palmiet Pumped Storage Scheme. Further potential for the development of water resources exists mainly with respect to the Berg River, although salinity in the lower reaches of the river is becoming a problem, largely as a result of irrigation return flows. Potential may exist for the abstraction of significant quantities of groundwater from the Table Mountain Group aquifers in the foothills to the east.

Strong economic growth in the Cape Town metropolitan area and vicinity is expected in the foreseeable future. This area is thus likely to form the nucleus for population growth in the Berg WMA.

Map A19: Location of the Berg Water Management Area[9]

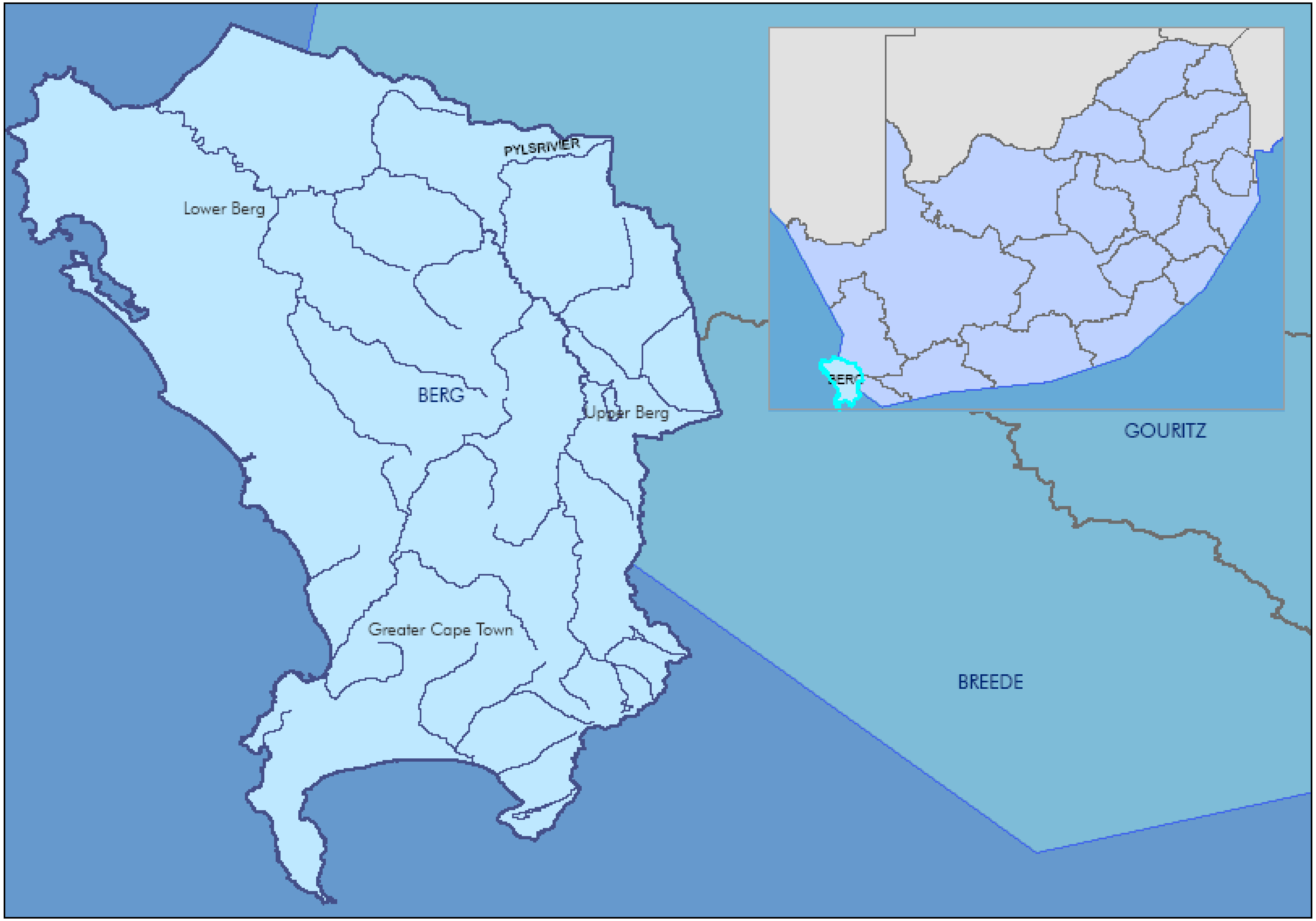

Table A19.1: Natural mean annual runoff and ecological Reserve (million m^3/annum)

Sector/sub-area	Natural mean annual runoff[i]	Ecological Reserve[i, ii]
	million m^3/annum	
Greater Cape Town	373	61
Upper Berg	849	124
Lower Berg	207	32
Total for the Berg WMA	1 429	217

Notes:

[i] Quantities are incremental and refer to the sub-area under consideration only.
[ii] The total volume is based on preliminary estimates, with impact on yield being a portion of this.
[iii] Does not include the MAR of 466 million m^3/annum of the Fish River in Namibia.

Table A19.2: Available yield in the year 2000 (million m^3/annum)

Sector/sub-area	Natural resource		Usable return flow			
	Surface water[i]	Groundwater	Irrigation	Urban	Mining and bulk industrial	Total local yield
	million m^3/annum					
Greater Cape Town	66	20	0	22	0	108
Upper Berg	284	15	8	15	0	322
Lower Berg	30	22	0	0	0	52
Total for the Berg WMA	380	57	8	37	0	482

Notes:

[i] After allowance for the impact on yield of the ecological component of the Reserve, river losses, alien vegetation, rain fed sugar cane and urban runoff.

Table A19.3: Water requirements for the year 2000 (million m^3/annum)

Sector/sub-area	Irrigation	Urban[i]	Rural[i]	Mining and bulk industrial[ii]	Power generation[iii]	Afforestation[iv]	Total local requirements
	million m^3/annum						
Greater Cape Town	46	343	5	0	0	0	394
Upper Berg	202	23	4	0	0	0	229
Lower Berg	53	23	5	0	0	0	81
Total for the Berg WMA	301	389	14	0	0	0	704

Notes:

[i] Includes component of Reserve for basic human needs at 25 litres per person per day.
[ii] Mining and bulk industrial water uses that are not part of urban systems.
[iii] Includes water for thermal power generation only (water for hydropower is generally available for other uses as well).
[iv] Quantities refer to the impact on yield only.

Table A19.4: Reconciliation of water requirements and availability for the year 2000 (million m^3/annum)

Sector/sub-area	Local yield	Transfers in[ii]	Local requirements	Transfers out[ii]	Balance[i]
	million m^3/annum				
Greater Cape Town	108	269	394	0	-17
Upper Berg	322	32	229	125	0
Lower Berg	52	18	81	0	-11
Total for the Berg WMA	482	319	704	125	-28

Notes:

[i] Shows negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
[ii] Transfers into and out of sub-areas may include transfers between sub-areas and WMAs. The addition of quantities transferred per sub-area does not necessarily correspond to the total transfers into and out of the WMA. The same applies to tables A19.5 and A19.6.

Table A19.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Greater Cape Town	111	350	508	0	-47	27
Upper Berg	405	32	235	206	-4	100
Lower Berg	52	18	87	0	-17	0
Total for the Berg WMA	568	400	830	206	-68	127

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes the Berg Water Project and return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development.
[iii] Shows negative balances.
[iv] Based on the raising of the Voëlvlei Dam, and potential diversions from Lourens River and Eerste River.

Table A19.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m^3/annum)

Sector/sub-area	Local yield[i]	Transfers in	Local requirements[ii]	Transfers out	Balance[iii]	Potential for development[iv]
	million m^3/annum					
Greater Cape Town	124	350	913	0	-439	27
Upper Berg	422	32	270	206	-22	100
Lower Berg	56	18	123	0	-49	0
Total for the Berg WMA	602	400	1 306	206	-510	127

Notes:

[i] Based on existing infrastructure and infrastructure under construction in 2000. Also includes the Berg Water Project and return flows resulting from a growth in requirements.
[ii] Based on growth in water requirements as a result of population growth and general economic development.
[iii] Shows negative balances.
[iv] Based on the raising of the Voëlvlei Dam, and potential diversions from Lourens River and Eerste River.

Reservations will apply to the Breede WMA with respect to the transfer of water from the Breede WMA to the Berg WMA. Current transfers are as follows:

- Transfers of 162 million m^3/annum from the Riviersonderend catchment.
- Transfers of approximately 22 million m^3/annum on average from the Palmiet River, with a maximum capacity of 50 million m^3/annum.
- Smaller transfers from the Breede WMA amounting to 9 million m^3/annum.

The construction of any large new water infrastructure in the Breede WMA that may impact materially on future water transfers to the Berg WMA will be subject to national approval in order to ensure that options for future water transfers are not inadvertently jeopardized – a reservation in this respect applies to the Breede WMA.

Considering the possible implications of climate change, and indications that its impacts may manifest first in the south-western parts of the country, it is important that the hydrological parameters in the Berg and Breede WMAs are monitored closely. No development or investment decisions should be made that neglect to take into account the actual or potential affects of climatic change on water resources.