Patterns of domestic water inadequacy on the South African West Coast

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Abstract

Regional surveys aimed at identifying water inadequacies are important in providing a proper empirical base for remedial actions regarding water supply. This study examines patterns of domestic water inadequacy in the Sandveld region along the arid South African West Coast. It is based on the results of a questionnaire survey conducted in August and September 1995 amongst 62 respondent communities between the Orange River in the north and the outskirts of Cape Town in the south. Aspects of water inadequacy that are investigated include the occurrence of water shortages as well as deficiencies in water quality and accessibility. Domestic water shortage is defined at two levels; a short-term shortage is deemed to exist where less than 25 ℓ is currently available *per capita* per day, and a medium-term shortage where between 25 and 55 ℓ are available. The study identifies seven communities in the former category and a further 12 in the latter. Virtually all of these water-short communities are small (< 1 000 population) agricultural, service or mission hamlets of which the majority are to be found in the former so-called "Coloured Rural Areas" in south-central Namaqualand. Most of the seven communities with serious quality deficiencies in their water supply, and a majority of the considerably larger number with suboptimal accessibility conditions, occur here as well. Yet the worst-off communities in both these respects – and also in terms of overall domestic water inadequacy – occur further south in two smallish clusters west of the lower Olifants River and in the Swartland district near Cape Town respectively.

Introduction

One of the better-known goals of the Reconstruction and Development Programme (RDP) adopted by South Africa's new Government of National Unity in 1994 was to provide "adequate" access to clean water for all citizens (ANC 1994). In the subsequent "Water Supply and Sanitation Policy" White Paper of the Department of Water Affairs and Forestry (DWAF) (1994) this commitment was translated into "the practical goal of providing access to basic water supply and sanitation services to all within seven years" (Goldblatt, 1996). The immensity of this task is illustrated by the White Paper's estimate that more than 12 m. people country-wide lacked an adequate supply of domestic water at the time. Moreover, the majority of them (61%, or 7.3 m.) lived in the rural and platteland areas where distances are vast and the target population thinly spread in numerous small communities (Palmer and Eberhard, 1995). In addition, it should not be forgotten that "adequacy" implies much more than merely the provision of a minimum quantity of domestic water. As pointed out by Emmett and Rakgoadi (1993), the supply should also meet certain minimum criteria with regard to its quality, accessibility and availability/reliability, thus increasing the costs of provision.

While the latter aspects are clearly as important as the quantity of domestic water provided, it is only to be expected that in areas where water demand exceeds supply the overriding concern will be the quest for a sufficient supply. One such area is the thinly-peopled and naturally arid South African West Coast where, as in most similar regions world-wide, there is a need for supplementary water for domestic use (Postel, 1992; Bester, 1993). Potential supplies are limited, however, not only by the meagre annual rainfall (as low as 25 mm in the Port Nolloth area) and the presence of only three perennial rivers (the Orange, Olifants and Berg), but also by the fact that borehole water in the area is often brackish in nature. Fortunately, this latter problem is now being tackled with great success through the recent commissioning of several desalination plants based on the locally developed tubular reverse osmosis membrane technology (Anon, 1996). Further improvement in the supply situation is currently being achieved through various RDP-funded projects that were begun in the 1997/1998 period, particularly in the northern parts of the region (Roberts, 1998). Few details have as yet come to hand regarding the specific nature and impact of these ongoing projects, however, or the way in which the beneficiary communities were selected. Meanwhile, research is still continuing on yet another supply possibility, that of tapping the abundant fogs along the coast (Olivier, 1997; Olivier and Van Heerden, 1999).

Whichever supply solutions may in due course be forthcoming for the various West Coast communities, it seems clear that it will require careful and innovative planning. West Coast communities are generally so small, poor and widely scattered, however, and suitable perennial water sources so few and far between, that such planning would probably best be done on a regional rather than on a local basis. A basic prerequisite in this regard – and this also applies to other water-short areas – is reliable prior information on the location and extent of existing as well as potential domestic water shortages. In view of this and as background to the fog-water research begun in 1994 (Olivier and Van Heerden, 1999), a survey was undertaken in August and September 1995 to determine the facts regarding the problem of domestic water inadequacy on the West Coast. The central purpose of the study was to map the spatial pattern of water shortage. Other aspects of water inadequacy were also examined, however, as was the general situation regarding domestic water supply in the region. It is of course likely that subsequent events may have outdated some of the findings described here. Hopefully, however, most of the material presented

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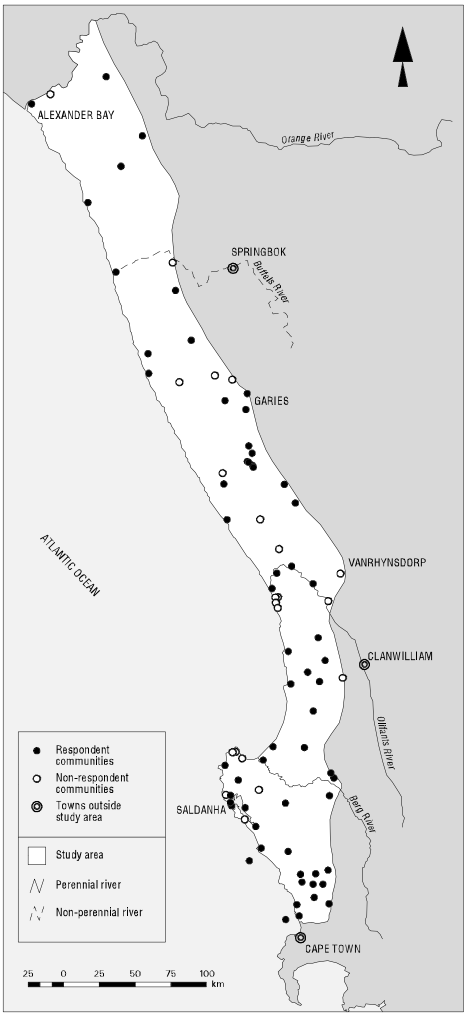

Figure 1
West Coast study area and the location of communities

may still be of use to those concerned in the ongoing effort to improve water provision to the various West Coast communities.

The study area coincides in broad terms with the Sandveld plain along the West Coast (see Fig.1). The area stretches over a distance of about 650 km and across two provinces (the Northern and Western Cape respectively), reaching from the Orange River in the north to the boundaries of the Cape Metropolitan area in the south. Its northern two thirds comprises the land between the coastline and the Great Escarpment. Near Vanrhynsdorp the latter swings eastwards, however, so that a combination of coastal mountains (the Olifants River range and the Piquetberg) and north-south transportation routes (the N7 and the Kraaifontein-Piquetberg railway line) was used as the basis of delimitation further south.

The paper commences with an attempt to lay a basis for the measurement of domestic water shortage; criteria relating to water quality, accessibility and availability/reliability are also briefly set out. Subsequent sections describe data collection and methodology, general features of the domestic water supply situation, and the spatial and other patterns of domestic water inadequacy in the area. Aspects included in the latter regard are the question of shortages as well as deficiencies in the quality and accessibility of the supply. The availability/ reliability of the supply could unfortunately not be considered as very little useful information was obtained in this respect.

Measuring domestic water (in)adequacy

As indicated above, minimum criteria have been developed to measure the adequacy of a water supply with regard to its quality, accessibility and availability/reliability; these criteria are set out in the section below. However, with regard to the question of domestic water shortage, perusal of the literature failed to identify an appropriate measurement criterion. Hence the first subsection below will attempt to lay the groundwork for the development of such a measure, to be more fully discussed in a later section.

Domestic water shortage: Definition and measurement

As a concept "domestic water shortage" may in principle be defined in straightforward fashion as a failure to supply a sufficient quantity of water for domestic use. Yet this deceptively simple description raises a number of important questions to which the answers are not necessarily self-evident. First, what is meant by "domestic use"? Does it refer to all the water consumed by a household, both inside and outside the house, or only to the quantity needed for basic household survival? Second, what is "sufficient supply"? And third, are the requisite consumption data in fact available so that the level of sufficiency can be determined in practice?

Defining "domestic" water use

Inspection of the literature shows that at least two definitions of the phrase "domestic water use" are currently in vogue. Certain authors define the concept very broadly by equating it with the total water consumption of a household. Thus Van Schalkwyk (1996) states that "Domestic water is required for drinking, cooking, dish washing, house washing, clothes washing, personal hygiene, gardening, sanitation and swimming pool maintenance"; presumably car washing may also be added to this list. Internationally, too (cf. Gilbert et al., 1972; Van Duuren, 1976; Anon, 1997), one finds that statistics purporting to show "domestic water utilisation" in fact refer to total household use, a category sometimes known as "residential" water use/demand (Grima, 1972; Steyn, 1992), or "water supply to residences" (Schutte and Pretorius, 1997).

In contrast to this broad definition, the RDP (ANC, 1994) defines domestic water use much more narrowly (if somewhat vaguely) as the "basic" water supply needed to ensure a healthy lifestyle ("adequate … for health"). DWAF (1994) takes a similar but more specific view and defines it ("basic" water supply) as the water used for direct consumption, the preparation of food and personal hygiene. *[There is some uncertainty regarding the precise meaning of the latter term. Van Schalkwyk (1996) restricts it to the "washing of hands and face,…cleaning teeth and bathing or showering". Gilbert et al. (1976), however, state that it refers to the washing of people, clothes and utensils (dishes). In the present study this latter view was accepted since it appears to be more in keeping with the ideal of "a healthy lifestyle"].* In this narrower definition "domestic water use" is evidently seen as referring only to that which is essential for civilised human survival, hence non-essential categories such as sanitation, gardening, pool maintenance, etc. are excluded. *[Limited gardening activities (e.g. small vegetable patches) may however still be possible through the judicious reuse* *of domestic water (so-called "grey" water)].*

It is obvious that the two definitions will produce divergent results in the calculation of domestic water shortage. However, before selecting one of them as the basis for such calculations, the question of a minimum value to define "sufficiency" must first be addressed.

TABLE 1
Suggested domestic water supply targets (ℓ/c·d): A comparison of figures from selected sources

Author/source and date	Immediate (short -term) goal	Medium-term goal	Long-term goal
World Health Organisation[1] (date and title not known)	30	-	-
Baum and Tolbert[2], 1985	20-50	-	-
Hardoy and Satterthwaite[3], 1989	50-65	-	-
Coetzee[4], 1991	50	-	-
Bahl and Linn[5], 1992	20-40	-	-
Fowler[6], 1992	20	50	Sufficient supply to sustain the environment and a healthy lifestyle for all
Palmer Development Group[7], 1993	30	-	-
Emmett and Rakgoadi, 1993	20-30	-	-
SEI[8], 1993	20-30	-	-
World Health Organisation[9], 1993	20-30	-	-
Hollingworth[10], 1994	30-50	-	-
ANC 1994	20-30	50-60	Supply on demand
Department of Health, 1994	25	-	-
DWAF, 1994	25	-	-

1, 2, 6 and 7: As quoted in Emmett and Rakgoadi, 1993.
3, 4, 5, and 10: As quoted in Goldblatt, 1997.
8 and 9 : As quoted in Department of Health, 1994.

Determining "sufficient supply"

It may be argued that actual consumption levels give the best indication of what consumers regard as a "sufficient" water supply. Yet average consumption rates vary widely amongst different societies, regions and socio-economic status groups as the following examples illustrate. Using the "broad" definition of domestic water use, firstly, Van Duuren (1976) stated that, at the international level, the population of developed countries consume an average of 300 ℓ/c·d, as opposed to those in developing countries with 100 ℓ. At the national level, secondly, urban and rural areas also differ with respect to "residential" water utilisation. Thus Third-World nomadic societies have been shown to consume as little as 10 to 30 ℓ/c·d, village communities 60 to 80 ℓ, and modern housing developments in Western-style urban areas between 400 and 800 ℓ (Gilbert et al., 1972). And in South Africa, finally, Van Schalkwyk (1996) recently found a range of 24 to 450 ℓ/c·d in developing communities in the Northern Transvaal (*sic*) between those with the lowest and highest levels of living respectively. Significantly, this differential is reduced – but does not disappear – if the "narrow" definition of domestic water use is applied to Van Schalkwyk's (1996) statistics; the respective values are 24 and 195 ℓ/c·d, with the figure for the lowest level of living group remaining the same despite the change in definition.

From the foregoing it is clear that not only the definition of domestic water use, but also the particular area or level of living group used as a point of departure, will impact decisively on the question of whether or not a domestic water shortage actually exists in any particular instance, or what its extent is. Under certain circumstances – e.g. in areas with a generally high level of living – there may be merit in using the first, comprehensive definition since the consumption categories excluded by the second definition (eg. gardening, pool maintenance and flush sanitation) are obviously important to such communities. Generally speaking, however – given the broad outlines of the water-supply problem in this country as described earlier, as well as the overall thrust of the RDP (improving the living conditions of disadvantaged communities) – there is little doubt that the second, more restricted definition has more relevance to the local situation than does the broader version. Planning initiatives at present underway in this regard do in fact take the more restricted definition as their point of departure (cf. DWAF, 1994). It is obvious, too (and undoubtedly correct) that it is the consumption needs of the lowest level of living category which have determined the supply targets which are being set. Thus current government policy – as first mooted in RDP documentation (ANC, 1994), a Department of Health report (1994) and the DWAF White Paper (1994) – sets an "immediate"-term goal (to be achieved within seven years) of providing access to a minimum water supply of 25 ℓ/c·d. This so-called "lifeline level" (Schutte and Pretorius, 1997) appears to have been derived from a variety of inputs during the immediately preceding years, with Table 1 suggesting that a broad consensus gradually developed around this value as constituting a "sufficient" level of water provision for basic domestic purposes. Van Schalkwyk's subsequent (1996) findings in the Northern Transvaal (see earlier) lends further credence in this respect. Furthermore, with regard to water-supply targets for the medium and long term, those sources that do address this matter again show substantial agreement; thus Table 1 indicates that a figure in the 50 to 60 ℓ/c·d range is being favoured as an acceptable medium-term goal (15 years, according to Fowler, 1992).

With 25 ℓ/c·d now firmly established as the government's minimum short-term supply goal, it seems reasonable to argue that a domestic water shortage may be said to exist if the actual supply/consumption level is below this figure. *[Communities opting for a higher service level than this minimum value will be required to bear the additional costs themselves (DWAF, 1994)].* Similarly, although the recent White Paper (DWAF, 1994) does not express itself in this regard, it seems in order for the purposes of this paper that 55 ℓ/c·d be accepted as the medium-term goal, with provision below this figure being regarded as a shortage at the medium-term level. This will in fact be the approach adopted in the present study.

Availability of consumption data

Accepting 25 and 55 ℓ/c·d as minimum criteria to define a domestic water shortage presupposes that actual consumption figures are known and that they comprise domestic use in the narrow, DWAF (1994) sense of the word. Unfortunately, neither of these presuppositions necessarily applies. In many parts of the country, especially amongst developing rural communities, actual consumption volumes for domestic purposes (however defined) are not known and can only be estimated (cf. Van Schalkwyk, 1996). In the more developed areas (including the West Coast), by contrast, most houses are metered so that actual consumption figures usually are available. Almost invariably, however, they refer to total household (= "residential") use, since the meter registers aggregate consumption and cannot distinguish between the quantities used for drinking, food preparation and personal hygiene on the one hand and other uses (e.g. water-borne sanitation, gardening, etc.) on the other. Here, too, a survey-based estimation procedure (or perhaps participant observation methods) could conceivably be used to disaggregate total consumption figures into the above two categories. The question arises, however, whether it might not be possible to devise a simpler, less time-consuming and cheaper measuring technique to establish the existence, extent and spatial distribution of domestic water shortages in an area. This matter will be addressed under **Data and methodology**.

Other measures of domestic water adequacy

In 1993 Emmett and Rakgoadi suggested the following adequacy criteria as being "acceptable" with regard to the quality, accessibility and availability/reliability of a water supply:

Quality:	All microbial (e.g. *E.coli*) measurements within the maximum allowable limits, and a maximum of one non-microbial parameter outside it.
Accessibility:	A maximum distance of 250 m to the water point, or 150 to 250 m if there is a descent of more than 25 m.
Availability/ reliability*:*	Water available 90 to 95% of the time.

In 1994 the RDP (ANC, 1994) and DWAF (1994) followed up on these recommendations by agreeing that the immediate aim should be a potable supply which meets the currently accepted minimum standards in terms of quality ("a clean, safe water supply" - ANC, 1994), and which is provided within a maximum distance of 200 m from the consumer. With regard to availability/reliability, DWAF (1994) added that the flow of water should be at least 10 ℓ/min. on a regular daily basis and that it should be available 98% of the time.

In view of the foregoing – and considering also the minimum supply target that has been set for "basic" water provision in the short term – the Government's overall domestic water supply aims may therefore be succinctly stated as follows: "The Department (of Water Affairs and Forestry) defines basic water supply as 25 ℓ per person per day of good quality water, provided at a maximum distance of 200 m on a regular and assured basis" (Goldblatt, 1996) *[In the interests of "speeding up the delivery" of minimum water services, the Government is presently considering an extension of this distance to a maximum of 500 m "in difficult areas" (Anon, 2000]*. Against this background the discussion now turns to the collection of data and the methodology used to calculate and map domestic water shortage in the study region.

Data and methodology

Data collection

The first step in the data collection process was to identify and map the various communities in the study region. Following consultation with Department of Health officials in the Western and Northern Cape provincial governments, as well as close examination of 1:250 000 and 1:500 000 maps of the area, 84 communities (= settlements) were identified; these are displayed in Fig.1 and are alphabetically listed in **Addendum 1.**

Information relating to domestic water use in the respective communities was obtained through a mail questionnaire survey conducted in August and September 1995. The questionnaires were completed by local authority officials (e.g. the town clerk or other municipal official, a Regional Services Council officer, a mining company representative, or the like) directly involved with, or with the requisite knowledge of, water provision in a particular community. It should therefore be noted that only "supply-side" data were used in the study. The scope of the research ruled out the possibility of balancing it with more intimate, social and contextual data reflecting the views, perceptions, experiences and concerns of members of the general public (the consumers). Information elicited from the officials mentioned included data regarding the community's total current water consumption for domestic (i.e. "residential") purposes, its population size, and the source(s), quality, accessibility and availability/reliability of its water supply. Mailed reminders and follow-up telephone calls were employed in an effort to maximise the response rate. Eventually 62 completed questionnaires were received, representing a 73.7% response.

Basic data for the 62 respondent communities appear in the table in **Addendum 2**. It should be noted that the data for Paternoster, Saldanha and Vredenburg comprise projections rather than the true figures, and that they pertain to 1993 instead of 1995. Inclusion of these communities despite this should be seen as an attempt to prevent an "unnatural" under-representation of the important West Coast Peninsula area in the analysis.

Inspection of **Addendum 2** shows that functionally the respondent communities are a mixed bag. *[The functional designation of communities was established through consultation with local officials and/or by making use of personal knowledge of the settlements concerned. It is not based on a detailed analysis of occupational or other statistics]*. Seven may be classed as service centres and nine as service hamlets; 13 are agricultural hamlets, seven mission stations, five fishing settlements, four each commuter towns and mining settlements, and three each holiday resorts and bird islands, while there is also an industrial centre, a transport town, an environmental education centre and a prison island (Robben Island); in addition three centres (Paternoster, Port Nolloth and Saldanha) display more than one dominant function.

In Fig. 2 the 62 respondent communities are mapped according to five population size classes. Population totals varied from more than 53 000 (Atlantis) to a single person (Malgas Island) and even nil (Jutten Island). Jutten Island's zero population meant that it was impossible to calculate a *per capita* consumption figure for it, thereby effectively excluding it from the analysis. *[The 5 ℓ/d total indicated in **Addendum 2** appears to be an average reflecting the water used by occasional visitors to the island]*. Moreover, an additional three communities (Goedverwacht, Robben Island and Wittewater) do not employ water meters and could therefore not provide consumption data. As a consequence only 58 of the 62 respondent communities could be examined for the existence or

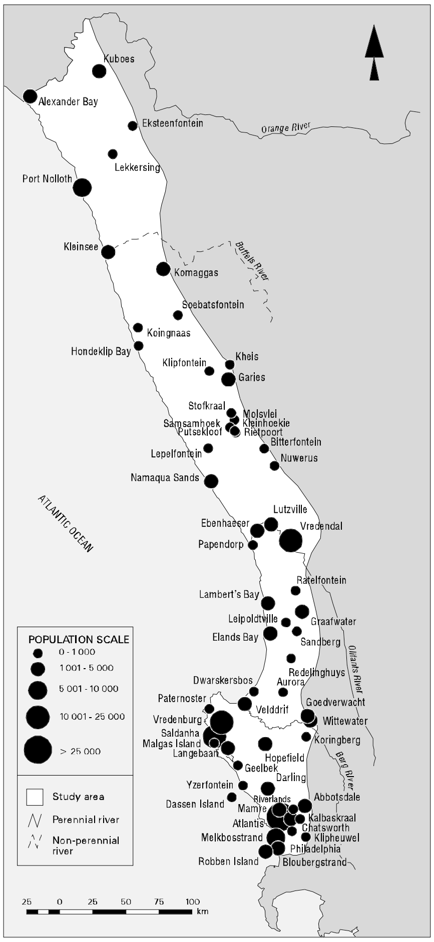

Figure 2
Location and size of respondent communities by population size class (August/September 1995)

otherwise of a water shortage. The average population total of these 58 communities was 3 110.

Methodology

The method employed for measuring shortage evolved in four steps. The first was to translate the total daily domestic (="residential") consumption figure for each of the 58 communities to the required ℓ/c·d format by dividing the former figure by the community's resident population total.

The second step was the decision (already noted) to define "domestic water consumption" as water used for drinking, cooking and personal hygiene, and "domestic water shortage" as a supply level of less than 25 ℓ/c·d in the short term, and less than 55 ℓ/c·d in the medium term.

The third step addressed the dilemma that the consumption figures obtained in the questionnaire survey relate to total household (="residential") use, rather than merely the water used for purposes of drinking, cooking and personal hygiene. Since the latter quantities are not known, on the face of it the existence or otherwise of a domestic water shortage (as defined) cannot be established. However, it is contended that the following propositions provide a means whereby the volume used for the three "essential" purposes may be separated from the more comprehensive measure within which it is subsumed, thus enabling one to test for shortage:

- When water is in short supply, a household may be expected to satisfy its most essential domestic needs (drinking, cooking and personal hygiene) first before using the remaining water (if any) for less essential purposes, e.g. sanitation, gardening, etc. (See also Pfeiff, 1998, in this regard).
- Since there appears to be consensus that 25 ℓ/c·d is the absolute minimum requirement for essential needs, it may further be assumed that, when actual consumption is less than this, all (or virtually all) of it is in fact being used for these purposes. To the extent that total household consumption (as metered) is less than 25 ℓ/c·d, a domestic water shortage may therefore be said to exist in the short term.
- By the same token, a current consumption level (as metered) of less than 55 ℓ/c·d represents a domestic water shortage at the medium-term level; this in effect means that the supply will have to be increased to at least that level in the next 15 years if the situation of shortage is to be eliminated.

The fourth and final step was the development of a formula embodying these propositions and through which the extent of the shortage (if any) may be calculated for both short and medium terms. This formula expresses domestic water shortage as a negative percentage deviation from the required minima of 25 and 55 ℓ/c·d respectively. The formula takes the following form:

$$S = \frac{D}{M} \times \frac{100}{1} - 100$$

in which:

S = Domestic water shortage or surplus, expressed as a percentage of the minimum requirement level.
D = Actual consumption (as metered) in ℓ/c·d
M = Minimum domestic water requirement level (25 and 55 ℓ/c·d for the short and medium terms respectively).

A positive result signals a surplus and the value itself indicates by what percentage the minimum requirement is exceeded. A negative outcome indicates a water shortage and the value gives the percentage of the deficit. To illustrate: If the actual consumption (as metered) is 17 ℓ/c·d, it implies that 68% of the short-term needs and 31% of the medium-term needs are currently being met. This translates into a shortage (deficit) of 32% in the short term (68 - 100 = -32) and 69% (31 - 100 = -69) in the medium term respectively. It needs to be repeated, however, that this methodology can only be applied in cases where consumption figures (actual or estimated) are in fact available.

Once the necessary calculations had been completed for the 58 communities in question, Statgraphics, Excel and Arc/Info software packages were used to present the results in a statistical, graphic and/or cartographic format. In the next section certain general features of the water supply situation on the West Coast are briefly set out, after which the patterns of domestic water shortage and of other indications of domestic water inadequacy are examined in greater depth.

General features of domestic water provision on the West Coast

Analysis of the questionnaire data revealed some interesting features regarding the sources, supply arrangements and price of domestic water in the study area. With regard to the actual **source of origin** of the water, a full 37 (60%) of the 62 respondent communities rely on boreholes, either totally (24 communities) or in part (13). In 10 cases the borehole water requires desalination to make it fit for human consumption.

A further 23 communities make use of river water in full or in part, either through direct extraction (four communities) or via a pipeline (15) or canal (four). Of these 23 communities, three are supplied from the Orange River, four from the Olifants and 14 from the Berg River; two of these rely partially also, and a further two even entirely, on episodic local streams.

Other water sources utilised include local "town dams" (three communities), fountains (five), wells (three), roof tanks (three) and even bare rock surfaces (five), with the water precipitated on it by rain, dew or fog being channelled to reservoirs by low retaining walls cemented on to the sloping rock surface. Also rather unusual is the fact that two of the four principal islands off the coast get part of their water by boat from the mainland. (It is noticeable, however, that the desalination of sea water plays no role in the region as yet). In total, 18 of the 62 communities rely on more than one type of water source.

The **responsibility for water supply** at all but three of the 62 respondent communities rests with some kind of overarching authority, e.g. the relevant local authority, a mining company or (at mission stations) the church organisation in question. These bodies supply all the water at 50 communities and 50 to 99% of it at a further nine. Only at Riverlands (100%) and Klipheuwel (60%) is all or most of the water obtained by the individual households themselves, while Leipoldtville residents buy their water from a local farmer.

The **price of water** shows considerable variation, from a staggering R32.00/kℓ (80c/25 ℓ) at Hondeklip Bay where it has to be trucked all of 17 km from Koingnaas, to being entirely free at 19 communities. Apart from the individually supplied Riverlands (population 7) and Klipheuwel (300), this latter group comprises a collection of equally minute agricultural, service or fishing hamlets (10 communities, average population 176), government-run establishments (e.g. three bird islands), mission stations and the like.

Of the remaining 43 communities where consumers have to pay for their water, 10 (again mostly mission stations or small agricultural or service hamlets) feature a monthly flat rate. At Goedverwacht this is only a nominal 25c/month. The norm, however, is in the R5.00 to R10.00 range (eight communities), with only Robben Island's water being more expensive at R16.55/ month. A similar level of variation is evident amongst the 33 communities where water is priced in terms of a set rate per kilolitre. Six of these – their populations ranging from 250 (Redelinghuys) to 15 641 (Vredendal) – pay less than R1.00/kℓ, while 19 were in the R1.00 to R2.00 range and five and two respectively in the R2.01 to R3.00 and R4.01 to R5.00 classes. As already noted, the small fishing village of Hondeklip Bay (population 588) had the dubious honour of topping the list at R32.00/kℓ. Thus while free water and the existence of a flat rate appear to be strongly associated with the smaller communities, there is little evidence of a positive correlation between population size and price at those communities where the set rate per kilolitre applies. Instead, price here appears to be purely a reflection of the particular water situation at each individual locality, including the relative scarcity or abundance of it.

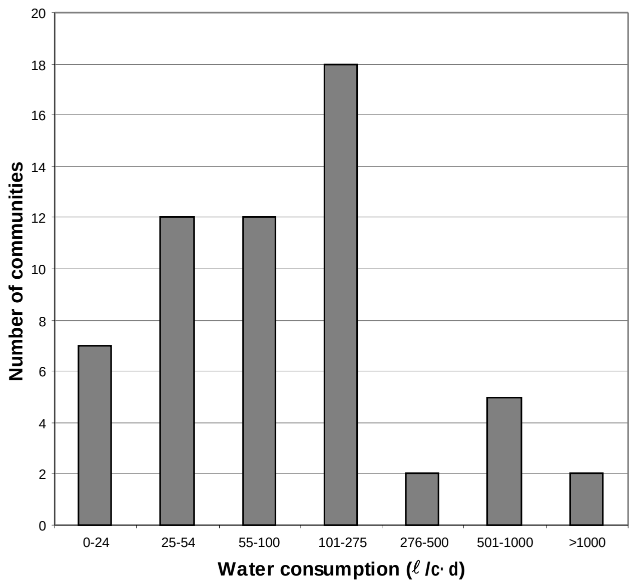

Figure 3
"Residential" water consumption levels of 58 respondent communities

Patterns of domestic water inadequacy

The chief focus in this section – as in the paper as a whole – is on the patterns of water shortage in the study region. Discussion of this topic is followed by a brief consideration of other indications of water inadequacy in the area.

Water shortages

This subsection looks successively at the average level of domestic water consumption in the study region; the communities where actual shortages occur; the relationship between shortage and community size; the regional distribution of shortages; and the needs and options regarding future water supply to the needy communities.

An area of below-average water consumption

Schutte and Pretorius (1997) quote the International Water Supply Organisation (ISWO) as stating that the average domestic (= "residential") water consumption level for those communities in South Africa served by water reticulation systems was 276 ℓ/c·d in 1993. Judged by this yardstick the West Coast is clearly an area of below-average water availability, as only nine (15.5%) of the 58 respondent communities for which such data were obtained had a consumption level in excess of that figure (see **Addendum 2** and Fig. 3). Close inspection shows, moreover, that the disproportionate consumption levels of the nine privileged communities derive in no small measure from the special, atypical water supply conditions obtaining there. Three subgroups may be distinguished in this regard:

- Mining settlements, benefiting from the extensive infrastructure installed by strong companies: cf. Alexander Bay, Kleinsee and Koingnaas; at Alexander Bay the negligible charge of 58c/kℓ probably also contributed to the extremely high consumption rate of 1 406 ℓ/c·d.
- Holiday resorts, where the exclusion of holiday and weekend visitors from the calculations obviously influenced the results:

TABLE 3 Communities experiencing an "immediate"-term shortage (<25 ℓ/c·d)								
Community	**Functional type**	**Resident population**	**Daily "residential" water consumption (ℓ)**		**% shortage**		**Min. additional litres needed daily**	
			Total	***Per capita***	**25 ℓ/c·d level**	**55 ℓ/c·d level**	**25 ℓ/c·d level**	**55 ℓ/c·d level**
Hondeklip Bay	Fishing settlm.	588	10 020	17	32	69	4 680	22 320
Kleinhoekie	Agricult. hamlet	74	1 480	20	20	64	370	2 590
Malgas Island	Bird island	1	10	10	60	82	15	45
Ratelfontein	Service hamlet	45	230	5	80	91	895	2 245
Samsamhoek	Agricult. hamlet	108	2 160	20	20	64	540	3 780
Sandberg	Service hamlet	52	260	5	80	91	1 040	2 600
Soebatsfontein	Agricult. hamlet	255	2 000	8	68	85	4 375	12 025
Total	-	1 123	16 160	-	-	-	11 915	45 605
Average	-	160	2 309	14	44	75	1 702	6 515

TABLE 4 Communities experiencing a medium-term shortage (≥25, but <55 ℓ/c·d)						
Community	**Functional type**	**Resident population**	**Daily "residential" water consumption (ℓ)**		**% shortage at 55 ℓ/c·d level**	**Min. additional litres needed daily at 55 ℓ/c·d level**
			Total	***Per capita***		
Abbotsdale	Commuter town	1 619	62 500	39	29	26 545
Ebenhaeser	Mission station	3 585	122 000	34	38	75 175
Kalbaskraal	Agricult. hamlet	628	18 750	30	45	15 790
Kheis	Mission station	818	22 904	28	49	22 086
Klipfontein	Agricult. hamlet	424	14 840	35	36	8 480
Leipoldtville	Service hamlet	275	11 000	40	27	4 125
Lepelfontein	Agricult. hamlet	328	15 088	46	16	2 952
Molsvlei	Agricult. hamlet	438	10 950	25	55	13 140
Philadelphia	Service hamlet	270	10 000	37	33	4 850
Putsekloof	Agricult. hamlet	270	8 100	30	45	6 750
Rietpoort	Mission station	395	11 850	30	45	9 875
Stofkraal	Agricult. hamlet	383	15 320	40	27	5 745
Total	-	9 433	323 302	-	-	195 513
Average	-	786	26 942	34	38	16 293

cf. Dwarskersbos, Langebaan and Yzerfontein, the last consuming a staggering 2 009 ℓ/permanent resident/d. At Velddrif, long a fishing town *par excellence*, the figure of 316 ℓ/c·d is probably in part a reflection of the recent development of the large Port Owen marina complex on its outskirts.

- Two upper-class commuter towns, Bloubergstrand and Melkbosstrand, located on the northern periphery of Cape Town and linked to its extensive water supply network.

If these nine "atypical" communities are removed from the calculations, the average water consumption of respondent communities falls quite precipitously from 205 to 133 ℓ/c·d, further accentuating the fact that consumption levels in this region are generally far below the national average.

Water-short communities

In stark contrast to those communities enjoying a super-abundance of water, seven others (12% of the 58 communities in question) experienced an actual domestic water shortage at the short-term level (< 25 ℓ/c·d; see Fig. 3). A further 12 (21%) registered a shortage at the medium-term level (≥25, but < 55 ℓ/c·d). Short- and/or medium-term shortages thus occur at one third (33%) of the communities in question. Tables 3 and 4 list the two groups of water-short communities, classifying them according to dominant function and indicating their respective population totals, current "residential" water consumption levels (total and *per capita*), the percentage shortage, and the minimum additional number of litres required to eliminate these shortages in both the short and medium term.

Inspection of Tables 3 and 4 shows that the seven communities experiencing a domestic water shortage at the "immediate"-term level (<25 ℓ/c·d) comprise three tiny agricultural settlements, two even smaller service hamlets, as well as a somewhat larger fishing village (Hondeklip Bay) and a bird island (Malgas). The average population of these seven communities is a mere 160. The 12 communities with a shortage at the medium-term level (≥25 but < 55 ℓ/c·d) are on average considerably larger (786), but again show a preponderance of agricultural and service hamlets (six and two communities respectively); three mission stations and a commuter settlement account for the remainder. Thus agricultural settlements (47%), service hamlets (21%) and mission stations (16%) together constitute about 84% of the water-short communities at both levels.

Water shortage and community size

The generally small size of the 19 water-short communities (a combined average population of 556 vs. 2 982 for the 62 respondent ones) calls for some comment. In the first place, this appears to reflect the wider South African pattern in which the smaller, mainly rural communities in the more remote country areas are the ones which have had to bear the brunt of inadequate domestic water provision in the past (Palmer and Eberhard, 1995). Communities that are larger in size usually have access to better infrastructure to meet the larger total demand; this appears to be a function of their stronger institutional arrangements, greater mobilisation capacity, fewer financial constraints, easier access to technical expertise for the design of appropriate water supply systems, and fewer capacity constraints in respect of the management and maintenance thereof. Additionally, larger communities also tend to require a higher *per capita* water supply for "residential" purposes. And if a large community experiences a shortage, both the number of people involved and the total deficit are of course larger than in the case of a small community; the "seriousness" of the problem is therefore also greater and tends to attract more attention and urgency in finding a solution. Thus one reason why virtually all water-short communities in the study region are to be found in the lowest size class (fewer than 1 000 inhabitants) may be the fact that in each case comparatively few people are affected and the total deficit appears to be negligible.

Yet community size as such should perhaps not be over-emphasised as an explanatory variable for the occurrence of water shortages. *[The converse may well be true, i.e. that the scarcity of water contributed to small community size].* Thus for the study region as a whole there is virtually no correlation between population size and *per capita* consumption (r = -0.003); even with the nine "atypical" communities excluded, the coefficient only increases to r = 0.25. Furthermore, besides the 17 water-short communities with fewer than 1 000 inhabitants each, 16 others in the same size class do not exhibit shortages **(Addendum 2).** Inspection shows that the majority (12) of this latter group – unlike all but one of their water-short counterparts (Philadelphia) – either belong to the favoured categories of mining and holiday settlements, are located on a main (tarred) road (Map Studio, 1993), and/or are within the ambit of a water-supply scheme centred on the Berg or Olifants Rivers. Also, 69% (vs. only 42% of the water-short ones) are located in the more humid regions south of the Olifants River, while 65% (vs. only 32%) have a mainly White population. It is therefore difficult to escape the impression that most of the water-short communities in the study region owe this status less to their small size than to their remoteness from regionally important water sources or communication routes, and/or to their isolation from the more dynamic sectors of the modern economy; in some cases, moreover, the low consumption figures may merely be a reflection of a location in a water-scarce area, and/or of the comparatively low level of living associated with a mainly Coloured population.

Answers given by respondent officials to the question of whether there is a domestic water shortage in the communities concerned, appear to be suggestive of the latter possibility. Thus in the <25 ℓ/c·d group (Table 3) the two Coloured communities of Kleinhoekie and Samsamhoek, despite consuming only 20 ℓ/c·d each, were not considered to be experiencing a shortage. In the ≥25 but <55 ℓ/c·d group (Table 4) the same answer was recorded for 10 of the 12 communities; nine of the 10 are likewise predominantly Coloured communities. By contrast communities consuming as much as 210 (Lambert's Bay), 150 (Dassen Island), 100 (Klipheuwel) and 75 ℓ/c·d (Chatsworth) were regarded as being water-short or – as with Aurora (211), Namaqua Sands (160), Atlantis (94) and Elands Bay (76) - to be facing such a situation within five years; of these eight communities only Chatsworth and Atlantis are predominantly Coloured. Clearly, therefore, the explanation for the existence or otherwise of actual or perceived shortages and of consumption levels in general must be sought in a combination of factors and not merely in the question of community size.

A second point arising from the generally small size of the water-short communities is that the total water-short population is actually quite small. Thus Tables 3 and 4 show that those in the <25 ℓ/c·d category account for a mere 0.6% (1 123) of the total respondent population of 184 905 **(Addendum 2),** while those with a medium-term shortage add another 5.1% (9 434). A comparatively minor increase in the water supply would therefore be sufficient (in individual as well as in collective terms) to take all 19 communities out of the water-short categories at either level. Tables 3 and 4 (final two columns) show the relevant details in this regard. Since these figures have obvious implications for future water provision they will be considered further under **Future water supply**. But prior to that the spatial distribution of shortages first needs our attention.

The spatial pattern of water shortages

Figure 4 shows the location and population size of the 19 water-short communities, indicating also the percentage shortage at the 25 and 55 ℓ/c·d levels respectively. Noticeable is the wide geographical dispersal of these communities, though none occurs north of the Buffels River. A major cluster is located between the Buffels and Olifants Rivers, with two minor ones south of the Olifants and Berg Rivers respectively. Except for a greater tendency towards such clustering amongst those with a medium-term shortage, the distribution patterns of the two groups of water-short communities display no substantial differences.

An interesting feature in Fig. 4 is the heavy concentration of water-short communities (both levels) in the centre of the study area in what used to be known as the "Coloured Rural Areas" of the erstwhile North-Western Cape. Ten (52.6%) of the 19 water-short communities – predominantly small farming hamlets – are located in these areas. Conversely, this means that only four of the 14 respondent communities here (Komaggas and the three Richtersveld communities of Kuboes, Eksteenfontein and Lekkersing) did not record a shortage at either level. At first glance these facts appear to be strongly suggestive of apartheid-era neglect of such areas. However, as already indicated, the influence of other factors (e.g. remoteness from major water sources and communication routes, isolation from the most dynamic economic sectors, location in a water-scarce area, and/or the comparatively low level of living of a mainly Coloured population) would also have to be considered before definite conclusions can be drawn in this regard.

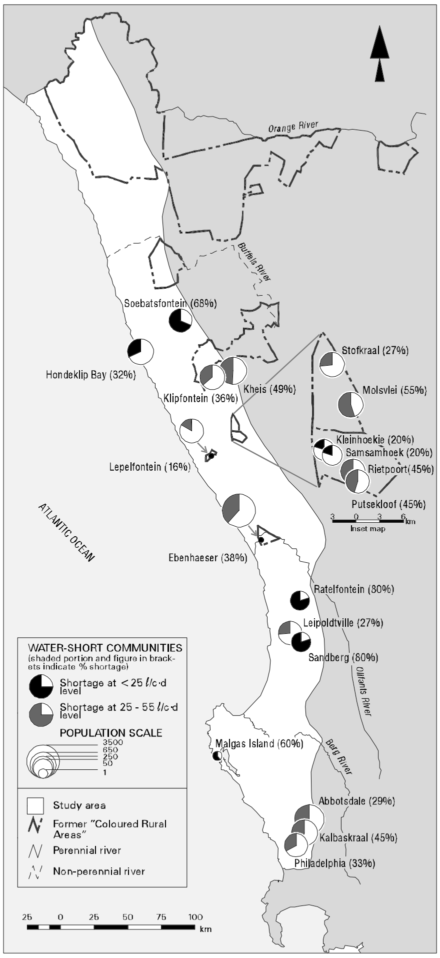

Figure 4

Distribution and population size of water-short communities, indicating the % shortage at "immediate" and medium-term levels respectively

Future water supply

While it is obvious that the planning of future water provision along the West Coast cannot focus narrowly only on the supply needs of communities currently experiencing water shortages, this section will of necessity restrict itself to the 19 such communities identified earlier. Tables 3 and 4 indicate the relatively minor additions to the water supply needed to take them all out of the water-short categories at either of the two deficit levels. Collectively, the seven minute communities presently suffering an "immediate-term" shortage will for instance require an extra daily aggregate of only 11.9 kℓ to bring them all to the desired minimum consumption level of 25 ℓ/c·d. Similarly, the twelve communities with a medium-term deficit need an added daily aggregate of only 195.5 kℓ to eliminate present shortages. A total additional supply of some 241 kℓ daily could in theory bring all 19 water-short communities up to the minimum target level for the medium term. This is only slightly more than is presently being consumed by the 2 000 inhabitants of Graafwater at a rate of 115 ℓ/c·d (see **Addendum 2**), thus representing a volume normally well within the compass of even a smallish conventional supply scheme.

However, due to the wide geographical dispersal of the water-short population across 19 scattered communities (Fig. 4), it seems highly unlikely that a single conventional scheme could be conceived to eliminate all existing shortages in the region. Such schemes might at most be feasible at the subregional level, thanks to the clustering of water-short communites in certain areas. Thus it seems possible that Philadelphia might in future be linked up to the Berg River's Voëlvlei scheme (as has recently been done at the nearby Kalbaskraal and Abbotsdale), and that Ebenhaeser, Ratelfontein, Leipoldtville and Sandberg might be supplied from the Olifants River. However, the latter three communities are separated from the river by intervening mountains, and most of the other water-short locations are probably too far from any of the three perennial rivers – besides being too small – to justify the expense that would be associated with such a conventional river-based supply scheme.

The foregoing consideration applies with special force to the 11 water-short communities north of the Olifants River. It is true that pipelines already convey Orange River water as far south as Springbok and Kleinsee, and Olifants River water as far north as the Namaqua Sands mining operation (Bester, 1993; Schloms, 1998). Yet the intervening distances between these termini and the communities in question are still considerable and the costs of bridging the gaps therefore probably too large (and the total water-short population too small) for this to be seriously considered. Realistically, these communities (and some of those south of the Olifants River as well) therefore appear to have but three options to improve their situation regarding domestic water supply: To expand delivery from their existing supply sources (which may not be possible); to find new underground sources further afield (which may not be available, or be too expensive to consider); or to turn to one or more of the more recently developed unconventional water-supply systems such as desalination and fog-water "harvesting". *[Schloms (1998) mentions one further supply possibility: Conveying winter run-off collected in storage dams in the higher-rainfall Kamiesberg mountains in the east to the water-short communities further west. The economic and practical feasibility of this proposal is however yet to be established]*.

Given the prevalence of coastal fogs in the area and the small quantities of supplementary water required per community to overcome present shortages, fog-water harvesting appears in principle to be a particularly attractive option for the region. Under roughly similar conditions at the Chilean fishing village of Chungungo, 50 4x12 m polypropylene fog screens together collect a daily average of 7 kℓ of good-quality water year-round, rising to as much as 110 kℓ in the rainy season (Pfeiff, 1998). Other advantages of this technology – particularly relevant in view of the small size, remoteness, relative poverty and unsophisticated character of the water-short communities – is its robust, "low-tech" nature, ease of operation and relative cheapness (compared to desalination, for instance). As already indicated, however, locally the success or otherwise of such a system is yet to be established under operational conditions (Olivier, 1997; Olivier and Van Heerden, 1999).

Other indications of water inadequacy

Questionnaire responses relating to the quality and accessibility of the water supply added to the picture regarding water inadequacy on the West Coast.

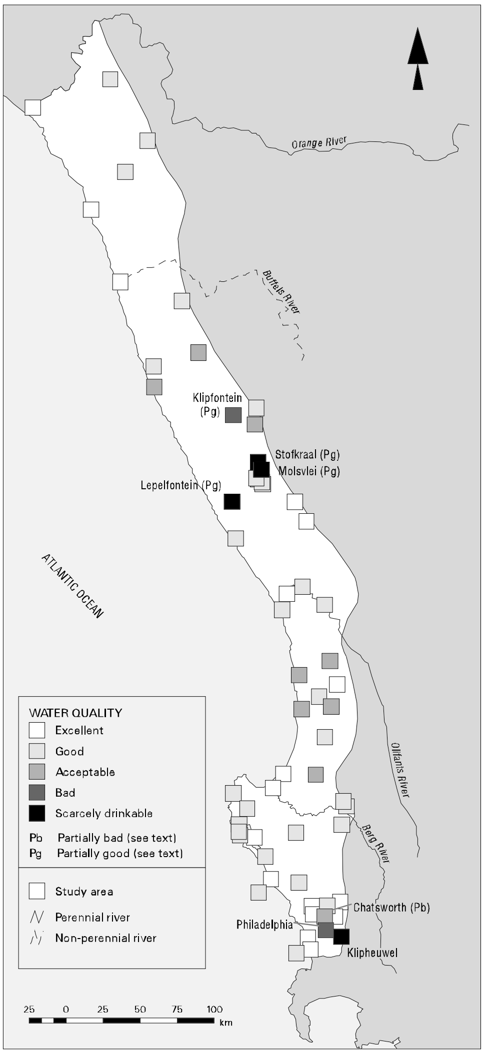

Figure 5
Perceptions of water quality

Water quality

Figure 5 indicates the variation in water quality as reported by officials involved with water provision in the various communities. It should be noted that the quality designation as indicated is in a number of cases merely the perceptual judgement of the official concerned since proper scientific test results are not always available.

Inspection of Fig. 5 shows that only seven of the 62 respondent communities reported a condition of less than acceptable water quality. These seven communities occur in two distinct concentrations. In the Swartland district in the south, Klipheuwel reported scarcely drinkable water while the quality at Philadelphia is described as bad. Both communities obtain their water from boreholes and roofs (at Klipheuwel partially from the Diep River also) and complaints centre around its bad taste due to high salinity; in addition Klipheuwel's water also has an unpleasant odour. The nearby Chatsworth is in a better position in that its water is described as being mainly good or acceptable. A serious quality problem does nonetheless exist, for the absence of a formal sewerage system has led to the contamination of certain of the underground sources (boreholes, wells and fountains) on which the community relies; in some cases the water has been declared unfit for human consumption.

A second cluster of communities with water quality problems occurs in certain of the former "Coloured Rural Areas" in the north-central region. Here, too (as at Chatsworth), at least some of the water is regarded as "good", thanks to the desalination of part of the yield from the brackish boreholes on which all four of these communities depend. (At Lepelfontein a partially self-built rock dome adds to the supply by trapping rain water). The desalination plants (operated by an outside consultant) are very small, however, and the cost of the water relatively high (R10/kℓ – Roberts, 1998), so that in each case the quantity of "good" water available (which is either reticulated separately or used to dilute some of the brackish water) is very limited; it is in fact barely sufficient to satisfy the communities' drinking and cooking needs. Stofkraal, Molsvlei and Lepelfontein have only 5 ℓ of freshwater/c·d, while Klipfontein boasts an average of 7 ℓ/c·d These minute quantities represent a mere 12.5%, 20%, 10.9% and 20% respectively of the total consumption figures of 40, 25, 46 and 35 ℓ/c·d in these communities. Clearly, therefore, by far the greater part (80 to 89.1%) of the water being consumed here is of a low quality, being either "very saline" as at Stofkraal, Molsvlei and Lepelfontein (hence the "scarcely drinkable" designation) or "brackish" (hence "bad") as at Klipfontein.

An aspect not shown in Fig. 5 is the wide variety of less serious complaints registered at some of the 55 communities where the overall assessment of water quality was positive or neutral. The most common such complaint related to the taste of the water. It was described as brackish/too saline at eight such communities (Elands Bay, Garies, Hondeklip Bay, Koringberg, Lambert's Bay, Riverlands, Robben Island – referring to the borehole water in summer – and Soebatsfontein), and as "sometimes unpleasant in summer" at Darling. Aurora's water, in turn, is distinguished by its acidity and high iron content.

Other complaints related to the appearance (colour) and odour of the water as well as the extent to which it represents a health risk. Yzerfontein's water is described as "turbid" and that at Redelinghuys and (ironically) Wittewater as "brown in winter". Aurora's water is apparently somewhat smelly at times while at Darling and Yzerfontein this effect is confined to the summer season. A health risk is assigned to Ratelfontein's and Sandberg's water because of its "chemical quality" *(sic)*. At Koringberg the water contains "bacteriological impurities" at times, although this is not considered to be a health risk. This assessment is also applied to the situation at Velddrif and Dwarskersbos where – particularly after the first winter rains - *E. coli* bacteria are to be found in the water. This, presumably, explains the respondent official's statement that problems occur at export-oriented fish processing plants at Velddrif because the quality of the water "does not meet SABS (standards)".

Water accessibility

Questionnaire responses regarding the accessibility of the water supply related to two principal matters: First, the location of the water point/point of delivery; and second, the distance, means of conveyance and height differential involved in those situations where the community relies on (a) public water point(s), either inside or outside the settlement concerned. Table 5 summarises the findings regarding the location of water points, with Fig. 6 showing the spatial variation in this regard.

TABLE 5
Location of water points

Location of water point(s)	Number of communities per locational category			Total (minority status not considered)
	Single locational category applicable to all residents	>1 locational category		
		Category/-ies applicable to majority of residents	Category/-ies applicable to minority of residents	
Private tap(s) in each house	34	3	-	37
Private tap(s) on premises	6	5	(1)	11
Public water point(s) in settlement	11	-	(7)	11
Public water point(s) outside settlement	3	-	-	3
TOTAL (minority status not considered)	54	8	(8)	62

In a previous section it was indicated that Emmett and Rakgoadi (1993) regard a maximum distance of 250 m to the water point as an "acceptable" level of accessibility, while current government policy aims to provide water within 200 m from each consumer. Yet the ultimate ideal must surely be to give full household access to all. Table 5 shows that in these terms only 34 of the 62 respondent communities in the study region currently have fully adequate access to water, with a tap/taps in each house. At a further three communities (Vredenburg, Kalbaskraal and Goedverwacht), the same applies to a majority of the inhabitants, though not to all. In Fig. 6 these three communities have been mapped according to their majority representation, with the subscripts 2 and/or 3 indicating the existence of differing accessibility conditions for a minority of the inhabitants.

The foregoing leaves 25 communities that are inadequately provided for in that they lack in-house access to water. Worst-off in this regard are three communities (Ratelfontein, Sandberg and Klipheuwel) which rely on public water point(s) located outside the settlement. Eleven others rely on public water points within the settlement, while a further 11 have tap(s) on the premises but not inside the house. However, at five communities in this latter group a minority of residents suffer lower access levels; this is indicated in Fig. 6 by the relevant subscripts next to the symbols for Chatsworth, Kheis, Komaggas, Lekkersing and Eksteenfontein respectively.

A noticeable feature is that 72% (18) of the 25 communities with less than fully adequate access have a predominantly (or entirely) Coloured population. Included in this group are all 14 respondent communities in the "Coloured Rural Areas", thus reinforcing the impression that inadequate water provision is a pervasive characteristic in these areas. A second feature follows from the foregoing, i.e. that the major concentration of communities with inadequate access is to be found north of the Olifants River (Fig. 6). A second cluster of five such settlements lies south and west of the Olifants River, with the two bird islands of Malgas and Jutten, plus Klipheuwel, Chatsworth and Abbotsdale as outliers in the south.

A surprise in Fig. 6 is that the three worst-off communities (public water point outside the settlement) are all south of the Olifants River and that none of these (Ratelfontein, Sandberg and Klipheuwel) are amongst the group of Coloured communities mentioned above. Soebatsfontein presents an occasional exception in this regard, however, for in the absence of sufficient wind to

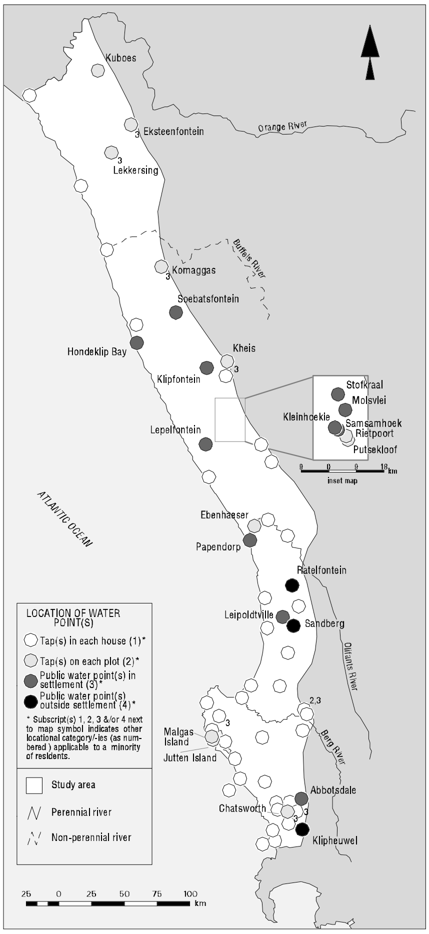

Figure 6
Accessibility of water supply: Location of water points

TABLE 6 **Accessibility to public water point(s)**									
Community	**Maximum distance to water point (m)**					**Means of water conveyance**			**Height differen-tial 50 m +**
	0-100	**101-250**	**251-500**	**501-1 000**	**1 001-5 000**	**Carried in containers or pushed on barrows**	**Containers on wagon/ bakkie/ truck**	**Tank truck**	
(i) Water point(s) outside settlement									
Klipheuwel					X	X	X		X
Ratelfontein		X				X			
Sandberg		X				X			
Subtotal	-	2	-	-	1	3	1	-	1
(ii) Water point(s) inside settlement									
Abbotsdale			X			X	X		X
Hondeklip Bay			X					X	
Kleinhoekie			X			X			
Klipfontein		X				X	X		
Leipoldtville	X						X		
Lepelfontein		X				X			
Molsvlei		X				X			X
Papendorp		X				X			
Samsamhoek			X			X			
Soebatsfontein			X			X			
Stofkraal		X				X			
**Chatsworth*			X			X	X		
Eksteenfontein			X			X	X		
Goedverwacht	X					X			
Kalbaskraal			X			X	X		X
Kheis		X					X		
Komaggas			X			X	X		X
Lekkersing	X					X			X
Vredenburg	X					X			
Subtotal	4	6	9	-	-	16	8	1	5
Total	4	8	9	-	1	19	9	1	6

*Italicised communities: Only a minority of residents reliant on the public water point(s) in question.

activate the single windmill within the settlement residents are at times obliged to utilise a water source outside its boundaries.

Communities served by (a) communal water point(s) inside the settlement, as well as those with taps on the premises, are centred in the northern parts of the study region. In the former category (which includes Soebatsfontein) only Abbotsdale, Leipoldtville and Papendorp lie south of the Olifants River, with Papendorp practically on its very banks. In the latter category the same applies to Ebenhaeser, with Malgas and Jutten Islands and also Chatsworth further south; the remaining seven communities in this category are all in the north. By contrast, the 37 communities with full household access to water for all (or the majority of) residents, dominate the southern parts of the study region and seem to follow the coastline to the north (Fig. 6). This appears to reflect the more developed nature of the former area and the occurrence of mining towns along the northern littoral.

Three important accessibility features relevant only to those communities (or sections of communities) served by (a) public water point(s) are the distance to the service point, the means of water conveyance employed, and the height differential involved. Table 6 indicates the findings in this regard. It should be noted that, in the case of those communities (or sections of communities) served by (a) communal water point(s) within the settlement, the distance and height figures are those which apply to the worst-off households in these respects, which may in most cases be assumed to be only a minority of those utilising the source. Keeping this qualification in mind, it is evident that more than half (12) of the 22 communities in Table 6 meet Emmett and Rakgoadi's (1993) adequacy standard with regard to distance to the water point, i.e. a maximum of less than 250 m. Moreover, at nine of the ten

TABLE 7
Weighting scheme for determining overall water inadequacy levels
(Highest weights indicate least favourable conditions)

Quantity of water supplied		**Quality of supply**		**Accessibility of supply**				
<25 ℓ/c·d	25-54 ℓ/c·d	Bad	Scarcely drinkable	Location of water point		Distance to public water point (m)		
8	2	4	6	Yard tap	Public tap	250-500	501-1 000	1 001-5 000
(Add 1 point if <15 ℓ/c·d, 2 if <10 ℓ/c·d)	(Add 1 point if <45 ℓ/c·d, 2 if <35 ℓ/c·d, 3 if 25-29 ℓ/c·d)	(Add 1 point each if taste, turbidity, odour and/or health risk particularly bad)		1	3	1	2	3
					(Add 2 points each if conveyed on foot/by barrow, and/or height differential > 50 m)			
Component maximum: 10 points		Component maximum: 10 points		Component maximum: 10 points				

All weights to be halved if only a minority of residents affected. Similarly, quality weights are halved if only a part of the supply is deficient in some respect, or if this quality deficiency is a sporadic or seasonal one.

communities where this distance is exceeded it is only a minority (or even " a minority of a minority") of the inhabitants which are affected (e.g. 21 families at Komaggas).

At Klipheuwel, however, all the water has to be carted over a distance much greater than the 250 m limit. Added to this is a height differential well in excess of the 25 m regarded as "acceptable" by Emmett and Rakgoadi (1993); this is also the case for a minority of residents at Abbotsdale and Molsvlei and for "a minority of a minority" at Kalbaskraal, Komaggas and Lekkersing. Fortunately, four of these communities are amongst the ten where all (Hondeklip Bay, Leipoldtville and Kheis), or at least some of the water, is conveyed by mechanical or animal-drawn means. Yet at nine communities – as also for sections of the population at 10 others – the carrying of heavy containers on foot or on a wheelbarrow is still the sole means of water conveyance, often over considerable distances and across uneven ground to boot.

Generally speaking Klipheuwel and (for a minority of residents) Abbotsdale, Kleinhoekie, Molsvlei, Samsamhoek, Soebatsfontein, Kalbaskraal and Komaggas appear to be the worst off communities with regard to water accessibility. At Klipheuwel there is a squatter community in the centre of the village which has no water whatsoever and has to rely on the river and the shop owner in this regard, while it is presumably the combination of bad quality (see **Water quality** above) and relative inaccessibility (>1 km distance, height differential >50 m) here which explains why residents who commute to Cape Town bring their drinking water home.

The general pattern of water inadequacy

One element which is missing in the foregoing examination of domestic water inadequacy patterns is the question of the availability (reliability) of the water supply. Unfortunately the questionnaire survey yielded only the sketchiest information in this regard – e.g. the fact that four communities (Dassen Island, Garies, Lutzville and Wittewater) sometimes experience water shortages during dry years. Apart from these fragments, however, no further data came to hand regarding the reliability of the water supply.

Nevertheless, by combining the available information on the three remaining components of water inadequacy (the quantity, quality and accessibility of the supply), it was possible to derive a general (if very subjective) measure of the overall inadequacy level in a particular community. Table 7 shows the weighting scheme employed in this regard, with equal weights being assigned to the three components.

The scheme rests on the assumption that an "adequate" level of water provision is one in which:

- the consumption level equals or exceeds 55 ℓ/c·d;
- the quality of the water (including its taste, colour, odour and the health risk involved) is at least of an "acceptable" standard; and
- every household in the community has an in-house water connection.

Hence "inadequacy" (as indicated by the points assigned to a particular community, to a possible maximum of 30) may be expressed as a negative percentage deviation from this adequacy standard. A score of 10 (out of a possible 30) therefore translates into a -33.3% deviation from adequacy, a score of 15 becomes -50%, etc.

The results of the foregoing exercise showed that 42 of the 62 respondent communities suffer at least some degree of water inadequacy as defined. However, for the purposes of this discussion the 17 communities where the inadequacy level did not reach -10% will be ignored. Table 8 lists the remaining 25 communities in five "inadequacy classes", while Fig. 7 shows the spatial pattern.

A noticeable feature once again (Table 8) is the small average size of these disadvantaged communities (694), and with it a steady decrease in average size as the level of inadequacy rises. Topping the list as the three worst-off communities in general terms are the three minute service hamlets of Klipheuwel (inadequacy level – 56.7%), Ratelfontein and Sandberg (both -53.3%). It comes as no surprise, further, to find 13 of the 14 respondent communities in the former "Coloured Rural Areas" included amongst the 25 worst-off communities in the study region, Kuboes being the only exception. The list also includes three other mainly Coloured communities, i.e. Abbotsdale, Chatsworth and Papendorp.

The spatial pattern (Fig.7) indicates four principal regions of water inadequacy, namely the Swartland area near Cape Town in the south, the Ratelfontein-Sandberg area west of the Olifants

TABLE 8 Communities with water inadequacy levels of -10% and higher, grouped by inadequacy class. (Higher negative values indicate increased inadequacy)		
Inadequacy class (%)	**Communities**	**Average population**
-10 to -20	Chatsworth, Ebenhaeser, Eksteenfontein, Komaggas, Leipoldtville, Lekkersing, Papendorp, Putsekloof, Rietpoort	1 224
-20,1 to -30	Abbotsdale, Kalbaskraal, Kheis, Philadelphia	834
-30,1 to -40	Klipfontein, Lepelfontein, Malgas Island, Stofkraal	284
-40,1 to -50	Hondeklip Bay, Kleinhoekie, Molsvlei, Samsamhoek, Soebatsfontein	293
>-50	Klipheuwel, Ratelfontein, Sandberg	132

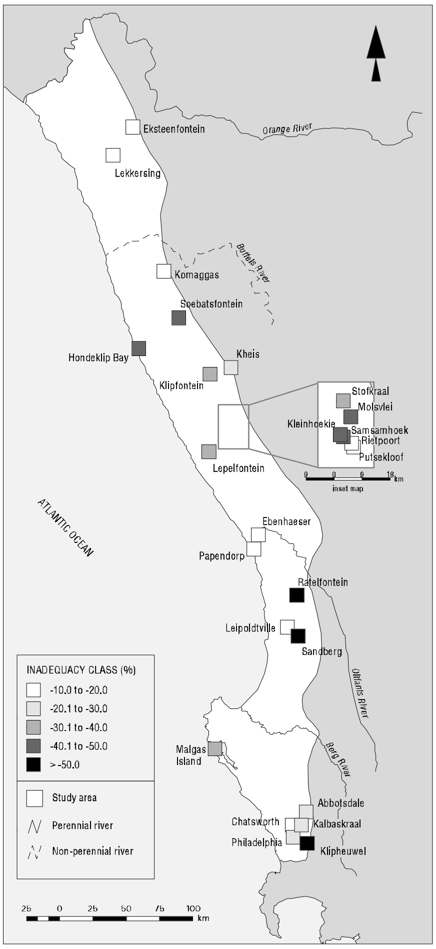

Figure 7
General pattern of water inadequacy by inadequacy class (percentage deviation from adequacy)

River, the former "Coloured Rural Areas" in south-central Namaqualand, and the Hondeklip Bay-Soebatsfontein area south of the Buffels River. Two minor pockets of inadequacy occur also in the southern Richtersveld and near the mouth of the Olifants River respectively.

In view of the arbitrary and subjective nature of the methodology employed, no claims can be made regarding the accuracy of the results displayed in this section. Yet the exercise does have the merit of providing at least some sort of general overview of water inadequacy patterns in the study region.

Conclusion

The study has shown that the arid West Coast region along South Africa's Atlantic seaboard contains a collection of mainly smallish and remotely located communities where domestic water supply conditions are sub-optimal at best and quite appalling in a few cases. Water shortages (defined as the availability of <25 ℓ/c·d in the short term and/or <55 ℓ/c·d in the medium term) were found to be particularly prevalent in the former so-called "Coloured Rural Areas" in south-central Namaqualand. These areas also contain a majority of the seven communities with serious quality deficiencies in their water supply and most of the considerably larger number with inadequate accessibility conditions. Surprisingly, however, the three worst-off communities in both these respects and also in terms of overall domestic water inadequacy occur further south in two minor inadequacy clusters west of the lower Olifants River and in the Swartland district near Cape Town respectively.

A weakness in the study was its non-official nature which meant that response to the questionnaire survey was voluntary and hence incomplete, excluding 22 communities from consideration. Provided that complete coverage can be obtained, such regional surveys are important nonetheless in providing a proper empirical base for remedial actions regarding water supply. Thus planning efforts to improve supplies as well as the necessary prioritising in this regard can only benefit from prior surveys of this nature. However, a basic prerequisite which should first be met is agreement on a generally acceptable definition of the hitherto rather nebulous concept of "domestic water shortage". The paper presents certain general ideas in this regard which may be relevant as a basis for further discussion. It also surveys the variety of supply options available to water-short West Coast communities and points to the relevance of unconventional supply solutions such as desalination and (possibly) fog-water "harvesting". Whilst still awaiting the results of investigations into the feasibility of the latter (Olivier, 1997; Olivier and Van Heerden, 1999), it does not seem inconceivable that certain West Coast communities may in future be confronted with a choice between desalination (reliable but expensive and “hi-tech” in nature) and fog-water “harvesting” (relatively cheap and “low-tech” in nature, but probably not as reliable) as a means of supplementing their meagre supplies of potable water.

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References

AFRICAN NATIONAL CONGRESS (ANC) (1994) *The Reconstruction and Development Programme:A Policy Framework*. African National Congress, Pretoria.

ANON (1996) South Africa’s first desalination plant for drinking water. *SA Waterbulletin* (special edn.) 9.

ANON (1997) *Transparencies to Educate*. Published by Encyclopaedia for Geography, Hengelo, The Netherlands.

ANON (2000) Government to speed up delivery of RDP services. *SA Waterbulletin* (May/June). 4.

BAHL R and LINN J (1992) *Urban Public Finance in Developing Countries.* Oxford University Press, Oxford.

BAUM WC and TOLBERT SM (1985) *Investing in Development.* Oxford University Press , New York.

BESTER R (1993) Noordwes-Kaapland: ‘n Geografiese Studie met die Klem op Water in die Ontwikkeling van die Gebied. MA Thesis, Univ. of Stellenbosch.

COETZEE H (1991) *Taps and Toilets: A Study of Water Supply in South Africa, with a Focus on Informal Settlements on the Witwatersrand.* Group for Environmental Monitoring, Johannesburg.

DEPARTMENT OF HEALTH (1994) *National Survey on Access to Drinking Water where Drinking Water is not Available in the Home or on the Premises.* EHMP 94/8, Pretoria.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (DWAF) (1994) Water Supply and Sanitation Policy. White Paper, Cape Town.

EMMETT T and RAKGOADI S (1993) *Water Supply and Sanitation Services in South Africa.* Southern Africa Labour and Development Research Unit, Cape Town.

FOWLER T (1992) Water and sanitation policy study. Summary paper presented to the Conf. towards a Democratic Sub-national Government, 23-25 October.

GILBERT F, WHITE D, BRADLEY J and WHITE A (1972) *Drawers of Water: Domestic Water Use in East Africa.* Univ. of Chicago Press, Chicago.

GOLDBLATT M (1996) Making the cup run over – The challenge of urban water supply for South Africa’s Reconstruction and Development Programme. *Geogr. J.* **39** (1) 21-26.

GOLDBLATT M (1997) Realising the right to sufficient water in South Africa’s cities. *Urban For.* **8** (2) 255-276.

GRIMA AP (1972) *Residential Water Demand.* Univ. of Toronto, Toronto.

HARDOY J and SATTERTHWAITE D (1989) Environmental problems in Third World cities: A global issue ignored? Paper presented at the Conf. Cities – The Mainspring of Economic Development in Developing Countries, Lille, France.

HOLLINGWORTH B (1994) Water supply: Service levels and performance standards. Paper presented at the National Water Supply and Sanitation Policy Conf., World Trade Centre, Kempton Park.

MAP STUDIO (1993) *1994 Road Atlas of South Africa.* Struik Publishing Group, Sandton.

OLIVIER J (1997) Fog: A possible solution to rural water problems? *S. Afr. Geogr. J.* **79** (3) 161-165.

OLIVIER J and VAN HEERDEN J (1999) The South African Fog Water Collection Project.WRC Report No.671/1/99, Pretoria.

PALMER DEVELOPMENT GROUP (1993) Evaluation of Water Supply to Developing Urban Communities in South Africa. Unpublished draft report prepared for the Water Research Commission.

PALMER I and EBERHARD R (1995) Evaluation of Water Supply to Developing Urban Communities. WRC Report 73/95, Pretoria.

PFEIFF M (1998) They harvest the clouds. *Reader’s Digest*, January, 85-89.

POSTEL S (1992) *The Last Oasis. Facing Water Scarcity.* Worldwatch Environmental Alert Series. Earthscan Publications, London.

ROBERTS T (1998) Personal communication. Dept. of Local Government and Housing, Northern Cape Province, Springbok.

SCHLOMS BHA (1998) Personal communication. Dept. of Geogr. and Environ. Studies, Univ. of Stellenbosch.

SCHUTTE CF and PRETORIUS WA (1997) Water demand and population growth. *Water SA* **23** (2) 127-133.

SEI (1993) *Environmental Problems and the Urban Household in the Greater Accra Metropolitan Area (GAMA).* Stockholm.

STEYN M (1992) Sosio-ekonomiese Verskille in Residensiële Waterverbruik op Stellenbosch. Honours research report, Dept. of Geogr., Univ. of Stellenbosch.

VAN DUUREN FA (1976) Resources deployed in water re-use. In: G Baker (ed.) *Resources of Southern Africa: Today and Tomorrow.* Northern Cape Printers, Kimberley. 242-250.

VAN SCHALKWYK A (1996) Guidelines for the Estimation of Domestic Water Demand of Developing Communities in the Northern Transvaal. WRC Report No. 480/1/96, Pretoria.

WORLD HEALTH ORGANIZATION (1993) *Environmental and Health Aspects of Planning Urban Areas.* Geneva.

ADDENDUM 1

Alphabetical list and questionnaire response of West Coast communities

Community	Response: yes/no	Community	Response: yes/no
Abbotsdale	✓	Lambert's Bay	✓
Alexander Bay	✓	Langebaan	✓
Atlantis	✓	Langebaanweg	×
Aurora	✓	Leipoldtville	✓
Bamboesbaai	×	Lekkersing	✓
Beauvallon	×	Lepelfontein	✓
Bitterfontein	✓	Louis Rood	×
Bloubergstrand	✓	Lutzville	✓
Brittannia Bay	×	Malgas Island	✓
Buffelsbank	×	Mamre	✓
Chatsworth	✓	Melkbosstrand	✓
Churchhaven	×	Molsvlei	✓
Darling	✓	Namaqua Sands	✓
Dassen Island	✓	Nuwerus	✓
Doringbaai	×	Papendorp	✓
Dwarskersbos	✓	Paternoster	✓
Ebenhaeser	✓	Philadelphia	✓
Eksteenfontein	✓	Port Nolloth	✓
Elands Bay	✓	Putsekloof	✓
Garies	✓	Ratelfontein	✓
Geelbek	✓	Redelinghuys	✓
Goedverwacht	✓	Rietpoort	✓
Graafwater	✓	Riverlands	✓
Hondeklip Bay	✓	Robben Island	✓
Hopefield	✓	Saldanha	✓
Jakkalsvlei	×	Samsamhoek	✓
Jutten Island	✓	Sandberg	✓
Kalbaskraal	✓	Soebatsfontein	✓
Karkams	×	Spoegrivier	×
Kheis	✓	St Helena Bay	×
Klawer	×	Stofkraal	✓
Kleinhoekie	✓	Stompneusbaai	×
Kleinsee	✓	Strandfontein	×
Klipfontein	✓	Tabakbaai	×
Klipheuwel	✓	Vanrhynsdorp	×
Kliphoek	×	Velddrif	✓
Koingnaas	✓	Vredenburg	✓
Komaggas	✓	Vredendal	✓
Koringberg	✓	Wallekraal	×
Kotzeshoop	×	Waterklip	×
Kotzesrus	×	Wittewater	✓
Kuboes	✓	Yzerfontein	✓

Total number of communities identified: 84
Total number of responses: 62
Response rate: 73.3%

ADDENDUM 2

Basic data for respondent communities (August/September 1995)

Community	Type	Resident population	Daily "residential" water consumption (ℓ) Total	*Per capita*
Abbotsdale	commuter town	1 619	62 500	39
Alexander Bay	mining settlement	3 200	4 500 000	1 406
Atlantis	industrial centre	53 310	5 000 000	94
Aurora	service hamlet	415	87 500	211
Bitterfontein	transport town	300	52 000	173
Bloubergstrand	commuter town	1 770	1 000 000	565
Chatsworth	commuter town	1 642	123 000	75
Darling	service centre	4 211	720 000	171
Dassen Island	bird island	4	600	150
Dwarskersbos	holiday resort	212	75 000	354
Ebenhaeser	mission station	3 585	122 000	34
Eksteenfontein	agricultural hamlet	538	37 660	70
Elands Bay	fishing village	1 065	81 108	76
Garies	service centre	1 500	199 560	133
Geelbek	environmental education centre	95 (max. capacity)	10 000+	105+
Goedverwacht	mission station	2 104	No meters	-
Graafwater	service centre	2 000	230 000	115
Hondeklip Bay	fishing settlement	588	10 020	17
Hopefield	service centre	4 600	600 000	130
Jutten Island	bird island	0	5	-
Kalbaskraal	agricultural hamlet	628	18 750	30
Kheis	mission station	818	22 904	28
Kleinhoekie	agricultural hamlet	74	1 480	20
Kleinsee	mining settlement	1 544	1 033 000	669
Klipfontein	agricultural hamlet	424	14 840	35
Klipheuwel	service hamlet	300	30 000	100
Koingnaas	mining settlement	593	351 000	592
Komaggas	mission station	3 562	324 142	91
Koringberg	service hamlet	250	1 600	64
Kuboes	agricultural hamlet	2 019	115 891	57
Lambert's Bay	fishing settlement	4 300	905 000	210
Langebaan	holiday resort	2 400	1 517 000	632
Leipoldtville	service hamlet	275	11 000	40
Lekkersing	agricultural hamlet	538	35 885	67
Lepelfontein	agricultural hamlet	328	15 088	46
Lutzville	service centre	3 000	776 000	259
Malgas Island	bird island	1	10	10
Mamre	mission station	5 000	500 000	100
Melkbosstrand	commuter town	5 230	5 200 000	994
Molsvlei	agricultural hamlet	438	10 950	25
Namaqua Sands	mining settlement (temporary construction camp)	2 500	400 000	160
Nuwerus	service hamlet	300	22 000	73
Papendorp	fishing settlement	213	17 280	81
Paternoster	fishing & holiday settlement	811	127 900*	158
Philadelphia	service hamlet	270	10 000	37
Port Nolloth	fishing and marine mining settlement	9 600	1 296 000	135
Putsekloof	agricultural hamlet	270	8 100	30
Ratelfontein	service hamlet	45	230	5

Community	Type	Resident population	Daily "residential" water consumption (ℓ)	
			Total	*Per capita*
Redelinghuys	service hamlet	250	35 000	140
Rietpoort	mission station	395	11 850	30
Riverlands	agricultural hamlet	7	1 000	143
Robben Island	prison island	1 300	No meters	-
Saldanha	fishing, military & port centre	14 404	2 499 150*	174
Samsamhoek	agricultural hamlet	108	2 160	20
Sandberg	service hamlet	52	260	5
Soebatsfontein	agricultural hamlet	255	2 000	8
Stofkraal	agricultural hamlet	383	15 320	40
Velddrif	fishing settlement	4 188	1 325 000	316
Vredenburg	service centre	18 036	2 801 950*	155
Vredendal	service hamlet	15 641	4 000 000	256
Wittewater	mission station	1 100	No meters	-
Yzerfontein	holiday resort	297	596 580	2 009
Total	-	184 905	36 981 673	-
Average	-	2 982	626 808	205

* Projections for 1993, based on official 1988 statistics. Source: West Coast Peninsula Transitional Council.