MINISTRY OF AGRICULTURE, WATER AND RURAL DEVELOPMENT

DEPARTMENT OF WATER AFFAIRS

REPUBLIC OF NAMIBIA

PERSPECTIVE ON WATER AFFAIRS

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1. INTRODUCTION

The purpose of this document is to provide a broad overview on water affairs in Namibia. Important aspects like the occurrence of water resources, the water demand and supply situation, the establishment of the existing water supply infrastructure as well as the institutions involved in water policy and water supply functions in the country are discussed. The performance of the water sector during the last number of years and the prospects for the future are also reviewed. The major sector objectives, policies and strategies are elaborated upon and subsequent programmes proposed to meet the challenges for the future development of the water schemes necessary to realize the expectations of the nation within the available natural resource, manpower and financial constraints.

2. WATER RESOURCES

2.1 BACKGROUND

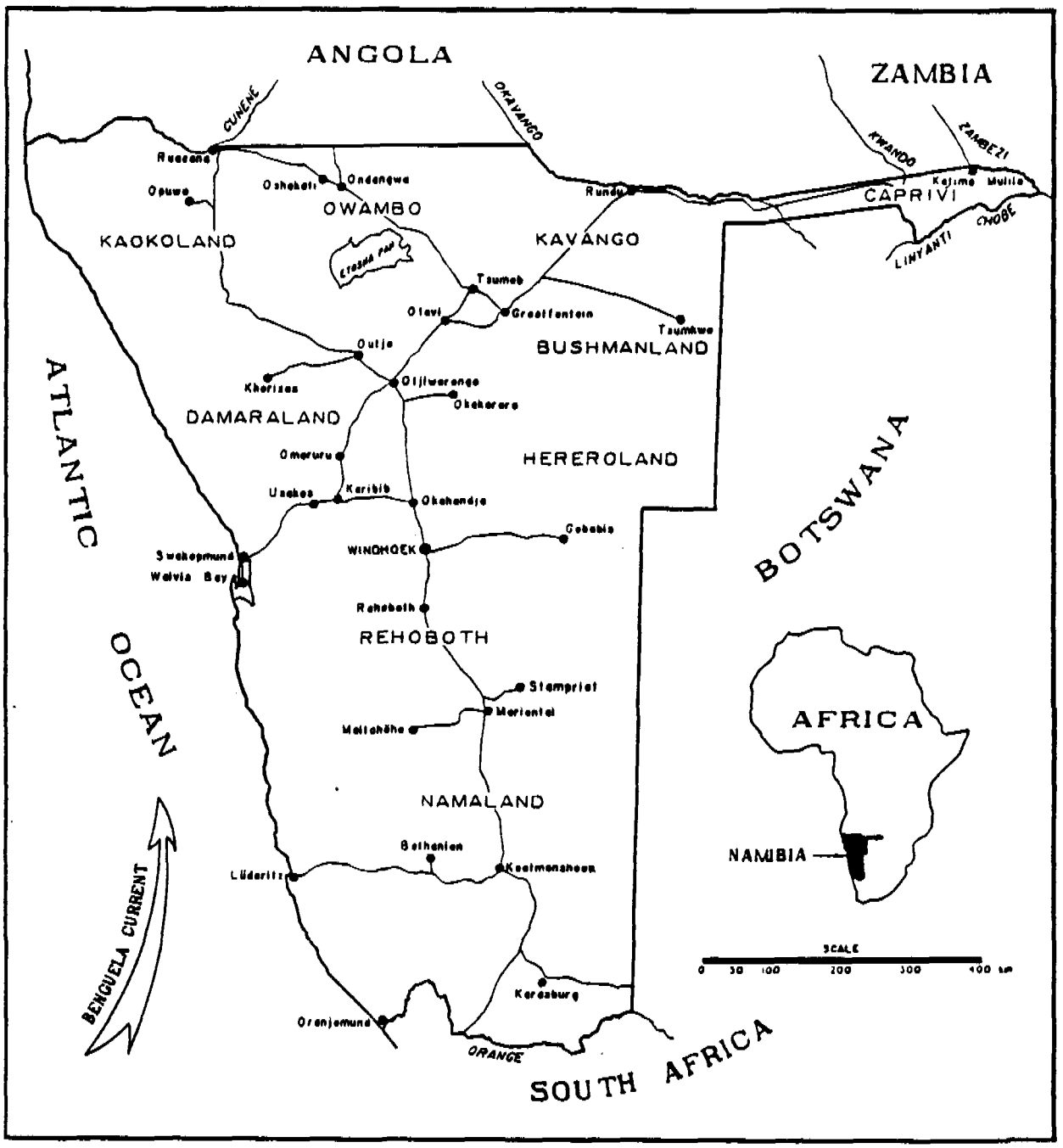
Namibia is situated on the south-western coast of Africa and has the Atlantic Ocean as its western border. Refer to **MAP 1** on page 2 for orientation.

Due to low rainfall and high evaporation Namibia is regarded as an arid region in which the total assured yield of both surface and underground water resources, excluding the perennial border rivers, is estimated at only 500 Mm^3/a. Of this potential about 38% is already being used for human, animal, industrial and agricultural purposes.

Although the increase in the standard of living, socio-economic and mining development, as well as the high average population growth of at least 3% per annum have increased the demand for State supplied water from 37 Mm^3 in 1970 at an average rate of 4,3% per annum to 86 Mm^3 in 1990, it has been estimated from the existing available information that the total annual water consumption in Namibia will continue to increase from an estimated 250 Mm^3 in 1990 to 400 Mm^3 by the year 2005.

The necessity of water supply infrastructure is determined by the demand for water, but the cost of a water supply project is affected by the location and availability of water sources in relation to the potential growth points. The

provision of adequate water supplies is therefore crucial to the sustained socio-economic development of an arid country like Namibia.



MAP 1: ORIENTATION

A sound knowledge of the occurrence of water sources and the judicious planning of new development which might create a specific water demand in a certain area in Namibia, are of vital importance for co-ordination and optimization of effort.

2.2 HYDROLOGY

2.2.1 Climate

The climate is governed by the country's geographic position in the southern tropics and is further influenced by the cold Benguela current. These conditions result in a mean annual rainfall of only 250 mm.

As far as the surface hydrology is concerned, the mean annual rainfall in the country ranges from less than 50 mm in the western region along the coastline to as high as 700 mm in the north-eastern Caprivi. The variability of the precipitation is an informative measure for evaluating the reliability of the expected rainfall and the average deviation in rainfall may be from as high as 80% of the mean annual rainfall in the dry south-western area to as little as 20% in the north-east.

Precipitation occurs mainly during the summer months between November and April by means of very intense, but scattered thunderstorms in the late afternoon and at night.

The potential average annual evaporation (A-pan evaporimeter) varies between 3 700 mm in the central-southern area to 2 600 mm in the north. From this it is evident that in those areas where the rainfall is at a minimum, the evaporation is at a maximum. Refer to **MAP 2** on page 4.

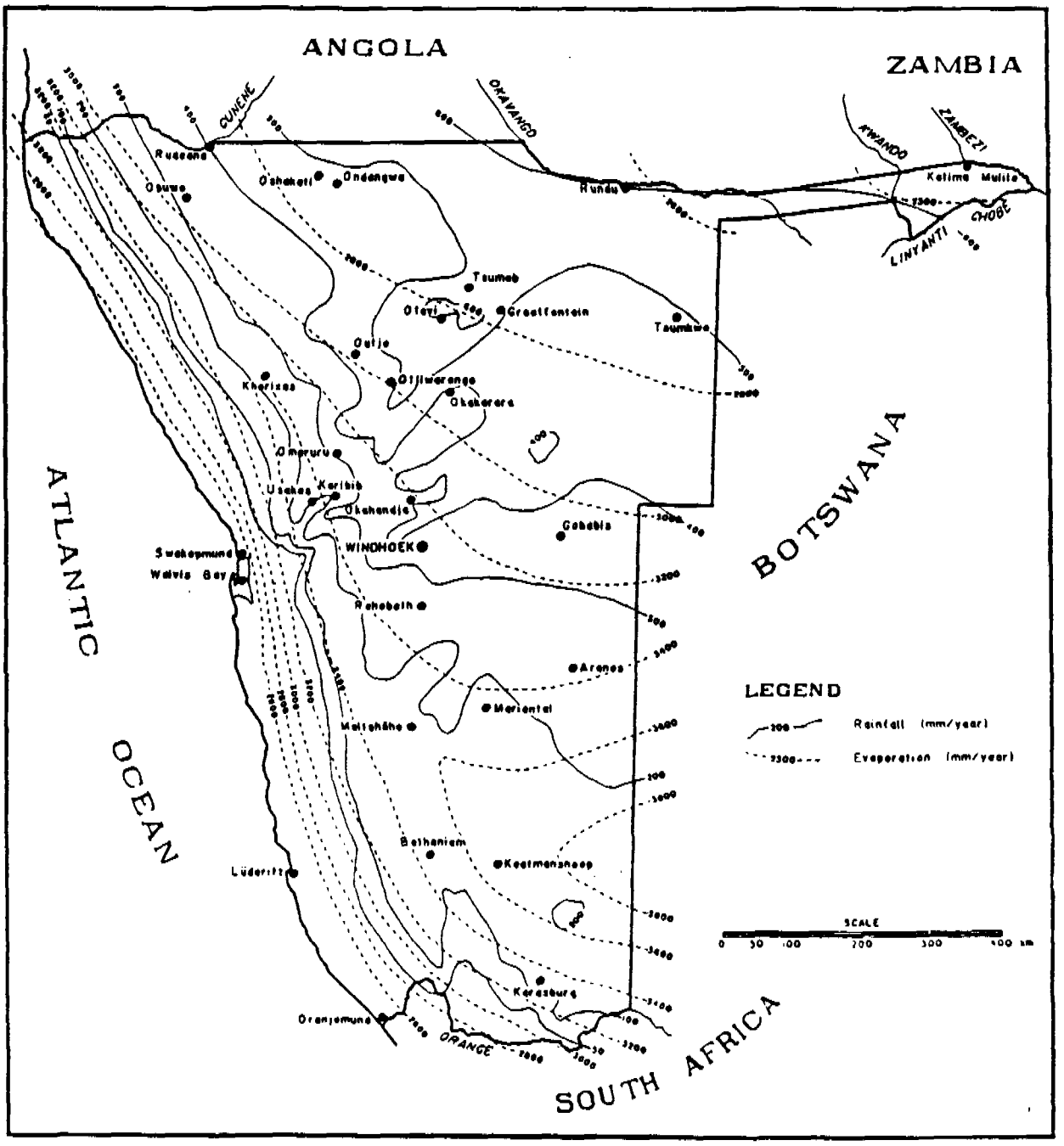
Namibia has an average of 10 hours of sunshine per day and the average daily temperature is 25° C. The absolute maximum and minimum temperatures may, however, vary between -10° C and + 40° C in some areas.

2.2.2 Hydrological Balance

All the climatic extremes contribute to a unique and extreme hydrological cycle in Namibia.

It is estimated that on average 83% of the total rainfall evaporates shortly after precipitation, 17% is available as surface runoff, of which 1% recharges

groundwater sources and 14% is lost through evapotranspiration. Only 2% remains to be harnessed in surface storage facilities. Refer to **FIGURE 1** on page 5.



MAP 2: RAINFALL AND EVAPORATION

2.2.3 Ephemeral Water Sources

Due to the erratic rainfall conditions the flow in the rivers in the interior

of the country is irregular and unreliable. The potential of the surface water sources is therefore very limited. Refer to **MAP 3** on page 7 for orientation on the location of the major ephemeral rivers in Namibia. It is estimated that the safe yield from surface water works which could be developed on these rivers is at least 200 Mm^3/a or 40% of the total water resources available in the interior of the country.

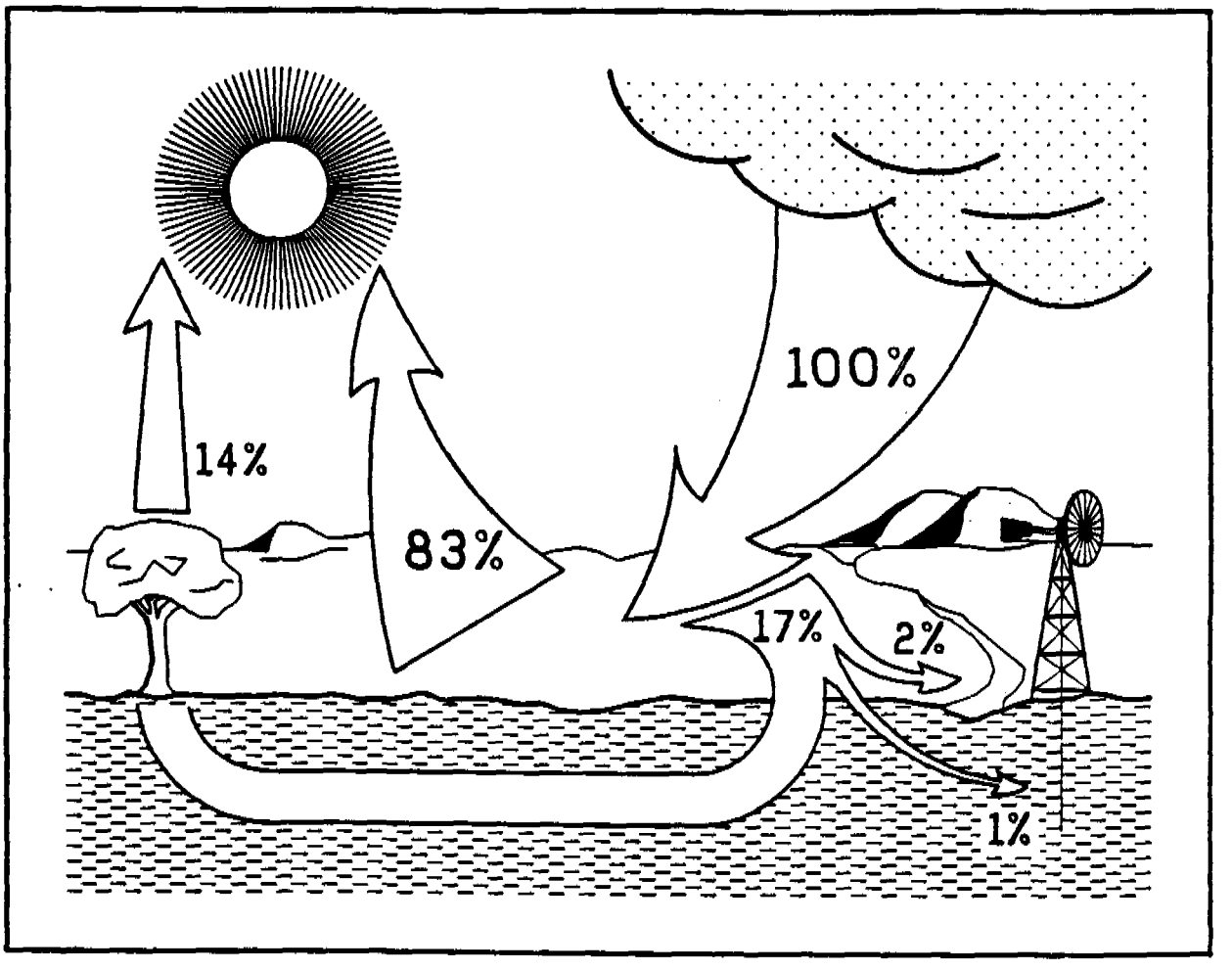


FIGURE 1: WATER BALANCE

Apart from the major dams in the country, it is estimated that more than 10 000 small excavation, earth and concrete dams with storage capacities varying between more than 5000 m^3 and less than 500 000 m^3 have been built to augment drinking water supplies on private farms and the rural regions. The total capacity of these dams are estimated at more than 300 Mm^3, but a

considerable reduction in capacity can be expected due to siltation. The safe yield of these water sources is also difficult to quantify due to their ephemeral nature.

2.2.4 Perennial Water Sources

The only perennial water sources available to Namibia are the Cunene, the Okavango, the Kwando-Linyanti-Chobe and the Zambezi rivers on the northern border and the Orange River on the southern border. However, the utilization of mutual water sources should be agreed upon between basin states and may be done according to the Helsinki rules as a basis for negotiation. At this point in time Namibia has access to an agreed 180 Mm^3/a from the Cunene River and at least 500 Mm^3/a from the Orange River. No formal or informal agreements have been reached on the utilization of water from the Okavango, the Kwando-Linyanti-Chobe or the Zambezi rivers, although it is planned that the Okavango-Grootfontein component of the Eastern National Water Carrier will eventually draw at least 60 Mm^3/a from the Okavango River.

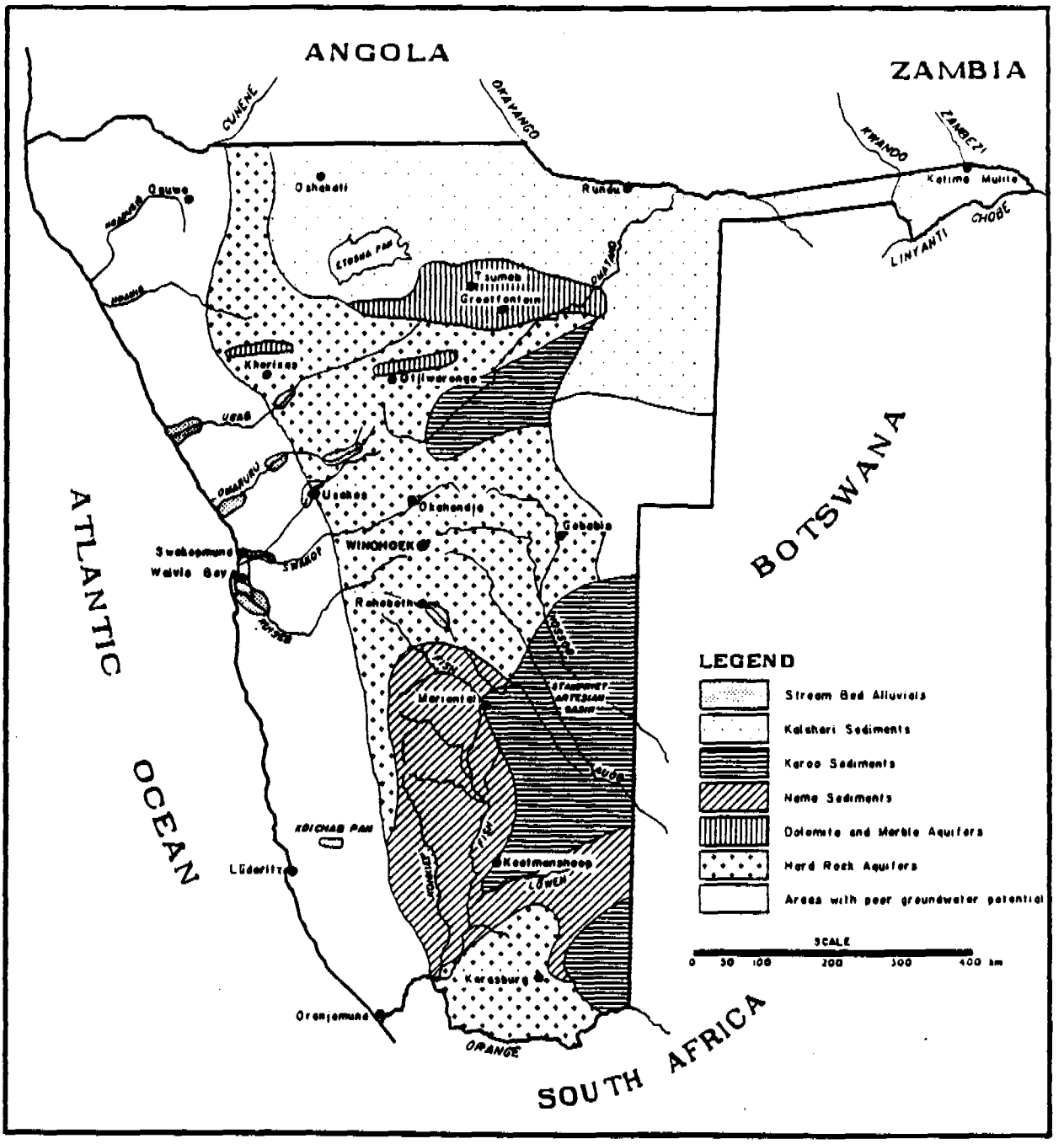
2.3 HYDROGEOLOGY

2.3.1 Background

As far as the hydrogeology in Namibia is concerned it must be made clear that practically all water available as groundwater originates from rainfall, whether precipitation occurred recently or in prehistoric times. The occurrence and recharge of groundwater depends on a combination of sufficient rainfall and favourable hydrogeological conditions. The groundwater sources in Namibia are associated with six major geological environments. Refer to **MAP** 3 on page 7.

2.3.2 Secondary Structures

The largest part of the country is covered by geologically ancient rocks which are inherently impervious. Groundwater is found in secondary structures along joints, bedding planes, shear zones and faults. These structures are abundant in folded areas and occur in practically all pre-Kalahari formations. The majority of stronger boreholes in these rocks are located on faults.



MAP 3: GEOHYDROLOGICAL ENVIRONMENTS

2.3.3 Carbonate Rocks

Carbonate rocks, including marble, limestone and dolomite which generally have solution cavities, can contain fair quantities of groundwater. These cavities

are formed when percolating rainwater dissolves carbonates and thus develop more readily along joints, faults and bedding planes. Good examples of such groundwater sources are found in the marble bands at Otjiwarongo and in the dolomitic Karst area in the Grootfontein-Otavi-Tsumeb triangle.

2.3.4 Volcanic Intrusions

Throughout large parts of Namibia volcanic magma has intruded the older formations in the form of pipes, dykes and sheets. The contacts between these features are frequently water bearing. In the south of the country more than 80% of the successful boreholes outside the artesian area were drilled along dolerite dykes.

2.3.5 Porous Sediments

Water bearing porous sediments are good aquifers and the most important of these aquifers in Namibia are the Auob and Nossob Sandstones of the Karoo Sequence, located in the central south-eastern region where artesian water occurs in the so-called Stampriet Artesian Basin. Two other, smaller artesian aquifers exist in the limestone and sandstone of the Schwarzkalk Subgroup of the Nama Group to the west of Maltahöhe and in the basal gravel beds of the Kalahari sediments in an area to the north-west of Tsumeb.

2.3.6 Unconsolidated to Semi-consolidated Sediments

Unconsolidated to semi-consolidated deposits of aeolian sands and unconsolidated to slightly cemented sediments cover approximately 30% of Namibia. These include the Kalahari beds in the northern and eastern parts of the country, as well as the deposits of the Namib Desert along the West Coast. In areas of adequate rainfall these deposits may contain groundwater.

2.3.7 Stream-bed Alluvials

The stream-bed alluvials or the sand-filled riverbeds are important sources of groundwater since they are periodically recharged by floods. The most important aquifers of this type are in the Kuiseb, Omaruru, Khan and Oanob rivers.

2.3.8 Occurrence of Groundwater

In the stream-bed alluvials the groundwater is mostly close to the surface, while in other environments the depth to the water table varies considerably depending on the quantity of water abstracted, topography, geology and climate of the area, but is on average about 100 m and up to 200 m or more at some locations. The emergence of groundwater as springs is rare.

The safe yield of the existing production boreholes may vary between as little as 0,5 m^3/h for rural communities and farm installations to as high as 120 m^3/h for domestic and industrial water supply schemes. An unsuccessful borehole is considered to be a borehole with a yield not suitable for the purpose for which it had been drilled and nearly 80% of all boreholes fall in this category. More than 80% of the population rely on water supplies from shallow wells or boreholes.

It is estimated that the safe yield of the groundwater sources in the country is at least 300 Mm^3/a or 60% of the total water resources available in the interior of the country.

2.4 WATER RESOURCE POTENTIAL

The potential yield from the different water resources available in Namibia is shown in **TABLE 1**.

TABLE 1: WATER RESOURCES POTENTIAL

SOURCE	POTENTIAL YIELD (Mm^3/a)
Groundwater	300
Dams in ephemeral rivers	200
Perennial sources:	
Okavango River (at Rundu)	5 500
Cunene River (at Ruacana)	5 000
Okavango River (at Mukwe)	10 000
Quando River (at Kongola)	1 300
Zambezi River (at Katima Mulilo)	40 000
Orange River (at Noordoewer)	11 000
WEIGHTED TOTAL	**60 000**

3. WATER DEMAND

3.1 CONSUMERS

There are five main groups of water users in Namibia, each with different demands on the available surface and groundwater sources:

1. Domestic (including rural, urban and industrial demand)
2. Livestock
3. Mining
4. Tourism
5. Irrigation

The estimated total annual water consumption in the various consumer categories during 1990 is shown in **TABLE 2.**

3.2 WATER CONSUMPTION

TABLE 2: TOTAL WATER CONSUMPTION IN 1990

CONSUMER		CONSUMPTION (Mm^3)
Domestic:		70,57
Urban	42,13	
Rural	28,44	
	70,57	
Stock		63,23
Mining		7,7
Tourism		0,8
Irrigation		106,60
TOTAL		**248,90**

The estimated average per capita or unit water consumption for the various consumers is shown in **TABLE 3** on page 11. The domestic water demand in the urban environment includes industrial water while the domestic water demand on commercial farms excludes stock water demand. The difference between the average domestic unit water consumption in the urban environment in the districts and the urban environment in the communal regions in Namibia is due to a higher degree of industrialization and better living standards in the major towns in the districts.

TABLE 3: UNIT WATER CONSUMPTION

AREA	CONSUMER	WATER CONSUMPTION (ℓ/day)
Districts	Domestic urban environment Domestic rural environment	330 85
Regions	Domestic urban environment Domestic rural environment	165 85
Farms	Domestic average	136
Country	Large stock Small stock	45 9

The water requirement for irrigation is determined by many factors, but an average of 15 000 m^3/ha/a is assumed for the estimated 7 000 ha presently under irrigation in Namibia. Refer to **TABLE 4**.

TABLE 4: AREA UNDER IRRIGATION

REGION	AREA (ha)
Stock farms	2 150
Orange River	1 800
Fish River (at Hardap)	1 500
Okavango River	700
Auob River (Stampriet Artesian Basin)	350
Grootfontein/Tsumeb/Otavi valley	260
Caprivi	100
Omaruru River	60
Damaraland	60
Kaokoland	60
Owambo	10
	10
TOTAL	**7 000**

3.3 ESTIMATED WATER DEMAND

The estimated future water demand of a developing country like Namibia during the next 15 years between 1991 and 2006 will depend largely on the success of the socio-economic, industrial and agricultural development policy of the Government. Substantial growth may result in the various sectors like agriculture, mining and industry or as a result of projects for the social upliftment of the population.

However, it is assumed that the average population increase would be 3% per annum to make provision for increased health care, family planning and the turnover in skilled expatriates. The effect of industrialization and an improvement in the standard of living may also contribute an additional annual increase of 0,7% in the domestic water demand.

The expected increase in stock drinking would probably not be more than 1% per annum and would therefore only result in a very small increase in water demand. The reason for this is the limitation on stock numbers due to the grazing capacity of the land and the expected cyclic drought conditions.

The increase in mining water demand will be determined by the rate at which new mines are developed and it has been assumed that at least three small mines with a water consumption of 2 Mm^3/a and two mines with a water consumption of 5 Mm^3/a would come into operation during the next 15 years.

Irrigation may have the largest impact on the future water consumption in Namibia, depending on the development of new, viable irrigation projects. The irrigability of the soils in Namibia has been determined on a broad basis and the classification in **TABLE 5** gives an indication of what soil types and areas may be available for further investigation when feasibility studies for specific projects have to be done.

TABLE 5: IRRIGABILITY OF SOILS

CLASSIFICATION	AREA (ha)	%
Highly Suitable	940 000	1,1
Suitable	2 660 000	3,2
Marginal	12 580 000	15,3
Unsuitable	66 250 000	80,4
TOTAL	**82 430 000**	**100,00**

From the above it is clear that due to the arid nature of the climate in Namibia, the soils are poor and more than 80% of the land is unsuitable for irrigation. Although less than 5% of the land area seems to be suitable for irrigation, it is assumed that at least an additional 5 000 ha of land would be brought under irrigation during the next 15 years. However, most of the water required for this purpose would have to be supplied from the perennial border rivers.

The tourism industry will also contribute to an increase in water demand, although it would be very small.

Please refer to **TABLE 6** for the estimated future water demand in Namibia.

TABLE 6: ESTIMATED FUTURE WATER DEMAND

CONSUMER	CONSUMPTION (Mm^3)			
	1990	1995	2000	2005
Domestic	67	81	95	115
Stock	64	67	70	75
Mining	12	15	25	30
Tourism	1	2	3	5
Irrigation	106	130	147	175
TOTAL	**250**	**295**	**340**	**400**

3.4 UTILIZATION OF WATER RESOURCES

From the previous discussions it follows that the water resources in Namibia can be divided into three major categories, namely perennial surface water, ephemeral surface water and groundwater. Refer to **TABLE 7** for information on the existing utilization of the available water resources.

TABLE 7: UTILIZATION OF WATER RESOURCES IN 1990

SOURCE	DEMAND ON SOURCES (Mm^3/a)	%
Perennial surface	58,05	23
Ephemeral surface	50,17	20
Groundwater	141,47	57
TOTAL	**249,79**	**100**

The information in **TABLE 7** shows that 43% of the water demand in Namibia is supplied from surface water sources and 57% from groundwater sources. This distribution may change drastically if more projects are developed to utilize the perennial water sources.

The estimated future water demand of the various consumers on each of the available categories of water resources is illustrated in **TABLE 8** on page 14.

TABLE 8: ESTIMATED CONSUMER DEMAND ON THE WATER RESOURCES

CONSUMER	DEMAND ON WATER RESOURCES (Mm^3)							
	PERENNIAL RIVERS		EPHEMERAL SURFACE		GROUNDWATER		TOTAL	
	1990	2005	1990	2005	1990	2005	1990	2005
Domestic	12,6	40	13,4	30	41,0	45	67	115
Stock	3,7	10	*	*	60,3	65	64	75
Mining	2	10	2,5	10	7,5	10	12	30
Tourism	-	2	0,3	1	0,7	2	1	5
Irrigation	39,7	95	33,8	50	31,5	30	106	175
TOTAL	**58**	**157**	**51**	**91**	**141**	**152**	**250**	**400**

* Very limited quantities of stock water are supplied from dams and the water has been incorporated in the demand on groundwater.

From **TABLE 8** it is clear that only 49% of the total estimated ephemeral surface and groundwater sources (500 Mm^3/a) will be utilized by the year 2005, but is is expected that the demand on the perennial water sources will increase by 270% during the same period.

4. INSTITUTIONS

4.1 BACKGROUND

Prior to the independence of Namibia, the supply of water in Namibia had been the responsibility of a number of authorities in the public sector, while the private sector also made a substantial contribution. There were four major water supply groups:

1 The Department of Water Affairs
2 The regional authorities
3 The local authorities
4 Private bodies

4.2 THE DEPARTMENT OF WATER AFFAIRS

Water resources policy is the portfolio responsibility of the Ministry of Agriculture, Water and Rural Development.

Within the Ministry the Department of Water Affairs is a central Government department whose objectives and functions are regulated by the Water Act (Act 54 of 1956) as amended and still applicable in the country. The Department is primarily responsible for exercising control over the conservation and utilization of the natural water resources in Namibia. The Act also provides for an Advisory Water Board which must advise the Minister on matters concerning the protection and utilization of water resources as well as the equitable distribution of water between different consumer group requirements in the country.

The chief executive official in the Department of Water Affairs is the Deputy Permanent Secretary for Water Affairs, who also acts as the Chairman of the Advisory Water Board. The Secretary is assisted by four Directors and thirteen Divisional Heads as is shown on the organisation diagram in **FIGURE 2** on page 16.

The various directorates are responsible for general administration, investigation into the occurrence of water resources, establishment of water schemes and supply of water in bulk to consumers. Each directorate has a number of functions and is divided into divisions which are responsible for the execution of those functions.

In order to provide in the growing water demand, the Department is actively engaged in the short, medium and long term planning of water projects in the interest of the nation as a whole. The timeous establishment of major water supply schemes for cities, towns, planned growth points and mines to cater for the domestic, industrial and agricultural water needs in the country takes place according to national and regional water plans.

The Department of Water Affairs is, through the National Planning Commission and the Ministry of Finance, responsible for the establishment of major state water projects. Bulk water is supplied in terms of water supply agreements.

The functions of the Department include the levy of bulk water tariffs, the disinfection of the water supplied, the provision of bulk water storage facilities where necessary and appropriate, as well as the control over the bacteriological and chemical quality of the water supplied.

The Department issues permits for the establishment, operation and maintenance of sewage and industrial effluent disposal works.

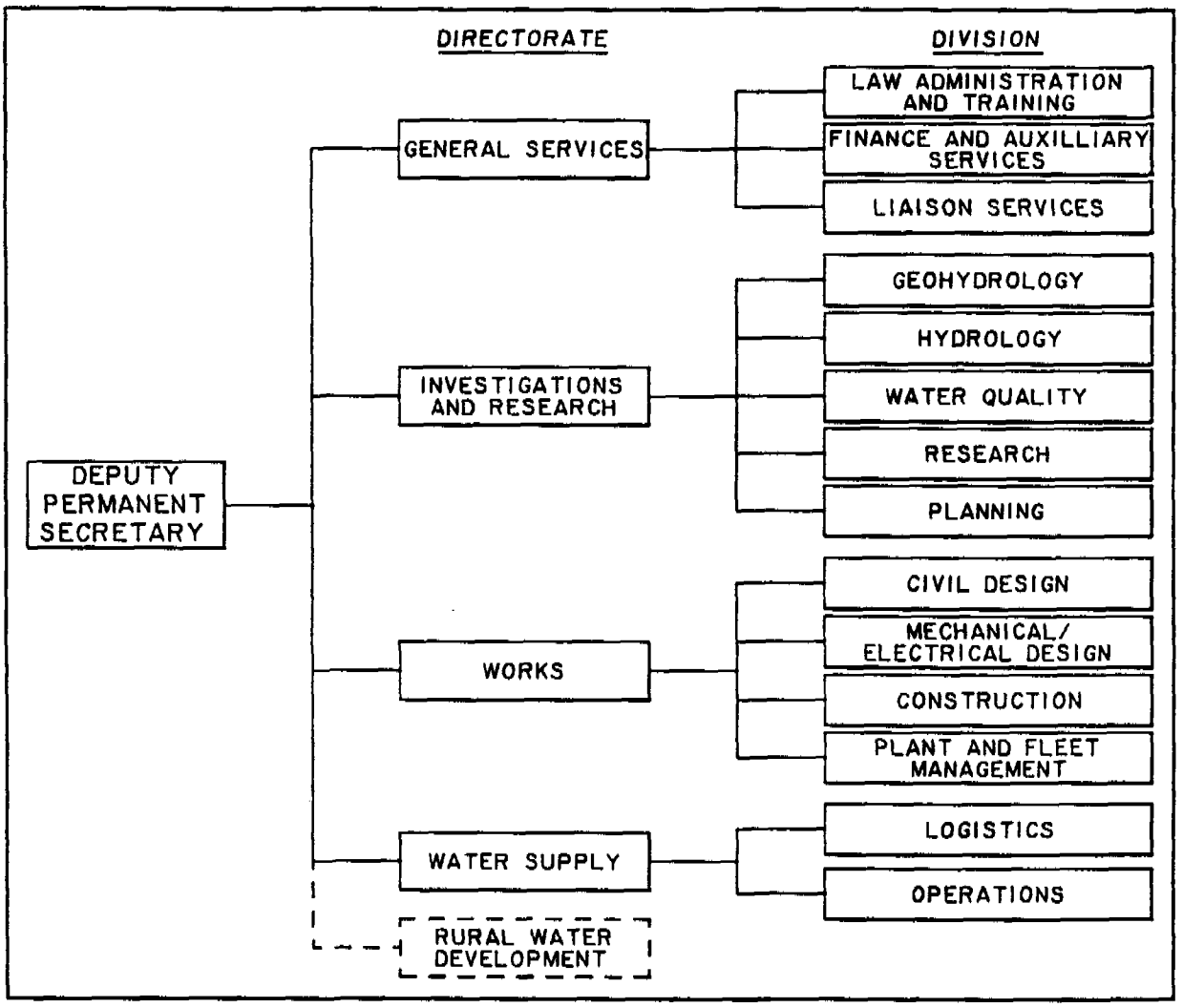


FIGURE 2: ORGANISATION DIAGRAM OF THE DEPARTMENT OF WATER AFFAIRS

4.3 REGIONAL AUTHORITIES

The now defunct regional authorities provided water for domestic and stock watering purposes on communal land, and also supplied water to the small

communities at rural settlements which are not considered to be planned growth points. These responsibilities have now reverted to the different Ministries involved.

In cases where the Department of Water Affairs supplied water in bulk to a regional authority, the authority had been responsible for the distribution of the water to stock farms, for other agricultural purposes like irrigation and for the reticulation of water in settlements. They also undertook the reticulation of water in urban centres on behalf of the now defunct Department of Governmental Affairs. These authorities normally relied on the Department of Water Affairs for water storage facilities, pressure in reticulation systems and the disinfection of water, although it had been considered their responsibility.

The old regional authorities paid the tariffs levied for bulk water supplied to them by the State and were encouraged to charge individual consumers for the water used. They were also responsible for sewage works and the disposal of industrial effluent in terms of permits issued by the Department of Water Affairs.

4.4 LOCAL AUTHORITIES

The formal local authorities or municipalities can be divided into two groups. There are those that buy water in bulk from State water supply schemes and a few that still supply their own water. Some examples of the latter are Tsumeb, Grootfontein, Omaruru and Outjo.

In most cases the Department undertakes the responsibility for the bulk storage of water where necessary, the provision of pressure in the reticulation systems and the disinfection of the water. In some cases this is done by the local authorities, but they are specifically responsible for the reticulation of water, the provision of sewage works and the disposal of industrial effluent in terms of permits issued by the Department of Water Affairs.

The local authorities pay the tariffs levied for bulk water supplied to them by the State and charge individual consumers for water reticulated to them.

4.5 PRIVATE BODIES

Private individuals or organisations supply water in relatively small quantities for domestic use, stock watering and irrigation to farms, game ranches, small mines and even on communal land at mission stations in particular.

The First National Development Corporation supplies large quantities of water for irrigation in the Kavango and the Caprivi.

In all these cases the establishment of the water supply schemes was financed by the specific private bodies themselves and in some cases they may have been assisted by the State to locate and site boreholes at a subsidized cost.

5. HEALTH AND ENVIRONMENTAL ASPECTS

5.1 WATER QUALITY

The water in the major surface storage dams in Namibia is generally of excellent quality, with the total dissolved solids ranging between 80 and 800 mg/ℓ. The water requires only clarification and disinfection to render it suitable for human consumption.

The chemical quality of groundwater is determined by the abundance of rainfall, the topography and the chemical composition of the geological formations through which the groundwater percolates before it accumulates in an aquifer. The groundwater in arid regions tends to contain concentrations of dissolved salts which may be unhealthy for humans and animals. The corrosive quality of such water may also cause damage to water supply equipment.

5.2 POTABILITY OF WATER

The more important criteria for the potability of groundwater for human or stock consumption are the concentration of total dissolved solids, nitrates, fluorides, sulphates and total hardness. The groundwater sources of the

country have been systematically analysed and a comprehensive set of maps showing the quality of groundwater in terms of the above-mentioned criteria has been prepared.

The chemical and physical guidelines for drinking water in Namibia are based on the guidelines of the World Health Organisation (WHO) as well as on results of local research and experience. The approved guidelines have been adjusted, within proven safe health margins, to suit local conditions and to avoid costly water treatment facilities, particularly for small, local water schemes serving rural communities. Refer to **TABLE 9** for some of the more important determinants of the approved Namibian drinking water quality guidelines.

TABLE 9: SOME DETERMINANTS OF THE NAMIBIAN DRINKING WATER GUIDELINES

DETERMINANT	UNIT	LIMITS			
		GROUP A	GROUP B	GROUP C	GROUP D
		EXCELLENT	GOOD	LOW HEALTH RISK	HIGHER HEALTH RISK
Conductivity	mS/m	150	300	400	> 400
Sulphate	mg/ℓ SO_4	200	600	1 200	>1 200
Nitrate	mg/ℓ N	10	20	40	> 40
Fluoride	mg/ℓ F	1,5	2,0	3,0	> 3,0

It is the objective of the Department of Water Affairs to supply water with a chemical quality equivalent to a Group A water, but if not possible, to supply water with a minimum requirement of at least a Group B water.

The microbiological guideline values for drinking water in Namibia are based on those of the World Health Organization. Water supplied by State water works is sampled regularly to determine chemical and bacteriological quality. Local distribution networks are also monitored to verify bacteriological quality.

5.3 WASTE WATER

5.3.1 Sanitation

The provision of sanitation facilities and the management of sewage the responsibility of the rural authorities, local authorities and private bodies

or individuals, depending on their areas of responsibily. Health and education authorities at national and regional levels were also responsible for extension services on the creation of sanitation facilities for rural communities and advising the people on the health hazards of unhygienic conditions.

5.3.2 Effluent Control

The Department of Water Affairs does not operate sewage or effluent disposal works, but is responsible for control over effluent discharge and water pollution. Regular inspections take place at some 1563 institutions who have been issued with effluent discharge permits.

5.4 ENVIRONMENTAL MATTERS

Environmental management programmes based on proper environmental impact assessments is also a commitment of the Department to identify problems, to avoid unnecessary conflict between development and conservation requirements as well as to ensure well balanced water infrastructure development.

6. PERFORMANCE AND PROGRESS IN THE WATER SECTOR

6.1 HISTORICAL BACKGROUND

6.1.1 General

In the recent past there was no national development plan which directed water resource development objectives, programming, funding and execution as part of a national development strategy. However, the best means available at the time were utilized and substantial progress was made in the field of water resource investigations, feasibility studies and master water planning, water scheme development, water supply organisation, water tariff policy, research and other water related aspects.

It is therefore not possible to judge progress against a national development programme, but due to the fact that the new dispensation must take the initiative to expand on past achievements, it would serve a useful purpose to

look at the historical background of water development in Namibia.

The historical development of the water sector in Namibia can be divided into 7 phases relating to the political and administrative situation that existed during the past 107 years since 1884. Refer to **TABLE 10.**

TABLE 10: HISTORICAL PHASES IN THE WATER DEVELOPMENT ADMINISTRATION IN NAMIBIA

PHASE	PERIOD
Pre-colonial	Up to 1884
German colonial	1885 - 1915
Military Administration	1915 - 1920
South West Africa Administration	1921 - 1969
Re-organisation	1969 - 1980
Government Service	1980 - 1990
Independence	1990 -

6.1.2 Pre-colonial Period

The first people who migrated to Namibia were nomadic hunters and stock farmers. These people never placed a burden on the natural ability of the available water resources by using advanced technology to abstract water in large quantities to supply in their needs because they obtained water from springs, shallow wells (up to 8 metres deep) in the beds of ephemeral rivers and surface water sources for as long as they yielded water. Whenever the water dried up, the population migrated to other locations where grazing and water were available, or they perished in the severe droughts which occur periodically in Namibia.

6.1.3 German Colonial Period

Namibia became a protectorate of the German Empire in 1884 and soon afterwards momentum was given to the development of agriculture, mining and infrastructure such as railways, roads and water schemes.

The early pioneers and settlers also had to rely on water which occurred naturally. As the population grew and development progressed, farms and towns were established on a permanent basis. It soon became apparent that more reliable and assured water supplies were required to support this development.

Wells were dug deeper and shallow boreholes were drilled with primitive equipment.

The German Government realised the importance of water development in Namibia and civil engineer Dr T Rehbock, who was commissioned in October 1896 to investigate the occurrence, availability and utilization of water resources in Namibia, produced a report in this regard by 1898. He also distributed the first raingauges to farmers in 1897 and evaluated the potential of six large dams albeit with very little hydrological data to substantiate their practical and economical viability.

By 1891 the first samples from water sources in Namibia were analyzed and in 1899 the first bacteriological examination of a water source was carried out. In 1903 the first drilling machine arrived in Namibia and by 1906 two drilling teams, one for the north and one for the south, were formed under the supervision and control of Dr Lotz, a government geologist, to centralize and conduct the search for groundwater on an organized basis.

Various reports on the availability of water resources and proposals for their development were published between 1897 and 1914. Important contributions were made by people like Herrmann, Kuhn, Range, Rehbock, Steiner and Von Zwergern (the father of sand storage dams in Namibia). In February 1909 the foundation for an organisation to investigate and develop the water resources in Namibia on a scientific basis was laid by a decision taken to that effect at an Agricultural Conference in Berlin. At that time the farming community was already assisting with the gathering of information on rainfall, runoff and evaporation. Their co-operation enabled Prof Dr F Jaeger, a geographer from Germany, to compile the first water register for the country in 1913. By that time the advice given by the German Government officials also enabled farmers to construct a substantial number of boreholes and farm dams in the country.

6.1.4 Military Administration Period

In July 1915 Namibia was occupied by the Union of South Africa and remained under a Military Administration until December 1920. During this intermediate period military engineers advised on drilling work and the construction of

farm dams. One of the largest farm dams at that time, the Voigtsgrund Dam in the Tsub River on the farm of Albert Voigts, was also completed in 1917 and is still in use today to irrigate some 15 ha of arable land. After the country had been declared a Class C Mandate by the League of Nations on 17 December 1920, it was entrusted for further administration to the Union of South Africa.

6.1.5 South West Africa Administration Period

In 1921 a new Administration for the Territory of South West Africa was formed and provision made for an Irrigation Department directed by a "Boring Engineer" who was in fact a senior boring inspector, Mr J Traas. His task was to organize the drilling of boreholes for stock watering and irrigation purposes. The Irrigation Department comprised a head office and branches for stores, meteorological services, a workshop, transport and fieldwork (drilling). The original staff complement was 30, mostly boring inspectors and drillers. The efforts of the drilling engineer to plug underground leaking boreholes in the Stampriet Artesian Basin was one of the first major projects and of particular importance because it contributed to the conservation of that important water resource. The Irrigation Department can therefore be seen as the forerunner of the present Department of Water Affairs.

In 1928 the Department of Works was formed. This Department incorporated the Irrigation Department and consisted of a number of sections, viz. Dams and Irrigation, Public Works and Roads. The Dams and Irrigation section included subsections for Meteorology and Drilling. At that time the Department of Works was the best staffed and equipped in the Administration to perform its duties.

On 1 May 1927 a very capable dam engineer, Martin Kindinger, was appointed as dam expert in the Irrigation Department to plan and supervise farm dam building activities in the country. The first Director of the Works Division was Mr Daniël Holtzhausen. Robbie Truter, later professor in civil engineering at the University of Stellenbosch in the Republic of South Africa (RSA), was appointed in 1929 as regional engineer and was involved in the construction of the Omatjenne Dam at Otjiwarongo as resident engineer.

Due to the Depression in the early thirties the Works Division lost all its engineering staff with only the Director remaining by 1937. In 1938 Dr Otto Wipplinger, who also later became professor in civil engineering at the University of Stellenbosch in the RSA, was appointed and continued to run the Dams and Irrigation Section in the Works Department. Prior to, and during the Second World War it was virtually impossible to recruit new engineering staff, but after the war Dr Wiplinger recommended the appointment of technical people like engineer H W Stengel (1946), geologists H Martin and H Korn, followed by engineers W Burchard and A Korte in 1948 and 1953 respectively. However, by 1957 the magnitude of work to develop water sources in the country had grown to such an extent that a separate Water Affairs Department was formed. Dr Wipplinger became the Director and this organization which was further strengthened by the appointment of additional engineers like S Burger, J Jordaan, F Kuchling, R Myburgh, M Schmidt and B Sinske as well as water chemist P Hamman. These people made important contributions towards the development of water affairs in Namibia.

In the period between 1920 and 1969 water resource development centred around assistance with borehole drilling and the establishment of small farm dams for stock drinking, the construction of ten gauging station in eight major rivers, the measurement of river flows (since 1940) and the determination of the silt load of the runoff in the rivers, the securing of access to the Cunene River at Erikson's Drift (Site of the Calueque Dam) and the preparation for the Ruacana Hydropower Project through the First and Second Border Agreements between the Union of South Africa and Portugal in 1926 and 1956 respectively, the evaluation of a large number of dam project proposals in view of the availability of better hydrological data and an energetic dam building programme by utilizing labour intensive methods to construct relatively small, but significant excavation, earth and concrete dams. Refer to **TABLE 11** on page 25 for a list of the more important dams completed up to 1969.

Attention was also given to water legislation measures through the Artesian Water Proclamation (1921), the promulgation of Water Ordinance No 13 of 1932, the Artesian Water Control Ordinance No 35 of 1955, the Water Act (Act 54 of 1956) and the Water Amendment Ordinance No 18 of 1968.

After the second World War a Territorial Development Fund was initiated to

provide financial support for development projects and facilitated the expansion of water resource investigation. In 1948 a Commission was appointed to recommend a long term policy for agricultural development. The importance of an integrated soil and water conservation policy was recognized and a Soil Conservation Board was established. This Board made a substantial contribution to co-ordinate the technical planning and development of agricultural water supply works and to provide the necessary assistance with the funding of farm dams and boreholes.

TABLE 11: DAM CONSTRUCTION BETWEEN 1926 AND 1968

NAME OF DAM	LOCATION	COMPLETION DATE
Augeikas	Daan Viljoen Game Park	1933
Avis	Windhoek	1933
Omatjenne	Otjiwarongo	1933
Van Rhijn	Keetmanshoop	1952
Daan Viljoen	Gobabis	1957
Goreangab	Windhoek	1959
Bondels	Karasburg	1960
Hardap	Marientaal	1962

In 1962 a Commission of Enquiry into South West Africa Affairs was appointed by the Republic of South Africa to provide guidelines for socio-economic development in Namibia. As a direct result of the hydrological research done and the experience gained in the planning, design and construction of water projects, the Water Affairs Department in the Administration was in an excellent position to advise the Commission on proposals for future water infrastructure development in the country. Some of the very important recommendations made on water projects were the continuation of the expansion of the Owamboland Regional Water Scheme by utilizing water from the Cunene River, the Naute Dam in the Löwen River near Keetmanshoop, the Ruacana Hydro-electric Power Scheme and the Calueque Dam for the diversion of Cunene water into Owambo, the Von Bach Dam at Okahandja, the Swakoppoort and Omatako dams, the pumping of water from the Okavango River into the interior of the country as well the extension of water points for domestic and stock water consumption in the remote rural areas. Many of these projects have been implemented and the resulting water supply infrastructure not only ensured the development and incorporation of reliable water resources, but reduced the risk of failure to supply in the estimated future bulk water demand of a growing nation.

6.1.6 Re-organization Period

In 1969 the Administration for South West Africa was re-organised and the Water Affairs Department was incorporated as a Directorate of the Department of Water Affairs in the Republic of South Africa. This move greatly increased the resources of the former Water Affairs Department in Namibia. It gave impetus to the development of a long term water supply strategy and the more rapid establishment of State water schemes. By 1974 a Master Water Plan for Namibia was approved. Several major dams and large groundwater supply projects were completed. The more important dams were Von Bach (1970), Naute (1971), Friedenau (1972), Dreihuk (1977), Swakoppoort (1979). Refer to **TABLE 15** on page 33. The significant piped groundwater and surface water schemes completed were the Central Namib Regional State Water Scheme (RSWS), the Owambo RSWS, the Otjituuo-Okakarara RSWS, the Swakoppoort-Windhoek RSWS and the upgrading of several water supply schemes to places like Gobabis, Karibib, Katima Mulilo, Khorixas, Opuwo, Rehoboth, Rundu, Usakos, as well as Erwee, Anker and Anichab in Damaraland. The construction of the first phase of the Eastern National Water Carrier also started during this period.

6.1.7 Government Service Period

On 1 July 1980 the Department of Water Affairs was weaned from its mother Department in the Republic of South Africa and became a separate and independent department in the then Government Service of Namibia. The Department was re-organised to facilitate the execution of the functions required to ensure the judicious and effective development of the water supply infrastructure in Namibia. In the decade between 1980 and 1990 the Department expanded its investigations and research activities, improved and extended existing water sehemes, established a number of additional water supply schemes to places like the Navachab Gold Mine near Karibib, Gibeon in Namaland, Kahenge and Kayengona in the Kavango, Linyanti in the Caprivi, Tsumkwe in Bushmanland, Epukiro and Talismanis in Hereroland, the Karstland Boreholes RSWS, the 260 kilometre Grootfontein-Omakato canal and major dams like Omatako (1983), Otjivero (1986) and Oanob (1990) (See **TABLE 15**), as well as an efficient water supply operation and maintenance organization. More detail on the activities of the Department of Water Affairs during the decade prior to Independence will be provided in the rest of this document.

6.1.8 Independence Period

On 21 March 1990 the new Government of the Republic of Namibia instituted the Ministry of Agriculture, Fisheries, Water and Rural Development in which the previous Department of Water Affairs was incorporated as the Department of Fisheries and Water with a Permanent Secretary as executive officer. Further institutional adjustment took place when the Fisheries Sector was incorporated in the newly formed Ministry of Fisheries and Marine Resources with effect from 19 February 1991. The Department of Water Affairs remained in the renamed Ministry of Agriculture, Water and Rural Development. Also refer to **TABLE 12** for a list of the most important executive officers involved with water affairs in Namibia since 1920.

TABLE 12: PAST EXECUTIVE OFFICERS IN WATER AFFAIRS IN NAMIBIA

NAME	TITLE	PERIOD
Mr J Traas	Senior Boring Inspector	01/01/1921 - 30/04/1927
Martin Kindinger	Irrigation Engineer	01/05/1927 - 31/08/1932
Daniël Holtzhausen	Director: Works	01/05/1928 - 31/12/1950
Dr Otto Wipplinger	Director: Water Affairs	01/01/1951 - 31/01/1967
Robert Myburgh	Director: Water Affairs	01/02/1967 - 31/12/1971
Charles Truebody	Director: Water Affairs	01/01/1972 - 30/11/1980
Jan Jordaan	Secretary: Water Affairs	01/12/1980 - 31/12/1987
Pedro Maritz	Secretary: Water Affairs	01/01/1987 - 31/03/1990
Calle Schlettwein	Permanent Secretary: Fisheries and Water	01/04/1990 - 18/02/1991
Pedro Maritz	Acting Permanent Secretary: Water Affairs	19/02/1991 -

6.3 WATER RESOURCE INVESTIGATIONS

Water resource investigations are mainly directed at gathering hydrological and hydrogeological information.

In the field of hydrology the required data on rainfall, evaporation, temperature, dam water levels, the silt load in flood waters and river flow is collected at a gauging station network throughout the country. The improvement and status of the gauging network during the past twenty years is shown at five year intervals in **TABLE 13** on page 28.

Although the full surface water potential of all the ephemeral rivers in Namibia has not yet been determined, much is known about the hydrology of the

major rivers like the Swakop, Omatako, Nossob, Oanob, Huarusib, Hoanib, Ugab, Omaruru, Kuiseb and the Fish.

TABLE 13: GAUGING STATION NETWORK

STATION TYPE	FINANCIAL YEAR				
	69/70	74/75	79/80	84/85	89/90
River flow recording	32	53	107	90	97
Artificial flow recording	0	0	0	2	7
Dam level recording	3	10	12	18	22
Evaporation and rain recording	0	9	10	11	9
Rain recording only	0	0	13	28	29
Recording Stations	**35**	**72**	**142**	**149**	**164**
River gauge plate	4	16	30	41	55
Artificial flow scale	0	0	0	1	2
Dam level gauge plate	3	3	3	8	6
Reading Stations	7	19	33	50	63
TOTAL STATIONS	**42**	**91**	**175**	**199**	**227**

In 1987 the Department started to produce an annual hydrological review for Namibia and the first Hydrological Review covered the 1986/87 rainy season.

The determination of the runoff potential in the ephemeral rivers at various locations for existing and possible new dams receives continuous attention while the monitoring of dam water levels and the annual depletion analysis of the major surface water works are important major tasks which facilitate the judicious management of the water sources in the country.

However, from the hydrological information available it is evident that the potential for major surface water storage works on the Omatako, Nossob, Swakop, Oanob and Löwen Rivers has been exhausted. Some potential remains to be utilized in the Huarusib, Hoanib, Ugab, Omaruru, Kuiseb and Fish Rivers. Of these rivers, the Fish River basin has the largest potential, estimated at 160 Mm^3/a of which 50 Mm^3/a has been developed at the Hardap Dam.

Some of the most important hydrological work done during the past five years was the re-evaluation of the flood risks at most of the major dams like Naute, Hardap, Swakoppoort, Omatako and Von Bach.

Other important hydrological work of a specialized nature include the Omaruru Delta groundwater recharge enhancement investigation, the determination of water releases required from the Oanob Dam for ecological purposes, the quantification of surplus water available from State dams for irrigation and the integrated system analysis for the Eastern National Water Carrier.

In the past the departmental investigations into the groundwater resources of Namibia had been directed at the location of water for the establishment of bulk water supply schemes or for the extension of existing water schemes. Refer to **FIGURE 3** for an indication of the drilling work done over the past ten years by the Department.

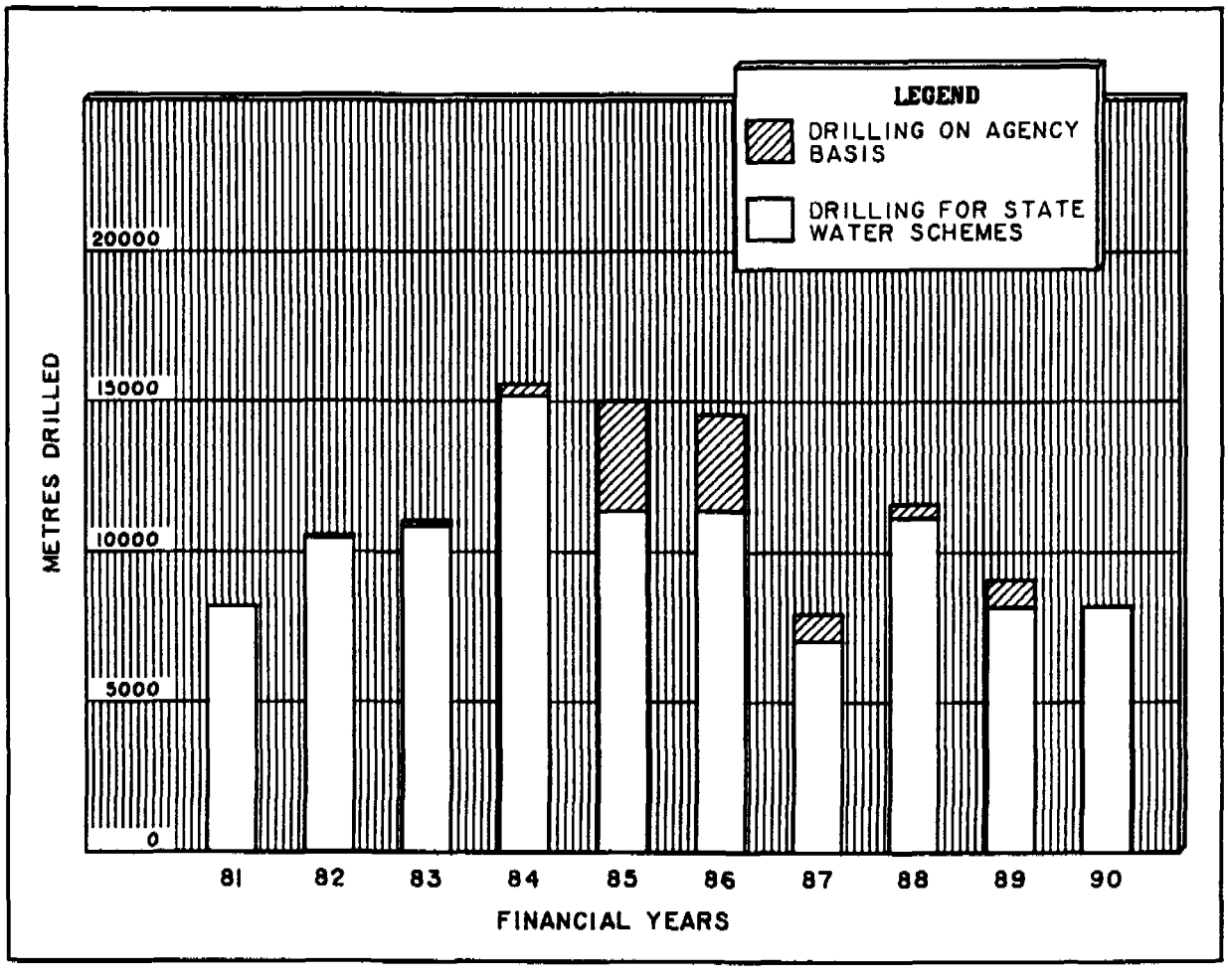


FIGURE 3: DRILLING ACTIVITIES

At certain times during the past, when drilling capacity was available, agency drilling work was also done for other Government institutions. All production

boreholes are usually subjected to pumptests in order to determine their long term safe yield.

Due to incentives like the provision of subsidies for drilling work on commercial farms and free borehole water quality analyses for farmers and other institutions, it was possible to obtain valuable hydrogeological information from all over the country. This information is not only stored in a borehole data bank, but assisted the Department to compile a comprehensive picture of the general hydrogeological potential of the country and provides a wealth of data which is available to all practising hydrogeologists in Namibia.

More than 130 000 boreholes have been drilled in Namibia in the search for water and due to the poor hydrogeological conditions, only approximately 32 000 boreholes are at present utilized for water supply purposes. Refer to **TABLE 14**.

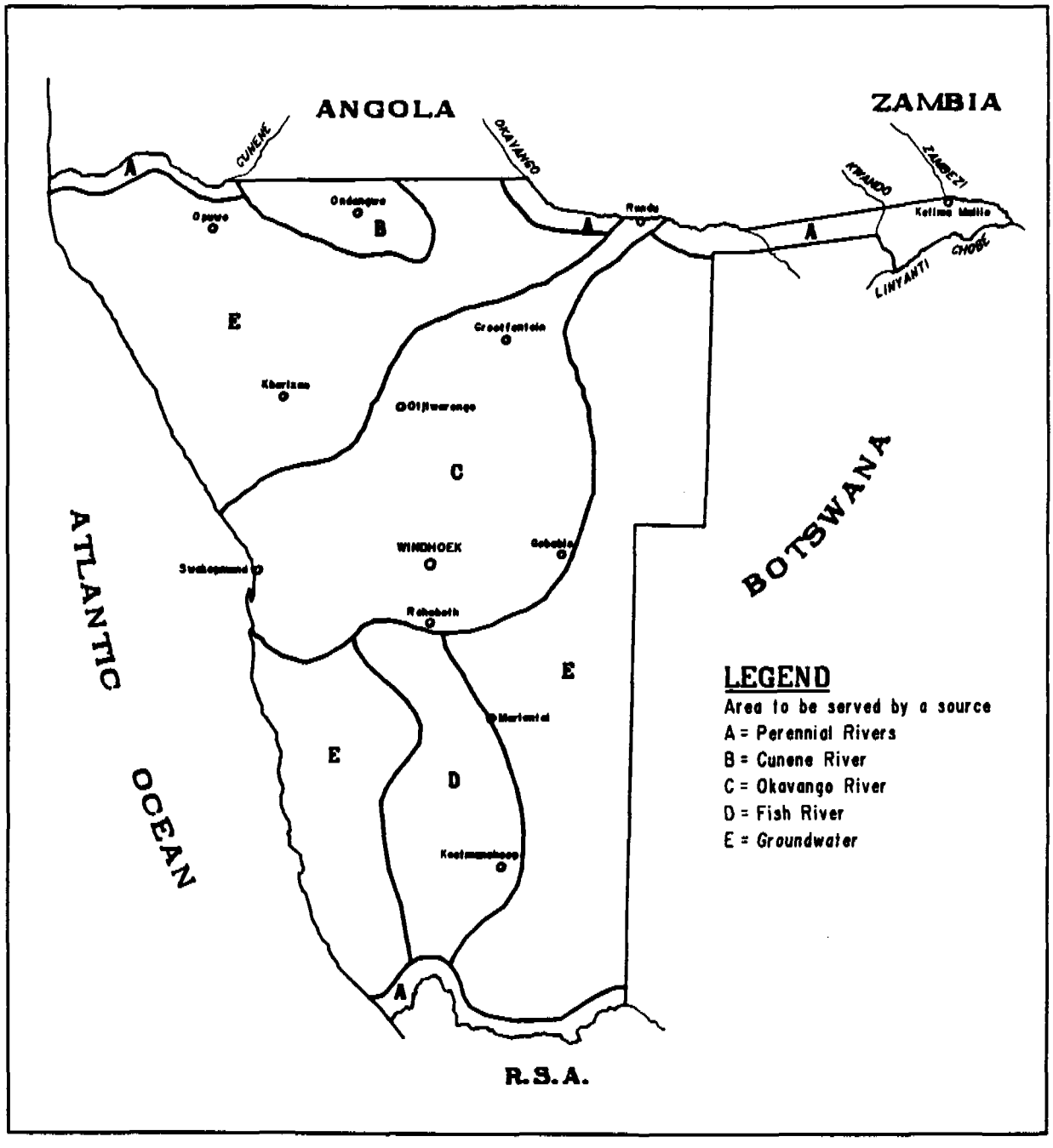
TABLE 14: PRODUCTION BOREHOLES IN NAMIBIA

AUTHORITY	NUMBER OF BOREHOLES OR WELLS IN OPERATION
Department of Water Affairs	320
Districts 180	
Regions 140	
320	
Local Authorities	70
Regional Authorities	3 780
Private	27 680
TOTAL	**31 850**

As a result of the ongoing process of water resource investigations the Department of Water Affairs has been able to draw up a map which indicates the most likely sources of water for the different regions in Namibia. This information is shown on **MAP 4** on page 31.

6.4 WATER SUPPLY INFRASTRUCTURE AND OPERATION

Due to the high cost of developing water supply schemes in an arid environment, the major responsibility for the water supply infrastructure rests with the central Government.



MAP 4: WATER RESOURCE AVAILABILITY

The Department of Water Affairs operates 187 water supply points which supplied a total of 86,6 Mm^3 of water during 1989/90. Of this quantity, 54,4 Mm^3 of potable water was supplied for domestic and industrial purposes, as well as 32,0 Mm^3 of raw water, mainly from dams, supplied for irrigation purposes. About 50% of the potable water was supplied from groundwater

sources. Of the total volume of water supplied, 54% was supplied for domestic and industrial purposes, 9% for mining operations and 37% for irrigation. Refer to **FIGURE 4** for a graphical representation of the water supplied between 1970 and 1990 to the main consumer groups in Namibia.

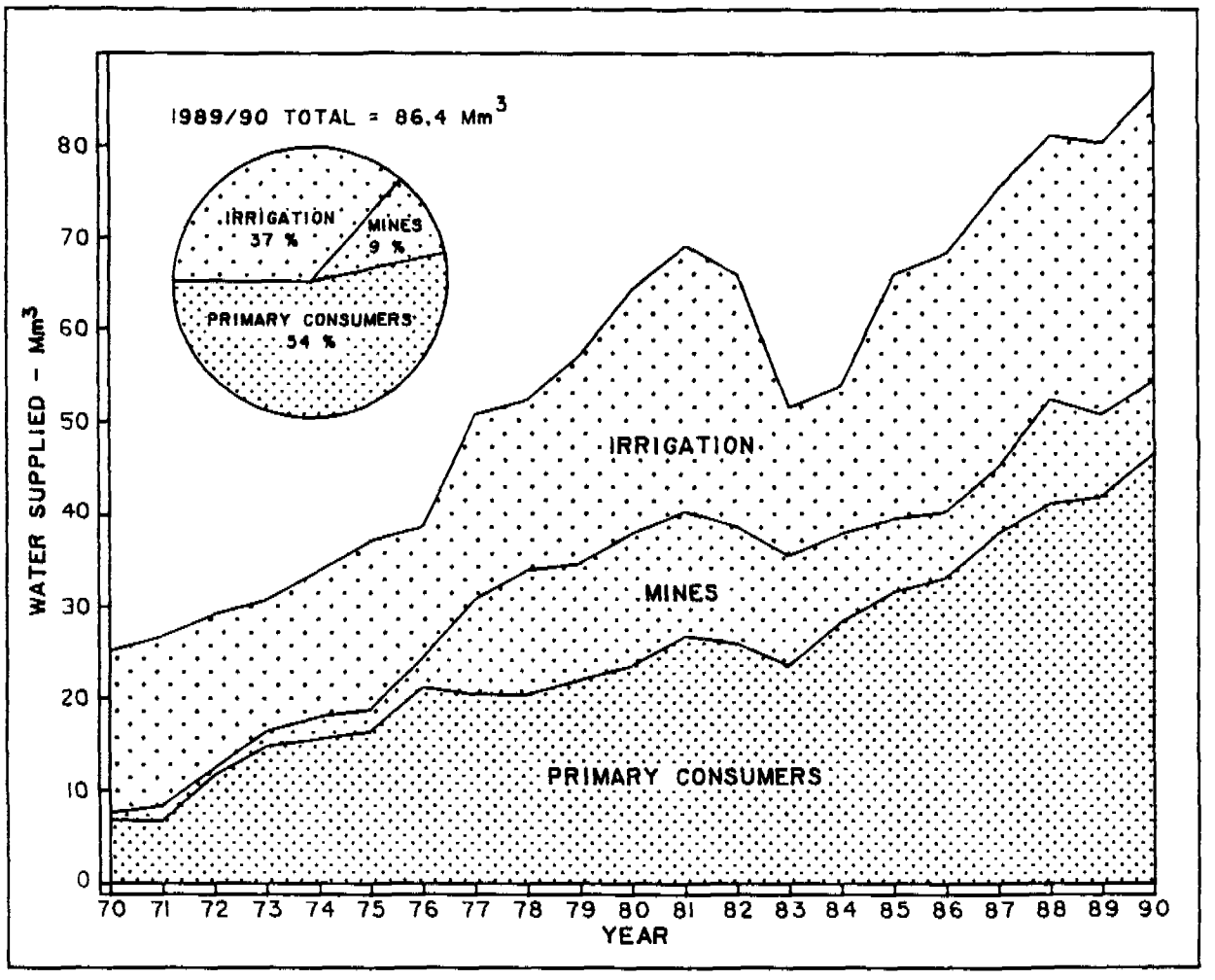


FIGURE 4: STATE WATER SUPPLIED

In 1990 the Department managed to supply bulk water conforming to Group A and Group B standards in 93,4% of all bulk water samples analysed, while 96,5% of the water samples analysed to determine the bacteriological quality of the drinking water supplied conformed to international standards. Only an average of 4,2% of the water samples taken from distribution networks did not comply with the required bacteriological water quality standards of the World Health Organization and this reflects the excellent bacteriological quality of water supplied by the formal water supply infrastructure in Namibia.

Most of the State water schemes are small and during 1989/90 only 41 water

schemes supplied more than 100 000 m^3/a while more than 70 of the water schemes supplied less than 50 000 m^3/a each. The largest water scheme supplied 9,32 Mm^3.

The Department of Water Affairs has constructed a number of major dams in the ephemeral rivers in Namibia. Information on the larger dams is given **TABLE 15.**

TABLE 15: INFORMATION ON DAMS

NAME OF DAM	TYPE OF STRUCTURE	HIGHT (m)	CAPACITY (Mm^3)	95% SAFE YIELD
Hardap	Rockfill	30	300,2	50,0
Naute	Concrete arch	37	83,6	12,0
Swakoppoort	Concrete arch	33	69,0	4,7
Von Bach	Rockfill	35	50,0	6,9
Omatako	Embankment	12	45,1	2,1
Oanob	Concrete arch	55	35,0	4,5
Otjivero-	Concrete gravity	21	17,6	1,4
combination	and embankment	17		
Dreihuk	Rockfill	21	15,5	0
Friedenau	Concrete gravity	23	6,7	0,5
TOTAL			**622,7**	**82,1**

A significant adverse factor is that on average only 13% of the capacity in the dams is available as a safe yield. Although not all dams are yet fully utilized, the total efficiency of the dams is relatively low and varies between 8% for Naute and 62% for Von Bach.

Although there are approximately 32 000 boreholes in operation as well as 9 major dams with storage capacities larger than 6 Mm^3 each, more than 10 000 farm dams with a total estimated storage capacity of more than 300 Mm^3 have been built to augment stock drinking supplies and to support limited irrigation practices.

The largest single State water project in Namibia is the Eastern National Water Carrier which is still to be completed. The purpose of the Water Carrier is to eventually import 60 Mm^3 of water per annum from the Okavango River on the north-eastern border of Namibia to augment water supplies in the central and west coast areas of the country. This project is developed in phases according to the water demand and the availability of capital funds.

One of the most recent links to this water scheme is the Swakoppoort Dam - Karibib Regional State Water Scheme which supplies water to the new Navachab Gold Mine near Karibib and to the expected regional development in the Karibib - Usakos - Omaruru areas. The location of the larger water supply schemes and major dams which have been constructed to satisfy the water needs of developing areas are shown in **MAP 5** on page 35.

Other regional State water schemes which are of major importance are those that supply water to the West Coast from well fields in the beds of the Kuiseb and Omaruru Rivers, into Owambo from the Cunene River, into Hereroland from the Eastern National Water Carrier and for the irrigation of 1 400 ha at Mariental. Nearly all the major towns in the country are supplied with water from regional state water schemes.

Many of the smaller towns and growth points receive State supplied water from local water sources, while most of the small rural settlements are self sufficient.

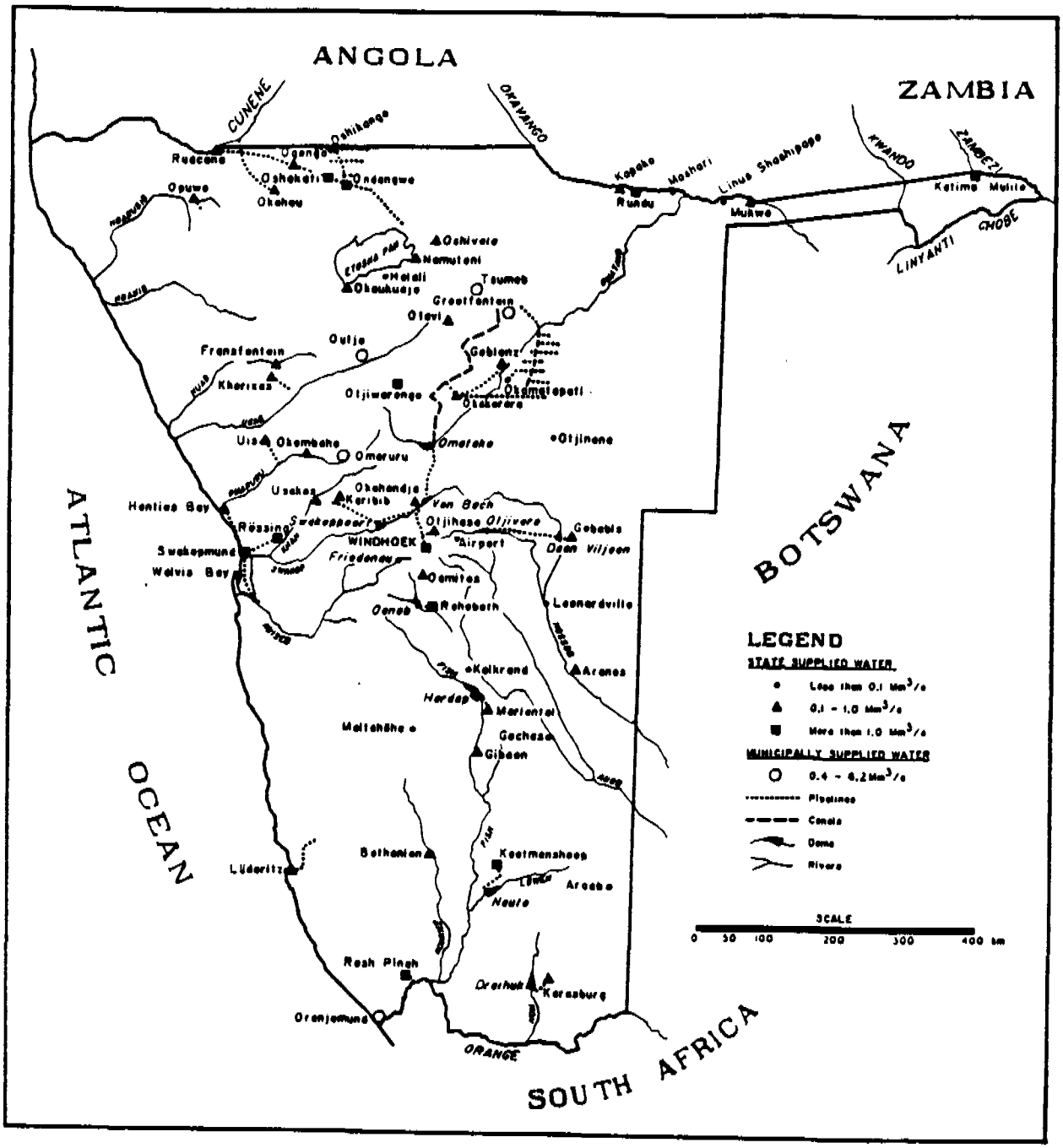
The water supply function has to a large extent been decentralized in eight regions which are served by regional offices as shown in **TABLE 16.**

TABLE 16: WATER SUPPLY : REGIONS AND HEADQUARTERS

REGION	HEADQUARTERS
Owambo	Oshakati
Kavango	Rundu
Waterberg	Otjiwarongo
Von Bach	Okahandja
Namib	Swakopmund
Nossob	Gobabis
Hardap	Mariental
Karas	Keetmanshoop

The effective operation and maintenance of the water supply infrastructure are important aspects to ensure the reliability with which water is supplied to consumers in Namibia. Due to the vastness of the country, a decentralized operation and maintenance management system is presently in use. This implies that the regional offices are responsible for all the day to day operation and maintenance of water schemes as well as the handling of any breakdowns that may occur. Major scheduled maintenance works on buildings and structures as

well as mechanical and electrical repair works are programmed and supervised on a centralized basis in Windhoek.



MAP 5: MAJOR DAMS AND LARGER WATER SUPPLY SCHEMES

6.5 FINANCING

The actual expenditure in the Department of Water Affairs during the last five

years are shown in **TABLE 17**. It can be calculated from the data in **TABLE 17** that the total expenditure of the Department of Water Affairs increased from R66,760 million in 1985/86 to R89,052 million in 1989/90 at an average rate of 5,9% per annum.

TABLE 17: WATER AFFAIRS EXPENDITURE

MAIN DIVISION	EXPENDITURE IN MILLION RAND				
	FINANCIAL YEARS				
	85/86	86/87	87/88	88/89	89/90
01 Administrative	2,470	3,291	2,860	3,580	9,252
02 Training	0,082	0,679	1,014	1,110	1,146
03 Investigations at National Level	6,664	4,690	7,119	6,906	6,735
04 Civil Works	1,174	*	1,275	1,413	1,581
05 Establishment of State Water Works	30,804	34,292	35,615	36,5652	37,187
06 Operation of State Water Works	22,792	19,146	25,784	18,091	31,733
07 Mechanical and Electrical Works	2,054	1,690	3,945	3,659	1,423
TOTAL	**66,760**	**63,789**	**77,612**	**81,324**	**89,057**

* The figure for Civil Works was incorporated with the Establishment of State Water Works.

The total annual capital expenditure on the water supply infrastructure over the past 20 years is presented in graphical form in **FIGURE 5** on page 37. Expressed in real terms, the value of capital work carried out annually has shown a steady decline since 1978.

The total investment in the water supply infrastructure is more than R400 million and the replacement value is estimated to be at least R1 500 million in 1990 values.

The Department has developed an improved computerized cost information base which makes it possible to allocate specific costs for water supply to the

various water schemes. Water tariffs are calculated accordingly for each scheme and the system differentiates between a capital cost component and running cost component of the total water cost. The running costs are subdivided into operating, maintenance and overhead costs.

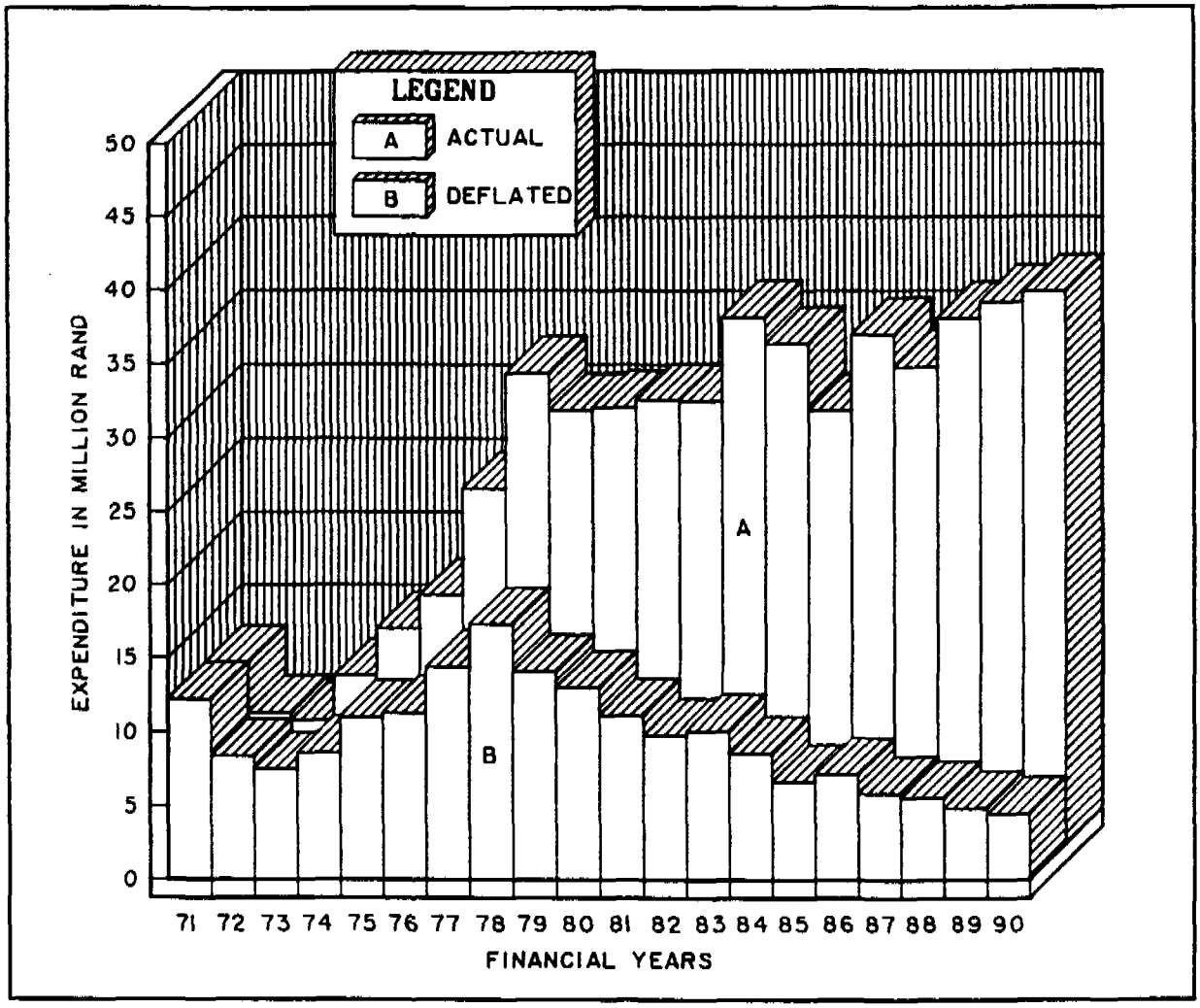


FIGURE 5: CAPITAL EXPENDITURE

The direct running costs of water supply services during 1990 amounted to R31,7 million and represents an overall unit cost of 36,7 cents per cubic metres of water supplied, irrigation water included. The largest single expenditure i.e. R13,5 million was in respect of energy (fuel and electricity for the transportation of water), whilst R11,6 million was for remuneration.

Refer to **TABLE 18** on page 38 for more information on the running cost of state

water schemes and income from water sales in the country during the past five financial years.

TABLE 18: EXPENDITURE ON AND INCOME FROM WATER SALES

ITEM	FINANCIAL YEAR				
	85/86	86/87	87/88	88/89	89/90
Potable water sold (Mm^3)	39, 944	44, 750	52, 083	50, 173	55,091
Running cost (R)	21, 825	26, 126	30, 928	33, 356	36,348
Unit Cost (c/m^3)	55	58	59	66	66
Income (R) (R million)	19 726	21, 359	27, 846	27, 345	29,843
Unit Income (c/m^3)	49	48	53	54	54
Deficit c/m^3)	-6	-10	-6	-12	-12

6.6 MANPOWER AND TRAINING

Manpower development has been an important factor ever since the former Administration for South West Africa appointed its first civil engineer, Mr Martin Kindinger, in 1926 to organize and co-ordinate the farm dam building activities of the Department. By 1928 the number of skilled personnel dealing with water matters in the newly formed Dam and Irrigation Section in the Works Department increased to 26 while the subsection for drilling had 40 officers.

In 1957, when the new Water Affairs Department was formed, staff numbers increased to 81. By 1969, just after the South West Africa Administration was re-organised and the Water Affairs Department became a Directorate of the Department of Water Affairs in the Republic of South Africa, the permanent staff numbered 436. By 1980, at the formation of the existing Department of Water Affairs, there were 696 persons employed as permanent staff. Since independence, further improvement was made to the personnel establishment. **TABLE 19** on page 39 shows the approved permanent personnel establishment of

the Department of Water Affairs as on 31 March 1990.

TABLE 19: APPROVED ESTABLISHMENT OF THE DEPARTMENT AS ON 31 MARCH 1990

CLASSIFICATION OF POSTS	POSTS APPROVED	POSTS FILLED	SHORTAGE (%)
Secretary	1	1	0
Director	4	3	0
Divisional Head	12	13*	0
Professional	85	65	24
Technical	127	103	19
Clerical	213	117	45
Artisan Staff	238	170	29
Security Personnel	112	83	26
Waterworks Officer	158	85	46
General	1 145	914	20
TOTAL	**2 095**	**1 555**	**26**

* On recommendation of the Public Service Commission, the Divisional Head: Operations North is held additional to the approved establishment.

From the above it is clear that there is a shortage in professional and technical staff as well as trained clerks, waterworks officers, artisans and security personnel.

The Functional Training Centre of the Department of Water Affairs assists with the training of artisans, water works officers and general assistants. The training centre can also assist other Ministries with certain training courses, but one of the major problems encountered at present is to obtain and retain the services of qualified and experienced training instructors. The cost of training staff is high, but the value of this facility to ensure that the water supply service is maintained has been proven in the past.

Although on the job training is possible in the Department, there is still a great lack of academical educational facilities in Namibia to train engineers, scientists and technicians.

Due to the Government policy that Namibians should be appointed in the Civil Service and the fact that many well qualified and experienced engineers, hydrologists and technicians find better employment opportunities in the private sector, it seems as if serious manpower problems in those categories could be experienced in future. This would not only lead to a deterioration

in capacity to manage the investigation, planning, design and establishment of water related infrastructure to support development, but would also increase the dependence of the public sector on the services of expatriates, which can only be obtained at high costs to the country. Serious attention should therefore be given to this situation.

6.7 RESEARCH

Although a formal Research Division has only been established in the Department after independence, the necessary research activities were done in the Research Section of the Water Quality Division.

Some of the major research activities of the Department centre around environmental impact assessment and management, such as the work on the aquatic weed infestation of the Eastern Caprivi rivers, the animal mortalities in Grootfontein-Omatako canal component of the Eastern National Water Carrier and ecological aspects concerning the abstraction of groundwater or the construction of new dams like the recently completed Oanob Dam and the proposed Omdel Dam. The ecological impact of water abstraction from groundwater sources on the vegetation in the Karst dolomitic area near Grootfontein and the linear oases in the ephemeral rivers like the Kuiseb, Swakop and Omaruru at the west coast yielded significant results to facilitate proper water abstraction strategies.

Other research which had been done includes baseline studies on the environment at places where new water schemes are envisaged, the desalination of brackish and sea water as well as scientific studies on problems of a chemical, physical, biological and limnological nature.

The value of applied research to provide cost effective applicable, practical solutions to in-house water related scientific problems in order to avoid or reduce increased expenditure on the establishment or maintenance of the water supply infrastructure, has been proved in the past.

6.8 THE WATER BOARD AND WATER ABSTRACTION CONTROL

The effective administration of the Water Act plays an import role in ensuring that the sensitive water sources in the country are judiciously managed and

protected. Certain powers are also vested in the Minister to regulate water utilization and an Advisory Water Board had been constituted as an objective body to advise the Minister on matters in this regard. In the past the Water Board attended to a large number of matters as reflected in **TABLE 20.**

TABLE 20: ACTIVITIES OF THE ADVISORY WATER BOARD

ACTIVITY	FINANCIAL YEAR				
	85/86	86/87	87/88	88/89	89/90
Number of Meetings	4	4	4	3	3
Cases dealt with	81	67	69	40	39
Permits approved for boreholes	74	94	133	70	124
Permits approved for irrigation	12	10	14	22	14
New dams authorized	3	2	8	1	1
Improvement of dams authorized	15	5	2	2	0

Since independence the Advisory Water Board has not convened due to the restructuring of the Board, but the required control over the water utilization in the country could be maintained. However, the re-instatement of the Water Board is receiving the necessary attention at all levels of management. As far as water abstraction and waste water control, as well as the conclusion of water supply related agreements are concerned, the activities of the Department are reflected in **TABLE 21.**

TABLE 21: WATER CONTROL AND AGREEMENTS

ACTIVITY	FINANCIAL YEAR				
	85/86	86/87	87/88	88/89	89/90
Abstraction applications approved	19	27	47	48	123
Abstraction applications refused	13	6	4	8	22
Waste water permits approved	13	11	14	20	15
Water supply agreements	30	20	56	28	111
Electricity supply agreements	3	5	5	3	8

7. PROSPECTS AND CONSTRAINTS

7.1 WATER RESOURCES

7.1.1 Surface Water

The limited availability of the surface and groundwater resources in the

interior of the country is due to climatic conditions which are beyond the control of man. However, the control over and judicious management of the water resources could stretch their capacity for the provision of water for socio-economic development until such time as major capital expenditure would be required to link the water resources in the interior with the perennial border rivers.

Although more of the ephemeral surface water sources can still be developed, the extent to which it can be done, is limited and also difficult to assess. However, it remains an important area for future investigation.

The future construction of dams to harness the potential in the ephemeral rivers will depend on the necessity for such development, technical feasibility, and the availability of capital funds to develop those projects.

The equitable and reasonable share of Namibia in the water of the border rivers is difficult to quantify, but the important fact is that those sources are of critical importance of Namibia, not only to supplement the available ephemeral water sources within the country in times of drought, but also to sustain future agricultural, industrial and socio-economic development.

One of the important tasks of the Government would therefore be to negotiate agreements between riparian countries on the utilization of the water resources of the perennial border rivers.

7.1.2 Groundwater

Due to the arid environment, the groundwater sources are sensitive to exploitation and are exhaustible. Where they are replenished by natural recharge they can be utilized for almost unlimited periods, provided that abstraction does not exceed the long term recharge potential. Efficient management and the protection of these renewable sources are therefore of vital importance to Namibia. This can be achieved through water level monitoring, groundwater modelling techniques, resource conservation and effective aquifer management, but these activities require adequate measuring equipment, computer facilities and competent hydrogeological staff.

A better understanding of the occurrence of groundwater is required to facilitate groundwater management and to advise Government on the optimum location of new socio-economic development projects. Manpower, equipment and funding may be viewed as serious constraint because very specialized services and equipment are required to do hydrogeological investigations and the costs are likely to be very high.

7.1.3 Water Resource Development

One of the major water supply constraints in Namibia are the adverse location of water sources in relation to places where the water demand is increasing and the cost to develop the necessary infrastructure to augment the water supplies. The depletion of underground water reserves due to over abstraction is also a matter of serious concern in those areas where the augmentation of the existing water resources could only be facilitated at high cost from remotely located water sources.

In the past, there was little or no competition between different types of water users since each could be supplied independently to a large extent, but it is envisaged that with the increasing demand for water as the economy develops, real competition will evolve, particularly between domestic, stock and irrigation consumption in the rural environment as well as between domestic, industrial and mining consumption in the urbanized areas.

A comprehensive approach to policy and planning in the water and water related sectors is essential to ensure that the existing surface and groundwater schemes are optimally utilized and that regional or national water resources are developed timeously.

The larger rural centres depend to a large extent on groundwater resources and many are already exploiting their resources to the maximum. The improvement of the water supply infrastructure will be difficult and capital intensive. Water conservation measures should therefore receive a high priority to alleviate the problems expected.

7.2 RURAL WATER SUPPLY

Rural areas and scattered settlements use small amounts of water which can continue to be withdrawn from local sources like ephemeral pans and wells or supplied from boreholes with handpumps or motor driven pumps. The major problem seems to be the security of supply during drought conditions or when maintenance support services break down. Catering for such small and scattered rural communities is potentially and prohibitively expensive and it is therefore important to stimulate community involvement, in order to transfer water supply responsibilities to the consumer to ensure that the people, farmers and livestock have enough water.

In spite of the fact that the formal water supply infrastructure provides water which conforms to high quality standards, there is reason to believe that water from traditional water sources in the rural areas is highly contaminated. The provision of a wholesome water supply clearly does not always produce the desired improvement in health because of the contamination of the water during transportation from a potable source to storage at home and from the storage point to consumption. Water sources can also be polluted by animal and human waste, but this situation can be rectified by the application of simple hygiene standards which are practical and attainable at reasonable costs, provided that full community participation can be achieved through effective extension work.

The construction of rural water supply schemes therefore has to be accompanied by a community health education programme so as to realize the full potential health benefits of a potable water supply project. A programme of action should be formulated to determine the extent of water pollution in homes and to safeguard community water supplies. The population should also be advised to reduce or avoid water consumption from traditional or open water sources which yield contaminated water.

The ultimate objective should be to incorporate the message into the health and education system of the country through workshops or seminars for all types of extension officers, clinic staff and teachers, as well as through educational material and the media.

7.3 ENVIRONMENTAL MANAGEMENT

As far as the environment is concerned, an important lesson learnt from past experience is that environmental aspects should be considered when investigating the feasibility of water supply projects. Environmental impact assessments should not be directed at prohibiting the development of new water schemes, but rather at identifying those environmental problems which would require careful management during or after the project construction.

7.4 MANPOWER

Some of the major constraints to the future development of the water supply infrastructure are likely to be the availability of skilled manpower and capital funds. Care should therefore be taken to ensure that manpower is trained and that the available funds are used for economically viable projects.

7.5 MAINTENENCE OF THE WATER SUPPLY INFRASTRUCTURE

Due to the ageing of the water supply infrastructure it is expected that the cost of maintenance would result in increasing expenditure to provide in the water demand. In 1990 R1,9 million was spent on maintenance work, 50% more than the previous year. Of this amount R1,2 million was appropriated for scheduled, preventative maintenance while R0,7 million was spent on breakdown services for water supply equipment. This is still much less than the estimated R4 million which should be invested annually to ensure the proper upkeeping of the infrastructure.

7.6 PRIVATIZATION

When looking at the future it is clear that water supply will remain a very important factor in ensuring growth and prosperity. To meet this end, the Department of Water Affairs will continue to play a vital role, but serious consideration should be given to transform a certain portion of the Department into a more rationalized corporation.

The functions of the Department can roughly be divided into four major groups.

There are the investigations into the water resources of the country, the establishment of water schemes, the operation and maintenance of water schemes and the water control functions. In view of the nature of the investigations and control activities, that is hydrology, hydrogeology, water quality control pollution control, environmental assessment, applied research, broad planning of the water supply infrastructure and administration of the Water Act, it is clear that these functions should remain within the Government. However, the design and construction of planned water schemes can be privatised as well as the operation and maintenance of viable bulk water supply schemes. By creating a more business-like organisation to manage the establishment and running of water schemes, a longer term financial strategy, which is not possible with the present budgeting system, can be pursued, better manpower development can be achieved and a better service can be provided to the community without neglecting the social obligations of the Government. This is not a new concept in Namibia or the southern African region and examples in this country are SWAWEK, TRANSNAMIB and ENOK.

8.MAJOR SECTOR OBJECTIVES

8.1 GENERAL APPROACH

8.1.1 Priorities

Although education, health, housing and agriculture had been identified by Government as the priorities for development in Namibia, it is clear that the additional infrastructure required to achieve these goals will invariably lead to an increase in water demand. Socio-economic development and water supply for domestic and agricultural purposes should therefore not be seen in isolation.

8.1.2 Strategy

The major aims of the water sector are to establish water supplies to support and facilitate the achievement of the Government's broad objectives for social upliftment, rural development and employment creation. The population must also be provided reasonable access to safe water for drinking, personal hygiene and other domestic purposes.

The Government is committed to support economic growth, but that sector relies heavily on the creation of adequate infrastructure and if viewed against the background of the scarce water potential in Namibia, proper action should be taken to ensure that enough water of acceptable quality is available at the right time. However, water is an expensive resource to develop and very fragile if not husbanded with care in the arid environment of Namibia. The Department must therefore plan, develop and operate the formal water supply infrastructure in an efficient way.

8.1.3 Costs

The Government will have to consider adequate financial support for the maintenance and extension of the existing water supply infrastructure, the provision of new water schemes where necessary, the improvement of health through hygienic water use practices in the rural environment and to conduct water resource investigations and feasibility studies to provide the necessary foundation on which to advise the Government on the short, medium and long term planning, programming and funding of the water supply infrastructure required in future.

The affordability of water supply to the various consumers is an important consideration for a healthy sector development programme. The participation of all beneficiaries at all levels in the identification of their reasonable needs, the planning and implementation of an appropriate water scheme as well as the operation and maintenance thereof in an economical way, is a comprehensive objective.

8.2 SPECIFIC OBJECTIVES

8.2.1 The Water Act

The promulgation of a new Water Act for Namibia is necessary to bring legislation in line with the Constitution, to confirm the mission of the Department of Water Affairs and to regulate the functions necessary to guard over the judicious utilization and conservation of the natural water resources in the country.

8.2.2 Manpower Development

Manpower development is an important facet of the total strategy to ensure adequate water supplies. However, the manpower required is very specialized and not easily obtainable. Special incentives for the training of engineers, hydrologists, computer programmers, technicians and artisans should be considered at Government level, while on the job training for the staff in jobs where less skill is required, will be taken care of by the Department.

Training of community water committees and rural scheme attendants to take proper care of communal water schemes are equally important.

8.2.3 Water Resource Investigations

Groundwater and surface water resource investigations as well as proper feasibility studies and environmental impact assessments of new water projects are major objectives to facilitate the design construction and eventual efficient operation of water supply schemes. It is also the set objective of the Department to be actively involved in the establishment of rural groundwater sources by utilizing the available hydrogeological development capacity and manpower resources.

8.2.4 Optimal Resource Utilization

In order to accommodate large water consuming industries and expanding communities, the available water resources should be optimally utilized through integrated and conjunctive use. The capital investment and recurring cost liability to the Government should also be addressed and scope exists for increasing the revenue accruing to Government by adjusting water tariffs to reflect the cost of providing a water supply service. Further investigations into this complex subject are required to enable the Department to propose an acceptable water tariff structure which would also accommodate rural water supply costs and affordability to Government.

8.2.5 Master Water Planning

National water planning always seems to be the solution to water supply

problems, but in view of the fact that the available data is relatively limited and the acquisition of additional data on a national basis will be prohibitively expensive, a comprehensive national master water plan is considered premature. The objective in water planning would therefore be to address water problems at a local and regional level as specific projects become necessary to study.

8.2.6 Funding

In view of the shortage of capital funds, other alternatives for funding should be sought. It is therefore an objective of the Department to take the initiative to submit project proposals, through the National Planning Commission, to make the international donor community aware of urgent water supply projects which may need funding. The same principle will also be applied as far as research and scientific equipment is concerned.

8.2.7 Institution Building

In conclusion it should also be stated that there must be co-ordination of water planning within the Government. It is therefore a major objective to define the different water related functions and to allocate these to the appropriate Ministries. Hopefully this will facilitate the creation of efficient water development plans and avoid duplication of effort. This objective will, to some extent, be achieved when the Government approves the proposed policy presently being prepared, by the middle 1991.

8.3 POLICY AND STRATEGY

8.3.1 General Responsibilities

The conservation and judicious utilization of water in the arid environment of Namibia should be encouraged to ensure that such a scarce commodity is used optimally for balanced development in all sectors of the economy. The limited water resources and high capital cost to establish the necessary water supply infrastructure require the implementation of a national water strategy to supply in the demand of the larger water consumers. The prevention of water resource pollution and the management of waste water discharge should also be

achieved through effluent and pollution control measures. These responsibilities have been entrusted to the Department and also include the bulk supply of water at a local, regional and national level.

8.3.2 Water Resource Allocation

The principle applied in the development of water sources for specific consumers is that local water sources must be utilized first, then a regional water source further away and finally a national water source which can supply water to several regions.

Where water sources have to be shared by a number of consumers, the priorities dictate that domestic consumers and stock watering requirements are the first to be satisfied. The second priority is seen as the demand for water by mines and industries. Irrigation is listed as a third priority while other use, such as for recreation, is considered to be the least important, although recreation and tourism possibilities play a role in evaluating the cost-benefits of all major dams.

8.3.3 Water Resource Development

As was indicated earlier, the available water sources within the country are limited and the integrated, combined use of water may bring relief. The only way in which to supplement the existing sources, is therefore to utilize the ephemeral surface water storage facilities and groundwater sources optimally on an integrated basis and to augment these sources with water from the assured perennial rivers on the borders of the country, when necessary.

The investment of funds to determine the water resource potential on a national basis, especially in the groundwater environment, is of critical importance to enable the Department to be able to advise Government on the optimal location of new development projects in future.

Financial assistance by other countries since independence, has made it possible to do regional hydrogeological investigations to make a more detailed assessment of the hydrogeological situation in certain regions. This information could be of great value to upgrade and extend the water supplies

for the rural communities in Namibia. Although the former Regional Authorities were responsible for the provision of boreholes and borehole water supplies to the rural communities, the data obtained from their drilling work was not always submitted to the Department for inclusion in the borehole data bank. This situation led to the loss of important data. In view of this problem in the past and to avoid duplication of effort, it seems logical that the responsibility for groundwater source development should be vested in the Department of Water Affairs.

The Department is at present conducting a baseline hydrogeological investigation into the groundwater situation in those communal areas which lacks the necessary information. This will facilitate a better understanding of the groundwater environment and will enable the Department to guide future development in a more orderly and scientific way.

8.3.4 Water Scheme Development

Namibia is a relatively fast developing country where a great deal of capital has been invested to provide an excellent infrastructure such as electricity and water supply, a transport and communication system, housing, and facilities for education, health and welfare. However, in addition to the many areas where the augmentation of existing state water schemes will become necessary in future, there will also be the need for the development of new projects which could be economically viable and would contribute to the economy of the country.

The development of future water supply projects will largely depend on the socio-economic growth in Namibia, the policies of the Government, the priorities for water projects in terms of other national development projects and the availability of capital funds.

The Eastern National Water Carrier has so far been completed between the central area of the country and the dolomitic groundwater area in the vicinity of Grootfontein. Increased demand resulting from additional linking of consumers to the existing network may in future necessitate the completion of the project up to the Okavango River, but a full investigation and evaluation of the groundwater potential in the vicinity of Grootfontein, Otavi and Tsumeb

is required before any final decision on further implementation can be taken.

The extension of the existing water supply network in Owambo must also receive attention and this has already lead to the renewal of international agreements between the countries bordering the Cunene River.

The Eastern Caprivi is locked between the Zambesi and the Kwando-Linyanti-Chobe rivers. The population living along these rivers relies on them for their water requirements, while the people in the interior depends on groundwater sources. Much can be done for the development of water resources and the improvement of the small rural water supply schemes in the region.

The augmentation of existing water schemes that depend on stored reserves in the alluvium of the ephemeral rivers may become a matter of urgency if development should increase substantially. Investigation into additional regional water sources for an area like the West Coast is considered to be a priority. The potential of the alluvial deposits in the Ugab River also needs to be investigated to provide for an anticipated increased demand in Damaraland.

There is reasonable potential for the development of dams in the Fish River, depending on economic viability and technical feasibility. The Fish River Basin has very little potential for mining development and the soils are generally too poor to initiate large scale irrigation projects. The groundwater sources can support the existing stock farming activities, but agriculture and the existing service industries cannot supply enough job opportunities for the growing population. Some form of industrial development, which could utilize the available manpower and water potential, must still be investigated.

The vast waterless hinterland in Hereroland East can be developed for stock farming purposes, but this also depends on the ability to locate adequate water sources and the introduction of sound grazing management practices.

In the less developed communal areas like Bushmanland, Damaraland, Kaokoland, Namaland and Southern Kavango humanitarian aid and financial assistance are required to improve the standard of living through rural water supply,

infrastructure development and agricultural extension in the field of animal husbandry and the small scale irrigation of arable land to improve self-sufficiency.

8.3.5 Irrigation

Owambo, Kavango and the Caprivi are typical areas with access to perennial water sources which could be developed for large scale irrigation projects.

The development of irrigation along the Orange River and its potential for the export of agricultural produce to a potentially large consumer like South Africa should receive attention and should be operated on a commercial basis to ensure sustained viability in the long term.

The development of irrigation projects in Eastern Owambo, the Kavango, the Western Caprivi Zipfel and the Eastern Caprivi are already under investigation and will respectively utilize the water resources in the Cunene, Okavango and Zambezi rivers.

8.3.6 Hydro-electric Power

Although the economy of the country is largely dependent on agriculture, mining and fishing, there is also a considerable potential for the generation and export of hydro-electric power. Much has already been done to investigate the potential of the Cunene River and specific feasibility studies may prove that the development of joint projects will be economically viable and to the benefit of all participating countries.

8.3.7 Water Cost and Tariffs

The cost of the water supply is very high and the objective of the present bulk water supply tariff policy of the Government is that domestic consumers with a piped water supply should pay for their water at a tariff that at least equals the running cost component where possible. In the case of larger centres such as Windhoek and Swakopmund, this objective has already been achieved. In smaller towns and settlements the running cost is still partly subsidized by the State. For those people who cannot afford to pay for water,

the water is supplied free of charge and is therefore fully subsidized by the State, but it is expected from the population to make at least a contribution in kind, for example by fetching water and maintaining their water supplies.

In the case of some commercial undertakings such as mines an economic tariff which covers the full capital and running cost is levied.

The tariff policy is generally directed towards bringing home to the consumer the value of water as a scarce commodity in an arid country. The water tariffs are subject to annual revision and periodic adjustment according to the economic situation in the country.

As result of the expected increased demand for water in the country, it is envisaged that the provision of adequate capital funds for new water supply infrastructure would be a vital prerequisite for sustained development in Namibia. The financing of the running costs of water supply schemes through budgeting and the generation of income through water tariffs should not be neglected in order to ensure an efficient and effective water supply service in future.

It should, however, always be kept in mind that this infrastructure is expensive to maintain. Inadequate maintenance could lead to a deterioration of these assets. Allocation of funds for maintaining the infrastructure should have a greater priority than the provision of capital for new projects.

8.3.8 Institutionalization

Since independence and the creation of the Ministry of Agriculture, Water and Rural Development, the Ministry of Local Government and Housing, the Ministry of Lands, Resettlement and Rehabilitation, the Ministry of Works, Transport and Communications as well as the Ministry of Health and Social Services, the need arose for a new look at the water development and supply situation in the Namibia. The Government established an inter-Ministerial Committee to investigate this matter and to make recommendations on the allocation of water supply responsibilities to the different Ministries. This work will be completed by the middle of 1991.

However, it seems clear that the present emphasis on bulk water supply will shift to include rural water development and that the Department of Water Affairs will have more responsibilities in this regard in future.

8.3.9 Research

The research policy of the Department is to engage in applied water related research which is directed at solving problems were research is required and finding solutions which could be utilized immediately to support the water supply function. The aim is also that applied research should be done within the available manpower and financial resources, but where specialized expertise are required, the assistance of qualified and experienced consultants should be called for. Another important principle is that applied research activities should be decentralized to the levels where the need and the obligation to achieve results, exists.

9.PROJECTS AND PROGRAMME PROPOSALS

9.1 CAPITAL PROJECTS

The Department of Water Affairs submitted applications for project aid for the financing of capital works during the 1991/92 financial year to the Director-General of the National Planning Commission on 31 January 1991. The applications for project aid are according to the requirements for the planned upgrading and extension of the formal water supply infrastructure in Namibia. The capital projects have been divided into two groups, being those that are continuing from the previous financial years and those that are new projects.

A summary of the applications for continuing works is shown in **TABLE 22** on page 56.

The new projects have been divided into projects aimed at the upgrading or extension of existing water projects and completely new projects. In view of the financial constraints facing the country, priorities have been allocated to the proposed new projects. For this purpose the projects have been grouped into categories A, B, and C, reflecting priorities in descending order of importance according to the information available to the Department at the

time the allocations were made. Category A projects have also been ranked in priority from A1 to A28. Refer to **TABLE 23** on page 57 for a list of the category A projects.

TABLE 22: APPLICATIONS FOR CONTINUING WORKS

PROJECT NUMBER	PROJECT NAME	ALL COSTS IN RAND X 1 000					
		TOTAL ESTIMATED COSTS	FUNDS VOTED		FUNDS REQUESTED		
			PREVIOUS YEAR	1990/91	1991/92	1992/93	1993/94
8687 0168 H	ENWC. Grootfontein-Omatako	112 818	111 868	690	260		
8687 0177 G	Oanob Dam	43 373	39 503	3 500	370		
8788 1409 B	Swakoppoort Dam-Karibib SWS	29 178	28 191	937	50		
9091 024 CL	Calueque Dam-Mahenene RSWS	410	-	290	120		
8687 0127 E	Central Namib RSWS	420	395	15	10		
8990 1072 L	Omdel Dam	28 312	27	2 520	12 000	12 165	1 600
8990 0141 H	Omarassa-Otjiwarongo	12 924	1 437	11 477	10		
8788 0193 F	Ai-Ais SWS	234	14	210	10		
8889 1436 C	Swakoppoort Dam-Karibib	4 720	80	1 500	2 220	820	100
8889 1438 F	Ogongo-Ohahau RSWS	12 302	5 142	5 600	1 510	50	
8687 0169 D	Hardap Dam-Mariental RSWS	1 493	138	10	1 215	130	
8788 0181 H	Completion of projects			100	100	100	100
TOTAL FOR CONTINUATION OF WORKS				26 849	17 875	13 265	1 800

Detailed priorities for categories B and C have not yet been finalised and the order in which these projects are listed has no bearing on their relative importance or priority. Refer to **TABLE 24** on page 58 for a list of the Category B and C projects.

Although all the projects listed in the applications for project aid had been motivated individually to the level required by the National Planning Commission, **TABLES 22 to 24** should be seen as the programme proposed for water supply infrastructure development.

TABLE 23: APPLICATIONS FOR EXTENSIONS AND NEW WORKS

PRIORITY	PROJECT NAME	STATUS	FUNDS REQUESTED (R X 1 000)				
			1991/92	1992/93	1993/94	1994/95	LATER
A 1	Ogongo Purification Plant	Implementation	1 935	1 215			
A 2	Omdel Swakopmund	Implementation	859				
A 3	Rural Water Supply in Owambo (off takes)	Implementation	2 150	2 470			
A 4	Ogongo-Oshakati	Design	615	3 700	23 778	49 772	
A 5	Housing at Otavi, Ombalantu, Aminuis and Kriess	Implementation	800	80			
A 6	Katima Mulilo-Mafuta	Design and Implementation	560	460	80		
A 7	Oshakati-Omakango-Oshikango	Design and Implementation	5 800	10 230	21 800	2 300	
A 8	Koichabpan-Luderitz	Design	300	320			
A 9	Schlip	Design	70	1 050	40		
A 10	Katima-Kongola	Design	200	800			
A 11	Ondangwa-Oshikango	Implementation	660	760	870	1 000	
A 12	Upgrading Caluequе (Phase II)	Implementation	1 700	1 100			
A 13	Central-Namib Telemetry	Implementation	440	30			
A 14	Heavy Equipment Workshop Complex	Design	270	300			
A 15	Opuwo	Implementation	320	30			
A 16	Hardap Regional Office	Design	165	100			
A 17	Ogongo-Okalongo	Design	620	7 000	5 000	600	
A 18	Andara	Implementation	85				
A 19	Amas-Karasburg	Design	90	2 015	95		
A 20	Kandjimi-Murangi	Implementation	396				
A 21	Karstland Boreholes	Implementation	110				
A 22	Karibib-Usakos	Design	120				
A 23	Maltahöhe	Design	80	1 175	50		
A 24	Orumana	Design	100	1 720	100		
A 25	Tses	Design	70	940	60		
A 26	Kavango Radio Communication	Implementation	860	50			
A 27	Ogongo Electrification	Implementation	240	10			
A 28	EMWC Game Remedial Measures	Implementation	600				

TABLE 24: APPLICATIONS FOR NEW PROJECTS CATEGORY B AND C PRIORITIES

PRIORITY	PROJECT NAME	STATUS	FUNDS REQUESTED (R X 1 000)				
			1991/92	1992/93	1993/94	1994/95	LATER
B	Kalkfeld	Design and Implementation	360				
B	Von Bach Regional Office	Design	265				
B	Aroab	Implementation	815	85			
B	Naute Dam Stoplogs	Implementation	710	200	30		
B	Orange River - Rosh Pinah	Design and Implementation	480	420	30		
B	Ruacana Housing	Implementation	400	40			
B	Otjimbingwe Housing	Implementation	172	15			
B	Okondjatu Housing	Implementation	172	15			
B	Bergsig Housing	Implementation	172	15			
B	Sesfontein Housing	Implementation	172	15			
B	Hardap Housing	Implementation	285	15			
B	Spitzkoppe Housing	Implementation	140	10			
B	Stampriet Housing	Implementation	140	10			
B	Tubussis Housing	Implementation	140	10			
B	Oshikango - Odibo	Implementation	452				
B	Naute Upgrading	Implementation	500				
B	Grünau	Implementation	20				
B	Pump Test Facility	Design	12				
B	Aigams Store	Design	90	822	88		
B	East of Ondangwa-Oshikango Road	Design	250				
C	Brukkaros Dam - Tses	Design	1 500	12 000	13 000		
C	Koës	Implementation	360				
C	Brandwag Operations Centre	Design	90	860	100		
C	Braunfels - Khorixas	Implementation	150				
C	Omatako - Von Bach	Implementation	600	1 290	120		
C	Katima Mulilo Housing	Implementation	200	20			

9.2 FOREIGN AID ASSISTANCE

The Department prepared a list of projects and project motivations which were submitted through the National Planning Commission to the donor community at the Donor Conference in New York in May 1990. Refer to **TABLE 25.** Interest has been shown in a number of the projects presented and an indication of the current situation is given in **TABLE 26** on page 60.

TABLE 25: SUMMARY OF THE PROPOSED INVESTMENT PROGRAMME FOR WATER DEVELOPMENT

PROJECT TYPE	PROJECT/PROGRAMME	PROJECT/PROGRAMME COST			
		NATIONAL INPUT RAND X 1 000	EXTERNAL INPUT US $ X 1000		
			TECHNICAL ASSISTANCE	EQUIPMENT/ CONSTRUCTION	TOTAL
Groundwater Investigations	1.1 Eastern Caprivi	80	640		640
	1.2 Karst Area	80	1 760		1 760
	1.3 Kavango, Bushmanland and Eastern Hereroland	30	180		180
	1.4 Mathematical modelling of aquifers	50	100		100
	1.5 Owambo	80	900		900
	1.6 West Coast	80	2 300		2 300
Feasibility Study	2.1 Area east of the Owambo Herringbone water supply scheme	40	160		160
	2.2 Long terms water supply to the West Coast	25	180		180
Feasibility Study, Design and Construction	3.1 Brukkaros Dam and irrigation scheme	200	900	14 100	15 000
	3.2 Extension of the Eastern National Water Carrier	400	3 700	137 800	141 000
	3.3 Katima Mulilo-Makanga-Kongola water supply scheme	150	500	12 000	12 500
	3.4 Otjituuo-Otjizondjou-Otjinene water supply scheme	200	2 000	57 000	59 000
	3.5 Irrigation scheme in Owambo	200	400	36 900	37 300
Design and Construction	4.1 Katima Mulilo-Mafuta water supply scheme	50	20	300	320
	4.2 Kavango Radio communication	50		400	400
	4.3 Ogongo-Okalongo water supply scheme	100	300	3 200	3 500
	4.4 Ogongo-Oshakati water supply scheme	200	500	10 500	11 000
	4.5 The Omdel Dam	200	1 200	16 500	17 700
	4.6 Oshakati-Omakango-Oshikango water scheme	200	2 000	27 000	29 000
	4.7 Rural water supply in Owambo	200		3 000	3 000
Maintenance	5.1 Electrical switchgear of older water supply scheme	100	100	500	600
	5.2 Radio operating system for the Koichab Pan-Luderitz water supply scheme	50		300	300
	5.3 Naute Dam-Keetmanshoop water supply scheme	100	30	600	630
	5.4 Ondangwa-Oshikango regional water supply (Repair of war damage)	50		200	200
	5.5 Ondangwa-Oshikango regional water supply scheme (Replacement of pipeline)	100		1 000	1 000
	5.6 The Von Bach-Windhoek water supply scheme	50		450	450
	5.7 West Coast water supply scheme	100		800	800

Any foreign financial assistance received will therefore be in line with the programme for water supply infrastructure development as proposed by the Department of Water Affairs in terms of the national priorities. Attention is also drawn to the fact that funds were requested for investigations as well as capital and maintenance work to ensure further balance in the general approach to support the water supply function.

TABLE 26: POSSIBLE FOREIGN ASSISTANCE IN THE WATER SECTOR

PROJECT	INTERESTED PARTY	ESTIMATED TOTAL PROJECT COST (RAND X 1000)
Groundwater investigations in the Caprivi, Bushmanland, Eastern Hereroland, Eastern Owambo and Kavango	European Economic Community	5 000
Omakango-Omafu Pipeline	France	6 800
Central Area Master Waterplan Study for Namibia	Germany/GTZ	11 400
Groundwater investigations into the dune area to the south of the Kuiseb River and in the Karst area	Germany/BGR	6 500
Ogongo-Oshakati canal	Germany/KfW	60 000
Groundwater scheme development in Owambo	India/WAPCOS	2 000
Provision of 2 air drilling machines	Japan	10 000
Calueque Pumpstation Phase I *	Netherlands	1 400
Calueque Pumpstation Phase II	Netherlands	3 500
Ogongo-Okalongo Regional State Water Scheme	Netherlands	9 000
Rural Water Supply in Owambo (Tapping points)	Netherlands	4 600
Western Owambo Irrigation	Netherlands	
Ogongo Purification Plant	Netherlands	3 200

* Completed

9.3 OTHER DEPARTMENTAL PROJECTS

Some investigations and maintenance projects in the Department are financed with funds from the recurring budget. A list of the most important of these projects is shown in **TABLE 27** on page 60.

TABLE 27: MAJOR OTHER DEPARTMENTAL PROJECTS

NAME OF PROJECT
INVESTIGATIONS AND RESEARCH
Animal mortality investigation : ENWC
Aquatic Weeds Research
Karstland plant ecological research
Kuiseb River ecological research
Oanob River ecological research
Orange River system analysis
Ugab River ecological baseline study
WATER SUPPLY MAINTENANCE
Gross Barmen replacement pipeline
Hardap irrigation
Odibo purification works
Okangkolo pipeline
Onambutu pipeline and reservoir
Onayena pumpstation
Ondobe pipeline
Ongenga pumpstation
Oshakati pumpstation
Oshandi pumpstation and tower
Oshikango mechanical works
Ruacana upgrading
Swakoppoort abstraction tower
Swartbank-Swakopmund pipeline
Von Bach clarifiers
Aranos upgrading
Noordoewer upgrading
Rietfontein-Talismans upgrading
GENERAL SERVICES
New water act
Artisan training program
Rural water supply training programme

10. SUMMARY AND CONSLUSIONS

Despite the arid hydrological conditions and the adverse location of water resources in relation to areas with large consumers, the Department of Water Affairs has, with the limited skilled manpower and financial resources at its disposal, succeeded in establishing as well developed water supply infrastructure.

The total water consumption in Namibia in 1990 is estimated at 248 Mm^3. This comprises 71 Mm^3 for domestic and industrial consumption, 63 Mm^3 for stock drinking, 106 Mm^3 for irrigation purposes and 8 Mm^3 for consumption by mining operations.

The average per capita consumption for the total population is 136 ℓ/day. The average per capita consumption in the rural areas is 85 ℓ/day and in the urban centres it varies between 165 ℓ/day for the less developed villages and 330 ℓ/day for the more industrialized and developed towns. However, it should also be realised that there are many communities in the rural areas which do not have access to adequate quantities of clean water for domestic consumption and which should receive urgent attention by the responsible authorities.

From the available information on water consumption and the water resources of Namibia, it is estimated that in 1990 at least 43% of the water or 108 Mm^3 came from surface water sources and 57% or 140 Mm^3 from groundwater sources. The estimated total water demand in Namibia by the year 2005 is 400 Mm^3. The domestic water demand will most probably increase by an average of 3,7% per annum to reach 115 Mm^3 in the next 15 years. Depending on realization of the policy of the Government to place a high priority on agricultural development, the water requirements for irrigation may result in an estimated increase of up to 3,4% per annum and a total consumption of 175 Mm^3 by the year 2005.

There were four major actors responsible for water supply in Namibia before independence. They were the Department of Water Affairs, the now defunct regional authorities, local authorities and private bodies. In view of the new Ministries and other organisations established since independence, it is clear that institutional re-organization and the division of water related responsibilities should receive proper attention, especially the rural water supply sector, to facilitate the orderly creation of potable water supplies which would ensure a better living and health for all in future.

It is clear that the future of the country depends on agricultural, industrial and mining development which would ensure the economic independence of the country by providing job opportunities and producing goods for internal consumption and export. This goal can only be achieved if adequate water can be supplied in time at the right locations to support the expected socio-

economic growth.

It is also imperative that agreements be reached to secure the utilization of all the perennial border rivers because the future water demand in Namibia will place an increasing burden on these sources.

The improvement of existing water supply schemes for rural communities and the expected increase in water demand as a result of a new drive in rural community development by the Government is an important water supply aspect which should receive prompt and effective attention to ensure that additional small water supply schemes can be established in time where required.

In conclusion it can be stated that the existing water sources in Namibia can supply in the water demand for the present and in the short term near future. Provision has been made in the planning of future water projects to supply in the water demand, but increased development and water consumption in the various sectors like mining, industry, agriculture and social welfare after independence, will necessitate immediate steps to augment the existing water supply infrastructure in order to sustain the required growth in the economy.

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