Seminar on technology transfer in water supply and sanitation in developing areas — Bophuthatswana

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- COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH (CSIR)
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- GOVERNMENT OF THE REPUBLIC OF BOPHUTHATSWANA
  - Department of Public Works and Water Affairs
  - Department of Health and Social Welfare
  - Department of Finance
  - Department of Prison Services
  - Department of Foreign Affairs & Tourism

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CURRENT STATUS AND FUTURE PLANS FOR WATER SUPPLY IN THE REPUBLIC OF BOPHUTHATSWANA

M. KHAN AND H. MASSOUDI

ENGINEERS FOR WATER SUPPLIES AND SANITATION
DEPARTMENT OF PUBLIC WORKS & WATER AFFAIRS
BOPHUTHATSWANA

SYNOPSIS

Supplying water for domestic, industrial and agricultural usage and disposal of waste water within the limitation of acceptable health standards throught Bophuthatswana is the full responsibility of the Department of Public Works and Water Affairs.

Approximately 76% of the population lives in the rural areas and almost all of them depend on basic water supply schemes such as bore-holes equipped with windmills and handpumps. Most of the large cities and towns are served with proper purified water. It is however the Departments policy and determination, regardless of geographical and geological circumstances, scattered population and financial difficulties, to perservere in the face of every obstacle and establish within a reasonable period of time the availability of potable and standardized water to all residents of Bophuthatswana.

The success of this effort will have a profound effect and influence on the economical growth of this country and would be a highest tribute towards the social foundation of Bophuthatswana.

INTRODUCTION

The Republic of Bophuthatswana with its unique geographical circumstances has a land area of 50 000 sq km and a population of 1,7 M with 76% of them living in rural villages.

The Department of Public Works and Water Affairs as a service department is responsible among many other things such as buildings, roads etc. for the supply of water for domestic, industrial and agricultural usage and disposal of waste water throughout the Republic of Bophuthatswana which is a major undertaking involving considerable pre-planning, design, construction, control and maintenance.

In the past few years despite all the various difficulties and lack of professional people, considerable progress has been made towards providing the entire population with a safe and sufficient water supply for various use throughout the Republic of Bophuthatswana.

All the large cities in the various regions are served with proper water supply schemes. The rural villages are not yet individually provided with Public Service, such as water supply, but all have access to either natural surface water, borehole water, or installed standpipes. It is the intention and determination of the Department of Works to ensure that with in the reasonable period of time potable water will be available to all residents of Bophuthatswana.

TABLE 1 : Distribution of the population in the various administrative areas together with the population who have access to a piped water supply.

TABLE 1

	Urban 1980	2010	Rural 1980	2010	Total 1980	Total 2010	Population To Water	%
TLHAPING TLHARO	2795	10000	114791	280000	117586	290000	66500	56,55
TAUNG	20050	70000	90443	250000	110493	320000	65000	20,31
MOLOPO	31408	140000	211874	630000	243383	770000	51408	21,12
MOGWASE	83641	243300	206414	356800	289455	772100	113641	39,26
GA RANKUWA	117400	329600	270200	557800	387600	887700	129400	33,38
TEMBA	26000	72900	248100	554500	274100	627400	106000	38,67
THABA 'NCHU	5500	20000	51100	150000	56600	170000	25000	45,05
TOTAL	**148900**		**1193022**		**1479217**	**387200**	**577449**	**37,69**

1.1 Rainfall & Water Resources in Bophuthatswana

The average annual rainfall of Bophuthatswana exceeds 600 mm in the Thaba 'Nchu area. It decreases gradually towards the north-west of the Country i.e. Ganyesa/Tlhaping Tlharo. However, there is considerable variation of rainfall from one place to other and year to the next. (See Table 2)

For details of topography, geomorphology and ground water potential - see attached Schedules for each region of the Country. (See Table 5)

Table No. 3 shows the main catchment areas as well as the mean annual runoff of the major rivers in Bophuthatswana. The total mean runoff is 322,91Mm³/a for the total catchment area of 29 504 sq. km. Most of the major Perennial rivers are outside the Bophuthatswana boundary. Although there are nine (9) small to large dams, (as shown in Table 4) 61,787Mm³/a of water is imported from R.S.A. for domestic and irrigation purpose.

Bophuthatswana depends on ground water resources for much of the water supplies to the rural areas. One important consideration is that natural conditions often dictate which type of water development is feasible. In many areas the surface rocks are not porous or fissured and contain little ground water. Occasionally ground water is contaminated by chemicals or harmful bacteria. In these cases it is usually necessary to pipe water from elsewhere. Several regional schemes are planned to cover such areas as shown in maps attached.

TABLE 2

Administrative Areas	Average/ Year 1985/86	Average/ Month
MOLOPO	475 mm	39,6 mm
TAUNG	326 mm	27 mm
THABA 'NCHU	613 mm	51,1 mm
GANYESA	391 mm	32,6 mm
TLHAPING TLHARO	355 mm	29,6 mm
MOGWASE	517 mm	43,1 mm
ODI 1 & 2	511 mm	42,6 mm
MORETELE 1 & 2	439 mm	36,6 mm

TABLE 3

MEAN ANNUAL RUNOFF OF MAJOR RIVERS IN BOPHUTHATSWANA

River	Mean Annual Runoff in (ml)	Catchment Area in (km^2)
MOSHANENG	4,32 mm^3	1600
MATLHWARING	7,0	2200
MOLOPO	23,78	2973
MAREETSANE	10,53	1145
NGOTWANE	10,31	518
SEHUJWANE	2,65	208
HARTS	58,9	9820
MARICO	150,0	8900
THULANE	23,8	843
SANDRIVIER	17,7	710
KORANNASPRUIT	6,99	227
WILDEBEESSPRUIT	6,93	264

TABLE 4

MAJOR DAMS SERVICING BOPHUTHATSWANA

Name of Dam	Source of Water (River)	Capacity 10 x m^3	Type of Structure	Embankment	
				Height (m)	Crest Length (m)
DISANENG	MOLOPO	15 700	Earthfill	16,4	1000
MOGWASE	NGOTWANE	18 300	Earthfill	18,8	350
SUHUJWANE	SUHUJWANE	4 150	Earthfill	26,2	255
EERSTEPOORT	MARICO	250 000	Concrete	26	266
MADIKWE	MADIKWE	7 210	Earthfill	13,5	1700
HOUWATER	MANKWE	3 700	Earthfill	-	-
NOOITGEDACHT	SANDRIVIER	1 400	Earthfill	13,1	750
KLIPVOOR	KUTSWANE	43 800	Earthfill	-	-
GROOTHOEK	KGABANYANE	11 800	Concrete	29	324

TABLE 5 : SHOWS TOPOGRAPHY & GENERAL GROUND/SURFACE WATER POTENTIAL IN EACH REGION

Region/District	Topography & General Geomophilogical Description	Litology	Water Potential	TDS	PH
THABA 'NCHU	The Sandstone, mudstones and shales have weathered to fairly regular plains which increase gradually from less than 1450m a.s.l. in the west to approximately 1650m a.s.l. in the south-east. The dolerite has weathered less than the sandstones, mudstones and shales and forms positive topography. The most prominent is the Thaba 'Nchu mountain, a portion of which is within the region, and which rises to approxiamtely 213m a.s.l. The vegetation encountered in this region comprises Transitional Cymbopogon, Themedaveld, which is a moderately dry grassveld. In many areas this is being inraded by Karoo vegetation.	Dolerite sheets Dykes & sills	(a) Groundwater: Low success rate of boreholes. The formation in this area present a good subterranean water source, estimated at $17mm^3/yr$. A mere 10% of available underground water is presently being utilized. Average borehole is 40m; (b) Surface water: Thaba 'Nchu mountain forms the apex of the three watersheds of the region. The western area drains westward by north and north-eastern part drain northward into Vet river. South-eastern area drains towards south-east in to Caledon river. Major rivers are all outside the region. The Groothoek dam is the only area with a capacity of $14mm^3/\ell$ yield of $216mm^3/a$.	250 500 mg/ℓ AV 360 mg/ℓ	

Region/District	Topography & General Geomophilogical Description	Lithology	Water Potential	TDS	PHS
TAUNG	Belongs to the highveld area, having gently undulating terrain at elevations of 1100m to 1300m a.s.l. The Taung district is covered extensively by Kalahari Thornveld, which is an Acacia Savannah including dry grasses. The area is underlain by, from the youngest to the oldest, the Dwyka formation, the Ghuaplato and the Bothaville formation	Shale and Tillite, Andesitic Lava, Quartizite Shale and Conglomerate	Ground Water, high hydrogeological potential exists over the western third of the district where bore-hole yields between 3 and 20m³/hr can be expected, failure rate 30% potential decreases to the east up to the Harts river being moderate to high. East of Taung the potential can be classified as moderate with yields between 3 and 10m³/hr failure rate 30% to 60% average depth of boreholes 42m. Surface water	500 to 1500 mg/ℓ	
KUDUMANE/ GANYESA	Flat topography which rises from just over 1000m a.s.l. in the extreme west to almost 1470 in the the south-east. There are few prominent features with the exception of Kuruman hills and the Rooiberge which stretches along the south-western boundary between Kuruman and Penryn and Makhubung hills in the western part between Perth and Heuningvlei. The hills generally rise to between 100m and 200m above the surrounding plain. These districts are covered extensively by Kalahari Thornveld which is an Acacia Savannah including dry grasses.	Ferruginous Shale, Jasper and Sandstone	(a) Ground Water: Hydrogeologically these districts can be subdivided in-to four areas - 1. <u>North Eastern Ganyesa</u> Hydrogeological potential high yielding 3 to 20m³/m. Failure rate 30%. 2. <u>Heuningvlei Area</u> The potential of the ironstone in the immediate vicinity of Heuningvlei is classified as moderate with boreholes ranging from 3 to 15m³/hr. Failure rate 30 to 60%.		

Region/District	Topography & General Geomophilogical Design	Lithology	Water Potential		
				TDS	PHS
			3. <u>South Western Tlhaping Tlharo</u> An abundance of water is available from the spring belt with estimated flows approximately 260ℓ/sec. Boreholes high yielding rate 30%. 4. Remaining are classified as poor to very poor, borehole yielding from 0,5 to $3m^3$/hr. Failure rate 40 to 80%.		
MOLOPO (DITSOBOTLA) LEHURUTSHE (MOLOPO)	The Kalahri formation (sands and calcareous sandstones, clay and gravels covers the biggest part of these districts of Molopo and Ditsobotla). These recent deposits are underlain by pre-cambrian rocks and occasional outlyers of the Karoo sequence giving rise to a relative complex geology. The central part of Lehurutshe district is a predominantly flat palin coinciding with basic rocks of the Bushveld Igneous Complex. To the north and to the south of this area the terrain has a dissected aspect, with a positive feature being formed by the more resistant dipping strata of the Transvaal Sequence. Bewteen these sub-parallel ridges the weather shale, lava	Kalahari formation	Ground Water, High potential can be expected in the dolomitic area of Polfontein poor potential in the area surrounding Kraaipan and Khunwana and moderate potential in the remaining area & Ditsobotla district. Failure rate ranges from 30% to 60% average depth of the borehole 35m to 54m. Apart from the moderately ground water potential of the area to the north of Mafikeng a poor ground water potential prevails in the Molopo district average depth of boreholes 79m.		

Region/District	Topography & General Geomophilogical Design	Lithology	Water Potential	TDS	PHS
	and diabase horizons have been eroded into valleys, forming the well known Bankenveld topography of the area marginal to the Bushveld Basin.				
MOGWASE (MADIKWE, MANKWE AND BAFOKENG)	Unculations occur in the topography with elevations ranging between 1050m to 1150m a.s.l. A clugster of hills in the southern part of Odi II with elevation up to 1356m a.s.l. The area is undertain by a wide variety of rock types. Out-crops of the Bushveld Igneous complex cover a large part of the area. Thin covers of recent alluvial deposits are present in the western part of Mankwe district.		The northern and southern part of Madikwe has moderate ground water potential with an exception to Lehurutshe area where high yielding boreholes are located (3 - 20m³/hr) The remaining area has a poor potential (0,5 - 5m³/hr) borehole depth 60m. The borehole statistics indicate that boreholes are generally poor and the failure rates are rather high.	500 750 mg/ℓ and most of the area up to 1500 mg/ℓ	6.5 to 5.5
GA-RANKUWA (ODI)	The area is rather flat around 1050 to 1100m a.s.l. In the south around Ga-Rankuwa the ground rises in an isolated spot to 1400m west of Hebron to 1320m a.s.l. the area is underlain by a wide variety of rock types. Out-crops of the Bushveld, Igneous complex and more specially the Rustenburg layered suite and Rashoop Granophire suite cover large parts. The central parts are basalts and Sedimentary rocks of Karoo Sequence.	Basalt and sedimentary rocks of Karoo sequence	The hydrogeological potential of the north eastern part is high to moderate and the extreme south part is high, the remaining area have a poor ground water potential. Borehole statistics indicate that yields are generally poor. Average depth 60m failure rate 30%.	upper limit of 1500	6.5 to

Region/District	Topography & General Geomophilogical Description	Lithology	Water Potential		
				TDS	PH
TEMBA (MORETELE)	Moretele II has a very gentle drop in elevation from west to east. The area is underlain by a wide variety of rock types. Basalts and sedimentary rocks of the Karoo sequence cover the entire district.	Basalts and sedimentary rocks of the Karoo sequence	The hydrogeologicalpotential decreases from north to south	below 1500 mg/ℓ	6.5 to 5.5

2. TYPES OF WATER SUPPLY SCHEMES IN BOPHUTHATSWANA

2.1 WATER SUPPLY SCHEME IN THE RURAL AREA

Most of the rural villages in Bophuthatswana are provided with a smaller water supply scheme which can be defined as basic schemes.

The most common and general type of these basic water supply schemes operating in Bophuthatswana today are boreholes equipped with handpumps or windmills pumping to a 50m³ capacity reservoir.

Some schemes consist of a pumping station (diesel pump) with the provision of a reservoir to ensure the storage and the availability of water for the surrounding population.

At the present time the Department is engaged in the construction of more advanced borehole schemes in the rural areas. These schemes consist of one or more boreholes equipped with windmills or diesel pumps which deliver water directly into reservoirs from where it is distributed to standpipes in the village. Some of these schemes have been completed and operate in the various regions, e.g. Vaalboshoek in Taung and Bultfontein in the Thaba 'Nchu area.

Other schemes are more sophisticated such as, Kgomotso Village Scheme in Taung area. Kgomotso Scheme consists of a 100m³/day capacity purification which has been established along the Harts river and provides the entire village with potable water in the standpipes at intervals of 200m. Apies River Scheme in the Temba area which provides 8 package purification plants (Sedimentation, Filteration, Chlorination type) along the Apies river. Each plant extracting raw water from the river will provide purified water to standpipes for public use.

It is the policy of the Department to establish more similar schemes in all the populated villages in Bophuthatswana.

Regions		Boreholes	NUMBER OF EQUIPPED BOREHOLES IN USE & TYPE OF EQUIPMENT									
			Total		Windmill		Handpump/ Animal Gear		Rotary Pump Motor/Engine		Unequipped Boreholes	
			No	%	No	%	No	%	No	%	No	%
THABA 'NCHU	-	Number	291	6,8	225	9,4	30	3,3	14	2,8	22	4,6
		Percentage	100		77,5		10,3		4,8		7,6	
TAUNG	-	Number	424	9,8	334	13,9	63	6,9	19	3,8	8	1,7
	-	Percentage	100	78,8		14,8		4,5	1,9		1,9	
KUDUMANE/GANYESA	-	Number	977	22,8	697	29,1	32	3,5	94	18,7	154	32,0
	-	Percentage	100		71,3		3,3		9,6		15,8	
MOLOPO/DITSOBOTLA	-	Number	986	23,0	672	28,0	139	15,3	69	13,7	106	22,0
LEHURUTSHE	-	Percentage	100		68,1		14,1		7,0		10,8	
MADIKWE/MANKWE	-	Number	991	23,1	360	15,0	304	33,4	178	35,4	149	31,0
BAFOKENG	-	Percentage	100		36,3		30,7		18,0		15,0	
ODI/MORETELE	-	Number	296	6,9	51	2,2	162	17,8	69	13,7	14	2,9
		Percentage	100		17,3		54,7		13,3		4,7	
MORETELE II	-	Number	327	7,6	58	2,4	181	19,8	60	11,9	28	5,8
	-	Percentage	100		17,7		55,4		18,3		8,6	
TOTAL			4292	100	2397	100	911	100	503	100	481	100
			100		55,9		21,2		11,7		11,2	

NOTE: 1. Above figures are from 1984 record and does not include private boreholes and dry boreholes.

2. Included in the above figures are a number of boreholes serving major borehole schemes, namely, Heuningvlei, Mogwase, *Thaba 'Nchu Schemes.*

WATER SUPPLY SCHEMES IN URBAN AREAS

All the urban areas in the Republic of Bophuthatswana are supplied with potable water either by mutual agreement between the Republic of South Africa and Bophuthatswana or Local Regional Schemes.

TABLE 7 : URBAN AREAS SUPPLIED THROUGHOUT R.S.A. OR REGIONAL SCHEME

Regions	Urban Areas Cities	Source of Supply	Source of Water
Molopo	Mmabatho	R.S.A.	Dolomitic compartment of Molopo
Taung	Taung - Pudimoe Pampierstad Kgomotso	Regional Scheme	Vaalharts Scheme Harts River
Ganyesa	-	-	-
Tlhaping Tlharo	-	-	-
Thaba 'Nchu	Thaba 'Nchu Town Selosesha	Regional Scheme	Groothoek Dam
Mogwase	Sun City, Mogwase, Tlhabane, Pokeng	R.S.A.	Vaalkop Water Board
	Madikwe	Regional Scheme	Madikwe Dam
Odi Moretele I	Ga-Rankuwa Mabopane	R.S.A.	Rand Water Board
Moretele II	Temba	Regional Scheme	Apies River

REGIONAL SCHEMES

Regional schemes which have been established to ensure the availablility of potable water to the urban areas are conventional plants using flocculation, redimentation and rapid gravity sand filtration for the larger demands and in some instances slow sand filtration. Two diffused air flottation plants have been installed in the Temba region.

The largest purification plant treats 18Mℓ per day and is situated at Groothoek dam in Thaba 'Nchu.

Some of these regional shcemes are also combined with local schemes to supply water to the rural areas such as lower Majagoro village which has been combined with Pampierstad Water Supply Scheme in the Taung Region.

TABLE 8 - shows the major water purification plants in Bophuthatswana.

FUTURE PLANS FOR WATER SUPPLY IN BOPHUTHATSWANA

Department of Public Works and Water Affairs is responsible for control and administration of the water act and the development of water resources for domestic, agricultural and industrial purposes within the Republic of Bophuthatswana.

The Department at present time is involved with preparing a national water plan for Bophuthatswana. This plan will not only determine the policies for the development of limited water resources in Bophuthatswana, but will also suggest a completely new and practical structure to meet the entire present and long term needs and objectives such as:-

1. Pre-planning, design, construction, control, maintenance and management of entire water matters in Bophuthatswana.

2. Availability of water in developing areas and potable water to the entire population of Bophuthatswana.

3. To ensure that the necessary organisational structure and system are set up to allow for the efficient planning, financing, development, utilization and administration of water resources.

4. Determination to ensure that the limited water resources being utilized for agricultural, industrial and tourism development as a means of promoting the standards of living and employment opportunities for all Bophuthatswana Citizens.

5. To ensure the maximum protection of natural environment and usage and disposal of waste water according to the international health standards.

6. To maintain Bophuthatswana's rightful share of surface and under ground water based on the International Principals and obtaining maximum practical benefits from them.

7. To obtain the maximum financial support from the Government or any other world organization to facilitate the implimentation of the objectives.

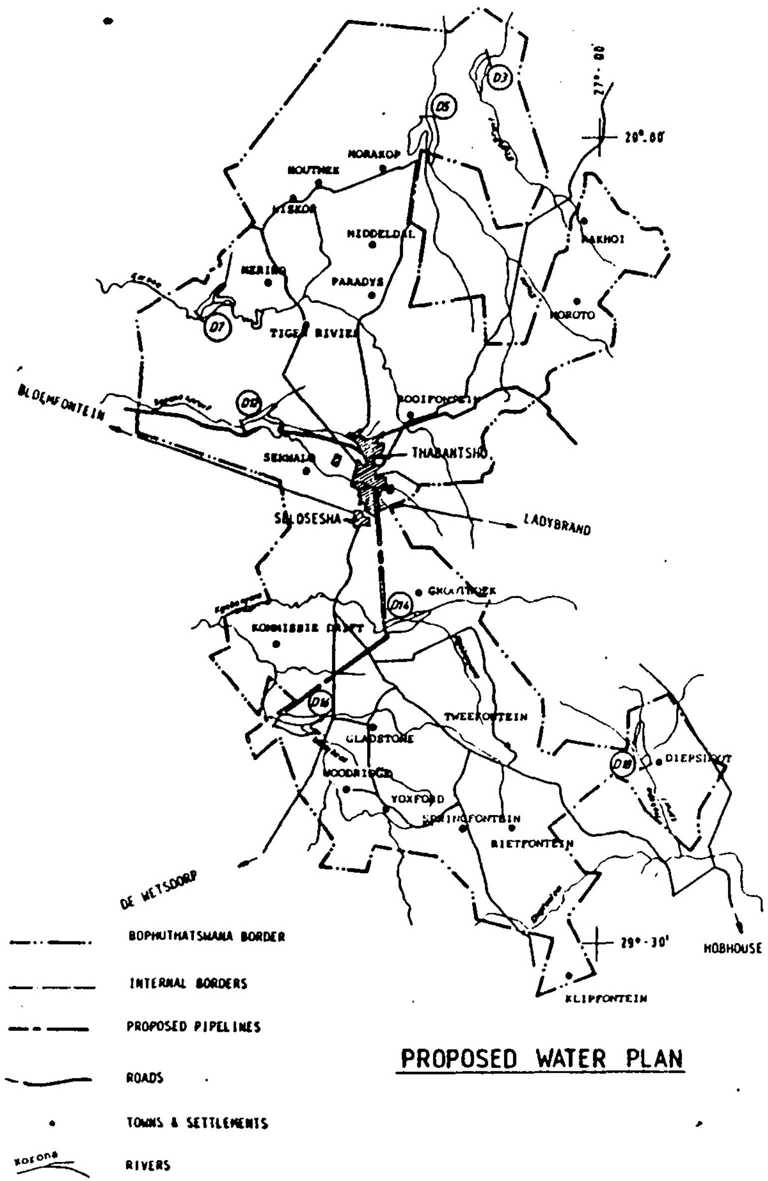
The achievement and materialization of these objectives is the dearest hope, goal and ardent desire of this Department and it would be the highest contribution towards the social foundation of this country from which the present generation and posterity will benefit.

TABLE 8 : WATER PURIFICATION PLANT

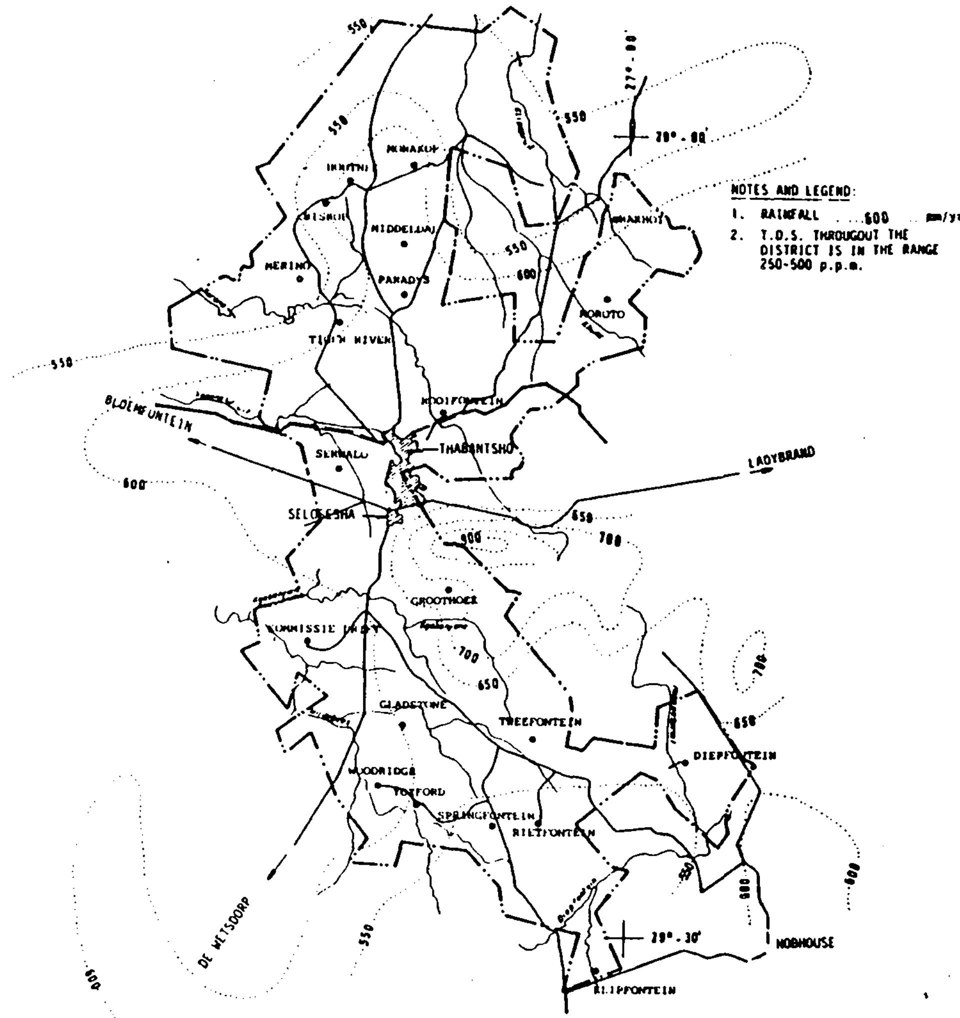
Name of the Plant	Area Served	Population Served	Source of Water	Capacity Designed	M³/Day Present Output
Temba D.A.F. Plant	Temba Town Area	19076	Apies River	12,000m³/d	6500m³/d
Moretele Teachers Training College D.A.F. Plant	College & Resident Quarters	± 1200	Apies River	430³/d	288m³/d
Temba Apies River Package Plant	Residents along Apies River	± 500	Apies River	48m³/d	48m³/d
Dinokana Eye	Lehurutshe Dinokana	68,928	Dinokana Eye Spring	5,000m³/d	5000m³/d
Madikwe	Madikwe	57,283	Madikwe Dam	7,200m³/d	3000m³/d
Motswedi	Motswedi Borakalalo	2400	Sehujwane Dam	2,450m³/d	540m³/d
Taung Pudimoe	Taung Pudimoe	Taung 5976 Pudimoe 3826	Vaalharts Irrigation Scheme	5,000m³/d	3000m³/d
Pampierstad	Pampierstad	15,037	Vaalharts Scheme	5,000m³/d	3000m³/d
Groothoek Dam	Thaba 'Nchu Selosesha	6,034 5,000	Groothoek Dam	18,000m³/d	3000m³/d
Selosesha	Selosesha	5,000	Selosesha Dam	2,500m³/d	2500m³/d
Kgomotso	Kgomotso Settlement	3,132	Vaalharts River	1,200m³/d	800m³/d

Name of the Plant	Area Served	Population Served	Source of Water	Capacity Designed	M^3/day Present Output
Water supplied from Magalies Water Board	Mogwase George Stegmann Hospital Sun City Tlhabane Saulspooort	82,710	Vaalkop Dam	-	8000m^3/d con-sumption
Water supplied from Rand Water Board	Klipgat Mabopane Ga-Rankuwa Soshanguve Winterveld	229000	Rand Water Board	-	40000m^3/d con-sumption

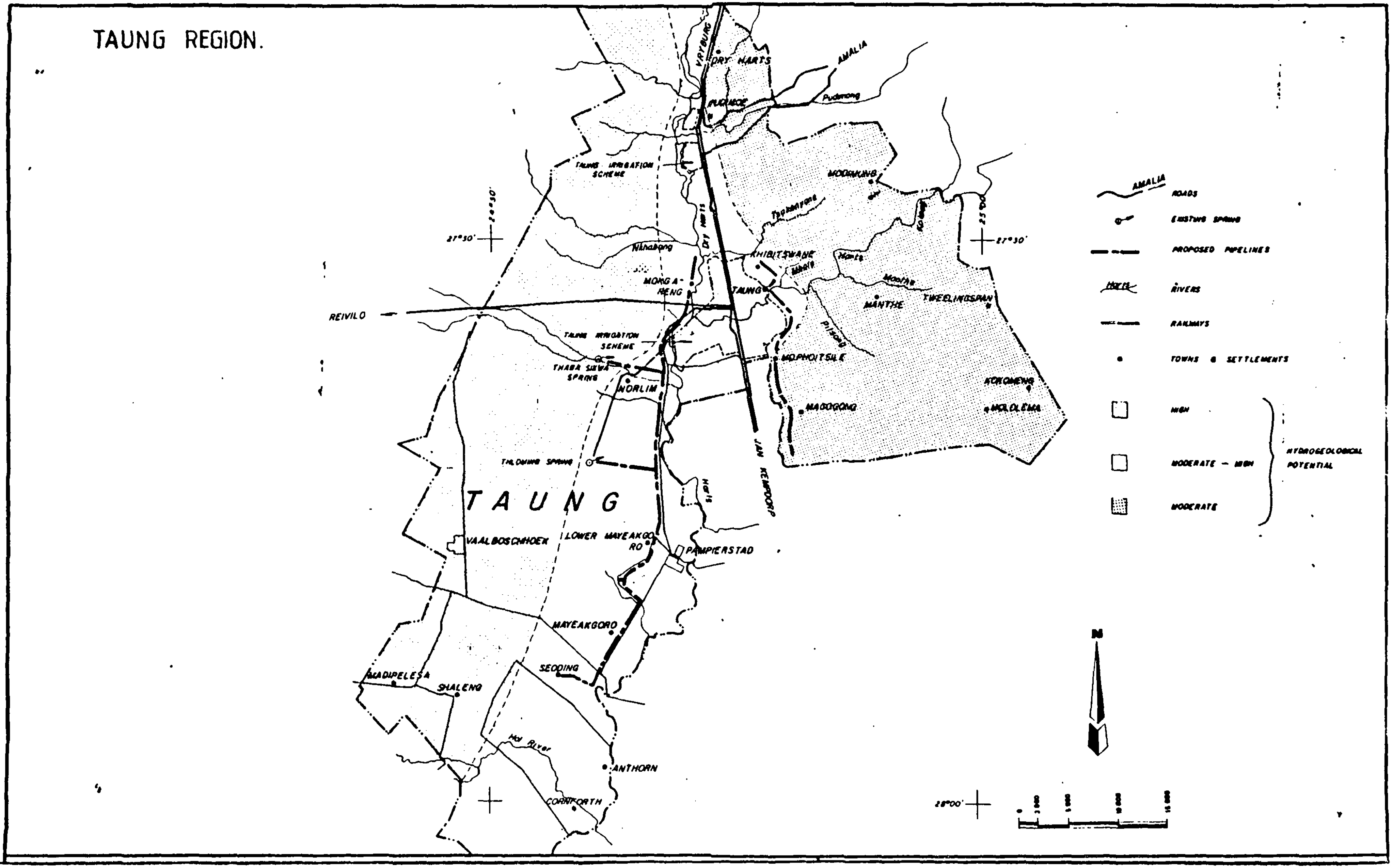
THABA-NCHU REGION.

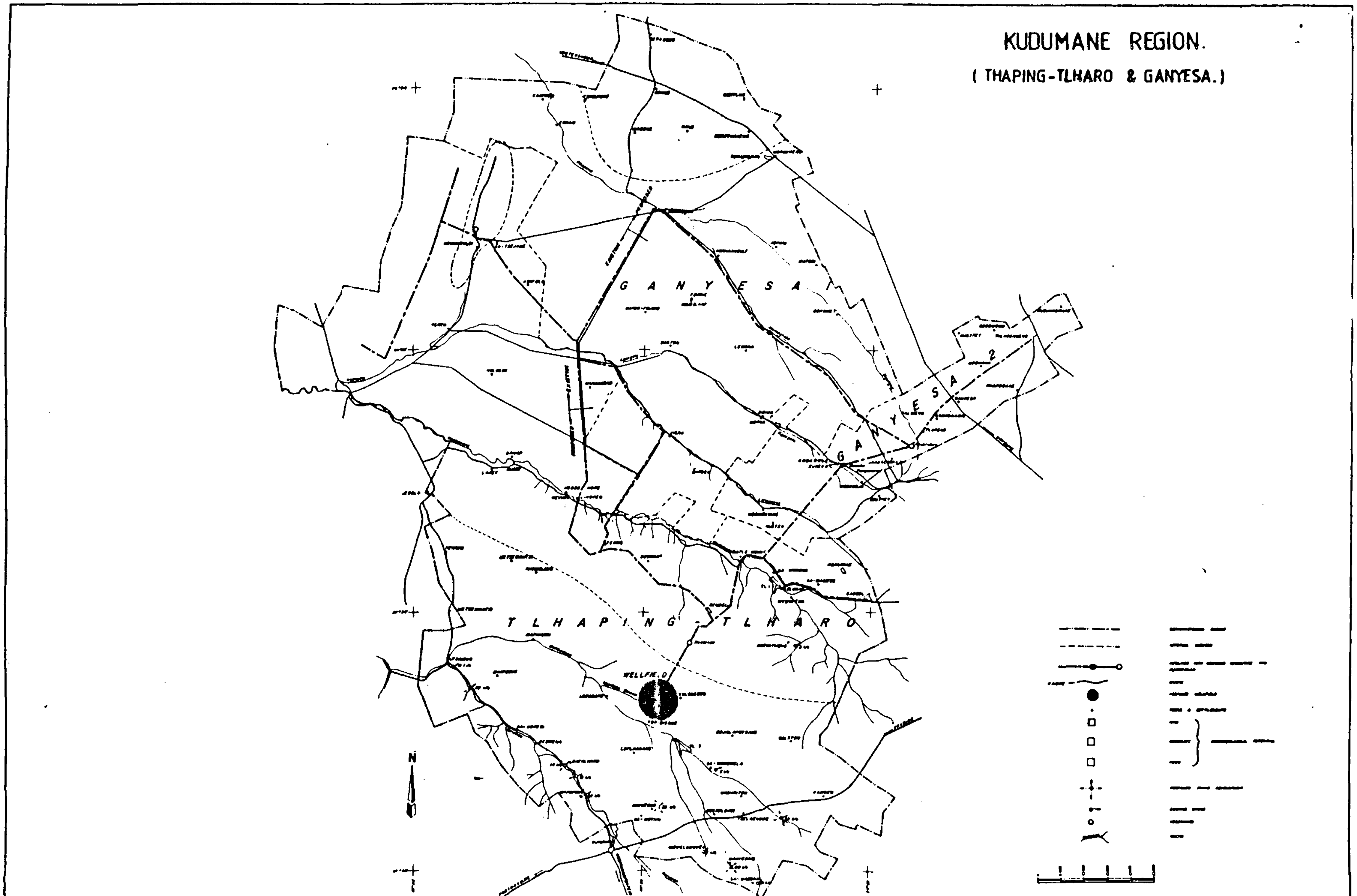


PROPOSED WATER PLAN



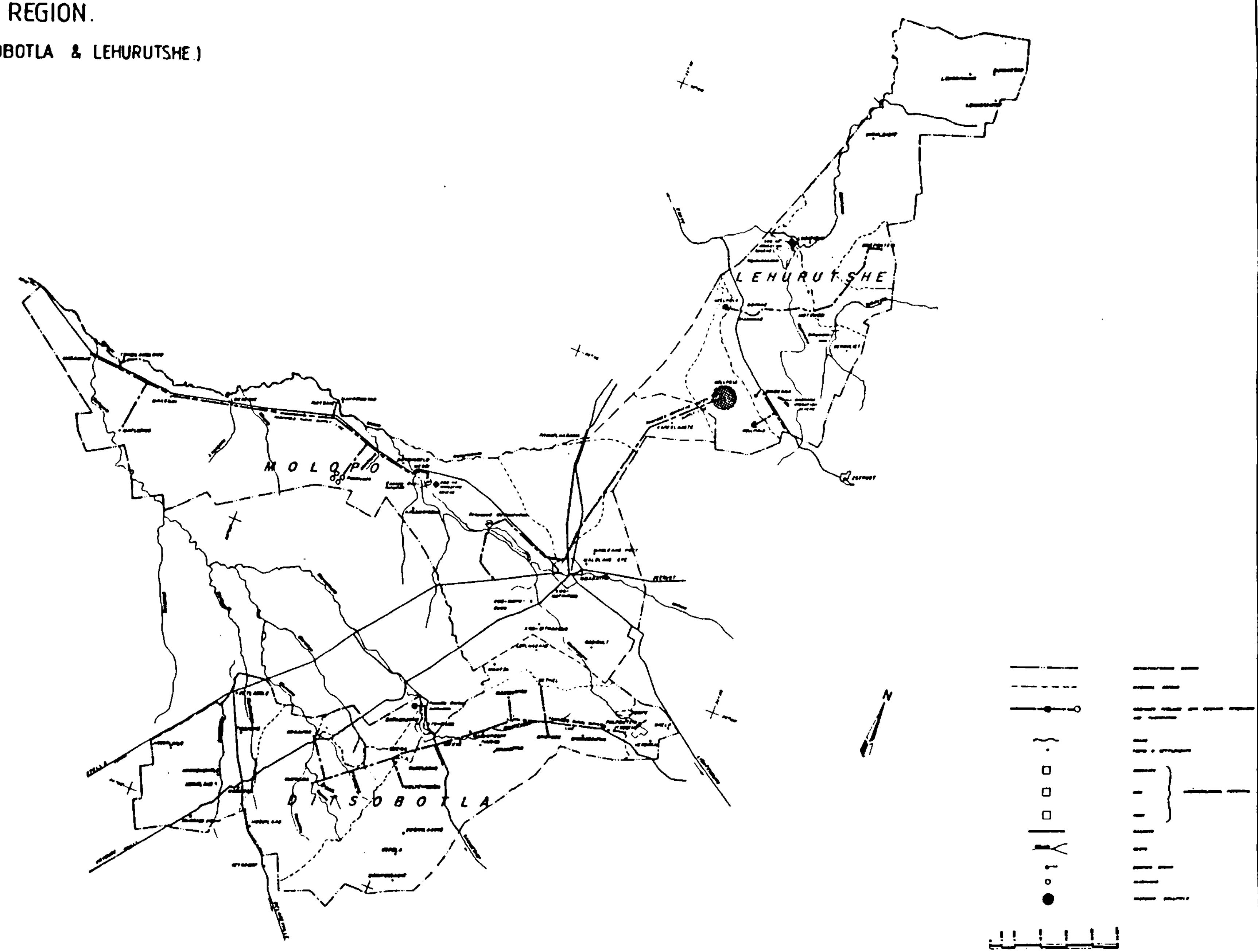
HYDROGEOLOGICAL MAP

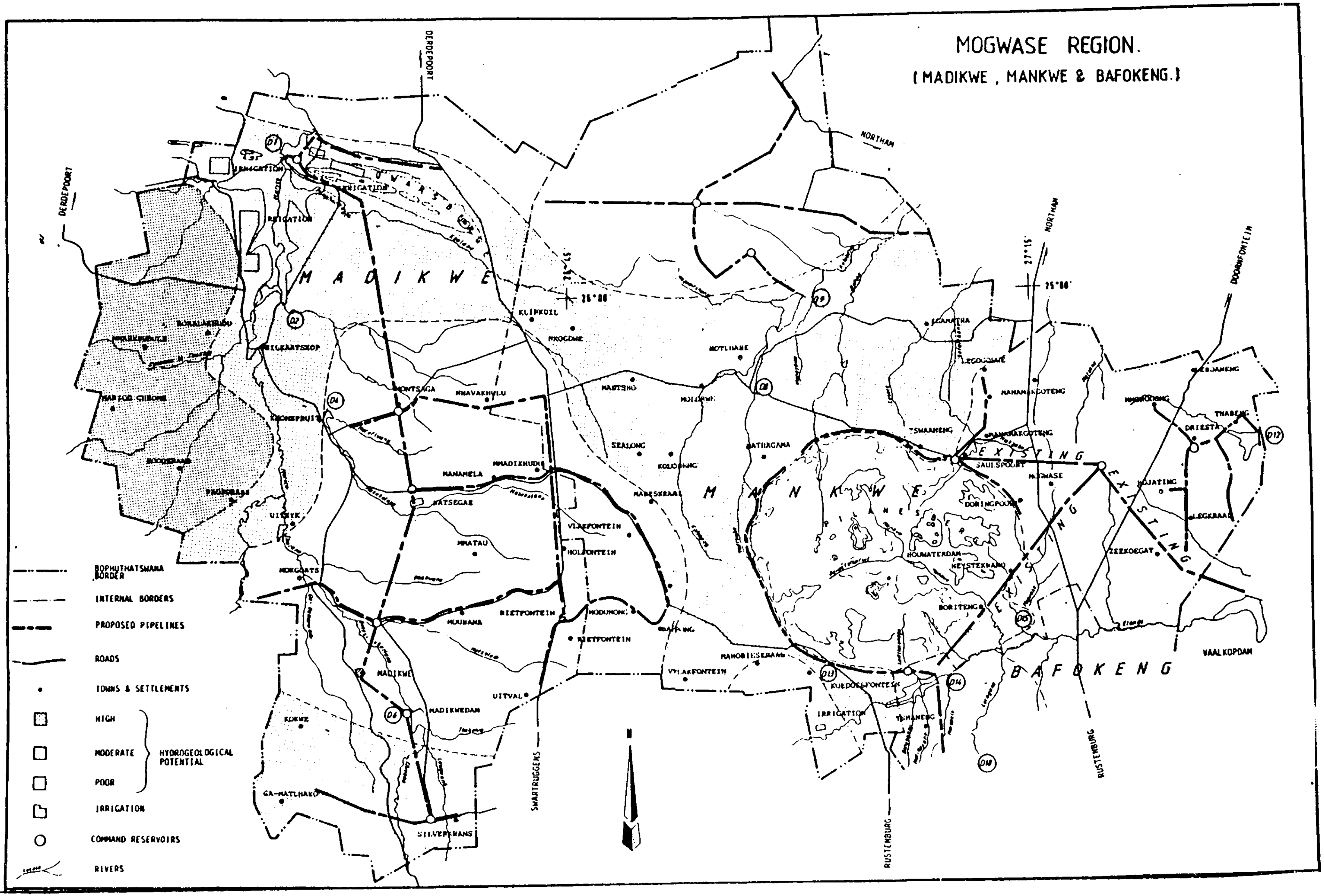

TAUNG REGION.
DRY HARTS
AMALIA
Pudimong
VRYBURG
TAUNG IRRIGATION SCHEME
MOORMUNG
Tlokwane
KHIBITSWANE
Nkhabong
MORGA-RENG
TAUNG
Harts
MANTHE
TWEELINGSPAN
REIVILO
TAUNG IRRIGATION SCHEME
THABA SIKWA SPRING
NORLIM
MOPHOITSILE
KOKOMENG
MAGOGONG
MOLOLEMA
TLHOWING SPRING
JAN KEMPDORP
TAUNG
VAALBOSCHHOEK
LOWER MAYEAKGORO
PAMPIERSTAD
MAYEAKGORO
SEODING
MADIPELESA
SHALENG
Hol River
ANTHORN
CORNFORTH
27°30'
24°30'
25°00'
28°00'
N
ROADS
EXISTING SPRING
PROPOSED PIPELINES
RIVERS
RAILWAYS
TOWNS & SETTLEMENTS
HIGH
MODERATE – HIGH
MODERATE
HYDROGEOLOGICAL POTENTIAL


KUDUMANE REGION.
(THAPING-TLHARO & GANYESA.)
G A N Y E S A 1
G A N Y E S A 2
T L H A P I N G - T L H A R O
WELLFIELD
N

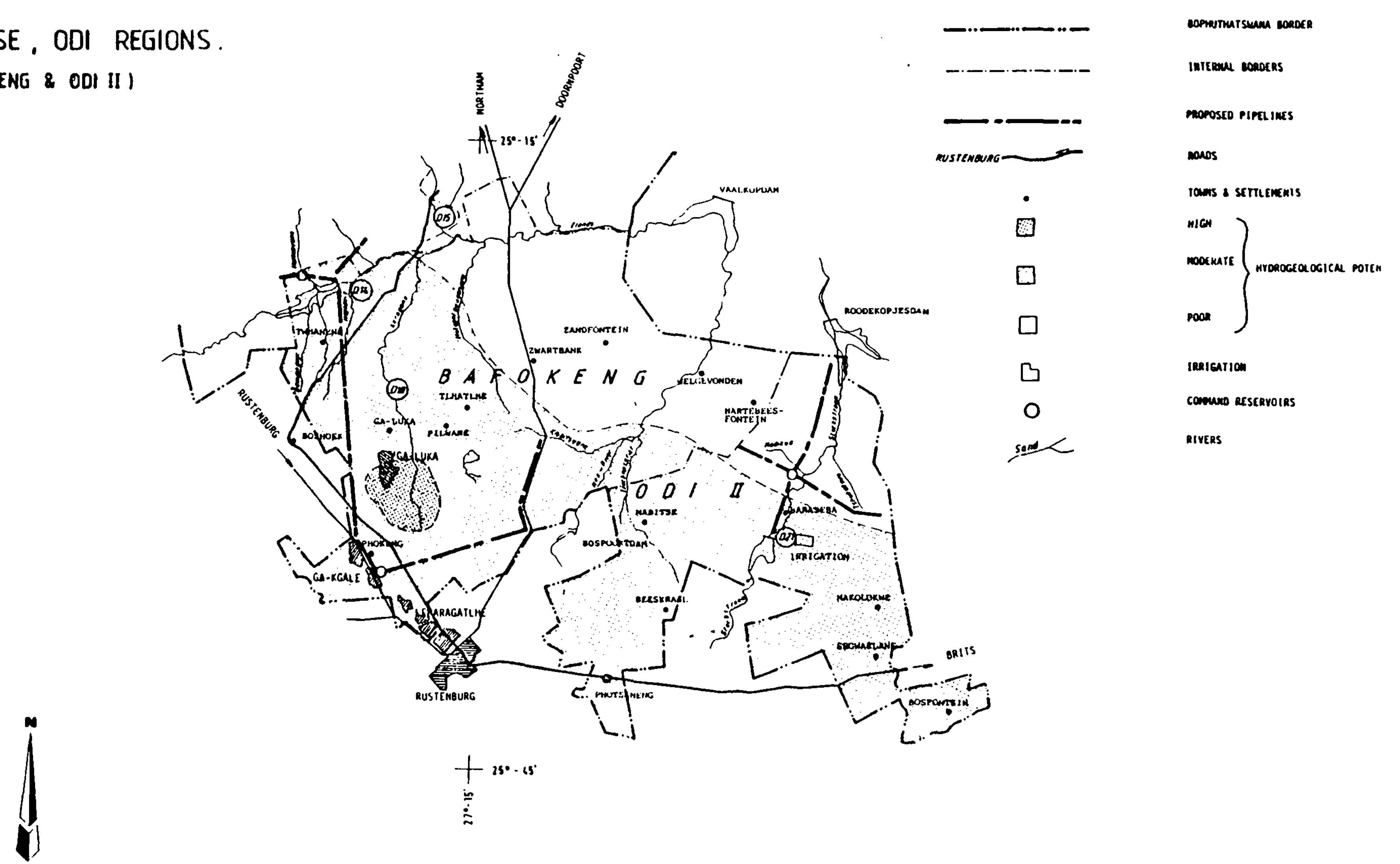
MOLOPO REGION.

(MOLOPO, DITSOBOTLA & LEHURUTSHE)

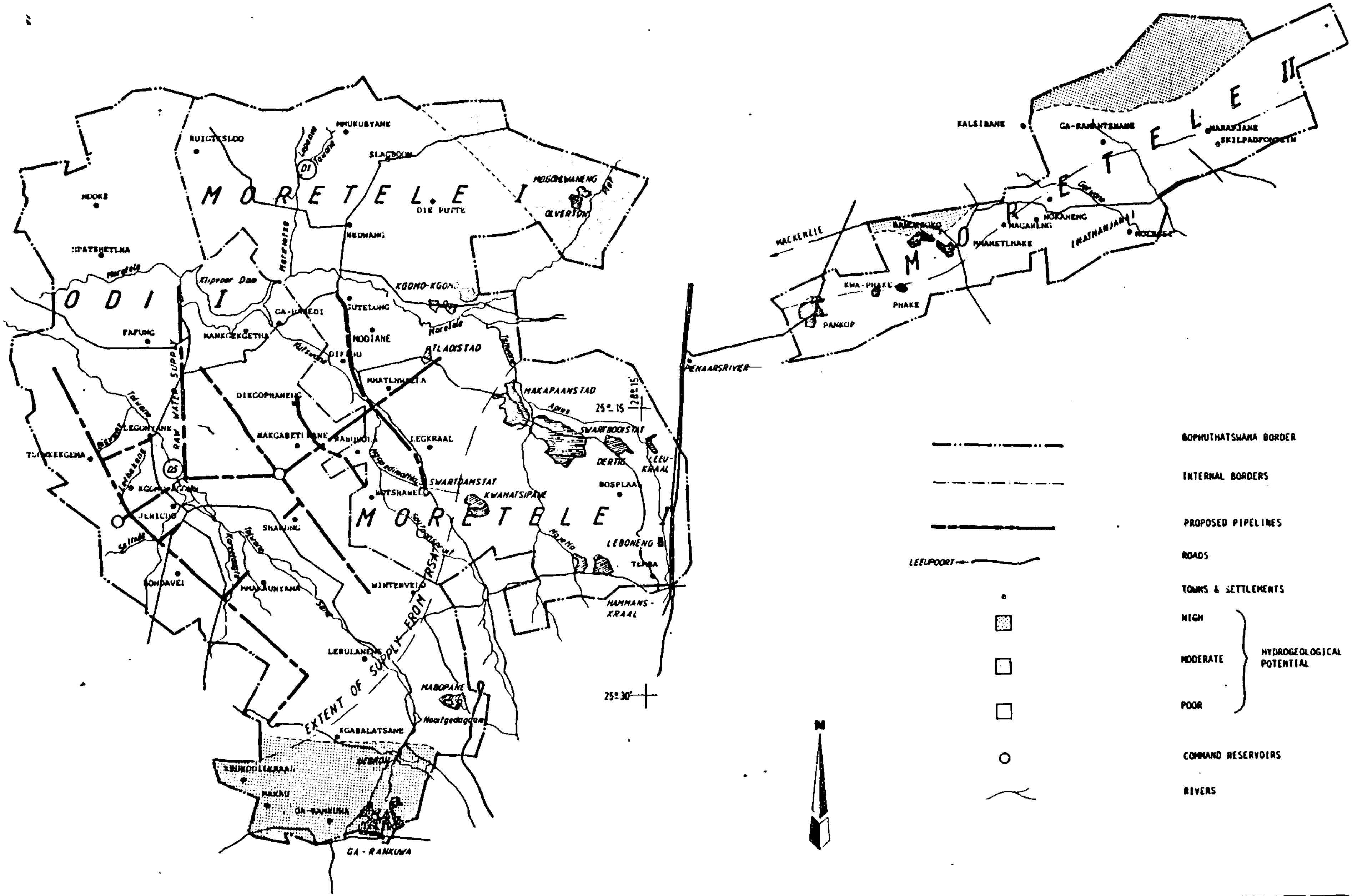


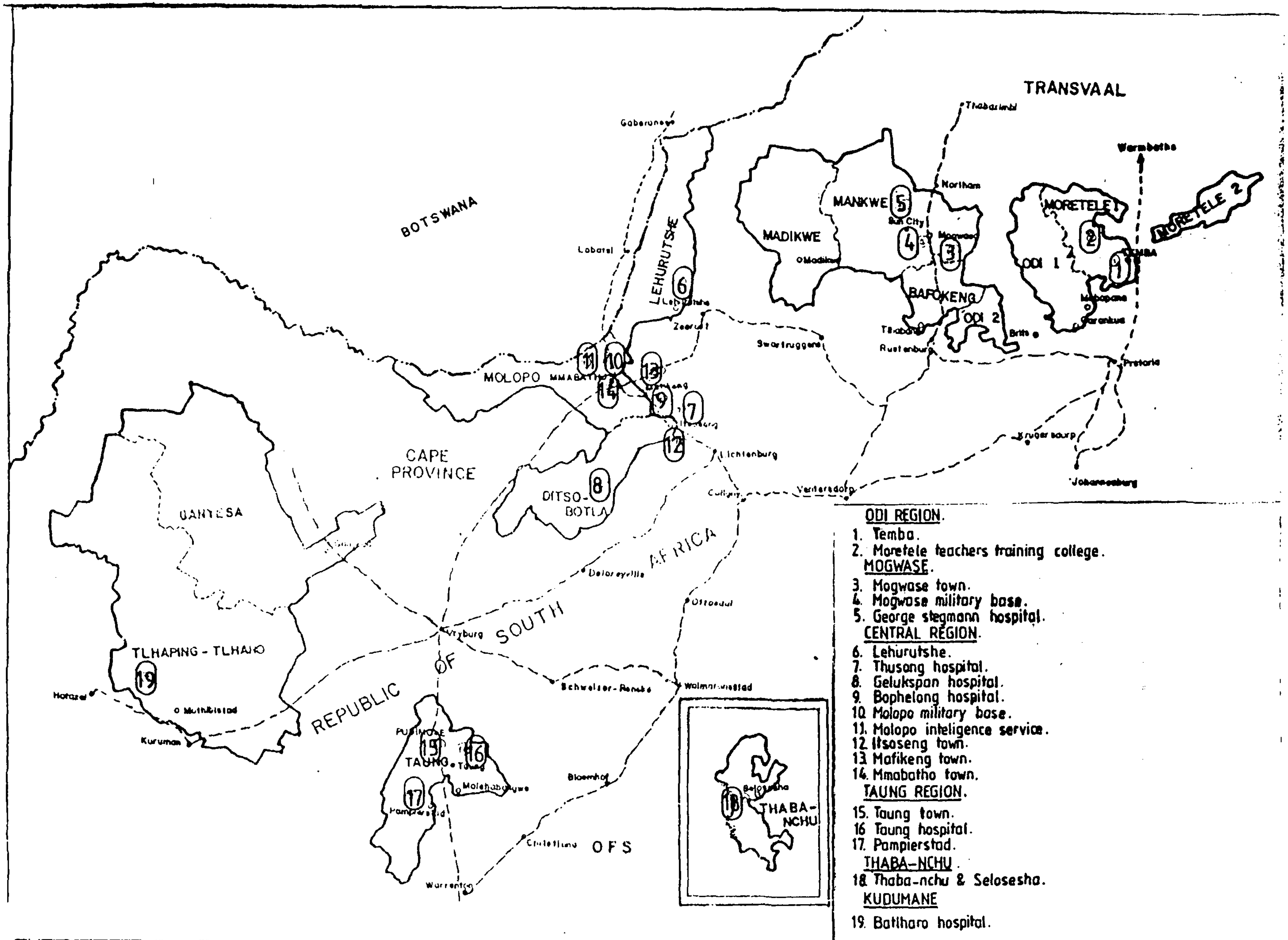

MOGWASE REGION.
(MADIKWE, MANKWE & BAFOKENG.)
MADIKWE
MANKWE
BAFOKENG
DERDEPOORT
NORTHAM
SWARTRUGGENS
RUSTENBURG
DOORNFONTEIN
VAALKOPDAM
EXISTING
BOPHUTHATSWANA BORDER
INTERNAL BORDERS
PROPOSED PIPELINES
ROADS
TOWNS & SETTLEMENTS
HIGH
MODERATE
POOR
HYDROGEOLOGICAL POTENTIAL
IRRIGATION
COMMAND RESERVOIRS
RIVERS

MOGWASE , ODI REGIONS .
(BAFOKENG & ODI II)



ODI, MORETELE REGIONS.





ODI REGION.
1. Temba.
2. Moretele teachers training college.

MOGWASE.
3. Mogwase town.
4. Mogwase military base.
5. George stegmann hospital.

CENTRAL REGION.
6. Lehurutshe.
7. Thusong hospital.
8. Gelukspan hospital.
9. Bophelong hospital.
10. Molopo military base.
11. Molopo inteligence service.
12. Itsoseng town.
13. Mafikeng town.
14. Mmabatho town.

TAUNG REGION.
15. Taung town.
16. Taung hospital.
17. Pampierstad.

THABA-NCHU.
18. Thaba-nchu & Selosesha.

KUDUMANE
19. Batlharo hospital.

PAPER: 1.2

CURRENT STATUS OF SANITATION IN THE REPUBLIC OF BOPHUTHATSWANA

S.P. ANDREWS
C.ENG. M.I.C.E. M.I.W.P.C.
DEPARTMENT OF PUBLIC WORKS AND WATER AFFAIRS
PRIVATE BAG X2037
MAFIKENG
8670

SYNOPSIS

The responsibilities of the Water Affairs Branch of the Department of Public Works and Water Affairs Bophuthatswana are not only restricted to the supply of water to a variety of population groups as outlined in the preceeding paper, but in addition endeavours to operate and maintain numerous waste water treatment plants around the Country.

Treatment processes are varied ranging from oxidation ponds to activated sludge treatment in the Urban areas and from septic tanks to no form of treatment at all in the Rural areas.

The only centres where the Department is not involved in waste water treatment are Sun City, the Thaba 'Nchu Sun and the City of Mmabatho.

INTRODUCTION

As previously stated the estimated population of Bophuthatswana is in the order of 3,0m of this number, and Mmabatho is included, some 750 000 people are served by water borne sewerage systems and hence some form of sewage treatment.

Locations of sewage treatment plants throughout the Country are indicated on the map which appears on page 14 of this paper and it will be apparent that facilities are generally remote from one another.

It must be pointed out that there will be inaccuracies relating to population served and sewage flows indicated in this paper. This is due to the lack of reliable census information and to totally inadequate flow measuring devices at some installations or no flow measuring instruments at all in many cases.

Table 1, indicates the various centres in Bophuthatswana which are served by some form of sewage treatment, the approximate population served, the design capacity of each system and the form of treatment employed.

It will be noted that in addition to Municipal waste water treatment plants, the Department of Public Works and Water Affairs operates and maintains sewage treatment facilities on behalf of the Department of Health, Education, Prisons, Defence and the Intelligence Service.

A large proportion of the sewage treatment plants listed were constructed before Independence and it will be seen that a variety of treatment methods have been adopted. For example the sewage treatment plant at Klipgat, which is in the highly densely populated Odi 1 region is based on the trickling filter process, whereas the population of the Rural Town of Itsoseng is served by an oxidation pond system.

The reason for this is perhaps due to different financing agencies being being involved.

Establishments such as the Molopo Military Base and the Teachers Training College at Moretele, which were constructed since Independence, are served by Bio Disc Units. These installations were constructed as part of the overall development of the Institution and regrettably without apparent consultation with the Water Affairs Branch of the Department of Public Works and Water Affairs. I trust a similar situation will not occur when future establishments are constructed.

Following Independence sewage treatment facilities in the Municipal areas have been constructed employing both the activated sludge process and trickling filtration, with the exception of Lehurutshe and Mogwase where temporary oxidation ponds have been installed.

It will be recognised therefore due to the wide variety of treatment methods to be controlled and the spread out nature of the Country the Departments task is somewhat daunting.

The title of this paper is somewhat restrictive if taken literally and therefore I wish to proceed on the basis of the situation of sanitation in Bophuthatswana and how I view it.

I will therefore consider the following points:

Urban Sanitation

Main Drainage

Raw Sewage Pumping

Sewage Treatment Processes, Design, Operation and Maintenance

Rural Sanitation

MAIN DRAINAGE

In all the Department of Public Works and Water Affairs maintains approximately 550 km of sewer pipes of various dimensions in the Urban Centres of Kudube (Temba), Ga Rankuwa, Mabopane, Mogwase, Tlhabane, Lehurutshe, Taung, Selosesha and Itsoseng.

Few problems are experienced due to sewer blockages which would indicate soundly designed and constructed systems.

RAW SEWAGE PUMPING

Due to the generally flat nature of the terrain in Bophuthatswana, sewage arriving at treatment plants usually necessitates the introduction of pumping installations. The Department operates and maintains some 25 Raw Sewage Pumping Stations throughout the Country. The types of pumping equipment installed range from small submersible type pumps to large vertical spindle units.

Obviously pumping stations are deep and almost all have no form of screening or grit removal facilities provided in order to protect the pumps. Consequently frequent blockages are experienced and a considerable number of motors are "burnt out" annually. Although many motors are protected against overload conditions they still burn out. At present this phenomenon is not understood, however investigations are being carried out and perhaps a solution will be found.

At one of the major Municipal waste water treatment plants raw sewage is collected at a large pumping station which is equipped with duplicate vertical spindle pumps each capable of discharging 80 ℓ/sec. The pumps are protected by a hand raked screen located some four metres below ground level which is reached by means of a vertical ladder. The situation is dangerous and consequently the pump attendant is reluctant to clean the screen and therefore even these large pumps become choked.

The burning of motors causes inconvenience and they are expensive to re-wind. I would therefore appeal to Engineers to give greater thought to the design of raw sewage pumping stations both from the point of view of pump protection and ease of maintenance. Perhaps a competition for the best designed raw sewage pumping station should be launched, always bearing in mind cost.

SEWAGE TREATMENT, PROCESSES, DESIGN, OPERATIONS AND MAINTENANCE

I wish to now turn to the above aspects and although I may be considered to be critical my criticism is intended to be constructive. This section may be considered in four parts based on the types of sewage treatment plants operated by the Department.

TRICKLING FILTERS

At present the Department operates two trickling filter type plants, one at Klipgat in the Odi Region and the second at Kudube in the Moretele 1 Region. A third unit is under construction at Pampierstad in the Taung Region. The Klipgat plant was designed to treat a sewage flow of approximately 33 000 m^3/day and serves the population of Ga Rankuwa, Mabopane and Soshanguve. The treatment plant is situated on a piece of land 6 ha in extent and the labour force establishment is approximately 120 persons. However at the moment the compliment is roughly 80. The plant is therefore very much understaffed. The vast area of the site requires a high degree of road maintenance and grass cutting.

The entire process employs mechanical screenings removal, manually cleaned grit channels, primary sedimentation, biological filtration, secondary filtration, rapid gravity filtration, preceeded by chlorination, final polishing by means of a maturation pond to discharge to the Sand River.

Sludge is removed from both sedimentation phases and pumped to heated sludge digesters. Supernatant liquor is withdrawn from the Digestors and returned for full treatment. Digested sludge is discharged to drying beds.

There are several basic design faults incorporated in the plant and these combined with poor maintenance are instrumental in the production of a very poor quality effluent.

Proposals are in hand for the implementation of a scheme intended to rectify the situation, the first of which will be to replace the twelve rotary distributors at a cost of R200 000,00. Whereever possible remedial measures will be carried out departmentally and all new equipment will be purchased against departmentally produced specifications.

The Kudube treatment plant is designed to treat some 4 500 m^3 of domestic and industrial waste daily. Although the plant is understaffed it is well maintained and produces a good quality effluent which is discharged to a set of five maturation ponds which originally served the town of Kudube. There are some aspects of the Kudube plant which cause concern, one of which is the operation of some 80 sluice valves, fortunately not all at the same time.

ACTIVATED SLUDGE

At present a three stage activated sludge sewage treatment plant serves the town of Selosesha in the Thaba Nchu Region and the City of Mmabatho controls the operation of two activated sludge plants.

At the Gelukspan, Thusong and Bophelong Hospitals "Orbal" plants have been installed to deal with waste water emanating from these establishments.

The Selosesha plant generally gives trouble free operation, the only difficulties being experienced to date have been related to the blockage of the return activated sludge pumps and consequently burnt out motors. In order to overcome this problem three different sets of overload devices have been fitted.

Staffing levels are small, consisting of one qualified operator, 6 labourers and 3 watchmen.

Effluent quality is normally very good and following chlorination the effluent is discharged to a stream and thence to a small dam.

The "Orbal" plants all produce high quality effluent, staffing levels are low and maintenance is simple. All three "Orbal" plants are in excess of 20 years of age and the unit at Thusong is operated by one labourer.

A fourth "Orbal" plant is under construction at Mogwase and three others are planned for Taung, Rooigrond Prison and the George Stegman Hospital.

<u>POND SYSTEMS</u>

There are several sets of oxidation ponds in Bophuthatswana, all of which appear to have been designed using different parameters. At present these are located at Mogwase (2 sets), Taung Town, Taung Hospital, Unibo, also at Taung, Lehurutshe, George Stegman Hospital, Pampierstad and Batlharo Hospital.

Generally pond systems are out of sight, out of mind and unmanned. Over recent years little or no maintenance has been carried out of any pond system, however, measures have been taken to rectify this situation and, hopefully before the end of the current finacial year a complete maintenance scheme will have been carried out.

Proposals are in hand to phase out most pond systems as and when they become overloaded.

BIO DISC UNITS

Three systems of this type are at present in operation, one at the Molopo Military Base, a second at the Kudube Training Centre and the third one serves the Moretele Teachers Training College.

All three installations receive pumped raw sewage flows and due to lack of pump protection frequent problems due to blockages which cause motors to be burnt out arise. Maintenance to date has been extremely poor through a lack of staff. Consequently the Department has expended considerable sums of money replacing gearboxes, motors, drive chains, cogs and bio-discs.

Unless regularly attended to the Bio Disc type treatment plant appears to be the most vulnerable installation.

HYBRID SYSTEM

There is an existing sewage treatment plant at the Rooigrond Prison which consists of anaerobic treatment in a large concrete tank followed by what could only be described as a revolving high rate roughing filter and then sedimentation. It does not work and to the best of my knowledge never has.

We have all heard of and probably seen Sanitary Lanes, however I have only recently discovered what these were used for as far as human waste disposal was concerned. Before the advent of water borne sewerage systems human waste was collected from each household by the local Sanitation Department. Traditionally toilets were constructed at the "bottom of the garden" adjacent to a Sanitary Lane. Inside the toilet was a "bucket", over which a removable seat was placed.

At the rear of each toilet facing the Sanitary Lane, a hole was left in the brickwork and a hinged door fitted over the hole. Under normal circumstances, the door was locked from the inside. However at times of collection the onus was on the property owner to see that the door was unlocked in order that the Sanitation Department could remove the bucket from the hole and empty the contents into the Pail Tanker. It was an offence for the door to be locked when collection was due and even as far back as 1898 the owner was fined a sum of £1 should he be guilty of this offence.

Many of the older houses in Mafikeng had this system of sanitation and signs of where the holes in the wall were left and where the hinged door was fitted can still be seen.

The only centres where "bucket" human waste disposal is still practiced in Bophuthatswana are at Thaba Nchu, Taung and a few houses in the old Railway Reserve Mafikeng. These will be phased out in the near future and replaced by fully water borne sewage system.

SEPTIC TANKS

There are very few houses in urban areas of the Country which are served by septic tanks.

RURAL SANITATION

There is little evidence of the use of septic tanks in the Rural areas of Bophuthatswana, probably due to the scarcity of water, unsuitable soil conditions and the relatively high cost of construction.

DRY WASTE DISPOSAL

It has previously been stated that approximately 75 % of the total population of Bophuthatswana live in the Rural areas. The type of development that has taken place in the Rural regions, has been termed "informal". Generally, stand or plot sizes are large, water supplies are scarce, water has to be carried long distances and therefore the volume of waste matter generated is relatively small compared with that emanating from the Urban Areas which contains a high proportion of water.

The Rural population has therefore resorted to simple forms of human waste disposal ranging from none whatsoever to "dry pit latrines".

We have all heard of the term "long drop", and I have endeavoured to establish when and where the term long drop was derived. Unfortunately I have been unable to learn of the exact origin,however a learned friend of mine informed me that they were incorpacted in many of the Medieval Castles of Europe. Not perhaps a particularly savoury topic, but toilets were placed high in the turrets of the castles which overlooked the inevitable moat. I believe the ladies used the upper levels and the gentlemen the lower. I am given to understand that toilets were so designed that the lower level users were not inundated by the high level participants. This could therefore be the origin of the "long Drop" which today is really in the form of a "short drop".

I recently conducted a brief survey of the "dry waste" disposal of human' waste in the Rural Areas adjacent to Mmabatho and Mafikeng and found that basically "short drops" prevailed.

Of the many houses that were visited it was evident that as far as householders are concerned, simple pit latrines are hyginically acceptable.

The pits are generally shallow, being no deeper than a couple of meters. In most soil types found in Bophuthatswana it is not necessary to line the pits. A simple concrete slab with a hole in the centre is constructed over the pit and a toilet placed on top of the slab.

Many of the toilets have no means of ventilation however I did not see any evidence of fly breeding or notice malodours. The use of coarse toilet paper of the printed type is quite acceptable as there are no pipes which could block.

Structures over the dry pit, have been built from a variety of materials ranging from prefabricated units, which are not particularly attractive, to plastered brick, galvanised sheeting and locally obtained stone.

The inevitable question will no doubt spring into our minds, what about the pollution of underground water supplies?

I have previously stated that "informal settlements" are widely spaced and generally water supplies of an underground nature are remoted from development, water is carried long distances by villagers and is used sparingly. The amount of waste water therefore generated is very small and I have found no evidence of the pollution of underground water supplies due to human excrement.

There have never to my knowledge, been cases of water borne deseases in the truly Rural Areas of Bophuthatswana, where water is obtained from underground sources.

You will be visiting a school tomorrow which is attended by 785 students and staffed by 18 teachers. The form of sanitation ? Pit latrines. If you find the situation unhygenic or offensive I shall be surprised. You will also note that the School is served by a single borehole to which is fitted a windmill. The borehole is less than 300 m from the School latrines, and yet there is no induction whatsoever of faecal pollution notwithstanding the fact that the establishment has been in operation for some 12 years.

CONCLUSIONS

I will conclude by saying that the activated sludge form of sewage treatment appears to have the most advantages in that the systems maybe relatively cheaply constructed, it is versatile and easily maintained.

More thought should be given to the design of raw sewage pumping stations and maintenance of existing installation should be improved which will require more staff.

We should, therefore, ask ourselves what is wrong with the dry pit human waste disposal system for the Rural Areas and at what stage should it be considered necessary to provide sophisticated, expensive, water borne sanitation?

TABLE NO 2

SEWAGE TREATMENT PLANT IN BOPHUTHATSWANA

NAME OF PLACE	POPULATION	CAPACITY m^3/day	TYPE
1. Temba	45 000	4,5 Mℓ/d	Biological Filters
2. Moretele TTC	± 900	140m^3/d	Bio Discs
3. Klipgat	122 000	33 Mℓ/d Present load ± 40 Mℓ/d	Biological Filters
4. Mogwase	30 000	5,0 m^3/d	Matruation Ponds
5. Lehurutshe	3 850	1 848 m^3/d	Maturation Ponds
6. Molopo Mil. Base	446	160m^3/d	Bio Discs
7. Kudube Training Centre	250	140 m^3/d	Bio Discs
8. Taung Town	3 826		Maturation Ponds
9. Bophelong Hosp.	±3 000	for 2 500 persons	Orbal Plant
10. Gelukspan Hosp.	1 000	1 100 persons	Orbal Plant
11. Itsoseng	18 673		Maturation Ponds
12. Thusong Hosp,	132		Orbal Plant
13. Rooigrond Prison	277		Bio Discs (Now ponds)
14, Pampierstad	15 037	4,0 Mℓ/d	Bio Filters
15. Selosesha	6 034	10,0 Mℓ/d	Activated Sludge
16. Bafokeng Civic	3 500		Bio Discs
17. George Stegman			Maturation Ponds
18. Batlharos Hosp.			Maturation Ponds with activated sludge recircling

Contents

PAPER: 1.3

SOLID WASTES DISPOSAL IN DEVELOPING AREAS

S J VERRIER

Pr. Eng., CE, MICE, MI(Mun)E., M(SA)1 CE, FIWM

CITY COUNCIL OF JOHANNESBURG
CITY ENGINEER'S DEPARTMENT
P O Box 4323
JOHANNESBURG
2000

SOLID WASTES DISPOSAL IN DEVELOPING AREAS

INTRODUCTION

In the time available it would be impossible to make a state of the art exposition of the scientific and technical principles involved in the disposal of wastes, even if I were qualified to do so. By the same token it is not possible to attempt to present a paper dealing with recent research. Both of these aspects are covered in numerous publications which are available through the Council for Scientific and Industrial Research and the Universities, both here and overseas. As a practising solid wastes manager I will therefore attempt to give a perspective of the current situation in South Africa and perhaps indicate a few of the steps that could be taken to improve current disposal practices.

As most people are aware there are substantial differences between European and American thinking on the question of waste disposal. For example in the United States the co-disposal of hazardous and domestic wastes is not supported and a growing number of people believe that alternatives to sanitary landfilling must be found. These views have led to the promulgation of legislation which is intended to control wastes from the cradle to the grave.[1] On the other hand many Europeans accept co-disposal and believe that waste disposal technology can achieve an acceptable balance between adequate protection of the environment and the rising cost of disposal. Nevertheless, in Europe there is a growing lobby which is seeking alternative solutions to traditional landfilling, such as composting and incineration. However, even these technologies are not without problems and the residues of these processes have to be landfilled, but under increasingly stringent conditions in Europe.

The current situation in South Africa

There is some difficulty in defining a 'developing area', the reason being that unless the economy is well into a post-industrial phase with zero population growth, development will be taking place. Many people consider a developing area to be a rural village or town which is expanding rapidly as a result of urbanisation and population growth. There are numerous local examples of this phenomenon in the independent States of Southern Africa with which many people are undoubtedly familiar. Examples would be Gabarone in Botswana, the Winterveld in Bophutatswana and Soshanguve in South Africa. However, the major metropolitan areas of South Africa, i.e. the PWV, Durban/Pinetown, Port Elizabeth/Uitenhage and Western Cape metropolitan regions are also developing at a rapid rate, which can only increase with the scrapping of the influx control legislation. In many respects the disposal of wastes in the metropolitan regions is a much more difficult problem than that in the rural areas due to the presence of large numbers of people.

In the metropolitan regions it is increasingly difficult to find suitable land for waste disposal. The reasons are the competing requirements for residential, commercial, industrial and recreational uses, together with increasing socio-political pressures against the use of available land for waste disposal purposes. This pressure is a reality facing all solid wastes managers and decision makers who are dealing with the need for future waste disposal sites in the metropolitan regions and is not restricted to any one socio-economic group. For some time it has become increasingly apparent that the public accepts the need for disposal sites but is intolerant of sites which are located in developed or developing areas. Consequently many of the new waste disposal sites are remote from the areas of waste generation. At the same time the level of expertise in the metropolitan regions has risen with the result that more attention is now paid to important hydrogeological considerations. This is a new phenomenon which in the past played little or no part in the commissioning of waste disposal sites. Furthermore, the government has also become aware of the possible negative impacts of waste disposal on the environment and has introduced legislation[2] which is designed to limit these negative impacts. The situation in the metropolitan regions is therefore one of increasing difficulty in commissioning new waste disposal sites within economic haul distances of the centres of waste generation. The inevitable consequence has been rapidly escalating disposal costs. In fact certain metropolitan regions could soon face the same situation that prevails in several metropolitan regions overseas where the disposal authorities have had to transport urban wastes over distances of up to 150km or more and in some cases even across international boundaries in order to satisfy legal, social and political pressures and requirements.

On the other hand waste disposal in urban developments in the rural areas presents problems which are very seldom addressed during the early years of the development, which is when they should be solved. Consequently visits to many of the major developing urban areas in Southern Africa will show that the systems used for the collection and disposal of wastes are poor and that the negative aspects of these services on the environment are substantial, and in some cases irreversible. Certain people may be aware of the waste disposal situation in these developing areas and can verify that waste is often indiscriminently deposited in natural watercourses, vleis and other situations where the waste is in contact with ground water. Unfortunately many of these communities depend on local surface and ground water for their potable water supplies. Furthermore, very often there is no infrastructure in these communities for the rendering of essential waste collection and disposal services on a community basis, with the result that, in some cases at least, these services are not rendered at all or are carried out on an ad-hoc basis by one-man contractors who have little idea of the negative impacts of their activities on the environment and are more concerned with making a living. After all, the development of a local authority with the expertise and the resources necessary to render community services is not a quick process. The problem is often exacerbated by land ownership as, quite understandably, land owners may be very reluctant to relinquish their assets in the interests of the community. In fact, at the outset wastes are deposited on the property with no thought of the negative impacts on the water regime in particular, or on the environment in general. The longer this situation prevails the more difficult it becomes for the community to take corrective action.

In so far as developing metropolitan regions and developing rural areas are concerned the status, and therefore the priority, of waste disposal seems to be relatively low. In existing urban areas the priority of waste disposal seems to be relatively low. In existing urban areas the priority of waste collection and disposal viz-a-viz other community services has been relatively low and many people are undoubtedly aware of the Cinderella nature of the cleansing services. In established urban areas this situation appears to be changing and the priority given by society to an essential health service is therefore rising. As higher priority needs such as health, education, security and transportation are satisfied waste collection and disposal services come to the fore, particularly when the public is exposed to campaigns which are aimed at creating awareness of the environment. There are several examples of current campaigns.

In the major cities the expectations of the public, in terms of cleansing services, and therefore of the politicians, are undoubtedly rising with the result that the task of rendering the required quality of environmental service is increasingly difficult. The cost of rendering environmental services is therefore rising quite substantially in real terms. Until fairly recently slightly in excess of 4% of local government expenditure was dedicated to cleansing services. While this figure may not have changed significantly there is no doubt that were it not for the increasing cost effectiveness of cleansing departments this percentage would have increased fairly substantially over the last 4 or 5 years.

On the other hand, as already indicated, in the developing rural areas the provision of waste collection and disposal services enjoys a very low priority. We are familiar with the higher priorities that these communities have placed on services such as security, health and education, all of which make demands on limited resources. The priority of cleansing services will only start increasing in response to community pressures generated by an increasing awareness of the impacts of these services on public health, on property values and on the quality of life.

Waste disposal should be defined as the storage, collection and disposal of wastes. Unfortunately there is a tendency to consider these aspects in isolation with detrimental consequences for society. The practising solid waste manager or the scientist may separate these aspects but a holistic approach is essential because of the inter-dependence between these apparently unrelated aspects of waste management. To illustrate the point it would be futile to set up a well planned waste disposal site in a community which had inadequate or non-existent waste storage or collection services. In such a community the wastes would probably not enter the controlled waste stream but would find its way into the environment with serious consequences. The converse of this situation would be equallly true in the sense that a highly organised collection service would be useless if a suitable disposal site had not been set up to receive the wastes. It follows that the decision maker and the solid waste manager need to take the broad view in considering the waste disposal service in developing areas. In fact the decision maker must as a matter of policy, strive to achieve a balance in the level of technology adopted, the quality of service rendered and the inevitable environmental impacts of the cleansing services.

SOLID WASTES DISPOSAL IN DEVELOPING AREAS

The balanced approach is not very difficult to achieve in so far as the controlled waste stream is concerned, provided that an appropriate infrastructure has been set up. On the other hand a balanced approach to the uncontrolled waste stream is extremely difficult to achieve and will never be cost-effective.

The current situation in South Africa in so far as waste disposal practice is concerned was researched by the Department of Water Affairs.[4] The findings are reflected in the following table from which it can be seen that the situation is surprisingly unsatisfactory in that 27% of the established local authorities merely dump their wastes on a convenient piece of ground and 20% burn their wastes. It is incredible that at a time where most first world countries have banned these practices nearly 400 local authorities continue to use them.

PRACTICE	PROVINCE					PERCENTAGE
	CAPE	NATAL	OFS	TVL	TOTAL	%
UNCONTROLLED DISPOSAL	121	27	46	31	225	27,6%
LANDFILL	126	53	40	120	339	41,6
BURNING	116	7	12	35	170	20,8
COMPOSTING	21	2	0	8	31	3,8
RECYCLING (PARTIAL)	0	4	7	14	25	3,1
NO SERVICE	7	3	3	12	25	3,1
TOTAL	391	96	108	220	815	100%

As the research was done in the established urban areas, one can conclude that the situation in the developing rural areas is worse. In fact any observant traveller will confirm the accuracy of this conclusion.

As far as can be established there has been no scientific assessment of the implications of the current waste disposal situation but if foreign experience is any guide Southern Africa is in for some nasty and expensive experiences. There have however been isolated attemps to determine the impacts of waste disposal on the environment, the most recent of which[5] was carried out in Johannesburg and demonstrated high levels of ground water pollution up to 1½ kilometres downstream of the disposal site. The site in question is located in a developed urban area and was used continuously for a period of 50 years, primarily for the disposal of household wastes. The research took place over a continuous period of 6 years and revealed that slugs of polluted water would emerge from the tip from time to time and travel downstream without being dispersed or diluted. The consequences, were the downstream area to be used as a source of potable water would almost certainly be severe public reaction once the problem was identified. The study in question was done in a water deficit area where the generation of leachates by precipitation is very low on a well managed site and is substantially lower than would be the case in the water excess areas which are situated along the eastern and southern seaboards of the country. The scientist in question has recently been commissioned to extend his research to four disposal sites situated in water excess and deficit regions in order to more accurately establish the extent and degree of ground water pollution that arises from waste disposal opertions. In addition Johannesburg has started a ground water monitoring programme and will take the necessary steps should the need arise.

Inevitably any discussion of ground water pollution and other environmental impacts raises the question of the skills required to effectively deal with these problems and to the definition of acceptable levels of pollution. From the figures tabulated earlier it is clear that many local authorities are unaware of the impacts of waste disposal and probably do no have the expertise required to deal with the inevitable environmental impacts. The reason is probably quite simply a lack of pressure by an uninformed or apathetic public. Fortunately the major part of the waste stream may be satisfactorily disposed of due to high population concentrations in a few urban areas which do apply acceptable sanitary landfilling techniques. Nevertheless, many local authorities are not applying the necessary controls and are undoubtedly doing irreversible damage to the groundwater.

In so far as the requisite levels of expertise are concerned there is no doubt that the management of waste storage, collection and disposal services must be carried out by professionally qualified people. At present there are no tertiary qualifications specific to solid wastes mangement available in this country but several related disciplines can suffice, provided that an intensive course of task-specific study is undertaken. Even in many of the major urban areas of this country the quality and quantitity of expertise dedicated to waste disposal activities is inadequate and many of these services are grossly undermanaged. On a recent study tour to Europe it was found that many of the major waste disposal sites are managed on a full time basis by professionally qualified staff and the planning and commissioning of new sites is the responsibility of suitably qualified staff organisations. On the other hand there is considerable doubt as to whether more than a handful of South African sites are managed on a full-time basis by adequately qualified personnel. This situation persists despite the serious environemtnal problems that have arisen in Europe, Japan, the United States and elsewhere as a result of poor waste disposal practices. Many of these cases are well known and led to the creation of the 'Superfund' in the United States with an initial capital outlay of $1,5bn. The fund was earmarked for the rehabilitation of sites which posed serious health threats and is nearing depletion despite the fact that the task is only just beginning.

Unfortunately it is obvious to any trained observer visiting local waste disposal facilities that the level of expertise used in the managment of these sites is too low. Many disposal sites are located in streams, vleis, in direct contact with the water table and in other sensitive situations. Many sites are reasonably well located but are mismanaged or undermanaged to the extent that the negative effects completely negate the possible benefits of good planning. The foregoing comments are certainly not a general criticism of local government or contractors, many of whom are doing a fine job.

In the developing rural areas many waste disposal practices arise as part of an organic growth process. Consequently the hydrogeological, town planning and economic factors and the control of disease and nuisance vectors are not given due consideration. Generally a stage is reached in the development of the area when it is realised that the waste disposal practices are a serious health hazard or public nuisance. However, by this time the damage is often so serious or irreversible that it requires a high level of scientific and managerial expertise to address the problems. In addition a good deal of capital could be necessary to redress the situation.

In the planning process it is essential that a full hydrogeological investigation be carried out by suitably qualified and experienced people, that the town planning considerations be addressed and that key factors such as cost effectiveness, choices of plant, routing to and from generation areas and the daily management of the site receive full expert consideration. A full environmental impact assessment is essential before a commitment is made to a particular site. The assessment must include detailed consideration of the appropriate management and engineering requirements of the site in question.

The Legal Situation

Until 1982 the control of waste disposal was embodied in at least 22 Acts of Parliament.[6] The major Acts were the Water Act of 1956, the Health Act of 1977,The Hazardous Substances Act of 1973 and the Regulation of Disposal of Pesticides Act. As a result the control of waste disposal activities was extremely fragmented and very little effective control was exercised. Consequently the Department of the Environment recently attempted to rationalise the situation via the Conservation of the Environment Act, No. 100 of 1982. The first regulations framed in terms of this Act are due for promulgation within the next few months and will have a major impact on waste disposal practice. The main purpose of this Act is to achieve a balance between the acceptable negative impacts of waste disposal on the environment and the costs of appropriate mitigating actions. This balance is achieved by a site licencing process which allows the Minister discretion in so far as certain of the regulations are concerned.[7]

Concurrent with the promulgation of the Regulations the Departments of Environment and Water Affairs have worked with the CSIR on the preparation of Guidelines which are intended to assist all parties affected by the Regulations. The Guidelines should be available before the end of this year. As a result of these actions there is good reason to believe that South Africa is ahead of several major industrialised countries in terms of legislation designed to control the disposal of wastes.

However, the existence of suitable legislation in itself will not achieve the objectives unless the Regulations are enforced. There is some doubt as to whether the State Departments have the necessary staff to enforce the Regulations and it is hoped that this difficulty will be remedied.

In the near future the Regulations will come into effect and local government and the Regional Services Councils will be expected to comply with the requirements. Inevitably the Regulations will be coming into force at the same time that the Regional Services Councils are coming into existence. The Regional Services Councils have, as a major objective the provision of infra-structural needs on a priority basis, and compliance with the Regulations may create difficult dilemmas for the Councils. This in turn, could increase the pressures on the enforcement agencies.

One can only hope that the Independent States of South Africa adopt Regulations similar to those framed in terms of Act 100 of 1982 before irreparable damage is done to ground water supplies and the environment in general. This is particularly important in those areas of the country where ground water is used as a potable water supply.

Insofar as the future is concerned the control of waste disposal operations should be improved by the enforcement of the Regulations, provided that mechanisms and resources are set aside for the purpose on a nationwide basis. It is essential that sufficient number of adequately qualified staff be recruited and trained to apply and enforce the Regulations on an enlightened basis.

Frequently one hears pleas for codes of practice and guidelines to be used by waste disposal operators. Addendum number 2 is a copy of the Service Standards which have been adopted by Johannesburg which comply in many respects with the operational requirements of the draft Regulations. These Service Standards are deficient and inadequate in some respects but they are probably as good as any which have been used recently under operational conditions in this country.

Almost inevitably the promulgation and enforcement of the new Regulations at a time of increasing pressure by the State to privatise will lead to the cry that waste disposal opations be privatised. There is no problem in principle with this view. However, it must be recognised that while the level of expertise in the private sector is relatively high it is of limited capacity and is totally inadequate in the short term to cope with any major move to privatise waste disposal. It is therefore essential that the private sector be given the opportunity to develop sufficient breadth and depth of expertise before it is asked to take over the task of waste disposal to any large extent.

1. Resource Conservation and Recovery Act - USA Congress of 1976. Comprehensive Environmental Response, Compensation and Liability Act (Superfund) - USA Congress 1980.

2. Conservation of the Environment Act, Act 100 of 1982.

3. Over the past 4 years expenditure on street cleansing in Johannesburg has increased by 56% whereas expenditure on all cleansing services, including street cleansing, has increased by 31%.

4. Dr Barnard. Paper presented to a Seminar of the IWM at the CSIR in 1982.

5. Jarrod Melville Ball - Degradation of Ground and Surface Water Quality in Relation to a Sanitary Landfill - Thesis for MSc in Engineering completed in Johannesburg, April, 1984.

6. The list of relevant Acts:

   *The Water Act, 1956
   *The Health Act, 1977
   *The Hazardous Substances Act, 1973
   *The Regulation of Disposal of Pesticides Act
   The Atmospheric Pollution Prevention Act, 1965
   The Foodstuffs, Cosmetics and Disinfectants Act, 1972
   The Dumping at Sea Control Act, 1980
   The Mines and Works Act, 1956
   The Nuclear Installations Act, 1963
   The Precious Stones Act, 1967
   The Mining Rights Act, 1967
   The Atomic Energy Act, 1967
   The Agricultural Produce Export Act, 1971
   The Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Amendment Act, 1977
   The Sea Fisheries Act, 1973
   The Merchant Shipping Act, 1951
   The Prevention and Combating of Pollution of the Sea by Oil Act, 1971
   The Marine Traffic Act, 1981
   The Se Shore Act, 1935
   Physical Planning Act, 1967.

7. See addendum 1

ADDENDUM 1

B Y L A E

REGULASIES KRAGTENS ARTIKEL 12(2)(a) VAN DIE WET OP OMGEWINGSBEWARING, 1982 (WET 100 van 1982), BETREFFENDE DIE BEHEER OOR DIE WEGDOEN VAN VASTE AFVAL

1. In hierdie bylae het enige uitdrukking waaraan in die Wet 'n betekenis geheg is, dieselfde betekenis en, tensy uit die samehang anders blyk, beteken -

"afvalbehandelingstoerusting" enige toerusting wat gebruik word vir die bewerking of wegdoen van vaste afval, vir die saampersing van vaste afval of bedekkingsmateriaal in regulasie 8(j) en (l) bedoel of vir die voorbereiding, restourasie of oppervalkverbetering van 'n afvalstortterrein;

"afvalstortterrein" 'n stuk grond waarop vaste afval geberg, gestort of bewerk word met die doel om dit weg te doen;

"die Wet" die Wet of Omgewingsbewaring, 1982 (Wet 100 van 1982);
"vaste afval" enige vullis of afval afkomstig van 'n woon-, handels- of nywerheidsgebied en ook enige vaste, halfvaste, vloeibare of gesagtige stof wat daarin voorkom, en wat nie kragtens enige ander Wet beheer word nie.

2. (a) Iemand wat op die datum van inwerkingtreding van hierdie regulasies 'n afvalstortterrein of afvalbehandelingstoerusting bestuur, moet binne 90 dae vanaf daardie datum die Direkteur-generaal van die bestaan van sodanige terrein of toerusting per aangetekende pos en op 'n vorm deur hom voorgeskryf, in kennis stel en binne 'n tydperk deur hom gespesifiseer die besonderhede in regulasie 5 genoem ten opsigte daarvan verstrek.

(b) Iemand wat van voorneme is om 'n afvalstortterrein of afvalbehandelingstoerusting te verkry, voor te berei, op te rig of verander of wat op die datum van inwerkingtreding van hierdie regulasies besig is met die verkryging, voorbereiding, oprigting of verandering van so 'n terrein of toerusting moet, voordat hy sodanige terrein of toerusting verkry, voorberei, oprig of verander of, al na gelang van die geval, voordat hy met sodanige verkryging, voorbereiding, oprigting of verandering voortgaan, die Direkteur-generaal per aangetekende pos van sodanige voorneme of besigheid in kennis stel en die besonderhede in regulasie 5 genoem ten opsigte van die betrokke terrein of toerusting verstrek.

3. Die Direkteur-generaal moet elke afvalstortterrein waarvan hy ingevolge regulasie 2 in kennis gestel word en ten opsigte waarvan 'n lisensie kragtens regulasie 6 toegestaan word, klassifiseer ooreenkomstig die geo-hidrologiese eienskappe daarvan en die soorte vaste afval wat daarop weggedoen word of weggedoen sal word en 'n register daarvan hou.

4. (a) Niemand mag na 'n datum deur die Minister by kennisgewing in die Staatskoerant afgekondig -

(i) behalwe op gesag van 'n geldige lisensie kragtens regulasie 6 toegestaan en ooreenkomstig enige voorwaardes verbonde aan daardie lisensie, enige afvalstortterrein of afvalbehandelingstoerusting verkry, voorberei, oprig of verander; of

(ii) binne die regsgebied van 'n plaaslike owerheid, liggaam of persoon wat die bevoegdheid het om die behandeling of wegdoen van vaste afval te onderneem, sodanige afval wegdoen nie, behalwe op 'n afvalstortterrein of deur middel van afvalbehandelingstoerusting in subparagraaf (i) bedoel.

(b) Die bepalings van paragraaf (a)(ii) is nie van toepassing nie ten opsigte van vaste afval wat tydelik in 'n houer geplaas word wat vir dié doel deur 'n plaaslike owerheid, liggaam of persoon in gemelde paragraaf vermeld, verskaf word vir latere wegdoen ingevolge hierdie regulasies.

5. Iemand wat aansoek doen om 'n lisensie ten opsigte van enige afvalstortterrein of afvalbehandelingstoerusting moet, tensy die Direkteur-generaal anders goedkeur, 'n omgewingsinvloedbeheerverslag aan die Direkteur-generaal verstrek.

6. Die Direkteur-generaal kan 'n lisensie ten opsigte van enige afvalstortterrein of afvalbehandelingstoerusting toestaan ooreenkomstig die aansoek of met sodanige wysigings of onderworpe aan die algemene voorwaardes wat hy van tyd tot tyd mag bepaal ten opsigte van die verskillende soorte afvalstortterreine soos ingevolge regulasie 3 geklassifiseer of die spesiale voorwaardes wat hy ten opsigte van die betrokke stortterrein mag oplê, of hy kan weier om 'n lisensie toe te staan en hy kan, nadat 'n lisensie toegestaan is, te eniger tyd die voorwaardes waaraan dit onderworpe is, intrek of bykomende voorwaardes neerlê.

7. (a) Die Direkteur-generaal kan enigiemand aanwys om die gebruik van enige afvalstortterrein of afvalbehandelingstoerusting te ondersoek en indien die Direkteur-generaal van oordeel is, nadat so iemand aan hom verslag gedoen het aangaande sy ondersoek, dat die gemelde terrein of toerusting onderhou of bedryf word op 'n wyse wat 'n openbare oorlas, gesondheidsgevaar of skending van die omgewing kan veroorsaak, kan hy die persoon wat vir die onderhoud en bedryf daarvan verantwoordelik is, skriftelik gelas om sodanige stappe binne 'n tydperk in die lasgewing vermeld te doen wat die Direkteur-generaal nodig ag vir die bereiking van die oogmerke van hierdie regulasies.

(b) Die Direkteur-generaal kan iemand wat hy kragtens paragraaf (a) aangewys het skriftelik magtig om enige grond of gebou met sodanige werksmense en toerusting as wat vir 'n ondersoek in gemelde paragraaf bedoel nodig mag wees, te betree.

(c) Indien enige persoon aan wie 'n lasgewing kragtens paragraaf (a) uitgereik is versuim om binne die vasgestelde tydperk aan die vereistes van daardie lasgewing te voldoen, kan die Direkteur-generaal, na skriftelike kennisgewing aan so iemand, uit gelde vir dié doel deur die Parlement bewillig -

(i) tydelik besit neem van die betrokke afvalstortterrein of afvalbehandlingstoerusting en toesien dat daar aan gemelde vereistes voldoen word; of

(ii) na behoorlike oorweging en kennisname van positiewe alternatiewelike reëlings, die lisensie wat ten opsigte van die betrokke afvalstortterrein of afvalbehandlingstoerusting uitgereik is, kanselleer en sodanige stappe doen as wat hy nodig ag vir die sluiting van daardie terrein of die beskikking oor daardie toerusting; en

(iii) die koste aldus aangegaan van daardie persoon verhaal.

(d) Niemand aan wie 'n lasgewing kragtens paragraaf (a) uitgereik is of wat deur stappe kragtens paragrawe (b) of (c) geraak word, is geregtig om enige koste, skade of verlies deur sodanige lasgewing of stappe veroorsaak, van die Direkteur-generaal, die Staat, 'n beampte van die Staat of enige ander persoon by sodanige lasgewing of stappe betrokke, te verhaal nie.

(e) iemand wat enige persoon kragtens paragrawe (b) of (c) gemagtig, hinder in die uitoefening van sy bevoegdhede of die verrigting van sy pligte, is aan 'n misdryf skuldig.

8. Iemand wat vaste afval wegdoen met -

(a) enige afvalstortterrein of afvalbehandelingstoerusting wat vir die doel gebruik word op so 'n wyse bedryf en onderhou dat enige openbare oorlas, gesondheidsgevaar of skending van die omgewing daardeur veroorsaak tot 'n minimum beperk word;

(b) enige afvalstortterrein wat vir die doel gebruik word, omhein indien nodig geag deur die Direkteur-generaal ten opsigte van elke besondere stortterrein en in die lisensie wat ten opsigte van daardie stortterrein uitgereik word voorgeskryf is;

(c) 'n weerbestande, duursame en duidelik leesbare kennisgewingbord in albei amptelike tale en 'n inheemse taal wat in die omgewing gebruik word by alle toegange aanbring, waarby ongematigde toegang tot die afvalstortterrein verbied word en waarop die werkure en die naam, adres en telefoonnommer van die lisensiehouer en van die persoon in beheer van daardie terrein, aangedui word;

(d) dié boorgate tot die diepte en met die tussenruimtes en toerusting wat die Direkteur-generaal ten opsigte van elke afvalstortterrein mag voorskryf, aanbring;

(e) monsters van water wat in daardie boorgate voorkom so laat ontleed en 'n aantekening van die ontledings vir so 'n tydperk hou as wat die Direkteur-generaal ten opsigte van elke afvalstortterrein voorskryf en 'n opsomming van daardie ontledings voor 15 Januarie en 15 Julie elke jaar aan die Direkteur-generaal stuur;

(f) met behulp van deeglike ontwerpte, opgerigte en instandgehoude werke -

(i) alle vloedwater wat uit die maksimum vloed met 'n gemiddelde frekwensie van een keer in 50 jaar ontstaan, van die afvalstortterrein afkeer;

(ii) alle afloopwater wat op die afvalstortterrein gedurende 'n tydperk van 24 uur uit die verwagte maksimum reënval met 'n gemiddelde frekwensie van een keer in 50 jaar ontstaan, op die afvalstortterrein terughou en voorsiening maak vir 'n vryboord van minstens 0,5 meter te alle tye; en

(iii) alle sypelwater en geërodeerde materiaal wat op die afvalstortterrein ontstaan, op die terrein terughou;

(g) daardie afval behandel soos in die lisensie van die betrokke afvalstortterrein of afvalbehandelingstoerusting voorgeskryf;

(h) 'n aantekening hou van die soorte en hoeveelhede van daardie afval wat daagliks weggedoen word vir die tydperk wat die Direkteur-generaal ten opsigte van elke besondere afvalstortterrein of soort afval voorskryf en 'n opsomming van daardie aantekening voor 15 Januarie en 15 Julie elke jaar aan die Direkteur-generaal verstrek;

(i) enige soort vaste afval wat die Direkteur-generaal spesifiseer in 'n houer plaas wat in daardie spesifikasie voorgeskryf word en wat duidelik gemerk is in albei amptelike tale en 'n inheemse taal wat in die omgewing gebruik word om die inhoud van die houer aan te dui, en gemelde afval wegdoen op 'n wyse in daardie spesifikasie voorgeskryf;

(j) alle lae afval aan die einde van elke werksdag met geskikte materiaal bedek, wat so gerangskik is dat reënwaterindringing tot 'n minimum beperk word en dat vrye afloop van oppervlaktewater na die werke in regulasie 8(f)(ii) en (iii) vermeld, verseker is;

(k) die Direkteur-generaal minstens ses maande vooruit in kennis stel van die beoogde sluiting van 'n afvalstortterrein;

(l) onmiddelik nadat werksaamhede by 'n afvalstortterrein laat vaar is, die hele oppervlakte van die stortterrein met 'n laag geskikte materiaal tot 'n diepte van minstens een meter na saampersing bedek, wat so gegradeer en afgerond is dat -

(i) geen poelvorming van neerslag plaasvind nie;

(ii) vrye afloop van reënwater sonder erosie verseker is; en

(iii) geen voorwerpe in die gebied voorkom wat die uiteindelike restourasie van die terrein kan belemmer nie, insluitende die herbeplanting daarvan indien die Direkteur-generaal dit vereis;

(m) die Direkteur-generaal onmiddelike per aangetekende pos kennis gee van 'n onderbreking van werksaamhede, om enige rede, van meer as 3 maande by 'n afvalstortterrein.

9. Iemand wat vaste afval wegdoen, mag nie -

(a) 'n afvalstortterrein met 'n onversadigde sone tussen die afval en die grondwater van minder as 2 meter bokant die hoë vlak van die watertafel gedurende die reënseisoen gebruik nie tensy geskikte siviele werke deur die Direkteur-generaal goedgekeur word;

(b) 'n afvalstortterrein geleë benede die hoogste vlak wat vloedwater in enige waterloop waarskynlik met 'n gemiddelde frekwensie van een keer in 50 jaar sal bereik, gebruik nie, tensy geskikte siviele werke deur die Direkteur-generaal goedgekeur word;

(c) enige afvalstortterrein wat deur hom gebruik word sonder die voorafgaande skriftelike toestemming van die Direkteur-generaal, tydelik of permanent, vir ander doeleindes as die wegdoen van vaste afval gebruik, verkoop, verhuur of vervreem nie; en

(d) 'n kontrakteur vir sodanige wegdoen aanstel nie, tensy 'n skriftelike ooreenkoms met daardie kontrakteur aangegaan is, welke ooreenkoms vir die volgende voorsiening moet maak:

(i) nakoming deur die kontrakteur, waar toepaslik, van hierdie regulasies;

(ii) die oorsprong, hoeveelheid en chemiese, fisiese en biologiese aard en samestelling van die afval wat weggedoen gaan word;

(iii) enige voorsorgmaatreëls wat deur die kontrakteur by die hantering van die afval getref moet word; en

(iv) die metode van wegdoen.

10. Iemand wat van voorneme is om na die datum van inwerkingtreding van hierdie regulasies, aansoek te doen om 'n lisensie om 'n nuwe afvalstortterrein te verkry, voor te berei of op te rig of 'n bestaande afvalstortterrein te verander, moet minstens dertig dae voordat hy aansoek doen, aan belanghebbende persone van sy voorneme kennis gee in 'n Afrikaanse en in 'n Engelse nuusblad wat in omloop is in die gebied waar hy van voorneme is om die afvalstortterrein te verkry, voor te berei, op te rig of te vernader, en hulle versoek om enige besware teen die voorgestelde aansoek binne 'n vermelde tydperk, wat nie korter mag wees nie as dertig dae vanaf die datum waarop aldus kennis gegee is, skriftelik aan die Direkteur-generaal voor te lê.

11. Die Direkteur-generaal kan enige bevoegdheid in hierdie regulasies aan hom verleen, skriftelik aan enige beampte van die Department oordra.

12. Die Minister kan, indien hy oortuig is dat die vrystelling of verslapping van enige bepaling van regulasies 8 of 9 in besondere omstandighede geregverdig is, vrystelling van sodanige bepalings aan enigiemand verleen, onderworpe aan die voorwaardes wat die Minister bepaal.

13. Iemand wat enige bepaling van hierdie regulasies of enige lasgewing daarkragtens uitgereik of spesifikasie neergelê of voorwaarde opgelê, oortree of nalaat om daaraan te voldon, is aan 'n misdryf skuldig en by skuldigbevinding strafbaar met 'n boete van hoogstens R1 000 of met gevangenisstraf vir 'n tydperk van hoogstens 2 jaar of met daardie boete sowel as daardie gevange-

nisstraf vir 'n tydperk van hoogstens 2 jaar of met daardie boete sowel as daardie gevangenisstraf of, in die geval van 'n voortdurende misdryf, met 'n boete van hoogstens R10 of met gevangenisstraf van hoogsten 5 dae of met daardie boete sowel as daardie gevangenisstraf ten opsigte van elke dag wat die misdryf voortduur.

14. Hierdie regulasies word geag aanvullend te wees tot en nie ter vervanging nie van enige ander wetgewing ingevolge waarvan die wegdoen van vaste afval beheer word.

CHAPTER 17

17.1 CODE OF PRACTICE FOR TIP SUPERVISORS

There are a number of important points which should regularly be attended to by the tip supervisor - these are listed below in point form for convenience:

1. Remember a refuse tip can be dangerous - SAFETY must be our password

2. Make sure that the flytraps are properly baited every day and placed in position at or near the work area

3. Make sure that direction indicators or personnel who are directing vehicles to the work area to it clearly and safely

4. Vehicles should tip their loads as close to the workface as possible ensuring that vehicles are safe and do not get bogged down - Garden refuse and bulky refuse should be tipped at the bottom end of the workface

5. Spread refuse and bin liners making sure that liners are punctured before pushing the refuse onto the workface - spread and flatten garden refuse and bulky objects at the bottom of the workface and then mix in with refuse from the top and roll into a gradual slope of approximately 30 degrees, i.e. the size of the work area will depend on the volume of refuse handled

6. Do not expose refuse for longer than is necessary i.e. commence with covering at starting point as soon as tracking has been done and good consolidation has been achieved - Covering to be done in layers of approximately 150 mm

7. Whilst work is in progress ensure that excavations are done in accordance with instructions received from top management. Excavated soil and other useful covering materials should be tipped in position for covering the day's work, building walls or making stockpiles

8. Control dust on tip roads and other areas by making use of water tankers, hoses or chemical means

9. Do not allow unauthorised salvaging - unauthorised persons should be requested to leave the tip site - Patrol tip boundary regularly to ensure that 2 metre high security fences and public notice boards are in order

10. Towards the end of the work day start pushing in the toe of the sloped workface to ensure that the minimum area requires covering - When all vehicles have ceased ripping the final portion of the tipping area must be prepared and the whole workface area covered completely and thoroughly

11. Control windblown paper by regular picking-up throughout the day - the tip should appear neat and tidy at all times

12. Constructed stormwater ditches must be checked regularly to see that they are serving their purpose and are not causing erosion - where erosion occurs such areas should be filled in as soon as practicable

13. Do not tip into dams of water caused by spring or surface water

14. Strict control should be exercised at the entrance of the tip to identify unwanted refuse, eg tyres

15. Effective use should be made of chloride of lime to control smells

16. Sufficient spare plant should be available to prevent essential operations on a tip from coming to a standstill

17. Fire hydrants should be erected at the tip face or extended water pipes could be used for fire fighting

18. It should be ensured that dangerous materials, which might cause cuts to vehicle tyres, are properly covered

19. Tip life is extended by maximum compaction of refuse and judicious use of cover material

20. Deep trenches should be dug to bury noxious material

21. Wet material or liquids should be mixed with dry material or fly-ash prior to disposal to obtain a more uniform moisture content within the tip.

17.2 IN THE EVENT OF FIRE

1. Report to senior personnel immediately

2. Do not attempt to deal with the fire on your own - Ensure that:

   (a) at least one person is available to give directions at ground level
   (b) that all flames are extinguished by means of your standby water tanker

3. Commence with the isolation of the burning refuse - Although it is important to note the direction of the wind, the burning material should always be pushed away or isolated from the workface or other refuse - This is done by means of cutting into the workface covering material and mixing and rolling it with the smouldering material - A layer of soil is always kept between the blade of the machine and the burning material - Care should be exercised by not driving the dozer onto the burning material

4. Once the burning material has been isolated and extinguished by means of covering and mixing it in with soil - it can be left for a while and worked into the workface at a later stage

In addition the tip supervisor should ensure that all plant operators:

17.3 INSTRUCTIONS TO PLANT OPERATORS

1. Sign attendance register and check on presence of all tip personnel - attend to timesheets, labour and tip returns

2. Set an example by wearing protective clothing, boots, goggles and respirator - Make sure other operators and tip drivers do the same as and when required

3. Discuss the wordplan for the day with tip personnel - do not cause unnecessary delays

4. Make sure that plant and vehicles are washed daily - Check with other drivers, ensuring that sump oil, gearbox oil and water levels are correct - Defects or oil leaks to be reported immediately.

5. It is good practice to backblade roadways whilst travelling with dozers to and from the work area

6. At completion of the day's work, all vehicles and plant must be parked within the security area and the gates must be locked by the operator

7. Park dozers and loaders with the blades/buckets on the ground - handbrakes must be applied and gear levers must be in the locked position

8. In the event of <u>any</u> vehicle finding it difficult to proceed on its own power because of slippery conditions or when a vehicle gets bogged down, assistance may be given <u>towing</u> such a vehicle

9. The operator and his personnel should be friendly towards all tip users - Strict discipline should however be maintained at all times - Abuse of vehicles and plant should be regarded in a serious light and be reported immediately

10. Speeding and other offences indicated by tip notice boards and signs should not be tolerated and be reported to the supervisors

11. Burning of refuse or fires on the tip must be prohibited

12. Be on the lookout for rodents or signs of rodent infestation. (This is normally not necessary on a properly operated tip site)

13. When toxic or hazardous refuse is delivered at the tip site contact senior staff for further instructions.

PAPER: 1.4

SANITATION FOR SCHOOLS IN RURAL AREAS

D C DE VILLIERS
B Sc (Eng) (Pretoria)
Building Services Division, National Building Research Institute
Council for Scientific and Industrial Research
P O Box 395, Pretoria, 0001

SYNOPSIS

An inexpensive sanitation system can satisfy basic health requirements if it is properly designed, constructed and maintained. On-site sanitation systems have been given an undeserved reputation for bad odours by systems which smell because they have not been maintained properly. Various on-site sanitation systems are discussed from the point of view that to provide facilities for as many schools as possible from available funds, the unit cost must be kept to a minimum.

SAMEVATTING

'n Goedkoop sanitasiestelsel kan basiese gesondheidsvereistes bevredig indien dit behoorlik ontwerp, opgerig en onderhou word. Ter plaatse-sanitasiestelsels het 'n onverdiende reputasie vir slegte reuke gekry as gevolg van stelsels wat sleg ruik omdat hulle nie behoorlik onderhou word nie. Verskillende ter plaatse-sanitasiestelsels word bespreek met die uitgangspunt: om soveel geriewe moontlik vir soveel skole moontlik uit beskikbare fondse te voorsien, moet die eenheidskoste tot 'n minimum beperk word.

INTRODUCTION

Since the 1970s, there has been a sharp increase in the number of school pupils in the lower-income areas of South Africa. Most of the available funds have been used to provide classrooms and sanitation facilities have often been neglected. Thus:

- some schools were built with inadequate sanitation facilities or none at all; or
- existing sanitation facilities have become overloaded to the point of failure as school populations have increased.

Since basic health education is a very important part of a child's schooling, it should be demonstrated by ensuring that every school has adequate sanitation facilities. This goal can only be achieved by providing cheaper facilities which will, neverless, not compromise health and safety standards, and which could later be upgraded to give greater user comfort.

It is extremely important that low-cost sanitation units use a minimum of water. This document will therefore focus on such systems which are simple to operate and easy to maintain. Table 1 lists the systems covered.

No one sanitation system can be regarded as ideal for every application. Under any one set of circumstances the most appropriate option can be selected from the technically feasible alternatives on the basis of cost. The aspects discussed below, must be considered before selecting a sanitation systems.

TABLE 1: Non-waterborne sanitation systems

	Sanitation system	Water requirements
1	Ventilated Improved Pit (VIP) latrines	None
2	Ventilated Vault Pit (VVP) latrines	None
3	Anaerobic digesters	None
4	Aqua privies	Minimal (a few litres per day)
5	Tipping tray and pour-flush	One to two litres per flush

NUMBER OF SANITATION UNITS TO BE PROVIDED PER SCHOOL

Each school should have a sufficient number of sanitation units to ensure that they are not overloaded since this can lead to insect infestation, bad odours and maintenance problems. Table 2 gives an indication of the number of sanitation units and hand basins that should be provided at a school. For primary schools the number of units indicated should be increased by one.

TABLE 2: Number of sanitation units, urinals and hand basins to be provided for a given number of pupils

Number of Pupils	Number of sanitation units to be provided				
	Boys			Girls	
	Units	Urinals	Hand basins	Units	Hand basins
5	1	0	1	1	1
10	1	1	1	1	1
15	1	1	1	2	1
26	2	2	2	2	2
40	2	2	2	3	2
48	3	3	3	3	3
75	3	3	3	4	3
100	4	4	4	5	4
120	4	4	4	6	4
150	5	5	5	6	5
175	5	5	5	Where the number of girls exceeds 150, add 1 sanitation unit for every 45 girls	5
240	6	6	6		6
	Where the number of boys exceeds 240, add 1 sanitation unit, 1 urinal and 1 hand basin for every 75 boys				Where the number of girls exceeds 240 add 1 hand basin for every 75 girls

In some areas girl pupils may outnumber the boys. In Lesotho, for example, the ratio between girls and boys attending school can be as high as 3 to 2.

GROUNDWATER POLLUTION

The pollution of groundwater as a result of on-site sanitation systems can be a matter of concern in areas where shallow groundwater is used for drinking. In dry areas where the toilet is well above the groundwater table, bacteria seldom travel further than 3 metres from the point of pollution. However, pollution can extend much further where:

- the underlying soil is very permeable;
- the underlying rock has open joints or fractures;
- the groundwater table is very high.

Pollution always takes place in the direction of the groundwater flow. For this reason, on-site sanitation systems should be located downstream of a well or borehole if this is at all possible. In cases where it is likely that the water may become polluted, it should be disinfected.

LOCATING AND DESIGNING A SANITATION COMPLEX

The toilet block should be located conveniently close to the classrooms and not closer than 30 m to a borehole or well. Where possible, the ventilation pipes of VIP or VVP systems should be on the sunny side of the building. The sanitation complex should also be located in such a way as to permit easy access for emptying the pits or septic tanks. The topography of the site should be thoroughly examined and steps taken to ensure that rainwater does not flood the sanitation complex or soakaway.

The superstructure should have a screen wall in front of the entrance to provide privacy, and should protect both user and toilet from the weather. For complete privacy each individual sanitation unit should have its own door which can be secured from the inside. The dividing walls between units should preferably be built to roof height. Latrine doors should open outwards to make the required internal floor area per toilet as small as possible.

The sanitation complex as a whole must be lockable from the outside to prevent vandalism during school holidays or at weekends.

To achieve proper through-ventilation, openings should be left at the tops of walls or between the top of the door and the roof. This is both to dissipate odours and to let the vent pipes of VIP and VVP latrines function properly. Sufficient natural light must be available, however the toilet must be dark enough inside to discourage flies from entering. The floor of the complex should have a slight slope to the outside of the building so that the complex can be hosed clean when necessary. This will also prevent rainwater from collecting.

The building materials used should be both weatherproof and able to exclude vermin. Preferably, the appearance of the toilet block should be in keeping with the school building.

SANITATION APPLIANCES

Different types of pedestal are required by the various sanitation systems, but they should all have a smooth surface for easy cleaning. Suitable materials are glass fibre reinforced polyester (GRP), UPVC or ceramics. Toilet paper or suitable scrap should be provided.

Hand basins should be fixed near the entrance of the sanitation complex. Wastewater from the basins should be discharged in such a way as to enable teachers to check whether pupils wash their hands and close the taps after they have used the facility.

Posters to remind pupils to wash their hands and to teach them to use the facility, should be fixed to the backs of the doors in the toilets. It should be made clear to every child how the toilet should be used.

Urinals must be provided for the boys else they are inclined to use outside walls which creates odour problems. Waterless urinals which function very well are available.

DESIGN QUANTITIES

The quantity and composition of human excreta depends on factors such as living conditions, diet, health, occupation and working environment.

According to a report of the World Bank (1980), adults in Third World countries produce about 350 g of solids and 1,2 kg of urine per day in rural areas, and about 250 g of solids and 1,2 kg urine in urban areas.

According to Walker (1975) a young child in South Africa produces between 60 and 70 g of solids per day while an older child will produce between 120 and 180 g. Rivett-Carnac (1983) established that a group of primary school children in Natal produced on average between 0,8 and 0,9 ℓ of waste per day. Morgan and Mara (1982), working in Zimbabwe, found that family pit latrines, where the latrine doubled as a bathroom and all wastewater was discharged into the pit, filled at a rate of 0,02 m^3 per person per year. In cases where no wastewater was discharged into the pit they filled, the rate was 0,04 m^3. They also concluded that pit latrines at schools had a particularly long life, most probably because the pit contents got a chance to digest properly during the school holidays.

After taking the above data into account, and the fact that an average school year consists of between 200 and 220 days it is recommended that school sanitation systems be designed to handle the following quantities of waste per child per year:

- Ventilated pit latrines : 0,016 m^3
- Vault pit latrines : 0,17 m^3
- Aqua privies : 0,012 m^3

If materials other than water or paper are used for personal cleansing, the design figures given above may need to be modified.

MAINTENANCE

The toilet block itself as well as the surrounding area must be properly maintained. Odour problems often arise because pupils, especially boys, urinate against the outside walls of latrines. Such bad odours must be attributed to unhealthy environmental conditions rather than a malfunctioning system. Continuous sanitary education is required to overcome this problem.

It is extremely important that a specific person be made responsible for maintaining the facilities and reporting any misuse of them. Although it is generally accepted that the Principal of a school will see to their upkeep, it does not often happen in practice. Perhaps, it is a good idea to give the pupils of each class in turn the job of cleaning the toilets. They will soon report those who misuse them.

GENERAL

A consistent low-technology approach, based purely on economics and sound engineering principles, must be followed throughout the planning, design and construction of an on-site sanitation system.

The overall goal in the light of South Africa's limited resources must be to improve existing bad sanitation facilities at as many schools as possible rather than to provide a limited number of schools with unnecessarily sophisticated First World systems. Client bodies must ensure that their design and construction assignments are appropriate to the community being served, are orientated towards the lowest-cost acceptable solution and that the community is involved.

SANITATION SYSTEMS

Ventilated pit latrine systems

Ventilated improved pit (VIP) latrines and ventilated improved double pit (VIDP) latrines, as described in NBRI Information Sheets X/BOU 2-71 and X/BOU 2-68 respectively, can easily be adapted to serve as sanitation systems for schools. Both systems can be designed as permanent facilities and the decision as to which to use depends only on whether they will be emptied by mechanical means, in which case a single pit system is best, or manually, when the double pit system should be chosen.

The VIDP latrine system

A number of superstructures as described in X/BOU 2-74 can be erected side by side (see Figure 1) so that:

Type 1. the two pedestals in neighbouring superstructures share a single pit (see Figure 2); or that

Type 2. each superstructure straddles two separate pits (see Figure 3).

Pits should be used alternately. When any one of the pits becomes full, all the pedestals should be moved to the empty pits and the used pits, whether full or not, should be capped. The contents can be emptied after they have been capped for at least a year, and before any of the secondary pits become full. The digested content needs no further treatment and can be used as fertiliser on the school garden.

The dividing walls between individual pits should extend right up to the cover slabs and the common wall between neighbouring superstructures should also be built to roof height. This is to avoid air flowing from one to the other and causing odour problems. There is a possibility in Type 1 superstructures, that if pressure differences develop in the two units which share a pit, bad odours could enter the unit with the lower inside air pressure via the pedestal. Until this possibility has been thoroughly investigated it is recommended that only Type 2 units be built.

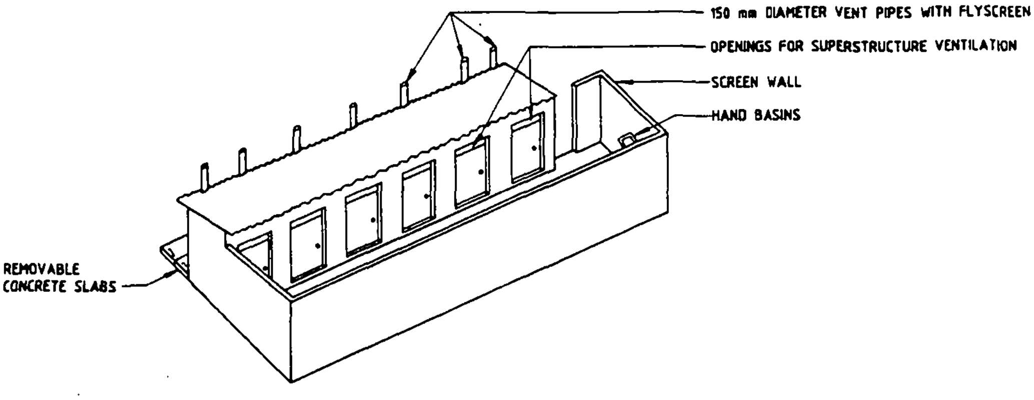


FIGURE 1: VIDP - latrine complex

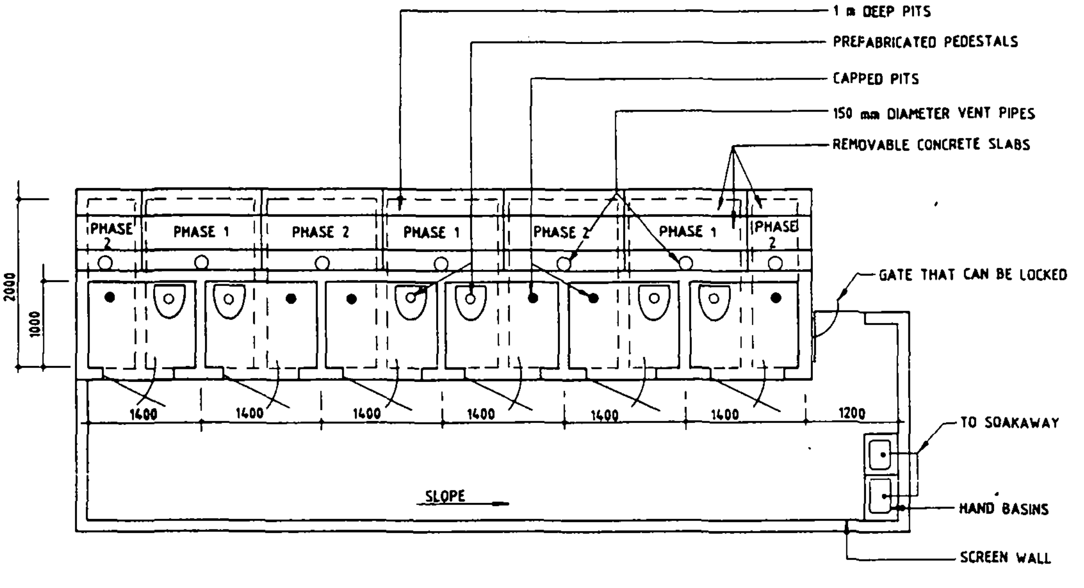


FIGURE 2: Plan of type 1 VIDP - latrine complex

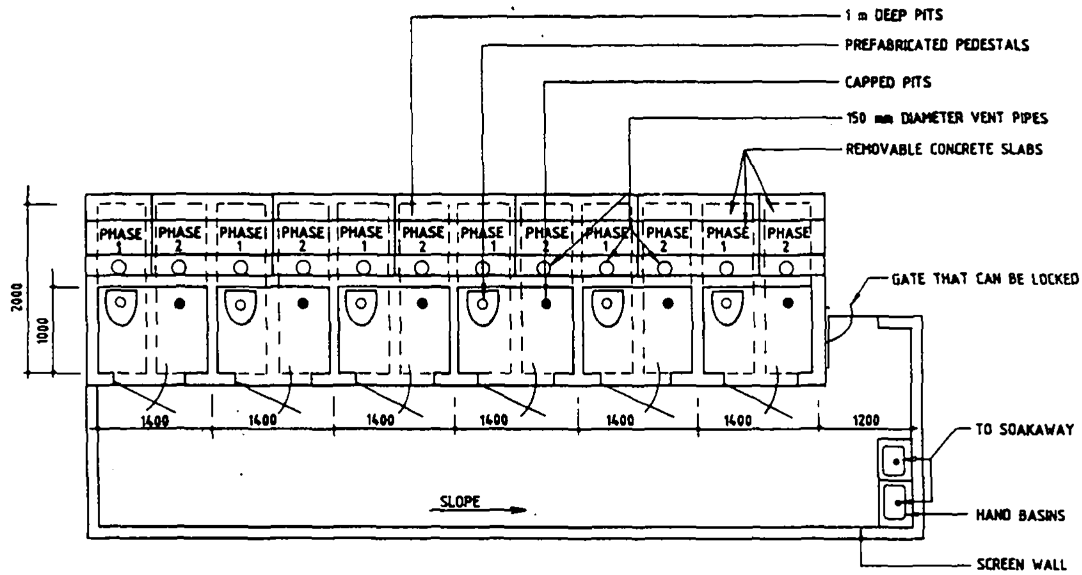


FIGURE 3: Plan of type 2 VDP - sanitation complex

Each pit should be ventilated separately by a 150 mm diameter ventilation pipe with a fly screen on top. Both pipe and fly screen should be corrosion resistant and so far tests indicate that aluminium and stainless steel gauze are the best materials.

The VIP latrine systems

VIP latrine systems fall into two types depending on the design of the substructure:

Type 1 : Each pit serves an individual superstructure.
Type 2 : One large pit serves a number of pedestals.

For Type 1 systems the same design principles apply as for VIDP systems except that the superstructure is served by a single pit. For Type 2 systems it is very important that the entire superstructure, though enclosing a number of separately walled off units serving a single large pit, has only one entrance. If more than one entrance is provided, an odour problem can arise, once again because of pressure differences inside the structure. Field tests have confirmed this phenomenon.

The design volume (V) of pits can be determined by using the following formula:

$$V = CPN + 0,5$$

Where: C = design capacity, m^3/user/year (usually 0,016; see section on design quantities)

P = number of pupils in the school divided by the number of sanitation units to be provided

N = period (in years) required between pit emptying (usually 3 to 5 years)

The additional half a cubic metre of space helps the vent pipes to function properly as the pit fills. Another point to be kept in mind is that it is more difficult to empty a deep pit than a shallow one. For this reason pits should be no deeper than 3 m.

The ventilated vault pit (VVP) latrine system

As has been described in NBRI Information Sheet X/BOU 2-70, the VVP latrine is basically a VIP latrine with the pit waterproofed so that no wastes can enter the soil. Ventilation and general design procedures are the same as for VIP systems and only the design quantities differ. Since no liquids percolate from the sub-structure, vault volumes are generally much higher than pit volumes and the periods between emptying are usually much shorter. To prevent any liquid from escaping, the vault must be completely plastered internally and painted with bitumen. When the vault becomes full, it should be emptied mechanically and the waste treated before disposal. The design volume (V) of a vault can be determined by using the above formula with the design capacity figure (C) of 0,17 given earlier.

The period (N) to be chosen between pit emptying cycles will depend on the type, size and availability of emptying equipment.

Wastewater from hand basins should preferably drain into a soakaway rather than into the vault which would shorten its emptying cycle, and thus increase the operating cost. The main disadvantages of the vault as against the pit system are its higher capital and operating costs, and the more advanced craftsmanship needed to build it. The only advantage of the VVP latrine system is that it does not pollute the soil or groundwater.

The anaerobic digester

The anaerobic digester is a simple sanitation system which can be regarded as an improved version of the conventional aqua privy. The system as a whole includes components such as an asbestos cement or glass fibre reinforced polyester tank (1,5 m^3) fitted with a mechanical agitator, two funnel shaped 100 mm diameter inlet pipes, a 100 mm diameter overflow pipe and a 12 mm diameter pipe to dissipate sewage gases. The function of the mechanical agitator is to break up scum and solid waste so that it can digest more readily and reduce sludge build up inside the tank. Since the tank does not function as both a digester and precipitator, silting takes place at a slower rate inside the tank. The disadvantage of this is that soakaways or absorption fields have to cope with increased quantities of silt which may cause a blockage.

Because the digesting process is anaerobic, aerobic organisms such as Leptospira (hookworm), Shigella and Spirochetes die within two days in the tank. The eggs of parasites such as Ascaris are not destroyed as easily and appear in the effluent, which should therefore be drained into an absorption field.

The tank of the anaerobic digester should be partially buried so that only the top 75 mm projects above ground level. A tank of the size being described can take up to three superstructures. These are placed so that the pedestals are directly above the inlet pipes and the human waste drops directly into the tank.

In normal use the anaerobic digester is kept full of water, however evaporation from the system is minimal and after the initial filling the tank need only be topped up from time to time to maintain the water seal. The initiation of the digesting process can be accelerated by throwing a bucketfull of sludge from a working digester into the new tank. Very little gas is produced by this system.

Paper should be used for personal cleansing and foreign matter such as stones and non-conventional cleaning materials should not be admitted because they may damage the mechanical agitator or cause a blockage.

A stick and plunger are provided with which the user must force excreta and paper into the tank after use. These should be handled with care because they may constitute a health hazard. A small amount of water should be used to clean the pedestal.

The advantages and disadvantages of the anerobic digester are listed below.

Advantages:

- Lower operational cost than a waterborne system.
- Permanent sanitation system.
- Very low water requirement.
- Little or no municipal involvement.
- Soakaways can be located far from habitations or water sources.

Disadvantages:

- High capital outlay compared with a pit latrine.
- Can cause groundwater pollution.
- Slight health risk.
- Contact with waste is possible via the stick and plunger.

- Supervision is necessary to ensure that the mechanical agitator is used correctly.

- The system is difficult to upgrade.

The aqua privy system

The aqua privy system which is quite simple to build and maintain, combines the partial treatment of human waste in a small septic tank located directly below the superstructure, with the disposal of treated effluent in a soakaway. Human excreta drops directly into the small septic tank via a chute. This chute is an integral part of the seat and its lower end is submerged 100 to 150 mm in the fluid to form a rough water seal. It is imperative that the water seal be maintained at all times in order to avoid problems with odours and insects. The tank must therefore be completely waterproof. It may be necessary from time to time to top up the tank to compensate for evaporation losses.

Scum and sludge gradually accumulate inside the tank which must be desilted with a vacuum tanker when it becomes two-thirds full. The accumulation takes place at about 0,012 m^3 per pupil per year and tanks are usually designed to last five years between desludging. Points to note when designing an aqua privy system are given below.

- The depth of liquid in the tank should usually be between 1 and 1,5 m.
- The inlets and outlets must be easily accessible for the purpose of clearing blockages.
- A desludging manhole should be provided.
- The tank must be constructed of a material which does not corrode under septic conditions.
- Wastewater from hand basins should discharge into the tank.

The sanitation complex can be of any type and because of the water seals, no short circuiting air flow can occur. The tank should be ventilated with a single 50 to 100 mm diameter vent pipe with a fly screen on top. This is to prevent mosquitoes from breeding in the tank. Since the tank must be kept full of water at all times, before a newly built tank is put into operation, it should be checked for leaks, which can cause many problems.

The aqua privy system has a number of advantages and disadvantages over the anaerobic digester.

Advantages

- Because its pedestal inlet is larger the use of the stick and plunger is eliminated.
- The system has no mechanical agitator and therefore the use of unconventional cleansing materials will have little effect on its efficiency.
- Aqua privy systems are easily upgradable to waterslot or flush systems.
- The cost of an aqua privy system, which depends on environmental conditions, is generally slightly less than an anaerobic digester.

Disadvantages

- Better workmanship is required than for an anaerobic digester.
- The risk of the tank leaking is greater because it is built on site rather than in a factory.
- The system may use more water.

The tipping tray, or waterslot system

This is more of a sanitation appliance than a system as such. The primary objective is to effect a water seal in a system such as a pit latrine, using only a small quantity of water. These units can also be used to upgrade a system such as an aqua privy to give more user comfort.

A special seat has an integral chute the lower end of which is sealed with one or two litres of water in a tray. The water in the tray is topped up automatically after every use. Two tipping tray models are available, a manual flush and an automatic. The latter is not recommended because it is activated by the mass of waste in the tray, which means that it may flush more than once, or not at all each time the toilet is used.

Tripping tray systems have several advantages and disadvantages.

Advantages

- No odours can escape from the pit or tank.
- The pit or tank contents cannot be seen.
- Insects cannot enter the pit or tank.
- It is comfortable to use.
- Only one or two litres of water are needed for each flush.
- It does not require further upgrading.
- It is aesthetically pleasing.

Disadvantages

- A reliable piped water supply is needed.
- The pit or absorption field must handle larger quantities of effluent.
- The units are costly compared with ordinary pedestals or water closets.

The pour-flush system

As with the tipping tray, the pour-flush toilet should be regarded as a sanitation appliance. Pour-flush pans with a 25 mm water seal are generally used with pits or septic tanks. A two-litre bucket of water is used to flush the pan. The main disadvantages of the system are that the user has to carry water to the toilet and that the effectiveness of the flush depends on human factors. The use of pour-flush toilets at schools is not recommended because children who do not use water for personal cleansing are unlikely to operate the system properly.

CONCLUSION

Alternative sanitation systems, if properly implemented, can be inexpensive and satisfy basic health requirements, though they may not provide the maximum user comfort. Systems should, initially, be as cheap as possible so that the maximum number of schools can be provided with proper facilities, but should be designed with a view to upgrading once the necessary funds become available.

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PAPER: 2.1

FERROCEMENT TANKS, TOILETS AND SPRING PROTECTIONS :

An introduction to the Techniques, Training and Transfer of a Holistic Water and Sanitation Strategy applicable to Rural and Peri-urban under-developed Areas.

CHRIS MANN

M.A. (London), M.A. (Oxon), B.A. (Wits.)
The Valley Trust, PO Box 33, Botha's Hill 3660

Abstract : This paper asserts that development theory and technological innovation are not value-free and cannot be discussed without reference to their social context. The water and sanitation projects described in this instance rest on three assumptions : that development should be holistic in scope; that those to whom development is directed should be viewed as subjects not objects; and that agents of development should themselves be subject to development. The technology described comprises ferrocement Roof Tanks, Ventilated Improved Pit Toilets and Spring Protections, that use a single triple-purpose mould. Training takes the form of little and often over an extended period.*

* Transfer involves the establishment of modern institutions of local government capable of managing the projects.

The Underlying Assumptions

The goal set by the United Nations for the International Drinking Water Supply and Sanitation Decade involves clean water and adequate sanitation for all people by the year 1990. This strategy fits in well with the emphasis on water and sanitation in the principles of primary health care set out in the World Health Organisation's Declaration of Alma-Ata, September 1978.

Attempts to improve water supply and sanitation in under-developed areas are thus consistent with the prevailing intellectual orthodoxies in the disciplines of development and health, challenged though these are by ideologies from the left and right. While this paper described practical techniques formulated within these orthodoxies a caveat must be made at the start. With the recent foundation of the Development Bank of Southern Africa and the use of the language of development by government we find an increasing application of the internationally orthodox concepts of development to Southern Africa. No doubt this has its advantages. The danger exists, however, that the facts of inequity will be rewritten as the problems of development. This is as much a practical as a theoretical point. This paper like this seminar addresses itself to the transfer of technology in developing areas. If the process of development is widely discredited as a political ploy by the supposed recipients of development, then there is little chance that its technologies will ever be transferable. Technology, in short, like development, cannot be discussed within a social vacuum and is never value-free. Space does not permit me to do more than merely mention three values that the technologies described in this paper attempt to promote.

These are, firstly that the agents of development should take a holistic view of the multiple causes of poverty and not be tempted into the design of specialised solutions for specific problems in isolation. Given the present specialisation of formal education this tendency is avoided when specialists work in teams involving other disciplines. Agents of development, secondly, should treat the recipients as subjects not objects, attempting to provide the circumstances in which the recipients realise their full potential as human beings. These agents of development, thirdly, should thus enter into real relationships with the subjects of development and be prepared to learn or be developed themselves.

Without the active promotion of underlying values such as these, it is difficult to imagine how a technology will be successfully transferred. Without them it is likely that "development" will soon join a dusty heap of discarded ideas, along with "progress" and "separate development".[1]

2. Technology

The toilets, tanks and spring protections all use ferrocement. The potential of ferrocement as a durable material for a variety of uses in underdeveloped areas is testified by the establishment in 1976 of the International Ferrocement Information Centre in Bangkok through the initiative of the U.S. National Academy of Science. In this case plaster is applied to chicken mesh secured with plain wire to a single, triple-purpose mould comprising six vertical sections of curved galvanised-iron bolted together. In circular configuration the mould is used for roof tanks and the reservoir tanks of spring protections. With the removal of one vertical section and bent round into a spiral, the mould is used for the superstructure of the toilet. Ferrocement is a relatively simple building technique and thus the strategy tackles three typical problems in underdeveloped areas, the lack of clean water, sanitation and employment. Technical specifications and construction methods are set out in The Valley Trust : Water and Sanitation Projects.[2]

FERROCEMENT TANKS, TOILETS AND SPRING PROTECTIONS

The spring protections comprise a V-box and filter which gathers water at the eye which is then led into the reservoir tank. Water which would otherwise trickle away unused is thus stored. The eye of the spring is fenced off and tests show that the quality of water is improved.[3]

The roof tank is built on a base, sealed with a concrete lid and has a capacity of 4 500 l. The tank, including labour, costs approximately the same as a galvanised-iron version but its greater durability makes it more economical. The N.I.W.R. is presently conducting research with The Valley Trust into the quality of water drawn from such tanks. There is no evidence to date that it is unsatisfactory.

The toilet is a modified version of the Blair Ventilated Improved Pit Toilet.[4] One innovation is a ferrocement backward-sloping pedestal.

3. Training

The subjects of training in under-developed areas are frequently without more than the elements of formal education and culturally at a distance from the required techniques. It is a superficial notion to believe that training, in these circumstances, is a matter of a few courses and follow-ups. Training in fact aims no less than to change a significant aspect of an individual or a community's behaviour and the depth and complexity of this aim should not be underestimated.

Perhaps the guiding maxim is "little and often", provided that the "often" occurs over an extended period. It is possible, therefore, to think of a period of initial training, where the needs of the subjects of training are assessed, and motivation and practical teaching, preferably by direct involvement, is begun. Initial training is followed by support training, where over an extended period reinforcement of the trainees' skills take place, weaknesses identified and challenged, and problems solved practically on site. The Western expectation of a gradual, linear accretion of skills is not as helpful as a concept of training as a gradual, cyclical process where basic principles are returned to with more understanding as experience grows.

4. Transfer

The transfer of the water and sanitation projects described above involves both the training of individuals and the training of the human infrastructure within the community capable of the long term implementation of the new technology. The Valley Trust has chosen this strategy in preference to acting as a specialist contractor in the area. The rate of construction has been slow but the method has lead to the training and establishment of first Development Committees and then a Development and Services Board which is currently involved in the establishment of a piped-water supply for the area. The communities' expressed need for water (and sanitation) has thus been translated into new structures of local government.[5]

That technology transfer has led to the emergence of a Services Board should come as no surprise to those familiar with the Tribal Authorities that characterise local government in rural and many peri-urban areas. In KwaZulu, for example, although there is a Legislative Assembly at national level, at local level the inherited powers of chiefly families continues in the form of Tribal Authorities. These institutions are at best not fully representative of the community and at worst cumbersome stumbling blocks to development. At present there is a Development Committee attached to each Tribal Authority in the area in which The Valley Trust works. The Committees have constitutions approved by the Tribal Authorities which have the right to veto but not interfere in development activities. Membership of a Development Committee is by election at an Annual General Meeting, much like a Town Board.

The responsibilities of a Development Committee with regard to the tank and toilet project include the administration of a rotating credit fund, the supervision of the two man construction team, the ordering of materials, the control of the tools and moulds, etc. Such administrative skills are not easily acquired. A Technical Officer regularly visits both the teams and members of the Development Committee and provides an extension service similar in some ways to that of an Agricultural Field Officer.

There is no reason to doubt that the principles on which this type of transfer is founded cannot be used with some modification in other rural and peri-urban areas.

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THE APPROACH TO THE DESIGN OF WATER AND SEWAGE-PURIFICATION WORKS

W J UYS,

DEPARTMENT OF DEVELOPMENT AID
P O BOX 384
PRETORIA
0001

SUMMARY

This paper highlights the importance of future maintenance and operational requirements in the total design concept of a facility. It promotes the idea of innovative design and also the fact that Client bodies must be realistic in their demands. It stresses the fact that the best technology fails if either the maintenance or the operation fails.

OPSOMMING

In hierdie verhandeling word die klem gelê op die belangrikheid van toekomstige instandhoudings- en bedryfsvereistes ten opsigte van die algehele ontwikkelingskonsep van 'n fasiliteit. Die idee van nuwe elemente in die ontwerp word bevorder, en realistiese eise van die kant van kliëntliggame word voorgestaan. Die feit dat die beste tegnologie faal as instandhouding en bedryf faal, word ook beklemtoon.

INTRODUCTION

The Department of Development Aid is responsible for the design, operation and maintenance of a very large number of purification installations which have been established for greatly varying communities ranging from large cities to small rural settlements. Throughout the years certain observations have been made concerning the design and operation of these facilities, and the object of this paper is to further a certain approach in the design philosophy with a view to optimizing the subsequent value of such facilities.

This paper will not prescribe or attempt to evaluate any specific technology, as the evaluation of available technology forms an inherent and a very important part of the entire design exercise. A common shortcoming of strict guidelines is the fact that they can impair innovative or creative designs. It must remain the total responsibility of the designer to propose optimal solutions to every problem, admittedly within the framework of preferences expressed in the Client's Manual, which should be well motivated and based on appropriate past experience.

This paper, in the first instance, addresses designers who are expected to be creative and innovative in regard to their designs, but on whom also rests the responsibility to adopt a realistic approach in their designs in order to offer technologies which are commensurate with the skills of the staff available to operate and maintain the works. This paper also makes an appeal to authorities not to demand techniques just because they are the best available or the most modern, but which may not be appropriate for the particular circumstances. Intricate or experimental processes should never be adopted unless full-time supervision of adequately trained staff could be assured.

SEWAGE AND WATER PURIFICATION IN RELATION TO THE WATER CYCLE

Sewage and water-purification plants are inherently merely the removers of pollution. The following well-known and often-repeated schematic representation of the water cycle clearly illustrates the relative positions of the two types of "pollution removers".

It is most important to realize that the degree to which pollution requires to be removed is dictated to a very large extent by the environment, and it may also not always be necessary to purify sewage to very high standards. In the Republic of South Africa, for instance, the Department of Water Affairs is willing to evaluate applications for simplified but safe disposal options for purification works up to approximately 800 cubic metres per day. An option of this nature should be investigated for communities up to 10 000 persons. In these cases oxidation ponds, aerated lagoons, anaerobic ponds, aerobic ponds, etc, should be considered. These options, which are all fairly low-cost and low-maintenance options for treatment, are, where required, linked to a properly designed irrigation system to provide adequate and safe disposal of sewage. The Department of Development Aid has available designs for standard sewage-purification works based on these proposals, in sizes ranging from those for 500 persons to 5 000 persons. Provision is generally made for the possible future upgrading of these systems, in which case existing oxidation ponds may be utilized as maturation ponds.

THE APPROACH TO THE DESIGN OF A PURIFICATION FACILITY GENERALLY ADOPTED

The usual approach to the design of a purification facility can be broken down into the following steps:

(a) Establish the size of the facility required by taking into account factors like growth rate, phased construction, etc.

(b) Find a suitable site for the works.

(c) Establish effluent standards (normally SABS 241 for drinking water or the General Standards for sewage purification).

(d) Evaluate processes capable of meeting the prescribed standards and evaluate construction materials. Choices are generally based on economy where all factors such as capital costs, energy costs, and an estimate of maintenance and operational costs are taken into account.

(e) Proceed with detail design, construction and commissioning.

(f) Complete a maintenance period of one year and hand over the works to the Client for all further operation and maintenance. Full and comprehensive operational and maintenance manuals are normally handed over to the Client at this or an earlier stage.

This general design approach is illustrated by the figure 2 (See page 11.)

It must first of all be emphasized that there is nothing inherently wrong with this approach, and it is also a feather in the cap of the South African engineer that it very seldom happens that a works cannot perform as designed if operated and maintained strictly according to the manuals. Yet it is patently obvious from the state of many of the facilities under the control of the Department that the total picture is not satisfactory. Throughout the years various reports have been prepared for the Department by Consultants regarding the state of works which do not function satisfactorily. The resulting recommendation can be classified into two main categories:

(a) If the consultants who originally designed the works have prepared the report, it is invariably and often justifiably stated that the works is not properly operated and maintained.

(b) If consultants (other than the designer) have been commissioned to prepare the report, major modifications to or the total scrapping of the existing facilities and their replacement based on alternative technology are often recommended.

Of the two types of reports the first is generally more correct.

The above two statements are made with the tongue in the cheek, but it does illustrate a very important fact that, without adequate maintenance and operational skills, even the best designed plant cannot function successfully, and hence the total project may not function satisfactorily. The most common error when design assumptions are made is that suitable staff for maintenance and operation will be available or will be found.

The interaction required for the proper functioning of an established facility is illustrated in figure 3 (See page 11.)

Should any one of the three main interactive functions fail, the works as a whole fails.

THE PROPOSED APPROACH TO THE DESIGNING OF PURIFICATION FACILITIES

Where the interactive and important role of maintenance and operation in the total success of the project has been well established, it is only realistic to use it as an important input in the total design exercise. The following amended approach is suggested:

(a) Establish the size of facility required, taking into account factors such as growth rate, phased construction, etc.

(b) Find a suitable site for the works.

(c) Establish realistic effluent standards which will be safe, acceptable to the consumers, and not harmful to the environment. This does not necessarily mean compliance with the SABS standards for drinking water or the General Standards for sewage effluents.

(d) Determine the level, experience and skill of readily available maintenance and operations personnel.

(e) Evaluate the available technology which will enable the personnel in (d) above to achieve the required effluent standards which have established under (c) above.

(f) If such technology exists, the design can proceed along conventional lines with all the normal optimizing etc.

(g) If the available facility based on the technology to achieve the required effluent standards cannot be operated or maintained by available personnel, the Client must immediately be informed and the problem must be addressed during the stage. In this respect the Consultant could assist the authority in the following manner:

    (1) Inform the Client of the problem and clearly define the type of personnel required.

    (2) Help the Client to obtain suitable personnel by recruitment, training, or, as a last resort, by secondment of own personnel, or arrange for the operation and maintenance to be executed under contract.

(3) Try to get the personnel involved during the design, construction and maintenance stages and to determine their capabilities at an early stage. It would be to advantage to incorporate reasonable requests by the operators.

(h) During the maintenance period special attention must also be given to staff training, and care must be taken to point out to them when equipment is being misused.

This proposed design approach differs from the general approach mainly in two respects:

(a) The experience and skills of available maintenance and operations personnel should be thoroughly investigated before discussions are held on the technology which is to be applied in the works.

(b) If the available facility based on the technology to achieve the required effluent standards cannot be operated or maintained by available personnel, the authority must be informed accordingly and the problem addressed at an early stage.

A number of colleges in the National States and the National Water Research Institute of the CSIR under contract with the Department of Development Aid present courses for the training of operations personnel and, also by way of in-service training programmes, a significant number of operators have already achieved a high degree of skill. However, since a large number of water and sewage-treatment plants have been established in developing areas during the past decade or two, and since even greater numbers of these plants are at present being planned or have been proposed, the shortage of adequately skilled personnel may even increase in the near future - a fact which should be realized by the authorities and designers.

In order to ensure better control over the erection and operation of water and sewage-treatment works, regulations for the erection, enlargement, operation and registration of water-care works were published in the Government Gazette dated 27 December 1985 of the Republic of South Africa, and indications are that some of the National and Independent States may follow suit. In this regard authorities and designers should also give attention to the classification of personnel according to educational qualifications and experience, who should be employed for the operation of water-care works.

In view of the above it is absolutely essential that, wherever possible, the technology adopted for water and sewage-treatment plants should be in accordance with the skills of available maintenance and operations personnel. Where this is impossible, the authorities should, before the design is accepted, consider the possibility of entering into operation and maintenance agreements with the designer or another suitable firm in the private sector in regard to operating the works, who would then be responsible for providing the staff in accordance with the regulations.

GENERAL RECOMMENDATION FOR DESIGNS

It was stated in the introduction that this paper does not envisage the evaluating of any technology. This in itself is a complex topic, and the "appropriateness" of technology largely depends on site-specific factors. In general, however, a number of guidelines have emerged over the years and, as they are based on real experience, it is worthwhile repeating them here. They are the following:

(a) Avoid automation if possible.

(b) Limit the use of mechanical equipment as much as possible.

(c) Use materials not prone to corrosion.

(d) Use simple and robust processes. The Department, for instance, prefers biological filters for sewage purification rather than activated sludge, because biological filters are far less sensitive to wrong operational decisions and will therefore be less prone to failure.

(e) Use interchangeable pumps and other mechanical equipment if possible.

(f) Incorporate sufficient safety measures to protect the equipment against unexpected damage.

(g) Avoid use of corrosive or potentially poisonous chemicals.

EXAMPLE OF THIS DESIGN APPROACH

To conclude this paper, the foregoing is illustrated by an example. The same firm of Consulting Engineers was appointed for the design of water-purification works for two different communities in KaNgwane. The following design inputs were given:

		EERSTEHOEK (Elukwatini)	MAYFLOWER (mPuluzi)
(a)	Size of works	100 litres per second (8,6 megalitres per day).	100 litres per second (8,6 megalitres per day).
(b)	Community	Urbanized; full services are provided including water-borne sewage. There are a Regional Hospital and Magistrate's Offices.	± 15% urbanized; full services are provided The rest of the population are distributed over a large area and have only a standpipe service.
(c)	Road access to works	A tarred road except over the last ± 5 km.	A tarred road, plus 30 km of very bad gravel road.
(d)	Operator	A trained operator seconded to the KaNgwane Department of Works by the Eastern Transvaal Development Board is available	No trained operator is available at this stage. A competent supervisor is available for inspections on a regular basis.
(e)	Electricity	Available.	Available.

With the above inputs in mind, it was decided to build a conventional rapid sand-filter type of works for Eerstehoek with all the normal chemical pre-treatment and sedimentation processes, etc. This was done, amongst other reasons, because the water-supply to this community had to be constant and reliable as there were no alternative sources that could be used in cases of emergencies.

It was decided, by the same token, to adopt a simplified technology approach in regard to Mayflower. A slow sand-filter type of works is at present under construction, which makes provision for chemical pre-treatment and for sedimentation to 50% of the normal inflow. This makes it possible to operate the works under full-flow conditions without pre-treatment during periods of low turbidities, it can pre-treat 50% of the flow and blend it with the 50% raw water during periods of medium turbidities, or it can operate with full pre-treatment at 50% capacity. Provision has also been made for the possible future extension and/or upgrading of the works if required.

The following table gives a comparison between the two types of "technology".

	Eerstehoek	Mayflower
Capital costs	R1,21 x 10^6	R1,01 x 10^6
Chemical consumption		
Alum	95 t/a	30 t/a
Lime	100 t/a	75 t/a
Electricity installed	65 kW	15kW
No of electrical motors	1 x lime-dosing unit	1 x lime-dosing unit
	3 x mixers	2 x mixers
	3 x dosing pumps	2 x dosing pumps
	2 x backwash pumps	
	2 x blowers	
No of valves requiring daily operation	6	4
Running costs at full flow	14,3 c per kilolitre	8,90 c per kilolitre
Regular operation actions	(a) Do a jar test and set optimal chemical dosage. Mix chemicals.	(a) Same as for Eerstehoek but only for 25% of the time.
	(b) Backwash filters. This is done by closing feed and clean-water outlet, opening air valve, switching on air blower, closing air valve, opening backwash valve, switching on back-wash pump, opening backwash outlet,	(b) Remove "Schmutzdecke" manually, approximately 2 times per year per filter.

	checking that filter is clean, switching off pump, closing backwash outlet, closing backwash valve opening clean-water outlet, opening feed inlet.	
	(c) Desludge sedimentation tank by opening sludge outlet valves.	(c) Desludge sedimentation tank.
	(d) Set chlorinator.	(d) Set chlorinator.
	(e) Decant water in sludge dams.	
Maintenance required	Chemical dosing equipment must be maintained and calibrated. Clean-water pumps and blowers must be lubricated and serviced. Valves must receive routine maintenance. Chlorination equipment must be checked for proper functioning.	Chemical dosing equipment must be maintained and calibrated. (used only for $\pm$ 3 months a year). Valves must receive routine maintenance. Chlorination equipment must be checked for proper functioning.

Figures in the above table indicate that, not only would the Mayflower plant require much less operation and maintenance skills, but it may also have cost advantages. However the plant will be commissioned only during June 1986, and the performance of this works could form the basis for reports of this nature at future seminars.

CONCLUSION

The above example demonstrates the possibility of utilizing appropriate technology in the design of water-care works in order to minimize operational and maintenance requirements, and in the particular case, at possibly lower capital and operational costs.

However the employment of such technology is in many cases impossible mainly as a result of the quality of inflow and/or outflow requirements where highly qualified personnel would be required for the operation and maintenance of the works.

Should such personnel be not available, the authorities should consider the possibility of entering into operation and maintenance agreements with the designer or another suitable firm. It could also be to advantage to extend the role of the designer so that he will also be involved in the operation and maintenance of the works.

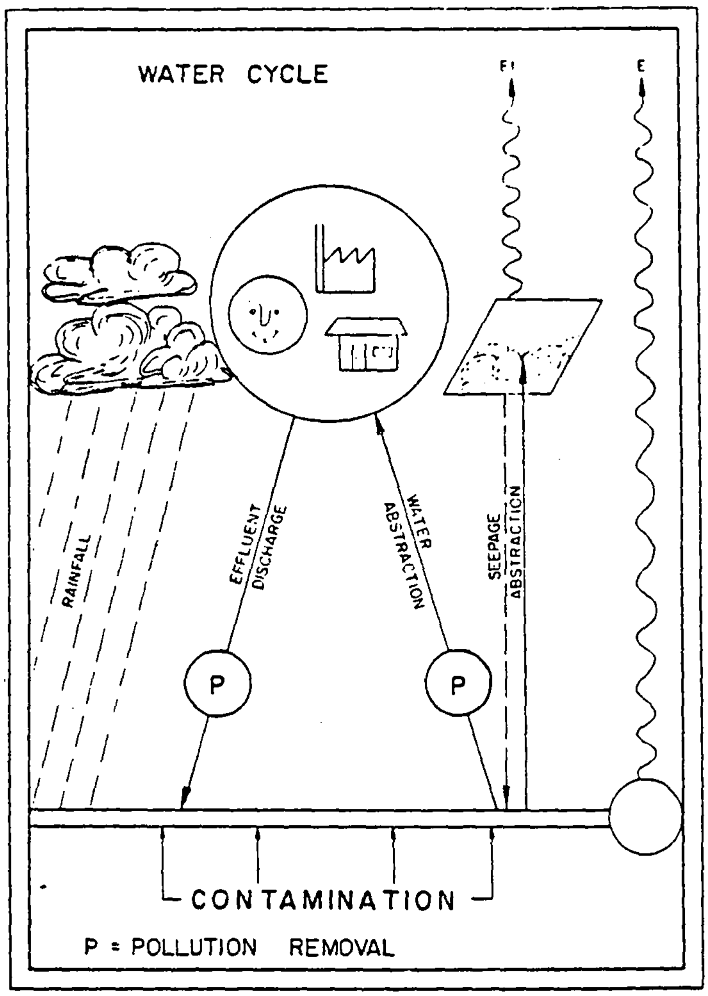

FIGURE 1 : SCHEMATIC REPRESENTATION OF THE WATER CYCLE

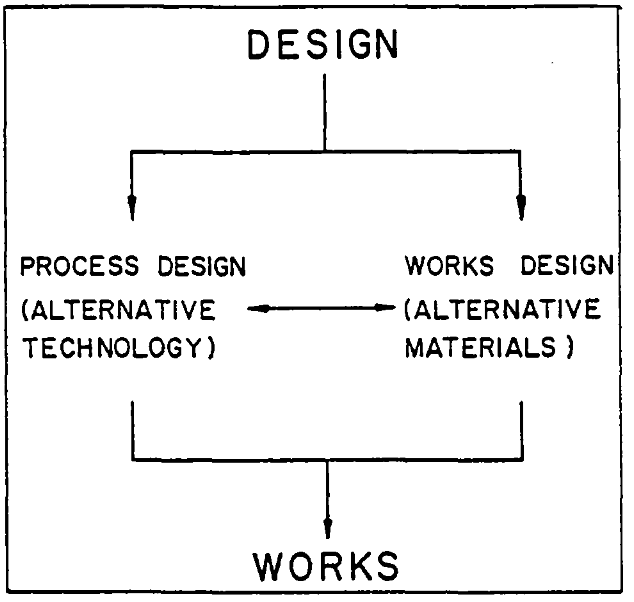

FIGURE 2 : CONVENTIONAL APPROACH TO THE DESIGN OF A PURIFICATION WORKS

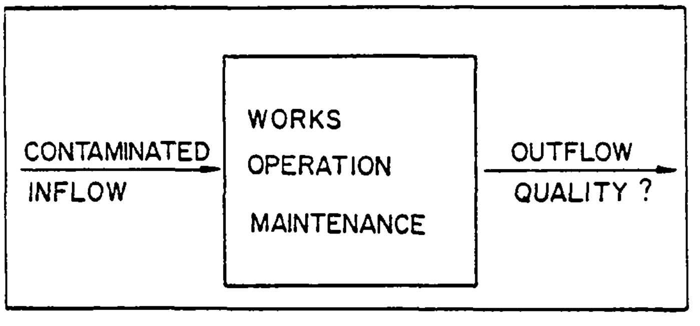

FIGURE 3 : THE THREE MAIN INTERACTIVE FUNCTIONS IN A PURIFICATION WORKS

PAPER: 2.3

THE USE AND MISUSE OF PONDS IN WASTEWATER SYSTEMS

Philip J. PYBUS

Pr. Eng. MA(Cantab)

Stewart Sviridov & Oliver, P.O. Box 784148, Sandton, Johannesburg 2146

ABSTRACT

The paper sets out the principal uses of ponds in wastewater treatment and management ranging from oxidation ponds for the treatment of the waste flows from small communities, to evaporation ponds for the disposal of intractible industrial waste. The misuses of ponds covers aspects of over-design, neglect and sheer stupidity.

EKSERP

Die verhandeling bestryk die vernaamste gebruike van damme in die suiwering en beheer van afvalwater, en die behartiging vanaf oksideerdamme vir die suiwering van afvalvloei uit klein gemeenskappe, tot verdampingsdamme vir die wegruiming van onhanteerbare nywerheidsafval. Die misbruike van damme sluit in oorontwerp, verwaarlosing en klinkklare stommiteit.

1.0 INTRODUCTION

1.1 Ponds have been used for various purposes in the treatment of wastewater of domestic origin in a number of different manners. They offer an apparently simple means of reducing organic and bacterial loadings in the wastewater at relatively low cost and with minimal operator input. The waste stabilization pond is, however, a complex biochemical reactor which defies precise design.[1]

1.2 This introductory paper describes the principal uses for pond systems as well as some of the problems that can arise.

2.0 USES OF POND SYSTEMS

2.1 Oxidation/Stabilization Pond Systems

The oxidation/stabilization pond system is the one most frequently associated with sewage treatment. The system is suitable for handling raw sewage, settled sewage or septic tank effluent and even easily biodegradable industrial effluents.

The circumstances under which an oxidation/stabilization pond system may be regarded as appropriate will differ from location to location. In Southern Africa it is not considered suitable for population equivalents greater than 5 000 nor for flows in excess of 600 m^3/d. A relatively large area is required for the ponds and the cost of this should be low.

The siting of the ponds should ensure that there is no likelihood of polluting ground water, particularly if any aquifers are close by. The tendency for ponds to be self-sealing with accumulations of sludge or other organic matter should not be relied upon to prevent groundwater pollution.

Wind direction should also be considered in locating pond systems and in general these should not be situated within 1,5 km of any dwelling when located upwind. This is due to the spreading of smells, flies, which can breed on floating scum, and mosquitoes which can breed on the edges of the pond if the vegetation is allowed to grow.

The design of various pond systems has been well documented and will not be dealt with here, although the latest Guide by R.J.L.C. Drews and published by the National Institute for Water Research [(2)] is recommended.

2.2 Oxidation/Stabilization Ponds in combination with Anaerobic Ponds

Anaerobic ponds perform a multiciplicity of functions. In the first instance they act as sedimentation basins reducing the solids loading into the primary facultative pond; they provide a period of anaerobiosis for the incoming sewage which assists in breaking down the organics in the waste stream prior to entering the primary pond. They also act as large, unheated, un-mixed digesters in the breakdown of the solid matter. The design of these can be sophisticated or unsophisticated depending on the expected period of use. At least three such ponds should be provided, each of which could act as primary, secondary or standby pond. The contents of the standby can be stabilising (digesting) or being allowed to dry out pending removal. It is preferable that means of access for mechanical equipment is provided when the necessity of emptying the ponds arises.

Such ponds can precede a stabilization pond system or even a conventional biological filtration works and will obviate the use of primary settling tanks and concrete digesters.

2.3 Maturation Ponds

Pond systems can be used very successfully as a polishing stage for humus tank effluents with significant bacterial and viral reductions.

It should however be noted that using ponds in this system will generally increase the suspended solids in the effluent to well above that which is acceptable for the General Standard due to the growth of photosynthetic micro-organisms.

The very extensive pond system provided at the Gammams Works in Windhoek eliminated virtually all viruses and formed one of the basic health safety barriers in the reclamation process. The algal suspension however lead to the need for and the development of a flotation unit which became an essential unit operation in the reclamation system.

2.4 Waste Sludge Lagoons

The use of ponds for wasting sludge from extended aeration activated sludge plants provides a relatively simple means of storing and stabilising the waste sludge. The usefulness arises from the facility to waste mixed liquor at a pre-determined rate, either through an orifice or by pumping into the pond without conscious effort being required from the operator and thus maintaining a constant solids retention time in the activated sludge system.

A loading rate of 400 kg COD/ha will not cause smells, such ponds having been operated within a couple of hundred metres of housing and would take about 1 year to fill. Higher loading rates could perhaps be tolerated but additional ponds would be needed as with the higher loading rate, these will fill up faster than the approximately 1 year rate for a 1,2 m deep pond at 400 kg COD/ha.

This system does not serve as a disposal method for the sludge. Pumping from the pond is not really a practical possibility as transverse flow of the consolidated sludge does not take place. It would therefore be necessary to provide a pump on a barge and conduct a dredging operation. Suitable pumps and barges are marketed as complete units. A simpler way is to drain the water off slowly and allow evaporation to take place. Even in very arid conditions (average rainfall 300 mm per annum) it can take from 9 to 12 months for the sludge to be sufficiently dry to be handled mechanically.

2.5 Balancing Storage

In works serving small populations there are likely to be high peak flows. A pond becomes very useful in providing storage so that instantaneous peak flows can be by-passed, thus reducing clarifier sizes. The preferred method is to pass only short duration peaks into a pond which can then be pumped back into the main works at a later stage (if gravity is possible this is advantageous), but always leaving residual water in the pond to maintain proper biological life. This should be topped up from time to time if the flow into it is limited. Alternatively use the last pond in a series designed for sludge lagooning.

2.6 Night Soil Lagoons

Ponds have been used to receive night soil. The main problem arising from this application comes from the extremely strong feed concentrations and the need is for evaporation of the liquid rather than treatment. One of the major problems is smell, and aeration can been used to minimise this.

2.7 Evaporation Ponds

Evaporation of the water from intractible organic effluents or concentrated saline streams is very much the "end of the line" or last resort approach to pollution control. It is nevertheless cost effective, particularly where good housekeeping has been practised and the wastes are highly concentrated in flows of small volume. The essential features are to provide a truly impermeable membrane below the water surface to eliminate all possibility of seepage and to be reasonably conservative in calculating evaporation rates and the possibility of overflow occurring during wet seasons.

2.8 High Rate Algal Ponds

Systems have been and are being developed for the production of protein in algal ponds with domestic sewage as feed. One such system comprised a shallow orbal type pond, which was lined, and with pumps to circulate the contents around the lagoon at a predetermined rate. The liquid retention time was 3½ days. A channel along the side of the lagoon was provided into which coagulants were added and as a result of auto-flotation the algal biomass could be harvested. In the system investigated a cooking pot was proposed with water heated jacket to elevate the temperature of the algae to 60°C for a period of 10 minutes for disinfection. Thereafter, the algal mass would be mixed with straw or mielie chaff and dried on covered open floors.

The cash economics of the system were not viable. The cost of the equivalent alternative protein cattle feed was equal to the cost of the coagulants added! A full economic study, taking into account any agricultural benefits, was not undertaken as the prognosis still appeared extremely poor.

The concept of protein recovery from pond systems should not, however, be neglected and the work undertaken by Dr Hensman after engineering development and large scale trials may well indicate the road for the future.

3.0 MISUSE OF PONDS

There are a number of possible misuses or misapplications of pond systems that should be avoided. The problems can be categorised under a number of generalise headings.

3.1 Overload

Overload conditions can be identified in a pond system most generally by smell or when changes are noted in the presence and colour of the organisms present.

It is probably unwise to assume that when the design load has been reached, the system is overloaded. Design criteria and methods cannot be refined to the point where they can predict with any degree of certainty what the effects of increasing load will be.

The systematic collection of performance data, including figures of incoming load as well as effluent quality, would undoubtedly assist the designers of the ponds. Outside of the NIWR there is a remarkable lack of available information as to the operation and performance of pond systems in Southern Africa.

3.2 Evaporation and Seepage

There are dangers in over-designing pond systems. Evaporation can play a very large role, particularly in the extreme months. These effects include the concentration not only of the conservative salts but also of the non-biodegradable organic matter in the incoming sewage. There has been one instance in the author's experience where the combined effects of evaporation and seepage on an under-loaded, over-designed system ensured that no effluent reached the recirculation pumps in the last pond!

3.3 Toxicity

Due to the high volume in pond systems relative to the incoming load they are capable of absorbing shock and short term toxic loading. However, they cannot continue to absorb long term loading of toxic compounds. In the very much longer term, however, it is possible that suitable acclimated organisms would develop and prosper.

3.4 Neglect

This is the most common abuse of pond systems. The very simplicity of the operational requirements of pond systems that can be limited to the removal of screenings, cleaning of grit channels and chlorination, if these are provided, is conducive to neglect. The only other operations are concerned with reducing floating solids by breaking these up and in controlling vegetation on the pond sides.

Man is a social being and does not work well on his own, except of his own choice. He also needs direction and guidance in what he is doing. To appoint a single person to look after an isolated pond system and expect this to be kept in tip-top condition is the height of optimism. Far better to appoint three or more people, with wider duties than just to attend to the ponds if there is insufficient work there, and set minimum standards of performance that must then be monitored and adherence enforced. Money thus spent will have more benefit than in built-in low maintenance capital intensive features.

3.5 Stupidity

Pond systems cannot survive the stupidity of man. An example of this concerns a tanning factory which discharged most of its saline effluent down the sewer provided for domestic flows. In addition, the on-site effluent treatment facility did not operate as hoped for by the tannery and a considerable amount of solid matter was also discharged down the same sewer.

As a consequence the pond system was easily found in the bush by following the smell. The anaerobic ponds were filled within two to three months and became totally ineffective. The primary pond never developed a significant population of algae due to the very high salinity of the incoming water and the evaporation pond, provided with an expensive lining, never received its proper quota of the saline water and the bottom was never even fully covered.

4.0 CONCLUSIONS

Ponds and pond systems provide a variety of possible uses in the treatment of domestic and industrial effluents. They can be constructed in a manner to provide low cost, high maintenance, or with initially high capital cost and subsequently lower maintenance costs. Careful thought must be given when selecting pond systems for any particular purpose as to their appropriateness in the particular circumstances and the results that are expected and can be achieved with the managerial and operational skills that are likely to be applied.

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SLOW SAND FILTRATION

FACTORS TO BE CONSIDERED

by

P.G. Williams
Senior Engineer
National Institute for Water Research

INTRODUCTION

This paper summarizes the principal factors to be considered when comparing slow sand filtration (SSF) with rapid sand filtration (RSF). The purpose is to provide a basis for discussing the role of SSF in water treatment in southern Africa.

DESCRIPTION OF SSF PROCESS

The SSF process involves passing raw or settled water downwards through a submerged bed of fine sand at a slow rate, typically 0,1 to 0,15 m/h, which is 1 to 2% of the flow rate through a RSF. The purified water is drawn off through an underdrainage system. The filter should only need to be cleaned every one to two months, when the head loss through the sand bed increases to about one metre. All of the increase in head loss occurs on the top surface of the sand bed, and is due to the build-up of a biologically active slime layer, called a 'schmutzdecke'. Cleaning the filter is done by draining the sand bed and manually scraping off the 'schmutzdecke', together with the top two to three centimetres of sand. The filter is then refilled and put back into service. The bed depth is gradually reduced by successive cleanings until, when it is about 600 mm deep, it is refilled by adding clean sand to bring it back to about one metre deep. Alternatively, the spent sand can be washed clean for reuse.

The SSF process combines both clarification and partial inactivation of pathogenic microorganisms in a single treatment process, without the need for flocculation chemicals or mechanical equipment. It has therefore long been considered to be an appropriate technology for small water treatment plants in rural areas. However, it does have certain disadvantages, which means that SSF should not be installed without an engineering assessment of the particular circumstances and comparison with the alternative of RSF.

FACTORS TO BE CONSIDERED

Raw water suspended solids

The suspended solids in the raw water will obviously affect the rate at which a SSF blocks up, together with the downflow rate that is adopted for the filter. Generally, turbidity is used as the measurement of raw water quality, and suggested limits are 5 NTU average with occasional peaks of up to 20 NTU(1). However, these limits are almost invariably exceeded in natural streams and rivers in southern Africa, at least for part of the year. Therefore, on this basis, some form of pretreatment is necessary prior to SSF.

Turbidity does not measure the characteristics of the suspended solids (i.e. concentration, size, organic/inorganic, electrostatic charge), and experience shows that these characteristics significantly affect the operation of SSF. Therefore, it is considered that there is a need for an alternative method of measuring water quality to supplement a supersede turbidity. This is an avenue of research which the NIWR intends following.

Final water quality requirements

In order to meet the SABS standard for domestic water(2) the turbidity should be less than 1 NTU (maximum allowable limit 10 NTU) and have no faecal coliforms in 100 mℓ sample. These limits cannot consistently be met by SSF alone.

The reduction in turbidity by SSF depends on the characteristics of the suspended solids and, although it is very effective in removing silt, NIWR experience has shown that colloidal clay particles can pass through SSF and, on occasions, cause the effluent to exceed 10 NTU.

SSF can achieve an average of more than 99% reduction in faecal coliforms. However, the efficiency of the process is affected for two or three days after the filter is cleaned and also by sudden changes in water temperature or chemical quality. Therefore chlorination after SSF must be used to achieve nil faecal coliforms/100 mℓ consistently. The NIWR, in collaboration with the Microbiology School of the University of the Witwatersrand, is currently investigating the biological purification processes in SSF.

SSF does not significantly affect the chemical quality of the water.

Availability of sand

The volume of sand required for SSF is about 50 times that required for RSF. Therefore the availability and cost of the sand is a major factor in determining the viability of SSF for a particular location.

The sand that is specified for SSF is generally finer than for RSF (i.e. effective size 0,15 to 0,35 mm[1] compared with 0,4 to 0,6 mm). However, it does not need to be so closely graded as for RSF because the filter is not cleaned by backwashing.

NIWR studies indicate that coarser sand can be used for SSF (effective size up to 0,6 mm) without any significant deterioration in the clarity or microbiological quality of the filtered water. This coarser sand increases the filter runs by 50 to 100% compared with fine sand, because the 'schmutzdecke' penetrates one to two centimetres into the top of the sand bed. However, this should not increase the cost of cleaning the filter, because in practice it is not practical to remove less than this amount when scraping off the 'schmutzdecke' with shovels.

Pretreatment

As mentioned previously, pretreatment prior to SSF is generally required for natural waters. The objective should be to remove most of the suspended solids in the raw water as simply as possible, in order to reduce the load on the SSF.

Plain settling is generally very effective, and therefore drawing water from a point in a lake or dam which is protected from disturbance by storms and wind would be ideal. Horizontal flow settling tanks at water treatment plants can also remove sand and silt without the need for chemical flocculation. A modification of this type of tank is the horizontal roughing filter (HRF) which is being investigated by the NIWR. The experimental HRF is a 12 m long channel by 1,1 m wide which is filled with gravel (1,2 mm effective size) to 0,6 m depth. Raw river water flows through the channel, below the surface of the gravel bed, at a rate of 0,5 m^3/h. This pretreatment system is followed by a pilot scale SSF, and there is also a control SSF which is fed with raw river water, both operating at a downflow rate of 0,1 m/h.

The HRF has proved to be very effective at reducing turbidity from as high as 60 NTU to generally less than 10 NTU, and also reducing the suspended solids from approximately 30 mg/ℓ to less than 3 mg/ℓ. The SSF runs have been increased from about 3 weeks to more than 3 months and the HRF has operated for more than 12 months without being cleaned. Therefore HRF appears to be a promising pretreatment system for small SSF plants (up to 50 m^3/d), and the results of the NIWR investigation will be the subject of a paper later in 1986.

Chemical flocculation followed by a settling tank has also been used for SSF pretreatment. However, this negates one of the advantages of SSF (no chemicals required), and also operational problems with the SSF have been experienced in some cases due to rapid blockage of the filters (less than one week). This is caused by carry-over of fine floc to the SSF, which settles onto the surface of the sand bed and forms a thin, impermeable layer of the chemical flocculant. There is a need for more research into the conditions under which chemical flocculants can be used with SSF.

<u>Process design of SSF</u>

<u>Downflow rate</u> - This is typically 0,10 to 0,15 m/h. Higher downflow rates are likely to make the filter runs unacceptably short because of the increased suspended solids loading, and also the hydraulic pressure required to force the water through the schmutzdecke increases rapidly with a higher flow rate.

<u>Period of operation</u> - SSF should preferably be operated continuously, in order to maintain a constant state for the biological purification processes. If this is not possible then they can be operated at a slower flow rate during off-peak periods or stopped (but not drained) for a few hours at a time.

<u>Number of filters</u> - There should be at least three filters at each SSF treatment plant, and the design should allow for one to be out of service for cleaning while the other two are in operation.

<u>Other process design factors</u> - These include the method of outlet control (overflow weir or control valve) and whether the filters should be covered to prevent algal growth.

Construction

Complexity v size - The construction of a SSF is less complex than a RSF because it is not cleaned by backwashing. Therefore there is no need for backwash pumps, air-scour equipment or special filter floor design with nozzles. However, these savings should be weighed-up against the much larger size of the SSF, which can make it more expensive to construct than a RSF of the same capacity.

Underdrainage system - The conventional underdrainage system of both SSF and RSF consists of several layers of graded gravel, in order to prevent penetration of the sand into the underfloor drainage system.

It is possible that the SSF underdrainage system could be simplified to a single layer of coarse gravel with a layer of commercial drainage fabric (e.g. Bidim) between the gravel and the sand. However, this option still needs to be tested in practice to determine whether it is effective.

Operation

The operation of SSF which has only settling (without chemical flocculation) is simpler than RSF, but the cleaning of it is more labour intensive. However, the schmutzdecke may be easier to dispose of than backwash water from RSF.

As mentioned previously, the effectiveness of SSF in purifying the water, and the period between cleaning of the filter depend on the influent water quality. Therefore, without chemical addition, there is little that the plant operator can do to improve SSF efficiency during periods of difficult raw water conditions (e.g. after storms, when the turbidity is high). This can make it difficult to control final water quality or to predict the requirements for labour to clean the filters.

Maintenance

The only maintenance which SSF is likely to require is periodic replacement of sand (every 4 to 5 years) when successive cleanings have reduced the depth of the sand bed to about 600 mm. SSF do not have the maintenance problems which can occur due to improper backwashing of RSF, such as mudballs or disturbance of the gravel underdrainage.

CONCLUSIONS

As stated in the introduction to this paper, its purpose is to provide a basis for discussing the role of SSF in water treatment in southern Africa. From an assessment of the factors to be considered in comparing SSF and RSF, the following conclusions can be drawn:

(a) SSF require some form of pretreatment to reduce the suspended solids loading, at least during part of the year. The horizontal roughing filter (HRF) appears to be a promising pretreatment process for small SSF treatment plants (up to 50 m^3/d). Chemical flocculation can cause SSF operational problems. Further research needs to be done on characterisation of raw water and also on pretreatment processes.

(b) SSF improves both the clarity and microbiological quality of raw water. However, SSF in itself cannot produce water which is guaranteed to consistently meet the SABS standards for drinking-water. Further research is necessary to gain a better understanding of the purification mechanisms of SSF, which may lead to process design improvements.

(c) The suitability of SSF depends on the availability of a local supply of suitable sand, as well as the facilities and personnel available for construction and operation of the particular water treatment plant.

(d) On-going improvements in technology of both SSF and RSF (e.g. use of fabric in the underdrainage of SSF and new designs of automatic backwashing RSF) need to be taken into account by design engineers.

For these reasons, the design of every small water treatment plant continues to be a matter requiring the judgement of skilled and experienced and engineers.

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PAPER: 2.5

OPERATION OF WATER CARE PLANTS

J.S. WIUM

Divisional Head: Advisory Services - Water Care

National Institute for Water Research, Council for Scientific and Industrial Research, P.O. Box 395, PRETORIA 0001

Paper to be presented at the Seminar on Technology Transfer in Water Supply and Sanitation in Developing Areas (S.265) at Mmabatho, Bophuthatswana 10 to 12 June 1986.

ABSTRACT

Various factors having an influence on the quality of process control by the operating staff at water care works are discussed. Shortcomings, especially with regard to control equipment, motivation and involvement of the supervisory staff are pointed out.

This paper is intended to stimulate discussion during a workshop session on Design, Training and Operation.

OPERATION OF WATER CARE PLANTS

Introduction

In the context of this Workshop, the term *Operation* is considered equivalent to *Treatment Plant Process Control*. This subject and aspects to be considered to ensure a good level of process control is so comprehensive that it cannot be fully covered within the time allocated for presenting this paper.

The discussion is therefore limited to the most important aspects based on experience gained in the national and independent states of southern Africa.

Recognizing the interactions between *Design, Training and Operation*, the focus is directed on *Motivation* of the operators and the role to be played by the *Supervisors*.

EFFICIENCY OF WATER CARE PLANTS

The three main factors that affect the efficiency of water and wastewater treatment plants are:

- Design
- Maintenance
- Operation.

Design

Discussion of design aspects will be limited in this paper to the minimum as this is dealt with by other papers in this Workshop session.

It can, however, not be completely overlooked that poor design sometimes makes the operation of such units extremely difficult.

Maintenance

It is often taken for granted that the operator should undertake maintenance work on the treatment plant. This attitude probably originated from the earlier days when operators mostly comprised artisans and this of course suited the employers quite well as this single person could perform duties that would otherwise require the employment of at least two people.

This attitude unfortunately still exists with a number of employers who fail to recognize that process control, if properly done, is a full-time task - especially when dealing with more sophisticated processes.

While it is definitely the duty of the operator to notice and report any mechanical plant malfunctions as early as possible, it is wrong to expect him to fix the equipment unless it is something fairly simple. Sufficient examples exist where equipment had to be replaced completely as result of operators trying to 'fix' it.

It is not quite understood why there is a resistance with some authorities to set up full-time properly equipped maintenance teams who should work to a predetermined maintenance programme in parallel with emergency repair teams.

QUALITY OF OPERATION

It stands to reason that the best designed and best maintained plant will not produce good results if the process control is improper.

The main factors affecting the quality of operation are:

- Personal abilities of the operator
- Level of his training (theoretical and practical)
- Motivation of the operator
- Supervision and control

In order to avoid non-relevant discussions at this Workshop, relating to operator personal abilities (or inabilities), the first-mentioned aspect will not be dealt with further.

Training

The importance of theoretical and practical training cannot be over-emphasized but a note of warning must be sounded immediately. Training, or rather the lack of it, is far too often used by employers as an excuse to shed their responsibilities to the operator. The popular phrase that 'once our operators have received the necessary training, matters will come right' is considered utter nonsense, unless it is followed up with further guidance.

Operators of good potential are often allowed to fall back into a groove of disconcern - mainly because after returning from a training course he finds that he cannot or is not allowed to implement what was taught at the course.

MOTIVATING THE OPERATOR

Salaries and career

It is unfortunate that some employers see monetary benefits as the only means of motivation for operators. It is true that many competent operators have left the water industry because of poor salaries, taking up another career as a clerk or truck driver for example. One of the most important questions to be answered is whether the employer has given enough attention to the creation of a posts structure to offer an attractive career to their water care operators.

Personal interest by the employer

There is sufficient justification for stating that generally, there is a tremendous communication gap between the operators and supervisors. This causes the operators to keep their technical problems to themselves instead of seeking the advice from the supervisors.

Can supervisors honestly state that they:

- get actively involved in the day-to-day tasks of the operators in so far as understanding their technical problems?

- take interest in personal matters which may affect the performance of the operators?

- understand the operators' aspirations and frustrations?

In-service training courses

In-service training courses should not only be utilized for training in the theoretical and practical aspects of water and wastewater treatment but also for making the candidates realize the importance of what they are doing, their service to the community and be informed of precisely where they fit into the organization.

Job-satisfaction

Previous mentioned factors could all contribute to creating job satisfaction. The environment in which the task is to be performed also plays an important role.

Many operators have to work at treatment plants where neglect and general disrepair is more the rule than exception. These adverse conditions exist not only on the plant itself but also in the buildings and offices. It is fully understood if no operator can feel motivated to do a good job under these circumstances.

SUPERVISION AND CONTROL

Flow measurements and control test equipment

It is of utmost importance that all treatment plants be supplied with suitable control and test equipment in order to monitor the functioning of each process unit. It is expected from a senior operator to determine the loading on a wastewater treatment plant and also to detect trends or malfunctions at an early stage. Similarly, senior operators should be able to calculate, check and control all chemical dosages and in order to do this, flow measurements and control tests are essential.

Involvement of the supervisors

Competent, well motivated and well trained operators can reach and maintain a high standard of process control whereas operators lacking these qualities will only achieve the minimum standards forced onto them by the supervisors. If this control falls away or is limited, as is the case in many instances, the process control of the plant collapses completely.

It is regretted that some supervisors apparently have no idea of what their duties should be. This is probably not their own fault as some of them are absolutely overloaded with tasks which does not concern process control.

Very few supervisors find time to listen and advise operators on problems experienced nor do they find time to scrutinise and check plant records. No wonder that it is often found that no records are kept and if they do keep 'records', that they are false. One way of 'keeping out of trouble' is to enter figures in the logbook that are guaranteed to keep the supervisor happy. During March of this year at a water treatment plant where aluminium sulphate is used as a flocculant, the pH of the treated water was entered in the logbook as 7,5 while it was in actual fact 4,3. Investigation showed that there was nothing wrong with the operator's pH meter.

Fortunately this is not typical of the situation everywhere. Fine examples can be given of not only the supervisors but also the senior operators showing initiative in their record keeping, plant control and conducting refresher courses for the operators and orientation courses for the learner operators. If there was a prize to be awarded for improvement on operation and process control, it would certainly have been won at this time by the responsible senior staff of Gazankulu. I am convinced that they will be eager to share their expertise with colleagues from other states.

CONCLUSION

In general, plant operation control is not satisfactory at all plants in the national states, TBVC countries and many of the smaller municipalities in the RSA. Improper supervision is probably the main reason for this situation.

RECOMMENDATIONS

In order to improve the quality of plant operation the following recommendations are made:

- Introduce properly manned and equipped maintenance teams

- Enhance the theoretical and practical training programme for operators as well as supervisors

- Upgrade the operators posts but don't fill the senior posts with unsuitable persons

- Introduce a more task-orientated work programme for supervisors

- Ensure that all plants are properly equipped with control test apparati.

ACKNOWLEDGEMENT

The National Institute for Water Research, CSIR is thanked for permission to present this paper.

PAPER: 3.1

A

BLUEPRINT FOR PROGRESS

C.G. CAMPION

CO-ORDINATOR-ADMINISTRATION
DROUGHT RELIEF P/BAG X2157
MAFIKENG BOPHUTHATSWANA

DROUGHT RELIEF ACTIVITIES IN BOPHUTHATSWANA DURING 1984, 1985 AND 1986.

A CRITICAL REVIEW OF THOSE ACTIVITIES AND A LOOK AT THE FUTURE FOR RURAL COMMUNITIES.

WHAT HAS BEEN DONE

WHAT COULD BE DONE

WHAT CAN BE DONE

Conditions and circumstances described may well apply to the Continent in general, are particularly relevant to Southern Africa and pertain specifically to Bophuthatswana.

Those who have been closely connected with Drought Relief programmes during the past three seasons have gone through two distinct phases.

If at first we were saddened and frustrated we are to-day infinitely wiser and mildly optimistic.

The knowledge gained has taught one simple fact:-

Man himself has created the conditions in which less than average rainfall can result in disasterous famine. A drought will only become a disaster if the land has been mismanaged before the drought, during the drought and after the drought.

If you would quarrel with that statement then let us ponder these questions?

Who else but MAN destroys the forests and woodlands?

Who else but MAN year after year persists in overgrazing the precious veldt?

Who else but MAN obstinately uses inappropriate tillage practices.

Who else but MAN abuses and misuses what small water supplies there are?

Who else but MAN could be so ignorant as to destroy the environment upon which his very existance depends?

And we can be justifiably sad, very sad, because we know beyond doubt that man can, if he chooses, prevent the further degradation of remaining natural resources.

But we have one consolation - it is not too late to put-right much of the damage already done.

So what has Drought Relief been doing?

We have been feeding 40 000 destitute men, women and children in the rural villages, We have been teaching these poor people to grow food for themselves.

We have been feeding thousands of cattle.

We have been distributing subsistance to the needy farmer.

We have been transporting water to villages where supplies have failed.

We have been sinking boreholes where supplies have failed.

We have been repairing boreholes where supplies have failed.

We have been creating job opportunities in the rural areas.

And we have had to face unpleasant facts.

The plight of the rural destitute was an apparent and very obvious condition easily perceived by the observant long before the current drought. The drought merely aggravated their problems. The sad fact remains that it required a near catastrophy to galvanise us into action.

Techniques for growing food on small plots in times of drought are not new. Experts in this important field have been propagating these skills for many years. Should this not be an on-going socio-economic programme regardless of drought?

Who will deny that good veldt management is a prerequisite to good livestock production?

Can there be on this Continent a serious farmer or properly trained extension officer who does not understand, recognise and respect the consequences of overgrazing?

Yet for some reason beyond comprehension we continue to grossly overload the grasslands.

In Southern Africa we are carrying over double the number of cattle the veldt can reasonably be expected to sustain.

Is it possible the farming communities in this region deliberately wish to degrade and destroy the very resource upon which their livelihood depends? It would appear so.

Farmers will continue to need subsistance in times of drought as long as they continue to grow crops unsuited to marginal rainfall areas by methods unsuited to such conditions.

It requires no great intelligence to recognize that we live in a drought prone area - Yet we persist in ignoring this cogent fact to our material detriment.

Our Crop Farmers ignore it, our Veldt Managers ignore it, our Planners ignore it, our Leaders ignore it.

We must ask ourselves some simple and pointed questions -

Why do we grow crops unsuited to marginal rainfall areas?

Why do we use tillage/.........

Why do we use tillage practices unsuited to marginal rainfall areas?

Are there no alternative crops more suited to our climatic conditions?

Are there no alternative tillage practices likely to produce better results?

Of course there are.

But these are not Drought problems - they are Agricultural problems.

In the financial year 1985/86 Drought Relief, using commercial contractors, sank 81 new boreholes and tested and equipped 31 of them. The high failure rate was expected.

During the same financial year, the Department of Public Works and Water Affairs, using commercial contractors, sank 213 new boreholes- 105 were successful.

Using its own rigs the Department sank a further 21 successful boreholes.

So we have, after a years affort, 157 new and useable boreholes.

But we need five times that number just to catch up with the backlog.

The majority of villages in Southern Africa rely on boreholes for their water supplies. The borehole equipment can be anything from a handpump, windmill to diesel engine. There may or may not be a reservoir. It is usual for both people and livestock to drink from these watering places.

The importance/.......

The importance of boreholes to man and beast, particularly in times of drought, cannot be over-emphasised.

There are over four thousand such boreholes in Bophuthatswana. For their maintenance the Department of Public Works and Water Affairs has established eight Regional offices and stores at which depots are stationed anything up to six mobile maintenance teams.

Early in 1984 reports of borehole failure began to stream into the Drought Relief office. At first it was assumed that the boreholes had dried-up due to the drought - very soon it became apparent that this was not the case. Whilst water tables may have dropped mechnical failure was invariably the problem.

Drought Relief, with the assistance of the Bophuthatswana Defence Force, mobilised emergency maintenance teams. These teams are still in the field.

At the request of Water Affairs, Drought Relief teams have moved into the Ganyesa and Kudumane areas in an attempt to cope with the backlog.

Bona-Bona is a good example of the situation we find. In this small area there are forty-three boreholes - only three of which were working.

Vast quantities of useable borehole equipment has been found lying in the bush. This valuable apparatus is refurbished at our workshop and brought back into service.

There are, we know, plans to pipe water into these districts. But these are long term proposals - in the meantime the boreholes must function.

Whilst we cannot look at water in isolation to other socio-economic activities we cannot look at them without it.

A village/.......

A village without water cannot sustain life, a school without water cannot educate and a health clinic without water is not a health clinic.

In Southern Africa there are hundreds upon hundreds of villages, schools and clinics in just that situation - they have no water.

Of all the Drought Relief schemes the most exciting and beneficial has been the Special Employment Action Programme.

This simple but effective scheme has brought the greatest relief to the greatest number.

At the height of activity over 40 000 rural people were receiving a daily wage of R3,00. This enabled parents to feed their children properly, clothe their families and cope with school fees.

Of greatest interest has been the type of work undertaken. The Tribal Authorities decided their own priorities and selected their own projects.

The work, all of it, was of direct benefit to the communities at large. Anything and everything has been tackled from brick making to dam construction, from the building of creches to clinics, from school extensions to tribal offices, from village vegetable gardens to new roads, from toilets to tennis courts. (Annexure "A")

Many of the projects are incomplete but, at the time of writing, negotiations are taking place to obtain funds for this important work to proceed.

Although not yet recognised the work of greatest long term importance performed by Drought Relief may well prove to be the establishment in 1985 of the Ecological Task Force and the resultant Report.

The proposals/......

The proposals contained in that report touched every aspect of rural life including Hydrology, Tillage practices, Animal Husbandry, Fuel wood, Sociology and Population Planning.

If a tenth part of the recommendations is implemented the quality of life for rural communities must automatically improve.

A great fear is that this report, like so many reports before it, will end up on a dusty shelf and all the well-intentioned and eminently practical solutions to our serious ecological problems will be forgotten. Until the next drought.

The importance of that report to this Seminar is that if you have an ecological problem you have a water problem and vis-à-versa.

In considering what part the Drought Relief organisation might properly play in the foreseeable future it has been necessary to take into account three important facts.

The first is that nearly 80% of the population throughout Southern Africa lives in rural areas.

The second is that water is the basic human need.

The third is that this Drought Cycle will not be the last Drought Cycle.

Drought Relief has never been under any illusion - it is the rural population that suffers greatest in times of drought and it is toward an improvement in the quality of rural life that we must direct our efforts.

To the city dweller such things as water reticulation and electricity are taken for granted.

To the villager such luxuries are only remote possibilities.

His horisons are much more limited. To him a water supply from any source is better than none. That the water should be potable is the luxury.

The grand and sophisticated Agricultural Schemes dotted around Southern Africa serving a few lucky farmers are beyond his reach or ken. His concern is with a wretchedly over-worked piece of land from which he hopes to feed his family.

Although the daily search for fuel is his wife's work, the search gets longer as she gets older. A readily available supply of fuel is another genuine need.

It is not much to ask - Water - Food and Fuel.

Surely a state with all the modern apparatus of government should be able to supply such simple need?

If we can add to those basic requirements a job opportunity, even on a temporary basis, life in the rural areas could loose much of its uninspiring toil and soften the harsh existance.

What part can Drought Relief play in what, in reality, is a programme for accelerated Rural Development?

RURAL WATER SUPPLIES

Currently the Division of Water Affairs of the Department of Public Works and Water Affairs is responsible for the whole spectrum of water supply throughout Bophuthatswana. This includes bulk supplies to cities and urban areas, sewage and water treatment plants, supplies to all hospitals, schools, police stations, clinics, rural villages, state owned farms, all primary supplies to agriculture, the maintenance and repair of over four thousand registered and equipped boreholes, and the motivation, planning and implementation of future programmes.

It is a fact that the Division of Water Affairs is at present expected to operate with approximately 25% of required staff in the artisan and technicial categories and personnel shortages exist in all other technical and professional areas.

It must be recognised that, unless the staff shortages are alleviated, no significant improvement in rural water supplies can be anticipated. Water is any Nation's most important resource. It is therefore imperative that our limited resource be managed and utilised with the utmost care and efficiency.

Let the Division of Water Affairs hand over to Drought Relief responsibility for new borehole supplies and borehole maintenance throughout Bophuthatswana.

Let the Division of Water Affairs be responsible for the long term planning and implementation of bulk supplies so necessary for the future welfare of all communities.

Let us release them from the irksome task of sinking boreholes and repairing cylinders in remote villages - work they must fail to perform efficiently without the necessary supervising staff.

EDUCATION

The very laudable schemes launched by Departments of Education and designed to upgrade the teaching methods in our schools are of little benefit to a Headmaster whose main concerns are insufficient classroom space for his 500 pupils and the fact that there is no water supply, only one toilet for the whole school, including staff, and most of the children sit on the floor..

Through the Special Employment Action Programme Drought Relief has partly built and, in some cases completed, 66 school extensions and has erected 120 school toilets. There will not be many schools in rural Africa that do not urgently need more classrooms, improved water supplies and better toilet facilities.

Let Drought Relief continue this good work - let us become responsible for upgrading and improving existing school facilities in the villages.

Let the Department concentrate on the fine new school programme and improved teaching methods.

SUBSISTANCE AGRICULTURE

Vast sums are poured into sophisticated agricultural projects. Hardly a penny piece is spent on the upgrading and improvement of subsistance agriculture at village level. Yet it is upon subsistance agriculture that the rural population depends.

Drought Relief has successfully introduced small plot techniques to thousands of families and believes there is a great deal more to be done in this direction.

Improvement of subsistance techniques must be of benefit to rural communities.

"Peasant" agriculture has been ignored throughout Africa. In consequence food production has dropped in relation to the growth in population. There has been a concentration on cash crops and not food crops. The peasant farmer has been left out of the development of agriculture in Africa.

The farmer is generally the farmer's wife. Spasmodic attempts are made to train the farmer - none whatever to train his wife.

Here again Drought Relief can help at village level.

Village Dams/.......

VILLAGE DAMS

Bophuthatswana is water poor. The management of our streams and rivers is therefore extremely important to agriculture and the rural communities.

South Africa is also water-poor but that country's agriculture benefits from over 500 000 "farm" dams.

Water Engineers commonly see as the penultinate goal after a long career constructing sewage works a commission to design another Aswan or Cabora Bassa. Let him be satisfied with a hundred village dams - they will be of more benefit in the long term.

Drought Relief has been responsible for the construction of seventeen such dams. The Tribal Authorities concerned selected the sites, the villagers hand-built the dams. There was no survey, no design and no machinery was used in their construction.

Today those dams have water in them and that water is being used. Perhaps the methods of construction can be criticised but the principle cannot.

SPECIAL EMPLOYMENT

The development of the rural areas in Africa as a whole is painfully slow.

We cannot blame the villager if he views fine talk of "Clean Water for All by 1990" and" Health for All by 2000" as simply hollow slogans. Who better than he remembers the promises of the past.

The excuses usually put forward for the failure of Rural and Community development projects are:

Lack of finance/......

(a) Lack of finance

(b) Lack of manpower resources

(c) Lack of Government "Commitment"

(d) Low input by the community

(e) Lack of personal involvement by individual villagers.

(f) The people had not been properly motivated.

And from the people we hear the oft repeated statement that "the project was imposed upon them." So they didn't like it.

Drought Relief believes we have the answer to all these excuses - in fact they stare us in the face.

Through the Special Employment Action Programme Drought Relief has proved beyond double that :-

(a) Vast sums of money are not necessary for the successful implementation of a community project and that, surprisingly the villagers themselves provide most of the capital required for materials.

(b) there is a huge reservoir of human resourcefulness and skills sitting and waiting in our villages.

(c) a Government wink is better than a nod and

(d) there are usually more volunteers seeking involvement than it has been possible to accommodate.

What was the secret of this unexpected success?

Drought Relief promised nothing - we merely undertook to pay a villager a small basic wage for a reasonable days work.

Drought Relief did not tell, did not even suggest, what sort of project or projects the village authority might undertake.

Drought Relief has never dealt with any other authority than the traditional authority. The Chief or Headmen, with their Councillors and villagers made the decisions.

Drought Relief was simply the catalyst not the catapult. The motivation came from the people themselves.

The results of these simple policies were electric and immediate.

So many worthy development programmes fail because the whole concept is approached from the opposite pole.

Planning takes places before the tribe hears about the project.

Government authority is obtained before the tribe hears about it.

Financial arrangements are made and contractors selected very often before the tribe hears about it.

It is not, in truth, a rural or community development project or programme. The rural communities are the last people to hear about the proposal and are certainly not "involved" in any true sense of that word.

Yet it is, and has been for a long time, an established fact that rural development programs are only successful when the local communities are completely involved and when the people clearly perceive that the success of the project is in their own interest.

How often/.....

How often do we hear donors say "if the people will do the work we will supply the expertise and money for materials."

Our approach was the reverse.

If the village wants a clinic and is prepared to buy the materials. Drought Relief will pay the villagers to do the work. It was that simple.

What are the direct benefits of such a policy -

The Clinic is built at half the price of contracting out the work or bringing in "expertise."

The Tribal Authority controls the project.

The villagers are directly "involved" and benefit immediately from that involvement.

The clinic belongs to the village - it is their clinic.

The community developes a "spirit". Less people are unemployed.

And nobody anywhere is imposing anything on anyone.

This of course is Community development at it's very best.

The Special Employment Action Programme has proved that it can be done.

It is a propitious start to what we believe must herald a new impetus to rural development in Southern Africa.

For the first time in three years of weary drought we have heard the village people sing at work.

It has renewed our confidence - once again our hopes are raised - once again we can feel optimistic about the future for our rural areas.

Let us hope it is not just another false start.

SPECIAL EMPLOYMENT ACTION PROGRAMME

ANNEXURE 'A'

PROJECT ANALYSIS MARCH 1986

DISTRICT	VILLAGES	NO. OF LBRS	BUILDINGS C/ROOMS-	TOILETS-	CLINIC-	CRECHES-	TENNIS-	CO/DAMS-	CHU-	T/OFFICE	BRICK MLD	CONSV. BSH/	C-SE	RDS MIT.	FNCG. MIT.	CLRNG SCHY-	HSY-	GY	VLG	CH	SCHOOL PAINTING
LEHURUTSHE	24	1383	1	8	-	-	-	1	1	-	4	-	6	3	17	1		2	1		5
KUDUMANE	70	2430	12	6	2	-	-	3	-	2	9	2	3	5	26	-	-	1	21		-
GANYESA	34	1088	23	-	8	-	-	-	1	3	1	-	-	1	-	-	-	-	-		-
TAUNG	60	4224	14	2	3	3	-	4	3	2	7	6	2	37	2	1	1	-	2		-
PHOKENG	16	424	-	-	-	1	-	1	-	-	1	-	-	-	1	6	-	-	16	14	-
ODI	17	1173	4	5	4	5	-	3	-	3	5	2	3	3	4	1	-	7	-	-	-
MANKWE	38	921	3	5	-	-	-	-	-	-	10	16	-	3	5	-	-	-	-	-	2
MORETELE	38	2275	-	-	1	-	-	1	-	2	5	5	-	24	6	5	-	15	-	-	4
MOLOPO	57	2317	7	2	2	2	1	1	1	3	14	4	-	5	3	21	1	1	2	-	-
MADIKWE	28	1849	-	-	-	-	-	-	-	-	15	1	1	-	-	-	-	-	11	-	-
DITSOBOTLA	35	4196	2	4	2	2	-	3	-	1	2	-	4	23	1	7	1	-	-	-	-
THABA'NCHU	32	284											1	20	3			6			2
TOTAL	449	22564	66	33	22	13	1	17	6	16	73	36	19	124	68	42	3	32	53	14	13

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PAPER: 3.2

COMMUNITY DEVELOPMENT STRATEGIES AND INVOLVEMENT

COMMUNITY DEVELOPMENT CONCEPT AND PHILOSOPHY

by

S O MOTEBE

Chief Community Development Officer

Dept of Health and Social Welfare, Mmabatho

Bophuthatswana Government
Private Bag X 2068
8670 Mafikeng

- The term Community Development has several international elements in concept to explain the processes by which the efforts of the people themselves are united with those of the state authorities to improve the Economic, Social, Educational or Cultural conditions of the communities, to intergrate these communities into the life of the nation and to enable them to contribute and participate fully to National progress. Hence the nature of Community Development processes in relation to people is both an Educational.
- and an organisational process

Educational because it is concenced in changing attitudes and practices as they are obstacles to social and economic inprovements.

Organizational because it requires the re-orientation of existing institutions for (creation of new institutions (types) to make self help fully effective.

Objectives to provide channels for government services.

(1) The objective is to help people find ways and means to organize self-help projects and programmes on a joint effort.

(2) To provide skills and appropriate technology and/or techniques for a co-operate action on plans.

(3) To determine their needs and solve their own problems.

(4) To excute plans with a maximum of reliance upon the communities' own resources and to suplement these resources, where necessary , with assistance and services from the state and other voluntary agencies outside the community.

2/...

STRUCTURAL REQUIREMENTS

COMMUNITY DEVELOPMENT APPROACH TO GRASS-ROOT LIAISON COMMITTEES

- Village development committees VDC and community Development Regional Boards as it is the case in Bophuthatswana need an approach that will make more effective use of the local initiative and energy for co-ordination of state and Welfare volunteer service and organizations.

CO-ORDINATION
STATE DEPARTMENTS AND OTHER AGENCIES

- Government Ministries and other servicing agencies require community development approach and orientation of the following :
  - The use of the knowledge and skills of all relevent national services in an intergrated way rather than in isolation.
  - To serve the altimate objective of a fuller quality of life for individuals within a family and community.
  - The technical services must be addressed in a manner which recognizes the indivisibility of the welfare of the individual.
  - providing machinery to ensure that all state department or agencies concerned participate in the formulation of policies, planning, implementation, and Evaluation of programmes with the people.

SERVICES

- Some of the services which may contribute to integrated community Development efforts are :
  - Agriculture and home economics extension services scientifically based and adapted to planned development and socio-cultural circumstances prevailing
  - Multipurpose co-operatives to increase production

and income through agriculture.

- Education and role of schools in Fundamental Education for people to understand problems of their Environment, their rights and duties as citizens etc.
- Vocational Guidance and Training for personal development and satisfaction of work situation.
- Health and social Welfare Services inculcating into the Public knowledge of health in relation to social and economic development.
- Small industries and Handicraft Centres in the rural areas to create job opportunities.

Community Development "Role" in Economic and Social Development

- The participation and involvement of self sustained Institutions capable of handling the economic and social needs of the Community manned by members of that community to guarantee continuity of the development.

Economic Development

Economic development may however require establishment of a bank, Raising loans, building roads, building dams, electricity or puting up a large silo for the restoration of large maize crop.

- Social Development

  - Social development may be concerned with a national employment policy, labour force, insurance regulations, or measures complemantary to those introduced through community Development and give direction. It may do this by increasing productivity or influencing the kinds of activities the people undertake and by educating them as consumers of both goods and services.

4/...

It is essential to note that if economic and social development are left alone to operate, this may weaken social coherence and so be conducive to community recesion at least over certain phases. Hence by promoting collective action, community development may keep recession in check and help the re-establishment of coherence at various levels and for different purposes.

LEADERSHIP

- To strengthen local leadership

  (a) well aquainted with the goals of community and rural development.

  (b) leadership together with the subject matter of vacational and technical training is the major ingridient for maintaining the momentum of development activities.

Inconclusion

Orientation and Training of Personnel

Training of personnel for Community Development is of vital importance, because of the role of human factors in the Community development process.

CATEGORIES

Training may fall into one or more of the following categories :-

- Political and administrative leaders
- Proffessional and technical personnel
- Sepcialized auxilliary workers
- Multipurpose or generalist - village level workers VDC
- Voluntary community leaders and workers.

PAPER: 4.1

HEALTH ASPECTS OF LOCAL WATER SUPPLIES

P.K. MOKGETHI

B.Sc (Hyg) Rhodes MB.Bch (Rand) D.T.M & H (WITS) D.P.H (WITS)

DEPARTMENT OF HEALTH AND SOCIAL WELFARE

PRIVATE BAG X2068

MAFIKENG 8670

Arising out of the U.N Water Conference in Argentina in 1977, the U.N General Assembly declared 1981 to 1990 as the International Drinking Water Supply and sanitation decade, aimed at a target of Clean Water for all by 1990 and at a larger WHO goal of"Health for all by year 2000"'

This is because it has been found out that death and disease arising out of contaminated drinking water and poor sanitation in rural and urban areas especially of Third World Countries is alarming. The World Health Organisation estimates that 80 per cent of all disease is water - borne i.e. both diarrhoeal diseases (including Cholera) and parasitic diseases (including malaria, trachoma and Bilharzia.

In this paper it is discussed how Bophuthatswana water supplies measure to the expected standards.

ORIGIN OF WATER

The Earth began its career as a mass of gas at a temperature of 4000°C almost as hot as the sun. By about 4700 million years ago it cooled enough for the gas to become liquids, and then, at 1500°C for the first Solid particles of crust to appear, floating on the molten earth. At 700°C the crust was about 6 miles thick and the cooling began to slow.
Around the earth hung a dense veil of cloud, formed as gases cooled to particles of liquid.

Then Rain for 60,000 years.

As the temperature dropped, spots of rain began to fall. Soon the drizzle became a downpour lasting for some 60,000 years as the high banked clouds shed their rain, filling the oceans and scouring the land. Cooled by the water, the earth's temperature gradually fell to near its present 20 - 30°C. Finally some 3,000 million years ago the rains stopped. This is feasible theory of the origin of our water supplies.

Potable water is derived mainly from Surface Sources such as lakes, rivers and streams and from underground sources such as wells and springs.
All statutory water undertakings are required to provide a supply of water which is both palatable and safe to drink, it must be clear, colourless odourless and tasteless and it must be free from toxic substances, pathogenic organisms and excessive amounts of substances in solution not normally detectable by the unaided senses.

The Chemical Composition of potable water is variable and the nature and concentration of the impurities in it depend upon the Source from which it is drawn. In any water obtained from a surface source traces of organic matter are present. Algae bacteria, Viruses and pyrogens may occasionally be present. In addition Ammonia, residual Chlorine and traces of metals may be detected.

There are international

There are international standards for the quality of water intended for human consumption. Toxic substances such as Arsenic, barium, Cadmium, chromium, copper cyanide, lead and selenium may constitute a danger to health if present in drinking water in excess of the recommended concentrations.

Fluoride is regarded as an essential constituent of drinking water, but may endanger health if present in excess. Chronic fluoride poisoning, manifestations of which include increased density and coarsened trabeculation of bone, may arise from continued ingestion of fluoride, and has occured in workers handling fluorides and in Communities using drinking water containing particularly high concentrations of natural fluorides. Ocular damage has also been reported.

In amounts higher than 2.5 p.pm it causes dental fluorosis and at amounts of 10 p.pm effects on bones occur-skeletal fluorosis. Ingestion of water containing 45 mg or more per litre of Nitrates may cause methaemaglobinaemia in infants.

The main consideration - however, in ensuring the safety of public water supplies is the removal of Bacteriological contamination.

Major epidemics of water - borne diseases can only be eliminated when

(1) Their bacteriological origin is recognised
(ii) The Sewage contamination of water supplies is minimised
(iii) Disinfection treatment is introduced

It must be noted, however that proper water supply - adequate in terms of both quantity and quality - is just one of the many factors necessary to promote good health. A good water supply will not guarantee health but an inadequate water supply will ensure poor health.
Should a safe, adequate supply not be readily available, resource will be made to any other water available, safe or otherwise.

The South African Bureau of Standards specification for water for domestic supplies specifies the recommended and maximum allowable physical, chemical and Bacterio logical limits for the purity of water for domestic supplies.

Selected extracts from this specification with particular health implications are given in figure I.

FIGURE I Selected extracts from the SABS specification for water for domestic supplies

Determinand	Unit	Recommended limit	Maximum allowable limit
Physical requirements			
Turbidity	NTU	1	5
Chemical requirements			
Nitrate plus nitrite*	mg/1 N	6	10
Fluoride	mg/1 F	1	1,5
Bacteriological requirements			
Total coliform bacteria count**	per 100ml	Nil	5
Faecal coliform bacteria count	per 100ml	Nil	Nil
Standard plate count	per ml	100	Not specified

*If nitrate plus nitrite (expressed as N) is present in concentrations in excess of 10 mg/1, the water may be unsuitable for use by infants under 1 year of age and an alternative source of supply must be found for such infants' use.

**(a) If any coliform bacteria are found in a sample, take a second sample immediately after the tests on the first sample have been completed: this shall be free from coliform bacteria; and

(b) not more than 5% of the total number of water samples (from any one reticulation system) tested per year may contain coliform bacteria.

Figure II.

FIGURE II Summarises the chemical (Nitrates and fluorides) results obtained from water sources in several districts of Bophuthatswana. These water samples were taken at random by the Environmental Section of the Department of Health during a Six months period in 1985.

FIGURE II

FIGURE II

Water - Chemical Analysis Results

District	No. of Samples	Nitrate in excess of 10 mg/lit	Fluorides in excess of 1.5 mg/lit
Moretele	36	6 i.e 27.9 11.7 13.3 10.4 13.7 12.4	10 i.e 1.9 1.7 2.5 3.6 3.8 2.0 9.0 2.3 1.8 20.3 1.8
Mankwe	81	4 16.4 12.0 14.8 21.5	6 5.5 1.6 2.6 1.8 1.7 1.7
Madikwe	46	8 19.9 23.8 24.6 18.8 22.2 24.8 42.0 11.6	-
Lehurutshe	18	-	3 11.3 15.9 15.9
Ganyesa	42	14 13.9 11.5 13.6 18.5 10.1 22.9 25.3 10.1 25.8 22 13.4 19.3 10.4 10.5	9 2.3 1.9 1.7 4.0 2.1 2.1 1.6 2.2. 1.6
Bafokeng	37	2 15.4 11.4	3 1.9 1.9 3.0
Molopo	54	20 13.8 11.3 16.9 12.3 13.9 12.5 11.1 10.1 11.7 10.8 11.4 12.7 13.1 12.8 11.2 16.6 10.0 20.0	-
Ditsobotla	8	1 10.7	

<u>Quality of Natural Waters</u> : <u>The typical type</u> of water used in Bophuthatswana villages.

The N I W R did a survey during 1984/85 to determine the faecal coliform results obtained from a number of typical rural water sources in several national states of Southern Africa, and all of the sources were being used at the time by local people for obtaining drinking - water without any form of treatment.

Figure III summarises the results:

<u>Figure III Examples of bacteriological water qualities in rural areas</u>

Location of water sample	Faecal Coliform Count (per 100 ml)
Hole beside the road	>400
Water from dam pumped to storage tank	40
Unprotected spring - water taken from a small stream draining from this stream	> 400
Protected spring	
(a) Sample from the spring outlet	2
(b) Sample from a bucket that had been filled from the spring	40
Stream with the catchment area protected by a fence	
(a) Sample from the stream	10
(b) Sample from the well into which the stream discharges	>400
Shallow well in dry steam bed	>400
Shallow well - water collected by buckets dropped into the well	>400
Borehole with handpump	
(a) in a sparsely populated area	Nil
(b) in a densely populated area	25
Borehole with windmill which discharges into an uncovered storage tank. Sample taken from tank.	100

Notes: 1. > means 'more than'

2. Rainwater tanks are also used during the wet season in some areas, but they were not in use during the periods that these water samples were taken.

It is apparent

It is apparent from these results that the waters from all except one source exceeded the SABS maximum allowable limit of all nil faecal coliforms/100 ml (Figure I), and several of the waters were grossly polluted. Faecal coliforms indicate that the water is faecally polluted, and therefore could contain pathogenic microorganisms (e.g. cholera, typhoid, infectious hepatitis). Therefore, there is a need for appropriate technology to disinfect these types of small water supplies. These results can be extrapolated to Bophuthatswana rural supplies.

URBAN AREAS.

In urban areas higher densities and living standards require a higher standard of service, The norm should be a reticulated water supply system from a Central purification plant, with outlets to suit the associated sanitation system.

All the Urban Areas of Bophuthatswana have reticulated water supply systems.

The following guidelines need to be mentioned for the interest of village and Township planners.

1. Public standposts - one per 100 - 250 people (25 - 125 persons/tab) and a per capita consumption of 20 - 30 l/day; the maximum walking distance within 100 and 200 metres.

2. On site stand post 30 - 60 l/per day

3. In-house water outlets 150 l per day per person.

The water supply system should be self-sustaining, which means that water must be sold at economic tariffs. This will also promote the conservation of water which is scarce : cost recovery methods appropriate to local conditions should be devised.

Defluoridation

DEFLUORIDATION

We have seen already that drinking water in some of our districts contain particularly high concentrations of natural fluorides.

Work done recently by NIWR has shown that fluoride can be removed very effectively from drinking water by the activated alumina process - Defluoridation Columns.

It is felt that due to the shortage of water in a large area of Bophuthatswana and as such of our underground water contains fluoride in quantities greater than the standards laid down i.e. 1,0 mg/l and 1,5 mg/l, use should be made in areas such as Madikwe, Mogwase and others, of these defluoridation columns.

There are two draw backs. Firstly high cost of equipment, e.g. a column to produce 10 000 to 25000 l/day would cost ± R25000. Secondly, skilled operation. The chemicals used for regeneration, are caustic soda and sulphuric acid, both potentially dangerous.

If the column is not operated efficiently; backwashed and regenerated, the adsorbed fluoride (F) could break away and be contained in the effluent water in a higher solution than the influent. Hence the reason for constant vigil and timeous backwashing etc.

MALARIA

Conditions which favour the presence and breeding of anopheles mosquitoes tend to the increase of malaria and vice versa, and whatever favours access of these insects and the parasite they contain also favour the acquisition of malaria.

Malaria is a disease of the open country and villages rather than towns Such conditions do exist in Bophuthatswana, and we have found A gambiae larvae along the Molopo river, especially in the region of Makgobistadt. This implies that there is a potential of Malaria being spread from these areas.

So far however,

So far however, there has been an occasional malaria patient and in almost all instances the disease was contracted beyond the Bophuthatswana borders.

I should mention here that our Environmental services should extend its malaria campaigns and surveillance to other regions of Bophuthatswana.

BILHARZIA

Cases of Bilharzia have been known to occur in the regions of
(1) Odi below the Klipvoordam

(2) Bafokeng below the Bospoortdam and

(3) In Mogwase - at a place called Mabeleapodi - near Sun City.

Now - a few slides and overhead transparencies.

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PAPER: 4.2

EPIDEMIOLOGICAL ASPECTS OF DEVELOPING AREAS

D J GORDON-SMITH

MB BCh (Witwatersrand), D.P.H. (London Unuversity)

Medical University of Southern Africa, Box 131, P.O. Medunsa, 0204

ABSTRACT

A review is given of the epidemiology and bacteriology of typhoid fever. Typhoid is the most important contaminating organism of human drinking water and thus of great interest to engineers and technologists.

Because of the intractable problem of the carrier state, it is suggested that in developing countries it is impossible to prevent the contamination of common water supplies.

The only way to deal with the contamination is by the disinfection of drinking water in the home.

EKSERP

'n Epidemiologiese en bakteriologiese opsomming van tifoied word gegee. Tifoied is die belangrikste organisme wat drinkwater vir menslike gebruik kontamineer en dus van groot belang vir ingenieurs en tegnoloe.

Weens die onhandelbare probleem van die opsporing van die draer-toestand in die ontwikkelende lande, word dit beweer dat dit onmoontlik is om kontaminasie van gemeenskaplike waterbronne te voorkom.

Die enigste oplossing is om die drinkwater in die huis te behandel en te ontsmet.

EPIDEMIOLOGICAL ASPECTS OF DEVELOPING AREAS ANOTHER LOOK AT TYPHOID FEVER

Resume

The Salmonella typhi bacillus is the most important contaminating organism of human drinking water. In Southern Africa, some 4 000 - 6 000 cases of typhoid are notified annually, but this figure can probably be multiplied by ten. The mortality rate is 10% in untreated cases, but this can be reduced to 1% when effective treatment with the appropriate antibiotics is available.

A review of the epidemiology and bacteriology of typhoid has been given. Typhoid has been selected as the most important disease affecting water engineers and technologists. Other diseases such as cholera and virus contaminations do not present such a formidable and on-going problem as typhoid.

1. The majority of the population in Southern Africa do not have access to purified and reticulated water. Their main sources of supply are rivers, dams, shallow wells and occasionally boreholes.

2. Only twenty percent of persons infected with typhoid become clinically ill and therefore become recognised as cases of typhoid.

3. Of all persons infected with typhoid, 10% of untreated cases will discharge bacilli in the faeces or urine for 3 months. 2% to 5% will become permanent carriers who will excrete the bacilli intermittently.

4. The majority of the rural population in Southern Africa do not have adequate latrine facilities, and therefore commonly defaecate in river water, or on river banks, or near to shallow wells.

5. It is not feasible to try to discover typhoid carriers. Even if they are detected, adequate treatment is not practicable in a developing country.

6. Under these circumstances, it is suggested that it is not possible to prevent the contamination of rural water supplies.

7. Under controlled conditions, it is possible to chlorinate the water in shallow wells on a regular basis.

8. Otherwise, the only possible way of controlling and preventing endemic typhoid in Southern Africa is by the home chlorination of all water intended for drinking.

9. To this end, an essential component of all health eduction programmes should be the teaching of home chlorination of drinking water by adding a few drops of household bleach to each litre of drinking water.

EPIDEMIOLOGICAL ASPECTS OF DEVELOPING AREAS
ANOTHER LOOK AT TYPHOID FEVER

The organisms of typhoid and paratyphoid fevers enter the body by the mouth. This is an undisputed fact.

Undoubtedly, the main source from which the intestinal contents are infected is the gall-bladder. Involvement of this organ is the basic factor in the natural history of the enteric fevers. The organisms can penetrate deeply into gall-stones, and may remain viable there for the persons lifetime.

Involvement of the kidney is probably common and as many as one-quarter or one-third of patients excrete S.typhi in the urine in the acute stage of the illness.

S.typhi survives in sewage for at least two weeks, and sewage swabs have proved very successful in establishing the presence of infection in an area. This can be traced back to its source by drain and toilet swabs.

Widal test. The O (somatic) antibodies are likely, in the absence of recent infection, to be at a low level, and if their titre is high in the serum of a febrile patient, they may be regarded as indicative of an active infection. The H (flagellar) antibodies, on the other hand, are specific to the Salmonella group, but, once produced, they tend to remain in the patients serum for many years.

S.typhi strains can be subdivided into at least 80 types by phage typing, and this is of very great importance in epidemiological investigations. There are few reports of carriers excreting more than one phage type.

Epidemiology

Evolutionary factors - "On the microorganismal, as on the human scene, some adapt to their environment, others continue to fight against it. S.typhi, for example, has settled down. It has found its ideal host, man, and, forsaking all others, except, perhaps, fruit-eating bats has attempted to establish a satisfactory relationship with him. Its first overtures may provoke a violent reaction from the chosen host, but, when the storm is past, S.typhi can retreat to the gall-bladder, and thereafter lead an undtroubled life, causing annoyance to no one in its retirement. Not so with S.typhimurium. It is an incorrigible gadabout, and has never been able to settle for any one host, and cattle, sheep, rats, pigs, parrots and poultry are all equally acceptable to it. Nor has it been able to fashion any stable symbiotic relationship with any host, and, indeed the symptoms it provokes, acute diarrhoea and vomiting, are an expression of biological incompatibility and an attempt to expel it as quickly as possible. An odd S.typhimurium may get through to the gallbladder, but the great majority do not, so that chronic carriers of S.typhimurium, human or animal, are quite rare, whereas, with S.typhi, the carrier state is common. S.typhi has learned the art of compromising with the establishment, but S.typhimurium is still an epidemiological rebel.

All this is, of course, part of an evolutionary story. S.typhi is near the end of its development, more or less adapted to its environment. S.typhimurium is still battling with it, a long way down the evolutionary scale. The advantages are not wholly with the former, for S.typhi, in adapting to its environment, has also become dependent on it, and is in something of an epidemiological rut. When the environment is altered by man and its sanitation, the organism is caught by its own sophistication, and is unable to cope with the unexpected change. S.typhimurium is in a much better position, in spite of its evolutionary immaturity, for its variety of hosts and its unrestricted way of life give it much more freedom to manoeuvre. S.typhi, in the more advanced countries, has become a rare cause of infection of man, gaining a foothold only when some defect in sanitation lets it through. Infections with S.typhimurium, on the other hand, are still very common, and have even increased, in conditions of hygiene and sanitation which have led to the elimination of S.typhi." (From A.B. Christie: "Infectious diseases", Churchill Livingstone 1980.)

It has been calculated in one investigation that not more than 20% of those exposed to S.typhi became ill.

Survival of S.typhi in water - S.typhi can survive in water for considerable periods. They die out more quickly in summer than in winter, and prefer aerobic conditions. The organisms depend upon suspended organic material for their nutrition, and die more rapidly in reservoirs and dams than in the more contaminated waters of rivers and streams. Thus the mere holding of water in reservoirs leads to a greater reduction in the bacterial count than any other process at the water purification plant. After a period of 3-4 weeks, a common period of storage, over 90% have died out.

Survival of S.typhi in sewage - In sewage, the organisms may survive for weeks, and 38 days is thought to be the maximum. But, under natural conditions, sewage is likely to be continually replenished with organisms if there are carriers or cases in the catchment area.

Survival of S.typhi in sea water - Sea water is rapidly bactericidal to S.typhi and there is little evidence that infection of man ever resulted from bathing in sea water contaminated with these bacteria. Sea water is unpalatable, and bathers are not likely to drink enough to ingest sufficient quantities of bacteria.

Waterborne outbreaks of typhoid - When S.typhi does reach the source of a water supply, they are likely to be present in relatively small numbers, but sufficient to cause numerous outbreaks of the disease.

A waterborne outbreak of typhoid tends to be explosive, because of the simultaneous drinking of contaminated water by a large number of people. Because there is a long incubation period (14+ days), this may lead to some uncertainty as to the source of infection.

Other means of infection

Shellfish - Mussels and oysters may become heavily infected with

S.typhi, and if eaten raw, can lead to fatal infections.

Milk and cream - Both are excellent culture media, and at warm temperatures the organisms will multiply very rapidly.

Ice-cream can be a suitable medium for the growth of the organisms and great care must be exercised during the manufacturing process.

Meat products and canned food - Meat which has been recently well-cooked is usually safe. Cooked meats stored overnight at room temperatures can become heavily infected if contaminated by a carrier. Cold meats can be readily contaminated by carriers. Food handlers must maintain the highest standards of hygiene at the workplace.

The Typhoid Carrier - In all the examples of modes of infection - water, milk, meat, pies and canned food, the ultimate source of infection in typhoid fever is invariably the human carrier.

S.typhi, once lodged in its human host, can be the most dogged of human parasites, and accounts of the carrier state persisting for 20-50 years are not uncommon.

As has been noted, only 20% of people, who become infected with S.typhi will become clinically ill. Of all those infected, whether symptomless or not, about 2-4% will become chronic but healthy carriers, and may remain so for all their lives. Large numbers of organisms may be excreted in the faeces daily, or the excretion may be intermittent, with no organisms being excreted at all for days or weeks. The bacilli usually take up residence in the gall bladders of women over the age of 20 years. Gallstones are commonly found in the carrier state, and because these stones are usually found in older women, this may explain the predominance of females over males.

Detection of carriers - The culture of rectal swabs, or of a specimen of faeces, is the most reliable method of detection. Blood tests such as the Widal or Vi tests, are not reliable and may confuse the investigation. Sewerage, drain and lavatory swabs are surprisingly reliable in the tracing of carriers.

The treatment of carriers - Prolonged treatment (three months) with antibiotics may cure the carrier state, but the necessary antibiotics are all expensive. After treatment, repeated cultures of faeces are necessary to ensure that the patient is cured. Surgical removal of the gall-bladder will result in a cure rate of 75 to 80%. But it is a major, and expensive, operation, with a possible mortality rate of 4%.

Prevention - The agent of the disease is known, as is its method of spread from person to person.

The infection should therefore be controllable by the application of the principles of hygiene and public health. In countries where the standard of public and private hygiene is high the incidence of enteric infection is low, the disease breaking through only when there is some unexpected and unforeseen weakness in the measures of control. In less developed areas, enteric fever is still one of the commonest infectious diseases.

If a community has a pure water supply, a pasteurized milk supply, and a water-carriage sewerage system, and if there is strict supervision of the preparation and distribution of food in factories, shops, kitchens and canteens, the incidence of enteric infection will be almost negligible. But at any point on these long lines of control, breakdown may occur, and the effectiveness of these controls may be measured by the magnitude of the disaster which may follow.

Control of carriers - The control of the carrier is a matter partly of public health control and partly of personal hygiene. A carrier must obviously take no part in employment concerned with the preparation of food and, when discovered in such employment, must be persuaded to leave it till declared free of infection. To control the spread of infection in the carrier's home is not a difficult problem, given an intelligent patient. The hands of a faecal or urinary carrier are always contaminated with the organisms after the carrier has passed faeces or urine, but the organism does not survive for more than about 20 minutes on dry hands, unless they are contaminated with faeces. Under the nails and in the nail-folds the organisms may persist longer. But the danger of infection from the carrier's hands can be very greatly reduced, or virtually eliminated, by thorough washing of the hands after toilet, and before preparing any food. Though there is little danger of the spread of infection through fomites, for the organisms will die rapidly outside the human body except on a favourable medium, the carrier should obviously have her own towel, and her own scrubbing-brush. If she washes her hands with any of the common detergents she can feel safe to carry out her household duties, and many carriers have done so for years without infecting anyone in their family. But if these standards of hygiene cannot be obtained, transfer of infection to other members of the household and to the community will inevitably occur.

PAPER 4.3

INCIDENCE OF MICROBIAL FLUORIDES AND NITRATE POLLUTION IN GROUNDWATER

S RAWHANI

Anglo American Research Laboratories

Crown Mines

PAPER: 4.3

INCIDENCE OF MICROBIAL, FLUORIDE AND NITRATE POLLUTION IN GROUNDWATER IN BOPHUTHATSWANA

S. RAWHANI

B.Sc. (Chem. Eng.) CNAA

Anglo American Research Laboratories, P.O. Box 106, Crown Mines, 2025

ABSTRACT

Data and maps on the incidence of microbial, fluoride and nitrate pollution in groundwater in Bophuthatswana are presented. The data indicate that 11% of the boreholes sampled since 1981 exceed the standard of zero faecal coliform/100 mℓ while 11% exceed the 1,0 mg/ℓ limit on fluorides and 17%, the 10 mg/ℓ of nitrates. Although extensive research and field investigation is required to identify the sources of contamination, fluorite is thought to be the main cause of high fluorides and agricultural developments, inadequate waste disposal and sanitation practices are the main contributors to high nitrate concentrations. The latter two are also chiefly responsible for microbial pollution. Chlorination is recommended for disinfection but further research is required to identify cheap and technologically simple processes for small scale removal of fluorides and nitrates.

1. THE NEED FOR SAFE AND ADEQUATE WATER

> "So Moses brought Israel from the Red sea and they went out into the wilderness of Shur; and they went three days in the wilderness and found no water. And when they came to Marah, they could not drink of the waters of Marah, for they were bitter: therefore the name of it was called Marah. And the people murmured against Moses, saying, What shall we drink? And he cried unto the Lord, and the Lord showed him a tree, which when he had cast into the waters, the waters were made sweet"
>
> Exodus 15:22-26

Ever since the "beginning" water has been synonymous with life and it may be said that innovations in its purification methods have involved more than just pure human effort. It has long been known that contaminated water can be a cause of diseases and their transmission. Cyrus the Great on his military expeditions circa 580 B.C. carried boiled water in great silver urns. The Roman civilisation and many others remote in time conceived and executed extensive water systems and benefited as a result. The quest for safe and adequate water will continue for as long as life itself, for not only does the survival of all living matter depend on it but also there is a general improvement in the environment and the quality of life through better personal hygiene and sanitation wherever water is available.

Not withstanding the tremendous progress made so far, a great deal remains to be accomplished. The United Nations Water Conference in 1977 emphasized that priority in water and sanitation should be accorded to the "poor and less privileged"[1]. World Health Organisation reports that in 1980 only 29% of the rural population in developing countries were served by drinking water as opposed to 75% in towns, and only 13% of the rural areas were covered by sanitation schemes as compared with 53% in towns[2]. World Health estimates that approximately "80% of all illness in the developing world is associated with lack of safe water"[3].

This paper addresses microbial, fluoride and nitrate presence in excess of the prescribed standards in groundwater in Bophuthatswana. It reports on the results of chemical and bacteriological analysis obtained since August 1981 by the Water Pollution Control Section of the Department of Health and Social Welfare from samples of water collected from new or established wells and boreholes submitted by the Health Inspectorate or the Department of Public Works and Water Affairs.

2. GROUNDWATER IN BOPHUTHATSWANA

Bophuthatswana has an estimated population of 2,5 million[4] in fourteen districts distributed over an area of 44109 square kilometers[5]. There is a general shortage of water in the country worsened by the present draught. Water is supplied by several sources from both surface and groundwater. Some of these sources have been utilised to near exhaustion while the potential of others remains to be ratified and realised by developments in science and technology and by funds being made available for this purpose. Aquifers are one such source about which little is known. The few studies which have been conducted in the past have not been nearly sufficient and have highlighted the need for further meticulous and wide-spread studies.

Presently boreholes and wells are established "at random" mostly on a hit or miss basis wherever there is demand for them. Samples of water from any source that is newly established and meets the standards of the Department of Water Affairs from a hydraulic yield point of view and which is intended for public use is sent to the National Water Pollution Control Laboratory at Klipgat, near Ga-Rankuwa in Odi I for analysis. Only if the water meets the standards for drinking water will the borehole be declared fit, equipped and opened to the public. The analytical information that is presented in this paper is therefore limited by this "random selection" of sites for sampling, and by the number of samples submitted. A more comprehensive study should aim at accurate, frequent, systematic and exhaustive sampling procedures and amongst other data, extending over several years, consider population densities, total demand and rate of consumption from all sources of water, and epidemiological and public health statistics.

TABLE 1

POPULATION, BOREHOLES AND SAMPLES SUBMITTED BY REGIONS

District	Population 1980 data	Boreholes		Samples*	
		No.	Density**	Chemical	Bacterial
Thaba'Nchu	56602	291	5,13	39	0
Taung	110493	424	3,83	45	5
Tlhaping-Tlharo	83045	977	8,26		
Ganyesa	34541			35	0
Ditsabotla	97807			20	0
Molopo	93090	986	4,05	73	0
Lehurutshe	52485			51	0
Madikwe	50755			140	16
Mankwe	75673	991	4,48	277	5
Bafokeng	93699			54	14
Odi I + II	340060	623	1,17	763	245
Moretele I + II	193093			161	112
TOTAL	1281343	4292	3,35	1693	397

* Samples submitted for analysis since August, 1981.
** No. of boreholes per 1 000 head population (potential groundwater users).

Bophuthatswana has 4 292 public boreholes mostly in rural areas and an additional estimated 1 700 on private land giving a total of approximately 6 000[6]. Although the borehole density figures presented (see Table 1) are not strictly accurate, due to such assumptions as that the boreholes are the only source of water and that all have an equal yield, non-the-less they provide some indication of the degree of development of the groundwater resources in each region. However there are well developed alternative sources of water supply, e.g. the majority of the population in Odi I are supplied by Rand Water Board water so that the actual number of boreholes per 1 000 consumers of groundwater is higher than the indicated value of 1,17. The discrepancy in the samples column in the case of Odi and Moretele districts arises because of the inclusion of a number of legally private but practically public boreholes in the sampling programme.

3. MICROBIAL CONTAMINATION

A simple filtering mechanism usually stops most micro-organisms that may be present in surface water percolating through the ground within the top layers of the soil and prevents them from reaching the water table. The average depth of the water table in Bophuthatswana is approximately 50 m with a spread of 20-170 m[6]. Most available data on microbiological analysis is fragmented. Odi I and II and to some extent Moretele are the only districts where a systematic campaign of bacteriological groundwater analysis is being carried out. Taung and Taba'Nchu have had sampling initiated periodically under the regional hospital superintendents and health inspectors. The sampling in other districts is done at random and often it is only conducted when a source of water is suspected of contamination as a result of an increase in the incidence of waterborne disease.

Although some boreholes have yielded positive counts of faecal coliforms, (see Table 2) as yet there has not been any outbreak of waterborne disease that could be exclusively traced to microbially contaminated groundwater. However, due to the widespread dolomitic and limestone formations which abound with fissures and faults, especially near the surface, the possibility of groundwater contamination by external sources cannot be ruled out. The most widely used and therefore highly suspected system of excrement disposal specially in the rural and peri-urban areas in the pit laterine. To this could be added a long list of other possible sources of contamination, some of the more notable of which are inadequately designated or serviced septic tanks, maturation and oxidation ponds, sewerage systems, sewage treatment plants and rubbish dumps. Because of uncertainty in the direction and rate of flow of groundwater, the capacity, extent and structure of aquifers, the nature of soil, and flaws in the bed rock, isolating the source of contamination may prove to be impractical. A few limited outbreaks of diarrhoea and typhoid fever which have occurred as a result of consuming groundwater, were traced to secondary sources of contamination such as dirty buckets and cans and shallow hand dug and banked wells which could be easily contaminated by domestic and wild animals. Surface run off into such wells or into inadequately protected boreholes has also been a cause of contamination in the past.

TABLE 2
INCIDENCE OF MICROBIAL GROUND WATER CONTAMINATION

District	Samples submitted since 1981				
	No.	0 faecal	100 coliform/100 mℓ	250 sample	Worst count
Thaba'Nchu	0	-	-	-	-
Taung	5	5	1	0	156
Tlhaping-Tlharo	0	-	-	-	-
Ganyesa	0	-	-	-	-
Ditsabotla	0	-	-	-	-
Molopo	0	-	-	-	-
Lehurutshe	0	-	-	-	-
Madikwe	16	3	1	1	320
Mankwe	5	4	2	1	282
Bafokeng	14	0	0	0	-
Odi I & II	245	32	6	2	724
Moretele I & II	112	1	0	0	21
Total	397	45	10	4	-

The national total of 45 contaminated sources or even 32 in Odi I and II representing a more broadly based and accurate 13,0% (see Figure 1), may be alarming but can be brought into perspective by considering that if on average there is an estimated one pathogen for every 100 000 faecal coliform in water, it can be shown that even for the worst case of 724 faecal coliform/100 mℓ, one pathogen may be found in every 14ℓ of water. If it takes 100 pathogenic organisms per person to cause an illness, theoretically a man would have to drink 1,4 m^3 of water per day before falling ill. At an average consumption rate of 2ℓ per person per day, this implies one illness per person in nearly two years or an average of 0,52 per person per annum. Some measure of comparison is provided by considering that a survey published in the United States of America[7] indicates that in 1968, of a total of 586 groundwater sources sampled, on average 14% were contaminated. A WHO review reports that on the basis of 22 studies on diarrhoeal illnesses in children under 5 in African, Asian and Latin American countries, there were 2.2 illnesses per child per year[8].

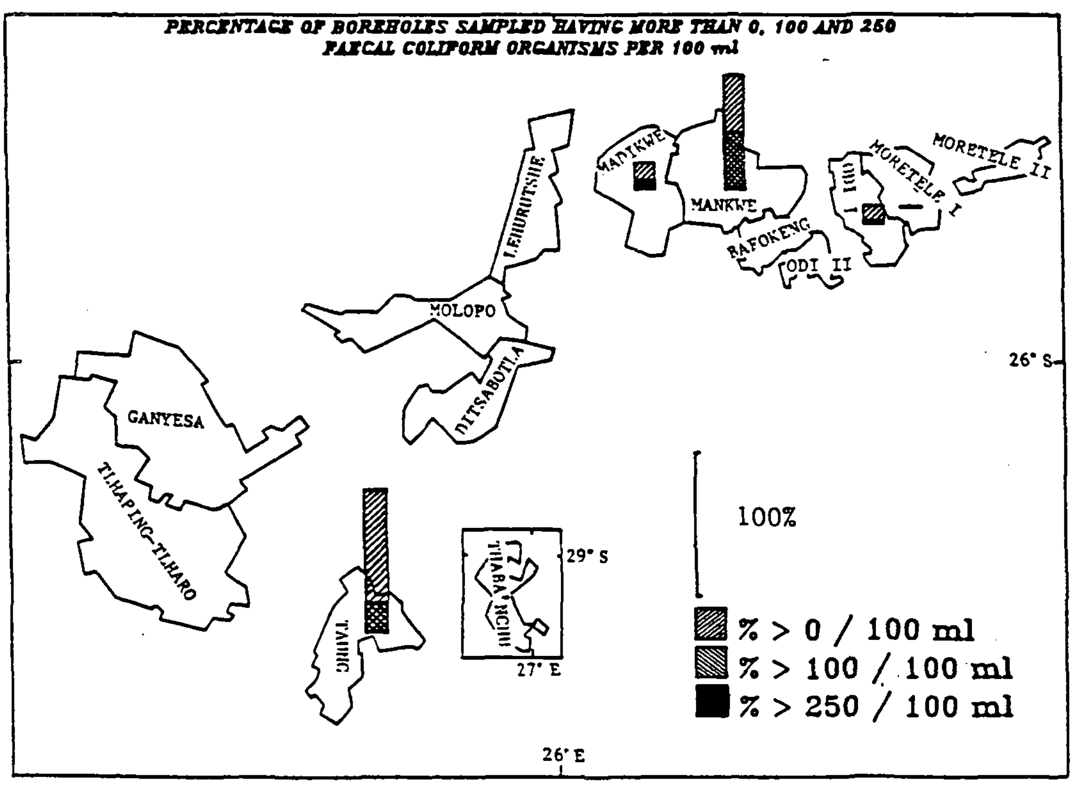

FIGURE 1 - MICROBIAL CONTAMINATION IN GROUNDWATER

GROUNDWATER POLLUTION IN BOPHUTHATSWANA

Initial batch chlorination with HTH, of the contaminated sources followed by subsequent regular dosages, has proved successful in controlling the proliferation of disease. Several simple and cheap designs for chlorinators are available[9]. The Flowrite chlorinator which was designed and developed by the NIWR and which underwent field trials in Winterveldt, Odi I is particularly worthy of mention not least because of its ease of operation, simple rugged structure, capability of coping with fluctuating flowrates, and relatively low cost of manufacturing. Depending on the nature and extent of contamination, slow sand filtration may also be used successfully either as a complement or an alternative to chlorination. In the short term, separating the source of water form the point source of contamination may alleviate the problem. In the majority of cases though, contamination seems to be from a diffuse source.

The importance of the role of the health inspectors, regional hospitals, and schools in public health education in this regard and that of the water supply and sanitation authorities in adequate and efficient provision of services can not be over emphasized.

4. FLUORIDES

Fluorides occur naturally in the earth's crust predominantly as fluorospar or calcium fluoride, CaF_2, and to a lesser extent as cryolite (sodium aluminium fluoride Na_3AlF_6) and various fluosilicates ($(SiF_6)^{2-}$). Fluorospar is mostly found in phosphate bearing rocks but it is also widely associated with granite and dolomatic formations. Numerous significant deposits are known in South Africa as shown in Figure 2, some of them are mined commercially. The majority of these deposits, however, are in small and scattered pockets universally found in the granite of the Bushveldt type and the dolomitic and limestone deposits of the Highveldt.

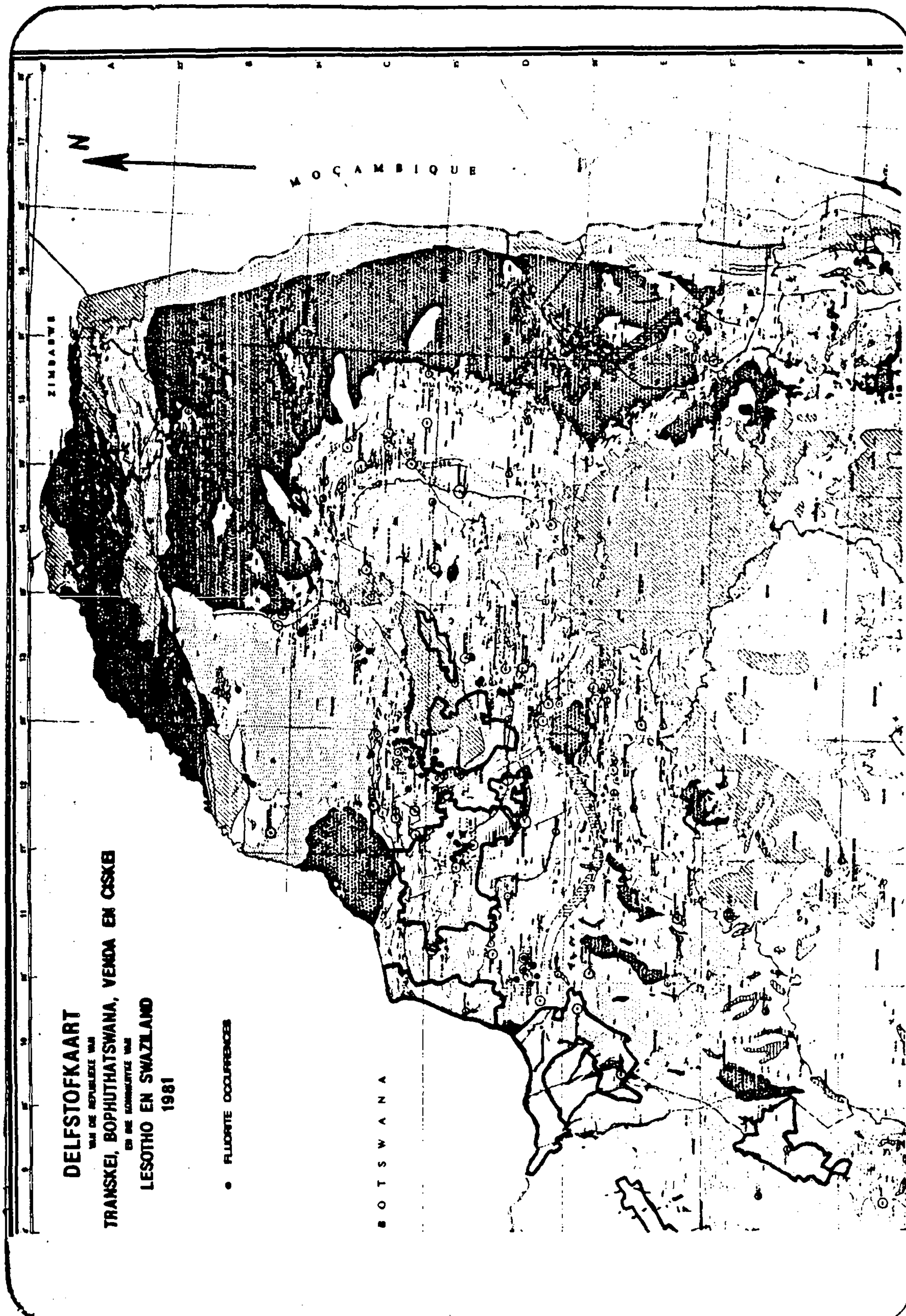

FIG. 2 MAJOR FLUORITE DEPOSITS

The effect of fluoride on health depends on its daily amount of intake. Water is the main source of fluoride in normal diet. Low concentration of fluoride in water causes dental caries while high concentration can give rise to dental and skeletal fluorosis. Churchill[10] first presented evidence in 1930 showing that on average mottling teeth (dental fluorosis) does not appear unless the fluoride ion concentration is in excess of approximately 1 mg/ℓ and that the degree and severity of mottling increased as the fluoride level rose. It was also shown later[11] that the incidence of dental caries decreased with increasing fluoride concentration. In the US the maximum allowable concentration of flouride in drinking water varies between 1,4 mg/ℓ and 2,4 mg/ℓ depending on the annual average of maximum

TABLE 3

INCIDENCE OF FLUORIDE POLLUTION IN GROUND WATER

District	Samples submitted since 1981				
	No.	1	1,5 mg/ℓ F	3	Worst case
Thaba'Nchu	39	5	3	0	1,8
Taung	45	1	0	0	1,1
Tlhaping-Tlharo	35	0	0	0	-
Ganyesa	35	12	4	2	25,8
Ditsabotla	20	4	0	0	1,4
Molopo	73	1	0	0	1,1
Lehurutshe	51	0	0	0	-
Madikwe	140	3	2	2	6,3
Mankwe	277	44	36	6	8,8
Bafokeng	54	5	1	1	4,1
Odi I & II	763	89	54	6	13,7
Moretele I&II	161	24	18	4	9
Total	1693	188	118	21	-

daily air temperatures[12], because of the temperature dependence of the daily water consumption. In Bophuthatswana, since the whole country lies within the same geographical and climatic region, one standard of a recommended limit of 1 mg/ℓ and a maximum allowable limit of 1,5 mg/ℓ F is enforced.

The incidence of high fluoride concentration in groundwater in Bophuthatswana is summarised in Table 3 and presented graphically in Figure 3. As can be seen, high fluoride sources are scattered widely spread but fortunately only form 7% of the total number of sources sampled so far. The worst case of 25,8 mg/ℓ is of concern, specially in Ganyesa, an area in which alternative sources of water are not easily found.

Several methods for the reduction of fluoride concentration to well within acceptable limits are available. Though the details of the processes are beyond the scope of this paper, precipitation or co-precipitation during coagulation,

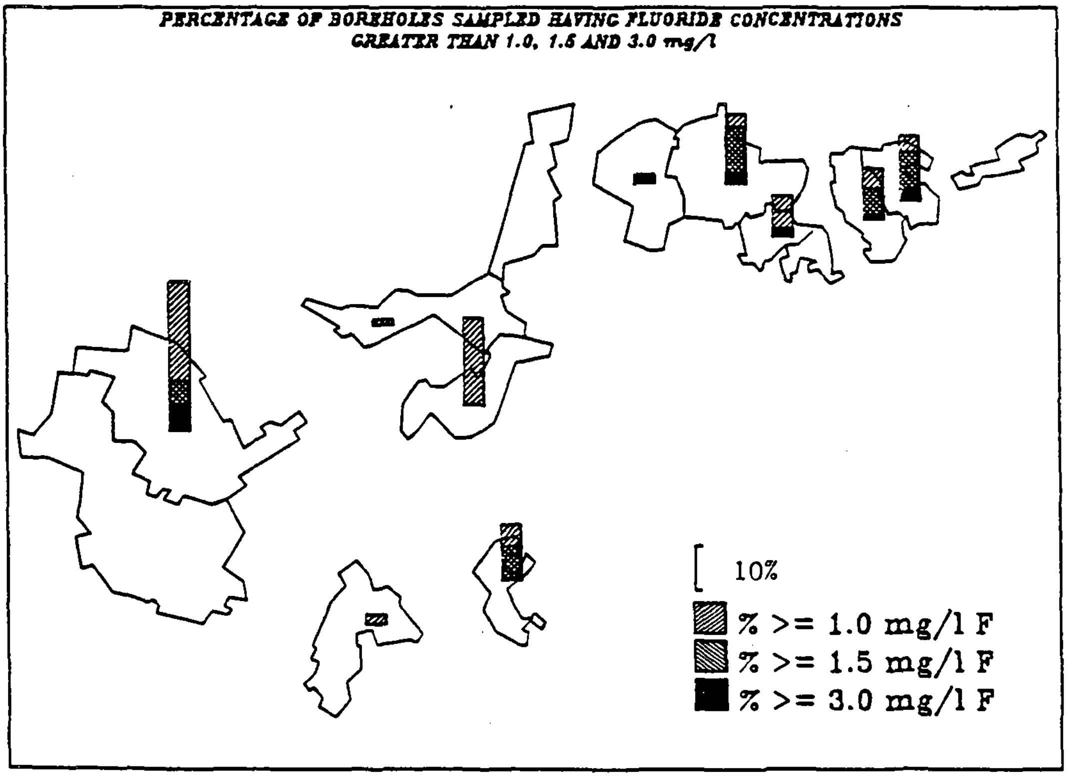

FIGURE 3 - FLUORIDE POLLUTION IN GROUNDWATER

desalination, ion exchange and adsorption are technologically well tried and established[10,12,13] but due to high cost, lack of expertise and general impracticability of providing each contaminated source with its own fluoride removal system, are not generally used. Development of cheaper methods would make fluoride removal a practical matter for many communities.

The subject of low concentration of flouride in groundwater and possible need for minimum standards and fluoridation of water has not been addressed in this paper but deserves investigation.

4. NITRATES

Nitrogen is abundantly found in living organisms and in the atmosphere where through lightning (and the internal combustion engine) it forms nitrates which dissolve in rain droplets to form weak solutions of nitric acid. In the soil the acid forms various salts which being highly soluble, rapidly migrate to the water table and accumulate in groundwater. Nitrates may also be "fixed" directly from the atmosphere by bacteria of nitrosamonas and nitrobacter species, or enter the environment as waste such as in dead or decaying matter. Nitrates in water may not only cause eutrophication in surface impoundments but more significantly, if consumed, especially by infants they may be converted to nitrite by bacteria in the gastric tract. In the blood nitrite converts haemoglobin to methaemoglobin which is incapable of transporting oxygen, giving rise to methaemoglobinemia or "Blue Babies" disease. In infants who are predisposed to the disease it can be fatal. Few cases of disease occur where nitrate-nitrogen concentrations are below 10 mg/ℓ and it does not occur in breast fed babies.

Following an extensive isotopic and chemical study of nitrates in groundwater in Springbok Flats north of Pretoria. Heaton[14] made the following conclusions:

a) The main contribution to groundwater nitrates in 'black turf' soil in basalt areas is from increased nitrification in the soil. This is brought about by decay and mineralisation of the natural vegetation destroyed when virgin land is converted to arable land.

b) The role of soil nitrification in pollution is by far more significant than that of other potential sources such as rainwater, fertilizers and human and animal waste.

c) Soil nitrification is a recently initiated (about 30 years), rapid (½ life of approximately 5 days in sandstone areas[15]), and currently active process.

Similar conclusions have been drawn from studies in Israel and the USA[15]. While there is no reason why the above conclusions should not apply equally well to similar areas in Bophuthatswana, e.g. to parts of Odi or Moretele, there are still vast areas of land which are uncultivated. In such areas, e.g. in parts of Madikwe or Mankwe most of the boreholes with high nitrate content are found in close vicinity of residences. This is partly because there is little demand for boreholes elsewhere but also the contribution to groundwater nitrates from animal and human waste cannot be disregarded as they assume a more significant role compared to soil nitrification in such 'virgin' areas. For most of the rest of the country it is believed that both these mechanisms and a few more such as fertilisers and rain water also contribute towards high nitrates.

The distribution and severity of nitrate pollution in ground water is summarised in Table 4. The value of 120 mg/ℓ NO_3-N is particularly high. There are however statistics from other parts of the world e.g. U.S. quoting one case of 127 mg/ℓ found in a survey[12].

As the economy of Bophuthatswana grows and its agriculture develops, more land is expected to be cleared of its natural vegetation and converted to farm land using modern intensive agricultural methods. Large areas, established within the last ten years are already under cultivation in several agricultural development projects[4] such as near Taung, Itsoseng, Disaneng, Motswedi, etc. It is expected that because of such activity there will be a gradual increase in the level of nitrates in groundwater within the next 20-50 years. The present situation is shown graphically in figure 4.

TABLE 4

INCIDENCE OF NITRATE POLLUTION IN GROUND WATER

District	Samples submitted since 1981				
	No.	10	20 mg/ℓ NO_3-N	45	Worst case
Thaba 'Nchu	39	1	1	0	29,5
Taung	45	0	0	0	-
Tlhaping-Tlharo	35	0	0	0	-
Ganyesa	35	6	1	0	20,9
Ditsabotla	20	5	2	0	27,2
Molopo	73	7	5	2	45,5
Lehurutshe	51	4	1	0	24,9
Madikwe	140	16	6	0	39,2
Mankwe	277	24	6	2	70,8
Bofokeng	54	0	0	0	-
Odi I and II	763	191	87	31	120,0
Moretele I and II	161	32	18	4	50,9
Total	1693	286	127	39	-

Nitrates may be removed from water by desalination, ion exchange or biological denitrification. All available processes require qualified operators, are rather expensive, and difficult to operate successfully at low and interrupted flow. Research is required to develop processes that are more suitable for use.

5. ACKNOWLEDGEMENT

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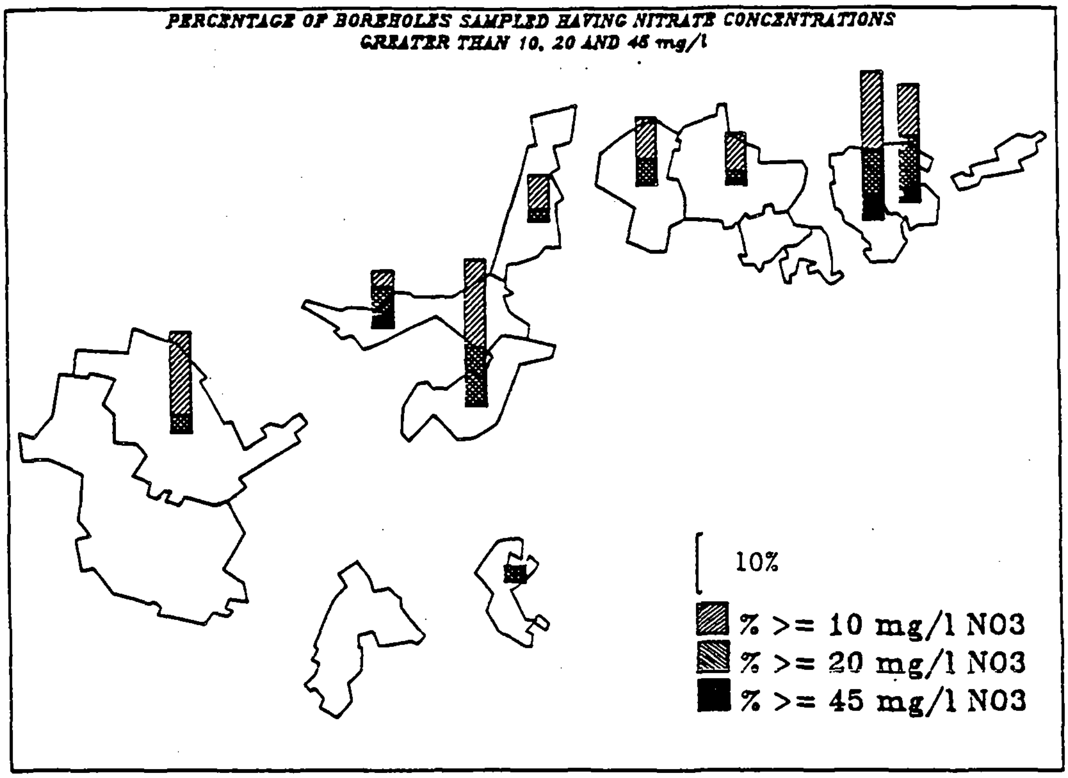

FIGURE 4 - NITRATE POLLUTION IN GROUNDWATER

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PAPER: 5.2

WATER SUPPLY AND DISTRIBUTION FOR DEVELOPING COUNTRIES

R.J. LABURN

Pr.Eng, D.Eng (Witwatersrand), M.Sc (Civil Engineering)

Watermeyer Legge Piesold & Uhlmann Consulting Engineers,
P.O. Box 221, Rivonia, 2128

The paper reviews the importance of harnessing all surface waters in Southern Africa for the benefit of all with an equitable distribution of the water.

Design parameters such as per capita consumption of water, residual pressures and the necessity for payment of water consumed are discussed.

Die referaat bied 'n oorsig van die noodsaaklikheid om alle oppervlakwater in Suid-Afrika tot die gelykmatige voordeel van almal te gebruik.

Ontwerp parameters soos per capita water verbruik, water druk vir woongebiede en die noodsaaklikheid van betaling vir water verbruik word bespreek.

It is apposite that much attention is being given to water supply in Southern Africa during this decade which is the International Decade for Drinking Water and Sanitation. Much has been and is being achieved towards the high goal of supplying water of adequate quality to all.

Water supply in a region such as Southern Africa is characterised by a persistent need to meet a demand which increases at an alarming rate compared with developed European countries and which is aggravated by an overall scarcity of water resources and supply in its semi-arid climate.

Development of water resources in the past has concentrated upon the need to meet urban mining and industrial needs of the principal growth points in the RSA and to supply water probably on a less assured basis for agriculture and irrigation. Water supplies for rural communities have been on a localised basis with underground sources being relied upon in most instances. In spite of concerted efforts the supply to the most important industrial regions has been insufficient for more than one third of the time during the past 20 years to satisfy the requirements of these regions.

That water supply to rural areas has coped, albeit poorly, is due to a very low per capita demand in these areas probably in the order of less than 50 litres/person/day and when meagre supplies became inadequate during periods of drought, and drawdown of underground supplies, water in relatively small quantities may have had to be transported to within reasonable distance of where the users where located.

There can be little doubt that the chronic paucity of supply of water and its dubious quality must have contributed to indifferent health of many rural communities.

With the development of communities, their increased population and their justified expectation, if not demand, for more water of unquestioned quality, the water engineer is confronted with problems that are most challenging and demand careful long term planning.

WATER - NO RESPECTER OF MAN MADE BOUNDARIES

We should remind ourselves that rivers seldom form the boundary of countries and even when they do there is the problem of sharing the river's water. Thus we must accept that rivers, the main potential source of water supply, disect countries, all of which have a right to certain of the water. The Helsinki rules lay down how water should be apportioned amongst riparian countries and communities and this should apply to recently established National States as well.

A compounding problem is that there are instances where most of the river's resources have been harnessed to supply the already developed and developing regions and areas. Little water remains for the developing countries and their rural communities so that water further afield has to be sought and made available. If further away, it will cost more to deliver to where it is required so that costs would be disproportionally higher. One questions the practice of "first come first served" as being equitable or valid today in Southern Africa where new growth centres are being developed at an encouraging and necessary fast rate.

Consideration is no doubt being given by Government to an overall survey of water demands and water resources of all communities and it is to be sincerely hoped that a satisfactory solution can be agreed upon with respect to adequate quantities of water being made available to all at reasonable costs. Schemes shared jointly by neighbouring states should be planned for the benefit of all and to the advanatage of all.

There can be no doubt that the provision of an adequate, healthy and attractive water supply is an important factor in improving the quality of life of communities.

It is high time that the practice of women and children spending a disproportionate time each day in fetching water be addressed. There are important social factors and benefits in folk gathering at communal supply points when drawing water but to spend hours going to and from such points to home is not acceptable. Traditionally folk did this but there were fewer people and closer water supply points in the past, but not so today.

One is lead therefore to the need to reticulate water to within reasonable distances of all. This embraces a very vast programme. Ultimately we should strive to provide water within a few hundred metres of everybody. This is an obvious objective but costs in providing even such basic reticulation are very high, pipelines and water carrying conduits are expensive and always constitutes a major portion of the cost of supplying water.

There are two fundamental constraints or problems. The one is ensuring that there is sufficient water for the people's needs, not wants, and the second is that there are funds to pay for providing such service or facility.

How much water is needed? Usually a lot less than what is wanted.

Experience the world over reveals man's inherent selfish nature and lack of appreciation of water. If he does not pay for water, he will not conserve it and will waste it and his appreciation will be appropriate only when he has to pay for it.

These fundamental facts, namely daily per capita need, upon which designs are based, the tariff for water and its accessibility, should be addressed somewhat more fully for they dominate the decision making for all water supply schemes and thereof.

a) Design Criteria

1. Per capita consumption or the needs of each person per day

   In the RSA various authorities have made it known that 50 litres/person/day, is an accepted figure. Assuming a family of 5 or 6 this means that between 250 - 300 litres per family/day is the designed figure and in fact 300 is usually taken. In contrast to this, the internationally accepted figure for rural areas in developing countries is 50 litres per family/day in villages and 100 litres per family/day in small towns.

   I am not suggesting that there be a reduction in living standards but rather a realistic supply of water, particularly as water is at such a premium in most of our rural areas. We should also bear in mind that supply pipelines are designed on the assumption that every consumer is drawing water of at the same time.

2. Peak Loads

Designers use a peaking factor of 3 times the consumption during highest month, which is about 1,5 times the annual average. What is probably meant is that during a peak period of say an hour or so, draw-off rate could be three times higher than the highest monthly average hourly draw-off i.e. 4,5 times higher than the annual average draw-off.

Are these design ratios realistic and practical for they have a very significant bearing in the design of all supply pipelines. They may be correct particularly in cases where reservoirs are not provided and the demand is fed solely from the supply pipeline. The function of reservoirs prudently provided is, inter alia, to assist the distribution system in meeting demands. Particular reticulation pipelines may indeed have to be sized to meet high peaks for short periods but pipeline systems feeding reservoirs and ring mained systems need not be designed for such high peak loads. In any event must peaks be met and maintained for long periods? Design is based upon the assumption that if all outlets were to be opened simultaneously pressures would not fall from the designed maximum of 120 kPa to 60 kPa which is more than an adequate residual pressure to deliver water. Consideration should be given to accepting a lower pressure during times of peak draw-off.

3. Pressure at Standpipe or House

South African standards stipulate that static head at the highest take-off point should be 100 kPa.

consumers. Pipelines usually comprise the major element of the capital cost of the supply scheme. Unless water is paid for, there will never be sufficient for the wants of the people. When required to pay for water people's wants approach more closely their needs. It is realised that payment for water is a sensitive issue, cutting across the traditional approach to water supply and use, but having to expend large sums of money to provide for the needs of more and more people is also not traditional and will have to be paid for at least in part by consumers. Payment is the surest and probably the only manner in which to ensure that supplies remain sufficient for a reasonable period. This does not suggest that water supplies should not be subsidised but a tariff for water used is essential to control use and to conserve supplies as in most cases they will be strained to the limit. There are obvious practical problems that have to be solved, such as the cost of metering, the breakdown of usage from communal stand pipes etc. It may be necessary for village headman to be levied for the water used by the people under such a person.

As an example of the effect that water metering has on consumption, the unmetered consumption per black household in the Cape Town water supply undertaking is 895 litres/day whereas metered consumption in a middle class white household is 680 litres/day and in a middle class coloured household is 400 litres/day metered. It is only in the upper class white household where the consumption of 1100 litres/day exceeds the unmetered consumption of a black household, but consumption in excess of 2000 litres/household/day are being experienced in newly established urban areas in Gazankulu.

In an attempt to bridge the wide gap that exists between traditional non-payment for water and payment for water consumed it may be prudent to allow individuals a minimum

This appears to be a conservative and high figure, bearing in mind that for many decades, an adequate household water supply pressure was that equivalent to the pressure of a small tank in the ceiling above a single storey house i.e. about 20 kPa. Such a high minimum terminal pressure as 100 kPa results in added expense because of the need for higher grades of pipe and higher pumping costs.

TARIFF FOR WATER

It is only in the established towns and cities in Southern Africa that consumers are accustomed to having to pay for water based on metered supplies to individual homes or supply points. Certain towns and cities, some major in size have only recently converted to metered supplies. This is probably because there was seemingly an abundance of water. A method of deriving income from water supplied in such cities and towns was by means of an added tax per household or stand.

Traditionally rural people have not been required to pay for their water, either because they fetched it themselves from a natural source or from a well or a borehole supplied by a Government body or owner as part of the essential and vital needs of the people. Payment was probably never contemplated.

Against this background it is now becoming necessary to expend relatively large capital sums on a water supply where dams, pipelines, pumps, reservoirs, treatment plants and operating costs have to be paid for. The cost of supplying water varies from area to area and is particularly dependent upon distance of the reliable source from consumers and the distribution of water to within reasonable distance of all quantity per capita, say 10 litres/person/day at no cost and charge for consumption in excess of such a figure. The objective of charging for water is thus two fold. Firstly to receive some income to off-set capital and operating costs for water supplied and secondly, and possibly more importantly, restrict wastage of water and reduce consumption to close to the needs of the people.

These principles apply equally in rural or village or town areas but are particularly essential where urbanisation is taking place.

CONCLUSION

This short paper deliberately avoids technical considerations of water supply problems and design because it is considered that certain fundamental principles should be dealt with as a matter of priority and of uniformity in many of the developing states in Southern Africa.