WATER SUPPLY AND SANITATION IN DEVELOPING COUNTRIES

EDITOR
Bernard J. Dangerfield

(Deputy Secretary, The Institution of Water Engineers and Scientists)





Compiled and Published by The Institution of Water Engineers and Scientists, London, England.

CONTENTS

				\supset						Page	
Prefac	e	•••	•••	•••	•••	•••		•••	•••	. v	
Note o	n The Institution o	of Wat	er Engir	neers an	ıd Scier	ntists		•••	•••	vii	
Ackno	wledgements		•••		•••	<i></i>				viii	
Contri	butors	•••	•••						•••	ix	
	er 1: Water Suppoduction	oly and	l Sanita	tion in	Develo	ping (Countri	ies—			
1	The Problem									.1 1	
	A Step Towards a		On					•••		1	
	The Cost of the D									2	
				•••	•••	•••		•••	•••	2	
	Financing the Dec			•••	•••	•••	•••	•••	•••	3	
	Access to Service		• • •	•••	• • •	• • •	•••	•••	• • • •		
	Public Health Asp			•••				<u></u>	• • • •	4	
	Institutional Deve				y Partic	cipatio	n, and	i rainir	1g	4	
	Cost Recovery and			•••		•••	•••	•••	• • • •	5	
9.	Summary and Co	nclusio	ons	•••	•••	•••	•••	•••	•••	5	
Chapt	er 2. Economic :	and So	cial Co	ndition	s						
. 1.	Introduction									7	
	Population Grow						•••	•••		7	
	Health Condition			•••						9 X	
	Obstacles to Impr									10	
	Economic Resour				•••	•••	•••			12	
			for Day			•••	•••	•••	•••	15	
6.	Longer Term Pro	spects	ior Dev	eiopine	nı	•••	••••	•••	•••	13	
Chapt of t	er 3. Infections l he Decade	Relateo	l to Wa	ter and	Excret	a: the	Health	Dimer	ision		
1.	Health Priorities	in the l	Decade							25	
2.	Classifying Infect	ions R	elated to			v and	Sanitat	ion		26	
	Decade-related Ir			• • • •						34	
_	Conclusions—He									43	
	References			···						46	
٥.	References	•••	•••	•••	• • •	•••	• • •	•••	•••	. 10	
Chapt	ter 4. The Role of	of Dev	elopmer	ıt Bank	ks in In	ternati	onal F	unding		,	
1.	Introduction									47	
2.	Project Identifica	ation								50	
	Project Preparati		•••	•••	•••			•••		51	
	Project Appraisa									53	
	Loan Negotiation						•••			59	
	Implementation									60	
	- ·		_			•••	•••	•••	•••	62	
7.	Evaluation	• • •	•••	• • •	• • •	• • •	• • •	• • •	• • •	02	

Chapte	er 5. Population and	Water Ne	eds					
1.	Introduction	•••		•••				65
2.	Population Estimates				•••			67
	Requirements for Surv							72
	Domestic Water Dema							73
	Industrial, Commercia							80
	Water for Fire-fighting		•••		•••	•••		82
	Unaccounted-for Water	•		•••				82
	References							84
-	er 6. Water Resource							0.5
	Introduction		•••	•••	•••	•••	•••	85
	Water Resources Asses		•••	•••	•••	•••	•••	96
	Water Resources Deve	•	•••	•••	•••	•••	•••	120
4.	References	•••	•••	•••	•••	•••	•••	125
Chant	er 7. Water Quality a	nd Treatn	nent					
1.								129
	Quality of Water and	reatment	Dogwin	 ad	•••	•••	•••	100
	Pre-treatment		•		•••	•••	•••	120
			•••	•••	•••	•••	•••	1.40
	Coagulants and Coagu			•••	•••	•••	•••	140
	Mixing and Flocculation		•••	•••	•••	•••	•••	1 40
	Sedimentation	***	•••	•••	•••	•••	•••	161
7.	Choice of Settling Bas	ın	•••	•••	•••	•••	•••	151
	Design of Basins		:••	•••	•••	•••	•••	1.50
	Filtration		•••	•••	•••	•••	•••	158
	Disinfection		•••	•••	•••	•••	•••	159
	Additional Treatment			•••	•••	•••	•••	161
	Waterworks Wastes an	_		•••	•••	•••	•••	162
13.	References	•••	•••	•••	•••	•••	•••	162
Chapt	er 8. Urban Water Si	ipply						
_	Introduction							163
								169
	Distribution Systems							178
. 4	Operation and Mainte	nance	•••			•••		189
5.	Operation and Mainte References	nunce				•••		191
Δni	pendix A: Pipes, Valve						• • • •	192
Anı	pendix B: Trunk Mair	Selection	n (an e					
, rb)	alternatives							199
Anı	pendix C: Hydraulic T						• • • •	200
1.0	penum or riyuruumo r	••••	•••	•••	•••	•••	•••	200
Chapt	ter 9. Urban Sanitatio	n and Su	rface W	ater D	rainage	:		
	Introduction	•••		•••	•••			203
2.	Surface Water Draina	ge					•••	204
	Foul Sewerage							211
	Sewage Treatment and					•••		224
	Sludge Treatment and					•••		231
	Marine Disposal of Li			•••				234
7	Defenence	-						224

v	٦.	_	Τ.	•	J

Ch	apt	er 10. Rural Wate	r Supply a	nd Sanit	ation					
	1.	Introduction						•••		239
	2.	The Rural Problem	1	•••						239
	3.	The Rural Econom	ıy			• • • •	•••		•••	242
	4.	Studies				•••		•••		245
	5.	Design			• • •				•••	248
	6.	Construction		•••	•••		•••		•••	258
	7.	Management, Ope	ration, and	Mainter	nance	•••				259
	8.	References		•••		•••	•••		• • •	260
C	ant	er 11. Low-cost T	Cooknology							
CI	-		•							262
	1.			•		•••	•••	•••	•••	263
		Self-help and Com	•	-		•••	•••	•••	•••	264
,		Low-cost Water Su	• - •	•••	•••	•••	•••	• • •	•••	265 279
(Low-cost Sanitatio			•••	•••	•••	•••	•••	288
		Waste Reclamation			•••	•••	•••	•••	•••	
		Local Organization			•••	• • • •	•••	•••	•••	292 294
	7.	References		•••	•••	•••	•••	•••	•••	294
Cl	hapt	er 12. Operation	and Maint	enance						
1	1	Introduction								297
		Operation								297
1		Maintenance								316
		References						•••		330
	٠.	References		•••	•••	•••	•••	•••	•••	330
C	hapt	ter 13. Institution	al Requirer	nents						
	_	rt 1: Legal and M	-		s					
		The Nature of Inst	Ŭ							333
		Laws, Regulations				•••	•••	•••		334
		Management Strue				•••	•••			339
	J.	Public Informatio	n and Darti	 icipation						345
	٦.	Tuone imormatio	ii aiiu i aiti	cipation	•••	•••	•••	•••	•••	777
	Pa	rt 2: Financial As	spects							
	1.	Introduction								349
	2.	Sources of Funds								349
	3.	Tariff Structure								354
	4.	Tariff Rates								359
	5.	Affordability								360
		Rural Services								361
		References		•••						362
			•							
C	hapt	ter 14. Education	and Traini	ing						
	Pa	art 1: Education a	nd Trainin	g of Wa	ter Eng	ineers	and Sci	ientists		
		Levels of Operating				•••	•••		•••	363
		Professional and								364
		Development (For								364
		Undergraduate Co				•••	•••		•••	365
		Accreditation of F								366

Chapter 14—continued

6. Special Requirements of the Water	er Engi	neer				367
7. Technician Engineer		• • •				368
8. Training and Experience						368
9. Research in Water Engineering						370
Appendix A: Postgraduate Courses i		J.K.		•••	···	370
Part 2: Sector Education and Resea	ırch					
1. Working in Developing Countrie	s					371
A District Distriction						374
2 District and Decree						376
4 O 4 T 1 7 T 1 7 T 1 T 1 T 1 T 1 T 1 T 1 T 1						377
						377
- D C		•••	•••	•••	•••	379
6. References	•••	•••	•••	•••	•••	576
Part 3: Institutional Training						
1. Philosophy and Principles						379
2. Education and Training						379
3. Training for Support Services						387
4. Certification						389
5. The Creation of Training System						300
5. The Creation of Training System	.5	•••	•••	•••	•••	370
Conversion Factors			•••			394
ndov						304