Contents

	Page
Preface	xi
Abbreviations used throughout the book	xiv
Definitions	xv
1 Sewage and sewage disposal	1
1.1 Introduction .	1
1.2 Origin of sewage	2
1.3 Nature of sewage	3
1.4 Sewage treatment	3
1.5 Small scale sewage treatment	5
1.5.1 Septic tanks	5
1.5.2 Biological fillers	07
1.5.5 Activated studge putits 1.5.4 Non-hiological sewage treatment processes	, ,
1.6 Aerohic and anaerohic processes	/ 8
1.7 Types of micro-organisms	8
1.7.1 Bacteria	9
1.7.2 Fungi	ó
1.7.3 Protozoa	-
1.7.4 Rotifers and higher organisms	10
2 Characterization and measurement of sewage, effluents and sludges	11
2.1 Determination of dissolved oxygen (D.O.)	11
2.2 Determination of pollutional load	12
2.2.1 Biochemical oxygen demand (B.O.D.)	12
2.2.2 Chemical oxygen demands	15
2.2.3 Instrumental methods	15
2.3 Solids determinations	16
2.4 Sludge quality	16
2.5 Measurement of sludge properties	17
3 Effluent discharge – legislation and standards	19
3.1 Legal responsibility for sewage treatment	19
3.1.1 Common law	19
3.1.2 Public Health Acts	20
3.1.3 Discharge of effluents	20
3.2 Camping and caravan sites	21
3.3 Discharge standards	21
3.3.1 Royal Commission standards	22
3.3.2 Anticipated discharge requirements	22

	4 Difficulties of sewage treatment at small and variable communities	24
	4.1 Flow and loading factors for sewage works design	24
	4.1.1 Mass of B.O.D. 5	24
	4.1.2 Dry weather flow (D.W.F.)	25
	4.2 Diurnal variations in sewage flows and treatment capacity	25
	4.2.1 Separate sewerage systems	25
	4.2.2 Combined sewerage systems	27
	4.3 Annual variations in sewage flows	27
	4.4 Origin and characteristics of sewage	29
	4.5 Small communities	30
	4.5.1 Population	30
	4.5.2 Per capita sewage flow	31
	4.5.3 Per capita B.O.D. 5 values	31
	4.6 Camping and caravan sites	32
	4.6.1 Population	32
	4.6.2 Flow and B.O.D. 5 loadings	32
	4.7 Hotels	34
	4.7.1 Population	34
	4.7.2 Flow and B.O.D. 5 loadings	34
	4.8 Other types of community	35
	4.9 Problems associated with the siting of a sewage works	36
	4.10 Miscellaneous problems	37
	4.11 Operation and maintenance	38
	4.12 Conclusions	38
2	Chemical sanitation and physico-chemical treatment	41
	5.1 Chemical sanitation	41
	5.2 Strength and volume of sewage from chemical sanitation systems	42
	5.3 Sanitary fluids	43
	5.3.1 Formaldehyde	43
	5.3.2 Caustic soda	44
	5.3.3 Phenol/coal tar fluids	45
	5.3.4 Miscellaneous chemical agents	45
	5.4 Ancillary actions of sanitary fluids	46
	5.5 Disposal facilities for chemical sanitation liquids at camping and	
	caravan sites	46
	5.6 Physico-chemical treatment	48
6	Cessmools and sentic tanks	50
Ŭ	6.1 Cosmoole	50
	6.2 Sludge disection tembre	50
	6.3 Imhoff tanks	51
/	6.4 Sentic tanks	51
	6.4.1 Siging of tamba	53
	6.4.2 Overflow rates and wein overflow notes	53
	6.4.3 Soum and studge production	54
	644 Fiftuent quality	55
	Server Difficult quality	56
7	Settlement processes	60
'	71 Introduction	28
	7.1 Introduction	58
	1.1.1 Cluss I sellement	52

7.1.2 Class II settlement	59
7.1.3 Zone settlement	59
7.2 Design criteria	60
7.2.1 Overflow rates	61
7.2.2 Weir loadings	62
7.2.3 Tank shape	62
7.3 Primary settlement	63
7.3.1 Applicability	64
7.3.2 Sludge volumes and moisture contents	64
7.3.3 Capacity and shape	64
7.3.4 Inlets	65
7.4 Secondary settlement tanks	65
7.5 rackage plants	00
8 Aerobic treatment processes	69
8.1 Introduction	69
8.2 The activated sludge process	70
8.2.1 Variations in the basic process	71
8.2.2 Kinetics of the processes	72
8.2.3 Aeration processes	73
8.2.4 Oxidation ditches	74
8.2.5 Operational parameters for activated sludge plants	75
8.2.6 Contact stabilization	78
8.3 Percolating filters	78
8.3.1 Conventional loading	79
8.3.2 Recirculation and alternating double filtration	79
8.3.3 Conventional percolating filter design	79
9 The rotating biological filter	82
9.1 Introduction	82
9.2 Description of the process	82
9.3 Design criteria	83
9.3.1 Disc speed	83
9.3.2 Temperature effects	84
9.3.3 Flow rates	84
9.3.4 Toxic and other materials	84
9.3.5 Design loadings	85
9.3.6 Power requirements	86
9.3.7 Start-up time	88
9.3.8 Sludge production and settlement	88
9.4 Environmental aspects	88
9.5 Summary	89
10 Sludge production and disposal	90
10.1 Introduction	00
10.1 1 Cesspools and primary sottlement tanks	90
10.1.2 Sentic tanks and Imhoff tanks	90
10.1.3 Activated sludge units and percolating filters	91
10.2 Sludge types	92
10.2.1 Detritus sludge	92

vii

Contents

 10.2.2 Primary sludges 10.2.3 Secondary sludges 10.3 The effect of sludge moisture content 10.4 Sludge conditioning 10.5 Sludge treatment 10.6 Disposal of sludges 10.6.1 Tankering 10.6.2 Land disposal 10.6.3 Drying beds 	92 93 94 95 96 97 97 97 97
11 Tertiary treatment	100
11.1 The need for tertiary treatment	100
11.2 Tertiary treatment and suspended solids	100
11.3 Treatment methods	101
11.3.1 Grass plots	101
11.3.2 Clarifiers	102
11.3.3 Microstrainers	102
11.3.4 Sand filtration	102
11.3.5 Lagoons	103
11.4 Summary	103
\$~* * \$	
12 Structural design and construction	105
12.1 Introduction	105
12.1.1 Special requirements for sewage works	105
12.1.2 Structural types	105
12.1.3 Materials	106
12.2 Analysis and design of water retaining structures	107
12.2.1 Design loading	107
12.2.2 Analysis	107
12.2.3 Design of water retaining structures	110
12.3 Construction	113
12.3.1 General	113
12.3.2 Joints	114
12.4 Resistance to corrosion	115
12 Dumme and numering of sources	112
15 rumps and pumping of sewage	110
13.1 Introduction	116
13.2 Pumping of sewage and system resistance	110
13.2.1 Estimation of system resistance	110
13.3 1 Positive displacement numps	120
13.3.2 Rotodynamic numps	120
13.4 Pump operation and matching	120
13.5 Maintenance and general usage	123
14 Operation and maintenance of small sewage works	125
14.1 Septic tanks	125
14.2 Preliminary treatment	126
-	

Contents	;
----------	---

14.2.1 Screens	126
14.2.2 Grit channels	127
14.2.3 Storm tanks	127
14.3 Settlement tanks	127
14.4 Biological treatment	128
14.4.1 Activated sludge	128
14.4.2 Percolating filters	129
14.4.3 Rotating biological filters	130
14.5 Activated sludge package plants	130
·14.6 Sludge beds	131
14.7 Aerobic digestion	131
14.8 Mechanical equipment	132
14.9 Tertiary treatment	132
14.9.1 Grass plots	132
14.9.2 Sand filters	132
14.9.3 Pebble bed clarifiers	133
14.10 General works	133
14.10.1 Attention to site	133
14.10.2 Works safety and security	134
14.10.3 Routines and records	135
14.11 Start-up and close-down of sewage works	137
14.11.1 Activated sludge plants	137
14.11.2 Biological filter plants	138
14.12 Additional equipment	139
14.13 Conclusions	140
15 Comparison of treatment processes and plant designs	141
15.1 Requirements of treatment works	141
15.2 Comparison of treatment methods	142
15.3 Isolated cottages	144
15.3.1 Septic tank	144
15.3.2 Construction of the septic tank	145
15.3.3 Settlement units	145
15.3.4 Other treatment methods	146
15.4 Small community	147
15.4.1 Treatment of sewage from a separate sewerage system	148
15.4.2 Treatment of sewage from a combined sewerage system	154
15.4.3 Inka Bioreactor package plant	155
15.4.4 Ames Crosta Babcock BioDisc	157
15.5 Camping and caravan site	159
15.5.1 Primary settlement	160
15.5.2 Biological treatment	160
15.5.3 Final settlement	161
15.5.4 Tertiary treatment	161
15.5.5 Satec diffused air plant	161
15.5.6 CJB Rotating Disc Process	165
15.6 Sludge treatment and disposal	167
16 Sewage treatment in hot climates	168
16.1 Volume and nature of sewage	168
16.7 Effluent standards	170

ix

16.3 Effect of temperature on bioxidation	170
16.4 Treatment processes	171
16.4.1 Oxidation ponds	171
16.4.2 Settlement processes	172
16.4.3 Activated sludge process	172
16.4.4 Percolating filters	173
16.5 Sludge treatment	174
16.6 Conclusions	175
Index	76