

Quantity and Quality of Wastewater Generated in Restaurants in Makurdi, Nigeria and a Prototype In-House Treatment System

Clement I. Beetsch¹, Rufus Sha'Ato^{*1,2}, Terrumun Amom Tor-Anyiin³ & Paul Aunde Annuneh³

1. Department of Chemistry
2. Center for Innovation in Procurement, Environmental & Social Standards, CIPESS
3. Department of Fisheries & Aquaculture, Joseph Sarwuan Tarka University (Formerly Federal University of Agriculture), Makurdi, BENUE STATE, NIGERIA

Contact: rshaato@uam.edu.ng

ABSTRACT

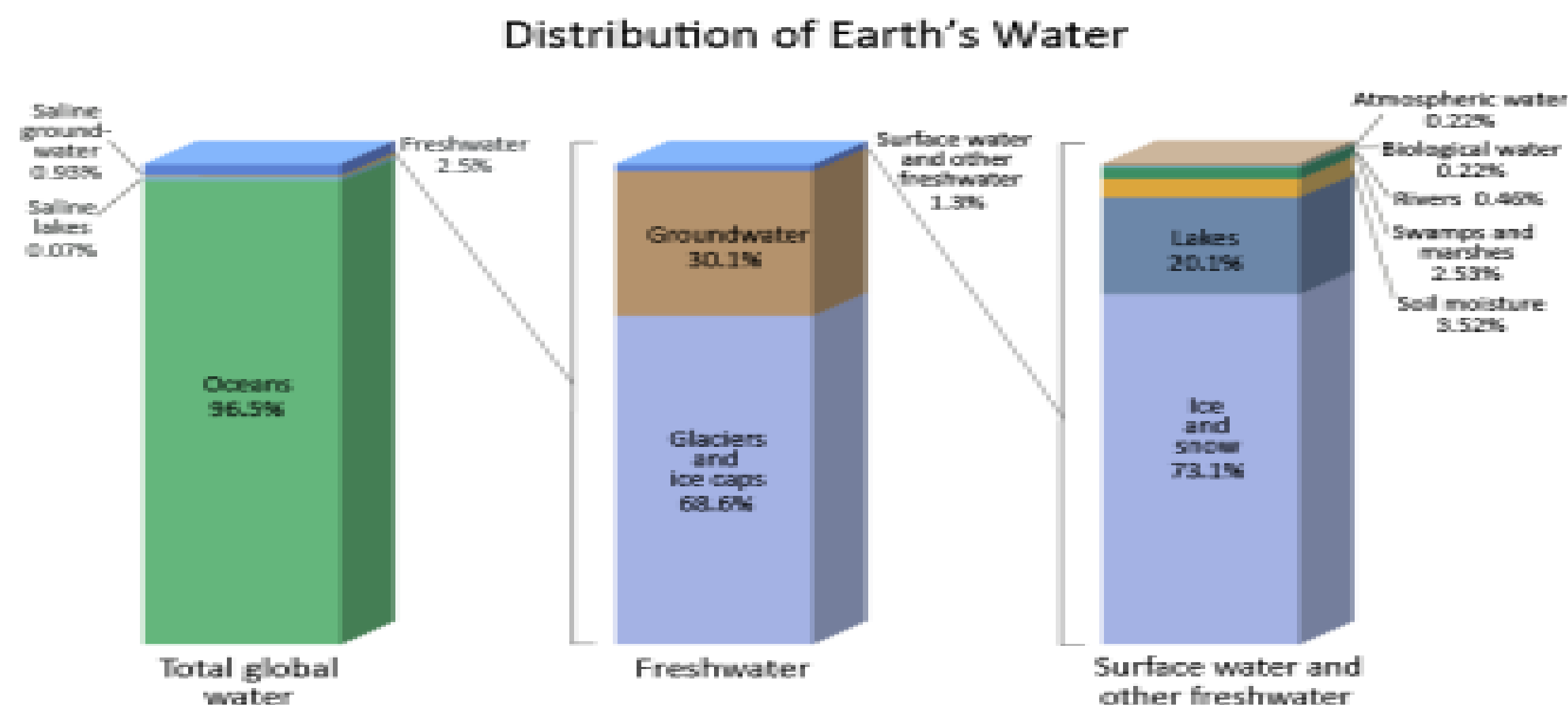
Domestic and small-scale commercial activities in Nigeria use water and discard the resultant waste freely around the premises or in open drains without regard to the environmental and public health consequences. Meanwhile, access to clean, potable water remains a challenge across the country. To contribute to the national effort at sustainable water use, wastewater generated (from washing of hands, plates, pots and cutlery) in twenty-five (25) restaurants in Makurdi Metropolis, Central Nigeria, was collected daily, in a four-day week regime, for thirty-five weeks. The aim was to determine the quantity of wastewater generated, its chemical characteristics and the potential for re-use after simple treatment. Results showed that waste water generation amounted to about one million litres within the study period while quality characterization for colour, turbidity, conductivity, pH, total dissolved solids (TDS), suspended solids (SS), total solids (TS), total hardness, dissolved oxygen (DO), biochemical oxygen demand (BOD), mineral content (Mn, Zn, Cr, NO₃⁻, SO₄²⁻, PO₄²⁻), and total coli form bacteria count showed that all the wastewater samples analyzed gave values for these parameters that were close to each other in all the restaurants. On treating the waste water using conventional water treatment methods, the values of all the parameters reduced to near potable standards (WHO /Nigeria Guidelines for Drinking Water Quality) and remained stable three months after, while > 80% of the waste water subjected to the treatment regime was recovered. Encouraged by this result we developed a low-technology system for treatment of the wastewater for re-use. Emphasis is on the ease and affordability of construction of the plant and treatment requirements. The system is portable and material investment in its assembly is low and powered by gravity only. We conclude that it is practically feasible and worthwhile to recover wastewater from restaurants^{II} and similar outfits for re-use after proper treatment, to ease the pressure of water scarcity in this area.

Keywords: Wastewater, Makurdi, Nigeria, water quality, water treatment, recycle

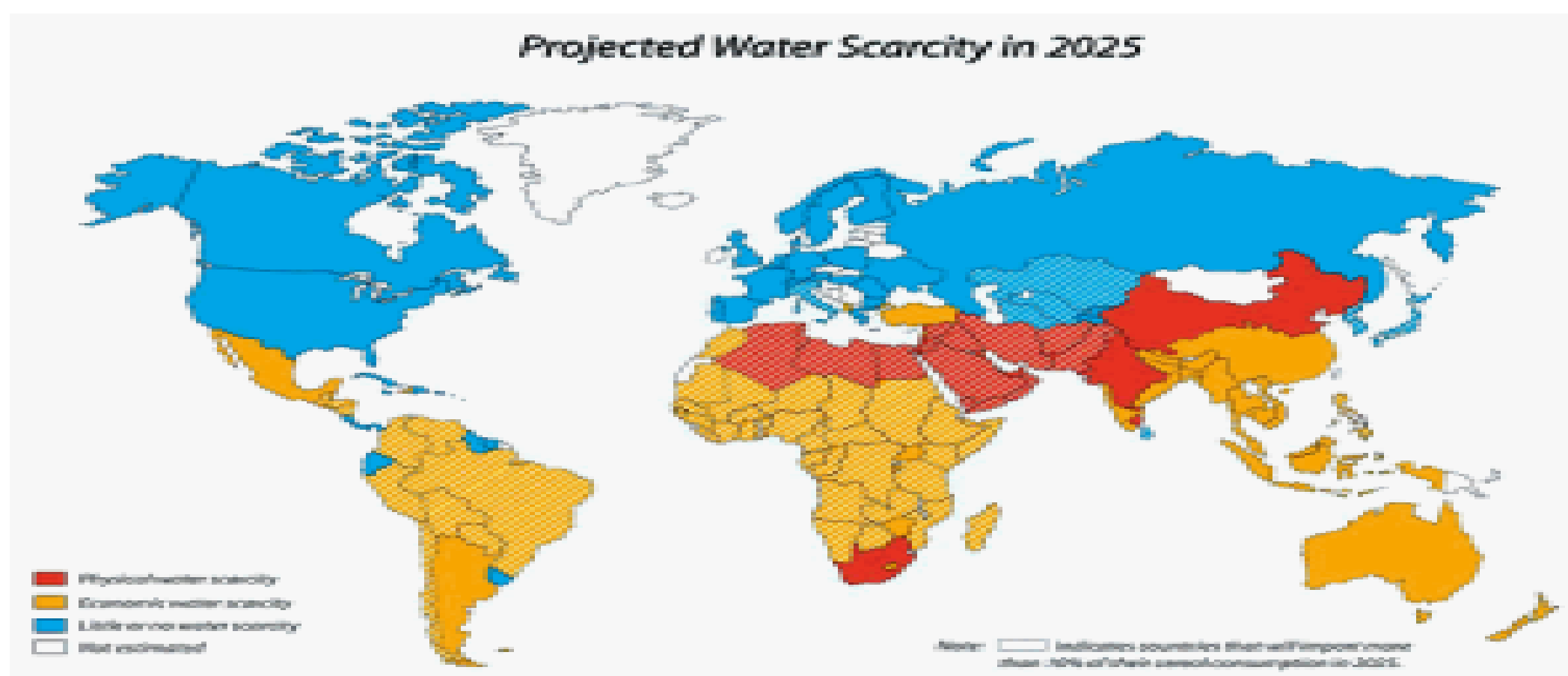
I. INTRODUCTION

- Water is an essential resource/commodity the world over
- It is a basic necessity of life, not only for people but for every type of plant and animal as well. Water accounts for about 65% of our body weight. If we lost as little as 12% of it, we would soon die.
- The world's supply of freshwater is limited – hence scarcity (Fig. 1&2)

- Water scarcity is the lack of sufficient available water resources to meet water needs within a region. It affects every continent and around 2.8 billion people around the world at least one month out of every year.
- More than 1.2 billion people lack access to clean drinking water – mostly in poor countries.
- Meanwhile wastewater is generated every day in homes, small businesses, etc, in these areas.
- In DEVELOPING COUNTRIES the waste water is discarded in open areas or drains around settlements/towns/cities.



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, *Water in Crisis: A Guide to the World's Fresh Water Resources*.



<http://www.fewresources.org/water-scarcity-issues-were-running-out-of-water.html>

There is therefore the need to develop low-tech systems to treat wastewater for re-use at the homestead level to combat water scarcity.

OBJECTIVE:

The aim of this project was to assess the QUANTITY and QUALITY of wastewater generated in restaurants in Makurdi (7.73375 [latitude in decimal degrees], 8.52139 [longitude in decimal degrees]; population >300,000) in Benue State, North Central Nigeria. The city has a large number of restaurants and open air taverns/bistros.

MATERIALS AND METHODS

Wastewater generated (from washing of hands, plates, pots and cutlery) in twenty-five (25) restaurants/taverns in Makurdi Metropolis, Benue State, North Central Nigeria, was collected daily, in a four-day week regime, for thirty-four weeks. The quality was determined using standard methods.

Wastewater was treated using conventional methods, from which a prototype treatment unit was constructed. Water from this treatment unit was subsequently analysed for its quality and the shelf-life also tested.

IV. RESULTS

- a. Quantity of wastewater generated (Table 1.)

Restaurant	Volume (L)	Volume (m³)	Volume (m³)	Volume (m³)
1	100	0.1	0.1	0.1
2	150	0.15	0.15	0.15
3	200	0.2	0.2	0.2
4	250	0.25	0.25	0.25
5	300	0.3	0.3	0.3
6	350	0.35	0.35	0.35
7	400	0.4	0.4	0.4
8	450	0.45	0.45	0.45
9	500	0.5	0.5	0.5
10	550	0.55	0.55	0.55
11	600	0.6	0.6	0.6
12	650	0.65	0.65	0.65
13	700	0.7	0.7	0.7
14	750	0.75	0.75	0.75
15	800	0.8	0.8	0.8
16	850	0.85	0.85	0.85
17	900	0.9	0.9	0.9
18	950	0.95	0.95	0.95
19	1000	1.0	1.0	1.0
20	1050	1.05	1.05	1.05
21	1100	1.1	1.1	1.1
22	1150	1.15	1.15	1.15
23	1200	1.2	1.2	1.2
24	1250	1.25	1.25	1.25
25	1300	1.3	1.3	1.3
Total	13000	13.0	13.0	13.0

- b. Physicochemical characteristics of the wastewater (Table 2)

Table 2: Physico-chemical quality of waste water generated in some restaurants in Makurdi Metropolis

	WATER 1		WATER 2		WATER 3		
	MEAN	STD	MEAN	STD	MEAN	STD	
Conductivity (µS/cm)	1000	100	1000	100	1000	100	1
Temperature (°C)	27.0	0.5	27.0	0.5	27.0	0.5	2
pH	7.0	0.2	7.0	0.2	7.0	0.2	3
Dissolved oxygen (mg/L)	8.0	0.5	8.0	0.5	8.0	0.5	4
Total dissolved solids (mg/L)	100	10	100	10	100	10	5
Total suspended solids (mg/L)	10	1	10	1	10	1	6
Total solids (mg/L)	110	11	110	11	110	11	7
Hardness (mg/L)	100	10	100	10	100	10	8
Calcium (mg/L)	50	5	50	5	50	5	9
Magnesium (mg/L)	50	5	50	5	50	5	10
Chloride (mg/L)	100	10	100	10	100	10	11
Sulfate (mg/L)	100	10	100	10	100	10	12
Nitrate (mg/L)	10	1	10	1	10	1	13
Ammonia (mg/L)	10	1	10	1	10	1	14
Biochemical oxygen demand (mg/L)	10	1	10	1	10	1	15
Chemical oxygen demand (mg/L)	10	1	10	1	10	1	16
Total coliform (per 100 ml)	100	10	100	10	100	10	17
Fecal coliform (per 100 ml)	10	1	10	1	10	1	18
Salmonella (per 100 ml)	10	1	10	1	10	1	19
Shigella (per 100 ml)	10	1	10	1	10	1	20
Staphylococcus aureus (per 100 ml)	10	1	10	1	10	1	21
Escherichia coli (per 100 ml)	10	1	10	1	10	1	22
Enterobacteriaceae (per 100 ml)	10	1	10	1	10	1	23
Streptococcus faecalis (per 100 ml)	10	1	10	1	10	1	24
Streptococcus lactis (per 100 ml)	10	1	10	1	10	1	25
Streptococcus thermophilus (per 100 ml)	10	1	10	1	10	1	26
Streptococcus salivarius (per 100 ml)	10	1	10	1	10	1	27
Streptococcus pyogenes (per 100 ml)	10	1	10	1	10	1	28
Streptococcus pneumoniae (per 100 ml)	10	1	10	1	10	1	29
Streptococcus agalactiae (per 100 ml)	10	1	10	1	10	1	30
Streptococcus dysgalactiae (per 100 ml)	10	1	10	1	10	1	31
Streptococcus mitis (per 100 ml)	10	1	10	1	10	1	32
Streptococcus oralis (per 100 ml)	10	1	10	1	10	1	33
Streptococcus sanguinis (per 100 ml)	10	1	10	1	10	1	34
Streptococcus salivarius (per 100 ml)	10	1	10	1	10	1	35
Streptococcus pyogenes (per 100 ml)	10	1	10	1	10	1	36
Streptococcus pneumoniae (per 100 ml)	10	1	10	1	10	1	37
Streptococcus agalactiae (per 100 ml)	10	1	10	1	10	1	38
Streptococcus dysgalactiae (per 100 ml)	10	1	10	1	10	1	39
Streptococcus mitis (per 100 ml)	10	1	10	1	10	1	40
Streptococcus oralis (per 100 ml)	10	1	10	1	10	1	41
Streptococcus sanguinis (per 100 ml)	10	1	10	1	10	1	42
Streptococcus salivarius (per 100 ml)	10	1	10	1	10	1	43
Streptococcus pyogenes (per 100 ml)	10	1	10	1	10	1	44
Streptococcus pneumoniae (per 100 ml)	10	1	10	1	10	1	45
Streptococcus agalactiae (per 100 ml)	10	1	10	1	10	1	46
Streptococcus dysgalactiae (per 100 ml)	10	1	10	1	10	1	47
Streptococcus mitis (per 100 ml)	10	1	10	1	10	1	48
Streptococcus oralis (per 100 ml)	10	1	10	1	10	1	49
Streptococcus sanguinis (per 100 ml)	10	1	10	1	10	1	50
Streptococcus salivarius (per 100 ml)	10	1	10	1	10	1	51
Streptococcus pyogenes (per 100 ml)	10	1	10	1	10	1	52
Streptococcus pneumoniae (per 100 ml)	10	1	10	1	10	1	53
Streptococcus agalactiae (per 100 ml)	10	1	10	1	10	1	54
Streptococcus dysgalactiae (per 100 ml)	10	1	10	1	10	1	55
Streptococcus mitis (per 100 ml)	10	1	10	1	10	1	56
Streptococcus oralis (per 100 ml)	10	1	10	1	10	1	57
Streptococcus sanguinis (per 100 ml)	10	1	10	1	10	1	58
Streptococcus salivarius (per 100 ml)	10	1	10	1	10	1	59
Streptococcus pyogenes (per 100 ml)	10	1	10	1	10	1	60
Streptococcus pneumoniae (per 100 ml)	10	1	10	1	10	1	61
Streptococcus agalactiae (per 100 ml)	10	1	10	1	10	1	62
Streptococcus dysgalactiae (per 100 ml)	10	1	10	1	10	1	63
Streptococcus mitis (per 100 ml)	10	1	10	1	10	1	64
Streptococcus oralis (per 100 ml)	10	1	10	1	10	1	65
Streptococcus sanguinis (per 100 ml)	10	1	10	1	10	1	66
Streptococcus salivarius (per 100 ml)	10	1	10	1	10	1	67
Streptococcus pyogenes (per 100 ml)	10	1	10	1	10	1	68
Streptococcus pneumoniae (per 100 ml)	10	1	10	1	10	1	69
Streptococcus agalactiae (per 100 ml)	10	1	10	1	10	1	70
Streptococcus dysgalactiae (per 100 ml)	10	1	10	1	10	1	71
Streptococcus mitis (per 100 ml)	10	1	10	1	10	1	72
Streptococcus oralis (per 100 ml)	10	1	10	1	10	1	73
Streptococcus sanguinis (per 100 ml)	10	1	10	1	10	1	74
Streptococcus salivarius (per 100 ml)	10	1	10	1	10	1	75
Streptococcus pyogenes (per 100 ml)	10	1	10	1	10	1	76
Streptococcus pneumoniae (per 100 ml)	10	1	10	1	10	1	77
Streptococcus agalactiae (per 100 ml)	10	1	10	1	10	1	78
Streptococcus dysgalactiae (per 100 ml)	10	1	10	1	10	1	79
Streptococcus mitis (per 100 ml)	10	1	10	1	10	1	80
Streptococcus oralis (per 100 ml)	10	1	10	1	10	1	81
Streptococcus sanguinis (per 100 ml)	10	1	10	1	10	1	82
Streptococcus salivarius (per 100 ml)	10	1	10	1	10	1	83
Streptococcus pyogenes (per 100 ml)	10	1	10	1	10	1	84
Streptococcus pneumoniae (per 100 ml)	10	1	10	1	10	1	85
Streptococcus agalactiae (per 100 ml)	10	1	10	1	10	1	86
Streptococcus dysgalactiae (per 100 ml)	10	1	10	1	10	1	87
Streptococcus mitis (per 100 ml)	10	1	10	1	10	1	88
Streptococcus oralis (per 100 ml)	10	1	10	1	10	1	89
Streptococcus sanguinis (per 100 ml)	10	1	10	1	10	1	90
Streptococcus salivarius (per 100 ml)	10	1	10	1	10	1	91
Streptococcus pyogenes (per 100 ml)	10	1	10	1	10	1	92
Streptococcus pneumoniae (per 100 ml)	10	1	10	1	10	1	93
Streptococcus agalactiae (per 100 ml)	10	1	10	1	10	1	94
Streptococcus dysgalactiae (per 100 ml)	10	1	10	1	10	1	95
Streptococcus mitis (per 100 ml)	10	1	10	1	10	1	96
Streptococcus oralis (per 100 ml)	10	1	10	1	10	1	97
Streptococcus sanguinis (per 100 ml)	10	1	10	1	10	1	98
Streptococcus salivarius (per 100 ml)	10	1	10	1	10	1	99
Streptococcus pyogenes (per 100 ml)	10	1	10	1	10	1	100