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(100) Lesaca,R.M.
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Urban and industrial growth in developing countries has increased the demand for water and the related need for more information on water and sewage treatment. This project, conducted by the University of Oklahoma, focuses on that need by developing a global network of adaptive and innovative technologies based on economic, social, political and cultural factors. A series of detailed reports have been produced that are designed to assist planners in their selection of suitable water and wastewater treatment processes appropriate to the material and manpower resource capabilities of particular countries at particular times.

"Prediction Methodology for Suitable Water and Wastewater Processes," George W. Reid and Richard Discenza.
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"Prediction Methodology for Suitable Water and Wastewater Processes. Supplement I: Manual Computation Methods," George W. Reid and Richard Discenza.
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"Prediction Methodology for Suitable Water and Wastewater Processes. Supplement II: Computer Program," George W. Reid and Richard Discenza.
PN-AAD-293

"Data Requirement," University of Oklahoma Bureau of Water and Environmental Resources Research.
PN-AAD-295

"A Mathematical Model for Predicting Water Demand, Wastewater Disposal and Cost of Water and Wastewater Treatment Systems in Developing Countries," George W. Reid and Michael I. Muiga.
PN-AAD-294

"Treatment Methods for Water Supplies in Rural Areas of Developing Countries," Ir. L. Huisman.
PN-AAD-284
PN-AAD-285

"Sewage Treatment in Developing Countries," L.W. Canter and J.F. Malina.
PN-AAD-286

"Contributions to a Mail Survey on Practical Solutions in Drinking Water Supply and Wastes Disposal for Developing Countries," International Reference Centre for Community Water Supplies, The Hague.
PN-AAD-287

"A Catalog of Water Supply and Waste Disposal Methods for Individual Units," George W. Reid.
PN-AAD-283

"Historic Implication for Developing Countries of Developed Countries' Water and Wastewater Technology," George W. Reid and Kay Coffey.
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"Evaluation of Lower Cost Methods of Water Treatment in Latin America," Odyer A. Sperandio and Jose Perez C.
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"Socio-Economic Conditions which Pertain to Cost of Construction and Operation of Water and Sewage Treatment Facilities and Quality of Water Consumption in Kenya," Erasto Muga.
PN-AAD-290

"A Water Sterilization Study in the Philippines," Reynaldo M. Lesaca.
PN-AAD-282

"The Study of Microbial Treatment of Nightsoil," Taiwan Institute of Environmental Sanitation.
PN-AAD-281

"Study of an Existing Water Treatment Plant on Simple Design and Operating System for Supplying Drinking Water to Rural Communities in the Lower Mekong Basin Countries," Thailand Ministry of Public Health, Department of Health, Rural Water Supply Division.
PN-AAD-280

A WATER STERILIZATION STUDY IN THE PHILIPPINES

Under Contract With
The University of Oklahoma Project
on
Lower Cost Methods of Water and Waste
Treatment in Developing Countries
(USAID Contract Number: AID/CM-ta-C-73-13)

F I N A L R E P O R T

Prepared by

Reynaldo M. Lesaca
Commissioner
National Pollution Control Commission
Corner Pedro Gil Street, Taft Avenue
Manila, Philippines

April 1976

A WATER STERILIZATION STUDY IN THE PHILIPPINES

DR. REYNALDO M. LESACA
Commissioner
National Pollution Control Commission

The Philippines is one of the many developing countries which at this stage presents a scene of rapid urbanization and industrial development. This is accompanied by a marked rise in population and rapid growth of towns and cities. As towns and cities expand there is a corresponding increase in demand for water for domestic and industrial use. These demands for increasing quantities of water mean that sources hitherto regarded as unsafe have to be improved and tapped to provide for the need of the populace.

The problems of water supply are greatest in rural areas, where the bulk of the population resides and will continue to live. It is also here where major public health problems occur. Health hazards arising from the contamination of drinking water with human wastes bring about the incidence in the area of enteric diseases which include typhoid fever, bacillary dysentery, diarrhea, infectious hepatitis and cholera. In some cases there eventually erupts epidemics.

Philippine Health Statistics[1] has reported the number of cases and deaths due to water-borne diseases in provinces, cities and towns, some of which are shown in Table I for the areas included in the study. The statistics however do not distinguish between outbreaks attributable to water supplies either public or private from those that are food-borne.

Urban communities are not exempt from problems arising from inadequate water supply. The presence of squatters in and around cities present environmental problems that are continually plaguing urban communities. Municipal water supply and waste disposal invariably are the major problems. The multiplicity of demands from inadequate water sources brings about the degradation of the quality of water. A treated water of sanitary quality becomes of doubtful quality due to unsanitary handling, transport and storage by the consumers.

Small communities lying outskirts of towns are not reached by piped water systems or even public artesian wells. Some are fortunate to have natural springs in the area and these can serve as their water supply source. It provides the community with water for their household use even without previous sanitary survey to determine its quality. More often than not, improvement or protection of the water source is completely neglected. This often becomes the source of associated health problems.

OBJECTIVES OF THE PROJECT

The main objective of this study is to determine the most effective and economical method of disinfecting untreated water in rural areas to make them safe for domestic use. It is envisioned that the method of treatment that will be recommended will be formulated in a form that can be instituted in the rural areas,utilizing materials available in every household and most important, instructions will be presented in most simple terms that even an unlettered individual can carry out and be assured of safe drinking water.

A number of disinfectants previously considered, such as HTH, iodine and potassium permanganate, were originally planned to be used but after considering the availability, local costs and application, it was decided to limit the disinfectants to only two: sodium hypochlorite and calcium hypochlorite solutions. The factors considered were its availability and economic cost. They can be obtained even in rural areas in the Philippines at very minimal cost.

The use of chlorine as disinfectant is universally accepted and the bactericidal properties of hypochlorite has been solidly established and no review is needed here.

AREAS OF STUDY

Based on the report of the Director General of WHO, to the Twenty Third World Health Assembly, some 28 percent of the population of developing countries can be described as urban; and the balance of 78 percent being rural. Less than 10 percent of rural inhabitants are supplied with safe water.[2]

On water supply in this country, available information revealed that there are some 25,500 artesian wells mostly located in the rural areas each supplying about 350 person per well. There are also as estimated 1000 big-cased deep wells which serves as sources for water-works systems. Natural springs total some 7,000 that had been developed as water supply sources.[3]

As part therefore of the objectives of the study, the targets considered for improvement of water supply by disinfection are the rural areas where water problems are more acute and urban communities where supplementary supply are provided by deep wells.

Works of other local researchers also revealed that more than half of the water sources utilized for domestic use showed the presence of coliform organism.[4,5,6]

The Areas Considered for the Study have been Classified as follows:

1. Small towns with no existing piped water system; where residents have to depend entirely on artesian wells, drilled wells or sanitary dug wells provided with pitcher pumps.

2. Areas that depend on natural springs as water source.

3. Areas served by waterworks (urban) with centralized water treatment, but due to inadequate supply, resort to deep wells as supplementary water source.

4. Housing subdivision with centralized (urban) water system but lacking treatment prior to distribution.

SAMPLING METHODS

Observing standard precautionary measures, water samples were collected from the designated areas for bacteriological examination in a 120 ml sterile bottle with bakelite cover, direct from the source. For chemical analysis and disinfecting procedures, water was collected in a previously cleaned 20 gallon plastic container. A 120 ml sample is taken from this container(secondary container)also for bacteriological examination.

DISINFECTION PROCEDURES

Two methods for determining chlorine demand were studied to select the simplest but effective method and of attaining the desired residual that will produce water safe for drinking and domestic use.

Method I - Chlorine Demand Laboratory Method[8]

This method uses a series of two (2) liters capacity glass jars into which were measured 500-ml portions of water samples. To these were added individually, serial concentrations of chlorine solutions with continuous mixing. The contact time periods considered were 15, 30 and 60 minutes after which chlorine residuals were determined. Samples for bacteriological examinations before and after chlorination were removed from the glass jars and placed in sterile containers with dechlorinating agents.

Method II - Short Method Disinfection[9]

To ten (10) or twenty (20) liters of the water in a glass aquarium is added a measured amount of chlorine solution (in ppm) to make a concentration of 0.1 ppm or more as the case may be. A thermometer is placed and the temperature is observed and recorded. The mixture is stirred continuously by a magnetic stirrer. At the end of 10 minutes time contact, the residual chlorine is measured by Orthotolidine and Orthotolidine-arsenite Methods. Additional chlorine solution is added if residual concentration is low. Repeated additions of chlorine solution and determination of residuals are done until a 0.5 - 1.00 ppm value is attained.

TECHNIQUE EVALUATION

The result of the method study is shown in Tables II, III and IV. Both methods showed initially decreasing concentrations of residual chlorine with increasing dosage due to the demand exerted by some organic matter and bacterial cells present in the water. Subsequent additions of increments of chlorine after the indicated time contact period, produced a corresponding rise in residual chlorine levels, demonstrated by both methods. It has been shown also that with increasing chlorine dose, coli-group bacteria are progressively reduced with a corresponding reduction in plate counts.

The coliform bacteria were not completely removed in Method I leaving an MPN of less than 3 coliforms per 100 ml using the multiple tube dilution technique of three 10-ml, three 1-ml and three 0.1-ml portions of the sample. The plate counts showed reduction in number but not to a significant degree. The method of choice that was adopted for the study was Method II due to the ease in performing the chlorination process and in controlling the temperature and determination of pH values. It also demonstrated a more effective sterilization of samples as shown by the subsequent bacteriological examinations of samples from dug wells and springs as shown on Tables V and VI.

DETERMINATION OF pH AND DEGREE OF DISINFECTION

Immediately after the designated contact period, the pH of water is determined. A 50 to 100 ml sample portion is taken by a measuring pipette and transferred to a sterile sample bottle containing a dechlorinating agent. It is examined bacteriologically to get an estimate of the number of surviving bacteria. The determinations are performed after every residual chlorine determination until the desired residual is reached.

BACTERIOLOGICAL PROCEDURES

The important aspect of the evaluation and control of pollution in water is the determination of the bacterial quality of the water. At the present time, the coliform organisms are used as the standard indicator of fecal contamination of water. They are found not only to be very ubiquitous in nature but they can even multiply in water under certain conditions. The presence of the coliform-organism group in water may not necessarily indicate fecal contamination but its absence is an excellent index of the safety of the water.

It was felt that the standard bacteriological tests for determining the presence of the coliform organisms and that of the fecal-coliform group will serve as the best index of the safety of water after treatment. Supplementary determination for the total bacterial count was

included in the battery of tests to determine the effectiveness of chlorination.

The multiple tube dilution technique was followed for the detection of the presence of the coliform group and the specific test for fecal-coliform group in this study.[8]

All samples were tested in serial dilutions in 5 tubes of 10 ml, 1.0-ml, 0.1-ml and 0.01-ml portions. Plate counts similarly were made from the above dilutions. The plates containing 30 to 300 colonies were considered in making the colony counts.

PHYSICAL AND CHEMICAL ANALYSIS

The water samples were also analyzed for physical properties and for its chemical constituents before and after disinfection procedures.

RESULTS OF THE STUDY

The first group of water sources studied were sanitary dug wells with pitcher pumps. The results of this first series of treatment are shown in Table V. The mean concentration of chlorine solution needed to disinfect the water samples was 1.27 and 1.28 ppm leaving a mean residual of 0.54 - 0.53 ppm for NaOCl and $CaOCl_2$ respectively, except for sample numbers 2,6 and 7 which required a significantly higher dose to eliminate bacterial content. The mean chlorine demand was 0.73 to 0.75 ppm.

Bacteriological quality of the water sampled directly from the pitcher pump showed absence of fecal-coli types and presence of coli group with a MPN ranging from 0 - 2400 per 100ml.

The bacteriological quality of the water when collected in secondary containers showed that the number of coliforms had increased, ranging from 14 to 2400 bacteria per 100 ml. This finding disclosed that significant bacterial contamination is acquired when water is stored in secondary containers.

The figures in the table also show the effectiveness of treatment by both chlorinating agents, where coliform organisms eliminated in 10 samples for NaOCl and in 9 samples for $CaOCl_2$. The standard plate counts showed that majority of the samples had high bacterial content for both original sample and the water taken from secondary containers. After treatment bacterial content was not considerably removed or some bacterial strains were resistant to chlorine. These bacteria however, may be assumed to be of no sanitary significance.

The second series of twelve (12) samples were from natural springs. The mean concentrations of chlorine required for disinfection were 1.75 ppm

and 1.82 ppm leaving a residual of 0.84 ppm and 0.8 ppm respectively as shown in Table VI. In this set of samples, determinations for both free available and combined available chlorine were made in the seven (7) samples tested. The chlorine demand as shown was approximately 1.0 ppm for both agents.

From the results of the bacteriological examination of spring waters, it appears that water from natural springs that are unprotected are definitely of poorer bacteriological quality than those from pitcher pumps. Water taken from the source and from secondary containers were found grossly contaminated with coliform group, and occasionally with the fecal-coliform group.

The bacterial quality improved after treatment. Some of the samples however were not completely decontaminated as samples number 1, 2, 3 and 6 were still positive for coliform with MPN ranging from 2 to 33 per 100 ml. It may be inferred that a stronger dose of chlorine and longer time-contact period may be necessary for complete removal of the coliform group.

The plate counts obtained similarly are high indicating its poor quality. It was considerably reduced in number after treatment. Sample number three (3) still showed significantly high bacterial count and the majority of samples were not rendered sterile as they still demonstrated presence of bacteria that may include other species.

The third series of samples are from deep wells which serves to supplement the inadequate supply coming from piped water systems. These were taken from suburban communities of Greater Manila Area.

For the eleven (11) samples treated, the mean chlorine concentration found sufficient to remove coliform bacteria ranges from 1.35 to 1.37 ppm, and leaving a residual of 0.68 to 0.65 ppm. The combined available chlorine was very low and the greater portion of residual was made up of the free available chlorine. The chlorine demand exerted was 0.68 to 0.70 ppm which was the lowest required among the three sets of samples.

The sanitary quality of water from deep wells were definitely better than those coming from dug wells with pitcher pumps and springs. The mean MPN for the coliform group was six (6) per 100 ml for the sample obtained direct from the source and 608 per 100-ml. for secondary containers. This is shown in Table VII.

As demonstrated in previous samples, the plate count was high in majority of the samples. Removal by chlorination was complete in some samples. There was significant reduction in number in the rest of the samples although some chlorine resistant bacteria remained.

CHEMICAL TESTS

The chemical properties analyzed for all samples are pH, total residue, alkalinity, chlorides, hardness, nitrate and sulfate. The results are shown in tables VIII, IX and X. In all samples in the three groups of sources, chlorination produced a very insignificant rise in pH, decrease in total residue, sulfates and nitrates and very slight increase in chlorides and hardness. The changes in these constituents are all very negligible to alter the potable quality of the water.

DISCUSSION

The vital importance of good water for human consumption, agriculture and industry is well reorganized. Any city, town and community, large or small has a fundamental need for water not only adequate and available but of a quality that is biologically safe and palatable water of good mineral quality.

Where cities are provided with treated water, ground water sources serves as a supplementary source. Where towns or rural communities are not provided by a public water system, ground water serves as the regular source and are in most cases used without previous treatment of any sort. Ground waters have been shown to be free from bacteria as they have been removed by natural purification process through soil filtration. Several studies[10,11,12] however have shown that ground water sources have become contaminated and have demonstrated the presence of coliform bacteria. Untreated ground water have also been found most frequently to be the cause of water-borne disease outbreaks in the United States. Contamination of ground waters have been attributed to various sources, leaks into well-casing or into suction pipes, seepage from septic tanks interspersed with water wells, waste disposal sites where waste leached towards ground water discharge of water wells.

The bactericidal effectiveness of many compounds used to improve the sanitary quality of water are well known and proven in water treatment. Among them are chlorine, chlorine dioxide, potassium permanganate, ozone, iodine, etc. They not only solve problems of bacterial contamination but has proven to have beneficial eff ts in solving problems in color, odor and taste. The use of chlorine nevertheless has come to be universally accepted and used by a large number of water utilities to render water safe and prevent occurrence of water-borne diseases. The use of chlorine as disinfectant has the added advantage of being able to impart excess active chlorine as residual to the water which would mean that any additional incidental post-treatment pollution to the water would be negated by the residual chlorine.

Studies have shown that factors as pH, temperature and time-contact influences the disinfecting action of chlorine. In this study, the chlorination process was carried out at room temperature at the natural

pH of the water and a time contact of 10 minutes for every incremental addition which totals generally to a contact time of up to 60 minutes depending on the bacterial quality of the water under treatment. The temperature observed ranges from 25.5°C - 29°C due to variations in day to day temperature which was observed not to cause any effect on the disinfection process. Evident from the observations from all the determinations, as shown in the tables, the pH values increased in units ranging from 0.3 to 0.7. Natural pH was from pH 7.2 and occasional pH 9.1. Hayes et al,[13] in their studies on the effect of disinfection, on stability and bactericidal activity of chlorine found, that there was little loss of available chlorine in 24 hours at pH values ranging from 4.9 to 9. Based on these findings the chlorine residual of 0.5 ppm obtained as the desired concentration in the treated water, the safety of the water can be assured for 24 hours which ordinarily is the maximum holding time of stored water in the household.

The presence of free chlorine in the water in forms of free available and combined available also would indicate that bacteria causing water-borne disease had been killed and would take care of any post-purification contamination for further safety. Similar observations were made by Nesfield[14] in his experiment on the sterilization of drinking water by chlorine.

As indicated in Table V the sanitary dug wells with pitcher pumps are used as water source by communities not reached by piped water systems. Majority of them are in the rural areas where daily water supply are stored in secondary containers as clay jugs, galvanized from tanks or plastic containers that are sufficient for a day's use. The quality of water obtained from the pumps were positive for coliform 90 percent of the time which further suffers in quality when improperly stored. Contamination with bacteria of coliform or non-coli species increased as has been demonstrated by bacteriological analysis. It is in this light that disinfection of the water by consumers becomes a necessity for health protection purposes.

The chlorination of the water from these sources demonstrated a significant decrease in number of bacteria and the sanitary quality of the water has been greatly improved. More important would be the elimination of coliform organisms in the samples.

Bacteriological findings of the samples obtained from natural springs, utilized as water sources for domestic use disclosed relatively high coliform density in water from both the original source and secondary containers. These springs are not protected from the elements and outside sources of contaminations. As demonstrated in the first series of samples secondary containers contribute further to degradation of the water quality.

Despite addition of a higher concentration of chlorine dosage, disinfection process resulted only in 75 percent removal of coliform organisms. Considerable reduction in bacterial count was effected but some samples still retained some chlorine resistant bacteria.

The fecal-coli group was found in some samples which points to a greatest hazard tc health of consumers generally indifferent or unaware of serious consequences that results from contamination of water with enteric organisms.

These findings indicate that springs are poor sources of drinking water and it is indicated that protection from contamination is essential before they should be made available to the public. While these measures are not available, chlorination by the consumers seem to be the only logical solution to make the water from these sources available and safe for public consumption.

The water obtained from deep wells from the third area of study study showed a similar bacteriological quality as those from dug wells where 72 percent of the samples from the source contain coliform organism and were 100 percent positive for samples taken from the secondary containers. It is significant to note that all samples were negative for fecal-coliform. Complete removal of bacteria was demonstrated in 50 percent of the samples and the rest still showed miminal bacterial count.

It appears that deep wells produce water, of a quality better than dug wells and definitely superior to water from springs.

SUMMARY AND CONCLUSION

The mean concentration of chlorine added to the water adequate for effective disinfection, ranges from 1.18 to 1.75 ppm for sodium hypochlorite and 1.28 to 1.82 ppm for calcium hypochlorite as shown in Table XI. The concentration of chlorine required to purify the samples from the different sources were subsequently analyzed for significant differences. Using the t tests, the results failed to show any significant differences in chlorine doses, existing either between the different group of water samples or between the types of chlorinating agents. Thus both solutions are equally effective.

For effective disinfection of water used in communities small or large, urban or rural, a method of improving the sanitary quality of water from human consumption can be easily accomplished by chlorination process. Sodium hypochlorite and calcium hypochlorite solutions were found excellent as sterilizing agents for drinking water by the procedure used in the study.

Table I

CASES AND DEATH OF ENTERIC WATER-BORNE DISEASES IN SOME CITIES AND TOWNS IN THE PHILIPPINES*

A R E A	CHOLERA - EL TOR				TYPHOID-PARA TYPHOID FEVER AND OTHER SAL. INFECTIONS			
	Cases		Death		Cases		Death	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate
URBAN								
Caloocan City	167	51.3	-	-	270	0.8	6	1.8
Manila	604	42.1	77	5.4	908	43.9	77	5.4
Pasay City	83	35.9	4	1.7	78	63.3	2	0.9
Quezon City	128	14.3	13	1.5	303	6.9	8	0.9
RURAL								
Bulacan	122	12.8	9	0.9	96	10.1	7	0.7
Cavite	37	7.8	18	3.8	58	12.2	3	0.6
Rizal	468	23.7	12	0.6	401	20.3	8	0.4

*Data from Philippine Health Statistics, 1973

Table II

RESIDUAL CHLORINE LEVELS OBTAINED AFTER CHLORINATION AT DIFFERENT DOSES
(Method I)

TIME	15 Minutes				30 Minutes				60 Minutes				AVERAGE			
RIALS	1	2	3	4	1	2	3	4	1	2	3	4	15	30	60	
HLORINE DSE																
0.5	0.20	0.07	0.20	0.20	0.18	0.06	0.25	0.20	0.12	0.05	0.25	0.15	0.16	0.17	0.14	0.15
0.75	0.35	0.10	0.40	0.30	0.25	0.10	0.40	0.30	0.18	0.07	0.35	0.30	0.28	0.26	0.30	0.28
1.0	0.42	0.12	0.45	0.45	0.32	0.12	0.45	0.40	0.30	0.10	0.40	0.40	0.36	0.32	0.30	0.33
5.0	3.54	2.12	3.54	3.18	3.19	1.77	3.54	3.54	2.83	1.06	3.54	3.54	3.09	2.98	2.74	2.93
10.0	8.14	7.08	9.55	7.79	7.08	6.73	8.40	7.79	6.73	6.40	8.14	7.08	8.14	7.50	7.08	7.57
15.0	12.40	9.91	12.74	12.03	10.97	9.20	12.03	12.03	10.62	8.50	11.68	11.68	11.77	11.05	10.62	11.14
20.0	14.87	15.20	17.37	15.90	14.51	14.87	16.63	15.90	14.16	14.20	16.63	15.58	15.83	15.47	15.14	15.48

Table III

RESULTS OF BACTERIOLOGICAL EXAMINATIONS OF GROUND WATERS
BEFORE AND AFTER CHLORINATION USING HYPOCHLORITE SOLUTIONS
(Method I)

TYPE OF WELL	SAMPLING POINT	COLIFORM GROUP - MPN	STANDARD PLATE COUNT AT 35°C
DUG WELL	At Source	23	10
	Secondary Container	2400	95000
DEEP WELL	At Source	2400	43000
	Secondary Container	2400	620000

CHLORINE DOSAGE	RESIDUAL CHLORINE				COLIFORM GROUP - MPN				STANDARD PLATE COUNT AT 35°C			
	Deep Well		Dug Well		Deep Well		Dug Well		Deep Well		Dug Well	
	NaOCl	$CaOCl_2$	NaOCl	CaO Cl_2	After NaOCl Add'n	After $CaOCl_2$ Add'n	After NaOCl Add'n	After $CaOCl_2$ Add'n	After NaOCl Add'n	After $CaOCl_2$ Add'n	After NaOCl Add'n	After $CaOCl_2$ Add'n
.5	.25	.15	.15	.05	2400	<3	<3	1100	150000	3100	280	16000
.75	.35	.18	.3	.07	<3	4	<3	460	530	43000	10	29000
1	.4	.3	.4	.1	<3	<3	<3	460	30	25000	0	5400
5	3.54	2.83	3.54	1.06		<3		4				
10	8.14	6.73	7.08	6.4		<3		<3				
15	11.68	10.62	11.68	8.5		<3		<3				
20	16.63	14.16	15.58	14.20		<3		<3				

Table IV

RESIDUAL CHLORINE LEVELS AFTER CHLORINE TREATMENT WITH DIFFERENT DOSES AFTER 10 MINUTES CONTACT PERIOD
(Method II)

CHLORINE DOSE	CONTACT TIME	RESIDUAL CHLORINE				
2 ppm	10 minutes	.07 ppm	.07 ppm	.07 ppm	.1 ppm	.05 ppm
2.5	"				.15	.05
3	"	.15	.15	.15	.12	.07
3.5	"				.2	.08
4	"	.2	.2	.2	.25	.1
4.5	"				.3	.15
5	"	.25	.25	.25	.35	.2

Table V

RESULTS OF BACTERIOLOGICAL EXAMINATIONS OF TREATED WATER
FROM SANITARY DUG WELLS BY HYPOCHLORITE SOLUTIONS OF SODIUM AND CALCIUM

SAMPLE IDENTIFICATION	NaOCl		$CaOCl_2$		COLIFORM GROUP - MPN			
	CHLORINE DOSE	RESIDUAL CHLORINE	CHLORINE DOSE	RESIDUAL CHLORINE	AT SOURCE	SECONDARY CONTAINER	After NaOCl Add'n	After $CaOCl_2$ Add'n
PITCHER PUMPS								
1. Tandang Sora Elementary School	.7ppm	.65ppm	.8ppm	.75ppm	350	2400	0	0
2. Rodriguez Subdivision	4.3	.6	5	.45	2400	2400	0	2400
3. Sapang Palay Elementary School	.6	.55	.7	.65	46	540	0	0
4. Bo. Balacan, Meycauayan, Bulacan	.9	.5	.9	.5	11	2400	2	0
5. Bo. Libtong, Meycauayan, Bulacan	.6	.55	.7	.4	8	2400	0	0
6. Bo. Talaba, Bacoor, Cavite	1.6	.5	1.6	.55	0	23	0	2
7. Las, Piñas, Rizal	1.7	.5	1.6	.6	17	130	0	0
8. San Rafael, Montalban, Rizal	.6	.6	.7	.55	23	33	0	0
9. Busgos, Montalban, Rizal	.6	.5	.6	.45	13	33	0	0
10. Marilag, San Vicente, U.P. Village Quezon City	.8	.5	.9	.55	0	70	0	0
11. Fatima, San Vicente, U.P. Village Quezon City	.6	.45	.6	.35	0	14	0	0
T O T A L	14	5.90	14.1	5.8	2868	10443	2	2402
M E A N	1.27	.54	1.28	.53	261	9495	.18	218
R A N G E	0.6-4.3	0.45-65	0.6-5	0.35-.75	0-2400	14-2400	0-2	2-2400

Table V (Continuation)

SAMPLE IDENTIFICATION	FECAL COLIFORM - MPN				STANDARD PLATE COUNT AT 35°C			
	AT SOURCE	AT SECONDARY CONTAINER	After NaOCl Add'n	After $CaOCl_2$ Add'n	AT SOURCE	AT SECONDARY CONTAINER	After NaOCl Add'n	After $CaOCl_2$ Add'n
1. Tandang Sora Elementary School	0	0	0	0	7900	8400	0	540
2. Rodriguez Subdivision	0	0	0	0	23	3300	220	0
3. Sapang Palay Elementary School	0	0	0	0	39000	40000	700	0
4. Bo. Balacan, Meycauayan, Bulacan	0	0	0	0	2400	1100	22	0
5. Bo. Libtong, Meycauayan, Bulacan	0	0	0	0	450	690	2900	570
6. Bo. Talaba, Bacoor, Cavite	0	0	0	0	3800	4500	0	2
7. Las Piñas, Rizal	0	0	0	0	8500	2800	990	250
8. San Rafael, Montalban, Rizal	0	0	0	0	4700	5800	1	7
9. Burgos, Montalban, Rizal	0	0	0	0	260	100	0	5
10. Marilag, San Vicente, U.P. Village Quezon City	0	0	0	0	10	37	0	0
11. Fatima, San Vicente, U.P. Village Quezon City	0	0	0	0	5	37	0	0
T O T A L	0	0	0	0	67000	67000	4800	1400
M E A N	0	0	0	0	6100	6100	440	130
R A N G E	0	0	0	0	5-39000	37-40000	0-2900	0-570

Table VI

RESULTS OF BACTERIOLOGICAL EXAMINATIONS OF TREATED WATER FROM SPRINGS BY HYPOCHLORITE SOLUTION OF SODIUM AND CALCIUM

SAMPLE IDENTIFICATION	NaOCl					$CaOCl_2$				
	CHLORINE DOSE	TOTAL RESIDUAL CHLORINE	FREE AVAILABLE CHLORINE	COMBINED AVAILABLE CHLORINE	CHLORINE DEMAND	CHLORINE DOSE	TOTAL RESIDUAL CHLORINE	FREE AVAILABLE CHLORINE	COMBINED AVAILABLE CHLORINE	CHLORINE DEMAND
1. Bo. Bocal, Cardona, Rizal	1.0	.45	-	-	.55	1.4	.6	-	-	.8
2. Bo. Tabang, Cardona Rizal	3.5	.5	-	-	3	4.2	.5	-	-	3.7
3. Bo. San Isidro, Montalban, Rizal	1.0	.45	-	-	.55	1.2	.65	-	-	.55
4. San Roque, Montalban, Rizal	1.8	1.0	-	-	.8	2.2	.8	-	-	1.4
5. San Rafael, Montalban, Rizal	1.6	.95	-	-	.65	1.0	.65	-	-	.35
6. Muntinlupa, Rizal	2.0	1.0	.9	.1	1.0	2.0	.95	.85	.1	1.05
7. San Jose, Dasmariñas Cavite	1.4	1.0	1.0	0	.4	1.4	1.0	1.0	0	.4
8. Bo. Langkaan, Dasmariñas, Cavite	1.2	1.0	1.0	0	.2	1.2	1.0	1.0	.0	.25
9. Silang, Cavite	1.7	0.8	.75	.05	.9	1.4	.85	.8	.05	.55
10. Silang, Cavite	1.8	.95	.85	0	.85	1.8	.95	.95	0	.85
11. Bo. Amon, Silang, Cavite	1.8	1.0	.95	.05	.8	2.0	1.0	1.0	0	1.0
12. Bo. Gonzales, Silang Cavite	2.2	1.0	.95	.05	1.2	2.0	.75	.7	.05	1.25
T O T A L	21	10.1	6.5	.25	10.9	21.8	9.7	6.3	.2	12.1
M E A N	1.75	.84	.928	.036	.908	1.82	.8	.9	.028	1.0
R A N G E	1.0	.45	.75	0	.2	1.0	.5	.7	0	2
	3.5	1.0	1.0	.1	3.0	4.2	1.0	1.0	.1	3.7

Table VI (Continuation)

SAMPLE IDENTIFICATION	COLIFORM GROUP - MPN				FECAL-COLIFORM - MPN				STANDARD PLATE COUNT AT 35°			
	SOURCE	CONTAINER	After NaOCl Add'n	After $CaOCl_2$ Add'n	SOURCE	CONTAINER	After NaOCl Add'n	After $CaOCl_2$ Add'n	SOURCE	CONTAINER	After NaOCl Add'n	After $CaOCl_2$ Add'n
1. Bo. Bocal, Cardona, Rizal	2400	2400	33	9	0	0	0	0	1900	3800	54	57
2. Bo. Tabang, Cardona, Rizal	2400	2400	0	4	0	0	0	0	9300	10000	38	18
3. Bo. San Isidro, Montalban, Rizal	920	920	2	0	1	1	0	0	40000	14000	6500	1300
4. San Roque, Montalban, Rizal	2400	2400	0	0	0	0	-	-	8200	1200	9	13
5. San Rafael, Montalban, Rizal	240	2400	0	0	0	0	0	0	770	800	34	50
6. Muntinlupa, Rizal	2400	2400	8	5	0	0	0	0	2100	3000	0	0
7. San Jose, Dasmariñas, Cavite	2400	2400	0	0	4	4	0	0	30000	88000	2	0
8. Bo. Langkaan, Dasmariñas, Cavite	33	240	0	0	0	0	0	0	3500	20000	0	2
9. Silang, Cavite	920	920	0	0	0	0	0	0	4400	19000	1	2
10. Silang, Cavite	2400	2400	0	0	0	0	0	0	3300	6800	47	39
11. Bo. Amon, Silang, Cavite	2400	2400	0	0	2	2	0	0	6700	15000	0	2
12. Bo. Gonzales, Silang, Cavite	2400	2400	0	0	0	0	0	0	2500	4300	0	3
T O T A L	21313	23680	43	18	7	7	0	0	110000	190000	6700	1500
M E A N	1776	1973	4	2	.58	.58	0	0	9100	1600	560	120
R A N G E	33 2400	240 2400	0 33	0 9	0 4	0 4	0 0	0 0	770 40000	800 88000	0 6500	0 1300

Table VII

RESULTS OF BACTERIOLOGICAL EXAMINATIONS OF TREATED WATER FROM DEEP WELL BY HYPOCHLORITE SOLUTIONS OF SODIUM AND CALCIUM

SAMPLE IDENTIFICATION	NaOCl					$CaOCl_2$				
	CHLORINE DOSE	TOTAL RESIDUAL CHLORINE	FREE AVAILABLE CHLORINE	COMBINED AVAILABLE CHLORINE	CHLORINE DEMAND	CHLORINE DOSE	TOTAL RESIDUAL CHLORINE	FREE AVAILABLE CHLORINE	COMBINED AVAILABLE CHLORINE	CHLORINE DEMAND
1. Caloocan City	1.7	1.0	.95	.05	.7	1.7	.95	.9	.05	.75
2. Caloocan City	1.4	1.0	.9	.1	.4	1.6	.95	.9	.05	.65
3. Caloocan City	1.2	.7	.65	.05	.5	1.2	.7	.65	.05	.5
4. Caloocan City	1.2	.65	.6	.05	.55	1.2	.6	.55	.05	.6
5. Herran, Manila	1.8	.6	.6	0	1.2	1.4	.55	.5	.05	.85
6. Harrison, Manila	1.0	.58	.53	.05	.42	1.2	.7	.65	.05	.5
7. Valenzuela, Bulacan	1.0	.6	.55	.05	.4	1.0	.58	.53	.05	.42
8. Cescraft Marina, Parañaque, Rizal	1.6	.4	.35	.05	1.2	1.8	.4	.35	.05	1.4
9. Manpower, Parañaque, Rizal	1.2	.75	.7	.05	.45	1.2	.65	.6	.05	.55
10. San Dionision, Parañaque, Rizal	1.6	.63	.6	.03	.97	1.4	.4	.38	.02	1.0
11. San Isidro, Las Piñas, Rizal	1.2	.55	.55	0	.65	1.0	.5	.5	0	.5
T O T A L	14.9	7.46	6.98	.48	7.44	15.1	7.18	6.71	.47	7.72
M E A N	1.35	.68	.63	.043	.68	1.37	.65	.61	.042	.701
R A N G E	1.0 1.8	.4 1.0	.35 .95	0 0.1	.4 1.2	1.0 1.8	.4 .95	.35 .9	0 .05	.42 1.4

Table VII (Continuation)

SAMPLE IDENTIFICATION	MPN - COLIFORM GROUP				MPN FECAL-COLIFORM				STANDARD PLATE COUNT AT 35°			
	SOURCE	CONTAINER	After NaOCl Add'n	After $CaOCl_2$ Add'n	SOURCE	CONTAINER	After NaOCl Add'n	After $CaOCl_2$ Add'n	SOURCE	CONTAINER	After NaOCl Add'n	After $CaOCl_2$ Add'n
1. Caloocan City	2	1600	0	0	0	0	0	0	0	900	0	6
2. Caloocan City	2	49	0	0	0	0	0	0	0	7500	1	0
3. Caloocan City	5	17	0	0	0	0	0	0	210	230	0	0
4. Caloocan City	0	46	0	0	0	0	0	0	240	1000	0	0
5. Herran, Manila	0	7	0	0	0	0	0	0	0	210	5	0
6. Harrison, Manila	11	2400	0	0	0	0	0	0	24	1300	30	0
7. Valenzuela, Bulacan	33	130	0	0	0	0	0	0	6400	17000	1	8
8. Cescraft Marina, Parañaque, Rizal	0	9	0	0	0	0	0	0	2100	5300	0	6
9. Manpower, Parañaque, Rizal	7	22	0	0	0	0	0	0	580	3000	5	0
10. San Dionisio, Parañaque Rizal	4	8	0	0	0	0	0	0	140	4600	80	1100
11. San Isidro, Las Piñas, Rizal	2	2400	0	0	0	0	0	0	210	170	0	66
T O T A L	66	6688	0	0	0	0	0	0	9900	41200	120	1200
M E A N	6	608	0	0	0	0	0	0	900	3700	11	110
R A N G E	0 33	7 2400	0	0	0	0	0	0	0 6400	170 17000	0 80	0 1100

Table VIII

PHYSICAL AND CHEMICAL ANALYSIS OF WATER FROM SANITARY DUG WELLS BEFORE AND AFTER CHLORINATION

SAMPLE IDENTIFICATION	NaOCl		$CaOCl_2$		pH			Total Residue		
	CHLORINE DOSE	RESIDUAL CHLORINE	CHLORINE DOSE	RESIDUAL CHLORINE	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$
PITCHER PUMPS										
1. Tandang Sora Elementary School	.7	.65	.8	.75	8.1	8.3	8.4	286	275	269
2. Rodriguez Subdivision	4.3	.6	5.0	.45	8.55	8.9	9.0	1198	1160	1156
3. Sapang Palay Elementary School	.6	.55	.7	.65	8.3	8.7	8.6	249	226	25
4. Bo. Balacan, Meycauayan, Bulacan	.9	.5	.9	.5	8.8	9.0	9.1	302	287	26
5. Bo. Libtong, Meycauayan, Bulacan	.6	.55	.7	.4	8.5	9.0	8.9	342	337	33
6. Bo. Talaba, Bacoor, Cavite	1.6	.5	1.6	.55	8.25	9.15	8.7	3599	3578	358
7. Las Piñas, Rizal	1.7	.5	1.6	.6	8.25	8.7	8.25	852	803	81
8. San Rafael, Montalban, Rizal	.6	.6	.7	.55	8.15	8.6	8.5	242	218	22
9. Burgos, Montalban, Rizal	.6	.5	.6	.45	7.8	8.2	8.2	219	207	19
10. Marilag, San Vicente, U.P. Village, Quezon City	.8	.5	.9	.55	7.55	8.2	8.35	498	520	52
11. Fatima, San Vicente, U.P. Village Quezon City	.6	.45	.6	.35	7.8	9.1	8.25	288	273	27
T O T A L	14	5.90	14.1	5.8	90.05	95.85	94.25	8075	7884	789
M E A N	1.27	.54	1.28	.53	8.2	8.71	8.57	734	717	7
R A N G E	0.6 4.3	0.45 .65	0.6 5	0.35 .75	7.55 8.8	8.2 9.15	8.2 9.1	219 3599	207 3578	19 35

Table VIII (Continuation)

SAMPLE IDENTIFICATION	ALKALINITY			CHLORIDES			HARDNESS			NITRATE		
	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$
1. Tandang Sora Elementary School	196	196	196	8.5	9.5	9	78	80	82	2.48	2.48	2.16
2. Rodriguez Subdivision	392	390	400	309	310	310	185	194	210	8.86	8.68	6.91
3. Sapang Palay Elementary School	202	202	204	7.5	7.5	8.5	44	44	44	3.65	3.2	3.26
4. Bo. Balacan, Meycauayan, Bulacan	203	205	204	9	10	11.5	44	44	45	2.97	1.55	2.75
5. Bo. Libtong, Meycauayan, Bulacan	242	244	244	17	19	18	98	98	98	8.15	7.04	6.38
6. Bo. Talaba, Bacoor, Cavite	390	390	390	1415	1560	1565	612	616	616	1.5	1.24	1.15
7. Las Piñas, Rizal	312	314	312	170	171	172	202	204	204	47	43.76	42.26
8. San Rafael, Montalban Rizal	112	112	112	8	9	8.5	70	70	72	11.83	11.5	9.48
9. Burgos, Montalban, Rizal	96	96	96	9	9.5	10	59	60	60	8.9	8.55	7.98
0. Marilag, San Vicente U.P. Village, Q.C.	240	240	240	64.5	66.5	67	224	224	226	40.67	40.67	34.11
1. Fatima, San Vicente U.P. Village, Q.C.	169	173	172	9	10	10.5	75	76	77	1.28	1.24	.88
T O T A L	2554	2562	2570	20265	2182	2190	1691	1710	1734	136	12859	116.44
M E A N	232	233	234	184	198	199	154	155	158	12.3	11.69	10.59
R A N G E	96 392	96 390	96 400	7.5 1415	7.5 1560	8.5 1565	44 612	44 616	44 616	1.28 47	1.24 43.76	0.88 42.26

Table IX

PHYSICAL AND CHEMICAL ANALYSIS OF SPRING WATERS BEFORE AND AFTER CHLORINATION

SAMPLE IDENTIFICATION	NaOCl					$CaOCl_2$				
	CHLORINE DOSE	TOTAL RESIDUAL CHLORINE	FREE AVAILABLE CHLORINE	COMBINED AVAILABLE CHLORINE	CHLORINE DEMAND	CHLORINE DOSE	TOTAL RESIDUAL CHLORINE	FREE AVAILABLE CHLORINE	COMBINED AVAILABLE CHLORINE	CHLORINE DEMAND
1. Bo. Bocal, Cardona, Rizal	1.0	.45			.55	1.4	.6			.8
2. Bo. Tabang, Cardona, Rizal	3.5	.5			3	4.2	.5			3.7
3. Bo. San Isidro, Montalban, Rizal	1.0	.45			.55	1.2	.65			.55
4. San Roque, Montalban, Rizal	1.8	1.0			.8	2.2	.8			1.4
5. San Rafael, Montalban, Rizal	1.6	.95			.65	1.0	.65			.35
6. Muntinlupa, Rizal	2.0	1.0	.9	.1	1.0	2.0	.95	.85	.1	1.05
7. San Jose, Dasmariñas, Cavite	1.4	1.0	1.0	0	.4	1.4	1.0	1.0	0	.4
8. Bo. Langkaan, Dasmariñas, Cavite	1.2	1.0	1.0	0	.2	1.2	1.0	1.0	0	.2
9. Silang, Cavite	1.7	0.8	.75	.05	.9	1.4	.85	.8	.85	.55
10. Silang, Cavite	1.8	.95	.85	0	.85	1.8	.95	.95	0	.85
11. Bo. Amon, Silang, Cavite	1.8	1.0	.95	.05	.8	2.0	1.0	1.0	0	1.0
12. Bo. Gonzales, Silang, Cavite	2.2	1.0	.95	.05	1.2	2.0	.75	.7	.05	1.25
T O T A L	21	10.1	6.5	.25	10.9	21.8	9.7	6.3	.2	12.1
M E A N	1.75	.84	.928	.036	0.908	1.82	.8	.9	.028	1.0
R A N G E	1.0 3.5	.45 1.0	.75 1.0	0 .1	.2 3.0	1.0 4.2	.5 1.0	.7 1.0	0 .1	.2 3.70

Table IX (Continuation)

SAMPLE IDENTIFICATION	pH			Total Residue			Alkalinity			Chlorides		
	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$
1. Bo. Bocal, Cardona, Rizal	8.1	8.95	9.0	297	292	307	140	140	138	8	9	9.5
2. Bo. Tabang, Cardona, Rizal	8.7	9	9	118	160	184	136	136	136	4	12.5	15
3. Bo. San Isidro, Montalban, Rizal	9.1	9.25	9.2	247	309	288	190	190	190	6	6	6.5
4. San Roque, Montalban, Rizal	9	9.1	9.2	216	228	231	138	138	138	3.5	7.5	10
5. San Rafael, Montalban, Rizal	8.8	9	9.1	218	214	197	122	122	124	5	7	10
6. Muntinlupa, Rizal	8.25	8.5	8.6	387	383	379	212	212	212	10	14.5	16
7. Bo. Langkaan, Dasmariñas, Cavite	7.65	8.45	8	417	293	345	48	48	48	8.5	10	10.5
8. San Jose, Dasmariñas, Cavite	7.85	8.75	8.2	332	338	340	48	52	50	8	11	12
9. Silang, Cavite	7.4	8.3	8.8	475	331	372	28	28	28	32.5	37.5	38.5
10. Silang, Cavite	7.9	8.55	8.7	353	338	417	25	25	25	44.5	50	51.5
11. Bo. Amon, Silang, Cavite	8.1	8.85	8.7	243	242	243	18	18	18	13	13.5	14.5
12. Bo. Gonzales, Silang, Cavite	7.95	9.2	8.5	272	280	252	18	19	19	13	15	16
T O T A L	98.8	105.9	105	3575	3408	3555	1123	1128	1126	156	193.5	210
M E A N	8.23	8.82	8.75	298	284	296	94	94	94	13	16.12	17.5
R A N G E	7.4 9.1	8.3 9.25	8 9.2	118 475	160 383	184 417	18 212	18 212	18 212	3.5 44.5	6 50	6.5 51.5

Table IX (Continuation)

SAMPLE IDENTIFICATION	Hardness			Nitrate			Sulfate		
	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$
1. Bo. Bocal, Cardona, Rizal	98	98	98	0	0	0			
2. Bo. Tabang, Cardona, Rizal	64	67	70	0	0	0			
3. Bo. San Isidro, Montalban, Rizal	126	127	128	2.3	5	.35			
4. San Roque, Montalban, Rizal	73	68	82	3.76	3.32	4.43			
5. San Rafael, Montalban, Rizal	80	80	84	6.91	6.87	4.12			
6. Muntinlupa, Rizal	92	92	94	2.6	2.2	1.2	4	3.2	3.2
7. San Jose, Dasmariñas, Cavite	92	94	97	5.5	2.57	4	3	2.2	1.6
8. Bo. Langkaan, Dasmariñas, Cavite	87	87	94	7.1	6.9	5.1	3	2.2	2.2
9. Silang, Cavite	76	77	81	38.8	35.9	31	17.7	15	12.6
10. Silang, Cavite	80	78	82	28.8	27.7	27	13.2	11.4	12.6
11. Bo. Amon, Silang, Cavite	42	42	44	17.5	17.7	17.1	7.4	7.0	7.0
12. Bo. Gonzales, Silang, Cavite	49	44	51	20.4	20.1	19.5	15.5	14.4	15
T O T A L	959	954	1005	133.67	128.26	113.8	63.8	55.4	54.2
M E A N	80	80	84	11.14	10.69	9.48	9.1	4.6	4.5
R A N G E	42 126	42 127	44 128	0 38.8	0 35.9	0 31	3 17.7	2.2 15	1.6 12.6

Table X

PHYSICAL AND CHEMICAL ANALYSIS OF WATER FROM DEEP WELL BEFORE AND AFTER CHLORINATION

SAMPLE IDENTIFICATION	NaOCl					$CaOCl_2$				
	CHLORINE DOSE	TOTAL RESIDUAL CHLORINE	FREE AVAILABLE CHLORINE	COMBINED AVAILABLE CHLORINE	CHLORINE DEMAND	CHLORINE DOSE	TOTAL RESIDUAL CHLORINE	FREE AVAILABLE CHLORINE	COMBINED AVAILABLE CHLORINE	CHLORINE DEMAND
1. Caloocan City	1.7	1.0	.95	.05	.7	1.7	.95	.9	.05	.75
2. Caloocan City	1.4	1.0	.9	.1	.4	1.6	.95	.9	.05	.65
3. Caloocan City	1.2	.7	.65	.05	.5	1.2	.7	.65	.05	.5
4. Caloocan City	1.2	.65	.6	.05	.55	1.2	.6	.55	.05	.6
5. Herran, Manila	1.8	.6	.6	0	1.2	1.4	.55	.5	.05	.85
6. Harrison, Manila	1.0	.58	.53	.05	.42	1.2	.7	.65	.05	.5
7. Valenzuela, Bulacan	1.0	.6	.55	.05	.4	1.0	.58	.53	.05	.42
8. Cescraft Marina, Parañaque Rizal	1.6	.4	.35	.05	1.2	1.8	.4	.35	.05	1.4
9. Manpower, Parañaque, Rizal	1.2	.75	.7	.05	.45	1.2	.65	.6	.05	.55
10. San Dioniso, Parañaque, Rizal	1.6	.63	.6	.03	.97	1.4	.4	.38	.02	1.0
11. San Isidro, Las Piñas, Rizal	1.2	.55	.55	0	.65	1.0	.5	.5	0	.5
T O T A L	14.9	7.46	6.98	.48	7.44	15.1	7.18	6.71	.47	7.72
M E A N	1.35	.68	.63	.043	.68	1.37	.65	.61	.042	.701
R A N G E	1.0 1.8	.4 1.0	.35 .95	0 0.1	.4 1.2	1.0 1.8	.4 .95	.35 .9	0 .05	.42 1.4

Table X (Continuation)

SAMPLE IDENTIFICATION	pH			Total Residue			Alkalinity			Chloride		
	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$
1. Caloocan City	7.75	8.25	8.25	307	288	300	20	38	39	16.5	18.5	19.5
2. Caloocan City	7.5	7.9	8.4	304	293	303	22	40	39	16.5	18	18.5
3. Caloocan City	7.4	7.7	8.0	373	324	306	34	33	35	17	18	18.5
4. Caloocan City	7.65	8.45	8.35	336	304	308	34	37	37	17	17.5	18
5. Herran, Manila	8.15	8.6	8.5	622	603	604	32	32	32	312.5	315	315
6. Harrison, Manila	7.55	8.1	8.0	135	106	126	13	14	15	10	12	12
7. Valenzuela, Bulacan	8.1	8.7	8.75	410	342	348	42	42	44	30	30.5	31
8. Cescraft Marina, Parañaque, Rizal	8.2	9.1	9.2	1701	1623	1670	47	46	47	860	870	890
9. Manpower, Parañaque, Rizal	8.0	9.2	9.1	430	381	406	54	56	56	18	19	21
10. San Dionisio, Parañaque, Rizal	8.3	9.6	8.65	556	488	512	76	76	74	248	250	249
11. San Isidro, Las Piñas, Rizal	7.25	8.05	8.5	857	828	821	54	55	55	87	88.5	89
T O T A L	85.85	96.65	93.7	6031	5580	5704	428	469	473	1632.5	1657	1681.5
M E A N	7.8	8.4	8.5	548	507	518	39	43	43	148.4	150.6	152.8
R A N G E	7.25 8.3	7.7 9.2	8.0 9.2	135 1701	106 1623	126 1670	13 76	14 76	15 74	10 860	12 870	12 890

Table X (Continuation)

SAMPLE IDENTIFICATION	Hardness			Nitrate			Sulfate		
	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$	Before	After NaOCl	After $CaOCl_2$
1. Caloocan City	37	35	38	.8	.88	.8			
2. Caloocan City	38	38	39	1.0	.78	.6	5.6	5.15	4.6
3. Caloocan City	60	62	64	1.5	1.3	.92	8	5.6	7.5
4. Caloocan City	60	58	62	.78	.65	.32	12.7	9.2	10.8
5. Herran, Manila	46	47	47	2.61	3.14	2.7	10.2	5.6	9.8
6. Harrison, Manila	60	63	62	0	0	0	3.2	2	2.4
7. Valenzuela, Bulacan	28	24	26	.54	.3	.12	4.8	4.4	4.4
8. Cescraft Marina, Parañaque, Rizal	272	272	277	2.7	1.86	.443	7.4	5.4	4.9
9. Manpower, Parañaque, Rizal	166	168	170	1.24	1.06	.89	11.8	7.4	7.4
10. San Dionisio, Parañaque, Rizal	331	330	375	.8	.62	.35	18.45	15.2	15.65
11. San Isidro, Las Piñas, Rizal	15	15	19	.53	.35	.18	22	17.65	16.8
T O T A L	1113	1112	1139	12.5	10.94	7.32	104.2	77.8	84.2
M E A N	101	101	104	1.14	.99	.67	10.42	7.78	8.42
R A N G E	15 331	15 330	19 335	0 2.61	0 3.14	0 2.7	3.2 22	2 17.65	2.4 16.8

Table XI

MEAN CONCENTRATION AND STANDARD DEVIATIONS OF CHLORINE DOSE ADDED TO DIFFERENT SOURCES OF WATER

SOURCE	DISINFECTANT	MEAN CHLORINE DOSE	STANDARD DEVIATION	RESIDUAL CHLORINE
1. Pitcher Pumps	NaOCl	1.18	1.109	.54
	$CaOCl_2$	1.28	1.284	.53
2. Springs	NaOCl	1.75	.668	.84
	$CaOCl_2$	1.82	.846	.8
3. Deep Wells	NaOCl	1.35	.281	.68
	$CaOCl_2$	1.34	.269	.65

R E F E R E N C E S

1. Philippine Health Statistics, 1973. Disease Intelligence Center
   Department of Health, Republic of the Philippines

2. WHO Chronicle, Vol. 22 No. 8, August 1968
   World Health Organization. Geneva, Switzerland

3. Bureau of Public Works, Well and Springs Section
   Department of Public Works and Communications, 1974
   Republic of the Philippines

4. A Study on Defining Fecal and Non-Fecal Pollution of Untreated
   Drinking Water By The Use of E.C. Medium at Elevated Temperature,
   Clarita C. Centeno, Thesis for the Degree of Master of Public Health,
   Institute of Public Health, University of the Philippines, March 1970

5. Annual Report of Researches
   Bureau of Research Laboratories
   Department of Health, FY 1966-1967
   Republic of the Philippines

6. Bacteriological Quality of Drinking Water
   Supply Sources in Bay, Laguna
   Pantas, Fe Manansala, Thesis for MPH, Institute of Public Health,
   University of the Philippines, October 1968

7. Study on Drinking Water Quality and Standard
   Reynaldo M. Lesaca, Department of Engineering,
   Institute of Public Health, University of the Philippines
   National Research Council of the Philippines, May 1968

8. Standard Methods for Examination of Water and Waste-water
   13th Edition 1971, American Public Health Association
   1015 Eighteenth Street, NW, Washington D.C. 20036

9. Water Treatment Handbook
   Gilbert Degremont
   Stephen Austria and Sons Ltd.
   Caxton Hill, Hertiord S_6 77LU
   4th English Edition 1923

10. Water-Borne Disease Outbreaks 1946-60
SR Weibel, FK Dixon, RB Werdner and LJ McCabe
Journal of American Water Works Association
August 1964, Vol. 56, No. 8

11. Public Water Supplies, 4th Edition
F.E. Turneaure, Russel H.L. and Nichols Stavi
John Wiley and Sons Inc. 1948

12. Facts About Water As A Resource
James A. Shiar
Journal of American Water Works Association
April 1965, Vol. 57 No. 4

13. Effect of Acidification on Stability and Bacteriological Activity of Added Chlorines in Water Supplies
Hayes et al, Water Pollution Abstract, June 1965, Vol. 38 No.6

14. The Sterilization of Drinking Water By Chlorine
J.V. Nesfield, Water Pollution Abstract, May 1963, Vol. 36 No.5