

**A CRITICAL EVALUATION OF WASTEWATER
DISPOSAL FACILITIES IN SELECTED
UNDERSERVED SETTLEMENTS IN THE COLOMBO
MUNICIPAL AREA AND RECOMMENDATIONS FOR
IMPROVEMENTS**

Abdul Gaffoor Irshadh

08/10363



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Thesis submitted in partial fulfillment of the requirements for the degree Master of
Science

Department of Civil Engineering

University of Moratuwa

Sri Lanka

April 2013

DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgment any material previously submitted for a degree or a diploma in any of the university or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature:



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Date:

The above candidate has carried out research for the Masters thesis under my supervision.

Signature of the supervisor:

Date:

ABSTRACT

Sanitation has become a problem in many developing countries. According to reports from WHO and UNICEF in 2012 about 2.6 billion people around the world lack this facility and that counts to half the developing world lack even simple improved latrine. An underserved settlement (USS) is where communities live lacking access to basic services. Half the Colombo city's population lives in the USSs. It is essential to provide better sanitation and improved wastewater (WW) disposal systems.

To assess the type of water supply available, prevailing wastewater disposal methods and the sanitation system and to identify the types of toilets, six USSs were selected considering the municipal districts and the different types of WW disposal systems prevailing in the Colombo Municipal area, and surveyed.

The results were evaluated against the standards provided by Joint Monitoring Programme of the WHO.

During the study period there were 371 households (HHs) in six selected USSs. About 90% of the HHs has individual water connection.

One for each 10 to 12 HHs that have individual septic tanks, and minimum one cluster of HHs that use a common septic tank, from each USS were chosen as representatives for detail study in the aspects of water usage and WW disposal. The results for satisfactory septic tanks are varying from 40% to 100%. Nevertheless none of the household has septic system and that results in diverting the septic tank effluent to the storm water drains ending up polluting the water bodies.

In the toilet usage, only in one USS all the HHs have access to the improved sanitation facility. Except one USS in the other five, 50% of the HH which have improved toilets are named using unimproved toilets, because sharing.

Only in two USSs less than 15% HHs directly dispose WW to the storm water drains.

It is commendable that approximately 75% of the HHs, which has permanent housing, is willing for sanitation improvements.

Based on these results recommendations are given to enhance the sanitation in the USSs.

ACKNOWLEDGEMENT

First my gratitude is forwarded to the International Development Research Centre (IDRC) of Canada for their financial support for the course and the research.

Very special thanks belong to my supervisor, Prof. (Mrs.) N. Ratnayake (Senior professor, University of Moratuwa) and the Course Coordinator Dr. Jagath Manathunga (Senior Lecturer , University of Moratuwa) and all my tutors specially Dr. Mahesh Jayaweera, (Senior Lecturer, University of Moratuwa), for their inspiring lecturing and for their continuous guidance and endless support during my study and research. They were kind enough to find time for my thesis among their busy schedule of work.

During data collection in the underserved settlement, officials attached to the Drainage division of Colombo Municipal Council were very generous to cooperate with me. They do deserve my thanks.



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Special thanks with love and gratitude owes to my wife for the sacrifice for my higher education.

I would like to thank my late father who was my inspiration and my mother who has been my strength.

TABLE OF CONTENTS

| | Page |
|---|-----------|
| Declaration | i |
| Abstract | ii |
| Acknowledgment | iii |
| Table of Content | iv |
| List of figures | vii |
| List of Tables | ix |
| List of Abbreviations | XI |
| List of Appendices | XII |
| | |
| 1. Introduction | 01 |
| 1.1 Background | 01 |
| 1.1.1 Geography | 01 |
| 1.1.2 Political environment | 01 |
| 1.1.3 Sanitation | 01 |
| 1.2 Statement of Problem | 02 |
| 1.3 Objective and Scope of the Study | 03 |
| 1.4 Layout of the Report | 04 |
| | |
| 2. The Literature Review | 05 |
| 2.1 Definition of Terms | 05 |
| 2.2 Research methods | 07 |
| 2.2.1 Participant observation | 07 |
| 2.2.2 Surveys and Interviews | 08 |
| 2.3 Technologies | 08 |
| 2.3.1 Available on site sewerage disposal facilities | 08 |
| 2.3.1.1 Septic tank | 09 |
| 2.3.1.2 Two compartment septic tanks. | 09 |
| 2.3.1.3 Three compartment septic tank | 10 |
| 2.3.1.4 Determination of working capacity of septic tanks | 10 |
| 2.3.1.5 Up flow filter | 12 |
| 2.3.1.6 Settled sewerage | 13 |
| 3 Methodology | 15 |
| 3.1 Selection of Samples | 16 |
| 3.1.2 The Municipal Districts | 16 |
| 3.2 Disposal methods | 18 |
| 3.3 Characteristic of Underserved Settlements | 18 |
| 3.4 The Selection | 18 |
| 3.4.1 The Selection of individual and common septic tanks for detail study | 20 |

| | |
|---|----|
| 4. Results and Analysis | 22 |
| 4.1 Aliwatte USS | 22 |
| 4.1.1 Description of Study Area | 22 |
| 4.1.1.1 Location | 22 |
| 4.1.2 Results of the Household Survey | 23 |
| 4.1.2.1 population | 23 |
| 4.1.2.2 Household Information | 24 |
| 4.1.2.3 Types of water sources, Availability and Coverage | 24 |
| 4.1.2.4 Existence & condition of Latrines | 25 |
| 4.1.3 Description of Sanitation and Wastewater disposal | 27 |
| 4.1.3.1 Problems with Sanitation and Wastewater disposal | 30 |
| 4.2 The Settlement, Bodhiraja Mawathe | 30 |
| 4.2.1 Description of Study Area | 30 |
| 4.2.1.1 Location | 30 |
| 4.2.2 Results of the Household Survey | 31 |
| 4.2.2.1 population | 31 |
| 4.2.2.2 Household Information | 32 |
| 4.2.2.3 Types of water sources, Availability and Coverage | 32 |
| 4.2.2.4 Existence & condition of Latrines | 33 |
| 4.2.3 Description of Sanitation and Wastewater disposal | 35 |
| 4.2.3.1 Problems with Sanitation and Wastewater disposal | 39 |
| 4.3 34 Watte, Sturt Street | 40 |
| 4.3.1 Description of Study Area | 40 |
| 4.3.1.1 Location | 40 |
| 4.3.2 Results of the Household Survey | 41 |
| 4.3.2.1 Population | 41 |
| 4.3.2.2 Household Information | 42 |
| 4.3.2.3 Types of water sources, Availability and Coverage | 43 |
| 4.3.2.4 Existence & condition of Latrines | 44 |
| 4.3.3 Description of Sanitation and Wastewater disposal | 45 |
| 4.3.3.1 Problems with Sanitation and Wastewater disposal | 45 |
| 4.3.3.2 Methods to Improve Sanitation and Wastewater disposal | 46 |
| 4.4 183, 186 Watte Aramaya Place | 47 |
| 4.4.1 Description of Study Area | 47 |
| 4.4.1.1 Location | 47 |
| 4.4.2 Results of the Household Survey | 48 |
| 4.4.2.1 population | 48 |
| 4.4.2.2 Household Information | 48 |
| 4.4.2.3 Types of water sources, Availability and Coverage | 50 |
| 4.4.2.4 Existence & condition of Latrines | 51 |



| | | |
|-------------------|---|-----------|
| 4.4.3 | Description of Sanitation and Wastewater disposal | 51 |
| 4.4.3.1 | Problems with Sanitation and Wastewater disposal | 54 |
| 4.5 | 300 Watte, Hadhbodhiya, | 55 |
| 4.5.1 | Description of Study Area | 55 |
| 4.5.1.1 | Location | 55 |
| 4.5.2 | Results of the Household Survey | 56 |
| 4.5.2.1 | Population | 56 |
| 4.5.2.2 | Household Information | 56 |
| 4.5.2.3 | Types of water sources, Availability and Coverage | 58 |
| 4.5.2.4 | Existence & condition of Latrines | 58 |
| 4.5.3 | Description of Sanitation and Wastewater disposal | 59 |
| 4.5.3.1 | Problems with Sanitation and Wastewater disposal | 61 |
| 4.6 | 65 watte Swarna road | 61 |
| 4.6.1 | Description of Study Area | 61 |
| 4.6.1.1 | Location | 61 |
| 4.6.2 | Results of the Household Survey | 63 |
| 4.6.2.1 | Population | 63 |
| 4.6.2.2 | Household Information | 63 |
| 4.6.2.3 | Types of water sources, Availability and Coverage | 64 |
| 4.6.2.4 | Existence & condition of Latrines | 65 |
| 4.6.3 | Description of Sanitation and Wastewater disposal | 66 |
| 4.6.3.1 | Problems with Sanitation and Wastewater disposal | 68 |
| 4.7 | Summary | 68 |
| 4.8 | Evaluation of Underserved Settlements compared to improved sanitation | 68 |
| 5. | Conclusions & Recommendations | 74 |
| 5.1 | Conclusions | 74 |
| 5.2 | Recommendations | 76 |
| References | | 78 |
| Appendix A | Summary Table | 80 |
| Appendix B | The Questionnaire | 82 |
| Appendix C | Results of the Survey | 88 |

LIST OF FIGURES

| | Page |
|---|------|
| Figure 2.1: Schematic diagram of septic tank | 10 |
| Figure 2.2: Up-flow system | 13 |
| Figure 2.3: The schematic diagram of settled sewer and house connection | 14 |
| Figure 3.1: Flow diagram of research methodology | 15 |
| Figure 3.2: Administrative Districts of Colombo Municipal Council | 17 |
| Figure 4.1: The Location map of Aliwatte, Mattakkuliya | |
| Figure 4.2: Photos of different houses, Aliwatte, Mattakkuliya | 24 |
| Figure 4.3: The sketch of the USS Aliwatte, Mattakkuliya. | 26 |
| Figure 4.4: Picture of a Common toilet with common septic tank | 27 |
| Figure 4.5: Location map of the settlement, Bodhiraja Mawathe | 31 |
| Figure 4.6: The sketch of the USS Bodhiraja Mawatha | 34 |
| Figure 4.7: The commode fixed toilet, Bodhiraja Mawatha | 35 |
| Figure 4.8: The septic tank overflow pipe to the Storm water drain, Bodhiraja Mawatha. | 37 |
| Figure 4.9: The arrangement of the house in the USS, Bodhiraja Mawatha | 38 |
| Figure 4.10: Location map of 34 watte, Stuart Street | 40 |
| Figure 4.11: Sketch of 34 Watte, Stuart Street | 41 |
| Figure 4.12: The housing either side of the concrete passage, 34 Watte, Stuart Street | 42 |
| Figure 4.13: Water sealed type squatting pan | 44 |
| Figure 4.14: Picture of a Common toilet at 34 Watte, Stuart Street | 45 |
| Figure 4.15: Location map of 183,186 watte, Aramaya Place | 47 |
| Figure 4.16: The housing & concrete passage, 183,186 watte, Aramaya Place | 49 |
| Figure 4.17: Sketch of 183,186 Watte, Aramaya Place | 50 |
| Figure 4.18: Storm water drain at 183,186 watte Aramaya Place | 54 |
| Figure 4.19: Location map of 300 Watte, Hathbodhiya | 55 |
| Figure 4.20 : Sketch of 300 watte, Hathbodhiya | 56 |
| Figure 4.21: Existing housing at 300 watte, Hathbodhiya | 57 |

| | Page |
|--|------|
| Figure 4.22: Flow of WW in storm water drain, 300 Watte, Hathbodhiya | 60 |
| Figure 4.23: Location map of 65 watte, Swarna Road | 62 |
| Figure 4.24 : Sketch of 65 Watte, Swarna Road | 63 |
| Figure 4.25: Existing housing at 65 Watte , Swarna road | 64 |



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

LIST OF TABLES

| | Page |
|--|------|
| Table 2.1: Improved and Not Improved Sanitation Technologies | 6 |
| Table 3.1: Selected Under Served Settlements | 19 |
| Table 3.2: The selected Individual & Common septic tanks for further study | 21 |
| Table 4.1: Consumption of water by selected HH in Aliwatte, Mattakkuliya | 25 |
| Table 4.2: Wastewater generation of selected HH in Aliwatte | 28 |
| Table 4.3: Results of minimum satisfactory requirement for septic tanks according to Sri Lanka standard 745 : Part 1 : 2004 | 29 |
| Table 4.4: Consumption of water by selected HH in The Settlement, Bodhiraja Mawathe | 33 |
| Table 4.5: Wastewater generation of selected HH in The Settlement Bodhiraja Mawathe | 36 |
| Table 4.6: Results of minimum satisfactory requirement for septic tanks according to Sri Lanka Standard 745 : Part 1 : 2004 | 39 |
| Table 4.7: Consumption of water by selected HH in 34 Watte, Stuart Street | 43 |
| Table 4.8: Consumption of water by selected HH in 183,186 watte, Aramaya Place | 51 |
| Table 4.9: Wastewater generation of selected HH | 52 |
| Table 4.10: Results of minimum satisfactory requirement for septic tanks according to Sri Lanka standard 745 : Part 1 : 2004 | 53 |
| Table 4.11: Consumption of water by selected HH in the USS | 58 |
| Table 4.12: Wastewater generation of selected HH | 59 |
| Table 4.13: Results of minimum satisfactory requirement for septic tanks according to Sri Lanka standard 745 : Part 1 : 2004 | 61 |
| Table 4.14: Consumption of water by selected HH in the USS | 65 |
| Table 4.15: Wastewater generation and influent to the septic tanks in the selection | 66 |
| Table 4.16: Results of minimum satisfactory requirement for septic tanks according to Sri Lanka standard 745 : Part 1 : 2004 | 67 |

| | Page |
|--|------|
| Table 4.17: Availability of WW disposals by USS compared to satisfactory methods | 69 |
| Table 4.18: Availability of Toilets by USS with classification. | 70 |
| Table 4.19: Details of selection and satisfaction for septic tanks in the study area | 71 |
| Table 4.20: Details of Type of houses and Residences | 72 |
| Table 4.21: Willingness for contribution for the Improvement of sanitation | 73 |



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

LIST OF ABBREVIATIONS

| Abbreviation | Description |
|--------------|-------------------------------------|
| CMC | Colombo Municipal Council |
| Code | Sri Lanka Standard 745: part 1:2004 |
| HH | Household |
| JMP | Joint Monitoring Programme |
| USS | Underserved Settlement |
| UNICEF | United Nations Children's Fund |
| WHO | World Health Organization |
| WW | Wastewater |



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

List of Appendices

| Appendix | Description | Page |
|------------|-----------------------|------|
| Appendix A | Summary Table | 80 |
| Appendix B | The Questionnaire | 82 |
| Appendix C | Results of the Survey | 88 |



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk