# *APPENDIX*

# Appendix 1 Study on Disposal for Generated Sludge after Wastewater Treatment

# APPENDIX1 Study on Disposal for Generated Sludge after Wastewater Treatment

## 1. Current Situation

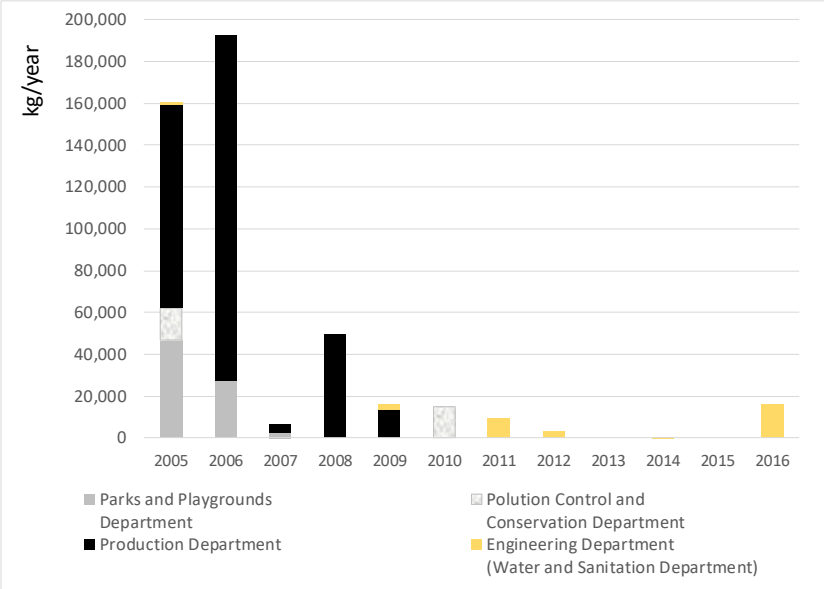
The amount of sludge from the existing wastewater treatment plant (WWTP) has not yet been recorded by the Yangon City Development Committee (YCDC). The amount is not large because the sludge treatment process is not yet operational.

Currently, the sludge is dried in a drying bed, and a portion of the dried sludge is occasionally used for purposes such as a soil conditioner. Accordingly, the dried sludge is not transported and disposed of outside of the WWTP.

## 2. Demand on the Dried Sludge

(1) Sludge Utilization in the Past Years

According to the records of sludge utilization from the WWTP, four departments of the YCDC, i.e., Engineering Department of Water and Sanitation (EDWS), Pollution Control and Cleaning Department (PCCD), Parks and Playgrounds Department, and Production Department, take the dried sludge from the WWTP as shown in Figure 1. The records indicate that the demand of sludge utilization is not stable and has been in a decreasing trend since 2010. The utilized amounts in 2007 and in 2012 to 2015 are very small compared to other years. EDWS is the only department which utilized the dried sludge after 2011.




Source: EDSW, YCDC

**Figure 1: Estimated Amount of Sludge Utilization Based on the Records of the YCDC**

(2) Tentative Estimation of Sludge Generation

The future generated amount of dried sludge is estimated as shown in Table 1. Compared to the maximum value in the past records, which is of a high value in 2006, a huge amount of dried sludge will be generated in the new WWTP. Using its value in 2006 as reference, the amount of utilized dried sludge is estimated to increase up to 25 times in 2025 and 63 times in 2035.

**Table 1: Estimated Amount of Sludge Utilization**

| Year | Dried Sludge Amount | Ratio (-) | Reference Value |
|---|---|---|---|
| 2025 | 4,800 (tons/year) | 25.3 | |
| 2030 | 7,900 (tons/year) | 41.6 | |
| 2035 | 12,000 (tons/year) | 63.2 | |
| 2006 | 190 (tons/year) | 1.0 | Maximum in record |

Source: JICA Study Team

(3) Lack of Demand on Sludge Utilization in the YCDC

The Japan International Cooperation Agency (JICA) Study Team and EDWS interviewed concerned departments that might have potential demand on the dried sludge as soil conditioner and for other purposes. The prospective departments are the Parks and Playgrounds Department and the Production Department of the YCDC.

The results of the interview conducted on 22-23 January 2018 are shown in Table 2. It was concluded that these two departments will not use the dried sludge for the same purpose as observed in the past seven years.

**Table 2: Result of the Interview with the Departments of YCDC about Sludge Utilization**

| Department of YCDC | Result of Interview |
|---|---|
| Parks and Playgrounds Department | - The department has not taken any sludge from the WWTP in recent years.<br>- In 2005, they used sludge from the WWTP under the corporation of the Engineering Department (Water and Sanitation) of the YCDC. They tested it in the golf field of the YCDC as land fill and soil conditioner for the grass. However, most of the grass were killed by insects, so they immediately stopped the program.<br>- The Parks and Playgrounds Departement does not want to use the sludge from the WWTP.<br>- They are using urea; which consists of 46% of nitrogen, potash for potassium, and chicken/cow manure. Urea is commonly used for grass and trees, although some are damaged in the process. Urea is produced in Thailand and imported to Myanmar. The potash can be easily collected from local whisky factories.<br>- In addition, small amounts of chicken manure is used for rose flower. A small amount of cow manure is also used for some flowers.<br>- They mainly need good quality of soil to fill some shallow parts. |
| Production Department | - The department has approximately 10,000 acres of paddy fields that is rented to farmers who use both organic and inorganic fertilizers. The |

| | |
|---|---|
| | farmers prefer organic fertilizers even though raw materials of organic fertilizers are limited.<br>- Based on experience, the sludge from the WWTP is better for rough trees or timber and is not suitable for flowers and soft trees.<br>- Therefore, it is difficult for the department to use the WWTP sludge.<br>- Currently, the department is using half a ton of urea for every 100 acres of timber field at the beginning of plantation every two years.<br>- They think it is better to use the sludge as land fill material instead of soil conditioner. Although they have approximately 40 acres of fish ponds and they need to fill the area, with the current demand, the department cannot wait for the operation of the new WWTP. Besides, such demand is not continuous. |

Source: JICA Study Team Interview

(4) Necessity of a Disposal Facility in the Future

The EDWS envisages that they would, as much as possible, utilize sludge generated from the new WWTP enhanced by the project instead of simply disposing of it as solid waste. The JICA Study Team respects their idea, and EDWS may endeavour to promote the use of dried sludge, while EDWS does not have any promotional plan yet. However, it is probably not possible to utilize all of the sludge from the new WWTP facility considering the estimated generation rate and the possible demand for dried sludge as described above.

Therefore, it is necessary to find and secure a site and/or facility for sludge disposal to prepare for the future generation since the EDWS has not disposed of the sludge of the WWTP to the disposal facility.

## 3. Alternative Study for Final Disposal

(1) Sites Proposed by the EDWS/YCDC for Sludge Disposal

Upon inquiry by the JICA Study Team about possible locations for a sludge disposal facility last January 2018, the EDWS/YCDC considered and proposed two land areas owned by the YCDC. The locations of the sites are shown in Figure 2.

However, upon comparison in Table 2, both land areas were evaluated as inappropriate by the JICA Study Team because they are surrounded by residential areas. It is probably difficult to make a consensus among stakeholders because they may complain about the development of the disposal facility and the offensive odour from the sludge. Supplemental information is given in the attachment.

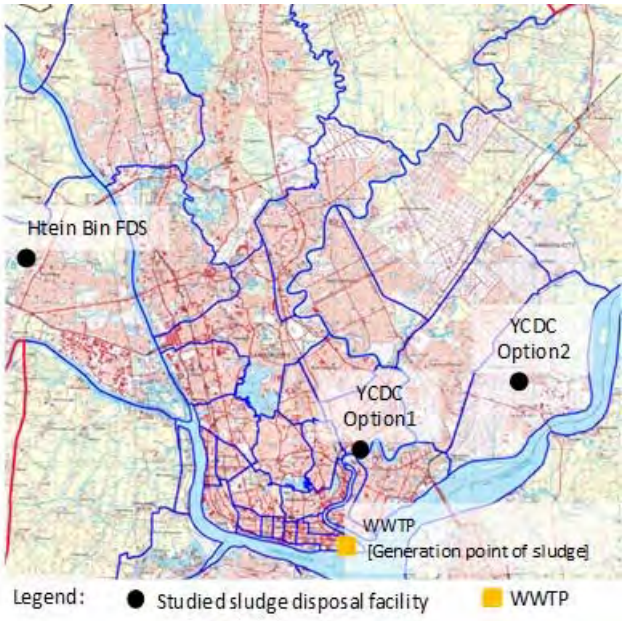



**Figure 2: Possible Locations for the Studied Final Disposal Facility of Sludge**

**Table 3: Comparison of Candidate Sites**

| | Option 1. [YCDC land 1, future WWTP site] | Option 2. [YCDC land 2] | Option 3. [Solid waste FDS Htain Bin FDS] |
|---|---|---|---|
| Township | East Dagon Myothit | Thingangyun | Htain Tha Yar |
| Area | 86 acres (34 ha) | 5 acres (2 ha) | 150 acres (60 ha) |
| Residents | None within the site, several people in the periphery | More than 500 within the site, more people in the periphery | None |
| Transport distance from WWTP | 18 km | 5 km | 32 km |
| Necessary arrangements | Agreements/acceptance of residents;<br>Improvement of access road | Resettlement, agreements/acceptance of residents | Coordination with PCCD |
| Advantage | • Treatment and disposal are managed by the Water and Sanitation Department.<br>• The future WWTP sludge will also need a drying area. | • Treatment and disposal are managed by the Water and Sanitation Department. | • Serious additional social and environmental impact is not expected.<br>• Coordination among departments of YCDC |
| Disadvantage | • Impact of odor to residents in the periphery<br>→ Detailed confirmation is required according to the JICA environmental and social consideration guideline | • Impact brought by resettlement<br>• Impact of odor to periphery residents<br>→ Detailed confirmation is required according to the JICA environmental and social consideration guideline | • Transportation distance is the biggest disadvantage<br>• Possible environmental impact due to improper management of FDS |
| Evaluation | Inappropriate | Inappropriate | Acceptable |

Source: JICA Study Team

(2) Final Disposal Site of Solid Waste

The JICA Study Team suggested for EDWS to confirm the possibility of the disposal of the sludge to the final disposal site (FDS) of solid waste managed by the PCCD of YCDC as Option 3 because it is a practice commonly implemented in other countries.

Accordingly, EDWS organized a meeting on 18 January 2018 with PCCD and the JICA Study Team to discuss if the existing FDS would receive the sludge generated from the WWTP.

PCCD stated the following:

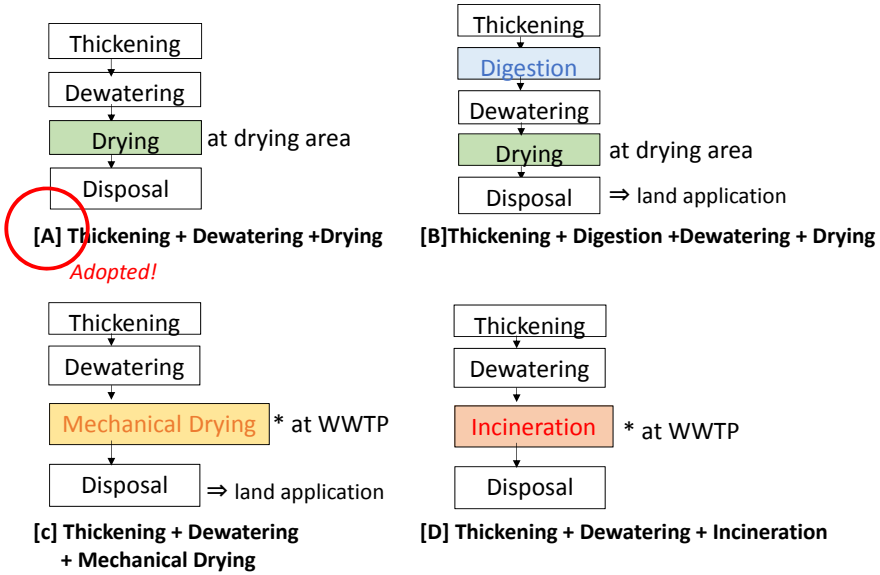
- The sludge disposal issue would be solved through the coordination between EDWS and PCCD.
- Htain Bin FDS can receive the sludge generated from WWTP if the sludge is dried after the dewatering process in the WWTP.

The JICA Study Team considered the option of sludge drying within the FDS because negative social impact that is likely to occur due to the offensive odour from the sludge sun drying process would not be expected. Regarding the JICA Study Team's inquiry about the possibility of installing a sludge drying facility, the YCDC stated the following:

- EDWS must adopt the costlier option within the WWTP area, which is the mechanical drying process instead of sun drying at the FDS, so that the negative impact of odour during transportation of sludge may be avoided and so that special vehicles for odour prevention will not be necessary.
- The PCCD required EDWS to dry the sludge before hauling to the FDS. The PCCD expressed concern in the landfill operation and management in case the dewatered sludge before drying would be disposed of at the solid waste FDS.

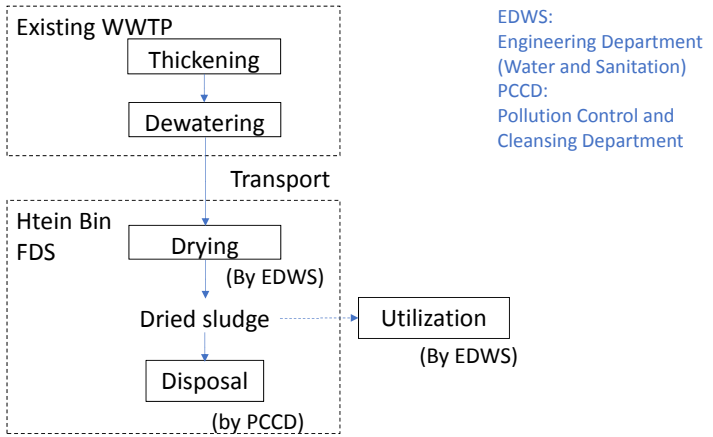
As a result of the series of meetings between relevant officials, including the ones from EDWS and PCCD, the EDWS reported to the JICA Study Team on 27 February 2018 that PCCD agreed that the FDS of solid waste, with Htein Bin FDS considered, would accept only dried sludge as solid waste after wastewater treatment. These agreements were reported in the official letter dated 22 February 2018 from EDWS to the JICA Study Team as well.

# Sludge treatment options

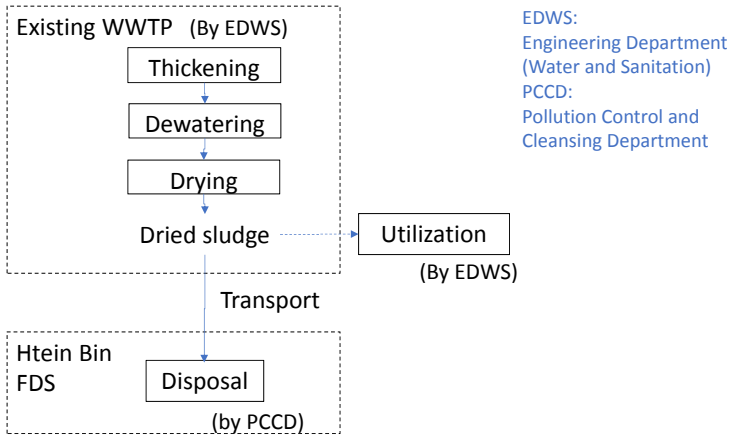



# Sludge drying area/facility

- Function: Drying of sludge (Natural [sun drying] or Mechanical)
- Amount of sludge (80% moisture): 120m3/day
- Amount of dried sludge(approx. 30m3/day):

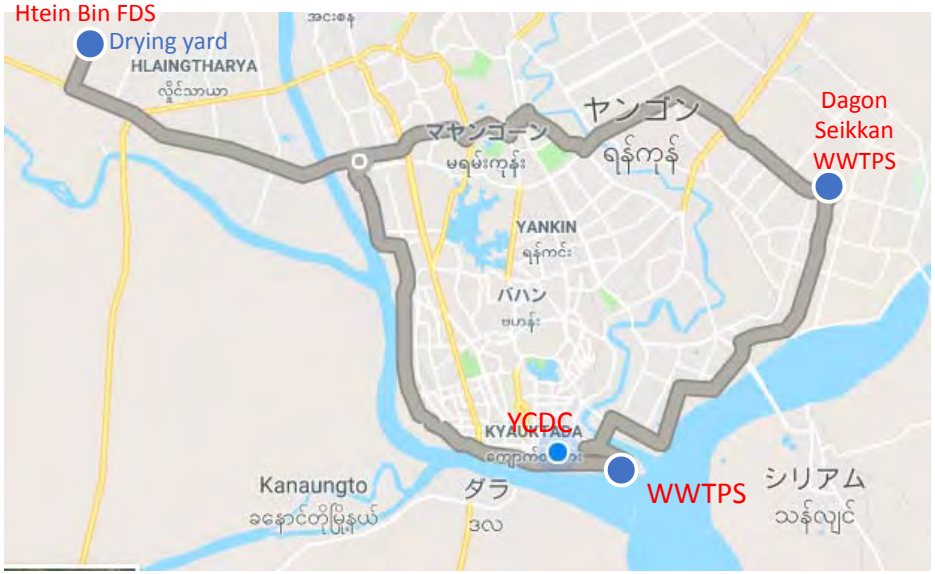



Option: sludge treatment and disposal flow




Option: sludge treatment and disposal flow

# Location of related facilities




# Location of candidate places for drying


Option 1
(Dagon Seikkan WWTPS, owned by YCDC)

Wider area, surrounded by residential area

Road surrounding the site

Squatter settlement
(Eastern vicinity of site)

Facility of gas pipeline (North Eastern vicinity of the site)

Sign of gas pipeline facility

Dagon Seikkan WWTPS [Option1, owned by YCDC]


## Option 2, (YCDC Land) inside boundary

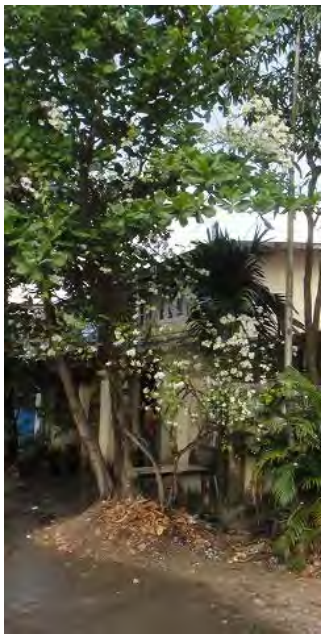
Occupied with existing facilities and residences

Residences of YCDC Families

Residences of YCDC Families

Residences of YCDC Families

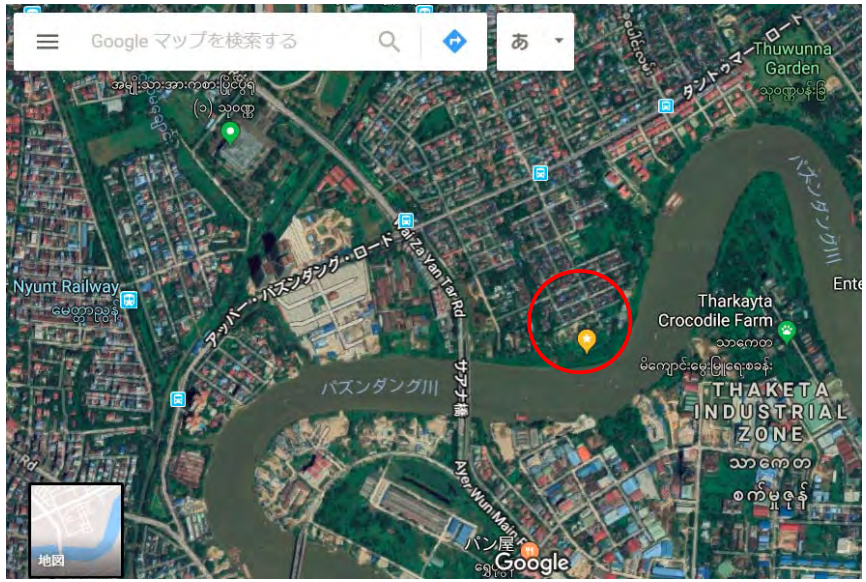
PCCD District office



## Option 2 (YCDC Land) Vicinity

Beside to the private residences

Option 2 (YCDC Land)




| | |
|---|---|
|  |  |
| Private residence | Private residence |
|  | |
| River along the site | |

Present final disposal site (FDS) of solid waste, Htein Bin FDS [as example]

Htein Bin Final Disposal Site [FDS] managed by PCCD/YCDC

# Appendix 2 Presentation About Operation and Maintenance for MBR System

**APPENDIX2 Presentation About Operation and Maintenance for MBR SYSTEM**

1

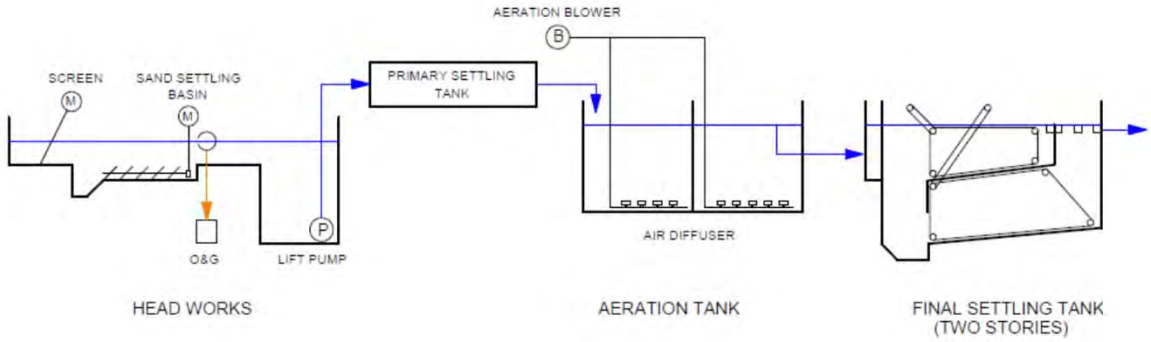
# OPERATION & MAINTENANCE

# for MBR SYSTEM



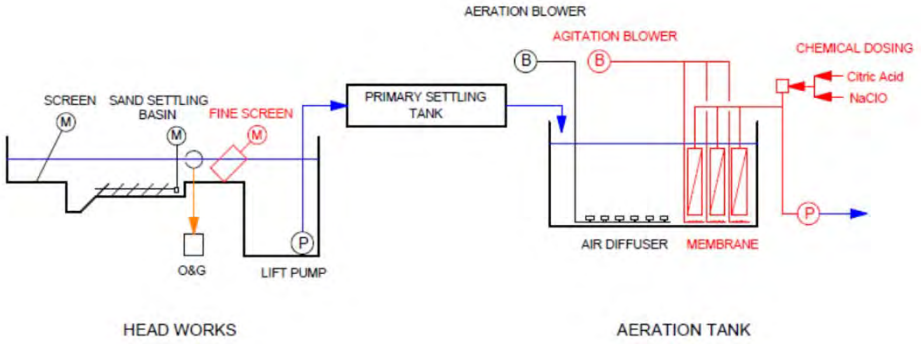
## CAS SYSTEM FLOW

2



## MBR FLOW

3




FEASIBILITY STUDY FOR SEWERAGE SYSTEM DEVELOPMENT IN YANGON CITY

## SYSTEM COMPARISON FOR MBR and CAS SYSTEM

4

| DESCRIPTION | MBR | CAS |
|---|---|---|
| Overall | Equipment amount is more than CAS System | Less Equipment |
| Foot Print(*1) | Small (40 ~60) | Large (100) |
| Power Consumption(*2) | High (130~180) | Low (100) |
| Chemical Usage | High | Low |
| Sludge Generation | Slightly Lower (95) | Higher than MBR (100) |
| Control | Complicated | Simple |
| Membrane Life Time | 8 to 10 years | - |

(*1) Foot Print is considered only Aeration Tank and Final Settling Tank.
(*2) Power Consumption depends on MBR Agitation Blower Capacity.

FEASIBILITY STUDY FOR SEWERAGE SYSTEM DEVELOPMENT IN YANGON CITY

## SAFE OPERATION FOR MEMBRANE (1/2)

5

**Prolong Membrane Life Time is key point of MBR System.**

**Important points of Operation are as follows: -**

| Description | Explanation | Method |
|---|---|---|
| To Avoid **Membrane Fouling** | Bacteria, Calcium etc., will adhere on the surface of Membrane and clogged into membrane pores.<br>Long adherence in pores becomes difficult to remove.<br>Thus, Membrane Flux reduces | Periodical Chemical Cleaning Required.<br>Normally, 3 months/time.<br><br>Using Citric Acid and NaClO. |
| To Avoid **Polymer leak** | When polymer for Dewatering Unit overdose, residual polymer will return to aeration Tank.<br>If Polymer adheres on membrane, Flux will reduce | 1. Polymer for Dewatering Unit shall be properly adjusted.<br>2. Never drain un-used polymer solution. |

FEASIBILITY STUDY FOR SEWERAGE SYSTEM DEVELOPMENT IN YANGON CITY

## SAFE OPERATION FOR MEMBRANE (2/2)

6

| Description | Explanation | Method |
|---|---|---|
| To Avoid **No-Flow Agitation** | While no filtering, Agitation Air shall stop.<br>If no filtering but still continuous agitate, it will damage Membrane physically. (for Flat type) | MBR shall operate always.<br>Avoid number control operation for Membrane at low flow rate. |
| **Agitation Air Pipe Drain** | Diffusers of Agitation Air will be clogged by sludge accumulated at bottom of Membrane Unit.<br>If diffuser clogged and less agitation, Membrane fouling will occur faster. | Diffuser Flushing shall be done manually for daily. |
| **Fine Screen** | Membrane required 1 to 2mm opening screen before Aeration Tank.<br>Fine Screen shall not by-pass except emergency. | Proper Maintenance for Fine Screen as well as Coarse Screen |
| **Oil & Grease Removal** | If Oil attaches on Membrane surface, it will not be removed easily. Sometime, special cleaning required. | Oil Separator shall operate properly. Separated Oil shall transfer to dumping site. |

FEASIBILITY STUDY FOR SEWERAGE SYSTEM DEVELOPMENT IN YANGON CITY

## MLSS Management (1/2)

7

**Membrane Fouling: All of Causes come from MLSS.**

**TO Check and Adjust MLSS for Avoid rapid Membrane Fouling.**

### MLSS Concentration

**CHECK:**
Measure MLSS daily and confirm MLSS is between 8,000 to 12,000 mg/l
**ADJUST:**
If MLSS is Lower than 8,000 mg/l, Stop Waste Sludge withdraw.
If MLSS is Higher than 12,000 mg/l, increase Waste Sludge withdraw.

### VISCOSITY

**CHECK:**
Measure MLSS Viscosity daily and confirm Viscosity is 60 mPa・sec or less.
**ADJUST:**
Check Oil & Grease or Polymer leak into Aeration Tank and Rectify these problems.
If no leakage of the above, reduce MLSS Concentration but higher than 8,000 mg/l.

FEASIBILITY STUDY FOR SEWERAGE SYSTEM DEVELOPMENT IN YANGON CITY

## MLSS Management (2/2)

8

### FILTERABILITY

**CHECK:**
Measure Filterability and confirm 10 (ml/5min) or more.
**Measurement Method:**
Using quantitative filter paper (5C) and measure filtered water amount after 5min.
**ADJUST:**
Check MLSS Settling Condition (Sludge Volume Index).
If Bulking occurs, rectify case by case.
Or this may be same problem described in Viscosity.

### DO

**CHECK:**
Measure DO in Aeration Tank and confirm 1 mg/l or more.
**ADJUST:**
Adjust Aeration Blower operation.

FEASIBILITY STUDY FOR SEWERAGE SYSTEM DEVELOPMENT IN YANGON CITY

## ADDITIONAL BACK-UP

9

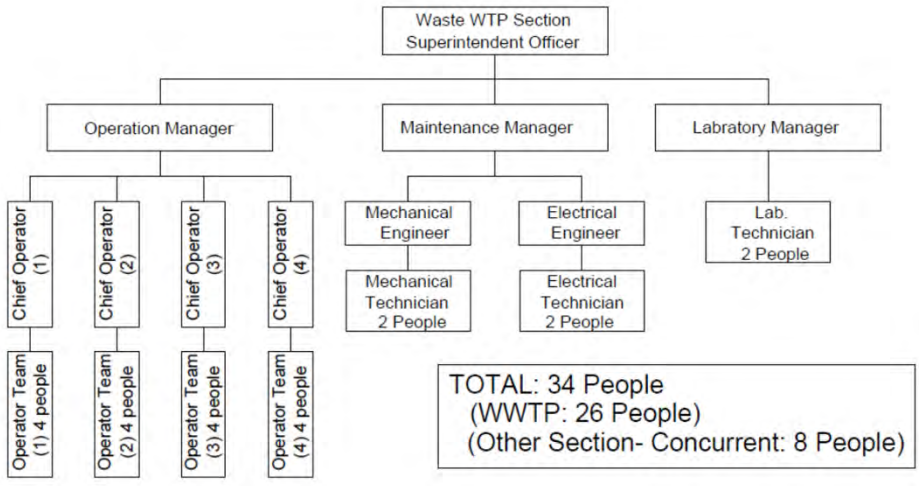
| DESCRIPTION | MBR |
|---|---|
| Training | We recommend Operator's Training for Membrane Treatment by Manufacturer.<br>Example:<br>• 2 to 3 months off shore on job in-hand training for Operation Manager and Chief Operators. |
| Manufacturer's Inspection | We also recommend Manufacture inspection.<br>Example:<br>• One year later after commissioning.<br>• Every two Years<br>• Internet data transfer and checked and comment by manufacturer |
| Instrument Engineer | Instrument Engineer shall join in O&M team.<br>• MBR System is operated 90% Automatic.<br>• Programming of operation is in PLC and/or SCADA.<br>• In case circuit board in PLC/SCADA is mulfanction, Instrument Engineer shall rectify. |

FEASIBILITY STUDY FOR SEWERAGE SYSTEM DEVELOPMENT IN YANGON CITY

## O&M Recommendation (1/3)

10

### Recommended O&M Organization




FEASIBILITY STUDY FOR SEWERAGE SYSTEM DEVELOPMENT IN YANGON CITY

## O&M Recommendation (2/3)

11

### Required Skill for Main Personnel

| Position | Required Skill (MBR) | Station |
|---|---|---|
| Superintendent Officer | Full Knowledge of Bio Process and trained for membrane Technology (Senior Engineer) | WWTP |
| Operation Manager | Full Knowledge of Bio Process and trained for membrane Technology as well as basic chemical matter. | WWTP |
| Maintenance Manager | Knowledge of rotating Machine and Basic knowledge of Electrical and Instrumentation | Other Section |
| Mechanical Engineer | Knowledge of Mechanical Machines repairing/maintenance and familiarize Membrane Cassettes. | Other Section |
| Instrumentation/ Electrical Engineer | Knowledge of SCADA, PLC Signal components. Knowledge of Electrical Panel and Machine maintenance. | Other Section |
| Laboratory Manager | Full Knowledge of Analysis Method. | WWTP |

FEASIBILITY STUDY FOR SEWERAGE SYSTEM DEVELOPMENT IN YANGON CITY

## O&M Recommendation (3/3)

12

### Roles and Tasks for Main Personnel

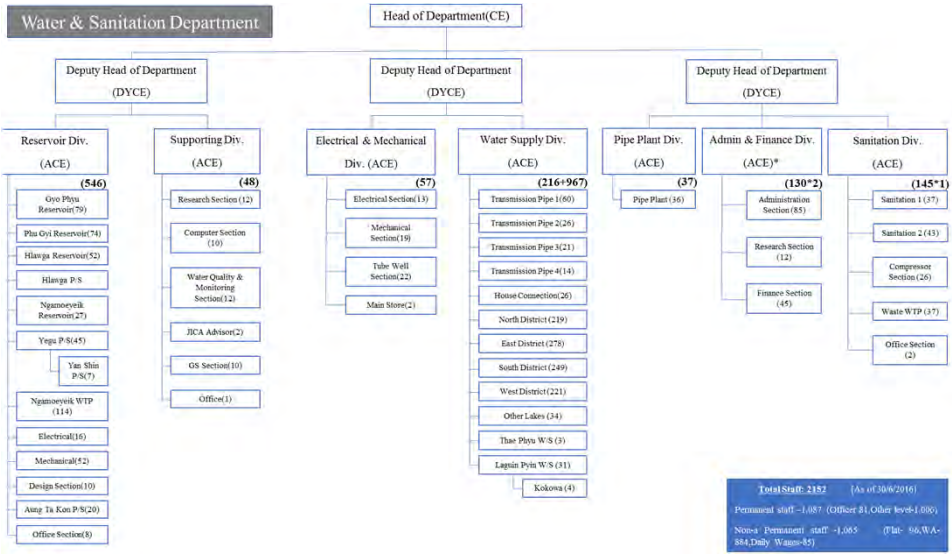
| Position | Roles and Tasks | Report To |
|---|---|---|
| Superintendent Officer | 1. Full responsible Personnel for WWTP O&M<br>2. To Organize and lead O&M Team<br>3. To Organize and lead Emergency System | Deputy Head of Department |
| Operation Manager | 1. To lead operator team and act as Deputy Superintendent Officer<br>2. To find problem and inform related team for taking action<br>3. To adjust machines according to information received from other team. | Superintendent Officer |
| Maintenance Manager | 1. To lead Maintenance Team<br>2. Routine maintenance works<br>3. To receive information from Operation Manager for defective items.<br>4. To rectify and repair defective items as soon as possible. | Superintendent Officer & Operation Manager |
| Laboratory Manager | 1. To Lead Laboratory Team<br>2. To check analysis data and inform Operation Manager<br>3. To do Jar Test for sludge Dewatering Unit Chemical Feeding rate and inform Operation Manager daily base. | Superintendent Officer & Operation Manager |

NOTE: This Organization is not included for SLUDGE DRYING FACILITY

FEASIBILITY STUDY FOR SEWERAGE SYSTEM DEVELOPMENT IN YANGON CITY

# Data (Present Condition)

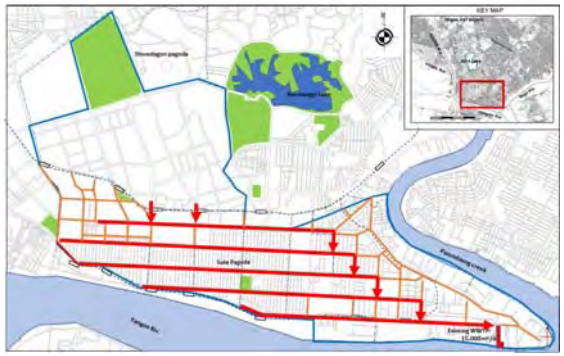
13



# Appendix 3 Comparison of Sewer Line Route

## APPENDIX3 COMPARISON OF SEWER LINE ROUTE

**Table 1 Comparison of Sewer Line Route**

| | 2 Routes | 3 Rotes | 5 Routes |
|---|---|---|---|
| Schematic Image of each route |  |  |  |
| Construction Cost (MMK/JPY) | MMK 103,607,000,000<br>(JPY 8,281,890,000) | MMK 92,710,000,000<br>(JPY 7,410,860,000) | MMK 90,499,000,000<br>(JPY 7,234,070,000) |
| Pipe length (m) | Trunk:15.3 km<br>Branch: 23.3 km<br>Total: 38.6 km | Trunk: 18.1 km<br>Branch: 16.3 km<br>Total: 34.4 km | Trunk: 20 km<br>Branch: 13.4 km<br>Total 33.4 km |
| Number of shafts | Total: 261 nos | Total: 233 nos | Total: 230 nos |
| Workability | - The heaviest traffic congestion during construction will be expected because of the longest length and the largest number of shaft.<br>- Construction period might be also the longest.<br>- Difficult to find the large number of shaft locations. | - Total length and number of shaft are bigger than 5 routes.<br>- Length of trunk sewer will be shorter, while branch sewer will be longer than 5 routes. | - The least traffic congestion will be expected becase pipe length to be installed is the shortest.<br>- Construction period is also the shortest.<br>- The most simple alignment for pipe jacking method |
| Compatible with Drainage System | The number of crossing point with drainage lines from north to south in CBD area is the smallest. | The number of crossing point with drainage lines from north to south in CBD area is the less. | The number of crossing point with drainage lines from north to south in CBD area is the biggest. |
| Evaluation | - Trunk sewer will be the shortest, however branch sewer in order to collect sewage by trunk sewer will be the longest.<br>- Less economical due to pipe length and number of shafts than other alternatives. | - Pipe length of smaller and larger diameter pipe is longer than 5 routes<br>- Construction cost is higher than 5 routes<br>- Less crossing with drainage lines | - the lowest construction cost<br>- Largest number of crossing with drainage lines |
| | Not Recommended | Not Recommended | Recommended |

Note: Pipe length and number of shaft was estimated temporary for the comparison purpose only. Construction cost was estimated roughly with unit price in the previous studies.

# Appendix 4 Capacity Calculation of the WTF

# APPENDIX 4

**Yangon Sewage**

# CALCULATION SHEET

## (MBR SYSTEM)
### 56,000 m3/d x 2 TRAIN

# 1. BASIC CONDITIONS

## 1-1 BASIC ITEMS

| | | | | |
|---|---|---|---|---|
| (1) Name | : | | Yangon Sewage | |
| (2) Land Area | : | Approximately | 2.5 | ha |
| (3) Ground Level | : | | 4.70 | m |
| (4) Inlet Pipe Invert Level | : | | -13.50 | m |
| (5) Land Use | : | | Existing Plant | |
| (6) Collection System | : | | Separate Sewer System | |
| (7) Treatment Meth | **[ Sewage Treatment ]** | | MBR System | |
| | **[ Sludge Treatment ]** | | Thickening + Dewatering + Drying | |
| (8) Effluent Discharge Point | : | | Yangon | River |
| (9) Discharge Point Water Level | : | | 3.95 | m |
| (10) Design Target Year | : | | 2040 | |

## 1-2 Design Population

Design Population (STP) Proposed Project: _____ PE (Population Equivalent)

## 2 DESIGN CALCULATION

### 2- DESIGN CONDITION AND CRITERIA

#### 2-1-1 Design Sewage Flow

1) Ultimate Flow

| ITEM | $m^3$/day | $m^3$/hr | $m^3$/min | $m^3$/sec |
|---|---|---|---|---|
| Max Daily Flow ($Q_1$) | 112,000 ($Q_{1\text{-}D}$) | 4,667 ($Q_{1\text{-}H}$) | 77.78 ($Q_{1\text{-}M}$) | 1.296 ($Q_{1\text{-}S}$) |
| Hourly Maximum (PEAK FLOW)($Q_2$) | 168,000 ($Q_{2\text{-}D}$) | 7,000 ($Q_{2\text{-}H}$) | 116.67 ($Q_{2\text{-}M}$) | 1.944 ($Q_{2\text{-}S}$) |

2) Train 1

| ITEM | $m^3$/day | $m^3$/hr | $m^3$/min | $m^3$/sec |
|---|---|---|---|---|
| Max Daily Flow ($Qn_1$) | 56,000 ($Qn_{1\text{-}D}$) | 2,333 ($Qn_{1\text{-}H}$) | 38.89 ($Qn_{1\text{-}M}$) | 0.648 ($Qn_{1\text{-}S}$) |
| Hourly Maximum (PEAK FLOW)($Q_2$) | 84,000 ($Qn_{2\text{-}D}$) | 3,500 ($Qn_{2\text{-}H}$) | 58.33 ($Qn_{2\text{-}M}$) | 0.972 ($Qn_{2\text{-}S}$) |

3) Train 2

| ITEM | $m^3$/day | $m^3$/hr | $m^3$/min | $m^3$/sec |
|---|---|---|---|---|
| Max Daily Flow ($Qe_1$) | 56,000 ($Qe_{1\text{-}D}$) | 2,333 ($Qe_{1\text{-}H}$) | 38.89 ($Qe_{1\text{-}M}$) | 0.648 ($Qe_{1\text{-}S}$) |
| Hourly Maximum (PEAK FLOW)($Q_2$) | 84,000 ($Qe_{2\text{-}D}$) | 3,500 ($Qe_{2\text{-}H}$) | 58.33 ($Qe_{2\text{-}M}$) | 0.972 ($Qe_{2\text{-}S}$) |

#### 2-1-2 Design Sewage Quality

| ITEM | INFLUENT | Primary Treatment | | Secondary Treatment | | |
|---|---|---|---|---|---|---|
| | Sewage (mg/L) | Removal % (%) | Effluent (mg/L) | Removal Ratio (%) | EFFLUENT (mg/L) | Total Removal |
| BOD | 250 | 34% | 165 | 87.9% | 20 | 92.0% |
| SS | 250 | 40% | 150 | 96.7% | 5 | 98.0% |
| COD | 500 | - | | | 100 | |
| T-N (No data) | 30 | 16% | 25 | | 25 | 16.7% |
| | | | | | | |

## 2-1-3 Design Criteria

| ITEMS | UNIT | Standard Application | Application |
|---|---|---|---|
| **Grit Chamber** | | | |
| (1) Hydraulic Load | m3/m2/day | 1800 | 1800 |
| (2) Maximum Velocity | m/sec | 0.3 | 0.3 |
| (3) Retention Time | min | 1.5 | 1.5 |
| **Primary Clarifier** | | | |
| (1) Surface Load for Daily Average | m3/m2/d | 35~75 | 75 |
| (2) Water Depth | m | 4 | 4 |
| (3) Weir Loading | m3/m/d | 250 | 250 |
| (4) Solid Recovery | % | 40~50% | 40% |
| (5) Sludge Concentration | % | 1% | 1% |
| (6) Settling Time | hr | 1.5 | 1.5 |
| (7) BOD Recovery Rate | % | | 34% |
| (8) Organic Contents in Sludge | % | 50~85% | 85% |
| **Reaction Tank** | | | |
| (1) BOD-SS Load | kg/kg/day | 0.1~0.25 | 0.2 |
| (2) MLSS Concentration | mg/l | 8000~10000 | 8,000 |
| (3) Return Sludge Ratio | % | - | - |
| (4) SRT | day | NA | NA |
| (5) Water Depth | m | - | 5 |
| (6) Hydraulic Retention Time (HRT) | hr | Calculation | 2.9 |
| (7) Oxygen Requirement | $kgO_2$/kg-substrate | 1.5 | 1.5 |
| (8) BOD Yield | % | 30~60% | 50% |
| (9) Dissolved BOD Rate | % | 40~50% | 40% |
| (10) SS Sludge Yield | % | 90 ~95% | 90% |
| (11) Sludge self oxidization rate | 1/day | 0.01~0.07 | 0.030 |
| (12) Remain Oxygen in Aeration Tan | mg/l | 1~2 | 2.0 |
| **MBR (in Aeration Tank)** | | | |
| (1) Flux | m3/m2/d | - | 0.70 |
| (2) Flux at peak flow | m3/m2/d | - | 1.40 |
| (3) Water Depth | m | | |
| (4) Sludge Concentration | % | =MLSS | 1.0% |

| ITEMS | UNIT | Standard Application | Application |
|---|---|---|---|
| **Disinfection** | | | |
| (1) Retention Time | min | 15 | 15.0 |
| (2) NaClO Dosing Rate | mg/l | 5 | 5.0 |
| (3) NaClO Concentration | % | 12% | 10% |
| | | | |
| (1) Retention Time | sec | 5 or more | 5 |
| (2) UV Transmission | % | 65 | NA |
| **Gravity Thickener** | | | |
| (1) Solid Loading for Daily Average | kg/m2/d | 60～90 | 90 |
| (2) Water Depth | m | 3~4 | 4.0 |
| (3) Solid Recovery | % | 90% | 90% |
| (4) Sludge Concentration | % | 2%~4% | 4% |
| **Mechanical Thickener** | | | |
| (1) Loading Capacity | m3/h/unit | Manufacturer | 120 |
| (2) Sludge Recovery | % | 90% | 90% |
| (3) Sludge Con( | % | 4~5% | 4% |
| (4) Polymer Dosing rate | % | 0.3% | 0.3% |
| (5) Polymer Dilution Rate | % | 0.2% | 0.2% |
| -1-3-8 Anaerobic Digester | | | |
| Digestion Time | day | 20 | 20 |
| Digestion Ratio for Organic Mat | m3/kg | 0.5 | 0 |
| Organic Ratio (Inlet) | % | 80% | 40% |
| Organic Ratio (Outlet) | % | 66.7 | Calculation |
| Digested Sludge Water Content | % | 1.6 | Calculation |
| **Sludge Dewatering Unit** | | | |
| (1) Solid Capacity | kg/hr/unit | - | - |
| (2) Dewatered Sludge Water Conten | % | 80% | 85% |
| (3) Sludge Recovery | % | 90% | 90% |
| (4) Polymer Dosing rate (per DS) | % | | 1.5% |
| (5) Polymer Dilution Rate | % | 0.2% | 0.2% |
| (6) Coagulant Dosing Rate | % | 20.0% | 15.0% |
| (7) Coagulant Dilution Rate | % | 16.0% | 16.0% |

# 2-2-1 MASS BALANCE CALCULATION (ULTIMATE)

## DESIGN CONDITION

| | | |
|---|---|---|
| Inlet Quantity (ULTIMATE) | $m^3/d$ | 112,000 |
| Inlet Quantity (Train 1) | | 56,000 |
| Inlet Quantity (Train 2) | | 56,000 |
| Inlet SS | mg/l | 250 |
| Outlet SS | mg/l | 5 |
| Primary Tank Sludge Removal Rat | % | 40% |
| Concentration of Primary Sludge | % | 1.0% |
| Removal of BOD in Primary Sludg | % | 34.0% |
| BOD Yield Coefficient | % | 50% |
| Waste Sludge Solids Content | % | 1.0% |
| MLSS | mg/l | 8,000 |
| Recovery Ratio of Gravity Thicker | % | 90% |
| Concentration of Gravity thickenec | % | 4% |
| Recovery Ratio of Mechanical Thc | % | 90% |
| Concentration of Mechanical Thicl | % | 4% |
| Recovery Ratio of Dewatering Uni | % | 90% |
| Water Contents of Sludge Cake | % | 85% |

**Train 1**

INLET

| | | |
|---|---|---|
| Inlet Quantity | $m^3/d$ | 56,000 |
| Inlet SS | kg/d | 14,000 |
| Inlet SS Concntration | mg/l | 250 |
| Inlet BOD Concentration | mg/l | 250 |
| Inlet BOD amount | kg/d | 14,000 |
| Inlet Ntrogen Concentration | mg/l | 30 |
| Inlet Nitrogen Amount | kg/d | 1,680 |

Primary Clarifier (Sludge)

| | | |
|---|---|---|
| Primary Sludge Concentration | % | 1.0% |
| Primary Sludge Dry Solid | kg/d | 5,600 |
| Primary Sludge Quantity | m3/d | 560 |
| Primary Sludge BOD Quantity | kg/d | 4,760 |

Reactor inlet

| | | |
|---|---|---|
| Flow | m3/d | 55,440 |
| BOD Amount | kg/d | 9,240 |
| BOD | mg/l | 167 |
| SS Amount | kg/d | 8,400 |
| SS | mg/l | 152 |
| N Amount | kg/d | 27 |
| N Concentration | mg/l | 0 |

Sludge Generation

| | | |
|---|---|---|
| BOD Sludge Yield | | 0.40 |
| Sludge from Dissolved BOD | kg/d | 1,478 |
| Sludge from SS | kg/d | 7,560 |
| Sludge self Oxidization | kg/d | 1,608 |
| Sludge Generation | kg/d | 7,431 |

MBR

| | | |
|---|---|---|
| Sludge Concentration | % | 1.00% |
| Waste Sludge DS | kg/d | 7,153 |
| Waste Sludge Quantity | m3/d | 715 |

Gravity Thickener (for Primary Sludge)

| | | |
|---|---|---|
| Thickened Sludge DS | kg/d | 5,040 |
| Thckened Sludge Quantity | $m^3/d$ | 126 |
| Supernatant SS | kg/d | 560 |
| Supernatant Quantity | $m^3/d$ | 434 |
| Supernatant SS Concentration | mg/l | 1,290 |
| Supernatant BOD Quantity | kg/d | 476 |
| Supernatant N Concentration | mg/l | 30 |
| Supernatant N Quantity | kg/d | 13 |
| Supernatant BOD Concentration | mg/l | 912 |

Mechanical Thickener (for Secondary Sludge)

| | | |
|---|---|---|
| Polymer Dosing Rate | %-DS | 0.3% |
| Polymer Dosing Amount | kg-ss/d | 21 |
| Dilution Rate for Polymer make up | % | 0.2% |
| Dilution Water Amount | m3/d | 11 |
| Thickened Sludge DS | kg/d | 6,709 |
| Thckened Sludge Quantity | $m^3$/d | 168 |
| Supernatant SS | kg/d | 466 |
| Supernatant Quantity | $m^3$/d | 558 |
| Supernatant SS Concentration | mg/l | 834 |
| Supernatant BOD Quantity | kg/d | 186 |

**Train 2**

| | | |
|---|---|---|
| Inlet Quantity | $m^3$/d | 56,000 |
| Inlet SS | kg/d | 14,000 |
| Inlet SS Concntration | mg/l | 250 |
| Inlet BOD Concentration | mg/l | 250 |
| Inlet BOD amount | kg/d | 14,000 |
| Inlet Ntrogen Concentration | mg/l | 30 |
| Inlet Nitrogen Amount | kg/d | 1,680 |

Primary Clarifier (Sludge)

| | | |
|---|---|---|
| Primary Sludge Concentration | % | 1.0% |
| Primary Sludge Dry Solid | kg/d | 8,179 |
| Primary Sludge Quantity | m3/d | 818 |
| Primary Sludge BOD Quantity | kg/d | 5,809 |

Reactor inlet

| | | |
|---|---|---|
| Flow | m3/d | 61,181 |
| BOD Amount | kg/d | 11,276 |
| BOD | mg/l | 184 |
| SS Amount | kg/d | 12,269 |
| SS | mg/l | 201 |
| N Amount | kg/d | 1,658 |
| N Concentration | mg/l | 27 |

Sludge Generation

| | | |
|---|---|---|
| BOD Sludge Yield | | 0.40 |
| Sludge from Dissolved BOD | kg/d | 1,804 |
| Sludge from SS | kg/d | 11,042 |
| Sludge self Oxidization | kg/d | 1,774 |
| Sludge Generation | kg/d | 11,072 |

MBR

| | | |
|---|---|---|
| Sludge Concentration | % | 1.00% |
| Waste Sludge DS | kg/d | 10,766 |
| Waste Sludge Quantity | m3/d | 1,077 |

Gravity Thickener (for Primary Sludge)

| | | |
|---|---|---|
| Thickened Sludge DS | kg/d | 7,361 |
| Thckened Sludge Quantity | $m^3/d$ | 184 |
| Supernatant SS | kg/d | 818 |
| Supernatant Quantity | $m^3/d$ | 634 |
| Supernatant SS Concentration | mg/l | 1,290 |
| Supernatant BOD Quantity | kg/d | 581 |
| Supernatant N Concentration | mg/l | 50 |
| Supernatant N Quantity | kg/d | 32 |
| Supernatant BOD Concentration | mg/l | 1,091 |

Mechanical Thickener (for Secondary Sludge)

| | | |
|---|---|---|
| Polymer Dosing Rate | %-DS | 0.3% |
| Polymer Dosing Amount | kg-ss/d | 32 |
| Dilution Rate for Polymer make up | % | 0.2% |
| Dilution Water Amount | m3/d | 16 |
| Thickened Sludge DS | kg/d | 9,721 |
| Thckened Sludge Quantity | $m^3/d$ | 243 |
| Supernatant SS | kg/d | 1,077 |
| Supernatant Quantity | $m^3/d$ | 850 |
| Supernatant SS Concentration | mg/l | 1,267 |
| Supernatant BOD Quantity | kg/d | 431 |

Thickened Mixed Sludge Tank

| | | |
|---|---|---|
| Sludge Concentration | % | 4.00% |
| Sludge DS | kg/d | 28,832 |
| Waste Sludge Quantity | $m^3/d$ | 721 |

Dewatering Unit (Estimation)

| | | |
|---|---|---|
| Polymer Dosing Rate | %-DS | 1.50% |
| Polymer Dosing Amount | kg-ss/d | 432 |
| Dilution Rate for Polymer make up | % | 0.20% |
| Dilution Water Amount | m3/d | 216 |
| PAC Dosing Rate | %-DS | 15% |
| PAC Dosing Amount | kg-ss/d | 4,325 |
| PAC Concentration | % | 16% |
| Specific Gravity | - | 1.2 |
| PAC Dosing flow | m3/d | 22.5 |
| Water Content of Cake | % | 85% |
| Cake DS | kg/d | 30,230 |
| Cake Quantity | $m^3/d$ | 202 |
| Supernatant SS | kg/d | 3,359 |
| Supernatant Quantity | $m^3/d$ | 758 |
| Supernatant SS Concentration | mg/l | 4,431 |
| Supernatant BOD Quantity | kg/d | 1,344 |
| Supernatant N Concentration | mg/l | 30 |
| Supernatant N Amount | kg/d | 23 |
| Supernatant BOD Concentration | mg/l | 1,772 |

Other Water

| | | |
|---|---|---|
| Teated Water Reuse | m3/d | 4656 |
| City Water Drain | m3/d | 25 |

Inlet Condition to Primary Clarifier

| | | |
|---|---|---|
| Quantity | $m^3/d$ | 63,915 |
| SS | kg/d | 20,279 |
| SS Concentration | mg/l | 317 |
| BOD Amount | kg/d | 17,017 |
| BOD Concentration | mg/l | 266 |

Return from Gravity, Mechanical Thickener and Dewatering Unit

| | | |
|---|---|---|
| Quantity | $m^3/d$ | 3,234 |
| SS | kg/d | 6,279 |
| SS Concentration | mg/l | 1,942 |
| BOD Amount | kg/d | 3,017 |
| BOD Concentration | mg/l | 933 |

Effluent (Before Disinfection)

| | | |
|---|---|---|
| Quantity | $m^3/d$ | 114,829 |
| Outlet SS Concentration | mg/l | 5 |
| SS | kg/d | 574 |
| BOD Concentration | mg/l | 20 |
| BOD Amount | kg/d | 2,297 |

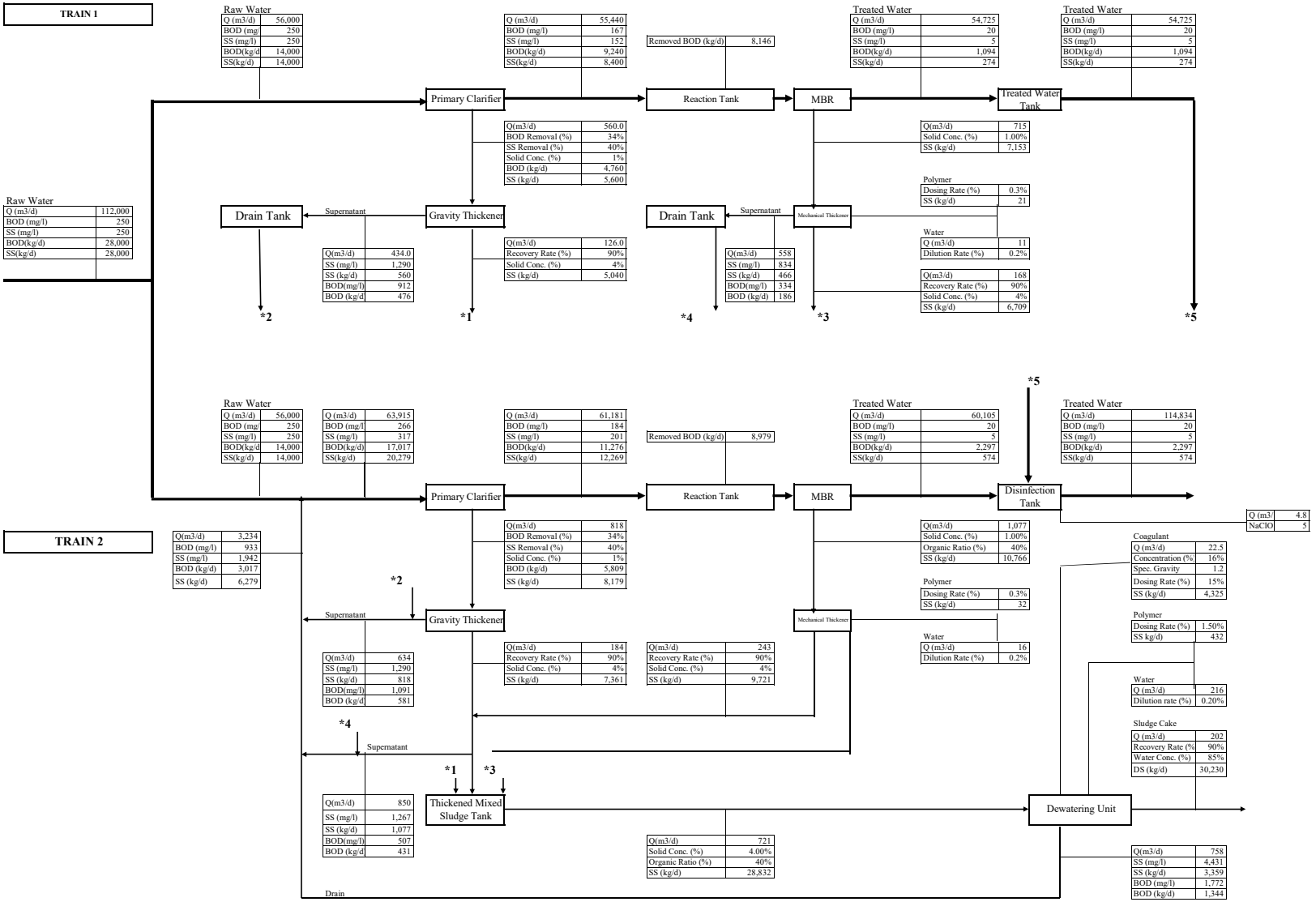
Disinfection Tank

| | | |
|---|---|---|
| NaClO Dosing Rate | mg/l | 5.00 |
| NaClO Concentration | % | 12% |
| NaClO Dosing Amount | kg/d | 574 |
| NaClO Doing Flow | m3/d | 4.8 |

Effluent (After Disinfection)

| | | |
|---|---|---|
| Quantity | $m^3/d$ | 114,834 |
| Outlet SS Concentration | mg/l | 5 |
| SS | kg/d | 574 |
| BOD Concentration | mg/l | 20 |
| BOD Amount | kg/d | 2,297 |

# MASS BALANCE SHEET (ULTIMATE)



**2 Capacity Calculation (Head Works)**

| ITEM | SYMBOL | DESIGN | | | |
|---|---|---|---|---|---|
| **Screen** | | | | | |
| 1 Hourly Max Flow | Q2-D= | 168,000 | m3/d | | |
| 2 Mimimum Flow Rate | Vscmin= | 0.4 | m/s | | |
| 3 Max Fow Rate | Vscmax= | 1 | m/s | | |
| 4 Target Flow Rate at Peak Flow | Vsc= | 0.8 | m/s | | |
| 5 estimated Water Depth | Dsc= | 0.5 | m | | |
| Train | Tg= | 3 | | | |
| 6 Required Channel width | Wsc= | Q2-D/24/3600/Dsc/Vsc/tg== | | 1.62037037 | |
| | | | Say | 1.62 | m |
| **PUMP PIT** | | | | | |
| 1 Peak Flow | Q2= | 168,000 | m3/d | | |
| 2 Retention Time | Tp= | 5 | min | | |
| 3 Required Pit Volume | Vrp= | 583 | m3 | | |
| 4 Pit Depth | Dpit= | 4 | m | | |
| 5 Required Area | Apit= | 146 | m2 | | |
| Size (half of Shaft) | | | | | |
| Diameter | | 22 | m | | |
| Actual Area | | 308 | m2 | | |
| Actual Volume | Vpa= | 1,232 | m3 | | |
| Actual Retention Time | Tpa= | 10.6 | min | (3 Pits Total) | |
| **LIFT PUMP** | | | | | |
| 1 TRAIN 1 | | | | | |
| Flow Rate | | | | | |
| Design | Qe1-D= | 56,000 | m3/d | 38.9 | m3/min |
| Peak | Qe2-D= | 84,000 | m3/d | 58.3 | m3/min |
| **2** TRAIN 2 | | | | | |
| Flow Rate | | | | | |
| Design | Qn1-D= | 56,000 | m3/d | 38.9 | m3/min |
| Peak | Qn2-D= | 84,000 | m3/d | 58.3 | m3/min |
| **3** Selection of Pump | | | | | |
| Flow Control | | 70% | | | |
| Pump Capacity | | 30 | m3/min | | |
| Operation method | | | | | |
| Design | Qe1-D= | 38.9 | m3/min | 65% | 2 pump Operation |
| | Qn1-D= | 38.9 | m3/min | 65% | 2 pump Operation |
| Peak | Qe2-D= | 58.3 | m3/min | 97% | 2 pump Operation |
| | Qn2-D= | 58.3 | m3/min | 97% | 2 pump Operation |
| 3 Specification | | 30 m3/min x 25mH x 4 sets (+2sets common stand-by) | | | 185 kW/set |
| | | Dry Pit Submergible Pump | | | |

### 2.4 Capacity Calculation (TRAIN 1)

| ITEM | SYMBOL | DESIGN | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Oil Collector** | | | | | | | | |
| Channel Quantity | Uc= | 1 | channels | | | | | |
| Channel Size | | W | L | D | | | | |
| | | 2 | 4.5 | 1 | | | | |
| Design Flow | Qn1s= | 0.648 | m3/sec | | | | | |
| Design Max Flow | Qn2s= | 0.972 | m3/sec | | | | | |
| Max Flow for each Channel | Qmc= | Qn2s/Uc= | 0.972 | m3/sec | | | | |
| Channel Loss Calculation | | | | | | | | |
| Hydraulic Radius | Rh= | D*W/(2D+W)= | 0.500 | | | | | |
| Flow Velocity | Vf= | Qmc/(D*W)= | 0.49 | m/sec | | | | |
| Rough Coefficient | n= | 0.014 | | | | | | |
| Hydraulic Gradient | I= | (n*Vf／Rh^2/3)^2= | 0.000117 | | | | | |
| Head Loss | Hd= | I*L= | 0.0005 | m | | | | |
| Pipe Skimmer Specification | | 300mm dia x opening 100mm | | | | | | |
| Oil Separation | | | | | | | | |
| Batch Tank | | W | L | D | | | | |
| | | 1.5 | 2 | 1 | | | | |
| Floating Scum Collector | | Float + Hose | | | | | | |
| Waste Oil & Grease Tank | | 200 | lit | | | | | |
| Return Water Pump | | 0.1 m3/m x 10mH | | | | | | |
| **Grit Chamber** | | | | | | | | |
| 1 Hourly Max Flow | Q2-D= | 84,000 | m3/d | | | | | |
| 2 Surface Load | Sfl-G= | 1,800 | m3/m2/day | | | | | |
| 3 Required Surface Area | Sa-G= | Q2-D/Sfl-G= | 46.7 | m2 | | | | |
| 4 Tank Width | W= | 1.5 | m | | | | | |
| 5 Tank Length | L= | 12 | m | | | | | |
| 6 Train | Tg= | 3 | Train | | | | | |
| 7 Tank Depth | D= | 2.50 | m | | | | | |
| 8 Actual Surface Area | Saa-G | W*L*Tg= | 54 | m2 | > | 46.7 | OK | |
| 9 Required Retention Time | Tdist= | 1.5 | min | | | | | |
| 10 Required Volume | Vdist= | Q2-D/24/60*Tdist= | | 88 | m3 | | | |
| 11 Required Length | L= | Vdist/W/D/Tg= | | 7.78 | m | < | 12 | |
| 12 Tank Design | | W 1.5m x L 12 m x D 2..5m (Water level) x 3 train | | | | | | |
| **Fine Screen** | | | | | | | | |
| 1 Hourly Max Flow | Q2-D= | 84,000 | m3/d | | | | | |
| 2 Mimimum Flow Rate | Vscmin= | 0.4 | m/s | | | | | |
| 3 Max Fow Rate | Vscmax= | 1 | m/s | | | | | |
| 4 Target Flow Rate at Peak Flow | Vsc= | 0.8 | m/s | | | | | |
| 5 Estimated Water Depth | Dsc= | 0.5 | m | | | | | |
| Train | Tg= | 3 | | | | | | |
| 6 Required Channel width | Wsc= | Q2-D/24/3600/Dsc/Vsc/tg== | 0.810185185 | | | | | |
| | | Say | 1.5 | m | | | | |
| **Distribution Weir** | | | | | | | | |
| 1 Distribution Weir | | | | | | | | |
| Flow throgh Distribution Weir | Qdw= | Qn2-D/Udist | 10,500 | m3/d | | | | |
| | | Where | | | | | | |
| | | Udist: Distribution Points= | 8 | Places | | | | |
| Allowable Water Level | Hwlp= | 0.3 | m | | | | | |
| Weir Calculation | | Qdw=1.838*B*Hwlp^(3/2) | | | | | | |
| | | Where | | | | | | |
| | | Bdist: Weir Width | | | | | | |
| | | Bdist=Qpw/1.838/Hwlp^(3/2) | | | | | | |
| Required Weir Width | Bdist= | 0.40 | m | | | | | |
| | | Say | 0.6 | m | | | | |

| ITEM | SYMBOL | DESIGN |
|---|---|---|
| **Primary Clarifier** | | |
| 1 Design Condition | | |
| Design Flow | Qnd= | 63,915 $m^3$/day (From Mass Balance) |
| Type | | Rectangular Type |
| Unit Number | UN= | Train 4 unit; Basin/Train 2 unit; Total 8 unit |
| 2 Design Criteria | | |
| Surface Load | Lh= | 75 m3/m2/day |
| Settling Time | Ts= | 1.5 hr |
| 3 Calculation | | |
| Flow Per Unit | Qu= | Qd / UN = 7,989 m3/day |
| Required Area | A= | Qu/Lh = 107 m2/unit |
| 4 Size | W | 4.80 m |
| | L | A/W= 22.2 m |
| | | Say 23.0 |
| 5 Required Depth | Dnp= | Qu/24/W/L= 3.0 m |
| 6 Specification | | 4.8mW x 13.6 mL x 3.8mD x 2 story with Scraper x 8 x2 sets |
| 7 Weir Calculation | | |
| Weir Load | Lwnp= | 250 m3/m/d |
| Required Weir Length | Llwnp= | Qu/Lwnp= 32.0 m total |
| 8 Scum Skimmer | | |
| Pipe Skimmer | | 300mm dia skimmer x 8 nos. |
| Scum Pit | | 1.5m x 2m x 2mD x 2 sets |
| Scum Pump | | 0.2 m3/min x 10m Submersible pump to Sludge Tank |
| 9 Primary Sludge Pump | | |
| Primary Sludge Amount | Qs= | 818 m3/d total (from Mass Balance) |
| Operation Hour | Tpsp= | 8 hours/day |
| Quantity | Upsp= | 4 sets/total |
| Required Flow Rate | Qpsp= | Qs/Tpsp/Upsp= 26 m3/h |
| | | = 0.43 m3/min |
| Specification | | End Suction Non Clog Type |
| | | 0.5 m3/min x 10mH x 4sets (+4sets Stand-by) |
| **REACTION TANK** | | |
| 1. Reaction Tank Size | | |
| Inlet Flow | Qdr | 61,181 m3/d (from Mass Balance) |
| Inlet BOD Concentration | BOD in | 184 mg/l |
| Inlet BOD Amount | BOD ia | Qdr*BODin *10^-3= 11,276 kg/d |
| BOD SS Load | BSL | 0.20 |
| MLSS Concentration | MLSS | 8000 mg/l |
| Required Reaction Tank Volume | Vreact | BODia/BSL/MLSS *1000= 7,047 m3 |
| Train | Tra | 4 Train |
| Required Volume for each train | Vret | Vreact/Tra= 1,762 m3 |
| Reaction Tank Size | | |
| Width | Wre | 10 m |
| Length | Lre | 28 m |
| Depth | Dre | 6.7 m |
| Volume | Vreta | 1,876 m3 > 1,762 OK |
| Total Aeration Volume | Vretat | 7,504 m3-total |

| ITEM | SYMBOL | DESIGN |
|---|---|---|
| **MBR** | | |
| 2 Design Condition | | |
| Design Flow | Qdr | 61,181 $m^3$/day (From Mass Balance) |
| Type | | Flat or Hollow Fibre Type Membrane |
| Flux | Fln | 0.7 m3/m2d 29.2 lmh |
| Flux at Peak | Flmax | 1.05 m3/m2d 43.8 lmh |
| Membrane Area per Cassettes | Ac | 600 m2 |
| Cassette quantity | | |
| Required Membrane Area | Arq | Qsec/Fln= 87,402 m2 |
| Required Cassette quantity | Ncs | Arq/Ac= 146 nos. |
| Actual Cassette quantity | Ncsa | 156 nos. |
| Actual Membrane Area | Arqa | Ncsa*Ac= 93600 m2 |
| Actual Flux | Flna | Qdr/Arqa= 0.654 m3/m2d 27.24 lmh |
| Actual Flux at Peak | Flmaxa | Flna *1.5= 0.980 m3/m2d 40.85 lmh |
| Cassette Installtion Area | | |
| Cassette size | | W 944.0 L 2186.0 H 4213 |
| Permeate Pump | | |
| 1 line Cassettes qantity | U1line= | 13 |
| Required Flow Rate | F1line= | U1line *Ac*Fln= 5,460 m3/d 3.79 m3/min |
| | | U1line *Ac*Flmax 8,190 m3/d 5.69 m3/min |
| | | say 4.0 m3/min x 5mH x 3 sets |
| Agitation Blower | | |
| Air Flow per Cassette | Famu | 2 Nm3/min/cassettes |
| Cassette Quantity | Ncsa | 156 nos |
| Total Air Flow | Qamt | Famu*Ncsa= 312 Nm3/min |
| Oxygen Transfer rate for Diffuser | Eam | 13% |
| SOR calculation for MBR Blower | SORm | Qamt*(Eam*10^-2*ρ*Ow)*60 |
| | | $\rho$ : Air Density= 1.293 kg air/$Nm^3$ |
| | | Ow: Oxygen Weigh per Air Unit 0.233 kg-O2/kg-air |
| | SORm | 733 kg-O2/h |
| Specification | | 78 Nm3/min x 7mH x 4 (+1 S/B) |
| 3 Oxygen Requirement(Blower Calculation) | | |
| 3.1 Oxygen Demand | | |
| 1) Oxygen Demand for Organic Matter | | |
| Oxygen Demand | Db = | (BODin-BODout)*Qin /1000*B |
| | | Where |
| | | BODin: BOD Inlet 184 mg/l (Mass Balance) |
| | | BODout: BOD outlet 20 mg/l (Treated Water) |
| | | Qin: Flow Inlet 61,181 m3/d (Mass Balance) |
| | | B: Required Oxygen per BOD removal per k 0.45 kg-O2/kg-BOD |
| Oxygen Demand Calculation | Db= | 4,524 kg-O2/day |
| 2) Oxygen Demand for Nitrification | | |
| Oxygen Demand | Dn= | C*(Nnin-Nnout)*Qin/1000 |
| | | Where |
| | | C: Oxygen Requirement for nitrification per l 4.57 kg-O2/kg-N |
| | | Nnin: inlet Organic Nitrogen 27 mg/l (Mass Balamce) |
| | | Nout: Outlet Organic Nitrige 25 mg/l |
| Oxygen Demand Calculation | Dn= | 586 kg-O2/day |
| 3) Oxygen Demand for | | |
| For Endogenous Respiration | De= | Vreta*MLSS*Tra* $\eta$ /1000 |
| | | Where |
| | | Vreta: Reaction Tank Volum 1,876 m3 |
| | | MLSS: MLSS in Aeration T 8000 mg/l |
| | | Tra: Train 4 |
| | | $\eta$ : Oxygen demand for Endogeneous Respiration per MLVSSkg |
| | | 0.1 kg-O2/kg-MLVSS |
| Oxygen Deman Calculation | De= | 6,003 kg-O2/day |

| ITEM | SYMBOL | DESIGN |
|---|---|---|
| 4) Remaining O2 in Reaction Tank | D0= | Ca*Qin/1000<br>Where<br>Ca: Remaining O2 Concentration 2 mg/l<br>Qin: 61,181 m3/d |
| Oxygen Deman Calculation | D0= | 122 kg/d |
| 5) Total Oxygen Demand | AOR | Db+Dn+De+D0= 11,236 kg/d |
| 3.2 Standard Oxygen Demand | SORa | $SORa=(AOR*Csw * r) / (1.024^{(T-20)} * \alpha *( \beta * Cs * r-C_A))/t$<br><br>Where<br>Csw: Oxygen saturation concentration in clean water at temperature 20℃ Csw= 8.84 mg/l<br>T: Temperature of Water T= 26 ℃<br>$\alpha$ : Ratio of Oxygen transfer rate in the waste to that in clear water at the same temperature $\alpha$ = 0.7<br>$\beta$ : Ratio of Oxygen saturation concentration in the waste to that in clean water $\beta$ = 0.95<br>Cs: Oxygen saturation concentration in clean water at Temperature T Cs= 8.11 mg/l<br>$C_A$: Residual dissolved oxygen concentration in the waste water $C_A$= 2 mg/l<br>r : Correction of Cs from water depth r=1+(H/2)/10.24= 1.32<br>H : Water Depth(Average of HWL and LWL) H= 6.5 m<br>t : Aeration time per day t= 24 hr/day |
| Calculation of SOR | SORa= | 829 kg-O2/h 19,894 kg/d |
| Required SOR for Blower | SOR = | SORa-SORm= 96 kg-O2/h |
| 3.3 Air Requirement | Qair= | $SOR/(Ea\times10^{-2}\times \rho \times Ow)/60=$<br><br>Where<br>Ea: Diffuser Efficiency at Diffuser Depth= 20%<br>$\rho$ : Air Density= 1.293 kg air/$Nm^3$<br>Ow: Oxygen Weigh per Air Unit 0.233 kg-O2/kg-air |
| Calculation of Qair | Qair= | 27 Nm3/min |
| Actual Air Flow | Qaa= | Qair*(273+T)/273= 31 m3/min<br>(T=40℃) 44,842 m3/day |
| Equipment | | Agitation Blower 78Nm3/min x 7mH x 8sets (total)<br>Aeration Blower 42Nm3/min x 7mH x 4 sets (Total)<br>Common Stand-by 78 Nm3.min x 7mH x 1 set |
| 3.4 Fine Diffuser | | |
| Diffuser Flow | Qdif= | 5.00 Nm3/h/pc |
| Diffuser Quantity | Xdif= | 326 pc |
| 4. Waste Sludge Pump | | |
| Waste Sludge Quantity | Qw= | 1,077 m3/day (from Mass Balance) |
| Operation Hour | Tw= | 8 hours |
| Quantity | Uw= | 4 sets |
| Required Flow Rate | Qws= | Qw/Tw/Uw= 33.64 m3/h<br>= 0.56 m3/min |
| Specification | | End Suction Non Clog Type<br>0.6m3/min x 10mH x 4 sets (+4sets Stand-by) |

| ITEM | SYMBOL | DESIGN |
|---|---|---|
| **CHEMICAL CLAENING** | | |
| 1 Chemical Feeding | | |
| Flow per cassettes | Vc= | Volume 1200 x 2 = 2400 lit/cassettes |
| | Qch= | Feed Rate 180~240 240 lit/min |
| Chemical Concentration | Ccl= | NaClO 0.25~0.6% 0.50% |
| | Cac= | Citric Acid 0.5~1% 1% |
| Cleaning cassettes No. | Xclean= | one Permeate Pump : 13 cassettes |
| Cleaning Solution Volume | Vct= | Vc*Xclean= 31.2 m3 |
| Cleaning Solution Feed Rate | Qcht= | Qch*Xclean= 3.12 m3/min |
| Chemical Usage per Cleaning | | |
| NaClO | Vclc= | Vct*Ccl*1000= 156 kg/cleaning as 100% NaClO |
| | | 1,182 lit/cleaning as 12% NaClO |
| Citric Acid | Vacc= | Vct*Cac*1000= 312 kg/cleaning as 100% Citric Acid |
| | | 348 lit/cleaning as 70% Citric Acid |
| | | Density 1.28 kg/lit |
| Required Chemical Tank Volume | | |
| NaClO | Vtcl= | Vclc*30/1000= 35 m3 as 12% NaClO |
| | | 1 month retentior : say every day 1 line cleaning (8 days interval) |
| Citric Acid | Vtac= | Aacc*8/1000= 2.8 m3 as 70% Citrica Acid |
| | | 1 month retentior : say every month 1 time per 1 line (total 8 lines) |
| Required Chemical Feed Tank | Vcfeed= | Vc/1000= 2.4 m3 |
| Specification | | 1. NaClO Tank 70 m3 |
| | | Note: add Disinfection for final 70m3 x 2 sets |
| | | 2. NaClO Feed Tank 2.4 m3 |
| | | 3. NaClO Transfer Pump 19.7 lit/min |
| | | 4.NaClO Feed Pump 120 lit/min x 2 sets |
| | | 5. Ciric Acid Tank 5 m3 |
| | | 6.Citrc Acid Feed Tank 2.4 m3 |
| | | 7. Citric Acid Transfer Pump 5.80 lit/min |
| | | 8. Citric Acid Feed Pump 240 lit/min |
| **TREATED WATER TANK** | | |
| Required Capacity | | |
| Water Reuse | Qreuse= | 2,656 m3/day |
| Retention Time | Ttrw= | 40 min for Water Reuse |
| Required Capacity | Xtrw= | 74 m3 |
| **DISINFECTION TANK (Ultimate)** | | |
| Required Capcity | | |
| Required Retention Time | Tdis= | 15 min (Including pipe Line) |
| Flow Rate | Qdis= | 114,834 m3/d (from Mass Balance) |
| Require Tank Volume | Vdis= | Qdis/24/60*Tdis= 1196 m3 |
| Pipe Line Volume | Vp= | 530 m3 (1.5m dia x 300m) |
| Actual Required Volume | Vda= | Vdis-Vp= 666 m3 |
| Dimension | | 3.1mW x41.2mL x 5.37mH= 686 m3 |
| Chlorine Dosing Rate | Ccl= | 5 mg/l |
| Required Chlorine amount | Wcl= | Qdis*Ccl*10^-3= 574 kg/day |
| Chlorine Concentration | Clconc= | 10% |
| Required NaClO flow rate | Qcl= | 5,742 lit/day |
| Required Dosing Pump Capacity | Qclp= | 4.0 lit/min |
| | | Say 2 lit/min x 2 sets (+1) |

**3 Capacity Calculation (TRAIN 1)**

| ITEM | SYMBOL | DESIGN |
|---|---|---|
| **Oil Collector** | | |
| Channel Quantity | Uc= | 1 channels |
| Channel Size | | W L D |
| | | 1 4.5 1 |
| Design Flow | Qn1s= | 0.648 m3/sec |
| Design Max Flow | Qn2s= | 0.972 m3/sec |
| Max Flow for each Channel | Qmc= | Qn2s/Uc= 0.972 m3/sec |
| Channel Loss Calculation | | |
| Hydraulic Radius | Rh= | D*W/(2D+W)= 0.333 |
| Flow Velocity | Vf= | Qmc/(D*W)= 0.97 m/sec |
| Rough Coefficient | n= | 0.014 |
| Hydraulic Gradient | I= | (n*Vf／Rh^2/3)^2= 0.000802 |
| Head Loss | Hd= | I*L= 0.0036 m |
| Pipe Skimmer Specification | | 400mm dia x opening 100mm |
| Oil Separation | | |
| Batch Tank | | W L D |
| | | 1.5 2 1 |
| Floating Scum Collector | | Float + Hose |
| Waste Oil & Grease Tank | | 200 lit |
| Return Water Pump | | 0.1 m3/m x 10mH |
| **Grit Chamber** | | |
| 1 Hourly Max Flow | Q2-D= | 84,000 m3/d |
| 2 Surface Load | Sfl-G= | 1,800 m3/m2/day |
| 3 Required Surface Area | Sa-G= | Q2-D/Sfl-G= 46.7 m2 |
| 4 Tank Width | W= | 2 m |
| 5 Tank Length | L= | 10 m |
| 6 Train | Tg= | 2 Train |
| 7 Tank Depth | D= | 2.50 m |
| 8 Actual Surface Area | Saa-G | W*L*Tg= 40 m2 > ### OK |
| 9 Required Retention Time | Tdist= | 1.5 min |
| # Required Volume | Vdist= | Q2-D/24/60*Tdist= 88 m3 |
| # Required Length | L= | Vdist/W/D/Tg= 8.75 m < 10 |
| # Tank Design | | W 2 m x L 10 m x D 2.0m (Water level) x2 train |
| **Fine Screen** | | |
| 1 Hourly Max Flow | Q2-D= | 84,000 m3/d |
| 2 Mimimum Flow Rate | Vscmin= | 0.4 m/s |
| 3 Max Fow Rate | Vscmax= | 1 m/s |
| 4 Target Flow Rate at Peak Flow | Vsc= | 0.8 m/s |
| 5 estimated Water Depth | Dsc= | 0.5 m |
| Train | Tg= | 2 |
| 6 Required Channel width | Wsc= | Q2-D/24/3600/Dsc/Vsc/tg== 1.215277778 |
| | | Say 1 m |
| **Distribution Weir** | | |
| 1 Distribution Weir | | |
| Flow throgh Distribution Weir | Qdw= | Qn2-D/Udist 10,500 m3/d |
| | | Where |
| | | Udist: Distribution Points= 8 places |
| Allowable Water Level | Hwlp= | 0.3 m |
| Weir Calculation | | Qpw=1.838*B*Hwlp^(3/2) |
| | | Where |
| | | Bdist: Weir Width |
| | | Bdist=Qpw/1.838/Hwlp^(3/2) |
| Required Weir Width | Bdist= | 0.40 m |
| | | Say 0.4 m |

| ITEM | SYMBOL | DESIGN |
|---|---|---|
| **Primary Clarifier** | | |
| 1 Design Condition | | |
| Design Flow | Qnd= | 56,000 $m^3$/day (From Mass Balance) |
| Type | | Rectangular Parallel Flow |
| Unit Number | UN= | Train 4 unit; Basin/Train 2 unit; Total 8 unit |
| 2 Design Criteria | | |
| Surface Load | Lh= | 75 m3/m2/day |
| Settling Time | Ts= | 1.5 hr |
| 3 Calculation | | |
| Flow Per Unit | Qu= | Qd / UN = 7,000 m3/day |
| Required Area | A= | Qu/Lh = 93 m2/unit |
| 4 Size | W | 4.42 m |
| | L | A/W= 21.12 m |
| | | Say 20.00 m |
| 5 Depth | D= | 2.8 m |
| Settling Time | Tsa= | D*L*W*24/Qu= 0.85 |
| 6 Specification | | 4.42mW x 16mL x 2.8 mD with Scraper x 4 sets |
| 7 Weir Calculation | | |
| Weir Load | Lwnp= | 250 m3/m/d |
| Required Weir Length | Llwnp= | Qu/Lwnp= 28.0 m |
| 8 Scum Skimmer | | |
| Pipe Skimmer | | 400mm dia skimmer x 8 nos. |
| Scum Pit | | 1 m3 x 2 sets |
| Scum Pump | | 0.1 m3/min x 10m Submersible pump to Sludge Tank |
| 9 Primary Sludge Pump | | |
| Primary Sludge Amount | Qs= | 560 m3/d total (from Mass Balance) |
| Operation Hour | Tpsp= | 8 hours/day |
| Quantity | Upsp= | 8 sets/total |
| Required Flow Rate | Qpsp= | Qs/Tpsp/Upsp= 9 m3/h |
| | | = 0.15 m3/min |
| Specification | | Submergible pump<br>0.1 m3/min x 10mH x 16sets |
| **REACTION TANK** | | |
| 1. Reaction Tank Size | | |
| Inlet Flow | Qdr | 55,440 m3/d (from Mass Balance) |
| Inlet BOD Concentration | BOD in | 167 mg/l |
| Inlet BOD Amount | BOD ia | Qdr*BODin *10^-3= 9,240 kg/d |
| BOD SS Load | BSL | 0.20 |
| MLSS Concentration | MLSS | 8,000 mg/l |
| Required Reaction Tank Volume | Vreact | BODia/BSL/MLSS *1000= 5,775 m3 |
| Train | Tra | 4 Train |
| Required Volume for each train | Vret | Vreact/Tra= 1,444 m3 |
| Reaction Tank Size | | |
| Width | Wre | 9.0 m |
| Length | Lre | 45 m |
| Depth | Dre | 3.3 m |
| Volume | Vreta | 1,337 m3 > ### OK |
| Total Aeration Volume | Vretat | 5,346 m3-total |

| ITEM | SYMBOL | DESIGN |
|---|---|---|
| **MBR** | | |
| 2 Design Condition | | |
| Design Flow | Qdr | 55,440 $m^3$/day (From Mass Balance) |
| Type | | Flat Type Membrane |
| Flux | Fln | 0.7 m3/m2d 29.2 lmh |
| Flux at Peak | Flmax | 1.4 m3/m2d 58.3 lmh |
| Membrane Area per Cassettes | Ac | 400 m2 |
| Cassette quantity | | |
| Required Membrane Area | Arq | Qsec/Fln= 79,200 m2 |
| Required Cassette quantity | Ncs | Arq/Ac= 198 nos. |
| Actual Cassette quantity | Ncsa | 156 nos. |
| Cassette Installtion Area | | |
| Cassette size | | W 944.0 L 2186.0 H 2923 |
| Permeate Pump | | |
| 1 line Cassettes qantity | U1line= | 20 |
| Required Flow Rate | F1line= | U1line *Ac*Fln= 5,460 m3/d ###'min |
| | | U1line *Ac*Flmax 10,920 m3/d m3/min |
| | | say 3.6 m3/min x 5mH x 3 sets |
| Air Flow per Cassette | Famu | 2 Nm3/min/cassettes |
| Cassette Quantity | Ncsa | 156 nos |
| Total Air Flow | Qamt | Famu*Ncsa= 312 Nm3/min |
| Oxygen Transfer rate for Diffuser | Eam | 9% |
| SOR calculation for MBR Blower | SORm | Qamt*(Eam*10^-2*ρ*Ow) *60 |
| | | ρ : Air Density= 1.3 kg air/$Nm^3$ |
| | | Ow: Oxygen Weigh per Air Unit 0.2 kg-O2/kg-air |
| | SORm | 508 kg-O2/h |
| Specification | | 78 m3/min x 4.mH x 4 (+1 S/B) |
| 3 Oxygen Requirement(Blower Calculation) | | |
| 3.1 Oxygen Demand | | |
| 1) Oxygen Demand for Organic Matter | | |
| Oxygen Demand | Db = | (BODin-BODout)*Qin /1000*B |
| | | Where |
| | | BODin: BOD Inlet 167 mg/l (Mass Balance) |
| | | BODout: BOD outlet 20 mg/l (Treated Water) |
| | | Qin: Flow Inlet 55,440 m3/d (Mass Balance) |
| | | B: Required Oxygen per BOD removal per k 0.5 kg-O2/kg-BOD |
| Oxygen Demand Calculation | Db= | 3,659 kg-O2/day |
| 2) Oxygen Demand for Nitrification | | |
| Oxygen Demand | Dn= | C*(Nnin-Nnout)*Qin/1000 |
| | | Where |
| | | C: Oxygen Requirement for nitrification per 4.6 kg-O2/kg-N |
| | | Nnin: inlet Organic Nitrogen 27 mg/l (Mass Balamce) |
| | | Nout: Outlet Organic Nitrigen 1 mg/l |
| Oxygen Deman Calculation | Dn= | 6,650 kg-O2/day |
| 3) Oxygen Demand for | | |
| For Endogenous Respiration | De= | Vreta*MLSS*Tra* η /1000 |
| | | Where |
| | | Vreta: Reaction Tank Volume 1,337 m3 |
| | | MLSS: MLSS in Aeration Ta 8000 mg/l |
| | | Tra: Train 4 |
| | | η : Oxygen demand for Endogeneous Respiration per MLVSSkg 0.1 kg-O2/kg-MLVSS |
| Oxygen Deman Calculation | De= | 4,277 kg-O2/day |

| ITEM | SYMBOL | DESIGN |
|---|---|---|
| 4) Remaining O2 in Reaction Tank | D0= | Ca*Qin/1000<br>Where<br>Ca: Remaining O2 Concentration 2 mg/l<br>Qin: 55,440 m3/d |
| Oxygen Deman Calculation | D0= | 111 kg/d |
| 5) Total Oxygen Demand | AOR | Db+Dn+De+D0= 14,697 kg/d |
| 3.2 Standard Oxygen Demand | SORa | $SORa=(AOR*Csw * r) / (1.024^{(T-20)} * \alpha *( \beta * Cs * r-C_A))/t$<br><br>Where<br>Csw: Oxygen saturation concentration in clean water at temperature 20℃ Csw= 8.8 mg/l<br>T: Temperature of Water T= 26 ℃<br>$\alpha$ : Ratio of Oxygen transfer rate in the waste to that in clear water at the same temperature $\alpha$ = 0.8<br>$\beta$ : Ratio of Oxygen saturation concentration in the waste to that in clean water $\beta$ = ###<br>Cs: Oxygen saturation concentration in clean water at Temperature T Cs= 8.1 mg/l<br>$C_A$: Residual dissolved oxygen concentration in the waste water $C_A$= 2 mg/l<br>r : Correction of Cs from water depth r=1+(H/2)/10.24= ###<br>H : Water Depth(Average of HWL and LWL) H= ### m<br>t : Aeration time per day t= 24 hr/day |
| Calculation of SOR | SORa= | 946 kg-O2/h 22,696 kg/d |
| Required SOR for Blower | SOR = | SORa-SORm= 438 kg-O2/h |
| 3.3 Air Requirement | Qair= | $SOR/(Ea\times10^{-2}\times \rho \times Ow)/60=$<br><br>Where<br>Ea: Diffuser Efficiency at Diffuser Depth= ###<br>$\rho$ : Air Density= 1.3 kg air/$Nm^3$<br>Ow: Oxygen Weigh per Air Unit 0.2 kg-O2/kg-air |
| Calculation of Qair | Qair= | 121 Nm3/min |
| Actual Air Flow | Qaa= | Qair*(273+T)/273= 133 m3/min<br>(T=26℃) 191,116 m3/day |
| Specification | | 30 Nm3/min x 4mH x 4 sets (+1 set S/B) |
| Waste Sludge Quantity | Qw= | 715 m3/day (from Mass Balance) |
| Operation Hour | Tw= | 8 hours |
| Quantity | Uw= | 4 sets |
| Required Flow Rate | Qws= | Qw/Tw/Uw= 22.35 m3/h<br>= 0.37 m3/min |
| Specification | | End Suction Non Clog Type<br>0.3m3/min x 10mH x 4 sets (+4sets Stand-by) |

| ITEM | SYMBOL | DESIGN |
|---|---|---|
| **CHEMICAL CLAENING** | | |
| 1 Chemical Feeding | | |
| Flow per cassettes | Vc= | Volume 1200 lit/cassettes |
| | Qch= | Feed Rate 180~240 240 lit/min |
| Chemical Concentration | Ccl= | NaClO 0.25~0.6% 0.50% |
| | Cac= | Citric Acid 0.5~1% 1% |
| Cleaning cassettes No. | Xclean= | one Permeate Pump : 19.5 cassettes |
| Cleaning Solution Volume | Vct= | Vc*Xclean= 23.4 m3 |
| Cleaning Solution Feed Rate | Qcht= | Qch*Xclean= 4.68 m3/min |
| Chemical Usage per Cleaning | | |
| NaClO | Vclc= | Vct*Ccl*1000= 117 kg/cleaning as 100% NaClO |
| | | 886 lit/cleaning as 12% NaClO |
| Citric Acid | Vacc= | Vct*Cac*1000= 234 kg/cleaning as 100% Citric Acid |
| | | 261 lit/cleaning as 70% Citric Acid |
| | | Den 1.3 kg/lit |
| Required Chemical Tank Volume | | |
| NaClO | Vtcl= | Vclc*30/1000= 27 m3 as 12% NaClO |
| | | say 70 m3 |
| | | 1 month retention : say every day 1 line cleaning (8 days interval) |
| Citric Acid | Vtac= | Aacc*8/1000= 2.1 m3 as 70% Citrica Acid |
| | | 1 month retention : say every month 1 time per 1 line (total 8 lines) |
| Required Chemical Feed Tank | Vcfeed= | Vc/1000= 1.2 m3 |
| Specification | | 1. NaClO Tank 70 m3 |
| | | NOTE: Same size with New Plant |
| | | 2. NaClO Feed Tank |
| | | 3. NaClO Transfer Pump |
| | | 4.NaClO Feed Pump Item 2 to 8,Use New |
| | | 5. Ciric Acid Tank Plant Chemical Feed |
| | | 6.Citrc Acid Feed Tank System as commom |
| | | 7. Citric Acid Transfer Pump |
| | | 8. Citric Acid Feed Pump |
| **TREATED WATER TANK** | | |
| Required Capacity | | |
| Water Reuse | Qreuse= | 2,000 m3/day |
| Retention Time | Ttrw= | 40 min for Water Reuse |
| Required Capacity | Xtrw= | 56 m3 |

**3 Capacity Calculation (Sludge Stream)**

| ITEM | SYMBOL | DESIGN | | | |
|---|---|---|---|---|---|
| **Gravity Thickener for Primary Sludge** | | | | | |
| 1 Sludge Flow | Qgtn= | 818 | m3/d | (from Mass Balance-New) | |
| | Qgte= | 560 | m3/d | (from Mass Balance-Ex) | |
| Total | Qgt= | 1,378 | m3/d | | |
| 2 Solid Loading | Slg= | 90 | kg/m2/d | | |
| 3 SS in Sludge | SSgn= | 8,179 | kg/d | (from Mass Balance-New) | |
| | Ssge= | 5,600 | kg/d | (from Mass Balance-Ex) | |
| Total | Ssg= | 13,779 | kg/d | | |
| 4 Required Area | Arg= | SSg/Slg= | 153.1 | m2 | |
| 5 Unit No. | Ugt= | 2 | Units | | |
| 6 Required Area for each Unit | Argu= | Arg/Ugt= | 76.6 | m2 | |
| 7 Required Diameter | Dgt= | sqrt(Arg*4/pi)= | 9.9 | m | |
| 8 Designed Diameter | Dgta | | 10 | m | |
| 9 Water Depth | Hwd= | | 4 | m | |
| 10 Total Volume | Vgt= | Pi()*Dgta^2/4*Hwd= | | 314 | m3 |
| 11 Retention Time | Trgt= | Vgt/Qgt*24= | 9.2 | hours | |
| 12 Thickener Pump | | | | | |
| Flow for New Plant | Qgsln= | 184 | | | |
| Flow for Existion | Qgsle= | 126 | | | |
| Flow Rate | Qgsl= | 310.03 | m3/d | | |
| Operation Hour | Tgsl= | 8 | h/d | | |
| Quantity | Ugsl= | 2 | sets | | |
| Required Flow Rate | Qgp= | 19.38 | m3/h | | |
| | | 0.32 | m3/min | | |
| Specification | | 0.4 m3/min x 10mH x 2 sets (+ 2 sets Stand-by) | | | |
| **Mechanical Thickener for Secondary Sludge** | | | | | |
| 1 Sludge Flow | Qmtn= | | 1,077 | m3/d | (from Mass Balance-New) |
| | Qmte= | | 715 | m3/d | (from Mass Balance-Ex) |
| Total | Qmt= | | 1,792 | m3/d | |
| 2 Loading Capacity | Slmt= | | 90 | m3/h/unit | |
| 3 Operation Hour | Homt= | | 24 | h/d | |
| 4 Operation day per Week | Tomt= | | 7 | days/week | |
| 5 Required Thickening Capacity | Qumt= | Qmt*7/Homt/Tomt= | | 75 | m3/h |
| 2 Required quantity | Umt= | Qumt/Slmt= | 0.83 | Unit | |
| 6 Designed Quantity | Umta= | 1 | Units | | |
| 7 Polymer Dosing Rate | Rmtp= | 0.30% | per DS | | |
| 8 Sludge Flow | SSmtn= | 10,766 | kg/d | (from Mass Balance-New) | |
| | Ssmte= | 7,153 | kg/d | (from Mass Balance-Ex) | |
| Total | SSmt= | 17,919 | kg/d | | |
| 9 Required Polymer amount (For Dosing Pump selection) | Mpmt= | SSmt*Rmtp= | 53.8 | kg/d | (for Unitility calculation) |
| 10 Sludge Concentration (Inlet) | Cssmt= | SSmt/Qmt= | 10.00 | kg/m3 | ### |
| 11 SS flow per unit | SSmtu= | Slmt*Cssmt= | 900.0 | kg/h | |
| 12 Required Polymer amount per u | Mpmtu= | Ssmtu*Rmtp= | 2.7 | kg/h/unit | |
| 13 Polymer Dilution Rate | Lpdrp= | 0.20% | | | |
| 14 Required Polymer feed Flow (For Polymer Tank Selection) | Qpmt= | Mpmtu/Lpdrp= | 1,350 | lit/h/unit | |
| 15 Polymer tank retention time | Hmtpt= | 8 | hours | | |
| 16 Required Tank Volume (total) | Vptmt= | Qpmt*Hmtpt*Umta*10^-3= | | 10.8 | m3 |
| 17 Tank quantity | Uptmt= | 1 | unit | | |
| 18 Tank Capacity | Vpmtu= | Vptmt/Uptmt= | 10.8 | m3/unit | |
| Equipment | | Feed Pump | | 1.5 m3/min x 10mH x 2 unit | |
| | | Mechanical Thickener | | 90 m3/h/unit x 1 Unit (+ 1 Stand-by) | |
| | | Polymer Dosing Pump | | 1080lit/h x 1 Unit (+ 1 stand-by) | |
| | | Auto Polymer Feed Equipment | | 1.4 m3/h x 1 unit (+1 unit Stand-by) | |

## 3 Capacity Calculation (Sludge Stream)

| ITEM | SYMBOL | DESIGN |
|---|---|---|
| **SLUDGE Tank** | | |
| Sludge Flow to Mechanical Thi | Qfm= | 896 m3/d |
| Retention time 4 hours | Vslt= | 149 m3 |
| Tank Size | W= | 8 m |
| | L= | 5 m |
| | D= | 4 m |
| | | 160 m3 |
| **Mixed Sludge Tank** | | |
| Sludge Flow to Dewatering Unit | | |
| From Gravity Thickener | Qg= | 310.03 m3/d |
| From Mech Thickener | Qm= | 411 m3/d |
| Total | | 720.79 m3/d |
| Retention | | 4 hours |
| Required Volume | | 120.13 m3 |
| Tank Size | W= | 8 m |
| | L= | 4 m |
| | D= | 4 m |
| | | 128 m3 |
| **Dewatering Unit** | | |
| 1 Sludge Flow | | |
| | Qdwe= | 721 m3/d |
| 2 Solid Loading Capacity | Ldw= | 880 kg/h/unit |
| 3 Dry Solid Flow | | |
| | SSdw= | 28,832 kg/d |
| 4 Operation Hour | Hodw= | 24 h/d |
| 5 Operation day per Week | Todw= | 7 days/week |
| 6 Required Dewatering Capacity | Ssudw= | SSdw*7/Hodw/todw= 1,201 kg-ds/h |
| 4 Required Quantity | Udw= | Ssudw/Ldw= 1.37 Unit |
| 5 Design Quantity | Udwa= | 2 Unit |
| Polymer | | |
| Polymer Dosing Rate | Rdwp= | 1.5% |
| Required Polymer amount | Mpdw= | SSdw*Rdwp= 432.5 kg/d (for Unitility calculation) |
| (For Dosing Pump selection) | | |
| SS flow per unit | Ldw= | 880 kg/h/unit |
| Required Polymer amount per u | Mpdwu= | Ldw*Rdwp= 13.2 kg/h |
| Polymer Dilution Rate | Lpdw= | 0.2% |
| Required Polymer feed Flow | Qpdw= | Mpdwu/Lpdw= 6600 lit/h |
| | | 110.0 lit/min |
| (For Polymer Tank Selection) | | |
| Polymer tank retention time | Hdwpt= | 8 hours |
| Required Tank Volume (total) | Vptdw= | Qpdw*Hdwpt*Udwa*10^-3= 105.6 m3 |
| Tank quantity | Uptdw= | 5 unit |
| Tank Capacity | Vpdwu= | Vptdw/Uptdw= 21.12 m3/unit |

## 3 Capacity Calculation (Sludge Stream)

| ITEM | SYMBOL | DESIGN | | | | |
|---|---|---|---|---|---|---|
| Coagulant | | | | | | |
| Coagulant Dosing Rate | Rdwc= | 15% | | | | |
| Required Coagulant amount | Mcdw= | SSdw*Rdwc= | | 4,325 | kg/d | (for Unitility calculation) |
| (For Dosing Pump selection) | | | | | | |
| SS flow per unit | Ldw= | | 880.0 | kg/h/unit | | |
| Required Coagulant amount per | Mcdwu= | Ldw*Rdwc= | | 132.0 | kg/h | |
| Coagulant Dilution Rate | Lcdw= | | 16% | | | |
| Required Coagulant feed Flow | Qcdw= | Mcdwu/Lcdw= | | 825.0 | lit/h | |
| | | | | 13.8 | lit/min | |
| (For Coagulant Tank Selection) | | | | | | |
| Coagulant tank retention time | Hdwct= | | 8 | hours | | |
| Required Tank Volume (total) | Vctdw= | Qcdw*Hdwc | | 6.60 | m3 | |
| Tank quantity | Uctdw= | | 2 | Units | | |
| Tank Capacity | Vcdwu= | Vctdw/Uctdw= | | 3 | m3/unit | |
| Sludge Feed Pump Capacity | Qslf= | Ldw/Ctsl= | 22000 | lit/h= | 0.4 | ′min |
| | | Ctsl= | 4% | | | |
| Equipment | | Feed Pump x 3 unit | | 0.36667 | m3/min | |
| | | Dewatering Unit x 2 Unit (+1 Stand-by) | | 880.0 | kg/h/unit | |
| | | Polymer Doing Pump x 3 unit | | 110.0 | lit/min | |
| | | Coagulant Dosing Pump x 3unit | | 13.8 | lit/min | |
| | | Auto Polymer Feed Equipment x 2 unit | | 15 | m3/h/unit | |
| | | Coagulant Tank x 2 unit | | 9 | ′unit | |

## 3 Capacity Calculation (Odour Treatment)

| ITEM | SYMBOL | DESIGN | | | | | |
|---|---|---|---|---|---|---|---|
| **BIO TOWER** | | | | | | | |
| Head Works | | | | | | | |
| Air Exchange I | Tair= | 6 | times/hour | | | | |
| Head Works Room Volume | | | | | | | |
| | Vhead= | Grid +Pump pit | | 3,081 | m3 | | |
| | | Note: Pump Room and other place shall be normal ventilation | | | | | |
| | | | | | | Chimney | |
| Odour Flow Rat | QairH= | 18,487 | m3/h= | 5.14 | ı3/sec | 0.7 | m |
| Linear Velocity | Lvb= | 0.3 | m/s | | | | |
| Required Area | Aair= | QairH/Lvb | 17.1 | m2 | | | |
| S/V | Asv= | 200 | m3/m3/h | | | | |
| Required Medi | Vmedia= | QairH/Asv | 92.4 | m3 | | | |
| Size | W= | 2 | m | | | | |
| | L0= | 8.6 | m | | 4.3 | m x 2 cel | |
| Actual L | L= | 10.0 | m | | | | |
| Media Height | Hmed= | 5.40 | m | | | | |
| Actual H | H= | 8 | mH | | | | |
| Sludge Dewatering Room | | | | | | | |
| Air Exchange I | Tair= | 6 | times/hour | | | | |
| Dewatering Ro | Vdew= | 2,100 | m3 | | | Chimney | |
| Odour Flow Rat | QairS= | 12,600 | m3/h | | | 0.5 | m |
| Linear Velocity | Lvb= | 0.3 | m/s | | | | |
| Required Area | Aair= | QairS/Lvb | 11.7 | m2 | | | |
| S/V | Asv= | 200 | m3/m3/h | | | | |
| Required Medi | Vmedia= | QairS/Asv | 63.0 | m3 | | | |
| Size | W= | 3.00 | m | | | | |
| | L0= | 3.9 | m | | 1.9 | m x 2 cel | |
| Actual L | L= | 9.5 | m | | | | |
| Media Height | Hmed= | 5.40 | m | | | | |
| Actual H | H= | 8 | mH | | | | |

| | Description | Flow Rate (m3/d) Max | Velocity (m/sec) | Required Size (m) | Pipe Size (mm) |
|---|---|---|---|---|---|
| 1 | Feed Pipe | | | | |
| 1.1 | From Pump to WTF 1 | 105,000 | 1.5 | 1.015657 | 1100 |
| 1.2 | From Pump to WTF 2 | 63,000 | 1.5 | 0.786725 | 800 |
| 2 | Overflow pipe | | | | |
| 1.1 | After WTF 1 Settling Tank | 105,000 | 1.50 | 1.015657 | 1100 |
| 1.2 | After WTF 2 Settling Tank | 63,000 | 1.00 | 0.963537 | 1000 |
| 3 | Before Disinfection Tank | 168,000 | 1.00 | 1.57345 | 1500 |

| Facility | Purpose of Use | | ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ystem | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total Number of Unit | Number of Duty Operation | Number of Simultaneous Operat | Water Supply Amount per | Water Supply Hours | Maximum Instantaneous Water | Hourly Maximum Water Suppl | Daily Water Supply Amou | Filtered Water | | |
| | | unit | unit | unit | /min・un | hr/d・un | L/min | $m^3/h$ | $m^3/d$ | | | |
| | (Reuse Water) | | | | | | | | | | | |
| | Reaction Tank | 160 | 160 | 160 | 15 | 24 | 2,400 | 144.0 | 3456.0 | | | Scum Removal Water (nozzles) |
| | Dewatering Unit | 8 | 8 | 8 | 100 | 24 | 800 | 48.0 | 1152.0 | | | |
| | Floor Washing | 1 | 1 | 1 | 20 | 8 | 100 | 6.0 | 48.0 | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | Sub-Total | | | | | | 3,300 | 198 | 4,656 | | | |

# Appendix 5 Capacity Calculation of the Existing WTF

# APPENDIX 5

## Temporary Facility (Existng WTF)

## CALCULATION SHEET

## (Conventional Activated Slude Method)

# 1. BASIC CONDITIONS

## 1-1 BASIC ITEMS

(1) Name :

(2) Land Area : Approximately ha

(3) Ground Level : 30.60 m

(4) Inlet Pipe Diameter and Invert Level :

(5) Land Use : Existing

(6) Collection System : Separate Sewer System

(7) Treatment Meth **[ Sewage Treatment ]** Standard Activated Sludge Method
**[ Sludge Treatment ]**

(8) Effluent Discharge Point : River

(9) Discharge Point Water Level : m

(10) Design Target Year :

## 1-2 Design Population

Design Population (STP)Proposed Project: PE (Population Equivalent)

**2 DESIGN CALCULATION**

**2-1 DESIGN CONDITION AND CRITERIA**

## 2-1-1 Design Sewage Flow

1)Proposed Project

| ITEM | $m^3$/day | $m^3$/hr | $m^3$/min | $m^3$/sec |
|---|---|---|---|---|
| Daily Average ($Q_1$) | 2,000 ($Q_{1\text{-}D}$) | 83 ($Q_{1\text{-}H}$) | 1.39 ($Q_{1\text{-}M}$) | 0.023 ($Q_{1\text{-}S}$) |
| Hourly Maximum (PEAK FLOW)($Q_2$) | 2,000 ($Q_{2\text{-}D}$) | 83 ($Q_{2\text{-}H}$) | 1.39 ($Q_{2\text{-}M}$) | 0.023 ($Q_{2\text{-}S}$) |

**2-1-2 Design Sewage Quality**

| ITEM | INFLUENT | Primary Treatment | | Secondary Treatment | | |
|---|---|---|---|---|---|---|
| | Sewage (mg/L) | Removal % (%) | Effluent (mg/L) | Removal Ratio (%) | EFFLUENT (mg/L) | Total Removal |
| BOD | 600 | 32% | 408 | 95.1% | 20 | 96.7% |
| SS | 600 | 40% | 360 | 94.4% | 20 | 96.7% |
| COD | 500 | - | | | 60 | |
| T-N | - | | | | | |
| AMN | - | | | | - | |
| Nitrate N | - | | | | - | |
| T-P | - | | | | - | |
| Oil & Grease | - | | | | 2 | |

**2-1-3 Design Criteria**

| ITEMS | UNIT | Standard Application | Application |
|---|---|---|---|
| Reaction Tank | | | |
| (1) BOD-SS Load | kg/kg/day | 0.1~0.25 | 0.2 |
| (2) MLSS Concentration | mg/l | 3,000 | 3,000 |
| (3) Return Sludge Ratio | % | 100 | 100 |
| (4) SRT | day | NA | NA |
| (5) Water Depth | m | 4 | 4.2 |
| (6) Hydraulic Retention Time (HRT) | hr | Calculation | |
| (7) Oxygen Requirement | $kgO_2$/kg-subatrate | 1.5 | 1.5 |
| (8) BOD Yield | % | 50% | 50% |
| (9) Organic Ratio in SS | % | 50%~85% | 80% |
| (10) Sludge self oxidization rate | 1/day | 0.01~0.07 | 0.05 |
| (11) Remain Oxygen in Aeration Tank | mg/l | 1~2 | 2.0 |
| Secondary Clarifier | | | |
| (1) Surface Load for Daily Average | m3/m2/d | 20 | 20 |
| (2) Water Depth | m | 3.5 | 3.5 |
| (3) Weir Loading | m3/m/d | 150 | 150 |
| (4) Sludge Concentration | % | 0.80% | 0.8% |
| (5) Settling Time | hr | 4 | 4.0 |

## 2.3 Capacity Calculation (Liquid Stream)

| ITEM | SYMBOL | DESIGN |
|---|---|---|

# REACTION TANK

| | | | | | |
|---|---|---|---|---|---|
| 1. Reaction Tank Size | | | | | |
| Inlet Flow | Qdr | 2,000 m3/d | | | |
| Inlet BOD Concentration | BOD in | 600 mg/l | | | |
| Inlet BOD Amount | BOD ia | Qdr*BODin *10^-3= | 1,200 kg/d | | |
| BOD SS Load | BSL | 0.2 | | | |
| MLSS Concentration | MLSS | 3000 mg/l | | | |
| Required Reaction Tank Volume | Vreact | BODia/BSL/MLSS *1000= | 2,000 m3 | | |
| Train | Tra | 1 Train | | | |
| Required Volume for each train | Vret | Vreact/Tra= | 2,000 m3 | | |
| Reaction Tank Size | | | | | |
| Width | Wre | 18 m | | | |
| Length | Lre | 50 m | | | |
| Depth | Dre | 4 m | | | |
| Volume | Vreta | 3,780 m3 | | > 2,000 | OK |
| Total Aeration Volume | Vretat | 3,780 m3-total | | | |
| 2 Oxygen Requirement(Surface Aerator Calculation) | | | | | |
| 2.1 Oxygen Demand | | | | | |
| 1) Oxygen Demand for Organic Matter | | | | | |
| Oxygen Demand | Db = | (BODin-BODout)*Qin /1000*B | | | |
| | | Where | | | |
| | | BODin: BOD Inlet | 600 mg/l | | |
| | | BODout: BOD outlet | 20 mg/l | (Treated Water) | |
| | | Qin: Flow Inlet | 2,000 m3/d | | |
| | | B: Required Oxygen per BOD removal per kg | | 0.45 | kg-O2/kg-BOD |
| Oxygen Demand Calculation | Db= | 522 kg-O2/day | | | |
| 2) Oxygen Demand for Nitrification | | | | | |
| Oxygen Demand | Dn= | C*(Nnin-Nnout)*Qin/1000 | | | |
| | | Where | | | |
| | | C: Oxygen Requirement for nitrification per kg | | 4.57 | kg-O2/kg-N |
| | | Nnin: inlet Organic Nitrogen : | 0 mg/l | (Mass Balamce) | |
| | | Nout: Outlet Organic Nitrigen | 0 mg/l | | |
| Oxygen Deman Calculation | Dn= | 0 kg-O2/day | | | |
| 3) Oxygen Demand for | | | | | |
| For Endogenous Respiration | De= | Vreta*MLSS*Tra* $\eta$ /1000 | | | |
| | | Where | | | |
| | | Vreta: Reaction Tank Volume= | 3,780 m3 | | |
| | | MLSS: MLSS in Aeration Tank | 3000 mg/l | | |
| | | Tra: Train | 1 | | |
| | | $\eta$ : Oxygen demand for Endogeneous Respiration per MLVSSkg | | 0.1 | kg-O2/kg-MLVSS |
| Oxygen Deman Calculation | De= | 1,134 kg-O2/day | | | |
| 4) Remaining O2 in Reaction Tank | D0= | Ca*Qin/1000 | | | |
| | | Where | | | |
| | | Ca: Remaining O2 Concentration | | 2 | mg/l |
| | | Qin: | 2,000 m3/d | | |
| Oxygen Deman Calculation | D0= | 4 kg/d | | | |
| 5) Total Oxygen Demand | AOR= | Db+Dn+De+D0= | 1,660 kg/d | | |
| 6) Surface Aerator Oxygen Transfer | Ox= | 1.5 kg-O2/kWh | | | |
| 7) Standard Surface Aerator Oxygen Transfer | | | | | |
| | Oxs= | Ox *(A*Cs-C)/Cs*1.024^(t-20)*B= | 1.073 kg-O2/kWH | | |
| | | Where: | | | |
| | | A: Coefficient for Saturated Oxygen Concentration: | | 0.95 | |
| | | Cs: Average Saturated Oxygen Concentration: | | 9.88 | mg/l |
| | | C: Reaminig DO Concentration | | 2 | mg/l |
| | | t: temperature | | 25 | ℃ |
| | | B: Power Efficiency | | 85% | |
| 8) Required Aerator kW | Kwr= | AOR/24/Oxs= | 64.46101274 kW | | |
| 9) Equipment | | 37kW x 3 sets =111kW | | OK | |

## SECONDARY SETTLING TANK

| ITEM | SYMBOL | DESIGN |
|---|---|---|
| 1.Design Condition | | |
| Design Flow | Qsec | 2,000 $m^3$/day (From Mass Balance) |
| Type | | Squire Settling Tank |
| Unit Number | Tsec | Train: 1 unit; Basin/Train: 1 unit; Total: 1 unit |
| 2. Design Criteria | | |
| Surface Load | Lsec | 10 m3/m2/day |
| Settling Time | Ts | 4.0 hr |
| 3. Calculation | | |
| Flow Per Unit | Qusec | Qsec / Usec = 2,000 m3/day |
| Required Area | Afs | Qusec/Lsec = 200 m2/unit |
| Tank Width | Dfsa | 18.0 m |
| Required Area | Lfsa | Afs/Dfsa= 11.1 m2/unit |
| Actual Length | La | 24.0 m |
| Actual Area | Aa | Dfsa*La= 432.0 m2 |
| Actual Surface Load | Lseca | Qusec/Aa = 4.6 m3/m2/d < 10 OK |
| Weir Loading | Lw | 150.0 m3/m/d |
| Required Weir Length | Lew | Qusec/Lw= 13.3 m<br>Say 18.0 m |
| 2.Specification | | Square Settling Tank 18m x 24m x 1 sets |
| 3. Return Sludge Pump | | |
| MLSS | MLSS= | 3,000 mg/l |
| Secondary Sludge Concentration | Sc= | 8,000 mg/l |
| Required Return Sludge Rate | Rr= | MLSS/(Sc-MLSS)= 0.60 - |
| Required Return Sludge Flow | Qrr= | Qusec*Rr= 1,200 m3/d |
| Return Sludge Flow (more than Rr) | Qr= | 1,200 m3/d (50% Return) |
| Operation Hour | Tr= | 24 hours/day |
| Quantity | Ur= | 1 sets |
| Required Flow Rate | Qrs= | Qr/Tr/Ur= 50 m3/h<br>= 0.8 m3/min |
| Specification | | Submergible Pump<br>0.1m3/min x 5mH x 8 sets |
| 4. Waste Sludge Pump | | |
| Waste Sludge Quantity | Mw= | 1,200 kg/d BOD Sludge Yield 100% |
| Concentration | Csl= | 0.6 % |
| Waste Sludge Flow | Qw= | 2.0 m3/d |
| Operation Hour | Tw= | 6 hours |
| Quantity | Uw= | 1 sets |
| Required Flow Rate | Qws= | Qw/Tw/Uw= 0.33 m3/h<br>= 0.01 m3/min |
| Specification | | Submergible Pump<br>0.01m3/min x 10mH x 1 sets (+1sets Stand-by) |

# Appendix 6 Flow Calculation (CBD)

## *APPEDIX6 Flow Calculation (CBD)*

| Section | Section (downstream) | Area | | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) − (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Accumulation | Partial | Accumulation | Unit Vol. | Black water vol. Partial | Black water vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. | Invert level (bottom) | Invert level | Earth Covering | Man-hole, head | | |
| | | | | | | | | | | | | | | | | Up | Up | Up | Up | M | | |
| | | | | | | | | | | | | | | | | Dw | Dw | Dw | Dw | H | | |
| | | ha | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | m | m | m | | |
| **Line1** | | | | | | | | | | | | | | | | | | | | | | |
| Ld7 | Ld15 | 1.53 | 5.54 | 138.0 | 272.0 | 0.0143 | 0.0025 | 0.009 | | | 0.009 | 200 | 6.50 | 0.842 | 0.026 | 14.800 | 11.269 | 11.529 | 3.27 | | | 2.857 |
| | | | | | | | | | | | | | | | | 14.199 | 10.372 | 10.632 | 3.57 | | | 0.017 |
| Ld15 | Ld20 | 3.36 | 8.90 | 273.0 | 545.0 | 0.0143 | 0.0056 | 0.015 | | | 0.015 | 250 | 5.00 | 0.857 | 0.042 | 14.199 | 10.322 | 10.632 | 3.57 | | | 2.857 |
| | | | | | | | | | | | | | | | | 12.954 | 8.957 | 9.267 | 3.69 | | | 0.027 |
| Ld20 | Ld21 | 5.37 | 14.27 | 432.0 | 977.0 | 0.0143 | 0.0089 | 0.024 | | | 0.024 | 300 | 4.00 | 0.865 | 0.061 | 12.954 | 8.907 | 9.267 | 3.69 | | | 2.585 |
| | | | | | | | | | | | | | | | | 11.052 | 7.179 | 7.539 | 3.51 | | | 0.037 |
| Ld4 | Ld16 | 3.44 | 3.44 | 238.0 | | 0.0143 | 0.0057 | 0.006 | | | 0.006 | 200 | 12.00 | 1.144 | 0.036 | 17.355 | 14.095 | 14.355 | 3.00 | | | 6.316 |
| | | | | | | | | | | | | | | | | 13.852 | 10.539 | 10.799 | 3.05 | 0.70 | | 0.030 |
| Ld10 | Ld16 | 4.17 | 7.61 | 279.0 | 279.0 | 0.0143 | 0.0069 | 0.007 | | | 0.007 | 200 | 6.00 | 0.809 | 0.025 | 14.199 | 10.939 | 11.199 | 3.00 | | | 3.623 |
| | | | | | | | | | | | | | | | | 13.852 | 9.265 | 9.525 | 4.33 | | | 0.018 |
| Ld16 | Ld21 | 4.25 | 11.86 | 308.0 | 587.0 | 0.0143 | 0.007 | 0.020 | | | 0.020 | 250 | 5.00 | 0.857 | 0.042 | 13.852 | 9.215 | 9.525 | 4.33 | | | 2.143 |
| | | | | | | | | | | | | | | | | 11.052 | 7.675 | 7.985 | 3.07 | | | 0.022 |
| Ld21 | Lt2 | 3.83 | 29.96 | 284.0 | 1261.0 | 0.0143 | 0.0063 | 0.050 | | | 0.050 | 400 | 3.00 | 0.908 | 0.114 | 11.052 | 7.079 | 7.542 | 3.51 | | | 2.303 |
| | | | | | | | | | | | | | | | | 9.143 | 5.627 | 6.090 | 3.05 | 0.60 | | 0.065 |
| Ld11 | Ld12 | 3.00 | 3.00 | 232.0 | 232.0 | 0.0143 | 0.005 | 0.005 | | | 0.005 | 200 | 6.00 | 0.809 | 0.025 | 13.852 | 10.592 | 10.852 | 3.00 | | | 5.000 |
| | | | | | | | | | | | | | | | | 12.765 | 9.200 | 9.460 | 3.31 | | | 0.020 |
| Ld12 | Ld17 | 3.01 | 6.01 | 253.0 | 485.0 | 0.0143 | 0.005 | 0.010 | | | 0.010 | 200 | 6.00 | 0.809 | 0.025 | 12.765 | 9.200 | 9.460 | 3.31 | | | 2.500 |
| | | | | | | | | | | | | | | | | 11.727 | 7.682 | 7.942 | 3.79 | | | 0.015 |
| WD1 | Ld17 | 150.00 | 150.00 | | | 0.0071 | 0.1227 | 0.123 | | | 0.123 | 600 | 2.20 | 1.019 | 0.288 | 9.350 | 5.148 | 5.828 | 3.52 | | | 2.347 |
| | | | | | | | | | | | | | | | | 9.350 | 4.737 | 5.417 | 3.93 | | | 0.165 |
| Ld17 | Lt2 | 4.05 | 10.06 | 192.0 | 677.0 | 0.0143 | 0.0067 | 0.139 | | | 0.139 | 600 | 2.20 | 1.019 | 0.288 | 13.617 | 4.737 | 5.417 | 8.20 | | | 2.066 |
| | | | | | | | | | | | | | | | | 9.143 | 4.315 | 4.995 | 4.15 | | | 0.149 |
| Lt2 | Pb2 | 11.67 | 46.79 | 591.0 | 1852.0 | 0.0163 | 0.022 | 0.211 | | | 0.211 | 700 | 2.00 | 1.076 | 0.414 | 9.143 | 4.215 | 5.005 | 4.14 | | | 1.963 |
| | | | | | | | | | | | | | | | | 9.719 | 3.033 | 3.823 | 5.90 | | | 0.203 |
| ED1 | Lt1 | 150.00 | 150.00 | | | 0.0071 | 0.1227 | 0.123 | | | 0.123 | 600 | 2.20 | 1.019 | 0.288 | 8.550 | 4.870 | 5.550 | 3.00 | | | 2.347 |
| | | | | | | | | | | | | | | | | 8.550 | 4.870 | 5.550 | 3.00 | | | 0.165 |

## *APPEDIX6 Flow Calculation (CBD)*

| Section | Section (downstream) | Area | | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) – (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Accumulation | Partial | Accumulation | Unit Vol. | Black water vol. Partial | Black water vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. | Invert level (bottom) | Invert level | Earth Covering | Man-hole, head | | |
| | | | | | | | | | | | | | | | | Up<br>Dw | Up<br>Dw | Up<br>Dw | Up<br>Dw | M<br>H | | |
| | | ha | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | m | m | m | | |
| Lt1 | Pb2 | 7.16 | 7.16 | 209.0 | 209.0 | 0.0163 | 0.0135 | 0.136 | | | 0.136 | 600 | 2.20 | 1.019 | 0.288 | 12.492<br>9.719 | 4.870<br>4.410 | 5.550<br>5.090 | 6.94<br>4.63 | | | 2.115<br>0.152 |
| Pb2 | Pb3 | 3.18 | 45.34 | 309.0 | 2161.0 | 0.0208 | 0.0077 | 0.355 | | | 0.355 | 800 | 1.90 | 1.147 | 0.577 | 9.719<br>7.491 | 2.933<br>2.346 | 3.813<br>3.226 | 5.91<br>4.27 | | | 1.626<br>0.222 |
| Pb3 | Ky1 | 2.92 | 48.26 | 286.0 | 2447.0 | 0.0208 | 0.007 | 0.362 | | | 0.362 | 800 | 1.90 | 1.147 | 0.577 | 7.491<br>8.107 | 2.346<br>1.802 | 3.226<br>2.682 | 4.27<br>5.42 | | | 1.595<br>0.215 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Pb1 | Ky1 | 2.92 | 2.92 | 201.0 | 201.0 | 0.0208 | 0.007 | 0.007 | | | 0.007 | 200 | 10.00 | 1.044 | 0.033 | 12.102<br>8.107 | 8.842<br>4.832 | 9.102<br>5.092 | 3.00<br>3.02 | <br>2.00 | | 4.714<br>0.026 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Ky1 | Ky2 | 0.00 | 60.26 | 312.0 | 2759.0 | 0.0167 | 0.000 | 0.369 | | | 0.369 | 800 | 1.90 | 1.147 | 0.577 | 8.107<br>8.056 | 1.802<br>1.209 | 2.682<br>2.089 | 5.42<br>5.97 | | | 1.565<br>0.208 |
| Ky2 | Bo2 | 1.89 | 62.15 | 294.0 | 3053.0 | 0.0167 | 0.0037 | 0.373 | | | 0.373 | 800 | 1.90 | 1.147 | 0.577 | 8.056<br>5.436 | 1.209<br>0.651 | 2.089<br>1.531 | 5.97<br>3.91 | | | 1.549<br>0.205 |
| Bo2 | Bo3 | 5.90 | 156.78 | 292.0 | 3345.0 | 0.0069 | 0.0047 | 0.377 | | | 0.377 | 800 | 1.90 | 1.147 | 0.577 | 5.436<br>4.536 | 0.651<br>0.096 | 1.531<br>0.976 | 3.91<br>3.56 | | | 1.530<br>0.200 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo1 | Bo3 | 5.52 | 201.29 | 231.0 | 231.0 | 0.0069 | 0.004 | 0.004 | | | 0.004 | 250 | 5.00 | 0.857 | 0.042 | 8.004<br>4.536 | 4.694<br>1.139 | 5.004<br>1.449 | 3.00<br>3.09 | <br>2.40 | | 9.545<br>0.038 |
| Bo3 | Bo5 | 10.32 | 211.61 | 294.0 | 3639.0 | 0.0069 | 0.008 | 0.390 | | | 0.390 | 900 | 1.70 | 1.173 | 0.746 | 4.536<br>4.452 | -0.004<br>-0.504 | 0.986<br>0.486 | 3.55<br>3.97 | | | 1.914<br>0.356 |
| | | | | | | | | 0.000 | | | | | | | | | | | | | | |
| Pz1 | Pz4 | 4.58 | 4.58 | 160.0 | 160.0 | 0.0177 | 0.009 | 0.009 | | | 0.009 | 200 | 7.00 | 0.873 | 0.027 | 7.200<br>6.800 | 3.940<br>2.820 | 4.200<br>3.080 | 3.00<br>3.72 | | | 2.872<br>0.018 |
| Pz5 | Pz4 | 4.01 | 4.01 | 241.0 | 241.0 | 0.0177 | 0.008 | 0.008 | | | 0.008 | 200 | 7.00 | 0.873 | 0.027 | 6.600<br>5.800 | 3.340<br>1.653 | 3.600<br>1.913 | 3.00<br>3.89 | | | 3.293<br>0.019 |
| Pz4 | Pz6 | 0.00 | 8.59 | 57.8 | 298.8 | 0.0177 | 0.000 | 0.018 | | | 0.018 | 250 | 5.00 | 0.857 | 0.042 | 6.800<br>5.800 | 1.603<br>1.314 | 1.913<br>1.624 | 4.89<br>4.18 | | | 2.386<br>0.024 |
| Pz6 | Bo5 | 7.27 | 15.86 | 253.0 | 551.8 | 0.0177 | 0.015 | 0.033 | | | 0.033 | 300 | 4.50 | 0.918 | 0.065 | 5.800<br>4.452 | 1.264<br>0.126 | 1.624<br>0.486 | 4.18<br>3.97 | | | 2.000<br>0.033 |
| Pz9 | Bo5 | 0.00 | 19.80 | 286.0 | 286.0 | 0.0177 | 0.000 | 0.000 | | | 0.000 | 200 | 6.50 | 0.842 | 0.026 | 4.933<br>4.452 | 1.673<br>-0.186 | 1.933<br>0.074 | 3.00<br>4.38 | | | #DIV/0!<br>0.026 |
| Bo5 | Pz14 | 0.00 | 303.63 | 263.0 | 3902.0 | 0.0069 | 0.000 | 0.422 | | | 0.422 | 900 | 1.70 | 1.173 | 0.746 | 4.452<br>4.369 | -0.886<br>-1.333 | 0.104<br>-0.343 | 4.35<br>4.71 | | | 1.767<br>0.324 |

## *APPEDIX6 Flow Calculation (CBD)*

| Section | Section (downstream) | Area | | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) – (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Accumulation | Partial | Accumulation | Unit Vol. | Black water vol. Partial | Black water vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. | Invert level (bottom) | Invert level | Earth Covering | Man-hole, head | | |
| | | | | | | | | | | | | | | | | Up | Up | Up | Up | M | | |
| | | | | | | | | | | | | | | | | Dw | Dw | Dw | Dw | H | | |
| | | ha | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | m | m | m | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| **Line2** | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| Ld2 | Ld6 | 3.56 | 3.56 | 275.0 | 275.0 | 0.0143 | 0.006 | 0.006 | | | 0.006 | | | | | 15.920 | 12.660 | 12.920 | 3.00 | | | 3.898 |
| | | | | | | | | | | | | 200 | 5.00 | 0.738 | 0.023 | 14.717 | 11.285 | 11.545 | 3.17 | | | 0.017 |
| Ld5 | Ld6 | 1.49 | 1.49 | 167.0 | 167.0 | 0.0143 | 0.003 | 0.003 | | | 0.003 | | | | | 14.800 | 11.540 | 11.800 | 3.00 | | | 9.200 |
| | | | | | | | | | | | | 200 | 5.00 | 0.738 | 0.023 | 14.717 | 10.705 | 10.965 | 3.75 | | | 0.021 |
| Ld6 | Ld14 | 2.36 | 2.36 | 134.0 | 409.0 | 0.0143 | 0.004 | 0.012 | | | 0.012 | | | | | 14.717 | 11.235 | 11.545 | 3.17 | | | 3.415 |
| | | | | | | | | | | | | 250 | 5.00 | 0.857 | 0.042 | 13.665 | 10.265 | 10.575 | 3.09 | 0.30 | | 0.030 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| Ld8 | Ld14 | 7.52 | 7.52 | 287.0 | 287.0 | 0.0143 | 0.012 | 0.012 | | | 0.012 | | | | | 14.310 | 11.050 | 11.310 | 3.00 | | | 2.097 |
| | | | | | | | | | | | | 200 | 6.50 | 0.842 | 0.026 | 13.665 | 9.185 | 9.445 | 4.22 | | | 0.014 |
| Ld9 | Ld14 | 1.21 | 1.21 | 163.0 | 163.0 | 0.0143 | 0.002 | 0.002 | | | 0.002 | | | | | 14.199 | 10.939 | 11.199 | 3.00 | | | 13.000 |
| | | | | | | | | | | | | 200 | 6.50 | 0.842 | 0.026 | 13.665 | 9.880 | 10.140 | 3.53 | | | 0.024 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| Ld14 | Ld18 | 3.65 | 3.65 | 268.0 | 677.0 | 0.0143 | 0.006 | 0.033 | | | 0.033 | | | | | 13.665 | 10.215 | 10.575 | 3.09 | | | 2.080 |
| | | | | | | | | | | | | 300 | 5.00 | 0.967 | 0.068 | 11.744 | 8.375 | 8.735 | 3.01 | 0.50 | | 0.035 |
| Ld19 | Ld18 | 2.60 | 2.60 | 162.0 | 839.0 | 0.0143 | 0.004 | 0.004 | | | 0.004 | | | | | 12.954 | 9.644 | 9.954 | 3.00 | | | 9.767 |
| | | | | | | | | | | | | 250 | 5.00 | 0.857 | 0.042 | 11.744 | 8.434 | 8.744 | 3.00 | 0.40 | | 0.038 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| Ld18 | Ld13 | 4.00 | 4.00 | 292.0 | 1131.0 | 0.0143 | 0.007 | 0.044 | | | 0.044 | | | | | 11.744 | 8.275 | 8.738 | 3.01 | | | 2.615 |
| | | | | | | | | | | | | 400 | 3.00 | 0.908 | 0.114 | 7.215 | 3.699 | 4.162 | 3.05 | 3.70 | | 0.070 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| Ld1 | Ld13 | 5.26 | 5.26 | 549.0 | 549.0 | 0.0143 | 0.009 | 0.009 | | | 0.009 | | | | | 17.265 | 14.005 | 14.265 | 3.00 | | | 2.989 |
| | | | | | | | | | | | | 200 | 6.50 | 0.842 | 0.026 | 14.310 | 10.437 | 10.697 | 3.61 | | | 0.017 |
| Ld13 | Ld22 | 2.00 | 2.00 | 270.0 | 819.0 | 0.0143 | 0.003 | 0.056 | | | 0.056 | | | | | 14.310 | 10.237 | 10.700 | 3.61 | | | 2.050 |
| | | | | | | | | | | | | 400 | 3.00 | 0.908 | 0.114 | 7.215 | 3.727 | 4.190 | 3.03 | 5.70 | | 0.058 |
| Ld22 | Ld27 | 2.30 | 2.30 | 295.0 | 1114.0 | 0.0143 | 0.004 | 0.059 | | | 0.059 | | | | | 7.215 | 3.727 | 4.190 | 3.03 | | | 1.919 |
| | | | | | | | | | | | | 400 | 3.00 | 0.908 | 0.114 | 4.975 | 1.442 | 1.905 | 3.07 | 1.40 | | 0.055 |
| Ld27 | Ld29 | 2.33 | 2.33 | 313.0 | 1427.0 | 0.0143 | 0.004 | 0.063 | | | 0.063 | | | | | 4.975 | 1.342 | 1.912 | 3.06 | | | 2.923 |
| | | | | | | | | | | | | 500 | 2.40 | 0.942 | 0.185 | 4.571 | 0.590 | 1.160 | 3.41 | | | 0.122 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |

## *APPEDIX6 Flow Calculation (CBD)*

| Section | Section (downstream) | Area | | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) – (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Accumulation | Partial | Accumulation | Unit Vol. | Black water vol. Partial | Black water vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. | Invert level (bottom) | Invert level | Earth Covering | Man-hole, head | | |
| | | | | | | | | | | | | | | | | Up | Up | Up | Up | M | | |
| | | | | | | | | | | | | | | | | Dw | Dw | Dw | Dw | H | | |
| | | ha | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | m | m | m | | |
| Ld28 | Ld23 | 2.10 | 2.10 | 293.0 | 293.0 | 0.0143 | 0.004 | 0.004 | | | 0.004 | 200 | 6.00 | 0.809 | 0.025 | 7.200 | 3.940 | 4.200 | 3.00 | | | 7.143 |
| | | | | | | | | | | | | | | | | 5.500 | 2.182 | 2.442 | 3.06 | | | 0.022 |
| Ld23 | Ld29 | 2.99 | 2.99 | 276.0 | 276.0 | 0.0143 | 0.005 | 0.008 | | | 0.008 | 200 | 6.00 | 0.809 | 0.025 | 11.744 | 8.484 | 8.744 | 3.00 | | | 2.976 |
| | | | | | | | | | | | | | | | | 4.571 | 1.228 | 1.488 | 3.08 | 5.60 | | 0.017 |
| Ld29 | Ld31 | 2.20 | 2.20 | 294.0 | 1997.0 | 0.0143 | 0.004 | 0.075 | | | 0.075 | 500 | 2.40 | 0.942 | 0.185 | 4.571 | 0.590 | 1.160 | 3.41 | | | 2.457 |
| | | | | | | | | | | | | | | | | 4.868 | -0.115 | 0.455 | 4.41 | | | 0.110 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| Ld24 | Ld31 | 1.94 | 1.94 | 277.0 | 277.0 | 0.0143 | 0.003 | 0.003 | | | 0.003 | 200 | 7.00 | 0.873 | 0.027 | 12.772 | 9.512 | 9.772 | 3.00 | | | 8.438 |
| | | | | | | | | | | | | | | | | 4.868 | 1.573 | 1.833 | 3.04 | 6.00 | | 0.024 |
| Ld31 | Ld33 | 2.20 | 2.20 | 288.0 | 2285.0 | 0.0143 | 0.004 | 0.082 | | | 0.082 | 600 | 2.20 | 1.019 | 0.288 | 4.868 | -0.215 | 0.465 | 4.40 | | | 3.508 |
| | | | | | | | | | | | | | | | | 5.053 | -0.849 | -0.169 | 5.22 | | | 0.206 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| Ld30 | Ld25 | 1.92 | 1.92 | 293.0 | 293.0 | 0.0143 | 0.003 | 0.003 | | | 0.003 | 200 | 6.00 | 0.809 | 0.025 | 8.000 | 4.740 | 5.000 | 3.00 | | | 7.813 |
| | | | | | | | | | | | | | | | | 7.000 | 2.982 | 3.242 | 3.76 | | | 0.022 |
| Ld25 | Ld33 | 1.93 | 1.93 | 278.0 | 278.0 | 0.0143 | 0.003 | 0.006 | | | 0.006 | 200 | 6.50 | 0.842 | 0.026 | 11.052 | 7.792 | 8.052 | 3.00 | | | 4.063 |
| | | | | | | | | | | | | | | | | 5.053 | 1.785 | 2.045 | 3.01 | 4.20 | | 0.020 |
| Ld33 | Lt4 | 2.21 | 2.21 | 294.0 | 2579.0 | 0.0143 | 0.004 | 0.092 | | | 0.092 | 600 | 2.20 | 1.019 | 0.288 | 5.053 | -0.849 | -0.169 | 5.22 | | | 3.124 |
| | | | | | | | | | | | | | | | | 6.212 | -1.496 | -0.816 | 7.03 | | | 0.196 |
| | | | | | | | | 0.000 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| Ld32 | Ld26 | 1.90 | 1.90 | 290.0 | 290.0 | 0.0143 | 0.003 | 0.003 | | | 0.003 | 200 | 6.00 | 0.809 | 0.025 | 6.600 | 3.340 | 3.600 | 3.00 | | | 8.065 |
| | | | | | | | | | | | | | | | | 7.000 | 1.600 | 1.860 | 5.14 | | | 0.022 |
| Ld26 | Lt4 | 3.25 | 3.25 | 279.0 | 279.0 | 0.0143 | 0.005 | 0.009 | | | 0.009 | 200 | 6.50 | 0.842 | 0.026 | 9.143 | 5.883 | 6.143 | 3.00 | | | 3.059 |
| | | | | | | | | | | | | | | | | 6.212 | 0.770 | 1.030 | 5.18 | 3.30 | | 0.018 |
| Lt4 | Pb6 | 6.50 | 6.50 | 592.0 | 3171.0 | 0.0163 | 0.012 | 0.113 | | | 0.113 | 700 | 2.00 | 1.076 | 0.414 | 6.212 | -1.596 | -0.806 | 7.02 | | | 3.664 |
| | | | | | | | | | | | | | | | | 6.039 | -2.780 | -1.990 | 8.03 | | | 0.301 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| Lt3 | Pb6 | 2.00 | 2.00 | 269.0 | 269.0 | 0.0163 | 0.004 | 0.004 | | | 0.004 | 200 | 6.50 | 0.842 | 0.026 | 9.719 | 6.459 | 6.719 | 3.00 | | | 6.842 |
| | | | | | | | | | | | | | | | | 6.039 | 2.711 | 2.971 | 3.07 | 2.00 | | 0.022 |
| Pb6 | Pb7 | 7.64 | 7.64 | 290.0 | 3461.0 | 0.0208 | 0.018 | 0.135 | | | 0.135 | 700 | 2.00 | 1.076 | 0.414 | 6.039 | -2.780 | -1.990 | 8.03 | | | 3.062 |
| | | | | | | | | | | | | | | | | 5.516 | -3.360 | -2.570 | 8.09 | | | 0.279 |
| Pb7 | Ky5 | 8.29 | 8.29 | 307.0 | 3768.0 | 0.0208 | 0.020 | 0.155 | | | 0.155 | 800 | 1.90 | 1.147 | 0.577 | 5.516 | -3.460 | -2.580 | 8.10 | | | 3.718 |
| | | | | | | | | | | | | | | | | 6.070 | -4.043 | -3.163 | 9.23 | | | 0.422 |
| Ky5 | Ky6 | 8.60 | 8.60 | 315.0 | 4083.0 | 0.0167 | 0.017 | 0.172 | | | 0.172 | 800 | 1.90 | 1.147 | 0.577 | 6.070 | -4.043 | -3.163 | 9.23 | | | 3.359 |
| | | | | | | | | | | | | | | | | 7.469 | -4.642 | -3.762 | 11.23 | | | 0.405 |

## *APPEDIX6 Flow Calculation (CBD)*

| Section | Section (downstream) | Area | | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) − (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Accumulation | Partial | Accumulation | Unit Vol. | Black water vol. Partial | Black water vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. | Invert level (bottom) | Invert level | Earth Covering | Man-hole, head | | |
| | | | | | | | | | | | | | | | | Up | Up | Up | Up | M | | |
| | | | | | | | | | | | | | | | | Dw | Dw | Dw | Dw | H | | |
| | | ha | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | m | m | m | | |
| Ky6 | Bo6 | 8.10 | 8.10 | 289.0 | 4372.0 | 0.0167 | 0.016 | 0.188 | | | 0.188 | 800 | 1.90 | 1.147 | 0.577 | 7.469 | -4.642 | -3.762 | 11.23 | | | 3.077 |
| | | | | | | | | | | | | | | | | 4.800 | -5.191 | -4.311 | 9.11 | | | 0.390 |
| Bo6 | Bo7 | 7.96 | 7.96 | 292.0 | 4664.0 | 0.0069 | 0.006 | 0.194 | | | 0.194 | 800 | 1.90 | 1.147 | 0.577 | 4.800 | -5.191 | -4.311 | 9.11 | | | 2.977 |
| | | | | | | | | | | | | | | | | 4.229 | -5.745 | -4.865 | 9.09 | | | 0.383 |
| Bo7 | Pz14 | 7.86 | 7.86 | 291.0 | 4955.0 | 0.0069 | 0.006 | 0.200 | | | 0.200 | 800 | 1.90 | 1.147 | 0.577 | 4.229 | -5.745 | -4.865 | 9.09 | | | 2.884 |
| | | | | | | | | | | | | | | | | 4.369 | -6.298 | -5.418 | 9.79 | | | 0.377 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Line1⇒ | | | | | | | | | | | | | | | | | | | | | | |
| Pz14 | Pz16 | 7.81 | 7.81 | 291.0 | 5246.0 | 0.0177 | 0.016 | 0.638 | | | 0.638 | 1,200 | 1.40 | 1.290 | 1.459 | 4.369 | -6.698 | -5.383 | 9.75 | | | 2.285 |
| | | | | | | | | | | | | | | | | 4.481 | -7.106 | -5.791 | 10.27 | | | 0.821 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Pz8 | Pz10 | 3.46 | 3.46 | 201.0 | 201.0 | 0.0177 | 0.007 | 0.007 | | | 0.007 | 200 | 6.50 | 0.842 | 0.026 | 5.758 | 2.498 | 2.758 | 3.00 | | | 3.662 |
| | | | | | | | | | | | | | | | | 4.933 | 1.192 | 1.452 | 3.48 | | | 0.019 |
| Pz10 | Pz16 | 2.46 | 2.46 | 263.0 | 464.0 | 0.0177 | 0.005 | 0.012 | | | 0.012 | 250 | 5.00 | 0.857 | 0.042 | 4.933 | 1.142 | 1.452 | 3.48 | | | 3.443 |
| | | | | | | | | | | | | | | | | 4.469 | -0.174 | 0.137 | 4.33 | | | 0.030 |
| Pz15 | Pz16 | 3.20 | 3.20 | 294.0 | 294.0 | 0.0177 | 0.007 | 0.007 | | | 0.007 | 200 | 6.50 | 0.842 | 0.026 | 4.473 | 1.213 | 1.473 | 3.00 | | | 3.939 |
| | | | | | | | | | | | | | | | | 4.481 | -0.698 | -0.438 | 4.92 | | | 0.019 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Pz16 | Bo13 | 0.00 | 0.00 | 277.0 | 5523.0 | 0.0177 | 0.000 | 0.657 | | | 0.657 | 1,200 | 1.40 | 1.29 | 1.459 | 4.481 | -7.106 | -5.791 | 10.27 | | | 2.220 |
| | | | | | | | | | | | | | | | | 4.223 | -7.494 | -6.179 | 10.40 | | | 0.802 |
| ⇒Line3 | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |

## *APPEDIX6 Flow Calculation (CBD)*

| Section | Section (downstream) | Area | | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) − (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Accumulation | Partial | Accumulation | Unit Vol. | Black water vol. Partial | Black water vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. | Invert level (bottom) | Invert level | Earth Covering | Man-hole, head | | |
| | | | | | | | | | | | | | | | | Up | Up | Up | Up | M | | |
| | | | | | | | | | | | | | | | | Dw | Dw | Dw | Dw | H | | |
| | | ha | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | m | m | m | | |
| **Line3** | | | | | | | | | | | | | | | | | | | | | | |
| Ld34 | Ld39 | 5.13 | 5.13 | 435.0 | 435.0 | 0.0143 | 0.009 | 0.009 | | | 0.009 | 250 | 3.00 | 0.664 | 0.033 | 4.975 | 1.665 | 1.975 | 3.00 | | | 3.882 |
| | | | | | | | | | | | | | | | | 4.312 | 0.360 | 0.670 | 3.64 | | | 0.025 |
| Ld39 | Ld40 | 8.50 | 8.50 | 297.0 | 732.0 | 0.0143 | 0.014 | 0.023 | | | 0.023 | 300 | 3.00 | 0.749 | 0.053 | 4.312 | 0.310 | 0.670 | 3.64 | | | 2.345 |
| | | | | | | | | | | | | | | | | 4.204 | -0.581 | -0.221 | 4.43 | | | 0.030 |
| Ld40 | Ld41 | 10.62 | 10.62 | 286.0 | 1018.0 | 0.0143 | 0.018 | 0.040 | | | 0.040 | 500 | 2.20 | 0.902 | 0.177 | 4.204 | -0.781 | -0.211 | 4.42 | | | 4.403 |
| | | | | | | | | | | | | | | | | 4.381 | -1.410 | -0.840 | 5.22 | | | 0.137 |
| Ld41 | Lt7 | 8.74 | 8.74 | 288.0 | 1306.0 | 0.0143 | 0.015 | 0.055 | | | 0.055 | 500 | 2.20 | 0.902 | 0.177 | 4.381 | -1.430 | -0.860 | 5.24 | | | 3.236 |
| | | | | | | | | | | | | | | | | 4.482 | -2.064 | -1.494 | 5.98 | | | 0.122 |
| Lt7 | Lt8 | 8.34 | 8.34 | 293.0 | 1599.0 | 0.0163 | 0.016 | 0.070 | | | 0.070 | 500 | 2.20 | 0.902 | 0.177 | 4.482 | -2.064 | -1.494 | 5.98 | | | 2.514 |
| | | | | | | | | | | | | | | | | 4.365 | -2.708 | -2.138 | 6.50 | | | 0.107 |
| Lt8 | Pb10 | 8.18 | 8.18 | 298.0 | 1897.0 | 0.0163 | 0.015 | 0.086 | | | 0.086 | 600 | 2.00 | 0.971 | 0.275 | 4.365 | -2.808 | -2.128 | 6.49 | | | 3.205 |
| | | | | | | | | | | | | | | | | 5.605 | -3.404 | -2.724 | 8.33 | | | 0.189 |
| Pb10 | Pb11 | 8.23 | 8.23 | 286.0 | 2183.0 | 0.0208 | 0.020 | 0.106 | | | 0.106 | 600 | 2.00 | 0.971 | 0.275 | 5.605 | -3.404 | -2.724 | 8.33 | | | 2.602 |
| | | | | | | | | | | | | | | | | 4.927 | -3.976 | -3.296 | 8.22 | | | 0.169 |
| Pb11 | Ky9 | 8.81 | 8.81 | 313.0 | 2496.0 | 0.0208 | 0.021 | 0.127 | | | 0.127 | 600 | 2.00 | 0.971 | 0.275 | 4.927 | -3.976 | -3.296 | 8.22 | | | 2.165 |
| | | | | | | | | | | | | | | | | 4.758 | -4.602 | -3.922 | 8.68 | | | 0.148 |
| Ky9 | Ky10 | 15.72 | 15.72 | 302.0 | 2798.0 | 0.0167 | 0.030 | 0.157 | | | 0.157 | 700 | 1.80 | 1.021 | 0.393 | 4.927 | -4.702 | -3.912 | 8.84 | | | 2.497 |
| | | | | | | | | | | | | | | | | 5.651 | -5.246 | -4.456 | 10.11 | | | 0.236 |
| Ky10 | Bo10 | 16.31 | 16.31 | 294.0 | 3092.0 | 0.0167 | 0.032 | 0.189 | | | 0.189 | 700 | 1.80 | 1.021 | 0.393 | 5.651 | -5.246 | -4.456 | 10.11 | | | 2.080 |
| | | | | | | | | | | | | | | | | 4.552 | -5.775 | -4.985 | 9.54 | | | 0.204 |
| Bo10 | Bo11 | 13.45 | 13.45 | 292.0 | 3384.0 | 0.0069 | 0.011 | 0.200 | | | 0.200 | 700 | 1.80 | 1.021 | 0.393 | 4.552 | -5.775 | -4.985 | 9.54 | | | 1.969 |
| | | | | | | | | | | | | | | | | 4.273 | -6.301 | -5.511 | 9.78 | | | 0.193 |
| Bo11 | Bo12 | 16.39 | 16.39 | 294.0 | 3678.0 | 0.0069 | 0.013 | 0.213 | | | 0.213 | 800 | 1.60 | 1.052 | 0.529 | 4.273 | -6.401 | -5.521 | 9.79 | | | 2.488 |
| | | | | | | | | | | | | | | | | 4.201 | -6.871 | -5.991 | 10.19 | | | 0.316 |
| Bo12 | Bo13 | 29.45 | 29.45 | 294.0 | 3972.0 | 0.0069 | 0.023 | 0.236 | | | 0.236 | 800 | 1.60 | 1.052 | 0.529 | 4.201 | -6.871 | -5.991 | 10.19 | | | 2.242 |
| | | | | | | | | | | | | | | | | 4.223 | -7.342 | -6.462 | 10.68 | | | 0.293 |
| Line2⇒ | | | | | | | | | | | | | | | | | | | | | | |
| Bo13 | Bo19 | 16.60 | 16.60 | 293.0 | 4265.0 | 0.0069 | 0.013 | 0.906 | | | 0.906 | 1,200 | 1.40 | 1.290 | 1.459 | 4.223 | -7.742 | -6.427 | 10.65 | | | 1.610 |
| | | | | | | | | | | | | | | | | 4.219 | -8.152 | -6.837 | 11.06 | | | 0.553 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Pz3 | Pz7 | 6.45 | 6.45 | 176.0 | 176.0 | 0.0177 | 0.013 | 0.013 | | | 0.013 | 200 | 7.00 | 0.873 | 0.027 | 6.212 | 2.952 | 3.212 | 3.00 | | | 2.045 |
| | | | | | | | | | | | | | | | | 5.468 | 1.720 | 1.980 | 3.49 | | | 0.014 |
| Pz7 | Pz11 | 2.81 | 2.81 | 103.0 | 279.0 | 0.0177 | 0.006 | 0.019 | | | 0.019 | 250 | 5.00 | 0.857 | 0.042 | 5.468 | 1.670 | 1.980 | 3.49 | | | 2.211 |
| | | | | | | | | | | | | | | | | 5.758 | 1.155 | 1.465 | 4.29 | | | 0.023 |

## *APPEDIX6 Flow Calculation (CBD)*

| Section | Section (downstream) | Area | | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) – (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Accumulation | Partial | Accumulation | Unit Vol. | Black water vol. Partial | Black water vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. | Invert level (bottom) | Invert level | Earth Covering | Man-hole, head | | |
| | | | | | | | | | | | | | | | | Up | Up | Up | Up | M | | |
| | | | | | | | | | | | | | | | | Dw | Dw | Dw | Dw | H | | |
| | | ha | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | m | m | m | | |
| Pz11 | Pz12 | 10.40 | 10.40 | 343.0 | 622.0 | 0.0177 | 0.021 | 0.040 | | | 0.040 | 350 | 3.50 | 0.897 | 0.086 | 5.758 | 1.055 | 1.465 | 4.29 | | | 2.129 |
| | | | | | | | | | | | | | | | | 4.816 | -0.146 | 0.264 | 4.55 | | | 0.046 |
| Pz18 | Pz12 | 5.25 | 5.25 | 270.0 | 270.0 | 0.0177 | 0.011 | 0.011 | | | 0.011 | 250 | 5.00 | 0.857 | 0.042 | 4.825 | 1.515 | 1.825 | 3.00 | | | 3.889 |
| | | | | | | | | | | | | | | | | 4.816 | 0.165 | 0.475 | 4.34 | | | 0.031 |
| Pz12 | Pz13 | 3.43 | 3.43 | 75.7 | 697.7 | 0.0177 | 0.007 | 0.058 | | | 0.058 | 400 | 3.20 | 0.937 | 0.118 | 4.816 | -0.196 | 0.267 | 4.55 | | | 2.027 |
| | | | | | | | | | | | | | | | | 4.657 | -0.438 | 0.025 | 4.63 | | | 0.060 |
| Pz20 | Pz13 | 1.55 | 1.55 | 305.0 | 305.0 | 0.0177 | 0.003 | 0.003 | | | 0.003 | 250 | 5.00 | 0.857 | 0.042 | 4.700 | 1.390 | 1.700 | 3.00 | | | 13.125 |
| | | | | | | | | | | | | | | | | 4.657 | -0.135 | 0.175 | 4.48 | | | 0.039 |
| Pz13 | Pz17 | 0.00 | 0.00 | 59.3 | 757.0 | 0.0177 | 0.000 | 0.061 | | | 0.061 | 450 | 2.60 | 0.914 | 0.145 | 4.657 | -0.488 | 0.029 | 4.63 | | | 2.362 |
| | | | | | | | | | | | | | | | | 4.473 | -0.642 | -0.125 | 4.60 | | | 0.084 |
| Pz17 | Bo19 | 2.37 | 2.37 | 283.0 | 1040.0 | 0.0177 | 0.005 | 0.066 | | | 0.066 | 450 | 2.60 | 0.914 | 0.145 | 4.473 | -0.642 | -0.125 | 4.60 | | | 2.187 |
| | | | | | | | | | | | | | | | | 4.219 | -1.378 | -0.861 | 5.08 | | | 0.079 |
| Pz19 | Bo14 | 1.59 | 1.59 | 210.0 | 210.0 | 0.0177 | 0.003 | 0.003 | | | 0.003 | 200 | 6.50 | 0.842 | 0.026 | 4.825 | 1.565 | 1.825 | 3.00 | | | 7.879 |
| | | | | | | | | | | | | | | | | 4.434 | 0.200 | 0.460 | 3.97 | | | 0.023 |
| Bo15 | Bo14 | 8.08 | 8.08 | 315.0 | 315.0 | 0.0069 | 0.006 | 0.006 | | | 0.006 | 200 | 6.50 | 0.842 | 0.026 | 4.537 | 1.277 | 1.537 | 3.00 | | | 4.063 |
| | | | | | | | | | | | | | | | | 4.443 | -0.771 | -0.511 | 4.95 | | | 0.020 |
| Bo20 | Bo14 | 4.20 | 4.20 | 283.0 | 283.0 | 0.0069 | 0.003 | 0.003 | | | 0.003 | 200 | 6.50 | 0.842 | 0.026 | 4.851 | 1.591 | 1.851 | 3.00 | | | 7.879 |
| | | | | | | | | | | | | | | | | 4.443 | -0.249 | 0.011 | 4.43 | | | 0.023 |
| Bo14 | Bo19 | 7.32 | 7.32 | 298.0 | 613.0 | 0.0069 | 0.006 | 0.019 | | | 0.019 | 250 | 5.00 | 0.857 | 0.042 | 4.443 | -0.821 | -0.511 | 4.95 | | | 2.234 |
| | | | | | | | | | | | | | | | | 4.219 | -2.311 | -2.001 | 6.22 | | | 0.023 |
| Bo19 | Bo26 | 2.10 | 2.10 | 283.0 | 4548.0 | 0.0069 | 0.002 | 0.993 | | | 0.993 | 1,350 | 1.30 | 1.344 | 1.924 | 4.219 | -8.302 | -6.827 | 11.05 | | | 1.937 |
| | | | | | | | | | | | | | | | | 4.718 | -8.670 | -7.195 | 11.91 | | | 0.931 |
| ⇒Line4 | | | | | | | | | | | | | | | | | | | | | | |

## *APPEDIX6 Flow Calculation (CBD)*

| Section | Section (downstream) | Area | | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) – (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Accumulation | Partial | Accumulation | Unit Vol. | Black water vol. Partial | Black water vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. | Invert level (bottom) | Invert level | Earth Covering | Man-hole, head | | |
| | | | | | | | | | | | | | | | | Up | Up | Up | Up | M | | |
| | | | | | | | | | | | | | | | | Dw | Dw | Dw | Dw | H | | |
| | | ha | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | m | m | m | | |
| **Line4** | | | | | | | | | | | | | | | | | | | | | | |
| Ld44 | Lt11 | 6.10 | 6.10 | 319.0 | 319.0 | 0.0143 | 0.010 | 0.010 | | | 0.010 | | | | | 4.239 | 0.929 | 1.239 | 3.00 | | | 3.267 |
| | | | | | | | | | | | | 250 | 3.00 | 0.664 | 0.033 | 4.199 | -0.028 | 0.282 | 3.92 | | | 0.023 |
| Lt11 | Lt12 | 8.40 | 8.40 | 298.0 | 617.0 | 0.0163 | 0.016 | 0.026 | | | 0.026 | | | | | 4.199 | -0.228 | 0.289 | 3.91 | | | 5.405 |
| | | | | | | | | | | | | 450 | 2.40 | 0.878 | 0.14 | 3.978 | -0.943 | -0.426 | 4.40 | | | 0.114 |
| Lt12 | Pb14 | 8.43 | 8.43 | 297.0 | 914.0 | 0.0163 | 0.016 | 0.042 | | | 0.042 | | | | | 3.978 | -0.943 | -0.426 | 4.40 | | | 3.349 |
| | | | | | | | | | | | | 450 | 2.40 | 0.878 | 0.14 | 4.161 | -1.656 | -1.139 | 5.30 | | | 0.098 |
| Pb14 | Pb15 | 9.57 | 9.57 | 288.0 | 1202.0 | 0.0208 | 0.023 | 0.065 | | | 0.065 | | | | | 4.161 | -1.656 | -1.139 | 5.30 | | | 2.157 |
| | | | | | | | | | | | | 450 | 2.40 | 0.878 | 0.14 | 4.489 | -2.347 | -1.830 | 6.32 | | | 0.075 |
| Pb15 | Ky13 | 12.03 | 12.03 | 304.0 | 1506.0 | 0.0208 | 0.029 | 0.094 | | | 0.094 | | | | | 4.489 | -2.497 | -1.817 | 6.31 | | | 2.929 |
| | | | | | | | | | | | | 600 | 2.00 | 0.971 | 0.275 | 4.687 | -3.105 | -2.425 | 7.11 | | | 0.181 |
| Ky13 | Ky14 | 1.43 | 1.43 | 308.0 | 1814.0 | 0.0167 | 0.003 | 0.097 | | | 0.097 | | | | | 4.687 | -3.105 | -2.425 | 7.11 | | | 2.844 |
| | | | | | | | | | | | | 600 | 2.00 | 0.971 | 0.275 | 5.993 | -3.721 | -3.041 | 9.03 | | | 0.178 |
| Ky14 | Bo22 | 0.00 | 0.00 | 293.0 | 2107.0 | 0.0167 | 0.000 | 0.097 | | | 0.097 | | | | | 5.993 | -3.721 | -3.041 | 9.03 | | | 2.844 |
| | | | | | | | | | | | | 600 | 2.00 | 0.971 | 0.275 | 7.733 | -4.307 | -3.627 | 11.36 | | | 0.178 |
| Bo22 | Bo23 | 10.89 | 10.89 | 290.0 | 2397.0 | 0.0069 | 0.009 | 0.105 | | | 0.105 | | | | | 7.733 | -4.307 | -3.627 | 11.36 | | | 2.609 |
| | | | | | | | | | | | | 600 | 2.00 | 0.971 | 0.275 | 4.685 | -4.887 | -4.207 | 8.89 | | | 0.170 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo28 | Bo23 | 1.62 | 1.62 | 273.0 | 273.0 | 0.0069 | 0.001 | 0.001 | | | 0.001 | | | | | 4.765 | 1.505 | 1.765 | 3.00 | | | 20.000 |
| | | | | | | | | | | | | 200 | 6.50 | 0.842 | 0.026 | 4.685 | -0.270 | -0.010 | 4.69 | | | 0.025 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo23 | Bo24 | 5.65 | 5.65 | 295.0 | 2692.0 | 0.0069 | 0.005 | 0.111 | | | 0.111 | | | | | 4.685 | -4.887 | -4.207 | 8.89 | | | 2.473 |
| | | | | | | | | | | | | 600 | 2.00 | 0.971 | 0.275 | 4.448 | -5.477 | -4.797 | 9.25 | | | 0.164 |
| Bo24 | Bo25 | 0.00 | 0.00 | 293.0 | 2985.0 | 0.0069 | 0.000 | 0.111 | | | 0.111 | | | | | 4.448 | -5.477 | -4.797 | 9.25 | | | 2.473 |
| | | | | | | | | | | | | 600 | 2.00 | 0.971 | 0.275 | 4.458 | -6.063 | -5.383 | 9.84 | | | 0.164 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo29 | Bo25 | 0.96 | 0.96 | 217.0 | 217.0 | 0.0069 | 0.001 | 0.001 | | | 0.001 | | | | | 4.552 | 1.292 | 1.552 | 3.00 | | | 32.500 |
| | | | | | | | | | | | | 200 | 6.50 | 0.842 | 0.026 | 4.458 | -0.119 | 0.141 | 4.32 | | | 0.025 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo25 | Bo26 | 6.48 | 6.48 | 293.0 | 3278.0 | 0.0069 | 0.005 | 0.117 | | | 0.117 | | | | | 4.458 | -6.063 | -5.383 | 9.84 | | | 2.346 |
| | | | | | | | | | | | | 600 | 2.00 | 0.971 | 0.275 | 4.718 | -6.649 | -5.969 | 10.69 | | | 0.158 |
| | | | | | | | | | | | | | | | | | | | | | | |

## *APPEDIX6 Flow Calculation (CBD)*

| Section | Section (downstream) | Area | | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) – (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Accumulation | Partial | Accumulation | Unit Vol. | Black water vol. Partial | Black water vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. | Invert level (bottom) | Invert level | Earth Covering | Man-hole, head | | |
| | | | | | | | | | | | | | | | | Up | Up | Up | Up | M | | |
| | | | | | | | | | | | | | | | | Dw | Dw | Dw | Dw | H | | |
| | | ha | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | m | m | m | | |
| Bo30 | Bo26 | 1.68 | 1.68 | 224.0 | 224.0 | 0.0069 | 0.001 | 0.001 | | | 0.001 | 200 | 6.50 | 0.842 | 0.026 | 4.842 | 1.582 | 1.842 | 3.00 | | | 20.000 |
| | | | | | | | | | | | | | | | | 4.718 | 0.126 | 0.386 | 4.33 | | | 0.025 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Line3⇒ | | | | | | | | | | | | | | | | | | | | | | |
| Bo26 | Bo27 | 3.67 | 3.67 | 294.0 | 3572.0 | 0.0069 | 0.003 | 1.115 | | | 1.115 | 1,350 | 1.30 | 1.344 | 1.924 | 4.718 | -8.670 | -7.195 | 11.91 | | | 1.726 |
| | | | | | | | | | | | | | | | | 4.851 | -9.052 | -7.577 | 12.43 | | | 0.809 |
| Bo27 | Bo32 | 3.55 | 3.55 | 286.0 | 3858.0 | 0.0069 | 0.003 | 1.117 | | | 1.117 | 1,350 | 1.30 | 1.344 | 1.924 | 4.851 | -9.052 | -7.577 | 12.43 | | | 1.722 |
| | | | | | | | | | | | | | | | | 4.766 | -9.424 | -7.949 | 12.71 | | | 0.807 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo21 | Bo32 | 2.10 | 2.10 | 343.0 | 343.0 | 0.0069 | 0.002 | 0.002 | | | 0.002 | 200 | 6.50 | 0.842 | 0.026 | 4.537 | 1.277 | 1.537 | 3.00 | | | 15.294 |
| | | | | | | | | | | | | | | | | 4.766 | -0.953 | -0.693 | 5.46 | | | 0.024 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo32 | Bo40 | 9.14 | 9.14 | 210.0 | 4068.0 | 0.0069 | 0.007 | 1.126 | | | 1.126 | 1,350 | 1.30 | 1.344 | 1.924 | 4.766 | -9.424 | -7.949 | 12.71 | | | 1.708 |
| | | | | | | | | | | | | | | | | 4.534 | -9.697 | -8.222 | 12.76 | | | 0.798 |
| ⇒Line5 | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |

## *APPEDIX6 Flow Calculation (CBD)*

| Section | Section (downstream) | Area | | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) – (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Accumulation | Partial | Accumulation | Unit Vol. | Black water vol. Partial | Black water vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. | Invert level (bottom) | Invert level | Earth Covering | Man-hole, head | | |
| | | | | | | | | | | | | | | | | Up | Up | Up | Up | M | | |
| | | | | | | | | | | | | | | | | Dw | Dw | Dw | Dw | H | | |
| | | ha | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | m | m | m | | |
| **Line5** | | | | | | | | | | | | | | | | | | | | | | |
| Ky17 | Ky18 | 6.89 | 6.89 | 332.0 | 332.0 | 0.0167 | 0.013 | 0.013 | | | 0.013 | 250 | 5.00 | 0.857 | 0.042 | 4.510 | 1.200 | 1.510 | 3.00 | | | 3.158 |
| | | | | | | | | | | | | | | | | 5.224 | -0.460 | -0.150 | 5.37 | | | 0.029 |
| Ky18 | Bo33 | 8.28 | 8.28 | 296.0 | 628.0 | 0.0167 | 0.016 | 0.029 | | | 0.029 | 300 | 4.00 | 0.865 | 0.061 | 5.224 | -0.510 | -0.150 | 5.37 | | | 2.082 |
| | | | | | | | | | | | | | | | | 6.803 | -1.694 | -1.334 | 8.14 | | | 0.032 |
| Bo33 | Bo34 | 0.00 | 0.00 | 289.0 | 917.0 | 0.0069 | 0.000 | 0.029 | | | 0.029 | 350 | 3.50 | 0.897 | 0.086 | 6.803 | -1.744 | -1.334 | 8.14 | | | 2.935 |
| | | | | | | | | | | | | | | | | 4.765 | -2.756 | -2.346 | 7.11 | | | 0.057 |
| Bo34 | Bo35 | 17.95 | 17.95 | 592.0 | 1509.0 | 0.0069 | 0.014 | 0.044 | | | 0.044 | 400 | 2.00 | 0.741 | 0.093 | 4.765 | -2.806 | -2.343 | 7.11 | | | 2.133 |
| | | | | | | | | | | | | | | | | 4.552 | -3.990 | -3.527 | 8.08 | | | 0.049 |
| Bo35 | Bo36 | 7.13 | 7.13 | 291.0 | 1800.0 | 0.0069 | 0.006 | 0.049 | | | 0.049 | 400 | 3.00 | 0.908 | 0.114 | 4.552 | -3.990 | -3.527 | 8.08 | | | 2.312 |
| | | | | | | | | | | | | | | | | 4.842 | -4.863 | -4.400 | 9.24 | | | 0.065 |
| Bo36 | Bo37 | 9.03 | 9.03 | 292.0 | 2092.0 | 0.0069 | 0.007 | 0.057 | | | 0.057 | 450 | 2.40 | 0.878 | 0.14 | 4.842 | -4.913 | -4.396 | 9.24 | | | 2.478 |
| | | | | | | | | | | | | | | | | 4.793 | -5.613 | -5.096 | 9.89 | | | 0.084 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo31 | Bo37 | 3.35 | 3.35 | 225.0 | 225.0 | 0.0069 | 0.003 | 0.003 | | | 0.003 | 200 | 6.50 | 0.842 | 0.026 | 4.851 | 1.591 | 1.851 | 3.00 | | | 9.630 |
| | | | | | | | | | | | | | | | | 4.793 | 0.129 | 0.389 | 4.40 | | | 0.023 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo37 | Bo40 | 10.26 | 10.26 | 297.0 | 2389.0 | 0.0069 | 0.008 | 0.067 | | | 0.067 | 450 | 2.60 | 0.914 | 0.145 | 4.793 | -5.613 | -5.096 | 9.89 | | | 2.151 |
| | | | | | | | | | | | | | | | | 4.534 | -6.386 | -5.869 | 10.40 | | | 0.078 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Line4⇒ | | | | | | | | | | | | | | | | | | | | | | |
| Bo40 | Bo43 | 21.87 | 21.87 | 589.0 | 814.0 | 0.0069 | 0.017 | 1.211 | | | 1.211 | 1,350 | 1.30 | 1.344 | 1.924 | 4.534 | -9.697 | -8.222 | 12.76 | | | 1.589 |
| | | | | | | | | | | | | | | | | 4.247 | -10.462 | -8.987 | 13.23 | | | 0.713 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo41 | Bo39 | 9.79 | 9.79 | 287.0 | 287.0 | 0.0069 | 0.008 | 0.008 | | | 0.008 | 200 | 6.50 | 0.842 | 0.026 | 4.295 | 1.035 | 1.295 | 3.00 | | | 3.333 |
| | | | | | | | | | | | | | | | | 4.181 | -0.831 | -0.571 | 4.75 | | | 0.018 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Pz21 | Bo38 | 10.00 | 10.00 | 327.0 | 327.0 | 0.0177 | 0.021 | 0.021 | | | 0.021 | 250 | 5.00 | 0.857 | 0.042 | 4.825 | 1.515 | 1.825 | 3.00 | | | 2.049 |
| | | | | | | | | | | | | | | | | 4.734 | -0.120 | 0.190 | 4.54 | | | 0.022 |
| Bo38 | Bo39 | 44.56 | 44.56 | 627.0 | 954.0 | 0.0069 | 0.036 | 0.056 | | | 0.056 | 400 | 3.00 | 0.908 | 0.114 | 4.734 | -0.270 | 0.193 | 4.54 | | | 2.036 |
| | | | | | | | | | | | | | | | | 4.181 | -2.151 | -1.688 | 5.87 | | | 0.058 |

## *APPEDIX6 Flow Calculation (CBD)*

| Section | Section (downstream) | Area | | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) − (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Accumulation | Partial | Accumulation | Unit Vol. | Black water vol. Partial | Black water vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. | Invert level (bottom) | Invert level | Earth Covering | Man-hole, head | | |
| | | | | | | | | | | | | | | | | Up | Up | Up | Up | M | | |
| | | | | | | | | | | | | | | | | Dw | Dw | Dw | Dw | H | | |
| | | ha | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | m | m | m | | |
| Bo39 | Bo43 | 7.18 | 7.18 | 325.0 | 1279.0 | 0.0069 | 0.006 | 0.070 | | | 0.070 | 450 | 2.60 | 0.914 | 0.145 | 4.181 | -2.201 | -1.684 | 5.87 | | | 2.086 |
| | | | | | | | | | | | | | | | | 4.247 | -3.046 | -2.529 | 6.78 | | | 0.076 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo42 | Bo45 | 17.04 | 17.04 | 572.0 | 572.0 | 0.0069 | 0.014 | 0.014 | | | 0.014 | 250 | 5.00 | 0.857 | 0.042 | 4.295 | 0.985 | 1.295 | 3.00 | | | 3.088 |
| | | | | | | | | | | | | | | | | 3.762 | -1.875 | -1.565 | 5.33 | | | 0.028 |
| Bo44 | Bo45 | 11.29 | 11.29 | 376.0 | 376.0 | 0.0069 | 0.009 | 0.009 | | | 0.009 | 200 | 6.50 | 0.842 | 0.026 | 3.762 | 0.502 | 0.762 | 3.00 | | | 2.889 |
| | | | | | | | | | | | | | | | | 3.762 | -1.942 | -1.682 | 5.44 | | | 0.017 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo45 | Bo43 | 0.00 | 0.00 | 270.0 | 842.0 | 0.0069 | 0.000 | 0.023 | | | 0.023 | 300 | 4.00 | 0.865 | 0.061 | 3.762 | -2.042 | -1.682 | 5.44 | | | 2.699 |
| | | | | | | | | | | | | | | | | 3.780 | -3.122 | -2.762 | 6.54 | | | 0.038 |
| | | | | | | | | | | | | | | | | | | | | | | |
| Bo43 | WWTP | 23.21 | 23.21 | 414.0 | 414.0 | 0.0069 | 0.019 | 1.322 | | | 1.322 | 1,500 | 1.20 | 1.386 | 2.449 | 4.247 | -10.612 | -8.972 | 13.22 | | | 1.853 |
| | | | | | | | | | | | | | | | | 3.780 | -11.109 | -9.469 | 13.25 | | | 1.127 |

# Appendix 7 Flow Calculation (Dagon)

## *APPENDIX7 Flow Calculation (Dagon)*

| Section | Section (downstream) | Area | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) − (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Black Water Vol. | | | | | | | | | G.L. | Invert Level (bottom) | Invert Level | Earth Covering | Manhole, Haed | | |
| | | Partial | Partial | Accumulation | Unit Vol. | Partial | Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | Up / Down | Up / Down | Up / Down | Up / Down | | | |
| | | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | | m | m | | |
| **Dagon-West** | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 1 | 2 | 1.50 | 339.0 | 339.0 | 0.007 | 0.0012 | 0.001 | | | 0.001 | 200 | 5.00 | 0.738 | 0.023 | 18.544 | 15.284 | 15.544 | 3.00 | | | 19.167 |
| | | | | | | | | | | | | | | | 17.067 | 13.589 | 13.849 | 3.22 | | | 0.022 |
| 2 | 19 | 0.63 | 109.0 | 109.0 | 0.007 | 0.0005 | 0.002 | | | 0.002 | 200 | 5.00 | 0.738 | 0.023 | 17.067 | 13.589 | 13.849 | 3.22 | | | 13.529 |
| | | | | | | | | | | | | | | | 17.504 | 13.044 | 13.304 | 4.20 | | | 0.021 |
| 12 | 19 | 4.22 | 342.0 | 451.0 | 0.007 | 0.0035 | 0.004 | | | 0.004 | 200 | 5.00 | 0.738 | 0.023 | 17.567 | 14.307 | 14.567 | 3.00 | | | 6.571 |
| | | | | | | | | | | | | | | | 17.504 | 12.597 | 12.857 | 4.65 | | | 0.020 |
| | | | | | | | | | | | | | | | | | | | | | |
| 11 | 17 | 0.32 | 107.0 | 107.0 | 0.007 | 0.0003 | 0.000 | | | 0.000 | 200 | 5.00 | 0.738 | 0.023 | 18.544 | 15.284 | 15.544 | 3.00 | | | 76.667 |
| | | | | | | | | | | | | | | | 17.567 | 14.249 | 14.509 | 3.06 | 0.50 | | 0.023 |
| 17 | 18 | 1.02 | 208.0 | 315.0 | 0.007 | 0.0008 | 0.001 | | | 0.001 | 200 | 5.00 | 0.738 | 0.023 | 17.567 | 14.249 | 14.509 | 3.06 | | | 20.909 |
| | | | | | | | | | | | | | | | 16.688 | 13.209 | 13.469 | 3.22 | | | 0.022 |
| 27 | 18 | 2.44 | 148.0 | 148.0 | 0.007 | 0.002 | 0.002 | | | 0.002 | 200 | 5.00 | 0.738 | 0.023 | 17.434 | 14.174 | 14.434 | 3.00 | | | 11.500 |
| | | | | | | | | | | | | | | | 16.688 | 13.434 | 13.694 | 2.99 | | | 0.021 |
| 18 | 29 | 5.43 | 346.0 | 494.0 | 0.007 | 0.0044 | 0.008 | | | 0.008 | 200 | 5.00 | 0.738 | 0.023 | 16.688 | 13.209 | 13.469 | 3.22 | | | 3.067 |
| | | | | | | | | | | | | | | | 17.191 | 11.479 | 11.739 | 5.45 | | | 0.016 |
| 19 | 29 | 1.94 | 201.0 | 695.0 | 0.007 | 0.0016 | 0.007 | | | 0.007 | 200 | 5.00 | 0.738 | 0.023 | 17.504 | 12.597 | 12.857 | 4.65 | | | 3.382 |
| | | | | | | | | | | | | | | | 17.191 | 11.592 | 11.852 | 5.34 | | | 0.016 |
| 29 | 32 | 2.66 | 182.0 | 877.0 | 0.007 | 0.0022 | 0.017 | | | 0.017 | 250 | 5.00 | 0.857 | 0.042 | 17.071 | 11.429 | 11.739 | 5.33 | | | 2.545 |
| | | | | | | | | | | | | | | | 16.390 | 10.519 | 10.829 | 5.56 | | | 0.026 |
| 32 | 33 | 3.16 | 155.0 | 1032.0 | 0.007 | 0.0026 | 0.019 | | | 0.019 | 250 | 5.00 | 0.857 | 0.042 | 16.390 | 10.519 | 10.829 | 5.56 | | | 2.199 |
| | | | | | | | | | | | | | | | 16.314 | 9.744 | 10.054 | 6.26 | | | 0.023 |
| 33 | 35 | 3.71 | 228.0 | 1260.0 | 0.007 | 0.003 | 0.022 | | | 0.022 | 300 | 4.00 | 0.865 | 0.061 | 16.314 | 9.694 | 10.054 | 6.26 | | | 2.760 |
| | | | | | | | | | | | | | | | 16.712 | 8.782 | 9.142 | 7.57 | | | 0.039 |
| | | | | | | | | | | | | | | | | | | | | | |
| 3 | 4 | 0.97 | 224.0 | 224.0 | 0.007 | 0.0008 | 0.001 | | | 0.001 | 200 | 5.00 | 0.738 | 0.023 | 17.067 | 13.807 | 14.067 | 3.00 | | | 28.750 |
| | | | | | | | | | | | | | | | 16.467 | 12.687 | 12.947 | 3.52 | | | 0.022 |
| 4 | 21 | 0.61 | 106.0 | 330.0 | 0.007 | 0.0005 | 0.001 | | | 0.001 | 200 | 5.00 | 0.738 | 0.023 | 16.467 | 12.687 | 12.947 | 3.52 | | | 17.692 |
| | | | | | | | | | | | | | | | 16.306 | 12.157 | 12.417 | 3.89 | | | 0.022 |
| 13 | 21 | 2.08 | 232.0 | 232.0 | 0.007 | 0.0017 | 0.002 | | | 0.002 | 200 | 5.00 | 0.738 | 0.023 | 17.504 | 14.244 | 14.504 | 3.00 | | | 13.529 |
| | | | | | | | | | | | | | | | 16.306 | 13.084 | 13.344 | 2.96 | | | 0.021 |
| 21 | 31A | 2.30 | 195.0 | 427.0 | 0.007 | 0.0019 | 0.005 | | | 0.005 | 200 | 5.00 | 0.738 | 0.023 | 16.306 | 12.157 | 12.417 | 3.89 | | | 4.694 |
| | | | | | | | | | | | | | | | 17.418 | 11.182 | 11.442 | 5.98 | | | 0.018 |

## *APPENDIX7 Flow Calculation (Dagon)*

| Section | Section (downstream) | Area | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) − (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Partial | Accumulation | Unit Vol. | Black Water Vol. Partial | Black Water Vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. Up / Down | Invert Level (bottom) Up / Down | Invert Level Up / Down | Earth Covering Up / Down | Manhole, Haed | | |
| | | ha | m | m | $m^3/m^2/d$ | $m^3$/sec | $m^3$/sec | $m^3$/sec | $m^3$/sec | $m^3$/sec | mm | ‰ | m/sec | $m^3$/sec | m | m | | m | m | | |
| 20 | 31A | 2.26 | 229.0 | 229.0 | 0.007 | 0.0018 | 0.002 | | | 0.002 | 200 | 5.00 | 0.738 | 0.023 | 17.191 | 13.931 | 14.191 | 3.00 | | | 12.778 |
| | | | | | | | | | | | | | | | 17.418 | 12.786 | 13.046 | 4.37 | | | 0.021 |
| 31A | 31B | 0.82 | 99.0 | 328.0 | 0.007 | 0.0007 | 0.007 | | | 0.007 | 200 | 5.00 | 0.738 | 0.023 | 17.418 | 11.182 | 11.442 | 5.98 | | | 3.108 |
| | | | | | | | | | | | | | | | 17.222 | 10.687 | 10.947 | 6.28 | | | 0.016 |
| 31B | 34 | 0.91 | 90.0 | 418.0 | 0.007 | 0.0007 | 0.008 | | | 0.008 | 200 | 5.00 | 0.738 | 0.023 | 17.222 | 10.687 | 10.947 | 6.28 | | | 2.840 |
| | | | | | | | | | | | | | | | 17.019 | 10.237 | 10.497 | 6.52 | | | 0.015 |
| 30 | 34 | 2.37 | 230.0 | 230.0 | 0.007 | 0.0019 | 0.002 | | | 0.002 | 200 | 5.00 | 0.738 | 0.023 | 16.390 | 13.130 | 13.390 | 3.00 | | | 12.105 |
| | | | | | | | | | | | | | | | 17.019 | 11.980 | 12.240 | 4.78 | 0.00 | | 0.021 |
| 34 | 35 | 1.51 | 150.0 | 380.0 | 0.007 | 0.0012 | 0.011 | | | 0.011 | 200 | 5.00 | 0.738 | 0.023 | 17.019 | 10.237 | 10.497 | 6.52 | | | 2.054 |
| | | | | | | | | | | | | | | | 16.712 | 9.187 | 9.447 | 7.27 | 0.30 | | 0.012 |
| 35 | 41 | 2.35 | 236.0 | 616.0 | 0.007 | 0.0019 | 0.035 | | | 0.035 | 350 | 3.50 | 0.897 | 0.086 | 16.712 | 8.732 | 9.142 | 7.57 | | | 2.443 |
| | | | | | | | | | | | | | | | 17.272 | 7.906 | 8.316 | 8.96 | | | 0.051 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 5 | 6 | 1.00 | 230.0 | 230.0 | 0.007 | 0.0008 | 0.001 | | | 0.001 | 200 | 5.00 | 0.738 | 0.023 | 16.467 | 13.207 | 13.467 | 3.00 | | | 28.750 |
| | | | | | | | | | | | | | | | 18.804 | 12.057 | 12.317 | 6.49 | | | 0.022 |
| 7 | 6 | 2.36 | 497.0 | 497.0 | 0.007 | 0.0019 | 0.002 | | | 0.002 | 200 | 5.00 | 0.738 | 0.023 | 25.262 | 22.002 | 22.262 | 3.00 | | | 12.105 |
| | | | | | | | | | | | | | | | 18.804 | 15.517 | 15.777 | 3.03 | 4.00 | | 0.021 |
| 6 | 23 | 0.59 | 108.0 | 605.0 | 0.007 | 0.0005 | 0.007 | | | 0.007 | 200 | 5.00 | 0.738 | 0.023 | 18.804 | 12.057 | 12.317 | 6.49 | | | 3.260 |
| | | | | | | | | | | | | | | | 18.312 | 11.517 | 11.777 | 6.54 | | | 0.016 |
| 14 | 23 | 2.20 | 235.0 | 235.0 | 0.007 | 0.0018 | 0.002 | | | 0.002 | 200 | 5.00 | 0.738 | 0.023 | 16.306 | 13.046 | 13.306 | 3.00 | | | 12.778 |
| | | | | | | | | | | | | | | | 18.312 | 11.871 | 12.131 | 6.18 | | | 0.021 |
| 15 | 23 | 6.64 | 494.0 | 494.0 | 0.007 | 0.0054 | 0.005 | | | 0.005 | 200 | 5.00 | 0.738 | 0.023 | 24.357 | 21.097 | 21.357 | 3.00 | | | 4.259 |
| | | | | | | | | | | | | | | | 18.312 | 15.027 | 15.287 | 3.03 | 3.60 | | 0.018 |
| 23 | 36A | 2.41 | 203.0 | 697.0 | 0.007 | 0.002 | 0.016 | | | 0.016 | 250 | 5.00 | 0.857 | 0.042 | 18.312 | 11.467 | 11.777 | 6.54 | | | 2.584 |
| | | | | | | | | | | | | | | | 18.241 | 10.452 | 10.762 | 7.48 | | | 0.026 |
| 22 | 36A | 2.27 | 235.0 | 235.0 | 0.007 | 0.0019 | 0.002 | | | 0.002 | 200 | 5.00 | 0.738 | 0.023 | 17.418 | 14.158 | 14.418 | 3.00 | | | 12.105 |
| | | | | | | | | | | | | | | | 18.129 | 12.983 | 13.243 | 4.89 | 0.00 | | 0.021 |
| 24 | 36A | 7.74 | 496.0 | 496.0 | 0.007 | 0.0063 | 0.006 | | | 0.006 | 200 | 5.00 | 0.738 | 0.023 | 22.064 | 18.804 | 19.064 | 3.00 | | | 3.651 |
| | | | | | | | | | | | | | | | 18.241 | 14.924 | 15.184 | 3.06 | 1.40 | | 0.017 |
| 36A | 36B | 0.88 | 102.0 | 598.0 | 0.007 | 0.0007 | 0.025 | | | 0.025 | 300 | 4.00 | 0.865 | 0.061 | 18.241 | 10.402 | 10.762 | 7.48 | | | 2.425 |
| | | | | | | | | | | | | | | | 18.200 | 9.994 | 10.354 | 7.85 | | | 0.036 |
| 54 | 36B | 2.36 | 235.0 | 235.0 | 0.007 | 0.0019 | 0.002 | | | 0.002 | 200 | 5.00 | 0.738 | 0.023 | 17.222 | 13.962 | 14.222 | 3.00 | | | 12.105 |
| | | | | | | | | | | | | | | | 18.200 | 12.787 | 13.047 | 5.15 | 0.00 | | 0.021 |
| 36B | 41 | 3.99 | 229.0 | 464.0 | 0.007 | 0.0033 | 0.030 | | | 0.030 | 300 | 4.00 | 0.865 | 0.061 | 18.200 | 9.994 | 10.354 | 7.85 | | | 2.010 |
| | | | | | | | | | | | | | | | 17.272 | 9.078 | 9.438 | 7.83 | 0.00 | | 0.031 |
| 41 | 43 | 0.98 | 114.0 | 578.0 | 0.007 | 0.0008 | 0.066 | | | 0.066 | 450 | 2.60 | 0.914 | 0.145 | 17.272 | 7.806 | 8.323 | 8.95 | | | 2.185 |
| | | | | | | | | | | | | | | | 17.095 | 7.510 | 8.027 | 9.07 | | | 0.079 |

## *APPENDIX7 Flow Calculation (Dagon)*

| Section | Section (downstream) | Area | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) − (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Black Water Vol. | | | | | | | | | | | | | | | |
| | | Partial | Partial | Accumulation | Unit Vol. | Partial | Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. | Invert Level (bottom) | Invert Level | Earth Covering | Manhole, Haed | | |
| | | | | | | | | | | | | | | | Up | Up | Up | Up | | | |
| | | | | | | | | | | | | | | | Down | Down | Down | Down | | | |
| | | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | | m | m | | |
| 39 | 40 | 0.34 | 108.0 | 108.0 | 0.007 | 0.0003 | 0.000 | | | 0.000 | 200 | 5.00 | 0.738 | 0.023 | 16.712 | 13.452 | 13.712 | 3.00 | | | 76.667 |
| | | | | | | | | | | | | | | | 15.923 | 12.612 | 12.872 | 3.05 | 0.30 | | 0.023 |
| 40 | 43 | 2.90 | 234.0 | 342.0 | 0.007 | 0.0024 | 0.003 | | | 0.003 | 200 | 5.00 | 0.738 | 0.023 | 15.923 | 12.612 | 12.872 | 3.05 | | | 8.519 |
| | | | | | | | | | | | | | | | 17.095 | 11.442 | 11.702 | 5.39 | 0.00 | | 0.020 |
| 55 | 43 | 4.06 | 209.0 | 551.0 | 0.007 | 0.0033 | 0.003 | | | 0.003 | 200 | 5.00 | 0.738 | 0.023 | 17.100 | 13.840 | 14.100 | 3.00 | | | 6.970 |
| | | | | | | | | | | | | | | | 17.095 | 12.795 | 13.055 | 4.04 | 0.00 | | 0.020 |
| 43 | 45 | 2.41 | 223.0 | 565.0 | 0.007 | 0.002 | 0.074 | | | 0.074 | 500 | 2.40 | 0.942 | 0.185 | 17.095 | 7.460 | 8.030 | 9.07 | | | 2.488 |
| | | | | | | | | | | | | | | | 16.900 | 6.924 | 7.494 | 9.41 | | | 0.111 |
| 44 | 45 | 9.41 | 455.0 | 455.0 | 0.007 | 0.0077 | 0.008 | | | 0.008 | 200 | 5.00 | 0.738 | 0.023 | 19.800 | 16.540 | 16.800 | 3.00 | | | 2.987 |
| | | | | | | | | | | | | | | | 16.900 | 13.565 | 13.825 | 3.08 | 0.70 | | 0.015 |
| 47 | 45 | 5.58 | 344.0 | 344.0 | 0.007 | 0.0046 | 0.005 | | | 0.005 | 200 | 5.00 | 0.738 | 0.023 | 17.529 | 14.269 | 14.529 | 3.00 | | | 5.000 |
| | | | | | | | | | | | | | | | 16.900 | 12.549 | 12.809 | 4.09 | 0.00 | | 0.018 |
| 45 | 50 | 7.40 | 523.0 | 867.0 | 0.007 | 0.0061 | 0.093 | | | 0.093 | 600 | 2.20 | 1.019 | 0.288 | 16.900 | 6.824 | 7.504 | 9.40 | | | 3.105 |
| | | | | | | | | | | | | | | | 12.765 | 5.674 | 6.354 | 6.41 | | | 0.195 |
| 50 | 49B | 3.33 | 239.0 | 1106.0 | 0.007 | 0.0027 | 0.095 | | | 0.095 | 600 | 2.20 | 1.019 | 0.288 | 12.765 | 5.674 | 6.354 | 6.41 | | | 3.017 |
| | | | | | | | | | | | | | | | 13.617 | 5.148 | 5.828 | 7.79 | | | 0.193 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 9 | 8 | 0.88 | 194.0 | 194.0 | 0.007 | 0.0007 | 0.001 | | | 0.001 | 200 | 5.00 | 0.738 | 0.023 | 26.664 | 23.404 | 23.664 | 3.00 | | | 32.857 |
| | | | | | | | | | | | | | | | 25.262 | 20.934 | 21.194 | 4.07 | 1.50 | | 0.022 |
| 8 | 25 | 0.69 | 115.0 | 309.0 | 0.007 | 0.0006 | 0.001 | | | 0.001 | 200 | 5.00 | 0.738 | 0.023 | 25.262 | 20.934 | 21.194 | 4.07 | | | 17.692 |
| | | | | | | | | | | | | | | | 24.357 | 20.359 | 20.619 | 3.74 | | | 0.022 |
| 16 | 25 | 3.55 | 264.0 | 264.0 | 0.007 | 0.0029 | 0.003 | | | 0.003 | 200 | 5.00 | 0.738 | 0.023 | 24.672 | 21.412 | 21.672 | 3.00 | | | 7.931 |
| | | | | | | | | | | | | | | | 24.357 | 20.092 | 20.352 | 4.01 | 0.00 | | 0.020 |
| 25 | 46 | 4.94 | 208.0 | 472.0 | 0.007 | 0.004 | 0.008 | | | 0.008 | 200 | 5.00 | 0.738 | 0.023 | 24.357 | 20.092 | 20.352 | 4.01 | | | 2.805 |
| | | | | | | | | | | | | | | | 22.064 | 18.752 | 19.012 | 3.05 | 0.30 | | 0.015 |
| 46 | 48 | 10.29 | 297.0 | 769.0 | 0.007 | 0.0084 | 0.017 | | | 0.017 | 250 | 5.00 | 0.857 | 0.042 | 22.064 | 18.702 | 19.012 | 3.05 | | | 2.530 |
| | | | | | | | | | | | | | | | 19.100 | 15.717 | 16.027 | 3.07 | 1.50 | | 0.025 |
| 48 | 49A | 9.23 | 285.0 | 1054.0 | 0.007 | 0.0076 | 0.024 | | | 0.024 | 300 | 4.00 | 0.865 | 0.061 | 19.100 | 15.667 | 16.027 | 3.07 | | | 2.521 |
| | | | | | | | | | | | | | | | 17.529 | 14.127 | 14.487 | 3.04 | 0.40 | | 0.037 |
| 49A | 49B | 9.82 | 372.0 | 1426.0 | 0.007 | 0.008 | 0.032 | | | 0.032 | 350 | 3.50 | 0.897 | 0.086 | 17.529 | 14.077 | 14.487 | 3.04 | | | 2.671 |
| | | | | | | | | | | | | | | | 13.617 | 10.175 | 10.585 | 3.03 | 2.60 | | 0.054 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 49B | Cross Point | 7.30 | 187.0 | 187.0 | 0.007 | 0.006 | 0.134 | | | 0.134 | 600 | 2.20 | 1.019 | 0.288 | 13.617 | 5.148 | 5.828 | 7.79 | | | 2.155 |
| | | | | | | | | | | | | | | | 9.400 | 4.737 | 5.417 | 3.98 | | | 0.154 |
| | | | 11591.00 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

## *APPENDIX7 Flow Calculation (Dagon)*

| Section | Section (downstream) | Area | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) – (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Partial | Accumulation | Unit Vol. | Black Water Vol. Partial | Black Water Vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. Up / Down | Invert Level (bottom) Up / Down | Invert Level Up / Down | Earth Covering Up / Down | Manhole, Haed | | |
| | | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | | m | m | | |
| **Dagon-East** | | | | | | | | | | | | | | | | | | | | | |
| 1 | 34 | 3.19 | 383.0 | 383.000 | 0.007 | 0.0026 | 0.003 | | | 0.003 | 200 | 5.00 | 0.738 | 0.023 | 32.131 | 28.871 | 29.131 | 3.00 | | | 8.846 |
| | | | | | | | | | | | | | | | 26.852 | 23.556 | 23.816 | 3.04 | 3.40 | | 0.020 |
| 34 | 36 | 8.24 | 631.0 | 1014.000 | 0.007 | 0.0067 | 0.009 | | | 0.009 | 250 | 5.00 | 0.857 | 0.042 | 26.852 | 23.506 | 23.816 | 3.04 | | | 4.516 |
| | | | | | | | | | | | | | | | 21.344 | 17.951 | 18.261 | 3.08 | 2.40 | | 0.033 |
| | | | | | | | | | | | | | | | | | | | | | |
| 3 | 36 | 6.23 | 367.0 | 367.000 | 0.007 | 0.0051 | 0.005 | | | 0.005 | 200 | 5.00 | 0.738 | 0.023 | 27.400 | 24.140 | 24.400 | 3.00 | | | 4.510 |
| | | | | | | | | | | | | | | | 21.344 | 17.805 | 18.065 | 3.28 | 4.50 | | 0.018 |
| 36 | 11 | 1.53 | 240.0 | 1621.000 | 0.007 | 0.0012 | 0.016 | | | 0.016 | 250 | 5.00 | 0.857 | 0.042 | 21.344 | 17.755 | 18.065 | 3.28 | | | 2.692 |
| | | | | | | | | | | | | | | | 20.076 | 16.555 | 16.865 | 3.21 | | | 0.026 |
| | | | | | | | | | | | | | | | | | | | | | |
| 9 | 11 | 4.89 | 306.0 | 306.000 | 0.007 | 0.004 | 0.004 | | | 0.004 | 200 | 5.00 | 0.738 | 0.023 | 22.863 | 19.603 | 19.863 | 3.00 | | | 5.750 |
| | | | | | | | | | | | | | | | 20.076 | 16.773 | 17.033 | 3.04 | 1.30 | | 0.019 |
| 11 | 20 | 5.57 | 259.0 | 2186.000 | 0.007 | 0.0046 | 0.024 | | | 0.024 | 300 | 4.00 | 0.865 | 0.061 | 20.076 | 16.505 | 16.865 | 3.21 | | | 2.521 |
| | | | | | | | | | | | | | | | 15.983 | 12.569 | 12.929 | 3.05 | 2.90 | | 0.037 |
| | | | | | | | | | | | | | | | | | | | | | |
| 14 | 20 | 4.08 | 260.0 | 260.000 | 0.007 | 0.0033 | 0.003 | | | 0.003 | 200 | 5.00 | 0.738 | 0.023 | 16.601 | 13.341 | 13.601 | 3.00 | | | 6.970 |
| | | | | | | | | | | | | | | | 15.983 | 12.041 | 12.301 | 3.68 | | | 0.020 |
| 20 | 28 | 11.17 | 456.0 | 2902.000 | 0.007 | 0.0091 | 0.037 | | | 0.037 | 350 | 3.50 | 0.897 | 0.086 | 15.983 | 11.891 | 12.301 | 3.68 | | | 2.350 |
| | | | | | | | | | | | | | | | 11.665 | 8.195 | 8.605 | 3.06 | 2.10 | | 0.049 |
| | | | | | | | | | | | | | | | | | | | | | |
| 2 | 8 | 17.10 | 431.0 | 431.000 | 0.007 | 0.014 | 0.014 | | | 0.014 | 250 | 5.00 | 0.857 | 0.042 | 32.131 | 28.821 | 29.131 | 3.00 | | | 3.000 |
| | | | | | | | | | | | | | | | 27.400 | 24.066 | 24.376 | 3.02 | 2.60 | | 0.028 |
| 8 | 16 | 10.33 | 349.0 | 780.000 | 0.007 | 0.0085 | 0.023 | | | 0.023 | 300 | 4.00 | 0.865 | 0.061 | 27.400 | 24.016 | 24.376 | 3.02 | | | 2.711 |
| | | | | | | | | | | | | | | | 22.863 | 19.420 | 19.780 | 3.08 | 3.20 | | 0.039 |
| 16 | 21 | 8.50 | 298.0 | 1078.000 | 0.007 | 0.007 | 0.030 | | | 0.030 | 400 | 3.00 | 0.908 | 0.114 | 22.863 | 19.320 | 19.783 | 3.08 | | | 3.864 |
| | | | | | | | | | | | | | | | 16.601 | 13.126 | 13.589 | 3.01 | 5.30 | | 0.085 |
| 19 | 21 | 0.94 | 158.0 | 158.000 | 0.007 | 0.0008 | 0.001 | | | 0.001 | 200 | 5.00 | 0.738 | 0.023 | 15.400 | 12.140 | 12.400 | 3.00 | | | 28.750 |
| | | | | | | | | | | | | | | | 16.601 | 11.350 | 11.610 | 4.99 | | | 0.022 |

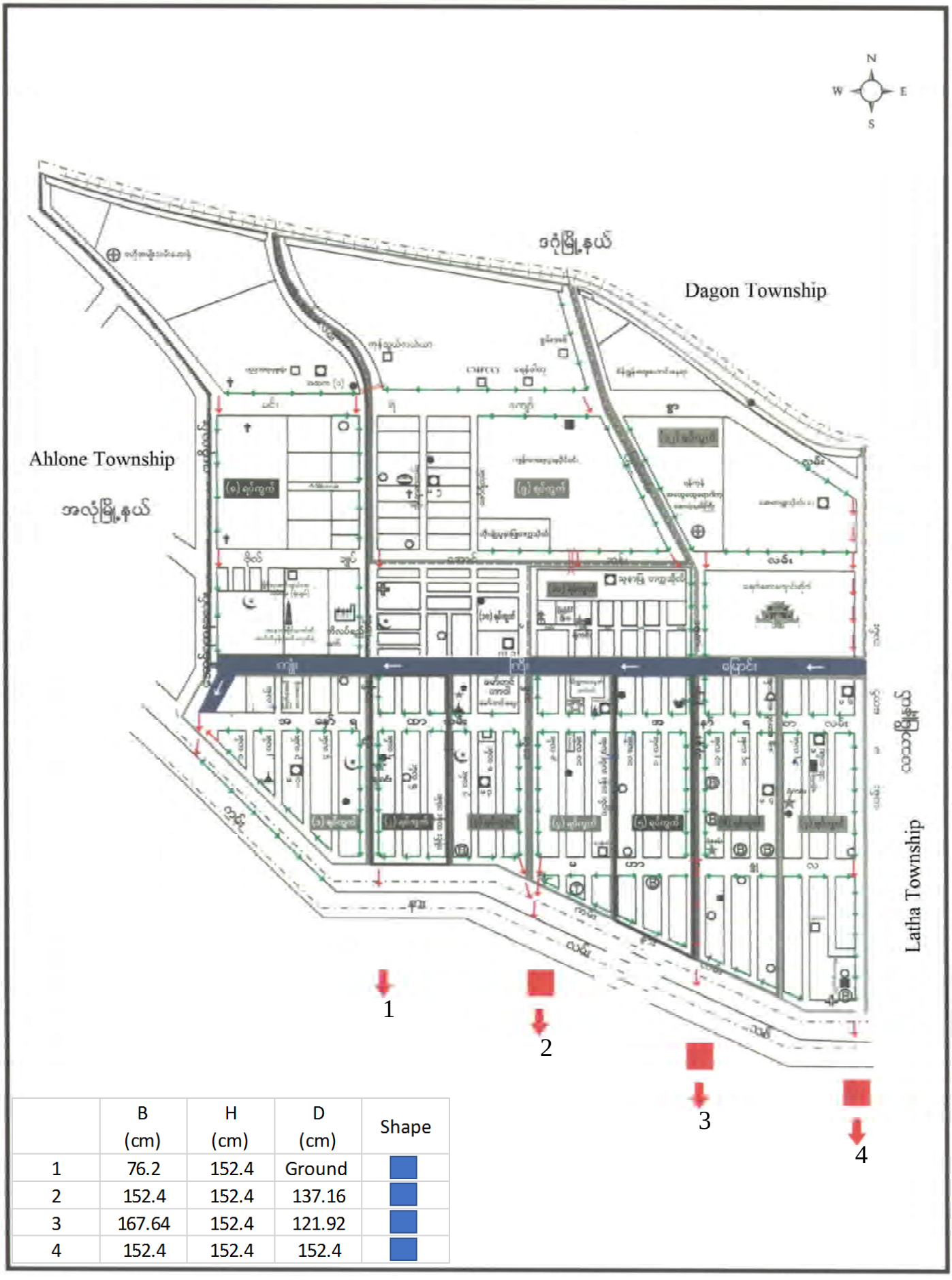
## *APPENDIX7 Flow Calculation (Dagon)*

| Section | Section (downstream) | Area | Length | | Discharge Volume | | | Other | | Total Vol. | Sewer | | | | | | | | | Remark | (Total Vol.) / (Discharge) (Discharge) − (Total Vol.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partial | Partial | Accumulation | Unit Vol. | Black Water Vol. Partial | Black Water Vol. Accumulation | Partial | Accumulation | | Diameter | Slope | Velocity | Discharge | G.L. Up / Down | Invert Level (bottom) Up / Down | Invert Level Up / Down | Earth Covering Up / Down | Manhole, Haed | | |
| | | ha | m | m | $m^3/m^2/d$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | $m^3/sec$ | mm | ‰ | m/sec | $m^3/sec$ | m | m | | m | m | | |
| 21 | 27 | 3.29 | 324.0 | 1560.000 | 0.007 | 0.0027 | 0.033 | | | 0.033 | 450 | 2.60 | 0.914 | 0.145 | 16.601 | 11.100 | 11.617 | 4.98 | | | 4.394 |
| | | | | | | | | | | | | | | | 12.099 | 8.558 | 9.075 | 3.02 | 1.70 | | 0.112 |
| 25 | 26 | 30.55 | 242.0 | 242.000 | 0.007 | 0.025 | 0.025 | | | 0.025 | 300 | 4.00 | 0.865 | 0.061 | 19.128 | 12.768 | 13.128 | 6.00 | | | 2.440 |
| | | | | | | | | | | | | | | | 17.148 | 11.800 | 12.160 | 4.99 | | | 0.036 |
| 26 | 23 | 2.00 | 248.0 | 490.000 | 0.007 | 0.0016 | 0.027 | | | 0.027 | 300 | 4.00 | 0.865 | 0.061 | 17.148 | 11.800 | 12.160 | 4.99 | | | 2.293 |
| | | | | | | | | | | | | | | | 14.828 | 10.808 | 11.168 | 3.66 | | | 0.034 |
| 22 | 23 | 4.76 | 331.0 | 331.000 | 0.007 | 0.0039 | 0.004 | | | 0.004 | 200 | 5.00 | 0.738 | 0.023 | 15.400 | 12.140 | 12.400 | 3.00 | | | 5.897 |
| | | | | | | | | | | | | | | | 14.828 | 10.485 | 10.745 | 4.08 | | | 0.019 |
| 23 | 27 | 2.43 | 240.0 | 1061.000 | 0.007 | 0.002 | 0.033 | | | 0.033 | 350 | 3.50 | 0.897 | 0.086 | 14.828 | 10.335 | 10.745 | 4.08 | | | 2.646 |
| | | | | | | | | | | | | | | | 12.099 | 7.995 | 8.405 | 3.69 | 1.50 | | 0.054 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 27 | 28 | 0.76 | 111.0 | 2732.000 | 0.007 | 0.0006 | 0.066 | | | 0.066 | 450 | 2.60 | 0.914 | 0.145 | 12.099 | 7.895 | 8.412 | 3.69 | | | 2.194 |
| | | | | | | | | | | | | | | | 11.665 | 7.606 | 8.123 | 3.54 | | | 0.079 |
| 28 | 29 | 0.53 | 51.7 | 5685.700 | 0.007 | 0.0004 | 0.103 | | | 0.103 | 600 | 2.20 | 1.019 | 0.288 | 11.665 | 7.456 | 8.136 | 3.53 | | | 2.793 |
| | | | | | | | | | | | | | | | 12.769 | 4.943 | 5.623 | 7.15 | 2.40 | | 0.185 |
| 33 | 32 | 1.39 | 185.0 | 185.000 | 0.007 | 0.0011 | 0.001 | | | 0.001 | 200 | 5.00 | 0.738 | 0.023 | 17.148 | 13.888 | 14.148 | 3.00 | | | 20.909 |
| | | | | | | | | | | | | | | | 15.410 | 12.063 | 12.323 | 3.09 | 0.90 | | 0.022 |
| 32 | 30 | 6.20 | 329.0 | 514.000 | 0.007 | 0.0051 | 0.006 | | | 0.006 | 200 | 5.00 | 0.738 | 0.023 | 15.410 | 12.063 | 12.323 | 3.09 | | | 3.710 |
| | | | | | | | | | | | | | | | 14.056 | 10.418 | 10.678 | 3.38 | | | 0.017 |
| 31 | 30 | 1.45 | 159.0 | 159.000 | 0.007 | 0.0012 | 0.001 | | | 0.001 | 200 | 5.00 | 0.738 | 0.023 | 14.828 | 11.568 | 11.828 | 3.00 | | | 19.167 |
| | | | | | | | | | | | | | | | 14.056 | 10.773 | 11.033 | 3.02 | | | 0.022 |
| 30 | 29 | 3.55 | 286.0 | 959.000 | 0.007 | 0.0029 | 0.010 | | | 0.010 | 200 | 5.00 | 0.738 | 0.023 | 14.056 | 10.418 | 10.678 | 3.38 | | | 2.233 |
| | | | | | | | | | | | | | | | 12.769 | 8.988 | 9.248 | 3.52 | | | 0.013 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 29 | Cross Point | 0.44 | 27.0 | 6671.700 | 0.007 | 0.0004 | 0.114 | | | 0.114 | 600 | 2.20 | 1.019 | 0.288 | 12.769 | 4.943 | 5.623 | 7.15 | | | 2.531 |
| | | | | | | | | | | | | | | | 8.600 | 4.883 | 5.563 | 3.04 | 0.00 | | 0.174 |
| | | | 6671.7 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

# Appendix 8 Location and Dimension of Existing Drainage Channels

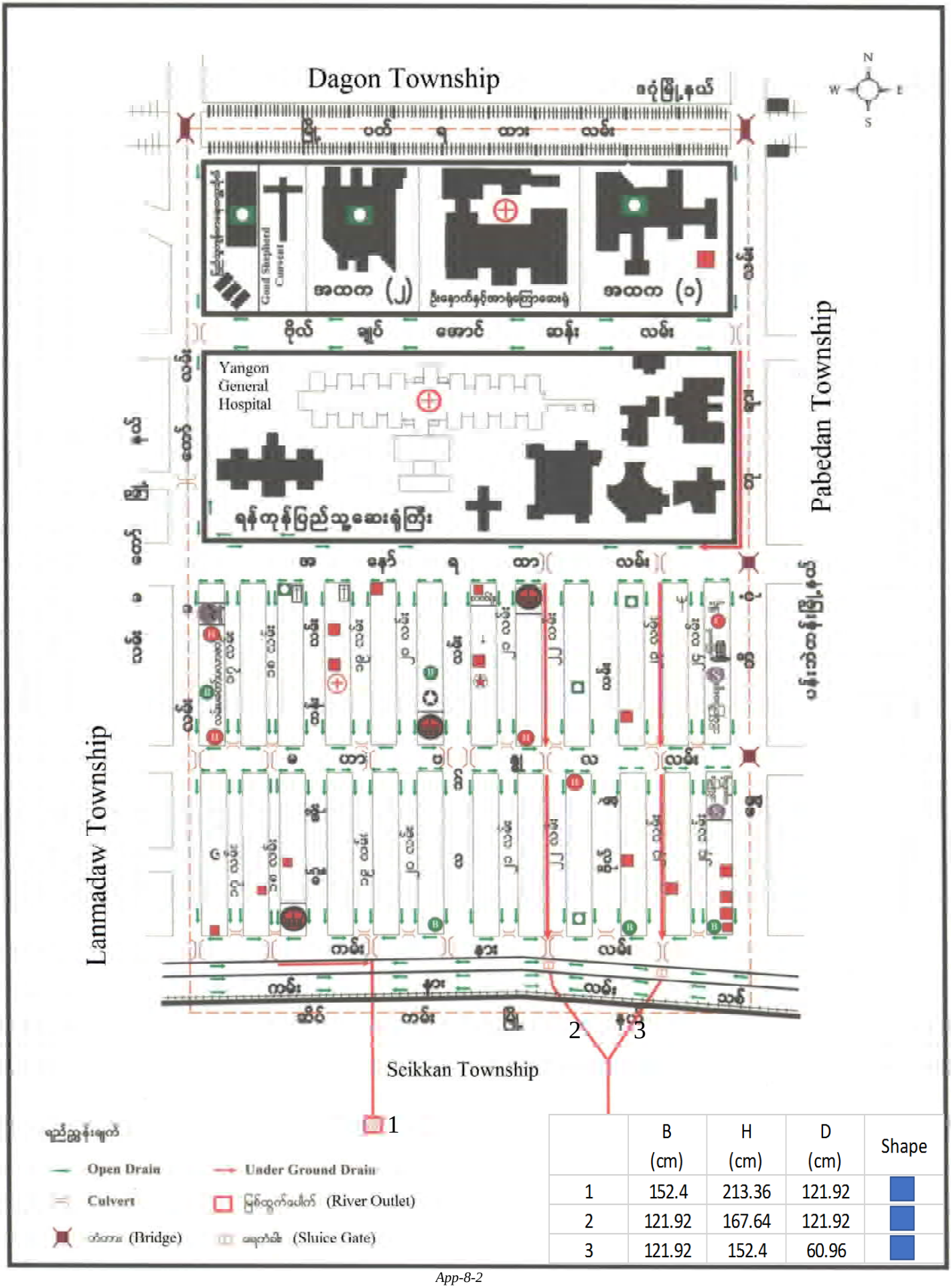
APPENDIX8 Layout Plan of Existing Drainage Channels

# Drainage and Channel Map in Lanmadaw Township



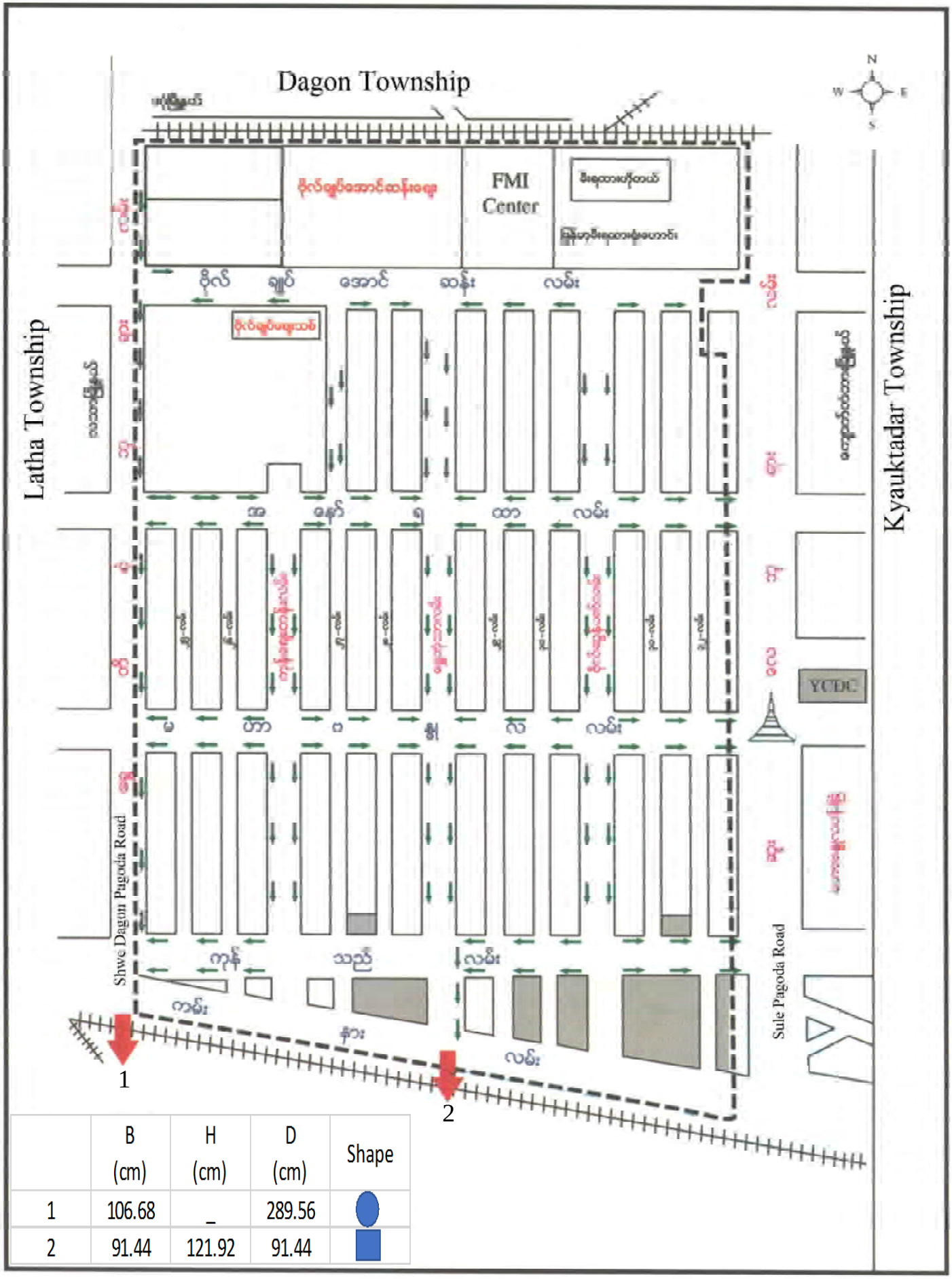

| | B (cm) | H (cm) | D (cm) | Shape |
|---|---|---|---|---|
| 1 | 76.2 | 152.4 | Ground | |
| 2 | 152.4 | 152.4 | 137.16 | |
| 3 | 167.64 | 152.4 | 121.92 | |
| 4 | 152.4 | 152.4 | 152.4 | |

# Drainage and Channel Map in Latha Township



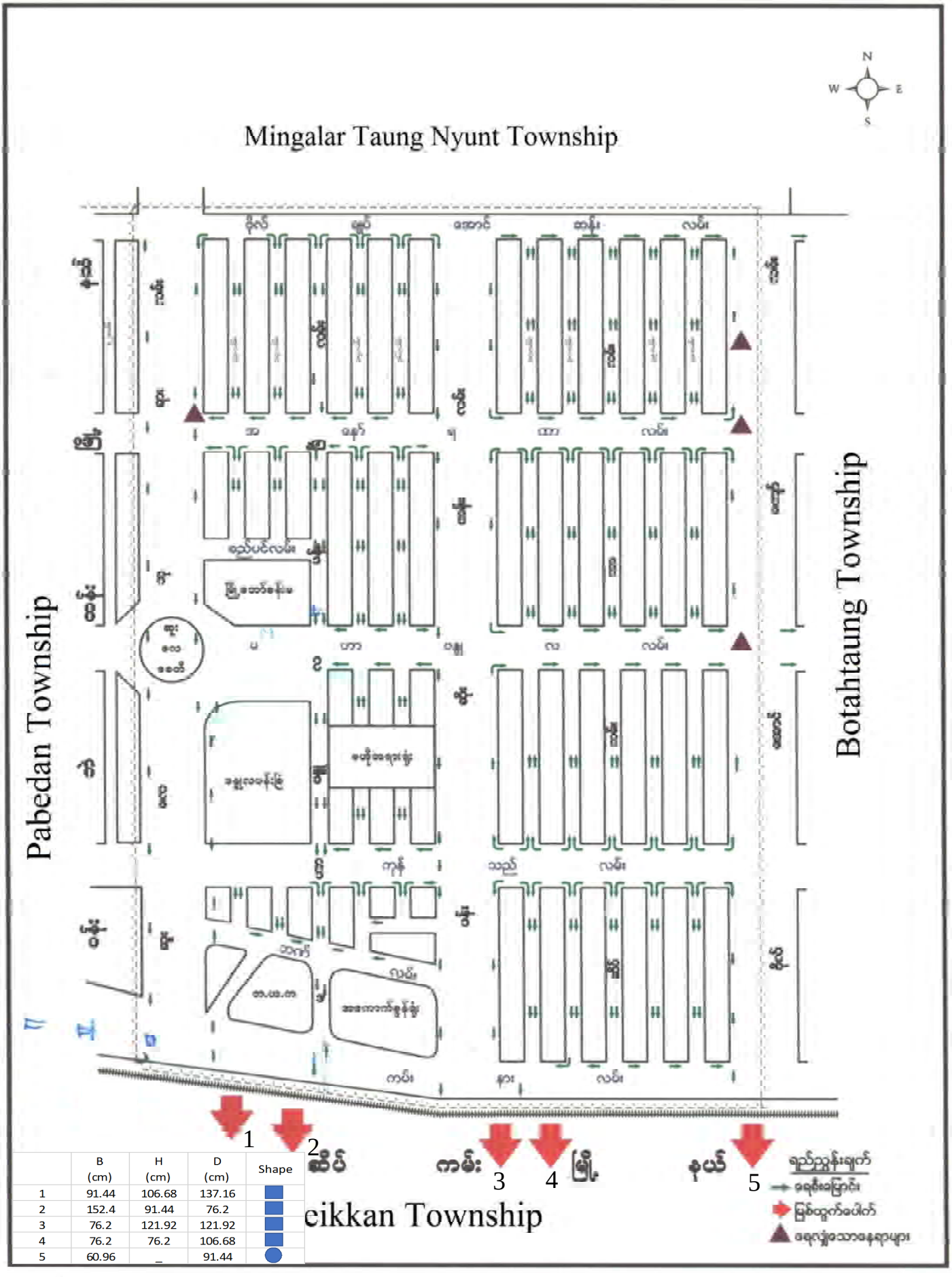

| | B (cm) | H (cm) | D (cm) | Shape |
|---|---|---|---|---|
| 1 | 152.4 | 213.36 | 121.92 | |
| 2 | 121.92 | 167.64 | 121.92 | |
| 3 | 121.92 | 152.4 | 60.96 | |

# Drainage and Channel Map in Pabedan Township

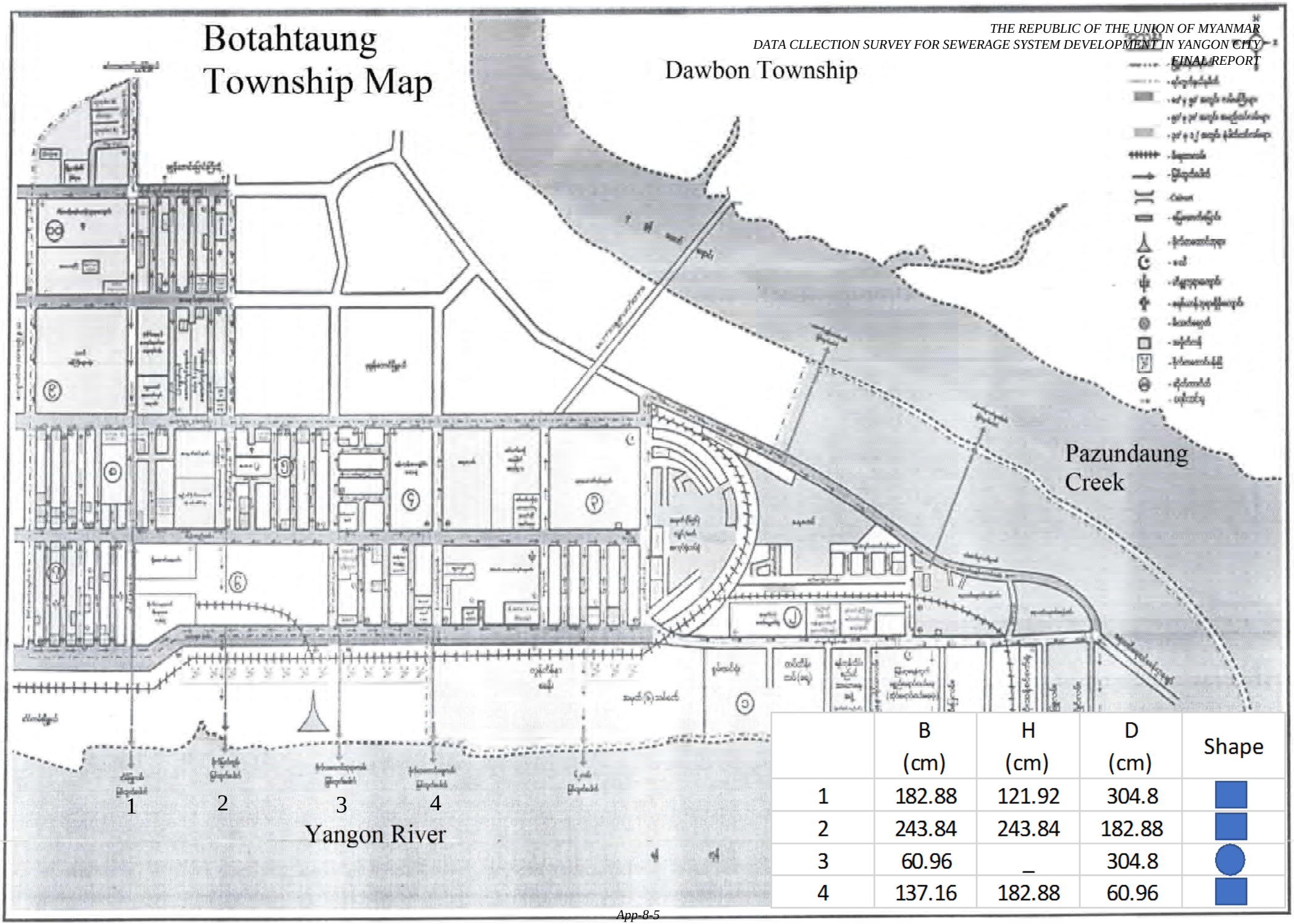



| | B (cm) | H (cm) | D (cm) | Shape |
|---|---|---|---|---|
| 1 | 106.68 | _ | 289.56 | |
| 2 | 91.44 | 121.92 | 91.44 | |

# Drainage and Channel Map in Kyauktadar Township




| | B (cm) | H (cm) | D (cm) | Shape |
|---|---|---|---|---|
| 1 | 91.44 | 106.68 | 137.16 | |
| 2 | 152.4 | 91.44 | 76.2 | |
| 3 | 76.2 | 121.92 | 121.92 | |
| 4 | 76.2 | 76.2 | 106.68 | |
| 5 | 60.96 | _ | 91.44 | |




| | B (cm) | H (cm) | D (cm) | Shape |
|---|---|---|---|---|
| 1 | 182.88 | 121.92 | 304.8 | |
| 2 | 243.84 | 243.84 | 182.88 | |
| 3 | 60.96 | _ | 304.8 | |
| 4 | 137.16 | 182.88 | 60.96 | |

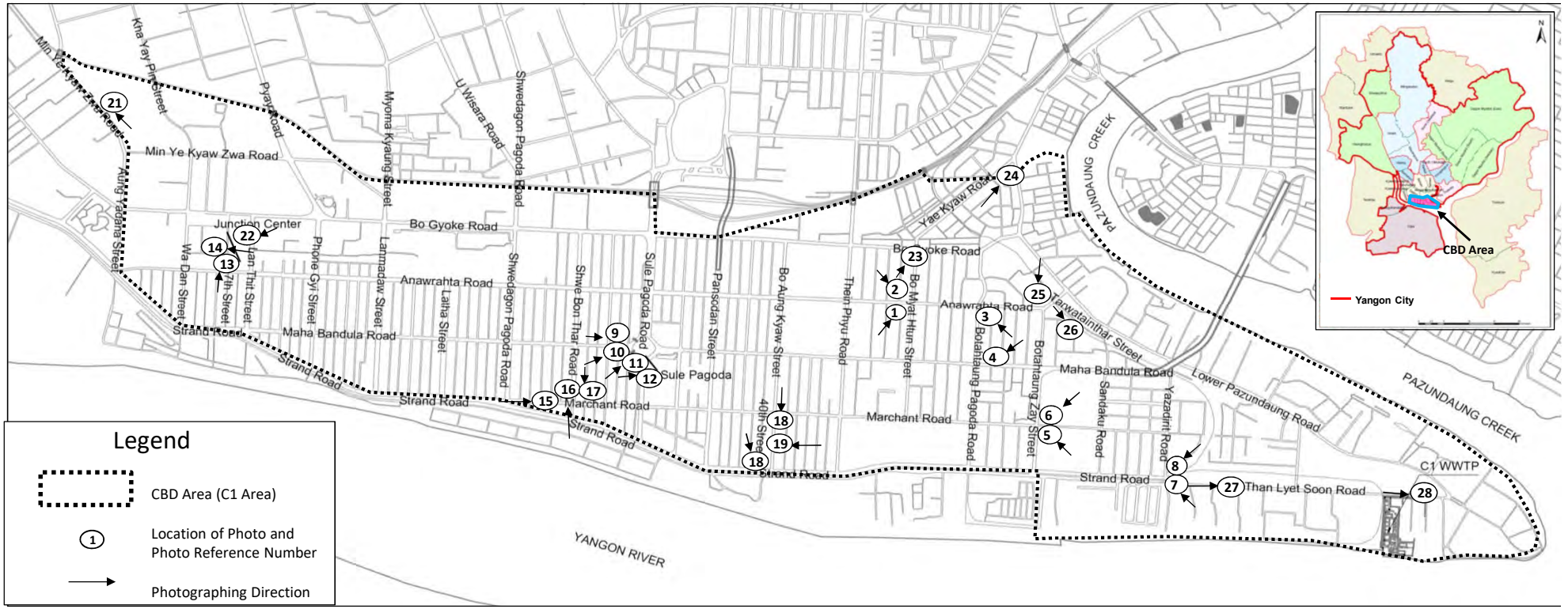
# Appendix 9 Site Photo List

# APPENDIX 9 Site Photo List

Table : Site Photo List

| No. | Item |
|---|---|
| A | CBD Area (C1 Area) |
| B | Dagon Area (Part of W1 Area) |
| C | Back Drainage Space (BDS) |
| D | Ejector System |
| E | C1 Wastewater Treatment Plant |
| F | Htein Bin Final Disposal Site |
| G | Meeting with YCDC |
| H | Thida Substation |

# Map A : CBD Area (C1 Area)



| | |
|---|---|
| No. | A - 1 |
| Location | Crossing of Anawrahta Rd. and Bo Myat Htun St. |
| Remark | |

| | |
|---|---|
| No. | A - 2 |
| Location | Crossing of Anawrahta Rd. and Bo Myat Htun St. |
| Remark | |

| | |
|---|---|
| No. | A - 3 |
| Location | Crossing of Maha Bandula Rd. and Botahtaung Pagoda St. |
| Remark | |



| | |
|---|---|
| No. | A - 4 |
| Location | Crossing of Maha Bandula Rd. and Botahtaung Pagoda St. |
| Remark | |

| | |
|---|---|
| No. | A - 5 |
| Location | Crossing of Merchant Rd. and Botahtaung Zay St. |
| Remark | |

| | |
|---|---|
| No. | A - 6 |
| Location | Crossing of Merchant Rd. and Botahtaung Zay St. |
| Remark | |

| No. | A - 7 |
|---|---|
| Location | Crossing of Strand Rd. and Yazadirit Rd. |
| Remark | |

| No. | A - 8 |
|---|---|
| Location | Crossing of Strand Rd. and Yazadirit Rd. |
| Remark | |

| No. | A - 9 |
|---|---|
| Location | Maha Bandula Rd. |
| Remark | West Side of Sule Pagoda |



| No. | A - 10 |
|---|---|
| Location | Maha Bandula Rd. |
| Remark | West side of Sule Pagoda |

| No. | A - 11 |
|---|---|
| Location | Maha Bandula Rd. |
| Remark | Southwest side of Sule Pagoda |

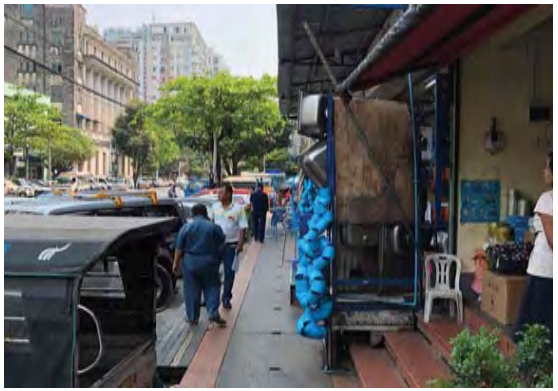
| No. | A - 12 |
|---|---|
| Location | Maha Bandula Rd. |
| Remark | Left side: Sule Pagoda<br>Front side: City Hall |

| | |
|---|---|
| No. | A - 13 |
| Location | 7th St. in Lanmadaw |
| Remark | Building around 7th St. |

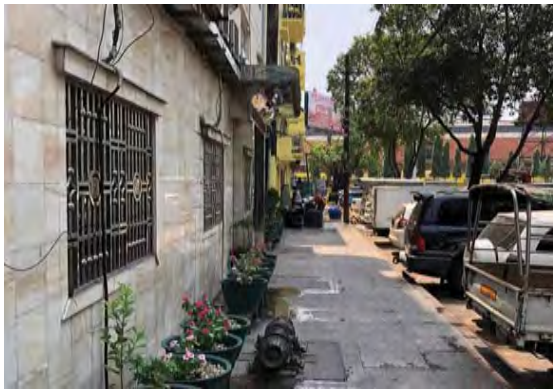
| | |
|---|---|
| No. | A - 14 |
| Location | 7th St. in Lanmadaw |
| Remark | Building around 7th St. |

| | |
|---|---|
| No. | A - 15 |
| Location | Merchant Rd. |
| Remark | Sidewalk of Merchant Rd<br>There was the drainage under the sidewalk. |





| | |
|---|---|
| No. | A - 16 |
| Location | Merchant Rd. |
| Remark | There was the drainage under the sidewalk. |



| | |
|---|---|
| No. | A - 17 |
| Location | Shwe Bon Thar Rd. |
| Remark | There was the drainage under the sideway. |

| | |
|---|---|
| No. | A - 18 |
| Location | 40th St. |
| Remark | South Direction |

| | |
|---|---|
| No. | A - 19 |
| Location | 40th St. |
| Remark | Storage Pump beside the 40th St. |

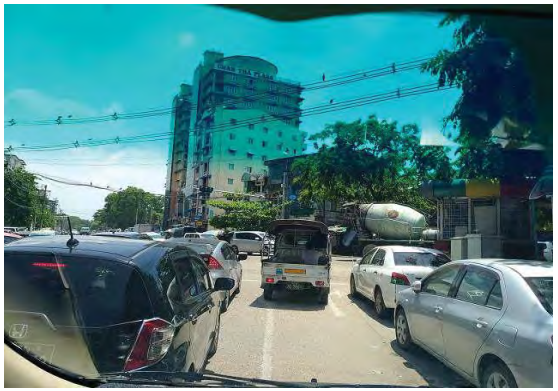
| | |
|---|---|
| No. | A - 20 |
| Location | 40th St. |
| Remark | North Direction |

| | |
|---|---|
| No. | A - 21 |
| Location | Min Ye Kyaw Zwa Rd. |
| Remark | |



| | |
|---|---|
| No. | A - 22 |
| Location | Behind Junction Center |
| Remark | No.10 Creek |

| | |
|---|---|
| No. | A - 23 |
| Location | Yae Kyaw Rd. |
| Remark | |



| | |
|---|---|
| No. | A - 24 |
| Location | Yae Kyaw Rd. |
| Remark | |

| No. | A - 25 |
|---|---|
| Location | Anawratha Rd. |
| Remark | |

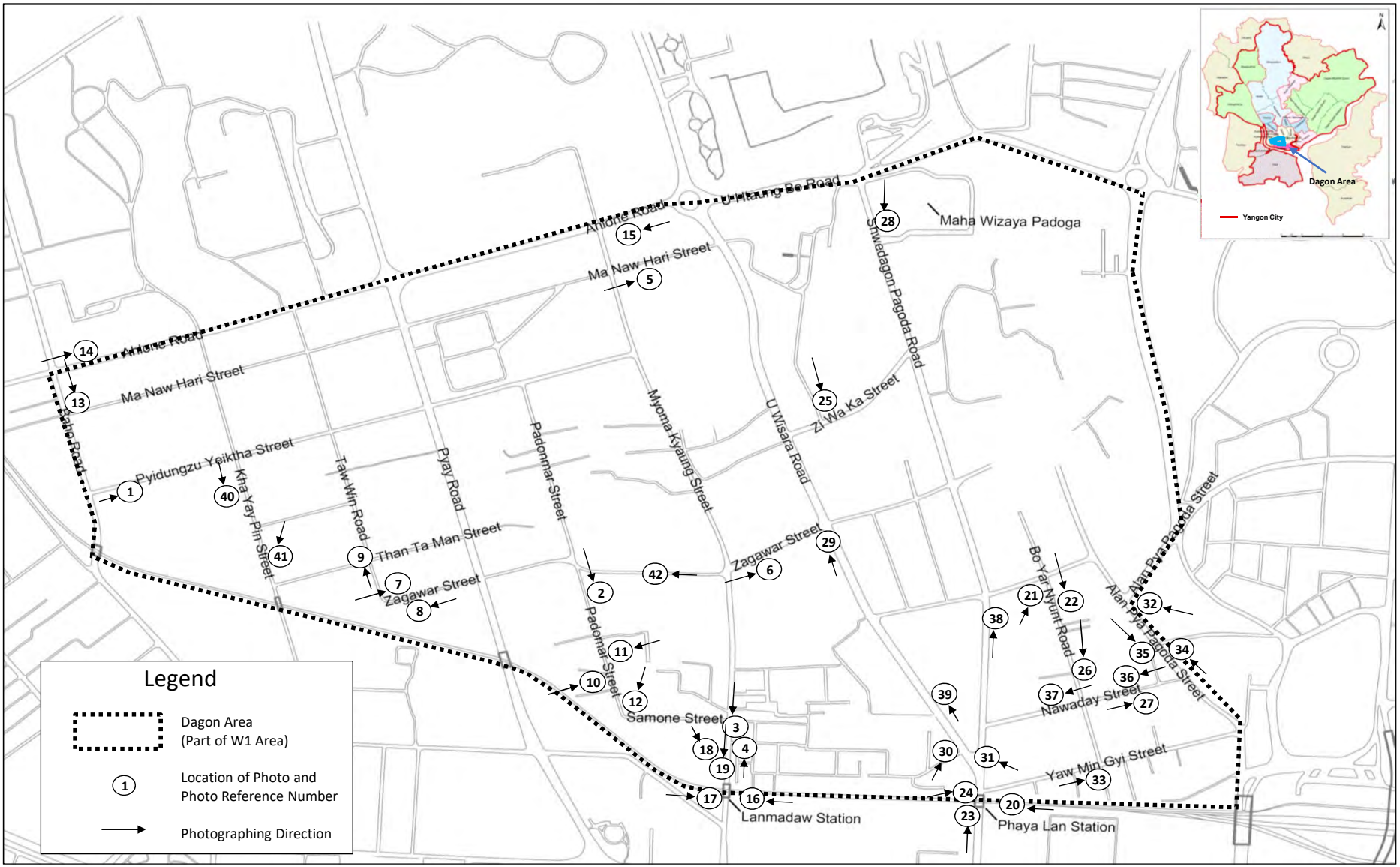
| No. | A - 26 |
|---|---|
| Location | Tarwatainthar St. |
| Remark | |

| No. | A - 27 |
|---|---|
| Location | Than Lyet Soon Rd. |
| Remark | |



| No. | A - 28 |
|---|---|
| Location | Than Lyet Soon Rd. |
| Remark | End of Than Lyet Soon Rd. |

# Map B : Dagon Area (Part of W1 Area)



| No. | B - 1 |
|---|---|
| Location | Pyidaungzu Yeiktha St. |
| Remark | |

| No. | B - 2 |
|---|---|
| Location | Padonmar St. |
| Remark | |

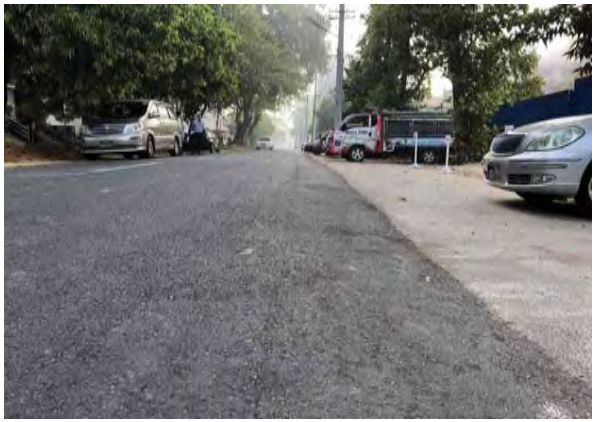
| No. | B - 3 |
|---|---|
| Location | Myoma Kyaung St. |
| Remark | South Direction<br>The Traffic to CBD Area |



| No. | B - 4 |
|---|---|
| Location | Myoma Kyaung St. |
| Remark | North Direction |

| No. | B - 5 |
|---|---|
| Location | Ma New Hari St. |
| Remark | |

| No. | B - 6 |
|---|---|
| Location | Zagawar St. |
| Remark | This site was dropped from pipe laying area because of redevelopment area. |



| No. | B - 7 |
|---|---|
| Location | Than Ta Man St. |
| Remark | |

| No. | B - 8 |
|---|---|
| Location | Zagawar St. |
| Remark | Unpaved Walkway |

| No. | B - 9 |
|---|---|
| Location | Taw Win Rd. |
| Remark | |



| No. | B - 10 |
|---|---|
| Location | Padonmar St. |
| Remark | Residential Section along the Padonmar St. |

| No. | B - 11 |
|---|---|
| Location | Padonmar St. |
| Remark | Embassy of Russia along the Padonmar St |

| No. | B - 12 |
|---|---|
| Location | Crossing of Padonmar St. and Samone St. |
| Remark | |

| No. | B - 13 |
|---|---|
| Location | Baho Rd. |
| Remark | |

| No. | B - 14 |
|---|---|
| Location | Ahlon Rd. |
| Remark | Traffic to the East side |

| No. | B - 15 |
|---|---|
| Location | Ahlon Rd. |
| Remark | |



| No. | B - 16 |
|---|---|
| Location | Lanmadaw Railway |
| Remark | Connected to "Main Sewer Line1 in CBD Area" by pipe jacking |

| No. | B - 17 |
|---|---|
| Location | Lanmadaw Railway |
| Remark | |

| No. | B - 18 |
|---|---|
| Location | Lanmadaw Railway |
| Remark | Water Channel beside the Lanmadaw Station (West Side) |

| No. | B - 19 |
|---|---|
| Location | Lanmadaw Railway |
| Remark | Water Channel beside the Lanmadaw Station (West Side) |

| No. | B - 20 |
|---|---|
| Location | Phaya Lan Railway |
| Remark | Connected to "Main Sewer Line1 in CBD Area" by pipe jacking |

| No. | B - 21 |
|---|---|
| Location | Crossing of Bo Yar Nyunt Rd. and Pan Tra St. |
| Remark | Over side of the gate was a military facility |



| No. | B - 22 |
|---|---|
| Location | Bo Yar Nyunt Rd. |
| Remark | Traffic volume is low. |

| No. | B - 23 |
|---|---|
| Location | Shwedagon Pagoda Rd. |
| Remark | Northwest side of the Phaya Lan Station<br>North Direction |

| No. | B - 24 |
|---|---|
| Location | Yaw Min Gyi St. |
| Remark | |

| No. | B - 25 |
|---|---|
| Location | Dorgah Of Second Bahadur Shah<br>Zi Wa Ka St. |
| Remark | |

| No. | B - 26 |
|---|---|
| Location | Bo Yar Nyunt Rd. |
| Remark | A lot of Street Parking |

| No. | B - 27 |
|---|---|
| Location | Alan Pya Pagoda St. |
| Remark | This site was used as the parking area. |



| No. | B - 28 |
|---|---|
| Location | U Wisara Rd. |
| Remark | West side of Maha Wizaya Pagoda |

| No. | B - 29 |
|---|---|
| Location | U Wisara Rd. |
| Remark | East side of Military Hospital |

| No. | B - 30 |
|---|---|
| Location | U Wisara Rd. |
| Remark | |

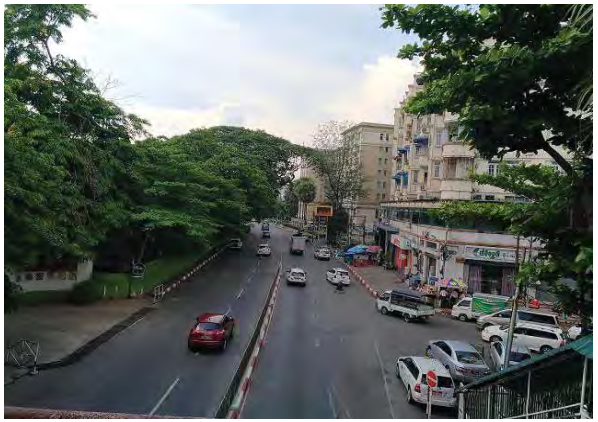
| No. | B - 31 |
|---|---|
| Location | Crossing of U Wisara Rd. and Shwedagon Pagoda Rd. |
| Remark | |

| No. | B - 32 |
|---|---|
| Location | Alan Pya Pagoda St |
| Remark | Over side of the gate was a military facility. |

| No. | B - 33 |
|---|---|
| Location | Yaw Min Gyi St. |
| Remark | |



| No. | B - 34 |
|---|---|
| Location | Alan Pya Pagoda St. |
| Remark | Left side: Elementary School |



| No. | B - 35 |
|---|---|
| Location | Alan Pya Pagoda St. |
| Remark | |


| No. | B - 36 |
|---|---|
| Location | Nawaday St. |
| Remark | |

| No. | B - 37 |
|---|---|
| Location | Nawaday St. |
| Remark | |

| No. | B - 38 |
|---|---|
| Location | Shwedagon Pagoda Rd. |
| Remark | |

| No. | B - 39 |
|---|---|
| Location | U Wisara Rd. |
| Remark | |



| No. | B - 40 |
|---|---|
| Location | Kha Yay Pin St. |
| Remark | |

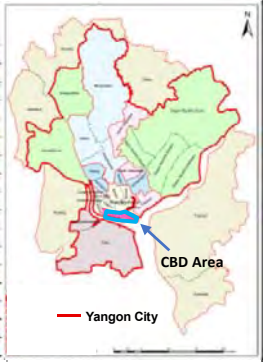
| No. | B - 41 |
|---|---|
| Location | Kha Yay Pin St. |
| Remark | |

| No. | B - 42 |
|---|---|
| Location | Zagawar St. |
| Remark | West Direction |

# Map C : BDS in CBD Area

## BDS in CBD Area

| BDS No. | Type | Remark | BDS No. | Type | Remark | BDS No. | Type | Remark | BDS No. | Type | Remark | BDS No. | Type | Remark | BDS No. | Type | Remark | BDS No. | Type | Remark | BDS No. | Type | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | A | Unimproved | 24 | A | Improved | 47 | B | Unimproved | 70 | A | Improved | 93 | A | Improved | 116 | B | Unimproved | 139 | A | Improved | 162 | A | Unimproved |
| 2 | A | Unimproved | 25 | A | Improved | 48 | B | Unimproved | 71 | A | Unimproved | 94 | A | Unimproved | 117 | B | Unimproved | 140 | A | Unimproved | 163 | A | Unimproved |
| 3 | A | Unimproved | 26 | A | Improved | 49 | B | Improved | 72 | A | Unimproved | 95 | A | Improved | 118 | B | Unimproved | 141 | A | Unimproved | 164 | A | Unimproved |
| 4 | A | Unimproved | 27 | A | Improved | 50 | B | Unimproved | 73 | A | Unimproved | 96 | A | Improved | 119 | B | Unimproved | 142 | A | Unimproved | 165 | A | Improved |
| 5 | A | Unimproved | 28 | A | Improved | 51 | B | Unimproved | 74 | A | Unimproved | 97 | A | Improved | 120 | B | Unimproved | 143 | B | Unimproved | 166 | A | Improved |
| 6 | A | Unimproved | 29 | B | Unimproved | 52 | B | Unimproved | 75 | A | Unimproved | 98 | A | Improved | 121 | B | Unimproved | 144 | A | Unimproved | 167 | A | Improved |
| 7 | A | Unimproved | 30 | B | Unimproved | 53 | B | Unimproved | 76 | A | Improved | 99 | A | Unimproved | 122 | A | Improved | 145 | A | Unimproved | 168 | A | Improved |
| 8 | A | Unimproved | 31 | B | Unimproved | 54 | B | Unimproved | 77 | A | Improved | 100 | A | Unimproved | 123 | A | Improved | 146 | B | Unimproved | 169 | A | Improved |
| 9 | B | Unimproved | 32 | B | Unimproved | 55 | B | Unimproved | 78 | B | Unimproved | 101 | A | Unimproved | 124 | A | Improved | 147 | B | Unimproved | 170 | A | Unimproved |
| 10 | B | Improvec | 33 | B | Improved | 56 | B | Unimproved | 79 | B | Unimproved | 102 | A | Unimproved | 125 | A | Improved | 148 | B | Unimprovec | 171 | A | Unimproved |
| 11 | B | Improvec | 34 | B | Unimproved | 57 | B | Unimproved | 80 | B | Unimproved | 103 | A | Unimproved | 126 | A | Improved | 149 | B | Unimprovec | 172 | A | Improvec |
| 12 | B | Improvec | 35 | B | Improved | 58 | B | Unimproved | 81 | A | Improvec | 104 | A | Improvec | 127 | B | Unimproved | 150 | B | Unimprovec | 173 | A | Improvec |
| 13 | B | Improvec | 36 | B | Unimproved | 59 | B | Unimproved | 82 | B | Unimproved | 105 | A | Unimproved | 128 | A | Unimproved | 151 | B | Unimprovec | 174 | A | Unimproved |
| 14 | B | Improvec | 37 | B | Unimproved | 60 | B | Unimproved | 83 | A | Unimproved | 106 | A | Improvec | 129 | A | Unimproved | 152 | A | Improved | 175 | A | Improvec |
| 15 | B | Unimproved | 38 | B | Unimproved | 61 | B | Improved | 84 | A | Unimproved | 107 | A | Improvec | 130 | A | Unimproved | 153 | A | Improved | 176 | A | Improvec |
| 16 | A | Improvec | 39 | B | Improved | 62 | B | Improved | 85 | A | Unimproved | 108 | A | Improvec | 131 | A | Unimproved | 154 | A | Unimprovec | 177 | A | Improvec |
| 17 | B | Unimproved | 40 | B | Unimproved | 63 | B | Improved | 86 | A | Improvec | 109 | A | Improvec | 132 | A | Unimproved | 155 | A | Unimprovec | 178 | A | Unimproved |
| 18 | B | Unimproved | 41 | B | Unimproved | 64 | B | Unimproved | 87 | A | Unimproved | 110 | B | Improvec | 133 | A | Unimproved | 156 | A | Unimprovec | 179 | A | Improvec |
| 19 | A | Improvec | 42 | B | Unimproved | 65 | B | Improved | 88 | A | Unimproved | 111 | A | Unimproved | 134 | A | Unimproved | 157 | A | Improved | 180 | A | Improvec |
| 20 | A | Improved | 43 | A | Improved | 66 | B | Unimproved | 89 | B | Unimproved | 112 | B | Unimproved | 135 | A | Unimproved | 158 | A | Unimproved | 181 | A | Unimproved |
| 21 | A | Improved | 44 | A | Improved | 67 | A | Unimproved | 90 | B | Unimproved | 113 | A | Unimproved | 136 | A | Unimproved | 159 | A | Unimproved | 182 | A | Unimproved |
| 22 | A | Improved | 45 | B | Improved | 68 | A | Improved | 91 | B | Unimproved | 114 | A | Unimproved | 137 | A | Improved | 160 | A | Unimproved | | | |
| 23 | A | Improved | 46 | B | Unimproved | 69 | A | Improved | 92 | A | Improved | 115 | B | Unimproved | 138 | A | Improved | 161 | A | Unimproved | | | |



| | |
|---|---|
| No. | C - 1 |
| Location | No.22 |
| Remark | Type A (Improved) |

| | |
|---|---|
| No. | C - 2 |
| Location | No.22 |
| Remark | Storm water pipe from roof to drainage<br>Type A (Improved) |

| | |
|---|---|
| No. | C - 3 |
| Location | No.22 |
| Remark | Chamber<br>Type A (Improved) |



| | |
|---|---|
| No. | C - 4 |
| Location | No.22 |
| Remark | Inside of Chamber<br>Type A (Improved) |

| | |
|---|---|
| No. | C - 5 |
| Location | No.23 |
| Remark | Type A (Improved) |

| | |
|---|---|
| No. | C - 6 |
| Location | No.23 |
| Remark | Type A (Improved) |

| | |
|---|---|
| No. | C - 7 |
| Location | No.23 |
| Remark | Type A (Improved) |

| | |
|---|---|
| No. | C - 8 |
| Location | No.23 |
| Remark | Inside of Chamber<br>Type A (Improved) |

| | |
|---|---|
| No. | C - 9 |
| Location | No.23 |
| Remark | Storm water pipe from roof to drainage.<br>Type A (Improved) |



| | |
|---|---|
| No. | C - 10 |
| Location | No.50 |
| Remark | Type B (Not Improved) |

| | |
|---|---|
| No. | C - 11 |
| Location | No.50 |
| Remark | Type B (Not Improved) |

| | |
|---|---|
| No. | C - 12 |
| Location | No.50 |
| Remark | Type B (Not Improved) |

| No. | C - 13 |
|---|---|
| Location | No.50 |
| Remark | Type B (Not Improved) |

| No. | C - 14 |
|---|---|
| Location | No.81 |
| Remark | Type A (Improved) |

| No. | C - 15 |
|---|---|
| Location | No.81 |
| Remark | Type A (Improved) |



| No. | C - 16 |
|---|---|
| Location | No.81 |
| Remark | Workers confirmed clogging<br>Type A (Improved) |

| No. | C - 17 |
|---|---|
| Location | No.81 |
| Remark | Inside of Chamber<br>Type A (Improved) |

| No. | C - 18 |
|---|---|
| Location | No.143 |
| Remark | Residents threw away garbage to BDS. It was difficult to discover the cause of pipe clogging because of much amount of garbage.<br>Type B (Not Improved) |

| | |
|---|---|
| No. | C - 19 |
| Location | No.143 |
| Remark | Type B (Not Improved) |

| | |
|---|---|
| No. | C - 20 |
| Location | No.143 |
| Remark | Inside of Chamber<br>Type B (Not Improved) |

| | |
|---|---|
| No. | C - 21 |
| Location | No.178 |
| Remark | Residents threw away garbage to BDS. Building was constructed on drainage of BDS.<br>Type A (Not Improved) |



| | |
|---|---|
| No. | C - 22 |
| Location | No.178 |
| Remark | Type A (Not Improved) |

| | |
|---|---|
| No. | C - 23 |
| Location | No.178 |
| Remark | Type A (Not Improved) |


| | |
|---|---|
| No. | C - 24 |
| Location | No.178 |
| Remark | Type A (Not Improved) |

| No. | C - 25 |
|---|---|
| Location | No.178 |
| Remark | Pipe was clogged |
| | Type A (Not Improved) |

| No. | C - 26 |
|---|---|
| Location | No.178 |
| Remark | Residents discharged black water into drainage due to pipe clogging. |
| | Type A (Not Improved) |

| No. | C - 27 |
|---|---|
| Location | No.179 |
| Remark | |
| | Type A (Improved) |



| No. | C - 28 |
|---|---|
| Location | No.179 |
| Remark | This surrounding place was dirty because the pipes were broken. |
| | Type A (Improved) |

| No. | C - 29 |
|---|---|
| Location | No.179 |
| Remark | |
| | Type A (Improved) |

| No. | C - 30 |
|---|---|
| Location | No.179 |
| Remark | Pipe was clogged |
| | Type A (Improved) |

| | |
|---|---|
| No. | C - 31 |
| Location | No.179 |
| Remark | Inside of Chamber |
| | Type A (Improved) |

| | |
|---|---|
| No. | C - 32 |
| Location | No.179 |
| Remark | Inside of Chamber |
| | Pipe was not clogged. |
| | Type A (Improved) |

| | |
|---|---|
| No. | C - 33 |
| Location | No.180 |
| Remark | Residents extended to their living space to BDS. |
| | Type A (Not Improved) |



| | |
|---|---|
| No. | C - 34 |
| Location | No.180 |
| Remark | Type A (Not Improved) |

| | |
|---|---|
| No. | C - 35 |
| Location | No.180 |
| Remark | Type A (Not Improved) |

| | |
|---|---|
| No. | C - 36 |
| Location | No.180 |
| Remark | Storm water & grey water were collected by same pipe |
| | Type A (Not Improved) |

| No. | C - 37 |
|---|---|
| Location | No.180 |
| Remark | Inside of Expanded Space on the drainage |
| | Type A (Not Improved) |

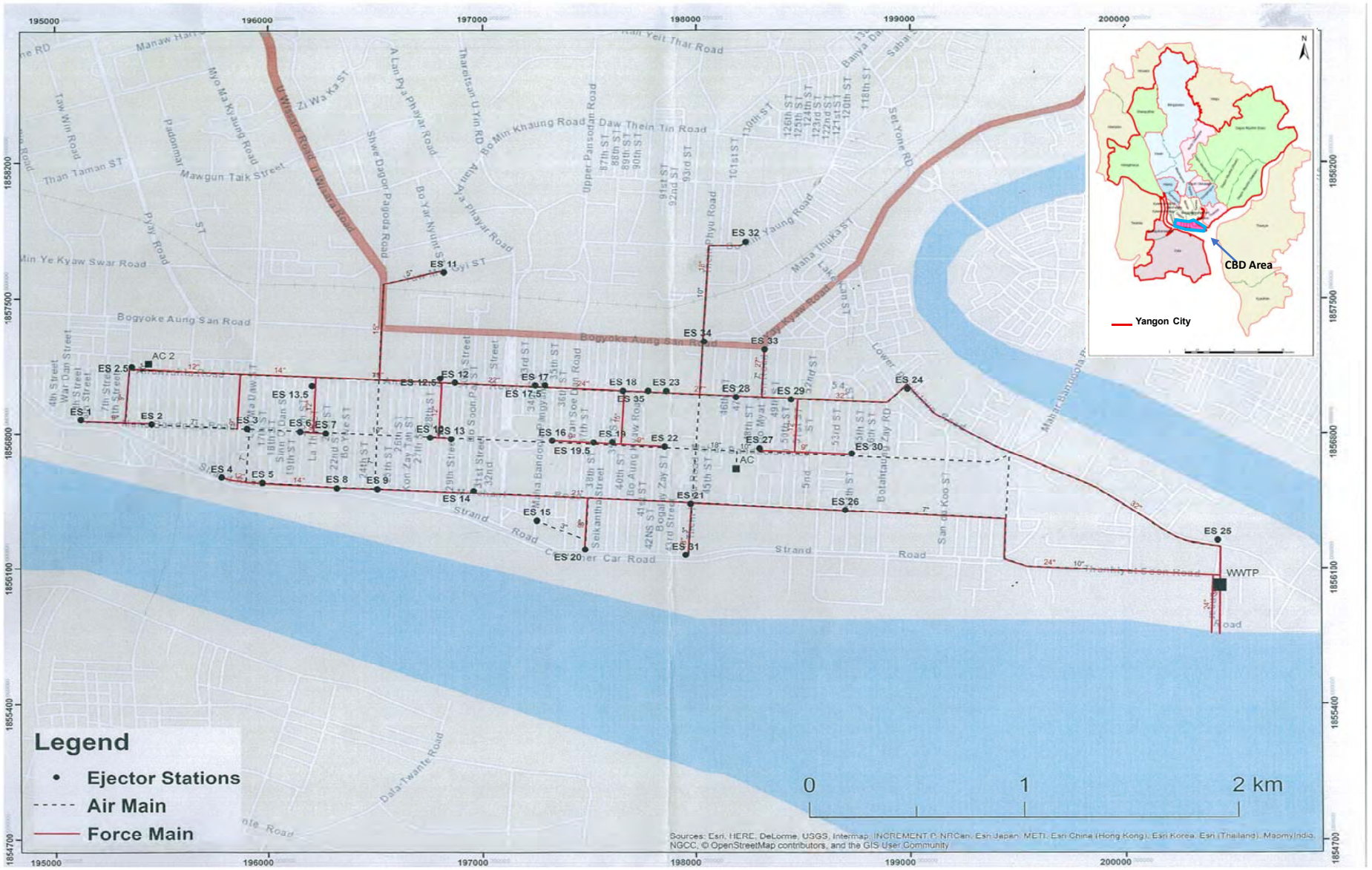
| No. | C - 38 |
|---|---|
| Location | No.180 |
| Remark | Roof was constructed by bamboo, wood, plastic and plate. |
| | Type A (Not Improved) |

| No. | C - 39 |
|---|---|
| Location | No.180 |
| Remark | BDS was used as material storage. |
| | Type A (Not Improved) |



| No. | C - 40 |
|---|---|
| Location | No.180 |
| Remark | Pipe was not clogged. |
| | Type A (Not Improved) |

# Map D : Ejector Station



| | |
|---|---|
| No. | D - 1 |
| Location | ES 21 |
| Remark | Entrance to Ejector Station |

| | |
|---|---|
| No. | D - 2 |
| Location | ES 21 |
| Remark | Inside of Ejector Station |

| | |
|---|---|
| No. | D - 3 |
| Location | ES 21 |
| Remark | Inside of Ejector Station<br>(Air Pressure Pump) |



| | |
|---|---|
| No. | D - 4 |
| Location | ES 21 |
| Remark | |

| | |
|---|---|
| No. | D - 5 |
| Location | ES 21 |
| Remark | |

| | |
|---|---|
| No. | D - 6 |
| Location | ES 21 |
| Remark | Sewage Pressure Feed Pipe |

| No. | D - 7 |
|---|---|
| Location | ES 21 |
| Remark | Bottom part of Air Pressure Pump |

| No. | D - 8 |
|---|---|
| Location | ES 21 |
| Remark | Air Compressor for ES21 |

| No. | D - 9 |
|---|---|
| Location | Air Compressor<br>(near YCDC Office) |
| Remark | Drawing about Ejector System<br>Main air compressor having air-blow performance to 35 Ejector Stations |

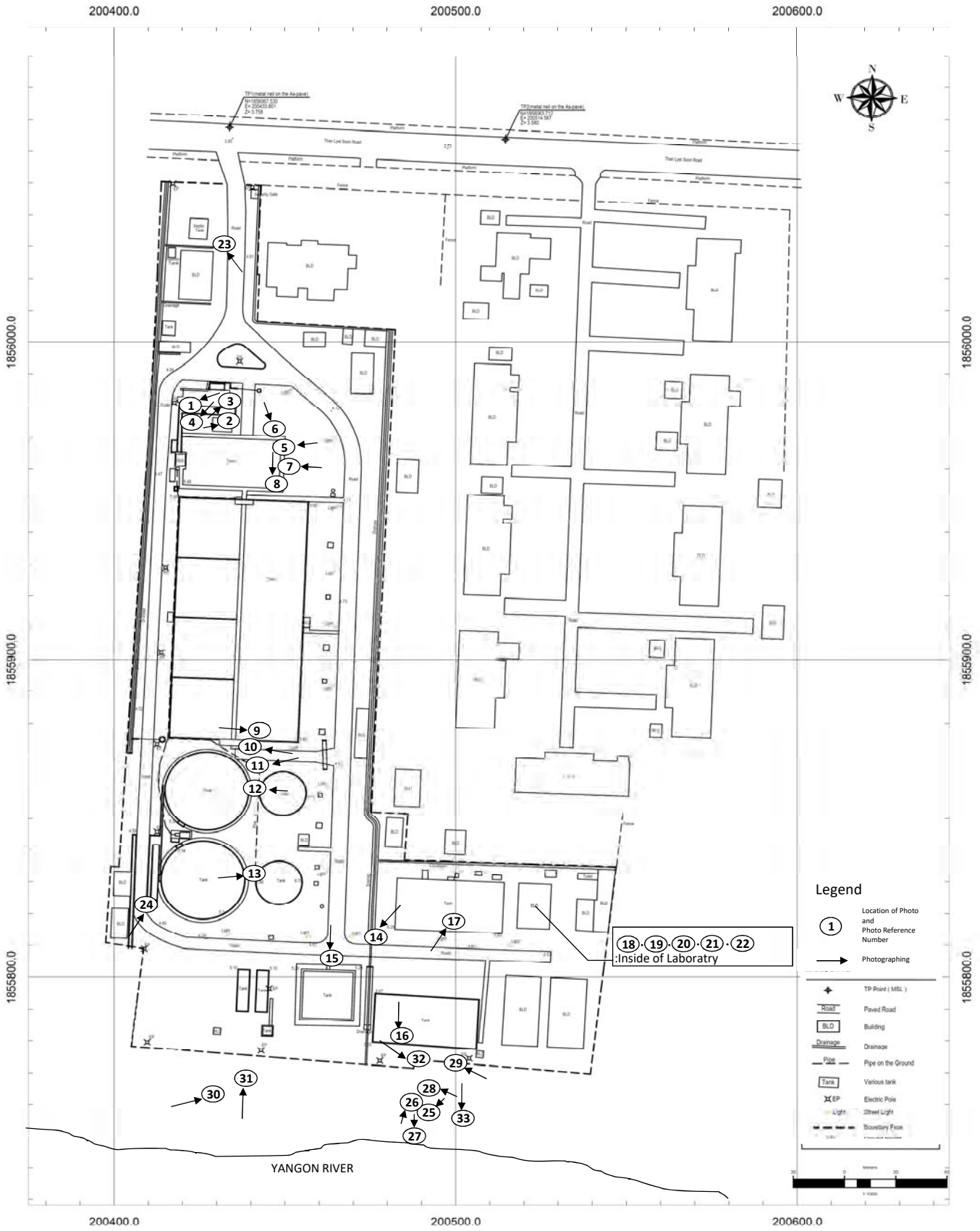


| No. | D - 10 |
|---|---|
| Location | Air Compressor<br>(near YCDC Office) |
| Remark | Air Compressor |

| No. | D - 11 |
|---|---|
| Location | Air Compressor<br>(near YCDC Office) |
| Remark | |

| No. | D - 12 |
|---|---|
| Location | Air Compressor<br>(near YCDC Office) |
| Remark | |

# Map E : C1 Wastewater Treatment Plant



| No. | E - 1 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Channel to Grit Chamber & Auto Bar Screen Pump Sump |

| No. | E - 2 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Grit Chamber & Auto Bar Screen Pump Sump |

| No. | E - 3 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Grit Chamber & Auto Bar Screen Pump Sump |



| No. | E - 4 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Primary Sedimentation Tank |

| No. | E - 5 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Primary Sedimentation Tank |

| No. | E - 6 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Primary Sedimentation Tank |

| No. | E - 7 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Primary Sedimentation Tank |

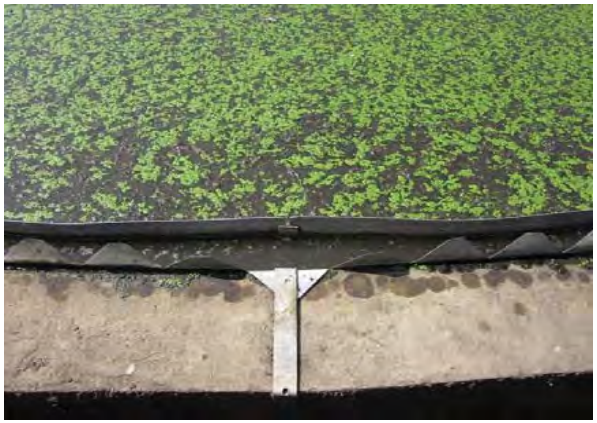
| No. | E - 8 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Aeration Tank<br>Surface Aeration Method |

| No. | E - 9 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Overflow Weir of Aeration Tank |



| No. | E - 10 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Equipment of Aeration Tank |

| No. | E - 11 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Secondary Sedimentation Tank |



| No. | E - 12 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Suspended Sludge on the Tank Surface |

| No. | E - 13 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Sludge Thickener |

| No. | E - 14 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Sun Dried Tank |

| No. | E - 15 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Dried Sludge in the Sun Dried Tank |



| No. | E - 16 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Yangon River beside the WWTP site |

| No. | E - 17 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Inside of Sludge Digesters |


| No. | E - 18 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Inside of Laboratory |

| No. | E - 19 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Inside of Laboratory |


| No. | E - 20 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Table related to Standards for Discharge of Effluent |

| No. | E - 21 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Laboratory Instrument |



| No. | E - 22 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Laboratory Instrument |

| No. | E - 23 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Workers were pulling out sewage from the septic tank truck . |

| No. | E - 24 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Outlet of Secondary Sedimentation Tank |

| No. | E - 25 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Outlet to Yangon River<br>・24-inch<br>・36-inch |

| No. | E - 26 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Outlet to Yangon River<br>(North Side) |

| No. | E - 27 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Outlet to Yangon River<br>(South Side) |



| No. | E - 28 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Outlet to Yangon River<br>There was a hole on the pipe. |

| No. | E - 29 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | Yangon River beside the WWTP site |

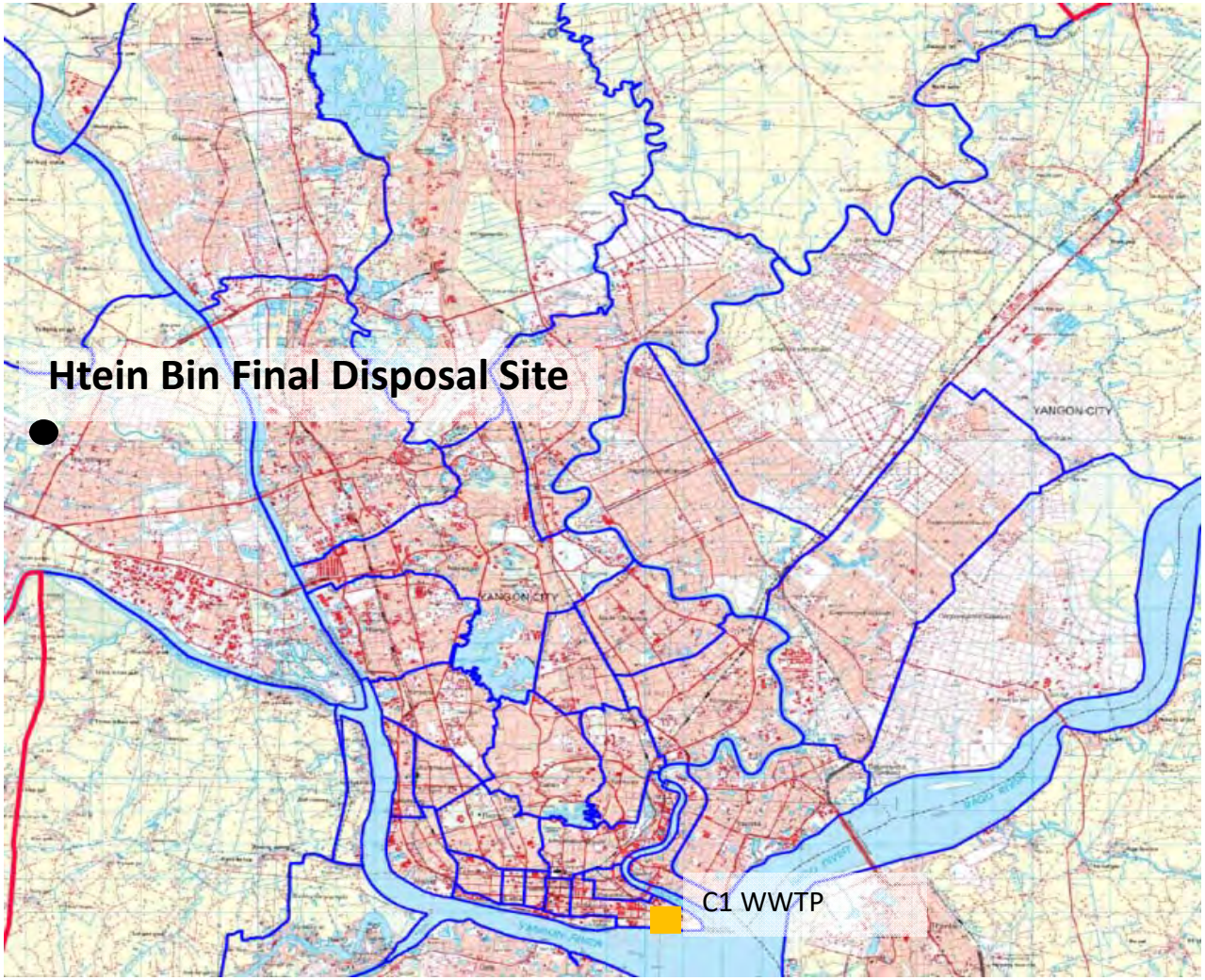
| No. | E - 30 |
|---|---|
| Location | C1 Wastewater Treatment Plant |
| Remark | The revetment was considerably decrepit. |

| | |
|---|---|
| No. | E - 31 |
| Location | C1 Wastewater Treatment Plant |
| Remark | Surface of the revetment |

| | |
|---|---|
| No. | E - 32 |
| Location | C1 Wastewater Treatment Plant |
| Remark | Pier leading from WWTP to the side of Yangon River |

| | |
|---|---|
| No. | E - 33 |
| Location | C1 Wastewater Treatment Plant |
| Remark | On the pier<br>(South Direction) |

# Map F : Htein Bin Final Disposal Site




Legend: ● Sludge Disposal Facility ■ C1 WWTP

| | |
|---|---|
| No. | F - 1 |
| Location | Site for Sludge Disposal (Htain Bin Final Disposal Site) |
| Remark | Inside of Final Disposal Site |

| | |
|---|---|
| No. | F - 2 |
| Location | Site for Sludge Disposal (Htain Bin Final Disposal Site) |
| Remark | Inside of Final Disposal Site |

| | |
|---|---|
| No. | F - 3 |
| Location | Site for Sludge Disposal (Htain Bin Final Disposal Site) |
| Remark | Disposal Solid Waste |

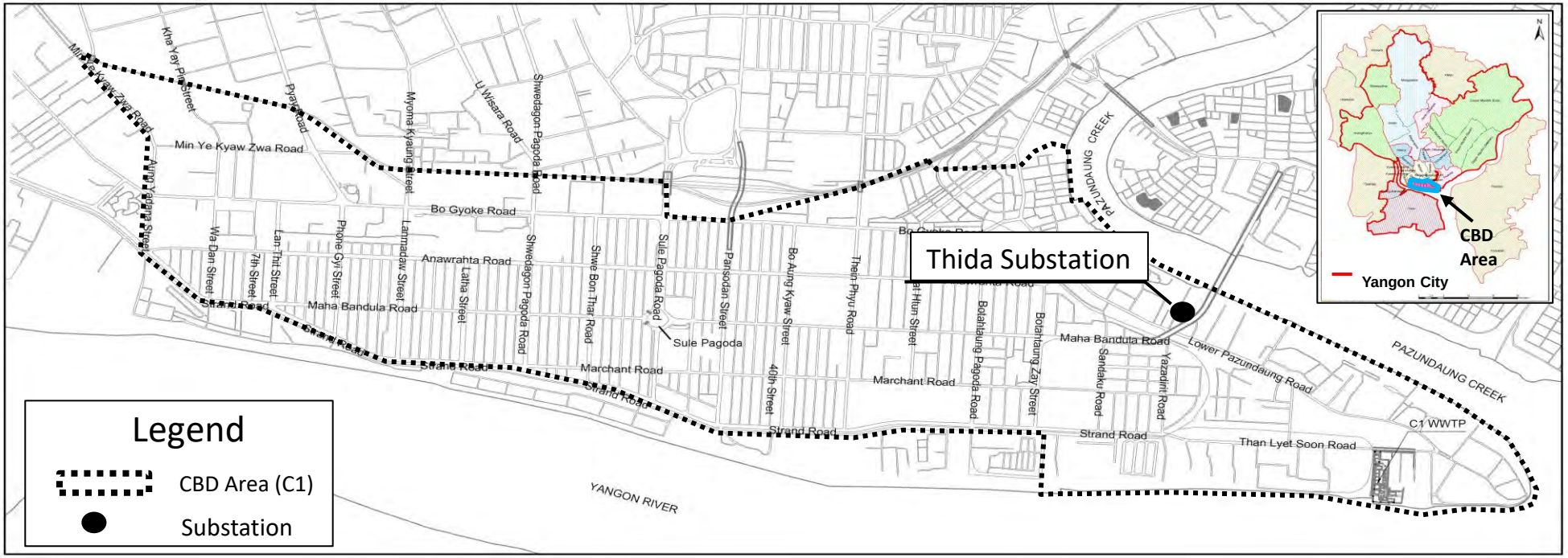


| | |
|---|---|
| No. | F - 4 |
| Location | Site for Sludge Disposal (Htain Bin Final Disposal Site) |
| Remark | Leachate in the Stream beside the Site |

| | |
|---|---|
| No. | F - 5 |
| Location | Site for Sludge Disposal (Htain Bin Final Disposal Site) |
| Remark | Surrounding Area and Stream beside the Site |


| | |
|---|---|
| No. | F - 6 |
| Location | Site for Sludge Disposal (Htain Bin Final Disposal Site) |
| Remark | Landfill equipment (Excavator) |

# Map G : Thida Substation




| No. | G - 1 |
|---|---|
| Location | Thida Substation |
| Remark | Under jurisdiction of Yangon Electricity Supply Cooperation |

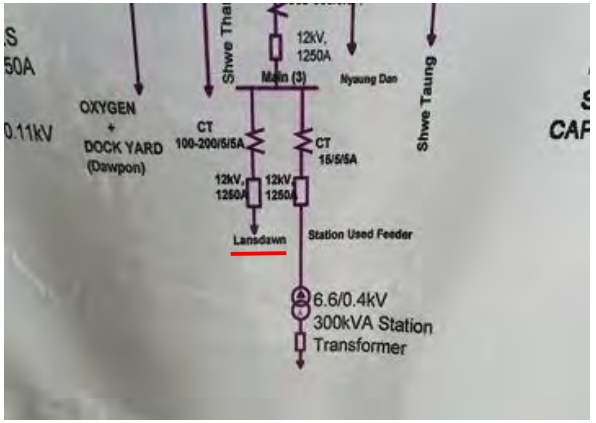
| No. | G - 2 |
|---|---|
| Location | Thida Substation |
| Remark | Equipment made in China, Vietnam and Japan was installed. |

| No. | G - 3 |
|---|---|
| Location | Thida Substation |
| Remark | |



| No. | G - 4 |
|---|---|
| Location | Thida Substation |
| Remark | Administration Building |


| No. | G - 5 |
|---|---|
| Location | Thida Substation |
| Remark | |




| No. | G - 6 |
|---|---|
| Location | Thida Substation |
| Remark | Lansdawn: The Surrounding Area with C1 WWTP<br>This substation supplied electricity to Lansdawn Area. |

# Appendix 10　Topographic Survey

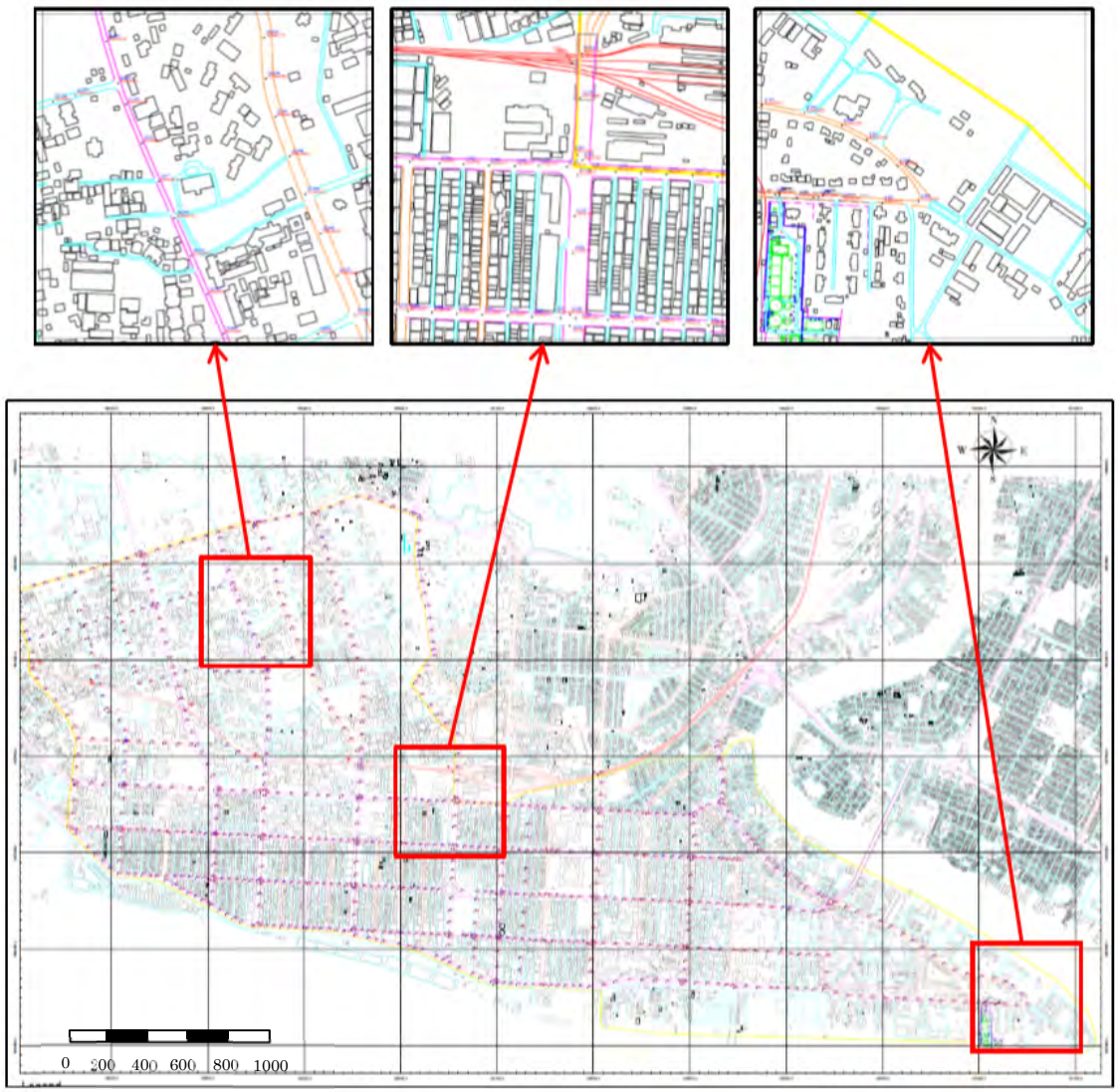
# APPENDIX 10 Topographic Survey

## Procurement of satellite Image

| | |
|---|---|
| Satellite name | Digital Globe World View 2 |
| Resolution | Standard: 0.5m, Max: 0.55m |
| Area | 96.13124443554632, 16.798499286525825<br>96.13095916097352, 16.76597798523054<br>96.19913978386454, 16.763838425934797<br>96.19971033301007, 16.79721555094838 |
| Observed date | 16th December, 2017 |
| Image Type | Ortho ready Standard, 4 Band (Pan-Sharpen) |
| Cloud Cover | 0.0% |
| Area Off Nadir | 24.7 degree |
| Sun Elevation | 47.0 degree |
| Format | Geo Tiff |


Source: JICA Study Team

**Whole data of feature mapping and its part**




Source: JICA Study Team

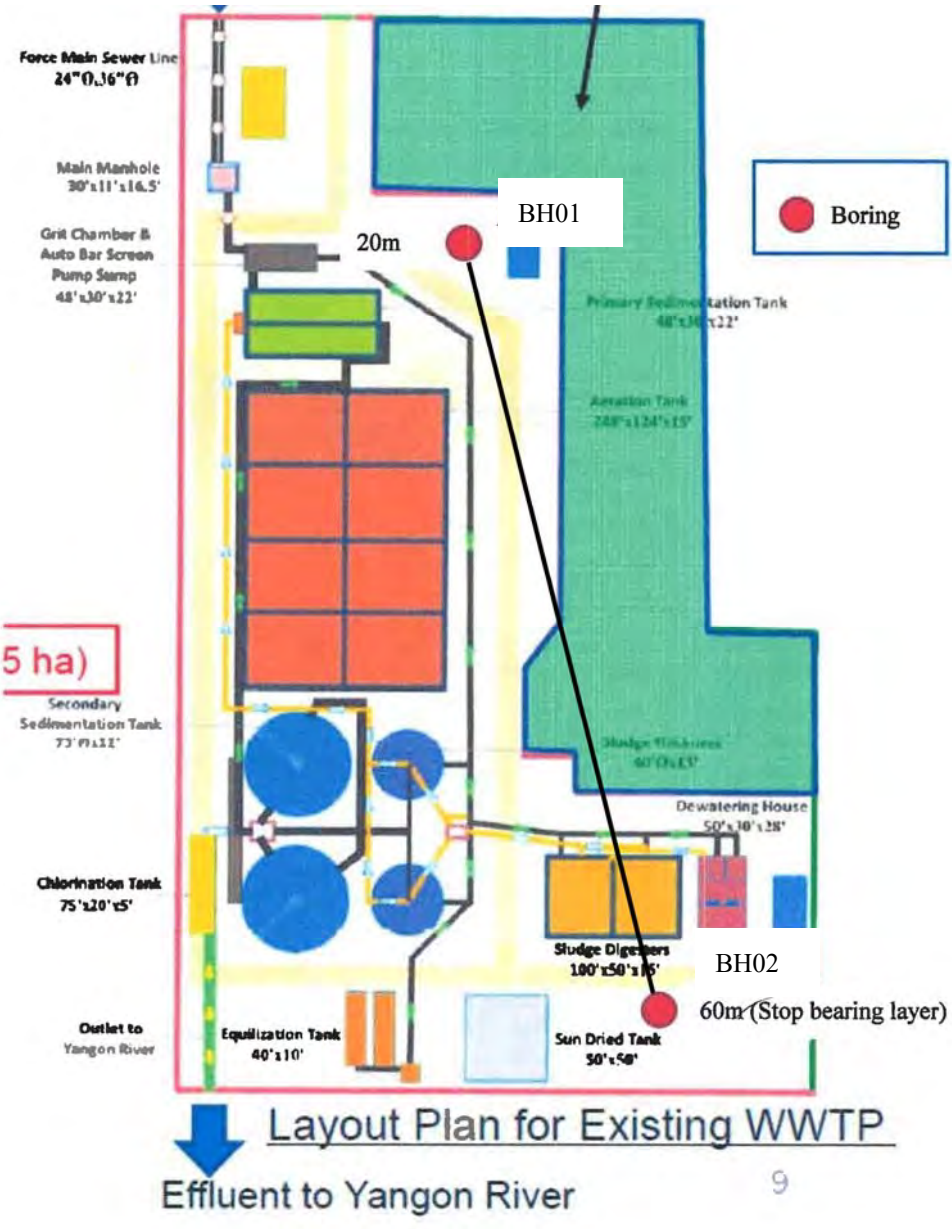
**Drawing by the plane table survey**


Source: JICA Study Team

# Appendix 11　Geotechnical Survey

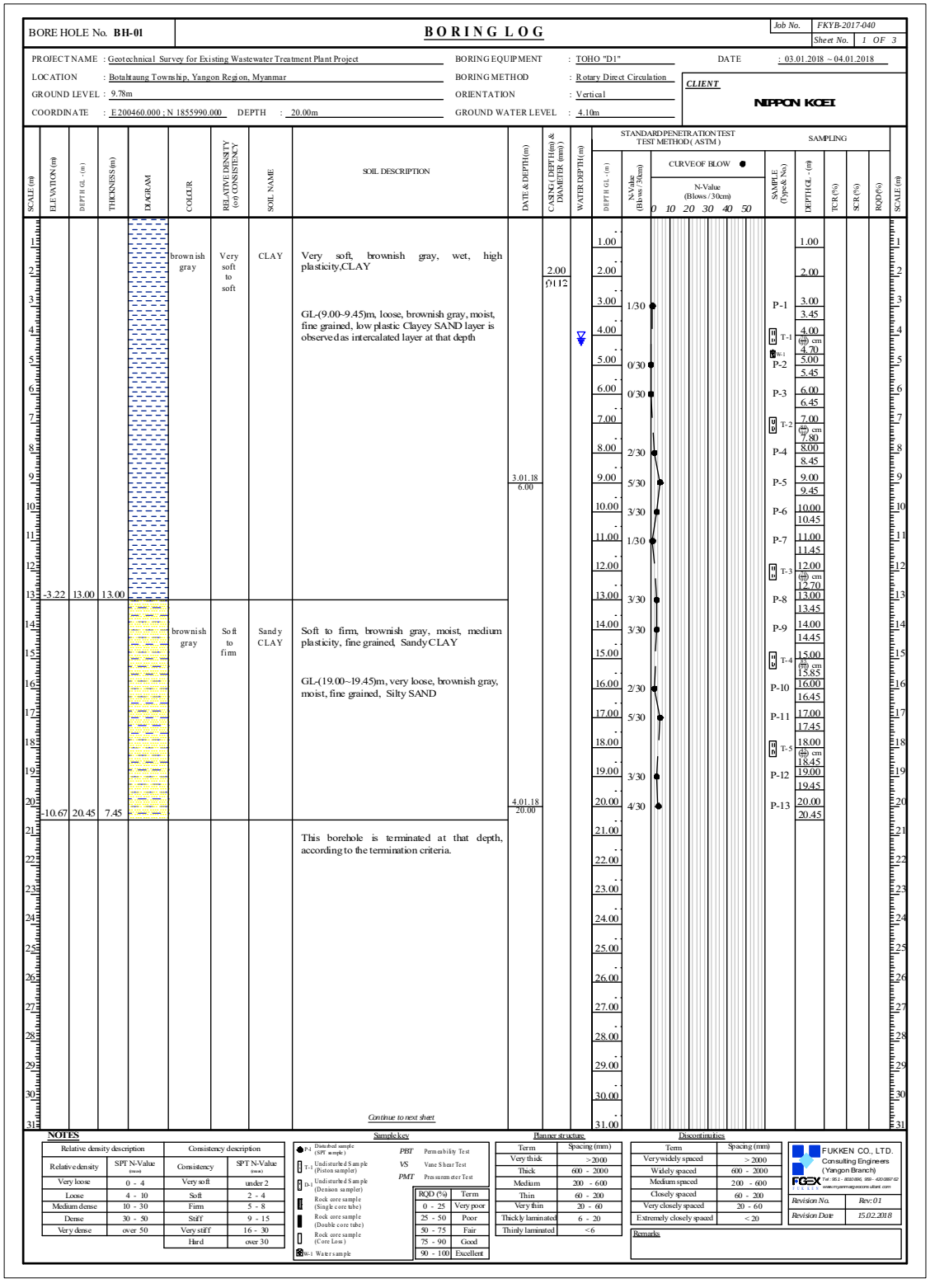
## APPENDIX11 Geotechnical Survey

**Location of Boring Survey**



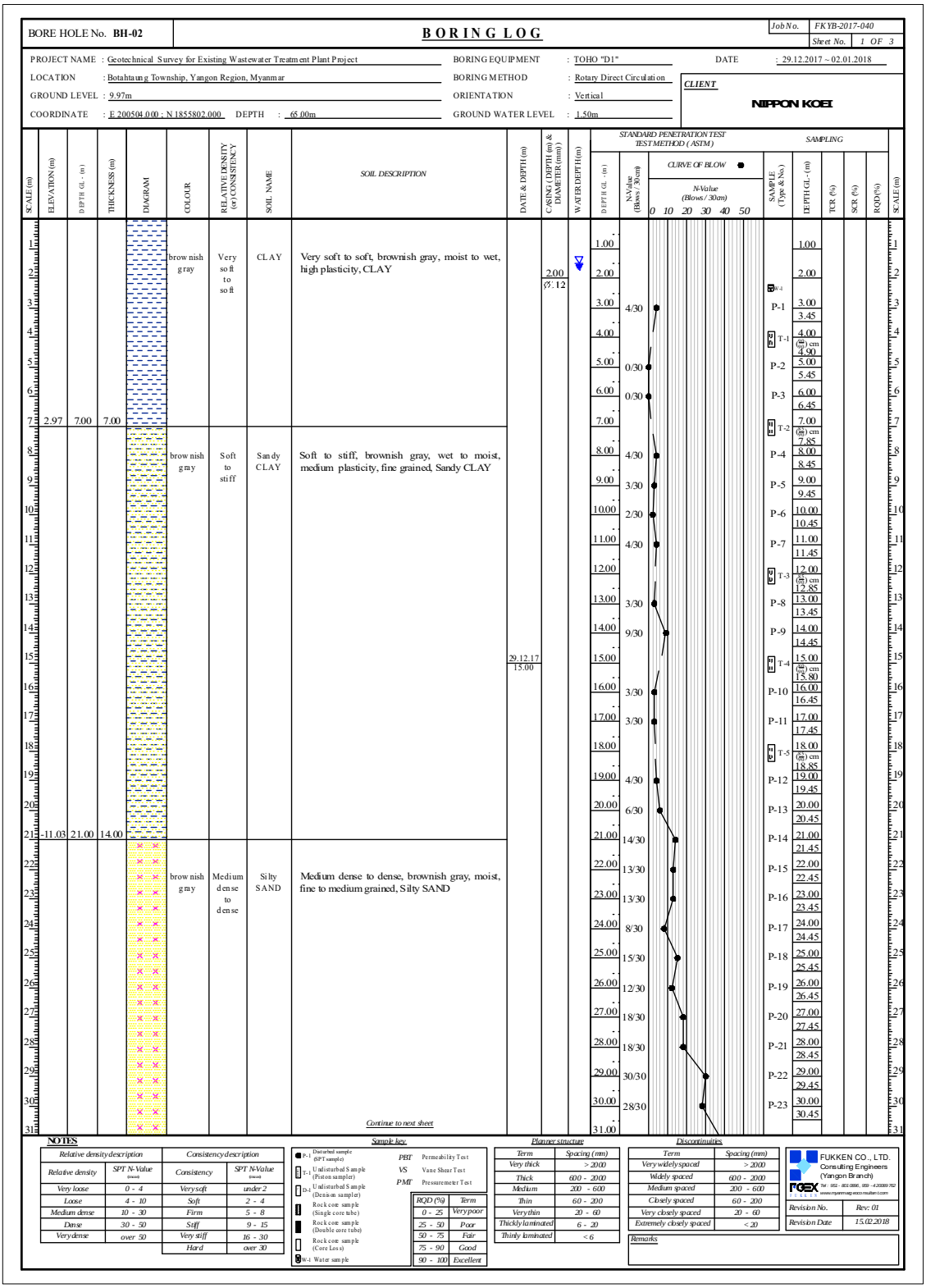

Source: JICA Study Team

# Result of BH-01, 20m Boring Survey

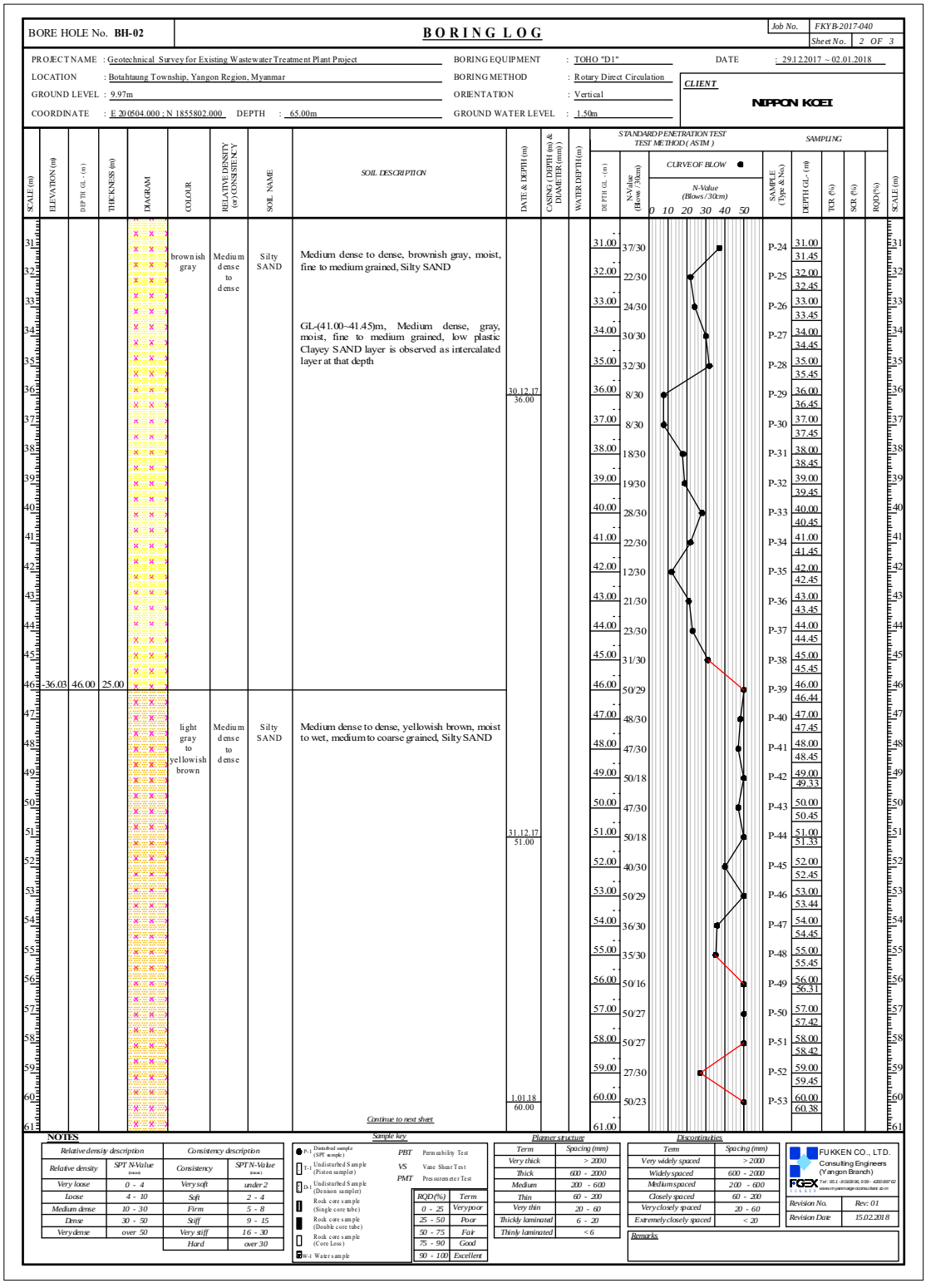



Source: JICA Study Team

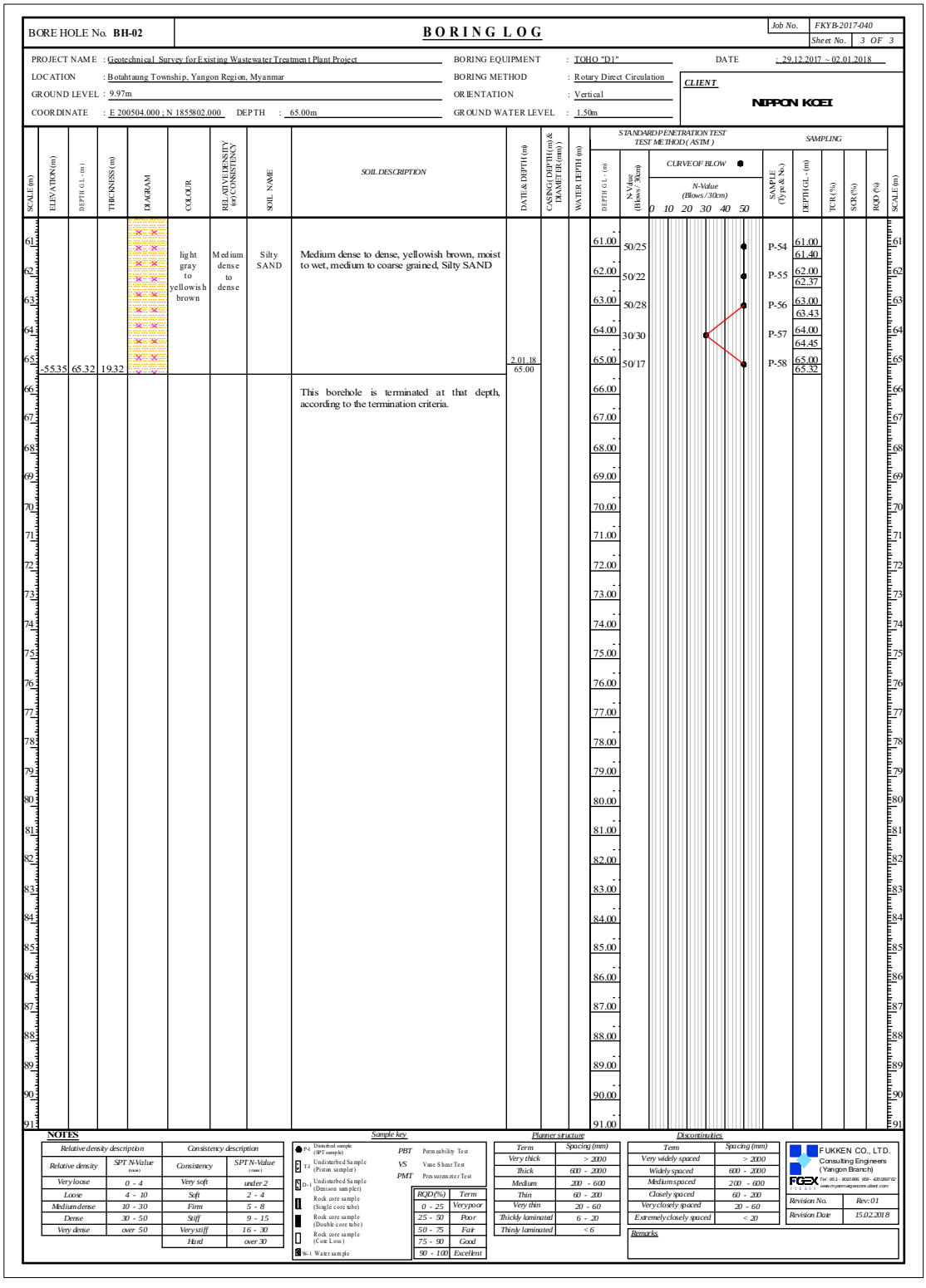
# Result of BH-02, 60m Boring Survey




Source: JICA Study Team




Source: JICA Study Team



BORE HOLE No. **BH-02**

**BORING LOG**

Job No. FKYB-2017-040
Sheet No. 3 OF 3

PROJECT NAME : Geotechnical Survey for Existing Wastewater Treatment Plant Project
LOCATION : Botahtaung Township, Yangon Region, Myanmar
GROUND LEVEL : 9.97m
COORDINATE : E 200504.000 ; N 1855802.000 DEPTH : 65.00m

BORING EQUIPMENT : TOHO "D1"
BORING METHOD : Rotary Direct Circulation
ORIENTATION : Vertical
GROUND WATER LEVEL : 1.50m

DATE : 29.12.2017 ~ 02.01.2018

CLIENT
NIPPON KOEI

| SCALE (m) | ELEVATION (m) | DEPTH G.L.- (m) | THICKNESS (m) | DIAGRAM | COLOUR | RELATIVE DENSITY & CONSISTENCY | SOIL NAME | SOIL DESCRIPTION | DATE & DEPTH (m) | CASING (DEPTH (m) & DIAMETER (mm)) | WATER DEPTH (m) | DEPTH G.L.- (m) | N Value (Blows/ 30cm) | CURVE OF BLOW N-Value (Blows/30cm) 0 10 20 30 40 50 | SAMPLE (Type & No.) | DEPTH G.L.- (m) | TCR (%) | SCR (%) | RQD (%) | SCALE (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61 | | | | | light gray to yellowish brown | Medium dense to dense | Silty SAND | Medium dense to dense, yellowish brown, moist to wet, medium to coarse grained, Silty SAND | | | | 61.00 | 50/25 | | P-54 | 61.00<br>61.40 | | | | 61 |
| 62 | | | | | | | | | | | | 62.00 | 50/22 | | P-55 | 62.00<br>62.37 | | | | 62 |
| 63 | | | | | | | | | | | | 63.00 | 50/28 | | P-56 | 63.00<br>63.43 | | | | 63 |
| 64 | | | | | | | | | | | | 64.00 | 30/30 | | P-57 | 64.00<br>64.45 | | | | 64 |
| 65 | -55.35 | 65.32 | 19.32 | | | | | | 2.01.18<br>65.00 | | | 65.00 | 50/17 | | P-58 | 65.00<br>65.32 | | | | 65 |
| 66 | | | | | | | | This borehole is terminated at that depth, according to the termination criteria. | | | | 66.00 | | | | | | | | 66 |
| 67 | | | | | | | | | | | | 67.00 | | | | | | | | 67 |
| 68 | | | | | | | | | | | | 68.00 | | | | | | | | 68 |
| 69 | | | | | | | | | | | | 69.00 | | | | | | | | 69 |
| 70 | | | | | | | | | | | | 70.00 | | | | | | | | 70 |
| 71 | | | | | | | | | | | | 71.00 | | | | | | | | 71 |
| 72 | | | | | | | | | | | | 72.00 | | | | | | | | 72 |
| 73 | | | | | | | | | | | | 73.00 | | | | | | | | 73 |
| 74 | | | | | | | | | | | | 74.00 | | | | | | | | 74 |
| 75 | | | | | | | | | | | | 75.00 | | | | | | | | 75 |
| 76 | | | | | | | | | | | | 76.00 | | | | | | | | 76 |
| 77 | | | | | | | | | | | | 77.00 | | | | | | | | 77 |
| 78 | | | | | | | | | | | | 78.00 | | | | | | | | 78 |
| 79 | | | | | | | | | | | | 79.00 | | | | | | | | 79 |
| 80 | | | | | | | | | | | | 80.00 | | | | | | | | 80 |
| 81 | | | | | | | | | | | | 81.00 | | | | | | | | 81 |
| 82 | | | | | | | | | | | | 82.00 | | | | | | | | 82 |
| 83 | | | | | | | | | | | | 83.00 | | | | | | | | 83 |
| 84 | | | | | | | | | | | | 84.00 | | | | | | | | 84 |
| 85 | | | | | | | | | | | | 85.00 | | | | | | | | 85 |
| 86 | | | | | | | | | | | | 86.00 | | | | | | | | 86 |
| 87 | | | | | | | | | | | | 87.00 | | | | | | | | 87 |
| 88 | | | | | | | | | | | | 88.00 | | | | | | | | 88 |
| 89 | | | | | | | | | | | | 89.00 | | | | | | | | 89 |
| 90 | | | | | | | | | | | | 90.00 | | | | | | | | 90 |
| 91 | | | | | | | | | | | | 91.00 | | | | | | | | 91 |

**NOTES**

| Relative density description | | Consistency description | |
|---|---|---|---|
| Relative density | SPT N-Value (max) | Consistency | SPT N-Value (max) |
| Very loose | 0 - 4 | Very soft | under 2 |
| Loose | 4 - 10 | Soft | 2 - 4 |
| Medium dense | 10 - 30 | Firm | 5 - 8 |
| Dense | 30 - 50 | Stiff | 9 - 15 |
| Very dense | over 50 | Very stiff | 16 - 30 |
| | | Hard | over 30 |

Sample key

| | | | |
|---|---|---|---|
| P-1 | Disturbed sample (SPT sample) | PBT | Permeability Test |
| T-1 | Undisturbed Sample (Piston sampler) | VS | Vane Shear Test |
| D-1 | Undisturbed Sample (Denison sampler) | PMT | Pressurmeter Test |
| | Rock core sample (Single core tube) | | |
| | Rock core sample (Double core tube) | | |
| | Rock core sample (Core Loss) | | |
| W-1 | Water sample | | |

| RQD(%) | Term |
|---|---|
| 0 - 25 | Very poor |
| 25 - 50 | Poor |
| 50 - 75 | Fair |
| 75 - 90 | Good |
| 90 - 100 | Excellent |

Planner structure

| Term | Spacing (mm) |
|---|---|
| Very thick | > 2000 |
| Thick | 600 - 2000 |
| Medium | 200 - 600 |
| Thin | 60 - 200 |
| Very thin | 20 - 60 |
| Thickly laminated | 6 - 20 |
| Thinly laminated | < 6 |

Discontinuities

| Term | Spacing (mm) |
|---|---|
| Very widely spaced | > 2000 |
| Widely spaced | 600 - 2000 |
| Medium spaced | 200 - 600 |
| Closely spaced | 60 - 200 |
| Very closely spaced | 20 - 60 |
| Extremely closely spaced | < 20 |

FUKKEN CO., LTD.
Consulting Engineers
(Yangon Branch)

| Revision No. | Rev:01 |
|---|---|
| Revision Date | 15.02.2018 |

Remarks

Source: JICA Study Team

# Appendix 12　Inventory Survey

**APPENDIX12 Inventory Survey**

# EXISTING WASTEWATER TREATMENT PLANT

## EQUIPMENT LIST

### Mechanical Equipment List

| M-1 (Grit Removal and Pumping Station) | | | | | |
|---|---|---|---|---|---|
| NO. | Equipment Name | Quantity | Motor kW | Specification | Manufacturere |
| 1.1 | Screen Facility | | | | |
| a. | Auto Bar Screen | 1 | 2.2 kW | Opening: 15mm | INOX |
| 1.2 | Grit Removal Facility | | | | |
| a. | Grit Collector | 1 | | Concrete Tank | |
| b. | Grit Separator | 1 | 0.55 kW | Flow: 54 m3/h, Grit: 2m3/h | INOX |
| c. | Grit Pump | 1+(1) = 2 | 1.7 kW | 15 m3/h x 12 mH (Submersible) | ABS |
| 1.3 | Raw Waste Water Pump Facility | | | | |
| a-1 | Raw Waste Water Pump | 1 | 22 kW | Submersible Pump | ABS |
| a-2 | Raw Waste Water Pump | 1+(1) = 2 | 24 kW | 500 m3/min x 10mH (Submersible) | ABS |
| b. | Hoist | 1 | | Hoist Beam only | |

| M-2 (Primary Settling Tank Facility) | | | | | |
|---|---|---|---|---|---|
| NO. | Equipment Name | Quantity | Motor kW | Specification | Manufacturere |
| 2.1 | Clarifier | 2 | 0.75 kW | 7.2m W x 27m L x 3.45m WD | MCON |
| 2.2 | Primary Sludge Pump | 2 | 1.2 kW | 13.5m3/min x 8mH (Submersible) | ABS |

| M-3 (Aeration Tank Facility) | | | | | |
|---|---|---|---|---|---|
| NO. | Equipment Name | Quantity | Motor kW | Specification | Manufacturere |
| 3.1 | Floatation Surface Aerator | 8 | 37 kW | 1.5kg-O2/kWH. 58rpm | Aquastar |

| M-4 (Secondary Settling Tank Facility) | | | | | |
|---|---|---|---|---|---|
| NO. | Equipment Name | Quantity | Motor kW | Specification | Manufacturere |
| 4.1 | Clarifier | 2 | 0.75 kW | 22.5m dia. x 3.9mD | MCON |
| 4.2 | Return Sludge Pump | 2 | 18.5 kW | 460 m3/h x 10mH (Submersible) | ABS |
| 4.3 | Excess Sludge Pump | 2 | 1.2 kW | 19 m3/h x 10mH (Submersible) | ABS |
| 4.4 | Scum Pump | 2 | 0.47 kW | 6.99 m3/h x 7 mH (Submersible) | ABS |

| M-5 (Disinfection Tank Facility) | | | | | |
|---|---|---|---|---|---|
| NO. | Equipment Name | Quantity | Motor kW | Specification | Manufacturere |
| 5.1 | Chlorine Dosing System | 1+(1) =2 | 0.2 kW | NaOCl 155 lit/h, with 3 m3 Tank x 2 | OBI |

| M-6 (Sludge Thickener Facility) | | | | | |
|---|---|---|---|---|---|
| NO. | Equipment Name | Quantity | Motor kW | Specification | Manufacturere |
| 6.1 | Center Drive Clarifier | 2 | 0.75 kW | 12m dia. x 3.9mD, 0.007 rpm | MCON |
| 6.2 | Thickened Sludge Pump | 2 | 1.5 kW | 0.1m3/min x 30mH (Mono) | MONO |

| M-7 (Aerobic Digester Facility) | | | | | |
|---|---|---|---|---|---|
| NO. | Equipment Name | Quantity | Motor kW | Specification | Manufacturere |
| 7.1 | Submersible Aerator | 8 | 6 kW | 10kg-O2/h at 4mD | ABS |
| 7.2 | Digested Sludge Pump | 2 | 1.5 kW | 0.1m3/min x 30mH (Mono) | MONO |

| M-8 (Sludge Dewatering Facility) | | | | | |
|---|---|---|---|---|---|
| NO. | Equipment Name | Quantity | Motor kW | Specification | Manufacturere |
| 8.1 | Dewatering Unit | 2 | 0.75 kW | Belt Press 1mW, 180kg-ds/h | INOX |
| 8.2 | Belt Washing Water Pump | 1 | 4 kW | 12 m3/h x 50mH | |
| 8.3 | Air Compressor | 1 | 1.1 kW | 220 lit/min x 8 bar | |
| 8.4 | Polymer Dosing System | 1+(1) =2 | 0.2 kW | 101 lit/h with 3 m3 Tank x 2 | OBI |

### Electrical Panel List

| E-1 (Transformer Room) | | | |
|---|---|---|---|
| NO. | Panel Name | Incoming | Load |
| 1 | Incomimg Panel | 6.6kV | 630 kVA |
| 2 | Capacitor Bank (20Kvar x 5) | | |
| 3 | Transformer (315kVA x 2 sets) | 6.6kV/440V | |
| 4 | Main Distribution Panel (1) | 440V | |
| | Main MCB | | 800A |
| | Outgoing 1 | | 400A |
| | Outgoing 2 | | 250A |
| | Outgoing 3 | | 200A |
| | Outgoing 4 | | 60A |
| | Outgoing 5 | | 60A |
| 5 | Main Distribution Panel (2) | 440V | |
| | Main MCB | | 800A |
| | Outgoing 6 | | 400A |
| | Outgoing 7 | | 250A |

| E-2 (Pump Control Room) | | | |
|---|---|---|---|
| NO. | Panel Name | Incoming | Load |
| 6 | Raw Waste Water Pump Panel | 400V | |
| | Raw Waste Water Pump A | | 22 kW |
| | Raw Waste Water Pump B | | 24 kW |
| | Raw Waste Water Pump C | | 24 kW |
| 7 | Grit Pump | 400V | 1.7 kW |
| 8 | Grit Separator | 400V | 2.2 kW |

| E-3 (Primary Settling Tank Control Room) | | | |
|---|---|---|---|
| NO. | Panel Name | Incoming | Load |
| 9 | Primary Settling Scraper A | 400V | 0.75 kW |
| 10 | Primary Settling Scraper B | 400V | 0.75 kW |
| 11 | Sludge Pump Panel | 400V | |
| | Primary Sludge Pump A | | 1.2 kW |
| | Primary Sludge Pump B | | 1.2 kW |

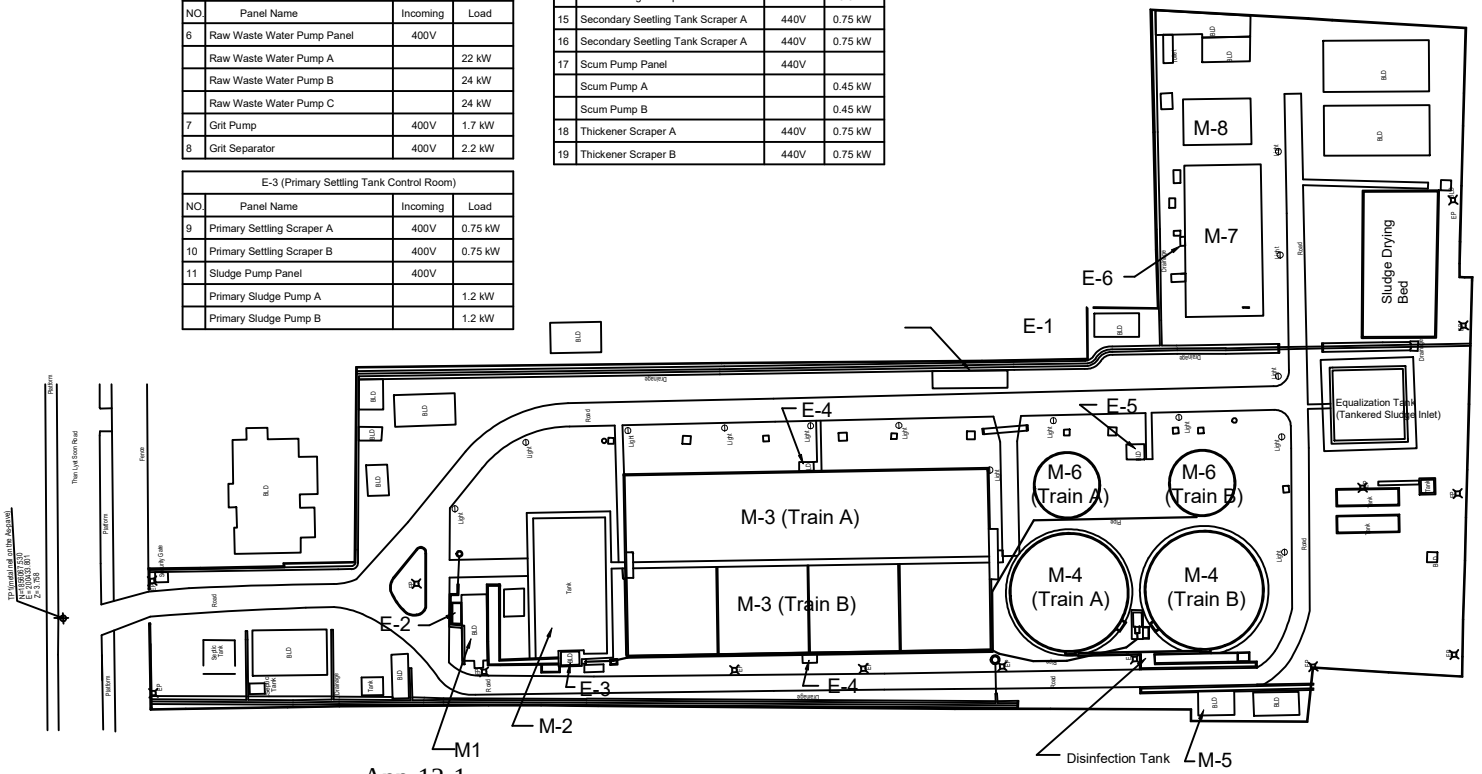
| E-4 (Aerator Control Room A & B) | | | |
|---|---|---|---|
| NO. | Panel Name | Incoming | Load |
| 12 | Aerator Panel A | 400 V | |
| | Surface Aerator A-1 | | 37 kW |
| | Surface Aerator A-2 | | 37 kW |
| | Surface Aerator A-3 | | 37 kW |
| | Surface Aerator A-4 | | 37 kW |
| 13 | Aerator Panel B | 440V | |
| | Surface Aerator B-1 | | 37 kW |
| | Surface Aerator B-2 | | 37 kW |
| | Surface Aerator B-3 | | 37 kW |
| | Surface Aerator B-4 | | 37 kW |

| E-5 (Secondary Settling Tank Control Room) | | | |
|---|---|---|---|
| NO. | Panel Name | Incoming | Load |
| 14 | Return Sludge Pump Panel | 400 V | |
| | Return Sludge Pump A | | 18.5 kW |
| | Return Sludge Pump B | | 18.5 kW |
| 15 | Secondary Seetling Tank Scraper A | 440V | 0.75 kW |
| 16 | Secondary Seetling Tank Scraper A | 440V | 0.75 kW |
| 17 | Scum Pump Panel | 440V | |
| | Scum Pump A | | 0.45 kW |
| | Scum Pump B | | 0.45 kW |
| 18 | Thickener Scraper A | 440V | 0.75 kW |
| 19 | Thickener Scraper B | 440V | 0.75 kW |

| E-6 (Digester Control Room) | | | |
|---|---|---|---|
| NO. | Panel Name | Incoming | Load |
| 20 | Digester Aerator Panel A | 400 V | |
| | Digester Aerator A-1 | | 5.9 kW |
| | Digester Aerator A-2 | | 5.9 kW |
| | Digester Aerator A-3 | | 5.9 kW |
| | Digester Aerator A-4 | | 5.9 kW |
| 13 | Digester Aerator Panel B | 440V | |
| | Digester Aerator B-1 | | 5.9 kW |
| | Digester Aerator B-2 | | 5.9 kW |
| | Digester Aerator B-3 | | 5.9 kW |
| | Digester Aerator B-4 | | 5.9 kW |

Legend

- TP Point ( MSL )
- Road — Paved Road
- BLD — Building
- Drainage — Drainage
- Pipe — Pipe on the Ground
- Tank — Various tank
- EP — Electric Pole
- Light — Street Light
- Boundary Fece — Ground Height



**Yangon Existing Sewage Treatment Plant**
**Mechanical Equipment Survey Data**

Present Condition : ◎ ; good condition , ○ ; Able to operate but maintenance required,
△; Better Renewal, X; to be consider different system/equipment

| No. | Description | Specification | Manufacturer/ Type | kW | Quantity | | | Present Condition | C/O | Year of Installation | Photps | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | OP | S/B | Total | | | | | |
| 1 | **Grit Removal and Pumping Station (Head Works)** | | | | | | | | | | | |
| 1.1 | Screen Facility | | | | | | | | | | | |
| a | Auto Bar Screen | Automatic Bar Screen<br>Opening 15mm | INOX (France)<br>Assmbl Thailand | 2.2 | 1 | | 1 | △ | Thailand | 2005 | Mechanical No. 1, 2 & 3 | |
| b | Screenings Bin | No Bin | | | | | | X | | | | |
| | | | | | | | | | | | | |
| 1.2 | Grit Removal Facility | | | | | | | | | | | |
| a | Grit Collector | | | | | | | X | | | | |
| b | Grit Separator | Mixing Wash Type with Screw Conveyor<br>54m3/h<br>Grit 2m3/h | INOX (France)<br>Assmbl Thailand | 0.55 | 1 | | 1 | ○ | Thailand | 2005 | Mechanical No. 5 | |
| c | Grit Pump | Submersible Pump<br>15m3/h x 12mH | ABS | 1.7 | 1 | 1 | 2 | △ | Ireland | 2005 | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| 1.3 | Pumping Facility | | | | | | | | | | | |
| a | Raw Waste Water Pump<br>(First Installation) | Non-Clog Type Submersible pump with<br>Quick Discharge Connection<br>460 m3/min x 10mH | ABS | 18.5 | 2 | 1 | 3 | Replaced | Ireland | 2005 | Mechanical No. 4 | |
| | Raw Waste Water Pump<br>(Second Installation) | Non-Clog Type Submersible pump with<br>Quick Discharge Connection<br>? m3/min x 10mH | ABS | 22 | 1 | | | ○ | Ireland | | | |
| | Raw Waste Water Pump<br>(Present Installation) | Non-Clog Type Submersible pump with<br>Quick Discharge Connection<br>500 m3/min x 10mH | ABS | 24 | 1 | 1 | 2 | ○ | Ireland | 2017 | | |
| b | Hoist | Beam + Chain Hoist (Hoist not find) | ? | | | | | X | | | | No Chain Hoist |
| c | Valve/Pipe/Support Condition | Check Valve | | | | | | ○ | | | | |
| | | | | | | | | | | | | |

| No. | Description | Specification | Manufacturer/ Type | kW | Quantity | | | Present Condition | C/O | Year of Installation | Photps | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | OP | S/B | Total | | | | | |
| 2 | **Primary Settling Tank Facility** | | | | | | | | | | | |
| 2.1 | Clarifier (w/Scum Skimmer) | 7.2mW x 27mL x 3.45mD<br>(24' x 90' x 11.5'D)<br>Travelling Bridge Type with Scum Skimmer<br>Speed 1.5m/min | MCON (USA)<br>Assmbl. Thailand | 0.75 | 2 | | 2 | △ | Thailand | 2005 | Mechanical No. 6 & 7 | |
| 2.2 | Primary Sludge Pump | Non-Clog Type Submersible pump with<br>Quick Discharge Connection<br>13.5m3/min x 8mH | ABS | 1.2 | 2 | | 2 | △ | Ireland | 2005 | | |
| | | | | | | | | | | | | |
| 3 | **Aeration Tank Facility** | | | | | | | | | | | |
| 3.1 | Surface Aerator | Floatation Surface Aerator | Aquastar<br>57.3~62.9kg O2/h<br>1.5kg O2/kWh<br>58rpm | 37kW | 8 | | 8 | ○<br>4 Units<br>Operation | Australia | 2005 | Mechanical No. 8 | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| 4 | **Final Settling Tank facility** | | | | | | | | | | | |
| 4.1 | Clarifier (w/Scum Skimmer) | Peripheral Drive Circular Clarifier (Travelling Bridge with Scum Scraper)<br>22.5 m dia. X 3.9m D<br>(75' x 13'D)<br>0.013rpm | MCON (USA)<br>Assmbl. Thailand | 0.75 | 2 | | 2 | △ | Thailand | 2005 | Mechanical No. 9 | |
| 4.2 | Return Sludge Pump | Submersible Pump<br>460m3/h x 10m | ABS | 18.5 | 1<br>(2) | 1<br>(0) | 2 | △ | Ireland | 2005 | Mechanical No. 10 | |
| 4.3 | Excess Sludge Pump | Submersible Pump<br>19 m3/h x 10m | ABS | 1.2 | 2 | | 2 | △ | Ireland | 2005 | | |
| 4.4 | Scum Pump | Submersible Pump<br>6.99 m3/h x 7 m | ABS | 0.47 | 2 | | 2 | △ | Ireland | 2005 | | |
| | | | | | | | | | | | | |
| 5 | **Disinfection Tank** | | | | | | | | | | | |
| 5.1 | Chlorine Dosing System | NaOCl 155lit/h<br>with 3m3 Tank x 2 | OBI | 0.2 | 1 | 1 | 2 | X | Italy | 2005 | Mechanical No. 11 | |
| | | | | | | | | | | | | |
| 6 | **Sludge Thickener Facility** | | | | | | | | | | | |
| 6.1 | Thickener | Center Drive Circular Clarifier<br>12m dia. X 3.9mD)<br>(40'x 13'D)<br>0.007rpm | MCON (USA)<br>Assmbl. Thailand | 0.75 | 2 | | 2 | X | Thailand | 2005 | | |
| 6.2 | Thickened Sludge Pump | Mono Pump<br>100 l/m x 30 m | Mono | 1.5 | 2 | | 2 | X | Australia | 2005 | | |
| | | | | | | | | | | | | |

| No. | Description | Specification | Manufacturer/ Type | kW | Quantity | | | Present Condition | C/O | Year of Installation | Photps | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | OP | S/B | Total | | | | | |
| 7 | **Aerobic Digester Facility** | | | | | | | | | | | |
| 7.1 | Submersible Aerator | Natural aspiration Submersible Aerator 10kgO2/h at 4m D | ABS | 6 | 8 | | 8 | X | Germany | 2005 | Mechanical No. 15 | |
| 7.2 | Digested Sludge Pump | Mono Pump 100 l/m x 30 m | Mono | 1.5 | 2 | | 2 | X | Australia | 2005 | | |
| | | | | | | | | | | | | |
| 8 | **Sludge Dewatering Facility** | | | | | | | | | | | |
| 8.1 | Dewatering Unit | Belt Press Belt Width 1m 180kg-DS/h | INOX (France) Assmbl. In Thailand | 0.55 | 2 | | 2 | X | Thailand | 2005 | Mechanical No. 13 | |
| 8.2 | Belt Washing Water Pump | 12m3/h x 5 bar | Part of Dewatering Unit | 4 | 1 | | 1 | X | | 2005 | | |
| 8.3 | Air Compressor | 220lit/min x 8 bar | Part of Dewatering Unit | 1.1 | 1 | | 1 | X | | 2005 | | |
| 8.4 | Polymer Dosing System | 101 lit/h with 3m3 Tank x 2 | OBI | 0.2 | 1 | 1 | 2 | X | Italy | 2005 | Mechanical No 14 | |
| | | | | | | | | | | | | |
| 9 | Sludge Drying Bed | | | | | | | | | | | |
| 9.1 | Drying Bed Condition | - | | | | | | △ | | | Mechanical No 12 | |
| 9.2 | Filtered Water Return Pump | | | | | | | △ | | | | |

Memo (Problem/Improvement Idea)

(Problems) Treatment condition is not good as plant ability. Improvement for treatment condition shall be depending on Operation and maintenance condition.

(Operation) Aerators shall operate for 24 hours/day. Present condition in Aeration Tank is not enough for Oxygen feed. SVI shall be measured daily base so as to find optimal operation condition.
Excess Sludge pump shall be installed and operate according to SVI measurement result.

(Maintenance) Inlet Screen shall be clean by water manually. Pump pit may be clean periodically so that pump life time can be prolonged.

**Yangon Existing Sewage Treatment Plant**
**Electrical Panel Survey Data**

Present Condition：◎；good condition , ○；able to operate but maintenance required,
△; Better Renewal, X; Bad Condition

| No. | Panel Name | Incoming | Load List | | Place | Panel Condition | Components Condition | Photpo No. | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | Name | A | | | | | |
| 1 | Incoming Panel | 6.6kV | | | Transformer Room | X | X | Electrical -No.1 | |
| 2 | Capacitor Bank | | | | Transformer Room | X | △ | Electrical -No.2 | 20Kvar x 5 |
| 3 | Transformer | 6.6kV x 400V | | | Transformer Room | X | ○ | Electrical -No.3 | 315kVA x 2 sets |
| 4 | Main Distribution Panel (1) | 400V | Main | 800 A | Transformer Room | X | △ | Electrical -No.4 | |
| | | | Outgoing 1 | 400 A | | X | △ | | |
| | | | Outgoing 2 | 250A | | X | △ | | |
| | | | Outgoing 3 | 200A | | X | △ | | |
| | | | Outgoing 14 | 60A | | X | △ | | |
| | | | Outgoing 5 | 60A | | X | △ | | |
| 5 | Main Distribution Panel (2) | 400V | Main | 800 A | Transformer Room | X | △ | Electrical -No.5 | |
| | | | point 6 | 400 A | | X | △ | | |
| | | | point 7 | 250A | | X | △ | | |
| 6 | Raw Water Pump | 400V | Raw Water Pump A | 22kW | | △ | △ | Electrical -No.11 | |
| | | | Raw Water Pump B | 24kW | Pump Control Room | △ | △ | | |
| | | | Raw Water Pump C | 24kW | | △ | △ | | |
| 7 | Grit Pump | 400V | Grit Pump | 1.7kW | Pump Control Room | △ | △ | Electrical -No.12 | |
| 8 | Grit Separator | 400V | Grit Separator | 2.2kW | Pump Control Room | △ | △ | Electrical -No.12 | |
| 9 | Primary Settling Tank | 400V | Primary Settling Scraper A | 0.75kW | Primary Settling | △ | △ | | |
| 10 | Primary Settling Tank | | Primary Settling Scraper B | 0.75kW | Tank Control Room | △ | △ | | |
| 11 | Sludge Pump | 400V | Primary Sludge Pump A | 1.2kW | Primary Settling | △ | △ | | |
| | | | Primary Sludge Pump B | 1.2kW | Tank Control Room | △ | △ | | |
| 12 | Surface Aerator A | 400V | Surface Aerator A-1 | 37kW | | △ | △ | Electrical -No.10 | |
| | | | Surface Aerator A-2 | 37kW | Aerator Control | △ | △ | | |
| | | | Surface Aerator A-3 | 37kW | Room | △ | △ | | |
| | | | Surface Aerator A-4 | 37kW | | △ | △ | | |
| 13 | Surface Aerator B | 400V | Surface Aerator B-1 | 37kW | | △ | △ | | |
| | | | Surface Aerator B-2 | 37kW | Aerator Control | △ | △ | | |
| | | | Surface Aerator B-3 | 37kW | Room | △ | △ | | |
| | | | Surface Aerator B-4 | 37kW | | △ | △ | | |

| No. | Panel Name | Incoming | Load List | | Place | Panel Condition | Components Condition | Photpo No. | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | Name | A | | | | | |
| 14 | Return Sludge Pump | 400V | Return Sludge Pump A | 18.5kW | Secondary Settling | X | △ | Electrical -No.8 | |
| | | | Return Sludge Pump B | 18.5kW | Tank Control Room | X | △ | | |
| 15 | Secondary Settling Tank A | 400V | Scraper A | 0.75kW | Secondary Settling | X | △ | Electrical -No.7 | |
| 16 | Secondary Settling Tank B | 400V | Scraper B | 0.75kW | Tank Control Room | X | △ | Electrical -No.7 | |
| 17 | Scum Pump | 400V | Scum Pump A | 0.45kW | Secondary Settling | X | △ | Electrical -No.9 | |
| | | | Scum Pump B | 0.45kW | Tank Control Room | X | △ | | |
| 18 | Thickener A | 400V | Scraper A | 0.75kW | Secondary Settling | X | △ | Electrical -No.7 | |
| 19 | Thickener B | 400V | Scraper B | 0.75kW | Tank Control Room | X | △ | Electrical -No.7 | |
| 20 | Aerobic Digester | 400V | No.1 Aerobic Digester | 5.9kW | Digester Room | X | △ | Electrical -No.6 | |
| | | | No.2 Aerobic Digester | 5.9kW | | X | △ | | |
| | | | No.3 Aerobic Digester | 5.9kW | | X | △ | | |
| | | | No.4 Aerobic Digester | 5.9kW | | X | △ | | |
| 21 | Aerobic Digester | 400V | No.5 Aerobic Digester | 5.9kW | Digester Room | X | △ | | |
| | | | No.6 Aerobic Digester | 5.9kW | | X | △ | | |
| | | | No.7 Aerobic Digester | 5.9kW | | X | △ | | |
| | | | No.8 Aerobic Digester | 5.9kW | | X | △ | | |

Note: Local Control Panels are not included such as  Dewatering Unit, Polymer Dosing Panel and NaOCl Doing Panel

# Yangon Existing WWTP
# Mechanical Equipment Photos

Photo took on 17th Jan 2017

| No | Description |
|---|---|
| 1 | Auto Bar Screen (Side View) |
| 2 | Auto Bar Screen (Front View) |
| 3 | Auto Bar Screen (Drive Side) |
| 4 | Pump Pit (Raw Water Pit) |
| 5 | Grit Separator |
| 6 | Primary Settling Tank (Scraper) |
| 7 | Primary Settling Tank (Overflow Trough) |
| 8 | Aeration Tank (Surface Aerator) |
| 9 | Secondary Settling Tank |
| 10 | Return Sludge Pump Pit |
| 11 | Disinfection Tank |
| 12 | Sludge Drying Bed |
| 13 | Sludge Dewatering Unit (Belt Press 1mW) |
| 14 | Sludge Dewatering Unit (Polymer Dosing Unit) |
| 15 | Aerobic Digester (Submersible Aerator) |
| | |

**No.1 Auto Bar Screen (Side View)**

**No.2 Auto Bar Screen (Front View)**





**No.3 Auto Bar Screen (Drive Side)**

**No.4 Pump Pit (Raw Water Pit)**

No.5 Grit Separator

No.6 Primary Settling Tank (Scraper)





No.7 Primary Settling Tank (Overflow Trough)

No.8 Aeration Tank (Surface Aerator)

**No.9 Secondary Settling Tank**

**No.10 Return Sludge Pump Pit**





**No. 11 Disinfection Tank**

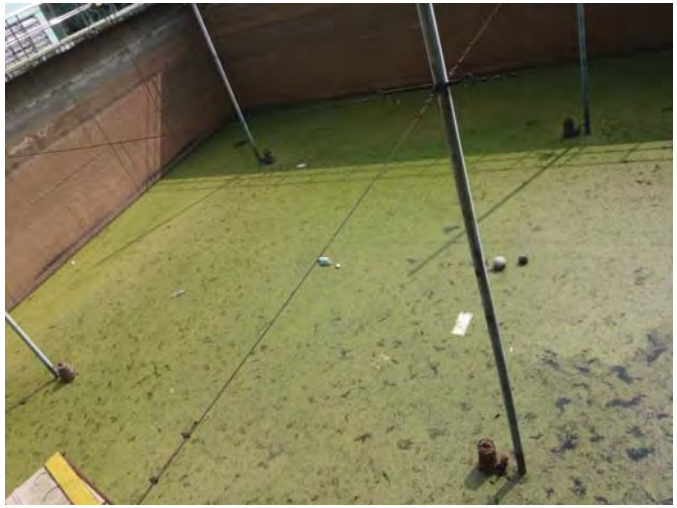
**No. 12 Sludge Drying Bed**

**No. 13 Sludge Dewatering Unit (Belt Press 1mW)**


**No. 14 Sludge Dewatering Unit (Polymer Dosing Unit)**







**No. 15 Aerobic Digester (Submersible Aerator)**

# Yangon Existing WWTP
# Electrical Panel Photos

Photo took on 17th Jan 2017

| No. | Description |
|---|---|
| 1 | Incoming Panel |
| 2 | Capacitor Bank |
| 3 | Transformer |
| 4 | Distribution Panel (1) |
| 5 | Distribution Panel (2) |
| 6 | Aerobic Digester Control Panel |
| 7 | Secondary Settling Tank Scrapers & Thickener Scrapers |
| 8 | Return Sludge Pump Panel |
| 9 | Scum Pump Panel |
| 10 | Surface Aerator Panel |
| 11 | Raw Waste Water Pump Panel |
| 12 | Grit Separator & Grit Pump |
| | |

**No.1 Incoming Panel**

**No.2 Capacitor Bank**





**No.3 Transformer**

**No.4 Distribution Panel (1)**

**No.5 Distribution Panel (2)**


**No.6 Aerobic Digester Control Panel**





**No.7 Secondary Settling Tank Scrapers & Thickener Scrapers**

**No.8 Return Sludge Pump Panel**


**No.9 Scum Pump Panel**

**No.10 Surface Aerator Panel**





**No.11 Raw Waste Water Pump Panel**

**No.12 Grit Separator & Grit Pump**

# Appendix 13 Structural Survey

## APPENDIX 13: Structural Survey

### 1. Visual Inspection (Reactor of C1 WWTP)

**Photo 1: Concrete Surface of Reactor in C1 WWTP**

The operation of the C1 Wastewater Treatment Plant (WWTP) started on 2005, which means that 13 years have passed since the start of operations at of the time of the survey in 2018. Since both storm water and wastewater are retained inside the facilities, visual inspection was conducted on the external wall of the semi-underground structure (upper part 15%-20%) for a reactor which is potentially reusable.

Cracks associated with deformation caused by foundation settlement were not found. However, cold joints and coarse concrete surface due to rough finishing works were observed. In addition, dirt and moss were observed on top of the wall.

Because the facility was painted originally, small cracks were not observed. It was concluded that the facility can be reused by repairing the surface finishing.

### 2. Concrete Chipping Survey (Reactor of C1 WWTP)

**Photo 2: Concrete Chipping Survey (Reactor of C1 WWTP)**

To examine re-utilization of the existing facility (reactor), a concrete chipping survey was conducted at one location approved by the Yangon City Development Committee (YCDC). The chipping work was done by the YCDC.

It was confirmed that the concrete covering depth is 70 mm, and corrosion was not observed according to the result of the neutralization test conducted separately, which is explained below.

### 3. Non-Destructive Concrete Strength Test (Reactor of C1 WWTP)

**Photo 3: Concrete Chipping Survey (Reactor of C1 WWTP) Figure 1: Schmidt Hammer**

As a simple method to measure compressive strength of concrete, the Schmidt hammer test was used to evaluate that of the existing concrete. To do this, a mesh of 20 3 cm x 3 cm squares was measured for each location, and the compression strength was estimated from the average of the rebound numbers at each location. The test was conducted at seven locations.

Regarding location No. 1, the surface was polished because it was rough due to the low accuracy of the mold construction. As a result, since the repulsion degree varied greatly, the test results considered were only from locations No. 2 to No. 7, excluding No.1.

Based on the measurement results of locations No. 2 to No. 7, a strength of approximately 45 to 50 N/mm$^2$ could be confirmed. It seems that the structure can be reused as a permanent structure after rehabilitation.

In the detailed design stage, a detailed survey, such as the core-completion test, is recommended to be conducted again.

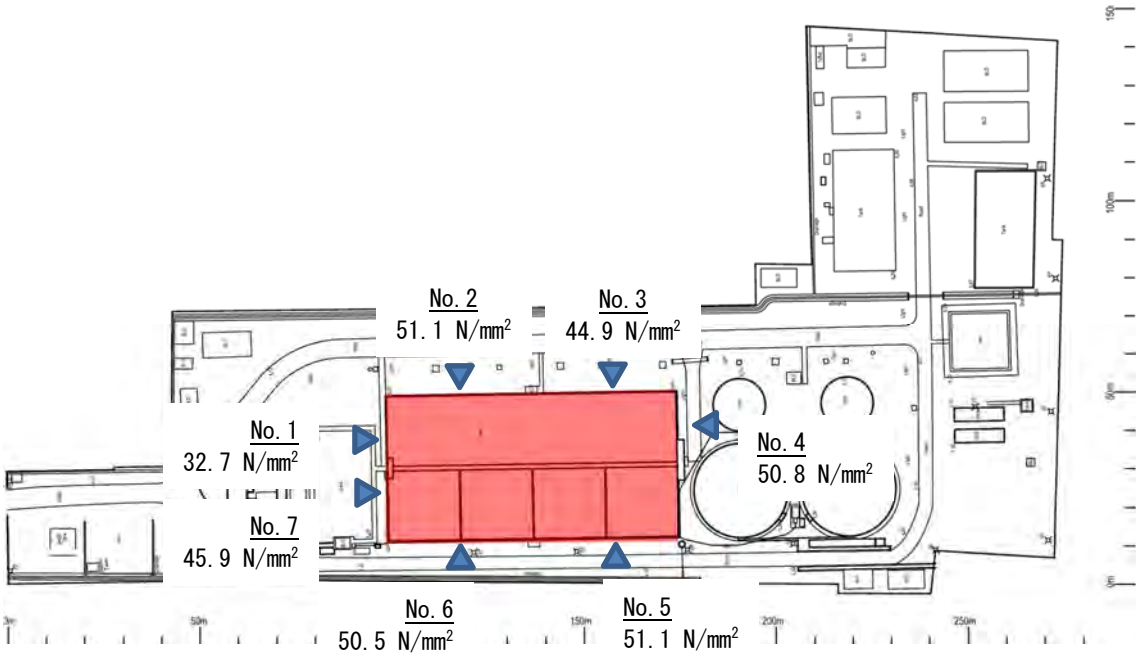



**Figure 2: Test Result (Target Facility: Reactor)**

**4. Neutralization Test (Reactor of C1 WWTP)**

At the location of the concrete chipping survey (chipping work was done by the YCDC), a neutralization test was conducted.

The result indicated that the neutralization depth was 10 mm. The neutralization rate coefficient was calculated using the formula below to predict the future status.

According to the prediction, it is estimated that the durable years of the structure is considerably long. Although the design compression strength was not obtained, a non-destructive concrete strength test using the Schmidt hammer test showed that the concrete compression strength was high enough. Therefore, there is a possibility that high-strength concrete was used. In this state, the concrete surface solidity is high, and the neutralization is less likely to progress from the concrete surface.

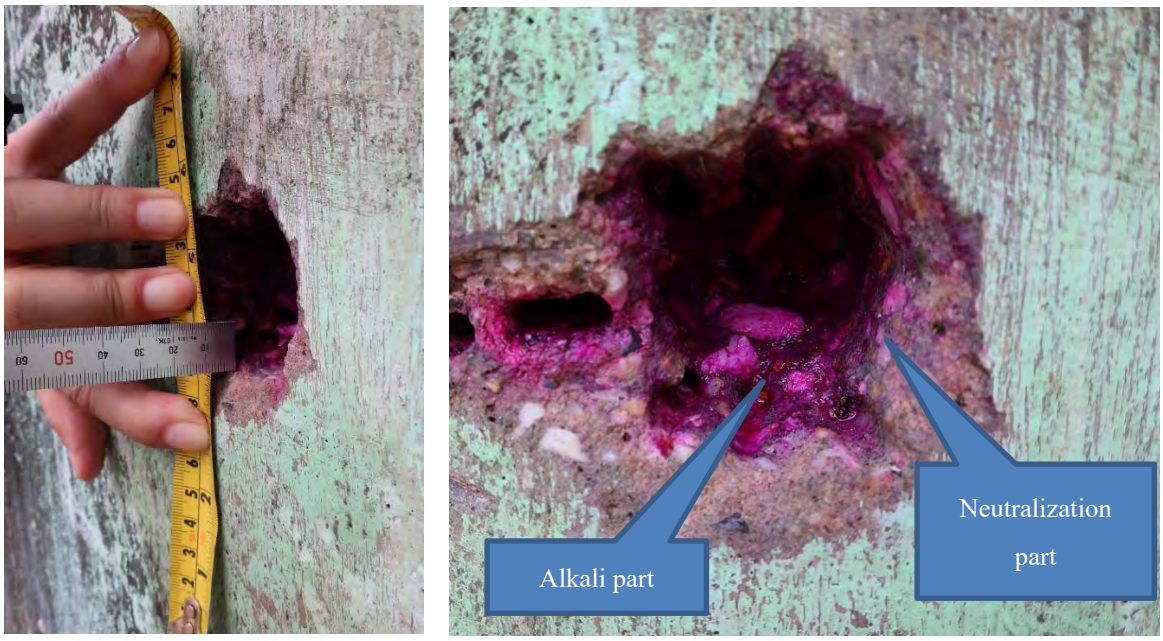



**Photo 3: Neutralization Test**

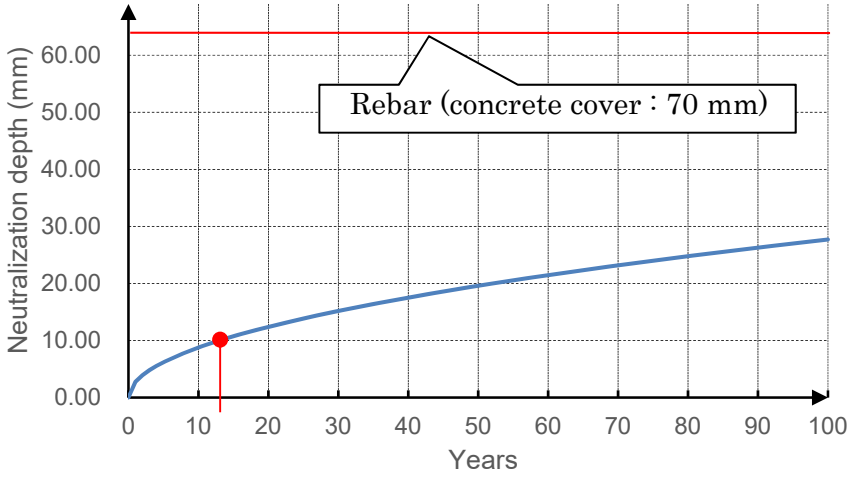
**Formula for calculation of concrete neutralization depth:**

$$X = A \times \sqrt{t}$$

X: neutralization depth (mm), A: neutralization rate coefficient,

t: passed years (year)

The following chart shows the calculated neutralization rate coefficient when it will be 10 mm after 13 years.




＜Photos＞

Schmidt Hammer Usage Explanation

Chipping Work on Reactor Wall (done by YCDC)


Schmidt Hammer Test Location (No.1)


Schmidt Hammer Test Location (No.2)


Schmidt Hammer Test Location (No.3)


Schmidt Hammer Test Location (No.4)

| | |
|---|---|
|  |  |
| Schmidt Hammer Test Location (No.5) | Schmidt Hammer Test Location (No.6) |
|  |  |
| Schmidt Hammer Test Location (No.7) | Phenolphthalein Reaction after Chipping Survey |

Source: JICA Study Team

# Appendix 14 Guidelines for High-Rise Building Construction Projects (Water Supply and Sanitation)

**APPENDIX14**

REPUBLIC OF THE UNION OF MYANMAR
COMMITTEE FOR QUALITY CONTROL OF
HIGH-RISE BUILDING CONSTRUCTION PROJECTS

CQHP

# GUIDELINES FOR HIGH-RISE BUILDING CONSTRUCTION PROJECTS (WATER SUPPLY AND SANITATION)

23rd February, 2017

# COMMITTEE FOR QUALITY CONTROL OF HIGH-RISE BUILDING CONSTRUCTION PROJECTS

## CONTENTS

## GUIDELINES FOR HIGH - RISE BUILDING CONSTRUCTION PROJECTS

## (SANITAY)

# COMMITTEE FOR QUALITY CONTROL OF HIGH-RISE BUILDING CONSTRUCTION PROJECTS
# GUIDELINE IV
# SANITATION

**Sanitation**

**1. Spent Water (R)**

1-1 Spent water contribution should be based on water demand as given in para. 1-1, Guideline III. It is recommended that at least 90% of the water consumed will be discharged as spent water.

1-1-1 Spent water consists of soil and waste water.Table 1, Appendix (R)

1-1-1-1 Soil water is the spent water from WCs and urinals.

1-1-1-2 Waste water is the spent water from basins, kitchen sinks, showers and bath tubs.

**2. Soil Water Treatment and Disposal (M)**

2-1 Soil water shall be treated before being discharged into a water course or public drain or municipal sewer.

2-1-1 The effluent quality of the treated soil water shall conform to the following:

| | Items of Analysis | Sewer | Watercourse | Controlled Water course |
|---|---|---|---|---|
| | | Units in milligram per litre or otherwise stated | | |
| 1 | BOD (5 days at 20 °C ) | 300 | 50 | 20 |
| 2 | COD | 450 | 100 | 60 |
| 3 | Total Suspended Solids | 300 | 50 | 30 |

Note: BOD value refers to 5-day incubation period at 20 °C.

2-1-2 Any sewage treatment system meeting the requirement shown in para 2-1-1 can be used.

2-1-3 Soil and waste water may be treated seperately before final disposal.

2-2 Soil water discharged into YCDC sewer , if allowed shall conform to the normal range generally specified for domestic soil water.( para 2-1-1 )

2-3 A permit shall be obtained from authority concerned for the discharge of treated soil water.

2-4 Effluent of treated soil water shall be disinfected with chlorine or by any other approved method where required.

2-5 Where effluent is chorinated, residual chlorine shall be between 0.1 and 0.2 mg/l.

**3. Waste Water Disposal**

3-1 Waste water from residences may be discharged directly after undergoing appropriate treatment followed by disinfection into public drain. (R)

3-2 However, waste water from kitchen sinks shall first be discharged into a grease trap before its disposal into public drain(M). Undergoing the same treatment as mentioned in para 3-1.

3-3 Waste water is prohibited from being discharged into YCDC sewer. However, if allowed the effluent quality shall conform to the normal range generally specified for domestic waste water.( para 2-1-1 )

3-4 A permit shall be obtained from authority concerned before waste water is disposed into public drain. (M)

3-5 Recycling of grey water may be used for purposes other than dometics such as drinking, cooking, washing, bathing etc.....

**4. Combined Soil and Waste Water Treatment and Disposal (M)**

4-1 Combined soil and waste water shall be treated before being discharged into a water course or public drain.

4-2 The effluent quality shall conform to that given in para 2-1-1 and disinfected as given in para (2-4, 2-5).

4-3 The effluent of the combined treated soil and waste water is prohibited from being discharged into town sewer.

4-4 A permit shall be obtained from authority concerned , YCDC, for the discharged of the treated combined soil and waste water.

**5. Soil and Waste Water Collection (M)**

5-1 Horizontal collecting pipes placed in ceilling shall be securely supported by hangers and given a slope with self-cleansing velocity of 3.0 ft/sec.

5-2 Sewer laid in ground shall be placed in proper bedding and given a slope with self-cleansing velocity of 3.0 ft/sec.

5-3 Sewer shall be laid in straight line.

5-4 However,manholes shall be placed where there is either a change of direction or gradient of sewer.

5-5 Provision of ducts with adequate space.

**6. Sewage Pumps (M)**

6-1 Pumps used for pumping soil and waste water shall meet the designer's requirement.

6-2 At least one stand-by pump shall be provided for duty pump/ pumps installed.

6-3 Characteristic curves for the sewage pumps installed showing the relationships between head, discharged, horse power and effciency shall be provided by the designer in the desing calculation.

**7. Soil, Waste and Vent Pipe System (M)**

7-1 Fully ventilated system shall be used.See also guide line VII para 2-1.

**8. Fittings (M)**

8-1 Pipes and fittings used shall be of the same material.

**9. Sanitary Appliances (M)**

9-1 All sanitary appliances used shall be of approved make.

**10. Specifications**

10-1 Specifications for the following should conform to any internationally recognized standard or approved make: (R)

10-1-1 Cast iron pipes and fittings for soil, waste and vent piping system.

10-1-2 PVC or uPVC pipes and fittings for soil, waste and vent piping system.

10-1-3 Any other materials other than those given in para 10-1-1 and 10-1-2.

10-1-4 Soil/Waste Water tank shall be water-proof both on the inside and outside of the tank.

**11. Installation ( R )**

11-1 Installation of soil, waste and vent pipes shall referred to SINGAPORE CODE OF PRACTICE ON SANITARY PLUMBING AND DRAINAGE SYSTEM (1976 or any up dated version) or any other recognized code of practices.

**12. Rain Water Collection and Disposal**

12-1 Neither soil nor waste water shall be discharged into rain water down pipes. (M)

12-2 Rain water shall therefore be collected and disposed of in a separate system. (M)

12-3 Rain water can be directly discharged into road side drain. (S)

12-4 Rain water gutter shall have the capacity of collecting rain water runoff from roof area. (M)

12-5 Rain water gutter outlets shall be designed to ensure free discharge into down pipes. (M)

12-6 Rain water gutter outlets pipe shall have the capacity of conveying rain water runoff from the gutter through the gutter outlet to the roadside drain. (M)

12-7 Materials for rain water down pipe should be of C.I, D.I, G.I, PVC or uPVC ,or of any approved material.Fabrication with M.S or G.I sheet should not be used. (R)

12-8 An external perimeter drain, shall consist of the volume of rainwater,effluent of soil and waste water from treatment system.The minimum velocity used shall be 0.7m/s .

# Appendix 15 Incineration of the Sludge from WWTP

## APPENDIX 15: Incineration of the Sludge from the Wastewater Treatment Plant (WWTP)

In the master plan conducted in 2014 by the Japan International Cooperation Agency (JICA), six wastewater treatment plants (WWTP) have been planned in Yangon City (core area) as shown in Figure 1.

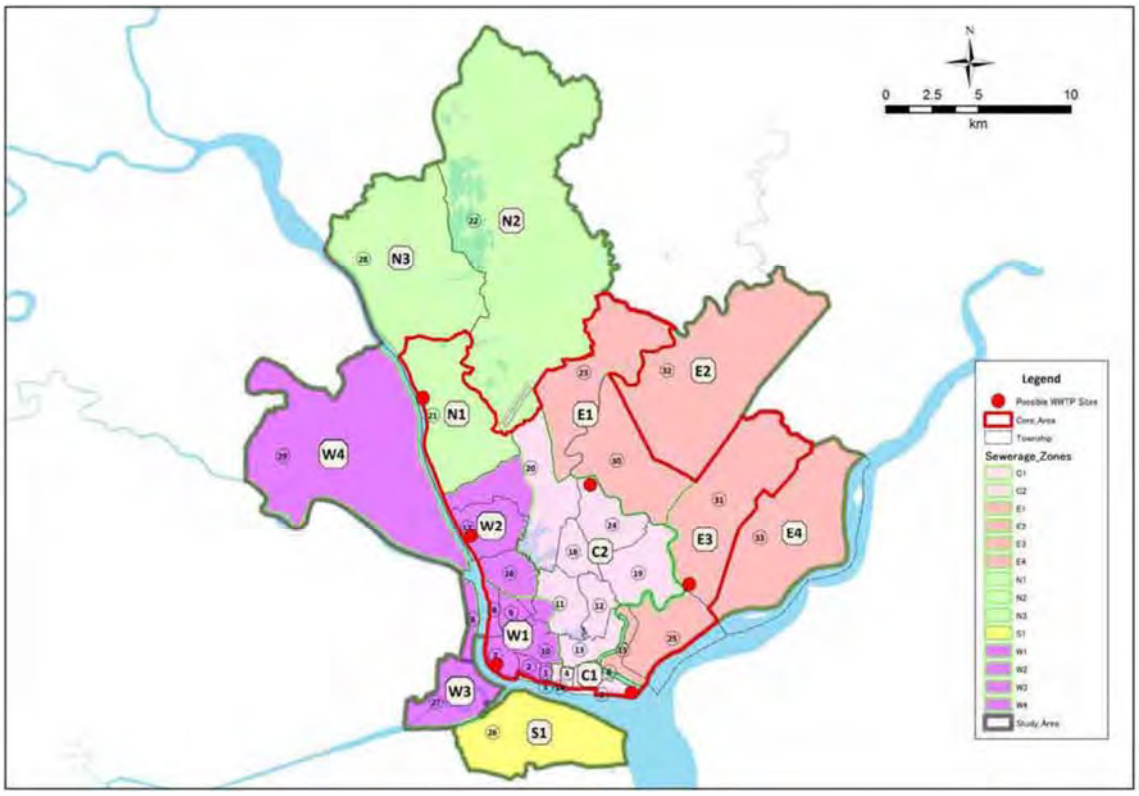



**Figure 1: Sewerage Zones in Yangon City**

Excess sludge will be generated after wastewater treatment. However, the available area for sludge disposal sites in Yangon City are quite limited; thus, the sludge, especially from the WWTP in the area near the city center, must be transported to a site outside the city center.

In general, the generated sludge is treated through a drying process in the WWTP and disposed of at the disposal site. However, due to the reason mentioned above, the Yangon City Development Committee (YCDC) would like to minimize the volume of sludge generated as much as possible by using an incinerator.

Basically, the incineration process is planned to be installed in several wastewater treatment facilities. The initial and operation costs are quite high compared to simply disposing of the dried sludge at a disposal site even if the sludge volume is greatly reduced by incineration. Some skilled operational staff and maintenance staff are also necessary.

In addition, a certain amount of calories is required for the operation of an incinerator. These calories of the sewage sludge, however, are normally low; thus, the fuel necessary for incineration

and co-incineration of the dewatered sewage sludge with solid waste is also considered in that case.

Also, there is a tendency that construction of an incineration facility is not acceptable to residents because of environmental issues.
Thus, an incineration facility should be planned by integrating and covering multiple zones instead of only one facility in one sewerage zone.

As mentioned in the background, YCDC is considering to plan for the installation of an incineration facility in the future by conducting a master plan of integrated sewage sludge management for the entire area of Yangon City.

# Appendix 16　Project Category and IEE Level Study in the JICA Guidelines

# APPENDIX 16 Project Category and IEE level Study in the JICA Guidelines

## Project Category in the JICA Guidelines

| Category | Description |
|---|---|
| A | Proposed projects are classified as "Category A" if they are likely to have significant adverse impacts on the environment and society. Projects with complicated or unprecedented impacts that are difficult to assess, or projects with a wide range of impacts or irreversible impacts, are also classified as "Category A". These impacts may affect an area broader than the sites or facilities subject to physical construction. "Category A", in principle, includes projects in sensitive sectors, projects that have characteristics that are liable to cause adverse environmental impacts, and projects located in or near sensitive areas. |
| B | Proposed projects are classified as "Category B" if their potential adverse impacts on the environment and society are less adverse than those of "Category A" projects. Generally, they are site-specific; few if any are irreversible; and in most cases, normal mitigation measures can be designed more readily. |
| C | Proposed projects are classified as "Category C" if they are likely to have minimal or little adverse impact on the environment and society. |

Source: JICA Guidelines for Environmental and Social Considerations (April 2010)

## IEE level study defined by the JICA Guidelines

| Item | Definition |
|---|---|
| IEE | "Initial Environmental Examination (IEE) level study" is a study that includes an analysis of alternative plans, a prediction and assessment of environmental impacts, and a preparation of mitigation measures, and monitoring plans based on easily available information including existing data and simple field surveys. |

Source: JICA Guidelines for Environmental and Social Considerations (April 2010)

# Appendix 17　Categorization for Sewerage Projects for Assessment Purposes of Myanmar

# APPENDIX 17 Categorization for Sewerage Projects for Assessment Purposes of Myanmar

| No. | Type of Economic Activity | Initial Environmental Examination (IEE) | Environmental Impact Assessment (EIA) |
|---|---|---|---|
| ***Waste Management*** | | | |
| 103. | Non-Hazardous Waste Disposal Facilities | Landfills < 10 t/d and total capacity < 25,000 t<br>Others < 50 t/d | Landfills ≥ 10 t/d or total capacity ≥ 25,000 t<br>Others ≥ 50 t/d |
| 104. | Non-Hazardous Waste Incinerators | < 3 t/h | ≥ 3 t/h |
| 105. | Non-Hazardous Waste Recycling, Recovery or Reuse Facilities | < 50 t/d | ≥ 50 t/d |
| 106. | Hazardous Waste Disposal Facilities | - | All sizes |
| 107. | Hazardous Waste Recycling, Recovery or Reuse Facilities | < 10 t/d | ≥ 10 t/d |
| 108. | Wastewater Treatment Plants (centralized systems) | - | All sizes |
| 109. | Wastewater and Storm Water Collection Systems | Length ≥ 1 km but < 10 km | ≥ 10 km |

Source: Notification (No. 616 / 2015) Annex "Categorization of Economic Activities for Assessment Purposes"

# Appendix 18　Flora and Fauna Species in Yangon Area

# APPENDIX18 Flora and Fauna Species in Yangon Area

## 1. List of Mammal Species recorded in Yangon

| No. | Scientific Name | Family Name | Common Name | IUCN/Status |
|---|---|---|---|---|
| 1 | *Herpestes javanicus* | Herpestidae | Small Asian Mongoose (or) Javan Mongoose | LC |
| 2 | *Herpestes urva* | Herpestidae | Crab eating Mongoose | LC |
| 3 | *Callosciurus phayrei* | Sciuridae | Phayre's Squirrel | LC |
| 4 | *Viverricula indica* | Viverridae | Small Indian Civet | LC |
| 5 | *Callosciurus erythraeus* | Sciuridae | Pallas's Squirrel | LC |
| 6 | *Mus musculus* | Muridae | Asian House Mouse | LC |
| 7 | *Paradoxurus hermaphroditus* | Viverridae | Common Palm Civet | LC |
| 8 | *Rattus rattus* | Muridae | House Rat | LC |
| 9 | *Bandicota indica* | Muridae | Greater Bandicoot Rat | LC |
| 10 | *Tupaia belangeri* | Tupaiidae | Northern Tree shrew | LC |
| 11 | *Lepus peguensis* | Leporidae | Burmese Hare | LC |
| 12 | *Pteropus giganteus* | Pteropodidae | Indian Flying Fox | LC |

LC = Least Concerned
Source: Field recorded data by Resource and Environment Myanmar Co., Ltd. (2017)

## 2. List of Bird Species recorded in Yangon

| No. | Scientific Name | Family Name | Common Name | IUCN Status |
|---|---|---|---|---|
| 1 | *Garrulax leucolophus* | Leiothrichidae | White-crested Laughingthrush | LC |
| 2 | *Orthotomus atrogularis* | Sylviidae | Dark-necked Tailorbird | LC |
| 3 | *Prinia rufescens* | Cisticiolidae | Rufescent prinia | LC |
| 4 | *Accipiter badius* | Accipitridae | Shikra | LC |
| 5 | *Acridotberes grandis* | Sturidae | White-Vented Myna | LC |
| 6 | *Acridothere javanicus* | Sturidae | Jungle Myna | LC |
| 7 | *Acridotheres tristis* | Sturnidae | Common Myna | LC |
| 8 | *Acrocephalus bistrigiceps* | Acrocephalidae | Black-browed reed-warbler | LC |
| 9 | *Acrocephalus orientalis* | Acrocephalidae | Oriental reed-warbler | LC |
| 10 | *Actitis hypoleucos* | Scolopacidae | Common Sandpiper | LC |
| 11 | *Ageithina tiphia* | Aegithinidae | Common Iora | LC |
| 12 | *Anas zonorhyncha* | Anatinae | Chinese spot-billed duck | LC |
| 13 | *Anastomus oscitans* | Ciconiidae | Asian Openbill | LC |
| 14 | *Anhinga melanogaster* | Anhingidae | Oriental Darter | LC |
| 15 | *Anthreptes malacensis* | Nectariniidae | Brown-throated sunbird | LC |
| 16 | *Anthus hodgsoni* | Motacillidae | Olive-backed Pipit | LC |
| 17 | *Apus nipalensis* | Apodidae | House Swift | LC |
| 18 | *Arachnothera longirostra* | Nectariniidae | Little Spiderhunter | LC |
| 19 | *Arachnothera magna* | Nectariniidae | Streaked Spiderhunter | LC |
| 20 | *Ardea alba* | Ardeidae | Great Egreat | LC |
| 21 | *Ardea cinerea* | Ardeidae | Grey Heron | LC |
| 22 | *Ardeola bacchus* | Arideidae | Chinese Pond Heron | LC |
| 23 | *Ardeola grayii* | Ardeidae | Indian Pond Heron | LC |
| 24 | *Ardeola grayii* | Ardeidae | Purple Heron | LC |
| 25 | *Artamus fuscus* | Artimidae | Ashy Woodswallow | LC |
| 26 | *Athene brama* | Strigidae | Spotted Owlet | LC |
| 27 | *Athus rufulus* | Motacillidae | Paddy field Pipit | LC |
| 28 | *Bubulcus coromandus* | Aredeidae | Eastern Cattle Egret | LC |
| 29 | *Butorides striata* | Ardeidae | Little heron | LC |
| 30 | *Cacomantis sepulcralis* | Cuculidae | Plaintive Cuckoo | NE |
| 31 | *Centropus sinensis* | Cuculidae | Greater Coucal | LC |
| 32 | *Ceropis daurica* | Hirundinidae | Red-rumped swallow | LC |
| 33 | *Chalcoparia singalensis* | Nectariniidae | Ruby-cheeked Sunbird | LC |
| 34 | *Charadrius placidus* | Charadriidae | Little winged Plover | NE |
| 35 | *Chlidonias leucopterus* | Sternidae | White wing Tern | LC |
| 36 | *Chloropsis aurifrons* | Eurylaimidae | Golden-fronted Leafbird | LC |
| 37 | *Chloropsis hardwickii* | Chloropseidae | Orange-bellied Leafbird | LC |
| 38 | *Chroicocephalus ridibundus* | Laridae | Black–headed Gull | LC |
| 39 | *Chrysococcyx xanthorhynchus* | Cuculidae | Violet Cuckoo | LC |
| 40 | *Chrysomma sinense* | Pachycephalidae | Yellow-eye Babler | LC |
| 41 | *Cinnyris jugularis* | Nectariniidae | Olive-Backed Sunbird | LC |
| 42 | *Circus macrourus* | Accipitridae | Pied Harrier | NT |
| 43 | *Cisticola juncidis* | Cisticolidae | Zitting Cisticola | LC |
| 44 | *Clamator coromandus* | Cuculidae | Chestnut-winged Cuckoo | LC |
| 45 | *Columba livia* | Columbidae | Rock Pegion | LC |
| 46 | *Copsychus malabaricus* | Muscicupidae | White-rumped Shama | LC |
| 47 | *Copsychus saularis* | Muscicapidae | Oriental Magpie Robin | LC |
| 48 | *Coracias benghalensis* | Coraciidae | Indian Roller | LC |
| 49 | *Coracias benghallensis* | Meropidae | Little-green-bee-Eater | LC |
| 50 | *Coracina melaschistos* | Campephagidae | Black-winged Cuckoo Shrike | LC |
| 51 | *Corvus macrorhynchos* | Corvidae | Large-billed Crow | LC |
| 52 | *Corvus splendens* | Corvidae | House Crow | LC |
| 53 | *Crypsirina temia* | Corvidae | Racket-tailed Treepie | LC |
| 54 | *Culicicapa ceylonensis* | Stenostiridae | Grey-headed canary flycatcher | LC |
| 55 | *Cypsiurus balasiensis* | Apodidae | Asiam Palm Swift | LC |

| No. | Scientific Name | Family Name | Common Name | IUCN Status |
|---|---|---|---|---|
| 56 | *Cypsiurus balasiensis* | Apodidae | Asian Palm-Swift | LC |
| 57 | *Dendrocitta vagabunda* | Corvidae | Rufous Treepie | LC |
| 58 | *Dendrocygne javanica* | Anatidae | Lesser Whistiling Duck | LC |
| 59 | *Dicaeum cruentatum* | Dicaeidae | Scarlet-backed Flowerpecker | LC |
| 60 | *Dicaeum ignipectus* | Dicaeidae | Fire-breasted Flowerpecker | LC |
| 61 | *Dicrurus aeneus* | Dicruridae | Bronzed Drongo | LC |
| 62 | *Dicrurus hottentottus* | Dicruridae | Hair-crested Drongo | LC |
| 63 | *Dicrurus leucophaeus* | Dicruridae | Ashy Drongo | LC |
| 64 | *Dicrurus macrocercus* | Dicruridae | Black Drongo | LC |
| 65 | *Dicrurus paradiseus* | Dicruridae | Greater Racket-tailed Drongo | LC |
| 66 | *Dicrurus remifer* | Dicruridae | Lesser Racket-tailed Drongo | LC |
| 67 | *Egretta garzetta* | Ardeidae | Little Egret | LC |
| 68 | *Elanus axillaris* | Accipitridae | Black-Shoulder kite | LC |
| 69 | *Eudynamys scolopaceus* | Cuculidae | Asian Koel | LC |
| 70 | *Eumyias thalassinus* | Muscicapidae | Verditer flycatcher | LC |
| 71 | *Ficedula parva albicilla* | Muscicapidae | Taiga flycatcher | LC |
| 72 | *Gallinago gallinago* | Scolopacidae | Common Snipe | LC |
| 73 | *Gallus gallus* | Phasianidae | Red junglefowl | LC |
| 74 | *Garrulax chinensis* | Leiothrichidae | Black-throated laughingthrush | LC |
| 75 | *Garrulax pectoralis* | Leiothrichidae | Greater Necklaced Laughingthrush | LC |
| 76 | *Geokichla citrina* | Turdidae | Orange-headed thrush | LC |
| 77 | *Glaucidium cuculoides* | Strigidae | Asian Barred Owlet | LC |
| 78 | *Gracupica contra* | Sturnidae | Asian pied Starling | LC |
| 79 | *Gracupica nigricollis* | Sturnidae | Black-collared starling | LC |
| 80 | *Halcyon pileata* | Alcedinidae | White-throated Kingfisher | LC |
| 81 | *Hirundo rustica* | Hirundinidae | Barn Swallow | LC |
| 82 | *Hirundo rustica* | Hirundinidae | House Swallow | LC |
| 83 | *Hydrophasianus chirurgus* | Jacanidae | Pheasant-tailed Jacana | LC |
| 84 | *Hypothymis azurea* | Monaarchidae | Black-naped monarch | LC |
| 85 | *Ixobrychus cinnamomeus* | Ardeidae | Cinnamon Bittern | LC |
| 86 | *Jynxtorquilla* | Picidae | Eurasian Wryneck | LC |
| 87 | *Lanius collurioides* | Laniidae | Burmese Shrike | LC |
| 88 | *Lanius cristatus* | Laniidae | Brown shrike | LC |
| 89 | *Lanius schach* | Campephagidae | Long-tail shrike | LC |
| 90 | *Leptocoma brasiliana* | Nectariniidae | Van Hasselt's Sunbird | LC |
| 91 | *Lonchura atricapilla* | Estrildidae | Chestnut Munia | LC |
| 92 | *Lonchura punctulata* | Estrildidae | Scally-breasted Munia | LC |
| 93 | *Lonchura striata* | Estrildidae | White-rump Munia | LC |
| 94 | *Malacocincla abbotti* | Pellorneidae | Abbott's Babbler | LC |
| 95 | *Megalaima australis* | Capitonidae | Coppersmith Barbet | NE |
| 96 | *Megalaima lineata* | Ramphastidae | Lineated Barbet | LC |
| 97 | *Merops ieschenaulti* | Meropidae | Chestnut-headed Bee-eater | LC |
| 98 | *Merops orientalis* | Meropidae | Little green bee-eater | LC |
| 99 | *Meropsori orientalis* | Meropidae | Green-Bee-Eater | LC |
| 100 | *Mesophoyx intermedia* | Ardeidae | Intermediate Egret | LC |
| 101 | *Metapidius indicus* | Jacanidae | Bronze-winged jacana | LC |
| 102 | *Microhierax caerulescens* | Falconidae | Collared falconet | LC |
| 103 | *Milvus lineatus* | Accipitridae | Black-eared Kite | LC |
| 104 | *Milvus migrans* | Accipitridae | Black Kite | LC |
| 105 | *Monticola solitarius* | Muscicapidae | Blue rock-thrush | LC |
| 106 | *Motacilla alba* | Motacillidae | White Wagtail | LC |
| 107 | *Motacilla cinerea* | Motacillidae | Grey Wagtail | LC |
| 108 | *Muscicapa dauurica* | Muscicapidae | Asian brown Flycatcher | LC |
| 109 | *Nepttapus coromandelianus* | Anatidae | Cotton -pygmy Goose | LC |
| 110 | *Nycticorax nycticorax* | Ardeidae | Black-crowned nightheron | LC |
| 111 | *Oriolus cruentus* | Oriolidae | Black–naped Oriole | LC |
| 112 | *Oriolus xanthornus* | Oriolidae | Black-hooded Oriole | LC |
| 113 | *Orthotomus atrogularis* | Sylviidae | Dark-necked Tailorbird | LC |
| 114 | *Orthotomus ruficeps* | Cisticolidae | Common Tailorbird | LC |
| 115 | *Passer domesticus* | Passeridae | House Sparrow | LC |
| 116 | *Passer flaveolus* | Passeridae | Plain-backed Sparrow | LC |
| 117 | *Passer montanus* | Passeridae | Eurasian tree Sparrow | LC |
| 118 | *Pellorneum ruficeps* | Pellorneidae | Puff-throated Babbler | LC |
| 119 | *Pericrocotus roseus* | Campephagidae | Rosy Minivet | LC |
| 120 | *Phaenicophaeus tristis* | Cuculidae | Green-billed Malkoha | LC |
| 121 | *Phalacrocorax niger* | Phalacrocoracidae | Little Cormorant | LC |
| 122 | *Phalacrocorax niger* | Phalacrocoracidae | Little-Cormorant | LC |
| 123 | *Phylloscopus fuscatus* | Phylloscopus | Dusky warbler | LC |
| 124 | *Pitta moluccensis* | Pittidae | Blue-winged pitta | LC |
| 125 | *Pitta sordida* | Pittidae | Hooded Pitta | LC |
| 126 | *Ploceus hypoxanthus* | Ploceidae | Asia Golden Weaver | NT |
| 127 | *Ploceus hypoxanthus* | Ploceidae | Asian golden weaver | NT |
| 128 | *Ploceus manyar* | Ploceidae | Streaked weaver | LC |
| 129 | *Ploceus phili* | Ploceidae | Baya weaver | LC |
| 130 | *Pluvialis fulva* | Charadriidae | Pacific Golden Plover | NE |
| 131 | *Prinia flaviventris* | Cisticolidae | YellowBellied Prinia | LC |
| 132 | *Prinia inornata* | Cisticolidae | Grey-breasted prinia | LC |
| 133 | *Prinia inornata* | Cisticolidae | Plain Prinia | LC |
| 134 | *Psittacula alexandri* | Psittacidae | Red-breasted Parakeet | NT |
| 135 | *Psittacula finschii* | Psittacidae | Grey-headed Parakeet | NT |

| No. | Scientific Name | Family Name | Common Name | IUCN Status |
|---|---|---|---|---|
| 136 | *Pycnonotus cafer* | Campephagidae | Red-vented Bulbul | LC |
| 137 | *Pycnonotus atriceps* | Pycnontidae | Black-headed Bulbul | LC |
| 138 | *Pycnonotus finlaysoni* | Pycnontidae | Stripe-throated Bul Bul | LC |
| 139 | *Pycnonotus melanicterus* | Pycnontidae | Black-crested Bulbul | LC |
| 140 | *Pyconotus blanfordi* | Pycnontidae | Streak-eared Bul Bul | LC |
| 141 | *Pyconotus jocosus* | Pycnontidae | Red-Whiskered Bul Bul | LC |
| 142 | *Saxicola caprata* | Muscicapidae | Pied Bushchat | LC |
| 143 | *Saxicola maura* | Muscicapidae | Eurasian Stonechat | NE |
| 144 | *Saxicola maurus* | Muscicapidae | Siberian stonechat | NE |
| 145 | *Streptopelia chinensis* | Columbidae | Spotted Dove | NE |
| 146 | *Streptopelia orientalis* | Columbidae | Oriental Turtle Dove | LC |
| 147 | *Streptopelia tranquebarica* | Columbidae | Red Collared Dove | LC |
| 148 | *Streptopelia tranquebarica* | Columbidae | Red-collared Dove | LC |
| 149 | *Sturnia malabarica* | Sturnidae | Chestnut-tailed Starling | LC |
| 150 | *Surniculus dicruroides* | Cuculidae | Drongo Cuckoo | LC |
| 151 | *Tachybaptus ruficollis* | Podicipedidae | Little grebe | LC |
| 152 | *Terpsiphone paradisi* | Monaarchidae | Asian paradise-flycatcher | LC |
| 153 | *Tinalia pileata* | Timalidae | Chestnut-Capped Babbler | LC |
| 154 | *Tringa ochropus* | Scolopacidae | Green Sandpiper | LC |
| 155 | *Turdoides gularis* | laniidae | White-throated Babbler | LC (endemic) |
| 156 | *Tyto alba* | Tytonidae | Barn Owl | LC |
| 157 | *Vanellus cinereus* | Charadriidae | Grey-headed Lapwing | NE |
| 158 | *Vanellus indicus* | Charadriidae | Red-wattled Lapwing | NE |
| 159 | *Yungipicus canicapillus* | Picidae | Grey-capped pygmy Woodpecker | LC |
| 160 | *Yungipicus moluccensis* | Picidae | Sunda pygmy Woodpecker | LC |
| 161 | *Zosterops palpebrosus* | Zosteropidae | Oriental white-eye | LC |

NE = Not Evaluated, LC = Least Concerned, NT = Near Threatened
Source: Field recorded data by Resource and Environment Myanmar Co., Ltd. (2017)

## 3. List of Reptile Species recorded in Yangon

| No | Scientific Name | Family Name | Common Name | IUCN/Status |
|---|---|---|---|---|
| 1 | *Calotes versicolor* | Agamidae | Garden Lizard | NE |
| 2 | *Calotes mystaceus* | Agamidae | Blue Forest Lizard | NE |
| 3 | *Calotes irawadi* | Agamidae | Ayeyarwady Forest Lizard | NE |
| 4 | *Eutropis quadricarinata* | Scincidae | Common Sun Skink | NE |
| 5 | *Hemidactylus frenatus* | Gekkonidae | Asian House Gecko | NE |
| 6 | *Ptyas mucosa* | Colubridae | Indian Rat Snake | NE |
| 7 | *Gekko gecko* | Gekkonidae | Tokay Gecko | NE |
| 8 | *Lycodon aulicus* | Colubridae | Dusky Wolf Snake | LC |
| 9 | *Xenochrophis piscator* | Colubridae | Chequered Keelback Water Snake | NE |
| 10 | *Dendrelaphis caudolineatus* | Colubridae | Stripe –tailed Bronze back Tree Snake | NE |
| 11 | *Daboia russelii* | Viperidae | Russel's Viper | NE |
| 12 | *Bungarus flaviceps* | Elapidae | Banded Krait | LC |
| 13 | *Xenopeltis unicolor* | Xenopeltidae | Sunbean Snake | NE |
| 14 | *Lissemys punctata* | Trionychidae | Indian flapshell turtle | LC |
| 15 | *Indotestudo elongate* | Testudinidae | Yellow headed-tortoise | EN |
| 16 | *Python bivittatus* | Pythonidae | Burmese Python | VU |

NE = Not Evaluated, LC = Least Concerned, EN = Endangered, VU = Vulnerable
Source: Field recorded data by Resource and Environment Myanmar Co., Ltd. (2017)

## 4. List of Amphibian Species recorded in Yangon

| No. | Scientific Name | Family Name | Common Name | IUCN/Status |
|---|---|---|---|---|
| 1 | *Kaloula pulchra* | Mycrohylidae | Banded Bullfrog (or) Malaysian Narrow mouth Toad | LC |
| 2 | *Hylarana erythraea* | Ranidae | Common Green Frog | LC |
| 3 | *Microhyla heymonsi* | Microhylidae | Arcuate-spotted Pygmy Frog | LC |
| 4 | *Fejervarya limnocharis* | Dicroglossidae | Asian Grass Frog | LC |
| 5 | *Leptophryne borbonica* | Bufonidae | Hourglass Toad | LC |
| 6 | *Duttaphrynus melanostictus* | Bufonidae | Black-Spectacled Toad or Asian Toad | LC |

LC = Least Concerned
Source: Field recorded data by Resource and Environment Myanmar Co., Ltd. (2017)

## 5. List of Fish Species recorded in Yangon

| No | Scientific Name | Family | Common Name | IUCN Status |
|---|---|---|---|---|
| 1 | *Notopterus notopterus* | Notopteridae | Grey featherback | LC |
| 2 | *Puntius spp* | Cyprinidae | Barb | LC |
| 3 | *Amblypharyngodon mola* | Cyprinidae | Mola carplet | LC |
| 4 | *Labeo rohita* | Cyprinidae | Rohu | LC |
| 5 | *Labeo angra* | Cyprinidae | Angra Labeo | LC |
| 6 | *Labeo stoliczkae* | Cyprinidae | Crap | NE |
| 7 | *Labeo calbasu* | Cyprinidae | Karnataka labeo | LC |
| 8 | *Cirrhinus mrigala* | Cyprinidae | Mrigal | LC |
| 9 | *Salmophasia sardinella* | Cyprinidae | Sardinella razorbelly minnow | LC |
| 10 | *Raiamas guttatus* | Cyprinidae | Burmese trout | LC |
| 11 | *Amblypharyngodon atkinsonii* | Cyprinidae | Burmese carplet | LC |
| 12 | *Osteobrama belangeri* | Cyprinidae | Manipur Osterobrama | NT |
| 13 | *Osteobrama cotio* | Cyprinidae | Cunma osteobrma | LC |
| 14 | *Puntius chola* | Cyprinidae | Chola barb | LC |

| No | Scientific Name | Family | Common Name | IUCN Status |
|---|---|---|---|---|
| 15 | *Puntius gonionotus* | Cyprinidae | Silver barb | LC |
| 16 | *Puntius sarana* | Cyprinidae | Olive barb | LC |
| 17 | *Catla catla* | Cyprinidae | Catla | LC |
| 18 | *Hilsa ilisha* | Clupeidae | Hilsa | NE |
| 19 | *Gudusia variegata* | Clupeidae | Burmese River Shad | LC |
| 20 | *Claris batrachus* | Clariidae | Walking Catfish | NE |
| 21 | *Lepidocephalichthys berdmorei* | Cobitidae | Burmese loach | LC |
| 22 | *Gagata cenia* | Sisoridae | Indian gagata | LC |
| 23 | *Bagarius bagarius* | Sisoridae | Gangetic goonch | NT |
| 24 | *Bagarius yarrellii* | Sisoridae | Goonch | NE |
| 25 | *Heteropneustes fossilis* | Heteropneustidae | Stinging catfish | LC |
| 26 | *Anabas testudineus* | Anabantidae | Climbing perch | DD |
| 27 | *Late calcarifer* | Centropomidae | Giant sea perch | NE |
| 28 | *Mystus montanus* | Bagridae | Wynaad mystus | LC |
| 29 | *Mystus vittatus* | Bagridae | Catfish | LC |
| 30 | *Mystus beekeri* | Bagridae | Day's mystus | LC |
| 31 | *Mystus leucophasis* | Bagridae | Catfish | NE |
| 32 | *Mystus cavasius* | Bagridae | Genetic mystus | LC |
| 33 | *Mystus pulcher* | Bagridae | Striped dwarf catfish | LC |
| 34 | *Hemibagrus menoda* | Bagridae | Menoda catfish | LC |
| 35 | *Neotropius acutriostris* | Schilbeidae | Dwarf cat-fish | NE |
| 36 | *Clupisoma prateri* | Schilbeidae | Brumese garua | LC |
| 37 | *Eutropiichthys vacha* | Schilbeidae | Batchwa vacha | LC |
| 38 | *Clupisoma macrophthalmus* | Schilbeidae | Burmes taakree | NE |
| 39 | *Ompok bimaculatus* | Siluridae | Indian butter catfish | NT |
| 40 | *Ompok pabo* | Siluridae | Pabo catfish | NT |
| 41 | *Wallago attu* | Siluridae | Boal | NT |
| 42 | *Macrognathus aral* | Mastacembelidae | Spiny eel | LC |
| 43 | *Macrognathus zebrinus* | Mastacembelidae | Burmese spiny eel | LC |
| 44 | *Mastacembelus armatus* | Mastacembelidae | Spiny-eel | LC |
| 45 | *Monopterus albus* | Synbranchidae | Rice swampeel | LC |
| 46 | *Monopterus cuchia* | Synbranchidae | Gangetic mudeel | LC |
| 47 | *Oreochromic spp* | Cichlidae | Mozambic cichlid | NE |
| 48 | *Claris batrachus* | Clariidae | Walking Catfish | NE |
| 49 | *Arius acutirostris* | Ariidae | Salweeen catfish | LC |
| 50 | *Rhinomugil corsula* | Mugilidae | Corsula | LC |
| 51 | *Xenentodon cancila* | Belonidae | freshwater garfish | LC |
| 52 | *Boleophthalmus boddarti* | Gobiidae | Boddart's goddle eye goby | LC |
| 53 | *Glossogobius giuris* | Gobiidae | Bareye Goby | LC |
| 54 | *Polynemus paradiseus* | Polynemidae | Mangoes fish | NE |
| 55 | *Cynoglossus lingua* | Cynoglossidae | Long tonguesole | NE |

NE = Not Evaluated, LC = Least Concerned, NT = Near Threatened, DD = Data Deficient
Source: Field recorded data by Resource and Environment Myanmar Co., Ltd. (2017)

## 6. List of Butterfly Species recorded in Yangon

| No. | Scientific Name | Family Name | Common Name | IUCN Status |
|---|---|---|---|---|
| 1 | *Papilio demoleus* | Papilionidae | Lime Butterfly | NE |
| 2 | *Papilio polytes* | Papilionidae | Common Mormon | NE |
| 3 | *Papilio memnon* | Papilionidae | Great Mormon | NE |
| 4 | *Papilio iswara* | Papilionidae | Great Helen | NE |
| 5 | *Papilio mahadeva* | Papilionidae | Burmese raven | NE |
| 6 | *Chilasa clytia* | Papilionidae | Common mime | NE |
| 7 | *Graphium sarpedon* | Papilionidae | Lime butterfly | NE |
| 8 | *Catopsilia pomona* | Pieridae | Lemon Emigrant | NE |
| 9 | *Catopsilia pyranthe* | Pieridae | Mottled Emigrant | NE |
| 10 | *Catopsilia scylla* | Pieridae | Orange Emigrant | NE |
| 11 | *Catopsilia florella* | Pieridae | Common vagrant | NE |
| 12 | *Hebomoia glaucippe* | Pieridae | Great Orange -tip | NE |
| 13 | *Ixias pyrene* | Pieridae | Yellow Orange-tip | NE |
| 14 | *Delias agostina* | Pieridae | Yellow Jezebel | NE |
| 15 | *Delias eucharis* | Pieridae | Common Jezebel | NE |
| 16 | *Delias hyparete* | Pieridae | Painted Jezebel | NE |
| 17 | *Pieris canidia* | Pieridae | Indian cabage white | NE |
| 18 | *Appias libythea* | Pieridae | Striped Albatross | NE |
| 19 | *Appias nero* | Pieridae | Orange albatross | NE |
| 20 | *Appias lalage* | Pieridae | Spot puffin | NE |
| 21 | *Appias lyncida* | Pieridae | Chocolate albatross | NE |
| 22 | *Leptosis nina* | Pieridae | Psyche | NE |
| 23 | *Gandaca harina* | Pieridae | Tree Yellow | NE |
| 24 | *Cepora nerissa* | Pieridae | Common gull | NE |
| 25 | *Dercas lycorias* | Pieridae | Plain sulphur | NE |
| 26 | *Eurema hecabe* | Pieridae | Common Grass Yellow | NE |
| 27 | *Eurema ada* | Pieridae | - | NE |
| 28 | *Eurema sari* | Pieridae | Chocolate Grass Yellow | NE |
| 29 | *Eurema blanda* | Pieridae | Three spot grass yellow | NE |
| 30 | *Eurema simulatrix* | Pieridae | Hill grass yellow | NE |
| 31 | *Danaus affinis* | Nymphalidae | Mangrove Tiger | NE |
| 32 | *Danaus chrysippus* | Nymphalidae | Plain Tiger | NE |
| 33 | *Danaus genutia* | Nymphalidae | Common Tiger | NE |

| No. | Scientific Name | Family Name | Common Name | IUCN Status |
|---|---|---|---|---|
| 34 | *Tirumala limniace* | Nymphalidae | Blue Tiger | NE |
| 35 | *Parantica agleoides* | Nymphalidae | Dark Glassy Tiger | NE |
| 36 | *Elymnias hypermnestra* | Nymphalidae | Common palmfly | NE |
| 37 | *Cethosia biblis* | Nymphalidae | Red lacewing | NE |
| 38 | *Cethosia penthesilea* | Nymphalidae | Orange lacewing | NE |
| 39 | *Cethosia cyane* | Nymphalidae | Leopard lacewing | NE |
| 40 | *Euthalia monina* | Nymphalidae | Malay Baron | NE |
| 41 | *Euthalia phemius* | Nymphalidae | White edged blue baron | NE |
| 42 | *Euploea core* | Nymphalidae | Crow | NE |
| 43 | *Euploea sylvester* | Nymphalidae | Double-blanded Crow | NE |
| 44 | *Athyma perius* | Nymphalidae | Common Sergeant | NE |
| 45 | *Ariadne ariadne* | Nymphalidae | Angled castor | NE |
| 46 | *Hypolimnas misippus* | Nymphalidae | Danaid Eggfly | NE |
| 47 | *Hypolimnas bolina* | Nymphalidae | Great Eggfly | NE |
| 48 | *Neptis soma* | Nymphalidae | Sullied sailer | NE |
| 49 | *Neptis hylas* | Nymphalidae | Common sailer | NE |
| 50 | *Neptis jumbah* | Nymphalidae | Chestnut-streaked sailer | NE |
| 51 | *Acraea violae* | Nymphalidae | Tawny Coster | NE |
| 52 | *Junonia lemonias* | Nymphalidae | Lemon Pansy | LC |
| 53 | *Junonia hierta* | Nymphalidae | Yellow Pansy | NE |
| 54 | *Junonia atlities* | Nymphalidae | Grey Pansy | NE |
| 55 | *Junonia almana* | Nymphalidae | Peacock Pansy | LC |
| 56 | *Mycalesis perseus* | Nymphalidae | Dingy bush brown | NE |
| 57 | *Melanitis leda* | Nymphalidae | Common Evening brown | NE |
| 58 | *Melanitis phedima* | Nymphalidae | Dark Evening brown | NE |
| 59 | *Zizula hylax* | Lycaenidae | Pygmy Grass blue | NE |
| 60 | *Una usta* | Lycaenidae | Pale four-line blue | NE |
| 61 | *Nacaduba beroe* | Lycaenidae | Opaque six-line blue | NE |
| 62 | *Castalius rosimon* | Lycaenidae | Common Pierrot | NE |
| 63 | *Udara rona* | Lycaenidae | - | NE |
| 64 | *Anthene lycaenina* | Lycaenidae | Pointed ciliate blue | NE |
| 65 | *Megisba malaya* | Lycaenidae | Malayan | NE |
| 66 | *Jamides canilda* | Lycaenidae | Jamides | NE |
| 67 | *Zizeeria maha* | Lycaenidae | Pale Grass Blue | NE |
| 68 | *Lambrix stellifer* | Hesperiidae | Starry Bab | NE |
| 69 | *Borbo cinnara* | Hesperiidae | Formosan Swift | NE |
| 70 | *Parnara ganga* | Hesperiidae | Continental Swift | NE |

NE = Not Evaluated, LC = Least Concerned
Source: Field recorded data by Resource and Environment Myanmar Co., Ltd. (2017)

## 7. List of Plant Species recorded in Yangon

| No. | Scientific Name | Family Name | Common Name | Habitat | IUCN Status |
|---|---|---|---|---|---|
| 1 | *Fuirena ciliaris* | Cyperaceae | - | Grass | LC |
| 2 | *Annona squamosa* | Annonaceae | Awza | Small Tree | NE |
| 3 | *Caraya arborea* | Lecythidaceae | Bambwe | Tree | NE |
| 4 | *Terminalia catappa* | Combretaceae | Banda | Tree | NE |
| 5 | *Physalis minima* | Solanaceae | Bauk-pin | Herb | NE |
| 6 | *Ficus religrosa* | Moraceae | Bawdi-nyaung | Tree | NE |
| 7 | *Monochoria vaginalis* | Pontederiaceae | Beda | Aquatic | LC |
| 8 | *Piper betle* | Piperaceae | Betle | Climber/Creeper | NE |
| 9 | *Mimosa rubicaulis* | Mimosaceae | Biat-hti-ka-yone | Herb | NE |
| 10 | *Duranta repens* | Vrebenaceae | Bo-kadaw-myet-hkone | Shrub | NE |
| 11 | *Lagenaria siceraria* | Cucurbitaceae | Bu | Climber/Creeper | NE |
| 12 | *Canna indica* | Cannaceae | Budatharana | Herb | NE |
| 13 | *Gnaphalium indium* | Asteraceae | Byaing-che | Herb | NE |
| 14 | *Theobroma cacao* | Malvaceae | Cacao | Small Tree | NE |
| 15 | *Fluegga virosa* | Euphorbiaceae | Chin ya | Small tree | NE |
| 16 | *Hibiscus cannabinus* | Malvaceae | Chin-baung | Shrub | NE |
| 17 | *Flueggea leucopyrus* | Euphorbiaceae | Chinya-phyu | Shrub | NE |
| 18 | *Lawsonia alba* | Lythraceae | Dan | Shrub | NE |
| 19 | *Moringa oleifera* | Moringaceae | Dan-da-lun | Tree | NE |
| 20 | *Cassia occidentalis* | Caesalpiniceae | Dangwe | Shrub | NE |
| 21 | *Lawsonia alba* | Lythraceae | Dan-gyi | Shrub | NE |
| 22 | *Cassia bicapsularis* | Caesalpiniaceae | Dan-kywe | Shrub | LC |
| 23 | *Moringa aleifera* | Moringaceae | Dantalon | Tree | NE |
| 24 | *Archidendron jiringa* | Mimosaceae | Danyin | Tree | NE |
| 25 | *Scoparia dulcis* | Scorphulariaceae | Darna-thu-kha | Herb | NE |
| 26 | *Lumnitzera racemosa* | Combretaceae | Dawei-hmaing | Small Tree | NE |
| 27 | *Millingtonia hortensis* | Bignoniaceae | Egayit | Tree | NE |
| 28 | *Eucalyptus camaldulensis* | Myrtaceae | Eucalypt | Tree | NE |
| 29 | *Helicodiceras muscivorus* | Araceae | Gamone-gwin-doe | Herb | NE |
| 30 | *Mesua ferrea* | Hypericaceae | Gangaw | Tree | NE |
| 31 | *Crocus sativus* | Iridaceae | Gon-ga-man | Herb | NE |
| 32 | *Spondias malayana* | Anacardiaceae | Gwe | Tree | NE |
| 33 | *Bhesa robusta* | Cleastraceae | Gwedauk | Tree | NE |
| 34 | *Dregea volubilis* | Asclepiadaceae | Gwe-dauk-nwe | Climber/Creeper | NE |
| 35 | *Oldenlandia corymbosa* | Rubiaceae | Hingalar | Herb | NE |
| 36 | *Amaranthus bitoides* | Amaranthaceae | Hin-nu-new | Herb | NE |
| 37 | *Amaranthus spinosus* | Amaranthaceae | Hin-nu-new-subak | Herb | NE |

| No. | Scientific Name | Family Name | Common Name | Habitat | IUCN Status |
|---|---|---|---|---|---|
| 38 | *Ceiba pentandra* | Bombacaceae | Hmo-bin | Tree | LC |
| 39 | *Tridax procumbens* | Asteraceae | Hmwezok-ne-gya | Herb | NE |
| 40 | *Dendrocalamus strictus* | Poaceae | Hmyin-wa | Bamboo | NE |
| 41 | *Rosa damascena* | Rosaceae | Hninsi | Shrub | NE |
| 42 | *Costus speciosus* | Costaceae | Htamasok | Herb | NE |
| 43 | *Glochdion fagifolium* | Euphorbiaceae | Htamasok gyi | Small Tree | NE |
| 44 | *Borassus flabellifer L.* | Areaceae | Htan | Tree | NE |
| 45 | *Tabernaemontana divaricata* | Apocynaceae | Htein | Shrub/Climber | NE |
| 46 | *Mimosa pudica* | Mimosaceae | Hti-ka-yone | Herb | LC |
| 47 | *Pinus insularis* | Pinaceae | Htinyu | Tree | NE |
| 48 | *Thyrsostachys siamensis* | Poaceae | Htiyo-wa | Bamboo | NE |
| 49 | *Crateva magna* | Capparaceae | Kadet | Tree | NE |
| 50 | *Diospyros discolor* | Ebenaceae | Kadiba | Tree | NE |
| 51 | *Hyptis suaveolens* | Lamiaceae | Kala pin sein | Herb | NE |
| 52 | *Lantana aculeata* | Verbenaceae | Kala-pan | Herb | NE |
| 53 | *Ficus palmata* | Moraceae | Kala-thapan | Tree | NE |
| 54 | *Alternanthera nodiflora* | Amaranthaceae | Kanaphaw | Herb | LC |
| 55 | *Dipterocarpus alatus* | Dipterocarpaceae | Kanyin-phyu | Tree | VU |
| 56 | *Clerodendrum villosum* | Verbenaceae | Ka-on | Herb | NE |
| 57 | *Erythrina arborescens* | Fabaceae | Kathis | Tree | NE |
| 58 | *Urena lobata* | Malvaceae | Katsene | Shrub | NE |
| 59 | *Ipomoea aquatica* | Convolvulaceae | Kazun-ywet | Climber/Creeper | LC |
| 60 | *Hibiscus-rosa-sinensis* | Malvaceae | Khaung-yan | Shrub | NE |
| 61 | *Luffa acutangula* | Cucurbitaceae | Kha-we | Climber/Creeper | NE |
| 62 | *Luffa acutangula* | Cucurbitaceae | Kha-we-yaing | Climber/Creeper | NE |
| 63 | *Acanthus illicifolius* | Acanthaceae | Khaya | Shurb | NE |
| 64 | *Solanum melongena* | Solanaceae | Khayan | Shrub | NE |
| 65 | *Solanum indicum L.* | Solanaceae | Khayan-kazaw | Shrub | NE |
| 66 | *Manikara hexandra* | Sapotaceae | Khayay | Tree | NE |
| 67 | *Mucuna pruriens* | Fabaceae | Khwela-ya | Climber | NE |
| 68 | *Ixora coccinea* | Rubiaceae | Kinmon | Shrub | NE |
| 69 | *Acacia concinna* | Mimosaceae | Kinmun-gyin | Shrub | NE |
| 70 | *Euphorbia milii* | Euphorbiaceae | Kiss-me-quick | Shrub | DD |
| 71 | *Albizia lebbek* | Mimosaceae | Kokko | Tree | NE |
| 72 | *Areca catechu* | Arecaceae | Kunthi-pin | Small Tree | NE |
| 73 | *Operculina turpethum* | Convolvulaceae | Kyahin-bin | Climber/Creeper | NE |
| 74 | *Bambusa bambos* | Poaceae | Kyakat-wa | Bamboo | NE |
| 75 | *Saccharum sinense* | Poaceae | Kyan | Grass | NE |
| 76 | *Benincasa hispida* | Cucurbitaceae | Kyauk-pha-yon | Climber/Creeper | NE |
| 77 | *Acalypha indica* | Euphorbiaceae | Kyaung-se-pin | Shrub | NE |
| 78 | *Oroxylum indicum* | Bignoniceae | Kyaung-sha | Tree | NE |
| 79 | *Coix lacryma-jobi* | Poaceae | Kyeik | Grass | NE |
| 80 | *Eclipta alba* | Asteraceae | Kyeik-hman | Herb | DD |
| 81 | *Ficus rumphii* | Moraceae | Kyein | Tree | NE |
| 82 | *Momordica charantia* | Cccurbitaceae | Kyet-hin-khar | Climber/Creeper | NE |
| 83 | *Amaranthus caudatus* | Amaranthaceae | Kyet-mauk | Herb | NE |
| 84 | *Achyranthes aspera* | Amaranthaceae | Kyet-mauk-sue-pyan | Herb | NE |
| 85 | *Ricinus communis* | Euphorbiaceae | Kyet-su | Small tree | NE |
| 86 | *Butea frondosa* | Fabaceae | Kyi-ah | Tree | NE |
| 87 | *Phragmites vallatoria* | Poaceae | Kyu | Grass | NE |
| 88 | *Tectona grandis* | Verbenaceae | Kyun | Tree | NE |
| 89 | *Glochidion fagifolium* | Euphorbiaceae | Kywe-hna-kaung-gyeik | Small Tree | NE |
| 90 | *Capparis spinosa* | Capparaceae | Kywel-na-khaung | Shrub | NE |
| 91 | *Combretum squamosum* | Combretaceae | Kywet-nwe | Shrub | NE |
| 92 | *Arytera littoralis* | Sapindaceae | Lamu | Small Tree | LR/LC |
| 93 | *Syzygium aromaticum* | Myrtaceae | Lay-hnyin | Small Tree | NE |
| 94 | *Hippeastrum reticulatum* | Amaryllidaceae | Lay-kunn-khatta | Herb | NE |
| 95 | *Bombax ceiba* | Bombacaceae | Let-pan | Tree | NE |
| 96 | *Tamarindus indica* | Caesalpiniaceae | Magyi | Tree | NE |
| 97 | *Gardenia sessiliflora* | Rubiaceae | Magyi-bauk | Small Tree | NE |
| 98 | *Markhamia stipulata* | Bignoniaceae | Ma-hlwa | Tree | NE |
| 99 | *Psidium guajava* | Myrtaceae | Malaka | Small Tree | NE |
| 100 | *Acacia auriculiformis* | Mimosaceae | Malaysia-padauk | Small Tree | LC |
| 101 | *Senna siamea* | Caesalpiniaceae | Mazali | Tree | NE |
| 102 | *Hygrophila phlomoides* | Acanthaceae | Migyaung-kunbat | Herb | NE |
| 103 | *Caryota mitis* | Arecaceae | Minbaw | Tree | NE |
| 104 | *Scaphium scaphigerum* | Steruliaceae | Mohbin | Tree | NE |
| 105 | *Raphanus sativus* | Brassicaceae | Monla-u | Herb | NE |
| 106 | *Brassica campestris* | Brassicaceae | Mon-nyin | Herb | NE |
| 107 | *Sphaeranthus indicus* | Asteraceae | Mwe-sok | Herb | LC |
| 108 | *Commelina diffusa* | Commelinaceae | Myat kyut | Herb | LC |
| 109 | *Oreocnide frutescens* | Urticaceae | Myauk u | Small Tree | NE |
| 110 | *Themeda triandra* | Poaceae | Myauk-mi | Grass | NE |
| 111 | *Microcos paniculata* | Tiliaceae | Mya-yar | Small Tree | NE |
| 112 | *Cynodon dactylon* | Poaceae | Mye-sa | Grass | NE |
| 113 | *Ziziphus oenoplia* | Rhamnaceae | Myesa-myet | Shrub, Climber | NE |
| 114 | *Dichanthium caricosum* | Poaceae | Myet-kha | Grass | NE |
| 115 | *Phyllanthus urinaria* | Euphorbiaceae | Mye-zi-phyu | Herb | NE |
| 116 | *Lannea coromandelia* | Anacardiaceae | Nabe | Tree | NE |
| 117 | *Ananas comosus* | Bromeliaceae | Nanat | Herb | NE |

| No. | Scientific Name | Family Name | Common Name | Habitat | IUCN Status |
|---|---|---|---|---|---|
| 118 | *Aeschynomene indica* | Fabaceae | Nan-bin | Herb | LC |
| 119 | *Justica decussata* | Acanthaceae | Nat-pan | Shrub | NE |
| 120 | *Clerodendrum natans* | Verbenaceae | Ngayan-padu | Shrub | NE |
| 121 | *Capsicum annuum* | Solanaceae | Ngayok | Shrub | NE |
| 122 | *Musa sapientum* | Musaceae | Nget-pyaw | Herb | NE |
| 123 | *Cassia fistula* | Caesalpinaceae | Ngu | Tree | NE |
| 124 | *Sesbania bispinosa* | Fabaceae | Nyan | Shrub | LC |
| 125 | *Ficus rumphii* | Moraceae | Nyaung | Tree | NE |
| 126 | *Ficus obtusifolia* | Moraceae | Nyaung-gyat | Tree | NE |
| 127 | *Oreocnide frutescens* | Urticaceae | Obok | Small Tree | NE |
| 128 | *Streblus asper* | Moraceae | Okhne | Small Tree | NE |
| 129 | *Aerva javanica* | Amaranthaceae | On-hnye | Herb | NE |
| 130 | *Pterocarpus macrocarpus* | Fabaceae | Padauk | Tree | NE |
| 131 | *Hedychium gracile* | Zingiberaceae | Pade-gaw | Herb | NE |
| 132 | *Althaea rosea* | Malvaceae | Pan-chinbaung | Shrub | NE |
| 133 | *Melia azedarach* | Meliaceae | Pan-tama | Small Tree | NE |
| 134 | *Butea frondosa* | Fabaceae | Pauk | Tree | NE |
| 135 | *Sesbania grandiflora* | Fabaceae | Paukpan-byu | Small Tree | NE |
| 136 | *Cinnamomum camphora* | Lauraceae | Payok | Tree | NE |
| 137 | *Alternanthera sessilis* | Amaranthaceae | Pazun-sar | Herb | LC |
| 138 | *Desmodium triflorum* | Fabaceae | Pe yaing | Herb | LC |
| 139 | *Vigna catjang* | Fabaceae | Pedaung-she | Climber/Creeper | NE |
| 140 | *Colocasia esculenta* | Araceae | Pein | Herb | LC |
| 141 | *Artocarpus heterophyllus* | Moraceae | Peinne | Tree | NE |
| 142 | *Costus speciosus* | Costaceae | Phalan taung hmwe | Herb | NE |
| 143 | *Casuarina equisetifolia* | Casuarinaceae | Pinle-kabwe | Tree | NE |
| 144 | *Ixora arborea* | Rubiaceae | Ponna-yeik | Small Tree | NE |
| 145 | *Calophyllum inophyllum* | Hypericaceae | Pon-nyet | Tree | LR/LC |
| 146 | *Eucalyptus torelliana* | Myrtaceae | Pyi-lon-chantha | Tree | NE |
| 147 | *Murraya koenigii* | Rutaceae | Pyindaw-thein | Small Tree | NE |
| 148 | *Lagerstroemia speciosa* | Lythraceae | Pyinma | Tree | NE |
| 149 | *Ficus benghalensis* | Moraecea | Pyi-nyaung | Tree | NE |
| 150 | *Cymbopogon citratus* | Poaceae | Sabalin | Grass | NE |
| 151 | *Jasminnum arborescens* | Oleaceae | Sabe | Shrub/Climber | NE |
| 152 | *Lactuca sativa* | Asteraceae | Salat-ywet | Herb | NE |
| 153 | *Cratoxylum pruniflorum* | Hypericaceae | Sa-thange-ohnauk | Tree | NE |
| 154 | *Delonix rigia* | Caesalpinaceae | Sein-ban | Tree | NE |
| 155 | *Delonix rigia* | Caesalpinaceae | Sein-ban gyi | Tree | NE |
| 156 | *Caesalpinia pulcherrima* | Caesalpinaceae | Seinban-gale | Small Tree | NE |
| 157 | *Tecoma stans* | Bignoniaceae | Sein-ta-kyu | Shrub | NE |
| 158 | *Bougainvillea spectabilis* | Nyctaginaceae | Sekku-pan | Climber/Creeper | NE |
| 159 | *Acacia inopinata* | Mimosaceae | Sha-hta-naung | Tree | NE |
| 160 | *Eryngium foetidum* | Apiaceae | Shan-nan-nan | Herb | NE |
| 161 | *Citris medica* | Rutaceae | Shauk | Shrub/Small Tree | NE |
| 162 | *Bambusa vulgaris* | Poaceae | Shwe-wa | Bamboo | NE |
| 163 | *Stemona tuberosa* | Stemonaceae | Simi-tauk | Herb | NE |
| 164 | *Heliotropium indium* | Boraginaceae | Sin-hna-maung | Herb | NE |
| 165 | *Eleusine indica* | Poaceae | Sin-ngo-myet | Grass | LC |
| 166 | *Ochna jabotapita* | Ochnaceae | Si-nwe | Shrub | NE |
| 167 | *Elaeis guineensis* | Arecaceae | Si-ohn | Tree | NE |
| 168 | *Albizia procera* | Mimosaceae | Sit | Tree | NE |
| 169 | *Acacia megaladena* | Mimosaceae | Subok | Small Tree | NE |
| 170 | *Acacia pennata* | Mimosaceae | Suboke-gyi | Climber/Creeper | NE |
| 171 | *Capparis sepiaria* | Capparaceae | Sugauk | Shrub | NE |
| 172 | *Ziziphus oenoplia* | Rhamnaceae | Supauk-pin | Shrub, Climber | NE |
| 173 | *Acacia pennata* | Mimosaceae | Suyit | Climber/Creeper | LC |
| 174 | *Bauhinia acuminata* | Caesalpiniaceae | Swe-daw | Small Tree | LC |
| 175 | *Azadirachta indica* | Meliaceae | Tama | Tree | NE |
| 176 | *Dichanthium caricosum* | Poaceae | Ta-myet-si | Grass | NE |
| 177 | *Zingiber squarrosum* | Zingiberaceae | Taukta | Herb | NE |
| 178 | *Coldenia procumbens* | Boraginaceae | Taukte-letwa | Herb | NE |
| 179 | *Garcinia cowa* | Hypericaceae | Taung-thale | Tree | NE |
| 180 | *Eleusine indica* | Poaceae | Taw pyindawthein | Grass | LC |
| 181 | *Pueraria sp.* | Febaceae | Taw-pe | Climber/Creeper | NE |
| 182 | *Crotalaria retusa* | Fabaceae | Taw-peiksan | Shrub | NE |
| 183 | *Malvastrum coromandelianum* | Malvaceae | Taw-pilaw | Herb | NE |
| 184 | *Leucas aspera* | Lamiaceae | Taw-pin-sein | Shrub | NE |
| 185 | *Chionanthus macrocarpus* | Oleaceae | Taw-sabe | Shrub | NE |
| 186 | *Syzygium fruticosum* | Myrtaceae | Taw-thabye | Tree | NE |
| 187 | *Hibiscus panduriformis* | Malvaceae | Taw-yone-padi | Shrub | NE |
| 188 | *Tabernaemontana divaricata* | Apocynaceae | Taw-zalat | Shrub/Climber | NE |
| 189 | *Plumeria obtusa* | Apocynaceae | Tayok-saga | Small Tree | NE |
| 190 | *Euphorbia neriifolia* | Euphorbiaceae | Ta-zaung | Small tree | NE |
| 191 | *Diospyros burmanica* | Ebenaceae | Te | Tree | NE |
| 192 | *Polyalthia simiarum* | Annonaceae | Thabut | Tree | NE |
| 193 | *Luffa aegyptiaca* | Cucurbiataceae | Thabut nwe | Climber/Creeper | NE |
| 194 | *Eugenia bracteolata* | Myrtaceae | Tha-bye | Tree | NE |
| 195 | *Syzygium grande* | Myrtaceae | Thabye gyi | Tree | NE |
| 196 | *Eugenia oblata* | Myrtaceae | Thabye-ni | Tree | NE |
| 197 | *Achras zapota* | Sapotaceae | Thagya | Tree | NE |

| No. | Scientific Name | Family Name | Common Name | Habitat | IUCN Status |
|---|---|---|---|---|---|
| 198 | *Aglaia odoratissima* | Meliaceae | Thanakha | Tree | NE |
| 199 | *Indigofera linifolia* | Fabaceae | Than-manaing-kyauk-manaing | Shrub | LC |
| 200 | *Mangifera indica* | Anacardiaceae | Tha-yet | Tree | DD |
| 201 | *Croton oblongifolius* | Euphorbiaceae | Thetyin-gyi | Shrub | NE |
| 202 | *Limonia acidissima* | Rutaceae | Thi | Tree | NE |
| 203 | *Anacardium occidentale* | Anacardiaceae | Thiho | Tree | NE |
| 204 | *Carica papaya* | Caricaceae | Thinbaw | Small Tree | DD |
| 205 | *Albizia falcata* | Mimosaceae | Thinbaw-magyi | Tree | NE |
| 206 | *Catharanthus roseus* | Apocynaceae | Thinbaw-ma-hnyo | Shrub | NE |
| 207 | *Peltophorum pterocarpum* | Caesalpiniaceae | Thinbaw-mezali | Tree | NE |
| 208 | *Hopea odorata* | Dipterocarpaceae | Thin-gan | Tree | VU |
| 209 | *Millettia pendula* | Febaceae | Thinwin | Tree | NE |
| 210 | *Sandoricum koetijabe* | Meliaceae | Thitto | Tree | NE |
| 211 | *Eucalyptus camaldulensis* | Myrtaceae | U-ca-lit | Tree | NE |
| 212 | *Dendrocalamus brandisii* | Poaceae | Wabo | Bamboo | NE |
| 213 | *Oxytenanthera albociliata* | Poaceae | Wa-gauk | Bamboo | NE |
| 214 | *Gossypium arboreum* | Malvaceae | Wah | Shrub | NE |
| 215 | *Bambusa wamin* | Poaceae | Wamin | Bamboo | NE |
| 216 | *Gigantochloa wanet* | Poaceae | Wa-net | Bamboo | NE |
| 217 | *Bambusa burmanica* | Poaceae | Waya | Bamboo | NE |
| 218 | *Sida acuta* | Malvaceae | Wet-chay-pan | Herb | NE |
| 219 | *Urena lobata* | Malvaceae | Wetchi-pane | Shrub | NE |
| 220 | *Murdannia crocea* | Commelinaceae | Wet-kyut | Herb | NE |
| 221 | *Ipomoea aquatica* | Convolvulaceae | Ye-kazun | Climber/Creeper | NE |
| 222 | *Cedrela febrifuga* | Meliaceae | Ye-tama | Tree | NE |
| 223 | *Ficus glomerata* | Moraceae | Ye-thapan | Tree | NE |
| 224 | *Morinda angustifolia* | Rubiaceae | Yeyo | Small Tree | NE |
| 225 | *Chukrasia velutina* | Meliaceae | Yinma | Tree | NE |
| 226 | *Abelmoschus esculentus* | Malvaceae | Yonbade | Shrub | NE |
| 227 | *Codiaeum variegatum* | Euphorbiaceae | Ywet-hla | Shrub | NE |
| 228 | *Kalanchoe pinnata* | Crassulaceae | Ywet-kya-pin-pauk | Herb | NE |
| 229 | *Pavetta indica* | Rubiaceae | Za-gwe-pan | Shrub | NE |
| 230 | *Cerbera manghas* | Apocynaceae | Zalat | Small tree | NE |
| 231 | *Averrhoa carambola* | Oxalidaceae | Zaung-yar | Small Tree | NE |
| 232 | *Dracaena fragrans* | Dracaenaceae | Zawgi taunghway | Shrub | NE |
| 233 | *Ziziphus jujuba* | Rhamnaceae | Zi | Tree | LC |
| 234 | *Gardenia jasminoides* | Rubiaceae | Zizawa | Shrub | NE |

NE = Not Evaluated, LR/LC = Lower Risk/Least Concerned, VU = Vulnerable, DD = Data Deficient
Source: Field recorded data by Resource and Environment Myanmar Co., Ltd. (2017)

# Appendix 19　EIA Budget Proposal

**APPENDIX 19 EIA Budget Proposal**

ရန်ကုန်မြို့တော်စည်ပင်သာယာရေးကော်မတီ

၁.၁၀.၂၀၁၈ မှ ၃၀.၉.၂၀၁၉ ထိ ငွေလုံးငွေရင်းအသုံးစရိတ်မှ သုံးစွဲမည့်လုပ်ငန်းများစာရင်း

(ကျပ်သန်း)

| စဉ် | ဆောင်ရွက်မည့်လုပ်ငန်းများ | မူလခန့်မှန်းခြေ | |
|---|---|---|---|
| | | သင့်ငွေ | စုစုပေါင်း |
| | ၆။ ဗိုလ်တထောင်မြို့နယ်၊ရေဆိုးသန့်စင်စက်ရုံ နှင့် Johkasou ဓာတ်ခွဲခန်းသုံးပစ္စည်းများ၊ဓါတ်ခွဲခန်းသုံးတိုင်းတာရေးပစ္စည်းများနှင့် ဆက်စပ်ပစ္စည်းများဝယ်ယူခြင်း။ | ၁၂၀.၀၀၀ | |
| | ၇။ လမ်းမတော်မြို့နယ် ၁၀-လမ်းလေမှုတ်စက်ရုံရှိ ၂၀၀HP လျှပ်စစ်လေမှုတ်စက်(၁)လုံး အကြီးစားပြုပြင်ခြင်း။ | ၁၀.၀၀၀ | |
| | ၈။ ဗိုလ်တထောင်မြို့နယ် ပင်မလေမှုတ်စက်ရုံအတွက် ၁၈"ØAir gate valve (၄)လုံးဝယ်ယူခြင်း။ | ၁၀.၀၀၀ | |
| | ၉။ လမ်းမတော်မြို့နယ် (၁၀)လမ်း ပင်မလေမှုတ်စက်ရုံအတွက် ၁၈"ØAir gate valve (၃)လုံး ဝယ်ယူခြင်း။ | ၇.၅၀၀ | |
| | ၁၀။ ဗိုလ်တထောင်မြို့နယ် ပင်မလေမှုတ်စက်ရုံ နှင့် လမ်းမတော်မြို့နယ် (၁၀)လမ်း လေမှုတ်စက်ရုံရှိ လေမှုတ်စက်ကြီးများအတွက် Section and delivery valve (၄၄)လုံးဝယ်ယူခြင်း။ | ၉.၇၀၀ | |
| | ၁၁။ အင်းစိန်မြို့နယ်အောင်ဇေယျတံတားအနီးရေဆိုးသန့်စင်စက်ရုံတည်ဆောက်ခြင်း။ 1.5 Billion | ၁၅၀.၀၀၀ | ✓(၁၈-၁၉) |
| | ၁၂။ လမ်းမတော်မြို့နယ်မိလ္လာတွန်းစက်အမှတ်(၁)ရေပယာနောက်ဖေးလမ်းကြား(၃)ခုမိလ္လာပိုက်လိုင်း၊Manhole များအသစ်လဲလှယ်ခြင်း။ | ၇၅၀.၀၀၀ | |
| | ၁၃။ ဗိုလ်တထောင်မြို့နယ်မိလ္လာတွန်းစက်အမှတ်(၂၈)ရေပယာနောက်ဖေးလမ်းကြား(၃)ခုမိလ္လာပိုက်လိုင်း၊Manhole များအသစ်လဲလှယ်ခြင်း။ | ၇၅၀.၀၀၀ | |
| | ၁၄။ ဗိုလ်တထောင်မြို့နယ် ရေဆိုးသန့်စင်စက်ရုံ Aeration Tank နှင့် Sumbersible Aerator အသစ်တပ်ဆင်ခြင်း။ | ၅၀.၀၀၀ | |
| | ၁၅။ ဗိုလ်တထောင်မြို့နယ် ရေဆိုးသန့်စင်စက်ရုံ"C1"တိုးချဲ့ခြင်းလုပ်ငန်းအတွက်ESIA(Environment Social Impact Access)ပြုလုပ်ခြင်း။ | ၅၀.၀၀၀ | |
| | ၁၆။ ဗိုလ်တထောင်မြို့နယ် ပင်မလေမှုတ်စက်ရုံ 200HP လျှပ်စစ် လေမှုတ်စက် (၂)လုံးအကြီးစားပြုပြင်ခြင်း။ | ၁၈.၀၀၀ | |
| | ၁၇။ မြို့တွင်း(၆)မြို့နယ်ရှိမိလ္လာတွန်းစက်(၂၀)လုံးအား လိုအပ်သောစက်အစိတ်အပိုင်းများအစားထိုးလဲလှယ်အဆင့်မြှင့်တင်ခြင်းနှင့် level control system နှင့် level control &compressor system အား လျှပ်စစ်စက်မှုပစ္စည်းများအစားထိုးလဲလှယ်တပ်ဆင်ခြင်း။ | ၂၀၇.၆၀၀ | |
| | ၁၈။ မြို့တွင်း(၆)မြို့နယ်ရှိ နောက်ဖေးလမ်းကြားများတွင် မိလ္လာကန်အဖုံးတပ်ဆင်ခြင်း၊ပျက်စီးသည့်အိုင်းများအသစ်အစားထိုးတည်ဆောက်ခြင်း။ | ၆၀.၀၀၀ | |
| | ၁၉။ မိလ္လာစွန့်ပစ်ခြင်းလုပ်ငန်းအတွက်လိုအပ်သောပစ္စည်းများဝယ်ယူခြင်း။ | ၅၀.၀၀၀ | |
| ၈ | **၁.၁.၁၀.၁ မြို့တွင်းရေဖူလုံရေး** | ၆၈၁၅.၀၆၀ | |
| | ၁။ တောင်ဥက္ကလာပမြို့နယ် ၁၂ရပ်ကွက် ဘရဏီ(၁၂၃)လမ်းတွင် တီထွေးရှင်းရန်အတွက် 110mmØHDPE ပိုက်(၈၀၀)ပေနှင့်90mmØ HDPE ပိုက်(၆၁၀၀)ပေ ဆက်သွယ်ခြင်း။ | ၅၁.၀၀၀ | |
| | ၂။ တောင်ဥက္ကလာပမြို့နယ်၁၃ရပ်ကွက်အတွင်းတီထွေးရှင်းရန်နှင့် Recycle Pipe များလဲလှယ်ရန်အတွက်110mmØHDPE ပိုက်(၃၀၀၀) ပေနှင့်90mmØHDPE ပိုက်(၂၈၇၀၀)ပေ ဆက်သွယ်ခြင်း။ | ၂၁၅.၆၀၀ | |

D:\1 year (laster) 12.1.2018Last (8-1-2018)

**Yangon City Development Committee**
**List of Proposed Projects within an interval of 1.10.2018 – 30.9.2019**

| Sr | Proposed Projects | Estimated amount (Million Kyats) | |
|---|---|---|---|
| | Implementation of ESIA (Environmental Social Impact Assessment) for WWTP Improvement inside $C_1$ | 50 | |

# Appendix 20　Conditions for the Calculation on Wastewater Volume

Population Growth (each TS) unit：person

| | 2014 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Latha | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 |
| Lanmadaw | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 | 47,160 |
| Pabedan | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 |
| Kyauktada | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 |
| Botahtaung | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 |
| Pazundaung | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 |
| Dagon | 25,082 | 28,222 | 29,148 | 30,074 | 30,999 | 32,064 | 33,130 | 34,195 | 35,260 | 36,325 | 37,390 | 38,455 | 39,520 | 40,585 | 41,651 | 45,201 | 48,751 |
| **Total** | **249,938** | **253,078** | **254,004** | **254,930** | **255,855** | **256,920** | **257,986** | **259,051** | **260,116** | **261,181** | **262,246** | **263,311** | **264,376** | **265,441** | **266,507** | **270,057** | **273,607** |

Source: Data Collection Survey for the Project for Updating the Strategic Urban Development Plan of the Greater Yangon, 2017, JICA

Water Supply Coverage Ratio(each TS) unit：%

| | 2014 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Latha | 85% | 91% | 93% | 95% | 97% | 98% | 98% | 99% | 99% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Lanmadaw | 70% | 76% | 78% | 80% | 82% | 84% | 86% | 88% | 90% | 92% | 94% | 96% | 98% | 100% | 100% | 100% | 100% |
| Pabedan | 88% | 94% | 96% | 98% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Kyauktada | 96% | 98% | 99% | 99% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Botahtaung | 98% | 99% | 99% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Pazundaung | 99% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Dagon | 47% | 53% | 55% | 57% | 59% | 61% | 63% | 65% | 67% | 69% | 71% | 73% | 75% | 77% | 79% | 89% | 100% |

Source: -Data 2014, 2020, 2025, 2030, 2035, 2040: Preparatory Survey for Greater Yangon Water Supply Improvement Project (Phase II), JICA, 2017
-Other data: Estimated by linear interpolation using the above data

Water Supply Served Population(each TS) unit：person

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Latha | 22,802 | 23,303 | 23,804 | 24,305 | 24,456 | 24,606 | 24,756 | 24,907 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 | 25,057 |
| Lanmadaw | 35,842 | 36,785 | 37,728 | 38,671 | 39,614 | 40,558 | 41,501 | 42,444 | 43,387 | 44,330 | 45,274 | 46,217 | 47,160 | 47,160 | 47,160 | 47,160 |
| Pabedan | 31,336 | 32,003 | 32,669 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 | 33,336 |
| Kyauktada | 29,256 | 29,455 | 29,654 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 | 29,853 |
| Botahtaung | 40,585 | 40,722 | 40,858 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 | 40,995 |
| Pazundaung | 48,213 | 48,293 | 48,374 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 | 48,455 |
| Dagon | 14,958 | 16,031 | 17,142 | 18,290 | 19,559 | 20,872 | 22,227 | 23,624 | 25,064 | 26,547 | 28,072 | 29,640 | 31,251 | 32,904 | 40,229 | 48,751 |
| **Total** | **222,991** | **226,592** | **230,230** | **233,905** | **236,268** | **238,674** | **241,123** | **243,614** | **246,147** | **248,573** | **251,042** | **253,553** | **256,107** | **257,760** | **265,085** | **273,607** |

*Water Supply Served Population(each TS) = (Population Growth (each TS)) x (Coverage Ratio of Water Supply(each TS))

Unit water consumption unit：lpcd

| | 2014 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Domestic | 111 | 122 | 125 | 129 | 132 | 136 | 139 | 143 | 146 | 150 | 153 | 157 | 160 | 163 | 167 | 183 | 200 |
| Commercial | 74 | 81 | 83 | 86 | 88 | 90 | 93 | 95 | 98 | 100 | 102 | 104 | 107 | 109 | 111 | 122 | 133 |
| **Total** | **185** | **203** | **208** | **214** | **220** | **226** | **232** | **238** | **244** | **250** | **256** | **261** | **267** | **272** | **278** | **306** | **333** |

Source: -Data 2014, 2020, 2025, 2030, 2035, 2040: Preparatory Survey for Greater Yangon Water Supply Improvement Project (Phase II), JICA, 2017
-Other data: Estimated by linear interpolation using the above data

Ground infiltration(each TS) unit：m3/d

| | area(ha) | unit (m3/ha/d) | total |
|---|---|---|---|
| Latha | 60 | 10 | 605 |
| Lanmadaw | 131 | 10 | 1,311 |
| Pabedan | 62 | 10 | 619 |
| Kyauktada | 70 | 10 | 702 |
| Botahtaung | 260 | 10 | 2,602 |
| Pazundaung | 107 | 10 | 1,067 |
| Dagon | 299 | 10 | 2,994 |
| **Total** | **990** | | **9,900** |

*Ground Infiltration = (Area(each TS)) x (Unit Vol.(10m3/ha/d))

| | | | |
|---|---|---|---|
| Peak Factor= | 1.1 | | |
| Peak Factor= | 1.5 | | infiltration volume |
| BDS available | 381 | ha | 3,810 m3/d |
| BDS is not available | 310 | ha | 3,096 m3/d |

Generated wastewater volume(daily max) unit：m3/d

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Latha | 5,744 | 6,006 | 6,273 | 6,547 | 6,745 | 6,945 | 7,146 | 7,350 | 7,556 | 7,709 | 7,862 | 8,015 | 8,168 | 8,322 | 9,087 | 9,853 |
| Lanmadaw | 9,425 | 9,871 | 10,330 | 10,800 | 11,290 | 11,792 | 12,307 | 12,834 | 13,373 | 13,903 | 14,445 | 14,999 | 15,563 | 15,852 | 17,293 | 18,734 |
| Pabedan | 7,661 | 8,015 | 8,377 | 8,748 | 8,968 | 9,188 | 9,408 | 9,628 | 9,848 | 10,052 | 10,256 | 10,459 | 10,663 | 10,867 | 11,885 | 12,904 |
| Kyauktada | 7,289 | 7,522 | 7,758 | 7,996 | 8,194 | 8,391 | 8,588 | 8,785 | 8,982 | 9,164 | 9,347 | 9,529 | 9,711 | 9,894 | 10,806 | 11,718 |
| Botahtaung | 11,902 | 12,194 | 12,488 | 12,783 | 13,053 | 13,324 | 13,595 | 13,865 | 14,136 | 14,386 | 14,637 | 14,887 | 15,138 | 15,388 | 16,641 | 17,894 |
| Pazundaung | 11,914 | 12,242 | 12,570 | 12,900 | 13,220 | 13,540 | 13,860 | 14,180 | 14,499 | 14,795 | 15,092 | 15,388 | 15,684 | 15,980 | 17,461 | 18,941 |
| Dagon | 6,626 | 6,968 | 7,332 | 7,720 | 8,156 | 8,620 | 9,113 | 9,635 | 10,186 | 10,756 | 11,357 | 11,988 | 12,652 | 13,348 | 16,815 | 21,169 |
| **Total** | **60,561** | **62,817** | **65,128** | **67,495** | **69,626** | **71,800** | **74,016** | **76,276** | **78,581** | **80,767** | **82,995** | **85,266** | **87,580** | **89,650** | **99,988** | **111,213** |

*Generated wastewater volume (daily max) = ((Water Supply Served Population(each TS)) x (Unit water consumption) + (Ground infiltration))* (Peak factor: 1.1)

Generated wastewater volume(hourly max) unit：m3/d

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Latha | 8,617 | 9,008 | 9,410 | 9,821 | 10,117 | 10,417 | 10,720 | 11,025 | 11,334 | 11,564 | 11,793 | 12,023 | 12,253 | 12,482 | 13,631 | 14,779 |
| Lanmadaw | 14,138 | 14,807 | 15,495 | 16,200 | 16,935 | 17,688 | 18,460 | 19,250 | 20,060 | 20,855 | 21,668 | 22,498 | 23,345 | 23,777 | 25,939 | 28,100 |
| Pabedan | 11,491 | 12,022 | 12,566 | 13,122 | 13,452 | 13,782 | 14,112 | 14,442 | 14,772 | 15,078 | 15,384 | 15,689 | 15,995 | 16,300 | 17,828 | 19,356 |
| Kyauktada | 10,933 | 11,283 | 11,637 | 11,995 | 12,290 | 12,586 | 12,881 | 13,177 | 13,472 | 13,746 | 14,020 | 14,293 | 14,567 | 14,841 | 16,209 | 17,577 |
| Botahtaung | 17,854 | 18,291 | 18,731 | 19,174 | 19,580 | 19,986 | 20,392 | 20,798 | 21,204 | 21,579 | 21,955 | 22,331 | 22,707 | 23,083 | 24,961 | 26,840 |
| Pazundaung | 17,870 | 18,362 | 18,856 | 19,351 | 19,830 | 20,310 | 20,790 | 21,269 | 21,749 | 22,193 | 22,637 | 23,082 | 23,526 | 23,970 | 26,191 | 28,412 |
| Dagon | 9,938 | 10,451 | 10,998 | 11,580 | 12,234 | 12,930 | 13,669 | 14,452 | 15,280 | 16,135 | 17,035 | 17,982 | 18,978 | 20,022 | 25,223 | 31,754 |
| **Total** | **90,842** | **94,226** | **97,692** | **101,243** | **104,439** | **107,699** | **111,024** | **114,414** | **117,871** | **121,150** | **124,492** | **127,898** | **131,370** | **134,475** | **149,982** | **166,819** |

*Generated wastewater volume (daily max) = ((Water Supply Served Population(each TS)) x (Unit water consumption) + (Ground infiltration)) x (Peak factor: 1.1) x (Peak factor: 1.5)

Development Progress unit：%

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CBD(BDS) | 0% | 0% | 0% | 0% | 17% | 50% | 83% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| CBD(NonBDS) | 0% | 0% | 0% | 0% | 0% | 0% | 25% | 75% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Dagon | 0% | 0% | 0% | 0% | 17% | 50% | 83% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

*Refer to「5.2.3. Sewerage Development Plan for 2040」and「8.1.2.(3) Construction Schedule」

Population density unit：person/ha

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Latha | 414 | 414 | 414 | 414 | 414 | 414 | 414 | 414 | 414 | 414 | 414 | 414 | 414 | 414 | 414 | 414 |
| Lanmadaw | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 |
| Pabedan | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 |
| Kyauktada | 425 | 425 | 425 | 425 | 425 | 425 | 425 | 425 | 425 | 425 | 425 | 425 | 425 | 425 | 425 | 425 |
| Botahtaung | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 |
| Pazundaung | 454 | 454 | 454 | 454 | 454 | 454 | 454 | 454 | 454 | 454 | 454 | 454 | 454 | 454 | 454 | 454 |
| Dagon | 94 | 97 | 100 | 104 | 107 | 111 | 114 | 118 | 121 | 125 | 128 | 132 | 136 | 139 | 151 | 163 |
| **Total** | **2,444** | **2,447** | **2,450** | **2,453** | **2,457** | **2,460** | **2,464** | **2,467** | **2,471** | **2,474** | **2,478** | **2,482** | **2,485** | **2,489** | **2,500** | **2,512** |

*Population density = (Population growth) / (Area)

Population growth（each package） unit：person

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CBD(BDS) | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 |
| CBD(NonBDS) | 110,420 | 110,420 | 110,420 | 110,420 | 110,420 | 110,420 | 110,420 | 110,420 | 110,420 | 110,420 | 110,420 | 110,420 | 110,420 | 110,420 | 110,420 | 110,420 |
| Dagon | 28,222 | 29,148 | 30,074 | 30,999 | 32,064 | 33,130 | 34,195 | 35,260 | 36,325 | 37,390 | 38,455 | 39,520 | 40,585 | 41,651 | 45,201 | 48,751 |
| **Total** | **253,078** | **254,004** | **254,930** | **255,855** | **256,920** | **257,986** | **259,051** | **260,116** | **261,181** | **262,246** | **263,311** | **264,376** | **265,441** | **266,507** | **270,057** | **273,607** |

*CBD (BDS) = (Population density) x (Area for CBD (BDS)), Refer to the next page
CBD (Non BDS)= (Total population growth(Latha, Lanmadaw, Pabedan, Kyautada, Botahtaung and Pazundaung))- (Population growth(CBD (BDS))
Dagon = Population growth in Dagon township

Water supply coverage ratio（each package） unit：%

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CBD(BDS) | 93% | 94% | 95% | 97% | 97% | 97% | 98% | 98% | 99% | 99% | 99% | 100% | 100% | 100% | 100% | 100% |
| CBD(NonBDS) | 93% | 94% | 95% | 97% | 97% | 97% | 98% | 98% | 99% | 99% | 99% | 100% | 100% | 100% | 100% | 100% |
| Dagon | 53% | 55% | 57% | 59% | 61% | 63% | 65% | 67% | 69% | 71% | 73% | 75% | 77% | 79% | 89% | 100% |

*Water supply coverage ratios in CBD(BDS) and CBD(Non BDS) are average of each township

House connection - construction progress unit：%

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CBD(BDS) | 0% | 0% | 0% | 0% | 17% | 50% | 83% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| CBD(NonBDS) | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 25% | 75% | 100% | 100% | 100% | 100% | 100% | 100% |
| Dagon | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 33% | 67% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

*Ratio for CBD(BDS) is set based on development progress. House connection for CBD(NonBDS) takes for 2 years, and that for Dagon takes for 3 years.
Further house connection shall be implemented in accordance with increasing water supply coverage ratio.

Ratio for house connection unit：%

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CBD(BDS) | 93% | 94% | 95% | 97% | 97% | 97% | 98% | 98% | 99% | 99% | 99% | 100% | 100% | 100% | 100% | 100% |
| CBD(NonBDS) | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 25% | 74% | 99% | 100% | 100% | 100% | 100% | 100% |
| Dagon | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 22% | 46% | 71% | 73% | 75% | 77% | 79% | 89% | 100% |

*Ratio for house connection = (Water supply coverage ratio) x (House connection - construction progress)
*The existing sewerage system will be used until 2023 in CBD(BDS). Water supply coverage ratio is used for ratio for house connection from 2017 to 2023

Connected Population unit：person

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CBD(BDS) | 106,330 | 107,697 | 109,064 | 110,431 | 110,927 | 111,423 | 111,918 | 112,414 | 112,910 | 113,292 | 113,673 | 114,055 | 114,436 | 114,436 | 114,436 | 114,436 |
| CBD(NonBDS) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27,237 | 81,987 | 109,684 | 110,052 | 110,420 | 110,420 | 110,420 | 110,420 |
| Dagon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,875 | 16,709 | 26,547 | 28,072 | 29,640 | 31,251 | 32,904 | 40,229 | 48,751 |
| **Total** | **106,330** | **107,697** | **109,064** | **110,431** | **110,927** | **111,423** | **111,918** | **120,289** | **156,857** | **221,825** | **251,429** | **253,747** | **256,107** | **257,760** | **265,085** | **273,607** |

*Connection ratio =(Population growth) x (Ratio for house connection)

Sewerage served population(connection ratio/future population) unit：%

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CBD(BDS) | 93% | 94% | 95% | 97% | 97% | 97% | 98% | 98% | 99% | 99% | 99% | 100% | 100% | 100% | 100% | 100% |
| CBD(NonBDS) | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 25% | 74% | 99% | 100% | 100% | 100% | 100% | 100% |
| Dagon | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 22% | 46% | 71% | 73% | 75% | 77% | 79% | 89% | 100% |
| **Total** | 42% | 42% | 43% | 43% | 43% | 43% | 43% | 46% | 60% | 85% | 95% | 96% | 96% | 97% | 98% | 100% |

*Sewerage served population = (Connected Population) / (Population growth)

Collection wastewater volume(Daily max) unit：m3/d

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CBD(BDS) | 630 | 630 | 630 | 630 | 630 | 630 | 630 | 34,289 | 35,185 | 35,997 | 36,812 | 37,633 | 38,458 | 39,158 | 42,654 | 46,151 |
| CBD(NonBDS) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8,330 | 25,576 | 34,887 | 35,676 | 36,470 | 37,145 | 40,519 | 43,893 |
| Dagon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,849 | 6,110 | 9,801 | 10,467 | 11,165 | 11,894 | 12,656 | 16,453 | 21,169 |
| **Total** | **630** | **630** | **630** | **630** | **630** | **630** | **630** | **37,138** | **49,626** | **71,374** | **82,167** | **84,474** | **86,823** | **88,959** | **99,626** | **111,213** |

*Collection wastewater volume (Daily Max) = (Connected Population) x (Unit water consumption) x (Peak factor: 1.1) +(Groundwater infiltration) x (Ratio for house connection) x (Peak factor: 1.1)
*Sewage Vol. from 2017 to 2023 in CBD(BDS) was observed volume including sewage transported by Vacuum Truck

Population in CBD (BDS)

| Line | Type | Pipe No. | Area | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ha | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2040 |
| Line1 | Trunk | Pb2 | 3.180 | 1,713 | 1,713 | 1,713 | 1,713 | 1,713 | 1,713 | 1,713 | 1,713 | 1,713 | 1,713 | 1,713 | 1,713 |
| Line1 | Trunk | Pb3 | 2.920 | 1,573 | 1,573 | 1,573 | 1,573 | 1,573 | 1,573 | 1,573 | 1,573 | 1,573 | 1,573 | 1,573 | 1,573 |
| Line1 | Trunk | Ky1 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Line1 | Trunk | Ky2 | 1.890 | 804 | 804 | 804 | 804 | 804 | 804 | 804 | 804 | 804 | 804 | 804 | 804 |
| Line1 | Trunk | Bo2 | 5.900 | 930 | 930 | 930 | 930 | 930 | 930 | 930 | 930 | 930 | 930 | 930 | 930 |
| Line1 | Trunk | Bo3 | 10.320 | 1,626 | 1,626 | 1,626 | 1,626 | 1,626 | 1,626 | 1,626 | 1,626 | 1,626 | 1,626 | 1,626 | 1,626 |
| Line1 | Trunk | Bo5 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Line2 | Trunk | Ld29 | 2.200 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 |
| Line2 | Trunk | Ld31 | 2.200 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 |
| Line2 | Trunk | Ld33 | 2.210 | 795 | 795 | 795 | 795 | 795 | 795 | 795 | 795 | 795 | 795 | 795 | 795 |
| Line2 | Trunk | Lt4 | 6.500 | 2,693 | 2,693 | 2,693 | 2,693 | 2,693 | 2,693 | 2,693 | 2,693 | 2,693 | 2,693 | 2,693 | 2,693 |
| Line2 | Trunk | Pb6 | 7.640 | 4,115 | 4,115 | 4,115 | 4,115 | 4,115 | 4,115 | 4,115 | 4,115 | 4,115 | 4,115 | 4,115 | 4,115 |
| Line2 | Trunk | Pb7 | 8.290 | 4,465 | 4,465 | 4,465 | 4,465 | 4,465 | 4,465 | 4,465 | 4,465 | 4,465 | 4,465 | 4,465 | 4,465 |
| Line2 | Trunk | Ky5 | 8.600 | 3,658 | 3,658 | 3,658 | 3,658 | 3,658 | 3,658 | 3,658 | 3,658 | 3,658 | 3,658 | 3,658 | 3,658 |
| Line2 | Trunk | Ky6 | 8.100 | 3,445 | 3,445 | 3,445 | 3,445 | 3,445 | 3,445 | 3,445 | 3,445 | 3,445 | 3,445 | 3,445 | 3,445 |
| Line2 | Trunk | Bo6 | 7.960 | 1,254 | 1,254 | 1,254 | 1,254 | 1,254 | 1,254 | 1,254 | 1,254 | 1,254 | 1,254 | 1,254 | 1,254 |
| Line2 | Trunk | Bo7 | 7.860 | 1,238 | 1,238 | 1,238 | 1,238 | 1,238 | 1,238 | 1,238 | 1,238 | 1,238 | 1,238 | 1,238 | 1,238 |
| Line2 | Trunk | Pz14 | 7.810 | 3,545 | 3,545 | 3,545 | 3,545 | 3,545 | 3,545 | 3,545 | 3,545 | 3,545 | 3,545 | 3,545 | 3,545 |
| Line2 | Trunk | Pz16 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Line3 | Trunk | Ld39 | 8.500 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 |
| Line3 | Trunk | Ld40 | 10.620 | 3,822 | 3,822 | 3,822 | 3,822 | 3,822 | 3,822 | 3,822 | 3,822 | 3,822 | 3,822 | 3,822 | 3,822 |
| Line3 | Trunk | Ld41 | 8.740 | 3,145 | 3,145 | 3,145 | 3,145 | 3,145 | 3,145 | 3,145 | 3,145 | 3,145 | 3,145 | 3,145 | 3,145 |
| Line3 | Trunk | Lt7 | 8.340 | 3,455 | 3,455 | 3,455 | 3,455 | 3,455 | 3,455 | 3,455 | 3,455 | 3,455 | 3,455 | 3,455 | 3,455 |
| Line3 | Trunk | Lt8 | 8.180 | 3,389 | 3,389 | 3,389 | 3,389 | 3,389 | 3,389 | 3,389 | 3,389 | 3,389 | 3,389 | 3,389 | 3,389 |
| Line3 | Trunk | Pb10 | 8.230 | 4,432 | 4,432 | 4,432 | 4,432 | 4,432 | 4,432 | 4,432 | 4,432 | 4,432 | 4,432 | 4,432 | 4,432 |
| Line3 | Trunk | Pb11 | 8.810 | 4,745 | 4,745 | 4,745 | 4,745 | 4,745 | 4,745 | 4,745 | 4,745 | 4,745 | 4,745 | 4,745 | 4,745 |
| Line3 | Trunk | Ky9 | 15.720 | 6,686 | 6,686 | 6,686 | 6,686 | 6,686 | 6,686 | 6,686 | 6,686 | 6,686 | 6,686 | 6,686 | 6,686 |
| Line3 | Trunk | Ky10 | 16.310 | 6,937 | 6,937 | 6,937 | 6,937 | 6,937 | 6,937 | 6,937 | 6,937 | 6,937 | 6,937 | 6,937 | 6,937 |
| Line3 | Trunk | Bo10 | 13.450 | 2,119 | 2,119 | 2,119 | 2,119 | 2,119 | 2,119 | 2,119 | 2,119 | 2,119 | 2,119 | 2,119 | 2,119 |
| Line3 | Trunk | Bo11 | 16.390 | 2,582 | 2,582 | 2,582 | 2,582 | 2,582 | 2,582 | 2,582 | 2,582 | 2,582 | 2,582 | 2,582 | 2,582 |
| Line3 | Trunk | Bo12 | 29.452 | 4,640 | 4,640 | 4,640 | 4,640 | 4,640 | 4,640 | 4,640 | 4,640 | 4,640 | 4,640 | 4,640 | 4,640 |
| Line3 | Trunk | Bo13 | 16.600 | 2,615 | 2,615 | 2,615 | 2,615 | 2,615 | 2,615 | 2,615 | 2,615 | 2,615 | 2,615 | 2,615 | 2,615 |
| Line3 | Trunk | Bo19 | 2.100 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 |
| Line4 | Trunk | Lt12 | 8.430 | 3,493 | 3,493 | 3,493 | 3,493 | 3,493 | 3,493 | 3,493 | 3,493 | 3,493 | 3,493 | 3,493 | 3,493 |
| Line4 | Trunk | Pb14 | 9.570 | 5,154 | 5,154 | 5,154 | 5,154 | 5,154 | 5,154 | 5,154 | 5,154 | 5,154 | 5,154 | 5,154 | 5,154 |
| Line4 | Trunk | Pb15 | 12.030 | 6,479 | 6,479 | 6,479 | 6,479 | 6,479 | 6,479 | 6,479 | 6,479 | 6,479 | 6,479 | 6,479 | 6,479 |
| Line4 | Trunk | Ky13 | 1.430 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 |
| Line4 | Trunk | Ky14 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Line4 | Trunk | Bo22 | 10.890 | 1,716 | 1,716 | 1,716 | 1,716 | 1,716 | 1,716 | 1,716 | 1,716 | 1,716 | 1,716 | 1,716 | 1,716 |
| Line4 | Trunk | Bo23 | 5.650 | 890 | 890 | 890 | 890 | 890 | 890 | 890 | 890 | 890 | 890 | 890 | 890 |
| Line4 | Trunk | Bo24 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Line4 | Trunk | Bo25 | 6.480 | 1,021 | 1,021 | 1,021 | 1,021 | 1,021 | 1,021 | 1,021 | 1,021 | 1,021 | 1,021 | 1,021 | 1,021 |
| Line4 | Trunk | Bo26 | 3.670 | 578 | 578 | 578 | 578 | 578 | 578 | 578 | 578 | 578 | 578 | 578 | 578 |
| Line4 | Trunk | Bo27 | 3.550 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 |
| Line4 | Trunk | Bo32 | 9.140 | 1,440 | 1,440 | 1,440 | 1,440 | 1,440 | 1,440 | 1,440 | 1,440 | 1,440 | 1,440 | 1,440 | 1,440 |
| Line5 | Trunk | Bo40 | 21.870 | 3,446 | 3,446 | 3,446 | 3,446 | 3,446 | 3,446 | 3,446 | 3,446 | 3,446 | 3,446 | 3,446 | 3,446 |
| Line5 | Trunk | Bo43 | 23.210 | 3,657 | 3,657 | 3,657 | 3,657 | 3,657 | 3,657 | 3,657 | 3,657 | 3,657 | 3,657 | 3,657 | 3,657 |
| Total | | | 380.9 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 | 114,436 |

# Appendix 21　Operation Indicator and Effect Indicator

## APPENDIX 21: Operation Indicator and Effect Indicator

Operation indicator and effect indicator and their definitions are shown as below.

**Table1 Operation Indicators and Effect Indicators**

| | Name | Value（2017） | Indicator（2029） |
|---|---|---|---|
| (1) | Population Treated (Persons) | 106,330 person*1 | 256,107 person*1 |
| (2) | Amount of Wastewater | 630 $m^3$/day | 86,823 $m^3$/day*1 |
| (3) | Capacity of the Facility | 15,000 $m^3$/day | 112,000 $m^3$/day |
| (4) | BOD Concentration | 98 mg/L | 20 mg/L |
| (5) | Percentage of Population Served | 42%*1 | 96%*1 |

*1: Refer to Appendix 20

Source：JICA Study Team based on JICA Operation Indicator and Effect Indicator Reference in ODA Loan Project

(1) Total of “number of residents who connect sewer which is installed in the BDS and is connected to the WWTP” and “number of residents who connect newly installed sewer in the project”
(2) Maximum daily amount of influent without rainwater inflow in the WWTP
(3) Wastewater treatment capacity of the facility (Daily Average)
(4) Maximum measurement value of the effluent from the WWTP
(5) Estimated by dividing “Total Population in the Study Area” into “Population Treated”

# Appendix 22　Household Interview Survey

# OVERVIEW OF THE RESEARCH


**【Objective】**

This scope of works will be applied to household surveys to be conducted for the data collection survey for sewerage system development in Yangon City

**【Term】**

From January 31st 2018 to February 12th, 2018

**【Data Collection】**

Interview to 7 Township (Dagon, Lanmadaw, Latha, Kyauktada, Pazundaung, Pabedan, Botahtaung)

**【Research Professionals】**

12 researchers and 2 team leaders of Trust Venture Partners (2 extra members)

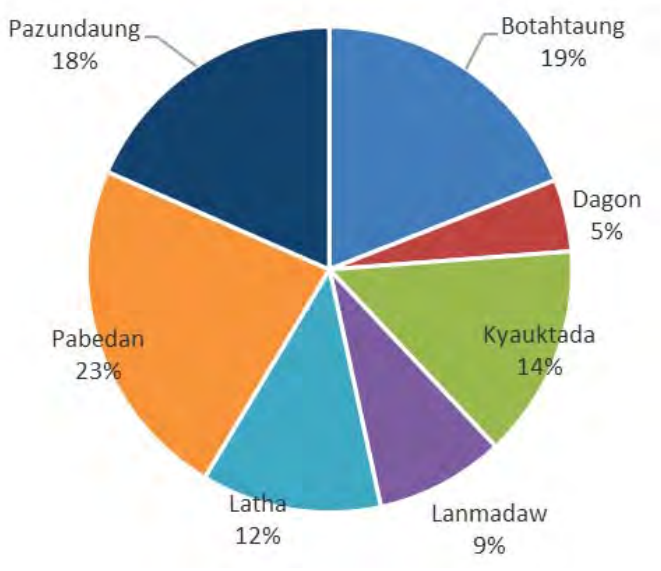


Trust Venture Partners

# TOWNSHIP

n = 500

| Township | Count |
|---|---|
| Botahtaung | 95 |
| Dagon | 24 |
| Kyauktada | 71 |
| Lanmadaw | 43 |
| Latha | 60 |
| Pabedan | 115 |
| Pazundaung | 92 |
| Total | 500 |



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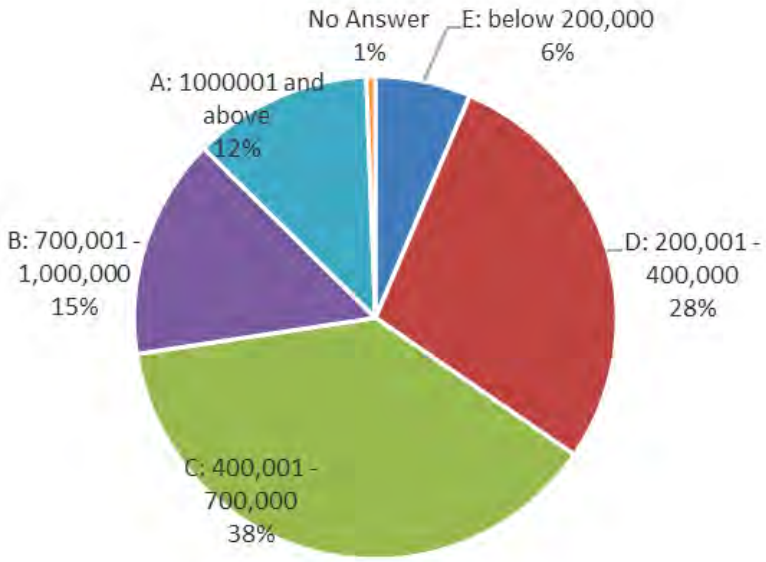
# SEC CLASSIFICATION

n = 500

| SEC | Incmoe range | Count |
|---|---|---|
| E | below 200,000 | 32 |
| D | 200,001 - 400,000 | 141 |
| C | 400,001 - 700,000 | 190 |
| B | 700,001 - 1,000,000 | 74 |
| A | 1000001 and above | 60 |
| - | No Answer | 3 |



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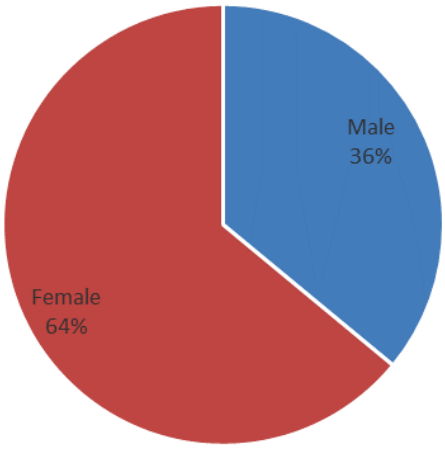
# TABLE : @ 001
# Q1A : GENDER
# BASE : ALL RESPONDENTS

n = 500




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| Q1a. Gender | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | Male | 180 | 180 | 0 | 5 | 28 | 36 | 111 | 28 | 32 | 69 | 41 | 9 | 1 |
| | Female | 320 | 0 | 320 | 10 | 48 | 89 | 173 | 32 | 42 | 121 | 100 | 23 | 2 |



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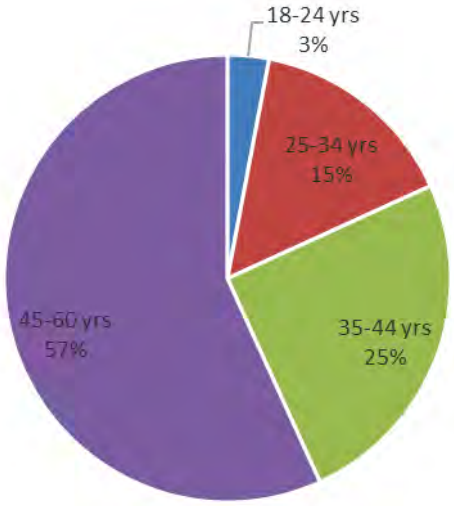
TABLE : @ 002
Q1B : AGE GROUP
BASE : ALL RESPONDENTS

n = 500

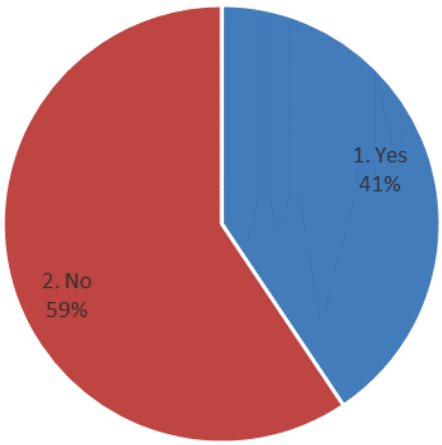



| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| Q1b. Age | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 18-24 yrs | 15 | 5 | 10 | 15 | 0 | 0 | 0 | 0 | 1 | 7 | 5 | 2 | 0 |
| | 25-34 yrs | 76 | 28 | 48 | 0 | 76 | 0 | 0 | 16 | 12 | 25 | 15 | 8 | 0 |
| | 35-44 yrs | 125 | 36 | 89 | 0 | 0 | 125 | 0 | 12 | 18 | 48 | 39 | 7 | 1 |
| | 45-60 yrs | 284 | 111 | 173 | 0 | 0 | 0 | 284 | 32 | 43 | 110 | 82 | 15 | 2 |



TABLE : @ 003
Q1C : ARE YOU HEAD OF HOUSEHOLD?
BASE : ALL RESPONDENTS

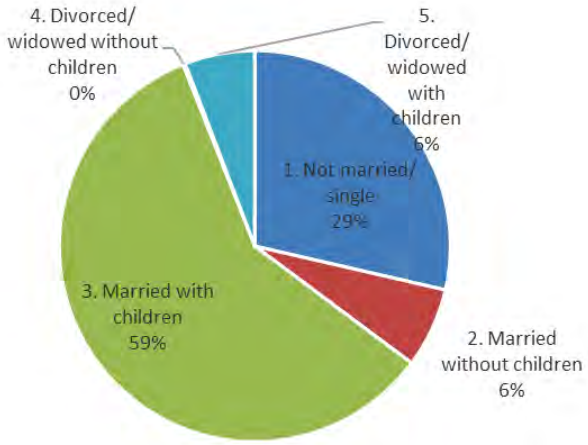
n = 500




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| Q1c. Head of household | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. Yes | 203 | 121 | 82 | 2 | 15 | 36 | 150 | 30 | 29 | 73 | 54 | 15 | 2 |
| | 2. No | 297 | 59 | 238 | 13 | 61 | 89 | 134 | 30 | 45 | 117 | 87 | 17 | 1 |

## TABLE : @ 004
## Q1D : MARITAL STATUS
## BASE : ALL RESPONDENTS

n = 500

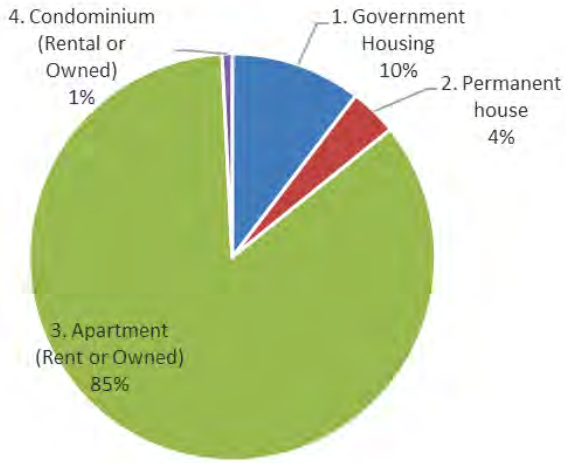



| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| Q1d. Marital status | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. Not married/ single | 143 | 51 | 92 | 10 | 24 | 47 | 62 | 15 | 13 | 53 | 45 | 16 | 1 |
| | 2. Married without children | 33 | 14 | 19 | 1 | 10 | 7 | 15 | 2 | 4 | 15 | 11 | 1 | 0 |
| | 3. Married with children | 294 | 113 | 181 | 4 | 41 | 70 | 179 | 42 | 53 | 109 | 76 | 12 | 2 |
| | 4. Divorced/ widowed without children | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| | 5. Divorced/ widowed with children | 29 | 2 | 27 | 0 | 1 | 1 | 27 | 1 | 3 | 13 | 9 | 3 | 0 |



## TABLE : @ 005
## Q2 : TYPE OF HOUSE
## BASE : ALL RESPONDENTS

n = 500




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| Q2. Househ type | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. Government Housing | 52 | 14 | 38 | 2 | 11 | 14 | 25 | 2 | 5 | 19 | 23 | 3 | 0 |
| | 2. Permanent house | 19 | 9 | 10 | 0 | 1 | 1 | 17 | 0 | 1 | 12 | 4 | 2 | 0 |
| | 3. Apartment (Rent or Owned) | 425 | 156 | 269 | 13 | 64 | 109 | 239 | 55 | 67 | 159 | 114 | 27 | 3 |
| | 4. Condominium (Rental or Owned) | 4 | 1 | 3 | 0 | 0 | 1 | 3 | 3 | 1 | 0 | 0 | 0 | 0 |

## TABLE : @ 006
## A1,A2,A3 : HOW MANY PEOPLE LIVE IN THE HOUSE?
## BASE : ALL RESPONDENTS

n = 500

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| A1. Number of adult (Male) | Count | 430 | 180 | 250 | 14 | 63 | 108 | 245 | 55 | 66 | 168 | 116 | 23 | 2 |
| | Average | 1.85 | 1.84 | 1.86 | 1.50 | 2.00 | 1.74 | 1.88 | 2.16 | 2.08 | 1.79 | 1.71 | 1.61 | 2.00 |
| A1. Number of adult (Female) | Count | 480 | 160 | 320 | 14 | 74 | 118 | 274 | 57 | 73 | 182 | 135 | 30 | 3 |
| | Average | 2.16 | 2.14 | 2.18 | 2.36 | 2.27 | 2.13 | 2.14 | 2.67 | 2.16 | 2.26 | 1.93 | 1.70 | 1.33 |
| A2. Number of senior citizens (Male) | Count | 102 | 35 | 67 | 2 | 20 | 30 | 50 | 14 | 12 | 39 | 32 | 5 | 0 |
| | Average | 1.07 | 1.09 | 1.06 | 1.50 | 1.10 | 1.03 | 1.06 | 1.14 | 1.00 | 1.13 | 1.00 | 1.00 | |
| A2. Number of senior citizens (Female) | Count | 163 | 68 | 95 | 5 | 27 | 57 | 74 | 26 | 24 | 59 | 45 | 8 | 1 |
| | Average | 1.18 | 1.13 | 1.21 | 1.00 | 1.15 | 1.09 | 1.27 | 1.27 | 1.13 | 1.14 | 1.20 | 1.25 | 1.00 |
| A3. Number of children (Male) | Count | 135 | 39 | 96 | 7 | 28 | 54 | 46 | 19 | 26 | 47 | 36 | 6 | 1 |
| | Average | 1.35 | 1.44 | 1.31 | 1.14 | 1.39 | 1.50 | 1.17 | 1.16 | 1.38 | 1.30 | 1.42 | 1.83 | 1.00 |
| A3. Number of children (Female) | Count | 135 | 41 | 94 | 5 | 38 | 49 | 43 | 24 | 27 | 49 | 29 | 5 | 1 |
| | Average | 1.33 | 1.32 | 1.33 | 1.20 | 1.42 | 1.37 | 1.21 | 1.67 | 1.22 | 1.24 | 1.34 | 1.00 | 1.00 |





## TABLE : @ 007
## A4 : WHAT KIND OF OCCUPATION FOR THE MAJOR INCOME SOURCE OF YOUR HOUSEHOLD?
## BASE : ALL RESPONDENTS

n = 500

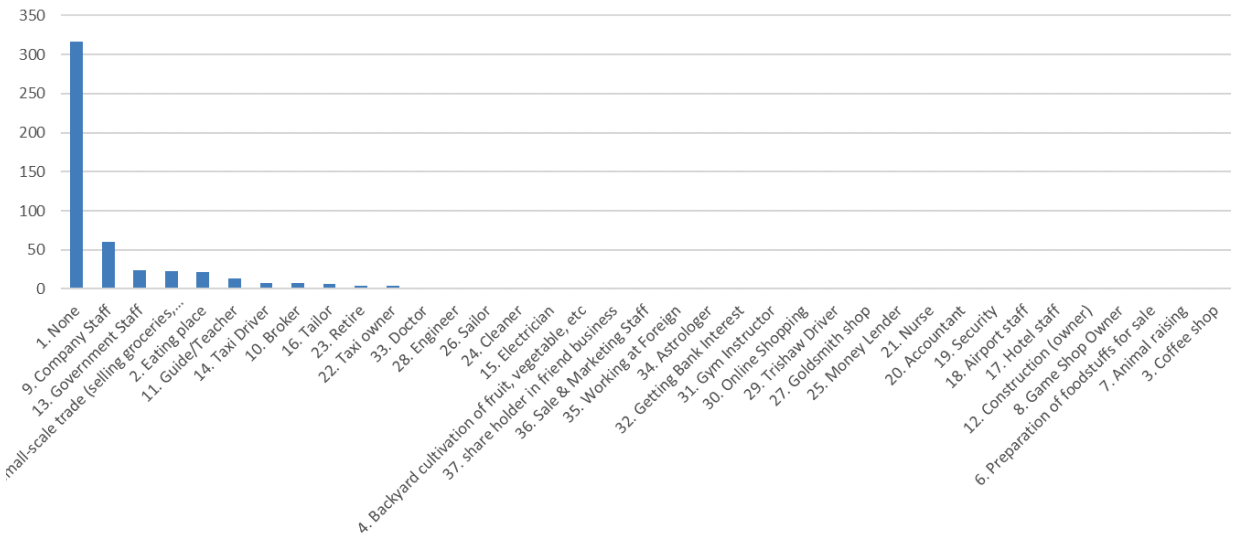

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| A4. Occupation | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. Dependent | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2. Independent /Self-employed business | 336 | 131 | 205 | 10 | 49 | 91 | 186 | 40 | 58 | 134 | 84 | 18 | 2 |
| | 3. Salaried employee | 114 | 34 | 80 | 3 | 21 | 23 | 67 | 9 | 14 | 44 | 41 | 6 | 0 |
| | 4. Sailor | 12 | 4 | 8 | 0 | 1 | 2 | 9 | 7 | 1 | 4 | 0 | 0 | 0 |
| | 5. Getting Bank Interest | 3 | 1 | 2 | 0 | 0 | 1 | 2 | 1 | 1 | 1 | 0 | 0 | 0 |
| | 6. Retire | 11 | 5 | 6 | 0 | 2 | 1 | 8 | 0 | 0 | 3 | 3 | 4 | 1 |
| | 7. Working at Foreign | 7 | 1 | 6 | 1 | 1 | 1 | 4 | 0 | 0 | 1 | 3 | 3 | 0 |
| | 8. Engineer | 3 | 0 | 3 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 1 | 0 | 0 |
| | 9. Taxi Driver | 10 | 3 | 7 | 0 | 1 | 4 | 5 | 0 | 0 | 3 | 7 | 0 | 0 |
| | 10. Doctor | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | 11. Share holder in friend business | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 12. Babysitter | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 13. General Worker | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 14. Mobile Phone & Accessories Shop | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

TABLE : @ 008

A5 : DOES ANY MEMBER OF THE HOUSEHOLD CARRY OUT ANY INCOME GENERATING ACTIVITIES HERE IN YOUR HOME?

BASE : ALL RESPONDENTS

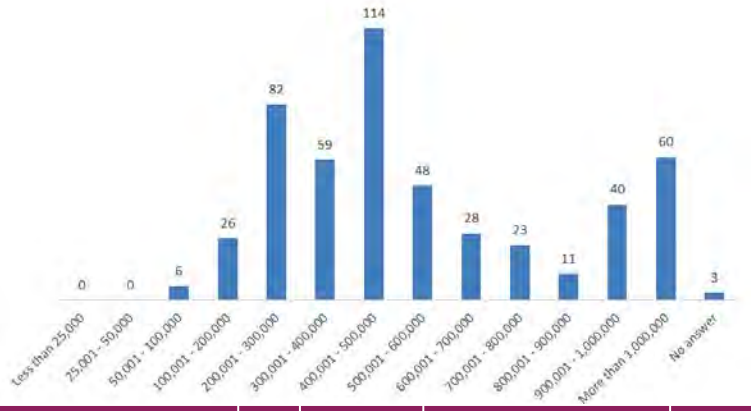
n = 500




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| A5. Income generating activities | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. None | 317 | 116 | 201 | 9 | 41 | 85 | 182 | 35 | 42 | 115 | 93 | 30 | 2 |
| | 9. Company Staff | 60 | 17 | 43 | 2 | 9 | 17 | 32 | 10 | 10 | 28 | 12 | 0 | 0 |
| | 13. Government Staff | 24 | 11 | 13 | 2 | 7 | 7 | 8 | 1 | 5 | 9 | 9 | 0 | 0 |
| | 5. Small-scale trade (selling groceries, cigarettes, fruit etc from house) | 23 | 9 | 14 | 0 | 4 | 7 | 12 | 3 | 6 | 11 | 3 | 0 | 0 |
| | 2. Eating place | 22 | 4 | 18 | 0 | 7 | 5 | 10 | 5 | 5 | 9 | 3 | 0 | 0 |
| | 11. Guide/Teacher | 13 | 4 | 9 | 0 | 1 | 1 | 11 | 2 | 2 | 6 | 3 | 0 | 0 |
| | 14. Taxi Driver | 8 | 1 | 7 | 0 | 4 | 0 | 4 | 0 | 0 | 5 | 3 | 0 | 0 |
| | 10. Broker | 7 | 4 | 3 | 2 | 0 | 1 | 4 | 0 | 1 | 4 | 2 | 0 | 0 |
| | 16. Tailor | 6 | 3 | 3 | 0 | 0 | 2 | 4 | 0 | 1 | 2 | 3 | 0 | 0 |
| | 23. Retire | 4 | 1 | 3 | 0 | 0 | 0 | 4 | 1 | 1 | 0 | 2 | 0 | 0 |
| | 22. Taxi owner | 4 | 3 | 1 | 0 | 1 | 1 | 2 | 2 | 1 | 1 | 0 | 0 | 0 |
| | 33. Doctor | 2 | 1 | 1 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 0 |
| | 28. Engineer | 2 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| | 26. Sailor | 2 | 1 | 1 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 1 | 0 | 0 |
| | 24. Cleaner | 2 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| | 15. Electrician | 2 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| | 4. Backyard cultivation of fruit, vegetable, etc | 2 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| | 37. share holder in friend business | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 36. Sale & Marketing Staff | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 35. Working at Foreign | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| | 34. Astrologer | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| | 32. Getting Bank Interest | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 31. Gym Instructor | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 30. Online Shopping | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | 29. Trishaw Driver | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 27. Goldsmith shop | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 25. Money Lender | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 21. Nurse | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 20. Accountant | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 19. Security | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 18. Airport staff | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 17. Hotel staff | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | 12. Construction (owner) | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 8. Game Shop Owner | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 6. Preparation of foodstuffs for sale | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 7. Animal raising | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 3. Coffee shop | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## TABLE : @ 009
## A6 : WHAT IS THE TOTAL MONTHLY INCOME OF YOUR HOUSEHOLD?
## BASE : ALL RESPONDENTS

n = 500




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| A6. Monthly household income | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | Less than 25,000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 25,001 - 50,000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 50,001 - 100,000 | 6 | 2 | 4 | 1 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 6 | 0 |
| | 100,001 - 200,000 | 26 | 7 | 19 | 1 | 8 | 5 | 12 | 0 | 0 | 0 | 0 | 26 | 0 |
| | 200,001 - 300,000 | 82 | 20 | 62 | 4 | 8 | 22 | 48 | 0 | 0 | 0 | 82 | 0 | 0 |
| | 300,001 - 400,000 | 59 | 21 | 38 | 1 | 7 | 17 | 34 | 0 | 0 | 0 | 59 | 0 | 0 |
| | 400,001 - 500,000 | 114 | 46 | 68 | 6 | 18 | 31 | 59 | 0 | 0 | 114 | 0 | 0 | 0 |
| | 500,001 - 600,000 | 48 | 15 | 33 | 1 | 5 | 8 | 34 | 0 | 0 | 48 | 0 | 0 | 0 |
| | 600,001 - 700,000 | 28 | 8 | 20 | 0 | 2 | 9 | 17 | 0 | 0 | 28 | 0 | 0 | 0 |
| | 700,001 - 800,000 | 23 | 7 | 16 | 0 | 0 | 4 | 19 | 0 | 23 | 0 | 0 | 0 | 0 |
| | 800,001 - 900,000 | 11 | 6 | 5 | 0 | 3 | 1 | 7 | 0 | 11 | 0 | 0 | 0 | 0 |
| | 900,001 - 1,000,000 | 40 | 19 | 21 | 1 | 9 | 13 | 17 | 0 | 40 | 0 | 0 | 0 | 0 |
| | More than 1,000,000 | 60 | 28 | 32 | 0 | 16 | 12 | 32 | 60 | 0 | 0 | 0 | 0 | 0 |
| | No answer | 3 | 1 | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 3 |



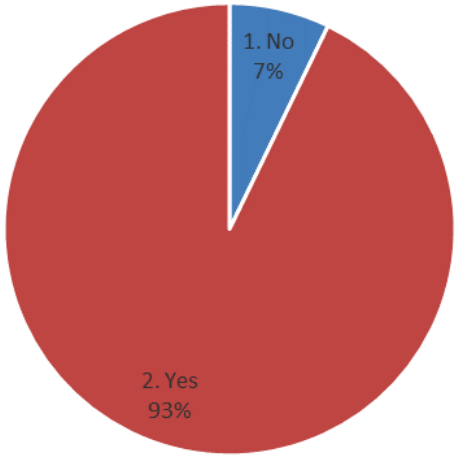
## TABLE : @ 010
## A7 : HOW MUCH IS YOUR AVERAGE MONTHLY EXPENDITURE?
## BASE : ALL RESPONDENTS

n = 500

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| A7-1. Food | Count | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | Average | 240,282.0 | 249,611.1 | 235,034.4 | 185,333.3 | 236,644.7 | 239,360.0 | 244,563.4 | 435,000.0 | 308,648.7 | 234,315.8 | 161,283.7 | 91,875.0 | 333,333.3 |
| A7-2. Clothing | Count | 407 | 153 | 254 | 12 | 67 | 93 | 235 | 56 | 66 | 159 | 107 | 16 | 3 |
| | Average | 26,371.0 | 27,483.7 | 25,700.8 | 145,00.0 | 34,074.6 | 26,268.8 | 24,821.3 | 55,750.0 | 35,984.9 | 21,679.3 | 14,803.7 | 7,187.5 | 30,000.0 |
| A7-3. Health | Count | 390 | 136 | 254 | 11 | 59 | 98 | 222 | 51 | 58 | 158 | 103 | 18 | 2 |
| | Average | 62,088.5 | 70,772.1 | 57,439.0 | 29,545.5 | 46,627.1 | 72,285.7 | 63,308.6 | 127,274.5 | 68,784.5 | 61,873.4 | 35,941.8 | 13,111.1 | 10,000.0 |
| A7-4. Education | Count | 261 | 90 | 171 | 5 | 34 | 76 | 146 | 47 | 48 | 102 | 59 | 4 | 1 |
| | Average | 146,053.0 | 161,003.7 | 138,184.2 | 57,000.0 | 135,955.9 | 143,144.7 | 152,968.0 | 349,361.7 | 156,291.7 | 95,686.3 | 70,980.2 | 37,500.0 | 100,000.0 |
| A7-5. Water (YCDC) | Count | 453 | 165 | 288 | 13 | 65 | 114 | 261 | 58 | 70 | 175 | 119 | 28 | 3 |
| | Average | 2,162.5 | 21,70.3 | 2,158.0 | 1,792.3 | 2,132.9 | 2,196.8 | 2,173.3 | 2,823.1 | 2,188.6 | 2,087.1 | 2,028.8 | 1,871.8 | 1,200.0 |
| A7-6. Water (Other) | Count | 399 | 155 | 244 | 14 | 65 | 104 | 216 | 51 | 67 | 156 | 103 | 20 | 2 |
| | Average | 10,372.1 | 10,248.4 | 10,450.6 | 8,564.3 | 10,786.2 | 10,295.2 | 10,401.6 | 15,715.7 | 11,209.0 | 10,686.2 | 7,539.8 | 6,365.0 | 7,500.0 |
| A7-7. Electricity | Count | 499 | 180 | 319 | 15 | 76 | 124 | 284 | 60 | 74 | 189 | 141 | 32 | 3 |
| | Average | 17,753.6 | 19,194.4 | 16,940.6 | 16,366.7 | 19,247.4 | 18,575.0 | 17,068.5 | 29,496.7 | 22,333.1 | 16,851.9 | 13,401.4 | 10,218.8 | 11,666.7 |
| A7-8. Communication | Count | 499 | 180 | 319 | 15 | 76 | 125 | 283 | 60 | 74 | 190 | 140 | 32 | 3 |
| | Average | 28,096.8 | 30,793.3 | 26,575.2 | 29,200.0 | 32,052.6 | 25,516.0 | 28,115.9 | 61,466.7 | 36,878.4 | 26,286.8 | 15,548.6 | 11,843.8 | 17,666.7 |
| A7-9. Gas, fuel, firewood (for cooking) | Count | 152 | 55 | 97 | 5 | 18 | 43 | 86 | 24 | 24 | 60 | 36 | 7 | 1 |
| | Average | 12,616.3 | 11,621.8 | 13,180.2 | 12,680.0 | 14,849.1 | 14,848.8 | 11,029.1 | 15,437.5 | 20,145.8 | 12,723.3 | 6,632.9 | 7,785.7 | 7,000.0 |
| A7-10. Transport | Count | 454 | 169 | 285 | 13 | 69 | 113 | 259 | 57 | 69 | 176 | 125 | 24 | 3 |
| | Average | 31501.10 | 40949.70 | 25898.25 | 15923.08 | 35695.65 | 27115.04 | 33079.15 | 83543.86 | 42942.03 | 23982.95 | 16956.00 | 6500.00 | 26666.67 |
| A7-11. House rental | Count | 58 | 23 | 35 | 2 | 21 | 18 | 17 | 12 | 12 | 18 | 15 | 1 | 0 |
| | Average | 182,251.7 | 239,678.3 | 144,514.3 | 157,500.0 | 233,238.1 | 157,222.2 | 148,682.4 | 347,500.0 | 174,166.7 | 178,777.8 | 56,173.3 | 250,000.0 | |
| A7-12. Loan payment | Count | 14 | 7 | 7 | 0 | 3 | 6 | 5 | 2 | 3 | 7 | 2 | 0 | 0 |
| | Average | 66,500.0 | 66,000.0 | 67,000.0 | | 40,000.0 | 73,833.3 | 73,600.0 | 49,000.0 | 114,666.7 | 62,714.3 | 25,000.0 | | |
| A7-13. Donation/ Social Activities | Count | 49 | 14 | 35 | 0 | 7 | 11 | 31 | 9 | 11 | 17 | 11 | 1 | 0 |
| | Average | 43,591.8 | 26,785.7 | 50,314.3 | | 25,000.0 | 105,272.7 | 25,903.2 | 147,777.8 | 38,000.0 | 15,529.4 | 10,818.2 | 5,000.0 | |
| A7-14. Bank Deposit | Count | 4 | 3 | 1 | 0 | 0 | 1 | 3 | 0 | 2 | 2 | 0 | 0 | 0 |
| | Average | 68,750.0 | 25,000.0 | 200,000.0 | | | 50,000.0 | 75,000.0 | | 105,000.0 | 32,500.0 | | | |
| A7-15. Business Interests | Count | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| | Average | 600,000.0 | | 600,000.0 | | | | 600,000.0 | | 600,000.0 | | | | |

## TABLE : @ 011
## B1 : ARE YOU CONNECTED TO YCDC PIPED WATER?
## BASE : ALL RESPONDENTS

n = 500

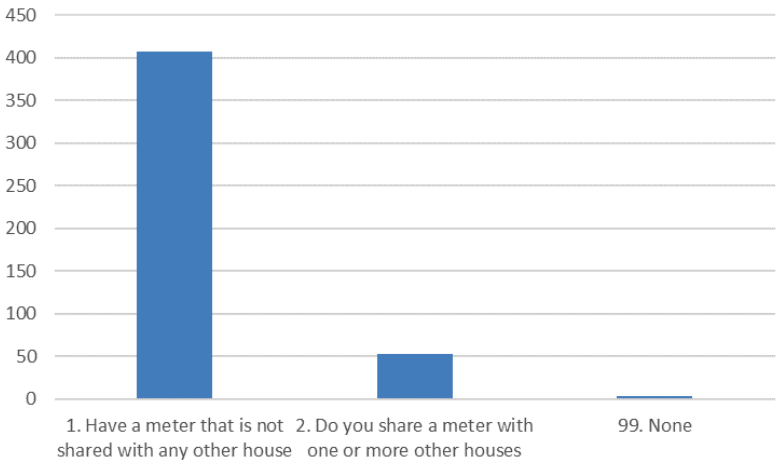



| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| B1. Connected to YCDC piped water | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. No | 36 | 12 | 24 | 1 | 9 | 10 | 16 | 2 | 4 | 14 | 13 | 3 | 0 |
| | 2. Yes | 464 | 168 | 296 | 14 | 67 | 115 | 268 | 58 | 70 | 176 | 128 | 29 | 3 |



## TABLE : @ 012
## B2 : OWN OR SHARE METER IF CONNECTED TO YCDC PIPED WATER
## BASE : RESPONDENTS THOSE WHO CONNECTED TO YCDC PIPED WATER

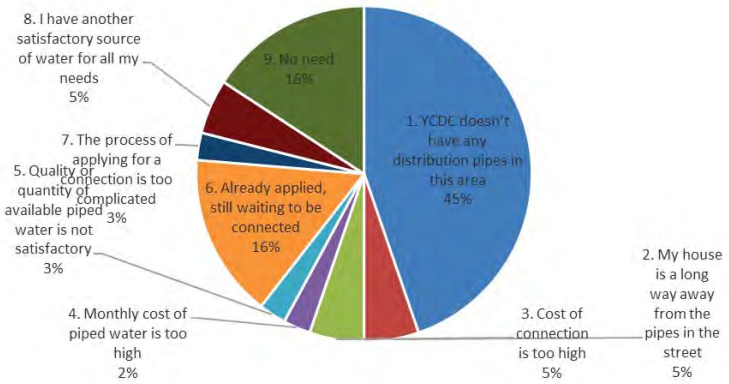
n = 464




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| B2. Own or share meter | Total | 464 | 168 | 296 | 14 | 67 | 115 | 268 | 58 | 70 | 176 | 128 | 29 | 3 |
| | 1. Have a meter that is not shared with any other house | 407 | 151 | 256 | 12 | 59 | 101 | 235 | 54 | 62 | 153 | 111 | 24 | 3 |
| | 2. Do you share a meter with one or more other houses | 53 | 16 | 37 | 2 | 8 | 14 | 29 | 4 | 6 | 22 | 16 | 5 | 0 |
| | 99. None | 4 | 1 | 3 | 0 | 0 | 0 | 4 | 0 | 2 | 1 | 1 | 0 | 0 |

## TABLE : @ 013
## B3 : WHAT ARE YOUR REASONS FOR NOT CONNECTING TO THE PIPED WATER SUPPLY?
## BASE : RESPONDENTS THOSE WHO DID NOT CONNECT TO YCDC PIPED WATER

n = 36




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| B3. Reasons | Total | 36 | 12 | 24 | 1 | 9 | 10 | 16 | 2 | 4 | 14 | 13 | 3 | 0 |
| | 1. YCDC doesn't have any distribution pipes in this area | 17 | 7 | 10 | 0 | 4 | 6 | 7 | 1 | 4 | 7 | 3 | 2 | 0 |
| | 2. My house is a long way away from the pipes in the street | 2 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| | 3. Cost of connection is too high | 2 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 0 |
| | 4. Monthly cost of piped water is too high | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 5. Quality or quantity of available piped water is not satisfactory | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 6. Already applied, still waiting to be connected | 6 | 2 | 4 | 0 | 1 | 1 | 4 | 1 | 0 | 1 | 4 | 0 | 0 |
| | 7. The process of applying for a connection is too complicated | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 8. I have another satisfactory source of water for all my needs | 2 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| | 9. No need | 6 | 1 | 5 | 0 | 2 | 2 | 2 | 0 | 0 | 2 | 4 | 0 | 0 |



## TABLE : @ 014
## C1 : ON AVERAGE, HOW MUCH WATER DOES YOUR HOUSEHOLD USE FROM DIFFERENT SOURCES EACH MONTH (IN UNIT)?
## BASE : ALL RESPONDENTS

n = 500

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| Total | Count | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| C1-1. YCDC piped water (own or shared) | Count | 450 | 164 | 286 | 13 | 64 | 114 | 259 | 58 | 69 | 175 | 119 | 26 | 3 |
| | Average | 24.25 | 24.45 | 24.13 | 19.15 | 24.81 | 24.07 | 24.44 | 33.10 | 24.83 | 23.11 | 22.65 | 19.77 | 8.33 |
| C1-2. Tanker | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| C1-3. Your own or neighbour's well | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| C1-4. A communal well/tap stand | Count | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| | Average | 22.00 | 22.00 | | | 22.00 | | | | | | 22.00 | | |
| C1-5. Bottled water | Count | 9 | 5 | 4 | 1 | 2 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 0 |
| | Average | 19.00 | 18.60 | 19.50 | 30.00 | 11.50 | 21.67 | 17.67 | 20.00 | 12.67 | 25.00 | 13.00 | 30.00 | |
| C1-6. River/canal/pond/stream | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| C1-7. Rain water | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| No Answer | | 48 | | | | | | | | | | | | |

## TABLE : @ 015
## C1 : ON AVERAGE, HOW MUCH WATER DOES YOUR HOUSEHOLD USE FROM DIFFERENT SOURCES EACH MONTH (IN KYAT)?
## BASE : ALL RESPONDENTS

n = 500

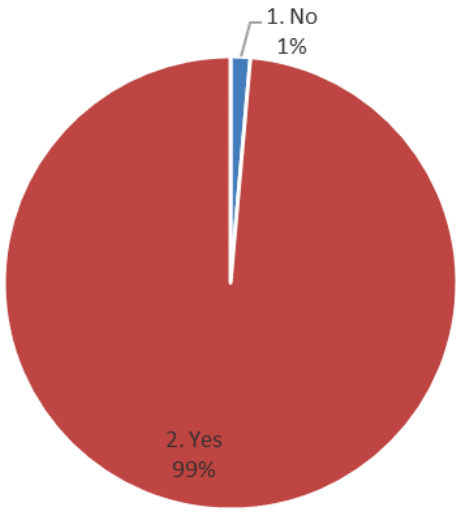
| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| Total | Count | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| C1-1. YCDC piped water (own or shared) | Count | 453 | 165 | 288 | 13 | 65 | 114 | 261 | 58 | 70 | 175 | 119 | 28 | 3 |
| | Average | 2,162.50 | 2,170.32 | 2,158.03 | 1,792.31 | 2,132.92 | 2,196.81 | 2,173.33 | 2,823.10 | 2,188.57 | 2,087.10 | 2,028.76 | 1,871.79 | 1,200.00 |
| C1-2. Tanker | Count | 5 | 1 | 4 | 0 | 1 | 1 | 3 | 0 | 0 | 1 | 4 | 0 | 0 |
| | Average | 2,000.00 | 2,000.00 | 2,000.00 | | 2,000.00 | 2,000.00 | 2,000.00 | | | 2,000.00 | 2,000.00 | | |
| C1-3. Your own or neighbour's well | Count | 16 | 4 | 12 | 1 | 4 | 4 | 7 | 1 | 1 | 5 | 8 | 1 | 0 |
| | Average | 5,800.00 | 10,875.00 | 4,108.33 | 1,800.00 | 5,125.00 | 1,500.00 | 9,214.29 | 30,000.00 | 1,500.00 | 5,860.00 | 3,375.00 | 5,000.00 | |
| C1-4. A communal well/tap stand | Count | 9 | 6 | 3 | 0 | 3 | 2 | 4 | 1 | 2 | 4 | 2 | 0 | 0 |
| | Average | 3,600.00 | 4,366.67 | 2,066.67 | | 2,000.00 | 2,600.00 | 5,300.00 | 4,000.00 | 2,600.00 | 4,800.00 | 2,000.00 | | |
| C1-5. Bottled water | Count | 390 | 150 | 240 | 13 | 64 | 100 | 213 | 51 | 65 | 153 | 99 | 20 | 2 |
| | Average | 10,277.56 | 10,112.00 | 10,381.04 | 9,084.62 | 10,587.50 | 10,575.00 | 10,117.61 | 15,049.02 | 11,450.77 | 10,598.37 | 7,450.51 | 6,115.00 | 7,500.00 |
| C1-6. River/canal/pond/stream | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| C1-7. Rain water | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| No Answer | | 7 | | | | | | | | | | | | |



Trust Venture Partners

## TABLE : @ 016
## C2 : DO YOU PAY FOR ANY OF THE WATER YOU USE (NOT INCLUDING COST OF CONSTRUCTING, OPERATING WELLS ETC)?
## BASE : ALL RESPONDENTS

n = 500




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| C2. Pay for using any water | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. No | 7 | 2 | 5 | 0 | 1 | 1 | 5 | 0 | 0 | 0 | 5 | 2 | 0 |
| | 2. Yes | 493 | 178 | 315 | 15 | 75 | 124 | 279 | 60 | 74 | 190 | 136 | 30 | 3 |



Trust Venture Partners

## TABLE : @ 017
## C3 : HOW MUCH DO YOU PAY FOR WATER PER MONTH FOR?
## BASE : RESPONDENTS WHO PAY FOR USING ANY WATER

n = 500

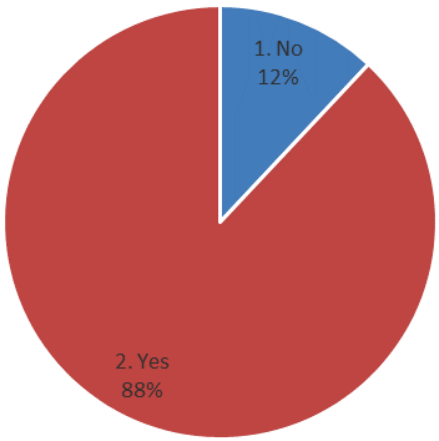
| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| C3-1. YCDC piped water (own or shared meter) | Count | 453 | 165 | 288 | 13 | 65 | 114 | 261 | 58 | 70 | 175 | 119 | 28 | 3 |
| | Average | 2,162.50 | 2,170.32 | 2,158.03 | 1,792.31 | 2,132.92 | 2,196.81 | 2,173.33 | 2,823.10 | 2,188.57 | 2,087.10 | 2,028.76 | 1,871.79 | 1,200.00 |
| C3-2. Water piped to your house by a private business | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| C3-3. Tanker | Count | 5 | 1 | 4 | 0 | 1 | 1 | 3 | 0 | 0 | 1 | 4 | 0 | 0 |
| | Average | 2,000.00 | 2,000.00 | 2,000.00 | | 2,000.00 | 2,000.00 | 2,000.00 | | | 2,000.00 | 2,000.00 | | |
| C3-4. Operation and maintenance of your own well | Count | 6 | 3 | 3 | 1 | 0 | 2 | 3 | 1 | 0 | 2 | 3 | 0 | 0 |
| | Average | 6,550.00 | 11,500.00 | 1,600.00 | 1,800.00 | | 1,500.00 | 11,500.00 | 30,000.00 | | 1,900.00 | 1,833.33 | | |
| C3-5. Water from your neighbour's well | Count | 10 | 1 | 9 | 0 | 4 | 2 | 4 | 0 | 1 | 3 | 5 | 1 | 0 |
| | Average | 5,350.00 | 9,000.00 | 4,944.44 | | 5,125.00 | 1,500.00 | 7,500.00 | | 1,500.00 | 8,500.00 | 4,300.00 | 5,000.00 | |
| C3-6. Use of a communal well/tap | Count | 9 | 6 | 3 | 0 | 3 | 2 | 4 | 1 | 2 | 4 | 2 | 0 | 0 |
| | Average | 3,600.00 | 4,366.67 | 2,066.67 | | 2,000.00 | 2,600.00 | 5,300.00 | 4,000.00 | 2,600.00 | 4,800.00 | 2,000.00 | | |
| C3-7. Bottled water | Count | 390 | 150 | 240 | 13 | 64 | 100 | 213 | 51 | 65 | 153 | 99 | 20 | 2 |
| | Average | 10,277.56 | 10,112.00 | 10,381.04 | 9,084.62 | 10,587.50 | 10,575.00 | 10,117.61 | 15,049.02 | 11,450.77 | 105,98.37 | 7,450.51 | 6,115.00 | 7,500.00 |
| No Answer | | 7 | | | | | | | | | | | | |



Trust Venture Partners

## TABLE : @ 018
## D1 : ARE YOU CONNECTED TO YCDC SEWER?
## BASE : ALL RESPONDENTS

n = 500



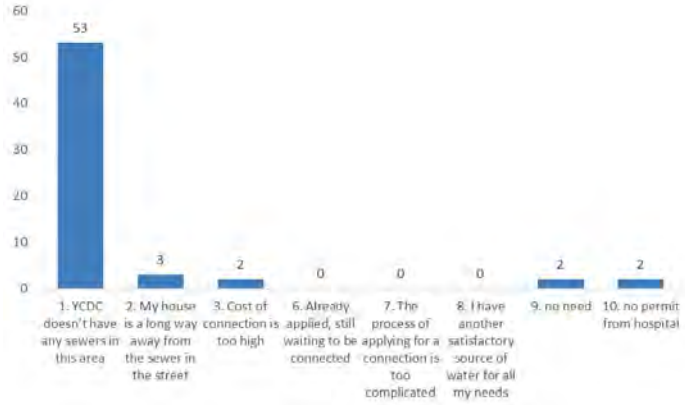

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| D1. Connected to YCDC Sewer | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. No | 60 | 19 | 41 | 3 | 11 | 17 | 29 | 1 | 7 | 29 | 18 | 5 | 0 |
| | 2. Yes | 440 | 161 | 279 | 12 | 65 | 108 | 255 | 59 | 67 | 161 | 123 | 27 | 3 |



Trust Venture Partners

## TABLE : @ 019
## D2 : WHAT ARE YOUR REASONS FOR NOT CONNECTING TO THE YCDC SEWER?
## BASE : RESPONDENTS THOSE WHO DID NOT CONNECT TO YCDC SEWER

n = 60

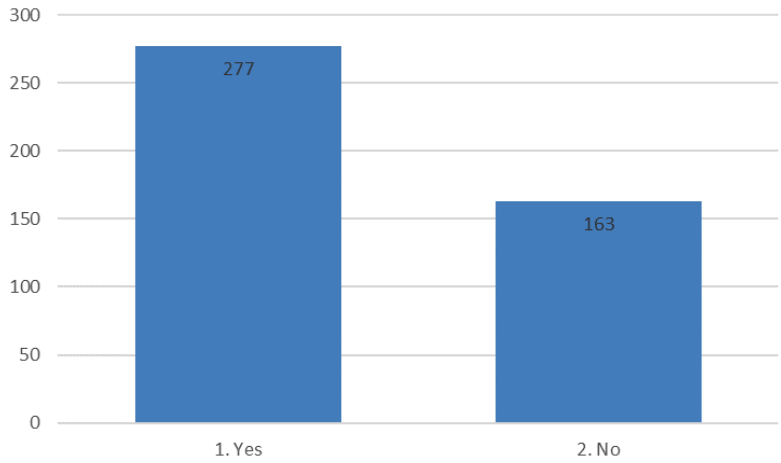



| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| D2. Reasons | Total | 60 | 19 | 41 | 3 | 11 | 17 | 29 | 1 | 7 | 29 | 18 | 5 | 0 |
| | 1. YCDC doesn't have any sewers in this area | 53 | 16 | 37 | 2 | 10 | 15 | 26 | 1 | 7 | 24 | 16 | 5 | 0 |
| | 2. My house is a long way away from the sewer in the street | 3 | 1 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| | 3. Cost of connection is too high | 2 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 |
| | 6. Already applied, still waiting to be connected | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 7. The process of applying for a connection is too complicated | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 8. I have another satisfactory source of water for all my needs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 9. no need | 2 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 0 |
| | 10. no permit from hospital | 2 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 |



## TABLE : @ 020
## E1 : ARE YOU SATISFIED WITH YCDC WASTEWATER SERVICE?
## BASE : RESPONDENTS THOSE WHO CONNECT TO YCDC SEWER

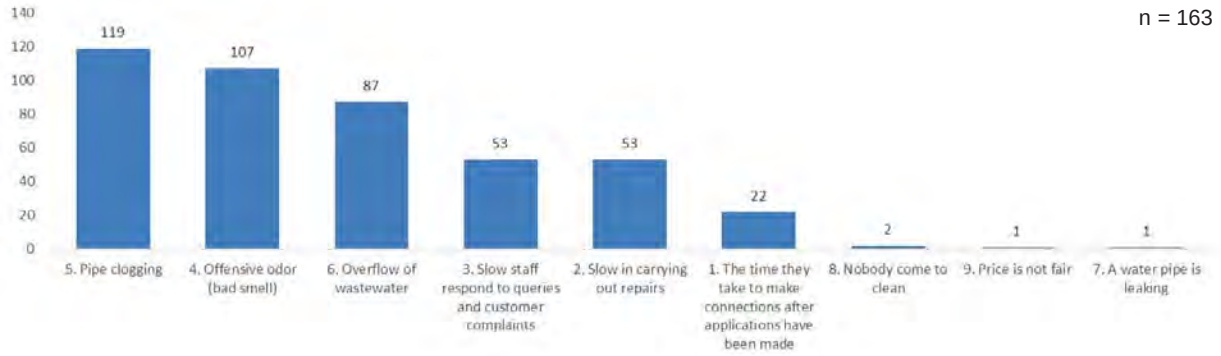
n = 440




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| E1. Satisfaction on YCDC Wastewater Service | Total | 440 | 161 | 279 | 12 | 65 | 108 | 255 | 59 | 67 | 161 | 123 | 27 | 3 |
| | 1. Yes | 277 | 95 | 182 | 11 | 50 | 71 | 145 | 37 | 39 | 108 | 70 | 20 | 3 |
| | 2. No | 163 | 66 | 97 | 1 | 15 | 37 | 110 | 22 | 28 | 53 | 53 | 7 | 0 |

## TABLE : @ 021
## E1.1 : UNSATISFIED REASONS
## BASE : RESPONDENTS THOSE WHO DO NOT SATISFIED ON YCDC WASTEWATER SERVICE

n = 163

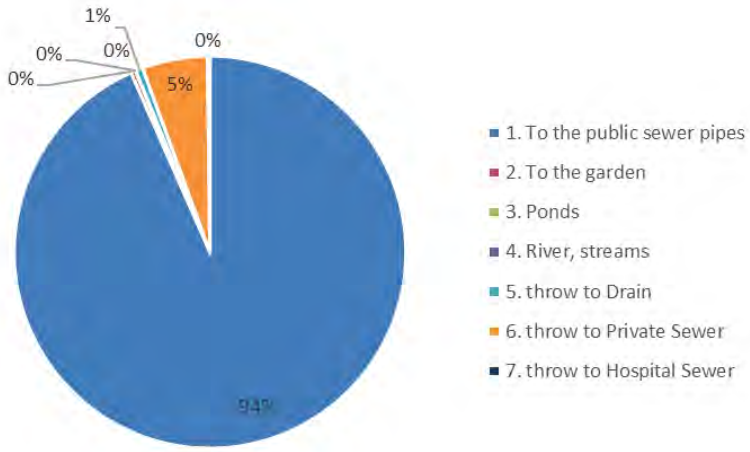



| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| E1.1. Reasons | Total | 163 | 66 | 97 | 1 | 15 | 37 | 110 | 22 | 28 | 53 | 53 | 7 | 0 |
| | 5. Pipe clogging | 119 | 52 | 67 | 0 | 13 | 27 | 79 | 18 | 23 | 38 | 33 | 7 | 0 |
| | 4. Offensive odor (bad smell) | 107 | 37 | 70 | 0 | 11 | 27 | 69 | 18 | 18 | 34 | 32 | 5 | 0 |
| | 6. Overflow of wastewater | 87 | 37 | 50 | 0 | 11 | 15 | 61 | 14 | 16 | 26 | 28 | 3 | 0 |
| | 3. Slow staff respond to queries and customer complaints | 53 | 23 | 30 | 0 | 5 | 14 | 34 | 10 | 14 | 10 | 17 | 2 | 0 |
| | 2. Slow in carrying out repairs | 53 | 25 | 28 | 1 | 3 | 10 | 39 | 7 | 12 | 13 | 20 | 1 | 0 |
| | 1. The time they take to make connections after applications have been made | 22 | 14 | 8 | 0 | 3 | 3 | 16 | 4 | 8 | 5 | 4 | 1 | 0 |
| | 8. Nobody come to clean | 2 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 |
| | 9. Price is not fair | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 7. A water pipe is leaking | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |



## TABLE : @ 022
## E2 : HOW DO YOU DISCHARGE WASTEWATER FROM YOUR HOUSE?
## BASE : ALL RESPONDENTS

n = 500



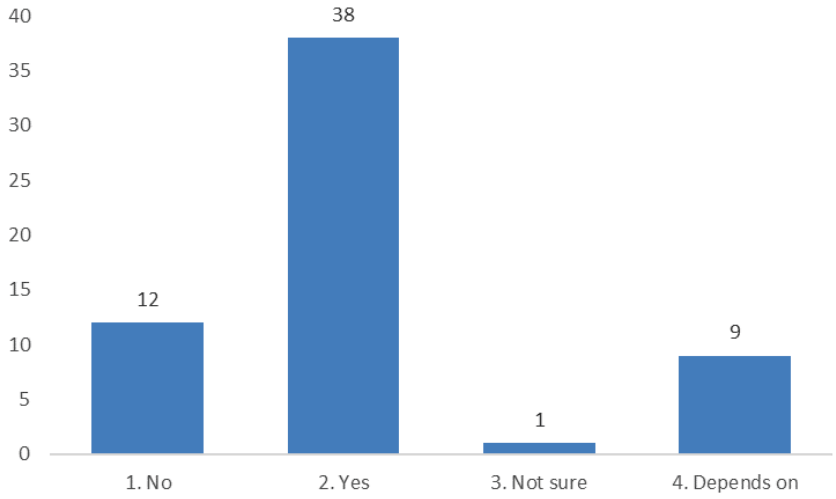

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| E2. Discharge wastewater | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. To the public sewer pipes | 467 | 171 | 296 | 14 | 71 | 118 | 264 | 59 | 71 | 175 | 130 | 29 | 3 |
| | 2. To the garden | 2 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| | 3. Ponds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 4. River, streams | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 5. throw to Drain | 3 | 1 | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 2 | 0 | 0 |
| | 6. throw to Private Sewer | 27 | 6 | 21 | 1 | 4 | 5 | 17 | 1 | 3 | 13 | 7 | 3 | 0 |
| | 7. throw to Hospital Sewer | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |

TABLE : @ 023

G1 : IF THE YCDC PROVIDES GOOD QUALITY FOR WASTEWATER SERVICE, WILL YOU CONNECT?

BASE : RESPONDENTS THOSE WHO DID NOT CONNECT TO YCDC SEWER

n = 60




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| G1. Connect on wastewater service | Total | 60 | 19 | 41 | 3 | 11 | 17 | 29 | 1 | 7 | 29 | 18 | 5 | 0 |
| | 1. No | 12 | 2 | 10 | 1 | 2 | 2 | 7 | 0 | 1 | 2 | 6 | 3 | 0 |
| | 2. Yes | 38 | 13 | 25 | 2 | 8 | 10 | 18 | 1 | 4 | 19 | 12 | 2 | 0 |
| | 3. Not sure | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 4. Depends on | 9 | 4 | 5 | 0 | 1 | 5 | 3 | 0 | 2 | 7 | 0 | 0 | 0 |



TABLE : @ 024

G2 : HOW MUCH WOULD YOUR HOUSEHOLD BE WILLING AND ABLE TO PAY IN ORDER TO CONNECT?

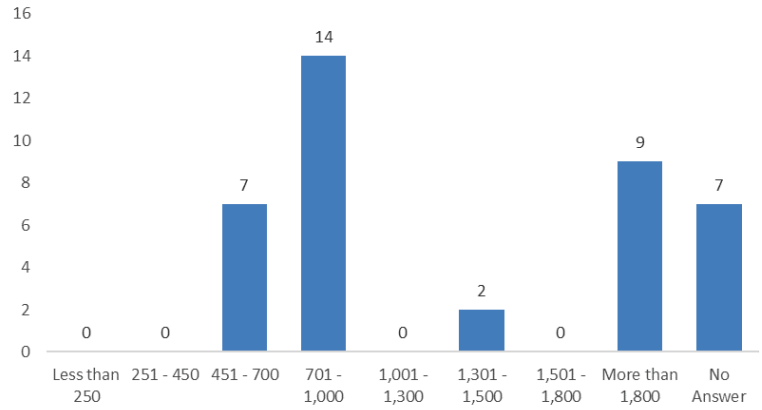
BASE : RESPONDENTS THOSE WHO ANSWER YES/NOT SURE CONNECT ON WASTEWATER SERVICE

n = 39

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| G2. Amount willing to pay in order to connect | Count | 39 | 13 | 26 | 2 | 8 | 10 | 19 | 1 | 4 | 20 | 12 | 2 | 0 |
| | Average | 15,562.50 | 12,394.23 | 17,146.63 | 12,500.00 | 11,140.63 | 20,556.25 | 15,118.42 | 20,000.00 | 12,500.00 | 17,084.38 | 15,437.50 | 5,000.00 | |

## TABLE : @ 025
## G3 : HOW MUCH IN MAXIMUM IS YOUR HOUSEHOLD WILLING TO PAY PER MONTH?
## BASE : RESPONDENTS THOSE WHO ANSWER YES/NOT SURE CONNECT ON WASTEWATER SERVICE

n = 39



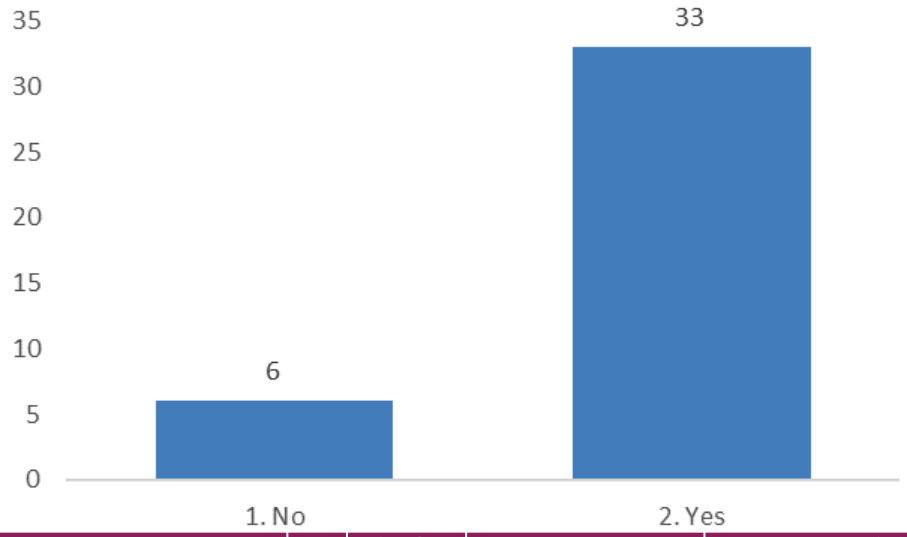

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| G3. Maximum amount willing to pay per month | Total | 39 | 13 | 26 | 2 | 8 | 10 | 19 | 1 | 4 | 20 | 12 | 2 | 0 |
| | Less than 250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 251 - 450 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 451 - 700 | 7 | 3 | 4 | 0 | 0 | 1 | 6 | 0 | 0 | 4 | 2 | 1 | 0 |
| | 701 - 1,000 | 14 | 5 | 9 | 0 | 3 | 3 | 8 | 1 | 2 | 7 | 3 | 1 | 0 |
| | 1,001 - 1,300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1,301 - 1,500 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| | 1,501 - 1,800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | More than 1,800 | 9 | 2 | 7 | 0 | 3 | 5 | 1 | 0 | 2 | 4 | 3 | 0 | 0 |
| | No Answer | 7 | 2 | 5 | 0 | 2 | 1 | 4 | 0 | 0 | 3 | 4 | 0 | 0 |
| G3. Maximum amount willing to pay per month | Count | 39 | 13 | 26 | 2 | 8 | 10 | 19 | 1 | 4 | 20 | 12 | 2 | 0 |
| | Average | 1631.25 | 1466.35 | 1713.70 | 1450.00 | 2032.81 | 2213.13 | 1175.00 | 1000.00 | 1750.00 | 1579.69 | 1877.08 | 750.00 | |





## TABLE : @ 026
## G4 : DO YOU PAY FOR THE CONSTRUCTION FEE OF HOUSE CONNECTION INSIDE YOUR PROPERTY AREA?
## BASE : RESPONDENTS THOSE WHO DID NOT CONNECT TO YCDC SEWER

n = 39




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| G4. Pay for the construction fee | Total | 39 | 13 | 26 | 2 | 8 | 10 | 19 | 1 | 4 | 20 | 12 | 2 | 0 |
| | 1. No | 6 | 1 | 5 | 0 | 2 | 1 | 3 | 0 | 0 | 2 | 4 | 0 | 0 |
| | 2. Yes | 33 | 12 | 21 | 2 | 6 | 9 | 16 | 1 | 4 | 18 | 8 | 2 | 0 |

## TABLE : @ 027
## G5 : WHEN YOU CONSIDER CONNECTING TO YCDC SEWER, WHAT ARE THE MOST IMPORTANT ISSUES FOR YOU?
## BASE : RESPONDENTS THOSE WHO WILLING TO PAY THE CONSTRUCTION FEE

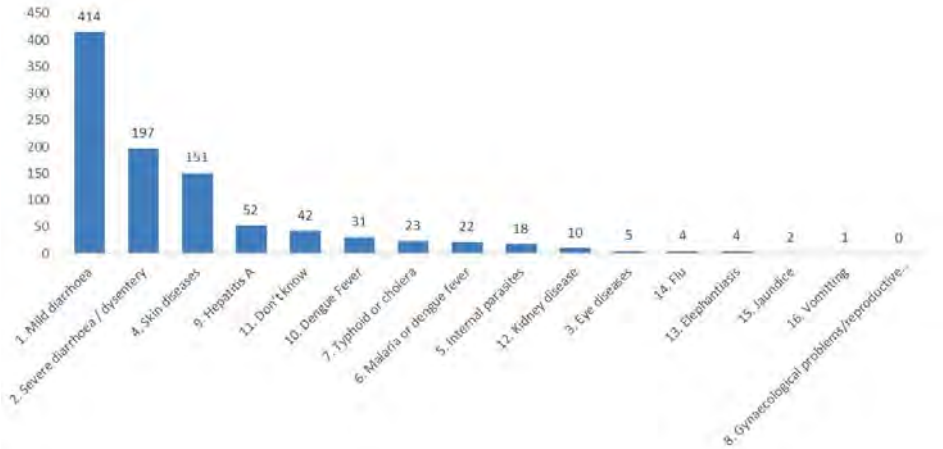
n = 33

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| G5. Price | Total | 33 | 12 | 21 | 2 | 6 | 9 | 16 | 1 | 4 | 18 | 8 | 2 | 0 |
| | First rank | 5 | 0 | 5 | 0 | 0 | 3 | 2 | 0 | 1 | 1 | 2 | 1 | 0 |
| | Second rank | 13 | 9 | 4 | 0 | 3 | 3 | 7 | 1 | 2 | 6 | 3 | 1 | 0 |
| | Third rank | 15 | 3 | 12 | 2 | 3 | 3 | 7 | 0 | 1 | 11 | 3 | 0 | 0 |
| G5. Environmental condition | Total | 33 | 12 | 21 | 2 | 6 | 9 | 16 | 1 | 4 | 18 | 8 | 2 | 0 |
| | First rank | 17 | 7 | 10 | 2 | 4 | 2 | 9 | 0 | 2 | 12 | 3 | 0 | 0 |
| | Second rank | 7 | 1 | 6 | 0 | 1 | 3 | 3 | 0 | 1 | 4 | 2 | 0 | 0 |
| | Third rank | 9 | 4 | 5 | 0 | 1 | 4 | 4 | 1 | 1 | 2 | 3 | 2 | 0 |
| G5. Reliability of service | Total | 33 | 12 | 21 | 2 | 6 | 9 | 16 | 1 | 4 | 18 | 8 | 2 | 0 |
| | First rank | 11 | 5 | 6 | 0 | 2 | 4 | 5 | 1 | 1 | 5 | 3 | 1 | 0 |
| | Second rank | 13 | 2 | 11 | 2 | 2 | 3 | 6 | 0 | 1 | 8 | 3 | 1 | 0 |
| | Third rank | 9 | 5 | 4 | 0 | 2 | 2 | 5 | 0 | 2 | 5 | 2 | 0 | 0 |



## TABLE : @ 028
## H1 : WHAT HEALTH PROBLEMS DO YOU BELIEVE CAN BE INFLUENCED BY THE WATER USED?
## BASE : ALL RESPONDENTS

n = 500



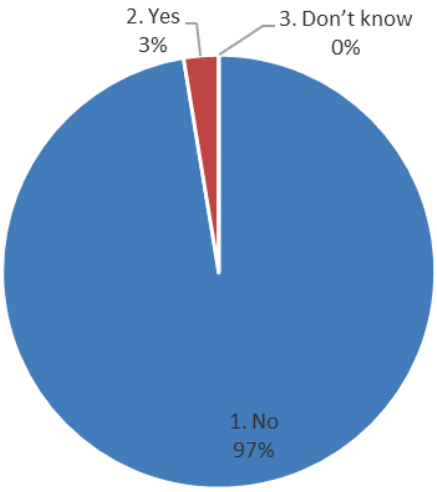

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| H1. Health problems | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. Mild diarrhoea | 414 | 148 | 266 | 15 | 60 | 106 | 233 | 48 | 60 | 159 | 119 | 25 | 3 |
| | 2. Severe diarrhoea / dysentery | 197 | 79 | 118 | 10 | 28 | 50 | 109 | 21 | 27 | 77 | 55 | 15 | 2 |
| | 4. Skin diseases | 151 | 48 | 103 | 2 | 18 | 38 | 93 | 24 | 26 | 57 | 40 | 3 | 1 |
| | 9. Hepatitis A | 52 | 19 | 33 | 1 | 2 | 16 | 33 | 6 | 13 | 15 | 16 | 2 | 0 |
| | 11. Don't know | 42 | 18 | 24 | 0 | 7 | 8 | 27 | 5 | 6 | 17 | 10 | 4 | 0 |
| | 10. Dengue Fever | 31 | 14 | 17 | 2 | 3 | 6 | 20 | 4 | 5 | 11 | 9 | 2 | 0 |
| | 7. Typhoid or cholera | 23 | 8 | 15 | 2 | 4 | 4 | 13 | 4 | 3 | 8 | 6 | 2 | 0 |
| | 6. Malaria or dengue fever | 22 | 7 | 15 | 1 | 3 | 3 | 15 | 5 | 1 | 8 | 4 | 4 | 0 |
| | 5. Internal parasites | 18 | 6 | 12 | 0 | 2 | 3 | 13 | 2 | 3 | 7 | 5 | 1 | 0 |
| | 12. Kidney disease | 10 | 5 | 5 | 1 | 2 | 2 | 5 | 0 | 3 | 5 | 2 | 0 | 0 |
| | 3. Eye diseases | 5 | 3 | 2 | 0 | 0 | 2 | 3 | 2 | 2 | 0 | 1 | 0 | 0 |
| | 14. Flu | 4 | 3 | 1 | 1 | 0 | 2 | 1 | 1 | 0 | 2 | 1 | 0 | 0 |
| | 13. Elephantiasis | 4 | 1 | 3 | 0 | 2 | 1 | 1 | 1 | 0 | 1 | 0 | 2 | 0 |
| | 15. Jaundice | 2 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| | 16. Vomitting | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 8. Gynaecological problems/reproductive tract infection | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

TABLE : @ 029

H2 : DO YOU THINK BAD WATER QUALITY HAS CAUSED ANY ILLNESS IN YOUR FAMILY IN THE PAST TWELVE MONTHS?

BASE : ALL RESPONDENTS

n = 500




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| H2. Have caused any illness | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. No | 487 | 176 | 311 | 13 | 76 | 122 | 276 | 58 | 73 | 183 | 139 | 31 | 3 |
| | 2. Yes | 13 | 4 | 9 | 2 | 0 | 3 | 8 | 2 | 1 | 7 | 2 | 1 | 0 |
| | 3. Don't know | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |



TABLE : @ 030.1

H3 : NUMBER OF ADULT HAS AFFECTED BY ILLNESS IN THE LAST TWELVE MONTHS

BASE : RESPONDENTS THOSE WHO HAVE CAUSED ANY ILLNESS IN FAMILY IN THE PAST TWELVE MONTHS BECAUSE OF BAD WATER QUALITY

n = 13

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| H3-1 Mild diarrhoea | Count | 8 | 3 | 5 | 2 | 0 | 2 | 4 | 1 | 1 | 4 | 2 | 0 | 0 |
| | Average | 2.00 | 1.00 | 2.60 | 1.00 | | 1.50 | 2.75 | 4.00 | 2.00 | 1.00 | 3.00 | | |
| H3-2. Severe diarrhoea | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-3. Eye diseases | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-4. Skin diseases | Count | 3 | 1 | 2 | 0 | 0 | 0 | 3 | 1 | 0 | 2 | 0 | 0 | 0 |
| | Average | 1.00 | 1.00 | 1.00 | | | | 1.00 | 1.00 | | 1.00 | | | |
| H3-5. Internal parasites | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-6. Malaria or dengue fever | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-7. Typhoid or cholera | Count | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| | Average | 1.00 | 1.00 | | | | | 1.00 | | | 1.00 | | | |
| H3-8. Gynaecological problems/reproductive tract infection | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-9. Hepatitis A | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-10. Dengue Fever | Count | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| | Average | 1.00 | | 1.00 | | | | 1.00 | | | | | 1.00 | |

## TABLE : @ 030.2
## H3 : NUMBER OF CHILD HAS AFFECTED BY ILLNESS IN THE LAST TWELVE MONTHS
## BASE : RESPONDENTS THOSE WHO HAVE CAUSED ANY ILLNESS IN FAMILY IN THE PAST TWELVE MONTHS BECAUSE OF BAD WATER QUALITY

n = 13

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| H3-1. Mild diarrhoea | Count | 3 | 0 | 3 | 0 | 0 | 1 | 2 | 1 | 1 | 0 | 1 | 0 | 0 |
| | Average | 1.33 | | 1.33 | | | 2.00 | 1.00 | 1.00 | 2.00 | | 1.00 | | |
| H3-2. Severe diarrhoea | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-3. Eye diseases | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-4. Skin diseases | Count | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | Average | 1.00 | | 1.00 | | | 1.00 | | | | 1.00 | | | |
| H3-5. Internal parasites | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-6. Malaria or dengue fever | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-7. Typhoid or cholera | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-8. Gynaecological problems/reproductive tract infection | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-9. Hepatitis A | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |
| H3-10. Dengue Fever | Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Average | | | | | | | | | | | | | |



## TABLE : @ 030.3
## H3 : TOTAL NUMBER IN HOUSEHOLD WHO SOUGHT TREATMENT FROM A HEALTH CARE PROVIDER FOR THIS ILLNESS
## BASE : RESPONDENTS THOSE WHO HAVE CAUSED ANY ILLNESS IN FAMILY IN THE PAST TWELVE

n = 13

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| H3-1. Mild diarrhoea | Total | 8 | 3 | 5 | 2 | 0 | 2 | 4 | 1 | 1 | 4 | 2 | 0 | 0 |
| | 0 | 7 | 2 | 5 | 2 | 0 | 2 | 3 | 1 | 1 | 4 | 1 | 0 | 0 |
| | 100 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| H3-4. Skin diseases | Total | 4 | 1 | 3 | 0 | 0 | 1 | 3 | 1 | 0 | 3 | 0 | 0 | 0 |
| | 0 | 4 | 1 | 3 | 0 | 0 | 1 | 3 | 1 | 0 | 3 | 0 | 0 | 0 |
| H3-7. Typhoid or cholera | Total | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| H3-10. Dengue Fever | Total | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| | 100 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |

## TABLE : @ 031
## H4 : WHAT WAS THE TOTAL AMOUNT OF MONEY THE HOUSEHOLD PAID FOR MEDICAL CARE FOR ALL MEMBERS WITH THE ILLNESSES DURING THE LAST 12 MONTHS?
## BASE : RESPONDENTS THOSE WHO HAVE CAUSED ANY ILLNESS IN FAMILY IN THE PAST TWELVE

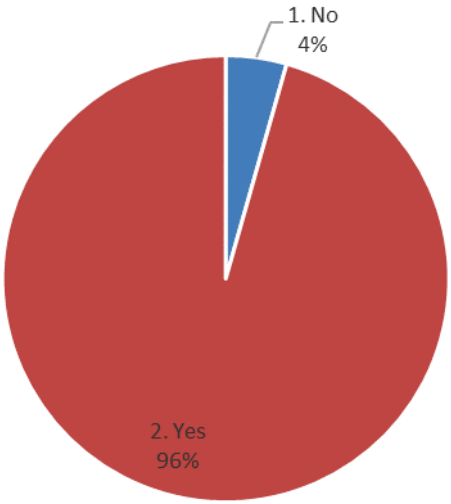
n = 13

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| H4. Amount of money pay for medical care | Count | 13 | 4 | 9 | 2 | 0 | 3 | 8 | 2 | 1 | 7 | 2 | 1 | 0 |
| | Average | 26,422.22 | 11,055.56 | 33,251.85 | 12,500.00 | | 22,140.74 | 31,508.33 | 25,900.00 | 5,000.00 | 31,263.49 | 20,711.11 | 26,422.22 | |



## TABLE : @ 032
## H5 : DOES THIS HOUSEHOLD HAVE ITS OWN TOILET?
## BASE : ALL RESPONDENTS

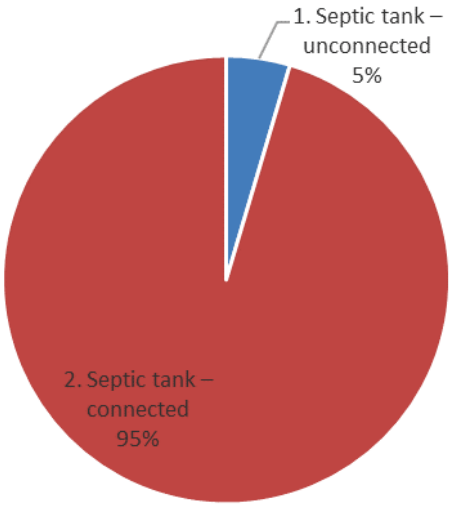
n = 500




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| H5. Have own toilet | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. No | 22 | 5 | 17 | 1 | 4 | 6 | 11 | 0 | 3 | 10 | 8 | 1 | 0 |
| | 2. Yes | 478 | 175 | 303 | 14 | 72 | 119 | 273 | 60 | 71 | 180 | 133 | 31 | 3 |

## TABLE : @ 033
## H6 : WHICH OF THE FOLLOWING BEST DESCRIBES THE TOILET?
## BASE : RESPONDENTS THOSE WHO HAVE OWN TOILET

n = 478

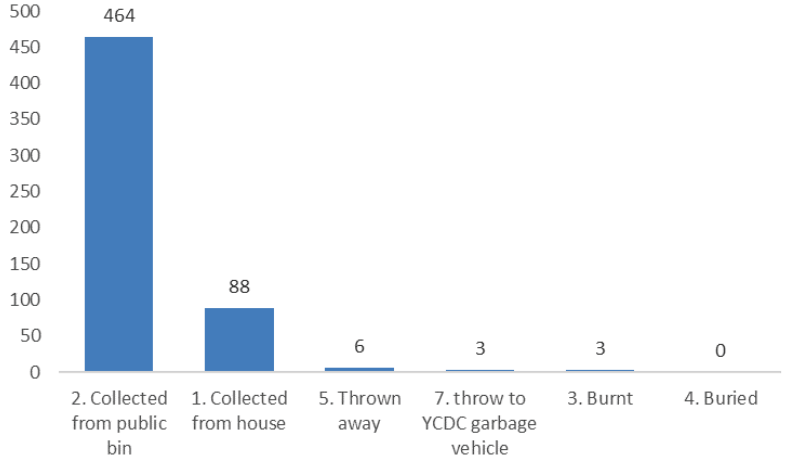



| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| H6. Unconnect or connect septic tank | Total | 478 | 175 | 303 | 14 | 72 | 119 | 273 | 60 | 71 | 180 | 133 | 31 | 3 |
| | 1. Septic tank – unconnected | 22 | 5 | 17 | 1 | 2 | 6 | 13 | 1 | 2 | 9 | 7 | 3 | 0 |
| | 2. Septic tank – connected | 456 | 170 | 286 | 13 | 70 | 113 | 260 | 59 | 69 | 171 | 126 | 28 | 3 |



## TABLE : @ 034
## H8 : HOW DO YOU DISPOSE OF YOUR HOUSEHOLD GARBAGE?
## BASE : ALL RESPONDENTS

n = 500



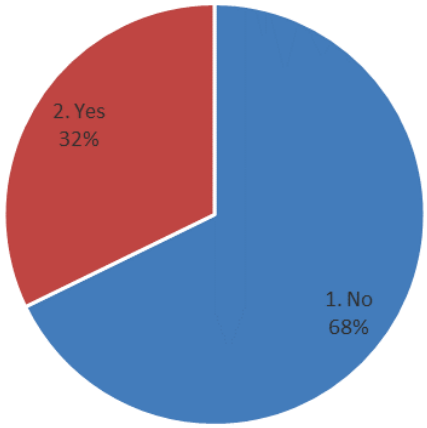

| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| H8. Dispose of household garbage | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 2. Collected from public bin | 464 | 167 | 297 | 13 | 69 | 120 | 262 | 55 | 69 | 177 | 129 | 31 | 3 |
| | 1. Collected from house | 88 | 34 | 54 | 4 | 14 | 18 | 52 | 12 | 13 | 33 | 27 | 3 | 0 |
| | 5. Thrown away | 6 | 1 | 5 | 0 | 0 | 2 | 4 | 0 | 1 | 2 | 2 | 0 | 1 |
| | 7. throw to YCDC garbage vehicle | 3 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 2 | 0 | 0 | 0 |
| | 3. Burnt | 3 | 0 | 3 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 2 | 1 | 0 |
| | 4. Buried | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

TABLE : @ 035

I1 : HAVE YOU EXPERIENCED ANY WATER-RELATED HAZARDS IN THE PAST 5 YEARS (FLOOD, ETC)?

BASE : ALL RESPONDENTS

n = 500




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| I1. Water-related hazards | Total | 500 | 180 | 320 | 15 | 76 | 125 | 284 | 60 | 74 | 190 | 141 | 32 | 3 |
| | 1. No | 339 | 125 | 214 | 9 | 55 | 89 | 186 | 41 | 52 | 128 | 95 | 22 | 1 |
| | 2. Yes | 161 | 55 | 106 | 6 | 21 | 36 | 98 | 19 | 22 | 62 | 46 | 10 | 2 |

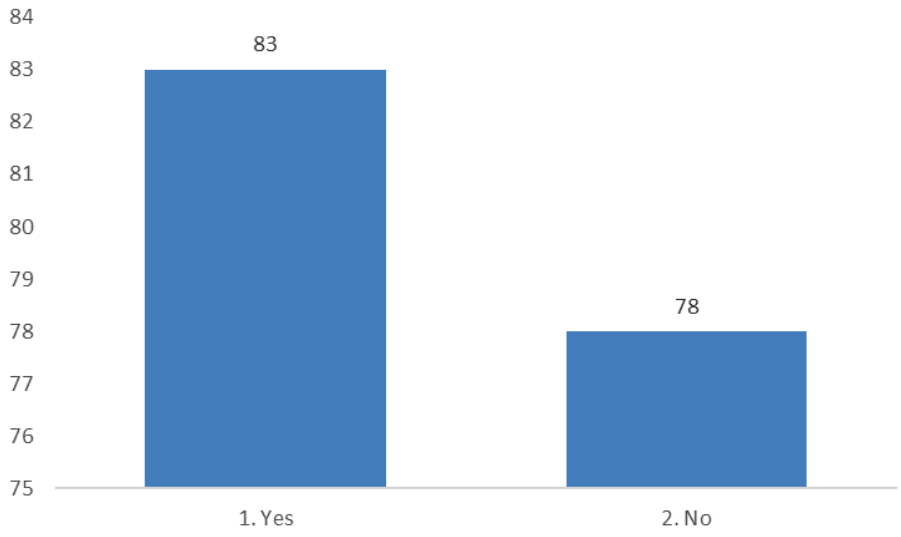


TABLE : @ 036

I2.2 : WHAT WAS AFFECTED TO YOUR LIVING CONDITION?

BASE : RESPONDENTS THOSE WHO HAVE EXPERIENCED ANY WATER-RELATED HAZARDS IN THE PAST 5 YEARS

n = 161




| | | Total | Gender | | Age | | | | SEC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 18-24 yrs | 25-34 yrs | 35-44 yrs | 45-60 yrs | SEC A | SEC B | SEC C | SEC D | SEC E | No answer |
| I22. Affected to living condition | Total | 161 | 55 | 106 | 6 | 21 | 36 | 98 | 19 | 22 | 62 | 46 | 10 | 2 |
| | 1. Yes | 83 | 27 | 56 | 3 | 8 | 23 | 49 | 5 | 10 | 33 | 27 | 6 | 2 |
| | 2. No | 78 | 28 | 50 | 3 | 13 | 13 | 49 | 14 | 12 | 29 | 19 | 4 | 0 |