# PLUMBING AND SANITARY SYSTEM DESIGN OF A MULTISTOREY RESIDENTIAL BUILDING

Md. Mirazul Islam
Sagor Podder
Md. Abu Kawcer Rakin
Afaz Uddin

DEPARTMENT OF CIVIL ENGINEERING

DAFFODIL INTERNATIONAL UNIVERSITY

# PLUMBING AND SANITARY SYSTEM DESIGN OF A MULTISTOREY RESIDENTIAL BUILDING

Submitted by

**Md. Mirazul Islam**

**Sagor Podder**

**Md. Abu Kawcer Rakin**

**Afaz Uddin**

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**Bachelor of Science in Civil Engineering**

## Department of Civil Engineering

**Daffodil International University**

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# APPROVAL

This is to certify that this project “Plumbing design of a building” is done by the following students under my direct supervision and this work has been carried out by them in the Department of Civil Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering.

List of Students:

| | |
|---|---|
| Md. Mirazul Islam | ID: 191-47-979 |
| Sagor Podder | ID: 191-47-942 |
| Md. Abu Kawcer Rakin | ID: 191-47-957 |
| Afaz Uddin | ID: 191-47-999 |

Signature of the Supervisor

**Dr. Miah M. Hussainuzzaman**

Associate Professor
Department of Civil Engineering
Daffodil International University

The project titled "**Plumbing and sanitary system design of a multistorey residential building**" submitted by Md. Mirazul Islam Student ID: 191-47-979, Sagor podder, Student ID: 191-47-942, Md. Abu Kawcer Rakin, Student ID: 191-47-957,, and Md. Afaz Uddin, Student ID: 191-47-999, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering on 16th October, 2022.

## BOARD OF EXAMINERS

**Dr. Miah M. Hussainuzzaman**
Supervisor
Department of Civil Engineering
Daffodil International University

-----------------------------

**Dr. Mohammad Hannan Mahmud Khan**
Chairman
Department of Civil Engineering
Daffodil International University

-----------------------------

**Kazi Obaidur Rahman**
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Department of Civil Engineering
Daffodil International University

-----------------------------

**Dr. Muhammad Mukhlesur Rahman**
Member (External)
Deputy Secretary
Ministry of Textiles and Jute
Govt of Bangladesh

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# DECLARATION

Declared that except where specified by reference to other works, the studies embodied in thesis is the result of investigation carried by the authors. Neither the thesis nor any part has been submitted to or is being submitted elsewhere for any other purposes.

Signature of the candidates

**MD. MIRAZUL ISLAM**
**ID NO: 191-47-979**

**SAGOR PODDER**
**ID NO: 191-47-942**

**MD. ABU KAWCER RAKIN**
**ID NO: 191-47-957**

**MD. AFAZ UDDIN**
**ID NO: 191-47-999**

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# DEDICATION

This Project is dedicated to Almighty Allah for his protection, kindness, strength over my life throughout the period and also to my family for his financial support and moral care towards me. Also to my mentor Dr. Miah M. Hussainuzzaman his academic advice he often gives to me. May Almighty Allah shield them from the peril of his world and bless their entire endeavor, Amen.

# ABSTRACT

Plumbing as a technology falls under the purview of building services, which helps an occupant to use their building for the purposes for which it has been developed. This study of plumbing system plan is aimed at planning a plumbing system that is compatible of eco-friendly environments and meet the 5 aspects of safety, economic, comfort, sustainable and aesthetics.

Multistoried buildings are inevitable in today's modern living. Other than structural stability there are lot of services being emphasized like water supply, sanitary, firefighting, etc., A civil engineer's scope under duty are not only to design and construct the structure, but also to provide the best services and maintenance. So we decide to take a case study of a proposed G+8 storey residential apartment, for that we decide to design a perfect engineering plumbing system. This report includes the necessary CAD files as well as all the calculations and considerations in detail.

# Table of Contents

# CHAPTER 1 INTRODUCTION

## 1.1 General

All the places where people live needs basic services like water supply and sanitation. In a residential or commercial building where people need to stay for longer period of time requires those services integrated into the building. Proper design and construction of those services ensures economy and safety of the users. Therefore, plumbing design is an integrated part of the detailed design of the building along with architectural, structural electrical designs. Building in large cities may require to have an approved design from the water supply authority to get a water and sewage connection. This project report presents such a design for a residential building.

## 1.2 Objectives Of The Study

The major objectives were identified and pointed out to fulfill the purposes are given below:

1. To determine the right size of different components of this system.
2. To determine the proper planning of plumbing system for a multistorey residential building

## 1.3 Limitation Of The Study

Some of the features of a complete design is not presented in this report which are:

- Some of the sizing options are fixed by architectural design and this report only verifies those size provided.
- Detailed design of structural elements to hold the plumbing in place is not included.
- Cost and volume estimation is not included.

## 1.4 Overview Of Research Program

- The research work conducted for achieving the objectives is presented through several chapters of this thesis. There are five more chapters of this thesis excluding the current chapter. Brief discussions of those chapters are stated below.

**Chapter 2 (Basic Information of the Project):** This chapter is provides to the general information of the project.

**Chapter 3 (Design of Water Supply System):** Water supply & distribution system is discussed here. The supply system used on a G+8 storied residential building.

**Chapter 4 (Design of Sewerage System):** Soil and waste water design and disposal system is discussed here. Also vent pipe design system is discussed.

**Chapter 5 (Rain Water Drainage System):** This chapter provides Rain water catchment area calculations, pipe sizing and disposal system.

## 1.5 Summary

This chapter of the report introduces the project and the report. The description summarizes all the design that are presented throughout the report along with the objectives and limitations. The following chapter provides the specific project data.

# CHAPTER 2 BASIC INFORMATION OF THE PROJECT

## 2.1 General Data Of The Project

A table has been given below to the details information of the project.

| | |
|---|---|
| Occupancy Type | Residential |
| Building Category | Small Apartment ($y_2$) |
| Building Storey | 9 Storied (G+8) |
| Number of Basements | N/A |
| Building Height | 99 ft |
| Number of Residents | 100 |
| Land Area | 3455 sft |
| Cover Area | 2786 sft |
| Floor Area | 2636 sft |
| Type of Structure | RCC Frame |

## 2.2 Location Of The Project

Address of the project : Plot-529, Mouza-Goran, R.S-5217, East Mothertek, Sobujbagh, Dhaka.

## 2.3 Plumbing Design Considerations

- BNBC 2020 has been followed for the design.
- Every flat has balconies.

Water Supply:

WASA is supplying water to the underground reservoir tank.

Water distribution system is gravity driven system (not a pressure system).

Own pumping system will be used to pump the water to the over head tank above the roof.

Master bed attached toilet considered hot water distribution system (10 gallon geyser). Others considered only cold water distribution system.

Water will be pumped to the over head tank (OHT) twice a day.

Underground water reservoir considered for 2 days.

Sewerage System:

- No sewers are available in the area. Buildings must have their own treatment facility- Septic tank.
- Two pipe system is used and hence Soil and Waste water are drained separately.
- Only black water (from soil stack) will be diverted into septic tank.
- Effluent from septic tank will flow to the existing drain of building front.
- All waste water will directly flow to the existing drain of building front.

Storm / Rain Water:

- There is no rain water harvesting system.
- Rain water from roof and balcony will be collected by separate stack system.
- Rain water will dispose to above ground and finally flow will be released to the existing drain of building front.

# CHAPTER 3 DESIGN OF WATER SUPPLY SYSTEM

## 3.1 General

A water supply system design requires the following components to be considered:

- Calculation of demand and estimate the water volume.
- Determine / Check adequacy of the underground water reservoir.
- Calculate / select the capacity of the pump to deliver water to the over head tank within a certain time limit (say, about 30 minutes pumping). This will include the pump riser size.
- Determine / Check adequacy of the underground water reservoir.
- Design the distribution pipe line over the roof and the risers.
- Design the distribution pipes over each of the facilities. Generally these pipes run over the false slab of the toilets and through the walls.
- Check the pressure of the most vulnerable water fixture (predicted to have the lowest pressure). This fixture is generally located on the top floor and having the longest supply pipe network.

### 3.1.1 Demand Calculation

Use total people number and per capita demand for specific occupancy type.

Total demand = Population * per capita demand

=> Q= p * q

Here, p= Number of flats/apartment * 6 persons/flat

q= 120 lpcd (for small apartment ($y_2$) from table 8.5.1(a) BNBC 2020)

Determined demand for a 9-storey apartment building with 16 flats with 6 persons in each flat:

Q= p * q

= (16*6) * 120

= (96+4) * 120

= 12000 Liters/Day

= 12.0 $m^3$/day

### 3.1.2 Under Ground (UG) Reservoir

Generally the Architect provides the design and location for such reservoirs. In such case it is necessary to check the adequacy of the volume provided. A ratio of

Volume/Demand provides the security or extra water that can be stored in case of a water supply disruption. The actual volume of the reservoir should include dead volumes at bottom (never be pumped out) and free board (at top, which will never be filled).

Water demand V = 12 $m^3$/day

Require Volume of UG water tank,

$V = (12 + 12)$ [From BNBC 2020 Table 5.9.1.2.c]

$= 24.0\ m^3$

Depth of UG water tank,

$H = V^{1\backslash 3}$

$= (24)^{1/3}$

$= 2.884$ m

Free board, FB = 0.15 m

Total depth, H = H + FB

$= 2.884 + 0.15$

$= 3.034$ m

Tank Area,

$A = L * B = V / H$

$\Rightarrow A = 24 / 2.884$

$= 8.32\ m^2$

Assume, length to width ratio of 2

$\Rightarrow L = 2B$

Now, Area, $A = L * B$

$\Rightarrow 2B * B = 8.32\ m^2$

$\Rightarrow B^2 = 8.32 / 2 = 4.16$

$\Rightarrow B = \sqrt{4.16} = 2.039$ m

Therefore,

$L = 2B$

$= 2 * 2.039 = 4.078$ m

UG Water Tank Size

L = 4.078 m, B = 2.039 m, H = 3.034 m

Figure for the UGWT is shown in CAD #16.

### 3.1.3 Over Head Water Tank (OHWT)

In this part of the report the available size provided or set by the Architect is being checked. If architectural design is not available than the size is designed. Larger OHT size leads to higher live load. As it has been decided to pump twice everyday, therefore the size of OHT should include 50% daily demand, dead volume and volume for free board. This results in the size is about 60~70% of daily demand.

Daily water demand, V= 12.0 m3/day

It is decided that the users will pump 50% of the daily demand twice a day.

So, the required volume of OHT water tank

$V = 0.5*12.0 = 6.0\ m^3$

Depth of OHT, $H = V^{1\backslash 3} = (6.0)^{1/3}$

$= 1.817$ m

Free board, FB = 0.15 m

Total depth, H = H + FB = 1.817+0.15 = 1.96 m

Tank Area, $A = 6.0 / 1.90 = 3.15\ m^2$

Assume, L = 2 B

$A = 2\ B * B = 3.15\ m^2$

$\Rightarrow B^2 = 3.15 / 2 = 1.57$

$\Rightarrow B = \sqrt{1.57} = 1.25$ m

Therefore, L = 2B = 2 * 1.25 = 2.51 m

OHT water tank Size

L = 2.51 m, B = 1.25 m, H = 1.96 m

Figure for the OHWT is shown in CAD #16.

### 3.1.4 Pump Selection

Pump capacity should be such that, it matches the electricity type (volt) and should be able to pump the desired volume within 30 minutes or so.

Estimation of power required for the pump

$$KW = \frac{Q(l/s) \times Head(m)}{75 \times Efficiency} \times 0.746$$

Here, $Q = 6.0\ m^3/hr. = \frac{6000lts}{1*60*60} = 1.67lps$

Efficiency = 50%

and, Head = (34.65+6.4) = 41.05 m

$$KW = \frac{1.67 \times 41.05}{75 \times 0.5} \times 0.746 = 1.37$$

Following PWD-2018 Schedule,

Selecting Multi Stage-Three Phase Pump.

Pump Capacity Details:

HP= 2

Q= 20-140 lpm

Head= 30-56 m

Suction pipe diameter= 32 mm and

Delivery pipe diameter= 25 mm.

### 3.1.5 Riser Size

Riser size is related to pump delivery pipe diameter. With the pumping rate, head and diameter of the pipe, head loss can be calculated. The water velocity should not exceed 1.5 m/s (to minimize water hammer). Typical figure for risers along with the OHT and UG reservoir and pump is shown in CAD #16.

## 3.2 Distribution Piping Design

CAD#06 & CAD#12 are provided showing riser, and distribution piping over the false ceiling with all the branches. BNBC provides the typical standard diameter for these pipes. For example all risers to the fixtures to be 13 mm dia (0.5 inch) pipes, while pipes running over the false ceiling are 19 mm in diameter (0.75 inch). But, those standards should be checked for pressure drop study.

### 3.2.1 Pressure Check For Distribution Network.

The distribution pipeline diameters are checked for pressure. The objective of this calculation is to ensure minimum water pressure in the most difficult fixture. Most difficult fixture is generally located on the top floor with the highest pipe length from the source. The calculation table also helps to identify any inadequacy in the preliminary design and take corrective measures, i.e. adjust the diameter of the pipes which produce excessive head loss.

An isometric sketch showing the pipe layout on the roof and the risers were created to better understand this design and head-loss calculation. **CAD#5, CAD#06 and CAD#07** are used to get a total picture of that part of network which are used to deliver water to the most difficult fixture.

The Hazen Williams equation is used for head-loss calculations. The equation can be written in the following form:

$$Q = 3.7 \times 10^{-6} C D^{2.63} \left(\frac{H}{L}\right)^{0.54}$$

Where, Q = Flows, lps
C = Roughness coefficient (100 – 140 for rough to smooth pipes)
D = Diameter, mm
H = Head loss, m
L = Length of pipe, m

For a definite value of C, the equation can be written as:

$$\frac{H}{L} = 1.39 \times 10^6 \frac{Q^{1.85}}{D^{4.87}} \text{ ---- ---- --- [for C = 130]}$$

This above formula is used to calculate the head-loss or pressure check. WSFU were obtained from BNBCTable 8.0.1in . Besides BNBC Table 8.0.2(a), 8.0.2(b), 8.0.2(c)is used to get the equivalent lengths for different valves and fittings. BNBC figure 8.0.1 is used to convert WSFU values to lpm values. For lower range of values a simple conversion factor is used as it is very difficult to obtain lpm values in that range.

*Table 1: Analysis and design of distribution pipes based on head loss calculation*

| Pipe | Length, L (m) | Diameter, D (mm) | WSF U | GPM | LPM | LPS | H/L | H |
|---|---|---|---|---|---|---|---|---|
| A-Elbow | 1.83 | 63 | 184 | 62 | 234.98 | 3.916 | 0.030 | 0.055 |
| AB | 2.75 | 63 | 184 | 62 | 234.98 | 3.916 | 0.030 | 0.082 |
| B- Elbow | 1.83 | 63 | 184 | 62 | 234.98 | 3.916 | 0.030 | 0.055 |
| BC | 2.03 | 63 | 184 | 62 | 234.98 | 3.916 | 0.030 | 0.061 |
| BC-Gate | 0.85 | 63 | 184 | 62 | 234.98 | 3.916 | 0.030 | 0.025 |
| C-Elbow | 1.83 | 63 | 184 | 62 | 234.98 | 3.916 | 0.030 | 0.055 |
| CD | 1.95 | 63 | 184 | 62 | 234.98 | 3.916 | 0.030 | 0.058 |
| D-Tee | 3.66 | 63 | 184 | 62 | 234.98 | 3.916 | 0.030 | 0.110 |
| DE | 7.798 | 50 | 80 | 38 | 144.02 | 2.400 | 0.037 | 0.291 |
| E-Elbow | 1.53 | 50 | 80 | 38 | 144.02 | 2.400 | 0.037 | 0.057 |
| EF | 4.25 | 50 | 80 | 38 | 144.02 | 2.400 | 0.037 | 0.159 |
| F-Elbow | 1.53 | 50 | 80 | 38 | 144.02 | 2.400 | 0.037 | 0.057 |
| FG | 0.45 | 50 | 80 | 38 | 144.02 | 2.400 | 0.037 | 0.017 |
| FG-Gate | 0.7 | 50 | 80 | 38 | 144.02 | 2.400 | 0.037 | 0.026 |
| G-Elbow | 1.53 | 50 | 80 | 38 | 144.02 | 2.400 | 0.037 | 0.057 |
| GH | 0.92 | 50 | 80 | 38 | 144.02 | 2.400 | 0.037 | 0.034 |
| H-Tee | 3.05 | 50 | 80 | 38 | 144.02 | 2.400 | 0.037 | 0.114 |
| HI | 0.61 | 25 | 10 | 14.6 | 55.33 | 0.922 | 0.186 | 0.114 |
| I-Tee | 1.53 | 25 | 10 | 14.6 | 55.33 | 0.922 | 0.186 | 0.285 |
| IJ | 0.46 | 25 | 10 | 14.6 | 55.33 | 0.922 | 0.186 | 0.086 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| J-Elbow | 0.79 | 25 | 10 | 14.6 | 55.33 | 0.922 | 0.186 | 0.147 |
| JK | 1.95 | 25 | 10 | 14.6 | 55.33 | 0.922 | 0.186 | 0.363 |
| K-Tee | 1.53 | 25 | 10 | 14.6 | 55.33 | 0.922 | 0.186 | 0.285 |
| KL | 0.6 | 19 | 5 | 9.4 | 35.63 | 0.594 | 0.314 | 0.188 |
| L-Tee | 1.22 | 19 | 5 | 9.4 | 35.63 | 0.594 | 0.314 | 0.383 |
| LM | 0.97 | 19 | 4 | 8 | 30.32 | 0.505 | 0.233 | 0.226 |
| M-Elbow | 0.61 | 19 | 4 | 8 | 30.32 | 0.505 | 0.233 | 0.142 |
| | | | | | | | | 3.533 |

Note: WSFU to GPM was determined using IPC 2018 Table [Appendix]

Total Head = 5.491m

Head loss = 3.533m

Available Head = 1.958m = 2.78psi

### 3.2.2 Typical Figure For Connections

Typical standard for valves, joints, clumps etc. are also provided in the CAD.

# CHAPTER 4 DESIGN OF SEWERAGE SYSTEM

## 4.1 General

The detailed calculations for the design of different components are presented in this chapter. The sewerage plumbing pipes for each floors are generally located below the floor slab and the vertical stacks run through the designated voids to the building drains.

A waste water drainage system design requires the following components to be considered:

- Determine the wastewater load in terms of fixture unit from each bathroom or other units which produces wastewater.
- Selection / Check adequacy of the size (diameter) of the branch pipes according to BNBC.
- Selection / Check adequacy of the size (diameter) of the vertical stack pipes according to BNBC.
- Determining the grade and diameter of the building drain.
- Design the septic tank.

## 4.2 WASTE WATER LOADS

There are four toilet unit locations and two kitchen location in the first to eight typical floor plan and ground floor have one number of toilet for care taker. All these kitchens and toilets are using a total of four (4) ducts to run down the vertical stacks. Waste water loads are calculated based on the Fixture Unit (FU) system. In this system a load value is assigned for each type of wastewater fixture. The relevant table from BNBC [Table 8.6.12] is provided in Appendix: BNBC Tables. FU values are picked up from that table to determine the total FU load coming from each toilet to each type of vertical stacks. The fixture unit loads to different stacks from these toilets are listed in the following table:

Table 4.1: Listing of fixture unit loads from each toilet and kitchen (Ground to $8^{th}$ Floor)

| DUCT-1 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FIXTURES | GF | 1F | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | No.of Fixture | FU |
| Water closet (flush tank) | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 48 |
| Wash Basin (domestic) | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 8 |
| Kitchen sink | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Shower | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 32 |
| Laundry | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 27 |
| Floor trap | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 9 |
| **DUCT-2** | | | | | | | | | | | |
| FIXTURES | G.F | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | No. of Fixture | FU |
| Water closet (flush tank) | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 48 |
| Wash Basin (domestic) | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 16 | 16 |
| Kitchen sink | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 16 |
| Shower | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 32 |
| Laundry | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 27 |
| Floor trap | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 9 |
| **DUCT-3** | | | | | | | | | | | |
| FIXTURES | G.F | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | No. of Fixture | FU |
| Water closet (flush tank) | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 48 |
| Wash Basin (domestic) | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 16 | 16 |
| Kitchen sink | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 16 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Shower | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 32 |
| Laundry | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 27 |
| Floor trap | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 9 |

| **DUCT-4** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FIXTURES | G.F | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | No. of Fixture | FU |
| Water closet / Long pan (flush tank) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 54 |
| Wash Basin (domestic) | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 8 |
| Kitchen sink | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Shower | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 32 |
| Bib cock | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1.5 |
| Laundry | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 27 |
| Floor trap | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 9 |

Table 4.2: Listing of total fixture unit loads on different stack (Ground to 8$^{th}$ Floor)

| **Duct No.** | **Total Fixture Unit Load on Waste Stack (WS)** | **Total Fixture Unit Load on Soil Stack (SS)** |
|---|---|---|
| 1 | 76 | 48 |
| 2 | 100 | 48 |
| 3 | 100 | 48 |
| 4 | 77.5 | 54 |
| **Total** | 353.5 | 198 |

**CAD #19** includes the section detail of fixture.

## 4.3 Selection Of Branch And Stack Pipe Size

All branch pipes are selected to be 100 mm in diameter. This uniform size selection will eliminate the need of reducers and will reduce the hassle of maintaining different sized pipe stocks for any repair work. According to Table 8.6.14 from BNBC (Appendix: BNBC Tables) this 100 mm branch pipe can take up to 160 FU load and hence this selection is more than enough. That table also indicate that the vertical stacks of this size can take up to 500 FU load and hence this design or selection is enough. CAD#13 includes a sketch of stack with velocity reducer arrangement. CAD #14 & CAD#15 includes typical soil stack, waste water stack, rain water stack & vent stack joint details.

## 4.4 Design Of Building Drain

Total load on building drains for SS and WS are 198 and 353.5 FU accordingly. Therefore, according to BNBC Table 8.6.15 (Appendix: BNBC Tables), Ø150 mm pipe is selected with a slope of 1/100. This setup has a capacity of 700 FU load. Layout of the building drain with, Septic tank, building sewer etc are shown in CAD #01. A layout of the UG reservoir for water supply is shown in CAD #01. These two elements are separated by sufficient distance to prevent any chance of cross contamination. CAD#14 and CAD#15 shows the detailed of stack connections and CAD#18 shows detailed sections of typical inspection pits for building drains.

## 4.5 Design Of Septic Tank.

Septic tank has been designed according to the process described in the text book. All the details for septic tank arrangements are provided in CAD #17.

Size of Septic Tank,

Length = 4.078 m
Width = 2.039 m
Depth = 3.034 m

# CHAPTER 5 DESIGN OF STORM WATER DRAINAGE SYSTEM

## 5.1 General

There is no special arrangements to store and manage storm water for this building. Arrangements were made to discharge rain water easily from roof through several rain stacks to the building drain.

## 5.2 Storm Water Management System

Rain/storm water is disclosed to building drain and will flow to the available drainage system.

Roof rain water disposal system detailed are shows in CAD#04.

# CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

## 6.1 General

An extensive computational plumbing design has been performed on G+8 storey residential building. This project is about to design a plumbing & sanitary system. So, at first a details has been made in second chapter for better understanding of the project information. Necessary plumbing design consideration are also included in that chapter. The detailed water supply design process has been discussed in chapter-3. Necessary tables & figure are also included in that chapter. In chapter-4 the sewerage system design has been provided. And chapter-5 discussed the rain water management system.

## 6.2 Conclusion Of The Study

A plumbing system design for multistorey residential building is described in this thesis. Determined the right size of pipe for water supply, sanitary and drainage works. Also designed UGWR, OHWT, septic tank, centrifugal pump, inspection pit, etc. All the design parameter determined according to Bangladesh National Building Code-2020.

## 6.3 Future Scopes And Recommendation

- A recyclable plumbing system which enables regarding it waste water/rain could be done for sustainable and energy efficient purpose of this project.
- A comparative study on cost analysis can be done as well as the fire fighting system design can be done for further research.

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6: Haq S.A. (2021), Plumbing Principles and Practice (Second Edition).

7: Alfred Laws, A. Calvin , Engineered Plumbing Design II by Steele.

8: M. Javaid, Drainage Systems.

9: Harris C. M. (1991), Practical Plumbing Engineering, McGraw-Hill.

# <u>Appendices</u>

Appendix: BNBC Tables

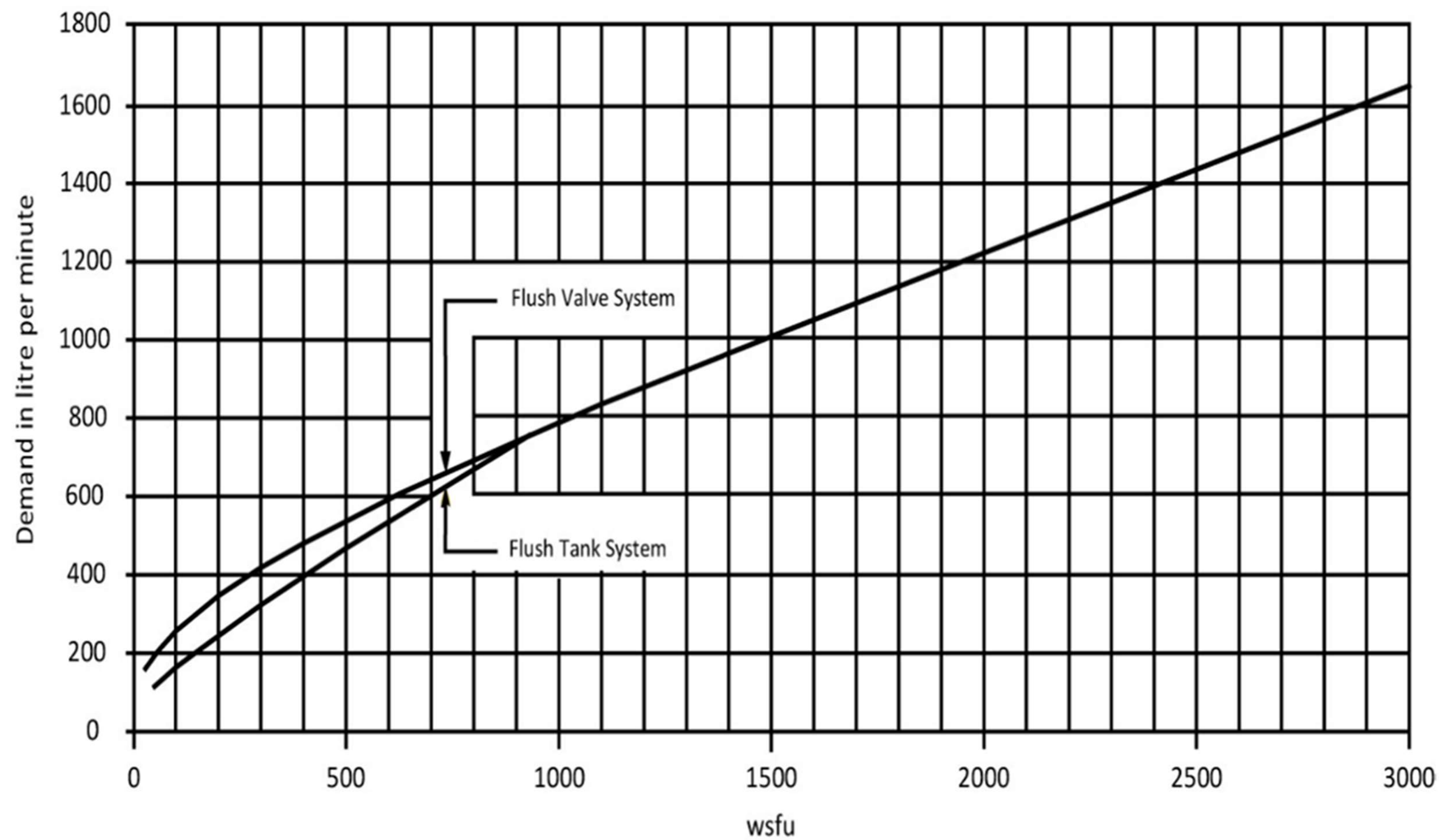


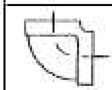
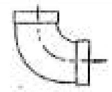
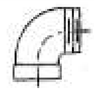
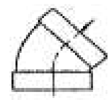
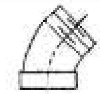
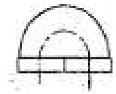

**Figure 8.O.1 Water supply demand for various load in water supply fixture units (Wsfu)**

**Table 8.O.1: Water Supply Fixture Unit (wsfu) Values for Various Plumbing Fixtures**

| Fixture or group | Supply Control | wsfu Cold | Hot | Total |
|---|---|---|---|---|
| Bath group | Flush tank | 4.5 | 3 | 6 |
| Bath group | Flush valve | 6 | 3 | 8 |
| Bathtub | Faucet | 1.5 | 1.5 | 2 |
| Bidet | Faucet | 1.5 | 1.5 | 2 |
| Combination | Faucet | 2 | 2 | 3 |
| Kitchen sink | Faucet | 1.5 | 1.5 | 2 |
| Laundry tray | Faucet | 2 | 2 | 3 |
| Laundry | Faucet | 1.5 | 1.5 | 2 |
| Pedestal urinal | Flush valve | 10 | - | 10 |
| Restaurant sink | Faucet | 3 | 3 | 4 |
| Service sink | Faucet | 1.5 | 1.5 | 2 |
| Shower head | Mixing Valve | 3 | 3 | 4 |
| Stall or wall urinal | Flush tank | 3 | - | 3 |
| Stall or wall urinal | Flush valve | 5 | - | 5 |
| Water closet | Flush tank | 5 | - | 5 |
| Water closet | Flush valve | 10 | - | 10 |

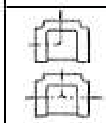
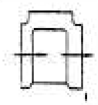
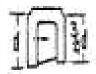
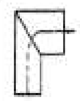
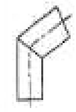
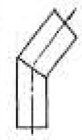
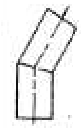
* Fixture with both cold and hot water supplies, the weight for maximum separate demands may be considered 75% of total wsfu.

**Table 8.O.2(a): Fitting Losses In Equivalent Metre of Pipe - Screwed, Welded, Flanged, Flared and Brazed Connections**

| Nominal Pipe or Tube Size (mm) | Smooth Bend Elbows | | | | | |
|---|---|---|---|---|---|---|
| | 90° Std* | 90° Long Rad.** | 90° Street* | 45° Std* | 45° Street* | 180° Std* |
| |  |  |  |  |  |  |
| 10 | 0.43 | 0.27 | 0.70 | 0.21 | 0.34 | 0.70 |
| 13 | 0.49 | 0.31 | 0.76 | 0.24 | 0.40 | 0.76 |
| 19 | 0.61 | 0.43 | 0.98 | 0.27 | 0.49 | 0.98 |
| 25 | 0.79 | 0.52 | 1.25 | 0.40 | 0.64 | 1.25 |
| 32 | 1.01 | 0.70 | 1.71 | 0.52 | 0.92 | 1.71 |
| 38 | 1.22 | 0.79 | 1.92 | 0.64 | 1.04 | 1.92 |
| 50 | 1.53 | 1.01 | 2.50 | 0.79 | 1.37 | 2.50 |
| 63 | 1.83 | 1.25 | 3.05 | 0.98 | 1.59 | 3.05 |
| 75 | 2.29 | 1.53 | 3.66 | 1.22 | 1.95 | 3.66 |
| 88 | 2.75 | 1.80 | 4.58 | 1.43 | 2.23 | 4.58 |
| 100 | 3.05 | 2.04 | 5.19 | 1.59 | 2.59 | 5.19 |
| 125 | 3.97 | 2.50 | 6.41 | 1.98 | 3.36 | 6.41 |
| 150 | 4.88 | 3.05 | 7.63 | 2.41 | 3.97 | 7.63 |
| 200 | 6.10 | 3.97 | - | 3.05 | - | 10.07 |
| 250 | 7.63 | 4.88 | - | 3.97 | - | 12.81 |
| 300 | 9.15 | 5.80 | - | 4.88 | - | 15.25 |
| 350 | 10.37 | 7.02 | - | 5.49 | - | 16.78 |
| 400 | 11.59 | 7.93 | - | 6.10 | - | 18.91 |
| 450 | 12.81 | 8.85 | - | 7.02 | - | 21.35 |
| 500 | 15.25 | 10.07 | - | 7.93 | - | 24.71 |
| 600 | 18.30 | 12.20 | - | 9.15 | - | 28.67 |

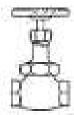
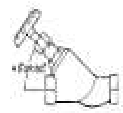
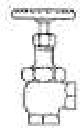
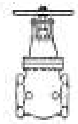
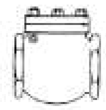
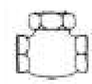
** = R/D approximately equal to 1, ** = R/D approximately equal to 1.5*

**Table 8.O.2(b): Fitting Losses in Equivalent Metre of Pipe - Screwed, Welded, Flanged, Flared and Brazed Connections**

| Nominal Pipe or Tube Size (mm) | Smooth Bend Tees | | | | Metre Elbows | | | |
|---|---|---|---|---|---|---|---|---|
| | Flow Thru | Straight-Thru Flow | | | 90° Ell | 60° Ell | 45° Ell | 30° Ell |
| | Branch | No Reduction | Reduced ¼ | Reduced ½ | | | | |
| |  |  |  |  |  |  |  |  |
| 10 | 0.82 | 0.27 | 0.37 | 0.43 | 0.82 | 0.34 | 0.18 | 0.09 |
| 13 | 0.92 | 0.31 | 0.43 | 0.49 | 0.92 | 0.40 | 0.21 | 0.12 |
| 19 | 1.22 | 0.43 | 0.58 | 0.61 | 1.22 | 0.49 | 0.27 | 0.15 |
| 25 | 1.53 | 0.52 | 0.70 | 0.79 | 1.53 | 0.64 | 0.31 | 0.21 |
| 32 | 2.14 | 0.70 | 0.95 | 1.01 | 2.14 | 0.92 | 0.46 | 0.27 |
| 38 | 2.44 | 0.79 | 1.13 | 1.22 | 2.44 | 1.04 | 0.55 | 0.34 |
| 50 | 3.05 | 1.01 | 1.43 | 1.53 | 3.05 | 1.37 | 0.70 | 0.40 |
| 63 | 3.66 | 1.25 | 1.71 | 1.83 | 3.66 | 1.59 | 0.85 | 0.52 |
| 75 | 4.58 | 1.53 | 2.14 | 2.29 | 4.58 | 1.95 | 0.98 | 0.61 |
| 88 | 5.49 | 1.80 | 2.44 | 2.75 | 5.49 | 2.23 | 1.22 | 0.73 |
| 100 | 6.41 | 2.04 | 2.75 | 3.05 | 6.41 | 2.59 | 1.37 | 0.82 |
| 125 | 7.63 | 2.50 | 3.66 | 3.97 | 7.63 | 3.36 | 1.83 | 0.98 |
| 150 | 9.15 | 3.05 | 4.27 | 4.88 | 9.15 | 3.97 | 2.14 | 1.22 |
| 200 | 12.20 | 3.97 | 5.49 | 6.10 | 12.20 | 5.19 | 2.75 | 1.56 |
| 250 | 15.25 | 4.88 | 7.02 | 7.63 | 15.25 | 6.41 | 3.66 | 2.20 |
| 300 | 18.30 | 5.80 | 7.93 | 9.15 | 18.30 | 7.63 | 3.97 | 2.44 |
| 350 | 20.74 | 7.02 | 9.15 | 10.37 | 20.74 | 8.85 | 4.58 | 2.75 |
| 400 | 23.79 | 7.93 | 10.68 | 11.59 | 23.79 | 9.46 | 5.19 | 3.05 |
| 450 | 25.93 | 8.85 | 12.20 | 12.81 | 25.93 | 11.29 | 5.80 | 3.36 |
| 500 | 30.50 | 10.07 | 13.42 | 15.25 | 30.50 | 12.51 | 6.71 | 3.97 |
| 600 | 35.08 | 12.20 | 15.25 | 18.30 | 35.08 | 14.95 | 7.63 | 4.88 |

** = R/D approximately equal to 1, ** = R/D approximately equal to 1.5*

**Table 8.O.2(c): Valve Losses in Equivalent Metre of Pipe - Screwed, Welded, Flanged and Flared Connections**

| Nominal Pipe or Tube Size (mm) | Globe | 60° – Y | 45° – Y | Angle* | Gate | Swing Check** | Lift Check |
|---|---|---|---|---|---|---|---|
| |  |  | |  |  |  |  |
| 10 | 5.19 | 2.44 | 1.83 | 1.83 | 0.18 | 1.53 | Globe Lift and Vertical Lift: Same as Globe Valve** |
| 13 | 5.49 | 2.75 | 2.14 | 2.14 | 0.21 | 1.83 | |
| 19 | 6.71 | 3.36 | 2.75 | 2.75 | 0.27 | 2.44 | |
| 25 | 8.85 | 4.58 | 3.66 | 3.66 | 0.31 | 3.05 | |
| 32 | 11.59 | 6.10 | 4.58 | 4.58 | 0.46 | 4.27 | |
| 38 | 13.12 | 7.32 | 5.49 | 5.49 | 0.55 | 4.88 | |
| 50 | 16.78 | 9.15 | 7.32 | 7.32 | 0.70 | 6.10 | |
| 63 | 21.05 | 10.68 | 8.85 | 8.85 | 0.85 | 7.63 | |
| 75 | 25.62 | 13.12 | 10.68 | 10.68 | 0.98 | 9.15 | |
| 88 | 30.50 | 15.25 | 12.51 | 12.51 | 1.22 | 10.68 | |
| 100 | 36.60 | 17.69 | 14.34 | 14.34 | 1.37 | 12.20 | |
| 125 | 42.70 | 21.66 | 17.69 | 17.69 | 1.83 | 15.25 | |
| 150 | 51.85 | 26.84 | 21.35 | 21.35 | 2.14 | 18.30 | |
| 200 | 67.10 | 35.08 | 25.93 | 25.93 | 2.75 | 24.40 | |
| 250 | 85.40 | 44.23 | 32.03 | 32.03 | 3.66 | 30.50 | |
| 300 | 97.60 | 50.33 | 39.65 | 39.65 | 3.97 | 36.60 | Angle Lift: Same as Angle Valve |
| 350 | 109.8 | 56.43 | 41.18 | 41.18 | 4.58 | 41.18 | |
| 400 | 125.05 | 64.05 | 54.90 | 54.90 | 5.19 | 45.75 | |
| 450 | 140.3 | 73.20 | 61.00 | 61.00 | 5.80 | 50.33 | |
| 500 | 158.6 | 83.88 | 71.68 | 71.68 | 6.71 | 61/00 | |
| 600 | 186.05 | 97.60 | 80.83 | 80.83 | 7.63 | 73.20 | |

* These loses do not apply to valves with needle point type seat, ** Losses also apply to the in-line, ball type check valve.

**TABLE E103.3(2)**
**LOAD VALUES ASSIGNED TO FIXTURES[a]**

| FIXTURE | OCCUPANCY | TYPE OF SUPPLY CONTROL | LOAD VALUES, IN WATER SUPPLY FIXTURE UNITS (wsfu) | | |
|---|---|---|---|---|---|
| | | | Cold | Hot | Total |
| Bathroom group | Private | Flush tank | 2.7 | 1.5 | 3.6 |
| Bathroom group | Private | Flushometer valve | 6.0 | 3.0 | 8.0 |
| Bathtub | Private | Faucet | 1.0 | 1.0 | 1.4 |
| Bathtub | Public | Faucet | 3.0 | 3.0 | 4.0 |
| Bidet | Private | Faucet | 1.5 | 1.5 | 2.0 |
| Combination fixture | Private | Faucet | 2.25 | 2.25 | 3.0 |
| Dishwashing machine | Private | Automatic | — | 1.4 | 1.4 |
| Drinking fountain | Offices, etc. | $^3/_8$" valve | 0.25 | — | 0.25 |
| Kitchen sink | Private | Faucet | 1.0 | 1.0 | 1.4 |
| Kitchen sink | Hotel, restaurant | Faucet | 3.0 | 3.0 | 4.0 |
| Laundry trays (1 to 3) | Private | Faucet | 1.0 | 1.0 | 1.4 |
| Lavatory | Private | Faucet | 0.5 | 0.5 | 0.7 |
| Lavatory | Public | Faucet | 1.5 | 1.5 | 2.0 |
| Service sink | Offices, etc. | Faucet | 2.25 | 2.25 | 3.0 |
| Shower head | Public | Mixing valve | 3.0 | 3.0 | 4.0 |
| Shower head | Private | Mixing valve | 1.0 | 1.0 | 1.4 |
| Urinal | Public | 1" flushometer valve | 10.0 | — | 10.0 |
| Urinal | Public | $^3/_4$" flushometer valve | 5.0 | — | 5.0 |
| Urinal | Public | Flush tank | 3.0 | — | 3.0 |
| Washing machine (8 lb) | Private | Automatic | 1.0 | 1.0 | 1.4 |
| Washing machine (8 lb) | Public | Automatic | 2.25 | 2.25 | 3.0 |
| Washing machine (15 lb) | Public | Automatic | 3.0 | 3.0 | 4.0 |
| Water closet | Private | Flushometer valve | 6.0 | — | 6.0 |
| Water closet | Private | Flush tank | 2.2 | — | 2.2 |
| Water closet | Public | Flushometer valve | 10.0 | — | 10.0 |
| Water closet | Public | Flush tank | 5.0 | — | 5.0 |
| Water closet | Public or private | Flushometer tank | 2.0 | — | 2.0 |

For SI: 1 inch = 25.4 mm, 1 pound = 0.454 kg.

a. For fixtures not listed, loads should be assumed by comparing the fixture to one listed using water in similar quantities and at similar rates. The assigned loads for fixtures with both hot and cold water supplies are given for separate hot and cold water loads and for total load. The separate hot and cold water loads being three-fourths of the total load for the fixture in each case.

**TABLE E103.3(3)**
**TABLE FOR ESTIMATING DEMAND**

| SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSH TANKS | | | SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSHOMETER VALVES | | |
|---|---|---|---|---|---|
| Load | Demand | | Load | Demand | |
| (Water supply fixture units) | (Gallons per minute) | (Cubic feet per minute) | (Water supply fixture units) | (Gallons per minute) | (Cubic feet per minute) |
| 1 | 3.0 | 0.04104 | — | — | — |
| 2 | 5.0 | 0.0684 | — | — | — |
| 3 | 6.5 | 0.86892 | — | — | — |
| 4 | 8.0 | 1.06944 | — | — | — |
| 5 | 9.4 | 1.256592 | 5 | 15.0 | 2.0052 |
| 6 | 10.7 | 1.430376 | 6 | 17.4 | 2.326032 |
| 7 | 11.8 | 1.577424 | 7 | 19.8 | 2.646364 |
| 8 | 12.8 | 1.711104 | 8 | 22.2 | 2.967696 |
| 9 | 13.7 | 1.831416 | 9 | 24.6 | 3.288528 |
| 10 | 14.6 | 1.951728 | 10 | 27.0 | 3.60936 |
| 11 | 15.4 | 2.058672 | 11 | 27.8 | 3.716304 |
| 12 | 16.0 | 2.13888 | 12 | 28.6 | 3.823248 |
| 13 | 16.5 | 2.20572 | 13 | 29.4 | 3.930192 |
| 14 | 17.0 | 2.27256 | 14 | 30.2 | 4.037136 |
| 15 | 17.5 | 2.3394 | 15 | 31.0 | 4.14408 |
| 16 | 18.0 | 2.90624 | 16 | 31.8 | 4.241024 |
| 17 | 18.4 | 2.459712 | 17 | 32.6 | 4.357968 |
| 18 | 18.8 | 2.513184 | 18 | 33.4 | 4.464912 |
| 19 | 19.2 | 2.566656 | 19 | 34.2 | 4.571856 |
| 20 | 19.6 | 2.620128 | 20 | 35.0 | 4.6788 |
| 25 | 21.5 | 2.87412 | 25 | 38.0 | 5.07984 |
| 30 | 23.3 | 3.114744 | 30 | 42.0 | 5.61356 |
| 35 | 24.9 | 3.328632 | 35 | 44.0 | 5.88192 |
| 40 | 26.3 | 3.515784 | 40 | 46.0 | 6.14928 |
| 45 | 27.7 | 3.702936 | 45 | 48.0 | 6.41664 |
| 50 | 29.1 | 3.890088 | 50 | 50.0 | 6.684 |
| 60 | 32.0 | 4.27776 | 60 | 54.0 | 7.21872 |
| 70 | 35.0 | 4.6788 | 70 | 58.0 | 7.75344 |
| 80 | 38.0 | 5.07984 | 80 | 61.2 | 8.181216 |
| 90 | 41.0 | 5.48088 | 90 | 64.3 | 8.595624 |
| 100 | 43.5 | 5.81508 | 100 | 67.5 | 9.0234 |
| 120 | 48.0 | 6.41664 | 120 | 73.0 | 9.75864 |
| 140 | 52.5 | 7.0182 | 140 | 77.0 | 10.29336 |
| 160 | 57.0 | 7.61976 | 160 | 81.0 | 10.82808 |
| 180 | 61.0 | 8.15448 | 180 | 85.5 | 11.42964 |
| 200 | 65.0 | 8.6892 | 200 | 90.0 | 12.0312 |
| 225 | 70.0 | 9.3576 | 225 | 95.5 | 12.76644 |
| 250 | 75.0 | 10.026 | 250 | 101.0 | 13.50168 |

*(continued)*

**TABLE E103.3(3)-continued**
**TABLE FOR ESTIMATING DEMAND**

| SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSH TANKS | | | SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSHOMETER VALVES | | |
|---|---|---|---|---|---|
| Load | Demand | | Load | Demand | |
| (Water supply fixture units) | (Gallons per minute) | (Cubic feet per minute) | (Water supply fixture units) | (Gallons per minute) | (Cubic feet per minute) |
| 275 | 80.0 | 10.6944 | 275 | 104.5 | 13.96956 |
| 300 | 85.0 | 11.3628 | 300 | 108.0 | 14.43744 |
| 400 | 105.0 | 14.0364 | 400 | 127.0 | 16.97736 |
| 500 | 124.0 | 16.57632 | 500 | 143.0 | 19.11624 |
| 750 | 170.0 | 22.7256 | 750 | 177.0 | 23.66136 |
| 1,000 | 208.0 | 27.80544 | 1,000 | 208.0 | 27.80544 |
| 1,250 | 239.0 | 31.94952 | 1,250 | 239.0 | 31.94952 |
| 1,500 | 269.0 | 35.95992 | 1,500 | 269.0 | 35.95992 |
| 1,750 | 297.0 | 39.70296 | 1,750 | 297.0 | 39.70296 |
| 2,000 | 325.0 | 43.446 | 2,000 | 325.0 | 43.446 |
| 2,500 | 380.0 | 50.7984 | 2,500 | 380.0 | 50.7984 |
| 3,000 | 433.0 | 57.88344 | 3,000 | 433.0 | 57.88344 |
| 4,000 | 525.0 | 70.182 | 4,000 | 525.0 | 70.182 |
| 5,000 | 593.0 | 79.27224 | 5,000 | 593.0 | 79.27224 |

For SI: 1 inch = 25.4 mm, 1 gallon per minute = 3.785 L/m, 1 cubic foot per minute = 0.28 $m^3$ per minute.

**TABLE E103.3(4)**
**LOSS OF PRESSURE THROUGH TAPS AND TEES IN POUNDS PER SQUARE INCH (psi)**

| GALLONS PER MINUTE | SIZE OF TAP OR TEE (inches) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 5/8 | 3/4 | 1 | 1 1/4 | 1 1/2 | 2 | 3 |
| 10 | 1.35 | 0.64 | 0.18 | 0.08 | — | — | — |
| 20 | 5.38 | 2.54 | 0.77 | 0.31 | 0.14 | — | — |
| 30 | 12.10 | 5.72 | 1.62 | 0.69 | 0.33 | 0.10 | — |
| 40 | — | 10.20 | 3.07 | 1.23 | 0.58 | 0.18 | — |
| 50 | — | 15.90 | 4.49 | 1.92 | 0.91 | 0.28 | — |
| 60 | — | — | 6.46 | 2.76 | 1.31 | 0.40 | — |
| 70 | — | — | 8.79 | 3.76 | 1.78 | 0.55 | 0.10 |
| 80 | — | — | 11.50 | 4.90 | 2.32 | 0.72 | 0.13 |
| 90 | — | — | 14.50 | 6.21 | 2.94 | 0.91 | 0.16 |
| 100 | — | — | 17.94 | 7.67 | 3.63 | 1.12 | 0.21 |
| 120 | — | — | 25.80 | 11.00 | 5.23 | 1.61 | 0.30 |
| 140 | — | — | 35.20 | 15.00 | 7.12 | 2.20 | 0.41 |
| 150 | — | — | — | 17.20 | 8.16 | 2.52 | 0.47 |
| 160 | — | — | — | 19.60 | 9.30 | 2.92 | 0.54 |
| 180 | — | — | — | 24.80 | 11.80 | 3.62 | 0.68 |
| 200 | — | — | — | 30.70 | 14.50 | 4.48 | 0.84 |
| 225 | — | — | — | 38.80 | 18.40 | 5.60 | 1.06 |
| 250 | — | — | — | 47.90 | 22.70 | 7.00 | 1.31 |
| 275 | — | — | — | — | 27.40 | 7.70 | 1.59 |
| 300 | — | — | — | — | 32.60 | 10.10 | 1.88 |

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kpa, 1 gallon per minute = 3.785 L/m.

**Table 8.6.12: Fixture Units for Different Sanitary Appliances or Groups**

| Type of Fixture | Fixture Unit Value as Load Factor |
|---|---|
| One bathroom group consisting of water closet, wash basin and bath tub or shower stall : | |
| a) Flush Tank water closet | 3 |
| b) Flush-valve water closet | 6 |
| Bathtub* | 2 |
| Bidet | 2 |
| Combination sink and tray (drain board) | 2 |
| Drinking fountain | 0.5 |
| Floor traps† | 1 |
| Kitchen sink, domestic | 2 |
| Wash basin, ordinary‡ | 1 |
| Wash basin, surgeon's | 2 |
| Shower stall, domestic | 2 |
| Shower (group) per head | 3 |
| Urinal, wall hung | 4 |
| Urinal, stall | 4 |
| Water closet, tank operated | 3 |
| Water closet, valve operated | 6 |

* A shower head over a bath tub does not increase the fixture unit value.

† Size of floor trap shall be determined by the area of surface water to be drained.

‡ Wash basin with 32 mm and 40 mm trap have the same load value.

**Table 8.6.14: Maximum Number of Fixture Units that can be connected to Branches and Stacks**

| Diameter of Pipe (mm) | Any Horizontal Fixture Branch[a] | One Stack of 3 Storeys in Height or 3 Intervals | More than 3 Storeys in Height | |
|---|---|---|---|---|
| | | | Total for Stack | Total at One Storey or Branch Interval |
| 30 | 1 | 2 | 2 | 1 |
| 40 | 3 | 4 | 8 | 2 |
| 50 | 6 | 10 | 24 | 6 |
| 65 | 12 | 20 | 42 | 9 |
| 75 | 20 | 30 | 60 | 16 |
| 100 | 160 | 240 | 500 | 90 |
| 125 | 360 | 540 | 1100 | 200 |
| 150 | 620 | 960 | 1900 | 350 |
| 200 | 1400 | 2200 | 3600 | 600 |
| 250 | 2500 | 3800 | 5600 | 1000 |
| 300 | 3900 | 6000 | 8400 | 1500 |
| 375 | 7000 | b | b | b |

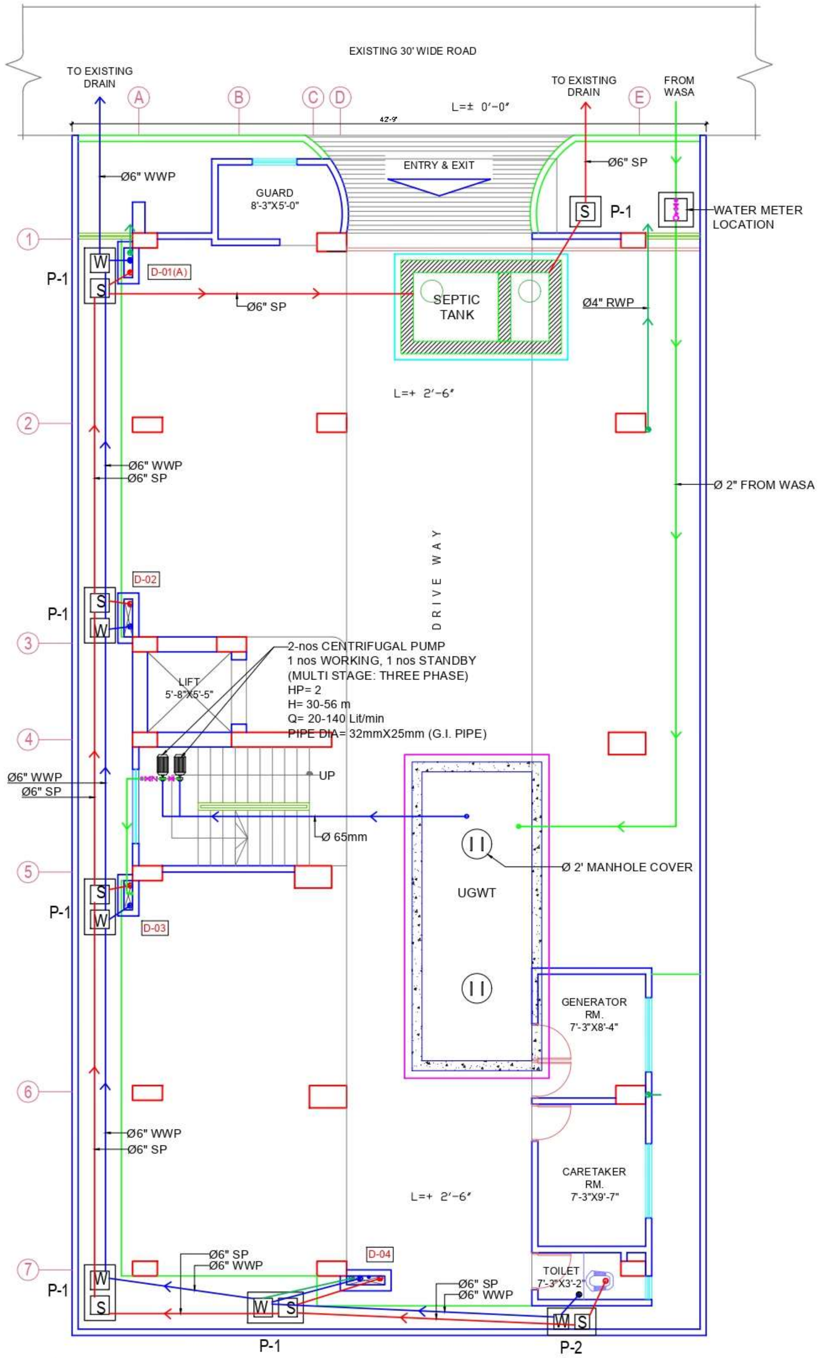
[a] Does not include branches of the building sewer. [b] Sizing load based on design criteria

**Table 8.6.15: Maximum Number of Fixture Units that can be connected to Building Drains and Sewers**

| Diameter of Pipe (mm) | Maximum Number of Fixture Units that can be Connected to any Portion* of the Building Drain or the Building Sewer for Various Slopes | | | |
|---|---|---|---|---|
| | 1/200 | 1/100 | 1/50 | 1/25 |
| 100 | - | 180 | 216 | 250 |
| 150 | - | 700 | 840 | 1000 |
| 200 | 1400 | 1600 | 1920 | 2300 |
| 250 | 2500 | 2900 | 3500 | 4200 |
| 300 | 2900 | 4600 | 5600 | 6700 |
| 375 | 7000 | 8300 | 10000 | 12000 |

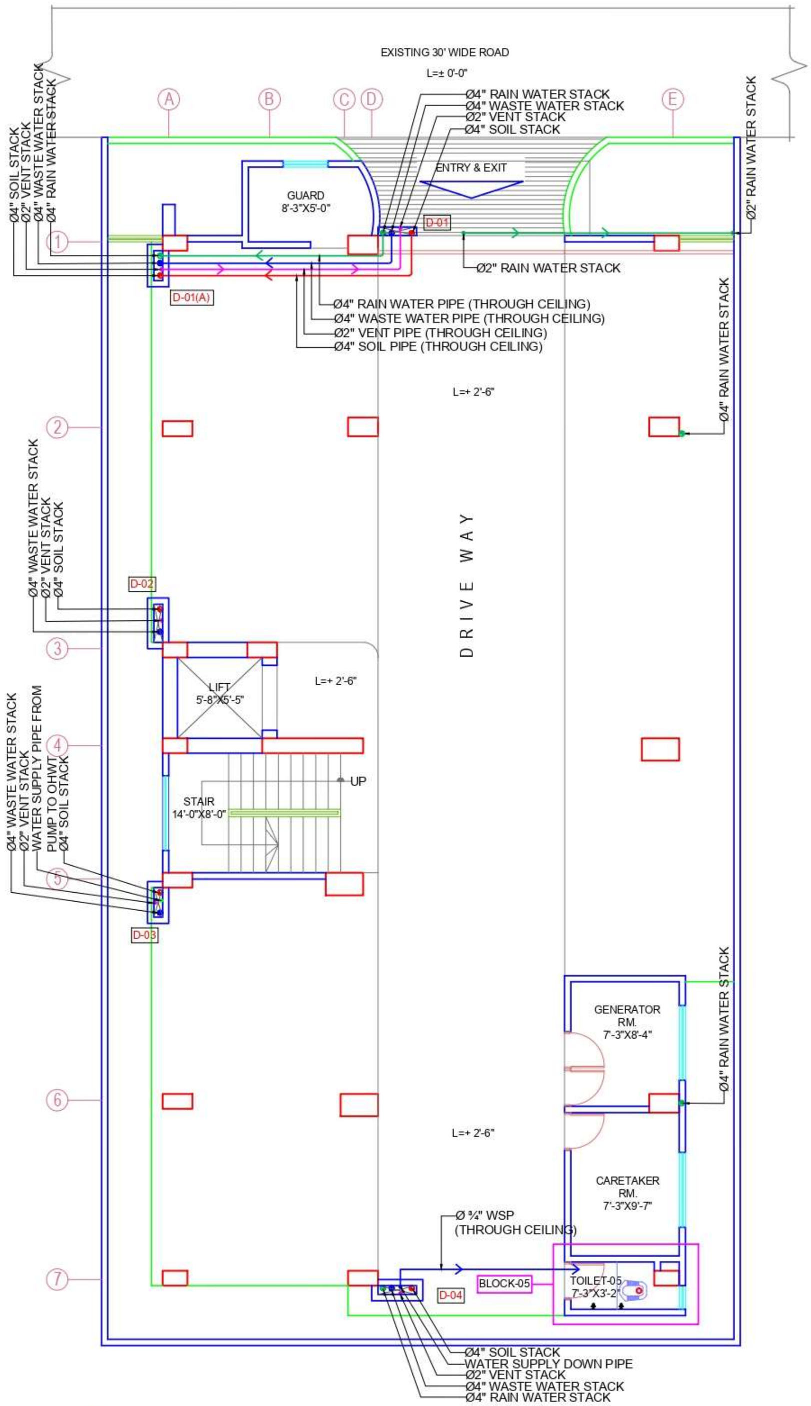
* Includes branches of building sewer

Appendix: CAD Files



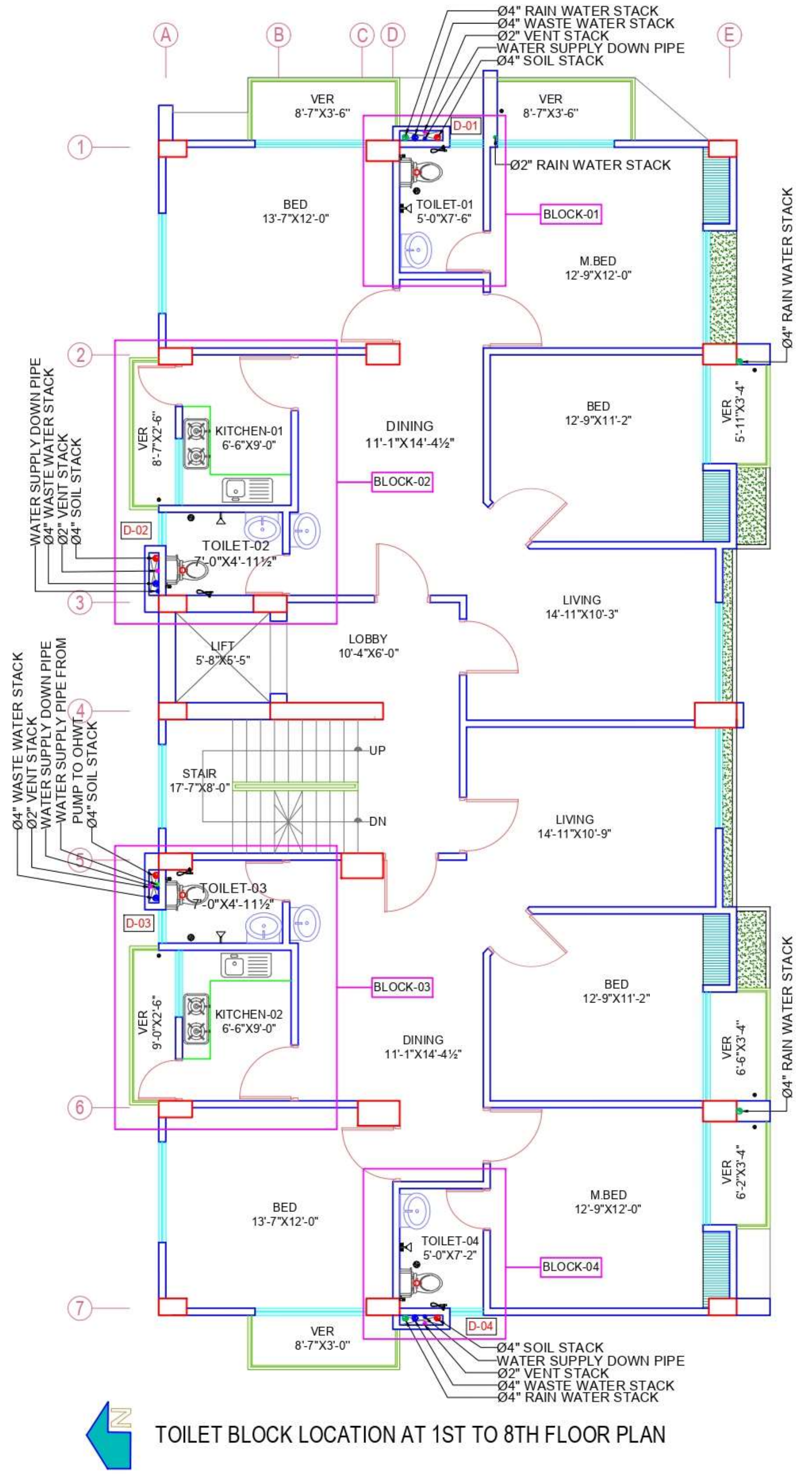

UGWR, LIFTING PUMP, SEPTIC TANK, SOAK WELL LOCATION AND SOIL, WASTE, RAIN WATER DISPOSAL LAYOUT AT GROUND FLOOR PLAN

**CAD#01**

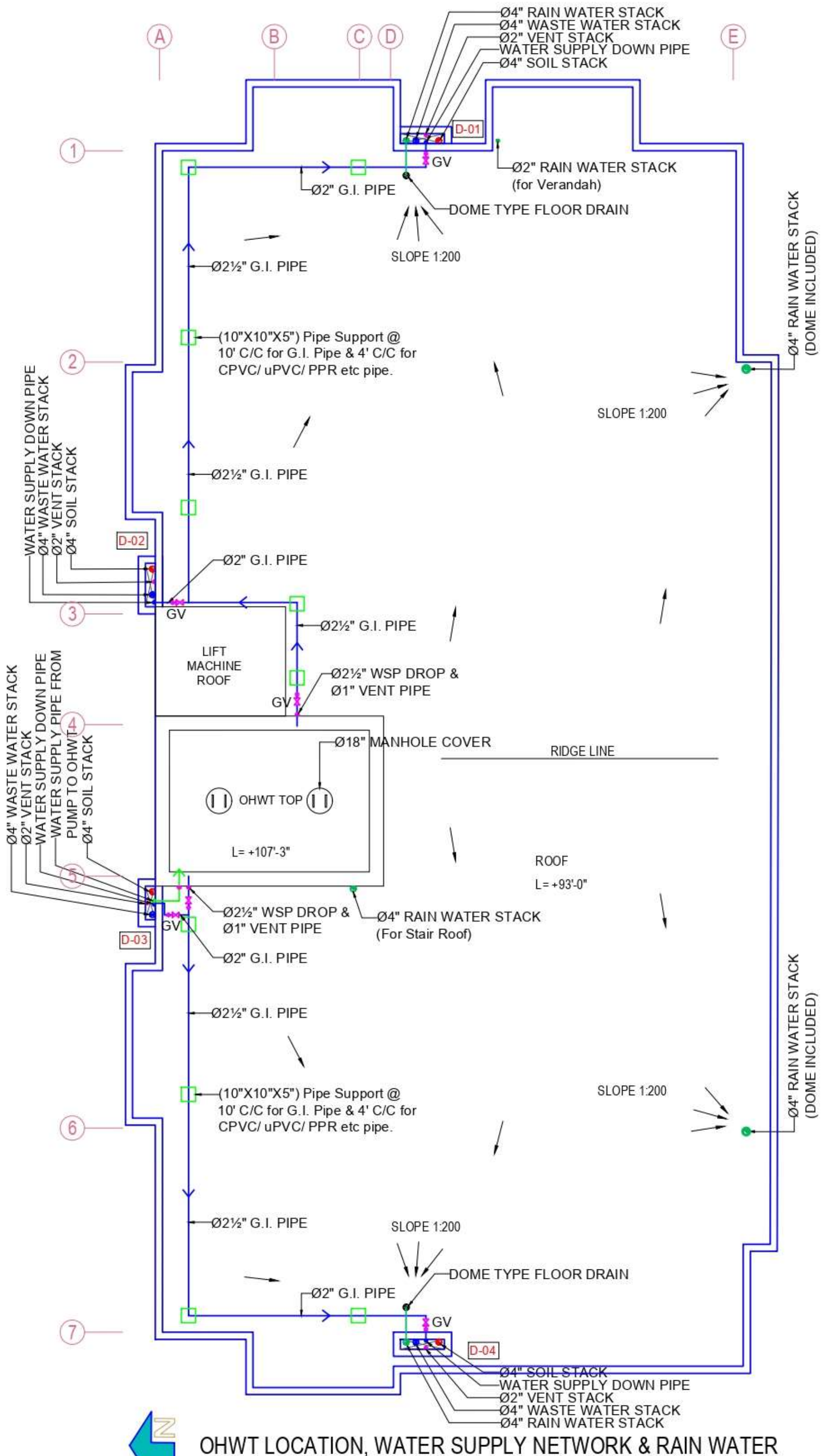



TOILET BLOCK LOCATION AT GROUND FLOOR PLAN & REFLECTED PIPE LAYOUT AT GROUND FLOOR CEILING

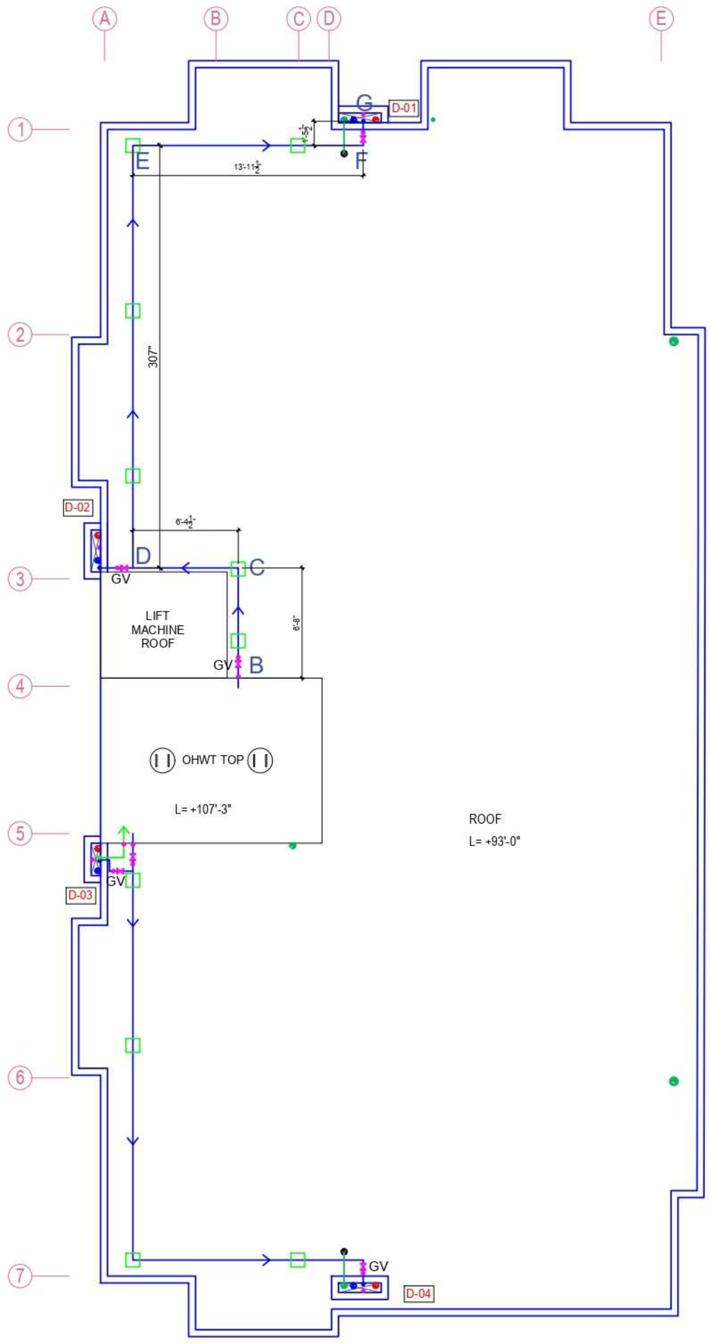
**CAD#02**


Ø4" RAIN WATER STACK
Ø4" WASTE WATER STACK
Ø2" VENT STACK
WATER SUPPLY DOWN PIPE
Ø4" SOIL STACK
VER 8'-7"X3'-6"
D-01
Ø2" RAIN WATER STACK
BED 13'-7"X12'-0"
TOILET-01 5'-0"X7'-6"
BLOCK-01
M.BED 12'-9"X12'-0"
Ø4" RAIN WATER STACK
WATER SUPPLY DOWN PIPE
Ø4" WASTE WATER STACK
Ø2" VENT STACK
Ø4" SOIL STACK
VER 8'-7"X2'-6"
KITCHEN-01 6'-6"X9'-0"
DINING 11'-1"X14'-4½"
BED 12'-9"X11'-2"
VER 5'-11"X3'-4"
BLOCK-02
D-02
TOILET-02 7'-0"X4'-11½"
LIVING 14'-11"X10'-3"
LIFT 5'-8"X5'-5"
LOBBY 10'-4"X6'-0"
Ø4" WASTE WATER STACK
Ø2" VENT STACK
WATER SUPPLY DOWN PIPE
WATER SUPPLY PIPE FROM PUMP TO OHWT
Ø4" SOIL STACK
STAIR 17'-7"X8'-0"
UP
DN
LIVING 14'-11"X10'-9"
TOILET-03 7'-0"X4'-11½"
D-03
BED 12'-9"X11'-2"
BLOCK-03
VER 9'-0"X2'-6"
KITCHEN-02 6'-6"X9'-0"
DINING 11'-1"X14'-4½"
VER 6'-6"X3'-4"
Ø4" RAIN WATER STACK
BED 13'-7"X12'-0"
M.BED 12'-9"X12'-0"
VER 6'-2"X3'-4"
TOILET-04 5'-0"X7'-2"
BLOCK-04
D-04
VER 8'-7"X3'-0"
Ø4" SOIL STACK
WATER SUPPLY DOWN PIPE
Ø2" VENT STACK
Ø4" WASTE WATER STACK
Ø4" RAIN WATER STACK
TOILET BLOCK LOCATION AT 1ST TO 8TH FLOOR PLAN

**CAD#03**

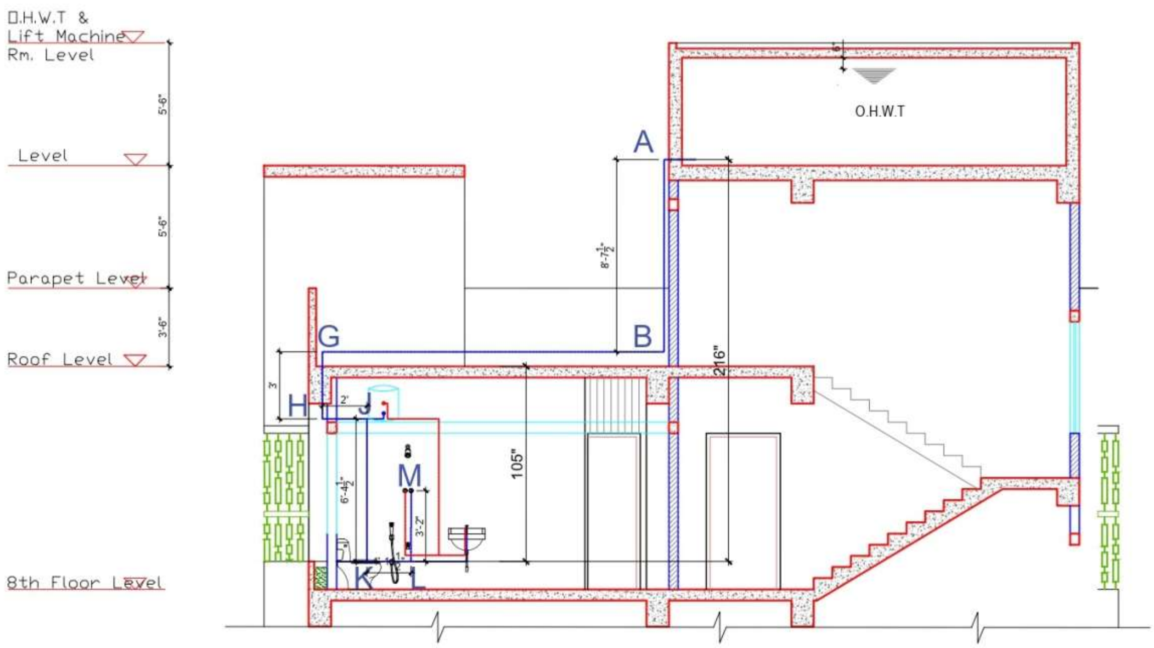

Ø4" RAIN WATER STACK
Ø4" WASTE WATER STACK
Ø2" VENT STACK
WATER SUPPLY DOWN PIPE
Ø4" SOIL STACK
D-01
GV
Ø2" RAIN WATER STACK
(for Verandah)
Ø2" G.I. PIPE
DOME TYPE FLOOR DRAIN
SLOPE 1:200
Ø2½" G.I. PIPE
Ø4" RAIN WATER STACK
(DOME INCLUDED)
(10"X10"X5") Pipe Support @
10' C/C for G.I. Pipe & 4' C/C for
CPVC/ uPVC/ PPR etc pipe.
WATER SUPPLY DOWN PIPE
Ø4" WASTE WATER STACK
Ø2" VENT STACK
Ø4" SOIL STACK
D-02
LIFT
MACHINE
ROOF
Ø2½" WSP DROP &
Ø1" VENT PIPE
Ø18" MANHOLE COVER
RIDGE LINE
OHWT TOP
L= +107'-3"
ROOF
L= +93'-0"
Ø4" WASTE WATER STACK
Ø2" VENT STACK
WATER SUPPLY DOWN PIPE
WATER SUPPLY PIPE FROM
PUMP TO OHWT
Ø4" SOIL STACK
D-03
Ø4" RAIN WATER STACK
(For Stair Roof)
D-04
OHWT LOCATION, WATER SUPPLY NETWORK & RAIN WATER
DISPOSAL SYSTEM AT ROOF PLAN

**CAD#04**

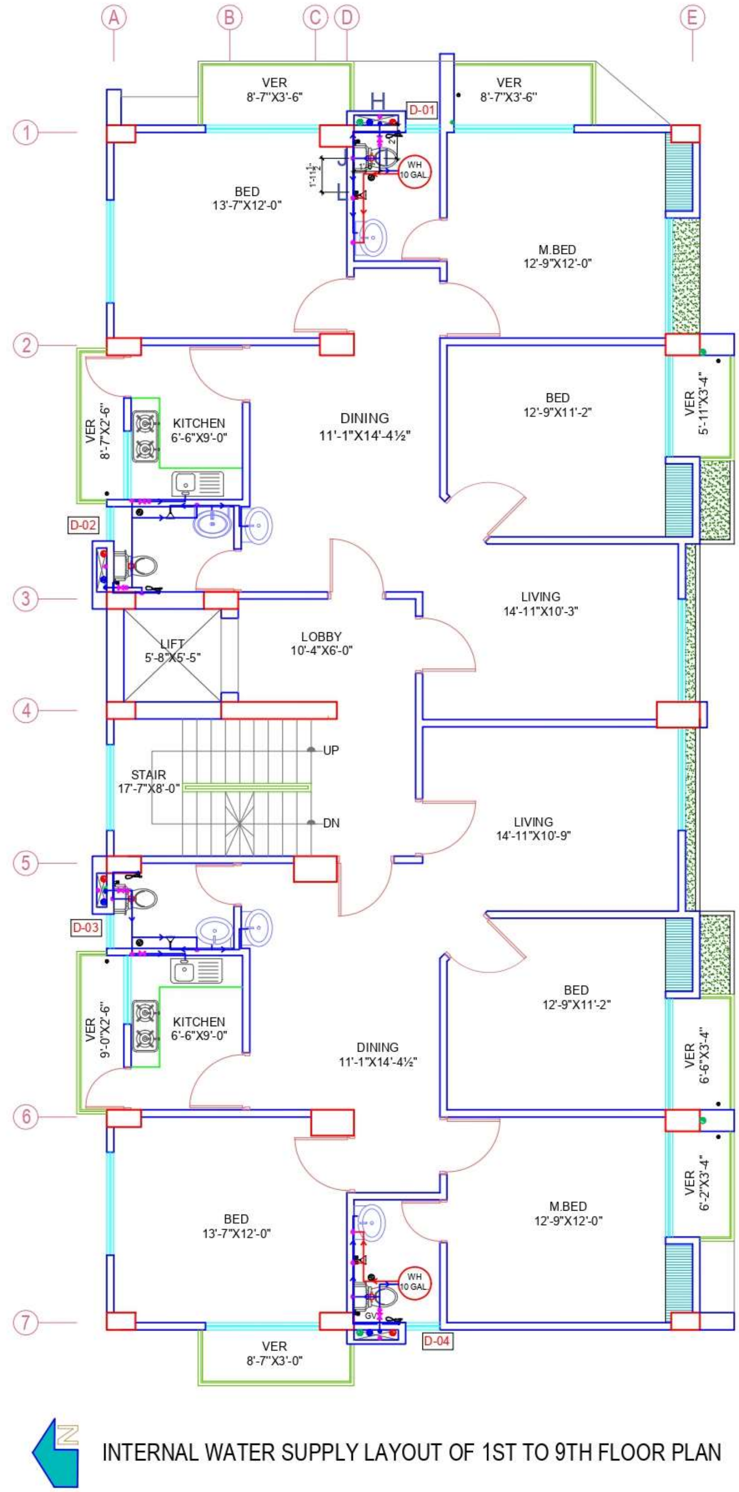



OHWT LOCATION, WATER SUPPLY NETWORK & RAIN WATER DISPOSAL SYSTEM AT ROOF PLAN

**CAD#05**

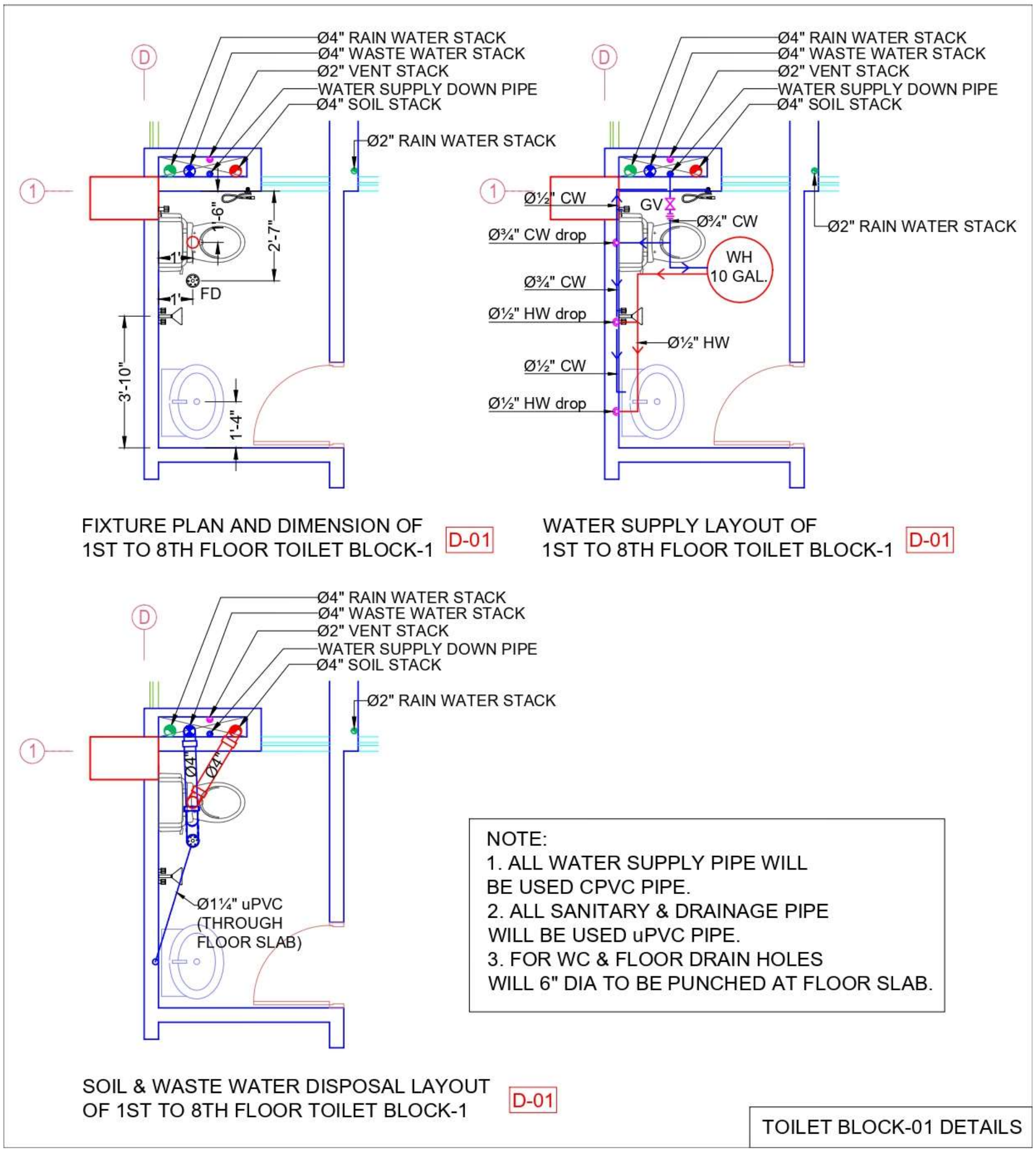

O.H.W.T &
Lift Machine
Rm. Level
Level
Parapet Level
Roof Level
8th Floor Level
5'-6"
5'-6"
3'-6"
O.H.W.T
A
B
G
H
J
M
K
L
8'-7½"
216"
105"
6'-4½"
3'-2"
2'
3

**CAD#06**




INTERNAL WATER SUPPLY LAYOUT OF 1ST TO 9TH FLOOR PLAN

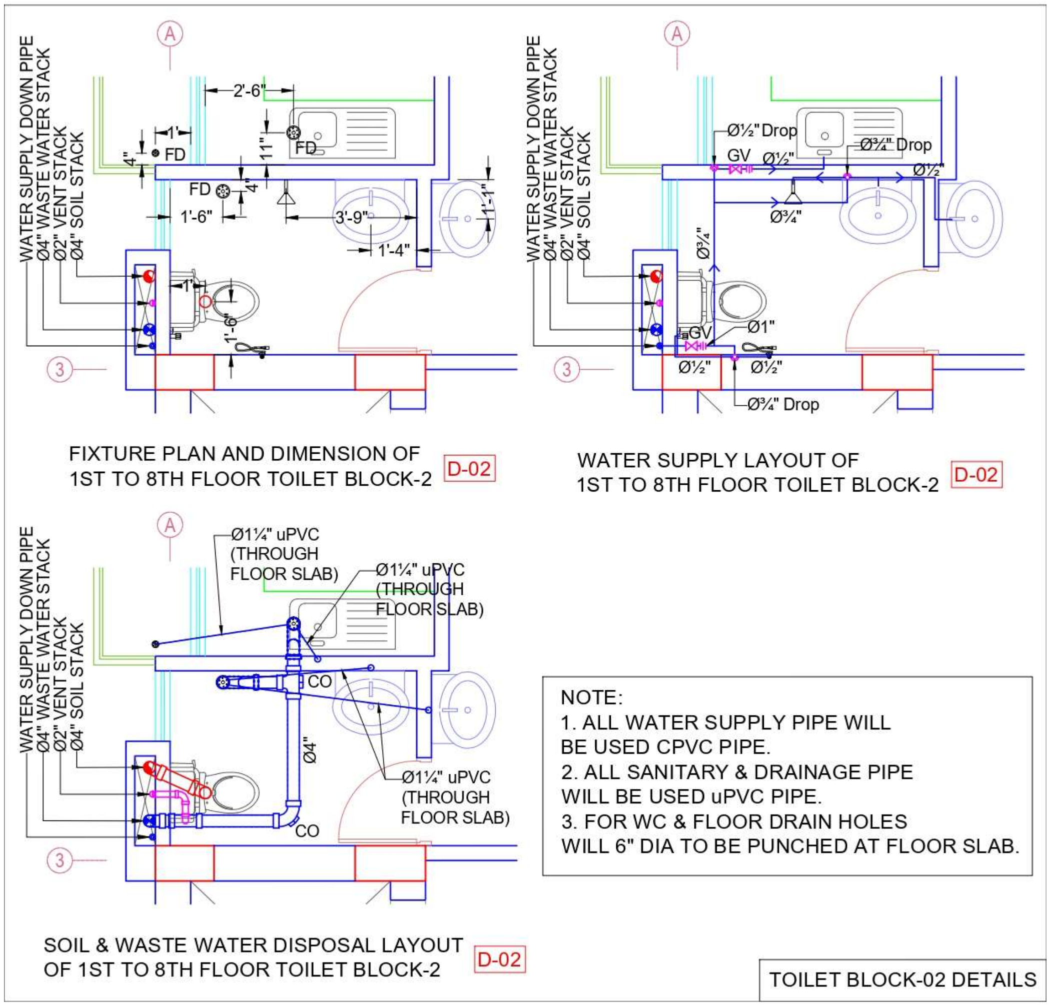
**CAD#07**


Ø4" RAIN WATER STACK
Ø4" WASTE WATER STACK
Ø2" VENT STACK
WATER SUPPLY DOWN PIPE
Ø4" SOIL STACK
Ø2" RAIN WATER STACK
FD
FIXTURE PLAN AND DIMENSION OF
1ST TO 8TH FLOOR TOILET BLOCK-1
D-01
Ø½" CW
GV
Ø¾" CW
Ø¾" CW drop
WH
10 GAL.
Ø¾" CW
Ø½" HW drop
Ø½" HW
Ø½" CW
Ø½" HW drop
WATER SUPPLY LAYOUT OF
1ST TO 8TH FLOOR TOILET BLOCK-1
D-01
Ø1¼" uPVC
(THROUGH
FLOOR SLAB)
NOTE:
1. ALL WATER SUPPLY PIPE WILL
BE USED CPVC PIPE.
2. ALL SANITARY & DRAINAGE PIPE
WILL BE USED uPVC PIPE.
3. FOR WC & FLOOR DRAIN HOLES
WILL 6" DIA TO BE PUNCHED AT FLOOR SLAB.
SOIL & WASTE WATER DISPOSAL LAYOUT
OF 1ST TO 8TH FLOOR TOILET BLOCK-1
D-01
TOILET BLOCK-01 DETAILS

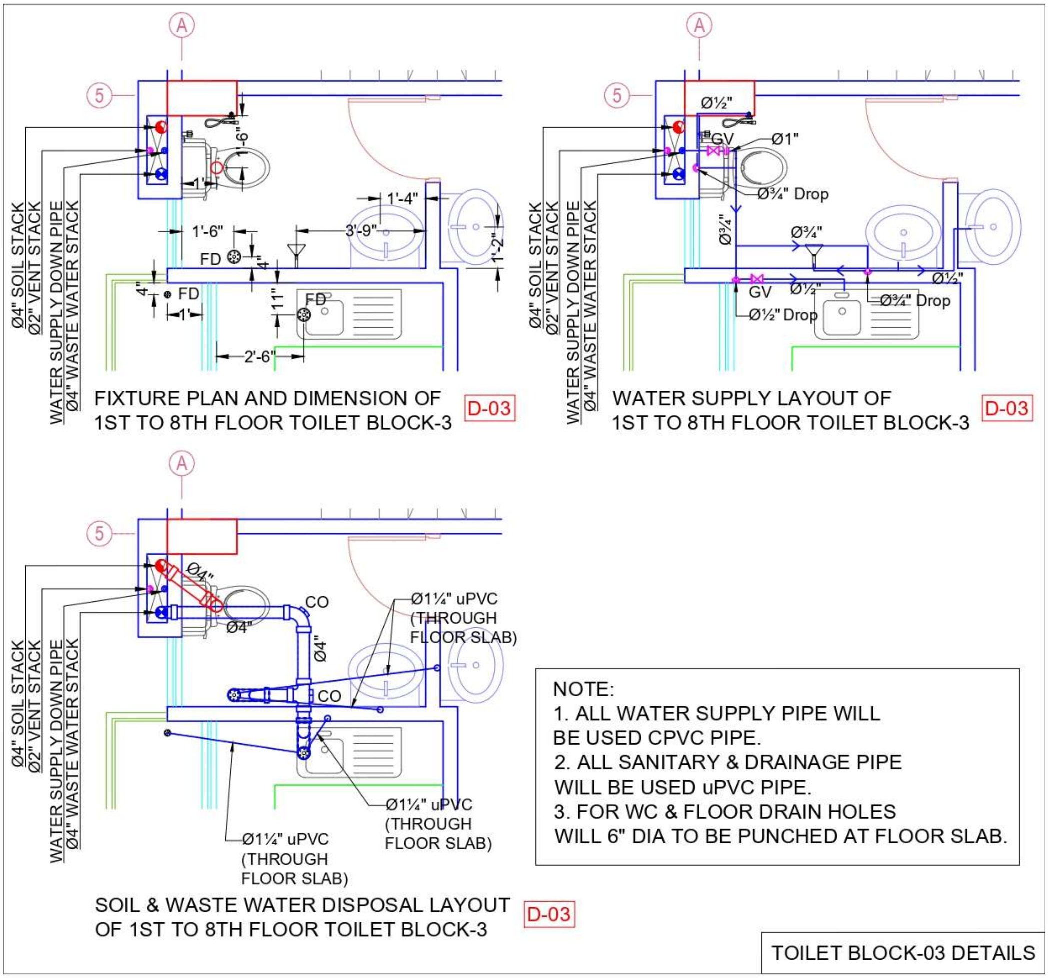
**CAD#08**

| DUCT-4 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FIXTURES | G.F | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | No. of Fixture | FU |
| Water closet / Long pan (flush tank) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 54 |
| Wash Basin (domestic) | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 8 |
| Kitchen sink | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Shower | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 32 |
| Bib cock | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1.5 |
| Laundry | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 27 |
| Floor trap | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 9 |

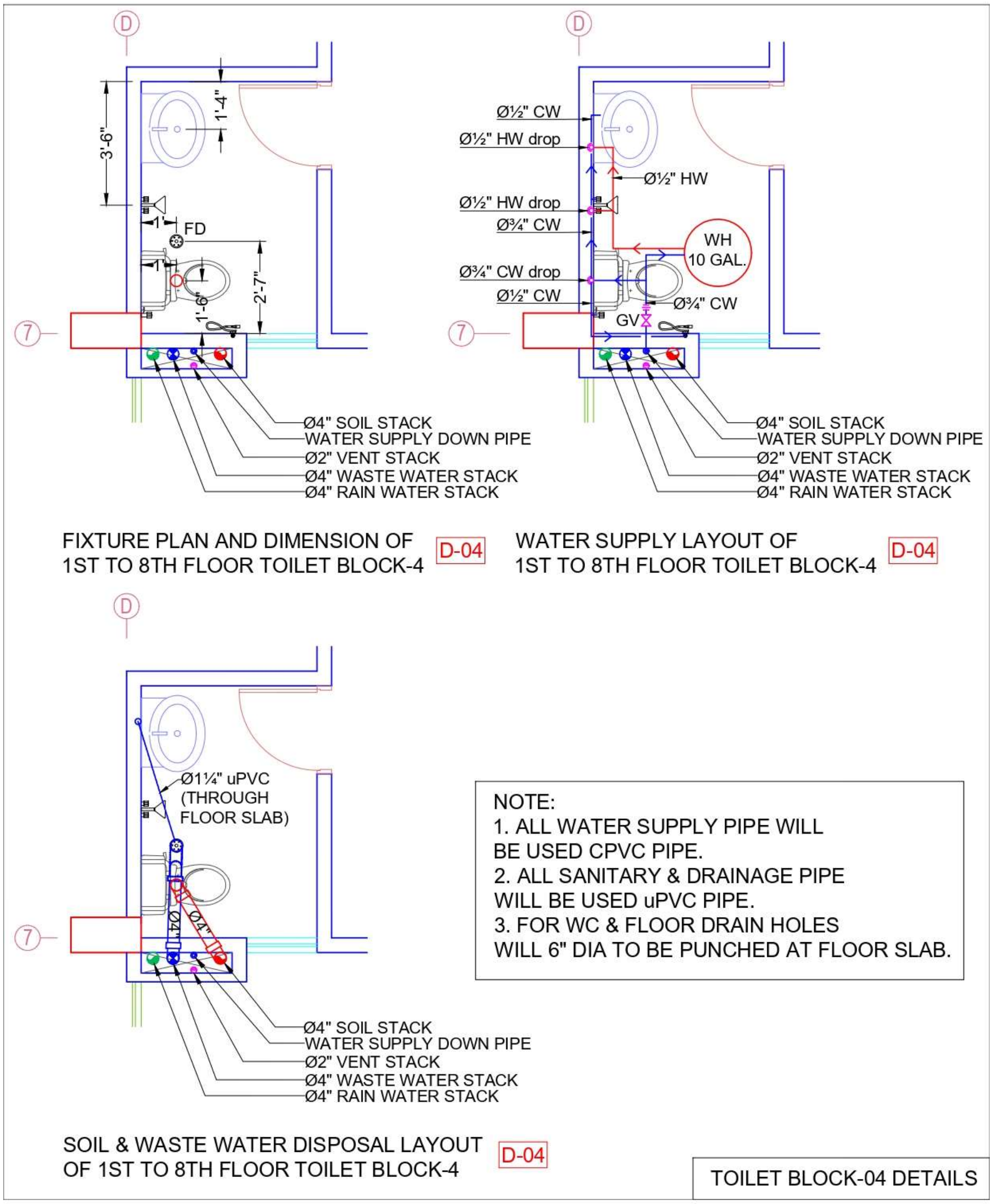

| DUCT-4 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FIXTURES | G.F | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | No. of Fixture | FU |
| Water closet / Long pan (flush tank) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 54 |
| Wash Basin (domestic) | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 8 |
| Kitchen sink | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Shower | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 32 |
| Bib cock | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1.5 |
| Laundry | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 27 |
| Floor trap | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 9 |


WATER SUPPLY DOWN PIPE
Ø4" WASTE WATER STACK
Ø2" VENT STACK
Ø4" SOIL STACK
FD
2'-6"
1'
11"
4"
1'-6"
3'-9"
1'-4"
1'-1"
FIXTURE PLAN AND DIMENSION OF
1ST TO 8TH FLOOR TOILET BLOCK-2
D-02
Ø½" Drop
GV
Ø½"
Ø¾" Drop
Ø¾"
Ø1"
Ø¾" Drop
WATER SUPPLY LAYOUT OF
1ST TO 8TH FLOOR TOILET BLOCK-2
D-02
Ø1¼" uPVC
(THROUGH
FLOOR SLAB)
CO
Ø4"
NOTE:
1. ALL WATER SUPPLY PIPE WILL
BE USED CPVC PIPE.
2. ALL SANITARY & DRAINAGE PIPE
WILL BE USED uPVC PIPE.
3. FOR WC & FLOOR DRAIN HOLES
WILL 6" DIA TO BE PUNCHED AT FLOOR SLAB.
SOIL & WASTE WATER DISPOSAL LAYOUT
OF 1ST TO 8TH FLOOR TOILET BLOCK-2
D-02
TOILET BLOCK-02 DETAILS

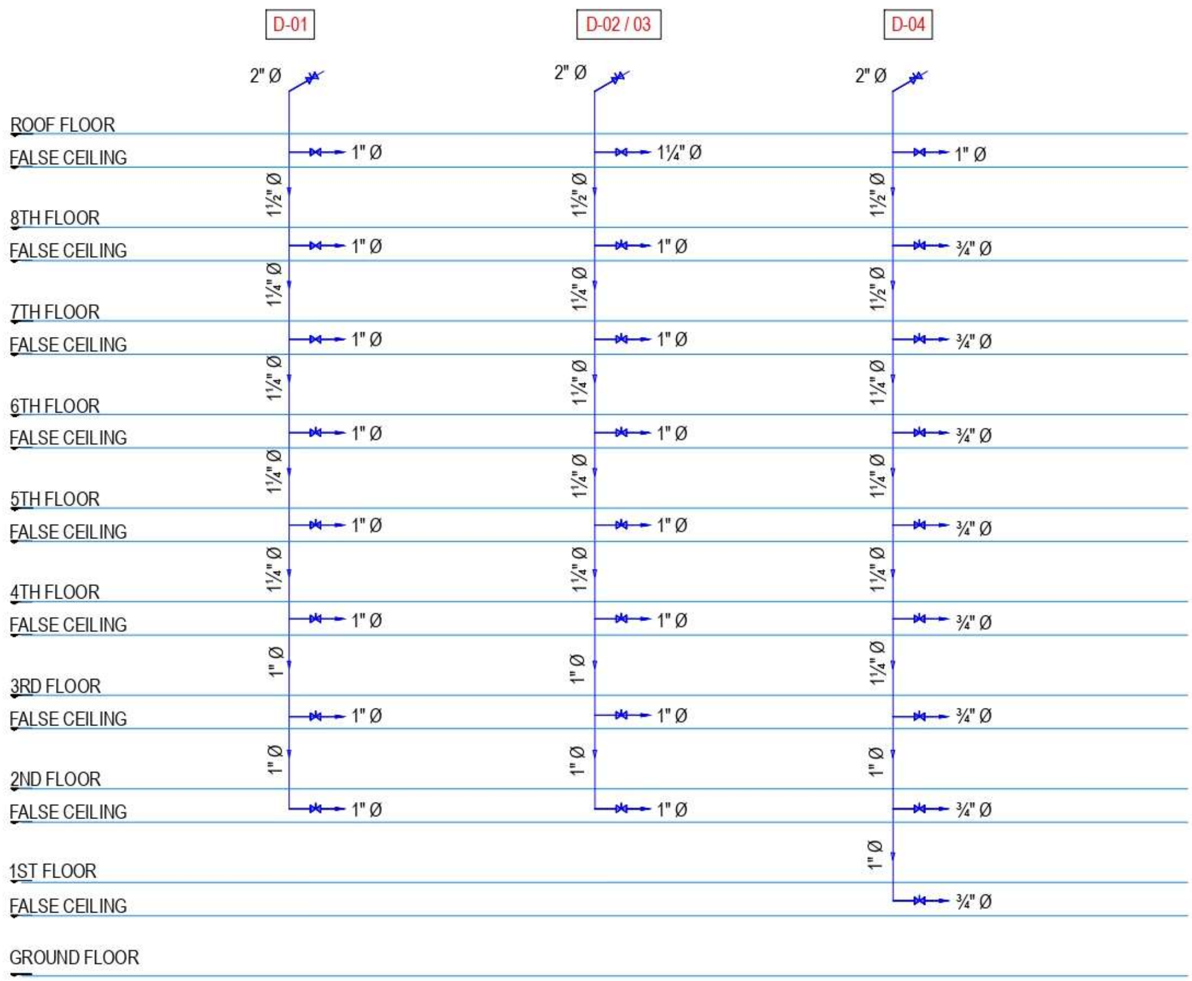
**CAD#09**


A
5
Ø4" SOIL STACK
Ø2" VENT STACK
WATER SUPPLY DOWN PIPE
Ø4" WASTE WATER STACK
1'-6"
1'
1'-4"
1'-6"
3'-9"
FD
4"
1'-2"
4"
FD
1'
11"
FD
2'-6"
FIXTURE PLAN AND DIMENSION OF
1ST TO 8TH FLOOR TOILET BLOCK-3
D-03
Ø½"
GV
Ø1"
Ø¾" Drop
Ø¾"
Ø¾"
GV
Ø½"
Ø½"
Ø¾" Drop
Ø½" Drop
WATER SUPPLY LAYOUT OF
1ST TO 8TH FLOOR TOILET BLOCK-3
D-03
Ø4"
CO
Ø4"
Ø4"
Ø1¼" uPVC
(THROUGH
FLOOR SLAB)
CO
Ø1¼" uPVC
(THROUGH
FLOOR SLAB)
Ø1¼" uPVC
(THROUGH
FLOOR SLAB)
NOTE:
1. ALL WATER SUPPLY PIPE WILL
BE USED CPVC PIPE.
2. ALL SANITARY & DRAINAGE PIPE
WILL BE USED uPVC PIPE.
3. FOR WC & FLOOR DRAIN HOLES
WILL 6" DIA TO BE PUNCHED AT FLOOR SLAB.
SOIL & WASTE WATER DISPOSAL LAYOUT
OF 1ST TO 8TH FLOOR TOILET BLOCK-3
D-03
TOILET BLOCK-03 DETAILS

**CAD#10**

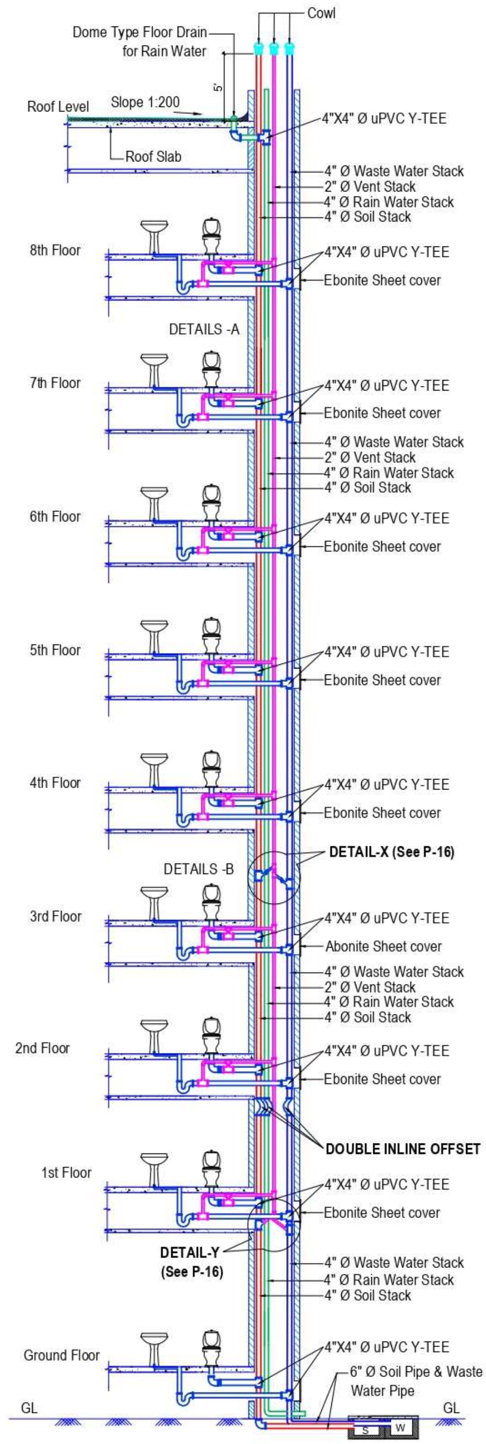

3'-6"
1'-4"
1'
FD
1'
2'-7"
1'-6"
Ø4" SOIL STACK
WATER SUPPLY DOWN PIPE
Ø2" VENT STACK
Ø4" WASTE WATER STACK
Ø4" RAIN WATER STACK
FIXTURE PLAN AND DIMENSION OF
1ST TO 8TH FLOOR TOILET BLOCK-4
D-04
Ø½" CW
Ø½" HW drop
Ø½" HW
Ø½" HW drop
Ø¾" CW
WH
10 GAL.
Ø¾" CW drop
Ø½" CW
Ø¾" CW
GV
Ø4" SOIL STACK
WATER SUPPLY DOWN PIPE
Ø2" VENT STACK
Ø4" WASTE WATER STACK
Ø4" RAIN WATER STACK
WATER SUPPLY LAYOUT OF
1ST TO 8TH FLOOR TOILET BLOCK-4
D-04
Ø1¼" uPVC
(THROUGH
FLOOR SLAB)
Ø4"
Ø4"
Ø4" SOIL STACK
WATER SUPPLY DOWN PIPE
Ø2" VENT STACK
Ø4" WASTE WATER STACK
Ø4" RAIN WATER STACK
NOTE:
1. ALL WATER SUPPLY PIPE WILL
BE USED CPVC PIPE.
2. ALL SANITARY & DRAINAGE PIPE
WILL BE USED uPVC PIPE.
3. FOR WC & FLOOR DRAIN HOLES
WILL 6" DIA TO BE PUNCHED AT FLOOR SLAB.
SOIL & WASTE WATER DISPOSAL LAYOUT
OF 1ST TO 8TH FLOOR TOILET BLOCK-4
D-04
TOILET BLOCK-04 DETAILS

**CAD#11**



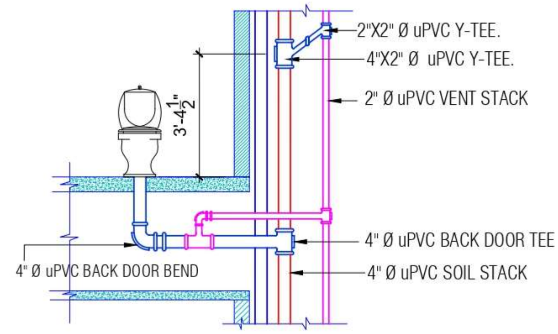

WATER SUPPLY FLOW DIAGRAM

**CAD#12**

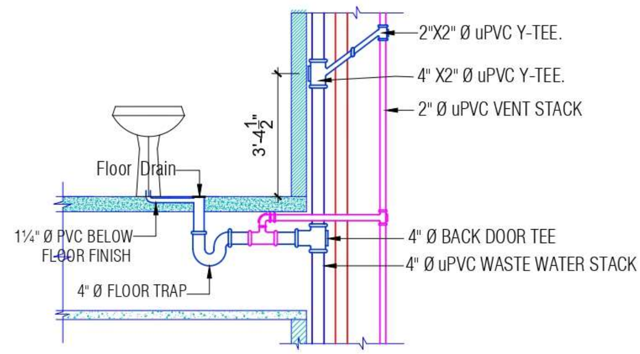



**SANITARY DRAINAGE STACK DIAGRAM**

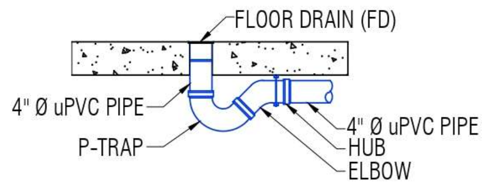
**CAD#13**




DETAIL-A: SOIL VENT

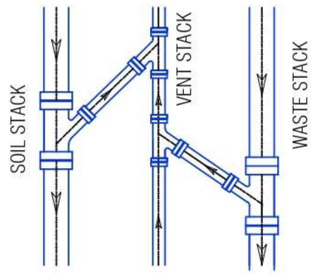



DETAIL-B: WASTE VENT

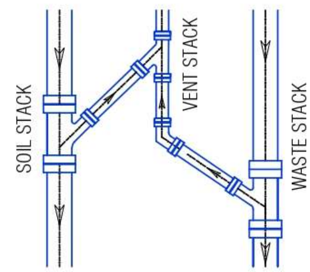



TYPICAL FLOOR DRAIN SYSTEM

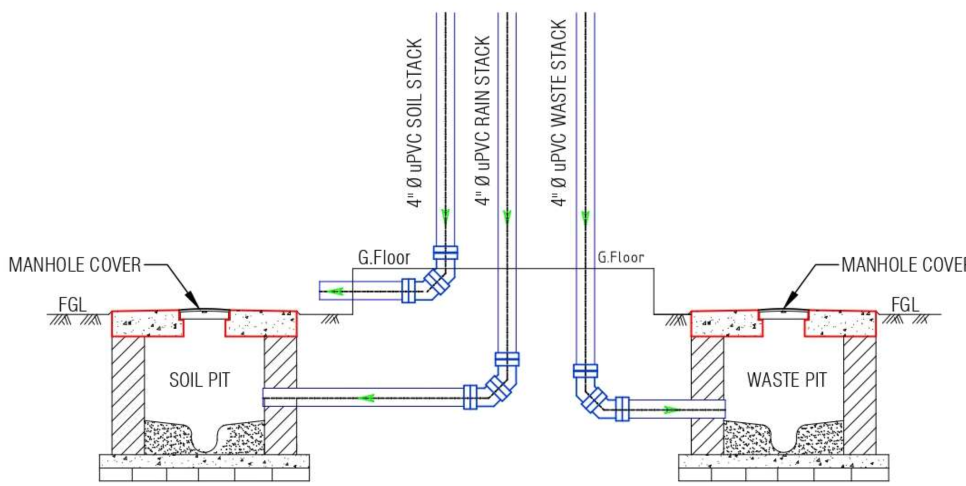
**CAD#14**




DETAIL OF " X "

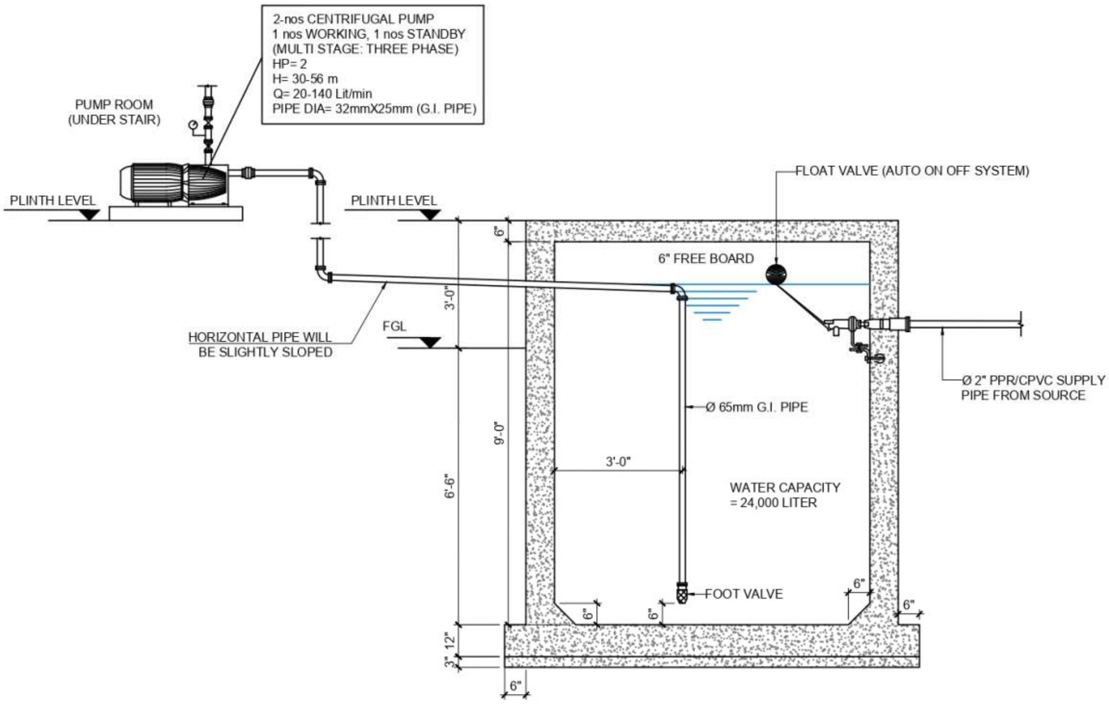



DETAIL OF " Y "

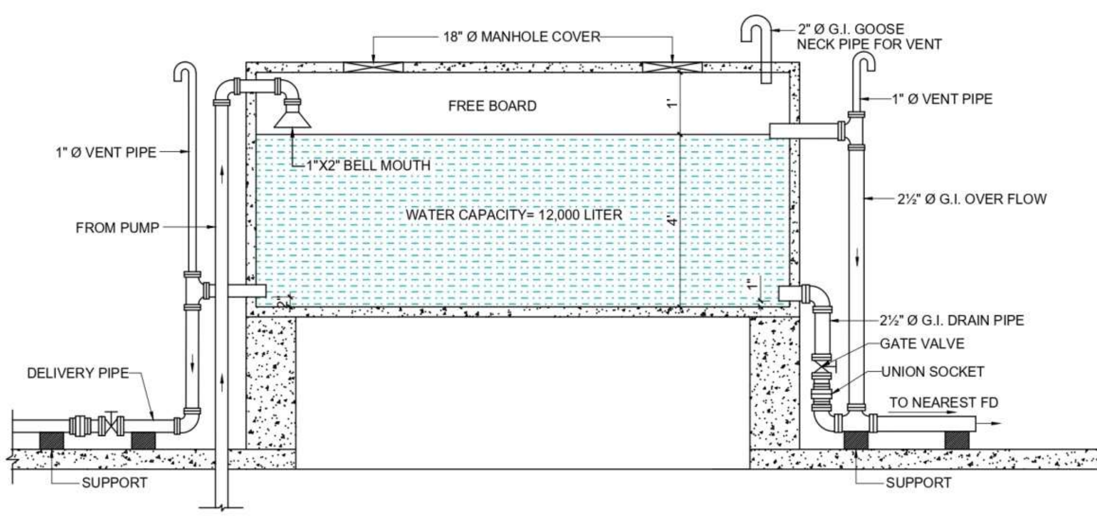



SHOWING STACK PIPE CONNECTION TO INSPECTION PIT

**CAD#15**

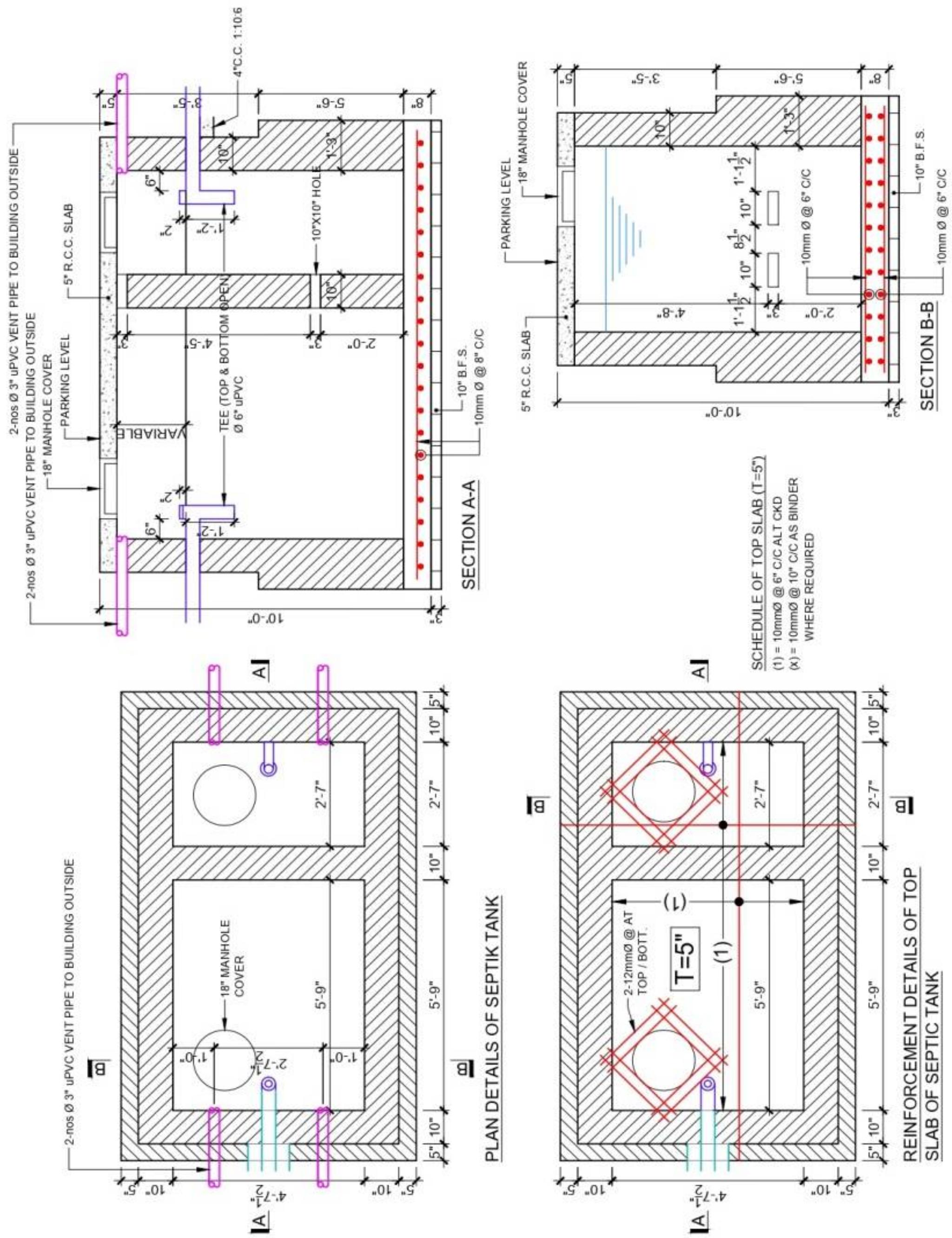



UNDERGROUND WATER RESERVOIR SECTION

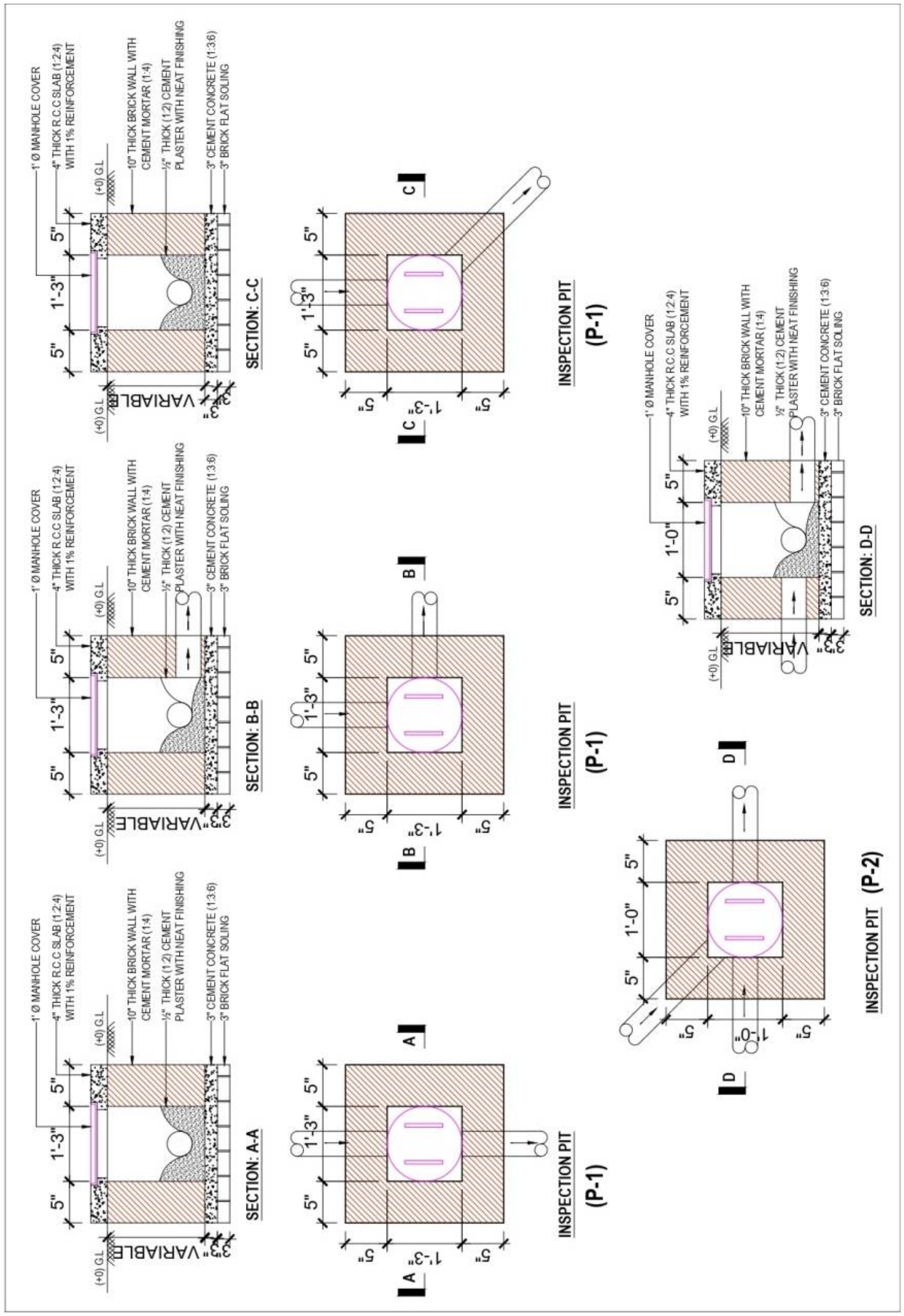



TYPICAL SECTION OF OVER HEAD WATER TANK

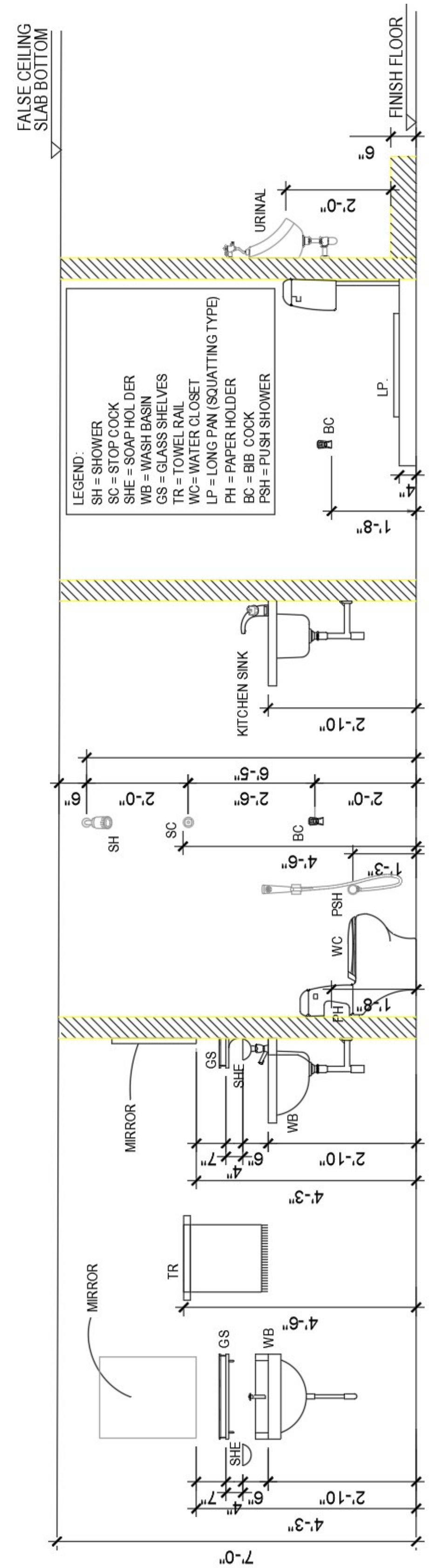
**CAD#16**


SECTION A-A
SECTION B-B
PLAN DETAILS OF SEPTIK TANK
REINFORCEMENT DETAILS OF TOP SLAB OF SEPTIC TANK
SCHEDULE OF TOP SLAB (T=5")
(1) = 10mmØ @ 6" C/C ALT CKD
(X) = 10mmØ @ 10" C/C AS BINDER WHERE REQUIRED
2-nos Ø 3" uPVC VENT PIPE TO BUILDING OUTSIDE
18" MANHOLE COVER
PARKING LEVEL
5" R.C.C. SLAB
TEE (TOP & BOTTOM OPEN) Ø 6" uPVC
10"X10" HOLE
4"C.C. 1:10:6
10" B.F.S.
10mm Ø @ 8" C/C
10mm Ø @ 6" C/C
2-12mmØ @ AT TOP / BOTT.
T=5"
VARIABLE

**CAD#17**


1' Ø MANHOLE COVER
4" THICK R.C.C SLAB (1:2:4) WITH 1% REINFORCEMENT
10" THICK BRICK WALL WITH CEMENT MORTAR (1:4)
½" THICK (1:2) CEMENT PLASTER WITH NEAT FINISHING
3" CEMENT CONCRETE (1:3:6)
3" BRICK FLAT SOLING
(+0) G.L
VARIABLE
SECTION: A-A
SECTION: B-B
SECTION: C-C
SECTION: D-D
INSPECTION PIT (P-1)
INSPECTION PIT (P-1)
INSPECTION PIT (P-1)
INSPECTION PIT (P-2)

**CAD#18**




PLUMBING FIXTURES TYPICAL SECTION

**CAD#19**