DESIGN AND COST ESTIMATION OF MEP SYSTEM FOR 4 STORIED RESIDENTIAL BUILDING
(Nikunjo Triplex)

A thesis by

Md. Masudur Rahman	: BME1901017474
Shawrov Sardar	: BME1903019166
Md. Mehedi Hasan	: ME2003022298
Md. Symon Nur Shanto	: ME2003022357
Md. Rejaur Rahman	: BME1701011355

Supervisor: M.A. FAISAL JUNAEAT IMRUL
Lecturer

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APPROVAL

This is to certify that the Project and Thesis Work (ME-400) Submitted by Md Masudur Rahman (Student id: BME1901017474), Md Shawrov Sardar (Student id: BME1903019166), Md. Mehedi Hasan (Student id: ME2003022298), Md. Symon nur shanto (Student id: ME2003022357) and Md Rejaur rahman (Student id: BME1701011355) entitled **"Design and cost estimation of Mep system for 4 storied residential building (Nikunjo Triplex) "** has been approved by the Examiners for the partial fulfillment of the requirements for the degree of Bachelor of science in Mechanical Engineering. Sonargaon University. Green road, Dhaka, Bangladesh.

M.A Faisal Junaeat Imrul
Lecturer
Department of Mechanical Engineering
Sonargaon University (SU)

STUDENT DECLARATION

This is to certify that the Thesis Report **"Design and cost estimation of Mep system for 4 storied residential building (Nikunjo Triplex) "** has been prepared as a part of completion of the Bachelor of Mechanical Engineering Program. I have discovered this paper very interesting, beneficial and insightful.

The entire Paper is based on our practical experience. I expect this paper to be informative as well as comprehensive. This thesis paper will help me a lot in my future career life.

Thank you very much for your guidance and cooperation during the course without which this thesis paper cannot be completed.

Moreover, if you have any further inquiries concerning any additional information, I would be very pleased to clarify that.

Yours Sincerely

Md. Masudur Rahman
Id No: BME1901017474

Md. Mehedi Hasan
Id No: ME2003022298

Shawrov Sardar
Id No: BME1903019166

Md. Symon nur shanto
Id No : ME2003022357

Md Rejaur rahman
Id No: BME1701011355

Dedication

To our parents and supervisor with heartfelt appreciation.

ACKNOWLEDGEMENT

"Allah, the Most Generous and the Almighty, is the one who deserves all the credit and glory for the successful completion of this thesis.

Initially, the authors would like to express their sincere gratitude and respect to the honorable lecturer and thesis supervisor, M.A Faisal Junaeat Imrul, of the Department of Mechanical Engineering at Sonargaon University (SU), Dhaka. His well-considered suggestions, timely advice, constant guidance, and encouragement have been invaluable throughout this research work.

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The authors acknowledge with thanks the contributions of all the authors and publishers of the books and journal articles referenced in this research.

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Finally, the authors express their deepest gratitude to their parents, whose unwavering support, sacrifice, and inspiration were the driving forces behind the successful completion of their thesis."

The Authors
Department of Mechanical Engineering
Sonargaon University (SU)
Dhaka, Bangladesh
May 2024

ABSTACT

This thesis presents a comprehensive design and cost estimation analysis of Mechanical, Electrical, and Plumbing (MEP) systems for a Design and cost estimation of Mep system for 4 storied residential building At Nikunjo Triplex. The aim of this study is to develop an efficient and cost-effective MEP design that meets the building's functional requirements, energy efficiency goals, and budget constraints.

The research methodology involved a detailed review of relevant literature, building codes, standards, and best practices related to MEP systems design for high-rise buildings. Based on this review, a systematic approach was adopted to develop the design parameters, system layouts, equipment selections, and cost estimation models for the MEP systems.

For the mechanical system, considerations were made for the HVAC (Heating, Ventilation, and Air Conditioning) system design, including load calculations, equipment sizing, ductwork layout, and energy efficiency measures. Various HVAC technologies and configurations were evaluated to optimize comfort levels while minimizing energy consumption and operational costs.

The electrical system design focused on power distribution, lighting design, and emergency backup systems. Load calculations, voltage drop analysis, and electrical safety standards were considered to ensure reliable and efficient electrical supply throughout the building.

In addition, plumbing and fire protection systems were designed to meet water supply, drainage, and fire safety requirements according to local regulations and industry standards. The plumbing design included pipe sizing, fixture selections, and water conservation measures, while the fire protection system comprised sprinkler systems, fire alarm systems, and emergency evacuation plans.

Cost estimation models were developed for each MEP system component, considering factors such as material costs, labor costs, equipment prices, and installation expenses. A comprehensive cost analysis was conducted to determine the total project budget and identify opportunities for cost optimization without compromising system performance or quality.

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NOMENCLATURE

BOD - bottom of duct	L – litre(s)
BOP - bottom of pipe	lav – lavatory
BOT - bottom	lbs – pounds
BP - back pressure	LT – laundry tray
B & S - bell-and-spigot	m – meter(s)
BSMT - basement	m2 – meters squared
BTU - British thermal unit	MJ – mechanical joint
BV - butterfly valve	WC – water closet (toilet)
oC - degrees Celsius	UR – urinal
C - condensate line	T&P – temperature and pressure relief
C to C - center to center	SS – service sink
CA - compressed air	SJ – slip joint or soldered joint
CAL - calorie	SH – shower
CAP - capacity	RD – roof drain
CD - condensate drain	Psig – pounds per square inch gauge
CF - chemical feed, cubic foot	Psia – pounds per square inch absolute
CFH - cubic feet per hour	Psi – pounds per squared inch
CFM - cubic feet per minute	PRV – pressure relief valve or pressure reducing valve
CI - cast iron	PP-R – polyvinyl chloride
CIRC - circular	PEX – crosslinked polyethylene
CL - center line	PE – polyethylene
CM - centimetre	mm – millimeters
CM2 - square centimetre	**NFPA:** National Fire Protection Association
CO - clean out	BNBC – Bangladesh National Building code
COL - column	ASHRAE: (American Society of Heating, Refrigerating and Air-Conditioning Engineers)
CONC - concrete, concentric	FPS – Fire Protection System
CONN - connect, connection	FDS – Fire Detection System
CONT - continuation	PM – Pump Room
CPVC - chlorinated polyvinyl chloride	MPS – Manual Pull Station
CR - condenser return	FP Fire Protection
CRW - chemical resistant waste	FS Flow Switch
CS - condenser supply	FT Foot or Feet
CTR - center	FV Flush Valve
CU - cubic	NC Normally Closed
CU FT. - cubic feet	NO Normally Open
CU IN. - cubic inches	PIV Post Indicator Valve
CV - check valve	PLBG Plumbing
CW - cold water	TS Tamper Switch

Table : 1.3

CHAPTER-1

Introduction

In the contemporary urban landscape, the design and implementation of Mechanical, Electrical, and Plumbing (MEP) systems are critical components in the construction of residential buildings. The efficiency, sustainability, and cost-effectiveness of these systems significantly impact the habitability and operational expenses of the building throughout its lifecycle. This thesis aims to delvelop into the intricate process of designing and estimating the costs associated with MEP systems for a specific context: a four-storied residential building located in Nikunjo Triplex.

1.1 Contextual Background

Nikunjo Triplex stands as a notable residential complex within its locality, characterized by its architectural significance and demographic diversity. As urbanization continues to shape the built environment, residential structures like those in Nikunjo Triplex face evolving demands for comfort, safety, and energy efficiency. Therefore, an in-depth understanding of MEP systems' design and cost implications becomes imperative to meet these demands effectively.

1.2 Overview

The primary objective of this thesis is to provide a comprehensive framework for the design and cost estimation of MEP systems tailored to the specific requirements of a four-storied residential building at Nikunjo Triplex. This involves: Conducting a thorough analysis of the building's architectural and structural characteristics to inform MEP system design.

- Identifying the key components and parameters of MEP systems, including heating, ventilation, air conditioning (HVAC), electrical, and plumbing systems, considering both technical specifications and local regulatory standards.
- Utilizing engineering principles and software tools to develop optimized designs that prioritize energy efficiency, occupant comfort, and sustainability.
- Performing detailed cost estimations for the procurement, installation, and maintenance of MEP systems, accounting for material costs, labor expenses, and long-term operational considerations.

Evaluating the economic feasibility and return on investment (ROI) of various MEP design options, with a focus on minimizing upfront capital expenditure while maximizing long-term savings and performance.

CHAPTER-2

Literature Review

The design and cost estimation of Mechanical, Electrical, and Plumbing (MEP) systems for residential buildings represent a critical aspect of contemporary architectural and engineering practices. This literature review aims to provide a comprehensive overview of the existing scholarship, methodologies, and best practices pertinent to MEP system design and cost estimation, particularly within the context of multi-story residential constructions such as the one proposed for Nikunjo Triplex.

2.1 Theoretical Frameworks of MEP System Design:

The theoretical underpinnings of MEP system design encompass a wide array of disciplines, including mechanical engineering, electrical engineering, and fluid dynamics. Researchers such as K. Yeomans and R. K. Wanhill have contributed significantly to this domain by elucidating the fundamental principles governing the design and operation of HVAC (Heating, Ventilation, and Air Conditioning) systems, plumbing networks, and electrical installations in residential buildings. Their works emphasize the importance of achieving thermal comfort, indoor air quality, and efficient energy utilization through the integration of advanced technologies and sustainable design strategies.

2.2 Regulatory Standards and Codes:

Compliance with regulatory standards and codes is paramount in ensuring the safety, durability, and performance of MEP systems in residential constructions. Scholars like J. Reynolds and R. E. Putnam have extensively documented the evolving landscape of building codes and standards, highlighting the critical role played by organizations such as the International Code Council (ICC), the National Fire Protection Association (NFPA), and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) in shaping the regulatory framework governing MEP system design. Their research underscores the necessity of adhering to these standards to mitigate risks associated with fire hazards, electrical faults, and plumbing failures.

2.3 Cost Estimation Methodologies:

Cost estimation forms an integral component of the MEP design process, necessitating the application of robust methodologies to forecast expenses accurately. Scholars such as W. D. Gosling and P. F. Ostwald have contributed seminal works on cost estimation techniques, including parametric estimation, analog estimation, and bottom-up estimation. Their research emphasizes the importance of accounting for material costs, labor costs, equipment costs, and overhead expenses when developing cost estimates for MEP systems. Moreover, advancements in Building Information Modeling (BIM) have facilitated more precise and collaborative cost estimation processes, enabling stakeholders to identify cost-saving opportunities and optimize project budgets.

2.4 Case Studies in Residential MEP Design:

Case studies offer valuable insights into the practical application of MEP design principles and cost estimation methodologies in real-world scenarios. Studies conducted by M. A. Altan and T. N. Wong have examined the challenges and solutions encountered in designing MEP systems for multi-story residential buildings, ranging from spatial constraints to energy efficiency considerations. These case studies underscore the importance of interdisciplinary collaboration, stakeholder engagement, and iterative design processes in achieving optimal outcomes in residential MEP design Projects.

CHAPTER- 3

Plumbing System

The plumbing system design for a 4-story residential building, such as an Nikunjo triplex, include ensuring safety, efficiency, and compliance. This involves:

- Safeguarding potable water sources and waste disposal.
- Optimizing water and energy usage.
- Meeting capacity demands for various uses.
- Implementing durable, accessible, and code-compliant systems.
- Integrating with other building systems.
- Enhancing fire protection measures.
- Promoting water quality and sustainability.
- Allowing for future expansion while maintaining cost-effectiveness.

3.1 Brief Report of Plumbing System

Project : 4-storied Residencial building of Nikunjo Triplex

Reference Standards.

REF-1 (BNBC-2021/Part-08/Chapter-05, 06, 07, 08)

3.2 Plumbing & Sanitary System:

Following utility System are covered in this project.

i. Room wise or floor wise pipe distribution system layout
ii. Horizontal, riser and floor pipe co-ordination system
iii. Supply water piping design to maintain certain pressure.
iv. Pump calculation layout
v. Overhead tank and distribution work with proper booster pump used
vi. Hot water distribution system
vii. Plumbing fixture installation system

3.2.1 Room wise or floor wise pipe distribution system layout

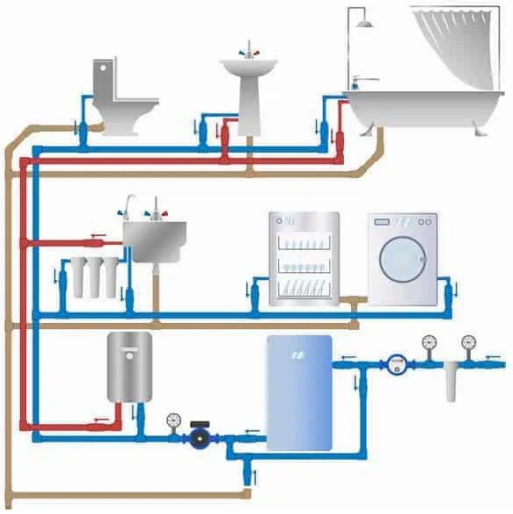


Figure 3.1 (REF-4)

Here's a general overview of how you might plan a plumbing system:

Floor Plan Analysis: Begin by analyzing the floor plans of each level of the building. Identify the locations of bathrooms, kitchens, utility rooms, and other areas that will require plumbing fixtures.

Water Supply Lines: Determine the main water supply entry point into the building. From there, plan the distribution of water supply lines to each floor and room. Consider the size of the pipes needed to ensure adequate water pressure and flow rate to each fixture.

Hot Water Distribution: If the building will have hot water, plan the distribution of hot water pipes from the water heater to each fixture that requires hot water. Consider installing recirculation systems to reduce wait times for hot water.

Drainage System: Plan the drainage system, including the location of drain pipes, vents, and cleanouts. Ensure proper slope for drainage pipes to facilitate the flow of wastewater to the main sewer or septic system.

3.2.2 Horizontal, riser and floor pipe co-ordination system

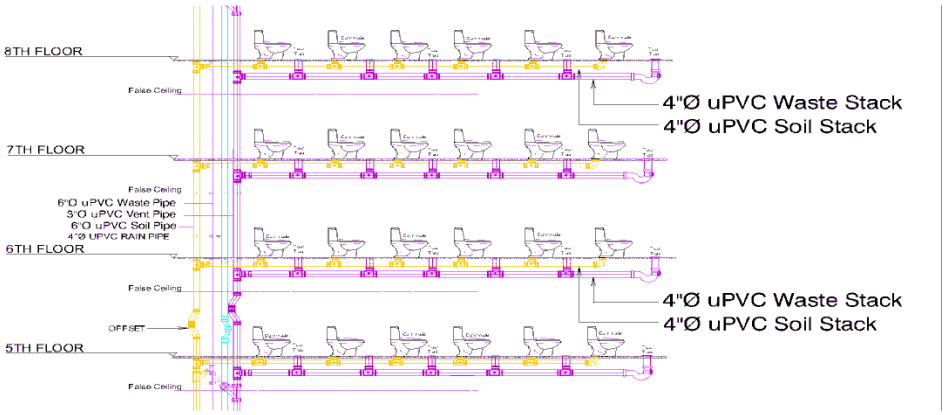


Figure 3.2

Coordinating plumbing systems involves three main components: horizontal pipes, which distribute water within each floor; riser pipes, which carry water vertically between floors; and floor pipes, which connect fixtures to the horizontal and riser systems.

Careful planning and alignment of these systems ensure efficient water distribution, drainage, and ventilation throughout the building. Key considerations include proper sizing, alignment, and compliance with building codes to create reliable and effective plumbing infrastructure.

3.2.3 Supply water Piping

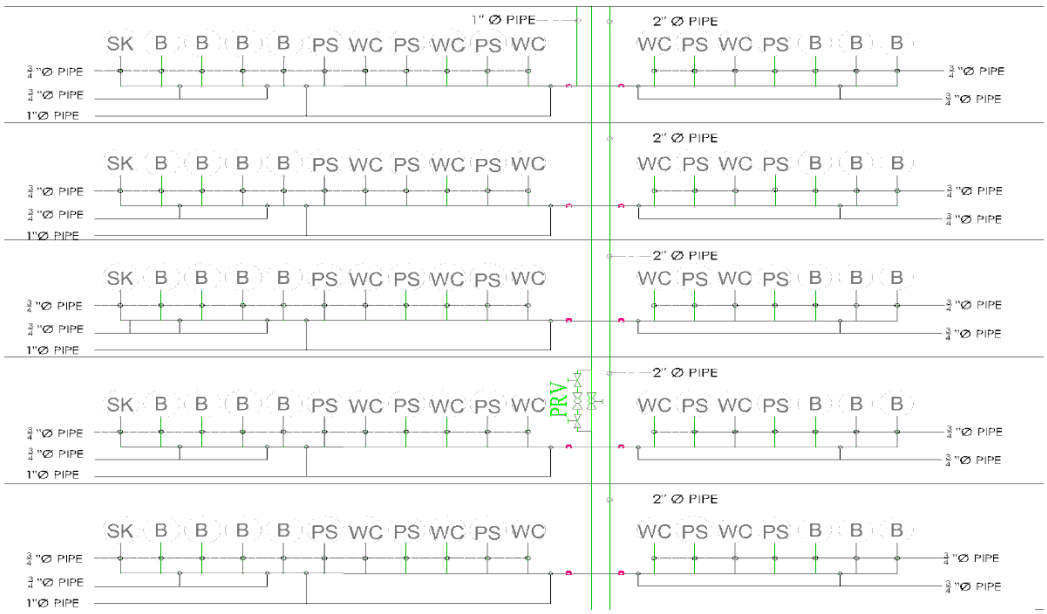


Figure 3.3

Designing a supply water piping system to maintain a certain pressure involves several considerations to ensure consistent and adequate water pressure throughout the building. Here's a short overview of the process:

Water Demand Analysis: Begin by determining the maximum water demand of the building. This includes considering factors such as the number of fixtures, their flow rates, and peak usage times.
Pressure Requirements: Identify the minimum acceptable pressure required at each fixture or point of use within the building. This could be influenced by factors such as building height, local regulations, and specific fixture requirements.

3.2.4 Pump layout

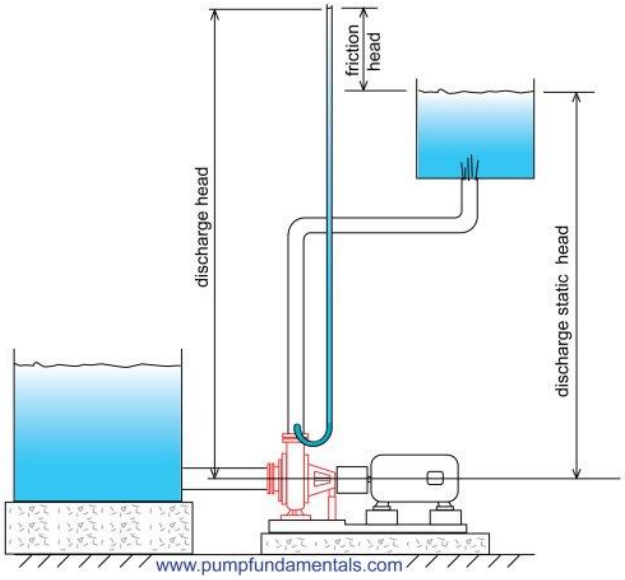


Figure 3.4 (REF-05)

A pump calculation layout involves determining the appropriate pump size and specifications needed to meet specific water supply requirements. By analyzing factors such as water demand, system head, and efficiency considerations, this layout ensures the selection of pumps optimized for performance and energy efficiency. This process results in a well-designed pumping system that delivers reliable water supply while minimizing energy consumption and operational costs.

3.2.5 Overhead tank and distribution work with proper booster pump used

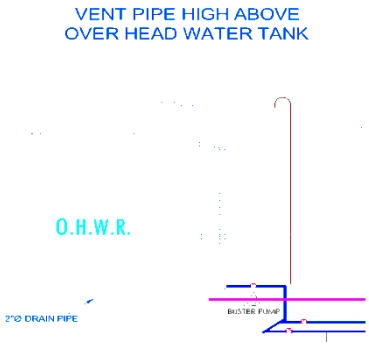


Figure 3.5

An overhead tank and distribution system, paired with a booster pump, ensures consistent water supply to buildings, especially in areas with low pressure. The system comprises an elevated tank storing water, with a booster pump that increases pressure for efficient distribution. Properly designed and installed, it guarantees reliable water flow to all points of use, enhancing convenience and functionality while addressing water pressure challenges effectively.

3.2.6 Plumbing fixture installation system

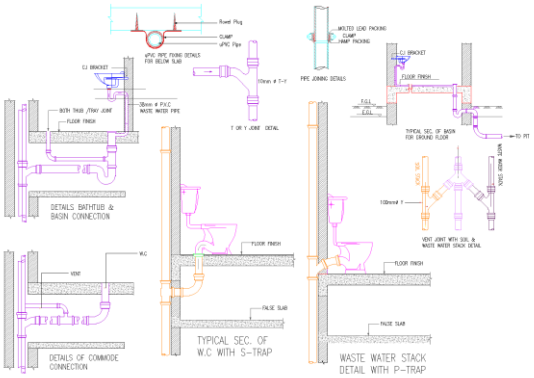


Figure 3.6

Plumbing fixture installation involves the proper placement and connection of fixtures such as

A. sinks,
B. toilets,
C. showers,
D. and appliances within a building's plumbing system

3.2.7 Rain water management system

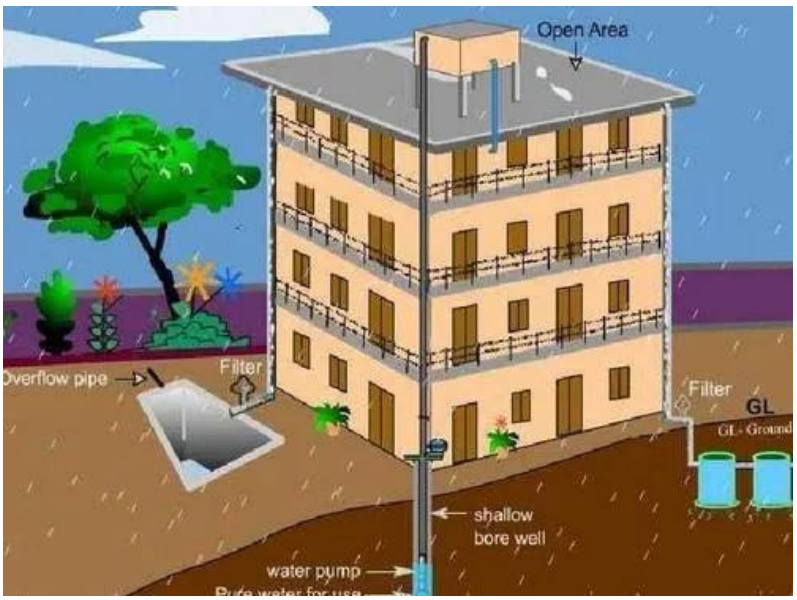


Figure 3.7 (REF-06)

A rainwater management system with a slotted drain system efficiently collects and directs rainwater away from surfaces to prevent flooding and erosion.

3.2.8 Soil and Waste Management.

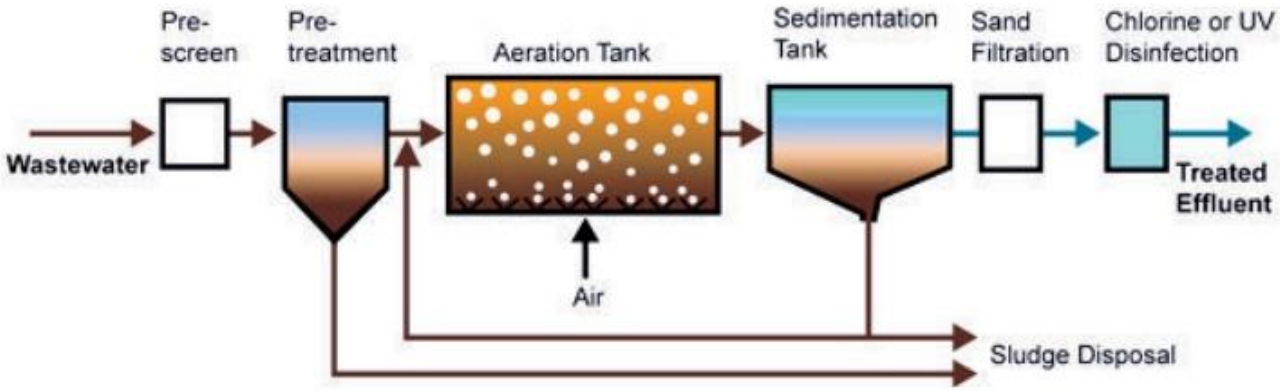


Figure 3.8 (REF-07)

The design of drainage piping depends on the load weight of all connected fixtures that might operate at any one time. The load weight in soil or waste pipes is related to the probability of usage of connected fixtures to those pipes. To estimate the load weight pipe, the relative load weight for different kinds of fixtures will as per BNBC. The maximum load weight of any piping in terms of fixture units may be estimated knowing the number and type of connected fixtures to a pipe using code.

The building drains and sewer shall be designed to discharge the peak simultaneously load weight flowing half-full with a minimum self-cleansing velocity of 0.75 m per second. However, flatter gradient may be used if required but the minimum velocity shall not be less than 0.6 meter per second. Again, undesirable to employ gradients giving a velocity of flow greater than 2.5 meter per second.

3.3 Plumbing Project Design And Drawings:

Name of Project : 4-storied Residential building of Nikunjo Triplex

We Designed the for a four story building, Showing how much water the building would requir, and how it would bd discharge

* Building Occupant 22 PERSONS (APPROXIMATE)
* Water Requirment :13,560 LITER Daily
* UGWR tank SIZE: 8'-4"X6'-10"X11'-5" (LxWxH)
* ACTIVE HEIGHT:9'-8"m
* CAPACITY:13,560 LITER
* Discharge Tank SIZE:6'-7"X4'-5"X7'-0" (LxWxH)
* ACTIVE HEIGHT:6'-0"
* CAPACITY: 5,046 LITER



PROJECT & PLUMBING INFORMATION

FOR
NIKUNJA TRIPLEX
AT
NIKUNJA

PROJECT NAME	:-	NIKUNJA TRIPLEX
PROJECT TYPE	:-	RESIDENTIAL BUILDING
LOCATION	:-	NIKUNJA, DHAKA
DESIGN TITLE	:-	PLUMBING DESIGN
TOTAL FLOOR	:-	2 STORIED WITH TWO BASEMENT
FLOOR INFORMATION	:-	BASEMENT-2:U.G.W.R & SUMP PIT BASEMENT-1:GENRAL STORE GROUND FLOOR:CAR PAERKING & RESIDENTIAL 1ST TO 2ND FLOOR:RESIDENTIAL
OCCUPANCY	:-	22 PERSONS (APPROXIMATE)
UNDER GROUND WATER RESERVOIR CAPACITY & SIZE	:-	SIZE:8'-4$\frac{1}{2}$"X6'-10"X11'-5" (LxWxH) ACTIVE HEIGHT:9'-8"m CAPACITY:13,560 LITER
OVER HEAD TANK CAPACITY & SIZE	:-	SIZE:5'-8"X5'-2"X6'-4" (LxWxH) ACTIVE HEIGHT:6'-0" CAPACITY:4,722 LITER
SEPTIC TANK CAPACITY & SIZE	:-	SIZE:6'-7"X4'-5"X7'-0" (LxWxH) ACTIVE HEIGHT:6'-0" CAPACITY:5,046 LITER

PLUMBING AND SANITARY LEGEND

SYMBOL	NAME
	uPVC SOIL STACK
	uPVC WASTE STACK
	uPVC RAIN STACK
	uPVC VENT STACK
	TREATED SUPPLY WATER RISER PIPE
	TREATED SUPPLY WATER RISER PIPE
	VERTICAL G.I. GAS PIPE
	FLOOR TRAP
	uPVC PLAIN BEND
	6" x 4" uPVC REDUCING TEE
	uPVC PLAIN TEE
	uPVC PLAIN Y-TEE
	6" x 4" uPVC REDUCING SOCKET
	uPVC P-TRAP
	OFFSET
	uPVC WASTE STACK with S-TRAP

SYMBOL	NAME
	uPVC SOIL PIPE
	uPVC WASTE WATER PIPE
	uPVC RAIN WATER PIPE
	uPVC VENT PIPE
	GEYSER
	GATE VALVE
	SUPPLY WATER PIPE
	SUPPLY WATER PIPE
	HOT WATER PIPE
	WASTE PIT
	SOIL PIT
	RAIN PIT
	MASTER PIT
	45° uPVC PLAIN BEND
	Cross Tee
	GAS LEAKAGE DETECTOR

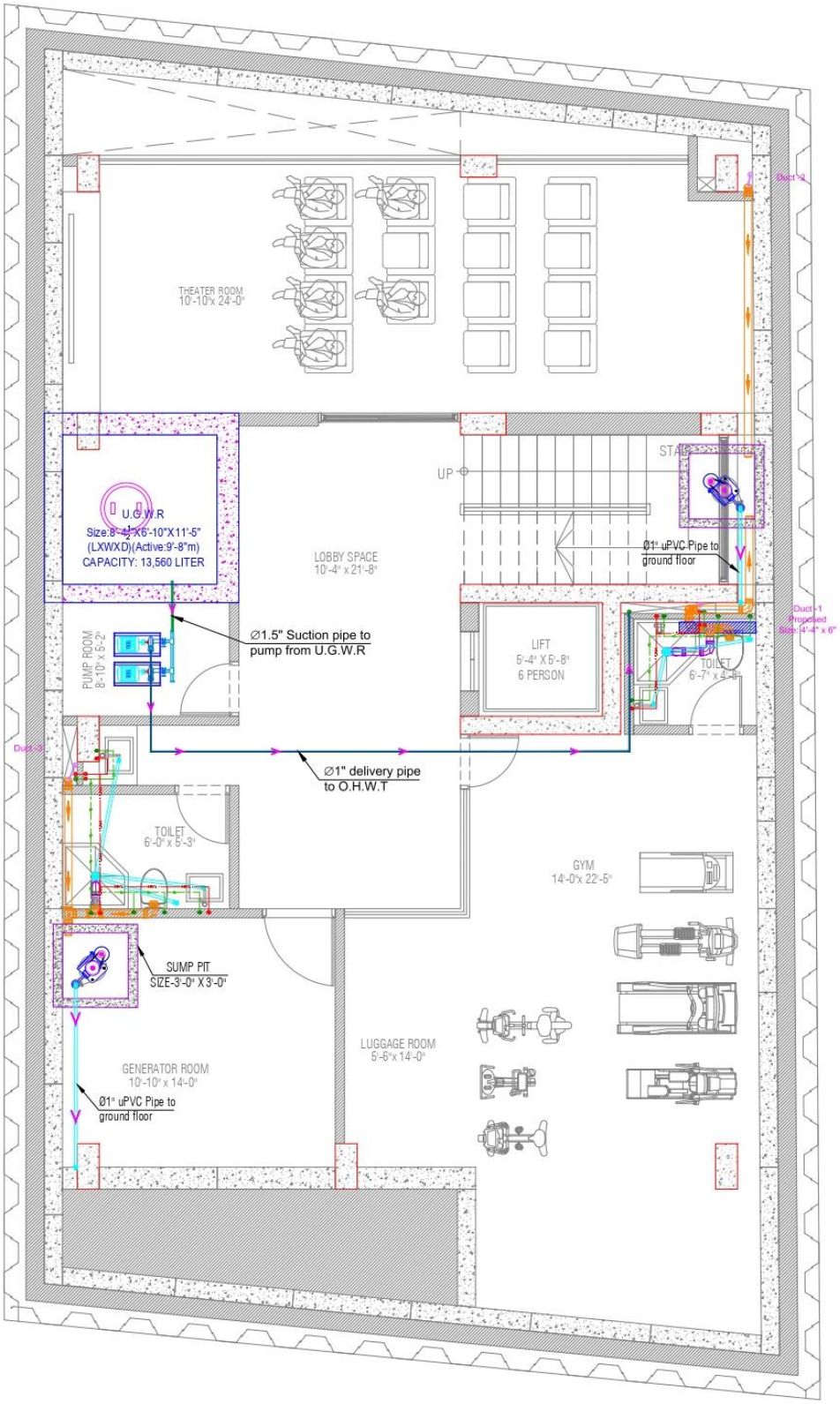
SYMBOL	NAME
B	BASIN
WC	WATER CLOSET
PS	PUSH SHOWER
SP	SHOWER POINT
T	TAP
BT	BATH TAP
KS	KITCHEN SINK
HT	HOUSE TAP
CW	CAR WASH

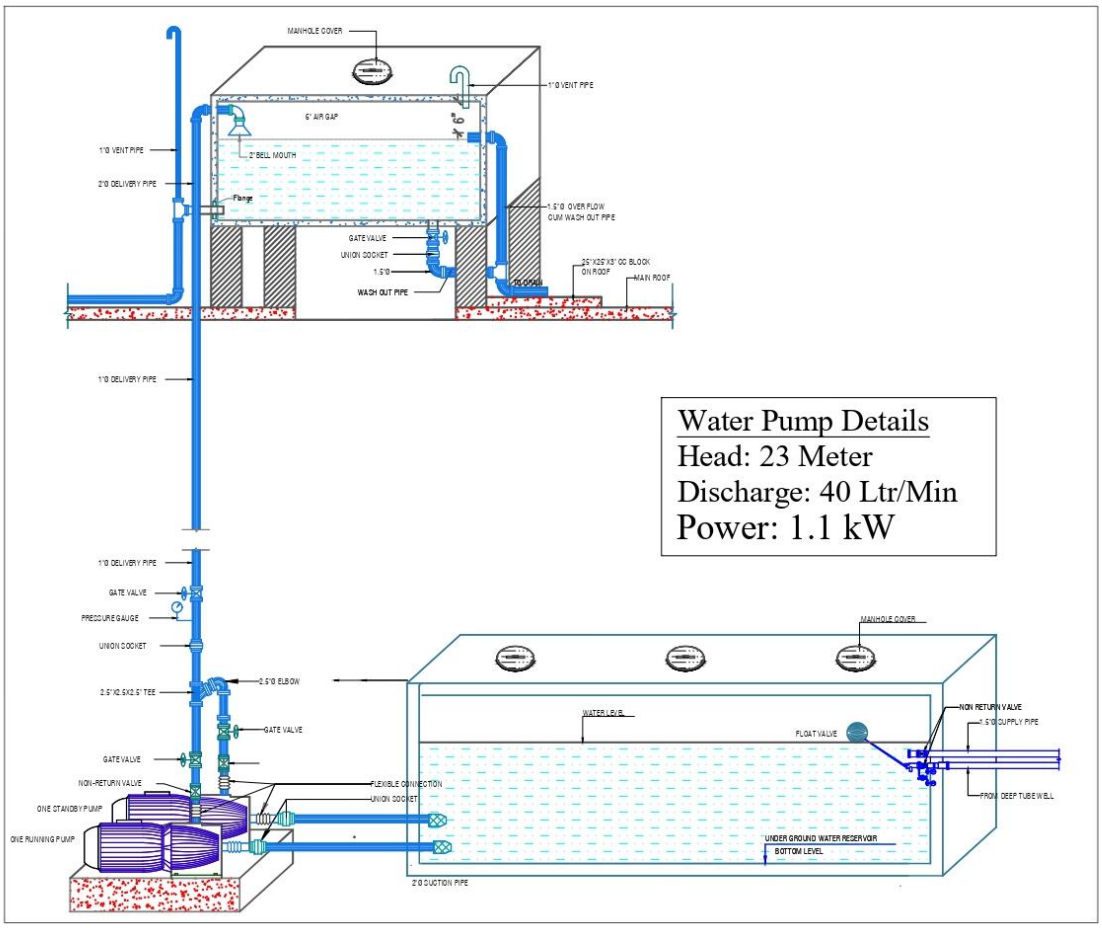
PLUMBING GENERAL NOTE:

01	SIZE AND LOCATION OF PITS MAY BE CHANGED DEPENDING ON SITE CONDITION.
02	2" or 4" uPVC VENT STACK MUST CONNECT THE SOIL AND WASTE STACK.
03	STRUCTURAL DESIGN SHOULD BE PREPARED BY THE STRUCTURAL ENGINEER.
04	THIS DESIGN CAN'T BE CHANGED WITHOUT OUR PERMISSION.
05	IF DESIGN OR DRAWING CHANGED WITHOUT OUR PERMISSION WHAT PROBLEM WILL OCCUR WE OR THIS COMPANY IS NOT RESPONSIBLE.

CO-ORDINATION OF PLUMBING, SUMP PIT & U.G.W.R LOCATION LAYOUT OF BASEMANT-02

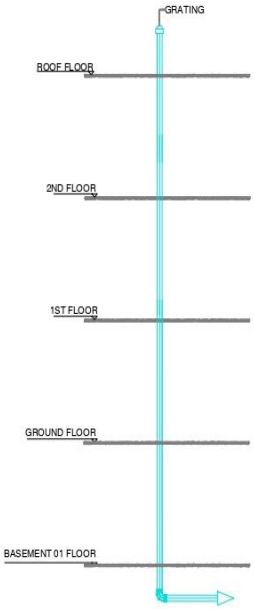
SCALE:- NOT TO SCALE



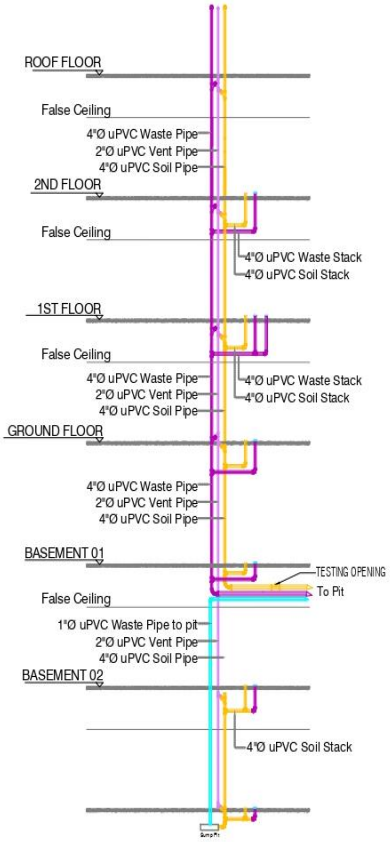


ISOMETRIC VIEW FOR PUMP INSTALLATION

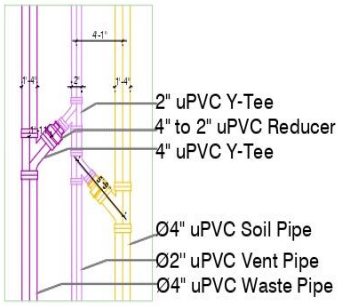
Ø4" RAIN PIPE



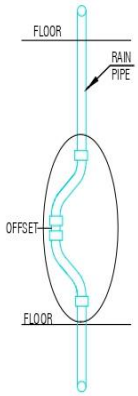
DUCT-01



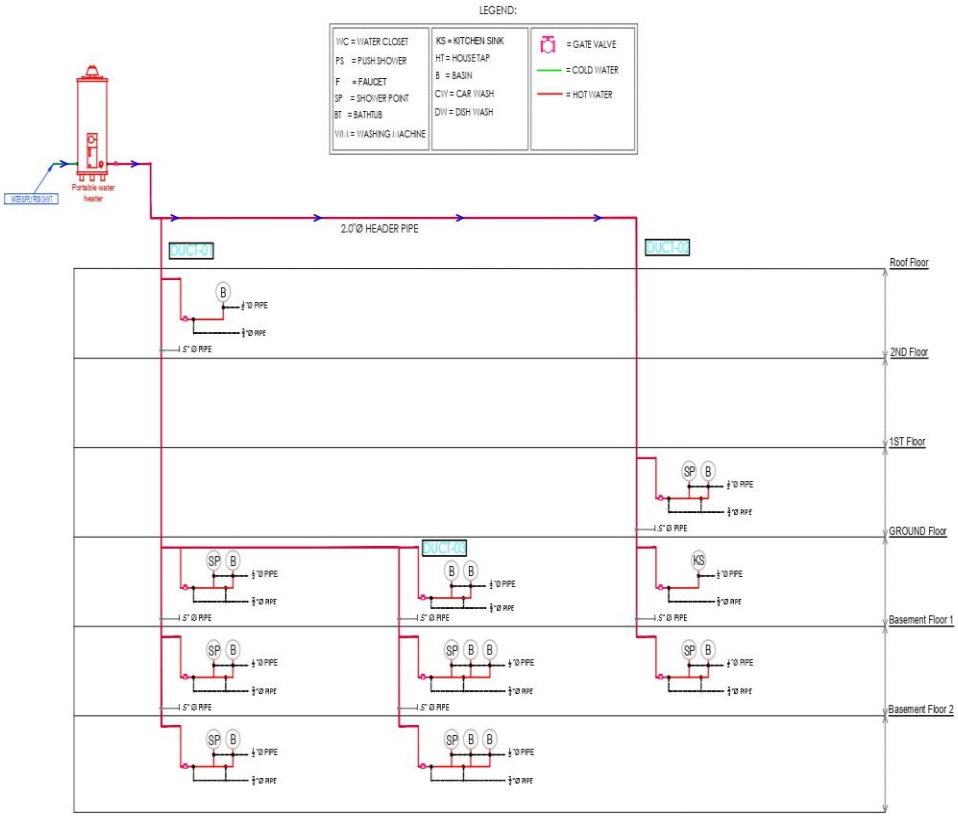
VENT CONNECTION DETAILS



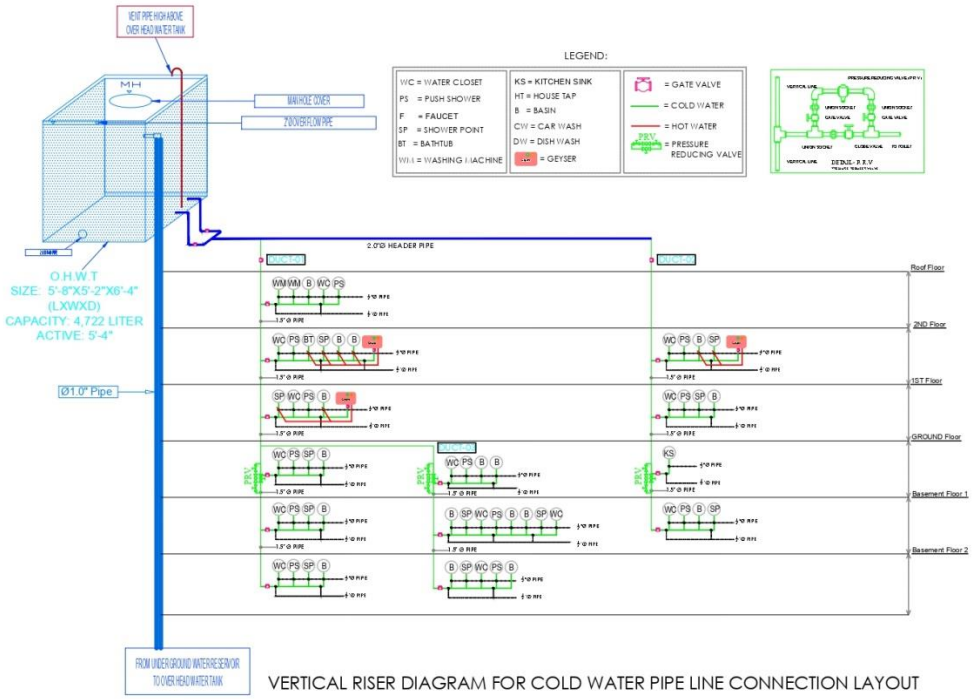
OFFSET DETAILS



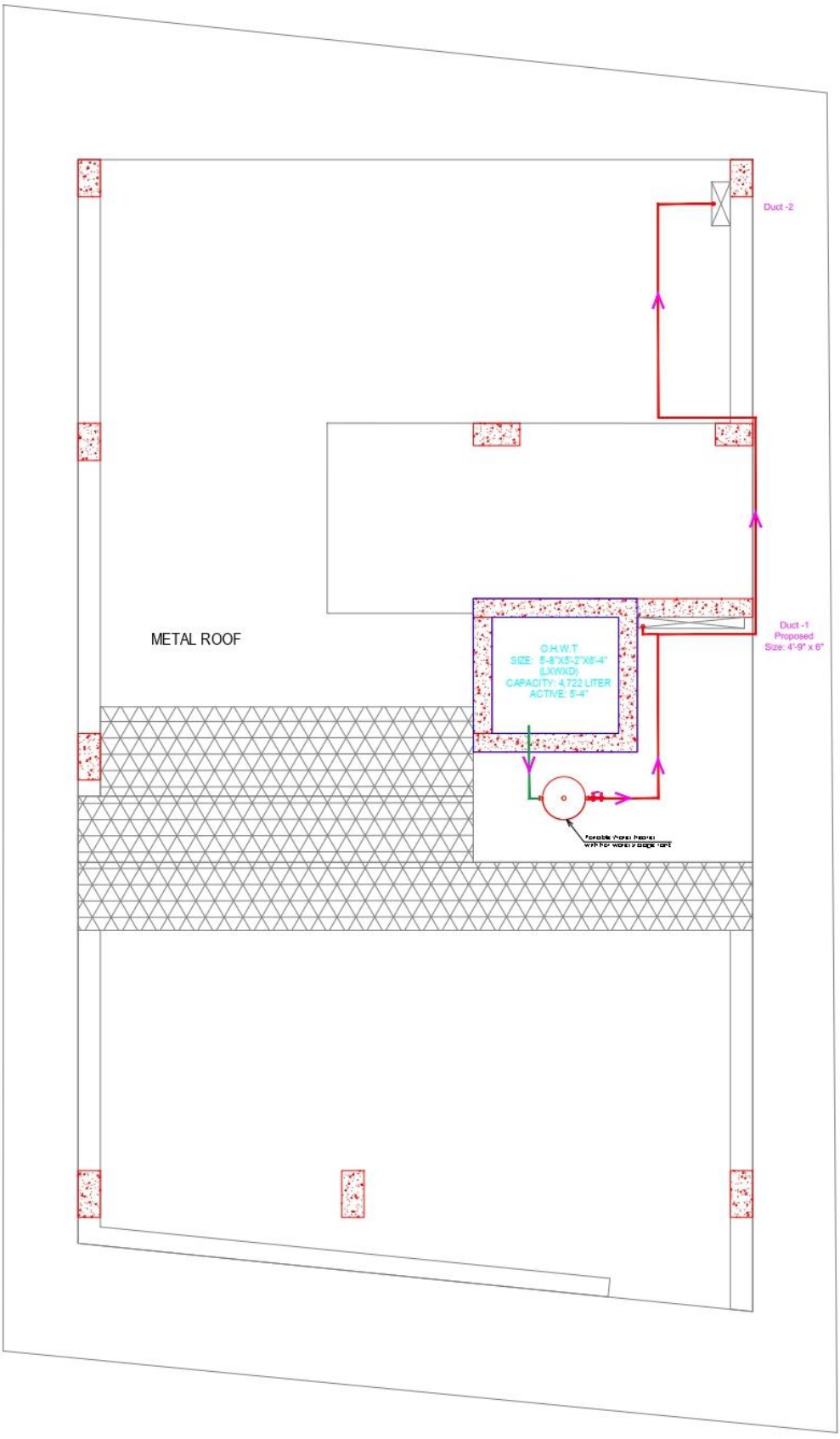
VERTICAL DIAGRAM FOR SOIL,WASTE,VENT AND RAIN STACK CONNECTION



VERTICAL RISER DIAGRAM FOR HOT WATER PIPE LINE CONNECTION LAYOUT

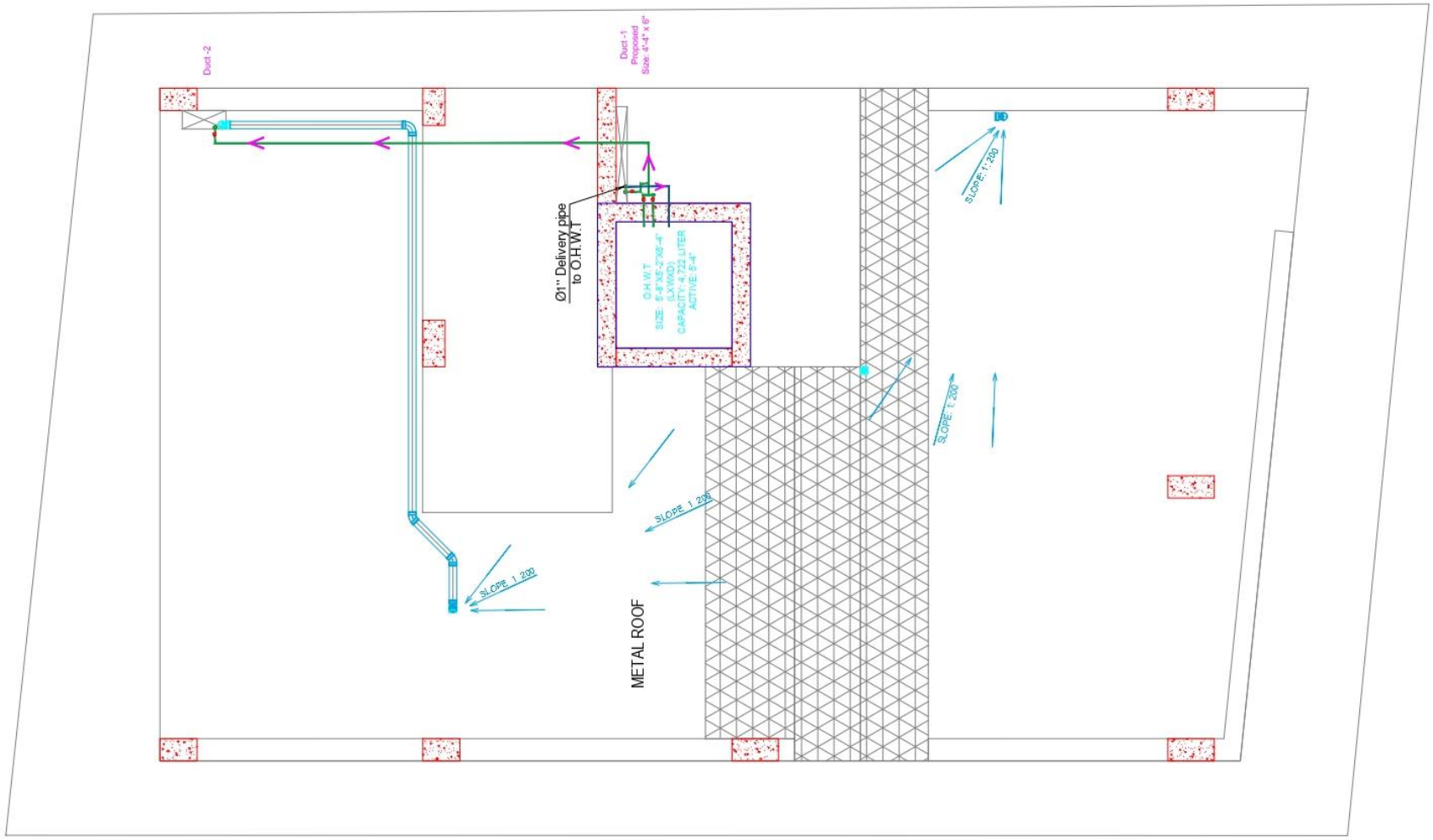


VERTICAL RISER DIAGRAM FOR COLD WATER PIPE LINE CONNECTION LAYOUT



HOT WATER SUPPLY LINE CONNECTION LAYOUT AT ROOF TOP FLOOR

SCALE:- NOT TO SCALE

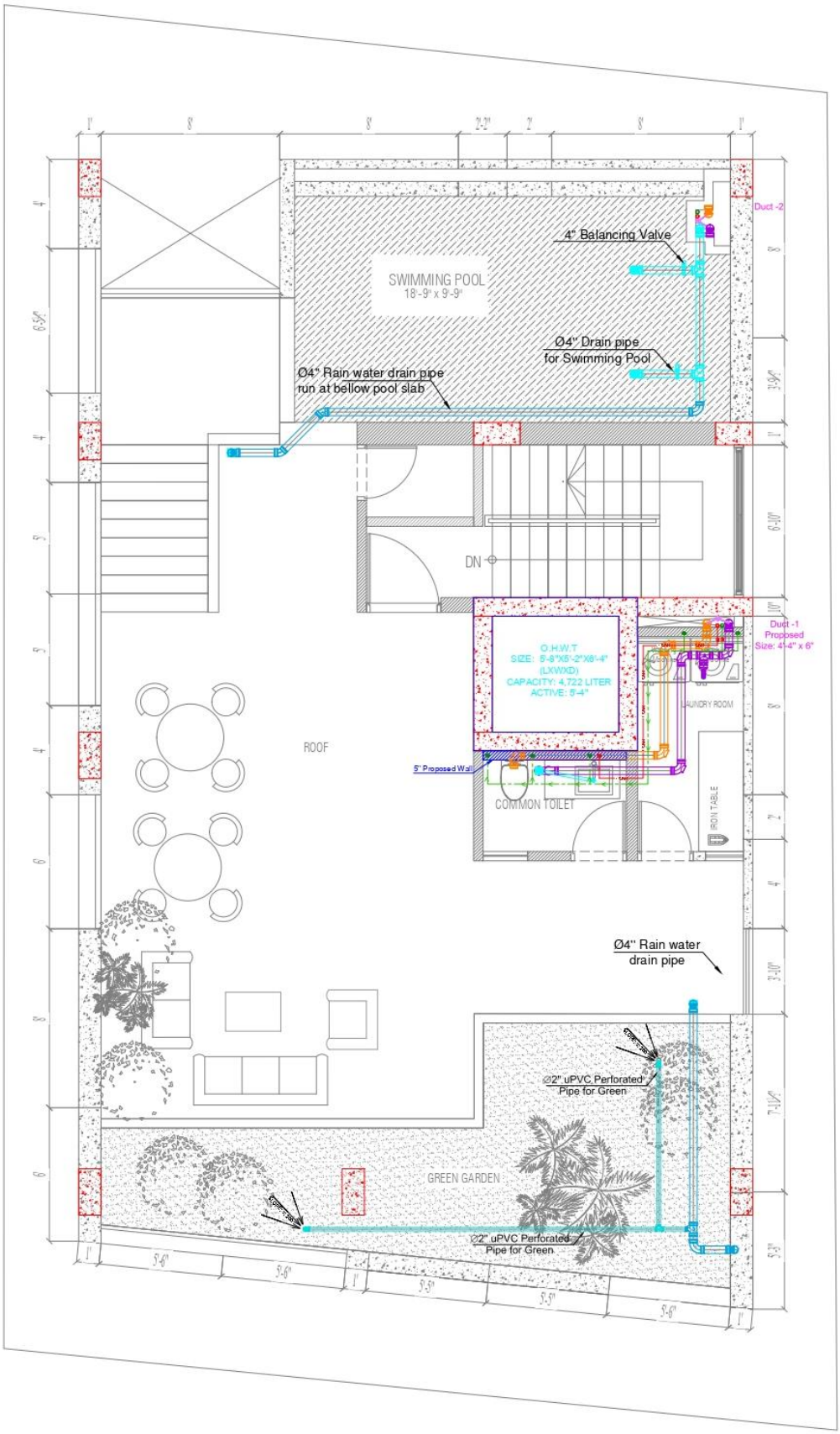


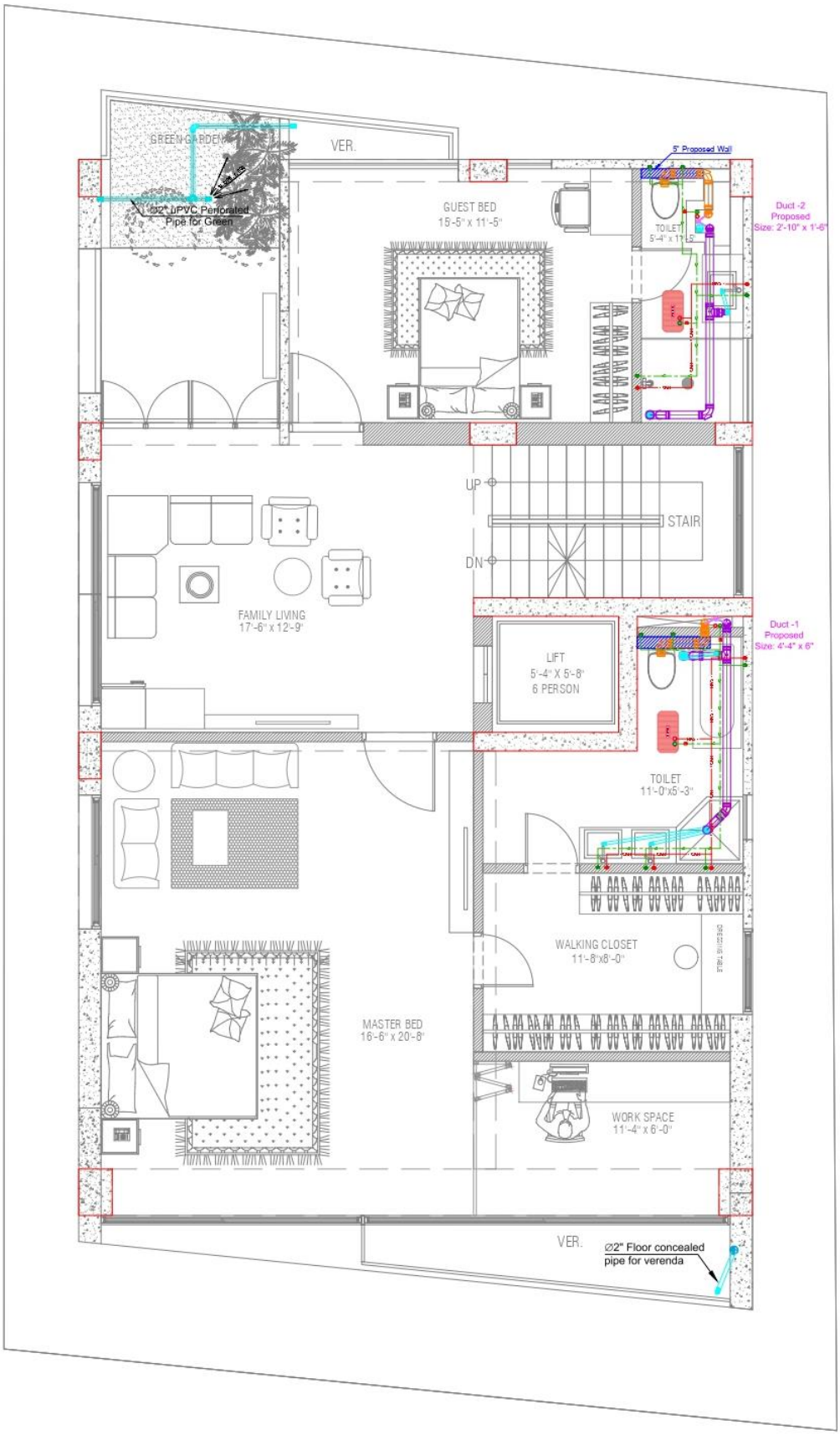
RAIN WATER DRAINAGE & COLD WATER SUPPLY LINE CONNECTION LAYOUT AT ROOF TOP FLOOR

SCALE:- NOT TO SCALE

CO-ORDINATION OF PLUMBING LAYOUT OF ROOF FLOOR

SCALE:- NOT TO SCALE



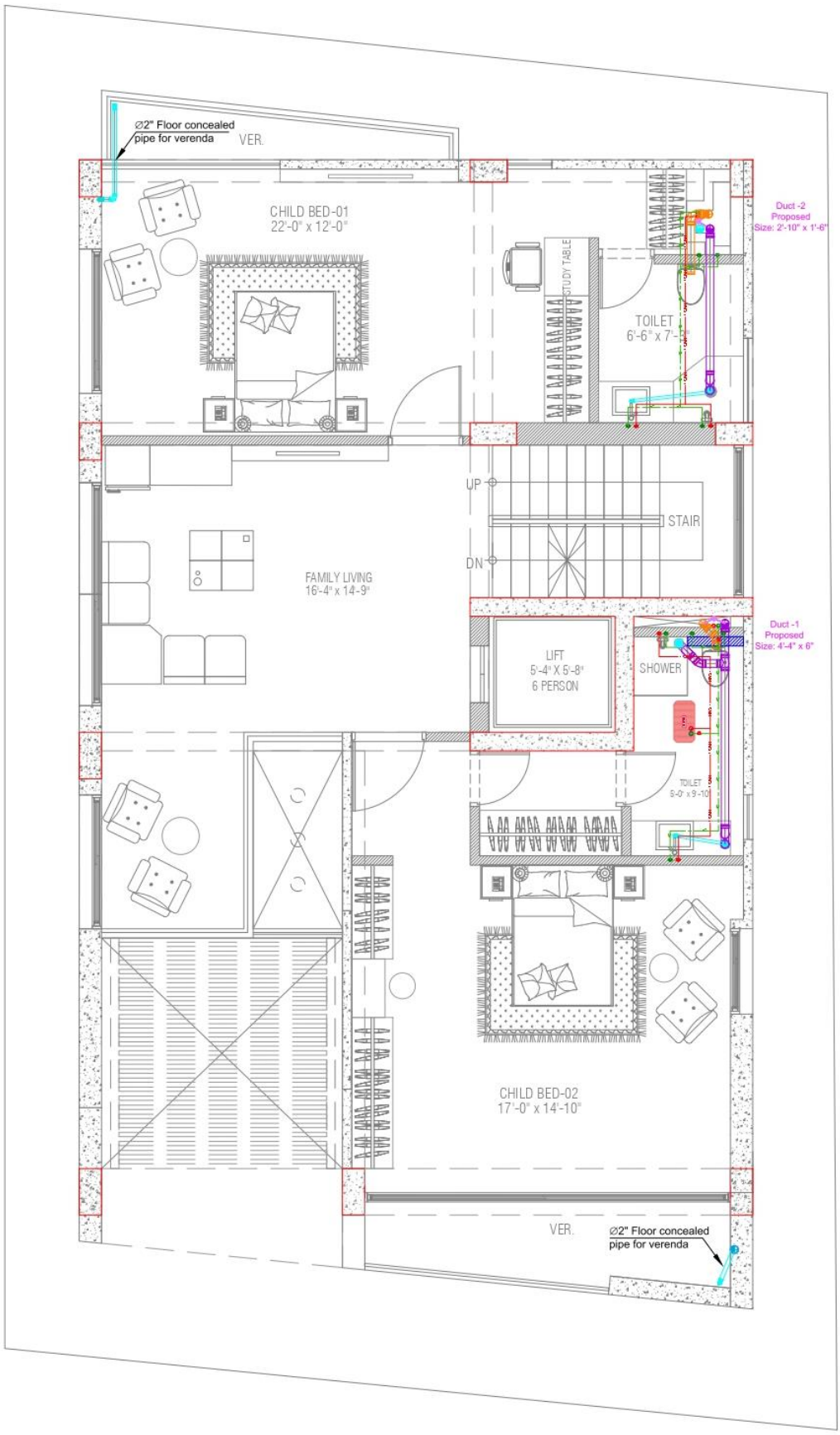


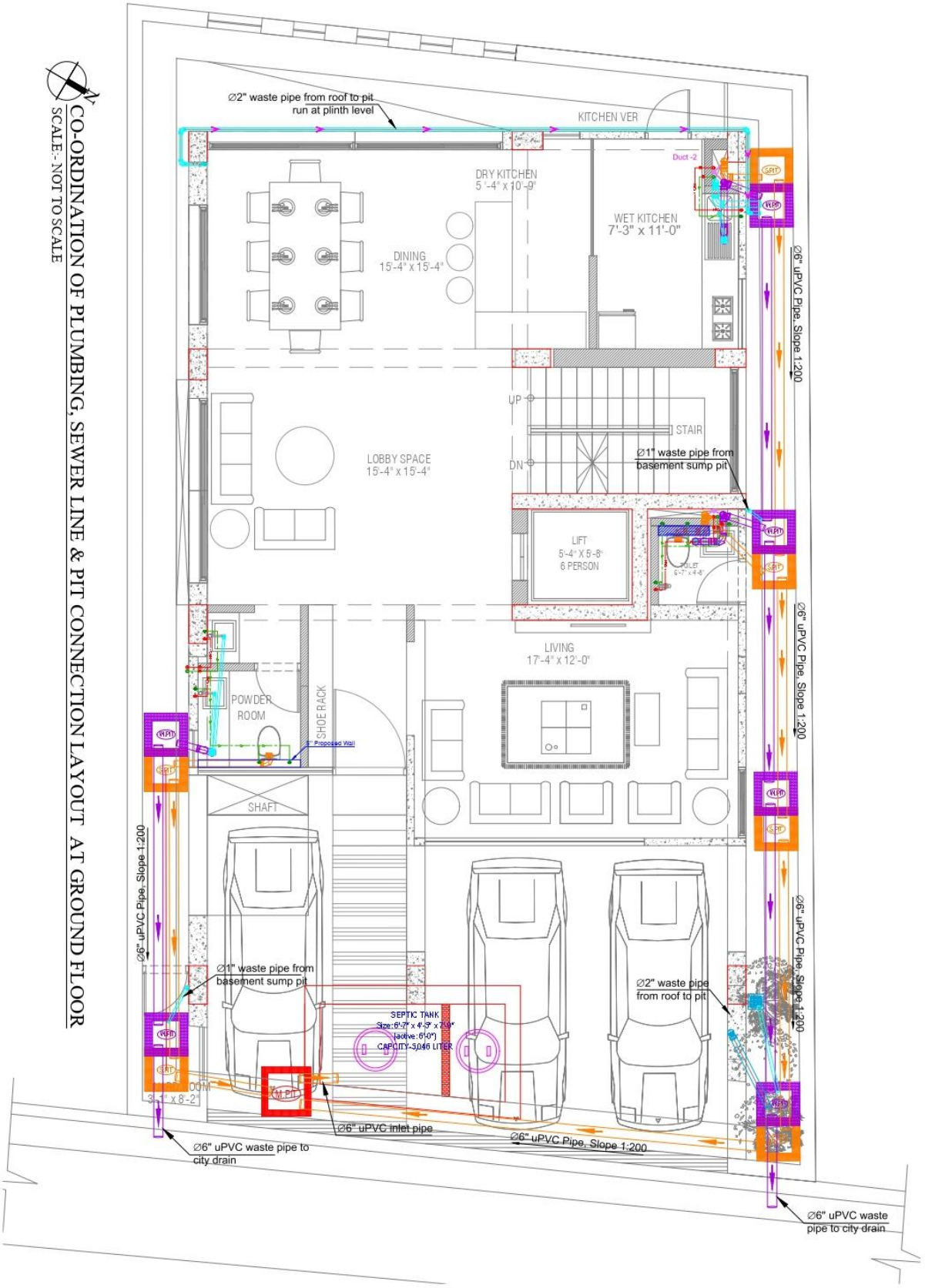
CO-ORDINATION OF PLUMBING LAYOUT OF 2ND FLOOR

SCALE:- NOT TO SCALE

CO-ORDINATION OF PLUMBING LAYOUT OF 1ST FLOOR

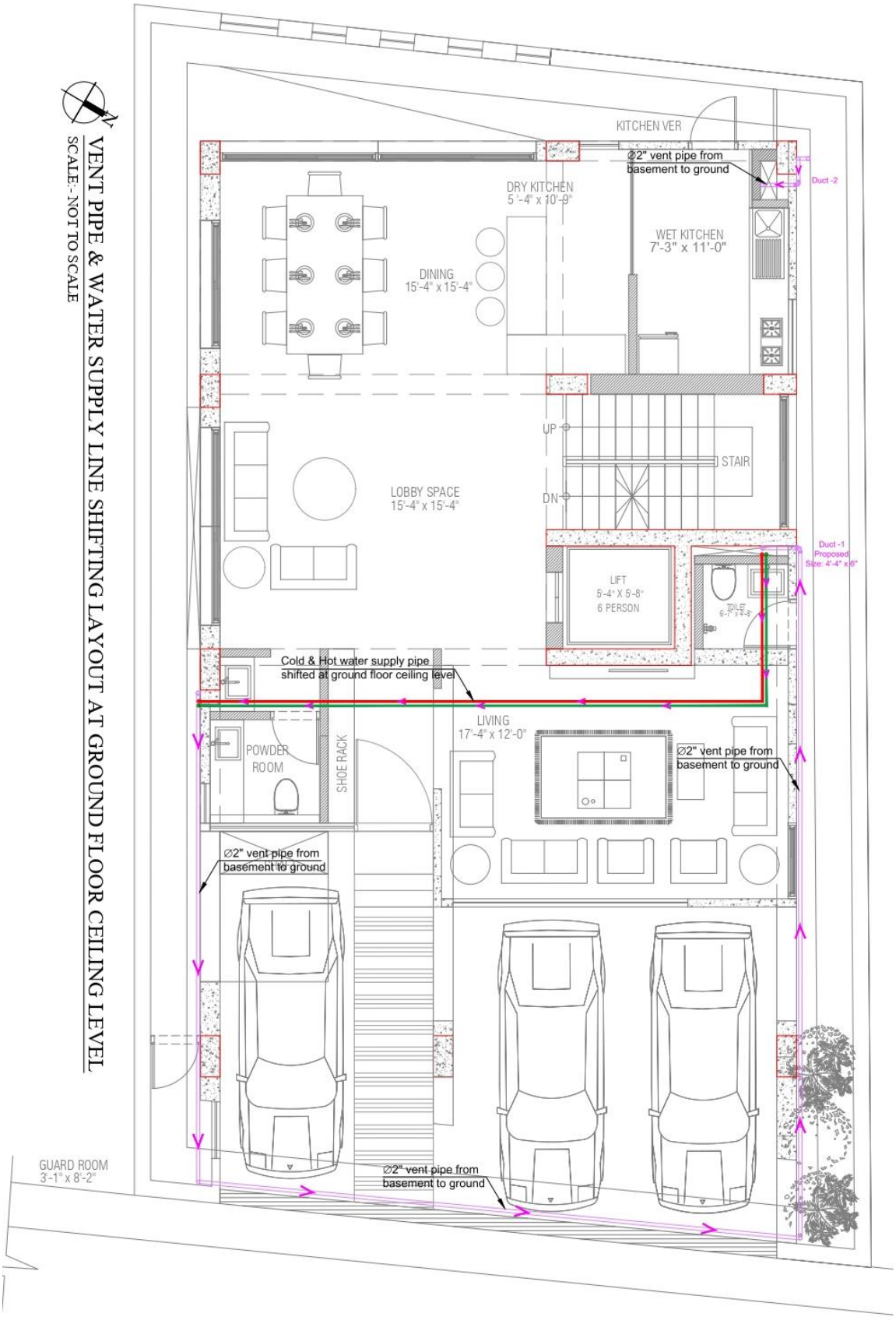
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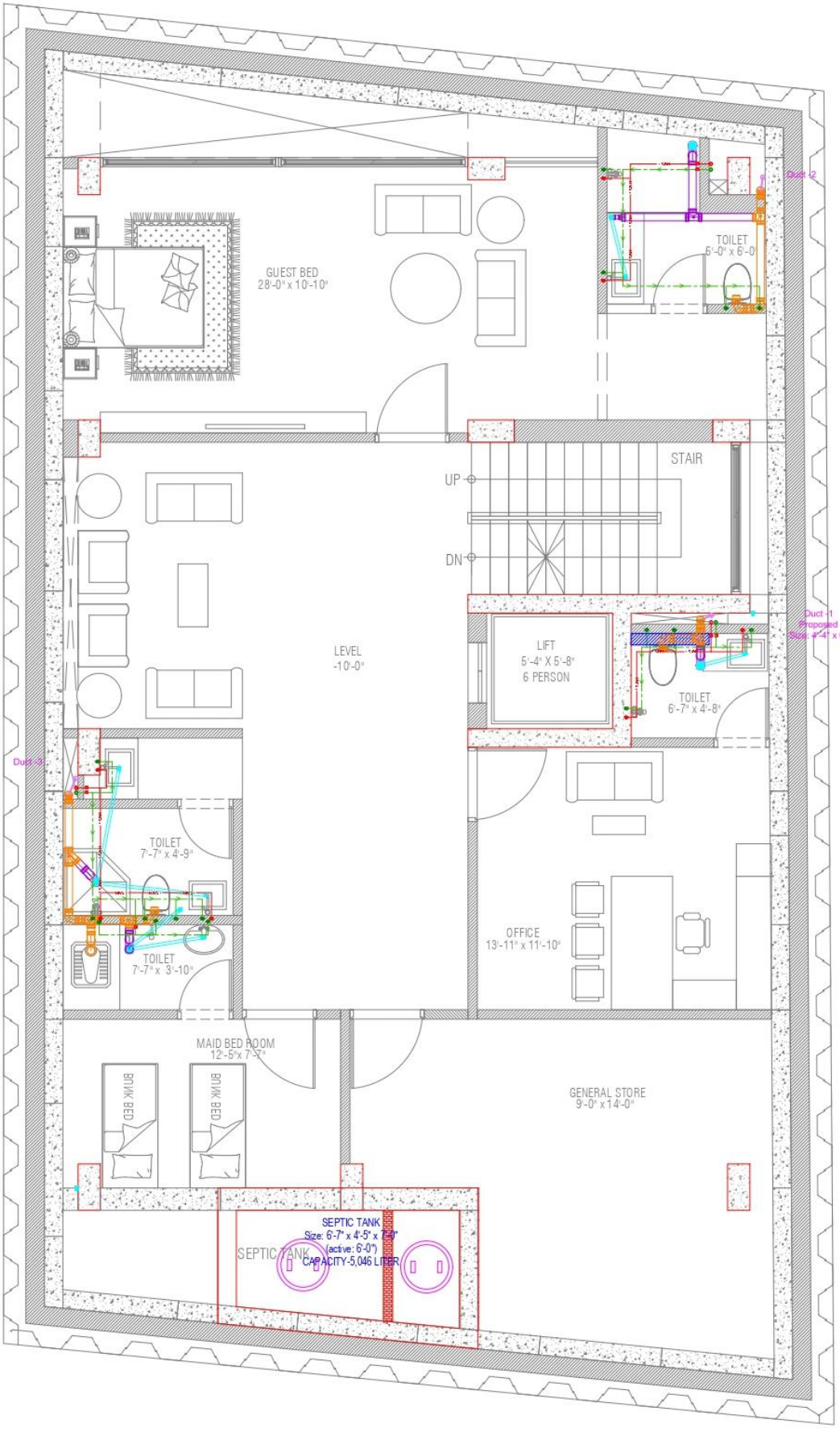
CO-ORDINATION OF PLUMBING, SEWER LINE & PIT CONNECTION LAYOUT AT GROUND FLOOR

SCALE:- NOT TO SCALE



VENT PIPE & WATER SUPPLY LINE SHIFTING LAYOUT AT GROUND FLOOR CEILING LEVEL

SCALE:- NOT TO SCALE



CO-ORDINATION OF PLUMBING LAYOUT OF BASEMANT-01

SCALE:- NOT TO SCALE

3.4 Plumbing Technical Specfication and Cost Estimation

Project Name : Nikunjo triplex					
Address: Nikunjo					
Date: 15.05.2024					
Bill of Quantities Sanitary and Plumbing Services					
Sl. No.	**Description of Work**	Unit	**Quantity**	**Unit Price (Taka)**	**Amount (Taka)**
	P.V.C pipes for soil , waste & rain water				
1	Supplying **100 mm inside dia best quality uPVC soil, waste and ventilation pipe** having specific gravity 1.35-1.45, wall thickness 3.4- 4.0 mm, and other physical, chemical, themal, fire resistivity properties etc. approved and accepted by the Engineer- in-charge.	rm	380.0	671.00	254,980.00
2	Supplying **50 mm inside dia best quality uPVC soil, waste and ventilation pipe** having specific gravity 1.35 - 1.45, wall thickness 2.5 mm - 3.0 mm, and other physical, chemical, themal, fire resistivity properties etc. approved and accepted by the Engineer- in-charge.	rm	**100.0**	481.00	48,100.00
3	**G.I pipe for water supply** -Supplying, fitting and fixing of G.I. pipe with all special fittingsall complete in all respects approved and accepted by the Engineer-in- charge.				
	62-65 mm dia G.I. pipe with wall thickness 3.25 mm, outside diameter min 71.5 mm, weight 6.15 kg/m, can withstand min 50 kg/cm^2 hydraulic pressure.	rm	28.0	1,607.00	44,996.00
4	**40 mm dia G.I. pipe** with wall thickness 3.25 mm, outside diameter min 46.5 mm, weight 3.83 kg/m, can withstand min 50 kg/cm^2 hydraulic pressure.	rm	275.0	880	242,000.00
5	Supplying, fitting and fixing of **European type glazed combi closet**, 725 mm x 360 mm x 840 mm size, 42.7 kg of weight, including plastic seat cover, cistern system,	nos	16.0	16,806.00	268,896.00
6	Supplying and fitting-fixing **hand / push shower(Moving type push shower)** for ablution including holder etc. all complete approved and accepted by the Engineer- in- charge.	nos	18.0	728	13,104.00
7	Supplying, fitting and fixing of **angle stop cock** etc. complete approved and accepted by the Engineer- in-charge.12 mm CP surface mounted angle stop cock (Heavy Type)	nos	54.0	709	38,286.00
8	Supplying different inside dia best quality **uPVC clean out / trap** having specific gravity 1.35 -1.45 and other physical, chemical, themal, fire resistivity properties etc complete approved and accepted by the Engineer-in- charge.	Nos	33.0	627	20,691.00

9	Supplying, fitting and fixing of 125 mm dia **stainless steel floor grating** in traps or in drains including making holes in walls/floors and mending good the damages with cement mortar (1:4) etc. all complete approved and accepted by the Engineer- in- charge.	Nos	62.0	298.00	18,476.00
10	Supplying, fitting and fixing of best quality 50mm G.I. gate valve with sealant etc. complete approved and accepted by the Engineer- in- charge.	Nos	95.0	1,472.00	139,840.00
11	Supplying, fitting and fixing of best quality G.I. check valve, threaded joint with sealant etc. complete approved and accepted by the Engineer- in- charge. A) 40 mm brass check valve	Nos	1.0	804	804.00
12	Construction of masonry inspection pit with 250 mm thick brick work in cement mortar (1:4) including necessary earth work, side filling and one layer brick flat soling, 75 mm thick (1:3:6) base concrete for making invert channel and 12 mm thick (1:2) cement plaster with neat finishing etc. all complete up to a depth of 700 mm approved and accepted by the Engineer- in- charge.				
	Clear 600 x 600 mm and depth 750 mm to 900 mm, average 825 mm for single 300 mm dia R.C.C. pipes and 400 mm PVC pipe.	Nos	11.0	8,754.00	96,294.00
	GRAND TOTAL				11,86,487.00

CHAPTER - 4

Fire Safety

Fire safety design focuses on minimizing the risk of fire and maximizing occupant safety in buildings. It involves implementing measures such as fire-resistant construction materials, adequate escape routes, smoke detection systems, and fire suppression equipment like sprinklers. The objective is to prevent fires from occurring, detect them early if they do, and facilitate safe evacuation and firefighting if needed. This holistic approach ensures buildings are resilient to fire hazards, protecting lives, property, and assets.

4.1 Brief Report of Fire Safety System

Project : 4-storied Residencial building at Nikunjo Triplex

Reference Standards.

REF-1 (BNBC-2021/Part-04)

REF-2 (NFPA-13,14, 20, 72, 101)

4.1.1 Fire Protection and Detection System Utilities:

Fire Protection System: Sprinkler coverage in basement to 1st floor & hydrant system for 2nd to roof floor with following items:

a) Piping layout
b) Fire Hose Box details
c) Sprinkler system details.
d) Fire UGWR details
e) Hose pressure/ loss calculation
f) Valve details.
g) Fire suppression system
h) Pump room layout
i) Pillar hydrant and fire brigade connection details.

Fire Detection System: Addressable type fire detections system proposed for entire project with following details.

a) Fixtures layout
b) Conduit layout
c) Details of device
d) Panel system with details
e) Circuit diagram and Fire Evacuation System

4.1.2 System Overview:

Fire Fighting system:

We plan the fire-fighting system in accordance with AHJ (Authority Having Jurisdiction) standards, and/or international standards such as **NFPA or FM or Local Standard as BNBC.**

a) Sprinkler System
b) Internal & External Fire hydrant
c) Addressable fire detection system

4.1.3 Sprinkler System:

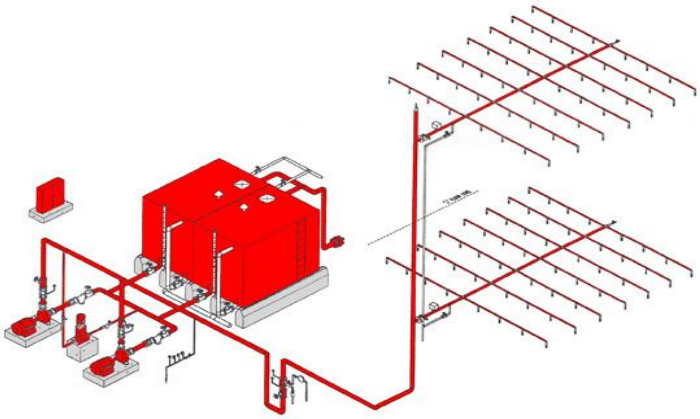


Figure 4.1 (REF-08)

Sprinkler systems are one of the most effective fire protection measures. They work by automatically releasing water when they detect a certain level of heat, effectively suppressing the fire or containing it until firefighters arrive. These systems are typically designed according to standards set by organizations like the NFPA (National Fire Protection Association) or FM Global.

4.1.4 Internal & External Fire Hydrant:



Figure 4.2 (REF-09)

Fire hydrants provide a ready source of water for firefighting operations. Internal hydrants are typically installed within buildings and are connected to the building's water supply. External hydrants

are located outside the building and are connected to the municipal water supply. Both types of hydrants are crucial for ensuring that firefighters have access to an adequate water supply to combat fires.

4.1.5 Addressable Fire Detection System:



Figure 4.3 (REF-10)

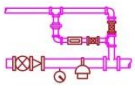
Addressable fire detection systems are advanced fire alarm systems that provide detailed information about the location of a fire or other emergency event within a building. These systems can pinpoint the exact location of a fire, which helps emergency responders take swift and targeted action. Addressable fire detection systems are typically designed and installed in accordance with standards set by organizations like the NFPA.

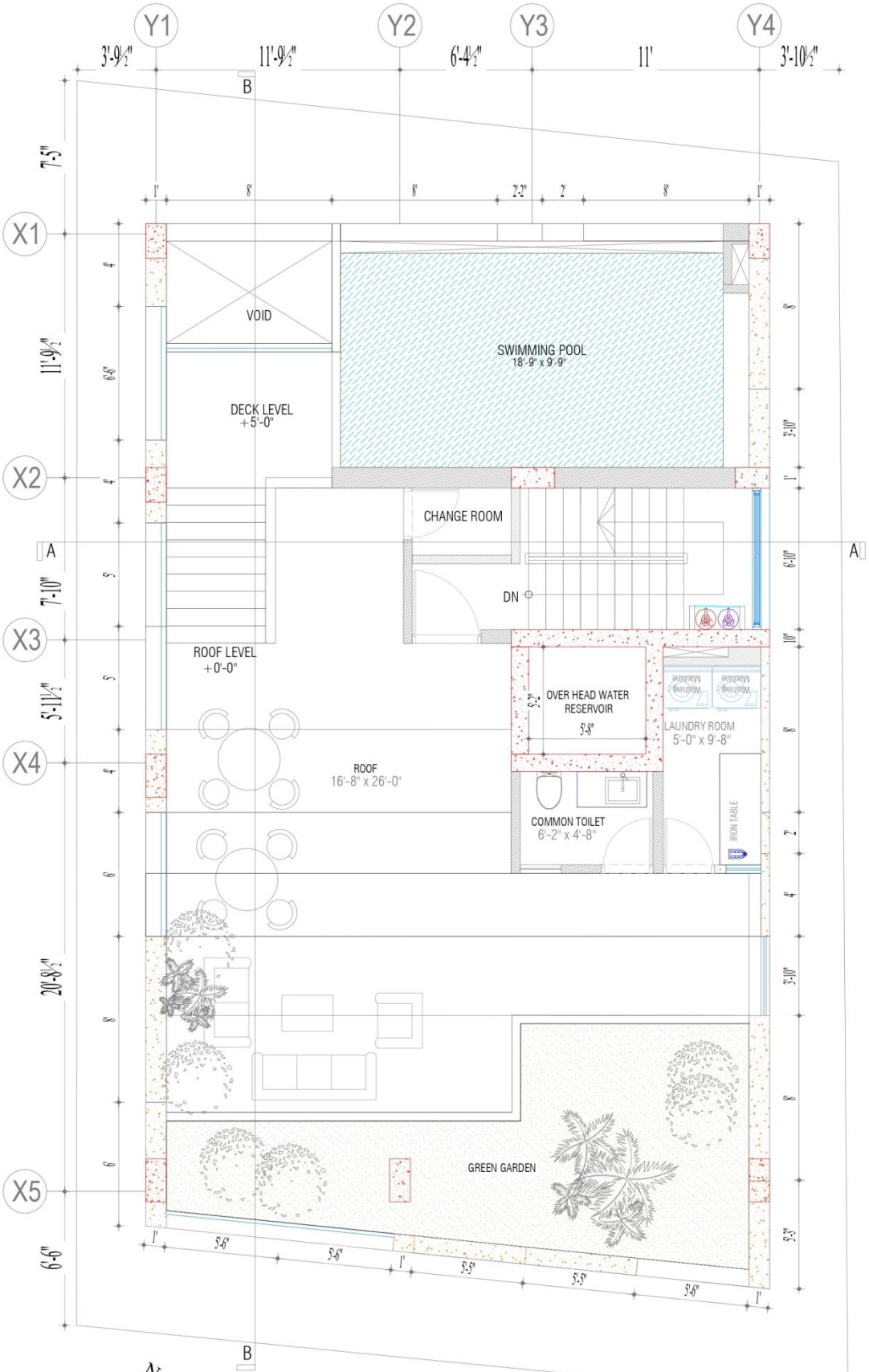
4.2 Fire Safety Project Design And Drawings:

Name of Project : 4-storied Residential building of Nikunjo Triplex

* We Have Designed fire safety system for a four story building to collectively detect and suppress fires.
* As Per Requirment we use
* ABC Fire Extinguisher
* Co2 Fire Extinguisher
* FM-200 To Suppress Fire

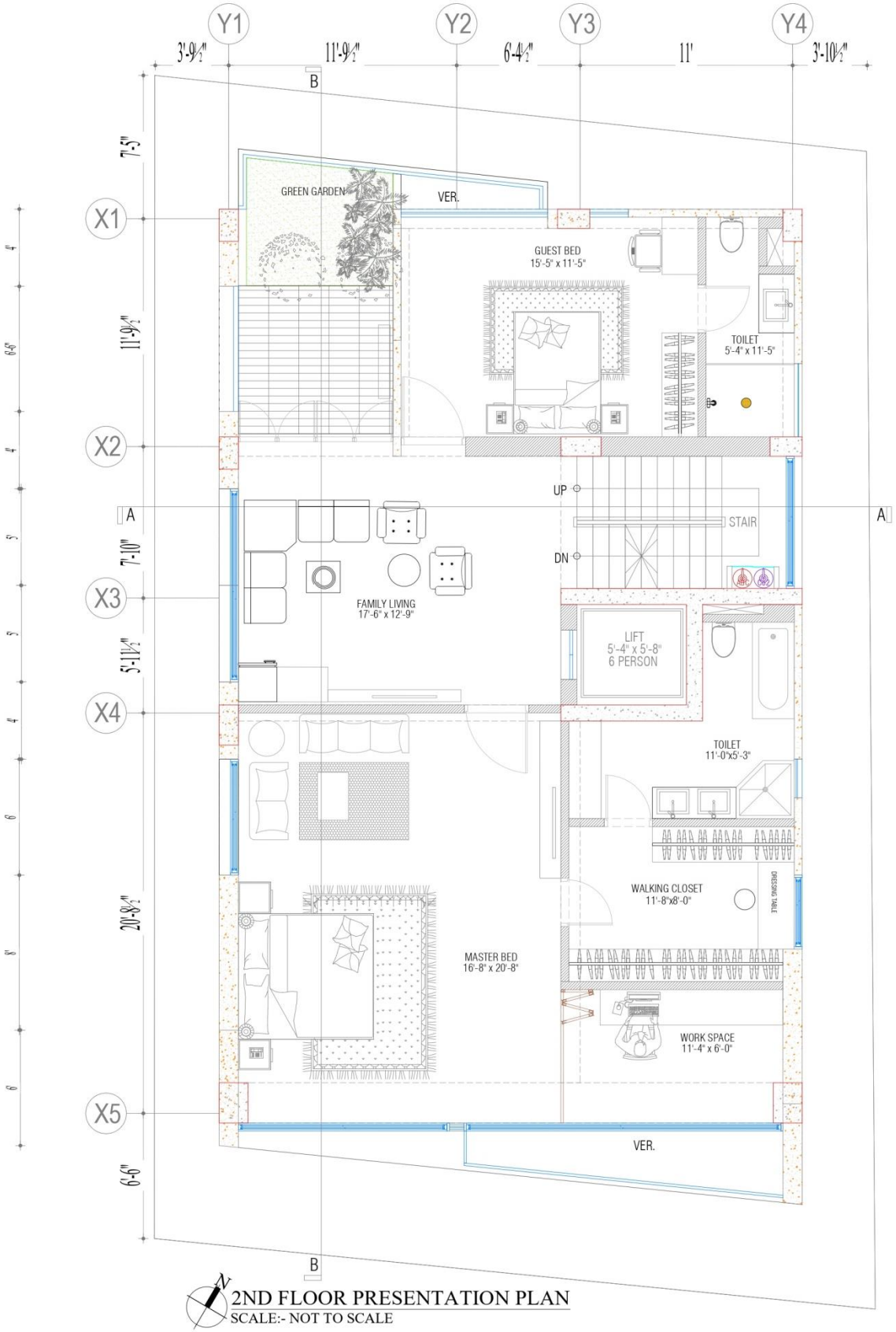
FIRE PROTECTION SYSTEM DRAWING
At Nikunjo Triplex

LEGEND			
	FIRE HOSE CABINET (FHC)		FIRE DOOR
	UPRIGHT SPRINKLER		BRIDGE CONNECTION
	PENDENT SPRINKLER		PILLAR HYDRANT
	FIRE EXTINGUISHER		ZONE CONTROL VALVE(ZVC)
	FM-200		FIRE PIPE



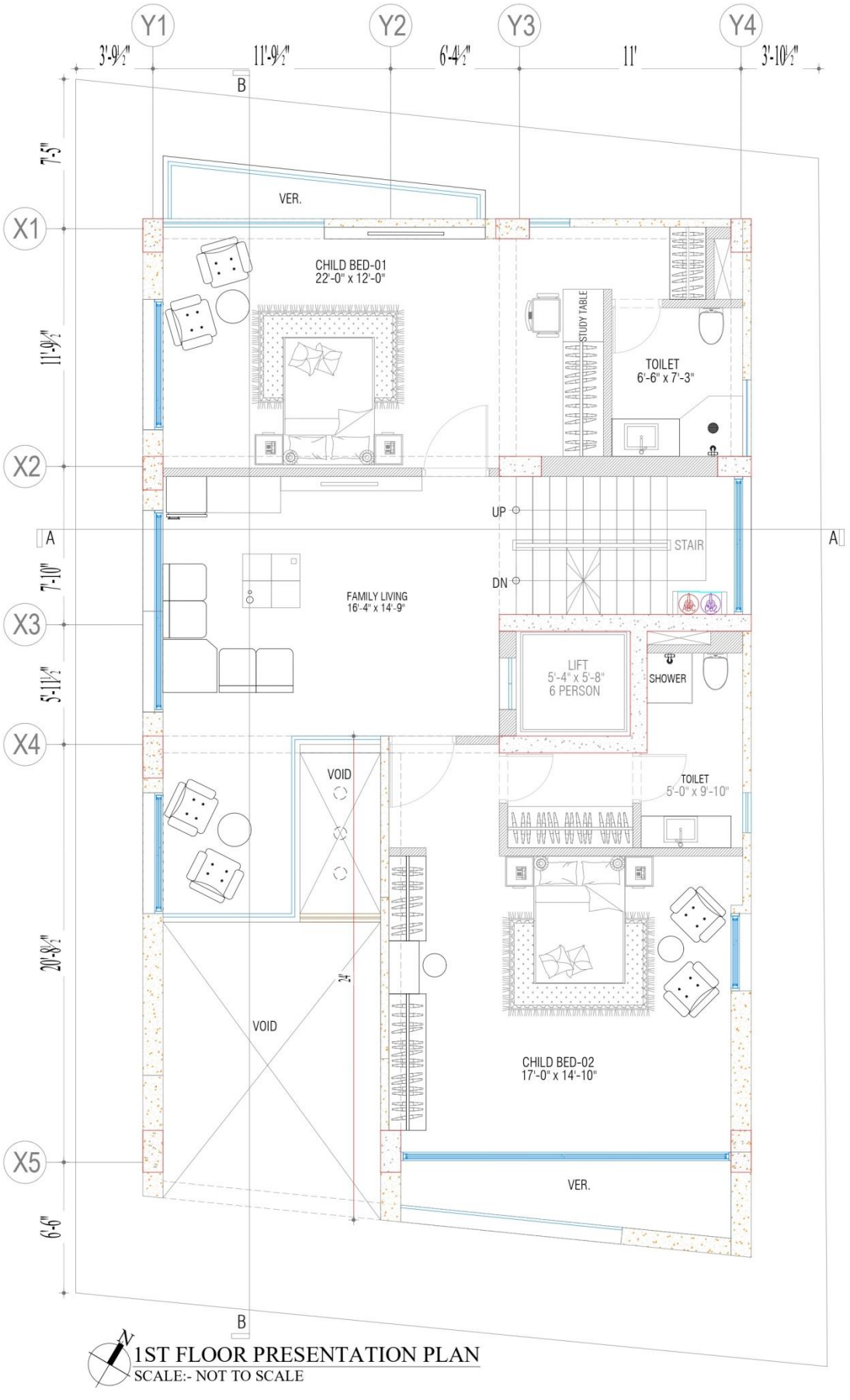
ROOF FLOOR PRESENTATION PLAN

SCALE:- NOT TO SCALE

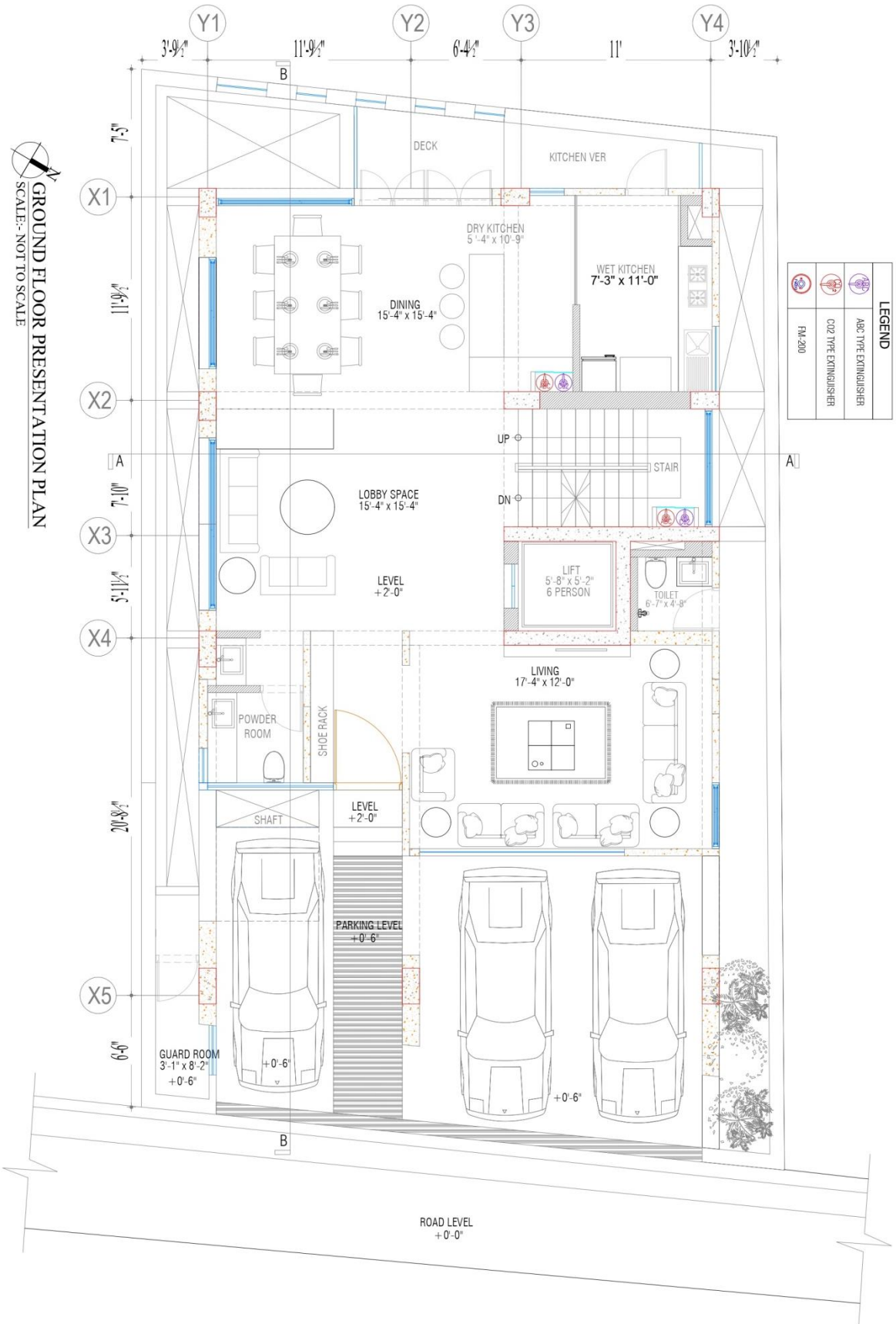


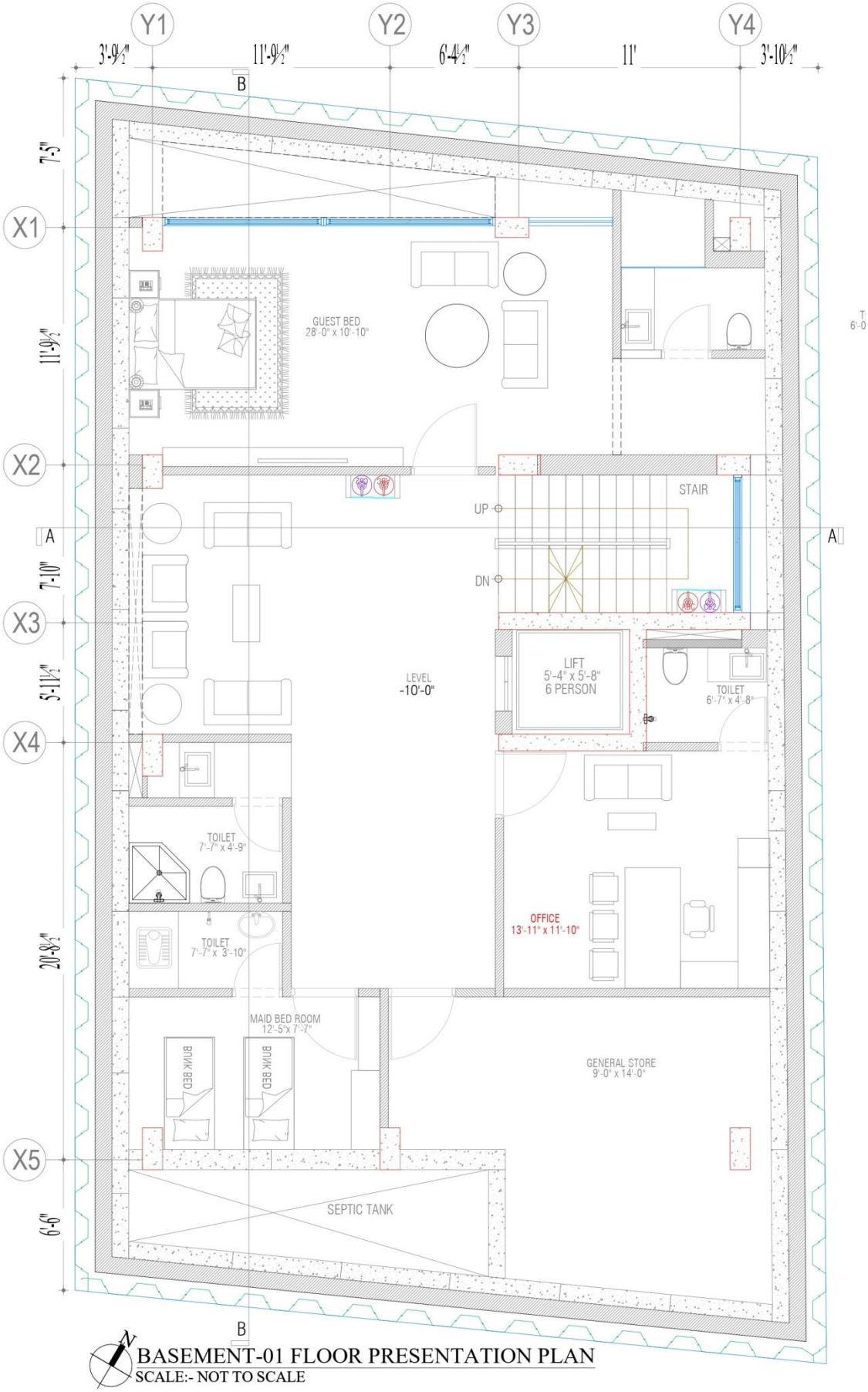
2ND FLOOR PRESENTATION PLAN

SCALE:- NOT TO SCALE



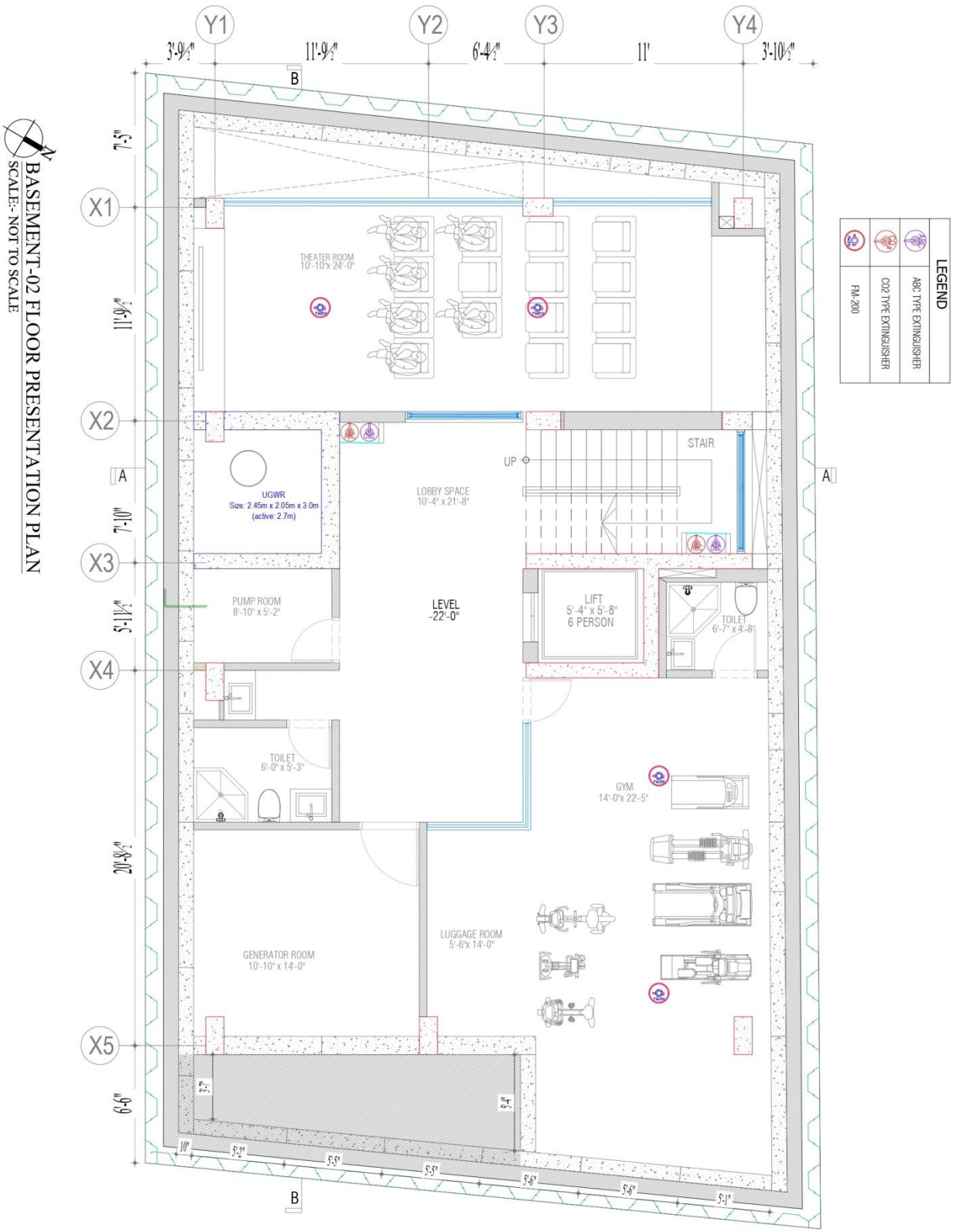
1ST FLOOR PRESENTATION PLAN
SCALE:- NOT TO SCALE


GROUND FLOOR PRESENTATION PLAN
SCALE:- NOT TO SCALE
Y1
Y2
Y3
Y4
3'-9½"
11'-9½"
6'-4½"
11'
3'-10½"
X1
X2
X3
X4
X5
A
B
DECK
KITCHEN VER
DRY KITCHEN
5'-4" x 10'-9"
WET KITCHEN
7'-3" x 11'-0"
DINING
15'-4" x 15'-4"
UP
DN
STAIR
LOBBY SPACE
15'-4" x 15'-4"
LEVEL
+2'-0"
LIFT
5'-8" x 5'-2"
6 PERSON
TOILET
6'-7" x 4'-8"
LIVING
17'-4" x 12'-0"
POWDER
ROOM
SHOE RACK
SHAFT
LEVEL
+2'-0"
PARKING LEVEL
+0'-6"
GUARD ROOM
3'-1" x 8'-2"
+0'-6"
+0'-6"
+0'-6"
ROAD LEVEL
+0'-0"
LEGEND
ABC TYPE EXTINGUISHER
CO2 TYPE EXTINGUISHER
FM-200



BASEMENT-01 FLOOR PRESENTATION PLAN

SCALE:- NOT TO SCALE



BASEMENT-02 FLOOR PRESENTATION PLAN

SCALE:- NOT TO SCALE

4.3 Fire Safety Technical Specfication and Cost Estimation

FIRE PROTECTION SYSTEM					
Project: NIKUNJA TRIPLEX					
Address: NIKUNJA-1					
Date: 15/05/2024					
Title: Cost Estimation BOQ of FIRE PROTECTION SYSTEM					
SL.	**DESCRIPTION**	**UNIT**	**QTY.**	**UNIT PRICE (BDT)**	**AMOUNT (BDT)**
1	**Portable Fire Extinguisher**				
	a) Dry Chemical Powder Type				
	Supply the following capacities multi purpose ABC&E dry chemical powder stored pressure type with manometer system Fire Extinguisher suitable for repeated use complete with wall bracket, CO Cartridge, easy refilling system etc. as per sample accepted/approved by the Consultant.Country of Origin: China or Equivalent				
	6 Kg. capacity.	Set	9.00	4,025.00	36,225.00
	b) Carbon-Di-Oxide (CO_2) Type				
	Supply & fixing the following capacities Carbon-di-Oxide type Fire Extinguisher suitable for repeated use complete with wall bracket, discharge nozzle etc. as per sampleaccepted/approved by the Consultant. Country of Origin: China or Equivalent				
	5 Kg. capacity.	Set	9.00	6,000.00	54,000.00
2	**FM 200 Fire Suppression System**				
	FM 200 fire suppression system shall be complete with control center with 24VDC battery back up, FM gas cylinder with discharge valve, nipple, victualic coupling and mounting, abort switch, release valve, low pressure switch, warning signal, 150mm dia alarm bell, strobe light, high pressure flexible hose, cable, conduit complete in all respect. Country of Origin: China or Equivalent				
	a) 95 lbs. FM 200	Set	4.00	150,000.00	600,000.00
				TOTALAMOUNT	**690,225.00**

CHAPTER – 5

Heating Ventilation and Airconditioning (HVAC) System Design

HVAC system include Variable Refrigerant Flow (VRF) systems offer several advantages, making them popular choices for heating, ventilation, and air conditioning (HVAC) in various buildings:

- Energy Efficiency.
- Zoning Flexibility
- Space-saving Design.
- Quiet Operation
- Individual Control
- Improved Indoor Air Quality
- Heat Recovery

Overall, VRF systems offer enhanced comfort, energy efficiency, and flexibility compared to traditional HVAC systems, making them a compelling choice for various building applications.

5.1 Brief Report of HVAC System

Project : 3-storied Residencial building of Nikunjo Triplex

REF-1 & 3 (BNBC & ASHRAE)

5.1.1 VRF System Scope .

a. Cooling load calculation.
b. Heating load calculation.
c. Ventilation calculation.
d. HVAC equipment selection.
e. Design and drawing schematic diagram network system from source to destination points of each unit.
f. Piping / ducting design for HVAC Systems by VRF.
g. Preparation of technical specification.

5.1.2 VRF System for Each Floor capacity:



Figure 5.1 (REF-11)

For this type of particular project we propose Variable Refrigerant flow (VRF) system. Complexity is the name of the game when describing the technical nature of how variable refrigerant flow technology works. The simplest explanation of VRF is to describe it as a large-scale ductless HVAC system that can perform at a high capacity. The specific design of a VRF system varies based on application. In general, VRF technology provides the ability for multiple indoor units or zones to operate on the same system. VRF systems can either be a heat pump system or a heat recovery system, which provides simultaneous heating and cooling

RECOMMENDED FACILITIES

- Dual Digital Inverter System
- High-efficient Plate Heat Exchanger
- Long Pipe Length
- Auto Commissioning Manager
- Geothermal Application
- New Communication Protocol

5.1.3 Ventilation System for Toilet, kitchen and Basement Floor

Ventilation systems are essential for toilet, kitchen, and basement floors for several reasons

- Moisture Control
- Odor Removal
- Air Circulation
- Contaminant Removal and Health and safety

5.1.4 Cooling Load Calculation:

Cooling load calculation involves determining the amount of heat that must be removed from a space to maintain a comfortable indoor temperature during warm weather. Factors such as outdoor temperature, solar radiation, internal heat gains from people, lighting, equipment, and building materials are taken into account. The calculation considers the heat transfer through walls, windows, roofs, and other building components to determine the size and capacity of the cooling system needed to maintain thermal comfort.

STANDARD DESIGN PRACTICE

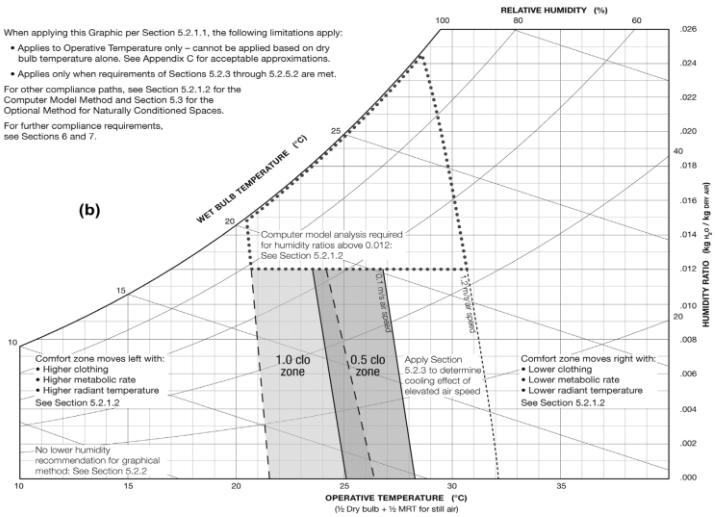


Figure 5.2 (REF-12)

Consideration for hvac load calculation:

- Geographical site conditions (latitude, longitude, wind velocity, precipitation etc.)
- Outdoor design conditions (temperature, humidity etc)
- Indoor design conditions (temperature, humidity etc)
- ROOM PRESSURE
- AIR QUALITY (CLEANLESS OF AIR)
- VENTIATION
- Building characteristics (materials, size, and shape)
- Configuration (location, orientation and shading)
- Operating schedules (lighting, occupancy, and equipment)
- Additional considerations (type of air-conditioning system, fan energy, fan location, duct heat loss and gain, duct leakage, type and position of air return system…)

5.1.5 Heating Load Calculation:

Table 3 Rates of Heat Gain from Occupants of Conditioned Spaces

Degree of Activity		Total Heat, Btu/h		Sensible Heat, Btu/h	Latent Heat, Btu/h	% Sensible Heat that is Radiant[b]	
		Adult Male	Adjusted, M/F[a]			Low *V*	High *V*
Seated at theater	Theater, matinee	390	330	225	105		
Seated at theater, night	Theater, night	390	350	245	105	60	27
Seated, very light work	Offices, hotels, apartments	450	400	245	155		
Moderately active office work	Offices, hotels, apartments	475	450	250	200		
Standing, light work; walking	Department store; retail store	550	450	250	200	58	38
Walking, standing	Drug store, bank	550	500	250	250		
Sedentary work	Restaurant[c]	490	550	275	275		
Light bench work	Factory	800	750	275	475		
Moderate dancing	Dance hall	900	850	305	545	49	35
Walking 3 mph; light machine work	Factory	1000	1000	375	625		
Bowling[d]	Bowling alley	1500	1450	580	870		
Heavy work	Factory	1500	1450	580	870	54	19
Heavy machine work; lifting	Factory	1600	1600	635	965		
Athletics	Gymnasium	2000	1800	710	1090		

Figure 5.3 (REF-13)

Heating load calculation involves determining the amount of heat that must be added to a space to maintain a comfortable indoor temperature during cold weather. Similar to cooling load calculation, factors such as outdoor temperature, building orientation, insulation levels, internal heat gains, and air infiltration are considered. The calculation accounts for heat loss through walls, windows, roofs, and other building components to determine the size and capacity of the heating system required to meet the heating demand.

1) Heat gain through wall, roof, ceiling and floor
2) Heat gain through window or others glass
3) Heat gain through internal load like human body, storage fruits , food etc.
4) Heat gain through electrical and mechanical equipment
5) Heat gain through outdoor air intake.

5.1.6 Cooling Loads Classified by Kinds of Heat

There are two distinct components of the air conditioning load;

(1) the sensible load (heat gain) and
(2) the latent load (water vapor gain).

Sensible Loads : Sensible heat gain is the direct addition of heat to a space, which shall result in increase in space temperatures.

The factors influencing sensible cooling load:

- Solar heat gain through building envelope (exterior walls, glazing, skylights, roof, floors over crawl space)
- Partitions (that separate spaces of different temperatures)
- Ventilation air and air infiltration through cracks in the building, doors, and windows
- People in the building
- Equipment and appliances operated in the summer
- Lights

Latent Loads : A latent heat gain is the heat contained in water vapor. Latent heat does not cause a temperature rise, but it constitutes a load on the cooling equipment. Latent load is the heat that must be removed to condense the moisture out of the air.

The sources of latent heat gain are:

- People (breathing)
- Cooking equipment
- Housekeeping, floor washing etc.
- Appliances or machinery that evaporates water
- Ventilation air and air infiltration through cracks in the building, doors, and windows The total cooling load is the summation of sensible and latent loads.

5.2 VRF System Project Design And Drawings:

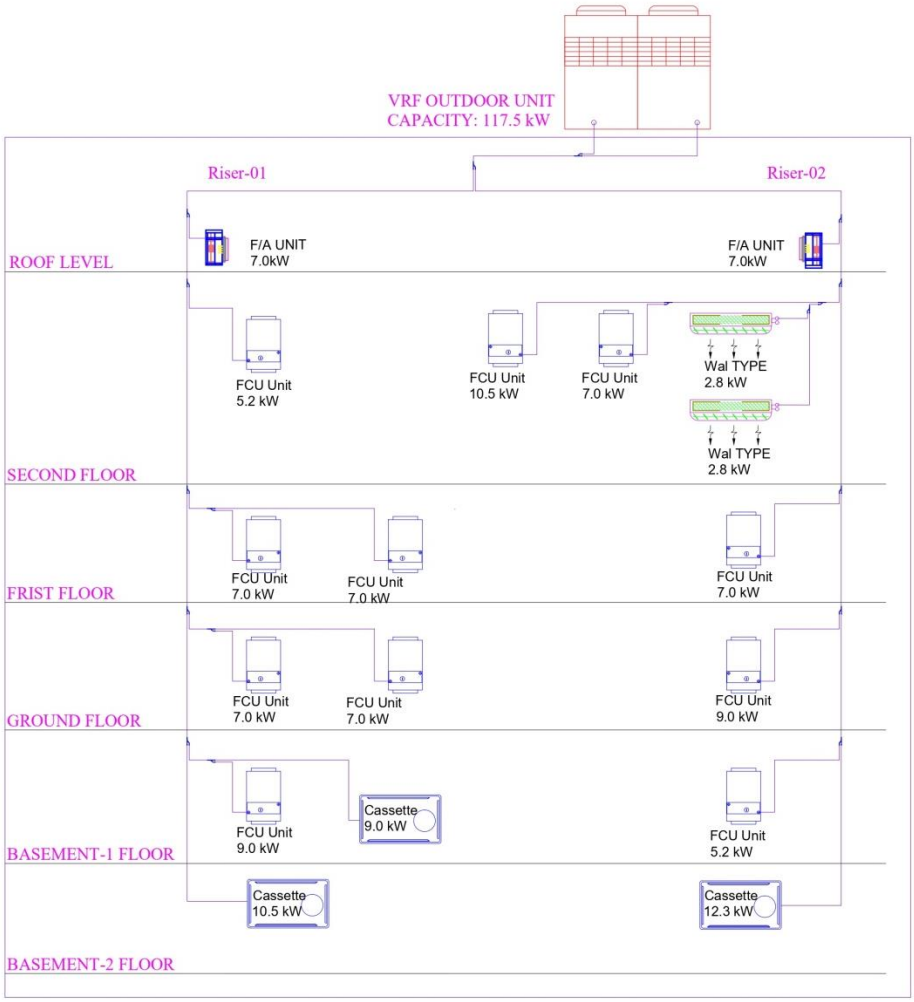
Name of Project : 4-storied Residential building of Nikunjo Triplex

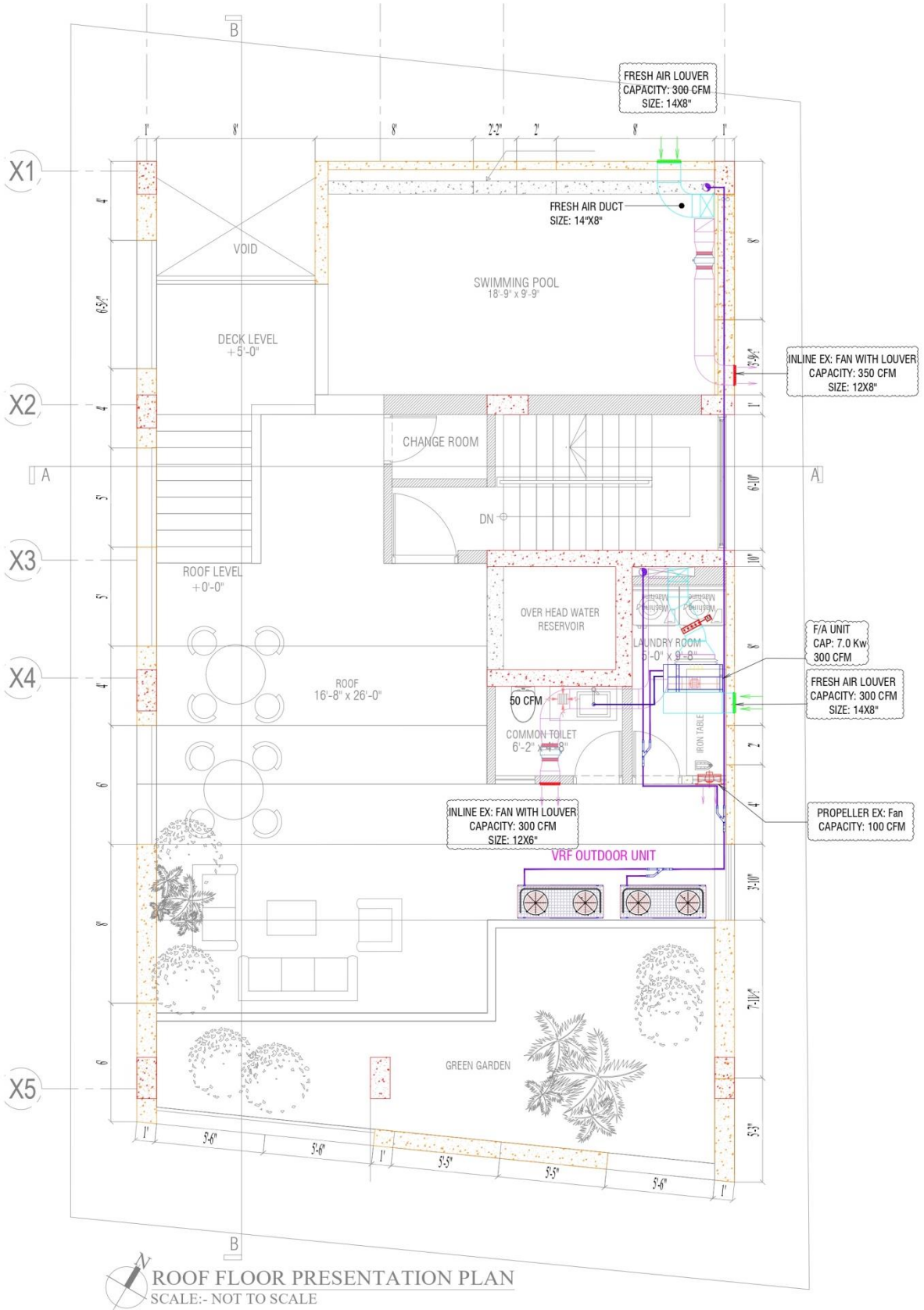
- We have Designed vrf system to maintain temperature and ventilation of a four story building.
- Vrf System Capacity 117.5 KW
- Inline Exhause Capacity: 300 CFM
- Fresh air capacity : 300 CFM



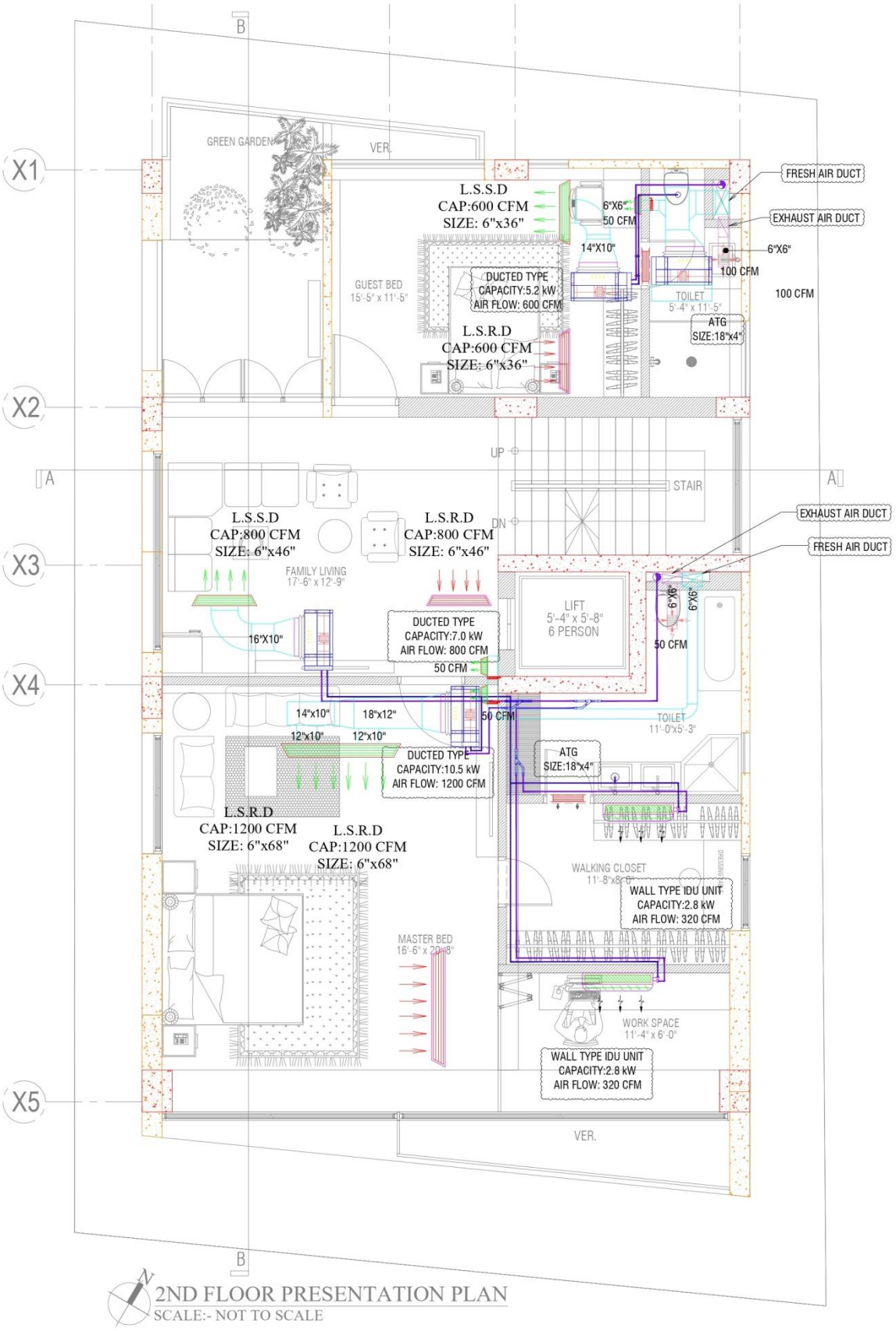
LEGENDS:

SYMBOL	DESCRIPTION	EQUIPMENT DESCRIPTION		SYMBOL	DESCRIPTION	EQUIPMENT DESCRIPTION	
		EQUIPMENT TYPE	QTY.			EQUIPMENT TYPE	QTY.
	VRF OUT DOOR	FLOOR MOUNTED	02		MOTORIZED FIRE DAMPER	CEILING MOUNTED	02
	FRESH AIR UNIT	CEILING MOUNTED	02		EXHAUST AIR LOUVER WITH BIRD SCREEN	WALL MOUNTED	07
	CASSETTE TYPE INDOOR	CEILING MOUNTED	02		AIR TRANSFER GRILLE	CEILING MOUNTED	14
	FRESH AIR GRILL	CEILING MOUNTED	14		FRESH AIR LOUVER WITH BIRD SCREEN	WALL MOUNTED	04
	PROPELLER FAN	WALL MOUNTED	02		EXHAUST AIR DUCT	CEILING MOUNTED	00
	REFRIGERANT GAS PIPE	CEILING MOUNTED	00		TFA DUCT	CEILING MOUNTED	00
	REFRIGERANT LIQUID PIPE	CEILING MOUNTED	00		FLEXIBLE CONNECTION	CEILING MOUNTED	14
	DRAIN PIPE	CEILING MOUNTED	00		DUCT & PIPE INSULATION	CEILING MOUNTED	00
	REFNET JOINT	CEILING MOUNTED	19		LINER SLOT SUPPLY DIFFUSER	CEILING MOUNTED	11
	CASSETTE TYPE INDOOR	CEILING MOUNTED	03		LINER SLOT RETURN DIFFUSER	CEILING MOUNTED	11
	DUCTED TYPE INDOOR	CEILING MOUNTED	11		INLINE FAN	CEILING MOUNTED	02


VRF OUTDOOR UNIT
CAPACITY: 117.5 kW
Riser-01
Riser-02
ROOF LEVEL
F/A UNIT
7.0kW
F/A UNIT
7.0kW
SECOND FLOOR
FCU Unit
5.2 kW
FCU Unit
10.5 kW
FCU Unit
7.0 kW
Wal TYPE
2.8 kW
Wal TYPE
2.8 kW
FRIST FLOOR
FCU Unit
7.0 kW
FCU Unit
7.0 kW
FCU Unit
7.0 kW
GROUND FLOOR
FCU Unit
7.0 kW
FCU Unit
7.0 kW
FCU Unit
9.0 kW
BASEMENT-1 FLOOR
FCU Unit
9.0 kW
Cassette
9.0 kW
FCU Unit
5.2 kW
BASEMENT-2 FLOOR
Cassette
10.5 kW
Cassette
12.3 kW

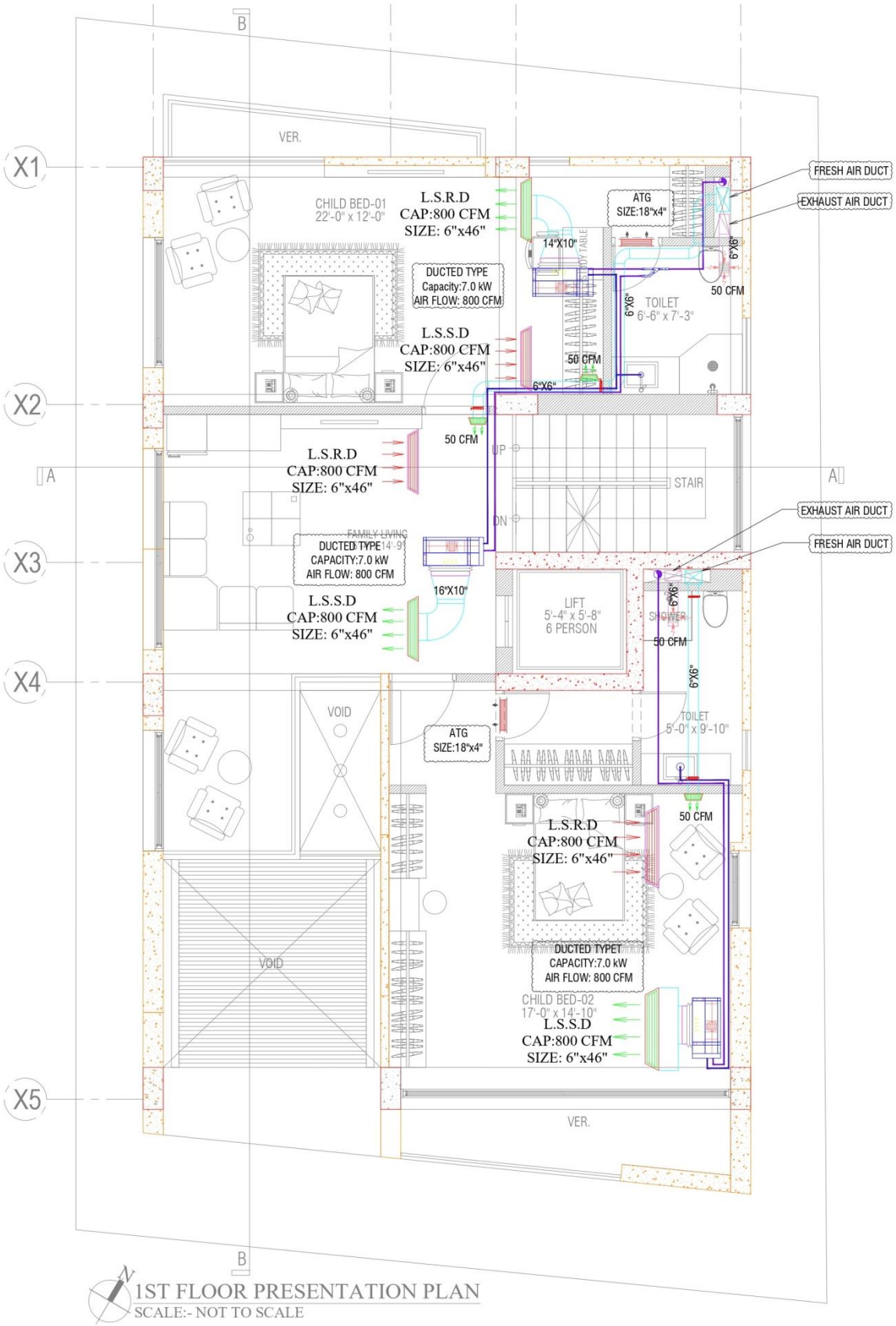


ROOF FLOOR PRESENTATION PLAN
SCALE:- NOT TO SCALE



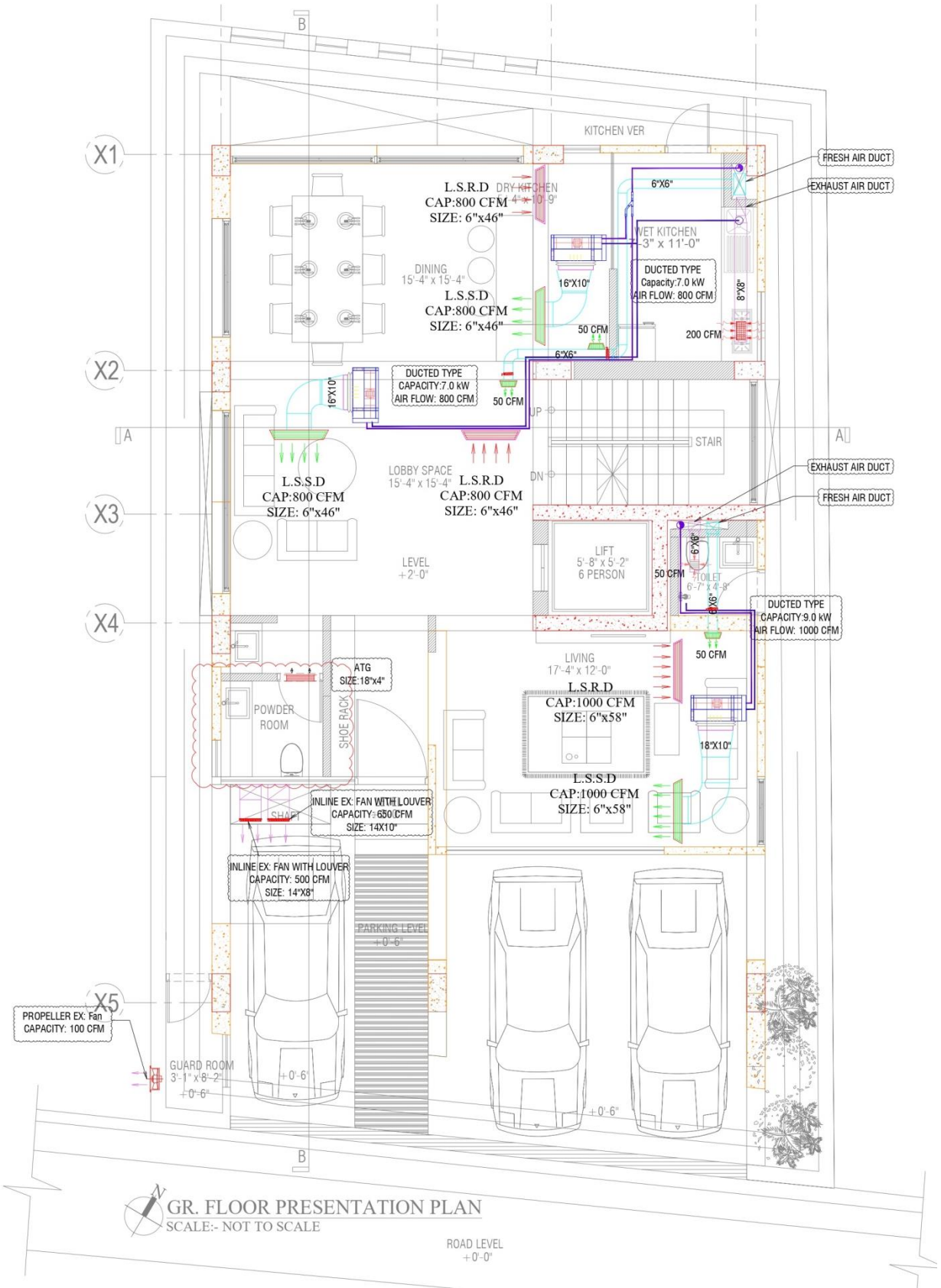
2ND FLOOR PRESENTATION PLAN

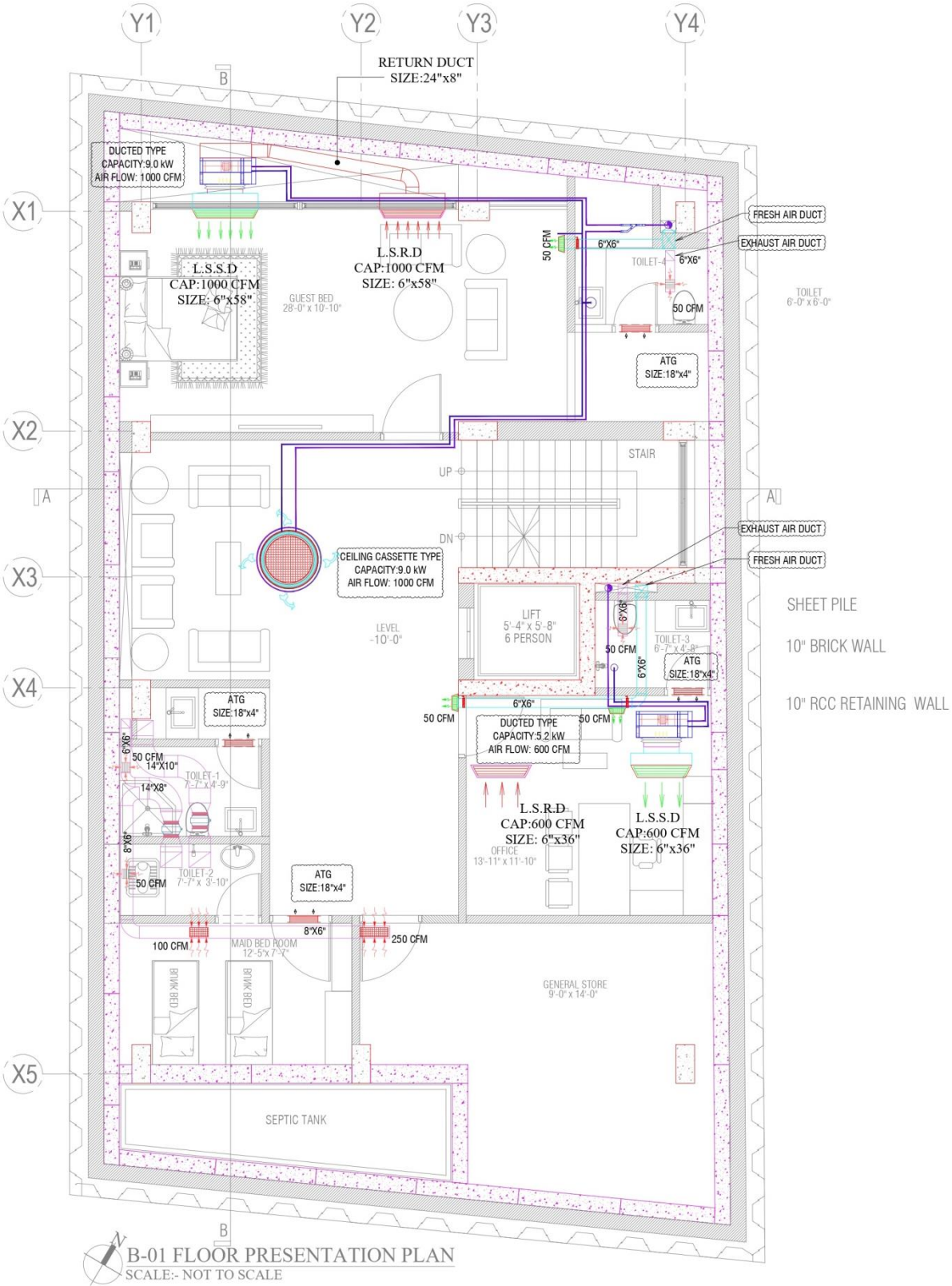
SCALE:- NOT TO SCALE



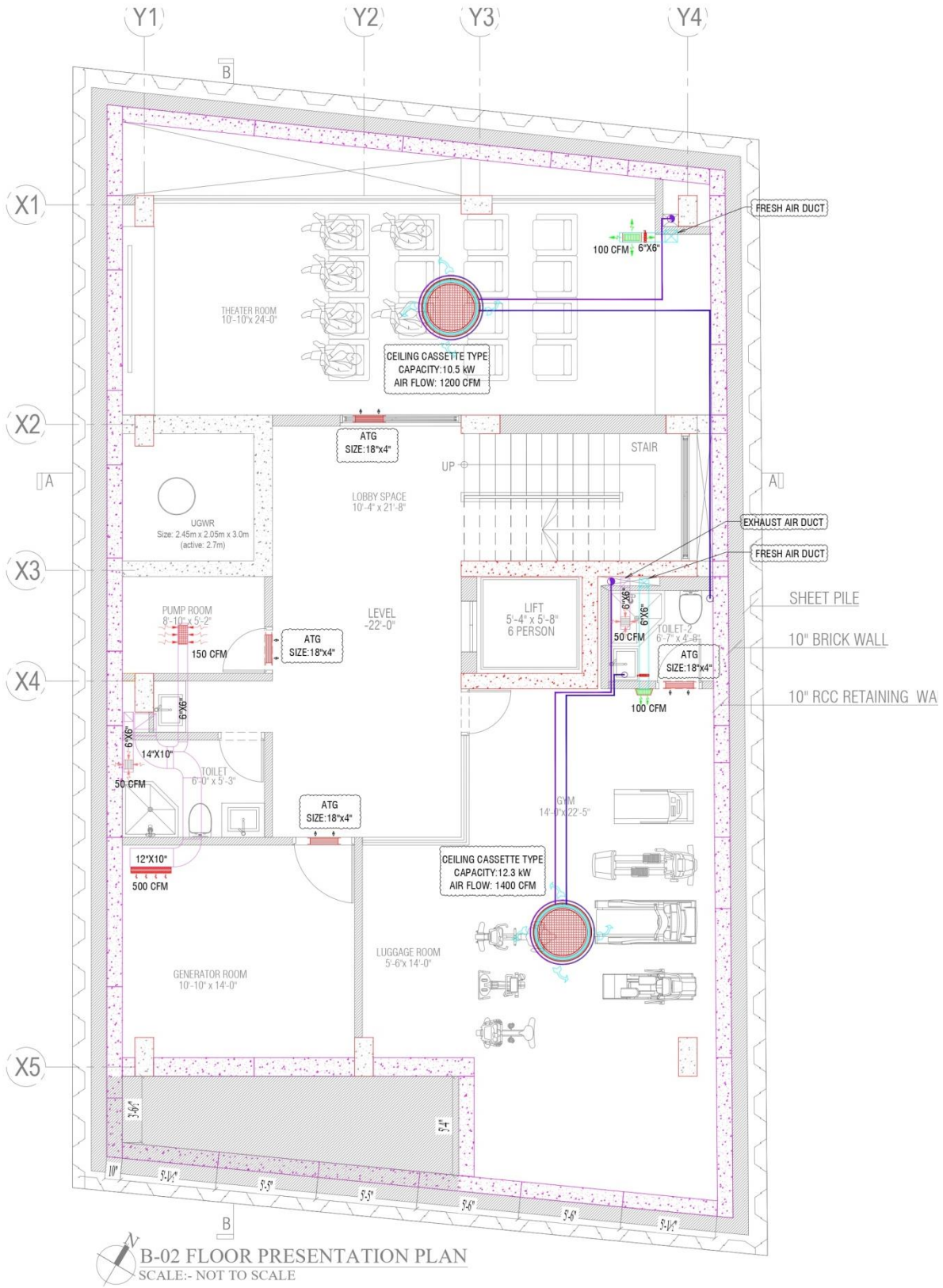
1ST FLOOR PRESENTATION PLAN

SCALE:- NOT TO SCALE


B
X1
X2
X3
X4
X5
A
KITCHEN VER
FRESH AIR DUCT
EXHAUST AIR DUCT
L.S.R.D
CAP:800 CFM
SIZE: 6"x46"
DRY KITCHEN
4'-3" x 10'-9"
6"X6"
WET KITCHEN
3" x 11'-0"
DINING
15'-4" x 15'-4"
L.S.S.D
CAP:800 CFM
SIZE: 6"x46"
16"X10"
DUCTED TYPE
Capacity:7.0 kW
AIR FLOW: 800 CFM
8"X8"
50 CFM
200 CFM
6"X6"
DUCTED TYPE
CAPACITY:7.0 kW
AIR FLOW: 800 CFM
16"X10"
50 CFM
UP
STAIR
LOBBY SPACE
15'-4" x 15'-4"
L.S.S.D
CAP:800 CFM
SIZE: 6"x46"
L.S.R.D
CAP:800 CFM
SIZE: 6"x46"
DN
EXHAUST AIR DUCT
FRESH AIR DUCT
LEVEL
+2'-0"
LIFT
5'-8" x 5'-2"
6 PERSON
6"X6"
50 CFM
TOILET
6'-7" x 4'-8"
6"X6"
DUCTED TYPE
CAPACITY:9.0 kW
AIR FLOW: 1000 CFM
50 CFM
LIVING
17'-4" x 12'-0"
L.S.R.D
CAP:1000 CFM
SIZE: 6"x58"
ATG
SIZE:18"x4"
POWDER
ROOM
SHOE RACK
18"X10"
L.S.S.D
CAP:1000 CFM
SIZE: 6"x58"
SHAFT
INLINE EX: FAN WITH LOUVER
CAPACITY: 650 CFM
SIZE: 14X10"
INLINE EX: FAN WITH LOUVER
CAPACITY: 500 CFM
SIZE: 14"X8"
PARKING LEVEL
+0'-6"
PROPELLER EX: Fan
CAPACITY: 100 CFM
GUARD ROOM
3'-1" x 8'-2"
+0'-6"
+0'-6"
+0'-6"
B
GR. FLOOR PRESENTATION PLAN
SCALE:- NOT TO SCALE
ROAD LEVEL
+0'-0"



B-01 FLOOR PRESENTATION PLAN
SCALE:- NOT TO SCALE



B-02 FLOOR PRESENTATION PLAN

SCALE:- NOT TO SCALE

5.3 VRF System Technical Specification and cost estimation

NIKUNJA TRIPLEX Cost Estimation BILL OF QUANTITY SCHEDULE FOR AIR CONDITIONING SYSTEM					
Sl. No.	**Item Details**	**Qty**	**Unit**	**Unit Price**	**Amount (Taka)**
1.0	**Variable Refrigerant Flow (VRF) System Outdoor Unit.**				
	Variable Refrigerant Flow (VRF/VRV) units having cooling capacities as mentioned below when air entering the coil at 78^0 DB / 66.5^0F WB. And leaving the coil at 55^0F DB 54.6^0F WB. Each unit shall be Single/Modular Type complete with DC Inverter Compressor, DX Condenser with Copper tube and Aluminum Fins. Condenser Fan with Fan guard, complete in all respect. . The unit shall operate when supplied with 400±10% V / 50hz / 3 Ph Electric power. The Condensing Units shall have Variable Frequency Drive Mechanism with necessarycomponents.				
	Country of Origin: UK/ EU/ Equivalent				
1.1	Cooling Capacity: 22.0 HP, 61.5 kW	2	Sets	559652.36	1119305
2.0	**VRF Fan Coil Unit (Indoor Unit)**				
	Supply of Fan Coil units having cooling capacities as mentioned below. Each unit shall be operated with Variable refrigerant Flow (VRF/VRV) outdoor units. FCU shall have refrigerant control valve (EXV) washable filter, fan speed controller etc. complete in all respect. Vent port shall be built in inside the unit. The unit shall operate when supplied with 220± 10% V / 50hz / 1 Ph Electric Power.				
	Country of Origin: UK/ EU/ Thailand/ Equivalent				
2.1	**Cassette Type Indoor Unit**				
2.1.1	Capacity: 12.3KW, 3.5TR	1	Sets		160215
2.1.2	Capacity: 11.2KW, 3.0TR	1	Sets		160215
2.1.3	Capacity: 9.0KW, 2.5TR	1	Sets		117000
2.2	**Ducted Type Indoor Unit**				
2.2.1	Capacity: 11.2KW, 3.0TR	1	Sets		148000
2.2.2	Capacity: 9.0KW, 2.5TR	2	Sets	95000	190000
2.2.3	Capacity: 7.1KW, 2.0TR	6	Sets	85000	510000
2.2.4	Capacity: 5.3KW, 1.5 TR	2	Sets	135000	67500
2.3.	**Wall Type Indoor Unit**				
2.3.1	Capacity: 2.8KW, 0.8TR	2	Sets		50000
2.3	**Ducted Type Fresh Air Indoor Unit**				
2.3.1	Capacity: 7.1 KW, 2.0TR	2	Sets		85000
3.0	**Refnet Joint.**	18	Nos		50000
	Supply, installation of refrigerant Y shapped Tee Joints specially prepared for VRF system manufactured by the VRF unit.				
	Country of Origin: UK/ EU/ Thailand/ Equivalent				
4.0	**Wireless Remote Controller**	18	Set		135000
5.0	**Central Controller**	1	Set		95000
	Total=				**2887235**

CHAPTER -6

Performance Test

6.1 HVAC System Performance Test:

Conduct tests to assess the efficiency and effectiveness of the Heating, Ventilation, and Air Conditioning (HVAC) system.

- Measure indoor air quality, temperature distribution, and system responsiveness.
  Each of these pollutants has a national air quality standard set by EPA to protect public health.
- Evaluate the HVAC system's ability to maintain desired comfort levels under various conditions (e.g., different weather conditions, occupancy levels)
  Humans generally feel comfortable between temperatures of 22 °C to 27 °C and a relative humidity of 40% to 60%. first cool the air to 14 °C (this removes some of the water from the air), and then heat the air to 24 °C. the heat and mass of water removed in the cooling phase, and the heat added in the heating phase.

6.2 Plumbing System Performance Test:

- Conduct flow rate tests for water supply lines and drainage systems.
  The most common residential plumbing flow rates are 1.5, 2.2, 3.0, and 4.0 GPM
- Evaluate the efficiency of water heaters and pumps.
- Check for leaks and pressure drops in the plumbing network.

6.3 Fire Safety System Performance Test:

- Test the functionality of ABC Fire Extinguisher, Co2 Type Extinguisher and FM-200
- Conduct simulations to assess evacuation procedures and the effectiveness of emergency lighting.

CHAPTER -7

Conclusion and Future Recommendation

7.1 Design Considerations:

The MEP systems are designed to ensure optimal functionality, energy efficiency, and occupant comfort throughout the building.

Adequate provisions for ventilation, heating, cooling, lighting, water supply, drainage, and waste management have been incorporated into the design.

The systems comply with local building codes, regulations, and standards to ensure safety and reliability.

7.2 Cost Estimation:

The cost estimation includes expenses related to equipment, materials, labor, installation, and contingency.

It is based on detailed calculations, specifications, and market rates for MEP components and services.

The estimated cost reflects a balance between quality, functionality, and affordability, aiming to deliver value to the client.

7.3 Future Recommendations:

Regular maintenance: Recommend implementing a schedule for regular maintenance and servicing of MEP systems to ensure their long-term performance and durability.

Energy efficiency upgrades: Suggest exploring opportunities for energy-saving upgrades such as LED lighting, energy-efficient HVAC systems, and smart controls to reduce operating costs and environmental impact.

Renewable energy integration: Assess the feasibility of integrating renewable energy sources such as solar panels or wind turbines to supplement the building's energy needs and reduce reliance on grid power.

Monitoring and optimization: Install monitoring systems to track energy consumption, indoor air quality, and water usage, allowing for continuous optimization and improvement of MEP system performance.

Adaptability for future needs: Design MEP systems with flexibility and scalability in mind to accommodate future changes or expansions in building usage or occupancy requirements.

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