Palestine Polytechnic University

College of Engineering & Technology
Mechanical Engineering Department

Graduation Project

The design of mechanical systems in residential Villa
Tira / Ram Allah

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Abstract

This project comes as the fruit of five years of hard work in the field of Refrigeration and Air conditioning engineering.

In this study a general study will be proposed for a villa in Ram Allah to design the the central heating, hot & cold water, sanitary drainage with high efficiency and good design.

Our project will contains soft ware discus these problems and contains presentation to expose our study to the doctors and discus them after we will finish from this project.

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CHAPTER ONE

INTRODUCTION

1 Introduction

1-1 Introduction

In this project, a trial is made to make the best Central Heating System to cover heating requirements in a Villa in Ram Allah

A central heating system consists of all the pipe work and radiators that are connected to the boiler. The boiler provides the heat but, it's the pump (Circulator) that moves the heated water from the boiler through the pipe work to the radiators, and back to the boiler for re-heating. There are many types of systems that can be installed, and which may be tailored to your own preferences. But a carefully designed and installed system will give many years of trouble free running and will not waste heat, therefore keeping fuel costs low.

The system with the least cost and full ability to cover the whole energy demand is designed with all the accessories required. Separate drawings are including in the project with complete specifications. A complete bill is given in local prices. At last, a discussion and recommendations paper is included.

So, central heating system, sanitary system and water supply system are represented on the drawings

1-2 Project Objectives

1- Our project is to make design for central heating system and plumping system

2- To prepare the required drawings for the above mentioned systems

3- To select the required equipments and parts and its specification of boiler, pipes… etc

4- Implementing the mechanical systems after a full study done

1-3 Project Benefits

We choose this project to prepare a full document for mechanical systems in the villa.

So, documents include

1- Heating load calculation for central heating system
2- Calculation for flow and pipes for plumping system
3- prepare the required drawings for the above mentioned systems
4- selection for the required equipments and parts and its specification of boiler, pipes… etc
5- Implementing the mechanical systems on the site

1-4 Budget

TASK	COST (NIC)
USING INTERNET	600
TRANSPORTATION FROM AND INTO THE PROJECT	200
OTHER TRANSPORTATION	100
PRINTING PAPERS	200
PRINTING DRAWING	600
TOTAL	1700

Table 1-1 Budgets

1-5 Time Planning

The project plan follows the following time schedule, which includes the related tasks of study and system analysis.

The following time plan is through the semester

The Semester Time Plan

Task/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Collecting Information about the project																
Study the mechanical draw.																
central heating system calculation& plumping system calculation																
Drawing planes & Selection of equipments																
Making bill of quantity (BOQ)																
Project Documentation																

Fig 1.1 the semester Time Plan

CHAPTER TWO

CENTAL HEATING SYSTEM COMPONENTS

2.1 INTRODUCTION

This chapter deals with the components used in central heating system and talks about the role of each component in the system

A central heating system consists of all the pipe work and radiators that are connected to the boiler. The boiler provides the heat but, it's the pump (Circulator) that moves the heated water from the boiler through the pipe work to the radiators, and back to the boiler for re-heating. There are many types of systems that can be installed, and which may be tailored to your own preferences. But a carefully designed and installed system will give many years of trouble free running and will not waste heat, therefore keeping fuel costs low.

Hot Water (Hydronic) Heating System

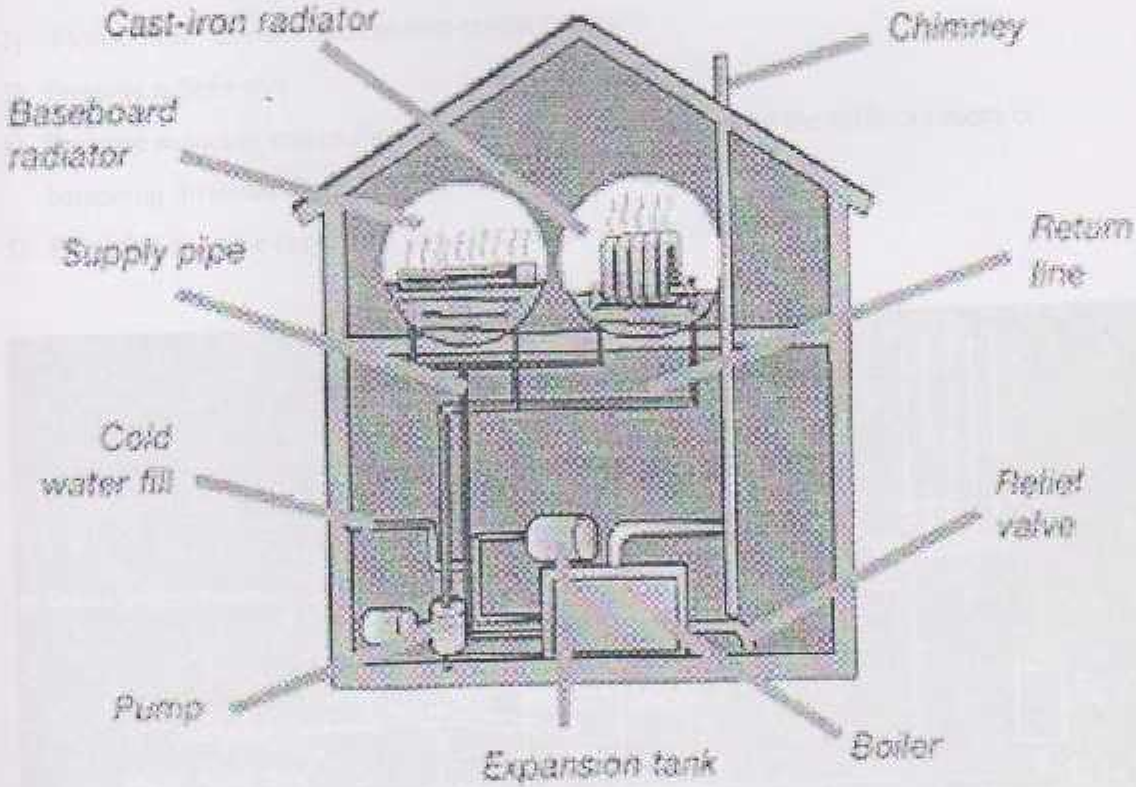


Fig 2.1 Central heating system components

2.2 Hot water heating system components

The main components of a central heating system using water circulation are:

1) Room heating elements (radiators or fan coils).

2) Boilers.

3) Piping network.

4) Circulating pump.

5) Expansion tank.

6) Oil tank.

7) Chimney.

Device and fitting are required in a hot water heating system, these include the following:

1) Air elimination device such as automatic air vent and manual air vents for room heating elements.
2) Flow control devices such as non-return valves.
3) Pressure relief valve.
4) Pressure reducing valves for balancing the piping network of the different room or balancing different zones.
5) Provision for pipe expansion and elimination of vibration.

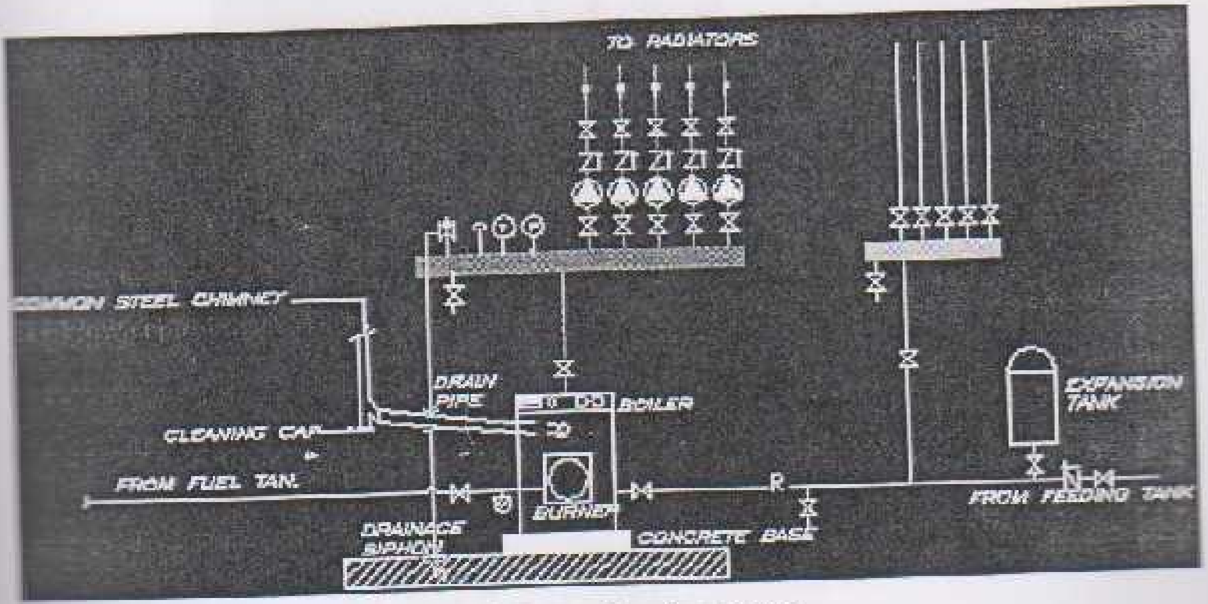


Fig 2.2 Central heating system

2.2.1 Room heating elements

Heat transfer elements facilitate the transfer of heat between the hot water and space to be heated; heating elements that are in common use in hot water heating system are Radiators

They are made of:-

1-Cast iron Radiators

2- Aluminum Radiators

3- Steel plates Radiators

So, we will use Aluminum Radiators in our project because it has low cost, light weight construction near 1.5 kg for one section , Limited thermal inertia and they are made of sections so could be lengthened and shortened easily

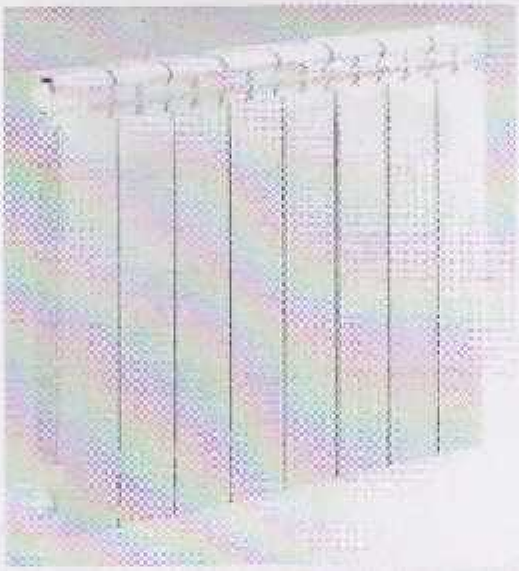


Fig 2.3Aluminum radiator

2.2.2 Boilers

Boilers are constructed of cast iron or steel sheets in various capacities and sizes, they maybe low pressure "200 kpa" or high pressure boilers "3200 kpa". Boilers are classified in a number of ways as follows:-

a) They may be classified on the basis of material out of which they are made as cast iron boilers or steel sheet boilers

b) They maybe classified on the basis of the operation pressure for example low pressure or high pressure boilers.

c) They maybe also classified on the basis of raw energy they use, for example, gas boiler, diesel boilers, or any other energy boiler.

d) Type of construction may be used for classification for example, fire tube or water tube boilers.

The boiler package contains, in addition to the boiler body, the burner, the safety control and jacket, the safety devices associated with boilers include relief valves, water level cut-off device, switch on-off device, and outlet and inlet temperature control thermostat.

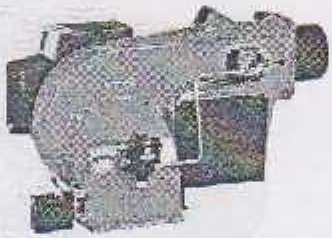


Fig 2.4 Burner

2.2.3 Piping network

We use radial pipe system, in this pipe system uses plastic pipe instead of metal pipe for circulating the hot water throughout the heating system.

The supply pipes of a certain number of radiators are connected to a single supply manifold, using special brass coupling, the return pipes are also connected to single return manifold. The supply and return manifold are respectively connected to the main supply and main return pipes of boiler which may be made from plastic or metal pipes.

2.2.4 Circulating pump

A circulating pump is simply a small pump whose purpose is to circulate the water in the hydraulic heating system: centrifugal pumps are the type normally used as circulators.

Modern hydronic heating system are closed therefore, there is no static head for the pump to overcome since the weight of water in riser piping is exactly counter balanced by an equal weight of water in the return piping, the circulator, therefore must overcome only the friction head in the piping, the circulator is therefore usually driven by small, frictional, horse power electrical motors.

Circulator pumps are normally low head, low flow units, they are low head because of absence of static head, and low flow, because of the high heat carrying capacity of water, they are either installed in line when the water flow from pump inlet to outlet is in the same direction or as base mounted where aright angle change in water direction from inlet to outlet is desired, most circulators are installed in line.

The circulator can be installed either in the main supply line, outgoing from the boiler, or in the main return line coming back to the boiler, in system with high head, it is normal practice to place the pump so that it pumps away from the boiler and expansion tank.

Fig 2.5 pump

2.2.5 Expansion tank

In a closed recalculating system (central heating system) a given amount of air or gas space is required to accommodate water expansion and pressurization. Since water expands when heated and contracts when cooled in direct proportion to the temperature change, and since water is incompressible, a lack of expansion space means that any volume increase due to heating will cause an immediate and definite pressure increase. Expansion tank is the primary device used to accommodate fluctuations in water volume within a closed system while maintaining a predetermined range of pressures, from the minimum cold-fill pressure up to (but not more than) the maximum working pressure of the system.

Fig 2.6 Close expansion tank

2.2.6 Oil tank.

A fuel storage tank can be an underground storage tank or an above ground storage tank as needed in the project.

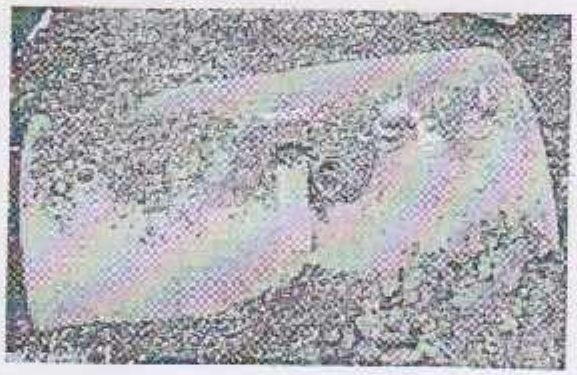


Fig 2.7 Underground oil tank

2.2.7 Chimney

A vertical hollow structure of steel, or reinforced concrete, built to convey gaseous products of combustion from a building or process facility. A chimney should be high enough to furnish adequate draft and to discharge the products of combustion without causing local air pollution.

2.2.7.1 Types of chimney:

1- **Cast-in-place concrete**
2- **Stainless steel.**
3- **Galvanized or aluminum sleeves**

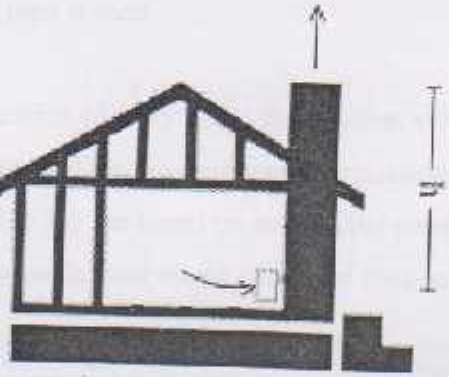


Fig 2.8 Chimney

2.8 Piping design

This section represents the principles and currently accepted design techniques for water piping systems used in air-conditioning applications. The principles and techniques described are applicable to hot water system. The water system discussed here is a recirculation type where the water is not discharged but flows in a repeating circuit from the heat exchanger to the heat exchanger. It is also a closed system because the flow of water is not exposed to the atmosphere at any point except at an insignificant area in the expansion tank.

2.8.1 Water piping design

2.8.1.1 Pipe friction loss

The pipe friction loss in a system depends on water velocity, pipe diameter, interior surface roughness and pipe length. Fig.2-1 (See Appendix A) shows the friction chart for closed recirculation piping system. The chart shows the water velocity, pipe or tube diameter and water quantity in addition to the friction rate per 100ft of equivalent pipe length.

2.8.1.2 Water velocity

The values of velocities recommended for water piping depend on two conditions:

1- The service for which the pipe is used.
2- The effects of erosion.

Table 2-1 lists recommended velocity range for different services. The design of water of piping systems is limited by the maximum permissible flow velocity. The maximum values listed in table 2-1 are based on established permissible sound levels of moving water and entrained water and on the effects of erosion.

service	Velocity range(FPM)
Pump discharge	4_10
Pump suction	4_7
Drain line	3_10
header	5_15
riser	5_15
General service	5_12

Table 2-1 shows values of recommended water velocities (FPM)

2.8.1.3 Pipe Equivalent length

The total equivalent length of a water piping system is determined from the straight length in addition of equivalent length of pipes due to fittings, valves and other elements in the piping system. Tables 2-6, 2-7 and 2-8 (See Appendix A) give the additional equivalent lengths for pipe for these various components.

2.9 Water Cycle in Central Heating System

A central heating system consists of all the pipe work and radiators that are connected to the boiler. The boiler provides the heat but, it's the pump (Circulator) that moves the heated water from the boiler through the pipe work to the radiators, and back to the boiler for re-heating. There are many types of systems that can be installed, and which may be tailored to your own preferences. But a carefully designed and installed system will give many years of trouble free running and will not waste heat, therefore keeping fuel costs low.

CHAPTER THREE

HEAT LOAD CALCULATION
&
HEATING SYSTEM SELECTION

3.1 INTRODUCTION

This chapter deals with the usual procedures used to estimate heating loads, in order to size heating equipments.

Heat transfer through a building envelope is influenced by the materials used; by geometric factors such as size, shape, and orientation; by the existence of internal heat sources; and by climatic factors.

The primary function of heat loss calculations is to estimate the capacity that will be required for various heating components necessary to maintain comfort within a space.

These calculations are therefore based on peak load calculations for heating and correspond to environmental conditions which are near the extremes normally encountered.

Loads are generally divided into the following two categories:

1- Transmission: heat loss or heat gain due to a temperature difference across a building element.

2- Infiltration: heat loss due to the infiltration of outside air into a conditioned space.

3- Ventilation: heat loss due to the ventilation of outside air into a conditioned space

3.2 Symbols

QH heating load (W)

U (wall) overall heat transfer coefficient for external wall ($W/m^2.°C$)

U (roof) overall heat transfer coefficient for roof ($W/m^2.°C$)

U (ceiling) overall heat transfer coefficient for ceiling ($W/m^2.°C$)

U (floor) overall heat transfer coefficient for floor ($W/m^2.°C$)

U (partition) overall heat transfer coefficient for internal partition ($W/m^2.°C$)

A area (m^2)

TD temperature difference (°C)

HRD humidity ratio difference (Kg H_2O/Kg dry air)

NO. Number of people

AFR air flow rate (L/s)

W light rate (W)

PR equipment input elec. Power

b wind coefficient

E percent fraction

Hp horse power

L length, crack

V velocity

q Heat loss or gain

3.3 GENERAL PROCEDURE

In estimating the heating load for the villa, the necessary steps can be outlined as follows:

1- Design value for outdoor winter is selected.

2- Indoor design conditions are selected on the activities to be carried out in the space.

3- The temperature in the unconditioned adjacent spaces is estimated. Usually the Average temperature between inside and outside is taken

4- Heat transfer coefficient and areas for the villa components are calculated from the villa plans and specifications. Surfaces between conditioned spaces must be omitted.

5- Rate of infiltration is estimated.

6- Rate of outside air required is estimated.

7-From the above data, transmission heat losses and infiltration and/or ventilation heat losses are computed these values are summed.

8- A certain pick-up load is required in order to reach the required condition in the space in a reasonable time.

3.4 PROCEDURE IN DETAILS

3.4.1 Outdoor design conditions selection

These include dry-bulb temperature Tout, relative humidity Φout and average air speed v. these values are usually tabulated local weather stations reports. Table 3-1 shows these values for Ram Allah town.

season	Dry-Bulb Temperature T_{out},°C	Relative Humidity Ø,%	Average air speed m/s
Heating	0	50	3.0
Cooling	35	50	1.5

Table 3-1 shows values for out door design condition for Ram Allah town

3.4.2 Indoor design conditions selection

Generally, an inside temperature equals 22° is taken as the inside design temperature in villa.

3.5 Heat transfer coefficient calculation

Usually heat transfer coefficients can be found for roof components, wall components, internal air, external air, and glass. Table 3-2 shows such values. Usually, the term "surface conductance", h(w/m2. °c) is used for air and the term "Thermal resistance", R(m2.c/w)is used with building materials, insulation and glass.

To find the overall heat transmission coefficients, this equation is used:

$$\frac{1}{U_{overall}} = R + 1/h \qquad (3\text{-}1)$$

component	Members of component	Resistance (R) $m^2.c^0/w$	Surface conductance (h) $w/m^2.c^o$
roof	Plaster, 1.5cm Hollow brick,20cm 10cm Concrete, 8cm Polystyrene,25mm Rubber Mortar, 2cm Tile, 2.5cm insulation		10.11 5.11 7.94 9.0 0.92 3.2 36 3.01 1.36
External wall	Hollow brick, 20cm		5.11
Internal wall	Plaster, 2cm Hollow brick.15cm	0.112	6.0
Internal air	Roof air Wall air Under floor air		9.26 8.29 6.13
External air	Any where		(winter)34.08 (summer)22.71
window	Single class		6.39

Table 3-2 shows values of Heat transmission coefficient Used in calculating heat losses or gain

The overall heat-transfer coefficient U is a function of the thermal resistances; so we can calculate the values of thermal resistance for commonly used building materials enclosed air spaces and building envelope boundaries

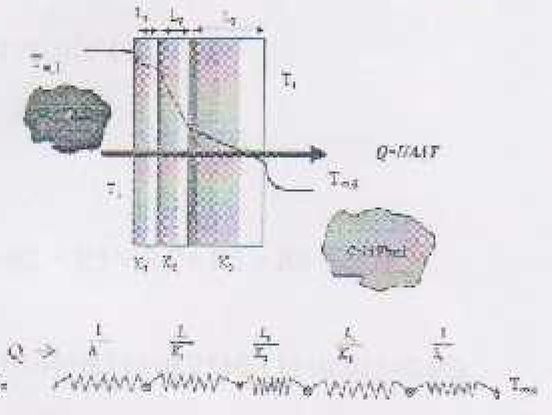
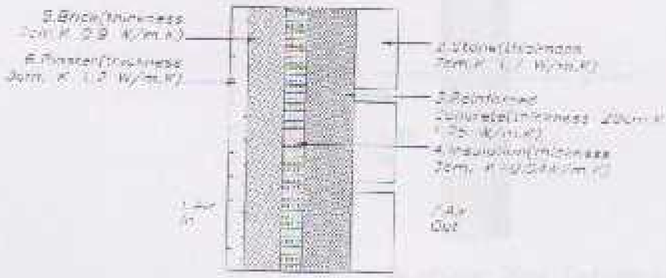


Fig 3.1Convection and conduction heat transfer

3.5.1 Calculation of external walls U value



Section For External Wall

R1=0.12 (m^2.K/W)

R2=d2 / K2 =0.07/1.7 =0.04 (m^2.K/W)

R3=d3 / k3 =0.20/1.75 =0.114 (m^2.K/W)

R4=d4 / k4 =0.03/0.04 =0.75 (m^2.K/W)

R5=d5 / k5 =0.1/0.9 =0.111 (m^2.K/W)

R6=d6 / k6 =0.03/1.2 =0.025 (m^2.K/W)

R7=0.06 (m^2.K/W)

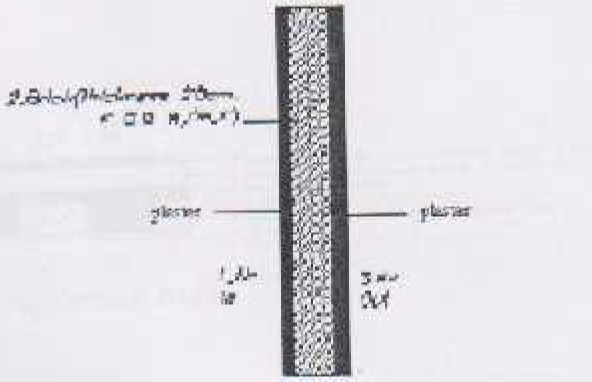
U overall=1/ $\sum$ (R1+ R2 + R3 + R4 + R5 + R6 + R7)

=1/ $\sum$ (0.12+0.04+0.114+0.75+0.111+0.025+0.06)

=1/1.22

=0.82 (W/m^2.K)

3.5.2 Calculation of internal walls U value



Section For Internal Wall

$R1=0.12\ (m^2.K/W)$

$R2=d2\ /\ K2=0.20/0.90=0.22\ (m^2.K/W)$

$R3=0.12\ (m^2.K/W)$

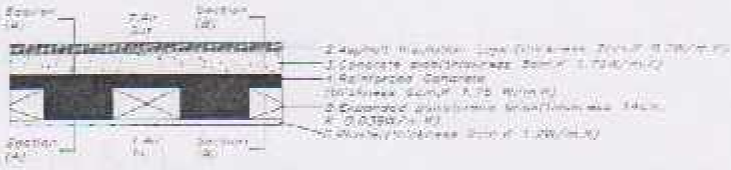
$U\ overall=1/\sum(R1+R2+R3)$

$=1/\sum(0.12+0.22+0.12)$

$=1/0.46$

$=2.17\ (W/m^2.K)$

3.5.3 Calculation of exposed roofs U value



Section For EXPOSED ROOFS

For section A:

$R1=0.12$ ($m^2.K/W$)

$R2=d2 / K2 = 0.02/0.70 = 0.0286$ ($m^2.K/W$)

$R3=d3 / k3 = 0.05/1.75 = 0.286$ ($m^2.K/W$)

$R4=d4 / k4 = 0.20/1.75 = 0.114$ ($m^2.K/W$)

$R5=d5 / k5 = 0.02/1.2 = 0.017$ ($m^2.K/W$)

$R6=0.06$ ($m^2.K/W$)

$U\ overall=1/ \sum (R1+ R2 + R3 + R4 + R5 + R6)$

$=1/ \sum (0.12+0.0286+0.286+0.114+0.017+0.06)$

$=1/0.63$

$=1.59$ ($W/m^2.K$)

For section B:

$R1=0.12\ (m^2.K/W)$

$R2=d2 / k2 =0.02/0.70 =0.0286\ (m^2.K/W)$

$R3=d3 / k3 =0.05/1.75 =0.286\ (m^2.K/W)$

$R4=d4 / k4 =0.06/1.75 =0.034\ (m^2.K/W)$

$R5=d5 / k5 =0.14/0.039 =3.59\ (m^2.K/W)$

$R6=d6 / k6 =0.02/1.2 =0.017\ (m^2.K/W)$

$R7=0.06\ (m^2.K/W)$

$U\ overall=1/ \sum (R1+ R2 + R3 + R4 + R5 + R6 + R7)$

$=1/ \sum (0.12+0.0286+0.286+0.034+3.59+0.017+0.06)$

$=1/4.14$

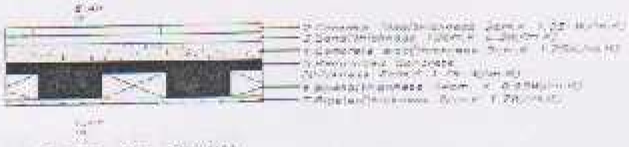
$=0.24\ (W/m^2.K)$

U overall = U overall for section A $\times$ 0.2 + U overall for section B $\times$ 0.8

$= 1.59\times0.2 + 0.24\times0.8$

$= 0.51\ (W/m^2.K)$

3.5.4 Calculation of ceiling U value



Section For CEILING

$R1=0.12\ (m^2.K/W)$

$R2=d2\ /\ K2=0.02/1.05=0.019\ (m^2.K/W)$

$R3=d3\ /\ k3=0.13/0.30=0.43\ (m^2.K/W)$

$R4=d4\ /\ k4=0.02/0.04=0.04\ (m^2.K/W)$

$R5=d5\ /\ k5=0.06/1.75=0.164\ (m^2.K/W)$

$R6=d6\ /\ k6=0.14/0.95=0.147\ (m^2.K/W)$

$R7=d7\ /\ k7=0.02/1.2=0.017\ (m^2.K/W)$

$R8=0.12\ (m^2.K/W)$

$U\ overall=1/\sum(R1+R2+R3+R4+R5+R6+R7+R8)$

$=1/\sum(0.12+0.019+0.43+0.04+0.164+0.147+0.017+0.12)$

$=1/1.06$

$=0.94\ (W/m^2.K)$

3.5.5 Calculation of glass U value

$R_{glass} = 1/U_{glass} = 1/3.7 = 0.27$ ($m^2.K/W$)

$R_{air\ in} = 0.12$ ($m^2.K/W$)

$R_{air\ out} = 0.06$ ($m^2.K/W$)

$U_{glass} = 1/\sum(R_{glass} + R_{air\ in} + R_{air\ out})$

$= 1/\sum(0.27 + 0.12 + 0.06)$

$= 1/0.45$

$= 2.22$ ($W/m^2.K$)

3.6 Infiltration Rate Calculation

The air flow due to infiltration is calculated from the equation

$$Q = L[a.\Delta T + b.v^2]^{\frac{1}{2}} \qquad (3\text{-}2)$$

Where

Q= Air flow m^3/h

L= crack area cm^2, it can be found in special tables as Shown in Table 3-3

a= stack coefficient (m^3/h) 2(cm)-4(K)-1, and taken as 0.00564 for Villa

b= wind coefficient (m^3/h) 2(cm)-4(m/s)-2, and taken as 0.00494 for light local shielding.

ΔT=temperature difference, K

v= average wind speed, m/s

Component	Infiltration leakage area (cm^2/cm^2)
External doors	11
Poor frame	1.7
Windows	5.2
Window frame	1.7
Extract fan	20

Table 3-3 shows values of Leakage infiltration area cm^2/cm^2

3.7 Ventilation requirements

The outdoor air requirements are listed in references for different spaces. Table 3-4 shows ventilation standard for sum applications.

Application	cfm/ft² of floor
Meeting rooms	1.0
Cafeteria	1.0
Kitchen	4.0
Store	1.0
Class room	0.5
toilet	2.0

Table 3-4 shows values of Ventilation standard for residences

3.8 Total calculation

Transmission loads can be calculated using this equation:

$$q = U_{overall} . A \Delta T \qquad (3\text{-}3)$$

Where:

q= heat loss (w)

U overall= overall heat transmission coefficient (W/m^2.°C)

A= area of heat transfer (m^2)

ΔT= temperature difference (°C)

To find ventilation and infiltration loads, the following equation is used:

$$q = 1.2 V \Delta T \qquad (3\text{-}4)$$

Where

V Is outdoor air flow in L/s

So, now we can calculate the heating load using this method for each room in the villa and we can choose the radiator in each room in each floor in the villa as in the following

For Basement floor

ROOM NAME	TOTAL LOAD IN Kcal
MULTIPURPOSE HALL	5701
GUEST ROOM	1398
BATH ROOM (1)	734
MAID ROOM	1071
BATH ROOM (2)	475
KITCHEN	1540
	TOTAL LOAD = 10.919 Kcal=12.70 KW

Table 3-5 loads in each room in the basement floor

RAD.NO.	NO. OF SECTION	RAD LENGTH CM	TYPE
1	11	100	AL 600
2	11	100	AL 600
3	11	100	AL 600
4	11	100	AL 600
5	11	100	AL 600
6	6	60	AL 600
7	9	84	AL 600
8	4	44	AL 600
9	12	108	AL 600
TOTAL	**86 SEC.**	-------	--------

Table 3-6 numbers of sections for each radiator in the basement floor

For Ground floor

ROOM NAME	TOTAL LOAD IN Kcal
RECEPTION AND DINNING	6386
LOBBY (1)	622
WATER CIRCIT	616
OFFICE	1626
BATH ROOM	490
ROOM BESIDE ELEVATOR	1549
BREAKFAST & LIVIVNG ROOM	6429
LOBBY (2)	804
ENTARANCE LOBBY	887
	TOTAL LOAD = 19.409 Kcal = 22.57 KW

Table 3-7 loads in each room in the ground floor

RAD.NO.	NO. OF SECTION	RAD LENGTH CM	TYPE
1	18	156	AL 600
2	16	140	AL 600
3	16	140	AL 600
4	5	54	AL 600
5	5	54	AL 600
6	14	124	AL 600
7	4	44	AL 600
8	12	108	AL 600
9	18	156	AL 600
10	16	140	AL 600
11	16	140	AL 600
12	7	68	AL 600
13	7	68	AL 600
TOTAL	**154 SEC.**	-------	--------

Table 3-8 numbers of sections for each radiator in the ground floor

For First floor

ROOM NAME	TOTAL LOAD IN Kcal
BATH(1)	520
M. BATH	850
BATH (2)	650
MASTER BED ROOM	2370
WALK IN CLOSET(1)	619
LOBBY (1)	493
BED ROOM	1960
LOBBY (2)	2457
LIVING ROOM	5900
BED ROOM(1)	2151
BATH(3)	482
BED ROOM(2)	1720
WALK IN CLOSET(2)	850
	TOTAL LOAD = 21022 Kcal= 24.45 KW

Table 3-9 loads in each room in the first floor

RAD.NO.	NO. OF SECTION	RAD LENGTH CM	TYPE
1	4	44	AL 600
2	7	68	AL 600
3	5	52	AL 600
4	18	156	AL 600
5	5	52	AL 600
6	4	44	AL 600
7	15	84	AL 600
8	19	164	AL 600
9	14	124	AL 600
10	11	100	AL 600
11	11	100	AL 600

12	17	148	AL 600
13	4	44	AL 600
14	14	124	AL 600
15	7	68	AL 600
TOTAL	**155 SEC.**	-------	--------

Table 3-10 numbers of sections for each radiator in the first floor

So, now we can calculate the heating load using this method for each floor and the result as following:-

Floor NAME	**TOTAL LOAD IN KCAL**
BASMENT FLOOR	10.919
GROUND FLOOR	19.409
FIRST FLOOR	21.022
	TOTAL LOAD=51.35 Kcal =59.71 KW

Table 3-11 total loads in each floor in the villa

3.9 Pick-up load

For intermittently heated buildings, or in the case of the night thermostat setback, additional heat is required for raising the temperature of air, building materials and material contents of a building to the specified indoor temperature. For temperature difference of 17°C and less, for the system to reach its design temperature in 1 hour, 20% of design heat loss is enough.

3.10 Heating Boiler calculations & Selection

For boiler capacity = total no. of all sections in floors × heat transfer per section

=395 sec. ×130(Kcal/h)

=51,350 (Kcal/h)

We add 8600(Kcal/h) for hot water cylinder with 200 l.

So, using the following equation

$$Q= m*cp*\Delta T$$

$$Q= 200*1*50*0.86 = 8,600 \text{ Kcal/h}$$

Note: We use 11,400 (Kcal/h) as a safety factor

Total boiler capacity = 51,350+8,600+11,400

= 71,350 (Kcal/h)

Boiler capacity in (kW) = (71,350×1.2)/860

=99.56(kW)

≈100 (kW)

<u>From catalogue</u>

Using Boiler of the type **Fondital cast-iron boiler mod. ALOR 120**(See Appendix A) of the following specifications:-

Thermal Output=124.8 KW

Maximum thermal power =114.0KW

Fig3.2 Boiler

3.11 Radiator calculation& Selection

Using radiators of the type **Fondital** Die-cast aluminum radiators GB 600/100 with capacity of one section =130 kcal (See Appendix A)

So, in order to calculate the numbers of sections of each radiator for any room:

No. of sections=heating load for the room (Kcal/h) heat transfer per section

For example: for the master room in first floor, the heating load is 2.593(KW), heat transfer per section is 130(Kcal/h), so:

Heating load in (Kcal/h) $=2.593\times860$

$=2230$

No. of sections=2230(Kcal/h) /130(Kcal/h)

$=17.2\approx17$ sections

Width of the radiator= (no of sections× width for each section) +valves for both sides

Width for each section=8cm

Valves for both sides=12cm

Width of the radiator= $(17\times8)+12$

$=148$cm

3.12 Collector capacity calculations & Selection

-There are 86 sections for basement floor

So

Collector capacity = no of sections × heat transfer per section

= 86sec ×130(Kcal/h)

=11,180 (Kcal/h)

Collector capacity in kW=Q (Kcal/h) / 860

=11,180/860

=13 kW

3.12.1 Flow rate & collector size calculations

Flow rate = (Q (kW) ×0.24)/ΔT

= (13KW×0.24)/15

=0.208 L/s

Flow rate =V×A

Assume V =0.9 m/s

Flow rate = V× ((π×d2)/4)

=0.9× ((π× d2)/4)

$d=\sqrt{(4\times flow/\pi\times0.9)}$

$d=\sqrt{flow}\times1.19$

Collector diameter $=\sqrt{flow}\times1.19$

$=\sqrt{0.208}\times1.19$

$=0.456\times1.19$

$=0.54''$

0.54" approximated to 0.75" diameter

-There are 154 sections for ground floor

So

Collector capacity = no of sections × heat transfer per section

= 154sec ×130 (Kcal/h)

=20,020 (Kcal/h)

Collector capacity in kW=Q (Kcal/h)/ 860

=20,020/860

=23.28 kW

Flow = (Q (kW) ×0.24)/ΔT

= (23.28 kW×0.24)/15

$= 0.37$ L/s

Collector diameter $= \sqrt{\text{flow}} \times 1.19$

$= \sqrt{0.37} \times 1.19$

$= 0.608 \times 1.19$

$= 0.72''$

0.72" approximated to 0.75" diameter

-There are 155 sections for first floor

So

Collector capacity = no of sections × heat transfer per section

$= 155 \text{sections} \times 130$ (Kcal/h)

$= 20{,}150$ (Kcal/h)

Collector capacity in kW=Q (Kcal/h) / 860

$= 20{,}150/860$

$= 23.43$ kW

Flow = (Q (kW) ×0.24)/ΔT

$= (23.43\text{kW} \times 0.24)/15$

$= 0.37$ L/s

Collector diameter $= \sqrt{flow} \times 1.19$

$= \sqrt{0.37} \times 1.19$

$= 0.608 \times 1.19$

$= 0.72''$

0.72" approximated to 0.75" diameter

3.13 Chimney Calculations& Selection

Chimney capacity = (boiler (kW) ×12000)/3.5

to obtain the capacity in Btu/h

= (100(KW) ×12000)/3.5

= 342857, 14 Btu/h

So, V type and head 50ft we choose chimney with 8" diameter

3.14 Pump Calculation & Selection

Pump is selected based on:

1- Water flow rate (GPM)

2- Pump horse power (hp) – friction head

$$hp = \Delta p \quad Q/550 \qquad (2\text{-}1)$$

Where,

Δp= pressure loss lb/ft2

Q= water flow rate ft3/s

Eq.-(3-1) can be put as:

$$hp = \frac{\Delta p(lb/in^2)}{550} * 144 * \frac{GPM}{60}(0.1337)$$

Or

$$hp = \frac{\Delta p(lb/in^2) * GPM}{1714} \quad (3\text{-}5)$$

3.14.1 Pump calculations

First of all we calculate the flow rate of the entire floor, let's take the ground floor:

No of sections required in this floor is=129 section.

Heating capacity of this floor=no. of sections × 130 (Kcal/h)

=129sec × 130 (Kcal/h)

=16,770 (Kcal/h)

Heating capacity in KW= heating capacity (Kcal/h) / 860

=16,770(Kcal/h) / 860

=19.5kW

Flow (L/s) = (heating capacity (kW) ×0.24)/15

= (19.5×0.24)/15

$=0.312$ L/s

Flow (m3/h) = Flow (L/s) × 3.6

$=0.312 \times 3.6$

$= 1.12$ m3/h

Head= (loop length (m) × 1.8 × 450)/12000

$= (80\times1.8\times450)/12000$

$=5.4$m

For safety:

Head $=5.4\times1.2$

$= 6.48\text{m}\approx7\text{m}$

Then by comparing this result with the pump curve we can select the suitable pump.

So, we select pump with flow rate = 1.12 m3/h and head = 7m

So, we use pump of the type **BIRAL PUMP NRB 15T** (medium–speed circulators with 3 speeds for heating and air conditioning) (See Appendix A)

3.15 Expansion tank calculation & selection

An expansion tank is used to maintain system pressure by allowing the water to expand when water temperature increases. It is normally required in a closed system. ASME has standardized the calculation of the capacity of closed expansion tanks. Water temperatures below 160°F use the following formula to determine the tank capacity:

$$V_t = \frac{E * V_s}{\frac{Pa}{Pf} - \frac{Pa}{Po}} \qquad (4\text{-}3)$$

Where:

Vt = minimum capacity of the tank (gallons)

E = percent increase in the volume of water in the system.

Vs= total volume of water in the system (gallons)

Pa= pressure in the expansion tank when water first enters, usually atmospheric pressure (ft of water absolute)

Pf =initial fill or minimum pressure of expansion tank (ft of water absolute)

Po = maximum operating pressure at the expansion tank (ft of water absolute).

3.15.1 Expansion tank calculations

Minimum capacity of the tank (gallons) =

$$V_t = \frac{E * V_s}{\frac{Pa}{Pf} - \frac{Pa}{Po}}$$

Where as:

E at 70° =2 %

By calculating the total flow of all the floors in l/s and convert to gallons per minute by multiply 15.852 we can get the total volume in gallons:

Vs= 170 gallon

Pa= 1 bar

Pf =2.2bar

Po = 5bar

Vt =(0.02*170)/((1/2.2)-(1/5))

=3.4/0.25

=13.6 gallons

Minimum capacity of the expansion in liter per second=13.6*3.6

=49 l/s

We take it 80l/s which are available.

3.16 Example of Calculation:-

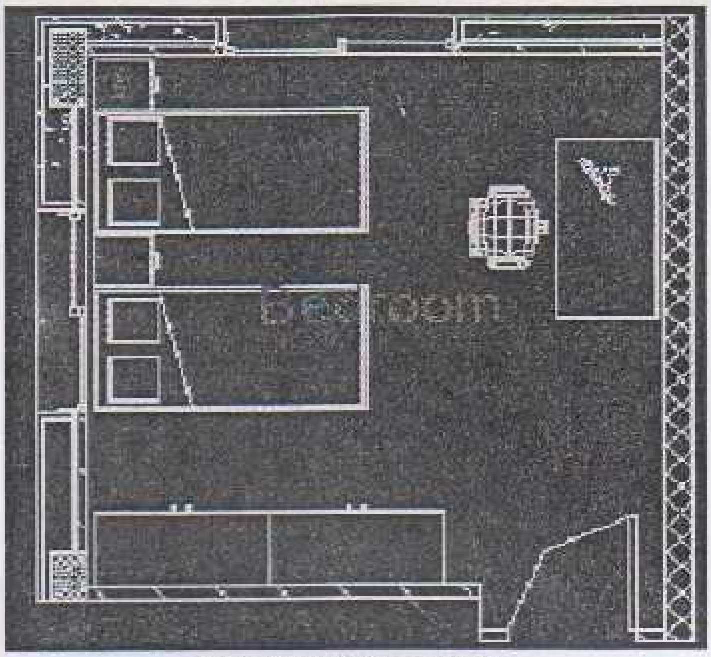


Fig3.3 Bed Room Plane

In order To calculate the load of the above Bed Room at first floor we must calculate the following:-

1- Heat transfer through walls:-

A- For north and west walls (external walls):-

$$q = U_{overall} . A\Delta T$$

$=0.82*11.8(22-0) + 0.82*12.8(22-0) = 213+231= 444$ W

B- For south wall (internal wall):-

We consider that there is no heat transfer because there is no temperature difference between heating spaces (all adjacent spaces have the same temperature as this room)

C- For cast wall (interior walls):-

We consider the temperature of the stair case is the average temperature between inside design temperature (Ti) and out side design temperature (To)

So,

Stair case temperature = (Ti+ To)/2

= (22+0) /2 = 11°C

Then

$$q = U_{overall} . A\Delta T$$

=2.17*14.4(22-11) = 344 W

2- Heat transfer through Roof:-

$$q = U_{overall} . A\Delta T$$

= 0.51*17.3*(22-0) = 194 W

3-Heat transfer through Floor:-

We consider that there is no heat transfer because there is no temperature difference between heating spaces (ground floor have the same temperature as this first floor)

4-For north and west glasses:-

$$q = U_{overall} . A\Delta T$$

=2.22*1.6(22-0) + 2.22*1.6(22-0) = 156 W

5- **Heat transfer through infiltration :-**

We will calculate heat load through infiltration by knowing the dimension of the windows that cause infiltration

$$Q\ inf = 862\ W$$

Then the total heating load equal the load through walls, Roof, floor, glasses, doors and loads through infiltration

So,

$$Q\ total = Q\ Trans + Q\ inf$$

$$Q\ Trans = Q\ transmition = Q\ walls + Q\ Roof + Q\ floor + Q\ wind + Q\ door$$

$$Q\ Trans = 444 + 194 + 156 + 344 = 1138\ W$$

SO,

$$Q\ total = Q\ Trans + Q\ inf$$

$$Q\ total = 1138 + 862 = 2000\ W$$

So, in order to calculate the numbers of sections of each radiator for any room:

No. of sections=heating load for the room (Kcal/h) /heat transfer per section

So, for the bed room in first floor, the heating load is 2(kW), heat transfer per section is 130(Kcal/h), so:

Heating load in (Kcal/h) $=2\times860$

$=1.72$ (Kcal/h)

No. of sections=1.72 (Kcal/h) /130 (Kcal/h)

$=13.7\approx 14$ sec

Width of the radiator= (no of sections× width for each section) +valves for both sides

Width for each section=8cm

Valves for both sides=12cm

Width of the radiator= $(14\times 8)+12$

$=124$cm

CHAPTER FOUR

SELECTION OF PLUMPING SYSTEM

4.1 INTRODUCTION:-

Plumping consist of two things which is water supply system and drainage distribution system

It is one of the most essential and vital subject that its problems face us every day and need a fast solution to treat it

Most dwellings and buildings, including those in rural areas are supplied with water from a public water supply, otherwise known as the mains supply. The design of a mains water supply needs to consider present demand and anticipated future demand, the size of the water mains, and the pressure of water in the mains which is known as the 'head', the height to which the water would rise in a vertical pipe.

The connection to the mains water supply is usually taken to the boundary of the site and finished with a stop valve or stop cock, housed in a suitable box or purpose chamber. This chamber may be fitted with a hinged cast iron cover. The cold water supply for the dwelling is taken from the stop valve to the building, 750 mm below ground level. A second stop valve should be fitted on the service pipe where it enters the building. Where possible this should be at the kitchen sink, although the location is not critical. Inside the house a drain cock should be fitted above the stop valve to allow the cold water system to be drained down.

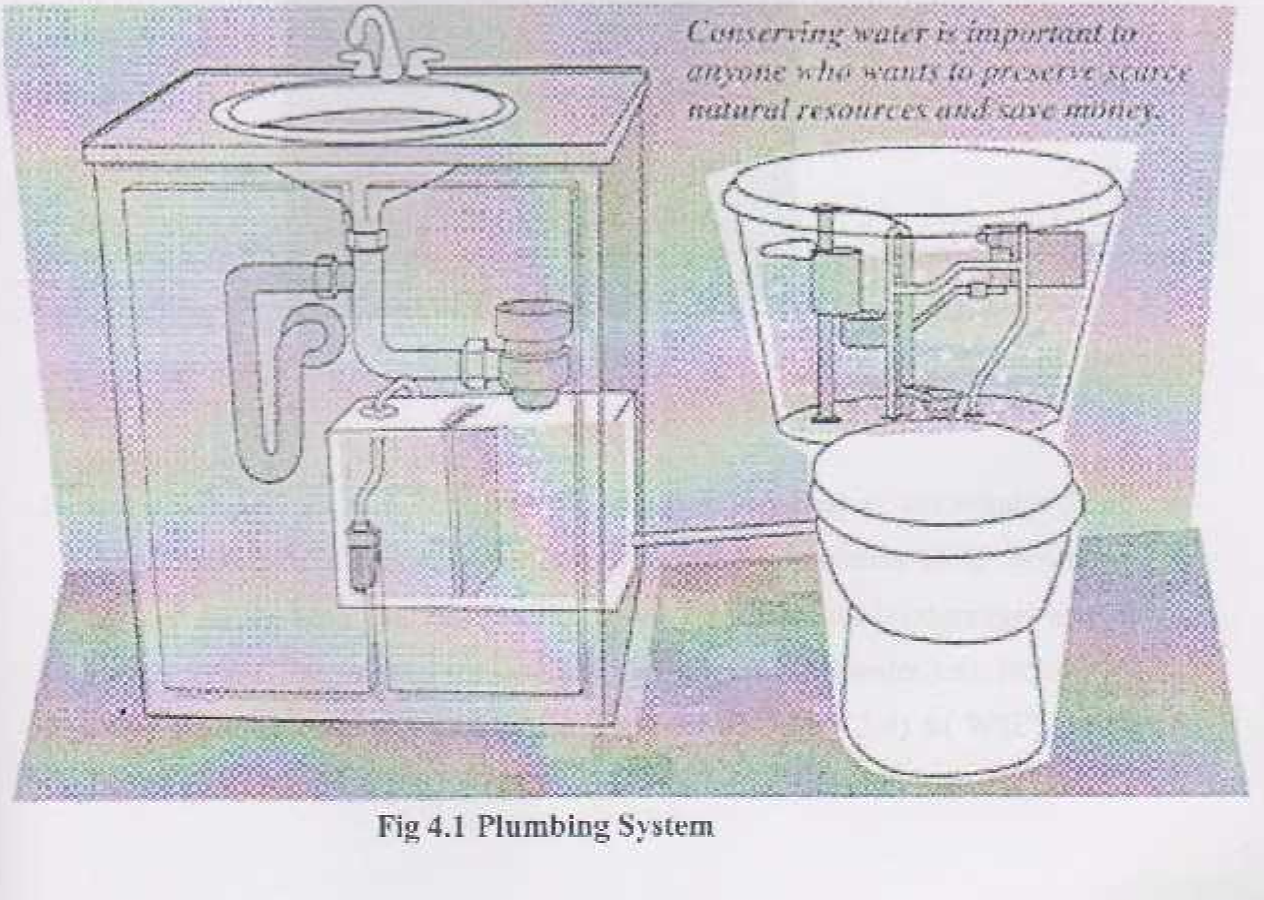


Fig 4.1 Plumbing System

4.2 Water System

4.2.1 Calculations For hot and cold water:-

To determine the pipe size for cold and hot water we must calculate the water supply fixture unit (WSFU) for each fixture and fixture unit total on each piping run out and determine the minimum flow pressure required at the most remote outlet.

We can determine the required pipe in each section using the friction head loss data calculated and the friction head chart as follows:-

Example: - to calculate the water supply fixture unit (WSFU) for each fixture in the Bath room shown

We have three fixtures (lavatory, shower, water closet with flush tank) each have (WSFU) as follow:-

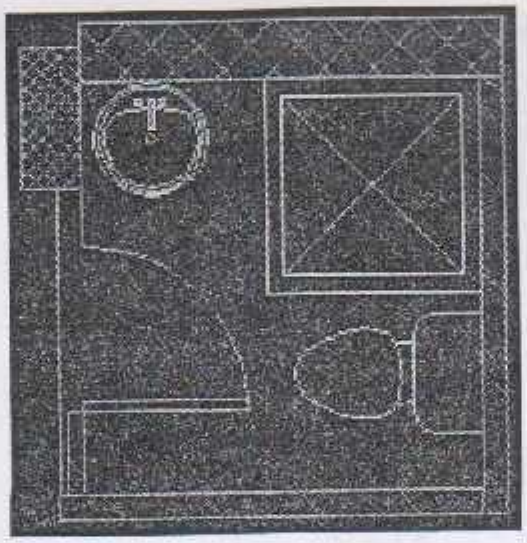


Fig 4.2 Bath Room

1- lavatory is a fixture with both cold and hot water supplies, so, the weights for maximum separate demands may be taken as three-quarters (3/4) the list demand for the supply in Table (4.1),so from Table (4.1) the lavatory (private) gives 1 WSFU for the total demand (for both cold and hot water) so, for cold water only or hot water only we take (3/4*WSFU = ¾*1= 3/4) &(WSFU =1 for both cold and hot water)

2- shower is a fixture with both cold and hot water supplies, so, the weights for maximum separate demands may be taken as three-quarters (3/4) the list demand for the supply in Table (4.1), so from Table (4.1) the shower (private) gives 2 WSFU for the total demand (for both cold and hot water) so, for cold water only or hot water only we take (3/4*WSFU = ¾*2= 1.5) &(WSFU =2 for both cold and hot water)

3- Water closet is a fixture with cold water supply only, so, the weights for maximum separate demands may be taken as three-quarters (3/4) the list demand for the supply in Table (4.1).so from Table(4.1)the water closet (private and with flush tank) gives 3 WSFU for the total demand (for both cold and hot water) so, for cold water only or hot water only we take (3/4*WSFU = ¾*3 =2.25) &(WSFU =3 for both cold and hot water)

4- So, from the above information we can do the following table:-

Fixture Unit	No. of Units	WSFU From table(9..3)	Total no. of WSFU For Cold Water	Total no. of WSFU For hot Water	Total no. of WSFU For hot & Cold Water
Lavatory (private)	1	¾*1	3/4	3/4	1
Shower (private)	1	¾*2	1.5	1.5	2
Water Closet flush tank(private)	1	¾*3	2.25	-----	2.25
----------	-------	------------	$\sum = 4.5$ WSFU	$\sum = 2.25$ WSFU	$\sum = 5.25$ WSFU

Table 4-1 WSFU for the Bath Room

Now we can calculate the number of fixture in each floor from Mechanical Drawing and so we can do the following table:-

Floor name	Total Lavatory	Total sink	Total Bath tube	Total Shower head	Total Water closet /flush tank
Basement	3	1	1	2	3
Ground floor	2	1	1	------	2
First floor	4	1	3	1	3
Continuous flow at garden	3/4"	------	-------	---------	--------------

Table 4-2 Total number for water supply fixture unit for cold and hot water

Now we can calculate the (WSFU) for each floor, So (WSFU) for each floor as in the following tables:

Fixture Unit	No. of Units	WSFU From table (4.1)	Total no. of WSFU For Cold Water	Total no. of WSFU For hot Water	Total no. of WSFU For hot Water Cold Water &
BASMENT FLOOR	--------	---------	------------	----------	----------
Lavatory (private)	3	¾ *1	2.25	2.25	3
Kitchen Sink(private)	1	¾ * 2	1.5	1.5	2
Bath tube(private)	1	¾ * 2	1.5	1.5	2
Water Closet flush tank(private)	3	¾ * 3	6.75	---------	6.75
Continuous flow for Garden	1	¾ * 3	2.25	---------	3
-------------------	-----------	----------	**∑ =14.25 WSFU**	**∑=5.25 WSFU**	**∑ =15.75 WSFU**

Table 4-3 Water supply unit for cold and hot water for basement floor

Fixture Unit	No. of Units	WSFU From table (4.1)	Total no. of WSFU For Cold Water	Total no. of WSFU For hot Water	Total no. of WSFU For hot Water Cold Water &
GROUND FLOOR	--------	---------	-----------	----------	----------
Lavatory (private)	2	¾ *1	1.5	1.5	2
Kitchen Sink(private)	1	¾ * 2	1.5	1.5	2
Bath tube(private)	1	¾ * 2	1.5	1.5	2
Water Closet flush tank(private)	2	¾ * 3	4.5	---------	4.5
-------------------	----------	----------	$\sum = 9$ WSFU	$\sum = 4.5$ WSFU	$\sum = 10.5$ WSFU

Table 4-4 Water supply unit for cold and hot water for ground floor

Fixture Unit	No. of Units	WSFU From table (9.3)	Total no. of WSFU For Cold Water	Total no. of WSFU For hot Water	Total no. of WSFU For hot Water Cold Water &
FIRST FLOOR	--------	---------	-----------	----------	----------
Lavatory (private)	4	¾ *1	3	3	4
Kitchen Sink(private)	1	¾ * 2	1.5	1.5	2
Bath tube(private)	3	¾ * 2	4.5	4.5	6
Water Closet flush tank(private)	3	¾ * 3	6.75	---------	6.75
-----------------	-----------	----------	$\sum = 15.75$ WSFU	$\sum = 9$ WSFU	$\sum = 19.25$ WSFU

Table 4-5 Water supply units for cold and hot water for first floor

4.2.2 Flow rate calculations

To calculate flow rate in gpm:-

FOR BASMENT FLOOR

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank for basement floor the estimating demand in gpm **for cold water = 14.25 WSFU.**

So by using interpolation =10.55 gpm

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank the for basement floor estimating demand in gpm **for hot water = 5.25 WSFU.**

So by using interpolation =4.25 gpm

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank the for basement floor estimating demand in gpm **for hot & cold water = 15.75 WSFU.**

So by using interpolation = 11.55gpm

Note: - For supply outlets likely **to impose continuous demand,** we estimate continuous separately and add to the total demand for fixture
We have1 faucets (Ø 3/4) for garden so from Table 4-2(See Appendix B)
The total flow in gpm = 2.25 **WSFU.** = 2 gpm

So the total cold and hot water demand needed = 11.55 + 2= 13.55 gpm

FOR GROUND FLOOR

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank for ground floor the estimating demand in gpm **for cold water = 9 WSFU.**

So by using interpolation =7.25 gpm

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank the for ground floor estimating demand in gpm **for hot water = 4.5 WSFU.**

So by using interpolation =3.875 gpm

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank the for ground floor estimating demand in gpm **for hot & cold water = 10.5WSFU.**

So by using interpolation = 8.4 gpm

So the total cold and hot water demand needed = 10.5 WSFU. = 8.4 gpm

FOR FIRST FLOOR

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank for first floor the estimating demand in gpm **for cold water = 15.75 WSFU.**

So by using interpolation =11.45 gpm

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank the for first floor estimating demand in gpm **for hot water = 9 WSFU.**

So by using interpolation = 7.25 gpm

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank the for first floor estimating demand in gpm **for hot & cold water = 19.25 WSFU.**

So by using interpolation = 13.48 gpm

So the total cold and hot water demand needed = 13.48 gpm

To calculate static head for Basement floor for cold water:-

Floor to floor height = 4.00

We have 3 floor (basement + ground+ first) and so 4.0*3.0 = 12.0

Sink outlet above basement level =1.05 m

& tank outlet above roof level = 0.75

So there is static head in this case = 12+ 0.75 -1.05 =11.40 m = 16.22 psi

To calculate the equivalent length:-

Pumps at Basement floor transfer the water through pipes to the tank at Roof from which it distribute the water through pipes to the collectors at the First, Ground & Basement floor

So we will calculate the equivalent length from the tank at roof to the farthest outlet at the Basement floor (sink) at farthest collector

FOR COLD WATER

Total length through shaft room from Roof to the Basement floor = 16.0 m

Total length in the Basement floor from riser at the shaft room to farthest out let (sink) at farthest collector = 18.0 m

So, the total length from roof tank to the farthest outlet at Basement the floor (sink) at farthest collector

Total length = 18.0 + 16.0= 34.0 m

To calculate the equivalent length we assumed 50% additional equivalent length to account for fittings there for the total developed length or the equivalent length as follows:

Equivalent length = Total length * 1.5

Equivalent length = 34 * 1.5 =51 m

Equivalent length = 51 * 3.28 = 167.28 ft

To calculate static head for Basement floor for hot water:-

Sink outlet above basement level =1.05 m

& heat exchanger outlet above basement level = 1.05 m

So there is no static head in this case and so static head equal zero

FOR HOT WATER

Total length through shaft room from heat exchanger to the Basement floor = 16.0 m

Total length in the Basement floor from collector to farthest outlet (sink) at farthest point= 13.5 m

So the total length from heat exchanger to the farthest outlet at Basement the floor (Sink) at farthest collector

Total length = 13.50 + 16.0= 29.50 m

To calculate the equivalent length we assumed 50% additional equivalent length to account for fittings there for the total developed length or the equivalent length as follows:

Equivalent length = Total length * 1.5

Equivalent length = 29.5* 1.5 =44.25m

Equivalent length = 44.25 * 3.28 = 145.14 ft

The minimum required flow pressure:-

The minimum required flow pressure at the most remote outlet on the Basement floor (sink) **is 8.0 psi** from table 4-2 (See Appendix B).

To calculate the friction head

For cold water

After calculating the above requirement we can calculate the friction head from the following equation:

Static Head = minimum required flow pressure + friction head

So friction head =16.22 + 8.0=24.22 psi

For hot water

Static Head = minimum required flow pressure + friction head

So friction head =0.0 + 8.0=8.0 psi

The usual design aims for uniform friction loss along the entire pipe length to do this we establish a fiction loss per 100 ft by dividing total loss by total length and then size the pipe accordingly.

Uniform design friction loss in psi/100ft is:-

FOR COLD WATER

Friction /100 ft = available friction head/ total equivalent length

Friction /100 ft =24.22 psi / 167.28*100 ft = 14.48psi / 100ft

So for flow rate 14.80 gpm and friction head loss 14.48 psi / 100ft from figure 4-9 (See Appendix B) the diameter of the pipe from the Roof tank to the collector at Basement floor 1" and the velocity is 5.5 fps and the friction head is 12 .0 psi / 100ft

FOR HOT WATER

Friction /100 ft = available friction head/ total equivalent length

Friction /100 ft =8.0 psi / 145.14*100 ft = 5.51 psi / 100ft

So for flow rate 4.25 gpm and friction head loss 5.51 psi / 100ft from figure 4-9 (See Appendix B) the diameter of the pipe from the heat exchanger to the collector at Basement floor 3/4" and the velocity is 2.5 fps and the friction head is 5.0psi / 100ft

Now we can determine pipe size, velocity of water and friction head for each floor as shown:-

	Equivalent length in (ft)	Pipe size in (inch)	Friction (psi/100ft)	Velocity(fps)	Section friction(psi)
nk to oor	167.28	1"	14.48	5.5	12.0
nk to r	113.16	1"	17.1	3.5	6.0
nk to	186.96	1.25"	8.56	3.2	3.5

Table 4-6 Pipe size, velocity of cold water and friction head for each floor

4.3 Sanitary Drainage system

4.3.1 Manhole Design

We design the manholes around the building so as that the sewage comes from the stacks flows in , then the sewage flows from one manhole to another so as reaching the septic tank.

The design of the manholes depend on the ground and its nature around the building, and so as the first manhole height should not be less than 50 cm. and then we calculate the height of the other manholes depending on the spacing between manholes and the slope of drainage pipes between manhole to be 1.2 % .

As a result of these calculations we estimate the invert level of the manhole that is the depth of the pipe entering the manhole. And we chose the diameter of the manhole depending on the depth of the manhole. As below

Φ60 cm for manhole depth (50-100) cm.

Φ80 cm for manhole depth (100-150) cm.

Φ100 cm for manhole depth (150-250) cm.

Φ120 cm for manhole depth > 250 cm

4.3.2 Manhole calculations

We assume the depth of the first manhole to be 50cm & we calculate the second manhole according to it and so on,

For manhole #2:

The distance between manhole #1 & manhole #2 is 9.8m,

Invert level for the manhole#2 is:

$y = ((s \times slope) + 5)/100$

Where: s is the distance between manhole#1 & manhole#2

Slope is 1.2

5cm is the point in manhole #2 where the pipe will be connected.

So:

y= ((9.8 × 1.2) +5)/100

= 0.168

We added to the invert level of manhole #1 to get the invert level to manhole#2

Invert level for manhole#2=-0.168-0.50

=-0.668=-0.67

Then we calculate the depth of manhole#2:

Depth=top level - invert level

=0.00-(-0.67)

= 67cm

depth→100cm ,Φ60

100 →150cm, Φ80

150 →200cm, Φ100

200 → , Φ120-150

So diameter of manhole#2 is 60

Manholes no.	Top level cm	Invert level cm	Depth cm	Diameter cm	Cover type
M1	0.0	- 0.5	50	60	Medium duty
M2	0.0	- 0.67	.67	60	Medium duty
M3	0.0	-3.62	3.62	120	Medium duty
M4	- 3.42	-3.92	50	60	Medium duty
M5	-3.42	-4.00	62	60	Medium duty
M6	-3.38	-4.11	73	60	Medium duty
M7	-3.38	-4.20	82	60	Medium duty
M8	-3.38	-4.30	92	60	Medium duty
M9	-3.38	-4.32	94	60	Medium duty
M10	-2.97	-3.47	50	60	Medium duty
M11	-3.12	-4.52	140	80	Medium duty

Table 4-7 shows manholes levels

Example:-

Here we will talk about the choose of diameter and the slope of the drainage pipe system and we will take this Bath Room as an example of how we will choose the diameter and the slope of the drainage pipe system

1-We will use pipes (Branches) from fixture unit to the floor trap (F.T) with diameter (1.5-2)" for lavatory and shower and with slope (2%)

2- We will use pipes (Building drains) from fixture unit to the manhole with diameter (4)" for water closet with flush valve and with slope (1%-1.5%)

3- We will use pipes (Sewage pipes) between manholes with diameter (4)" and with slope (1.2%) and the waste water will transfer between manholes until it reach the main manhole.

4- We will use floor trap (F.T) at the end of the branches as a collection box for this pipes and in order to provide a water seal to prevent odors, sewage gases and vermin's from entering building

5- We will use clean out (C.O) at the end of the branches in order to clean the pipes form any things that can blockage and close the pipes

6- We will use a stack with diameter (4)" in order to drain the waste water to the manholes

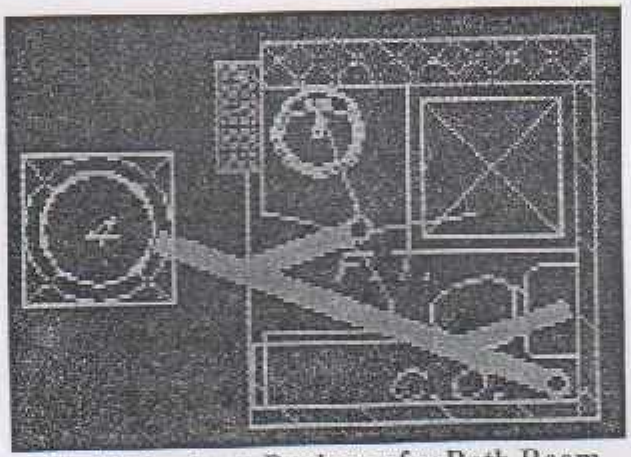


Fig 4.3 Sanitary Drainage for Bath Room

4.3.3 Drainage piping fill

1) Branches are designed to run maximum of 50% fill.
2) Stacks are designed to flow between 25-33% maximum.
3) Building drains and sewer drains may be designed over 50% fill

4.3.4 Drainage piping velocity

1) For branches the recommended velocity is 2 ft/s.
2) For building the recommended velocity is 3 ft/s.
3) For greasy the recommended velocity is 4 ft/s.

Velocity of water flow through drainage piping depends on

1) Pipe diameter

2) Slope

For the same diameter large pipe diameter required lower slope

For pipes of diameter $\leq 3''$ the minimum slope is 1/4 in/ft

For pipes of diameter $\geq 4''$ the minimum slope is 1/8 in/ft

CHAPTER FIVE

CONCLUSION And RECOMMENDATIONS

8.1 Recommendations of Central heating system

According our study we notice that:

1- Heating load calculated from the calculation is less than the load calculated from our expert in market. So, the first one is more economic and it is sufficient. So, we will be install the no. of section of radiators which is a result of our calculation

2- The pipes diameter calculated is less than the pipes diameter chosen from our Expert so, we will use the pipes diameter which is a result from calculation

3- The selected boiler from the load calculated from the calculation is less in its capacity than the boiler calculated from our expert which means that the first one is more economic and sufficient. So, we will be install the Boiler with capacity which is a result of our calculation

8.2 Recommendations of hot and cold water system

No.	Description	Result of calculations	From our expert
1	DIAMETER OF PIPE OF COLD WATER FOR BASEMENT FLOOR	1"	1"
2	DIAMETER OF PIPE OF COLD WATER FOR GROUND FLOOR	1"	1"
3	DIAMETER OF PIPE OF COLD WATER FOR FIRST FLOOR	1.25"	1"
4	DIAMETER OF PIPE OF HOT WATER FOR FIRST FLOOR	3/4"	1"

Table 5-1 shows values of diameters

According our study and from the above table we notice that:

1- Pipe diameter calculated some time is nearly the same as the pipe diameter chosen from our experts, and some time the first one is less than the second one which means that it is more economic and it is sufficient

8.3 Recommendations of sanitary drainage system

1- Most applied diameters are 4" this due to that the available pipes and fitting in the total market are 4" diameter which safe

2- For what concerning economical aspect we find that there is no much difference in the price of pipe and fitting as long as we are taking a bout diameter ≤ 4

REFRNCES:-

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[2] Mohammed A.hammad.1996, HEATING AND AIRCONDITIONING, 3 Ed, Mohammed A.Alsaad, Jordan.

[3] Arnell.N.1996, PLUMPING SYSTEM, 1st ed, john Wiley &sons, New York.

[4] McGRAW-HILL.2000, BUILDING DESIGN AND CONSTRUCTION HAND BOOK, six Ed, Frederick S. Merritt & Jonathan T. Ricketts, New York.

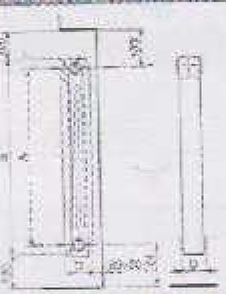
[5] Deh.gov site,
http://www.deh.gov.au/atmosphere/ozone/publications/questions.html

[6] Seav site,
http://www.seav.vic.gov.au/advice/business/calculating/greenhouse_gases.asp

APPENDIX A

3.1 catalogue of radiator

Solar **100**

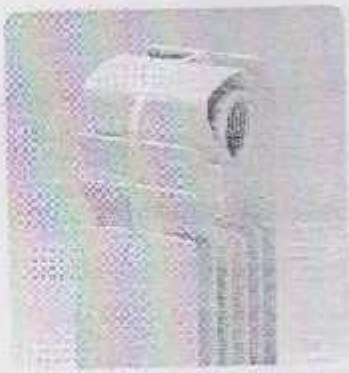


Dati tecnici

	mm	mm	mm	mm	pollici	litri/elem.	Kg/elem.	W/elem.		
350/100	97	427	350	80	G1	[illegible]	1.12	88.21	1.2974	0.8250
500/100	97	575	500	80	G1	[illegible]	1.43	130.85	[illegible]	[illegible]
600/100	97	672	600	80	G1	[illegible]	1.72	148.13	1.2911	[illegible]
700/100	97	775	700	80	G1	1.65	2.02	166.25	1.3419	0.8574
800/100	97	877	800	80	G1	[illegible]	2.24	183.45	[illegible]	0.8590

[illegible]

[illegible] UNI EN 442



350/100

n. elementi	[illegible]	T 50K W	[illegible]	[illegible]	[illegible]
1	[illegible]	88.21	[illegible]	[illegible]	[illegible]
2	[illegible]	176.42	[illegible]	[illegible]	[illegible]
3	[illegible]	264.63	[illegible]	[illegible]	[illegible]
4	[illegible]	352.84	[illegible]	[illegible]	[illegible]
5	[illegible]	441.05	[illegible]	[illegible]	[illegible]
6	[illegible]	529.26	[illegible]	[illegible]	[illegible]
7	[illegible]	617.47	[illegible]	[illegible]	[illegible]
8	[illegible]	705.68	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]

500/100

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9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

600/100

n. elementi	[illegible]	T 50K W	[illegible]	[illegible]	[illegible]
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[illegible]

700/100

n. elementi	[illegible]	T 50K W	[illegible]	[illegible]	[illegible]
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3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]

800/100

n. elementi	[illegible]	T 50K W	[illegible]	[illegible]	[illegible]
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4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

3.2 catalogue of boilers

CAST-IRON BOILERS
Mod. ALOR

MAIN FEATURES						
MODEL		80	100	120	140	160
Thermal output	kW	[illegible]	107.4	124.6	144.3	163.6
Maximum thermal power	kW	92	99	114	132	150
Minimum thermal power	kW	67	93	88	107	132
Efficiency at nominal load	%	91	91.2	91.4	91.8	90.7
Efficiency at reduced load (30%)	%	92.2	92.9	92.8	90.6	92.7
EC efficiency class		★★	★★	★★	★★	★★
Load loss at Δt = 50 K	%	0.58	0.54	0.51	0.46	0.45
Flue gas temperature	°C	180	179	177	176	175
Flue gas temperature at minimum power	°C	154	154	154	154	154
Flue gas flow rate at maximum thermal capacity (oil)	kg/h	141	155	182	222	251
Flue gas flow rate at maximum thermal capacity (natural gas)	kg/h	146	179	201	236	266
Volume on the flue gas side	dm³	95.5	108.2	129	142.8	152.6
Combustion chamber volume	dm³	64.5	77.2	90	102.8	115.6
Combustion chamber length	mm	589	705	820	951	1077
Water content	l	71.7	82.2	92.8	103.3	114.1
Number of elements		6	7	8	9	10
Load loss on flue gas side	Pa	38	40	46	50	53
Load loss on water side 10K Δt	Pa	800	1500	2200	3000	3000
Furnace pressure	Pa	30	40	46	50	60
Operating pressure	bar	4	5	5	5	5
Boiler water temperature range	°C	35 ÷ 90	60 ÷ 90	60 ÷ 90	60 ÷ 90	20 ÷ 90
Boiler water twin-thermostat differential	K	8	8	8	8	8
Minimum water flow rate of the boiler	l/h	2300	2600	3200	3800	4300
Maximum diameter of the burner head hole	mm	140	140	140	140	140
Diameter of M8 burner fixing holes	mm	170	170	170	170	170
Diameter of flue gas outlet	mm	200	200	200	200	200
Power supply	V/Hz	230/50	230/50	230/50	230/50	230/50
Mains fuse	A	4	4	4	4	4
Maximum electrical unit power input	W	575	575	575	575	575
Net weight	kg	340	380	425	470	510
CE Certificate	N°	49BN3550				

NOTE
Blown-air burners in compliance with current standards (CE mark under Directives CEE/73/23, CEE89/336 and CEE/90/396; EN 267) must be installed according to the Manufacturer's instructions. The burners must be regulated to give a CO_2 value as shown in the table below.

FUEL		MODEL				
		80	100	120	140	160
Natural gas G 20	% CO_2	9.5 ÷ 9.7	9.4 ÷ 9.7	9.7 ÷ 9.9	9.8 ÷ 10	10.2 ÷ 10.4
Oil	% CO_2	12.4 ÷ 12.8	12.2 ÷ 12.5	12.4 ÷ 12.5	12.4 ÷ 12.6	12.8 ÷ 13

fondital

Fondital F.I.N.V. S.p.A.
25078 VESTONE (Brescia) Italy - Via Mocenigo, 123
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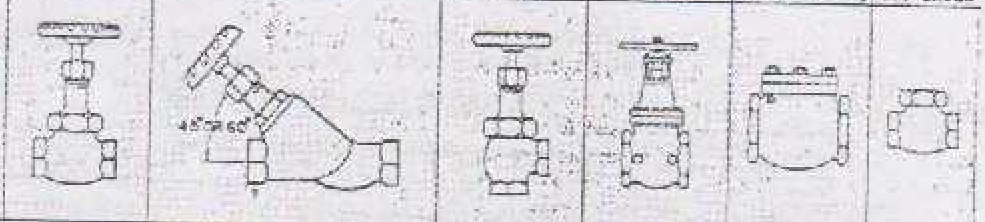
e-mail: fondital@fondital.it - export01@fondital.it
www.fondital.it

3.3 Table 2-6

Table A-6 —VALVE LOSSES IN EQUIVALENT FEET OF PIPE*

Screwed, Welded, Flanged, and Flared Connections



NOMINAL PIPE OR TUBE SIZE (In.)	GLOBE†	60° - Y	45° - Y	ANGLE†	GATE††	SWING CHECK‡	LIFT CHECK
3/8	17	8	6	6	0.6	5	Globe & Vertical Lift Same as Globe Valve**
1/2	18	9	7	7	0.7	6	
3/4	22	11	9	9	0.9	8	
1	29	15	12	12	1.0	10	
1 1/4	38	20	15	15	1.5	14	
1 1/2	43	24	18	18	1.8	16	
2	55	30	24	24	2.3	20	
2 1/2	69	35	29	29	2.8	25	
3	84	43	35	35	3.2	30	
3 1/2	100	50	41	41	4.0	35	
4	120	58	47	47	4.5	40	
5	140	71	58	58	6	50	
6	170	88	70	70	7	60	
8	220	115	85	85	9	80	
10	280	145	105	105	12	100	
12	320	165	130	130	13	120	Angle Lift Same as Angle Valve
14	360	185	155	155	15	140	
16	410	210	180	180	17	160	
18	460	240	200	200	19	180	
20	520	275	235	235	22	200	
24	610	320	265	265	25	240	

*Losses are for all valves in fully open position.

†These losses do not apply to valves with needle point type seats.

‡Losses also apply to the in-line, ball type check valve.

**For "Y" pattern globe lift check valve with seat approximately equal to the nominal pipe diameter, use values of 60° "Y" valve for loss.

††Regular and short pattern plug cock valves, when fully open, have same loss as gate valve. For valve losses of short pattern plug cocks above 6 ins. check manufacturer.

3.4 Table 2-7

Table A-7 95

—FITTING LOSSES IN EQUIVALENT FEET OF PIPE

Screwed, Welded, Flanged, Flared, and Brazed Connections

NOMINAL PIPE OR TUBE SIZE (in.)	SMOOTH BEND ELBOWS 90° Std*	90° Long Rad.†	90° Street*	45° Std*	45° Street*	180° Std*	SMOOTH BEND TEES Flow-Thru Branch	Straight-Thru Flow No Reduction	Reduced 1/4	Reduced 1/2
3/8	1.4	0.9	2.3	0.7	1.1	2.3	2.7	0.9	1.2	1.4
1/2	1.6	1.0	2.5	0.8	1.3	2.5	3.0	1.0	1.4	1.6
3/4	2.0	1.4	3.2	0.9	1.6	3.2	4.0	1.4	1.9	2.0
1	2.6	1.7	4.1	1.3	2.1	4.1	5.0	1.7	2.2	2.6
1 1/4	3.3	2.3	5.6	1.7	3.0	5.6	7.0	2.3	3.1	3.3
1 1/2	4.0	2.6	6.3	2.1	3.4	6.3	8.0	2.6	3.7	4.0
2	5.0	3.3	8.2	2.6	4.5	8.2	10	3.3	4.7	5.0
2 1/2	6.0	4.1	10	3.2	5.2	10	12	4.1	5.6	6.0
3	7.5	5.0	12	4.0	6.4	12	15	5.0	7.0	7.5
3 1/2	9.0	5.9	15	4.7	7.3	15	18	5.9	8.0	9.0
4	10	6.7	17	5.2	8.5	17	21	6.7	9.0	10
5	13	8.2	21	6.5	11	21	25	8.2	12	13
6	16	10	25	7.9	13	25	30	10	14	16
8	20	13	—	10	—	33	40	13	18	20
10	25	16	—	13	—	42	50	16	23	25
12	30	19	—	16	—	50	60	19	26	30
14	34	23	—	18	—	55	68	22	30	34
16	38	26	—	20	—	62	78	26	35	38
18	42	29	—	23	—	70	85	29	40	42
20	50	33	—	26	—	81	100	33	44	50
24	60	40	—	30	—	94	115	40	50	60

NOMINAL PIPE OR TUBE SIZE (in.)	MITRE ELBOWS 90° Ell	60° Ell	45° Ell	30° Ell
3/8	2.7	1.1	0.6	0.3
1/2	3.0	1.3	0.7	0.4
3/4	4.0	1.6	0.8	0.5
1	5.0	2.1	1.0	0.7
1 1/4	7.0	3.0	1.3	0.9
1 1/2	8.0	3.4	1.5	1.1
2	10	4.5	2.0	1.3
2 1/2	12	5.2	2.5	1.7
3	15	6.4	3.0	2.0
3 1/2	18	7.3	3.4	2.4
4	21	8.5	4.0	2.7
5	25	11	4.9	3.3
6	30	13	6.0	4.1
8	40	17	7.9	5.1
10	50	21	9.8	6.4
12	60	25	12	8.0
14	68	29	13	9.2
16	78	31	15	10
18	85	37	17	11
20	100	41	19	13
24	115	49	22	16

*R/D approximately equal to 1. †R/D approximately equal to 1.5.

Carrier Ref No. (4)

3. 5 Table 2-8

Table A-8 96

—SPECIAL FITTING LOSSES IN EQUIVALENT FEET OF PIPE

NOM. PIPE OR TUBE SIZE (in.)	SUDDEN ENLARGEMENT* d/D ¼	½	¾	SUDDEN CONTRACTION* d/D ¼	½	¾	SHARP EDGE* Entrance	Exit	PIPE PROJECTION* Entrance	Exit
⅜	1.4	0.8	0.3	0.7	0.5	0.3	1.5	.8	1.5	1.1
½	1.8	1.1	0.4	0.9	0.7	0.4	1.8	1.0	1.8	1.5
¾	2.5	1.5	0.5	1.2	1.0	0.5	2.5	1.4	2.8	2.2
1	3.2	2.0	0.7	1.6	1.2	0.7	3.7	1.8	3.7	2.7
1¼	4.7	3.0	1.0	2.3	1.7	1.0	5.3	2.6	5.3	4.3
1½	5.8	3.6	1.2	2.9	2.2	1.2	6.6	3.3	6.6	5.0
2	8.0	4.8	1.6	4.0	3.0	1.6	9.0	4.4	9.0	6.8
2½	10	6.1	2.0	5.0	3.8	2.0	12	5.6	12	8.7
3	13	8.0	2.6	6.5	4.9	2.6	14	7.2	14	11
3½	15	9.2	3.0	7.7	6.0	3.0	17	8.2	17	13
4	17	11	3.8	9.0	6.8	3.5	20	10	20	16
5	24	15	5.0	12	9.0	5.0	27	14	27	20
6	29	22	6.0	14	11	6.0	33	18	33	22
8	—	29	8.2	—	15	8.5	47	24	47	29
10	—	38	11	—	19	11	60	29	60	40
12	—	41	15	—	25	13	73	37	73	37
14	—	—	16	—	—	15	86	43	86	39
16	—	—	18	—	—	18	96	50	96	77
18	—	—	20	—	—	20	115	58	115	90
20	—	—	—	—	—	—	142	70	142	106
24	—	—	—	—	—	—	162	83	163	120

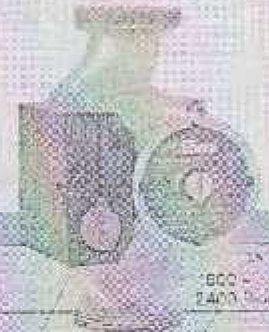
*Enter table for losses at smallest diameter "d."

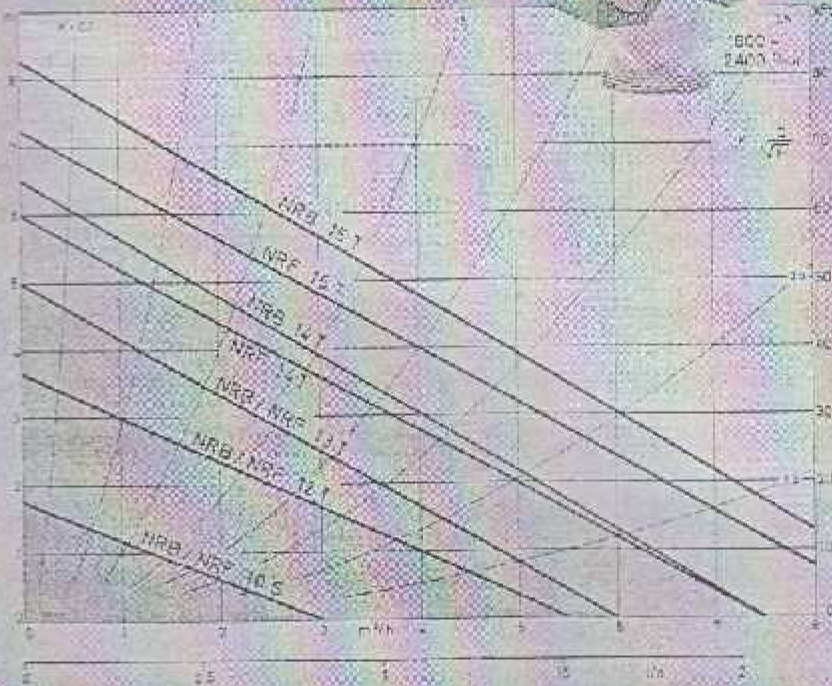
* Source = Ref. no (1)

3.6 catalogue of BIRALL PUMP

Biral *Redline*

Medium-speed circulators with 3 speeds for heating and air conditioning





Series:
NRB
NRF

Max. system pressure: NRB: 12 bar
Max. system pressure: NRF: 6 bar
Perm. water temperature: 110°C

Pump models with 2 or 3 capacity ranges and high starting torque provide greater efficiency and permit the performance to match the demand. A patented safety circuit ensures that the pump will start without problems at its lowest speed.

The "small ones" from Biral provide the highest dimension in reliability and savings precisely in those areas where the performance of small pumps is needed.

Certified Quality System Meeting the International Standards ISO 9001 / EN 29001
Biral for Quality Pumps!


בנית
Biral
The most economical
solution in the long run
Biral
Biral
Euroline
The circulators for
heating and
domestic hot water supply

APPENDIX B

Table 4.1 Water supply fixture unit and fixture branch size

Fixture[a]	Use	Type of Supply Control	Fixture Units[b]	Min. Size of Fixture Branch[d] in.
Bathroom group[c]	Private	Flushometer	8	—
Bathroom group[c]	Private	Flush tank for closet	6	—
Bathtub	Private	Faucet	2	½
Bathtub	General	Faucet	4	½
Clothes washer	Private	Faucet	2	½
Clothes washer	General	Faucet	4	½
Combination fixture	Private	Faucet	3	½
Dishwasher[e]	Private	Automatic	1	½
Drinking fountain	Offices, etc.	Faucet ⅜ in.	0.25	⅜
Kitchen sink	Private	Faucet	2	½
Kitchen sink	General	Faucet	4	½
Laundry trays (1–3)	Private	Faucet	3	½
Lavatory	Private	Faucet	1	⅜
Lavatory	General	Faucet	2	½
Separate shower	Private	Mixing valve	2	½
Service sink	General	Faucet	3	½
Shower head	Private	Mixing valve	2	½
Shower head	General	Mixing valve	4	½
Urinal	General	Flushometer	5	¾
Urinal	General	Flush tank	3	½
Water closet	Private	Flushometer	6	1
Water closet	Private	Flushometer tank	3	⅜
Water closet	Private	Flush tank	3	⅜
Water closet	General	Flushometer	10	1
Water closet	General	Flushometer tank	5	⅜
Water closet	General	Flush tank	5	⅜

Water supply outlets not listed above shall be computed at their maximum demand, but in no case less than the following values:

	Number of Fixture Units	
Fixture Branch[d]	Private Use	General Use
⅜	1	2
½	2	4
¾	3	6
1	6	10

[a] For supply outlets likely to impose continuous demands, estimate continuous supply separately and add to total demand for fixtures.

[b] The given weights are for total demand. For fixtures with both hot and cold water supplies, the weights for maximum separate demands may be taken as three-quarters the listed demand for the supply.

[c] A bathroom group for the purposes of this table consists of not more than one water closet, one lavatory, one bathtub, one shower stall or one water closet, two lavatories, one bathtub or one separate shower stall.

[d] Nominal I.D. pipe size.

[e] Some may require larger sizes—see manufacturer's instructions.

[f] Data extracted from Code Table B.5.2.

Source. Reproduced with permission from The National Standard Plumbing Code, published by The National Association of Plumbing Heating Cooling Contractors.

Table 4.2

Minimum Pressure Required by Typical Plumbing Fixtures

Fixture Type	*Minimum Pressure, p*
Sink and tub faucets	8
Shower	8
Water closet—tank flush	8
Flush valve—urinal	15
Flush valve—siphon jet bowl	
floor-mounted	15
wall-mounted	25
Flush valve—blowout bowl	
floor-mounted	25
wall-mounted	35
Garden hose	
½-in. sill cock	15
¾-in. sill cock	30
Drinking fountain	15

Source: *EPA Manual of Individual Water Supply Syst.* 1975 and manufacturers' data

Recommended Flow Rates for Typical Plumbing Fixtures

Fixture Type	*Flow, gpm*
Lavatory	3
Sink	[illegible]
Bathtub	[illegible]
Laundry tub	5
Shower	3–10
Water closets	
tank type	3
flush valve*	15–40
Urinal flush valve	15
Garden hose	
½-in. sill cock	3½
¾-in. sill cock	5
Drinking fountain	[illegible]

Source: Data extracted from various sources.

*Wide range of flows depends on low pressure.

Table for Estimating Demand

Supply Systems Predominantly for Flush Tanks		*Supply Systems Predominantly for Flushometers*	
*Load, WSFU**	*Demand, gpm*	*Load, WSFU**	*Demand, gpm*
6	5	—	—
10	8	10	27
15	11	15	31
20	14	20	35
25	17	25	38
30	20	30	41
40	25	40	47
50	29	50	51
60	33	60	55
80	39	80	62
100	44	100	68
120	49	120	[illegible]
140	53	140	78
160	57	160	83
180	61	180	[illegible]
200	65	200	[illegible]
225	70	225	[illegible]
250	75	250	[illegible]
300	85	300	[illegible]
400	105	400	125
500	125	500	140
750	170	750	[illegible]
1000	210	1000	[illegible]
1250	240	1250	[illegible]
1500	270	1500	[illegible]
1750	300	1750	300
2000	325	2000	325
2500	380	2500	380
3000	435	3000	435
4000	525	4000	525
5000	600	5000	600
6000	650	6000	650
7000	700	7000	700
8000	730	8000	730
9000	760	9000	[illegible]
10,000	790	10,000	[illegible]

*Water Supply Fixture Units

Source: Reproduced with permission from The National Standard Plumbing Code, published by The National Association of Plumbing Heating Cooling Contractors.

Table 4.6 Horizontal Fixture branches and stacks

Diameter of Pipe, in.	Maximum Number of Fixture Units That May Be Connected to			
	Any Horizontal Fixture Branch,[a] dfu	One Stack of Three Branch Intervals or Less, dfu	Stacks with More Than Three Branch Intervals	
			Total for Stack, dfu	Total at One Branch Interval, dfu
1½	3	4	8	2
2	6	10	24	6
2½	12	20	42	9
3	20[b]	48[b]	72[b]	20[b]
4	160	240	500	90
5	360	540	1100	200
6	620	960	1900	350
8	1400	2200	3600	600
10	2500	3800	5600	1000
12	3900	6000	8400	1500
15	7000			

[a]Does not include branches of the building drain.

[b]Not more than two water closets or bathroom groups within each branch interval nor more than six water closets or bathroom groups on the stack.

Note: Stacks shall be sized according to the total accumulated connected load at each story or branch interval and may be reduced in size as this load decreases to a minimum diameter of half of the largest size required.

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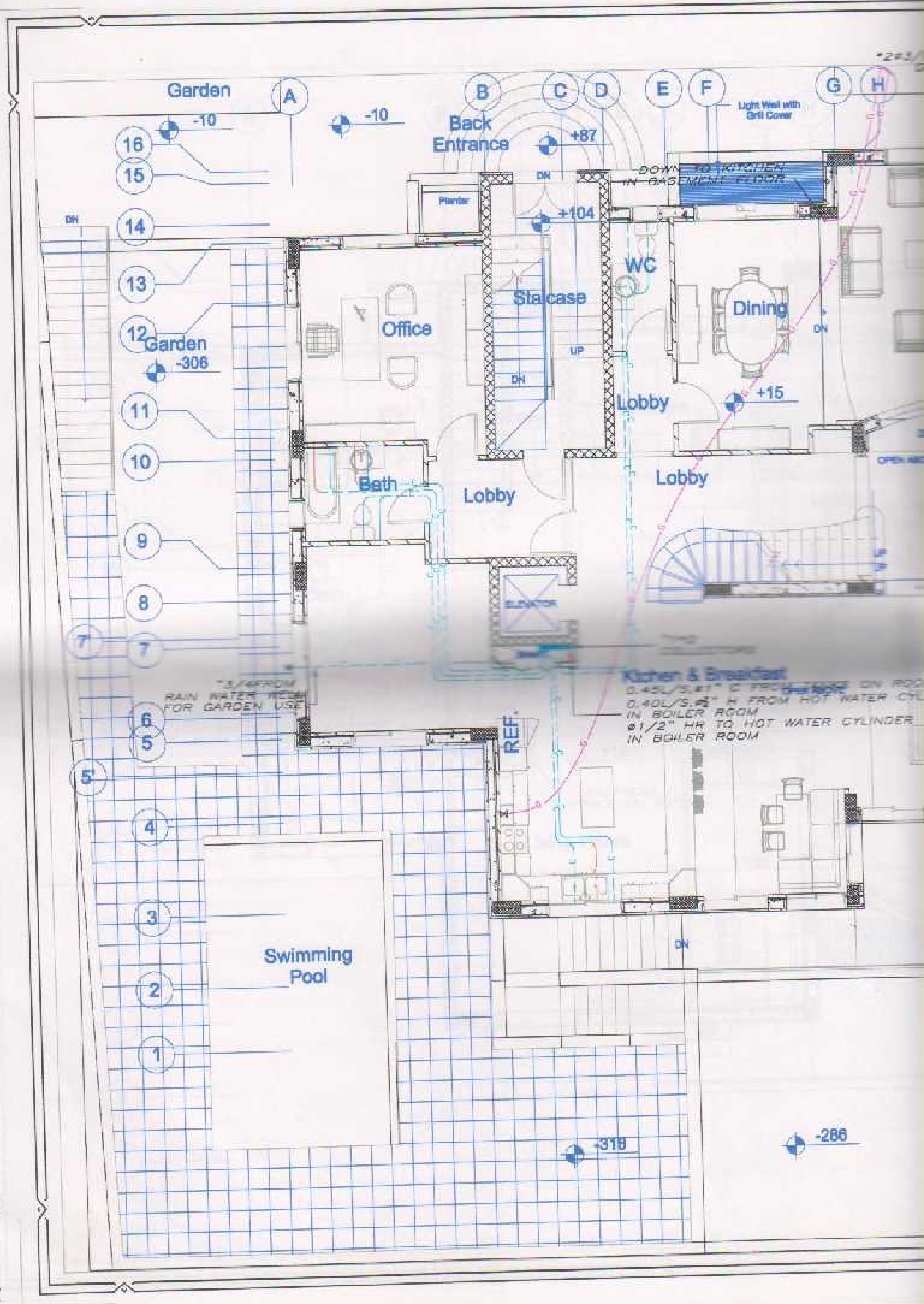
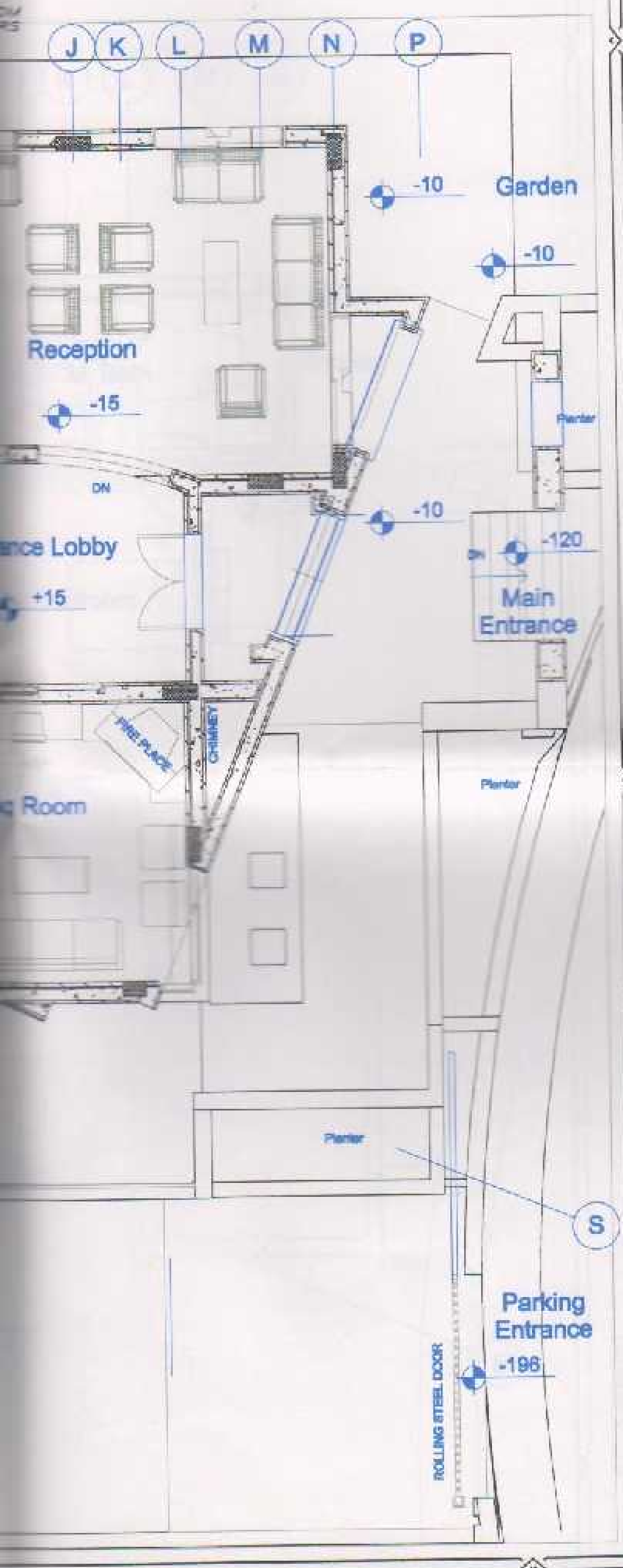

Garden
Back Entrance
-10
-10
+87
+104
DN
Planter
DOWN TO KITCHEN IN BASEMENT FLOOR
Light Well with Grill Cover
A
B
C
D
E
F
G
H
16
15
14
13
12
11
10
9
8
7
7'
6
5
5'
4
3
2
1
Garden
-306
Office
Staircase
UP
DN
WC
Dining
DN
+15
Lobby
Bath
Lobby
Lobby
ELEVATOR
"3/4FROM
RAIN WATER ROOM
FOR GARDEN USE
REF.
Kitchen & Breakfast
IN BOILER ROOM
ø1/2" HR TO HOT WATER CYLINDER
IN BOILER ROOM
Swimming Pool
DN
+318
-286



LEGEND

- SHUT-OFF VALVE
  صمام اغلاق
- FLOAT VALVE
  عوامة
- HOT WATER G.S. PIPE
  ماسورة ماء ساخن فولاذية
- COLD WATER G.S. PIPE
  ماسورة ماء بارد فولاذية
- HOT WATER POLYETHYLENE PIPE
  أنبوب ماء ساخن من البوليثيلين
- COLD WATER POLYETHYLENE PIPE
  أنبوب ماء بارد من البوليثيلين
- GAS SOFT COPPER PIPE
  أنبوب نحاسي لاستعمال الغاز
- HOT WATER RETURN PIPE
  أنبوب راجع للمياه الساخنة
- SOLAR SYSTEM PIPE
  مواسير النظام الشمسي

R	REV. BY	DATE	DESCRIPTION

PROJECT:

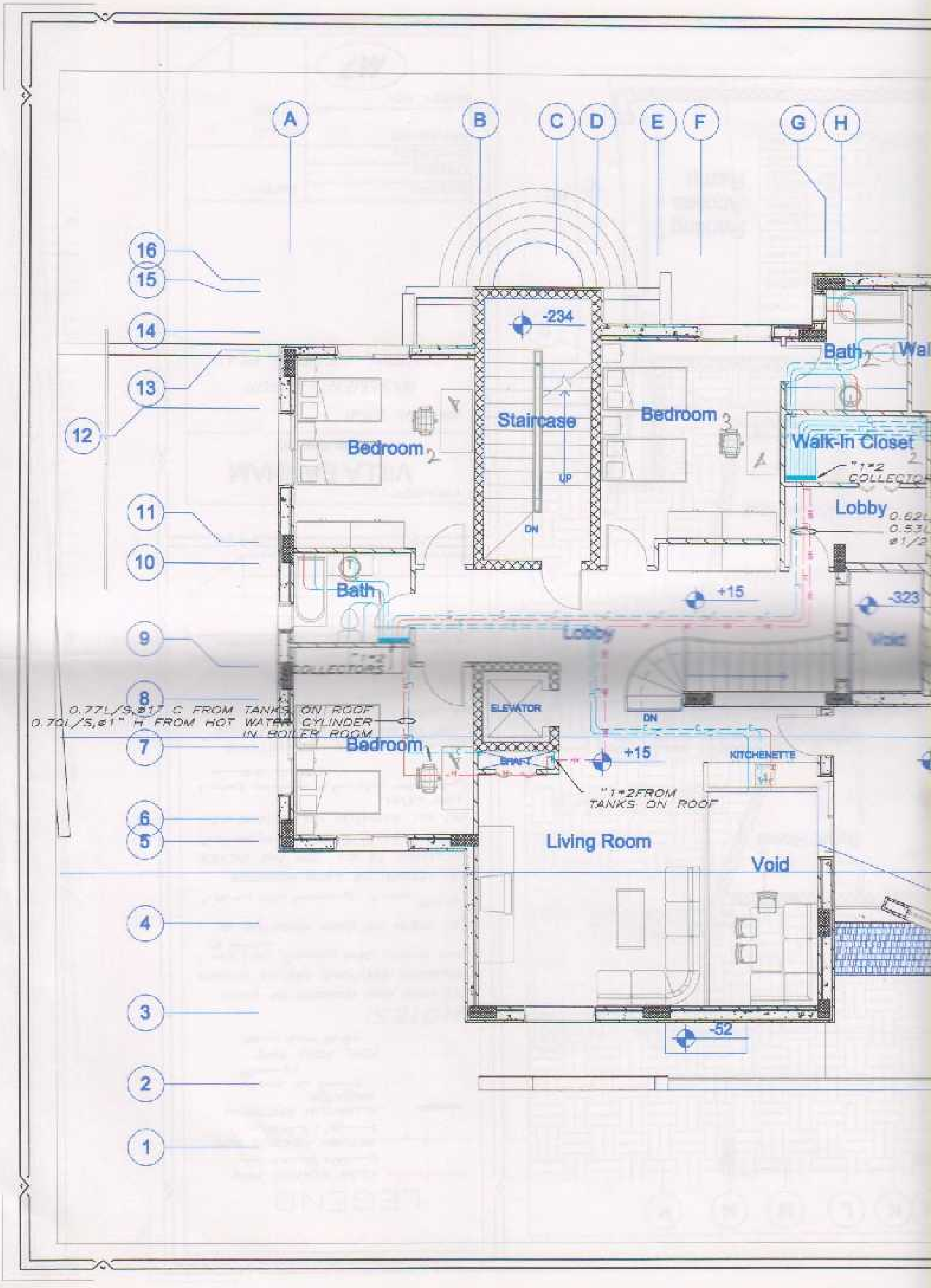
VILLA BARHAM

Tireh, Ramallah

DRAWING TITLE:

GROUND FLOOR
GAS & WATER PIPING PLAN

DESIGN:	DATE:
DRAWN:	
CHECKED: A.KHAFAJAH	
APPROVED :	SCALE: 1/100
SHEET NO: M5	



A
B
C
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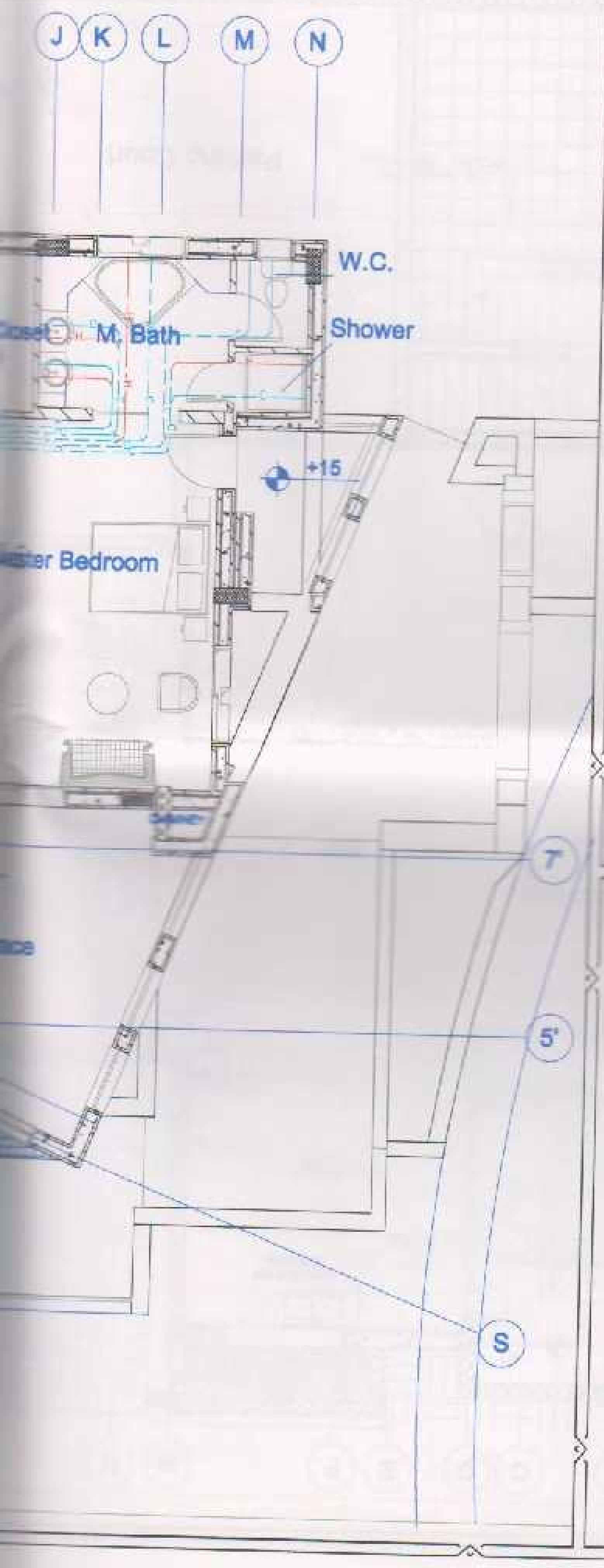
F
G
H
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
-234
Staircase
UP
DN
Bedroom 2
Bedroom 3
Bath 2
Walk-In Closet 2
"1*2 COLLECTO
Lobby
Bath
"1*2 COLLECTORS
+15
-323
Lobby
Void
0.77L/S,Ø1" C FROM TANKS ON ROOF
0.70L/S,Ø1" H FROM HOT WATER CYLINDER IN BOILER ROOM
ELEVATOR
Bedroom 1
SHAFT
DN
+15
KITCHENETTE
"1*2FROM TANKS ON ROOF
Living Room
Void
-52



LEGEND

- SHUT-OFF VALVE
  صمام اغلاق
- FLOAT VALVE
  عوامة
- HOT WATER G.S. PIPE
  ماسورة ماء ساخن فولاذية
- COLD WATER G.S. PIPE
  ماسورة ماء بارد فولاذية
- HOT WATER POLYETHYLENE PIPE
  أنبوب ماء ساخن من البوليثيلين
- COLD WATER POLYETHYLENE PIPE
  أنبوب ماء بارد من البوليثيلين
- GAS SOFT COPPER PIPE
  أنبوب نحاسي لاستعمال الغاز
- HOT WATER RETURN PIPE
  أنبوب راجع للمياه الساخنة
- SOLAR SYSTEM PIPE
  مواسير النظام الشمسي

R	REV. BY	DATE	DESCRIPTION

PROJECT:

VILLA BARHAM

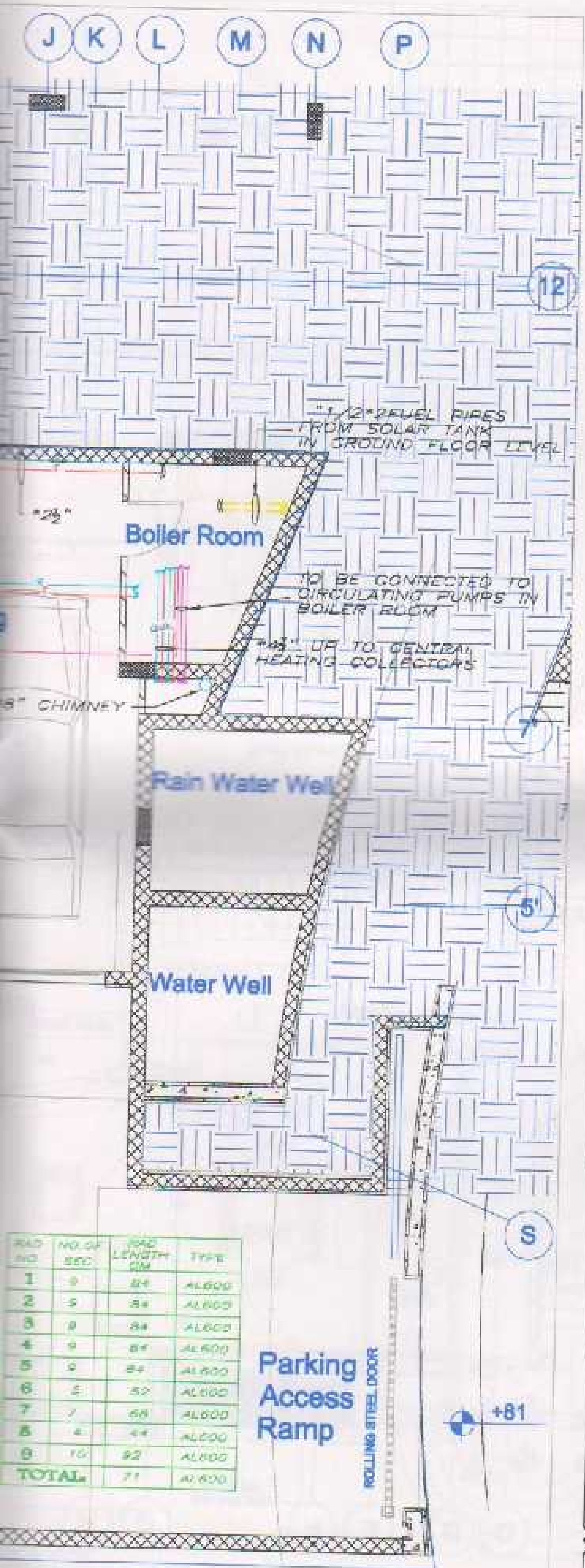
Tireh, Ramallah

DRAWING TITLE:

FIRST FLOOR
WATER PIPING PLAN

DESIGN:	DATE:
DRAWN:	
CHECKED:	
APPROVED :	SCALE: 1/100
SHEET NO: M6	

A
B
C
D
E
F
G
H
16
15
14
13
11
10
9
8
7
6
5
4
3
2
1
W.C.
Bath
Staircase
+0
Light Well with Grill Cover
Garden
Maid
Kitchen
COLLECTORS
UP
W DW
Bath
Guest Bedroom
ELEVATOR
SHAFT
Multi Purpose Hall
Swimming Pool
"3/4"+2 FOR POOL HEATING
Parking Court



RAD NO	NO. OF SEC	RAD LENGTH CM	TYPE
1	9	84	AL600
2	9	84	AL600
3	9	84	AL600
4	9	84	AL600
5	9	84	AL600
6	5	52	AL600
7	7	68	AL600
8	4	44	AL600
9	10	92	AL600
TOTAL	71		AL600

LEGEND

- FLOW HEATING PIPE
  خط تدفئة دافع
- RETURN HEATING PIPE
  خط تدفئة راجع
- ALUMINUM SECTIONAL RADIATOR
  راديتر من أصابع الألمنيوم
- FUEL FEED PIPE
  انبوب تزويد للوقود

NOTES:

(1) KIND AND NUMBER OF EACH RADIATOR SECTIONS ARE AS SHOWN.
١. نوع وعدد الأصابع لكل راديتر كما هو مبين

(2) WIDTH OF EACH RADIATOR IS 8 CM.
٢. عرض كل اصبع ٨ سم

(3) LENGTH OF EACH RADIATOR INCLUDES 12 CM. FOR THE VALVES.
٣. يشمل طول الراديتر ١٢ سم للصمامات

(4) ALL RADIATOR VALVES ARE AT LOW LEVEL.
٤. جميع صمامات الراديترات تكون في مستوى منخفض

(5) ALL RADIATOR CONNECTIONS ARE 16 MM. POLYETHYLENE PIPE
٥. كل التوصيلات للراديترات تكون من البولي ايثيلين قطر ١٦ ملم

R	REV. BY	DATE	DESCRIPTION

PROJECT:

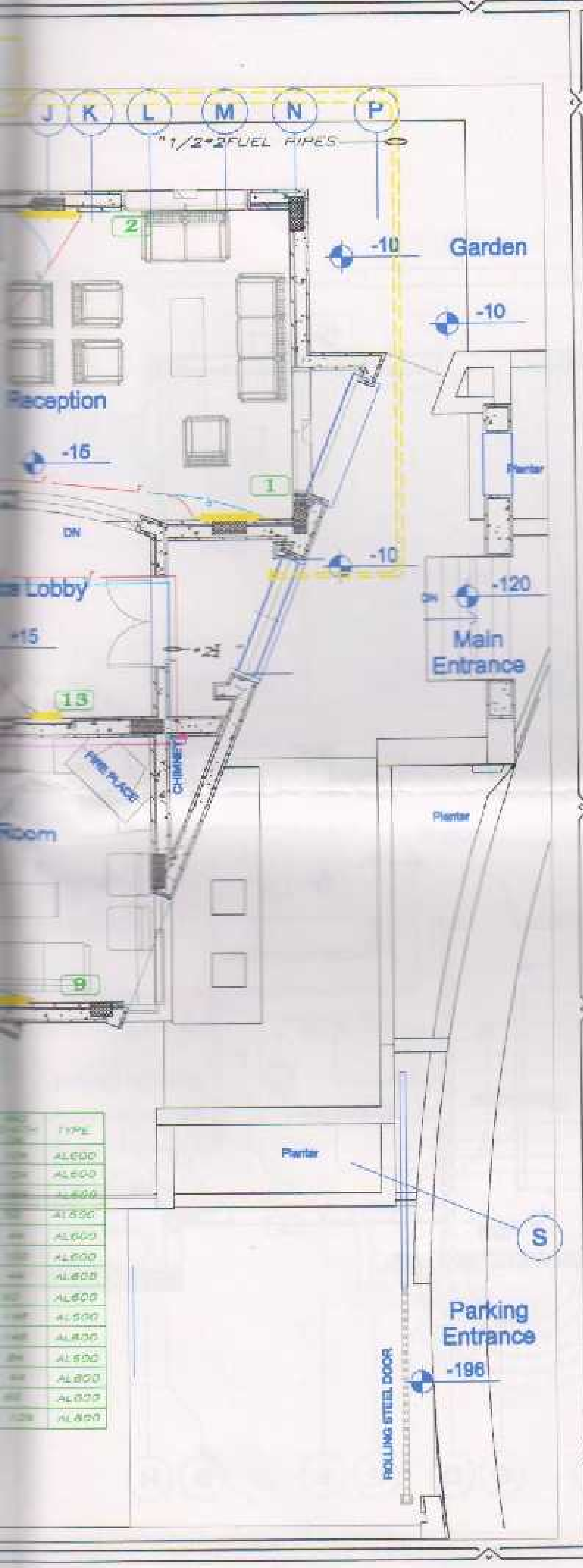
VILLA BARHAM

Tireh, Ramallah

DRAWING TITLE:

BASEMENT FLOOR
CENTRAL HEATING PLAN

DESIGN:	DATE:
DRAWN:	
CHECKED:	
APPROVED :	SCALE: 1/100
SHEET NO: M7	



LEGEND

FLOW HEATING PIPE
خط تدفئة دافع

RETURN HEATING PIPE
خط تدفئة راجع

ALUMINUM SECTIONAL RADIATOR
راديتر من أصابع الألمنيوم

FUEL FEED PIPE
انبوب تزويد للوقود

NOTES:

(1) KIND AND NUMBER OF EACH RADIATOR SECTIONS ARE AS SHOWN.
١- نوع وعدد الأصابع لكل راديتر كما هو مبين

(2) WIDTH OF EACH RADIATOR IS 8 CM.
٢- عرض كل اصبع ٨ سم

(3) LENGTH OF EACH RADIATOR INCLUDES 12 CM. FOR THE VALVES.
٣- يشمل طول الراديتر ١٢ سم للصمامات

(4) ALL RADIATOR VALVES ARE AT LOW LEVEL.
٤- جميع صمامات الراديترات تكون في مستوى منخفض

(5) ALL RADIATOR CONNECTIONS ARE 16 MM. POLYETHYLENE PIPE
٥- كل التوصيلات للراديترات تكون من البوليثيلين قطر ١٦ ملم

R	REV. BY	DATE	DESCRIPTION

PROJECT:

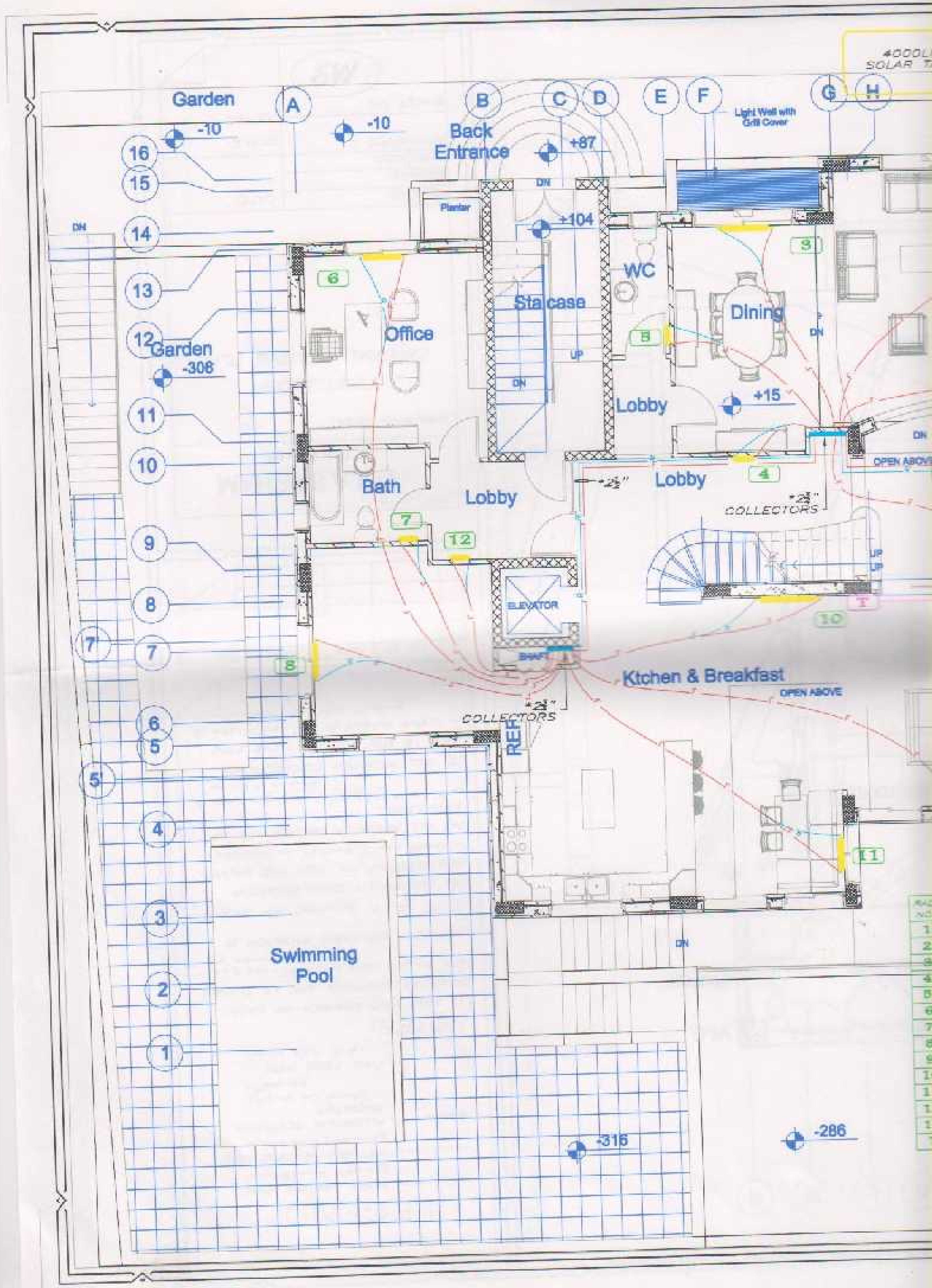
VILLA BARHAM

Tireh, Ramallah

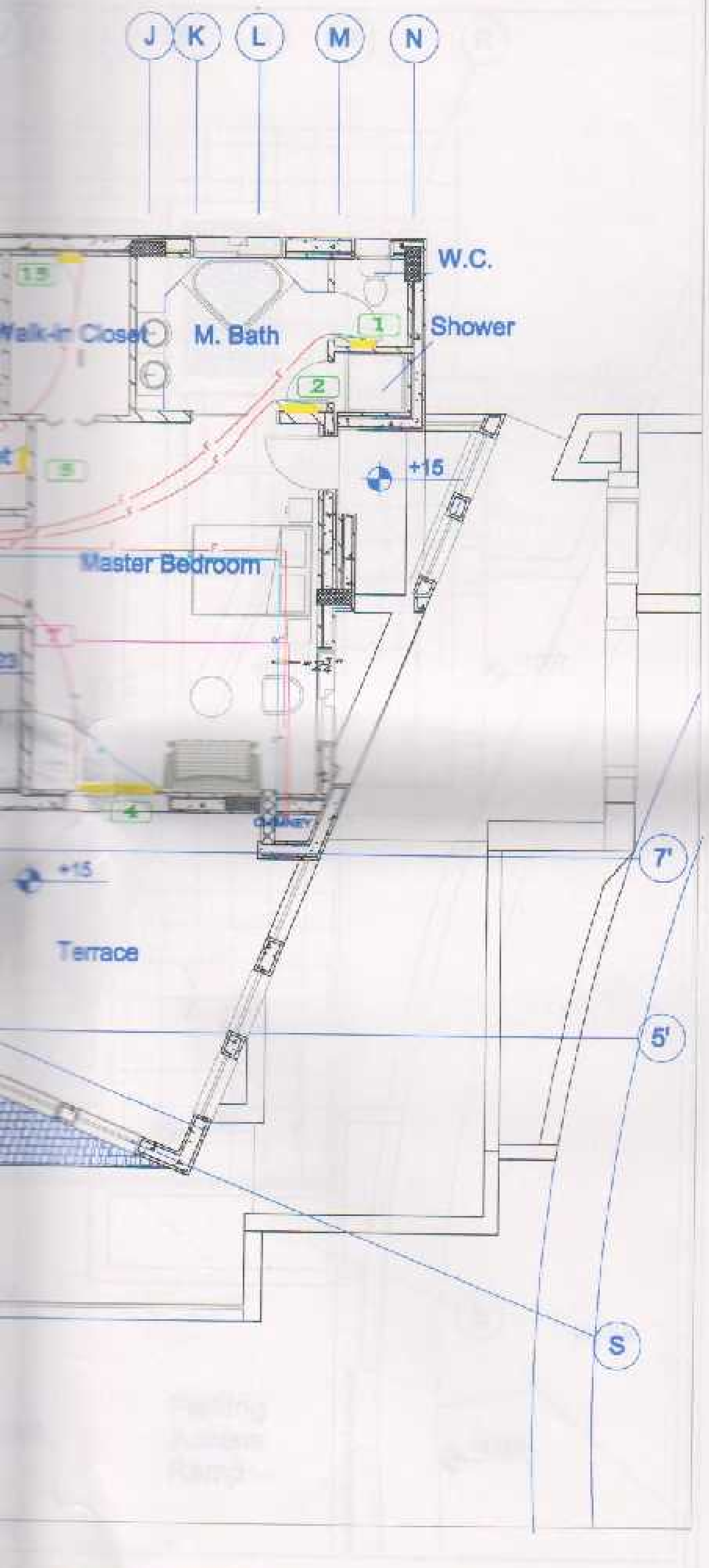
DRAWING TITLE:

GROUND FLOOR
CENTRAL HEATING PLAN

DESIGN:	DATE:
DRAWN:	
CHECKED:	
APPROVED :	SCALE: 1/100
SHEET NO: M8	



Garden
A
B
C
D
E
F
G
H
Light Well with Grill Cover
-10
-10
Back Entrance
+87
DN
Planter
+104
16
15
14
13
12
11
10
9
8
7
7'
6
5
5'
4
3
2
1
DN
6
Office
Staircase
UP
DN
WC
3
Dining
DN
5
Garden
-308
Lobby
+15
Bath
Lobby
"2½"
Lobby
4
OPEN ABOVE
"2½"
COLLECTORS
7
12
UP
UP
ELEVATOR
10
8
SHAFT
Ktchen & Breakfast
OPEN ABOVE
"2½"
COLLECTORS
REF
11
DN
Swimming Pool
-316
-286



LEGEND

- FLOW HEATING PIPE
  خط تدفئة دافع
- RETURN HEATING PIPE
  خط تدفئة راجع
- ALUMINUM SECTIONAL RADIATOR
  راديتر من أصابع الألمنيوم
- FUEL FEED PIPE
  أنبوب تزويد للوقود

NOTES:

(1) KIND AND NUMBER OF EACH RADIATOR SECTIONS ARE AS SHOWN.
١. نوع وعدد الأصابع لكل راديتر كما هو مبين

(2) WIDTH OF EACH RADIATOR IS 8 CM.
٢. عرض كل أصبع ٨ سم

(3) LENGTH OF EACH RADIATOR INCLUDES 12 CM. FOR THE VALVES.
٣. يشمل طول الراديتر ١٢ سم للصمامات

(4) ALL RADIATOR VALVES ARE AT LOW LEVEL.
٤. جميع صمامات الراديترات تكون في مستوى منخفض

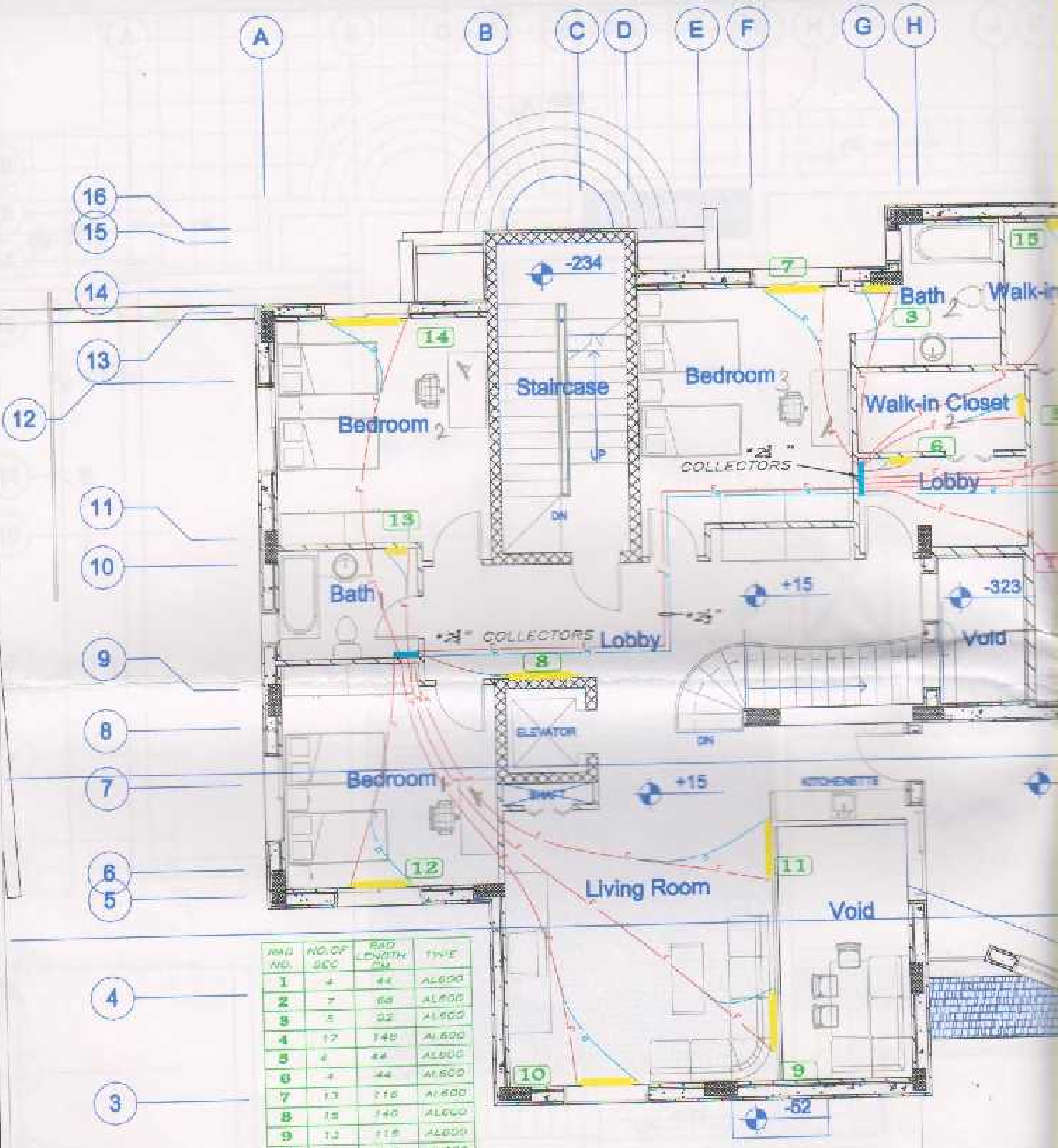
(5) ALL RADIATOR CONNECTIONS ARE 16 MM. POLYETHYLENE PIPE
٥. كل التوصيلات للراديترات تكون من البوليثلين قطر ١٦ ملم

R	REV. BY	DATE	DESCRIPTION

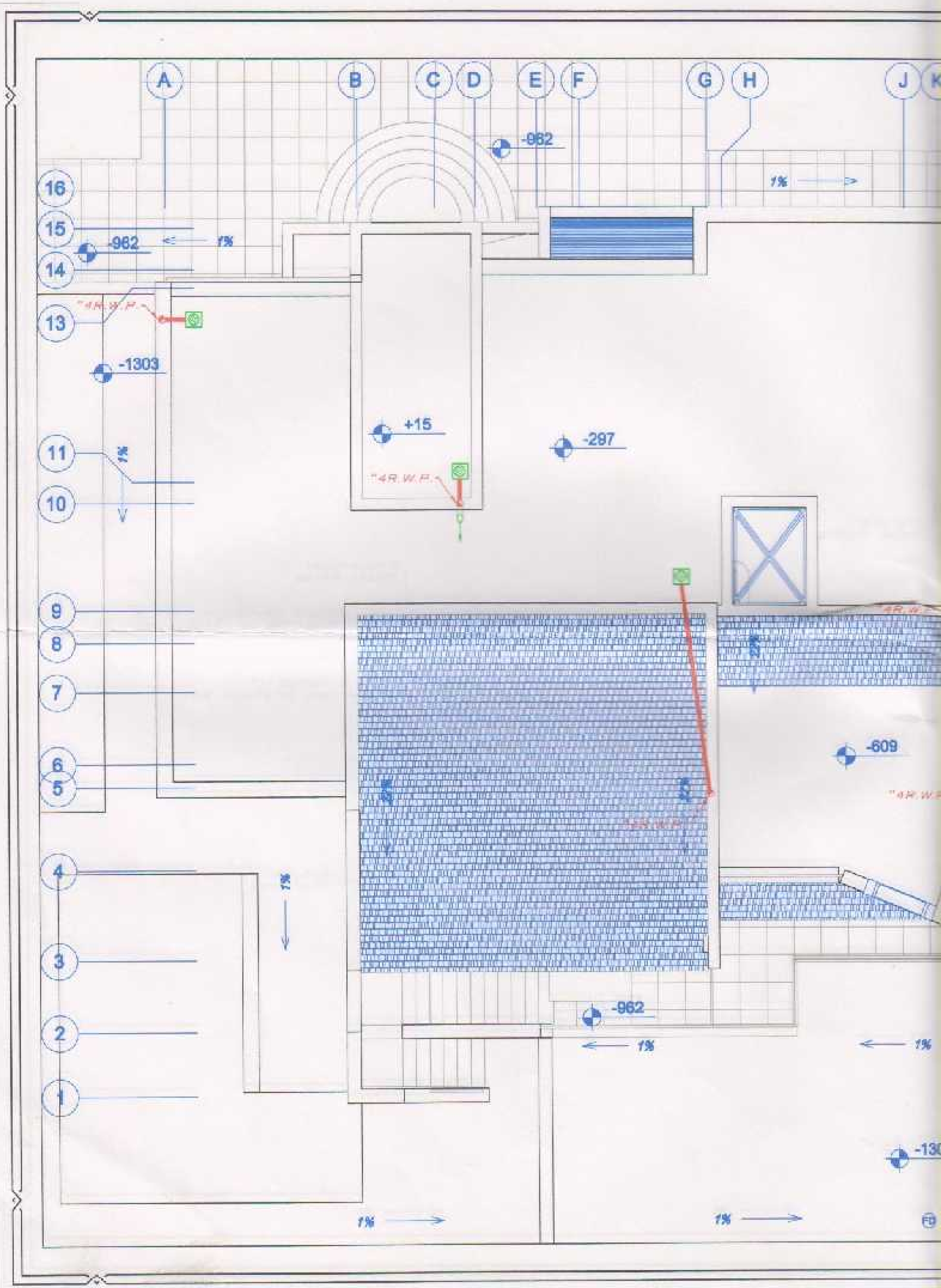
PROJECT:
VILLA BARHAM
Tireh, Ramallah

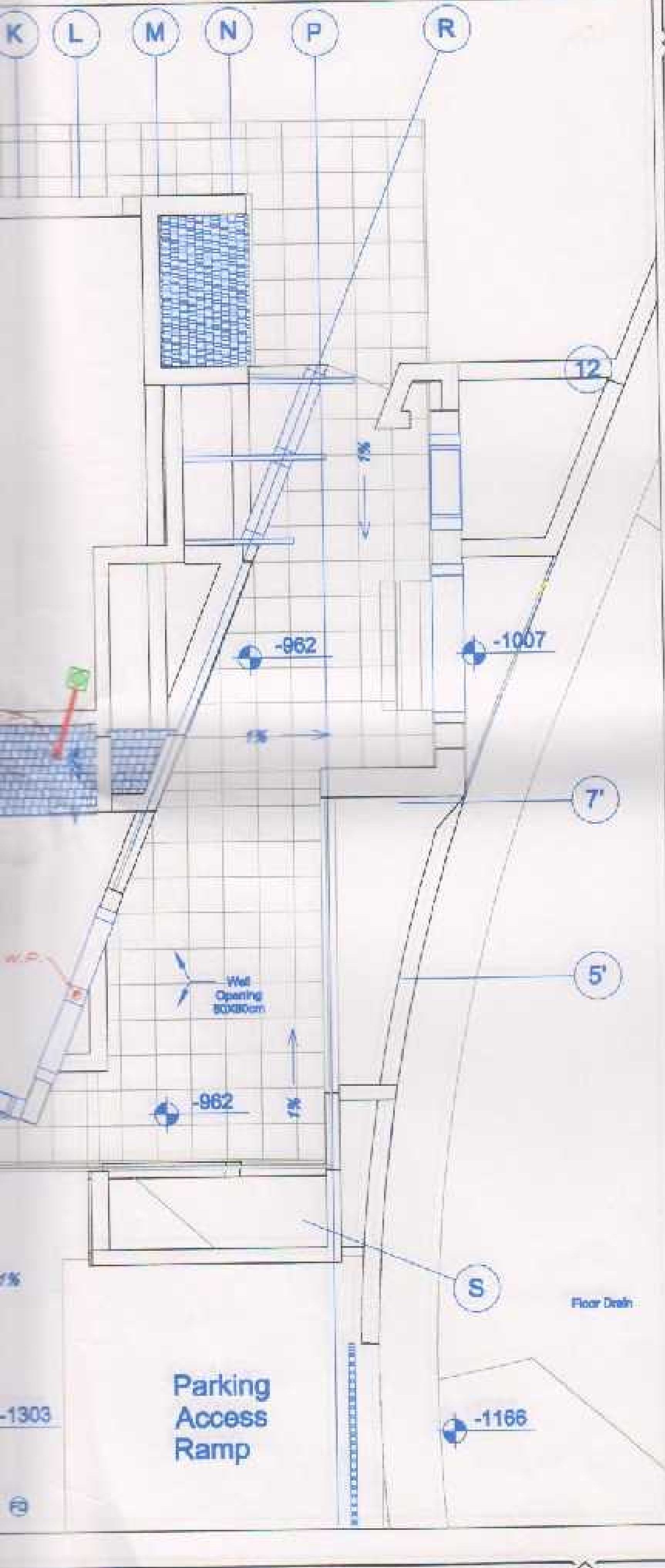
DRAWING TITLE:
FIRST FLOOR
CENTRAL HEATING PLAN

DESIGN:	DATE:
DRAWN:	
CHECKED:	
APPROVED :	SCALE: 1/100
SHEET NO: M9	



RAD NO.	NO. OF SEC	RAD LENGTH CM	TYPE
1	4	44	AL600
2	7	68	AL600
3	5	52	AL600
4	17	148	AL600
5	4	44	AL600
6	4	44	AL600
7	13	116	AL600
8	15	140	AL600
9	13	116	AL600
10	13	116	AL600
11	13	116	AL600
12	13	116	AL600
13	4	44	AL600
14	14	148	AL600
15	4	44	AL600
TOTAL		144	AL600


A
B
C
D
E
F
G
H
J
K
16
15
14
13
11
10
9
8
7
6
5
4
3
2
1
-962
-962
1%
-1303
+15
-297
"4R.W.P.
"4R.W.P.
-609
-962
1%
1%
1%
1%
1%
1%



LEGEND

ø S%
P.V.C. DRAIN PIPE DIAMETER (ø) SLOPE (S)
ماسورة تصريف بلاستيك
قطر (ø) ميل (S)

4" P.V.C. DRAIN PIPE (2% SLOPE)
ماسورة تصريف بلاستيك
قطر ٤ انش ميل ٢%

2" P.V.C. DRAIN PIPE (2% SLOPE)
ماسورة تصريف بلاستيك
بقطر ٢ انش ميل ٢%

F.T. — 4" FLOOR TRAP
مصيدة روائح ٤ انش

F.D. — 4"/2" FLOOR DRAIN
مصرف أرضي ٢/٤ انش

C.O. — 4" CLEAN OUT
فتحة تنظيف ٤ انش

R.W.P. — 4" RAIN WATER PIPE
ماسورة مطر ٤ انش

4" RAIN WATER DRAIN
مصرف مطر ٤ انش

4" RAIN WATER (FREE OUTLET)
مخرج حر لماسورة مطر

4" VENT & RISER
ماسورة تهوية عمودية ٤ انش

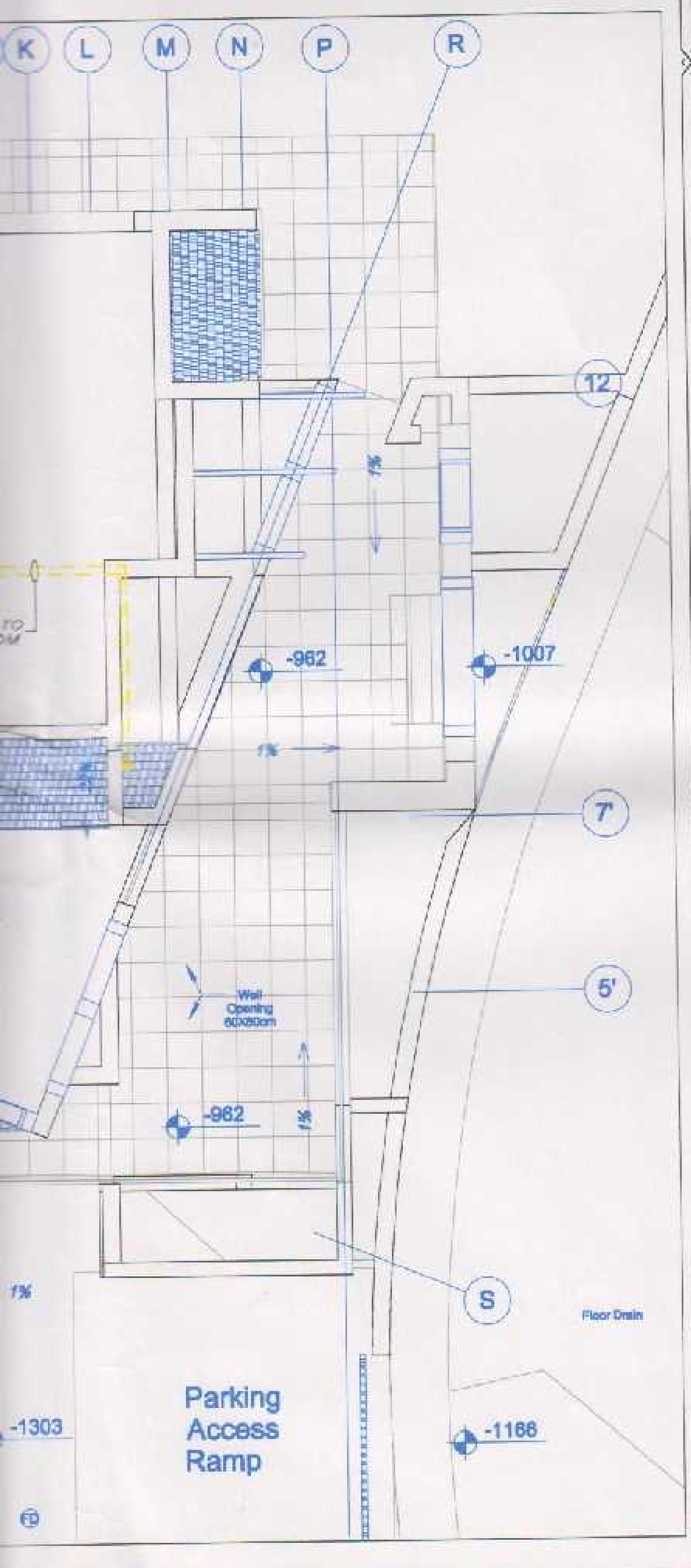
NO — CONCRETE MANHOLE
منهل اسمنتي

R	REV. BY	DATE	DESCRIPTION

PROJECT:
VILLA BARHAM
Tireh, Ramallah

DRAWING TITLE:
TOP ROOF DRAIN PLAN

DESIGN:	DATE:
DRAWN:	
CHECKED:	
APPROVED :	SCALE: 1/100
SHEET NO: M10	



LEGEND

SHUT-OFF VALVE
صمام اغلاق

FLOAT VALVE
عوامة

HOT WATER G.S. PIPE
ماسورة ماء ساخن فولاذية

COLD WATER G.S. PIPE
ماسورة ماء بارد فولاذية

HOT WATER POLYETHYLENE PIPE
انبوب ماء ساخن من البوليثيلين

COLD WATER POLYETHYLENE PIPE
انبوب ماء بارد من البوليثيلين

GAS SOFT COPPER PIPE
انبوب نحاسي لاستعمال الغاز

HOT WATER RETURN PIPE
انبوب راجع للمياه الساخنة

SOLAR SYSTEM PIPE
مواسير النظام الشمسي

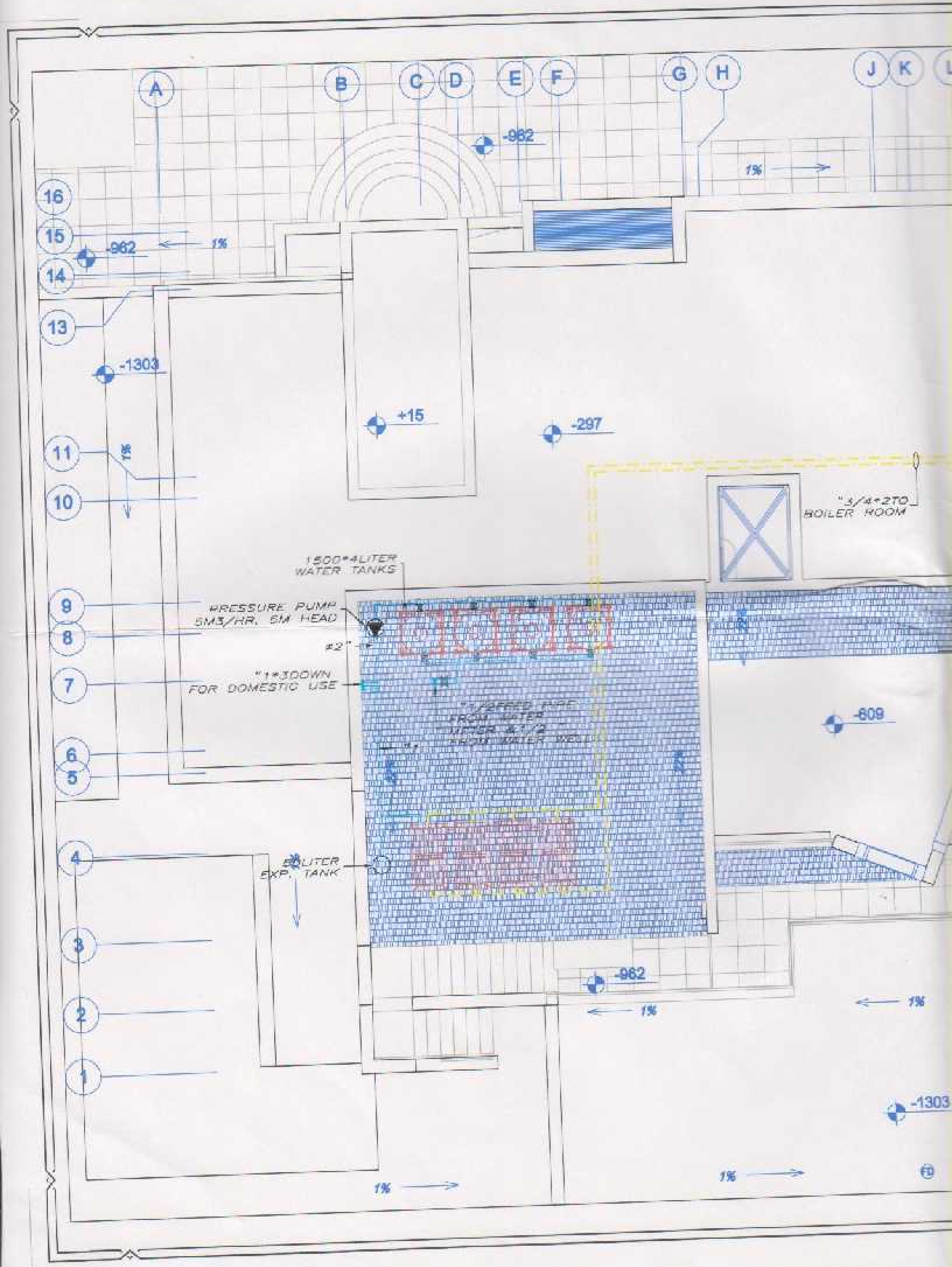
#	REV. BY	DATE	DESCRIPTION

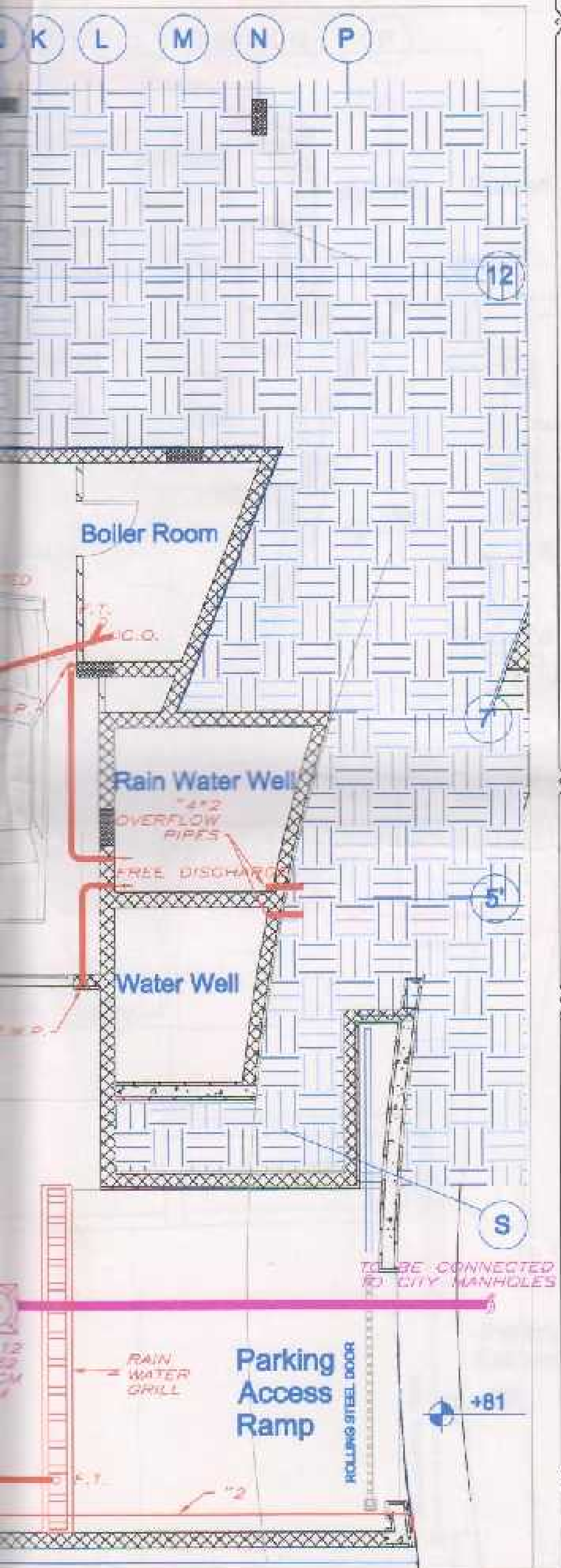
PROJECT:
VILLA BARHAM
Tireh, Ramallah

DRAWING TITLE:

TOP ROOF
WATER PIPING PLAN

DESIGN: DRAWN: CHECKED: APPROVED :	DATE:
	SCALE: 1/100
SHEET NO: M11	


A
B
C
D
E
F
G
H
J
K
-962
1%
16
15
-962
1%
14
13
-1303
+15
-297
11
10
"3/4*2TO
BOILER ROOM
1500*4LITER
WATER TANKS
9
PRESSURE PUMP
5M3/HR, 5M HEAD
8
#2"
7
"1*3DOWN
FOR DOMESTIC USE
-609
6
5
4
BOILER
EXP. TANK
3
-962
1%
1%
2
1
-1303
1%
1%



LEGEND

∅ S%	P.V.C. DRAIN PIPE DIAMETER (∅) SLOPE (S) ماسورة تصريف بلاستيك قطر (∅) ميل (S)
	4" P.V.C. DRAIN PIPE (2% SLOPE) ماسورة تصريف بلاستيك قطر ٤ انش ميل ٢%
	2" P.V.C. DRAIN PIPE (2% SLOPE) ماسورة تصريف بلاستيك بقطر ٢ انش ميل %
F.T.	4" FLOOR TRAP مصيدة روائح ٤ انش
F.D.	4"/2" FLOOR DRAIN مصرف ارضي ٢\٤ انش
C.O.	4" CLEAN OUT فتحة تنظيف ٤ انش
R.W.P.	4" RAIN WATER PIPE ماسورة مطر ٤ انش
	4" RAIN WATER DRAIN مصرف مطر ٤ انش
	4" RAIN WATER (FREE OUTLET) مخرج حر لماسورة مطر
	4" VENT & RISER ماسورة تهوية عمودية ٤ انش
NO	CONCRETE MANHOLE منهل اسمنتي

R	REV. BY	DATE	DESCRIPTION

PROJECT:

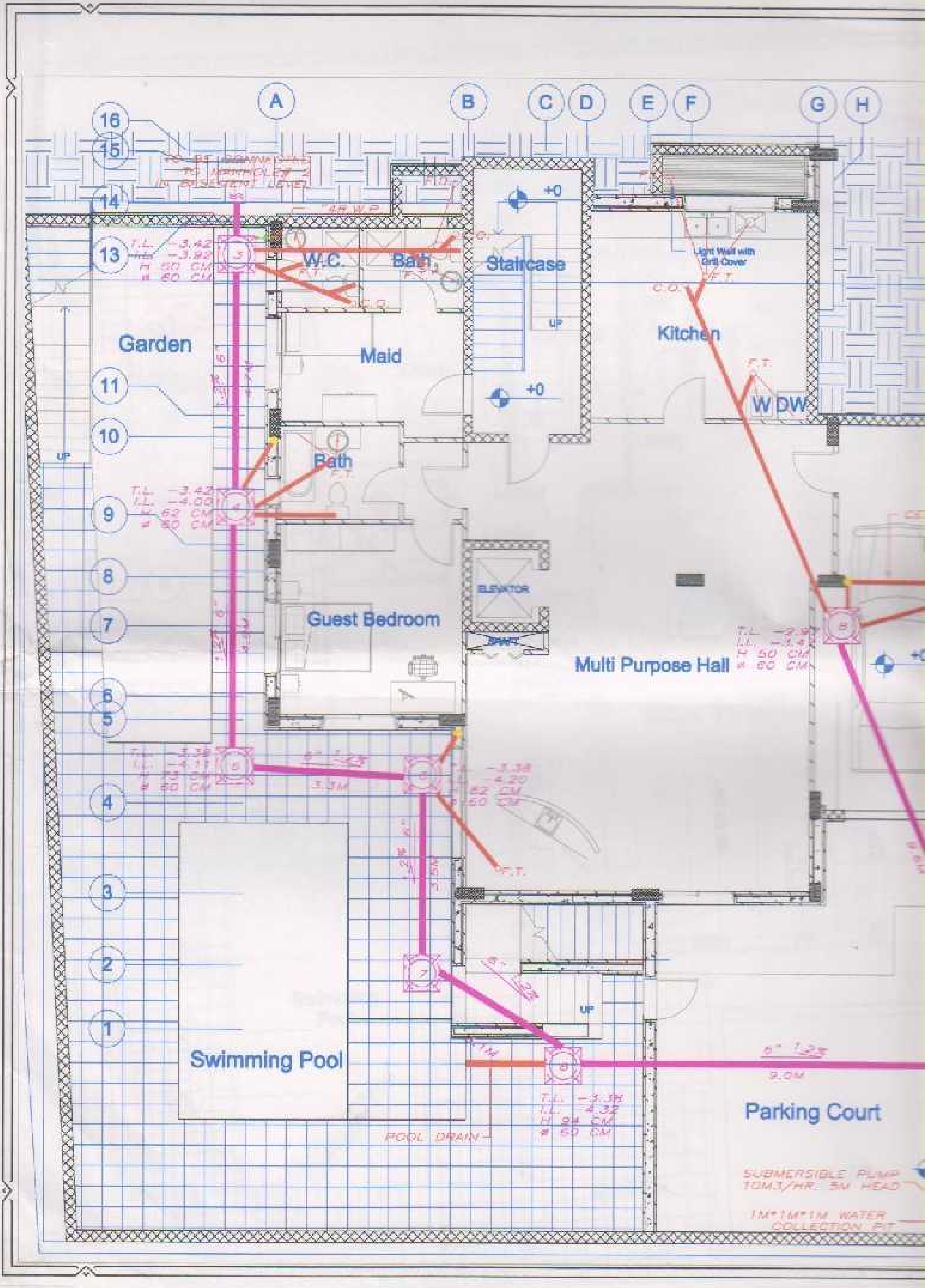
VILLA BARHAM

Tireh, Ramallah

DRAWING TITLE:

BASEMENT FLOOR SANITARY PLAN

DESIGN:	DATE:
DRAWN:	
CHECKED:	
APPROVED :	SCALE: 1/100
SHEET NO: M1	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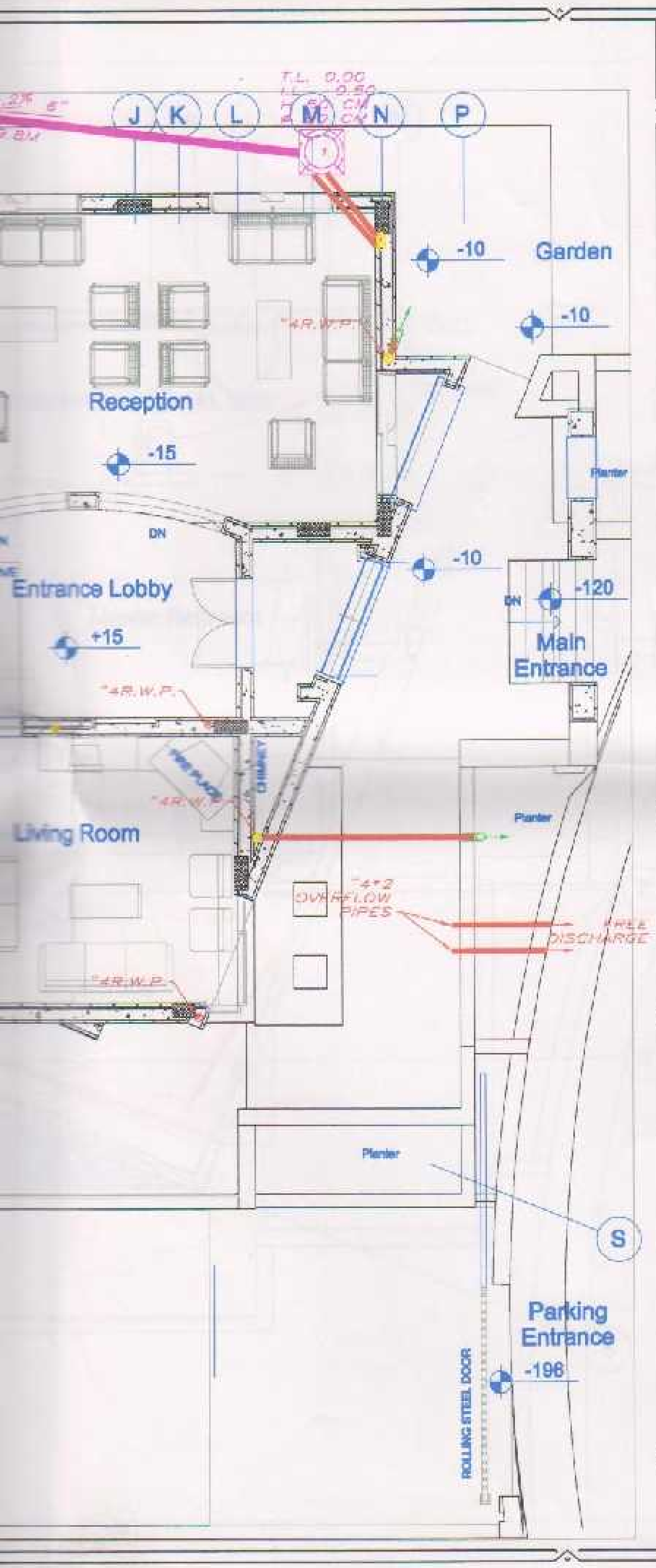
1
Garden
W.C.
Bath
Staircase
Kitchen
Light Wall with Grill Cover
Maid
Bath
Guest Bedroom
ELEVATOR
Multi Purpose Hall
Swimming Pool
Parking Court
W DW
UP
+0
C.O.
F.T.
T.L. -3.42
I.L. -3.92
H 50 CM
Ø 60 CM
T.L. -3.42
I.L. -4.00
H 62 CM
Ø 60 CM
T.L. -3.38
I.L. -4.20
H 62 CM
Ø 60 CM
3.3M
6" 1:25
9.0M
T.L. -3.3H
I.L. -4.32
H 94 CM
Ø 60 CM
POOL DRAIN
SUBMERSIBLE PUMP
10M3/HR. 3M HEAD
1M*1M*1M WATER
COLLECTION PIT



LEGEND

∅ S%	P.V.C. DRAIN PIPE DIAMETER (∅) SLOPE (S) ماسورة تصريف بلاستيك قطر (∅) ميل (S)
	4" P.V.C. DRAIN PIPE (2% SLOPE) ماسورة تصريف بلاستيك قطر ٤ انش ميل ٢%
	2" P.V.C. DRAIN PIPE (2% SLOPE) ماسورة تصريف بلاستيك بقطر ٢ انش ميل %
F.T.	4" FLOOR TRAP مصيدة روائح ٤ انش
F.D.	4"/2" FLOOR DRAIN مصرف ارضي ٤|٢ انش
C.O.	4" CLEAN OUT فتحة تنظيف ٤ انش
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	4" RAIN WATER DRAIN مصرف مطر ٤ انش
	4" RAIN WATER (FREE OUTLET) مخرج حر لماسورة مطر
	4" VENT & RISER ماسورة تهوية عمودية ٤ انش
NO	CONCRETE MANHOLE منهل اسمنتي

R	REV. BY	DATE	DESCRIPTION

PROJECT:

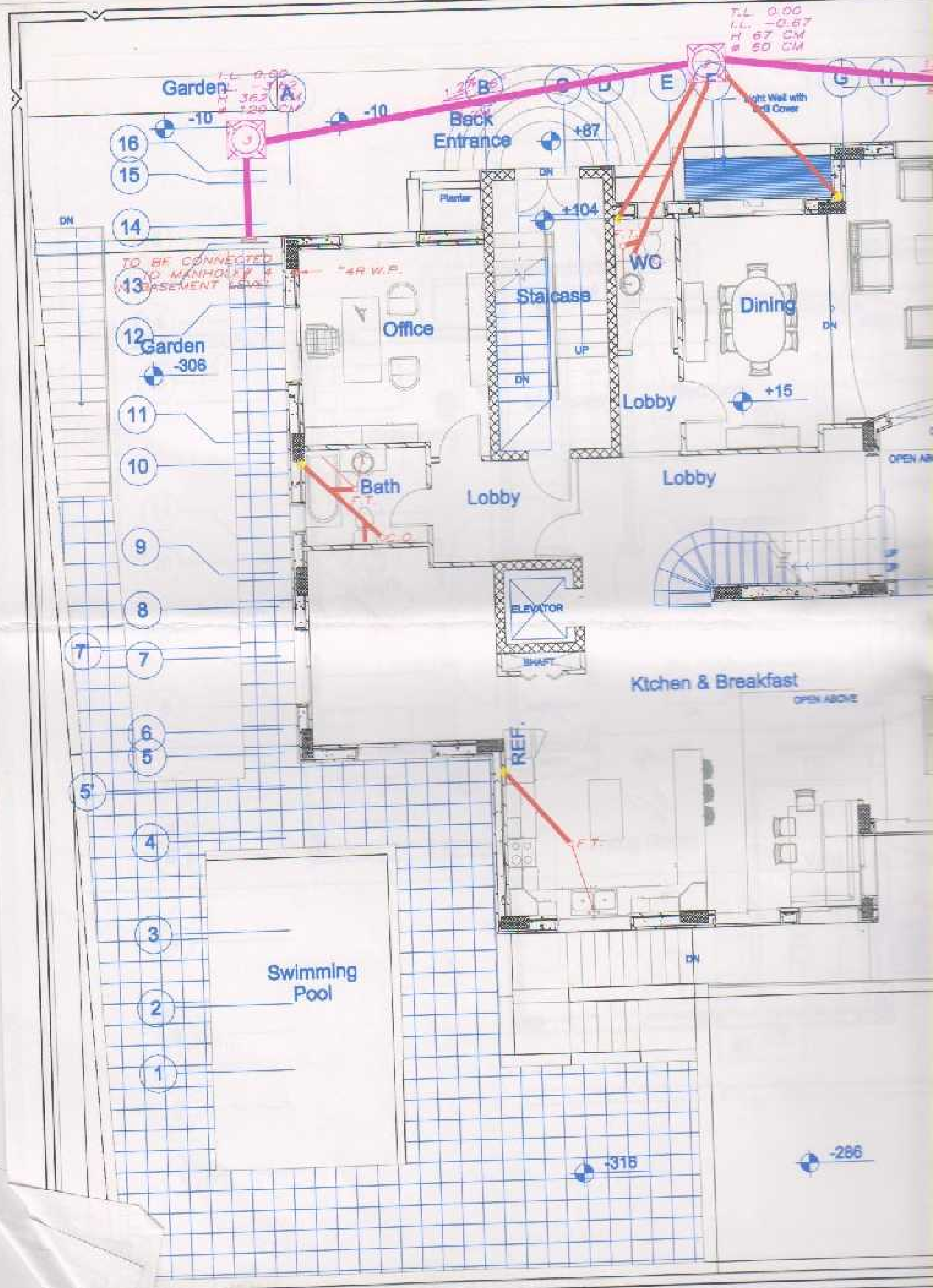
VILLA BARHAM

Tireh, Ramallah

DRAWING TITLE:

GROUND FLOOR
SANITARY PLAN

DESIGN: DRAWN: CHECKED:	DATE:
APPROVED :	SCALE: 1/100
SHEET NO:	M2



T.L 0.00
I.L. -0.67
H 67 CM
Ø 50 CM
Garden
Back Entrance
Light Wall with Grill Cover
-10
+87
+104
Planter
DN
UP
TO BE CONNECTED TO MANHOLE # 4 BASEMENT LEVEL
4R W.P.
Office
Staicase
WC
Dining
Lobby
+15
Garden
-306
Bath
F.T.
C.O.
Lobby
Lobby
OPEN ABOVE
ELEVATOR
SHAFT
Kitchen & Breakfast
OPEN ABOVE
REF.
F.T.
Swimming Pool
-316
-286
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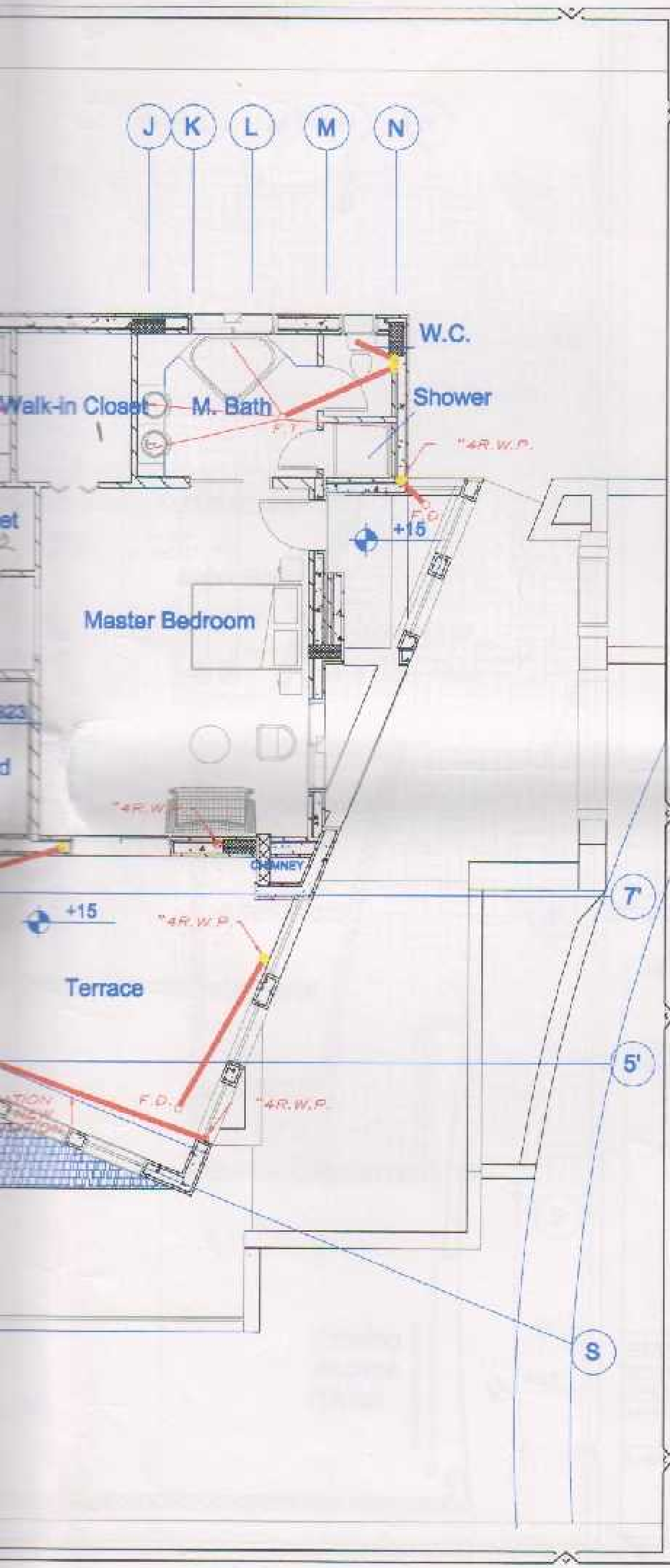


LEGEND

ø S%	P.V.C. DRAIN PIPE DIAMETER (ø) SLOPE (S) ماسورة تصريف بلاستيك قطر (ø) ميل (S)
	4" P.V.C. DRAIN PIPE (2% SLOPE) ماسورة تصريف بلاستيك قطر ٤ انش ميل ٢%
	2" P.V.C. DRAIN PIPE (2% SLOPE) ماسورة تصريف بلاستيك بقطر ٢ انش ميل %
F.T.	4" FLOOR TRAP مصيدة روائح ٤ انش
F.D.	4"/2" FLOOR DRAIN مصرف ارضي ٢/٤ انش
C.O.	4" CLEAN OUT فتحة تنظيف ٤ انش
R.W.P.	4" RAIN WATER PIPE ماسورة مطر ٤ انش
	4" RAIN WATER DRAIN مصرف مطر ٤ انش
	4" RAIN WATER (FREE OUTLET) مخرج حر لماسورة مطر
	4" VENT & RISER ماسورة تهوية عمودية ٤ انش
NC	CONCRETE MANHOLE منهل اسمنتي

R	REV. BY	DATE	DESCRIPTION

PROJECT:

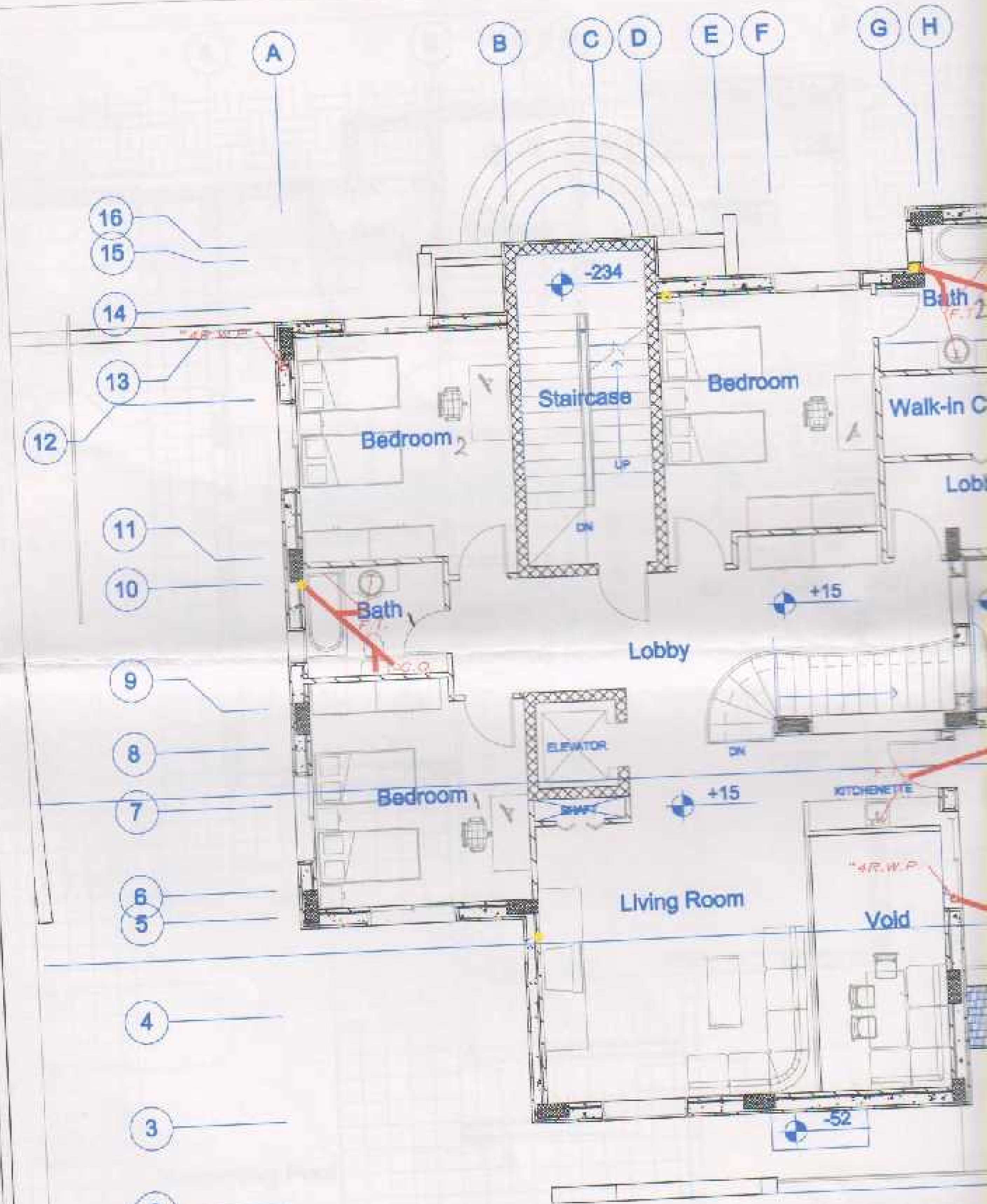
VILLA BARHAM

Tireh, Ramallah

DRAWING TITLE:

FIRST FLOOR
SANITARY PLAN

DESIGN:	DATE:
DRAWN:	
CHECKED:	
APPROVED :	SCALE: 1/100
SHEET NO: M3	



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UP
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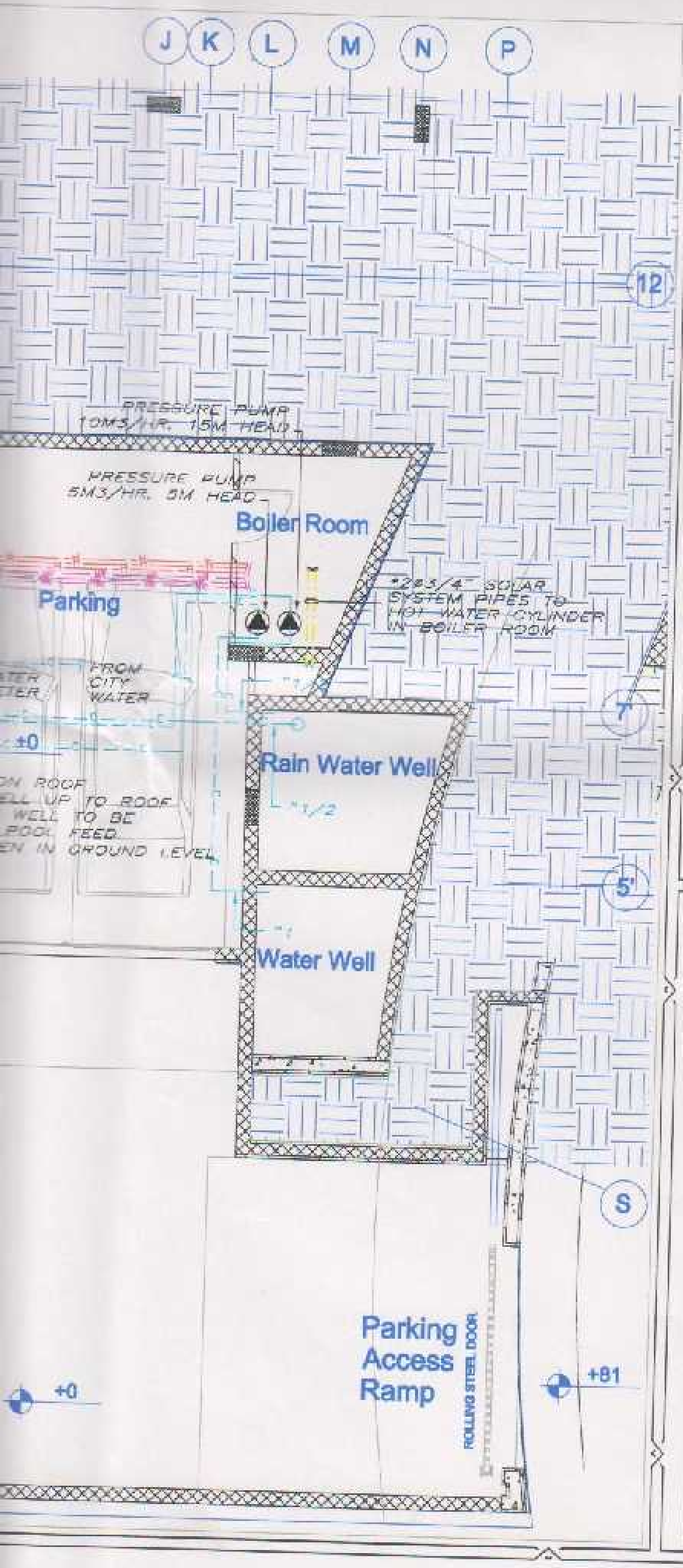
Bedroom
Bedroom 2
Bath
Bath
Lobby
+15
DN
ELEVATOR
SHAFT
+15
KITCHENETTE
Bedroom
Living Room
Void
4R.W.P
-52



LEGEND

SHUT-OFF VALVE
صمام اغلاق

FLOAT VALVE
عوامة

HOT WATER G.S. PIPE
ماسورة ماء ساخن فولاذية

COLD WATER G.S. PIPE
ماسورة ماء بارد فولاذية

HOT WATER POLYETHYLENE PIPE
أنبوب ماء ساخن من البوليثيلين

COLD WATER POLYETHYLENE PIPE
أنبوب ماء بارد من البوليثيلين

GAS SOFT COPPER PIPE
أنبوب نحاسي لاستعمال الغاز

HOT WATER RETURN PIPE
أنبوب راجع للمياه الساخنة

SOLAR SYSTEM PIPE
مواسير النظام الشمسي

R	REV. BY	DATE	DESCRIPTION

PROJECT:

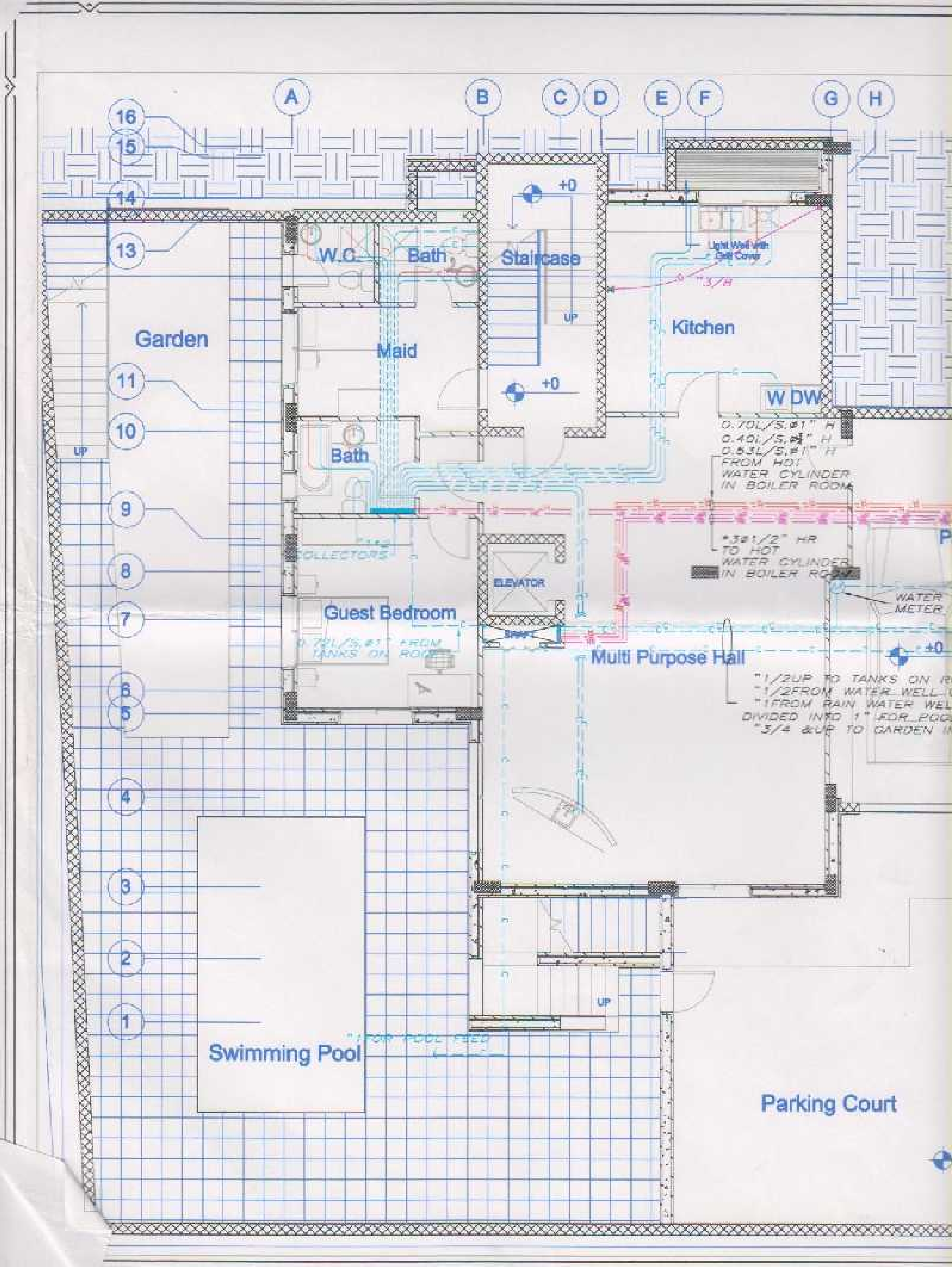
VILLA BARHAM

Tireh, Ramallah

DRAWING TITLE:

BASEMENT FLOOR
GAS & WATER PIPING PLAN

DESIGN:	DATE:
DRAWN:	
CHECKED:	
APPROVED :	SCALE: 1/100
SHEET NO: M4	



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W.C.
Bath
Staircase
+0
UP
Light Well with Grill Cover
Kitchen
Garden
Maid
W DW
Bath
0.70L/S,ø1" H
0.40L/S,ø" H
0.53L/S,ø1" H
FROM HOT
WATER CYLINDER
IN BOILER ROOM
COLLECTORS
"3ø1/2" HR
TO HOT
WATER CYLINDER
IN BOILER RO
ELEVATOR
WATER
METER
Guest Bedroom
0.72L/S,ø1" FROM
TANKS ON ROOF
SHAFT
Multi Purpose Hall
+0
"1/2UP TO TANKS ON R
"1/2FROM WATER WELL
"1FROM RAIN WATER WEL
DIVIDED INTO 1" FOR POO
"3/4 &UP TO GARDEN I
UP
UP
"1FOR POOL FEED
Swimming Pool
Parking Court

For Basement floor

ROOM NAME	TOTAL LOAD IN Kcal
MULTIPURPOSE HALL	5701
GUEST ROOM	1398
BATH ROOM (1)	734
MAID ROOM	1071
BATH ROOM (2)	475
KITCHEN	1540
	TOTAL LOAD = 10.919 Kcal=12.70 KW

Table 3-5 loads in each room in the basement floor

RAD.NO.	NO. OF SECTION	RAD LENGTH CM	TYPE
1	11	100	AL 600
2	11	100	AL 600
3	11	100	AL 600
4	11	100	AL 600
5	11	100	AL 600
6	6	60	AL 600
7	9	84	AL 600
8	4	44	AL 600
9	12	108	AL 600
TOTAL	86 SEC.	-------	--------

Table 3-6 numbers of sections for each radiator in the basement floor

For Ground floor

ROOM NAME	TOTAL LOAD IN Kcal
RECEPTION AND DINNING	6386
LOBBY (1)	622
WATER CIRCIT	616
OFFICE	1626
BATH ROOM	490
ROOM BESIDE ELEVATOR	1549
BREAKFAST & LIVIVNG ROOM	6429
LOBBY (2)	804
ENTARANCE LOBBY	887
	TOTAL LOAD = 19.409 Kcal = 22.57 KW

Table 3-7 loads in each room in the ground floor

RAD.NO.	NO. OF SECTION	RAD LENGTH CM	TYPE
1	18	156	AL 600
2	16	140	AL 600
3	16	140	AL 600
4	5	54	AL 600
5	5	54	AL 600
6	14	124	AL 600
7	4	44	AL 600
8	12	108	AL 600
9	18	156	AL 600
10	16	140	AL 600
11	16	140	AL 600
12	7	68	AL 600
13	7	68	AL 600
TOTAL	154 SEC.	-------	--------

Table 3-8 numbers of sections for each radiator in the ground floor

For First floor

ROOM NAME	TOTAL LOAD IN Kcal
BATH(1)	520
M. BATH	850
BATH (2)	650
MASTER BED ROOM	2370
WALK IN CLOSET(1)	619
LOBBY (1)	493
BED ROOM	1960
LOBBY (2)	2457
LIVING ROOM	5900
BED ROOM(1)	2151
BATH(3)	482
BED ROOM(2)	1720
WALK IN CLOSET(2)	850
	TOTAL LOAD = 21022 Kcal= 24.45 KW

Table 3-9 loads in each room in the first floor

RAD.NO.	NO. OF SECTION	RAD LENGTH CM	TYPE
1	4	44	AL 600
2	7	68	AL 600
3	5	54	AL 600
4	18	156	AL 600
5	5	44	AL 600
6	4	84	AL 600
7	15	84	AL 600
8	19	164	AL 600
9	14	44	AL 600
10	11	132	AL 600
11	11	124	AL 600

12	17	132	AL 600
13	4	44	AL 600
14	14	124	AL 600
15	7	68	AL 600
TOTAL	**155 SEC.**	-------	--------

Table 3-10 numbers of sections for each radiator in the first floor

So, now we can calculate the heating load using this method for each floor and the result as following:- -

Floor NAME	**TOTAL LOAD IN KCAL**
BASMENT FLOOR	10.919
GROUND FLOOR	19.409
FIRST FLOOR	21.022
	TOTAL LOAD=51.35 Kcal =59.71 KW

Table 3-11 total loads in each floor in the villa

3.9 Pick-up load

For intermittently heated buildings, or in the case of the night thermostat setback, additional heat is required for raising the temperature of air, building materials and material contents of a building to the specified indoor temperature. For temperature difference of 17°C and less, for the system to reach its design temperature in 1 hour, 20% of design heat loss is enough.

3.10 Heating Boiler calculations & Selection

For boiler capacity = total no. of all sections in floors × heat transfer per section

=395 sec. ×130(Kcal/h)

=51,350 (Kcal/h)

We add 10,000(Kcal/h) for hot water cylinder and 10,000(KCAL/HR) for pool hot water supply.

Total boiler capacity = 51,350+10,000+10,000

= 71,350 (Kcal/h)

Boiler capacity in (kW) = (71,350×1.2)/860

=99.56(kW)

≈100 (kW)

From catalogue

Using Boiler of the type **Fondital cast-iron boiler mod. ALOR 120**(See Appendix A) of the following specifications:-

Thermal Output=124.8 KW

Maximum thermal power =114.0KW

Fig3.2 Boiler

2- shower is a fixture with both cold and hot water supplies, so, the weights for maximum separate demands may be taken as three-quarters (3/4) the list demand for the supply in Table (4.1), so from Table (4.1) the shower (private) gives 2 WSFU for the total demand (for both cold and hot water) so, for cold water only or hot water only we take (3/4*WSFU = ¾*2= 1.5) &(WSFU =2 for both cold and hot water)

3- Water closet is a fixture with cold water supply only, so, the weights for maximum separate demands may be taken as three-quarters (3/4) the list demand for the supply in Table (4.1),so from Table(4.1)the water closet (private and with flush tank) gives 3 WSFU for the total demand (for both cold and hot water) so, for cold water only or hot water only we take (3/4*WSFU = ¾*3 =2.25) &(WSFU =3 for both cold and hot water)

4- So, from the above information we can do the following table:-

Fixture Unit	No. of Units	WSFU From table(9_3)	Total no. of WSFU For Cold Water	Total no. of WSFU For hot Water	Total no. of WSFU For hot & Cold Water
Lavatory (private)	1	¾*1	3/4	3/4	1
Shower (private)	1	¾*2	1.5	1.5	2
Water Closet flush tank(private)	1	¾*3	2.25	-----	3
--------	------	-----------	∑ = 4.5 WSFU	∑= 2.25 WSFU	∑ = 6 WSFU

Table 4-1 WSFU for the Bath Room

Now we can calculate the number of fixture in each floor from Mechanical Drawing and so we can do the following table:-

Floor name	Total Lavatory	Total sink	Total Bath tube	Total Shower head	Total Water closet /flush tank
Basement	3	1	1	2	3
Ground floor	2	1	1	------	2
First floor	4	1	3	1	3
Continuous flow at garden	3/4"	------	--------	----------	--------------

Table 4-2 Total number for water supply fixture unit for cold and hot water

Now we can calculate the (WSFU) for each floor, So (WSFU) for each floor as in the following tables:

Fixture Unit	No. of Units	WSFU From table (4.1)	Total no. of WSFU For Cold Water	Total no. of WSFU For hot Water	Total no. of WSFU For hot Water Cold Water &
BASMENT FLOOR	--------	---------	-------------	----------	----------
Lavatory (private)	3	¾ *1	2.25	2.25	3
Kitchen Sink(private)	1	¾ * 2	1.5	1.5	2
Bath tube(private)	1	¾ * 2	1.5	1.5	2
Water Closet flush tank(private)	3	¾ * 3	6.75	---------	9
Continuous flow for Garden	1	¾ * 3	2.25	---------	3
------------------	-----------	----------	$\sum$=14.25 WSFU	$\sum$=5.25 WSFU	$\sum$=18 WSFU

Table 4-3 Water supply unit for cold and hot water for basement floor

Fixture Unit	No. of Units	WSFU From table (4.1)	Total no. of WSFU For Cold Water	Total no. of WSFU For hot Water	Total no. of WSFU For hot Water Cold Water &
GROUND FLOOR	--------	---------	-----------	----------	----------
Lavatory (private)	2	¾ *1	1.5	1.5	2
Kitchen Sink(private)	1	¾ * 2	1.5	1.5	2
Bath tube(private)	1	¾ * 2	1.5	1.5	2
Water Closet flush tank(private)	2	¾ * 3	4.5	---------	6
-----------------	-----------	----------	$\sum = 9$ WSFU	$\sum = 4.5$ WSFU	$\sum = 12$ WSFU

Table 4-4 Water supply unit for cold and hot water for ground floor

Fixture Unit	No. of Units	WSFU From table (9.3)	Total no. of WSFU For Cold Water	Total no. of WSFU For hot Water	Total no. of WSFU For hot Water Cold Water &
FIRST FLOOR	--------	----------	-----------	----------	----------
Lavatory (private)	4	¾ *1	3	3	4
Kitchen Sink(private)	1	¾ * 2	1.5	1.5	2
Bath tube(private)	3	¾ * 2	4.5	4.5	6
Water Closet flush tank(private)	3	¾ * 3	6.75	---------	9
-----------------	-----------	----------	$\sum = 15.75$ WSFU	$\sum = 9$ WSFU	$\sum = 21$ WSFU

Table 4-5 Water supply units for cold and hot water for first floor

4.2.2 Flow rate calculations

To calculate flow rate in gpm:-

<u>FOR BASMENT FLOOR</u>

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank for basement floor the estimating demand in gpm **for cold water = 14.25 WSFU.**

So by using interpolation =10.55 gpm

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank the for basement floor estimating demand in gpm **for hot water = 5.25 WSFU.**

So by using interpolation =4.25 gpm

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank the for basement floor estimating demand in gpm **for hot & cold water = 18 WSFU.**

So by using interpolation = 12.80gpm

Note: - For supply outlets likely **to impose continuous demand,** we estimate continuous separately and add to the total demand for fixture
We have1 faucets (Ø 3/4) for garden so from Table 4-2(See Appendix B)
The total flow in gpm = 2.25 **WSFU.** = 2 gpm

So the total cold and hot water demand needed = 12.80 + 2= 14.80 gpm

FOR GROUND FLOOR

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank for ground floor the estimating demand in gpm **for cold water = 9 WSFU.**

So by using interpolation =7.25 gpm

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank the for ground floor estimating demand in gpm **for hot water = 4.5 WSFU.**

So by using interpolation =3.875 gpm

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank the for ground floor estimating demand in gpm **for hot & cold water = 12 WSFU.**

So by using interpolation = 9.2 gpm

So the total cold and hot water demand needed = 12 WSFU. = 9.2 gpm

FOR FIRST FLOOR

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank for first floor the estimating demand in gpm **for cold water = 15.75 WSFU.**

So by using interpolation =11.45 gpm

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank the for first floor estimating demand in gpm **for hot water = 9 WSFU.**

So by using interpolation = 7.25 gpm

By using Table 4-2 (See Appendix B) for supply system predominantly for flush tank the for first floor estimating demand in gpm **for hot & cold water = 21 WSFU.**

So by using interpolation = 14.6 gpm

So the total cold and hot water demand needed = 14.6 gpm

To calculate static head for Basement floor for cold water:-

Floor to floor height = 4.00

We have 3 floor (basement + ground+ first) and so 4.0*3.0 = 12.0

Sink outlet above basement level =1.05 m

& tank outlet above roof level = 0.75

So there is static head in this case = 12+ 0.75 -1.05 =11.40 m = 16.22 psi

To calculate the equivalent length:-

Pumps at Basement floor transfer the water through pipes to the tank at Roof from which it distribute the water through pipes to the collectors at the First, Ground & Basement floor

So we will calculate the equivalent length from the tank at roof to the farthest outlet at the Basement floor (sink) at farthest collector

FOR COLD WATER

Total length through shaft room from Roof to the Basement floor = 16.0 m

Total length in the Basement floor from riser at the shaft room to farthest out let (sink) at farthest collector = 18.0 m