DESIGN OF STORM WATER DRAINAGE SYSTEM FOR THE CENTER OF HALHUL CITY

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CERTIFICATION

Palestine Polytechnic University (PPU)

Hebron- Palestine

The Senior Project Entitled:

DESIGN OF STORM WATER DRAINAGE SYSTEM FOR THE CENTER OF HALHUL CITY

Prepeared By:

MOHAMMED AL-ZOGHEIR **RADI AL-JOULANI**

In accordance with the recommendation of the project supervisors, and the acceptance of all examining committee members , this project has been submitted to the Department of Civil and Architectural Engineering in the College of Engineering and Technology in partial fulfillment of the requirements of Department for the degree of Bachelor of Science in Engineering.

Project Supervisors **Department Chairman**

CHAPTER FOUR

ANALYSIS AND DESIGN

4.1 Introduction

In this project, an attempt is made to evaluate and design storm water drainage system for the Halhul city, in order to solve the problem causes by the cumulative flooded storm water in the streets. In this chapter, the layout of the system established will be presented followed by discussion of detailed design computations and the final design and profiles of the suggested storm water drainage system.

4.2 Layout of the System

The first step in designing a storm water drainage system is to establish an overall system layout that includes a plan of the area, showing roads, streets, buildings, other utilities, topography, and soil type.

In suggesting the layout of storm water drainage system for Halhul city, the following basic steps were followed:

1. Obtain a topographic map of the area to be served.
2. Locate the catchments area of the city and determine the area of these catchments, the catchments are determined by using GIS and Arc View program.
3. Sketch in preliminary closed channel system to serve all the areas.
4. Sewers layout is followed natural drainage ways so as to minimize excavation and pumping requirements.
5. Establish preliminary channel sizes that can drain the required water runoff.
6. Revise the layout so as to optimize flow-carrying capacity at minimum cost. Channel lengths and sizes are kept as small as possible, channel slopes are minimized, and followed the ground surface slope to minimize the depth of excavation, and the numbers of appurtenances are kept as small as possible.

The final general layout of storm water drainage system for Halhul city is illustrated in Fig. 4.1. The detailed layouts for different places are shown in Figure B.1 (B.1a-B1f) of Appendix-B.

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CHAPTER ONE
INTRODUCTION

1.1 Background

The wide expansion and accelerated development and grow of Halhul city has led to change in the hydrological and geomorphological features. Most of the areas in Halhul city don't have a natural drainage outlet. Heavy rainfall causes storm water to collect in low areas and flood streets and walk way. Rapid growth has decreased the open area available for percolation and rainwater and has greatly increased the runoff to low lying areas.

In view of this prevailing condition, the drainage system in Halhul city would have a new characteristic and development of new water drainage system is very necessary to drain excess water from streets. This study is conducted to design a storm drainage system for the center of Halhul city.

Data must be developed on topography, geology, hydrology, climate, ecological elements, and social and economic conditions. Topographic maps with existing and proposed streets provide the most important information for preliminary flow routing.

1.2 Problem Definition

Drainage as a mean of disposal, till recently- has been largely a neglected aspect in the West Bank now, water drainage is very important due to water accumulation on the streets as a result of heavy precipitation (running water), population growth, and the development and extension of West Bank cities.

Halhul city is located in a semi – arid region with rainfall generally limited to autumn and winter months. In the past, the open areas of much of Halhul city easily observed most of this rainfall and provided the primary source for recharging the ground water aquifer. Most of the areas in Halhul city do not have a natural drainage outlet. Heavy rainfall causes storm water to collect in low areas and flood streets and walk ways. Rapid growth has decreased the open areas available for percolation of rainwater and has greatly increased the runoff to low lying areas.

In view of this condition, design of a new storm water drainage system in Halhul city becomes very essential. A new drainage system which admits all the flood discharge from the catchments and with low initial and maintenance cost.

1.3 Project Objectives

The overall objective of this study is to investigate water drainage system in Halhul city and propose storm water drainage system for the city. Achievement of this objective requires estimation of the accumulated areas, the quantities of water, topography of the city, the existing drainage system, etc. More specifically the main objectives of this project are:

1- Study in general, drainage system patterns in Halhul city.
2- Determine the sub catchments and catchments of the study area with the help of aerial photogram metric map and Geographical Information System (GIS).
3- Design of a new storm water drainage network for the center of the city.
4- Development of several plans for the construction of the proposed storm water network and prepare bill of quantity.
5- Finally, providing suggestion and recommendations regarding the reuse of collected water at the end of disposal.

1.4 Project Area

Halhul is a city in Hebron Governorate, located six km north of Hebron city in the southern part of the West Bank. It is bordered by Sa'ir and Ash Shuyukh towns to the east, Beit Ummar and Al Arrub Camp to the north, Kharas and Nuba to the west, and Hebron city and Beit Kahil to the south (see Figure 1.1). The general view and the aerial photographs for Halhul city is presented in Figures (1.2) and (1.3).

Halhul city is a beautiful and attractive area and is considered the highest inhabited place in Palestine. It extends over a mountainous area north of the Hebron Mountains at an elevation of 986 m above the sea level. The mean annual rainfall in Halhul town is 583 mm, the average annual temperature is 16 °C, and the average annual humidity is 61 % (ARIJ GIS).

According to the 2007 Palestinian Central Bureau of Statistics (PCBS) Census, the total population of Halhul in 2007 was approximately 22,128, of whom 21,872 were living in Halhul and 38 were living in Al Baqqar and 218 in Khirbet al Hasaka. There were 3,961 households residing in 4,550 housing units. The population of Halhul village constituted 4% of the total population of Hebron Governorate. Based on the growth rate of (3.5%), the estimated population for Halhoul city for year 2012 is 26281 person, and for the design year 2035 (23 years ahead) will increase to approximately 60,000 inhabitants.

Halhul city town is considered an agricultural town. Lying on a total area of 39,000 dunums, of which 9,000 dunums are residential area and the remaining, are agricultural lands. Almost 80% of the housing units in Halhul city have been connected to a water network since 1978. Currently, the Palestinian Water Authority is the main provider of water in the town. The per capita water consumption for domestic use does not exceed 80 liter per day. There is no sewage disposal network, and the bulk of domestic and wastewater is discharged and disposed of in cesspits. This causes ground water pollution.

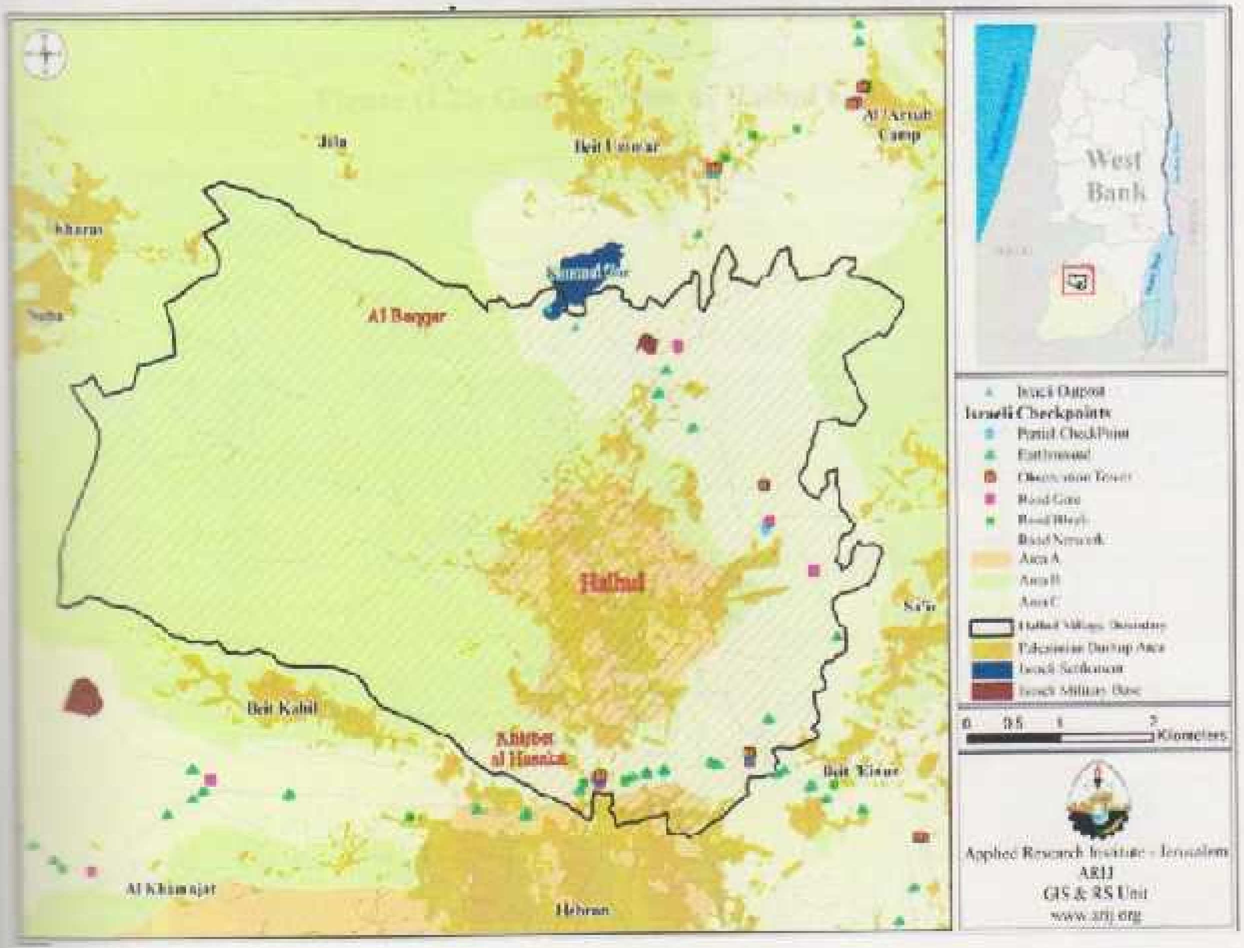


Figure (1.1): Halhul Location and Borders

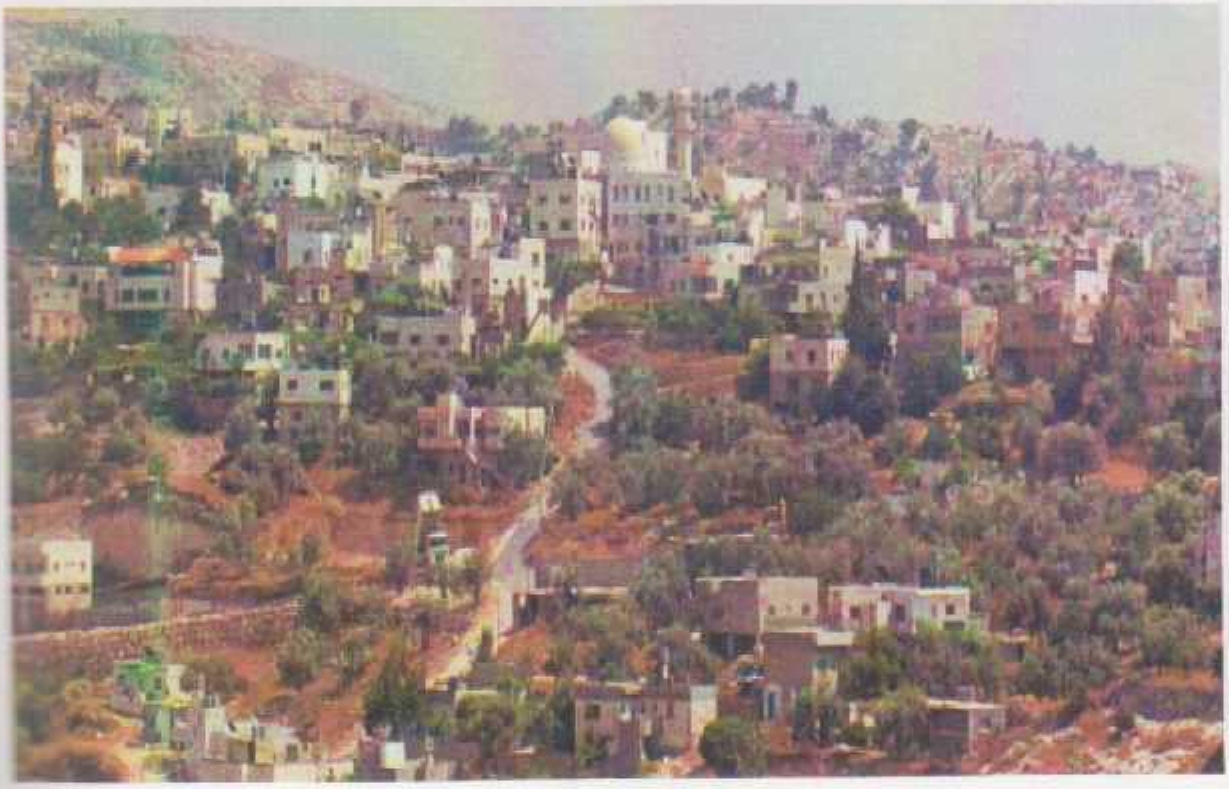


Figure (1.2): General View of Halhul City

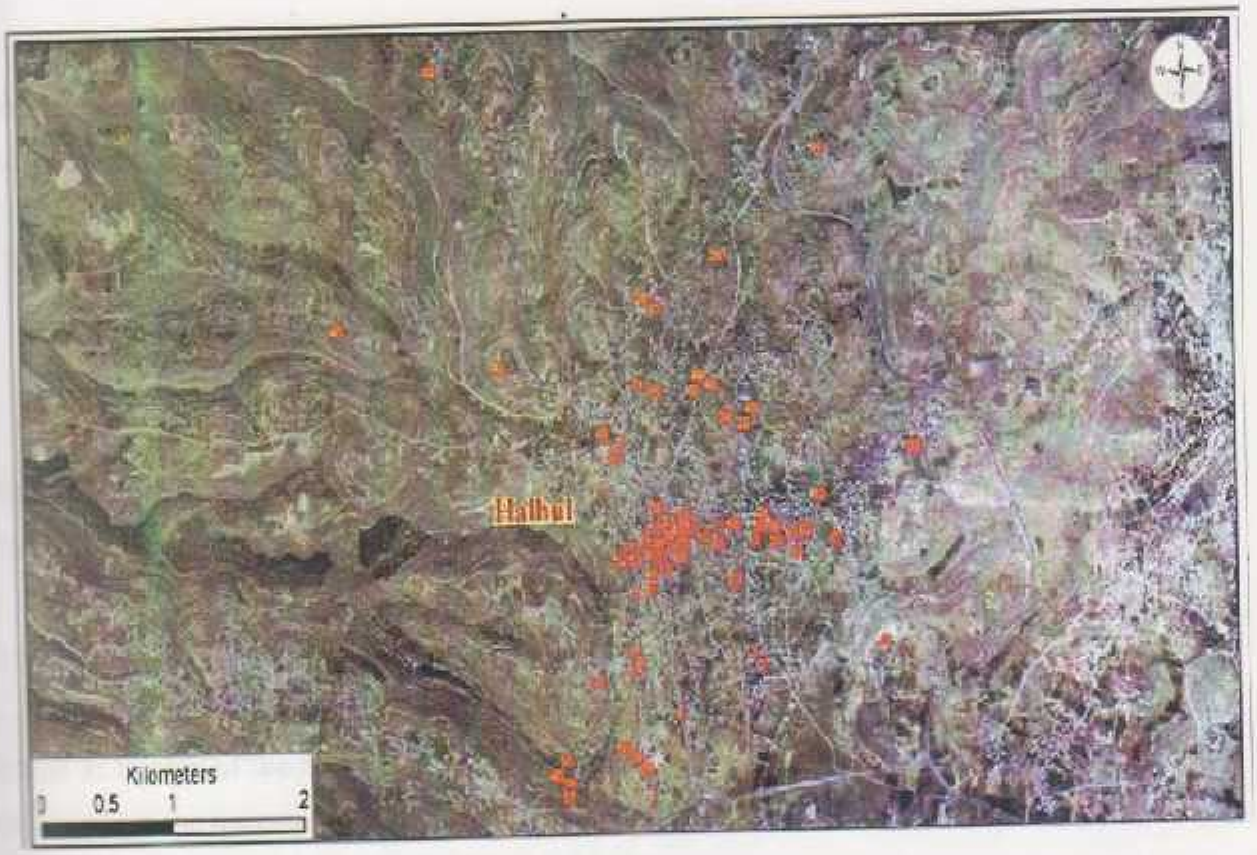


Figure (1.3): Aerial Picture for the Halhul City

1.5 Stages of the Project

The project consists of six phases, which are proposed to be completed in accordance with time schedule shown in (Table 1.1). The description of each of the six phases of the project and tasks involved is listed below:

Table (1.1): Phases of the Project with their Expected Duration

Phase No.	Title	Duration								
		02/12	03/12	04/12	05/12	09/12	10/12	11/12	12/12	01/13
1	Collection and Analysis of Data	■	■							
2	Perform the Surveying Works		■	■						
3	Design of the Storm Water System			■	■	■				
4	Draw layouts and Profiles					■	■	■		
5	Preparing Bill of Quantity							■	■	
								■	■	■

Phase 1: Collection and Analysis of Data

During this phase, available data and information were collected from different sources. Moreover, many site visits to the project area were undertaken. First phase included the following tasks:

1. Collection of the basic data of Hulhul city
2. Collection of aerial and topographical maps of the area.
3. Collection of meteorological and hydrological data (rainfall, temperature, wind speed, evaporation) from Metrological Station.

Phase 2: Perform the Surveying Works

The tasks which were performed in the second phase are:

1. Evaluation of the contour maps and matching it with actual ground level in the project area.
2. Establish the catchments and sub-catchments areas.
3. Establish the routes of the proposed storm water pipes.

Phase 3: Design of the Storm Water System

In this phase the necessary hydraulic calculations needed for the design of the main trunk were carried out. This phase includes the following tasks:

1. Finalized the layout of the proposed storm water drainage system for the project area.
2. Establish the design criteria and conducting the needed hydraulic calculations.
3. Find out the pipes diameters and other design parameters.

Phase 4: Draw layouts and Profiles

Plan drawings and profiles with appropriate scales for the designed storm water pipes were prepared.

Phase 5: Preparing Bill of Quantity

After finishing the design calculation of the main trunks, the research team prepared bill of quantity of the project.

Phase 6: Writing the Report

Upon the completion of the work, one final report was written and submitted to the Department of Civil and Architectural Engineering at Palestine Polytechnic University.

1.6 Organization of the Report

The study report has been prepared in accordance with the objectives and scope of work. The report consists of five chapters.

The **First chapter** entitled **"Introduction"** describes the background of the project, problem definition, project objectives, project area, phases of the project and the summary of the chapters.

Chapter Two entitled **"Design of Storm Water Drainage System"** describes the storm water runoff, hydraulic consideration; design of storm water sewers, and the summary of the chapter.

Chapter Three entitled **"Design and Planning Criteria"** describes introduction, catchment areas, rainfall characteristics, runoff flow, design parameters, and the summary of the chapter.

Chapter Four entitled **"Analysis and Design"** describes introduction, layout of the system, design computations, the proposed storm water drainage system, profiles of drainage channels, and the summary of the chapter.

Chapter Five entitled **"Bill of Quantity"** deals with the quantities needed to complete the design system.

Chapter Six entitled **"Conclusions"** discusses the conclusions of the study.

CHAPTER

2 *DESIGN OF STORM WATER DRINAGE SYATEM*

CHAPTER TWO
DESIGN OF STORM WATER DRAINAGE SYSTEM

2.1 Introduction

Rapid effective removal of storm runoff was a luxury not found in many cities in the early nineteenth century. Today, the modern city dweller has come to think of this as an essential service. Urban drainage facilities have progressed from crude ditches and stepping stones to the present intricate coordinates systems of curbs, gutters, inlets, and under ground conveyance.

The design must consider meteorological factors, geomorphological factors, and the economic value of the land, as well as human value considerations such as aesthetic and public safety aspects of the design. The design of storm water detention basins should also consider the possible effects of inadequate maintenance of the facility.

2.2 Storm Water Runoff

Storm water runoff is that portion of precipitation which flows over the ground surface during and a short time after a storm. The dependence parameters that controlled the quantity of the storm water which carried by a storm or combined sewer are the surface of the drainage area that, the intensity of the rainfall (l/s.ha), and runoff coefficient C dimensionless (the condition of the surface). There are many methods and formulas to determine the storm flow.

2.2.1 Rational Method

The rational method has probably been the most popular method for designing storm systems. It has been applied all over the world and runoff is related to rainfall intensity by the formula,

$$Q = C.i.A \qquad (2.1)$$

Where Q = peak runoff rate (l/sec).

C = runoff coefficient, which is actually the ratio of the peak runoff rate to the average rainfall for a period known as the time of concentration.

i = average rainfall intensity, mm/min, for period equal to the time of concentration.

A = drainage area (ha).

For small catchments areas, it continues to be a reasonable method, provided that it is used properly and that results and design concepts are assessed for reasonableness. This procedure is suitable for small systems where the establishment of a computer model is not warranted.

The steps in the rational method calculation procedure are summarised below:

1- The drainage area is first subdivided into sub-areas with homogeneous land use according to the existing or planned development.

2- For each sub-area, estimate the runoff coefficient *C* and the corresponding area *A*.

3- The layout of the drainage system is then drawn according to the topography, the existing or planned streets and roads and local design practices.

4- Inlet points are then defined according to the detail of design considerations. For main drains, for example, the outlets of the earlier mentioned homogeneous sub-areas should serve as the inlet nodes. On the other hand in very detailed calculations, all the inlet points should be defined according to local design practices.

5- After the inlet points have been chosen, the designer must specify the drainage sub-area for each inlet point A and the corresponding mean runoff coefficient *C*. If the sub-area for a given inlet has non-homogeneous land use, a weighted coefficient may be estimated.

6- The runoff calculations are then done by means of the general rational method equations for each inlet point, proceeding from the upper parts of the watershed to the final outlet. The peak runoff, which is calculated at each point, is then used to determine the size of the downstream trunk drain using a hydraulic formula for pipes flowing full.

7- After the preliminary minor system is designed and checked for its interaction with the major system, reviews are made of alternatives, hydrological assumptions are verified, new computations are made, and final data obtained on street grades and elevations. The engineer then should proceed with final hydraulic design of the system.

2.2.2 Runoff Coefficient, C

Runoff coefficient is a function of infiltration capacity, interception by vegetation, depression storage and evapotranspiration. It is requires greatest exercise of judgment by engineer and assumed constant, actually variable with time. It is desirable to develop composite runoff coefficient (weighted average) for each drainage area as:

$$C = \frac{\sum Ci.Ai}{\sum Ai} \tag{2.2}$$

Where Ai = i^{th} area.

Ci = i^{th} runoff coefficient.

The range of coefficients with respect to general character of the area is given in the following tables (Table 2.1 and Table 2.2).

Table (2.1): The Range of Coefficient with Respect to General Character of the Area (Sarikaya, 1984)

Description of Area	Runoff Coefficients
Business	
Down town	0.70 to 0.95
Neighborhood	0.50 to 0.70
Residential	
Single-Family	0.30 to 0.50
Multi-unit, detached	0.40 to 0.60
Multi-unit, attached	0.60 to 0.75
Residential (suburban)	0.25 to 0.40
Apartment	0.50 to 0.70
Industrial	
Light	0.50 to 0.80
Heavy	0.60 to 0.90
Parks, Cemeteries	0.10 to 0.25
Playground	0.20 to 0.35
Railroad yard	0.20 to 0.35
Unimproved	0.10 to 0.30

Table (2.2): The Range of Coefficient With Respect to Surface Type of the Area (Sarikaya, 1984)

Character of Surface	Runoff Coefficients
Pavement	
Asphalt and concrete	0.70 to 0.95
Brick	0.70 to 0.85
Lawns, Sandy soil	
Flat, 2 percent	0.05 to 0.10
Average,2to7percent	0.10 to 0.15
Steep, 7 percent	0.15 to 0.20
Roofs	0.75 to 0.95
Lawns, Heavy soil	
Flat, 2 percent	0.13 to 0.17
Average,2 to 7percent	0.18 to 0.22
Steep, 7 percent	0.25 to 0.35

2.2.3 Rainfall Intensity, i

In determining rainfall intensity for use in rational formula it must be recognized that the shorter the duration, the greater the expected average intensity will be. The critical duration of rainfall will be that which produces maximum runoff and this will be that which is sufficient to produce flow from the entire drainage area. Shorter periods will provide lower flows since the total area is not involved and longer periods will produce lower average intensities. The storm sewer designer thus requires some relationship between duration and expected intensity. Intensities vary from place to another and curves or equations are specified for the areas for which they were developed.

The rainfall intensity depends on many factors through which we can do our calculations; we can list these factors as follow:

1- Average frequency of occurrence of storm (n) or (f).

Average frequency of occurrence is the frequency with which a given event is equaled or exceeded on the average, once in a period of years. Probability of occurrence, which is the reciprocal of frequency, (n) is preferred by sum engineers. Thus, if the frequency of a rain storm a 5-year (f=5), then probability of occurrence n=0.20. Selection of storm design rain frequency based on cost-benefit analysis or experience. There is range of frequency of often used:

a. Residential area: f = 2 to 10 years (5 year most common).
b. Commercial and high value districts: f = 10 to 50 (15 year common).
c. Flood protection: f = 50 year.

2- Intensity, duration and frequency characteristics of rainfall.

Basic data derived from gage measurement of rainfall (Point rainfall) over along period can be used to obtain a rainfall height diagram that show the relation between the height of rain (mm) and time (min). The slope of the curve or rain height per unit time is defined as rain intensity:

$$i = (\Delta \text{ height of rain} / \Delta \text{ time}) \left[\frac{mm}{\min}\right]$$

The rain intensity in litter per second. hectare is equal:

$$i(\frac{l}{s.ha}) = 166.7i\left[\frac{mm}{\min}\right]$$

In order to drive intensity-duration-frequency curves long-term observation of rainfall is needed. Analysis of such observation is given in any text in sanitary engineering.

3- Time of Concentration

The time of concentration is the time required for the runoff to become established and flow from the most remote part (in time) of the drainage area to the point under design.

$$t_c = t_i + t_f \quad (2.3)$$

Where: t_c: time of concentration.

t_i: inlet time.

t_f: flow time.

$$\text{Time of flow in storm, } t_f = \frac{\text{Length of pipe line (L)}}{\text{Velocity of flow (v)}} \quad (2.4)$$

Inlet time (t_i): is the time required for water to flow over ground surface and along gutters to drainage inlet. Inlet time is function of rainfall intensity, surface slope, surface roughness, flow distance, and infiltration capacity and depression storage.

2.2.4 Catchments Area, A

Most of the catchments are partly developed with residential facilities. The catchments are moderately flat with rural, residential and commercial land uses. The rural areas are located at the downstream end of the catchments.

2.3 Hydraulic Consideration

2.3.1 Introduction

Wastewater systems and (storm water) are usually designed as close channels except where lift stations are required to overcome topographic barriers. The hydraulic problems associated with these flows are complicated in some cases by the quality of the fluid, the highly variable nature of the flows, and the fact that an unconfined or free surface exists. The driving force for open-channel flow and sewer flow is gravity. For the hydraulic calculations of sewers, it is usually assumed uniform flow in which the velocity of flow is constant, and steady flow condition in which the rate discharge at any point of a sewer remains constant (Metcalf,1982).

2.3.2 Hydraulic Design Equations

In principle all closed channel flow formulas can be used in hydraulic design of sewer pipes. The following are the most important formulas:

1. Chezy's formula:

$$V = C\sqrt{RS} \tag{2.5}$$

Where V: the velocity of flow (m/s).

C: the Chezy coefficient; $C = \frac{100\sqrt{R}}{m+\sqrt{R}}$, where m = 0.35 for concrete pipe or 0.25 for vitrified clay pipe

R: the hydraulic radius (m)

S: the slope of the sewer pipe (m/m).

2. Darcy-Weisbach formula: It is not widely used in wastewater collection design and evaluation because a trial and error solution is required to determine pipe size for a given flow and head loss, since the friction factor is based on the relative roughness which involves the pipe diameter, making it complicated. Darcy-Weishbach formula states that

$$H = \lambda \frac{L \times V^2}{D \times 2g} \tag{2.6}$$

Where H: the pressure head loss

L: the length of pipe (m).

D: the diameter of pipe (m)

λ : the dimensionless friction factor generally varying between 0.02 to 0.075.

3. The Manning formula: Manning's formula, though generally used for gravity conduits like closed channel, it is also applicable to turbulent flow in pressure conduits and yields good results, provided the roughness coefficient n is accurately estimated. Velocity, according to Manning's equation is given by:

$$V = \frac{1}{n} R^{2/3} S^{1/2} \tag{2.7}$$

Where n: the Manning's roughness coefficient [$1/n\ (k_{str}) = 75\ m/s^{1/3}$].

R: the hydraulic radius = area /wetted perimeter (R= A/P).

- For circular pipe flowing full, R=D/4.
- For open channel flowing full, R=A/P.

The Manning's roughness coefficient depends on the material and age of the conduit. Commonly used values of n for different materials are given in Table (2.3).

Table (2.3): Common Values of Roughness Coefficient Used In the Manning Equation (Sarikaya, 1984)

Material	Commonly Used Values of n
Concrete	0.013 and 0.015
Vitrified clay	0.013 and 0.015
Cast iron	0.013 and 0.015
Brick	0.015 and 0.017
Corrugated metal pipe	0.022 and 0.025
Asbestos cement	0.013 and 0.015
Earthen channels	0.025 and 0.003

2.3.3 Hydraulics of Partially Filled Section

The filling rate of a sewer is an important consideration, as sewers are seldom running full, so storm water sewers designed for 40% or 50% running full, that is means only 40 % to 50 % of the pipe capacity should be utilized to carry the peak flow.

Partially filled sewers are calculated by using partial flow diagram and tables indicating the relation between water depth, velocity of flow and rate flow .The hydraulic characteristics are similar as for closed channels, but the velocity of flow is reduced by increased air friction in the pipe with increasing water level, particularly near the top of the pipe. The velocity of flow and the flow rate are reduced at filling rates between 60% and 100%; the water level in the pipe is unstable at filling rates above 90% or 95%.

2.4 Storm Water Sewers Design

Designing a community storm system is not a simple task. It requires considerable experience and a great deal of information to make proper decisions concerning the layout, sizing, and construction of a storm network that is efficient and cost-effective. The design engineer needs to generally undertake the following tasks (Qasim, 1985, Peavy, 1985):

1. Define the service area.
2. Conduct preliminary investigations.
3. Develop preliminary layout plan and profile.
4. Selection of design parameters.
5. Review construction considerations.
6. Conduct field investigation and complete design and final profiles.
7. Prepare contract drawing and specifications.

2.4.1 Service area

Service area is defined as the total area that will eventually be served by the drainage system.. It is important that the design engineers and project team become familiar with the surface area of the proposed project.

2.4.2 Preliminary Investigation

The design engineer must conduct the preliminary investigations to develop a layout plan of the drainage system. Site visits and contacts with the city and local planning agencies and state officials should be made to determine the land use plans, zoning regulations, and probable future changes that may affect both the developed and undeveloped land. Data must be developed on topography, geology, hydrology, climate, ecological elements, and social and economic conditions. Topographic maps with existing and proposed streets and other utility lines provide the most important information for preliminary flow routing (Qasim, 1985).

If reliable topographic maps are not available, field investigations must be conducted to prepare the contours, place bench marks, locate building, utility lines, drainage ditches, low and high areas, stream, and the like. All these factors influence the sewer layout.

2.4.3 Layout Plan

Proper storm sewer layout plan and profiles must be completed before design flows can be established. The following is a list of basic rules that must be followed in developing a sewer plan and profile (Qasim, 1985).

1. Select the site for disposal of the storm water at the end of the network, generally the lowest elevation of the entire drainage area.
2. The preliminary layout of storm sewers is made from the topographic maps. In general, sewers are located on streets, or on available right-of-way; and sloped in the same direction as the slope of the natural ground surface.
3. The trunk storm sewers are commonly located in valleys. Each line is started from the intercepting sewer and extended uphill until the edge of the drainage area is reached, and further extension is not possible without working downhill.
4. Main storm sewers are started from the trunk line and extended uphill intercepting the laterals.
5. Preliminary layout and routing of storm sewage flow is done by considering several feasible alternatives. In each alternative, factors such as total length of storm sewers, and cost of construction of laying deeper lines versus cost of construction, operation, and maintenance of lift station, should be evaluated to arrive at a cost- effective drainage system.
6. After the preliminary storm sewer layout plan is prepared, the street profiles are drawn. These profiles should show the street elevations, existing storm sewer lines, and manholes and inlets. These profiles are used to design the proposed lines.

Finally, these layout plans and profiles are revised after the field investigations and storm sewer designs are complete (Viessman, 1985).

2.4.4 Selection of Design Parameters

Many design factors must be investigated before storm sewer design can be completed. Factors such as design period; peak, average, and minimum flow; storm sewer slopes and minimum velocities; design equations ...etc. are all important in developing storm sewer design. Many of the factors are briefly discussed below.

1. **Design Flow Rate:** Storm water sewers should be designed to carry the largest storm that occurred in the period of design; commonly it is 5 years because of consideration of the cost and the frequently factors.

2. **Minimum Size:** As mentioned earlier, the minimum storm sewer size recommended is 250 to 300 mm for closed system, and for open channel depend on the type of profile that selected.

3. **Minimum and Maximum Velocities:** In storm water sewers, solids tend to settle under low-velocity conditions. Self-cleaning velocities must be developed regularly to flush out the solids. Most countries specify minimum velocity in the sewers under low flow conditions. The minimum allowable velocity is 0.75 m/s, and 0.9 m/s is desirable. This way the lines will be flushed out at least once or twice a day. The maximum velocities for storm water system are between 4 to 5 m/s. The maximum velocity is limited to prevent the erosion of sewer inverts.

4. **Slope:** For closed system minimum slopes determined from minimum velocities, for minimum velocity 0.9 m/s, the slopes are shown in Table 2.4.

Table (2.4): Minimum Recommended Slopes of Storm Sewer (n = 0.015) (Sarikaya, 1984)

Pipe Diameter (D)		Slope (min)	Slope (max) =1/D
mm	inch	mm	cm
250	10	0.00735	0.04
300	12	0.00576	0.033
450	18	0.00336	0.0222
600	24	0.00229	0.0167

For minimum velocity of 0.75m/s the slopes shown above should be multiplied by1.56.

Maximum slopes determined from maximum velocities, 0.9/D (cm) can be used as a guide.

5. Depth: The depth of storm sewers when using closed system is generally just enough to receive flow but not less than 1 m below the ground surface. Depth depends on the water table, lowest point to be served, topography, and the freeze depth. But for the open channel it is at the ground surface.

6. Appurtenances: Storm Sewer appurtenances include manholes, inlets, outlets and outfall, and others. Appropriate storm sewer appurtenances must be selected in design of storm water sewers.

7. Design Equations and Procedures: Storm water sewers are mostly designed to flow partially full. Once the peak, average, and minimum flow estimates and made general layout and topographic features for each line are established, the design engineer begins to size the sewers. Design equations proposed by Manning, Chezy, Gangullet, Kutter, and Scobey have been used for designing sewers and drains. The Manning equation, however, has received most widespread application. This equation is expressed below:

$$V=\frac{1}{n}R^{2/3}S^{1/2} \tag{2.7}$$

And as mentioned earlier, the runoff flow is calculated using the following formula:

$$Q = C.i.A \tag{2.1}$$

Various types of monographs have been developed for solution of problems involving sewers flowing full. Monographs based on Manning's equation for circular pipe flowing full and variable n values are provided in Figure 2.1. Hydraulic elements of circular pipes under partially-full flow conditions are provided in Figure 2.2. It may be noted that the value of n increases with the depth of flows Figure 2.1. However, in most designs n is assumed constant for all flow depths. Also, it is a common practice to use d, v, and q notations for depth of flow, velocity, and discharge under partial flow condition while D, V, Q notations for diameter, velocity, and discharge for sewer flowing full. Use of equations 2.1 and 2.7 and Figures 2.1 and 2.2, one can design the drainage system.

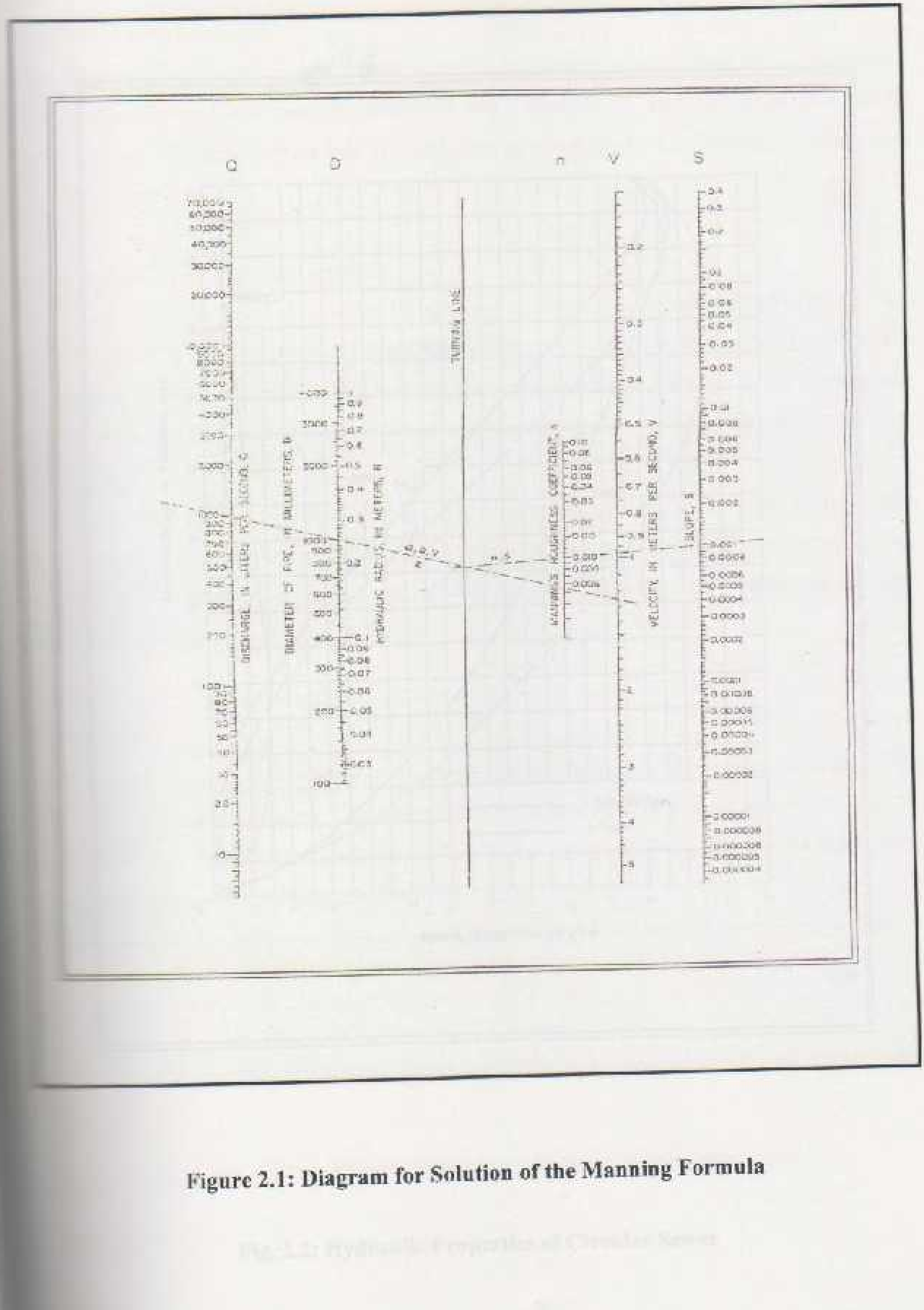
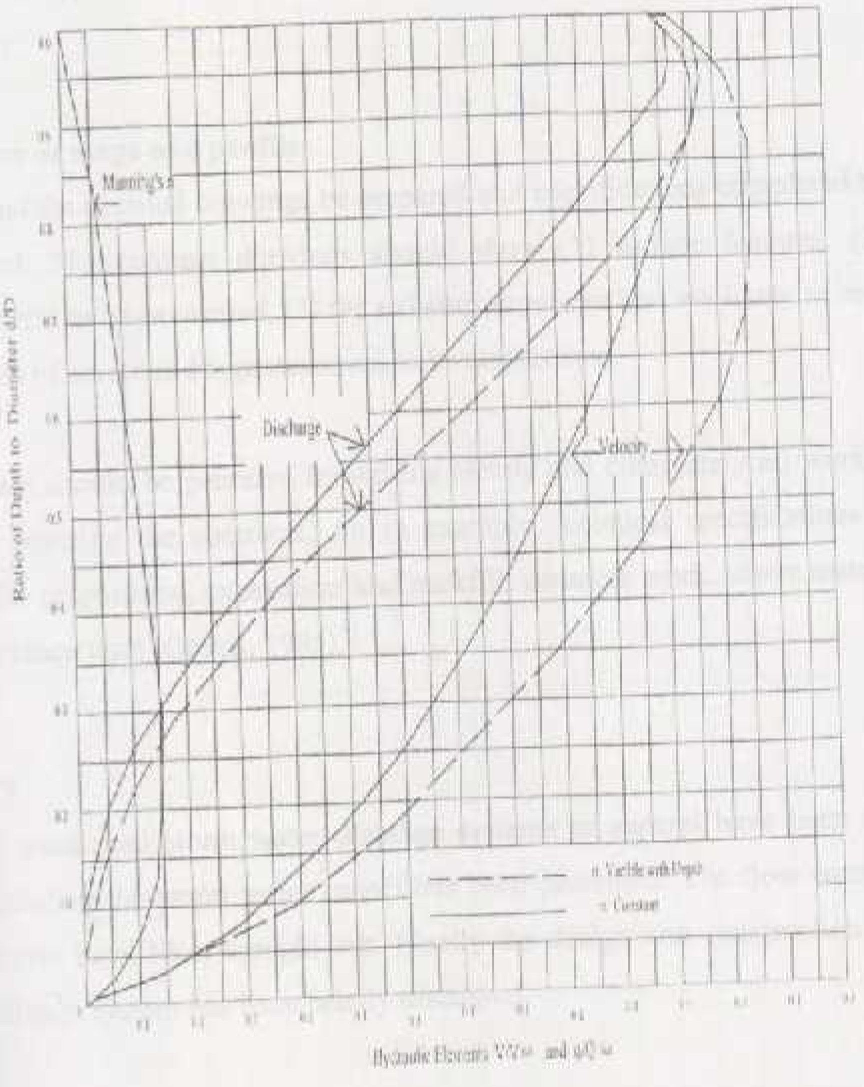


Figure 2.1: Diagram for Solution of the Manning Formula



Fig, 2.2: Hydraulic Properties of Circular Sewer

2.4.5 Design Computations

After the preliminary sewer layout plan is prepared, the design computations are accomplished. Design computations for sewers are repetitious and therefore, are best performed in a tabular format. Table 2.5 is typical of the way in which data can be organized to facilitate computations for closed system.

2.4.6 Preparation of maps and profile

It is important that the detailed drawings be prepared and specifications completed before the bid can be requested. The contract drawings should show (1) surface features, (2) depth and character of material to be excavated, (3) the existing structures that are likely to be encountered, and (4) the details of sewer and appurtenances to be constructed.

The specifications should be prepared by writing clearly and completely all work requirements and conditions affecting the contracts. As an example, technical specifications should cover items such as site preparation, excavation and backfill, concrete work, sewer materials and pipe laying, and acceptance tests (Qasim, 1985).

2.5 Summary

In this chapter, municipal storm water drainage systems in general have been described. The method of calculating the storm water runoff has been presented. The flow equations of sewer pipes and channels have been brought out. Finally the design and construction of community storm water drainage system has been briefly discussed.

Table [illegible] Typical Computation Sheet for Storm Water Design of Closed System

NUMBER	LOCATION			LENGTH	LENGTH COMULATIVE	AREA of Street	C FACTOR Street	AREA of Land	C Factor of land	SUM(AC) COMULATIVE	Tc	(I)	Q	Qi
	LINE NAME	UPPER MH. NO	LOWER MH. NO.	(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
1	A	1	2											
2	A	2	3											
3	A	3	4											
4	A	4	5											
5	A	5	6											
6	A	6	7											
7	A	7	8											
8	A	8	9											
9	A	9	10											
10	A	10	11											
11	A	11	12											
12	A	12	13											
13	A	13	14											
14	A	14	15											
15	A	15	16											
16	A	16	17											
17	A	17	18											
18	A	18	19											
19	A	19	20											
20	A	20	21											

CHAPTER

3 DESIGN AND PLANNING CRITEREA

3.1 Introduction

3.2 Catchment Areas

3.3 Rainfall characteristics

3.4 Runoff Flow

3.5 Design Parameters

3.6 Summary

CHAPTER THREE
DESIGN AND PLANNING CRITERIA

3.1 Introduction

In the previous chapters, the problem of the study has been defined and the objectives of the project have been listed. The characteristics of the project area of Halhul city have been described. Storm water drainage system and design of storm water sewers were explained. In this chapter, basis for planning and design will be discussed including catchment areas, rainfall characteristics, runoff flow, and the design parameters.

3.2 Catchment Areas

Halhul city is divided into three main drainage catchment areas; the city is divided into regional catchment areas based on the topography of the area and street. The three main catchments are divided into many sub-catchments areas as illustrated in Figure 3.1.

3.3 Rainfall Characteristics

3.3.1 General Condition

The average annual rainfall in Halhul city for the last five years is 550 mm, of which about 98 percent falls between October and April. There are two well defined seasons, the wet season start in October and extending into April, and the dry season extending from May to September.

3.3.2 Intensity-Duration Curve

Standard runoff calculations are based on rainfall intensity for a given time period (rainfall intensity-duration curve). Hebron station measurements have been used as the basis for rainfall throughout Halhul city. The data obtained are used to draw the intensity- duration curve for Halhul city. The calculation is presented in Table 3.1.

Table 3.1: Intensity-Duration Relationship for Five Years Period in Hebron Area $i(mm/hr) = b*m^T$

Return Period (5 years), B = 66.53 and m= 0.993					
Duration(min)	15	75	105	165	180
Rainfall(mm)	15.5	10.2	12.3	9.8	21.3

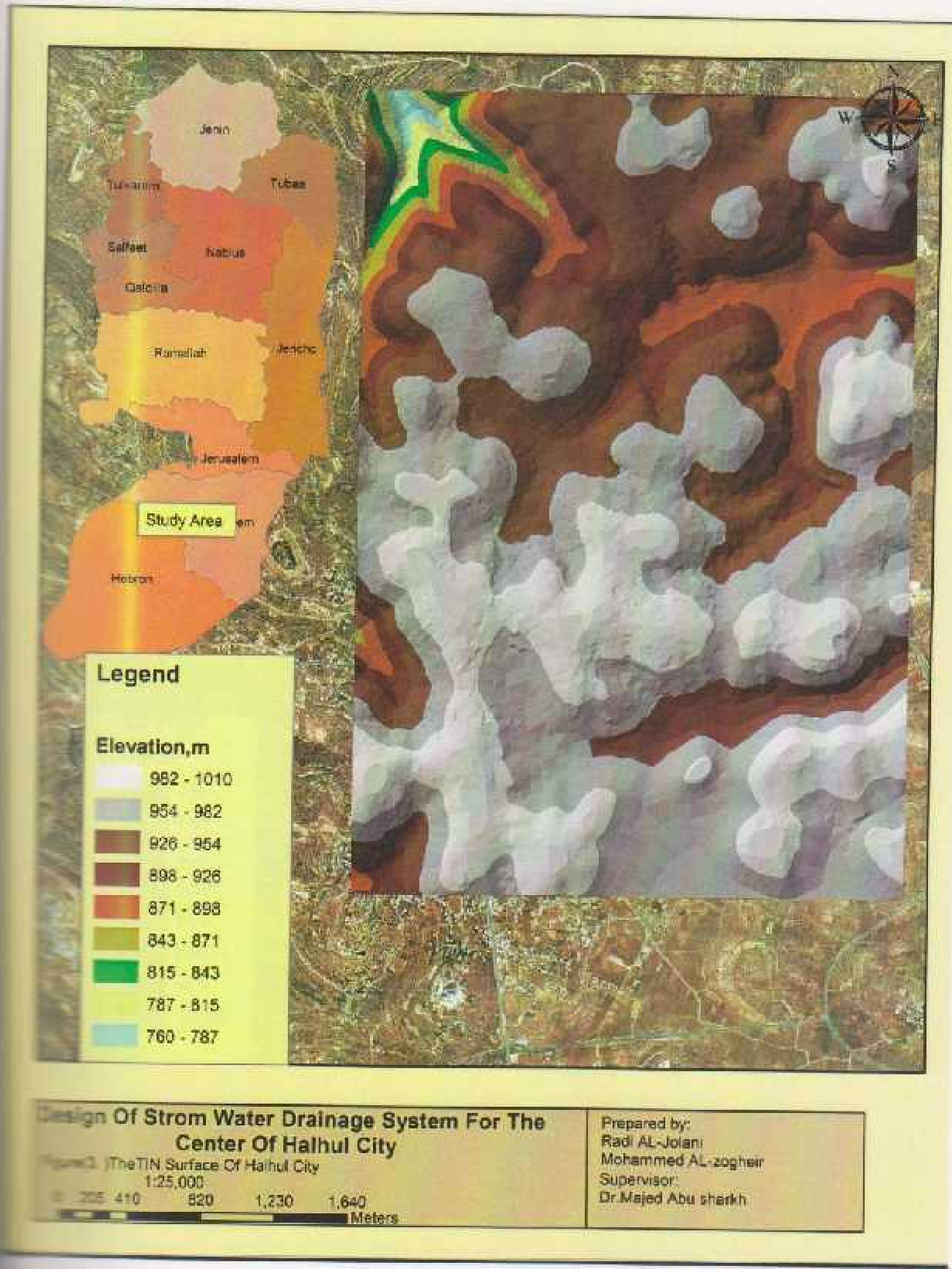


Figure (3.1): The TIN Surface of Halhul City

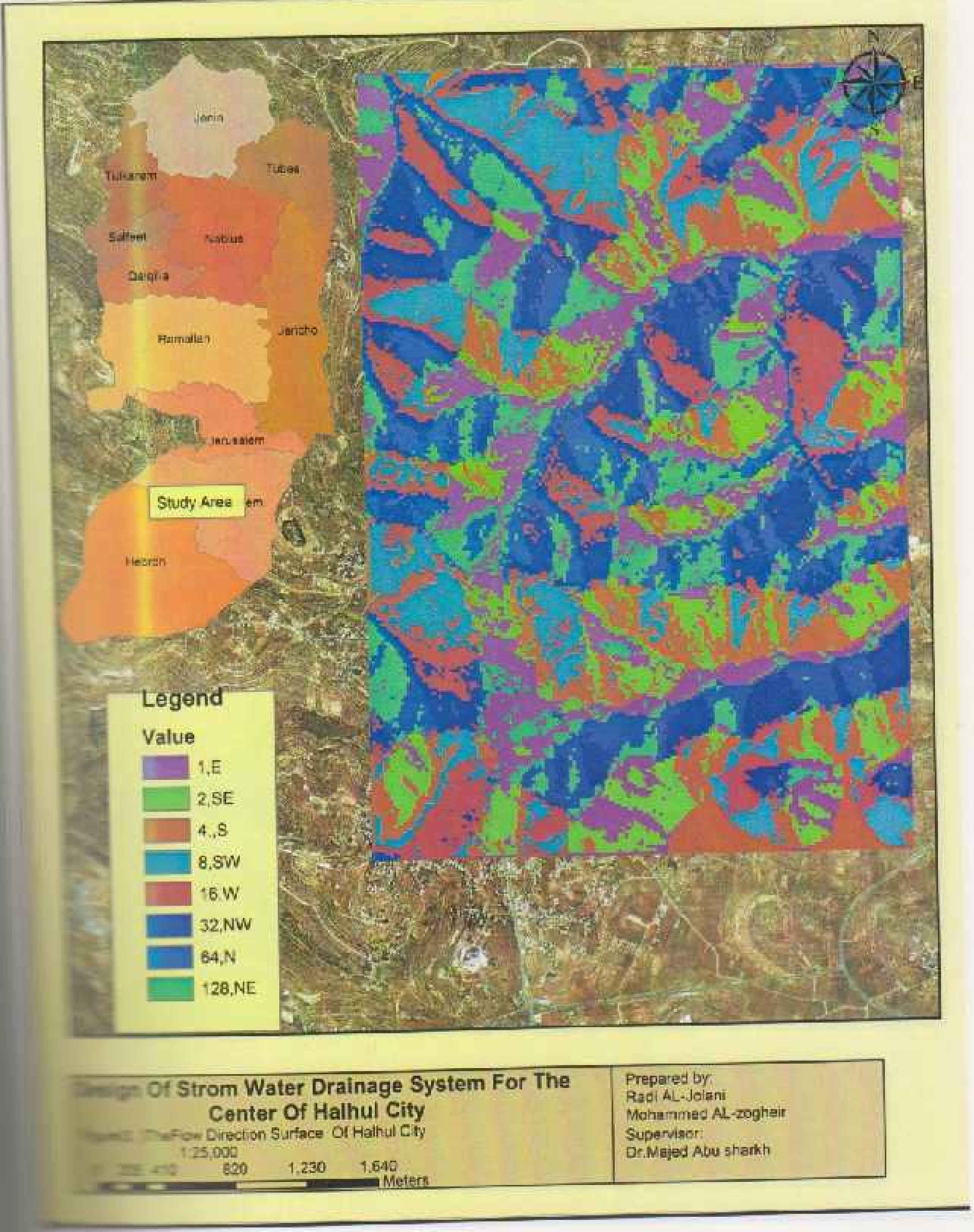


Figure (3.2): The Flow Direction Surface of Halhul City

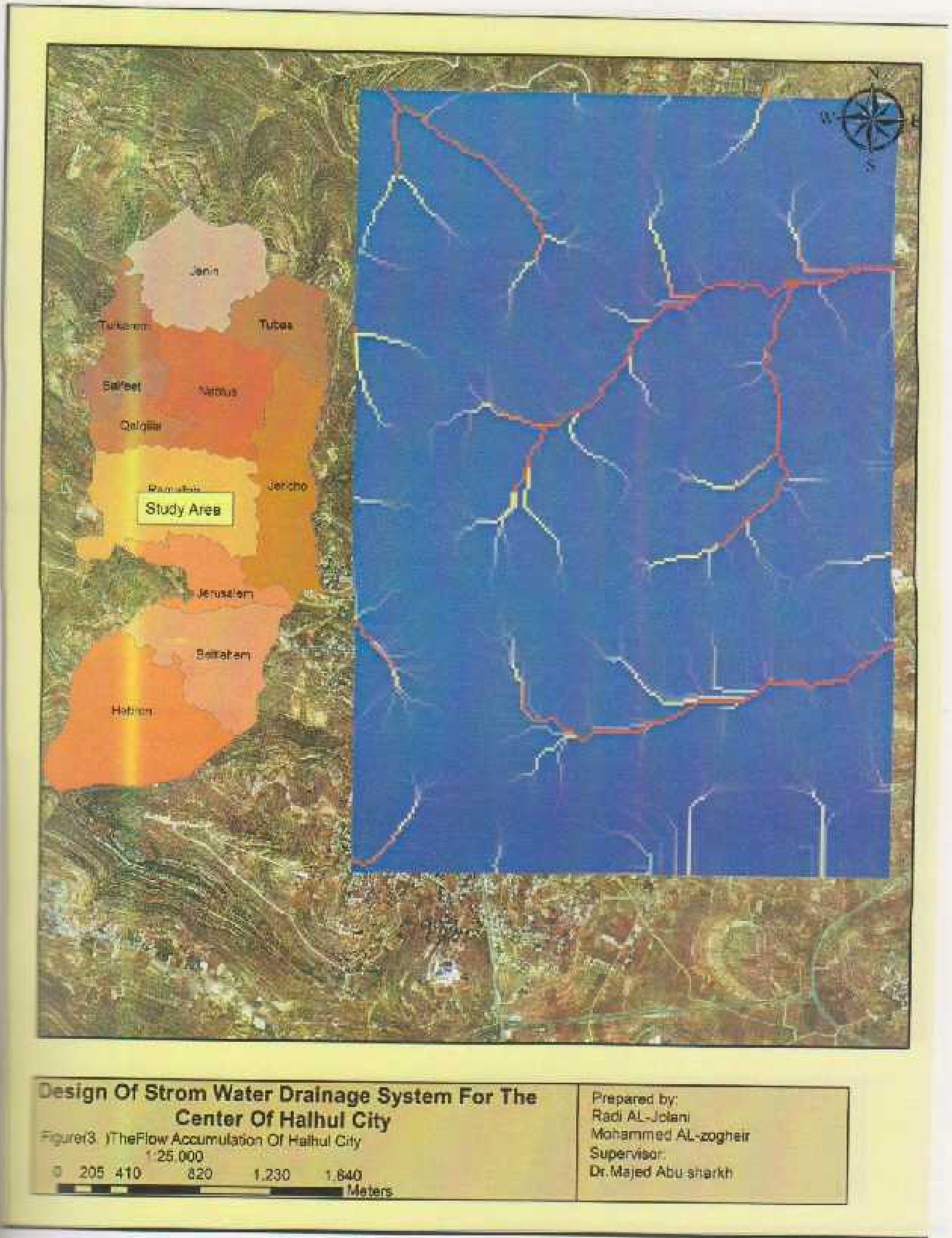


Figure (3.3): The Flow Accumulation of Halhul City

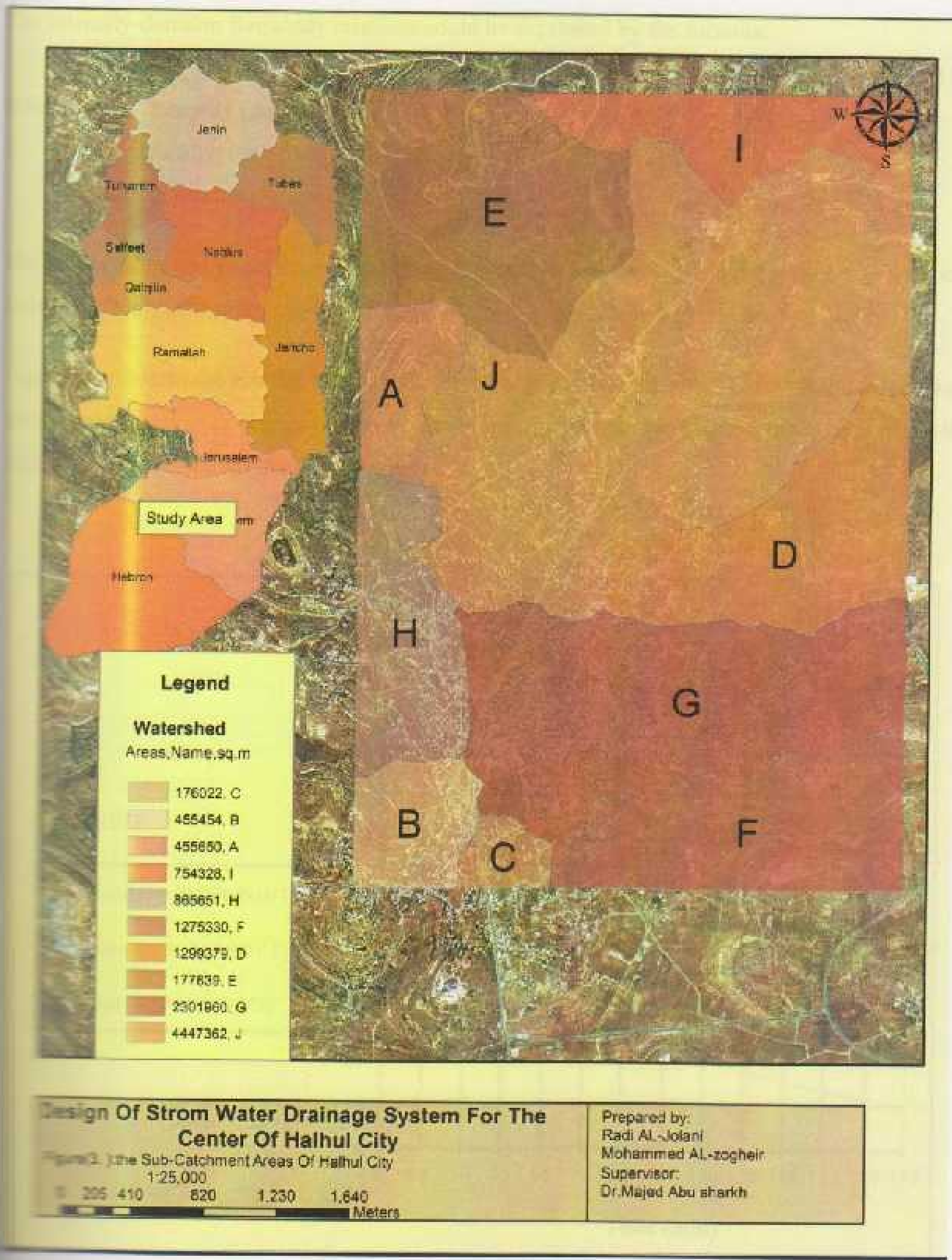


Figure (3.4): The Sub-Catchment Areas of Halhul City

The intensity-duration frequency relations could be expressed by the formula:

$$i = b*m^T \quad (3.1)$$

Where i: intensity (mm/hr).

T: duration time (min).

b,m: constants.

The values of m and b are determined using the data in the Table 3.1 and by the help of Excel software. This allowing tracing the curve of Figure 3.2 for Halhul city.

Figure 3.2 presents the rainfall intensity-duration curve for Hebron area. The typical curve along with Gaza city curve is also presented in the figure. As shown in the figure, the typical curve is higher; hence, the rainfall intensity is more.

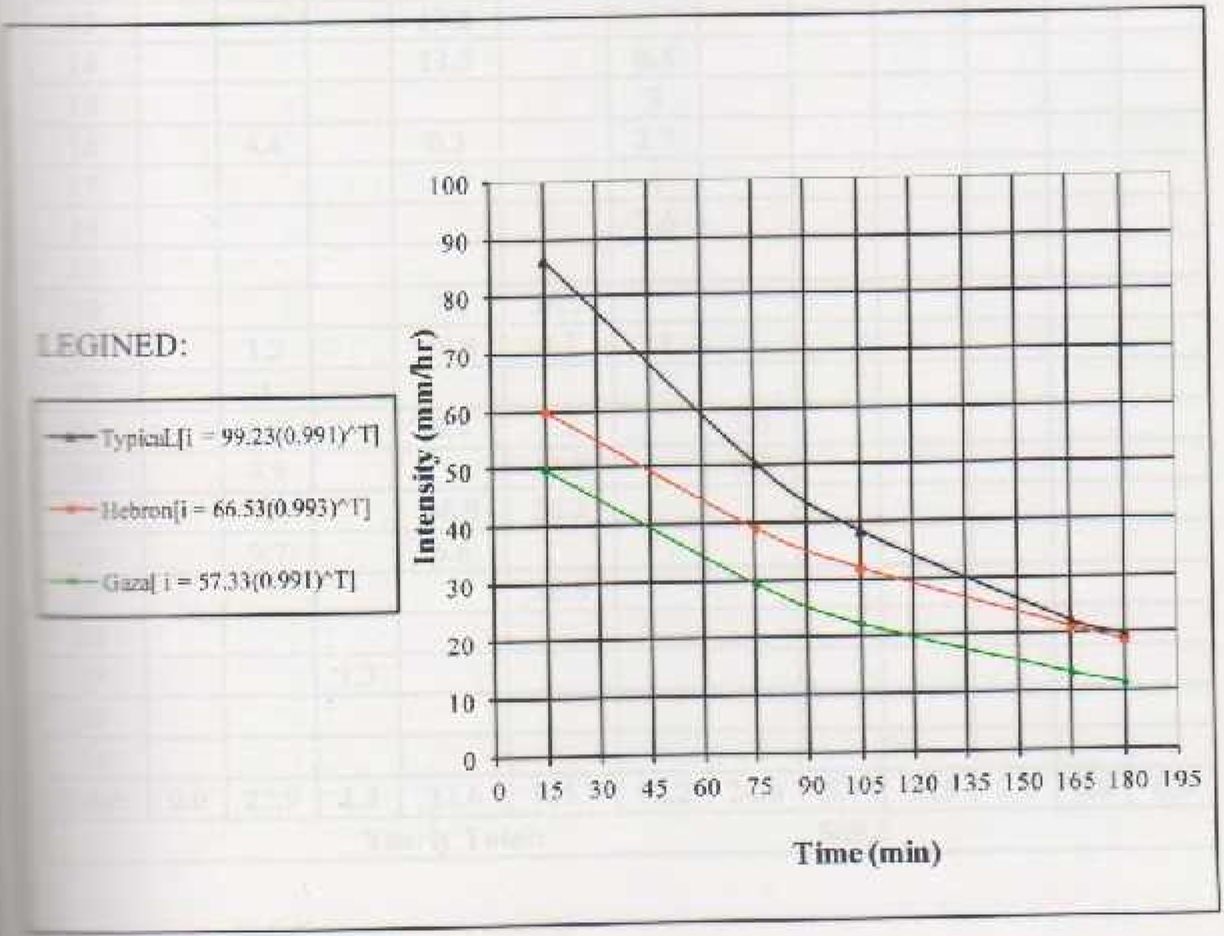


Figure 3.5 - The Rainfall Intensity- Duration Curve

Total Monthly Rainfall for Halhul Station (mm)

Table(3-2):Season (2000-2001)

	MONTH											
DAY	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1				9								
2				7.4					45.9			
3					1.2				11			
4						7.3						
5						19.2		1				
6					4	4						
7												
8						15		4.1				
9				10			4					
10				12		1	15					
11												
12				1.2								
13				19.2								
14				12.5		0.4						
15						3						
16		4.4		0.3		2.7						
17						2						
18						7.6						
19												
20				7.4	36.7							
21		1.2		38.8	0.2	11						
22		1				19						
23		0.5		9.4	1.8		5.5					
24		4.9			13.8		0.3					
25		1.2		86.8	56.2							
26		9.7		6.6								
27					31.8							
28												
29			1.3									
30												
31												
Total:	0.0	22.9	1.3	22.6	145.7	92.2	24.8	5.1	56.9	0.0	0.0	0.0
			Yearly Total:					569.5				

Total Monthly Rainfall for Halhul Station (mm)
Table(3-3):Season (2001-2002)

	MONTH											
DAY	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1				7								
2												
3					25.4			9.4				
4				0.2	2.8			8				
5				٦٢								
6				١٦,٥								
7			5									
8			0.6		54.3							
9					61							
10					42.6	12						
11					4.3	3.5						
12					2.7	24.7						
13						20.3						
14												
15				3.6					8.4			
16					0.7							
17			6.2				0.8		3.5			
18			18.5									
19												
20				37.6	26							
21				9.6	21			2.1				
22			12.6		35.6		1.2	0.8				
23			5.2									
24						0.6						
25												
26			4			0.2						
27		0.1	1.2		1							
28		2			42.2		13.6					
29		6.4	0.3		10							
30							31					
31												
Total:	0.0	8.5	53.6	136.5	329.5	61.3	47.4	20.3	11.9	0.0	0.0	0.0
		Yearly Total:						669.0				

Total Monthly Rainfall for Halhul Station (mm)
Table(3-4):Season (2002-2003)

	MONTH											
DAY	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1												
2												
3					7		2					
4						12						
5			4.4									
6												
7							11.8					
8						15.1						
9			0.8	16								
10				35								
11				33			3.3					
12			3.7	1.8			33					
13					0.8							
14					8.2	48.7						
15				3.7	15	12.2		0.5				
16		0.3										
17				21	1.1							
18				13.2	3.7		22					
19					5			0.3				
20		1.8		99.6	24.1			1.8				
21				12.4	10.3	12.5	4	1				
22				1.2	0.4	5.9						
23				36		5						
24			8				18					
25				11.6			21.8					
26				1.5			1	8.8				
27								3.7				
28						74.3						
29			4.2									
30		5.4		6								
31		6.7										
Total:	0.0	14.2	21.1	292	75.6	185.7	116.9	16.1	0.0	0.0	0.0	0.0
			Yearly Total:					721.6				

Total Monthly Rainfall for Halhul Station (mm)
Table(3-5):Season (2003-2004)

	MONTH											
DAY	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1						6						
2				0.8		10.4			0.6			
3				24								
4								1.8				
5				19		11.7	7					
6				0.6		5.2	10.8					
7				6.8		0.4						
8					29.6							
9					26.2							
10					1							
11			2.7									
12						4.6						
13					28.5							
14					30.8	4.2	0.7					
15				3	42.6	14.2	0.8					
16				0.6		8.2	4.8					
17												
18												
19				31.9		10.8						
20				54.3		14						
21												
22					8.5	8						
23												
24												
25												
26		0.1			0.1							
27					1.7							
28				0.7	13.6							
29		12.4		2.2								
30												
31												
Total:	0.0	12.5	2.7	144.5	182.6	97.7	24.1	1.8	0.6	0.0	0.0	0.0
				Yearly Total:				466.5				

Total Monthly Rainfall for Halhul Station (mm)
Table(3-6) :Season (2004-2005)

	MONTH											
DAY	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1												
2						3		2				
3					34.8			6.5				
4					30.5		0.9	3.5				
5						7.6						
6					44.5	1.2						
7				11.3		26.6						
8				9.2		33.3	0.2					
9						25	0.16					
10							17.4					
11				0.3		10.5	7.6					
12						10	5.8					
13							0.7					
14												
15												
16				6.1								
17			4.7									
18			1.4		1							
19			6.6									
20					1.4	1						
21												
22			26.6									
23			8		10							
24				16.6	30.8							
25				6.2								
26												
27			4.7									
28		0.9										
29		3.3										
30												
31												
Total:	0.0	4.2	211	49.7	153	118.2	49	12.7	0.0	0.0	0.0	0.0
			Yearly Total:					598.0				

Total Monthly Rainfall for Halhul Station (mm)
Table(3-7): Season (2005-2006)

	MONTH											
DAY	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1								55				
2								1.7				
3						4.1						
4					2.8	8.9		3.4				
5			2.4					18.5				
6			13.6									
7			1.4									
8					1.2							
9					13.9		5.4					
10					1.2	0.4	11					
11					0.8							
12					20.2							
13					0.8							
14					5.2	5.2						
15			2.8			14.9		0.2				
16			1.2		4	37.6		3.2				
17				5.8	12.4	12.1						
18				0.4	8.8							
19												
20		10.2	1.1		4.8							
21		0.2	25.8	0.4								
22												
23				4								
24				18.6				1.2				
25				33	1.1							
26				22	2.6	0.6						
27					2.7	1.8						
28					3.4							
29												
30												
31												
Total:	0.0	10.4	48.3	84.2	85.9	85.6	16.4	83.2	0.0	0.0	0.0	0.0
Yearly Total:								414.0				

3.4 Runoff flow

3.4.1 Runoff coefficient

The runoff coefficient is a function of the permeability of the surfaces and interception/ retention/ infiltration of storm water in the drainage area. In an developed area, C is a function of the surface and natural soil type. In a developed area, C is a function of the amount of paving and/or development. Because of this, runoff coefficient values for developed areas are closely linked to various type of land use. Typical C values are as shown below in Table 3.2.

Table 3.8: Typical Runoff Coefficients for Developed Area

Development	Coefficient
Pavement, Road/ Parking	0.9
Commercial/ Public	0.7
Residential Communities	0.6
Parks/ Unimproved areas	0.3
Irrigation areas	0.2
Natural zones	0.05

In this project used runoff coeficients(C) =0.15

3.4.2 Method of calculation

a. Concentration time (t_c): the concentration time was taken as t_c = ti+tf min, as it commonly used for consideration of safety.

b. Flow rate (Q): The discharge is calculated using Rational formula as

$$Q = C.i.A \qquad (2.1)$$

c. Rainfall intensity (i): It is calculated by using the formula:

$$i = b*m^T \qquad (3.1)$$

Parameters b and m correspond to the frequency used for the design rainfall. For the design rainfall used in the project, with a return period of f = 5 years. b = 66.53 and m= 0.992.

d. Manning formula: As mentioned earlier and according to usual practice, the sewers are designed for gravity flow using Manning's formula:

$$V = \frac{1}{n} R^{2/3} S^{1/2} \qquad (2.7)$$

Depending on pipe materials, the typical values of n are:

- Reinforced Concrete (RC) $n = 0.013$
- Polyvinyl Chloride (PVC) $n = 0.011$
- Ductile Iron: $n = 0.013$
- Asbestos Cement: $n = 0.012$

3.5 Design Parameters

3.5.1 Minimum and maximum velocities

Sewers should be "self cleansing" to limit the settling of grit, which in case of "closed channel" determined by the gradient of the sewer invert. The minimum velocity is 0.75 m/s and 0.9 m/s is desirable. The maximum velocity is limited to prevent the erosion of sewer inverts; it is between 4 to 7.5 m/s. In open channel design the minimum and maximum velocity depend on the size and type of profile were we use.

3.5.2 Storm water channels slope

The natural ground slope(G) is used because it is the technical and economic solution. But If Smin<G<Smax channel slope(S)=G, G>Smax S=Smax, G<Smin S=Smin.

3.5.3 Design period

In designing of storm water system the appropriate period that used is 25 years, which is selected in the this project.

3.6 Summary

In this chapter "Basis for Planning and Design criteria", catchment areas have been found, intensity-duration curve has been estimated, runoff flow chosen, and the design parameters have been described.

4 ANALYSIS AND DESIGN

4.3 Design Computations

4.3.1 Introduction

The detailed design of storm water sewers involves the selection of appropriate channel sizes and slopes to transport the quantity of storm water from the surrounding and upstream areas to the next channel in series, subject to the appropriate design constrains. The design computations and procedure for design storm water drainage system for Halhul city is illustrated in the design example given below. The design calculations necessary for storm water drainage system for the Halhul city are performed using StormCAD software. This computer program is developing by the Haestad Methods, Inc. More detailed about this program is given below.

4.3.2 What is StromCAD?

Design Storm CAD is an extremely powerful program for the design and analysis of gravity flow pipe networks. The program can be run within AutoCAD, giving you all the power of AutoCAD's capabilities, or in Stand-Alone mode utilizing its own graphical interface. StormCAD allows constructing a graphical representation of a pipe network containing all your information, such as pipe data, inlet characteristics, watershed areas, and rainfall information. This program gives a choice of conveyance elements including circular pipes, pipe arches, boxes and more. Rainfall information is calculated using rainfall tables, rainfall equations, or the National Weather Service's Hydro-35 data. StormCAD also plots the resulting Intensity Duration Frequency Curves.

The gravity network is solved using the built-in numerical model, which utilizes both the direct step and standard step gradually varied flow methods. Flow calculations are valid for both pressure and varied flow situations, including hydraulic jumps, backwater, and drawdown curves. StormCAD's flexible reporting feature allows customizing and printing the model results in both a report format and as a graphical plot.

4.3.3 Design Example

In the design of the gravity flow storm water drainage system, the design flow for each line is calculated first, and then the values of design flows are used to determine the diameters of the pipes and other design parameters such as velocity, flow, depth of flow, etc.

Example: In this example, the trial is made to design of flow storm water drainage channel for [illegible]

...ased on an analysis of local conditions and codes.

- Runoff coefficient (C) uses 0.15 and 0.7 for streets.
- Inlet time (T_i) use 10 minuets.
- Concentration time (T_c) use equation (2.3).
- Rainfall intensity = 66.53 $(0.993)^{\wedge Tc}$.
- Runoff rate depending on the formula: Q = C i A.

Solution: In the solution of this example, the design flow was first calculated, and then the design of the line was carried out using StormCAD software. The steps for calculating the design flow and street slope are as follow:

1. Lay out the storm water sewer. Draw a line to represent the proposed sewer.
2. Locate and number the upper and lower manhole of the line.
3. The data in the table are calculated as follow:
   a. The line number is given in column 1. The entries in columns 2 through 4 are used to identify the location and the numbers of the manholes. The distance between the two manholes, the tributary area in hectare and tributary sewer line number are given in columns 5, 6,7 and 9 respectively.
   b. The entries in columns 8 through 15 are used to identify rainfall intensity and to calculate the design flow. Runoff coefficient (C) is entered in column 8,10. The area in hectare is multiplied by runoff coefficient (C) and the result is given in column 7,9. The cumulative multiplication of the sewered area in hectare is multiplied by runoff coefficient (C) are given in column 11. The concentration time is shown in column 12 and rainfall intensity is given in column 13. Column (14) shows the cumulative runoff rate (Q) which obtained by multiply column (10) by column (13).

The computation table for line (A) is presented in Table in Table (4.1). The design table for the same line (A) is given in Table (4.2). The computation tables for the others lines is given in Appendix-A.

Table (4.1) Computation Table for Line A

NUMBER	LOCATION			LENGTH	LENGTH COMULATIVE	AREA of Street	C FACTOR Street	AREA of Land	C Factor of land	SUM(AC) COMULATIVE	Tc	(i)	Q	Qi
	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
1	C	1	2	88	88	0.1753	0.7	0	0.15	0.12271	11.46667	166.6402	20.44842	20.44842
2	C	2	3	52.5	140.5	0.0209	0.7	0	0.15	0.13734	12.34167	165.3272	22.70603	2.257614
3	C	3	4	70	210.5	0.0336	0.7	0	0.15	0.16086	13.50833	163.5925	26.3155	3.609462
4	C	4	5	53.5	264	0.3915	0.7	0	0.15	0.43491	14.4	162.2791	70.57679	44.26129
5	C	5	6	52.5	316.5	0.0342	0.7	0	0.15	0.45885	15.275	161.0004	73.87503	3.298244
6	C	6	7	65.5	382	0.0496	0.7	0	0.15	0.49357	16.36667	159.4192	78.68455	4.809513
7	C	7	8	40	422	0.026	0.7	0	0.15	0.51177	17.03333	158.4613	81.09572	2.411177
8	C	8	9	32	454	0.0184	0.7	0	0.15	0.52465	17.56667	157.699	82.73681	1.641083
9	C	9	10	81	535	0.0501	0.7	0	0.15	0.55972	18.91667	155.786	87.19656	4.45975
10	C	10	11	70	605	0.0487	0.7	0	0.15	0.59381	20.08333	154.1515	91.5367	4.340149
11	C	11	12	85	690	0.0365	0.7	0	0.15	0.61936	21.5	152.1898	94.26025	2.723548
12	C	12	13	108.5	798.5	0.0977	0.7	0	0.15	0.68775	23.30833	149.7219	102.9712	8.710978
13	C	13	8 B	11	809.5	0.003	0.7	0	0.15	0.68985	23.49167	149.4739	103.1146	0.143365

Calculation of section of culvert

-First culvert

A = 1279164.8953 m²

A = 127.91648953 ha

C = 0.15

I = 127.10

Q = C I A

Q = 0.15 * 127.10 * 127.9165

= 2438.73 l / s

A = Q/V

= 2438.73 $*10^{-3}/1$

= 2438.73 $*10^{-3}m^2$

The design culvert box concrete

B = (2438.73 $*10^{-3}$)½

B = 1.5m

The design of culvert circular concrete

$$A = \left(\frac{\pi * D^2}{4}\right)$$

$$2438.73 * 10^{-3} = \left(\frac{\pi * D^2}{4}\right)$$

D = 1.76 m.=>2m

Second culvert

= 225917.15 m²

= 22.591715 ha

= 0.15

= 127.10

= C I A

= 0.15 * 127.10 * 22.6

= 430.869 l / s

= Q/V

= 430.869 $*10^{-3}/1$

= 430.869 $*10^{-3}m^2$

The design culvert box concrete

= $(430.869 \ *10^{-3})^{½}$

= 0.656=>0.8m

The design of culvert circular concrete

$$= \left(\frac{\pi * D^2}{4}\right)$$

$$.869 \ *10^{-3} = \left(\frac{\pi * D^2}{4}\right)$$

= 0.74m.=>0.8m

- **Third culvert**

A = 779784 m^2

A = 77.9784ha

C = 0.15

I = 127.10

Q = C I A

Q = 0.15 * 127.10 * 77.99

=1486.879 l / s

A = Q/V

= 1486.879 $*10^{-3}$/1

= 1486.879 $*10^{-3} m^2$

If the design culvert box concrete

X = (1486.879 $*10^{-3}$)½

X = 1.22 m=>1.5m

If the design of culvert circular concrete

$$A = \left(\frac{\pi * D^2}{4}\right)$$

$$1486.879 \quad *10^{-3} = \left(\frac{\pi * D^2}{4}\right)$$

D = 1.37m.=>1.5m

4.4 The Proposed Storm Water Drainage System

In the proposed study for the Storm Water Drainage System for the center of Halhul, the trial is made to design the main trunks of the collection system. This section deals with the results of the suggested storm water drainage system.

The appropriate pipe diameters, lengths, land slopes, and location of the manholes are found by using the calculations given in the previous section. During and once the sewer design computations have been completed, alternative alignments have be examined, and the most cost– and energy–effective alignment has been selected.

The final results for the appropriate diameters for the proposed storm water drainage system for the center of Halhul, slopes and lengths of the pipes are given in Tables of Appendix-A. The calculated velocities, flow rates, and depth of flow in pipes are given in the same tables.

4.5 Profiles of Sewer

The profiles of sewer area assist in the design and are used as the basis of construction drawings. The profiles are usually prepared for each sewer line at a horizontal and vertical scale. The profile shows the ground or street surface, tentative manhole locations, elevation of important subsurface data such as rock, locations of borings, all underground structures, basement elevations, and cross streets. A plan of the line and relevant other structures are usually shown on the same street (McGhee, 1991).

After all the calculation is completed and all the maps of the proposed drainage system are prepared, detailed profiles for each sewer is drawn. The profiles of sewer lines are shown in Figures of Appendix-B. These profiles had shown the ground elevation, the proposed sewer lines, manholes (manholes number and the spacing between the manholes), depth of excavations, the diameters and slopes of the pipes.

CHAPTER

5 BILL OF QUANTITY

CHAPTER FIVE

BILL OF QUANTITY

5.1 – Excavations and backfilling

Item	Item Description	Unit	Quantity	Unit Price (€)	Total amount (€)
1.1	**Excavations and backfilling nominal pipe diameter 250 mm**				
1.1.1	Excavation of pipe trench in all kinds of soil, rock, etc, the price shall include cost of backfilling with selected suitable material approved by the engineer, and shall include leveling and compaction to a depth not exceeding 2m and disposing surplus material outside the site according to drawings. And specifications.	L.m	**3410**		
1.1.2	Ditto, but for excavations between 2.00-2.5m	L.m	**266**		
1.1.3	Ditto, but for excavations between 2.5-3 m	L.m	**139.5**		
1.1.4	Ditto, but more than 3m	Lm	**0**		
1.2	**Excavations and backfilling nominal pipe diameter 300 mm**				
1.2.1	Excavation of pipe trench in all kinds of soil, rock, etc, the price shall include cost of backfilling with selected suitable material approved by the engineer, and shall include leveling and compaction to a depth not exceeding 2 m and disposing surplus material outside the site according to drawings. And specifications.	L.m	**247.5**		
1.2.2	Ditto, but for excavations between 2.00-2.5m	L.m	**0**		
1.2.3	Ditto, but for excavations between 2.5-3 m	L.m	**0**		
1.2.4	Ditto, but more than 3m	L.m	**107.5**		
1.3	**Excavations and backfilling nominal pipe diameter 375 mm**				
1.3.1	Excavation of pipe trench in all kinds of soil, rock, etc, the price shall include cost of backfilling with selected suitable material approved by the engineer, and shall include leveling and compaction to a depth not exceeding 2 m and disposing surplus material outside the site according to drawings. And specifications.	L.m	**285**		
1.3.2	Ditto, but for excavations between 2.00-2.5m	L.m	**0**		
1.3.3	Ditto, but for excavations between 2.5-3 m	L.m	**170**		
1.3.4	Ditto, but more than 3m	Lm	**264.5**		
1.4	**Excavations and backfilling nominal pipe diameter *450 mm***				
1.4.1	Excavation of pipe trench in all kinds of soil, rock, etc, the price shall include cost of backfilling with selected suitable material approved by the engineer, and shall include leveling and compaction to a depth not exceeding 2 m and disposing surplus material outside the site according to drawings. And specifications.	L.m	**557.5**		
1.4.2	Ditto, but for excavations between 2.00-2.5m	L.m	**195.5**		
1.4.3	Ditto, but for excavations between 2.5-3 m	L.m	**140**		
[illegible]	[illegible] but more than 3m	Lm	**218.5**		

Item	Item Description	Unit	Quantity	Unit Price (€)	Total amount (€)
1.5	**Excavations and backfilling nominal pipe diameter 525 mm**				
1.5.1	Excavation of pipe trench in all kinds of soil, rock, etc, the price shall include cost of backfilling with selected suitable material approved by the engineer, and shall include leveling and compaction to a depth not exceeding 2 m and disposing surplus material outside the site according to drawings. And specifications.	L.m	557		
1.5.2	Ditto, but for excavations between 2.00-2.5m	L.m	225.5		
1.5.3	Ditto, but for excavations between 2.5-3 m	L.m	70		
1.5.4	Ditto, but more than 3m	Lm	0		
1.6	**Excavations and backfilling nominal pipe diameter 600 mm**				
1.6.1	Excavation of pipe trench in all kinds of soil, rock, etc, the price shall include cost of backfilling with selected suitable material approved by the engineer, and shall include leveling and compaction to a depth not exceeding 2 m and disposing surplus material outside the site according to drawings. And specifications.	L.m	1194		
1.6.2	Ditto, but for excavations between 2.00-2.5m	L.m	198.5		
1.6.3	Ditto, but for excavations between 2.5-3 m	L.m	0		
1.6.4	Ditto, but more than 3m	Lm	0		
1.7	**Excavations and backfilling nominal pipe diameter 750 mm**				
1.7.1	Excavation of pipe trench in all kinds of soil, rock, etc, the price shall include cost of backfilling with selected suitable material approved by the engineer, and shall include leveling and compaction to a depth not exceeding 2 m and disposing surplus material outside the site according to drawings. And specifications.	L.m	854		
1.7.2	Ditto, but for excavations between 2.00-2.5m	Lm	301.5		
1.7.3	Ditto, but for excavations between 2.5-3 m	Lm	0		
1.7.4	Ditto, but more than 3m	Lm	279.5		
1.8	**Excavations and backfilling nominal pipe diameter 900 mm**				
1.8.1	Excavation of pipe trench in all kinds of soil, rock, etc, the price shall include cost of backfilling with selected suitable material approved by the engineer, and shall include leveling and compaction to a depth not exceeding 2 m and disposing surplus material outside the site according to drawings. And specifications.	L.m	1025		
1.8.2	Ditto, but for excavations between 2.00-2.5m	Lm	102		
1.8.3	Ditto, but for excavations between 2.5-3 m	Lm	159.5		
1.8.4	Ditto, but more than 3m	Lm	0		
1.9	**Excavations and backfilling nominal pipe diameter 1050 mm**				
1.9.1	Excavation of pipe trench in all kinds of soil, rock, etc, the price shall include cost of backfilling with selected suitable material approved by the engineer, and shall include leveling and compaction to a depth not exceeding 2 m and disposing surplus material outside the site according to drawings. And specifications.	L.m	1018.5		
1.9.2	Ditto, but for excavations between 2.00-2.5m	Lm	48		
1.9.3	Ditto, but for excavations between 2.5-3 m	Lm	0		
1.9.4	Ditto, but more than 3m	Lm	54.5		

5.2- Pipes

Item	Item Description	Unit	Quantity	Unit Price €	Total amount €
	Pipes				
2.1	Supply, store and installation of pipes diameter 375(uPVC) with the Techen stamp or equivalent along with the fittings, according to drawings, and specifications.	L.m	898		
2.2	Ditto, but for pipes diameter **300mm(u PVC)**	L.m	355		
2.3	Ditto, but for pipes diameter **250mm(u PVC)**	L.m	4195.5		

5.2.1- Pipes

Item	Item Description	Unit	Quantity	Unit Price €	Total amount €
	Pipes				
2.1.1	Supply, store and installation of pipes diameter 1050(concrete) with the Techen stamp or equivalent along with the fittings, according to drawings, and specifications.	L.m	1121		
2.1.1	Ditto, but for pipes diameter **900mm**	L.m	1288.5		
2.1.2	Ditto, but for pipes diameter **750mm**	L.m	669		
2.1.3	Ditto, but for pipes diameter **600mm**	L.m	1392.5		
2.1.4	Ditto, but for pipes diameter **525mm**	L.m	712.5		
2.1.5	Ditto, but for pipes diameter **450mm**	L.m	1106.5		

5.3- Concrete manholes

Item	Item Description	Unit	Quantity	Unit Price €	Total amount €
3	**Concrete manholes (Precast manholes)**				
3.1	Supplying and installation of manhole, coated with coal tar epoxy, including excavations in all kinds of soil, rock, etc, shall include cost of backfilling with selected suitable material approved by the engineer, and steps and benching, heavy duty cover 25 tons for streets, and 8 tons for cross country fields and backfilling not exceeding 2m **.Diameter1200mm** according to drawings and specifications.	No.	79		
3.2	Ditto, but depth between 2.00-2.50m	No.	65		
3.3	Ditto, but depth between 2.50-3.00m	No.	30		
3.4	Ditto, but more than 3m	No.	31		

5.4 – Pipe bedding

Item	Item Description	Unit	Quantity	Unit Price €	Total amount €
4	**Pipe bedding**				
4.1	Supplying, installation and compaction of (**Absolet**) fine granular material, under, above and around pipe Diameter (according to depth at items 1.1) **1050mm** according to the drawings and specifications.	L.m	1121		
4.2	Ditto, but for pipes diameter 900mm	L.m	1288.5		
4.3	Ditto, but for pipes diameter 750mm	L.m	669		
4.5	Ditto, but for pipes diameter 600mm	L.m	1392.5		
4.6	Ditto, but for pipes diameter 525mm	L.m	712.5		
4.7	Ditto, but for pipes diameter 450mm	L.m	1106.5		
4.8	Ditto, but for pipes diameter 375mm	L.m	898		
4.9	Ditto, but for pipes diameter 300mm	L.m	355		
4.10	Ditto, but for pipes diameter 250mm	L.m	4195.5		

5.5– concrete works

Item	Item Description	Unit	Quantity	Unit Price €	Total amount €
5	**Concrete works**				
5.1	Supply and cast encasement plain concrete (B-200) surround for sewer, according to drawings and specifications.	m^3	11738.5		

5.6 – *Air leakage test*

Item	*Item Description*	*Unit*	*Quantity*	*Unit Price €*	*Total amount €*
6	*Air leakage test*				
.1	Air leakage test for **sewer pipelines** according to specifications, including for all temporary works				
1.1	Nominal bore 1050mm	L.m	1121		
1.2	Nominal bore 900mm	L.m	1288.5		
1.3	Nominal bore 750mm	L.m	669		
1.4	Nominal bore 600mm	L.m	1392.5		
1.5	Nominal bore 525mm	L.m	712.5		
1.6	Nominal bore 450mm	L.m	1106.5		
.7	Nominal bore 375mm	L.m	898		
.7	Nominal bore 300mm	L.m	355		
.7	Nominal bore 250mm	L.m	4195.5		
2	Water leakage test for all **manholes**, according to specifications, including for all temporary works.	NO.	205		

7 – Road reinstatement

Item	Item Description	Unit	Quantity	Unit Price €	Amount €
1	Provide and place mm, base coarse For all Sewer Pipes along with 50 mm asphalt over it, after compaction, all the work includes compaction, bitumen layer (1.0 lt./m 2) between the base coarse layer.	Lm	11738.5		

Summary

1	Excavations and backfilling	12089
2	Pipes	11738.5
3	Concrete manholes	205
4	Pipe bedding	11738.5
5	Concrete works	11738.5
6	Air leakage test	11738.5
7	Road reinstatement	11738.5

Discount as Percentage of the Total Amount = --------------------------

Total Contract Amount after Discount = -----------------

CHAPTER

6 ***CONCLUSIONS***

CHAPTER SIX

CONCLUSIONS

of Halbad city, considering the storm runoff, the wide expansion, unoriented development and growth of the city. The result brought out many important conclusions. The main conclusions drawn from the present study are summarized below:

1. Most of the areas in Halbad city do not have a natural drainage outlet. Heavy rainfall causes storm water to collect in low areas and flood streets and walkways.

2. The accumulation of storm water in the main streets in Halbad city causes problems to the peoples; subsequently there is a big need for immediate steps for construction of the deep and storm water drainage system for the center of Halbad city.

3. The flow in the proposed storm water drainage system is going by gravity; hence, the topographical features of the area are adopted.

CHAPTER SIX
CONCLUSIONS

In this project, the trial is made to evaluate and design storm water drainage system for the center of Halhul city, considering the water runoff, the wide expansion, accelerated development and growth of the city. The result brought out many important conclusions. The main conclusions drawn from the present study are summarized below:

1. Most of the areas in Halhul city do not have a natural drainage outlet. Heavy rainfall causes storm water to collect in low areas and flood streets and walk ways.

2. The accumulation of storm water in the main streets in Halhul city causes problems to the peoples; subsequently there is a big need for immediate steps for construction of the proposed storm water drainage system for the center of Halhul city.

3. The flow in the proposed storm water drainage system is going by gravity, hence, the topographical features of the area are allowed.

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APPENDIX-A: COMPUTATION TABLES

NUMBER	LOCATION			LENGTH	LENGTH CO	AREA of Str	C FACTOR Street	AREA of Lan	C Factor of land	SUM(AC) COMULATIVE	Tc	(i)	Q	Qi
	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
1	A	1	2	40	40	0.165	0.7	0.9327	0.15	0.255405	10.66667	167.8498	42.86968	42.86968
2	A	2	3	70	110	0.3931	0.7	1.0397	0.15	0.67048	11.83333	166.0887	111.3592	68.48948
3	A	3	4	70	180	0.1644	0.7	0.8279	0.15	0.941515	13	164.3461	154.7343	43.37515
4	A	4	5	70	250	0.1142	0.7	0.8456	0.15	1.14564	14.16667	162.6218	186.306	31.57168
5	A	5	6	70	320	0.2227	0.7	1.0005	0.15	1.42837	15.33333	160.9155	229.8469	43.5409
6	A	6	7	70	390	0.1221	0.7	0.9185	0.15	1.663915	16.5	159.2272	264.9405	35.09359
7	A	7	8	70	460	0.3467	0.7	1.1136	0.15	2.04438	17.66667	157.5565	322.1054	57.16497
8	A	8	9	70	530	0.2027	0.7	1.1015	0.15	2.35331	18.83333	155.9034	366.8891	44.78369
9	A	9	10	70	600	0.1302	0.7	0.7402	0.15	2.609675	20	154.2677	402.5885	35.6994
10	A	10	11	70	670	0.129	0.7	0.7412	0.15	2.811005	21.16667	152.6491	429.0974	26.50884
11	A	11	12	42	712	0.0634	0.7	0.4172	0.15	2.966565	21.86667	151.6861	449.9867	20.88931
12	A	12	13	98	810	0.1601	0.7	0.6747	0.15	3.141215	23.5	149.4627	469.4944	19.50773
13	A	13	14	70	880	0.1018	0.7	0.5179	0.15	3.31368	24.66667	147.8945	490.075	20.58064
14	A	14	15	95.5	975.5	0.4094	0.7	2.8036	0.15	3.677945	26.25833	145.7816	536.1765	46.10151
15	A	15	16	44.5	1020	0.5962	0.7	0.1	0.15	4.515825	27	144.8073	653.9246	117.748
16	A	16	17	70	1090	0.0523	0.7	0.7668	0.15	4.567435	28.16667	143.288	654.4586	0.534048
17	A	17	18	70	1160	0.0401	0.7	6.1015	0.15	4.710525	29.33333	141.7846	667.8799	13.42131
18	A	18	19	65.5	1225.5	0.3084	0.7	0.4	0.15	5.84163	30.425	140.3921	820.119	152.2391
19	A	19	20	102	1327.5	0.0466	0.7	2.9835	0.15	5.93425	32.125	138.2509	820.4155	0.296541
20	A	20	21	41.5	1369	0.0588	0.7	0.4388	0.15	6.422935	32.81667	137.3891	882.4413	62.0258
21	A	21	22	52.5	1421.5	0.0623	0.7	1.4423	0.15	6.532365	33.69167	136.3066	890.4042	7.962879
22	A	22	23	55.5	1477	0.0242	0.7	1.1831	0.15	6.76565	34.61667	135.1714	914.5225	24.11834
23	A	23	24	65	1542	0.0412	0.7	0.596	0.15	6.971955	35.7	133.854	933.224	18.70151
24	A	24	25	36.5	1578.5	0.0721	0.7	0.334	0.15	7.111825	36.30833	133.1198	946.7251	13.50103
25	A	25	26	52	1630.5	0.0178	0.7	0.478	0.15	7.174385	37.175	132.0809	947.5991	0.874079
26	A	26	27	78	1708.5	0.0374	0.7	0.849	0.15	7.272265	38.475	130.5376	949.3043	1.705112
27	A	27	28	15	1723.5	0.0096	0.7	0.4	0.15	7.406335	38.725	130.2429	1048.465	99.16027
28	A	28	29	64.5	1788	0.0259	0.7	0.6	0.15	7.484465	39.8	128.9833	1049.212	0.747895
29	A	29	30	87	1875	0.0279	0.7	0.2	0.15	7.593995	41.25	127.3034	1050.583	1.371012

NUMBE	LINE NAM	UPPER MH NO.	LOWER MH NO.	LENGT (m)	LENGTH (m)	AREA of (ha)	C FACTOR Street	AREA of Lar	C Factor of land	COMULATIVE (ha)	Tc (min)	(I) (l/s.ha)	Q (l/s)	Qi (l/s)
30	A	30	31	53	1928	0.0562	0.7	0.7093	0.15	7.[illegible]83335	42.13333	126.2908	1051.651	1.067362
31	A	31	32	87.5	2015.5	0	0.7	30.913	0.15	12.[illegible]6973	43.59167	124.6367	1052.235	0.58447
32	A	32	33	50.5	2066	0	0.7	5.098	0.15	13.40668	44.43333	123.6919	1618.448	566.2123
33	A	33	34	72	2138	0	0.7	1.3735	0.15	1[illegible].17138	45.63333	122.3572	1695.455	77.00778
34	A	34	35	70	2208	0	0.7	12.97	0.15	1[illegible]77405	46.8	121.0734	1703.49	8.034937
35	A	35	36	70	2278	0	0.7	25.45	0.15	1[illegible]22905	47.96667	119.8031	1919.574	216.0835
36	A	36	37	70	2348	0	0.7	1.4436	0.15	1[illegible]40405	49.13333	118.5461	2352.863	433.2892
37	A	37	38	70	2418	0	0.7	1.967	0.15	1[illegible]56945	50.3	117.3023	2354.457	1.593841
38	A	38	39	96	2514	0	0.7	2.7512	0.15	[illegible]51995	51.9	115.6178	2355.961	1.504551

NUMBER	LOCATION			LENGTH	LENGTH CO	AREA of Street	C FACTOR Street	AREA of Lanc	C Factor of land	SUM(AC) COMULATIVE	Tc	(I)	Q	Qi
	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
1	B	1	2	63.5	63.5	0.1065	0.7	0	0.15	0.07455	11.05833	167.2565	12.46897	12.46897
2	B	2	3	74	137.5	0.0899	0.7	0	0.15	0.13748	12.29167	165.4019	22.73946	10.27048
3	B	3	4	65.5	203	0.0905	0.7	0	0.15	0.20083	13.38333	163.7775	32.89144	10.15198
4	B	4	5	70	273	0.1155	0.7	0	0.15	0.28168	14.55	162.0591	45.64882	12.75738
5	B	5	6	70	343	0.0926	0.7	0	0.15	0.3465	15.71667	160.3588	55.56433	9.915505
6	B	6	7	69.5	412.5	0.0999	0.7	0	0.15	0.41643	16.875	158.6883	66.08255	10.51823
7	B	7	8	45	457.5	0.3218	0.7	2.3937	0.15	0.64169	17.625	157.6159	101.1405	35.058
8	B	8	9	107.5	565	0.1429	0.7	1.991	0.15	1.100775	19.41667	155.0834	273.8265	172.686
9	B	9	10	60	625	0.0995	0.7	0.888	0.15	1.469075	20.41667	153.6877	328.8933	55.06676
10	B	10	11	60	685	0.1349	0.7	1.7264	0.15	1.696705	21.41667	152.3045	361.5303	32.63706
11	B	11	12	64	749	0.1402	0.7	1.8155	0.15	2.053805	22.48333	150.8428	412.9163	51.38591
12	B	12	13	79.5	828.5	0.1468	0.7	1.1678	0.15	2.42889	23.80833	149.0466	465.1324	52.21618
13	B	13	14	69.5	898	0.429	0.7	0	0.15	2.90436	24.96667	147.4939	531.49	66.35759
14	B	14	15	70	968	0.1536	0.7	0	0.15	3.01188	26.13333	145.9464	542.6876	11.1976
15	B	15	16	70	1038	0.1309	0.7	0	0.15	3.10351	27.3	144.4151	551.3083	8.62071
16	B	16	17	70	1108	0.1472	0.7	0	0.15	3.20655	28.46667	142.8999	561.3303	10.02191
17	B	17	18	21.5	1129.5	0.0465	0.7	0	0.15	3.2391	28.825	142.4377	564.4846	3.154314
18	B	18	19	78	1207.5	0.1457	0.7	0	0.15	3.34109	30.125	140.7734	607.8898	43.40526
19	B	19	20	40	1247.5	0.0724	0.7	0	0.15	3.39177	30.79167	139.9275	662.1551	54.26526
20	B	20	21	70	1317.5	0.1657	0.7	0	0.15	3.50776	31.95833	138.4594	673.2354	11.08033
21	B	21	22	70	1387.5	0.1261	0.7	1.2	0.15	3.59603	33.125	137.0067	958.1574	284.9219
22	B	22	23	70	1457.5	0.1312	0.7	2.2855	0.15	3.86787	34.29167	135.5692	989.8412	31.68387
23	B	23	24	70	1527.5	0.129	0.7	1.8547	0.15	4.300995	35.45833	134.1468	1042.442	52.60064
24	B	24	25	70	1597.5	0.6039	0.7	1.25	0.15	5.00193	36.625	132.7393	1129.43	86.98804
25	B	25	26	70	1667.5	0.1198	0.7	1.193	0.15	5.27329	37.79167	131.3466	1158.106	28.67594
26	B	26	27	70	1737.5	0.1245	0.7	2.363	0.15	5.53939	38.95833	129.9685	1185.423	27.31748
27	B	27	28	70	1807.5	0.0695	0.7	2.11	0.15	5.94249	40.125	128.6048	1229.71	44.28686
28	B	28	29	70	1877.5	0.0499	0.7	1.704	0.15	6.29392	41.29167	127.2555	1266.413	36.70298
29	B	29	30	40	1917.5	0.0316	0.7	1.191	0.15	6.57164	41.95833	126.4908	1296.729	30.31617

NUMBER	LOCATION			LENGTH	LENGTH CO		C FACTOR Street	AREA of Lan	C Factor of land	SUM(AC) COMULATIVE	Tc	(i)	Q	Qi
	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
30	B	30	31	54.5	1972	0.1647	0.7	0.4	0.15	6.86558	42.86667	125.4563	1846.776	550.0465
31	B	31	32	48	2020	0	0.7	0.5	0.15	6.92558	43.66667	124.5522	1848.042	1.265953
32	B	32	33	69.5	2089.5	0	0.7	14.4767	0.15	7.00058	44.825	123.2547	1848.3	0.257958
33	B	33	34	70	2159.5	0	0.7	2.217	0.15	9.172085	45.99167	121.9615	2104.087	255.7868
34	B	34	35	70	2229.5	0	0.7	2.185	0.15	9.504635	47.15833	120.6819	2132.482	28.39585
35	B	35	36	69.5	2299	0	0.7	7.308	0.15	9.832385	48.31667	119.4246	2159.675	27.19211
36	B	36	37	70	2369	0	0.7	4.085	0.15	10.928585	49.48333	118.1716	2276.894	117.2196
37	B	37	38	69.5	2438.5	0	0.7	5.192	0.15	11.541335	50.64167	116.9406	2335.096	58.2016
38	B	38	39	70	2508.5	0	0.7	4.2127	0.15	12.320135	51.80833	115.7136	2411.053	75.95709
39	B	39	40	70	2578.5	0	0.7	10	0.15	12.95204	52.975	114.4995	2468.448	57.39521
40	B	40	41	70	2648.5	0	0.7	2.392	0.15	14.45204	54.14167	113.2982	2622.836	154.3875
41	B	41	42	70	2718.5	0	0.7	2.1331	0.15	14.81084	55.30833	112.1095	2645.881	23.0452
42	B	42	43	70	2788.5	0	0.7	1.1335	0.15	15.130805	56.475	110.9332	2663.954	18.07328
43	B	43	44	70	2858.5	0	0.7	1.1337	0.15	15.30083	57.64167	109.7693	2665.006	1.052432
44	B	44	45	70	2928.5	0	0.7	1.0337	0.15	15.470885	58.80833	108.6176	2665.855	0.848829

NUMBER	LOCATION			LENGTH	LENGTH CO	AREA of Stre	C FACTOR Street	AREA of Land	C Factor of land	SUM(AC) CUMULATIVE	Tc	(i)	Q	Qi
	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
1	C	1	2	88	88	0.1753	0.7	0	0.15	0.12271	11.46667	166.6402	20.44842	20.44842
2	C	2	3	52.5	140.5	0.0209	0.7	0	0.15	0.13734	12.34167	165.3272	22.70603	2.257614
3	C	3	4	70	210.5	0.0336	0.7	0	0.15	0.16086	13.50833	163.5925	26.3155	3.609462
4	C	4	5	53.5	264	0.3915	0.7	0	0.15	0.43491	14.4	162.2791	70.57679	44.26129
5	C	5	6	52.5	316.5	0.0342	0.7	0	0.15	0.45885	15.275	161.0004	73.87503	3.298244
6	C	6	7	65.5	382	0.0496	0.7	0	0.15	0.49357	16.36667	159.4192	78.68455	4.809513
7	C	7	8	40	422	0.026	0.7	0	0.15	0.51177	17.03333	158.4613	81.09572	2.411177
8	C	8	9	32	454	0.0184	0.7	0	0.15	0.52465	17.56667	157.699	82.73681	1.641083
9	C	9	10	81	535	0.0501	0.7	0	0.15	0.55972	18.91667	155.786	87.19656	4.45975
10	C	10	11	70	605	0.0487	0.7	0	0.15	0.59381	20.08333	154.1515	91.5367	4.340149
11	C	11	12	85	690	0.0365	0.7	0	0.15	0.61936	21.5	152.1898	94.26025	2.723548
12	C	12	13	108.5	798.5	0.0977	0.7	0	0.15	0.68775	23.30833	149.7219	102.9712	8.710978
13	C	13	8 B	11	809.5	0.003	0.7	0	0.15	0.68985	23.49167	149.4739	103.1146	0.143365

	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	LENGTH	LENGTH C	AREA of St	C FACTOR Street	AREA of Lan	C Factor of land	SUM(AC) COMULATIVE	Tc	(I)	Q	Qi
1				(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
2	D	1	2	94.5	94.5	0.2546	0.7	0	0.15	0.17822	11.575	166.4771	29.66954	29.66954
3	D	2	3	70	164.5	0.0394	0.7	0	0.15	0.2058	12.74167	164.7304	33.90151	4.231968
4	D	3	4	69.5	234	0.0287	0.7	0	0.15	0.22589	13.9	163.0143	36.8233	2.921786
5	D	4	5	72	306	0.0279	0.7	0	0.15	0.24542	15.1	161.2553	39.57528	2.751984
6	D	5	6	43	349	0.0192	0.7	0	0.15	0.25886	15.81667	160.2139	41.47297	1.897687
7	D	6	7	41	390	0.0158	0.7	0	0.15	0.26992	16.5	159.2272	42.9786	1.505629
8	D	7	8	52.5	442.5	0.0228	0.7	0	0.15	0.28588	17.375	157.9725	45.16119	2.182594
	D	8	19 B	69	511.5	0.0485	0.7	0	0.15	0.31983	18.525	156.3386	50.00179	4.840595

NUMBER	LOCATION			LENGTH	LENGTH CO	AREA of St	C FACTOR Street	AREA of Lan	C Factor of land	SUM(AC) COMULATIVE	Tc	(i)	Q	Qi
	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
1	E	1	2	86.5	86.5	0.0643	0.7	0	0.15	0.04501	11.44167	166.6779	7.502171	7.502171
2	E	2	3	77	163.5	0.038	0.7	0	0.15	0.07161	12.725	164.7552	11.79812	4.295949
3	E	3	4	31.5	195	0.0268	0.7	0	0.15	0.09037	13.25	163.9751	14.81843	3.020306
4	E	4	5	53	248	0.0192	0.7	0	0.15	0.10381	14.13333	162.6708	16.88685	2.068427
5	E	5	6	84	332	0.0326	0.7	0	0.15	0.12663	15.53333	160.6248	20.33992	3.453068
6	E	6	7	55.5	387.5	0.0373	0.7	0	0.15	0.15274	16.45833	159.2872	24.32952	3.989601
7	E	7	8	68.5	456	0.0214	0.7	0	0.15	0.16772	17.6	157.6515	26.44131	2.111794
8	E	8	9	32.5	488.5	0.01	0.7	0	0.15	0.17472	18.14167	156.8814	27.41032	0.969001
9	E	9	10	63.5	552	0.0292	0.7	0	0.15	0.19516	19.2	155.3875	30.32542	2.915106
10	E	10	11	42	594	0.0163	0.7	0	0.15	0.20657	19.9	154.4072	31.8959	1.570477
11	E	11	18 B	72	666	0.027	0.7	0	0.15	0.22547	21.1	152.7411	34.43854	2.542642

[illegible]	LINE [illegible]	UPPER [illegible] NO	LOWER [illegible] NO	LEN[illegible]	LENGTH[illegible]	AREA [illegible]	C FACTOR Street	AREA of La[illegible]	C Factor of land	SUM(AC) COMULATIVE	Tc	(i)	Q	Qi
				(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
1	F	1	2	69.5	69.5	0.1017	0.7	1.532	0.15	0.30099	11.15833	167.1054	50.29704	50.29704
2	F	2	3	70	139.5	0.0511	0.7	1.098	0.15	0.56656	12.325	165.3521	93.68187	43.38483
3	F	3	4	69.5	209	0.44	0.7	1.0849	0.15	1.03926	13.48333	163.6295	170.0536	76.37174
4	F	4	5	69	278	0.0363	0.7	0.2424	0.15	1.227405	14.63333	161.9371	198.7624	28.70879
5	F	5	6	70	348	0.0406	0.7	0.4	0.15	1.292185	15.8	160.238	207.0572	8.294784
6	F	6	7	59	407	0.0664	0.7	2.318	0.15	1.398665	16.78333	158.8198	222.1357	15.07854
7	F	7	21 B	13	420	0.01	0.7	0	0.15	1.753365	17	158.509	277.9242	55.78845

NUMBER	LOCATION			LENGTH	LENGTH CO	AREA of Str	C FACTOR Street	AREA of Lan	C Factor of land	SUM(AC) COMULATIVE	Tc	(I)	Q	Qi
	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
1	G	1	2	62.5	62.5	0.085	0.7	0.54	0.15	0.1405	11.04167	167.2817	23.50308	23.50308
2	G	2	3	70	132.5	0.078	0.7	1.032	0.15	0.281	12.20833	165.5266	46.51297	23.00989
3	G	3	4	69.5	202	0.0348	0.7	1.022	0.15	0.4904	13.36667	163.8022	80.3286	33.81563
4	G	4	5	69.5	271.5	0.0415	0.7	0.544	0.15	0.66806	14.525	162.0958	108.2897	27.96111
5	G	5	6	82.5	354	0.1645	0.7	0.597	0.15	0.77871	15.9	160.0932	124.6662	16.3765
6	G	6	7	101	455	0.0688	0.7	1.31	0.15	0.98341	17.58333	157.6753	155.0595	30.39325
7	G	7	8	105.5	560.5	0.0748	0.7	0	0.15	1.22807	19.34167	155.1886	190.5825	35.52301
8	G	8	9	56.5	617	0.0748	0.7	0	0.15	1.28043	20.28333	153.873	197.0236	6.44118
9	G	9	10	32	649	0.042	0.7	0	0.15	1.33279	20.81667	153.1329	204.094	7.070329
10	G	10	11	21	670	0.0733	0.7	0	0.15	1.36219	21.16667	152.6491	207.9371	3.843097
11	G	11	12	84.5	754.5	0.0121	0.7	1.35	0.15	1.4135	22.575	150.7178	213.0396	5.102581
12	G	12	11B	7.5	762	0.0372	0.7	0	0.15	1.62447	22.7	150.5476	244.5601	31.52041

NUMBER	LOCATION			LENGTH	LENGTH CO	AREA of Stre	C FACTOR Street	AREA of Land	C Factor of land	SUM(AC) COMULATIVE	Tc	(i)	Q	Qi
	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
1	H	1	2	105	105	0.0843	0.7	0	0.15	0.05901	11.75	166.2139	9.808282	9.808282
2	H	2	3	62.5	167.5	0.0486	0.7	0	0.15	0.09303	12.79167	164.6559	15.31794	5.509659
3	H	3	4	57	224.5	0.0446	0.7	0	0.15	0.12425	13.74167	163.2478	20.28354	4.965598
4	H	4	5	90.5	315	0.0961	0.7	0	0.15	0.19152	15.25	161.0368	30.84177	10.55823
5	H	5	6	65	380	0.3354	0.7	0	0.15	0.4263	16.33333	159.4673	67.9809	37.13913
6	H	6	7	75	455	0.0815	0.7	0	0.15	0.48335	17.58333	157.6753	76.21235	8.231452
7	H	7	8	70	525	0.0492	0.7	0	0.15	0.51779	18.75	156.0209	80.78608	4.573733
8	H	8	9	82	607	0.0612	0.7	0	0.15	0.56063	20.11667	154.1051	86.39592	5.609834
9	H	9	10	57.5	664.5	0.0466	0.7	0	0.15	0.59325	21.075	152.7757	90.63415	4.238237
10	H	10	11	81.5	746	0.0728	0.7	0	0.15	0.64421	22.43333	150.911	97.21837	6.584211
11	H	11	12	58.5	804.5	0.159	0.7	1.0193	0.15	0.75551	23.40833	149.5866	357.5743	260.3559
12	H	12	13	70	874.5	0.0532	0.7	1.4283	0.15	0.945645	24.575	148.0171	384.5317	26.95748
13	H	13	14	85	959.5	0.0941	0.7	1.718	0.15	1.22576	25.99167	146.1334	423.6846	39.15288
14	H	14	15	60	1019.5	0.0487	0.7	0.4025	0.15	1.51755	26.99167	144.8182	464.329	40.64439
15	H	15	16	64.5	1084	0.0454	0.7	0.44	0.15	1.609705	28.06667	143.4176	475.4201	11.0911
16	H	16	17	63.5	1147.5	0.1044	0.7	1.27	0.15	1.748785	29.125	142.0519	492.9783	17.55822
17	H	17	30 B	6.5	1154	0.002	0.7	0	0.15	1.940685	29.23333	141.9128	519.9682	26.98989

NUMBER	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	LENGTH (m)	LENGTH CO (m)	AREA of St (ha)	C FACTOR Street	AREA of Land	C Factor of land	SUM(AC) COMULATIVE (ha)	Tc (min)	(I) (l/s.ha)	Q (l/s)	Qi (l/s)
1	I	1	2	70	70	0.1791	0.7	0	0.15	0.12537	11.16667	167.0928	20.94842	20.94842
2	I	2	3	70	140	0.1014	0.7	0	0.15	0.19635	12.33333	165.3396	32.46444	11.51601
3	I	3	4	86.5	226.5	0.1014	0.7	0	0.15	0.26733	13.775	163.1986	43.62789	11.16345
4	I	4	5	52.5	279	0.0421	0.7	0	0.15	0.2968	14.65	161.9127	48.05569	4.427804
5	I	5	6	57.5	336.5	0.094	0.7	0	0.15	0.3626	15.60833	160.5159	58.20308	10.14739
6	I	6	7	82.5	419	0.108	0.7	0	0.15	0.4382	16.98333	158.5329	69.46912	11.26604
7	I	7	8	70	489	0.0638	0.7	0	0.15	0.48286	18.15	156.8696	75.74604	6.276918
8	I	8	9	83.5	572.5	0.1642	0.7	0	0.15	0.5978	19.54167	154.9082	92.60415	16.85811
9	I	9	10	56	628.5	0.1764	0.7	0	0.15	0.72128	20.475	153.6066	110.7934	18.18924
10	I	10	11	82	710.5	0.078	0.7	0	0.15	0.77588	21.84167	151.7204	117.7168	6.923427
11	I	11	12	77.5	788	0.3164	0.7	0	0.15	0.99736	23.13333	149.959	149.5631	31.84625
12	I	12	13	50.5	838.5	0.0262	0.7	0	0.15	1.0157	23.975	148.8222	151.1587	1.595649
13	I	13	14	70.5	909	0.0588	0.7	0	0.15	1.05686	25.15	147.2497	155.6223	4.463554
14	I	14	15	70	979	0.1652	0.7	0	0.15	1.1725	26.31667	145.7047	170.8388	15.21649
15	I	15	16	70	1049	0.0309	0.7	0	0.15	1.19413	27.48333	144.1759	172.1648	1.326068
16	I	16	17	53	1102	0.0269	0.7	0	0.15	1.21296	28.36667	143.0291	173.4886	1.323807
17	I	17	18	85.5	1187.5	0.0974	0.7	0	0.15	1.28114	29.79167	141.1983	180.8948	7.406172
18	I	18	19	74.5	1262	0.0343	0.7	0	0.15	1.30515	31.03333	139.6221	182.2278	1.333032
19	I	19	20	44	1306	0.1108	0.7	0	0.15	1.38271	31.76667	138.6995	191.7812	9.553382
20	I	20	21	105.5	1411.5	0.1007	0.7	0	0.15	1.4532	33.525	136.5121	198.3794	6.598164
21	I	21	22	56.5	1468	0.019	0.7	0	0.15	1.4665	34.46667	135.3549	198.4979	0.118512
22	I	22	23	61	1529	0.0209	0.7	0	0.15	1.48113	35.48333	134.1164	198.6439	0.146005
23	I	23	24	79.5	1608.5	0.0278	0.7	0.9291	0.15	1.50059	36.80833	132.5195	198.8574	0.213472
24	I	24	25	68.5	1677	0.0355	0.7	0.525	0.15	1.664805	37.95	131.1587	218.3536	19.49627
25	I	25	26	71.5	1748.5	0.0426	0.7	1.0228	0.15	1.773375	39.14167	129.7532	230.1011	11.74749
26	I	26	27	64.5	1813	0.0628	0.7	1.3222	0.15	1.970755	40.21667	128.4983	253.2386	23.13752
27	I	27	28	21	1834	0.0127	0.7	0	0.15	2.177975	40.56667	128.0923	278.9819	25.74325
28	I	28	29	133.5	1967.5	0.1684	0.7	0.20478	0.15	2.295855	42.79167	125.5414	288.2249	9.242985
29	I	29	30	62	2029.5	0.0595	0.7	0.9473	0.15	2.368222	43.825	124.3741	294.5454	6.320489

NUMBER	LOCATION			LENGTH	LENGTH CO	AREA of Str	C FACTOR Street	AREA of Land	C Factor of land	SUM(AC) COMULATIVE	Tc	(i)	Q	Qi
	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
30	I	30	31	61	2090.5	0.0842	0.7	1.2453	0.15	2.569257	44.84167	123.2361	316.6252	22.07988
31	I	31	32	79.5	2170	0.0815	0.7	1.5715	0.15	2.813102	46.16667	121.7687	342.5477	25.92246
32	I	32	33	68.5	2238.5	0.058	0.7	1.4715	0.15	3.089427	47.30833	120.5183	372.3325	29.78479
33	I	33	34	71.5	2310	0.0718	0.7	1.3548	0.15	3.360412	48.5	119.2269	400.6514	28.31888
34	I	34	35	64.5	2374.5	0.0725	0.7	0.944	0.15	3.614382	49.575	118.0737	426.7636	26.1122
35	I	35	36	21	2395.5	0.0707	0.7	1.4664	0.15	3.805472	49.925	117.7007	447.9067	21.14317
36	I	36	37	133.5	2529	0.069	0.7	2.0323	0.15	4.073732	52.15	115.3567	469.9324	22.02568
37	I	37	38	62	2591	0.0604	0.7	1.8341	0.15	4.420857	53.18333	114.2841	505.2336	35.30115
38	I	38	39	70.5	2661.5	0.0577	0.7	1.8284	0.15	4.735507	54.35833	113.0765	535.4745	30.24089
39	I	39	40	69	2730.5	0.0584	0.7	1.6175	0.15	5.019012	55.50833	111.9069	561.6622	26.18776
40	I	40	41	49	2779.5	0.0409	0.7	1.3438	0.15	5.249212	56.325	111.0837	583.1021	21.43984
41	I	41	42	90.5	2870	0	0.7	2.4045	0.15	5.609887	57.83333	109.5792	614.7271	31.62501

NUMBE	LINE NAME	UPPER MH NO.	LOWER MH NO.	LENGT	LENGTH	AREA of S	C FACTOR Street	AREA of Land	C Factor of land	SUM(AC) COMULATIVE	Tc	(i)	Q	Qi
				(m)	(m)	(ha)				(ha)	(min)	(l/s.ha)	(l/s)	(l/s)
1	J	1	2	69.5	69.5	0.0293	0.7	0	0.15	0.02051	11.15833	167.1054	3.427331	3.427331
2	J	2	3	94	163.5	0.0358	0.7	0.5726	0.15	0.04557	12.725	164.7552	7.507894	4.080563
3	J	3	4	68.5	232	0.0227	0.7	0.3507	0.15	0.14735	13.86667	163.0634	24.0274	16.5195
4	J	4	5	39.5	271.5	0.0136	0.7	0.194	0.15	0.209475	14.525	162.0958	33.95501	9.927618
5	J	5	6	58.5	330	0.0374	0.7	0.32	0.15	0.264755	15.5	160.6732	42.53904	8.584027
6	J	6	7	93.5	423.5	0.0584	0.7	0.257	0.15	0.353635	17.05833	158.4255	56.02479	13.48575
7	J	7	8	73.5	497	0.0315	0.7	0.168	0.15	0.414235	18.28333	156.6806	64.90258	8.877797
8	J	8	9	21.5	518.5	0.011	0.7	0.105	0.15	0.447135	18.64167	156.1738	69.83078	4.928201
9	J	9	10	48.5	567	0.0199	0.7	0.37	0.15	0.476815	19.45	155.0367	73.92381	4.09303
10	J	10	27 A	44.5	611.5	0.0173	0.7	0	0.15	0.544425	20.19167	154.0006	83.84178	9.917963

... Report For Al HALHUL Twon (Line A)

Manhole Report

Label	Ground Elevation (m)	Rim Elevation (m)	Sump Elevation (m)	Manhole Diameter (m)	Manhole Depth (m)
MH-1	990	990	988.25	1.2	1.75
MH-2	990	990	988.02	1.2	1.98
MH-3	990	990	987.64	1.2	2.36
MH-4	990	990	987.26	1.2	2.74
MH-5	990	990	986.88	1.2	3.12
MH-6	989.82	989.82	986.5	1.2	3.32
MH-7	989.48	989.48	986.12	1.2	3.36
MH-8	988.87	988.87	985.74	1.2	3.13
MH-9	987.18	987.18	985.04	1.2	2.14
MH-10	985	985	982.86	1.2	2.14
MH-11	984.51	984.51	982.37	1.2	2.14
MH-12	983.97	983.97	981.83	1.2	2.14
MH-13	983	983	980.86	1.2	2.14
MH-14	982.22	982.22	979.96	1.2	2.26
MH-15	982.8	982.8	979.27	1.2	3.53
MH-16	979.75	979.75	975.67	1.2	4.08
MH-17	975.13	975.13	972.84	1.2	2.29
MH-18	975	975	972.46	1.2	2.54
MH-19	975.15	975.15	972.1	1.2	3.05
MH-20	975	975	971.56	1.2	3.44
MH-21	975.33	975.33	971.32	1.2	4.01
MH-22	972.74	972.74	969.81	1.2	2.93
MH-23	970	970	967.56	1.2	2.44
MH-24	968.7	968.7	966.26	1.2	2.44
MH-25	967.99	967.99	965.55	1.2	2.44
MH-26	967	967	964.56	1.2	2.44
MH-27	965.32	965.32	962.88	1.2	2.44
MH-28	965	965	962.01	1.2	2.99
MH-29	961.84	961.84	959.18	1.2	2.66
MH-30	958.11	958.11	955.09	1.2	3.02
MH-31	955.38	955.38	952.94	1.2	2.44
MH-32	952.5	952.5	950.06	1.2	2.44
MH-33	951.44	951.44	949	1.2	2.44
MH-34	949.9	949.9	947.46	1.2	2.44
MH-35	947.71	947.71	945.27	1.2	2.44
MH-36	945.53	945.53	943.09	1.2	2.44
MH-37	943.79	943.79	941.35	1.2	2.44
MH-38	942.19	942.19	939.75	1.2	2.44
MH-39	940	940	937.59	1.2	2.41

Pipe Report

Label	Upstream Manhole	Downstream Manhole	Length (m)	Total Flow (l/s)	Section Shape	Section Size (mm)	Average Velocity (m/s)	Constructed Slope (m/m)	Average Pipe Cover (m)	Material
P-1	MH-1	MH-2	40	42.869	Circular	250mm	1.24	0.005	1.6	PVC
P-2	MH-2	MH-3	70	111.358	Circular	375mm	1.58	0.005	1.78	PVC
P-3	MH-3	MH-4	70	154.733	Circular	450mm	1.4	0.005	2.08	Concrete
P-4	MH-4	MH-5	70	186.304	Circular	525mm	1.48	0.005	2.39	Concrete
P-5	MH-5	MH-6	70	229.844	Circular	525mm	1.55	0.005	2.68	Concrete
P-6	MH-6	MH-7	70	264.937	Circular	525mm	1.59	0.005	2.8	Concrete
P-7	MH-7	MH-8	70	322.101	Circular	600mm	1.68	0.005	2.62	Concrete
P-8	MH-8	MH-9	70	366.884	Circular	600mm	2.23	0.009509	2.01	Concrete
P-9	MH-9	MH-10	70	402.583	Circular	600mm	3.53	0.030714	1.52	Concrete
P-10	MH-10	MH-11	70	429.091	Circular	600mm	1.99	0.006571	1.52	Concrete
P-11	MH-11	MH-12	42	449.98	Circular	600mm	2.56	0.012143	1.52	Concrete
P-12	MH-12	MH-13	98	469.487	Circular	600mm	2.36	0.009592	1.52	Concrete
P-13	MH-13	MH-14	70	490.067	Circular	600mm	2.64	0.012463	1.58	Concrete
P-14	MH-14	MH-15	95.5	536.168	Circular	750mm	2.17	0.006911	2.12	Concrete
P-15	MH-15	MH-16	44.5	653.908	Circular	750mm	4.38	0.04	2.13	Concrete
P-16	MH-16	MH-17	70	654.442	Circular	750mm	4.38	0.04	2.41	Concrete
P-17	MH-17	MH-18	70	667.863	Circular	750mm	2.01	0.005	1.64	Concrete
P-18	MH-18	MH-19	65.5	820.102	Circular	900mm	2.14	0.005	1.87	Concrete
P-19	MH-19	MH-20	102	820.398	Circular	900mm	2.14	0.005	2.32	Concrete
P-20	MH-20	MH-21	41.5	882.423	Circular	900mm	2.17	0.005	2.79	Concrete
P-21	MH-21	MH-22	52.5	890.343	Circular	900mm	4.15	0.028331	2.54	Concrete
P-22	MH-22	MH-23	55.5	914.461	Circular	900mm	4.74	0.04	1.76	Concrete
P-23	MH-23	MH-24	65	933.162	Circular	900mm	3.67	0.019538	1.52	Concrete
P-24	MH-24	MH-25	36.5	946.662	Circular	900mm	3.62	0.01863	1.52	Concrete
P-25	MH-25	MH-26	52	947.536	Circular	900mm	3.61	0.018462	1.52	Concrete
P-26	MH-26	MH-27	78	949.236	Circular	900mm	3.8	0.021154	1.52	Concrete
P-27	MH-27	MH-28	15	1,048.40	Circular	900mm	3.77	0.019333	1.52	Concrete
P-28	MH-28	MH-29	64.5	1,049.14	Circular	900mm	4.92	0.04	1.79	Concrete
P-29	MH-29	MH-30	87	1,050.51	Circular	900mm	4.92	0.04	1.62	Concrete
P-30	MH-30	MH-31	53	1,051.58	Circular	900mm	4.93	0.04	1.8	Concrete
P-31	MH-31	MH-32	87.5	1,052.16	Circular	900mm	4.57	0.032571	1.52	Concrete
P-32	MH-32	MH-33	50.5	1,618.38	Circular	900mm	4.29	0.020396	1.52	Concrete
P-33	MH-33	MH-34	72	1,695.38	Circular	900mm	4.39	0.020972	1.52	Concrete
P-34	MH-34	MH-35	70	1,703.42	Circular	900mm	4.09	0.030857	1.52	Concrete
P-35	MH-35	MH-36	70	1,919.50	Circular	900mm	4.23	0.030714	1.52	Concrete
P-36	MH-36	MH-37	70	2,352.79	Circular	900mm	4.99	0.024429	1.52	Concrete
P-37	MH-37	MH-38	70	2,354.38	Circular	900mm	4.82	0.022429	1.52	Concrete
P-38	MH-38	MH-39	96	2,355.89	Circular	900mm	4.83	0.0225	1.52	Concrete

Manhole Report

Label	Ground Elevation (m)	Rim Elevation (m)	Sump Elevation (m)	Manhole Diameter (m)	Manhole Depth (m)
MH-1	1,005.00	1,005.00	1,003.25	1.2	1.75
MH-2	1,005.00	1,005.00	1,002.90	1.2	2.1
MH-3	1,005.00	1,005.00	1,002.50	1.2	2.5
MH-4	1,001.64	1,001.64	999.86	1.2	1.78
MH-5	997.39	997.39	995.61	1.2	1.78
MH-6	992.64	992.64	990.86	1.2	1.78
MH-7	988.49	988.49	986.71	1.2	1.78
MH-8	986.26	986.26	984.46	1.2	1.8
MH-9	975.61	975.61	970.52	1.2	5.09
MH-10	970	970	965.52	1.2	4.48
MH-11	965	965	959.96	1.2	5.04
MH-12	960	960	954.63	1.2	5.37
MH-13	953.41	953.41	948.63	1.2	4.78
MH-14	947.81	947.81	945.78	1.2	2.03
MH-15	945	945	942.74	1.2	2.26
MH-16	945	945	942.36	1.2	2.64
MH-17	945	945	941.98	1.2	3.02
MH-18	944.38	944.38	941.84	1.2	2.54
MH-19	942.18	942.18	939.89	1.2	2.29
MH-20	941.57	941.57	939.28	1.2	2.29
MH-21	938.72	938.72	936.43	1.2	2.29
MH-22	934.25	934.25	931.96	1.2	2.29
MH-23	930.49	930.49	928.2	1.2	2.29
MH-24	926.79	926.79	924.5	1.2	2.29
MH-25	924.28	924.28	921.99	1.2	2.29
MH-26	922.9	922.9	920.61	1.2	2.29
MH-27	921.51	921.51	919.22	1.2	2.29
MH-28	920.12	920.12	917.55	1.2	2.57
MH-29	920	920	917.13	1.2	2.87
MH-30	920	920	918.52	1.2	1.48
MH-31	910	910	905.98	1.2	4.02
MH-32	906.63	906.63	903.39	1.2	3.24
MH-33	903.18	903.18	900.58	1.2	2.6
MH-34	900.48	900.48	897.66	1.2	2.82
MH-35	897.43	897.43	894.67	1.2	2.76
MH-36	894.46	894.46	891.86	1.2	2.6
MH-37	892.01	892.01	889.41	1.2	2.6
MH-38	889.8	889.8	887.2	1.2	2.6
MH-39	888.66	888.66	886.06	1.2	2.6
MH-40	887.53	887.53	884.93	1.2	2.6
MH-41	886.4	886.4	883.8	1.2	2.6
MH-42	885.26	885.26	882.66	1.2	2.6
MH-43	883.66	883.66	881.06	1.2	2.6
MH-44	881.92	881.92	879.32	1.2	2.6

Pipe Report

Label	Upstream Manhole	Downstream Manhole	Length (m)	Total Flow (l/s)	Section Shape	Section Size (mm)	Average Velocity (m/s)	Constructed Slope (m/m)	Average Pipe Cover (m)	Material
P-1	MH-1	MH-2	63.5	12.468	Circular	250 mm	1.66	0.005	1.66	PVC
P-2	MH-2	MH-3	74	22.738	Circular	250 mm	2.03	0.005	2.03	PVC
P-3	MH-3	MH-4	65.5	32.889	Circular	250 mm	1.87	0.039885	1.87	PVC
P-4	MH-4	MH-5	70	45.646	Circular	250 mm	1.52	0.060286	1.52	PVC
P-5	MH-5	MH-6	70	55.561	Circular	250 mm	1.52	0.067429	1.52	PVC
P-6	MH-6	MH-7	69.5	66.079	Circular	250 mm	1.52	0.059281	1.52	PVC
P-7	MH-7	MH-8	45	101.137	Circular	250 mm	1.53	0.049351	1.53	PVC
P-8	MH-8	MH-9	107.5	273.823	Circular	300 mm	3.13	0.12936	3.13	PVC
P-9	MH-9	MH-10	60	328.889	Circular	375 mm	3.1	0.04	3.1	PVC
P-10	MH-10	MH-11	60	361.526	Circular	375 mm	2.8	0.04	2.8	PVC
P-11	MH-11	MH-12	64	412.915	Circular	450 mm	3.04	0.03	3.04	Concrete
P-12	MH-12	MH-13	79.5	465.131	Circular	450 mm	3.2	0.04	3.2	Concrete
P-13	MH-13	MH-14	69.5	531.488	Circular	450 mm	2.91	0.04	2.91	Concrete
P-14	MH-14	MH-15	70	542.685	Circular	525 mm	1.6	0.04298	1.6	Concrete
P-15	MH-15	MH-16	70	551.305	Circular	750 mm	1.68	0.005	1.68	Concrete
P-16	MH-16	MH-17	70	561.326	Circular	750 mm	2.06	0.005	2.06	Concrete
P-17	MH-17	MH-18	21.5	564.48	Circular	750 mm	2	0.005	2	Concrete
P-18	MH-18	MH-19	78	607.865	Circular	750 mm	1.64	0.024647	1.64	Concrete
P-19	MH-19	MH-20	40	662.15	Circular	750 mm	1.52	0.0145	1.52	Concrete
P-20	MH-20	MH-21	70	673.2	Circular	750 mm	1.52	0.040286	1.52	Concrete
P-21	MH-21	MH-22	70	958.121	Circular	750 mm	1.52	0.063429	1.52	Concrete
P-22	MH-22	MH-23	70	989.804	Circular	750 mm	1.52	0.053286	1.52	Concrete
P-23	MH-23	MH-24	70	1,042.40	Circular	750 mm	1.52	0.052429	1.52	Concrete
P-24	MH-24	MH-25	70	1,129.39	Circular	750 mm	1.52	0.035429	1.52	Concrete
P-25	MH-25	MH-26	70	1,158.07	Circular	750 mm	1.52	0.019286	1.52	Concrete
P-26	MH-26	MH-27	70	1,185.38	Circular	750 mm	1.52	0.019429	1.52	Concrete
P-27	MH-27	MH-28	70	1,229.67	Circular	750 mm	1.65	0.023354	1.65	Concrete
P-28	MH-28	MH-29	70	1,266.37	Circular	1050 mm	1.64	0.00564	1.64	Concrete
P-29	MH-29	MH-30	40	1,296.69	Circular	1050 mm	1.9	0.005	1.9	Concrete
P-30	MH-30	MH-31	54.5	1,846.73	Circular	1050 mm	5.95	0.02	4.95	Concrete
P-31	MH-31	MH-32	48	1,848.00	Circular	1050 mm	2.22	0.04	2.22	Concrete
P-32	MH-32	MH-33	69.5	1,848.26	Circular	1050 mm	1.83	0.04	1.83	Concrete
P-33	MH-33	MH-34	70	2,104.04	Circular	1050 mm	1.52	0.038143	1.52	Concrete
P-34	MH-34	MH-35	70	2,132.44	Circular	1050 mm	1.62	0.04	1.62	Concrete
P-35	MH-35	MH-36	69.5	2,159.63	Circular	1050 mm	1.59	0.04	1.59	Concrete
P-36	MH-36	MH-37	70	2,276.85	Circular	1050 mm	1.52	0.034571	1.52	Concrete
P-37	MH-37	MH-38	69.5	2,335.05	Circular	1050 mm	1.52	0.031387	1.52	Concrete
P-38	MH-38	MH-39	70	2,411.00	Circular	1050 mm	1.52	0.015857	1.52	Concrete
P-39	MH-39	MH-40	70	2,468.40	Circular	1050 mm	1.52	0.015714	1.52	Concrete
P-40	MH-40	MH-41	70	2,622.79	Circular	1050 mm	1.52	0.015714	1.52	Concrete
P-41	MH-41	MH-42	70	2,645.83	Circular	1050 mm	1.52	0.015857	1.52	Concrete
P-42	MH-42	MH-43	70	2,663.90	Circular	1050 mm	1.52	0.022429	1.52	Concrete
P-43	MH-43	MH-44	70	2,664.96	Circular	1050 mm	1.52	0.024429	1.52	Concrete
P-44	MH-44	MH-45	70	2,665.80	Circular	1050 mm	1.52	0.024571	1.52	Concrete

Table (C) Sanitary Sewer Design Report For As HALHUL Twon (Line C)

Manhole Report					
Label	Ground Elevation (m)	Rim Elevation (m)	Sump Elevation (m)	Manhole Diameter (m)	Manhole Depth (m)
MH-1	987.46	987.46	985.71	1.2	1.75
MH-2	986.88	986.88	985.13	1.2	1.75
MH-3	987.22	987.22	984.86	1.2	2.36
MH-4	987.37	987.37	984.51	1.2	2.86
MH-5	985.5	985.5	983.7	1.2	1.8
MH-6	985.74	985.74	983.43	1.2	2.31
MH-7	986.46	986.46	983.11	1.2	3.35
MH-8	985.76	985.76	982.91	1.2	2.85
MH-9	985.19	985.19	982.75	1.2	2.44
MH-10	985.06	985.06	982.34	1.2	2.72
MH-11	985.7	985.7	981.99	1.2	3.71
MH-12	985.9	985.9	981.57	1.2	4.33
MH-13	986.26	986.26	981.02	1.2	5.24
MH-8B	986.26	986.26	980.97	1.2	5.29

Pipe Report										
Label	Upstream Manhole	Downstream Manhole	Length (m)	Total Flow (l/s)	Section Shape	Section Size (mm)	Average Velocity (m/s)	Constructed Slope (m/m)	Average Pipe Cover (m)	Material
P-1	MH-1	MH-2	88	20.448	Circular	250 mm	1.14	0.006591	1.5	PVC
P-2	MH-2	MH-3	52.5	22.705	Circular	250 mm	1.06	0.005	1.8	PVC
P-3	MH-3	MH-4	70	26.314	Circular	250 mm	1.1	0.005	2.35	PVC
P-4	MH-4	MH-5	53.5	70.575	Circular	250 mm	2.13	0.015295	2.08	PVC
P-5	MH-5	MH-6	52.5	73.873	Circular	300 mm	1.41	0.005	1.75	PVC
P-6	MH-6	MH-7	65.5	78.682	Circular	375 mm	1.45	0.005	2.45	PVC
P-7	MH-7	MH-8	40	81.093	Circular	375 mm	1.46	0.005	2.72	PVC
P-8	MH-8	MH-9	32	82.734	Circular	375 mm	1.47	0.005	2.27	PVC
P-9	MH-9	MH-10	81	87.193	Circular	375 mm	1.49	0.005	2.2	PVC
P-10	MH-10	MH-11	70	91.533	Circular	375 mm	1.51	0.005	2.83	PVC
P-11	MH-11	MH-12	85	94.256	Circular	375 mm	1.52	0.005	3.64	PVC
P-12	MH-12	MH-13	108.5	102.966	Circular	375 mm	1.55	0.005	4.41	PVC
P-13	MH-13	MH-8B	11	103.109	Circular	375 mm	1.55	0.005	4.88	PVC

Table (D) Sanitary Sewer Design Report For As HALHUL Twon (Line D)

Manhole Report						Pipe Report											
Label	Ground Elevation (m)	Rim Elevation (m)	Sump Elevation (m)	Manhole Diameter (m)	Manhole Depth (m)	Label	Upstream Manhole	Downstream Manhole	Length (m)	Total Flow (l/s)	Section Shape	Section Size (mm)	Average Velocity (m/s)	Constructed Slope (m/m)	Average Pipe Cover (m)	Material
MH-1	995.17	995.17	993.42	1.2	1.75	P-1	MH-1	MH-2	94.5	29.669	Circular	250 mm	2.45	0.040847	1	PVC
MH-2	991.31	991.31	989.53	1.2	1.78	P-2	MH-2	MH-3	70	33.9	Circular	250 mm	3.15	0.074571	1.52	PVC
MH-3	986.06	986.06	984.28	1.2	1.78	P-3	MH-3	MH-4	69.5	36.821	Circular	250 mm	3.68	0.108345	1.52	PVC
MH-4	978.5	978.5	976.72	1.2	1.78	P-4	MH-4	MH-5	72	39.572	Circular	250 mm	3.79	0.110833	1.52	PVC
MH-5	970.49	970.49	968.71	1.2	1.78	P-5	MH-5	MH-6	43	41.469	Circular	250 mm	4.03	0.126977	1.52	PVC
MH-6	965	965	963.22	1.2	1.78	P-6	MH-6	MH-7	41	42.974	Circular	250 mm	4.01	0.12122	1.52	PVC
MH-7	960	960	958.22	1.2	1.78	P-7	MH-7	MH-8	52.5	45.156	Circular	250 mm	4.32	0.14381	1.52	PVC
MH-8	952.42	952.42	950.64	1.2	1.78	P-8	MH-8	MH-19B	69	49.996	Circular	250 mm	4.5	0.147971	1.52	PVC
MH-19B	942.18	942.18	940.43	1.2	1.75											

Table (E) Sanitary Sewer Design Report For As HALHUL Twon (Line E)

Manhole Report						Pipe Report										
Label	Ground Elevation (m)	Rim Elevation (m)	Sump Elevation (m)	Manhole Diameter (m)	Manhole Depth (m)	Label	Upstream Manhole	Downstream Manhole	Length (m)	Total Flow (l/s)	Section Shape	Section Size (mm)	Average Velocity (m/s)	Constructed Slope (m/m)	Average Pipe Cover (m)	Material
MH-1	986.7	986.7	984.95	1.2	1.75	P-1	MH-1	MH-2	86.5	7.502	Circular	250 mm	0.78	0.005	1.64	PVC
MH-2	986.54	986.54	984.48	1.2	2.06	P-2	MH-2	MH-3	77	11.797	Circular	250 mm	1.68	0.030357	1.65	PVC
MH-3	983.9	983.9	982.12	1.2	1.78	P-3	MH-3	MH-4	31.5	14.817	Circular	250 mm	2.45	0.072698	1.52	PVC
MH-4	981.58	981.58	979.8	1.2	1.78	P-4	MH-4	MH-5	53	16.885	Circular	250 mm	1.15	0.007736	1.52	PVC
MH-5	981.14	981.14	979.36	1.2	1.78	P-5	MH-5	MH-6	84	20.338	Circular	250 mm	3.1	0.10875	2.78	PVC
MH-6	974.51	974.51	970.19	1.2	4.32	P-6	MH-6	MH-7	55.5	24.327	Circular	250 mm	3.66	0.15	2.78	PVC
MH-7	963.62	963.62	960.72	1.2	2.9	P-7	MH-7	MH-8	68.5	26.438	Circular	250 mm	3.75	0.15	2.07	PVC
MH-8	952.2	952.2	950.42	1.2	1.78	P-8	MH-8	MH-9	32.5	27.407	Circular	250 mm	3.68	0.138154	1.52	PVC
MH-9	947.68	947.68	945.9	1.2	1.78	P-9	MH-9	MH-10	63.5	30.322	Circular	250 mm	2.6	0.047874	1.52	PVC
MH-10	944.61	944.61	942.83	1.2	1.78	P-10	MH-10	MH-11	42	31.892	Circular	250 mm	1.16	0.005	1.56	PVC
MH-11	944.45	944.45	942.59	1.2	1.86	P-11	MH-11	MH-18B	72	34.434	Circular	250 mm	1.18	0.005	1.76	PVC
MH-18B	944.38	944.38	942.23	1.2	2.15				666							

Table (F) Sanitary Sewer Design Report For As HALHUL Twon (Line F)

Manhole Report						Pipe Report											
Label	Ground Elevation (m)	Rim Elevation (m)	Sump Elevation (m)	Manhole Diameter (m)	Manhole Depth (m)	Label	Upstream Manhole	Downstream Manhole	Length (m)	Total Flow (l/s)	Section Shape	Section Size (mm)	Average Velocity (m/s)	Constructed Slope (m/m)	Average Pipe Cover (m)	Material
MH-1	961.89	961.89	960.14	1.2	1.75	P-1	MH-1	MH-2	69.5	50.297	Circular	250 mm	4.31	0.130935	1.5	PVC
MH-2	952.79	952.79	951.01	1.2	1.78	P-2	MH-2	MH-3	70	93.681	Circular	250 mm	3.15	0.035297	1.53	PVC
MH-3	950.31	950.31	948.51	1.2	1.8	P-3	MH-3	MH-4	69.5	170.052	Circular	300 mm	3.89	0.041882	1.51	PVC
MH-4	947.42	947.42	945.56	1.2	1.86	P-4	MH-4	MH-5	69	198.76	Circular	300 mm	4.86	0.079354	1.55	PVC
MH-5	941.94	941.94	940.06	1.2	1.88	P-5	MH-5	MH-6	70	207.054	Circular	375 mm	3.74	0.032749	1.56	PVC
MH-6	939.77	939.77	937.74	1.2	2.03	P-6	MH-6	MH-7	59	222.132	Circular	525 mm	1.54	0.005	1.52	Concrete
MH-7	939.51	939.51	937.41	1.2	2.1	P-7	MH-7	MH-21B	13	277.92	Circular	525 mm	3.99	0.055769	1.53	Concrete
MH-21B	938.72	938.72	936.69	1.2	2.03											

Table (G) Sanitary Sewer Design Report For As HALHUL Twon (Line G)

Manhole Report						Pipe Report											
Label	Ground Elevation (m)	Rim Elevation (m)	Sump Elevation (m)	Manhole Diameter (m)	Manhole Depth (m)	Label	Upstream Manhole	Downstream Manhole	Length (m)	Total Flow (l/s)	Section Shape	Section Size (mm)	Average Velocity (m/s)	Constructed Slope (m/m)	Average Pipe Cover (m)	Material
MH-1	964	964	962.25	1.2	1.75	P-1	MH-1	MH-2	62.5	23.503	Circular	250 mm	1.07	0.005	1.62	PVC
MH-2	963.93	963.93	961.9	1.2	2.03	P-2	MH-2	MH-3	70	46.512	Circular	250 mm	1.93	0.01525	1.64	PVC
MH-3	962.59	962.59	960.81	1.2	1.78	P-3	MH-3	MH-4	69.5	80.327	Circular	250 mm	2.71	0.026331	1.52	PVC
MH-4	960.73	960.73	958.95	1.2	1.78	P-4	MH-4	MH-5	69.5	108.288	Circular	250 mm	3.76	0.051511	1.52	PVC
MH-5	957.12	957.12	955.34	1.2	1.78	P-5	MH-5	MH-6	82.5	124.664	Circular	250 mm	4.77	0.087879	1.52	PVC
MH-6	949.84	949.84	948.06	1.2	1.78	P-6	MH-6	MH-7	101	155.057	Circular	250 mm	4.22	0.097129	1.52	PVC
MH-7	940	940	938.22	1.2	1.78	P-7	MH-7	MH-8	105.5	190.58	Circular	250 mm	4.4	0.0947	1.53	PVC
MH-8	930	930	928.2	1.2	1.8	P-8	MH-8	MH-9	56.5	197.021	Circular	300 mm	4.17	0.080287	1.52	PVC
MH-9	925.51	925.51	923.63	1.2	1.88	P-9	MH-9	MH-10	32	204.091	Circular	375 mm	2.47	0.019112	1.55	PVC
MH-10	925	925	922.99	1.2	2.01	P-10	MH-10	MH-11	21	207.934	Circular	375 mm	3.01	0.031171	1.6	PVC
MH-11	924.29	924.29	922.3	1.2	1.99	P-11	MH-11	MH-12	84.5	213.036	Circular	375 mm	3.64	0.050414	1.59	PVC
MH-12	920	920	918.01	1.2	1.99	P-12	MH-12	MH-11B	7.5	244.556	Circular	375 mm	3.91	0.056	1.59	PVC
MH-11B	919.55	919.55	917.59	1.2	1.96											

Table (H) Sanitary Sewer Design Report For As HALHUL Twon (Line H)

Manhole Report						Pipe Report										
Label	Ground Elevation (m)	Rim Elevation (m)	Sump Elevation (m)	Manhole Diameter (m)	Manhole Depth (m)	Label	Upstream Manhole	Downstream Manhole	Length (m)	Total Flow (l/s)	Section Shape	Section Size (mm)	Average Velocity (m/s)	Constructed Slope (m/m)	Average Pipe Cover (m)	Material
MH-1	941.81	941.81	940.06	1.2	1.75	P-1	MH-1	MH-2	PVC	9.808	Circular	250 mm	1.67	0.034571	1.52	PVC
MH-2	938.18	938.18	936.4	1.2	1.78	P-2	MH-2	MH-3	PVC	15.317	Circular	250 mm	1.8	0.02928	1.52	PVC
MH-3	936.32	936.32	934.54	1.2	1.78	P-3	MH-3	MH-4	PVC	20.282	Circular	250 mm	1.86	0.018596	1.52	PVC
MH-4	935.23	935.23	933.45	1.2	1.78	P-4	MH-4	MH-5	PVC	30.84	Circular	250 mm	1.83	0.01768	1.52	PVC
MH-5	933.6	933.6	931.82	1.2	1.78	P-5	MH-5	MH-6	PVC	67.979	Circular	250 mm	2.34	0.019846	1.52	PVC
MH-6	932.28	932.28	930.5	1.2	1.78	P-6	MH-6	MH-7	PVC	76.21	Circular	250 mm	2.89	0.032133	1.52	PVC
MH-7	929.84	929.84	928.06	1.2	1.78	P-7	MH-7	MH-8	PVC	80.783	Circular	250 mm	2.7	0.025857	1.52	PVC
MH-8	928	928	926.22	1.2	1.78	P-8	MH-8	MH-9	PVC	86.392	Circular	250 mm	3.78	0.06061	1.52	PVC
MH-9	923	923	921.22	1.2	1.78	P-9	MH-9	MH-10	PVC	90.63	Circular	250 mm	2.92	0.029565	1.68	PVC
MH-10	921.27	921.27	919.49	1.2	1.78	P-10	MH-10	MH-11	PVC	97.214	Circular	250 mm	2.76	0.024731	1.64	PVC
MH-11	919.55	919.55	917.44	1.2	2.11	P-11	MH-11	MH-12	Concrete	357.569	Circular	600 mm	1.96	0.00692	2.16	Concrete
MH-12	919.42	919.42	917.01	1.2	2.41	P-12	MH-12	MH-13	Concrete	384.526	Circular	750 mm	1.77	0.005	3.27	Concrete
MH-13	920.08	920.08	916.63	1.2	3.45	P-13	MH-13	MH-14	Concrete	423.678	Circular	750 mm	1.81	0.005	3.87	Concrete
MH-14	920.81	920.81	916.17	1.2	4.64	P-14	MH-14	MH-15	Concrete	464.322	Circular	750 mm	1.86	0.005	3.81	Concrete
MH-15	920.5	920.5	915.84	1.2	4.66	P-15	MH-15	MH-16	Concrete	475.413	Circular	750 mm	1.87	0.005	3.91	Concrete
MH-16	920	920	915.49	1.2	4.51	P-16	MH-16	MH-17	Concrete	492.971	Circular	750 mm	1.88	0.005	4.11	Concrete
MH-17	920	920	915.14	1.2	4.86	P-17	MH-17	MH-30B	Concrete	519.96	Circular	750 mm	1.91	0.005		Concrete
MH-30B	920	920	915.11	1.2	4.89											

Manhole Report						Pipe Report											
Label	Ground Elevation (m)	Rim Elevation (m)	Sump Elevation (m)	Manhole Diameter (m)	Manhole Depth (m)	Label	Upstream Manhole	Downstream Manhole	Length (m)	Total Flow (l/s)	Section Shape	Section Size (mm)	Average Velocity (m/s)	Constructed Slope (m/m)	Average Pipe Cover (m)	Material
MH-1	1,007.20	1,007.20	1,005.45	1.2	1.75	P-1	MH-1	MH-2	70	20.948	Circular	250 mm	1.84	0.024286	1.5	PVC
MH-2	1,005.50	1,005.50	1,003.72	1.2	1.78	P-2	MH-2	MH-3	70	32.464	Circular	250 mm	1.87	0.018143	1.52	PVC
MH-3	1,004.20	1,004.20	1,002.42	1.2	1.78	P-3	MH-3	MH-4	86.5	43.627	Circular	250 mm	1.24	0.005	1.75	PVC
MH-4	1,004.20	1,004.20	1,001.95	1.2	2.25	P-4	MH-4	MH-5	52.5	48.054	Circular	250 mm	1.46	0.00719	1.75	PVC
MH-5	1,003.33	1,003.33	1,001.55	1.2	1.78	P-5	MH-5	MH-6	57.5	58.201	Circular	250 mm	2.06	0.015652	1.52	PVC
MH-6	1,002.40	1,002.40	1,000.62	1.2	1.78	P-6	MH-6	MH-7	82.5	89.467	Circular	250 mm	3.24	0.046667	1.52	PVC
MH-7	998.52	998.52	996.74	1.2	1.78	P-7	MH-7	MH-8	70	75.743	Circular	250 mm	3.13	0.039857	1.52	PVC
MH-8	995.7	995.7	993.92	1.2	1.78	P-8	MH-8	MH-9	83.5	92.801	Circular	250 mm	4.02	0.067904	1.52	PVC
MH-9	990	990	988.22	1.2	1.78	P-9	MH-9	MH-10	56	110.79	Circular	250 mm	4.75	0.094286	1.52	PVC
MH-10	984.69	984.69	982.91	1.2	1.78	P-10	MH-10	MH-11	82	117.713	Circular	250 mm	4.04	0.058941	1.6	PVC
MH-11	980	980	978.04	1.2	1.96	P-11	MH-11	MH-12	77.5	149.559	Circular	450 mm	1.39	0.005	1.69	Concrete
MH-12	980	980	977.63	1.2	2.37	P-12	MH-12	MH-13	50.5	151.154	Circular	450 mm	1.39	0.005	2.29	Concrete
MH-13	980.5	980.5	977.34	1.2	3.16	P-13	MH-13	MH-14	70.5	155.617	Circular	450 mm	1.4	0.005	2.78	Concrete
MH-14	980.3	980.3	976.96	1.2	3.34	P-14	MH-14	MH-15	70	170.833	Circular	450 mm	1.43	0.005	3.01	Concrete
MH-15	980.2	980.2	976.58	1.2	3.62	P-15	MH-15	MH-16	70	172.159	Circular	450 mm	1.43	0.005	2.49	Concrete
MH-16	978.51	978.51	976.2	1.2	2.31	P-16	MH-16	MH-17	53	173.482	Circular	450 mm	3.63	0.059575	1.68	Concrete
MH-17	975	975	973.01	1.2	1.99	P-17	MH-17	MH-18	85.5	180.888	Circular	450 mm	3.7	0.060819	1.52	Concrete
MH-18	969.77	969.77	967.78	1.2	1.99	P-18	MH-18	MH-19	74.5	182.221	Circular	450 mm	3.11	0.037584	1.52	Concrete
MH-19	966.94	966.94	964.95	1.2	1.99	P-19	MH-19	MH-20	44	191.774	Circular	450 mm	3.33	0.043409	1.52	Concrete
MH-20	965	965	963.01	1.2	1.99	P-20	MH-20	MH-21	105.5	198.372	Circular	450 mm	1.71	0.007299	1.52	Concrete
MH-21	964.2	964.2	962.21	1.2	1.99	P-21	MH-21	MH-22	56.5	198.49	Circular	450 mm	2.36	0.016637	1.52	Concrete
MH-22	963.23	963.23	961.24	1.2	1.99	P-22	MH-22	MH-23	61	198.636	Circular	450 mm	3.62	0.053216	1.54	Concrete
MH-23	960	960	957.97	1.2	2.03	P-23	MH-23	MH-24	79.5	198.849	Circular	525 mm	1.5	0.005	1.7	Concrete
MH-24	960	960	957.54	1.2	2.46	P-24	MH-24	MH-25	68.5	218.345	Circular	525 mm	1.58	0.005438	1.71	Concrete
MH-25	959.2	959.2	957.14	1.2	2.06	P-25	MH-25	MH-26	71.5	230.092	Circular	525 mm	3.04	0.03021	1.52	Concrete
MH-26	957.01	957.01	954.95	1.2	2.06	P-26	MH-26	MH-27	64.5	253.229	Circular	525 mm	5.36	0.136434	2.03	Concrete
MH-27	949.21	949.21	946.12	1.2	3.09	P-27	MH-27	MH-28	21	278.972	Circular	525 mm	5.7	0.15	2.03	Concrete
MH-28	945	945	942.94	1.2	2.06	P-28	MH-28	MH-29	133.5	288.214	Circular	525 mm	2.68	0.018352	1.52	Concrete
MH-29	942.52	942.52	940.46	1.2	2.06	P-29	MH-29	MH-30	62	294.534	Circular	525 mm	3.63	0.040806	1.54	Concrete
MH-30	940	940	937.89	1.2	2.11	P-30	MH-30	MH-31	78	316.613	Circular	600 mm	1.68	0.005	1.7	Concrete
MH-31	940	940	937.47	1.2	2.53	P-31	MH-31	MH-32	80	342.535	Circular	600 mm	4.23	0.05725	1.71	Concrete
MH-32	935	935	932.86	1.2	2.14	P-32	MH-32	MH-33	58.5	372.319	Circular	600 mm	4.87	0.133675	1.52	Concrete
MH-33	927.15	927.15	925.01	1.2	2.14	P-33	MH-33	MH-34	70	400.637	Circular	600 mm	4.07	0.083857	1.52	Concrete
MH-34	921.25	921.25	919.11	1.2	2.14	P-34	MH-34	MH-35	69	426.749	Circular	600 mm	4.39	0.094348	1.52	Concrete
MH-35	914.71	914.71	912.57	1.2	2.14	P-35	MH-35	MH-36	69	447.892	Circular	600 mm	4.85	0.114348	1.52	Concrete
MH-36	906.79	906.79	904.65	1.2	2.14	P-36	MH-36	MH-37	70.5	469.917	Circular	600 mm	4.71	0.060284	1.52	Concrete
MH-37	902.51	902.51	900.37	1.2	2.14	P-37	MH-37	MH-38	70	505.218	Circular	600 mm	4.29	0.044286	1.52	Concrete
MH-38	899.38	899.38	897.24	1.2	2.14	P-38	MH-38	MH-39	70.5	535.458	Circular	600 mm	4.42	0.046099	1.52	Concrete
MH-39	896.1	896.1	893.96	1.2	2.14	P-39	MH-39	MH-40	69	561.645	Circular	600 mm	4.48	0.046377	1.52	Concrete
MH-40	892.87	892.87	890.73	1.2	2.14	P-40	MH-40	MH-41	49	583.084	Circular	600 mm	4.92	0.057959	1.52	Concrete
MH-41	890	890	887.86	1.2	2.14	P-41	MH-41	MH-42	90.5	614.709	Circular	600 mm	4.25	0.066851	1.52	Concrete
MH-42	883.92	883.92	881.81	1.2	2.11											

Table (J) Sanitary Sewer Design Report For As HALHUL Twon (Line J)

Manhole Report

Label	Ground Elevation (m)	Rim Elevation (m)	Sump Elevation (m)	Manhole Diameter (m)	Manhole Depth (m)
MH-1	1,005.20	1,005.20	1,003.45	1.2	1.75
MH-2	1,000.00	1,000.00	998.22	1.2	1.78
MH-3	998.36	998.36	996.58	1.2	1.78
MH-4	996.88	996.88	995.1	1.2	1.78
MH-5	996.09	996.09	994.31	1.2	1.78
MH-6	992.2	992.2	990.42	1.2	1.78
MH-7	984.75	984.75	982.97	1.2	1.78
MH-8	973.79	973.79	972.01	1.2	1.78
MH-9	971.39	971.39	969.61	1.2	1.78
MH-10	970	970	968.22	1.2	1.78
MH27A	965.32	965.32	963.57	1.2	1.75

Pipe Report

Label	Upstream Manhole	Downstream Manhole	Length (m)	Total Flow (l/s)	Section Shape	Section Size (mm)	Average Velocity (m/s)	Constructed Slope (m/m)	Average Pipe Cover (m)	Material
P-1	MH-1	MH-2	69.5	3.427	Circular	250 mm	1.6	0.07482	1.5	PVC
P-2	MH-2	MH-3	94	7.507	Circular	250 mm	1.21	0.017128	1.52	PVC
P-3	MH-3	MH-4	68.5	24.026	Circular	250 mm	1.82	0.021168	1.52	PVC
P-4	MH-4	MH-5	39.5	33.953	Circular	250 mm	1.94	0.019241	1.52	PVC
P-5	MH-5	MH-6	58.5	42.537	Circular	250 mm	3.22	0.065983	1.52	PVC
P-6	MH-6	MH-7	93.5	56.022	Circular	250 mm	3.71	0.079358	1.52	PVC
P-7	MH-7	MH-8	73.5	64.899	Circular	250 mm	4.85	0.148707	1.52	PVC
P-8	MH-8	MH-9	21.5	69.827	Circular	250 mm	4.44	0.110233	1.52	PVC
P-9	MH-9	MH-10	48.5	73.92	Circular	250 mm	2.73	0.028041	1.52	PVC
P-10	MH-10	MH-27A	44.5	83.837	Circular	250 mm	4.58	0.104494	1.52	PVC