Palestine Polytechnic University

College Of Engineering

Civil and Architecture Department

Infrastructure Engineering

Graduation Project

Project Name:

DesignOfWaste Water Collection System For Beet EmraMarginalized Area

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ABSTRACT

This project concerned with the evaluation and design for the most important part of infrastructure in the marginalized areas of Yatta district. These areas are in critical situation, the basic infrastructure facilities are absence, which cause a series of negative environmental impacts. This subject is vital for our community, due to the recurring and accumulating problems, the situation at these areas is became dangers year by year. This project dealing with this important problem through studying, and evaluating the current situation of the basic elements infrastructure at (Beet Emra) area, then to make design for a new systems that could adapt with the current and future risks. The methodology used is based on collecting data about the area, its location, area, geography, the rainfall events, water consumption, drainage system and treatment facilities, the characteristics of the current systems, site visits, meeting and interviews, then a clear evaluation will built based on these data and information, and at the final stage a complete design for the waste water collection system for the whole area will be doing supported by all calculations, maps, tables, and drawings. Some software application will use for conducting this duties.

Key Words: Marginal Areas, Infrastructure, urban services, Evaluation.

DEDICATION

To our beloved Palestine and its capital Jerusalem, our martyrs and prisoners.

To our families within its inspiration and support and always doing beyond our ability to respond...

To those present on the road and believed in the idea and stood by us from the first day to its last...

To our fellows whom absorbed our stress and fear...

As for the first and most important position, for God and our hope, all hope for a promising future.

Project Team

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Project Team

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1.1. GENERAL INTRODUCTION:

One in nine people lack access to clean drinking water, and over 2.5 million people live without adequate sanitation facilities. Point-of-use water and sanitation technologies reduce the number of deaths caused by waterborne disease, while also freeing women and girls from the work required to transport and store water, allowing them more time to focus on education and income-generating activities.

Providing a developed infrastructure that significantly affects the economy of countries and is considered a key factor for achieving further progress and economic growth for the implementation of economic projects. It represents the infrastructure that includes technical structures that support society, such as roads, bridges, water and sanitation resources, electrical networks, telecommunications, etc. In addition, it can be defined as the physical components of interconnected systems that provide the necessary goods and services necessary to enable, sustain or improve conditions for community life or to achieve the services or facilities necessary to attract investments and grow the economy in order to achieve progress and prosperity, and in light of the lack of adequate infrastructure. It could negatively affect the region's economy, its productive capacity and competitiveness, as the infrastructure enhances the production and marketing process, in addition to being an influential and powerful factor in attracting local and foreign investments.

Social sustainability aims to secure access to water in the area sufficient for domestic use and small agricultural projects for the poor majority. Environmental sustainability aims to ensure adequate protection of watersheds, groundwater, freshwater resources and their ecosystems. Goal 6 of the Sustainable Development Goals provides to "ensure the availability and sustainable management of water and sanitation for all", And This project contributes to achieving sustainable development goals through its contribution to providing a marginalized area with sewage and water networks.

1.2.THE PROBLEM:

The wide expansion and accelerated development of Yatta has led to an increase in amount of water consumption.
As the municipality records indicate that the total amount of water consumed during the 6 months of 2006 in domestic use was 200,000 cubic meters, ie 1111 cubic meters per day or 46 cubic meters / hour .. Yatta is witnessing urban chaos, as the buildings are on the edge of the asphalt, and there are septic pits. The collection wells are almost mixed together, so the road infrastructure is generally destroyed.This study will be based on the present population of 105000 with annual population
growth of 4.5%. These plans should be capable of supplying water required to theentire areas of the town.

Yatta city lacks a sewage network, and its wastewater is disposed of through cesspits or open channels. The number of cesspits within the city limits is estimated at more than 6000 cesspits. These pits are emptied by dedicated tanks for that, and then they are emptied into neighboring wadis without any consideration for the environment. It is worth noting that in the Hebron governorate, wastewater treatment units are available, namely, the Hebron station and DeirSamet station, but these units are of low efficiency and are currently not working. Consequently, the wastewater resulting from the settlements flows into the surrounding valleys without any treatment, which leads to pollution of the soil and the degradation of natural resources, especially groundwater. It is known that the main wastewater stream in the Hebron governorate flows into Wadi al-Samen (Figures 1 & 2), as wastewater flows from the city of Hebron and its environs towards the city of Yatta through this valley. This valley starts from the Al-Haila area north of Yatta and extends through Wadi Al-Sada and Wadi Abu Al-Foul until Al-Dhahriya and then the Negev. About 2,300,00 cubic meters of wastewater are discharged annually through the main line of Hebron in Wadi Al-Samen.

Figure 1.1: Wastewater flow in Wadi al-Samen

Figure 1.2: Wastewater flow in Wadi al-Samen

The wastewater in Wadi El Samen is distinguished for being concentrated, as the results of laboratory tests of water samples taken by the Applied Research Institute - Jerusalem (ARIJ) showed that its biological load (the percentage of bio-absorbed oxygen) exceeded 624 mg / liter, which is thus higher than the percentage of Bio-absorbed oxygen, found in developed countries in addition to Israel (Table1.1). The high concentration of wastewater threatens nature and the ecosystem, causing health and environmental damage, emitting unpleasant odors, in addition to providing an environment for the reproduction of insects and the spread of epidemics and diseases. It was also found that the concentration of nitrates in wells near Wadi al-Saman is high compared to the internationally recommended percentage, and the reason for this is due to the mixing of wastewater with well water.

Table1.1: Characteristics of wastewater flow in Wadi al-Saman (Arij organization)

Bio-absorbed oxygen(ppm)	624
Suspended matter	1.37
Chloride(ppm)	575
Nitrate(ppm)	2.27
Nickel(ppm)	0.041
Curium(ppm)	0.03
Crome(ppm)	1.278
Zinc(ppm)	0.339
PH	7.82

The environmental impacts of discharging wastewater to the environment via Wadi al-Samen do not stop at the borders of Yatta, south of Hebron, only, but also affect the entire Hebron Governorate.Fig 1.3 shows Wadi Al-Samen path within the Borders of Hebron Governorate .

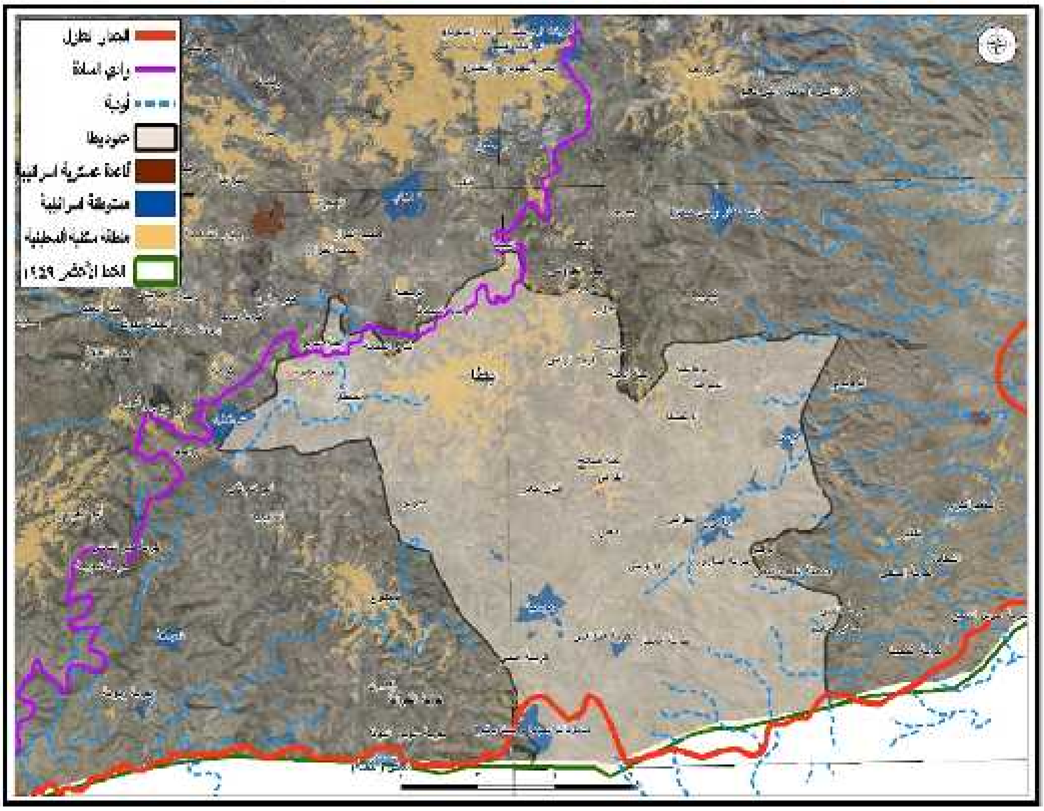

Figure1.3: Wadi Al-Samen path within the Borders of Hebron Governorate

(Arij Organization)

The negative effects resulting from the flow of wastewater through Wadi al-Samen are the emission of bad odors and the spread of harmful insects, as well as the expected effects on the soil and its ecosystem through the accumulation of salts and solids in the soil.

The situation is more complicated in Beet Emra.

1.3. IMPORTANCE OF THE PROJECT:

The importance of having infrastructure and achieving it in developing regions to meet their human needs and achieve infrastructure for sustainable development conditions. Beet Emra is one of the marginalized areas that require a solid infrastructure that meets the needs of citizens.

Beet Emra is considered one of the marginalized areas, The village is an archaeological site in itself. It is built on the ruins of the historic village of Zanouh and is famous for its cultivation of fruits, grapes and olives. It is linked in its daily dealings with the city of Yatta. Like the rest of Hebron Governorate, it suffers from the attacks of settlers and the Zionist army. acres of its land. The village also contains quarries .all of these things giving Beet emra a great value.

1.4. OBJECTIVIES:

Beet Emrawas taken as a project area, as it is a marginalized area... with its lack of public facilities and the basic needs of life's requirements.

This research will explain the current situation in Beet Emra ,The area will be fully studied and evaluated.

The main objectives of this project are:

1. Estimation of population and their densities for the design period for each catchment area.

2. Determination of the water consumption and consequently the wastewater productionfrom the different sources for each catchment area.

3. Evaluation of the collected data, propose collection system of the city and design of themain trunks of the network.

4. Showing the proposed wastewater network its parts on different maps for differentpurposes.

5. Preparation of Bill of Quantities for the main trunks.

6.Preparation the profiles of pipes .

1.5. METHODOLOGY:

The main tasks, which had been under taken in order to develop this project, are as follows:

1. Make some visits to the municipality to discuss the problems that the existing water has.

2. visiting the area, and talking with its residents, and understanding their water requirements.

3. Collection for the required data, information and maps related to the project area.

4. Studying the land use in the region.

5.Reviewing the required data consumption for current and future.

6. Drawing layouts for (waste water collection system and water supply distribution system

7. Quantities Calculation**.**

8. Design Calculations.

9. Bill of quantities.

10. Writing the final report.

1.6.TIME LINE PLAN:

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

Table 1.2:Project Timeline.

First Phase: Proposal:

By visiting the municipality, to find out what areas lack sanitation and the necessities of life.BeetEmrawas chosen due to its lack of basic needs and priorities such as sewage networks.

Second Phase: Data Collection:

During this phase available data and information were collected from different sources moreover many sides visits we're done this phase includes these following activities :

1. All needed maps for the area where collected.

2. Meteorological data were collected different resources.

3. collecting infrastructure data.

Third Phase: Study And Analysis:

During thus phase certain task were done as following:

1. Define the requirement activities.

2. Define the affected attribute.

3. Evaluate environmental impact and summarize them.

Fourth Phase: Drawing The Layout:

At this phase, a map of beet emrawas printed on a sheet of (A3) paper, and then it was transferred to Autocad.

It was hand drawn and rested with our supervisor to determine the most suitable areas for sewage networks.

Fifth Phase:Quantities and Design Calculations:

Sixth Phase: Writing Final Report:

In this final phase, all the information previously collected has been written, arranged and summarized to obtain a greater understanding of the situation in Beet Emra, attached to pictures that illustrate this ... and arranging the information in tables.

1.7. ORGANIZATIONOF THE PROJECT:

The study report has been prepared in accordance with the objectives and of work.

The report consists of these chapters:

The first chapter entitled "Introduction" provides basic information about Beet Emra, its lack of sanitation facilities, and shows the complexities in this area and the proposed water and sewage networks.

The second chapter entitled "Projected Area" provides an overview of the area’s history, location, climate, population and land use in Beet Emra.

The third chapter entitled "Design Criteria".

The fourth chapter entitled "Analysis And Design".

The fifth chapter entitled "Bill Of Quantities".

And The last chapter is "Conclusions".

CHAPTER TWO: PROJECT AREA

2.1. GENERAL INTRODUCTION:

Yatta city is one of the Palestinian cities,in the southern part of the West Bank, its 12 km south of Hebron city, it was called “Yuta,” which means flat land. Northern Negev. Its lands extend from Dhahriya in the west, from Dura in the northwest, and Hebron in the north to the Dead Sea in the east, and the Green Line next to the Negev has borders with Yatta.(Figure2.1) shows the location of Yatta.

The population of Yatta in the year 2016 was about 64,277 people, of which the males constitute about 51% and the females 49%, and the population increase is (4.5%).

more than other cities and towns in the West Bank, Yatta city faces a shortage of water. The demand for water in the city increases from year to year due to the development of societies and the increase in the cityPopulation.At the same time Yatta lacks a sewage network, wastewater is disposed through cesspits or open channels.These pits are emptied by dedicated tanks, then they are emptied into valleys adjacent to the area without any environmental considerations, and this poses a risk to the increase in diseases, insects and unpleasant odors in the atmosphere.

Yattacity has many areas that’s classified as marginalized areas, these areas suffer from very difficult condition and complicated situation, people in these areas live in very low level of life standards, no service, low quality ofinfrastructure and absence of basic needs.

Beet Emra is one example of these areas, it’s located 2 km west of Yatta with3,967 persons.

Beet Emra is an archaeological site in its own right. It is built on the ruins of the historic village of Zanouh and is famous for growing fruits, grapes and olives. It is linked in its daily dealings with the city of Yatta. Like the rest of Hebron, it suffers from attacks by settlers and the Zionist army, which occupies 1,000 dunums of its land. The village also contains quarries.

Beet Emra is considered one of the marginalized areas, as there are no water or sewage networks in Beet Emra and there are no sanitation facilities, so the situation of infrastructure there is very complicated and difficult for example water at Beet Emra has been connected to the water network since 2006.

For sanitation services: The village of Beet Emra does not have a sewage network. The wastewater is disposed of through cesspits and open channels.

2.2. LOCATION :

Beet Emra located 2 km west of Yatta, 9 km from the center of Hebron, and an altitude of 774 m above sea level,Figure 2.2below shows general view of Beet Emra.

Figure 2.2: General view of Beet Emra.

The boundaries of Beet Emra from the north, Al-Hadab, from the south, Al-Samofrom the west, Khirbet Karma, and from the east, Al-Muntar, Figure2.3 shows location map of Beet Emra and Figure2.4 showsBeet EmraDigital Elevation Model, which we can see thatThe region is considered a mountainous topography, where mountain peaks reach 770 meters, and valleys drop to 635 meters

2.3. CLIMATE :

Weather in Beet Emra is influenced by Interior Mediterranean climate . Mild with dry, hot summer. Warmest month has an average temperature of more than 72°F (22°C). At least four months with average temperatures over 50°F (10°C). Danger of frost in winter. At least three times as much precipitation during wettest winter months as in the driest summer month.

The warmest month in Beet Emra is July, when max temperature is about 34 fifth week is the warmest usually. The coldest month is January. In this month temperature could be even 11 at night! And be prepared for Fog, Rain and Thunderstorm.

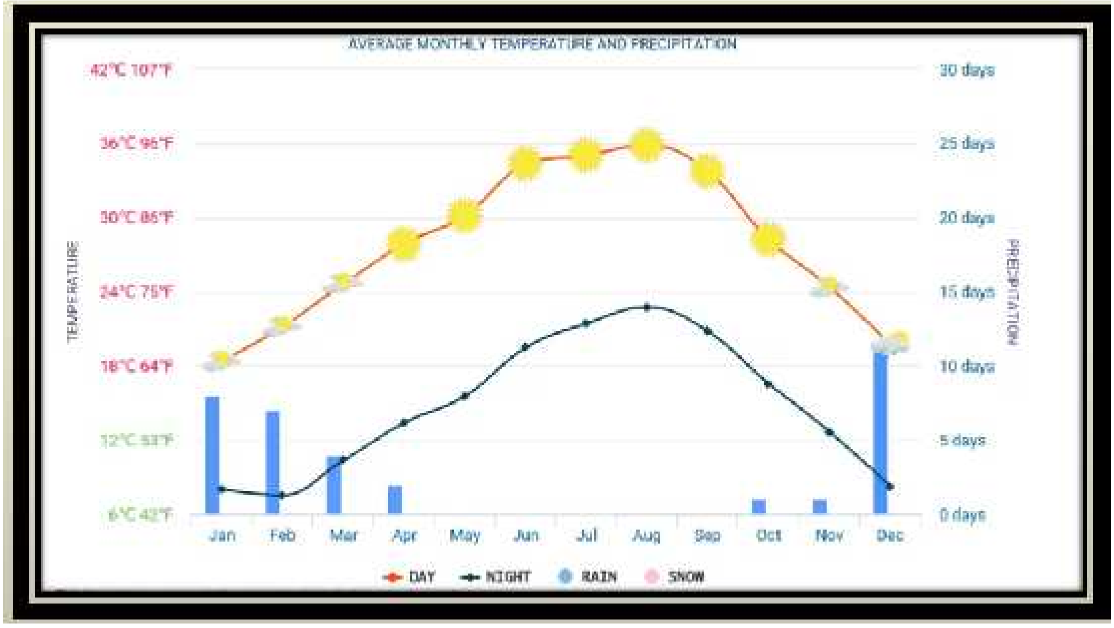

Figure2.5: Avearage Monthly Temperature and Perception (2015-2021)(Palestinian Meteorological)

Table2.1: Beet Emra Monthly Temperatures (2015 – 2021)

	January	February	March	April	May	June	July	August	September	October	November	December
Daytime Temperature	18°C	21°C	25°C	28°C	30°C	34°C	35°C	36°C	34°C	28°C	24°C	20°C
Night-time Temperature	8°C	8°C	10°C	13°C	16°C	19°C	21°C	23°C	21°C	17°C	13°C	8°C
Rainy days	6	7	4	2	0	0	0	0	0	1	1	11
Snow days	0	0	0	0	0	0	0	0	0	0	0	0

Rainfall distribution has become very poor compared to the older days leading to declining yields. As shown in Figure 2, the total annual rainfall in Yatta District has been fluctuating between highs of 1388 mm in 1988 and lows of 477 mm in the year 2015.

2.4. POPULATION:

2.4.1. POPULATION PROJECTION:

The base for the forecast is the 2020 population for Beet Emra obtained fromPalestine Central Bureau of Statistics (PCBS) of 3,967 person "Where the percentage of males is 51% and the percentage of females is 49%". The annual growth rate is2.5% .

It is worth noting that this research will make an estimate of the population until the next 25 years.To calculate the population for the coming 25 year, a geometric increase is assumed,

represented by the following equation:

$P_f = P_o * (1 + r)^n$

Where:

P_f: Future population.

P_o :Current population.

n : Time period.

r : Population growth.

2.4.2. POPULATION FORECAST:

The population of Beet Emra was approximately 3967 persons. And has annual average population growth of (2.5 %). Table 2.2 presents the population projection up to the year 2045.

Table2.2 : Population Forecast For Beet Emra(Project Team).

Year	2020	2025	2030	2035	2040	2045
Population(Capita)	3967	4488	5078	5745	6500	7355

2.5. ECONOMIC ACTIVITIES:

The economy of Beet Emra depends on several sectors, the most important of which is the agricultural sector, which absorbs about 58 percent of the workforce. and Israeli labor, which absorbs about 35% of the workforce. (See Fig2.6)

The results of the field survey of the labor distribution by economic activity in the village of Beet emra showed:

- The agricultural sector, which constitutes 58% of the working hands.
- The Israeli labor market, which constitutes 35% of the working hands.
- The trade sector, which constitutes 5% of the working hands.

- The employee sector constitutes 2% of the working hands.

Figure2.6: Distribution of the workforce by economic activity in Beet Emra

(Reoort of Applied Reaserch Institute-Arij Foundation)

Although the agricultural sector is the largest agricultural activity, it suffers from many obstacles, including:

1. The unavailability of water, and the difficulty of delivering it to agricultural lands.

2. Lack of suitable agricultural methods.

3. The flow of wastewater that passes from the village lands.

2.6. LAND USE :

Beet Emra area "which has an area of 7500dunums" and its lands are divided as follows: residential and agricultural areas, public buildings, antiquities areas, public areas and streets.

Figure 2.7clarifies landuse.

2.7. ROAD NETWORKAND TRANSPORTATION:

There is no official network of connections in Beet Emra. The available connectors are about ten private and illegal cars operate as unorganized sectors to serve citizens, otherwise residents are forced to walk.

The transportation sector in the village suffers from the lack of sufficient paved roads, and the lack of a sufficient number of vehicles in the village.

As for the roads, in the village there are 3 km main roads that are paved and in good condition, 10 km unpaved roads (8 km roads indoor, and 2 kmagricultural roads).

Fig2.8 shows the main road in Beet Emra and Fig2.9 shows the unpaved roads in Beet Emra.

2.8. RELIGIOUS AND ARCHAEOLOGICAL SITES:

There are four mosques in Beet Emra, and they are: ALsahaba Mosque, Rab’iIbnAmer Mosque and Om ALamad Mosque.

Figure2.8 The Main Sites In Beet Emra (Arij Organization).

As for the archaeological sites in the village, there is the Majd al-Baa’ Pool, which needs to be restored.

Figure2.9: Majd al-Baa’ Pool

2.9. SOLID WASTE COLLECTION:

In Beet Emra, there is a solid waste collection management system, and the village council is responsible for managing the collection waste in cooperation with the Joint Service Council for Planning and Development.

The amount of solid waste produced in the village is reported About 5 tons per day.

Waste is collected by a vehicle belonging to the Joint Service Board, and transported to a waste dump. Solid waste is disposed of inlandfill by burning and burying.

2.10. WATER

2.10.1. WATER CONSUMPTION:

Water demand in Beet Emra, like other West Bank towns, is continuously increasing dueto the increasing in population. The population is estimated to be 3967 parsons foryear 2020 and 7355 for year 2045. The result of all this is obvious, the total water requirement continuously increase, and per capita water consumption is also on increase.Water consumption is not constant, yearly, monthly, weekly, daily and hourly variations in water consummations are observed,Certain dryyears cause more consumption. In hot months, water consumed in drinking, bathing,and watering lawns and gardens. On holidays and weekends, the water consumption maybe high.Even during day, water use various with high use during morning hours and low use at night. Maximum daily demand or maximum daily consumption usually occurs duringsummer months Forecast water consumption, Average per capita daily consumption ranges from 12 to 18 liter per day.which is very small amount of water for the human consumption and the WHO criteria's that shows each person needs not less than 150 l/c.d

2.10.2. WATER SERVICES:

Beet Emrais suffering from very poor infrastructure facilities, and the most prominent feature of it is the absence of a water network inside the village.

Since ancient times, water used to reach Beet Emra from the Yatta city through a corroded network, until the network was interrupted during work on the main road, and Beet Emra water was cut off.

Nowadays, residents depend on wells and buy tanks, as the price of one tank is 120 shekels**.**

2.11.WASTE WATER FACILITIES:

Unfortunately the city have no sewerage system, they collect the sewage from houses by cesspits, which every house has one and then being collected and let rains thrown it to wadialsaman, and there is345 is cesspits in the area.

2.12.CONCLUSION:

The situation of yatta marginalizes areas is very bad. These areas needs to study and evaluate, Beet Emrahas been taken as an example of those areas. After that a complete design for a wastewater collection system done.

CHAPTER THREE: DESIGN PARAMETERS

3.1. GENERAL INTRODUCTION:

Once used for its intended purposes, the water supply of a community is considered to be wastewater. The individual conduits used to collect and transport wastewater to the treatment facilities or to the point of disposal are called sewers.

There are three types of sewers: sanitary, storm, and combined. Sanitary sewers are designed to carry wastewater from residential, commercial, and industrial areas, and a certain amount of infiltration /inflow that may enter the system due to deteriorated conditions of sewers and manholes. Storm sewers are exclusively designed to carry the storm water. Combined sewers are designed to carry both the sanitary and the storm flows.

The network of sewers used to collect wastewater from a community is known as wastewater collection system. The purpose of this chapter is to define the types of sewers used in the collection systems, types of wastewater collection systems that are used, the appurtenances used in conjunction with sewers, the flow in sewers, the design of sewers, and the construction and maintenance of sewers.

3.2MUNICIPAL SEWERAGE SYSTEM:

Types Of Sewers

The types and sizes of sewers used in municipal collection system will vary with size of the collection system and the location of the wastewater treatment facilities. The municipal or the community sewerage system consists of (1) building sewers (also called house connections), (2) laterals or branch sewers, (3) main and submain sewers, (4) trunk sewers.

House sewers connect the building plumbing to the laterals or to any other sewer lines mentioned above. Laterals or branch sewers convey the wastewater to the main sewers. Several main sewers connect to the trunk sewers that convey the wastewater to large intercepting sewers or the treatment plant.

The diameter of a sewer line is generally determined from the peak flow that the line must carry and the local sewer regulations, concerning the minimum sizes of the laterals and house connections. The minimum size recommended for gravity sewer is 200 mm (8 in).

Sewer Materials

Sewers are made from concrete, reinforced concrete, vitrified clay, asbestos cement, brick masonry, cast iron, ductile iron, corrugated steel, sheet steel, and plastic or polyvinylchloride or ultra-polyvinyl chloride. Concrete and ultra-polyvinyl chlorides are the most common materials for sewer construction.

3.3.TYPES Of WASTEWATER COLLECTION SYSTEMS:

Gravity Sewer System:

Collecting both wastewater and storm water in one conduit (combined system) or in separate conduits (separate system). In this system, the sewers are partially filled. A typical characteristic is that the gradients of the sewers must be sufficient to create self-cleansing velocities for the transportation of sediment. These velocities are 0.6 to 0.7 m/s minimum when sewers are flowing full or half-full. Manholes are provided at regular intervals for the cleaning of sewers.

Pressure Type System:

Collecting wastewater only. The system, which is entirely kept under pressure, can be compared with a water distribution system. Sewage from an individual house connection, which is collected in manhole on the site of the premises, is pumped intothe pressure system. There are no requirements with regard to the gradients of the sewers.

Vacuum Type System:

Collecting wastewater only in an airtight system. A vacuum of 5-7 m is maintained in the system for the collection and transportation of the wastewater. There is no special requirement for the gradients of the sewers.

Pressure and vacuum–types systems require a comparatively high degree of mechanization, automation and skilled manpower. They are often more economical than gravity system, when applied in low population density and unstable soil conditions. Piping with flexible joints has to be used in areas with expansive soils.

3.4.SEWER APPURTENANCES:

Manholes:

Manholes should be of durable structure, provide easy access to the sewers for maintenance, and cause minimum interference to the sewage flow. Manholes should be located at the start and at the end of the line, at the intersections of sewers, at changes in grade, size and alignment except in curved sewers, and at intervals of 40-60 m in straight lines.

The general shapes of the manholes are square, rectangular or circular in plan, the latter is common. Manholes for small sewers are generally 1.0-1.2 m in diameter. For larger sewers larger manhole bases are provided. The maximum spacing of manholes is 40-60 m depending on the size of sewer and available size of sewer cleaning equipment.

Standard manholes consist of base, risers, top, frame and cover, manhole benching, and step iron. The construction materials of the manholes are usually precast concrete sections, cast in place concrete or brick. Frame and cover usually made of cast iron and they should have adequate strength and weight.

Drop Manholes:

A drop manhole is used where an incoming sewer, generally a lateral, enters the manhole at a point more than about 0.6 m above the outgoing sewer. The drop pipe permits workmen to enter the manhole without fear of being wetted, avoid the splashing of sewage and corrosion of manhole bottom .

House Connections:

The house sewers are generally 10-15 cm in diameter and constructed on a slope of 2% m/m. house connections are also called, service laterals, or service connections. Service connections are generally provided in the municipal sewers during construction. While the sewer line is under construction, the connections are conveniently located in the form of wyes or tees, and plugged tightly until service connections are made. In deep sewers, a vertical pipe encased in concrete is provided for house connections.

Inverted Siphons

Inverted Siphons an inverted siphon is a section of sewer, which is dropped below the hydraulic grade line in order to avoid an obstacle such as a railway or highway cut, a subway, or a stream. Such sewers will flow full and will be under some pressure; hence they must be designed to resist low internal pressures as well as external loads.

It is also important that the velocity be kept relatively high (at least 0.9 m/s) to prevent deposition of solids in locations, which would be very difficult or impossible to clean.

Since sewage flow is subject to large variation, a single pipe will not serve adequately in this application. If it is small enough to maintain a velocity of 0.9 m/s at minimum flow, the velocity at peak flow will produce very high head losses and may actually damage the pipe. Inverted siphons normally include multiple pipes and an entrance structure designed to divide the flow among them so that the velocity in those pipes in use will be adequate to prevent deposition of solids.

3.5. DESIGN PARAMETERS:

Flow Rate Projections:

The total wastewater flow in sanitary sewers for industrial area is made up of two components:

(1) Domestic.

(2) Infiltration.

Sanitary sewers are designed for peak flows from domestic, and peak infiltration allowance for the entire service area. Theflowrateprojections are necessary to determine the required capacities of sanitary sewers.

- The peak coefficient

In general, this coefficient increases when the average flow decrease, it will be determined from the practice and experience of the designer. The following relation has been used commonly by the designer and gives satisfactory results:

$Pf = 1.5 + 2.5 / \sqrt{q}$ (3.1)

Where, q (in l/s) is the daily average flow rate of the network branch under consideration and Pf is the peak factor.

Hydraulic Design

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

$V = (1/n) R^{2/3} S^{1/2}$ (3.2)

Depending on pipe materials, the typical values of n is 0.01

1. Minimum and Maximum Velocities

To prevent the settlement of solid matter in the sewer ,the literature suggested that the minimum velocity at half or full depth – during the peak flow period – should not be less than 0.6 m/s , Usually, maximum sewer velocities are limited to about 3 m/s in order to limit abrasion and avoid damages which may occur to the sewers and manholes due to high velocities.

2. Pipes and Sewers

Experience indicates a minimum diameter of 200 mm (8 in) for sewer pipes. For house connections. Pipe Materials: Different pipe materials may be recommended for the sewers. Polyvinyl chloride, vitrified clay or polyethylene material for small size pipes (approximately up to the size 400 mm in diameter). Centrifugal cast reinforced concrete pipes may be used for larger diameter.

3. Manholes and Covers

Manholes should be located at changes in size, slope direction or junction with secondary sewer. Manholes spacing generally does not exceed 60 m.

4. Sewer Slope

For a circular sewer pipe, the slope must be between the minimum and maximum slope, the minimum and maximum slope is determined from minimum and maximum velocity. Generally the natural ground slope is used because it is the technical and economic solution, the solution is therefore recommended.

5. Depth of Sewer Pipe

The depth of sewers is generally 1.5 m below the ground surface. Depth should be enough to receive the sewage by gravity, avoid excessive traffic loads, and avoid the freezing of the sewer. It is recommended that the top of sewer should not be less than 1.5 m below basement floor.

Important Numbers:

- Maximum velocity = 3 m/s
- Minimum velocity = 0.6 m/s
- Maximum slope = 1.5%
- Minimum slope = 0.05%
- H/D = 70%
- Minimum diameter = 200 mm
- Minimum cover = 1.5 m
- Maximum cover = 5m.

CHAPTER FOUR : ANALYSIS AND DESIGN

4.1. GENERAL INTRODUCTION:

In the previous chapters, the problem of the study area has been defined and the objectives of the project have been listed. The characteristics of the project area (Beet Emra) have been described. Wastewater collection systems and design of sewer system were explained.

In this chapter, basis for planning and design will be discussed including present population, population forecasting, projected water consumption, town structure plan, and the design and planning criteria of the project.

4.2.LAYOUTE OF THE SYSTEM:

The first step in designing a sewerage system is to establish an overall system layout that includes a plan of the area to be sewered, showing roads, streets, buildings, other utilities, topography, and the lowest floor elevation or all buildings to be drained.

In establishing the layout of wastewater collection system for Beet Emra the following basic steps were followed:

1. Obtain a topographic map of the area to be served.

2. Visit the location.

3. Locate the drainage outlet. This is usually near the lowest point in the area and is often along a stream or drainage way.In Beet Emra, there are two points of the first towards to the east and the second point towardstothewest.

4. Sketch in preliminary pipe system to serve all the contributors.

5. Pipes are located so that all the users or future users can readily tap on. They are also located so as to provide access for maintenance and thus are ordinarily placed in streets or other rights-of-way.

6. Sewers layout is followed natural drainage ways so as to minimize excavation and pumping requirements. Large trunk sewers are located in low-lying areas closely paralleled with streams or channels.

7. Revise the layout so as to optimize flow-carrying capacity at minimum cost. Pipe lengths and sizes are kept as small as possible, pipe slopes are minimized, and

followedthe ground surface slope to minimize the depth of excavation, and the numbers of appurtenances are kept as small as possible.

8. The pumping is avoided across drainage boundaries. Pumping stations are costly and add maintenance problems. The final layout of wastewater collection system of Beet Emra illustrated in Figure (4.1), Which clearly shows four main lines and one submain line connected to main 3.

4.3.QUANTITY OF WASTEWATER:

The detailed design of sanitary sewers involves the selection of appropriate pipe sizes and slopes to transport the quantity of wastewater expected from the surroundings and upstream areas to the next pipe in series, which is subjected to the appropriate design constrains. The design computations are given below. After preparing the layout of the wastewater collection system the quantity of wastewater that the system must carry will be calculated using the data collected about the area.

Design example: Design a gravity flow sanitary sewer:

Design a gravity flow main sanitary sewer for the area to outfall. The following data will be collected and analyzed.

1. For current water consumption uses 35L/c.day.

2. For future water consumption uses 100L/c.day.

3. For current population

4. For future population : using the equation(3.1).

5. For population growth rate 2.5 %.

6. For design period use 25 years as a design period.

7. The wastewater calculates as 70% of the water consumption.

8. For infiltration allowance use 10% of the domestic sewerage flow.

9. Peaking factor depending on the formula :

$Pf = 1.5 + (2.5/\sqrt{q})$. Where q = average industrial sewage flow.

10. For the hydraulic design equation use the Manning equation with an n value of 0.01. To simplify the computations, we use the tables.

11. Minimum pipe size: The building code specifies 200 mm (8 in) as the smallest pipe size permissible for this situation.

12. Minimum velocity: To prevent the deposition of solids at low wastewater flows, use minimum velocity of 0.6 m/s during the peak flow conditions.

13. Minimum cover (minimum depth of cover over the top of sewer). The minimum depth of cover is 1.5 m.

Solution :

1. Lay out the sewer. Draw a line to represent the proposed sewer

2. Locate and number the manholes. Locate manholes at

(a) change in direction,

(b) change in slope,

(c) pipe junctions,

(d) upper ends of sewers,

(e) intervals from 50 m or less.

Identify each manhole with a number.

3. Prepare a sewer design computation
4. Based on the experience of numerous engineers, it has been found that the best approach for carrying out sewer computations is to use a computation table, The data in the table are calculated as follow:

4. The entries in columns 1 and 2 are used to identify the line numbers and street sewer name.

5. The entries in columns 3 through 5 are used to identify the sewer manholes, their numbers and the spacing between each two manholes.

6. The entries in column 6 used to identify unit sewage. Unit sewage = 80% multiplied bythe current consumption density divided area in dounm.

7. The entries in columns 7 and 8 are used tributary area, column 7 used incremental area, column 8 used total area in dounm.

8. To calculate municipal maximum flow rates columns 9, 10, are used. Column9 is municipal average sewage flow (unit sewage *total area), the peak factor column 10 is calculated using equation 3.2 as: $Pf = 1.5 + 2.5/ \sqrt{q}$, where q = Average industrial sewage flow (Column 9).

9. Column 11 used to calculate the Qmax ,the value of it comes from multiply column 10* column 9.

10. Column 12 calculate the infiltration which equal to 10% Qaverage (10% * column 9). Column 13 and column 15 used to show the maximum flow design which is come from column 11+ column 1.

To making design for all pipes a software program (sewer CAD) was used to calculate the pipe size , slope , velocity and cover of the pipe section 4.5 is showing the basics of working on sewer CAD program.

The calculations of wastewater quantities for all the lines are attached. (Table 4.1 – Table 4.7).

4.4.DESIGN USING SEWER CAD:

a. Open Sewer CAD, select file → import →DXF Background to import the DXF file.

Figure4.2 below shows thisstep.

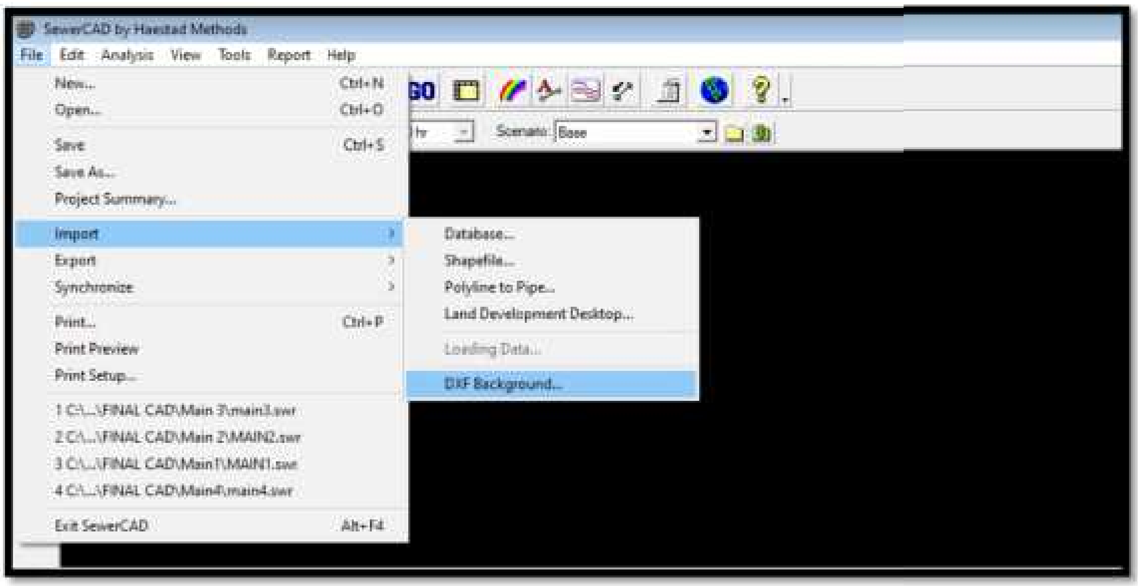

Figure4.2 Sewer Cad Step.

b. Specify file location is then press open, Figure(4.3) below shows this step. Figure (4.3) shows line (main1).

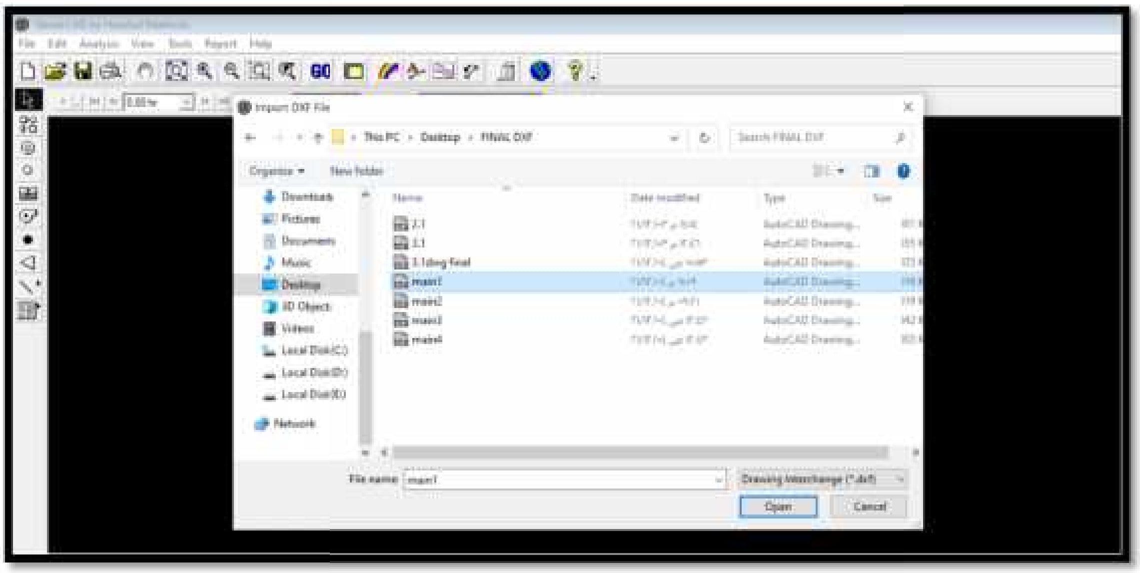

Figure4.3 Sewer Cad Step.

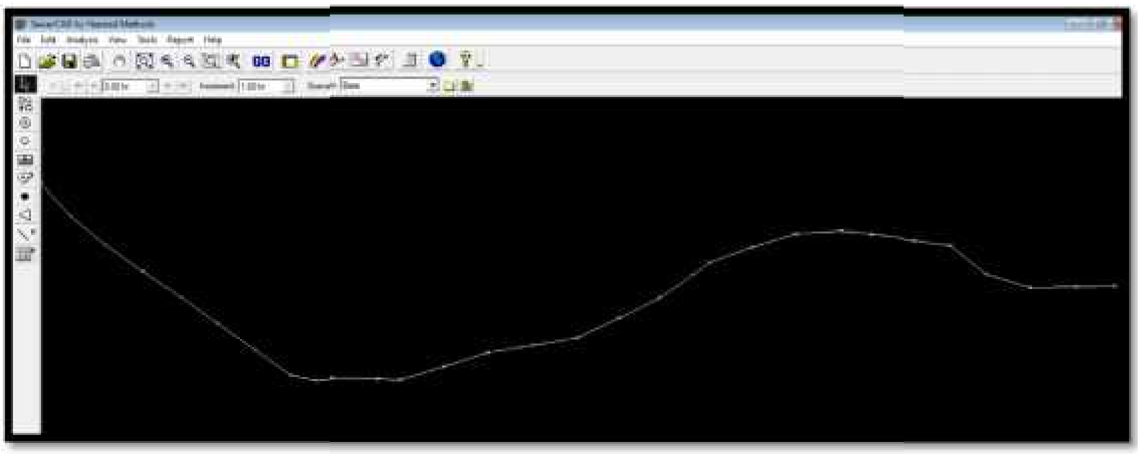

Figure4.4 Sewer Cad Step.

c. Press pipe icon, a massage will appear tell you to create a project .

d. Press yes and define the project then press next twice, then select finish, the Figure(4.5) below show thisstep.

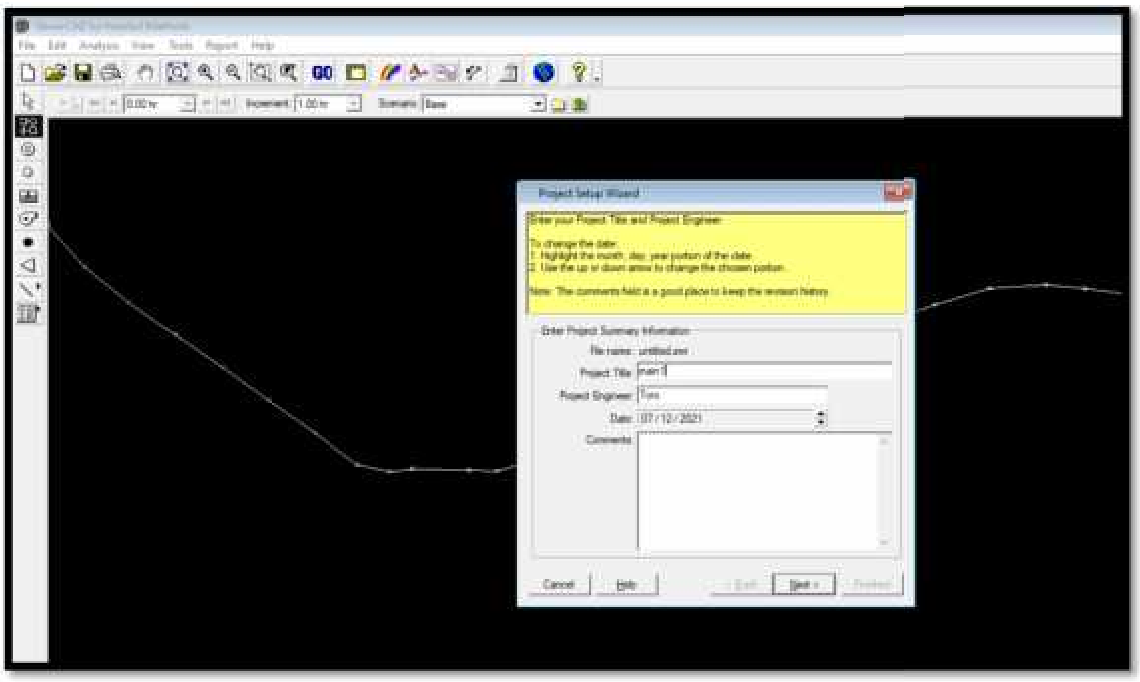

Figure4.5 Sewer Cad Step

e. Press pipe icon and connect between inlets, Figure(4.6) below shows the step.

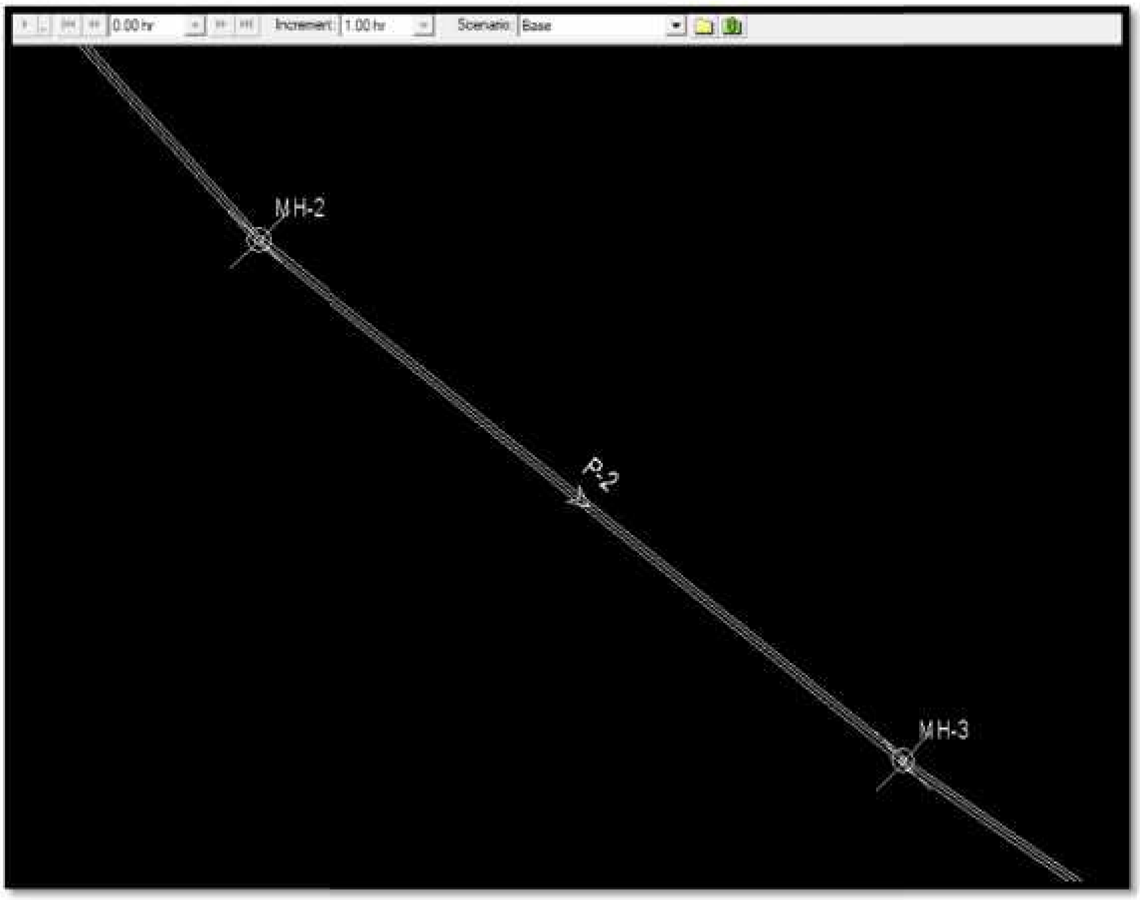

Figure4.6 Sewer Cad Step

F. After you connect between all inlets, press on the out let icon and click on the last inlet, then press yes to replace the inlet with outlet, the Figure(4.7) below shows the step.

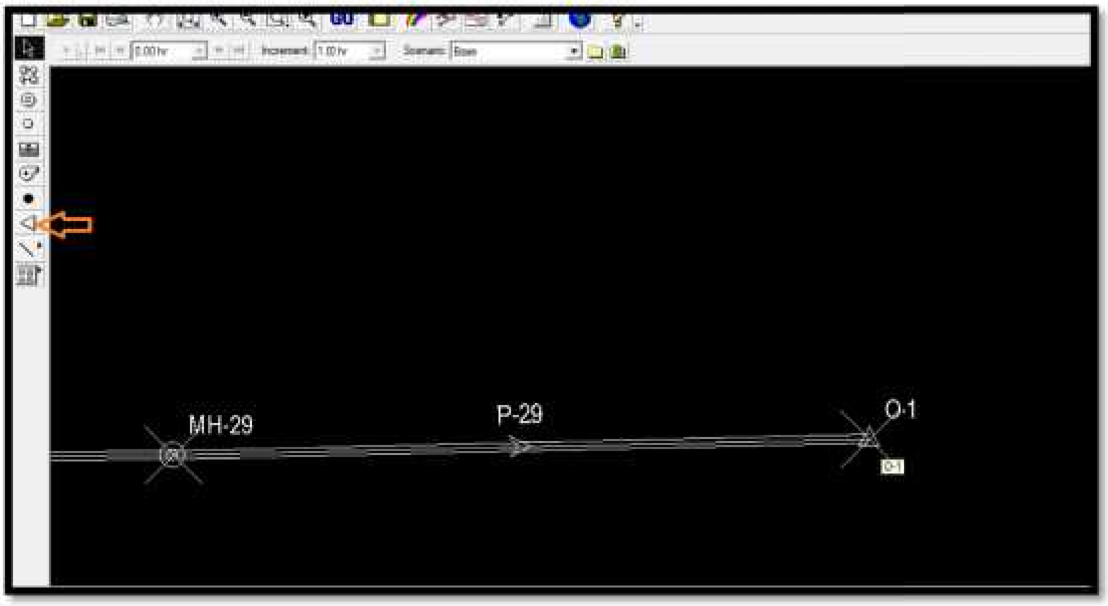

Figure4.7 Sewer Cad Step.

g. Save your project, then select analysis → alternatives → physical properties → edit, then start editing gravity pipe, see Figura(4.8)

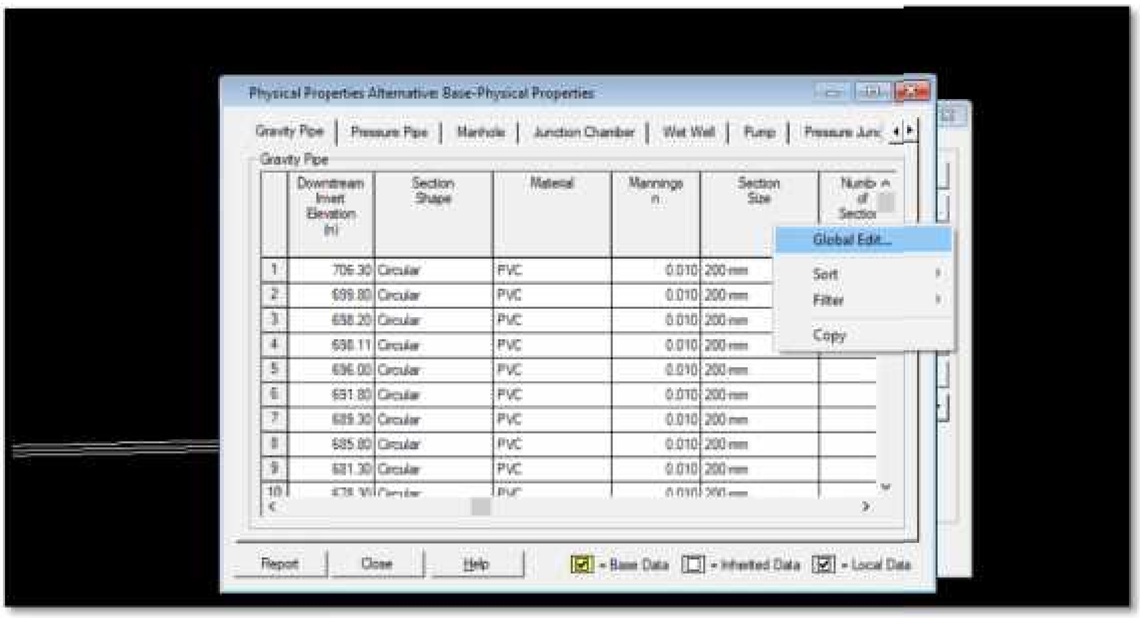

Figure4.8 Sewer Cad Step.

h. Select Manhole to enter the ground elevations of inlets, then select out let to enter its elevation. Then press close. Figure(4.9) below shows thestep.

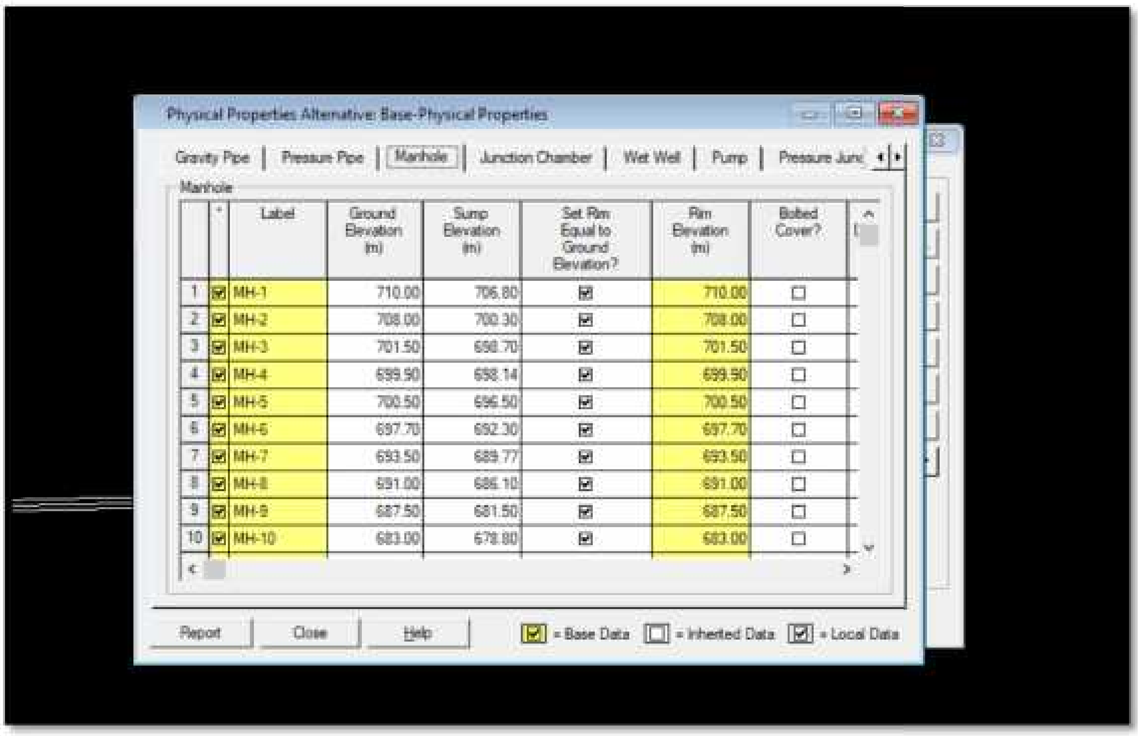

Figure4.9 Sewer Cad Step

i. Select sanitary → edit → manhole to select the type of load and toenter the load for each inlet, Figure(4.10) below shows thestep.

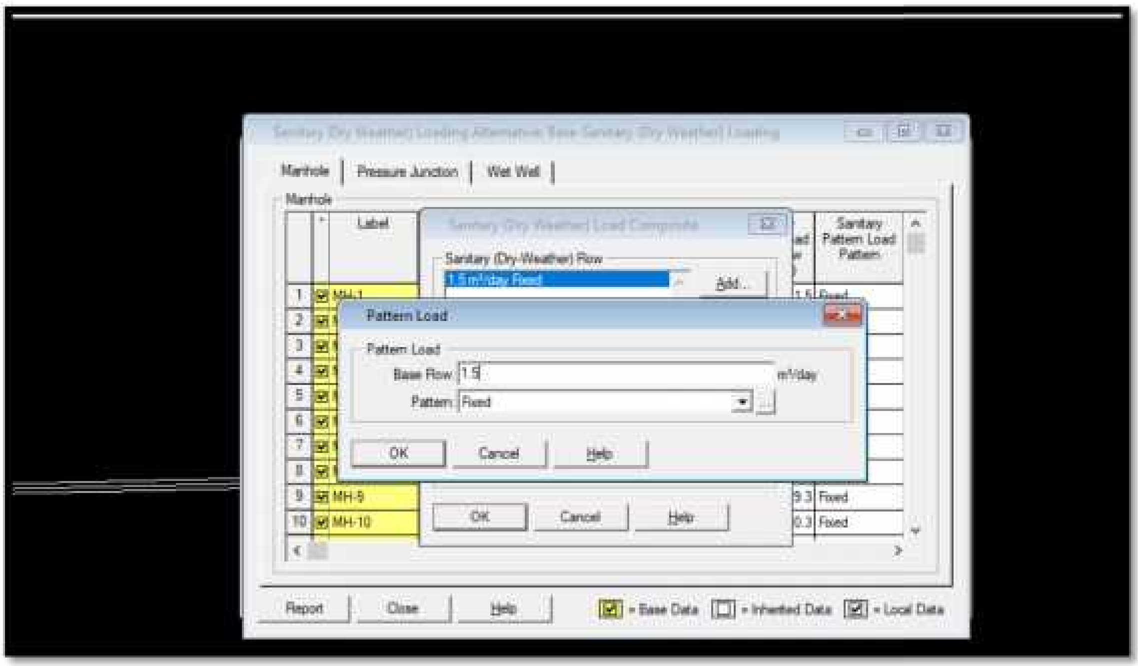

Figure4.10 Sewer Cad Step.

j. After doing this for each inlet press close,then select design constrains →edit to enter the design specifications, Figure(4.11) below shows the step.

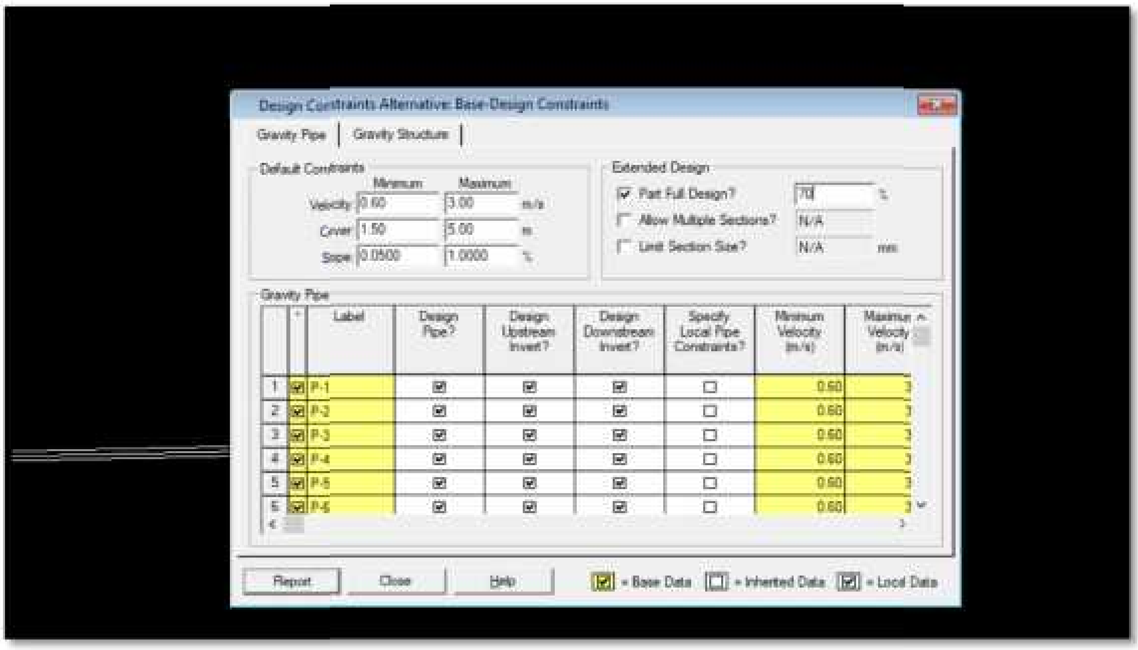

Figure4.11 Sewer Cad Step.

k. Last step press save, press GO button to start design then press on GO, Figure(4.12) below shows thestep.

Figure4.12 Sewer Cad Step.

L. If you have green light that mean there is no problems in the design work, but if you have yellow or red light that's mean there is problem, read the massages and fix these problems.

m. After finishing design work we need to show the pipe line profile and the profile, gravity pipe report and manhole report.

The profiles of sewer area assist in the design and are used as the basis of construction drawings. The profile is usually prepared for pipe sewer line at a horizontal and vertical scale. The profile shows the ground or street surface, inlets locations, elevation of street surface, pipe surface, pipe basement. After all the calculation is completed and all the maps of the proposed waste water collection system are prepared, detailed profile for sewer pipe line is drawn.Tables(4.8-4.21) below showing the calculations done by the program on sewer lines of Beet Emra.And the profile of sewer pipe line is shown in Drawing (4.13 – 4.49). This profile has shown the ground elevation, the proposed sewer pipe line.

Table 4.8:Gravity Pipes Table For Sewer Line(Main1).

	Label	Upstream Node	Downstream Node	Section Size	Material	Section Shape	Average Pipe Cover (m)	Length (m)	Average Velocity (m/s)	Constructed Slope (%)
P-1	P-1	MH-1	MH-2	200 mm	PVC	Circular	2.25	50.00	0.16	1.0000
P-2	P-2	MH-2	MH-3	200 mm	PVC	Circular	4.50	50.00	0.24	1.0000
P-3	P-3	MH-3	MH-4	200 mm	PVC	Circular	2.05	50.00	0.32	1.0000
P-4	P-4	MH-4	MH-5	200 mm	PVC	Circular	1.87	50.00	0.14	0.0500
P-5	P-5	MH-5	MH-6	200 mm	PVC	Circular	2.65	50.00	0.46	1.0000
P-6	P-6	MH-6	MH-7	200 mm	PVC	Circular	3.35	50.00	0.52	1.0000
P-7	P-7	MH-7	MH-8	200 mm	PVC	Circular	2.51	47.00	0.60	1.0000
P-8	P-8	MH-8	MH-9	200 mm	PVC	Circular	3.10	30.00	0.69	1.0000
P-9	P-9	MH-9	MH-10	200 mm	PVC	Circular	3.65	20.00	0.77	1.0000
P-10	P-10	MH-10	MH-11	200 mm	PVC	Circular	2.75	50.00	0.81	1.0000
P-11	P-11	MH-11	MH-12	200 mm	PVC	Circular	1.61	25.00	0.60	0.3852
P-12	P-12	MH-12	MH-13	200 mm	PVC	Circular	1.75	50.00	0.88	1.0000
P-13	P-13	MH-13	MH-14	200 mm	PVC	Circular	3.25	50.00	0.91	1.0000
P-14	P-14	MH-14	MH-15	200 mm	PVC	Circular	1.75	50.00	0.95	1.0000
P-15	P-15	MH-15	MH-16	200 mm	PVC	Circular	2.00	50.00	0.98	1.0000
P-16	P-16	MH-16	MH-17	200 mm	PVC	Circular	1.85	50.00	1.02	1.0000
P-17	P-17	MH-17	MH-18	200 mm	PVC	Circular	1.65	50.00	1.07	1.0000
P-18	P-18	MH-18	MH-19	200 mm	PVC	Circular	1.53	43.00	1.00	0.7907
P-19	P-19	MH-19	MH-20	200 mm	PVC	Circular	1.53	23.00	0.60	0.1902
P-20	P-20	MH-20	MH-21	250 mm	PVC	Circular	1.56	50.00	0.60	0.1863
P-21	P-21	MH-21	MH-22	250 mm	PVC	Circular	1.71	50.00	0.60	0.1761
P-22	P-22	MH-22	MH-23	250 mm	PVC	Circular	1.86	50.00	0.60	0.1670
P-23	P-23	MH-23	MH-24	250 mm	PVC	Circular	1.98	33.00	0.60	0.1615
P-24	P-24	MH-24	MH-25	250 mm	PVC	Circular	2.11	50.00	0.60	0.1573
P-25	P-25	MH-25	MH-26	250 mm	PVC	Circular	2.24	40.00	0.60	0.1535
P-26	P-26	MH-26	MH-27	250 mm	PVC	Circular	2.37	50.00	0.60	0.1514
P-27	P-27	MH-27	MH-28	250 mm	PVC	Circular	2.15	50.00	0.60	0.1496
P-28	P-28	MH-28	MH-29	250 mm	PVC	Circular	1.89	50.00	0.60	0.1496
P-29	P-29	MH-29	O-1	250 mm	PVC	Circular	1.97	43.00	0.60	0.1496

Table4.9:Manholes Table For Sewer Line(Main1).

	Label	Structure Diameter (m)	Ground Elevation (m)	X (m)	Y (m)	Sanitary Pattern Load Base Flow (m^3/day)
MH-1	MH-1	1.20	710.00	154,227.80	95,766.93	1.1
MH-2	MH-2	1.20	708.00	154,261.20	95,729.72	4.1
MH-3	MH-3	1.20	701.50	154,300.10	95,698.29	8.1
MH-4	MH-4	1.20	700.50	154,341.04	95,669.60	13.0
MH-5	MH-5	1.20	699.90	154,381.98	95,640.91	17.7
MH-6	MH-6	1.20	697.70	154,422.81	95,612.02	23.9
MH-7	MH-7	1.20	693.50	154,463.61	95,583.12	37.4
MH-8	MH-8	1.20	691.00	154,501.42	95,555.23	64.9
MH-9	MH-9	1.20	687.50	154,530.74	95,548.88	72.2
MH-10	MH-10	1.20	683.00	154,550.52	95,551.85	55.3
MH-11	MH-11	1.20	680.00	154,600.50	95,550.38	35.6
MH-12	MH-12	1.20	680.00	154,625.48	95,549.66	55.4
MH-13	MH-13	1.20	679.00	154,673.21	95,564.59	48.7
MH-14	MH-14	1.20	675.00	154,720.92	95,579.52	68.1
MH-15	MH-15	1.20	674.00	154,770.28	95,587.78	67.0
MH-16	MH-16	1.20	672.50	154,819.55	95,596.04	71.0
MH-17	MH-17	1.20	671.30	154,864.49	95,617.88	110.3
MH-18	MH-18	1.20	670.50	154,909.45	95,639.78	62.2
MH-19	MH-19	1.20	670.10	154,944.72	95,664.40	31.6
MH-20	MH-20	1.20	670.00	154,962.99	95,678.35	51.6
MH-21	MH-21	1.20	670.00	155,010.16	95,694.98	70.7
MH-22	MH-22	1.20	670.00	155,058.00	95,709.51	72.8
MH-23	MH-23	1.20	670.00	155,107.89	95,712.59	49.5
MH-24	MH-24	1.20	670.00	155,140.76	95,709.39	40.8
MH-25	MH-25	1.20	670.00	155,190.34	95,702.93	39.8
MH-26	MH-26	1.20	670.00	155,229.99	95,697.77	23.9
MH-27	MH-27	1.20	670.00	155,268.90	95,666.35	20.6
MH-28	MH-28	1.20	669.30	155,316.69	95,651.73	0.0
MH-29	MH-29	1.20	669.20	155,366.68	95,652.12	0.0

Table 4.10:Gravity Pipes Table For Sewer Line(Main2).

	Label	Upstream Node	Downstream Node	Section Size	Material	Section Shape	Average Pipe Cover (m)	Length (m)	Average Velocity (m/s)	Constructed Slope (%)
P-1	P-1	MH-1	MH-2	200 mm	PVC	Circular	3.62	50.00	0.41	1.5000
P-2	P-2	MH-2	MH-3	200 mm	PVC	Circular	3.52	50.00	0.66	1.5000
P-3	P-3	MH-3	MH-4	200 mm	PVC	Circular	2.82	50.00	0.67	1.5000
P-4	P-4	MH-4	MH-5	200 mm	PVC	Circular	2.90	40.00	0.69	1.5000
P-5	P-5	MH-5	MH-6	200 mm	PVC	Circular	2.52	50.00	0.76	1.5000
P-6	P-6	MH-6	MH-7	200 mm	PVC	Circular	2.77	50.00	0.79	1.5000
P-7	P-7	MH-7	MH-8	200 mm	PVC	Circular	2.32	50.00	0.81	1.5000
P-8	P-8	MH-8	MH-9	200 mm	PVC	Circular	2.77	50.00	0.84	1.5000
P-9	P-9	MH-9	MH-10	200 mm	PVC	Circular	2.97	50.00	0.84	1.5000
P-10	P-10	MH-10	MH-11	200 mm	PVC	Circular	2.82	50.00	0.84	1.5000
P-11	P-11	MH-11	MH-12	200 mm	PVC	Circular	2.52	50.00	0.84	1.5000
P-12	P-12	MH-12	O-1	200 mm	PVC	Circular	2.17	50.00	0.84	1.5000

Table4.11:Manholes Table For Sewer Line(Main2).

	Label	Structure Diameter (m)	Ground Elevation (m)	X (m)	Y (m)	Sanitary Pattern Load Base Flow (m^3/day)
MH-1	MH-1	1.20	709.60	155,354.91	95,099.06	19.4
MH-2	MH-2	1.20	704.60	155,356.30	95,149.05	73.7
MH-3	MH-3	1.20	699.80	155,364.71	95,198.34	0.9
MH-4	MH-4	1.20	696.40	155,372.32	95,247.78	13.2
MH-5	MH-5	1.20	693.00	155,377.28	95,287.42	42.5
MH-6	MH-6	1.20	690.20	155,394.94	95,334.26	15.0
MH-7	MH-7	1.20	686.90	155,412.46	95,381.05	14.3
MH-8	MH-8	1.20	684.50	155,429.88	95,427.92	26.7
MH-9	MH-9	1.20	681.20	155,447.20	95,474.83	0.0
MH-10	MH-10	1.20	677.50	155,464.33	95,521.79	0.0
MH-11	MH-11	1.20	674.10	155,465.43	95,571.77	0.0
MH-12	MH-12	1.20	671.30	155,444.46	95,617.17	0.0

Table 4.12:Gravity Pipes Table For Sewer Line(SubMain 3.1-part1).

	Label	Upstream Node	Downstream Node	Section Size	Material	Section Shape	Average Pipe Cover (m)	Length (m)	Average Velocity (m/s)	Constructed Slope (%)
P-1	P-1	MH-1	MH-2	200 mm	PVC	Circular	1.50	50.00	0.26	2.0000
P-2	P-2	MH-2	MH-3	200 mm	PVC	Circular	1.65	50.00	0.33	2.0000
P-3	P-3	MH-3	MH-4	200 mm	PVC	Circular	1.53	50.00	0.26	0.2800
P-4	P-4	MH-4	MH-5	200 mm	PVC	Circular	1.98	50.00	0.60	1.8677
P-5	P-5	MH-5	MH-6	200 mm	PVC	Circular	2.74	50.00	0.60	1.3626
P-6	P-6	MH-6	MH-7	200 mm	PVC	Circular	3.31	50.00	0.60	1.0714
P-7	P-7	MH-7	MH-8	200 mm	PVC	Circular	3.77	50.00	0.60	0.9206
P-8	P-8	MH-8	MH-9	200 mm	PVC	Circular	3.32	50.00	0.60	0.8426
P-9	P-9	MH-9	MH-10	200 mm	PVC	Circular	2.61	30.00	0.60	0.7937
P-10	P-10	MH-10	MH-11	200 mm	PVC	Circular	2.51	30.00	0.60	0.7801
P-11	P-11	MH-11	MH-12	200 mm	PVC	Circular	3.50	50.00	0.84	2.0000
P-12	P-12	MH-12	MH-13	200 mm	PVC	Circular	2.80	30.00	0.85	2.0000
P-13	P-13	MH-13	MH-14	200 mm	PVC	Circular	2.15	50.00	0.85	2.0000
P-14	P-14	MH-14	MH-15	200 mm	PVC	Circular	1.53	50.00	0.68	1.0800
P-15	P-15	MH-15	MH-16	200 mm	PVC	Circular	2.20	50.00	0.85	2.0000
P-16	P-16	MH-16	MH-17	200 mm	PVC	Circular	1.85	15.00	0.85	2.0000
P-17	P-17	MH-17	MH-18	200 mm	PVC	Circular	2.15	20.00	0.87	2.0000
P-18	P-18	MH-18	MH-19	200 mm	PVC	Circular	3.85	50.00	0.95	2.0000
P-19	P-19	MH-19	MH-20	200 mm	PVC	Circular	1.55	50.00	0.99	2.0000
P-20	P-20	MH-20	MH-21	200 mm	PVC	Circular	1.67	50.00	0.60	0.4338
P-21	P-21	MH-21	MH-22	200 mm	PVC	Circular	1.94	50.00	0.60	0.3994
P-22	P-22	MH-22	MH-23	200 mm	PVC	Circular	3.50	50.00	1.09	2.0000
P-23	P-23	MH-23	MH-24	200 mm	PVC	Circular	1.53	50.00	1.01	1.4800
P-24	P-24	MH-24	MH-25	200 mm	PVC	Circular	2.70	50.00	1.15	2.0000
P-25	P-25	MH-25	MH-26	200 mm	PVC	Circular	1.53	50.00	1.15	1.8800
P-26	P-26	MH-26	MH-27	200 mm	PVC	Circular	1.85	50.00	1.20	2.0000
P-27	P-27	MH-27	MH-28	200 mm	PVC	Circular	2.65	50.00	1.24	2.0000
P-28	P-28	MH-28	MH-29	200 mm	PVC	Circular	1.53	50.00	0.77	0.4800
P-29	P-29	MH-29	MH-30	200 mm	PVC	Circular	2.30	50.00	1.31	2.0000
P-30	P-30	MH-30	MH-31	200 mm	PVC	Circular	1.95	50.00	1.32	2.0000

Table 4.13:Gravity Pipes Table For Sewer Line(SubMain 3.1-part2)

	Label	Upstream Node	Downstream Node	Section Size	Material	Section Shape	Average Pipe Cover (m)	Length (m)	Average Velocity (m/s)	Constructed Slope (%)
P-31	P-31	MH-31	MH-32	200 mm	PVC	Circular	2.60	50.00	1.33	2.0000
P-32	P-32	MH-32	MH-33	200 mm	PVC	Circular	2.15	50.00	1.34	2.0000
P-33	P-33	MH-33	MH-34	200 mm	PVC	Circular	1.53	50.00	1.01	0.8800
P-34	P-34	MH-34	MH-35	200 mm	PVC	Circular	1.54	30.00	0.60	0.2021
P-35	P-35	MH-35	MH-36	200 mm	PVC	Circular	1.54	22.00	0.88	0.5426
P-36	P-36	MH-36	O-1	200 mm	PVC	Circular	2.51	39.00	1.43	2.0000

Table4.14:Manholes Table For Sewer Line(SubMain3.1-part1)

	Label	Structure Diameter (m)	Ground Elevation (m)	X (m)	Y (m)	Sanitary Pattern Load Base Flow (m³/day)
MH-1	MH-1	1.20	738.50	154,784.45	94,354.78	3.0
MH-2	MH-2	1.20	737.50	154,832.58	94,368.15	3.7
MH-3	MH-3	1.20	736.20	154,881.21	94,380.01	21.9
MH-4	MH-4	1.20	736.00	154,929.68	94,392.18	23.4
MH-5	MH-5	1.20	735.90	154,978.15	94,404.49	22.8
MH-6	MH-6	1.20	735.80	155,025.79	94,419.67	24.0
MH-7	MH-7	1.20	735.70	155,073.46	94,434.77	19.1
MH-8	MH-8	1.20	735.60	155,118.26	94,456.96	12.9
MH-9	MH-9	1.20	733.80	155,162.52	94,480.26	9.5
MH-10	MH-10	1.20	733.40	155,184.98	94,500.11	2.9
MH-11	MH-11	1.20	733.00	155,198.18	94,527.05	3.9
MH-12	MH-12	1.20	728.00	155,212.01	94,575.09	1.9
MH-13	MH-13	1.20	724.80	155,226.14	94,601.54	2.1
MH-14	MH-14	1.20	722.50	155,246.38	94,647.29	0.8
MH-15	MH-15	1.20	721.90	155,266.91	94,692.87	0.0
MH-16	MH-16	1.20	719.50	155,276.30	94,741.98	0.0
MH-17	MH-17	1.20	718.50	155,274.33	94,756.86	13.3
MH-18	MH-18	1.20	716.80	155,258.32	94,768.84	53.2
MH-19	MH-19	1.20	711.10	155,209.76	94,780.76	35.4
MH-20	MH-20	1.20	710.00	155,159.93	94,784.83	34.6
MH-21	MH-21	1.20	710.00	155,110.41	94,791.76	30.7
MH-22	MH-22	1.20	710.00	155,061.48	94,802.04	33.4
MH-23	MH-23	1.20	705.00	155,013.11	94,814.70	30.1
MH-24	MH-24	1.20	704.20	154,964.74	94,827.36	32.9
MH-25	MH-25	1.20	700.80	154,915.74	94,837.31	36.1
MH-26	MH-26	1.20	699.80	154,867.77	94,851.41	39.5
MH-27	MH-27	1.20	698.10	154,827.47	94,881.01	52.4
MH-28	MH-28	1.20	694.80	154,793.11	94,917.34	77.0
MH-29	MH-29	1.20	694.50	154,758.75	94,953.64	38.5
MH-30	MH-30	1.20	691.90	154,721.72	94,987.25	21.1

Table4.15:Manholes Table For Sewer Line(SubMain3.1-part2)

	Label	Structure Diameter (m)	Ground Elevation (m)	X (m)	Y (m)	Sanitary Pattern Load Base Flow (m³/day)
MH-31	MH-31	1.20	690.00	154,678.43	95,012.30	17.5
MH-32	MH-32	1.20	686.80	154,631.94	95,030.67	20.4
MH-33	MH-33	1.20	684.50	154,591.17	95,059.60	26.3
MH-34	MH-34	1.20	684.00	154,561.72	95,100.02	31.6
MH-35	MH-35	1.20	683.90	154,533.35	95,109.75	70.6
MH-36	MH-36	1.20	683.70	154,511.64	95,113.29	33.8

Table 4.16:Gravity Pipes Table For Sewer Line(Main3-part1).

	Label	Upstream Node	Downstream Node	Section Size	Material	Section Shape	Average Pipe Cover (m)	Length (m)	Average Velocity (m/s)	Constructed Slope (%)
P-1	P-1	MH-1	MH-2	200 mm	PVC	Circular	2.10	50.00	0.73	2.0000
P-2	P-2	MH-2	MH-3	200 mm	PVC	Circular	1.53	50.00	0.67	0.8800
P-3	P-3	MH-3	MH-4	200 mm	PVC	Circular	1.54	10.00	0.60	0.6208
P-4	P-4	MH-4	MH-5	200 mm	PVC	Circular	1.54	50.00	0.90	1.4358
P-5	P-5	MH-5	MH-6	200 mm	PVC	Circular	1.75	50.00	0.96	1.3600
P-6	P-6	MH-6	MH-7	200 mm	PVC	Circular	1.75	35.00	1.16	2.0000
P-7	P-7	MH-7	MH-8	200 mm	PVC	Circular	2.40	50.00	1.21	2.0000
P-8	P-8	MH-8	MH-9	200 mm	PVC	Circular	1.73	22.00	1.23	2.0000
P-9	P-9	MH-9	MH-10	200 mm	PVC	Circular	2.10	30.00	1.26	2.0000
P-10	P-10	MH-10	MH-11	200 mm	PVC	Circular	1.75	50.00	1.30	2.0000
P-11	P-11	MH-11	MH-12	200 mm	PVC	Circular	1.55	20.00	1.32	2.0000
P-12	P-12	MH-12	MH-13	200 mm	PVC	Circular	1.53	45.00	0.97	0.7556
P-13	P-13	MH-13	MH-14	200 mm	PVC	Circular	1.53	40.00	0.91	0.6000
P-14	P-14	MH-14	MH-15	200 mm	PVC	Circular	2.25	15.00	1.42	2.0000
P-15	P-15	MH-15	MH-16	200 mm	PVC	Circular	1.60	50.00	1.45	2.0000
P-16	P-16	MH-16	MH-17	200 mm	PVC	Circular	1.59	50.00	0.89	0.5000
P-17	P-17	MH-17	MH-18	200 mm	PVC	Circular	1.70	50.00	0.91	0.5000
P-18	P-18	MH-18	MH-19	200 mm	PVC	Circular	1.64	25.00	0.92	0.5000
P-19	P-19	MH-19	MH-20	200 mm	PVC	Circular	3.00	50.00	1.59	2.0000
P-20	P-20	MH-20	MH-21	200 mm	PVC	Circular	4.45	50.00	1.63	2.0000
P-21	P-21	MH-21	MH-22	200 mm	PVC	Circular	3.05	50.00	1.67	2.0000
P-22	P-22	MH-22	MH-23	200 mm	PVC	Circular	3.55	50.00	1.70	2.0000
P-23	P-23	MH-23	MH-24	200 mm	PVC	Circular	1.60	50.00	1.89	2.0000
P-24	P-24	MH-24	MH-25	200 mm	PVC	Circular	1.53	50.00	1.40	0.8800
P-25	P-25	MH-25	MH-26	200 mm	PVC	Circular	2.15	50.00	1.95	2.0000
P-26	P-26	MH-26	MH-27	200 mm	PVC	Circular	2.10	50.00	1.97	2.0000
P-27	P-27	MH-27	MH-28	250 mm	PVC	Circular	1.53	50.00	1.18	0.5000
P-28	P-28	MH-28	MH-29	250 mm	PVC	Circular	1.56	50.00	1.25	0.5616
P-29	P-29	MH-29	MH-30	250 mm	PVC	Circular	3.10	50.00	2.03	2.0000
P-30	P-30	MH-30	MH-31	250 mm	PVC	Circular	1.53	50.00	1.83	1.4800

Table 4.17:Gravity Pipes Table For Sewer Line(Main3-part2)

	Label	Upstream Node	Downstream Node	Section Size	Material	Section Shape	Average Pipe Cover (m)	Length (m)	Average Velocity (m/s)	Constructed Slope (%)
P-31	P-31	MH-31	MH-32	250 mm	PVC	Circular	2.95	50.00	2.06	2.0000
P-32	P-32	MH-32	MH-33	250 mm	PVC	Circular	1.53	50.00	2.03	1.8800
P-33	P-33	MH-33	MH-34	250 mm	PVC	Circular	3.05	50.00	2.09	2.0000
P-34	P-34	MH-34	MH-35	250 mm	PVC	Circular	1.64	50.00	1.24	0.5000
P-35	P-35	MH-35	MH-36	250 mm	PVC	Circular	1.85	50.00	1.24	0.5000
P-36	P-36	MH-36	MH-37	250 mm	PVC	Circular	2.45	50.00	2.10	2.0000
P-37	P-37	MH-37	MH-38	250 mm	PVC	Circular	2.05	50.00	2.10	2.0000
P-38	P-38	MH-38	MH-39	250 mm	PVC	Circular	1.90	50.00	2.10	2.0000
P-39	P-39	MH-39	MH-40	250 mm	PVC	Circular	1.58	28.00	1.24	0.5000
P-40	P-40	MH-40	MH-41	250 mm	PVC	Circular	1.72	25.00	1.24	0.5000
P-41	P-41	MH-41	MH-42	250 mm	PVC	Circular	1.67	50.00	1.70	1.1100
P-42	P-42	MH-42	MH-43	250 mm	PVC	Circular	2.22	28.00	2.12	2.0000
P-43	P-43	MH-43	MH-44	250 mm	PVC	Circular	2.80	50.00	2.12	2.0000
P-44	P-44	MH-44	MH-45	250 mm	PVC	Circular	1.75	50.00	2.13	2.0000
P-45	P-45	MH-45	MH-46	250 mm	PVC	Circular	1.53	50.00	2.00	1.6800
P-46	P-46	MH-46	MH-47	250 mm	PVC	Circular	1.64	50.00	1.25	0.5000
P-47	P-47	MH-47	MH-48	250 mm	PVC	Circular	1.90	50.00	1.25	0.5000
P-48	P-48	MH-48	O-1	250 mm	PVC	Circular	2.19	45.00	1.25	0.5000

Table4.18:Manholes Table For Sewer Line(Main3-part1).

	Label	Structure Diameter (m)	Ground Elevation (m)	X (m)	Y (m)	Sanitary Pattern Load Base Flow (m^3/day)
MH-1	MH-1	1.20	718.10	155,236.89	95,096.08	92.2
MH-2	MH-2	1.20	715.90	155,191.12	95,116.20	90.2
MH-3	MH-3	1.20	715.40	155,149.59	95,143.98	4.9
MH-4	MH-4	1.20	715.30	155,141.44	95,149.78	88.3
MH-5	MH-5	1.20	714.50	155,108.77	95,187.65	87.2
MH-6	MH-6	1.20	714.20	155,076.08	95,225.51	75.3
MH-7	MH-7	1.20	713.00	155,053.21	95,251.99	56.0
MH-8	MH-8	1.20	710.20	155,014.41	95,283.50	33.4
MH-9	MH-9	1.20	709.30	154,995.80	95,295.28	49.2
MH-10	MH-10	1.20	707.50	154,965.82	95,296.12	65.2
MH-11	MH-11	1.20	706.00	154,915.90	95,293.25	35.8
MH-12	MH-12	1.20	705.50	154,897.12	95,286.37	82.3
MH-13	MH-13	1.20	705.10	154,855.17	95,270.09	67.4
MH-14	MH-14	1.20	704.80	154,815.26	95,272.81	33.1
MH-15	MH-15	1.20	703.00	154,800.31	95,274.00	62.6
MH-16	MH-16	1.20	701.80	154,752.40	95,259.73	69.0
MH-17	MH-17	1.20	701.60	154,704.49	95,245.41	77.7
MH-18	MH-18	1.20	701.40	154,655.74	95,234.31	41.8
MH-19	MH-19	1.20	701.00	154,632.38	95,225.38	167.5
MH-20	MH-20	1.20	697.00	154,595.41	95,191.71	132.6
MH-21	MH-21	1.20	690.10	154,558.43	95,158.05	137.0
MH-22	MH-22	1.20	686.00	154,514.89	95,133.49	93.8
MH-23	MH-23	1.20	680.90	154,473.41	95,105.56	799.8
MH-24	MH-24	1.20	679.70	154,430.29	95,080.26	171.1
MH-25	MH-25	1.20	679.20	154,383.77	95,061.91	145.5
MH-26	MH-26	1.20	676.90	154,333.89	95,058.58	144.7
MH-27	MH-27	1.20	674.70	154,283.90	95,057.67	146.4
MH-28	MH-28	1.20	674.50	154,233.90	95,056.76	122.9
MH-29	MH-29	1.20	674.10	154,183.92	95,055.48	142.1
MH-30	MH-30	1.20	669.90	154,133.93	95,056.58	107.5

Table4.19:Manholes Table For Sewer Line(Main3-part2)

	Label	Structure Diameter (m)	Ground Elevation (m)	X (m)	Y (m)	Sanitary Pattern Load Base Flow (m^3/day)
MH-31	MH-31	1.20	669.10	154,084.06	95,060.19	112.3
MH-32	MH-32	1.20	665.20	154,043.00	95,088.71	69.7
MH-33	MH-33	1.20	664.20	154,001.93	95,117.23	84.9
MH-34	MH-34	1.20	660.10	153,967.24	95,153.23	20.5
MH-35	MH-35	1.20	660.00	153,936.60	95,192.73	8.6
MH-36	MH-36	1.20	659.90	153,909.01	95,234.45	15.1
MH-37	MH-37	1.20	657.00	153,881.48	95,276.19	23.3
MH-38	MH-38	1.20	654.90	153,853.94	95,317.91	16.7
MH-39	MH-39	1.20	653.10	153,838.06	95,365.35	19.3
MH-40	MH-40	1.20	653.00	153,830.45	95,392.28	21.9
MH-41	MH-41	1.20	653.00	153,816.62	95,413.09	30.5
MH-42	MH-42	1.20	652.10	153,788.11	95,454.18	45.5
MH-43	MH-43	1.20	650.10	153,768.70	95,474.36	36.2
MH-44	MH-44	1.20	646.50	153,756.87	95,522.93	28.0
MH-45	MH-45	1.20	645.00	153,755.82	95,572.91	27.2
MH-46	MH-46	1.20	644.10	153,761.06	95,622.63	24.0
MH-47	MH-47	1.20	644.00	153,767.48	95,672.25	15.4
MH-48	MH-48	1.20	644.00	153,773.20	95,721.93	0.0

Table 4.20:Gravity Pipes Table For Sewer Line(Main4)

	Label	Upstream Node	Downstream Node	Section Size	Material	Section Shape	Average Pipe Cover (m)	Length (m)	Average Velocity (m/s)	Constructed Slope (%)
P-1	P-1	MH-1	MH-2	200 mm	PVC	Circular	3.62	50.00	0.85	1.5000
P-2	P-2	MH-2	MH-3	200 mm	PVC	Circular	2.52	50.00	1.07	1.5000
P-3	P-3	MH-3	MH-4	200 mm	PVC	Circular	3.37	50.00	1.17	1.5000
P-4	P-4	MH-4	MH-5	200 mm	PVC	Circular	3.62	50.00	1.21	1.5000
P-5	P-5	MH-5	MH-6	200 mm	PVC	Circular	5.87	50.00	1.25	1.5000
P-6	P-6	MH-6	MH-7	200 mm	PVC	Circular	3.62	50.00	1.27	1.5000
P-7	P-7	MH-7	MH-8	200 mm	PVC	Circular	4.87	50.00	1.30	1.5000
P-8	P-8	MH-8	MH-9	200 mm	PVC	Circular	3.50	47.00	1.30	1.5000
P-9	P-9	MH-9	MH-10	200 mm	PVC	Circular	1.96	45.00	1.30	1.5000
P-10	P-10	MH-10	MH-11	200 mm	PVC	Circular	1.52	10.00	1.30	1.5000
P-11	P-11	MH-11	MH-12	200 mm	PVC	Circular	2.62	50.00	1.30	1.5000
P-12	P-12	MH-12	MH-13	200 mm	PVC	Circular	3.52	50.00	1.30	1.5000
P-13	P-13	MH-13	O-1	200 mm	PVC	Circular	1.50	20.00	1.12	1.0000

Table4.21:Manholes Table For Sewer Line(Main4).

	Label	Structure Diameter (m)	Ground Elevation (m)	X (m)	Y (m)	Sanitary Pattern Load Base Flow (m^3/day)
MH-1	MH-1	1.20	697.80	154,165.09	95,477.39	217.2
MH-2	MH-2	1.20	692.80	154,148.43	95,524.53	252.9
MH-3	MH-3	1.20	690.00	154,132.36	95,571.89	153.1
MH-4	MH-4	1.20	685.50	154,114.47	95,618.58	85.3
MH-5	MH-5	1.20	680.50	154,086.19	95,659.82	77.6
MH-6	MH-6	1.20	671.00	154,058.16	95,701.21	58.0
MH-7	MH-7	1.20	666.00	154,018.78	95,732.04	64.2
MH-8	MH-8	1.20	658.50	153,977.62	95,760.40	0.0
MH-9	MH-9	1.20	653.80	153,930.91	95,765.75	0.0
MH-10	MH-10	1.20	652.20	153,888.50	95,750.77	0.0
MH-11	MH-11	1.20	652.00	153,880.20	95,745.01	0.0
MH-12	MH-12	1.20	649.00	153,840.72	95,714.46	0.0
MH-13	MH-13	1.20	644.20	153,801.18	95,683.87	0.0

CHAPTER FIVE: BILL OF QUANTITIES

COLLECTION SYSTEM

No.	EXCAVATION	UNIT	QTY	UNIT PRICE		TOTAL PRICE	
				$	C	$	C
A1	Excavation of pipes trench in all kind of soil for one pipe diameter 200mm depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	4808				
A2	Excavation of pipes trench in all kind of soil for one pipe diameter 250mm depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	1142				
Sub-Total							
B	PIPE WORK						
B1	Supplying, storing and installing of PVC	LM	6250				
Sub-Total							
C	PIPE BEDDING AND BACKFILLING Dimension and material						
C1	Supplying and embedment of sand for one pipe diameter 200mm, depth up to 1.5 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	4808				
C2	Supplying and embedment of sand for one pipe diameter 250 mm, depth up to 1.5 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	1142				

D	MANHOLES, Details according to the drawing						
D1	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coating, 25-ton cast iron cover and backfill, size 1200mm, depth up to 1.0m.	NR	29				
D2	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coating, 25-ton cast iron cover and backfill, size 1200mm, depth up to1.5m.	NR	25				
D3	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coating, 25-ton cast iron cover and backfill, size 1200mm, depth up to 2.0m	NR	84				
Sub-Total							
E	Survy Work						
	Topographical survey required for shop drawings and as built DWGS using absolute Elev. And coordinate system	LM	6250				

CHAPTER SIX: CONCLUSION

In this project, we made a trial to design a waste water collection system for Beet Emra in Yatta city considering the annual growth of the people for the coming 25 years, the main conclusion drown from the present study are summarized below:

1. Beet Emra is one of the marginalized areas That considers in a bad condition, with an absence of sewage networks, water networks, or any health facilities.

2. The proposed project is a wastewater collection system from Beet emra, which will cover most of the area, there are some sites in the area that were not covered because it is a quarry area and uninhabitable and there are no residents and it is useless to pay costs for the network despite knowing the possibility that it is an uninhabitable area .

3. The sanitary system is consisting of four main lines, And one sub main line ,All lines in the sanitary system are running by gravity.

4. We have two types of pipes ,pipes 4808 LM with 200mm in diameter and pipes 1142 LM with 250 mm in diameter, and also we have 138 manholes in the system.

5. The design results showed speeds less than 0.6 m/s and the reason for this is the fall of the manhole at the beginning of the line and the absence of residents, so the values of the pattern load are few and the network is monitored and treated by flushing every six months.

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