DESIGN OF WASTEWATER COLLECTION SYSTEM FOR HALHOUL CITY

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HEBRON - WEST BANK

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CERTIFICATION

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The Senior Project Entitled:

DESIGN OF WASTEWATER COLLECTION SYSTEM FOR HALHOUL CITY

Prepared By:

Nidal Amro **Mohammed Al-Dasoqi** **Osama Al-najjar**

In accordance with the recommendations of the project supervisor, 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 the department for the degree of Bachelor of Science in Engineering.

Project Supervisor	**Department Chairman**
....	…………………………………....

MAY – 2006

إهـــــــداء

الى أقرب من في الوجود الى نفسي ... والدي الحبيبين.

الى أغلى من في الحياه على قلبي .... اخوتي الاعزاء.

الى من اهدتني بهم السماء .... اصدقائي الاحباء .

الى المنارات التي اضاءت لي الدرب .... اساتذتي الاجلاء .

الى كل اللحظات السعيدة التي قضيناها داخل اسوار هذه الجامعة الغراء .

الى أرواح كل الشهداء .... الى فلسطين الاباء .

الى كل شيء طاهر جميل في هذا الوطن المعطاء .

الى كل هؤلاء .... اهدي ما جنيت بعناء .

اسامة النجار　　محمد دسوقي　　نضال عمرو

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Mohammed Al-Dasoqi

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ABSTRACT

DESIGN OF WASTEWATER COLLECTION SYSTEM FOR HALHOUL CITY

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Palestine Polytechnic Univercity

Supervisor : Eng. Imad A. A. Al-zeer

Currently,there are no public wastewater collection and treatment facilities servicing city .Wastewater from individual residential houses is discharged directly into cesspits,allowing the wastewater to seep into the surrounding soil and percolate into the undelying aquifer .In many areas,these subsurface cesspits require frequent cleaning and replacement at a considerable cost.

The municipilty of Halhoul is planning to built sewer network and wastewater treatment facilities .

In this study ,an attempt is made to investigate and evaluate wastewater cololection system along with conceptual design that are suitable for Halhoul community ,cost effective and easy to operate and maintain .The design were made for the main trunk making into consideration the population growth for Halhoul City and the future water consumption for the coming 25 years that is the design period for the project .

The analysis and calculation shows that the proposed wastewater collection system can serve most of the area in Halhoul city with agravity system except for two areas where pumping station is required

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CHAPTER ONE
INTRODUCTION

1.1 Introduction

Raw wastewater is produced by different sources among which domestic and industrial are the most important two sources. Domestic wastewater originates primarily from residential, commercial, and public buildings while different types of industries produce the industrial wastewater, which often contains organic loads and terrace elements like heavy metals that have negative impact on the quality of wastewater. Also, water consumption rates, population density, industrial practices and social habits of people influence the characteristics of wastewater.

The disposal of raw wastewater without treatment creates major potential health and environmental problems to both the people and their surroundings. For the people, pathogens and other hazardous elements that exist in the raw wastewater cause different diseases, while for the surroundings it varies between destroying the soil, polluting the aquifers and creating nuisance due to the different pollutants that are found in the raw wastewater. For the above mentioned reasons, serious and major steps should be taken to collect, dispose and treat the raw wastewater before discharging it to the different water receiving bodies.

In Palestine, the sewerage facilities coverage does not exceed 35% with few newly erected wastewater treatment plants. In the Hebron district the situation is the same except for the Hebron city and Al-Fawwar camp, which have sewerage facilities covering 80% of the city, while no sewerage systems can be seen in the district except some preliminary studies for a number of towns and villages .

Halhoul like other cities and towns in Palestine have no sewerage facility. The people are using latrines, cesspits and few of them use septic tanks, which are emptied by cesspits emptier and tankers from time to time. These latrines and cesspits are deteriorating and they are in very bad condition, adding to this the increase in water consumption and consequently increase in wastewater production, resulting in over flows from the cesspits and excessive recharges of ground water in Halhoul area. So, for all these reasons,, this design of wastewater collection system study for Halhoul city has been conducted.

1.2 Problem Identification

The accelerated expansion and development of Halhoul city has resulted in an increase of water consumption and consequently in generation of large quantities of wastewater from various sources such as residential areas, commercial establishments and different industries. Due to the absence of wastewater collection system, the wastewater has been seeping into the ground through the overflows of the deteriorated cesspits and latrines that are commonly used in Halhoul. Moreover, in some areas wastewater flows directly into the wadis through open drains in different routes causing serious environmental and health problems. The main damaging consequences of these wastewater routes are offensive odors and smells, which is a proper media for breeding of mosquitoes, soil contamination, and polluting of the existing aquifers. The municipality of Halhoul is receiving on daily bases complains from the people asking a comprehensive solution for the wastewater problems in the city.

In view of this bad conditions, and since there is no sewerage or storm water networks exist, along with the fast increase of the environmental and health problems, a design of wastewater collection system study become a pressing necessity so as to solve all the problems that were mentioned above. This design study will considers the annual growth of the people and their water consumption for the coming 25 years, which will be the design period, along with the commercial and industrial development in the area.

1.3 Objectives of the Project

The overall objective of this project is to serve Halhoul area with a sewage collection system to reduce the problems caused by the free disposal of raw wastewater in the area. More specifically the main objectives of this study may be classified as follows:

1. Display the current situation of raw wastewater free disposal in Halhoul city which causes the different environmental and health problems.
2. Estimate the population and their densities for Halhoul up to the planning horizon of 2030, and determine the water consumption and consequent the wastewater production from different sources.
3. Define the area to be served by sewerage and divide it into main catchment areas according to existing situation using the topographical map and site visits. Then classifying them into classes.
4. Propose wastewater collection system for the city and design the main trunks of the proposed sewerage collection network.

5. Prepare the maps, drawings and profiles of the proposed main trunks, and then prepare bill of quantities for the proposed work.

The project will help in reducing the threat to the environment, water and land resources and to the health of the people living in Halhoul area.

1.4 Phases of the Project

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

1.4.1 First Phase: Data Collection and Survey

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

1. Collection of aerial and topographical maps for the area.
2. Collection of meteorological and hydrological data (temperature, wind speed, rainfall, evaporation…etc) from different sources.
3. Evaluation of city population densities in each zone of the city with their water consumption and predicting their numbers, densities and their water consumption in year 2030.
4. Determination of the wastewater quantities and projection of the wastewater production in year 2030.
5. Evaluation of the contour maps and matching it with actual ground levels.

Table 1.1: Phases of the Project with Their Expected Duration

Phase No.	Title	Duration								
		10/2005	11/2005	12/2005	01/2006	02/2006	03/2006	04/2006	05/2006	06/2006
One	Data collection and survey.	■	■	■	■					
Two	Design of wastewater Collection system.			■	■	■	■	■		
Three	Writing the report and other related jobs.						■	■	■	■

1.4.2 Second Phase: Design of Wastewater Collection System

During second phase, the necessary hydraulic calculation needed for the design of the main trunks will be carried out. The tasks, which will be performed in the second phase, are:

1. Establish a system layout, which includes the areas that are going to be served, existing streets and roads, topography… etc.
2. Establish the main catchment areas and routes of the sewer.
3. Establish the design criteria and conducting the needed sewer diameter by hydraulic calculation.
4. Preparing the needed different drawings for the designed sewers.
5. Show the proposed sites of pumping stations in the city.

1.4.3 Third Phase: Writing the Report and Other Related Jobs

After finishing the design calculations of the main trunks, the research team will prepare the specifications drawings, bill of quantities, preliminary maps and approximate cost of the project. Final report of the project will be prepared and submitted to the Department of Civil and Architectural Engineering at Palestine Polytechnic University.

1.5 Structure of the Report

The study report has been prepared in accordance with the objectives and scope of work. The report consists of six chapters. The first chapter entitled " Introduction" outlines the problem, project objectives, and phases of the project.Chapter two entitled "Basic Data of Halhoul City" decribes the project area, geography , climate, land use and road network , and water supplies,and waste water facility.Chapter three entitled " Basis for Planning and Design" presents information about population and their densities, the actual water consumption, land use, and design criteria applicable to the sewerage networks.Chapter four entitled "Analysis and Design" deals with the layout of the system, and design computations and procedures with design example.

Chapter five entitled " Bill of Quantites " deals with the item of the project estimated quantity of each item.

Chapter six entitled " Conclusions" discusses the conclusions of the study.

1.6 Summary

In this chapter, the problem of wastewater disposal in Halhoul area has been identified and the necessity of establishing and design wastewater collection system to the area has been pointed out. The objectives of the present study have been brought out and the procedures to achieve these objectives have been discussed. At the end, the structure of the final report of this study has been presented.

CHAPTER TOW

BASIC DATA OF HALHOUL CITY

CHAPTER TWO

BASIC DATA OF HALHOUL CITY

2.1 Introduction

In this chapter, basic data of Halhoul city will be briefly narrated. The topography and climate will be described. The water supply and waste water facility will be briefly presented**.**

2.2 Geography

Halhoul is located about 4 km north of the Hebron city and about 30 km south of Jerusalem, as shown on the project location plan, Fig. 2.1. Halhoul lies in the Hebron district elevated at about 1027 m above mean sea level to the north Hebron mountains and near the water divide line between the western and eastern edges of the mountains. The aerial map of Halhoul city is illustrated in Fig 2.2. The total area of the city is about 39000 dounm. Homes and businesses are served by small streets, alleys and dirt paths. The population within the municipal boundary has been determined by the Palestinians Bureau of Statistics .The present total population of the city is estimated at 21078 people.

2.3 Climateological Data

The climatelogical data presented in the following paragraphs were obtained from a survey carried out by Meteorological station which is located at the elevation of +1020 m in north of Hebron city. These data are pertinent to the Hebron district which includes the study area

2.3.1 Temperature

The monthly average temperature in the Hebron district ranges from 7.5˚C to 10˚C in the winter to 22˚C in the summer. The minimum temperature is -3˚C in January, while the maximum temperature is 40 ˚C in August. The ground temperature range from -5˚C in winter to 42 ˚C in the summer.

2.3.2 Winds

Western winds prevail in the Hebron district; although, southwesterly winds occur in winter and northwesterly winds occur in summer. During autumn and spring seasons, these western winds from the Mediterranean Sea are humid. Average wind velocities in summer are approximately 10Km/hr during the day, decreasing to 5 km/hr during the night and early morning hours. In winter, velocities reach 35 km/hr. From late April to mid-June, the Hebron district is hit by storms originating from the Arabian Desert. These storms known as Khamaseen bring very hot dry air full of sand and dust.

2.3.3 Evaporation and Humidity

The average annual evaporation in the Hebron district region for the period of 1970-1992 was about 1606.1 mm/year. The mean range of annual relative humidity varies from 60% to 75%, with humidity highest at night and lowest in mid-day. Mean daily evaporation varies from 2 mm/day in December to 8.5 mm/day in August. The average monthly evaporation of Al-Aroub weather station is 230 mm/month in the summer and 80 mm/month in the winter. It should be noted that there are only three months in the year where rainfall exceeds evaporation.

2.3.4 Precipitation

The mean annual rainfall recorded at the Hebron meteorological station for the 1970-1992 period was 601.82 mm/year. The mean annual rainfall in the Hebron district varies from year to year, while the rainfall reaches 1027 mm/year in the wet years; it drops to 200 mm/year during the dry years. The amount of rainfall decreases from 638 mm/year at Al-Aroub in the north to 383 mm/year at A1-Dhahriya in the south, and 200 mm/year at the eastern boundaries of the Hebron district.

The meteorological data recorded at the Hebron weather station are presented Table 2-1

2.4 Land Use And Road Network

2.4.1 Land Use

The land area of Halhoul is approximately 39,000 dounm, where 9,000 donums are residential area and the remaining are agricultural lands. There is no clear city plan defining land use in the various zones of Halhoul. However, the present residential zone will maintain the same character in the future. With the development of the city, the agricultural areas within the municipal boundaries will gradually be built up.

2.4.2 Roads

The plan of the existing and planned roads in Halhoul city has been obtained from Halhoul municipality (see Fig. 2.3). The main road which traverses the city from south to north is called the main Road. It connects the Hebron city with Jerusalem and it divide the city into two parts the eastern part and the Western part.

Table 2-1: Meteorological Conditions at the Hebron Weather Station for 1970-1992

Month	Rain fall mm	Max. Temp °C	Min. Temp °C	R.H %	Wind km/day	Evaporation mm/mon
Jan.	145.15	10.25	3.96	74.19	298.2	65.1
Feb.	131.31	11.50	4.70	72.22	306.7	81.2
March	89.60	14.57	6.46	65.96	303.5	93.0
April	36.98	19.59	9.93	54.62	275.7	138.6
May	4.12	23.63	13.23	48.25	223.5	165.8
June	0.46	25.90	15.77	51.03	221.9	199.5
July	0.00	27.16	17.04	56.77	220.3	220.7
August	0.00	27.23	16.96	59.88	208.8	225.0
Sept.	1.51	25.97	15.94	61.66	194.1	156.6
Oct.	13.59	23.18	14.02	58.89	193.5	111.6
Nov.	63.00	17.50	9.90	64.07	210.1	87.0
Dec.	116.10	12.09	5.62	72.69	242.3	62.0
Total	601.82					

2.5 Water Supplies

The city of Halhoul receives its water supply from Herodion wells near Bethlehem, which abstract from the eastern aquifer. Water from Herodion source is conveyed to the municipal boundary by 12" pipeline via Dir shaar pumping station near kfar Etzion. The pipelines owned and operated by Palestinian Water Authority and Israeli water Company, Makorot. These pipelines also supply other Palestinian communities.

The water in the city is distributed by a network of steel pipe lines and one main reservoirs of 500 cubic meter capacity located in Al-Nabi Younas area. The network is branch one and the diameters of the pipelines range from 2" to 10". Presently ninety percent of the residents of Halhoul city are connected to water distribution network.

There are many problems with water quality and continuity of supply. The water supply to Halhoul fall short of the requirements especially in summer due to limited quantities of water supplied to the city by the Israeli Company Makorot. During summer, the people suffer from water shortages. Plans to rehabilitate the water supply network and to increase supply rates are being prepared by municipality.

2.6 Water Facilities

As stated previously, there are no public wastewater treatment facilities serving the municipality of Halhoul. Wastewater from individual residences (homes) is discharged directly into subsurface pits, which allow the water to percolate directly into the surrounding soil and bedrock. The highly permeable soil and bedrock allows untreated wastewater to percolate directly into the underlying aquifer. In many areas, these subsurface see page pits require frequent cleaning and replacement at a considerable expense. The municipality are planning to build sewer network and treatment facility.

CHAPTER THREE

DESIGN AND PLANNING CRITERIA

3.1 Introduction

3.2 Population

3.3 Future Water Consumption

3.4 Town Master Plan

3.5 Design Parameters

3.6 Design and Planning Assumptions

3.7 Summary

CHAPTER THREE

DESIGN AND PLANNING CRITERIA

3.1 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 (Halhoul city) have been described. Wastewater collection systems and design of sewer system were explained. In this chapter, design and planning criteria will be discussed including present population, population forecasting, projected water consumption, town structure plan, and the design and parameters and planning assumption.

3.2 Population

3.2.1 Introduction

The ideal approach for population forecasting is by the study and use of previous census records, which cover along period. The longer the period, and the more comprehensive the census data, the more accurate will be the results, which will be obtained. In the analysis of these data, demographical, economical and political factors should be considered in order to develop a method of forecasting which will predict the expected growth rate, future population and its distribution in the different zones of the area under consideration.

In the city of Halhoul, as well as other Palestinian cities, there is great uncertainty in the political and economical future. Additionally, there were no accurate population data since the occupation of the West Bank in 1967, until 1997 when the Palestinian Central Bureau of Statistic (PCBS) conducted comprehensive census covering the West Bank and Gaza Strip. The final results of this census show that the total population of Halhoul city is 21078 inhabitants.

Due to the unstable condition of the area during the last 50 years, it would be very difficult to develop a statistical interpretation to extrapolate future population. Some reasonable assumptions have, therefore, been made to project the future population of the City of Halhoul over the next 25 years.

3.2.2 Population Forecast

Prediction of the future population of Halhoul is very difficult due to the lack of reliable historic data, and the political uncertainties, which will greatly influence future social and economic development. At the same time, the available data on past population growth do not constitute a reliable basis for projecting the future population growth in Halhoul.

The base for the forecast is the 2005 population for Halhoul obtained from PCBS of 21078 inhabitants. The rate of population growth for the purpose of our study was based on estimation used for other cities of similar population composition and characteristics. The rate of population growth in other cities in the West Bank is 3%.

A similar rate of growth was assumed for the cities of Gaza, Therefore, the rate of 3% per year was used for the future growth of the population of Halhoul city.

To calculate the population at the end of the design period (year 2030), a geometric increase is assumed, represented by the following equation:

$$P = P_0 * (1+ r)^n \qquad (3.1)$$

Where, P is the future population, P_0 is the present population, r is the annual population growth rate, and n is the period of projection.

Using the above assumption and equation, Table 3.1 presents the population projection up to the design horizon of 2030. The data show that the population of Halhoul is estimated to be 44133 in year 2030.

Table3.1: Population Forecasts for Halhoul City

Year	2005	2006	2011	2016	2021	2026	2030
Population	21078	21711	25168	29177	33824	39211	44133

3.2.3 Population Density

When determining the density of population, it is either related to the total municipal area (gross density) or to the built–up area only (net density). The gross density related to the municipal area includes large industrial areas, agricultural areas, un-built areas, public parks, large water surfaces, forests …etc. The net density is related to the built up urban area, but it includes small-scale industries, schools, public and commercial buildings, small parks for local use and roads.

Sewer design, however, is based on the net densities of population, because the provision of sewers is limited to the built-up areas. The net density of population varies considerably from city to city as well as within a city from district to district. It is between 30 –80 capita / hectare as shown in the population density map Fig (3.1).

There are no studies done concerning the population densities in the city of Halhoul. Population densities are based on the town structure plan , which serves for issuing building permit.

3.3 Future Water Consumption

3.3.1 Introduction

Water consumption is not constant, yearly, monthly, weekly, daily and hourly variations in water consumptions are observed. Certain dry years cause more consumption. In hot months water is consumed in drinking, bathing, and watering lawns and gardens. On holidays and weekends the water consumption may be high. Even during a day water use various with high use during morning hours and close to noon and low use at night. Maximum daily demand or maximum daily consumption usually occurs during summer months. The ideal approach to assess the existing and future per capita water consumption is by analyzing and extrapolating the available record on water consumption and demand in conjunction with the expected social and economical development. This approach can be adopted in areas having continuous supply systems where reliable information about population, population distribution and demand are known. There are problems adopting this approach for

Hebron area including Halhoul city due to insufficient data and also the intermittent water supply.

Restrictions on the Palestinian use of the annual ground water resources of the West Bank led to limited quantities availability of water and due to this condition, the average consumption of water in Halhoul city for all purposes does not exceed 40 cubic meter per capita per year. Given these circumstances, the approach to determine per capita water consumption depends on the analysis of the existing information in order to assume reasonable figures. The existing per capita consumption has already been assessed at 90 liter/capita. day.

3.3.2 Present Water Consumption

As mentioned earlier, and according to the data obtained from the previous studies (Abu Sharkh, 1994) and municipality on water consumption in Halhoul city, the per capita annual water consumption is approximately 90 l/c.d. The total water consumption in Halhoul were estimated to be 500000 cubic meter per year for year 2005 (1370 m^3 /day).

The total water supplies to the city were estimated to be 1370 cubic meter per day. The total water sold to the people is 1027.5 cubic meter per day, in which 25% of water supply is lost. In addition to water supplied by means of the municipal water installation, there are in use many house cisterns, which collect rainwater during winter and are used for domestic purposes, this may explain the difference between the total water consumption and the total water supplied to the city through the network, it also explain the low rate of the percent per capita water consumption.

3.3.3 Future Water Consumption

The present average consumption of water for domestic use in Halhoul is low (90 l/c.d) and does not represent the present and actual demand of water. So, the present water demand for domestic purposes of Halhoul where estimated with the assumption of better living standard and economic condition. Subsequently figures of 112.5 liter per capita per day water demand were employed (1.3 times present water consumption, which allow adequate (minimum) water demand in the present).

The forecast of future water consumption (demand) is made on the following assumptions:

1. The living standard of the population will gradually improve leading to a corresponding increase of the per capita water demand.
2. The development of new water resources and extension of the distribution system.
3. Present annual consumption is 32.8 cubic meter per capita (90 l/c.d) and the rate of increase in the annual water consumption per capita is equal to 1.5% (the percentage of increase in water consumption varies from 1% to 1.5% between developing countries and developed ones and we will assume it 1.2% .
4. The population of the city in year 2005 is 21078 person, and population growth rate is 3 % for the coming 25 years.
5. Design period (period or time of calculation) equal 25 years, up to 2030

Along with the increase in consumption, a program for the rehabilitation of the existing water distribution system would lead to reduction of waste through leakage. Based on the above assumptions, the population of Halhoiul city at years 2011, 2021 and 2030, and the annual residential water demand per capita for the same years were calculated along with water demand per capita per day.

The data obtained were given in Table 3.2

Table 3.2: Forecast Water Demand for Halhoul City

Year	Population	Water Demand (m^3/year)		Water Demand(l/c.d)
		Per Capita	Total	
2005	21078	41.1	866,306	112.5
2011	25168	44.1	1,110,167	120.85
2021	33824	49.7	1,681,053	136.2
2030	44133	55.3	2,440,555	151.6

It may be noted from Table 3.2 that the total water demand in the town for year 2005 is around 866,306 cubic meter per year, and it will reach 2,440,555 cubic meter in year 2032. The projected water consumption for the design period (year 2030) is 150 liter per capita per day. This figure is used in the design of the wastewater collection system of Halhoul area.

3.4 City Master Plan

3.4.1 Current Condition

The city of Halhoul is located about 8 km to the north of the Hebron city, and is surrounded by a number of smaller towns as shown previously on the location maps, Figure 2.1. The city is hilly with ground elevations from about 800 m to 1027 m above the sea level. Halhoul occupies an area of about 39000 dounms. The population of the city is about 21078 people for year 2005.

Economic activity is concentrated around agriculture, poultry, industry, and commerce. However, building growth and expansion has increased within the city limits, and the cultivated land for agriculture are largely outside the municipal boundary. The industry includes small factories located in different sections of the city .

3.4.2 Land Use Plan

The overall area of the city is distributed among the following:

1. **The Old City**: The old city is famous for its old buildings, two stories high, and its old passageways.
2. **Residential Area**: Residential buildings are scattered all over the city of Halhoul. There is no apparent system for organizing residential distribution or establishing a clear distinction between land use.
3. **Public Properties**: There is eleven schools which are located within the residential areas in one site of the city. The existing schools do not meet the

educational and schooling needs of the city. Public building such as the municipality is located in the center of the city.

4. **The Industrial Zone**: There is many factories that distribute in many zone of the city and at the main street of the city and there is no specialized area for this purpose.
5. **Agricultural Area**: It is about 40% - 50% of total area of Halhoul city .
6. **Roads**: The plan of the existing and planned roads in Halhul city has been obtained from Halhul municipality (see Fig. 2.3) The main road which traverses the city from south to north is called the main Road, It connects The Hebron city with Jerusalem and it divide the city into two parts the eastern part and the Western part.

3.4.3 City Master Plan

As a result of the long period of occupation, the city lacks well studied and prepared master plan for land use, city planning and the design of utilities. City master plan prepared by municipality conclude and suggested the following:

1. The existing interior roads serve the needs of the people, and take into account the boundary and ownership of land parcels.The proposals for future interior roads are indicative only the require detailed study to determine land ownership and road alignment.
2. Some of the existing interior roads are agricultural roads. All the building are constructed around these roads without any plan which cause to insufficient roads network for the needs of the people.

3. Public buildings, schools and their lands are needed to be increase to meet the current demand.
4. The old city must be protected in its current form and no new roads will be constructed within it.
5. Zone for industry should be determined and serviced by good roads and all necessary utilities to encourage industries scattered in different places to transfer the industrial zone.

The future plan has been developed based on these proposals and taking into account the existing situation.

3.5 Design Parameters

The following section include design criteria applicable to the sewerage and drainage system alternatives which will be considered for project implementation.

3.5.1 Flow Rate Projections

The total wastewater flow in sanitary sewers is made up of three components:

(1) Residential, commercial, and institutional wastewater, (2) industrial wastewater and (3) infiltration. Sanitary sewers are designed for peak flows from residential, commercial, institutional; and industrial sources for the entire service area, and peak infiltration allowance for the entire service area. The flow rate projections are necessary to determine the required capacities of sanitary sewers. These projections will be based on:

1. Population: Future population at the end of design period should be estimated. The estimated population of Halhoul City in the year 2030 is 44133 inhabitant.
2. The present domestic water consumption and future consumption: The present and future water consumption for domestic use were estimated and presented in section 3.3. The domestic water consumption at the end of the design period will be 150 liter per capita per day.
3. The institutional and industrial sewerage flow rates, such as commercials, schools, hospitals, industries, sport facilities.
4. The percentage of water going to the sewer: In general, the average wastewater flow may vary from 60 to 90 percent of the water used in the community. A value of 75 percent has generally been agreed upon by all the authors of earlier projects in the West Bank and other locations under similar conditions.
5. The service connection percentage: The percentage of houses that will be served by sewers will depend on the nature of the habitat in the catchment area considered and of the design period. It has been assumed that the service connections will increase, to full coverage for the urban population in year 2030
6. The uncontrolled inflow and infiltration: Infiltration is the entrance to the collection system of water from outside sources such as groundwater or seawater. Inflow is the entrance to the collection system of runoff during a rainfall event. Infiltration depends mainly on the state of the network; the depth at which it is buried and the groundwater elevations. Most of the sewers to be laid will be new and the ground water elevations in the area are low. Ground water infiltration seems then to be not significant. The network will be designed to avoid rainwater inflow . However , there will always be cases of manhole leaks, loose joints and

private individuals who link up their rainwater pipes to the sewerage network. Given the difficulty of accurately estimating these parameters and according to previous studies and data of another areas under similar conditions, a mean discharge increase of 2 % of the domestic seweag flow will be applied when dimensioning the sewerage system .

7. The peak coefficient: In general, this coefficient increases when the rate of connected population decrease, for example when the flow rate is weak. In the other hand , when the connected population is important , the variation around a mean discharge is weaker . As there are few field investigations conducted in the study area to estimate this factor; 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:

$$P_f = 1.5 + 2.5 / \sqrt{q} \qquad (3.2)$$

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

Using these assumptions, the flow rate projections were evaluated for the study area (Halhoul city).

3.5.2 Hydraulic Design

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

$$V = 1/n \, R^{2/3} \, S^{1/2} \qquad (2.3)$$

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

3.5.3 Minimum and Maximum Velocities

For a circular sewer pipe , the velocity at half-depth is equal to the velocity at full-depth .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 , but point out that the minimum self cleaning velocity of 1.0 m/s is to be preferred wherever this is practicable.

Usually, maximum sewer velocities are limited to about 3 m/s in order to limit abrasion and avoids damages which may occur to the sewers and manholes due to high velocities.

3.5.4 Pipes and Sewers

i) **Minimum Size of Sewers:** The adoption of a minimum size of sewer is necessary because some large objects such as scrub brushes , sometimes get into sewers . Experience indicates a minimum diameter of 150 mm (6 in) for sewer pipes . For house connections , smaller sizes may be used.

ii) Pipe Materials: Different pipe materials may be recommended for the sewers :

1. polyvinyl chloride PVC, vitrified clay VCP or polyethylene PE material for small size pipes (approximately up to the size 400 mm in diameter).
2. Centrifugal cast reinforced concrete pipes may be used for larger diameter .

3.5.5 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 and should never be greater than 100 m except in sewers which can be walker through gravity. The minimum cover over sewer line will be of 1 m , for the buried section.

3.5.5 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.

3.5.7 Depth of Sewer Pipe

As mentioned earlier, the depth of sewers is generally 1-2 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 m below basement floor.

3.5.8 Design Period

Sewers are designed on estimated future flows at the end of a design period . So the design period is thus the length of time throughout which the capacity of a sewer will be able to cope with the expected flows and may be assumed at :

1. drains (concrete) : 20 – 30 years .
2. sanitary sewers : 25 – 30 years .
3. pumping station : equipment :15 years, buildings : 25 – 30 years .

3.6 Design and Planning Assumptions

The design and planning assumptions used in this project are as follow:

1. Design period: 25 year (from 2005-2030).
2. Present population of Halhoul (year 2005): 21078 capita.
3. The population growth rate has been taken as 3 % .
4. The existing per capita water consumption has been assessed 90 l/c.d.
5. Total administrative area of municipality of Halhoul is 39000 donums.
6. Future population (year 2030) of Halhoul: 44133 capita.
7. Per capita water consumption by 2030 will reaches 150 l/c.d.
8. The wastewater production is about 75% of water consumption.
9. Formula to be used in design of sewers (Manning formula):

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

10. Minimum velocity: 0.6 m/sec.
11. Maximum velocity: 3 m/sec .
12. h/D ≤ 0.5 for main trunks.
13. Maximum manhole spacing: 50 m for main trunk.
14. Minimum pipe diameter:: 150mm (6 inch).
15. Infiltration rate equal 2 % of the domestic seweage flow .
16. Peak factor determine by equation:

$$P_f = 1.5 + (3 /\sqrt{q}) \quad (3.3)$$

17. Depth of sewer pipe: Minimum cover not less than 1.0 m .

3.7 Summary

In this chapter "Design and Planning Criteria ", the population of the study area has been estimated. The future water consumption in year 2030 (design period) has been projected. City master plan has been described .The design and planning criteria of the project has been pointed out. The overall design parameters summary have been listed.

CHAPTER FOUR

ANALYSIS AND DESIGN

CHAPTER FOUR

ANALYSIS AND DESIGN SAMPLE

4.1 Introduction

In this project, an attempt is made to evaluate and design wastewater collection system for Halhoul city, and develop a future plans for construction of the collection system, corresponding to population growth and the water consumption and subsequently the wastewater production from different sources in the future, in order to reduce the problem causes by the disposal of raw wastewater in the area. In this chapter, the layout of the system established will be presented .

4.2 Layout 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, soil type, and the cellar or lowest floor elevation of all buildings to be drained. Where part of the drainage area to be served is undeveloped and proposed development plans are not yet available, care must be taken to provide adequate terminal manholes that can later be connected to the system constructed serving the area.

In establishing the layout of wastewater collection system for Halhoul area, the following basic steps were followed:

1. Obtain a topographic map of the area to be served.
2. Locate the drainage outlet. This is usually near the lowest point in the area and is often along a stream or drainage way. In Halhoul area, the lowest point is in the northen part of the city.
3. Sketch in preliminary pipe system to serve all the contributors.
4. 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.
5. 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 paralleling streams or channels.
6. Establish preliminary pipe sizes. Six inches pipe size (usually the minimum allowable) can serve several hundred residences even at minimal grades.
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 followed the ground surface slope to minimize the depth of excavation, and the number 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 for Halhoul city is illustrated in Figures 4.1 , 4.2 and 4.3 .

4.3 Design Computation

The detailed design of sanitary sewers involves the selection of appropriate pipe sizes and slopes to transport the quantity of wastewater expected from the surrounding and upstream areas to the next pipe in series, subject to the appropriate design constrains. The design computations and procedure for Halhoul sanitary sewers is illustrated in the design example given below.

Design Example: Design a gravity flow sanitary sewer

Design a gravity flow trunk sanitary sewer for the area (part of Halhoul city) shown in the accompanying Figures 13 & 14. The trunk sewer is to be laid along Al-Nabi Younas street. Assume that the following design criteria have been developed and adopted based on an analysis of local conditions and codes.

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

2. For population growth use 3 %.
3. For water consumption use 90 l/c.d. for the current use and 150 l/c.d. for the future use. The wastewater calculates as 75% of the water consumption.
4. For infiltration allowance use 2% of the domestic sewage flow.
5. Peaking factor depending on the formula:

$$P_f = 1.5 + (2.5 / \sqrt{q}) \quad (3.2)$$

6. For the hydraulic design equation use the Manning equation with an n value of 0.013. To simplify the computations, use the tables in Appendix.
7. Minimum pipe size: The building code specifies 150 mm (6 in) as the smallest pipe permissible for this situation.

8. 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.
9. Minimum cover (minimum depth of cover over the top of the sewer). The minimum depth of cover is 1.0 m.

Solution

1.Lay out the trunk sewer. Draw a line to represent the proposed sewer (Figure 4.3).

2.Locate and number the manholes. Locate manholes at (1) change in direction, (2) change in slope, (3) pipe junctions, (4) upper ends of sewers, and (5) intervals from 90 to 180 m or less. Identify each manhole with a number.

3. Prepare a sewer design computation table. 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 necessary computations for the sanitary sewer shown in Figure 13 & 14 are presented in Table 4.2 The data in the table are calculated as follow:

- From manhole # 11 to manhole # 10.
- Sewer length = 50m .
- Partial sewered area =1.11 ha
- Cumulative sewered area = 1.11 ha.
- Density person for this area = 65 c/ha.
- Partial population person = 65 c/ha * 1.11 = 72 capita.
- Cumulative population persons = 72 capita.

- Average domiestic (q_m) = 72 (c) * 112.5 (l/c.day) = 8100 l/day = 0.094 l/s.
- Peak factor P_f = 1.5 +2.5 /√ (q_m) = 9.65 ,take it 4 .
- The infiltration = 0.008 l/s .
- Total average = Average domestic + Infiltration = 0.094 + 0.008 = 0.10 l/s .
- O-peak design = Maximum domestic + Infiltration = 0.38 + 0.008 = 0.38 l/s .
- Upstream elevation = 1004.99 , down stream elevation = 1004.99 m.
- Ground slope (G) = (1004.99 – 1004.99)/50= 0.0.
- Pipe slope(S) = 0.6% .
- Pipe diameter =6".
- Capacity from Manning Formula pipe flow chart at S= 0.006 and d= 15 cm we find Q_0 = 12 l/s and V_0 = 0.68 m/s .
- The ratio Q_p–max. / Q_f = 0.38 /12 = 0.0316

  from tables (appendix) V_p /V_0 and h/D = 0.47 and 0.118 rispictivly , then

  V-act = 0.68 * 0.47 = 0.32 m/s . (Acceptable for value of h/D < 0.5)
- Invert drop sewer = Slope of sewer * Length of sewer = 0.006 * 50 = 0.30m.
- Invert elevation of upper manhole = ((1004.99 – ((G – S) * distance) -1 – d) = ((1004.99 – ((0.0- 0.006 – 1 - 0.15 = 1004.14 m .

- From manhole # 10 to manhole # 9.
- Sewer length = 50m .
- Partial sewered area =0.8 ha
- Cumulative sewered area = 1.91 ha.
- Density person for this area = 65 c/ha.
- Partial population person = 65 c/ha * 0.80 = 52 capita.
- Cumulative population persons = 1.91 * 65 = 124 capita.
- Average domiestic (q_m) = 124 (c) * 112.5 (l/c.day) = 13950 l/day = 0.161 l/s.
- Peak factor P_f = 1.5 +2.5 /√ (q_m) = 7.7 ,take it 4 .
- The infiltration = 0.013 l/s .
- Total average = Average domestic + Infiltration = 0.161 + 0.013 = 0.17 l/s .
- O-peak design = Maximum domestic + Infiltration = 0.65 + 0.013 = 0.66 l/s .
- Upstream elevation = 1004.99 , down stream elevation = 1004.99 m.
- Ground slope (G) = (1004.99 – 1004.99)/50= 0.0.
- Pipe slope(S) = 0.6% .
- Pipe diameter =6˝.
- Capacity from Manning Formula pipe flow chart at S= 0.006 and d = 15 cm we find Q_0 = 12 l/s and V_0 = 0.68 m/s .
- The ratio Q_p–max. / Q_f = 0.66 /12 = 0.055

from tables (appendix) V_p / V_0 and h/D = 0.55 and 0.156 rispictivly , then V-act = 0.68 * 0.55 = 0.37 m/s . (Acceptable for value of h/D < 0.5)

- Invert drop sewer = Slope of sewer * Length of sewer = 0.006 * 50 = 0.30m.
- Invert elevation of upper manhole = ((1004.99 – ((G – S) * distance) -1 – d) = ((1004.99 – ((0.0- 0.006 – 1 - 0.15 = 1004.14 m .
- Invert elevation of manhole # 10 = 1004.99
- Manhole # 10 is the lower manhole with respect to the manhole # 11 & it is the upper manhole with respect to the manhole #9.

Comment: A computation table, such as the one shown in this example, not only saves time but also is useful for summarizing both the data and the computed results in an orderly sequence for subsequent use. The specific columns in a given computation table depend on the factors that must be considered in arriving at the peak design flows. Most sanitary and civil engineering consulting firms have developed tabulation forms of their own or sewer design computations. Although the forms may differ in specific details and in the order of presentation from this table, the same information is usually presented. Some engineering firms have developed computer programs for sewer design.

The calculated table for the wastewater collection sample of part of Halhoul area is presented in Table 4.1.

4.4 : SUMMARY

In this chapter , the layout of the proposed wastewater collection system for Halhoul city has been described . A sample detailed design computations have been given and discussed . Finally the sample profiles of sewers have been presented.

CHAPTER FIVE

BILL OF QUANTITIES

CHAPTER FIVE

BILL OF QUANTITIES

1- Excavation and backfilling

No	ITEM	UNIT	QTY	UNIT PRICE		TOTAL PRICE	
				$	C	$	C
1.1	Excavation of pipes trench all kind of soil for width = diameter + 0.4 m and disposing of the debris and the top soil unsuitable for backfill outside the site , the depth not exceeding 1.5m	LM	15749				
1.2	Excavation of pipes trench all kind of soil for width = diameter + 0.4 m and disposing of the debris and the top soil unsuitable for backfill outside the site , the depth for exceeding between 0.0 – 2.0m	LM	609				
1.3	Excavation of pipes trench all kind of soil for width = diameter + 0.4 m and disposing of the debris and the top soil unsuitable for backfill outside the site , the depth for exceeding between 0.0 – 2.5m	LM	122				
1.4	Excavation of pipes trench all kind of soil for width = diameter + 0.4 m and disposing of the debris and the top soil unsuitable for backfill outside the site , the depth for exceeding between 0.0 – 3.0m	LM	657				
1.5	Excavation of pipes trench all kind of soil for width = diameter + 0.4 m and disposing of the debris and the top soil unsuitable for backfill outside the site , the depth for exceeding 3.0m	LM	1065				

2- Pipes

No	ITEM	UNIT	QTY	UNIT PRICE		TOTAL PRICE	
				$	**C**	$	C
2.1	Supplying, storing and installing of pipes diameter 6 Inch (uPVC)	LM	10882				
2.2	Supplying, storing and installing of pipes diameter 8 Inch (uPVC)	LM	3384				
2.3	Supplying, storing and installing of pipes diameter 10 Inch (uPVC)	LM	1348				
2.4	Supplying, storing and installing of pipes diameter 12 Inch (uPVC)	LM	1938				
2.5	Supplying, storing and installing of pipes diameter 16 Inch (uPVC)	LM	650				
2.6	Embedment of sand for one pipe diameter 6 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site, the depth of sand is 0.4 m .	LM	10882				
2.7	Embedment of sand for one pipe diameter 8 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site, the depth of sand is 0.4 m .	LM	3384				
2.8	Embedment of sand for one pipe diameter 10 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site, the depth of sand is 0.4 m .	LM	1348				

2.9	Embedment of sand for one pipe diameter 12 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site, the depth of sand is 0.4 m .	LM	1938				
2.10	Embedment of sand for one pipe diameter 16 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site, the depth of sand is 0.4 m .	LM	650				

3- Concrete manholes

No	ITEM	UNIT	QTY	UNIT PRICE		TOTAL PRICE	
				$	C	$	C
3.1	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coating, 25-ton cast iron cover and backfill, size 1000mm depth up to 1.00m.	NR	336				
3.2	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coating, 25-ton cast iron cover and backfill, size 1000mm depth up to 2.50m	NR	45				
3.3	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coating, 25-ton cast iron cover and backfill, size 1000mm depth up to 5.00m	NR	12				

4- Pipe bedding

No	ITEM	UNIT	QTY	UNIT PRICE		TOTAL PRICE	
				$	C	$	C
4.1	Supplying, installation and compaction of (Absolete) fine granular materials, under, above and around pipe diameter 6 inch .	LM	10882				
4.2	Supplying, installation and compaction of (Absolete) fine granular materials, under, above and around pipe diameter 8 inch .	LM	3384				
4.3	Supplying, installation and compaction of (Absolet) fine granular materials, under, above and around pipe diameter 10 inch .	LM	1348				
4.4	Supplying, installation and compaction of (Absolete) fine granular materials, under, above and around pipe diameter 12 inch .	LM	1938				
4.5	Supplying, installation and compaction of (Absolete) fine granular materials, under, above and around pipe diameter 16 inch .	LM	650				

5- Concrete work

No	ITEM	UNIT	QTY	UNIT PRICE		TOTAL PRICE	
				$	C	$	C
5.1	Supplying and cast iron (B200) surround for sewer.	M3	65				
5.2	Supplying and installing of reinforced concrete (B200) protection concrete encasement for sewer pipe.	LM	160				

6- Air Leakage Test

No	ITEM	UNIT	QTY	UNIT PRICE		TOTAL PRICE	
				$	C	$	C
6.1	Air leakage test for sewer pipe lines 6, 8, 10, 12 and 16 according to specifications, including for all temporary works.	LM	18202				
6.2	Water leakage tests for manholes. Depth up to 1.00 meter according to specifications.	NR	336				
6.3	Water leakage test for manholes, depth up to 2.50 meter according to specifications.	NR	57				

7- Road reinstatement

No	ITEM	UNIT	QTY	UNIT PRICE		TOTAL PRICE	
				$	C	$	C
7.1	Removing and dispose of the asphalt and repaving and re-Asphalting after Backfill, road structure layers compacted basecoarse 125+125 mm , MCO layer 11/m2, asphalt layer 50mm(3/4")	LM	7562				
7.2	Dismaning and repairing edge (stone structure)	LM	18202				
7.3	. Topographical survey required for shop drawings and as built DWGS using absolute Elevation .and coordinate system	LM	18202				

CHAPTER SIX

CONCLUSIONS

CHAPTER SIX

CONCLUSIONS

In this project, new wastewater collection system for Halhoul city were proposed to overcome the current problem of wastewater disposal.

The analysis and design were made for the main trunks that show the following results:-

1. The design of the conventional gravity sewer were proposed with one site for outfall. Two pumping station are suggested in two places in the east and west region.
2. By network analysis the pipe length and sizes of the sewer netwoks were calculated.The diameters of the pipes ranges frome 200 to 300 mm in most of the areas.
3. The proposed wastewater collection system for Halhoul city, covers most of the areas of Halhoul but the network is complex because of the topography of Halhoul city .
4. The estimated cost of the proposed wastewater collection network is high.
5. The city of Halhoul and the neighbaring towns and villages like Shuyuch, Sair, Beit Ommar, Beit Fajjar, and El- Aroub can be share with one central outfall and wastewater treatment plant.

Appindex

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