Modeling of Wastewater Collection Network Using Arc GIS and SewerGEMS in Kabul, Afghanistan

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Abstract

This study was conducted to find out the feasibility of a decentralized wastewater collection system and model it in planned and unplanned areas by using Arc GIS and SewerGEMS software. One of the most critical environmental challenges of the Kabul city is the lack of a sewage collection, treatment, and disposal system. This has caused many health and environmental problems. For this study, the fifth district of Kabul city was selected as a study area and divided into nine study zones. The geometric model of the network was created in Arc GIS using Landuse and landcover, Digital Elevation Model, and Satellite Imagery. Hydraulic analysis and design of the system done by SewerGEMS software and the control of the parameters based on the design results done according to the standard design criteria of sewerage networks. The result of the hydraulic design of the modeled system shows that creating and implementing a decentralized and regional sewer collection network is the best solution for the city. After studying the results of hydraulic analysis and design and after reviewing and controlling the control parameters such as flow velocity, pipe diameter, slopes, pipe profiles, etc., it concluded that the hydraulic model has successfully designed and created. Implementation of such a model is applicable to district scales in the city and looks at the appropriate solution for this issue. It can cover almost all of the planned areas of the city and also most of the unplanned areas.

Keywords: wastewater, sewer networks, Kabul, Arc GIS, SewerGEMS.

1. Introduction

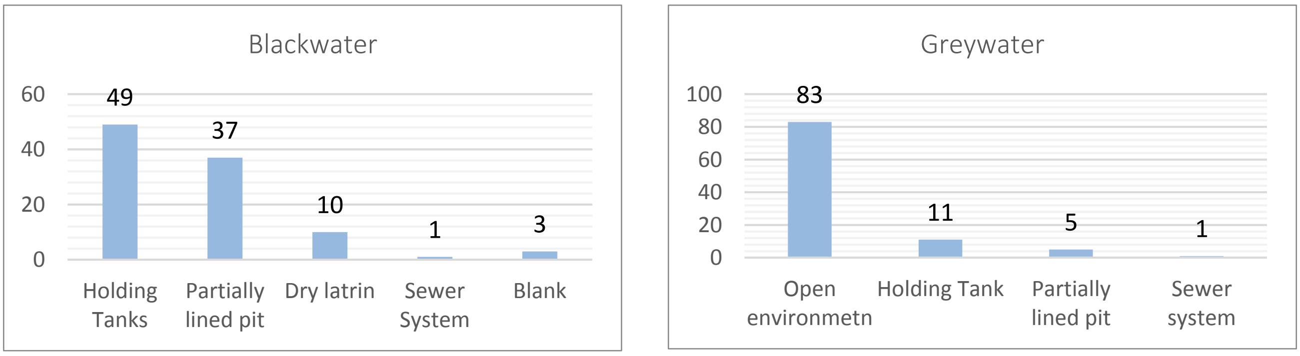
Wastewater collection, in a proper way, as well as its treatment and disposal, is one of the primary hygienic needs of any society. For managers and administrators of urban water and sewage systems, the appropriate solution for different parts of the city is the correct and timely selection of options that must define in terms of physical characteristics, environmental, economic, and social acceptance effects. One of the most critical environmental challenges of the Kabul city is the lack of a sewage collection, treatment, and disposal system. This has caused many health and environmental problems. Currently, Blackwater is conveying sewage tanks, septic tanks, semi-insulated wells, absorption wells, and dry toilets. Sewage from bathrooms, showers, kitchens, etc. (Greywater) is also disposed of using holding tanks, septic tanks, absorption wells, etc., but is mostly discharging into the open environment. The Kabul Municipality has introduced a small scale biological system of the wastewater treatment system and stated that unless severe and immediate action is taken to prevent the contamination of groundwater in Kabul, the groundwater will not be usable for the next few years (shafaqna 2019).

The only valid and available source of drinking water in Kabul is groundwater (Zaryab et al. 2017). Drinking water unfortunately contaminated in Kabul, and most groundwater sources in Kabul unfortunately contaminated with human coliforms (Afzali 2017). Studies show the poor condition of groundwater in Kabul city (Houben et al. 2009; Frahmand 2011; Hayat and Baba 2017; Rhimi and Murakmi 2017; Zaryab et al. 2017; Gesim and Okazaki 2018; Brati et al. 2019; Noori and Nasimi 2019; Zahid et al. 2019). The pollution caused some serious health concerns in the city. Since no official statistics on the disease and its causes are available. According to a report published on the BBC website on 10 Aug of this year(Ali 2017), the leading cause of diseases in Kabul is the use of contaminated water. This news page quotes the doctors of Antani Hospital as saying that the leading cause of epidemics of more than 70 percent of patients who registered in the hospital is drinking contaminated water.

Studies conducted by the Consortium for DEWATS Dissemination Society (2017) in Kabul in districts 2, 3, 4, 5, 10 11, and half of district 17 show that the dispose of black-water and greywater is different. Only one percent of households connected to the sewage collection system; 49 percent of households use holding tanks to dispose of their incoming sewage. 37% use partially lined pit latrines, and 10% use dry toilets. Studies by Paiman and Noori (2019) also show that about 84 percent of households discharge bath and kitchen water directly into the open environment, and 11 percent use the same septic tanks or other different tanks for disposal. Five percent of households use semi-insulated containers. Also, 94% of wells and septic tanks do not have an outlet for overflow flow, but if such a duct is available, it is either connected directly to the open air (37%) or connected to another well (63%) (Figure.1). Conditions for commercial institutions and facilities are slightly different. Most of them (81%) use septic tanks for commodity sewage, 13% use semi-insulated containers, and only 1% use dry toilets. But 1% still use small-scale decentralized treatment plants. Most greywater (59%) is directed directly to the open air. About 26% of these facilities use the same commodity sewage tank or a different tank to transfer this sewage. Five percent of the tanks are semi-insulated, but still, a small number of them have outlets connected to the open space or other wells.

The objective of this study is to find out the feasibility of the wastewater collection system in the Kabul using arc GIS and SewerGEMS software. For this research, a Landuse and Land cover map of the fifth district of Kabul city and Digital Elevation Model (DEM) and satellite imageries used for visualization and geometric modeling. Hydraulic analysis and design of the network done by software tool named Bentley's SewerGEM Version 8i. And parameters control according to the design results done based on the standard design criteria of sewerage networks.

A. Sewage disposal in residential areas



B. Sewage disposal in commercial areas

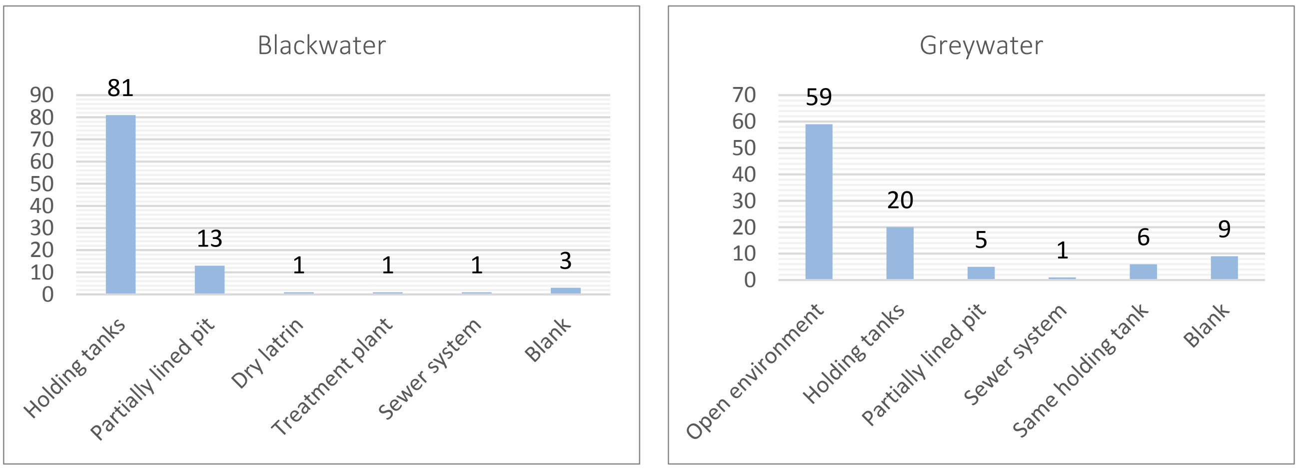


Figure 1. Sewage disposal in Kabul

2. Study area

The process of rapid urbanization is now universal, as more than half of the world's population lives in c ities (Bhave and Rahate 2018). Kabul city is the capital of Afghanistan, located in the central-east of the country. It's population estimated at 4.3 Million (CIA 2020; NSIA 2020). It is the largest national commercial center in the country, and after 2001 a lot of refugees returned to home countries from neighboring countries. Also, a lot of people came to Kabul from other provinces to find a job. The city has 22 municipality districts. District 5 (figure.1) is located in the western part of the town and considered a study area. This district is a populated area of the city, and according to data from Kabul Municipality, it has a population of about 86000. Its total area is about 28 $km^{2,}$ and its perimeter is about 30 km. The reason for selecting this area for the study is that it covers both planned and non-planned area. From the total area of the study area, only about 18% of it has covered by the planned area. The remaining 82% has developed in unplanned mode. Creating models for the unplanned area is time-consuming; therefore, the study area has divided into nine study zones, and the model has developed for only two zones. The total area of this zones area about 9 $km^{2,}$ and one of them covered the planed area, and the other one is an unplanned area (Figure.2). For the selection of the study zones, topographic conditions and future development have considered. If the model developed in the future, it could connect to the main sewer pipes of the existing zones.

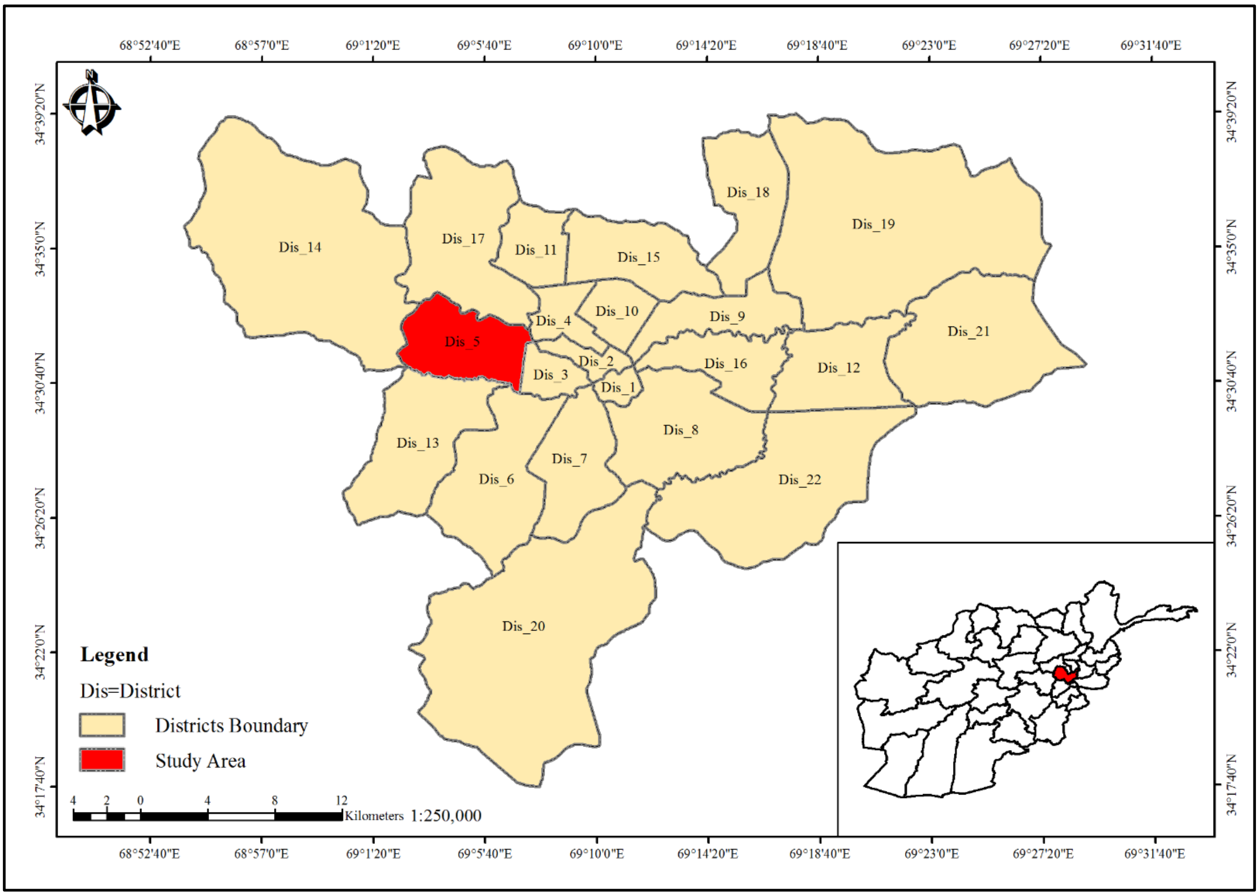


Figure 2. Location of the study area

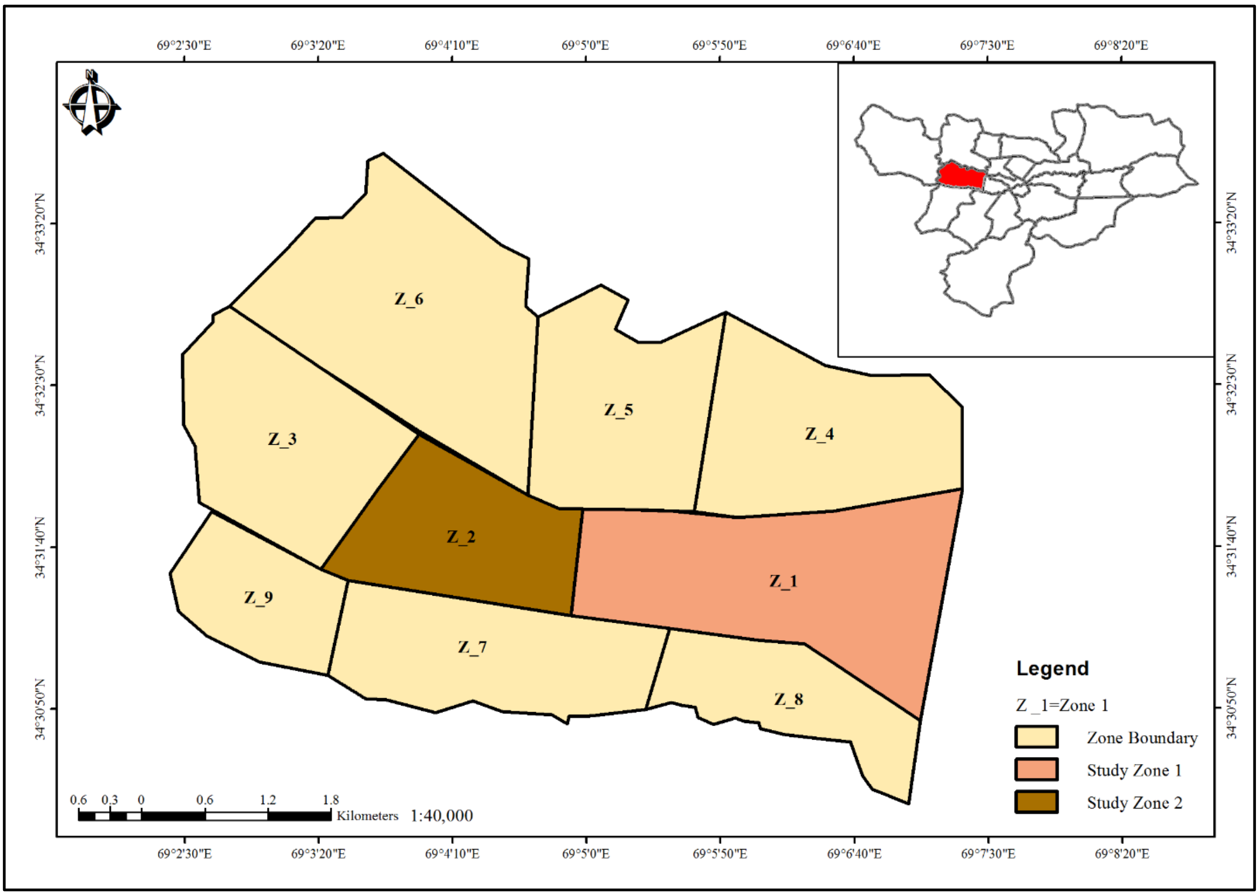


Figure 3. subdivision of the study area.

3. Software application

In this research, the sewage collection network designed in the fifth district of Kabul city. First, the required information for the design, including the length of the sewer pipes, the area of the sewer surfaces and ground elevation at the manholes, has been determined through Arc GIS software. The GIS vastly simplifies the various geospatial scales and can therefore minimize the cost and time of field surveys, which would have a key role to play in environmental conservation (Kumar et al. 2015; Bhave and Rahate 2018). Then, related information like topographic features, statistical information such as population and the per capita water consumption, and wastewater production in the desired geographical area prepared. This information is the basis of the design of the sewage network and developed through reputable sources such as booklets related to geographical knowledge.

To create a geometric model of the system, having land use and landcover is necessary for the study area—Landuse and landcover plan prepared by the ministry of earth and the urban development of Afghanistan. The LULC includes all build-up areas, agricultural, commercial, and institutional areas. The relative location of roads, streets, etc. also has been shown in LULC in the area (figure.3). According to the LULC, aided with satellite images of Kabul city, the number of houses in the area calculated. According to it, the population estimation and flow rate for hydraulic modeling of the system done.

In addition to the LULC aimed proper network routing, there is also a multiplication of contour lines and topographic plans of the area. In practice, it is doing by a geodetic survey and requires a lot of time and budget. However, Digital Elevation Model (DEM) used for research and the creation of basic models. DEM is an open-source data and has different resolutions. In this study, it is used with 30 meters by 30-meter resolutions.

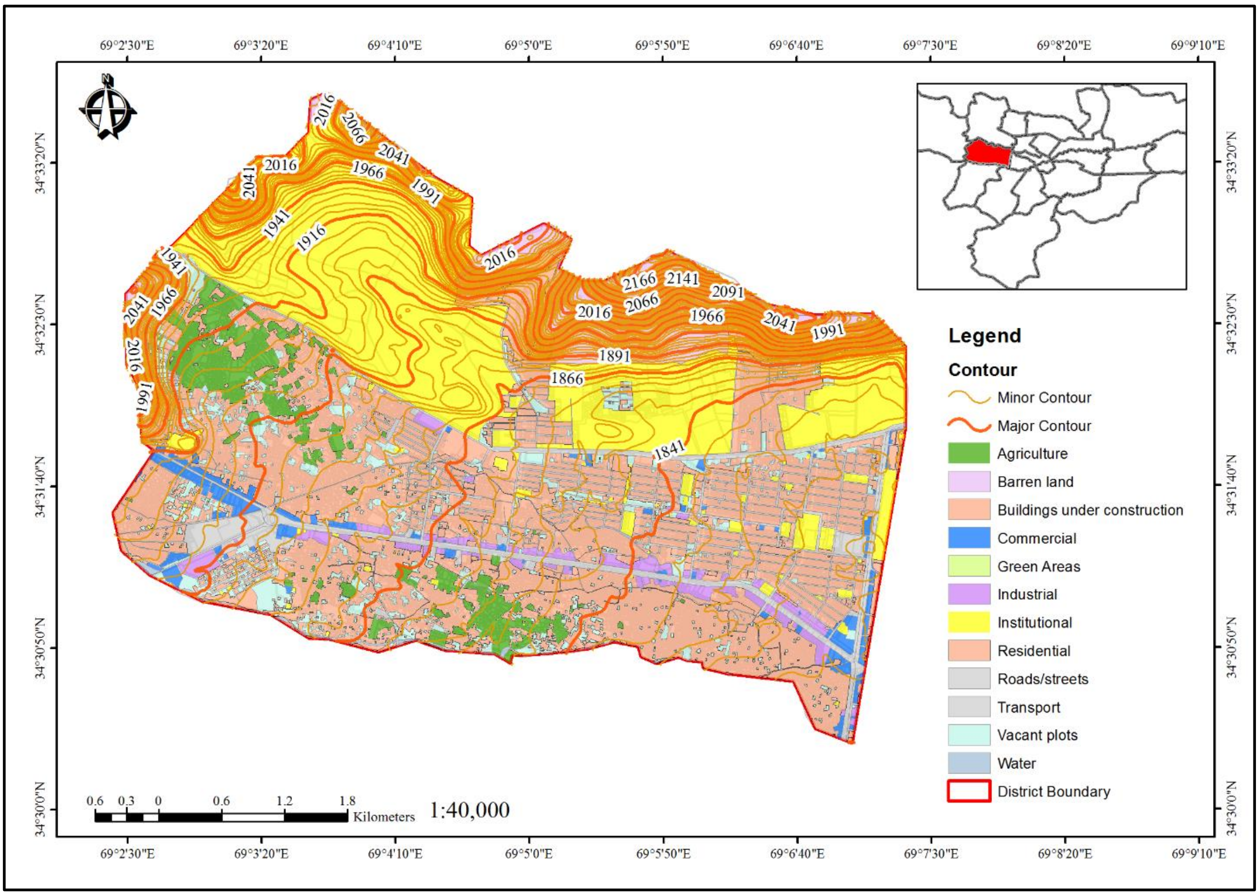


Figure 4. Landuse, Landcover and contour map of the study area

SewerGEMS is one of Bentley's most widely used software and one of the most powerful software for modeling sanitary and hybrid sewage systems. With the help of this software, exact sewage systems can be designed for buildings, houses, and urban context and have many applications in the water and sewage industries. With the help of this software, the municipal sewage system can be designed and optimized. The correct design and construction of the municipal sewage system will significantly help to preserve the environment, the health of humans and other living organisms, and also save water resources. One of the essential features of this software is that it is easy to work with while its powerful features. This software helps water and sewage engineers to be able to design accurate and intelligent systems in a short time and, at the same time, reduce costs. Reduce as much as possible; This software, with its strategic suggestions in various designs, makes the work of engineers very easy and saves their time and energy.

In this research, the essential information and geometric model of the system prepared by Arc GIS 10.6. Then the amount of flow has been received considering the per capita wastewater production for different places, and the required data entered into SewerGEMS for hydraulic design of the network.

4. Geometric modeling

The purpose of creating a geometric model of the system is to hypothetically adjust the routes of the wastewater collection network according to the LULC of the study area and its topography (figure.4). Sewage collection systems must design by the gravitational system so that the sewage flows from the source of production to the treatment unit and is disposed of or reused by gravity. But in many cases, pressure systems can also be used. The geometric model of the system, by default, shows the first figures of the model. In the geometric model, the position of the manholes and primary network routes indicated.

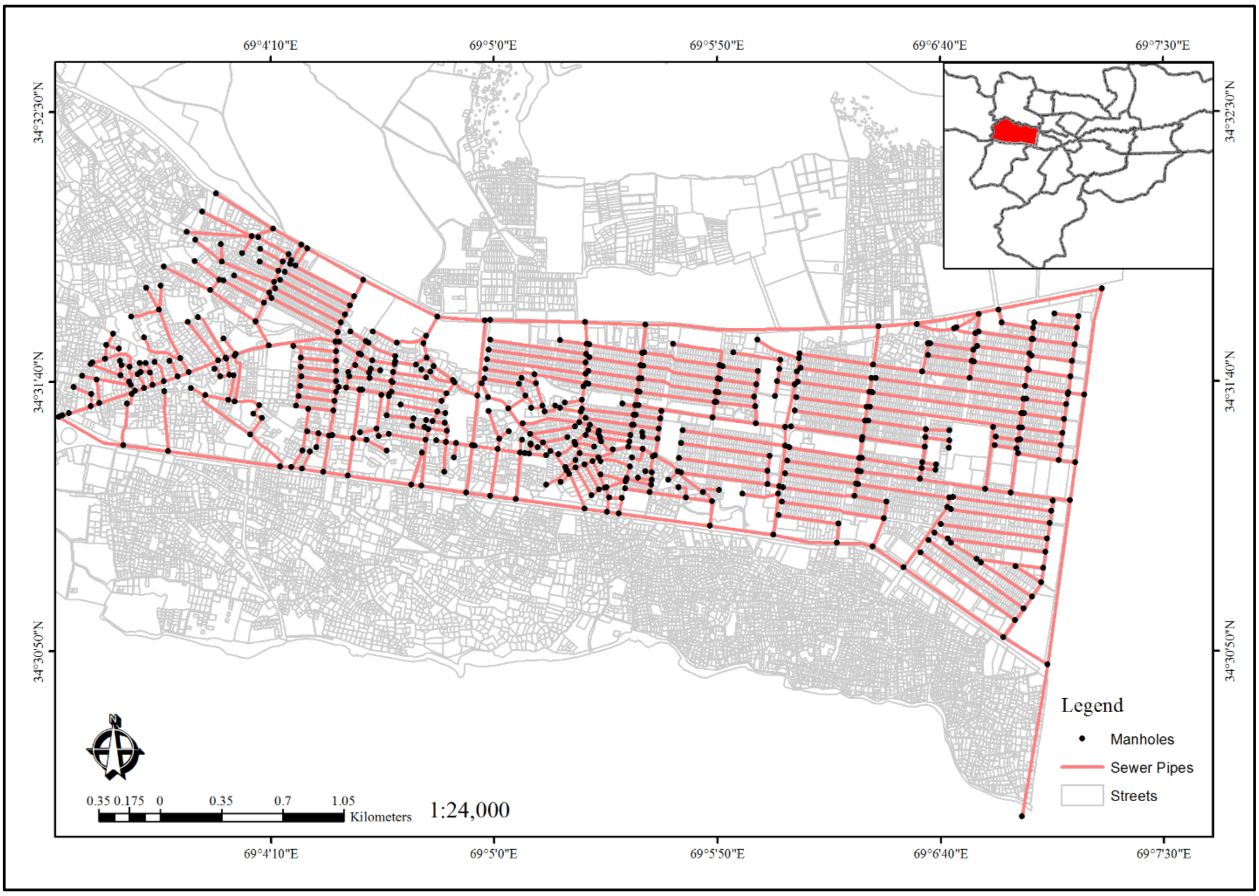


Figure 5. geometric model of the sewer network

5. Result and discussion

5.1. Population density

The total population of Kabul city estimated at 4.3 million and its area is 1023 km^2. The population density is 4500 capita/km^2. The exact area covered (two study zones of the fifth district of Kabul city), which considered in hydraulic design, is 8.834 square kilometers. Therefore, according to the population density, it is possible to find out the population of the covered area, which is about 40,000 people in total. On the other hand, in the area covered, there are mostly medium-sized and high-rise residential blocks, which will have a significant impact on the population density of the city. Therefore, to ensure the presentation of the model and its practical operation, an additional coefficient should be considered for the existing population of the study area. In the next calculations, the reliability coefficient considered being 1.8. Examining the reliability coefficient, the population of the study area is estimated at 72,000 people. Kabul is one of the cities with significant population growth. Therefore, calculating the population increase in hydraulic network design is one of the principles and requirements of accurate and standard design. One of the simplest and most widely used methods of population estimation is the geometric method, in which the following formula used.

$$P_n = P_0(1 + r)^n$$

Where; P_n- Population in the favorable year, P_0 – present population, r – population increase rate, n – years of the design period.

According to the design conditions and considerations, the life of water and sewage projects often considered being about 30 years. The population growth admitted to 2.5 percent per year. Taking into account the above conditions, the population in the next thirty years calculated as follows.

$$P_{30} = 72000\left(1 + \frac{2.5}{100}\right)^{30} = 151025 \text{ capita}$$

5.2. Discharge estimation

The amount of sewage flow considered in the network is the amount of water used for residential purposes. Because this system modeled separately, only the amount of wastewater flow in residential areas without rainwater considered. According to the current situation, the norm of water consumption in the cities of Afghanistan deemed to be 100 liters/capita/day (Seddeqi 2017). On the other hand, the amount of wastewater production generally taken 60-80% of water consumption. But in the current situation in Afghanistan, it is better to consider this norm equal to 100 percent. Because the waste of 20-40% of the water found for irrigation of green areas inside the yard, car washing, etc., this waste is not connecting to the municipal sewage system. But in Afghanistan, because the cost of water is higher and on the other hand, the level of society's economy is lower, and water is not using for car wash purposes inside residential houses as well as in-yard sprinklers, etc. According to per capita demand and a total population of the study area, the total amount of wastewater flow in the covered area can calculate as follows:

$$Q_{avg} = 151025 \times 100 = \frac{15102500\text{lit}}{\text{day}} = 15102\text{m}^3/\text{day}$$

The estimated total flow rate of residential areas in dry climate conditions (Dry Weather flow = DWF) is 15102 cubic meters per day. Based on the design conditions for sewerage networks, additional coefficients should consider ensuring the effective operation of the system. Additional coefficient due to groundwater infiltration, the inflow of rainwater, daily and hourly variation. Taken together, consider all of the above coefficients to be about 2, and the total maximum discharge is calculating as follows:

$$Q_{max} = 15102 \times 2 = 30204\ \text{m}^3/\text{day}$$

5.3. Hydraulic modeling and design

Hydraulic models are the most reliable technique in several types of research on sewer networks (Zhang et al. 2018). The purpose of creating a hydraulic model is to analyze the geometric model, which has already prepared in Arc GIS software. After hydraulic modeling, many of the elements considered necessary in the geometric modeling stage may require to remove from the system. Some of the default paths found in geometric modeling may not meet the hydraulic design requirements of the system. Therefore, hydraulic modeling is count as the central part of the work in the hydraulic design of sewerage networks. To create a hydraulic model, the methodology presented in (Figure.5).

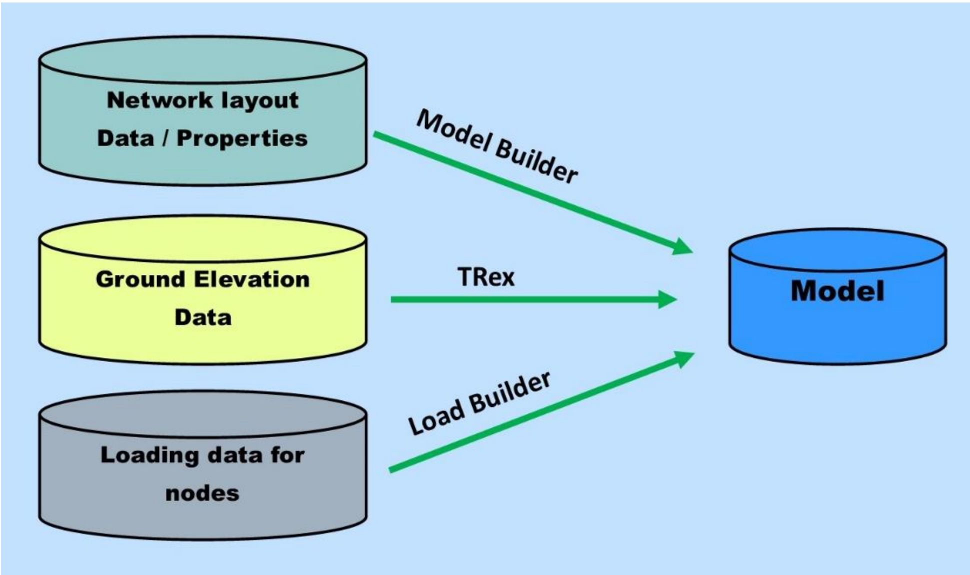


Figure 6. methodology for hydraulic modeling

The purpose of the hydraulic design of the network in the first stage is to find out the required diameter of the sewage pipes, which is determined based on the amount of discharge. Then the calculation of slope and control the velocity of flow in all the sewers. Because velocity is a critical parameter in fluid mechanics and has a specific limit, on the other hand, the sewer pipes are not designing as wholly filled, so the percentage of filling of the pipes should also be determined. In this study, the Area Load Data method used. And the distribution of discharge in the pipes has been done in the form of Equal Flow Distribution. The discharge in all pipes evenly distributed according to the area covered by each pipe. Of course, it should be noted that in fact, such conditions may not appear because some pipes will have more loads, and others will have fewer loads. However, since this model created to study the feasibility of modeling, this method is considered the most appropriate loading method.

The following settings for the hydraulic design of the network applied as a design scenario. The type of pipe material considered for the system is PVC, and its diameter is in the range of 150-600 mm. The maximum and minimum velocity values according to the design criteria, is considered 0.6-3.0 m/sec. The depth of pipes taken with a range of 0.9 – 4.0 m. The slope for the installation of the pipes fixed between 0.005 – 0.1 percent. Flow depth in each pipe considered as 50% full. To evaluate the incoming data and design settings, the created model has validated. After the validation steps, the hydraulic model calculated. The program calculates computational parameters and analyzes analytical parameters.

5.4. Presenting and evaluating the results

The design report provides brief information about the designed model. It includes the necessary details about the designer, such as name, specifications, model title, company, date of modeling, and design. It also provides a summary of the scenario used in model design. It presents the number of elements used in the model, 521 manholes, 521 pipes, and one outfall. Also, it shows the diameter and length of all diameter ranges of the pipes used in the network (Figure7). The total length of the system is 92602.4 meters.

Hydraulic Model Inventory: 5.stsw

Title	مدل سازی شبکه جمع آوری فاضلاب ناحیه پنجم شهر کابل
Engineer	پوهنیار علی رضا نوری
Company	پوهنتون پولی تخنیک کابل
Date	7/26/2019
Notes	

Scenario Summary

ID	1
Label	Base
Notes	
Active Topology	Base Active Topology
User Data Extensions	Base User Data Extensions
Physical	Physical Alternative - 3
Boundary Condition	Base Boundary Condition
Initial Settings	Base Initial Settings
Hydrology	Base Hydrology
Output	Base Output
Infiltration and Inflow	Base Infiltration and Inflow
Rainfall Runoff	Base Rainfall Runoff
Water Quality	Base Water Quality
Sanitary Loading	Base Sanitary Loading
Headloss	Base Headloss
Operational	Base Operational
Design	Base Design
System Flows	Base System Flows
SCADA	Base SCADA
Solver Calculation Options	Base Calculation Options

Network Inventory

Conduits	521	Taps	0
-Circle	521	Transitions	0
-Box	0	Cross Sections	0
-Ellipse	0	Outfalls	1
-Virtual	0	Catchments	0
-Irregular Channel	0	Low Impact Development Controls	0
-Trapezoidal Channel	0	Ponds	0
-Triangular Channel	0	Pond Outlet Structures	0
-Rectangular Channel	0	Headwalls	0
-Pipe-Arch	0	Pumps	0
Laterals	0	Wet Wells	0
Channels	0	Pressure Junctions	0
Gutters	0	SCADA Elements	0
Pressure Pipes	0	Pump Stations	0
Catch Basins	0	Variable Speed Pump Batteries	0
Manholes	521	Air Valves	0

Circle Inventory

Circle - 150.0 mm	80,508.8 m	Circle - 375.0 mm	1,405.3 m
Circle - 200.0 mm	3,732.6 m	Circle - 450.0 mm	2,145.7 m
Circle - 250.0 mm	2,159.0 m	Circle - 600.0 mm	881.0 m
Circle - 300.0 mm	1,770.1 m	Total Length	92,602.4 m

5.stsw
7/29/2019

Bentley Systems, Inc. Haestad Methods Solution Center
27 Siemon Company Drive Suite 200 W
Watertown, CT 06795 USA +1-203-755-1666

Bentley SewerGEMS V8i (SELECTseries 5)
[08.11.05.113]
Page 1 of 1

Figure 7. summary of hydraulic design

5.5. Control parameters

In the design of water and sewage networks, some parameters also identified as control parameters. Because of these computational parameters, the accuracy and correctness of the calculation controlled. For example, velocity is a control parameter that can be calculated and then checked. The velocity limit in sewer networks in the control range is 0.3-5.0 m/sec. The optimum interval is 0.6-1.8 m/sec. Therefore, in modeling and design of sewer networks, the velocity should be within the allowable limit or the desired limit. As illustrated in (Figure.8), the flow velocity is in the range of 0.3-5.0 m/sec. Also, it can control and check other parameters such as pipes diameters that introduced as standard from the program library should be calculated according to the amount of flow. As can be seen in the diameters column, all diameters have been selected based on standard available pipe sizes after calculating the system.

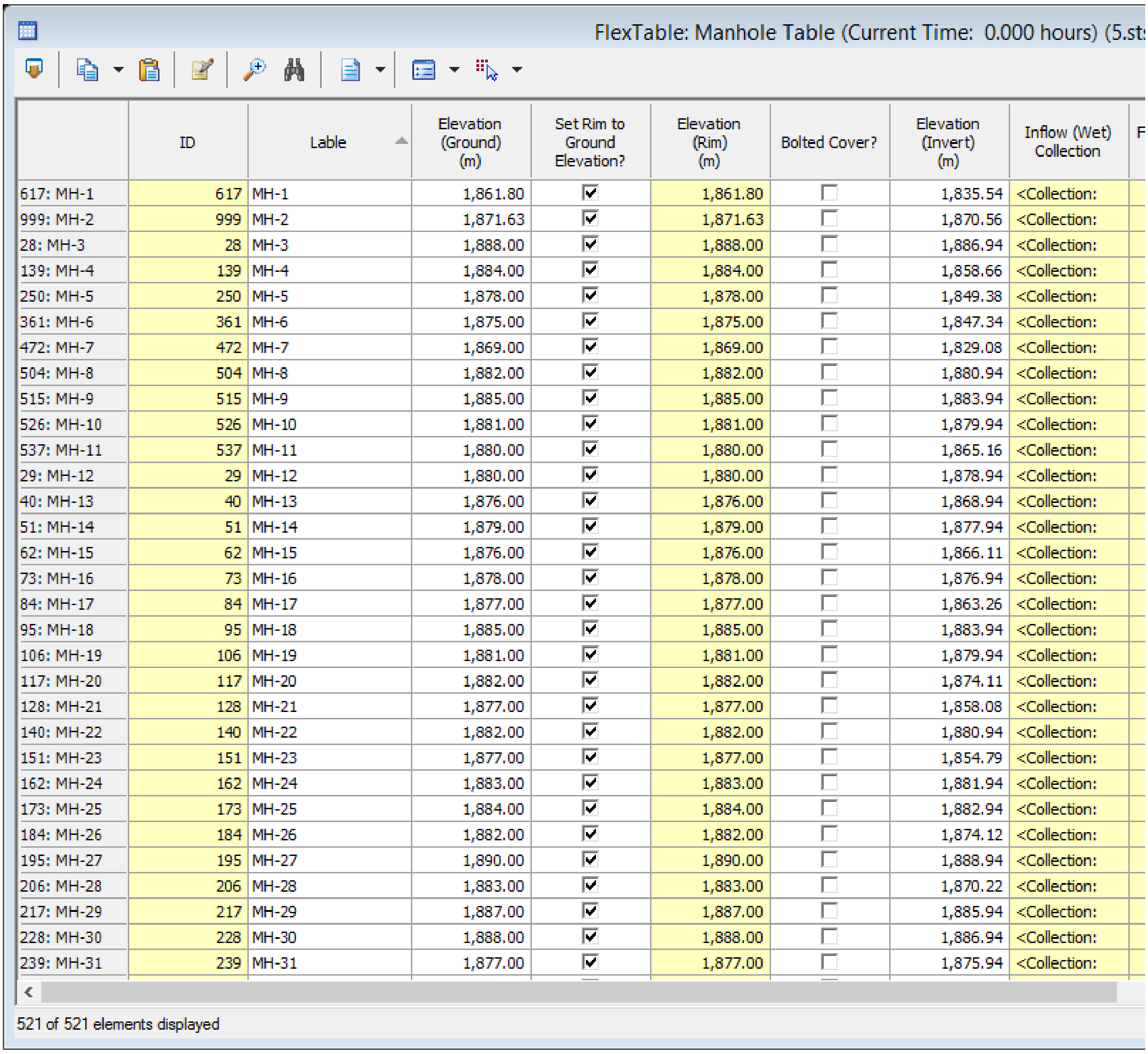
able: Conduit Table (Current Time: 0.000 hours) (5.stsw)

Length (User Defined) (m)	Length (Scaled) (m)	Slope (Calculated) (m/m)	Section Type	Diameter (mm)	Manning's n	Flow (Middle) (L/s)	Velocity (m/s)	Depth (Middle) (m)	Capacity (Full Flow) (L/s)
	881.0	0.050	Circle	600.0	0.013	347.23	4.87	0.57	1,372.97
	298.0	0.050	Circle	450.0	0.013	273.25	4.69	0.45	637.52
	694.7	0.050	Circle	450.0	0.013	258.58	4.62	0.45	637.52
	212.8	0.050	Circle	450.0	0.013	255.92	4.61	0.17	637.52
	207.5	0.050	Circle	450.0	0.013	247.25	4.56	0.45	637.52
	367.2	0.050	Circle	450.0	0.013	245.26	4.55	0.17	637.52
	365.3	0.050	Circle	450.0	0.013	217.26	4.39	0.16	637.52
	525.4	0.050	Circle	375.0	0.013	169.95	4.17	0.15	392.05
	67.3	0.050	Circle	375.0	0.013	167.95	4.15	0.15	392.05
	129.7	0.050	Circle	375.0	0.013	166.61	4.14	0.15	392.05
	395.3	0.050	Circle	375.0	0.013	147.29	4.00	0.38	392.05
	147.4	0.050	Circle	375.0	0.013	146.62	3.99	0.38	392.05
	140.3	0.050	Circle	375.0	0.013	141.29	3.95	0.38	392.05
	946.2	0.066	Circle	300.0	0.013	73.31	3.67	0.10	248.78
	258.0	0.050	Circle	300.0	0.013	94.64	3.58	0.12	216.23
	59.7	0.050	Circle	300.0	0.013	86.64	3.50	0.11	216.23
	363.7	0.050	Circle	300.0	0.013	85.31	3.48	0.30	216.23
	142.4	0.050	Circle	300.0	0.013	76.64	3.37	0.30	216.23
	210.1	0.050	Circle	250.0	0.013	58.65	3.16	0.25	132.97
	143.9	0.050	Circle	250.0	0.013	55.98	3.13	0.25	132.97

SORTED

Figure 8. Controlling the design parameters

The parameters related to the manholes also can be controlled through SewerGEMS. Among the essential parameters that should consider in manholes are the ground elevation and the depth of the manholes or invert elevation.



FlexTable: Manhole Table (Current Time: 0.000 hours) (5.st

	ID	Lable	Elevation (Ground) (m)	Set Rim to Ground Elevation?	Elevation (Rim) (m)	Bolted Cover?	Elevation (Invert) (m)	Inflow (Wet) Collection	F
617: MH-1	617	MH-1	1,861.80	☑	1,861.80	☐	1,835.54	<Collection:	
999: MH-2	999	MH-2	1,871.63	☑	1,871.63	☐	1,870.56	<Collection:	
28: MH-3	28	MH-3	1,888.00	☑	1,888.00	☐	1,886.94	<Collection:	
139: MH-4	139	MH-4	1,884.00	☑	1,884.00	☐	1,858.66	<Collection:	
250: MH-5	250	MH-5	1,878.00	☑	1,878.00	☐	1,849.38	<Collection:	
361: MH-6	361	MH-6	1,875.00	☑	1,875.00	☐	1,847.34	<Collection:	
472: MH-7	472	MH-7	1,869.00	☑	1,869.00	☐	1,829.08	<Collection:	
504: MH-8	504	MH-8	1,882.00	☑	1,882.00	☐	1,880.94	<Collection:	
515: MH-9	515	MH-9	1,885.00	☑	1,885.00	☐	1,883.94	<Collection:	
526: MH-10	526	MH-10	1,881.00	☑	1,881.00	☐	1,879.94	<Collection:	
537: MH-11	537	MH-11	1,880.00	☑	1,880.00	☐	1,865.16	<Collection:	
29: MH-12	29	MH-12	1,880.00	☑	1,880.00	☐	1,878.94	<Collection:	
40: MH-13	40	MH-13	1,876.00	☑	1,876.00	☐	1,868.94	<Collection:	
51: MH-14	51	MH-14	1,879.00	☑	1,879.00	☐	1,877.94	<Collection:	
62: MH-15	62	MH-15	1,876.00	☑	1,876.00	☐	1,866.11	<Collection:	
73: MH-16	73	MH-16	1,878.00	☑	1,878.00	☐	1,876.94	<Collection:	
84: MH-17	84	MH-17	1,877.00	☑	1,877.00	☐	1,863.26	<Collection:	
95: MH-18	95	MH-18	1,885.00	☑	1,885.00	☐	1,883.94	<Collection:	
106: MH-19	106	MH-19	1,881.00	☑	1,881.00	☐	1,879.94	<Collection:	
117: MH-20	117	MH-20	1,882.00	☑	1,882.00	☐	1,874.11	<Collection:	
128: MH-21	128	MH-21	1,877.00	☑	1,877.00	☐	1,858.08	<Collection:	
140: MH-22	140	MH-22	1,882.00	☑	1,882.00	☐	1,880.94	<Collection:	
151: MH-23	151	MH-23	1,877.00	☑	1,877.00	☐	1,854.79	<Collection:	
162: MH-24	162	MH-24	1,883.00	☑	1,883.00	☐	1,881.94	<Collection:	
173: MH-25	173	MH-25	1,884.00	☑	1,884.00	☐	1,882.94	<Collection:	
184: MH-26	184	MH-26	1,882.00	☑	1,882.00	☐	1,874.12	<Collection:	
195: MH-27	195	MH-27	1,890.00	☑	1,890.00	☐	1,888.94	<Collection:	
206: MH-28	206	MH-28	1,883.00	☑	1,883.00	☐	1,870.22	<Collection:	
217: MH-29	217	MH-29	1,887.00	☑	1,887.00	☐	1,885.94	<Collection:	
228: MH-30	228	MH-30	1,888.00	☑	1,888.00	☐	1,886.94	<Collection:	
239: MH-31	239	MH-31	1,877.00	☑	1,877.00	☐	1,875.94	<Collection:	

521 of 521 elements displayed

Figure 9. Ground and Invert Elevation of Manholes

The path profile of the sewer network pipes is another primary parameter that must be controlled. For implementation porpuses of sewage projects, the profile of all pipes required. But here only the farthest path, also called the critical path, is shown (Figure.10& 11). In the profile Ground Elevation, depth of manholes, Invert Elevation, pipe slope, the distance between manholes, and other necessary parameters presented.

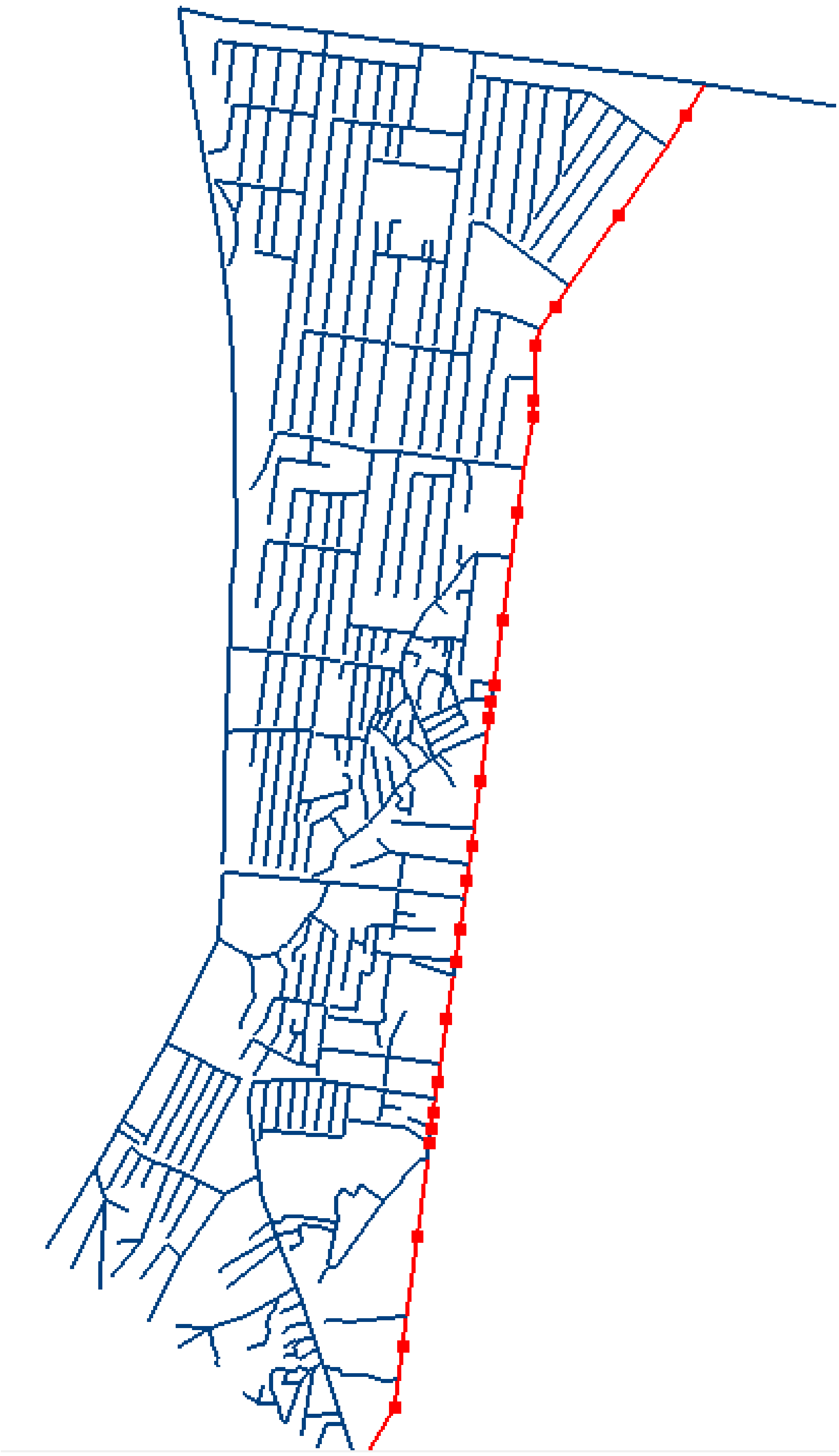


Figure 10. Profile path in plan

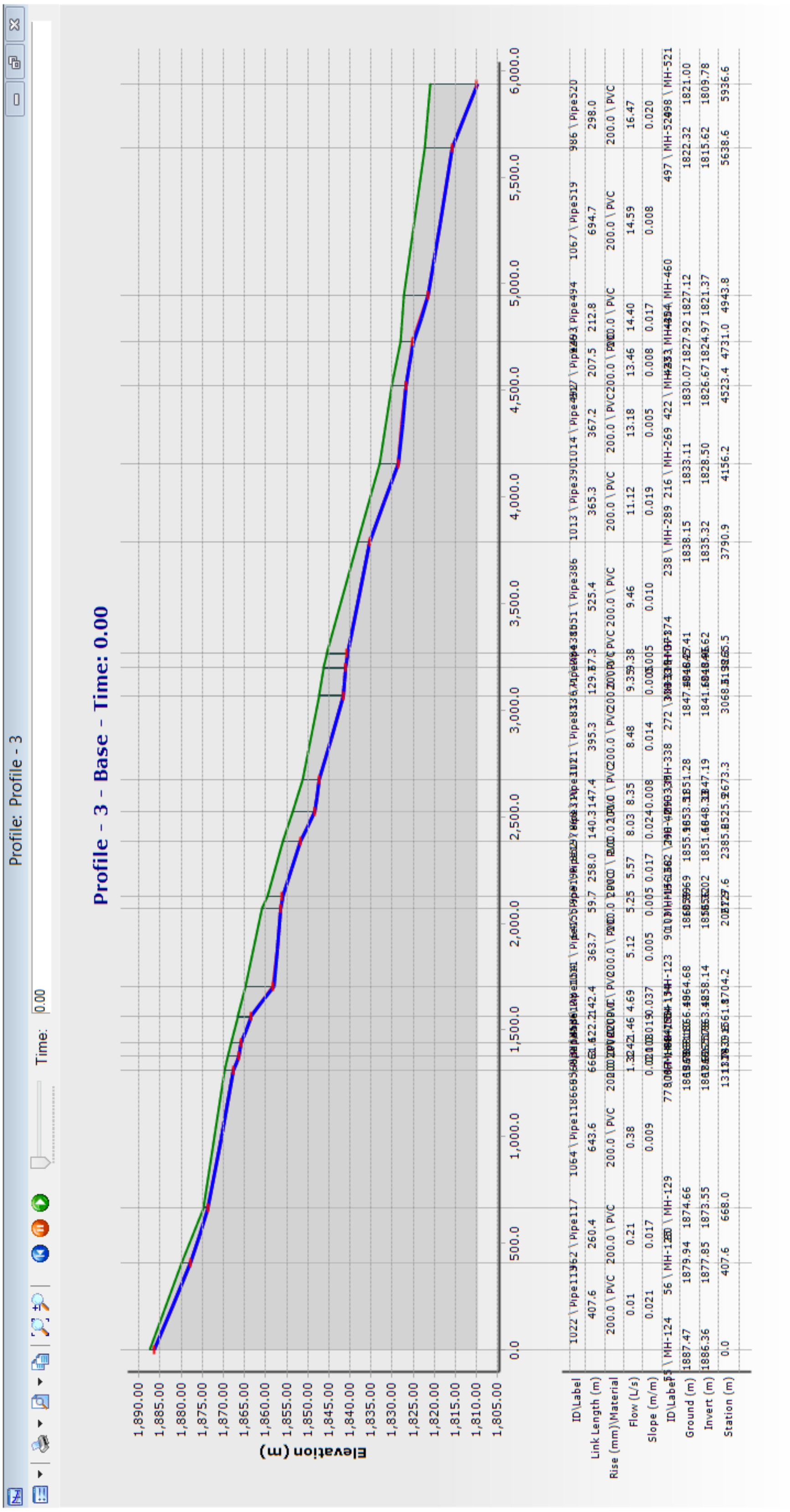


Figure 11. Profile of critical path

5.6. Present research results in the form of graphs and tables

The result of the design can display in different ways. One method already presented in (Figure.7). It is also possible to see manholes, pipes, in detail in the form of separate tables. As well as the pipe material, length, and all required information will show in the program report. The results also can be illustrated in the form of diagrams. By graph presentation, the changes in the parameter in the form of a diagram can be observed in terms of time in different elements of the model. For example, the variation in the hydraulic gradient in one of the manholes in 24 hours represented (Figure. 12). shows hydraulic gradients in one of the manholes in 24 hours. Of course, this option has a tangible result if the Extended period method used in the design scenario.

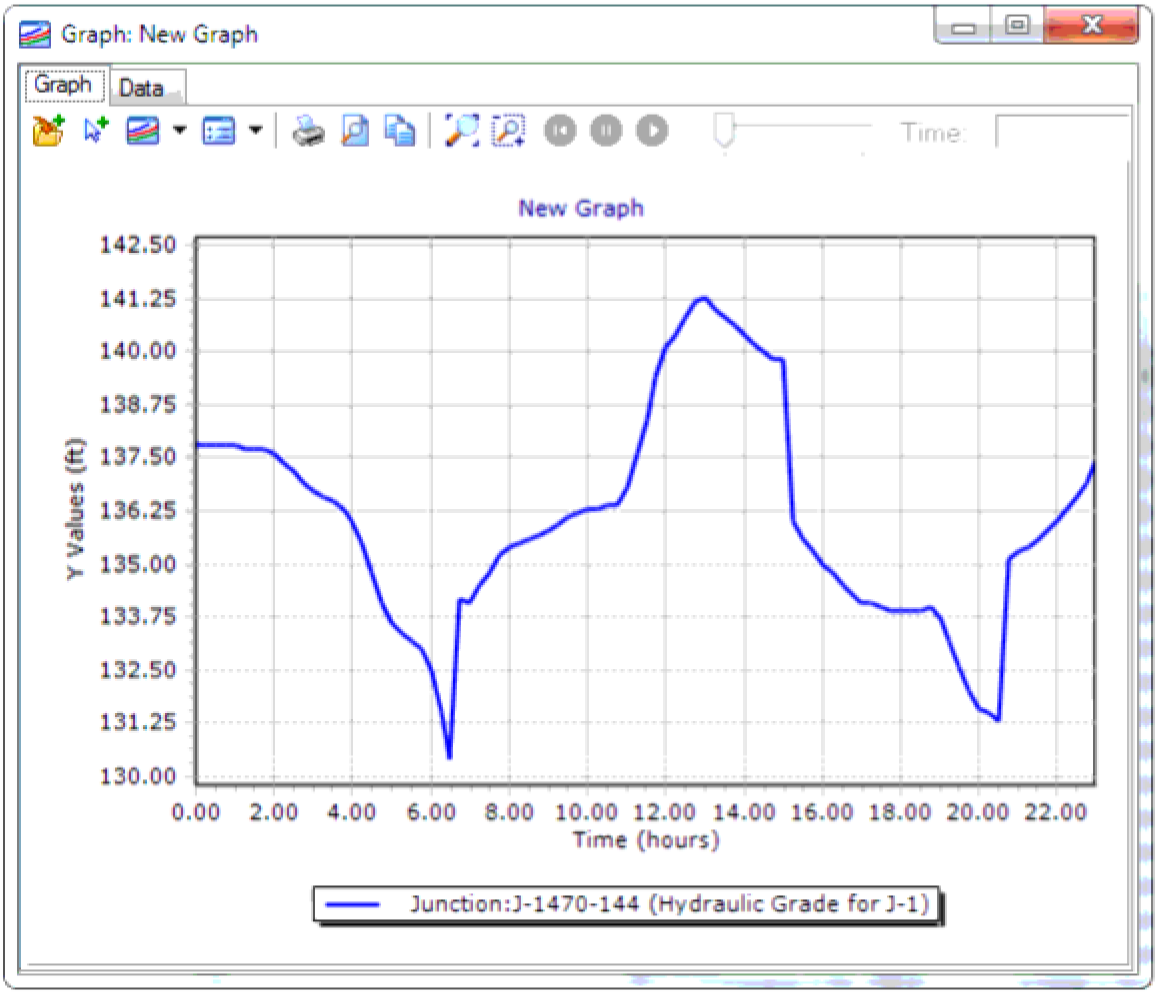


Figure 12. Hydraulic Grade for J-1

6. Conclusion

The main aim of this research was to evaluate the feasibility of decentralized wastewater collection systems or regional systems. Therefore, the fifth region as a sample and two of the nine study zones within it have been studied. LULC and contour map of the study area created using Satellite Image and DEM in the Arc MAP environment. The geometric model also has been created in the Arc MAP environment by creating separate shapefiles for pipes and manholes. The established geometric model is transferred from the Arc GIS environment to the SewerGEMS environment and prepared for hydraulic design.

The hydraulic design of the system was analyzed by SewerGEMS software. As can be seen from the geometric models and hydraulic analysis of the system, it is possible to create a decentralized and regional hydraulic model in Kabul city. Of course, the design of the hydraulic model at the level of the fifth area for two study zones by SewerGEMS software, after creating several models with different scenarios, was finally completed according to the amount of maximum discharge. After interpreting the results of hydraulic analysis and design and after reviewing and controlling the control parameters such as flow velocity, pipe diameter, slopes, pipe profiles, etc., it concluded that the hydraulic model had been successfully designed and created. Such models are applicable to district scales in the city.

As one can see from geometric modeling and satellite images of Kabul city, a very high percentage of Kabul city is unplanned areas. The lack of a regular urban plan causes significant challenges to the creation of such models—this study purpose auxiliary tools in the gravity system for planned and non-planned areas. The use of wet wells and lift stations in the network can mainly solve the system problem.

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