Design of Sewer Network for Vijayapur City Using SEWER Version 3.0 Software

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Abstract— In the present study VIJAYAPUR city's Sewer Network is designed which is located at State Karnataka, India. For the design of Sewer network, study of present population, population forecast for the three decades, daily water demand, flow characteristics and survey of the city is done. With the help of digital global positioning system and from the survey, a road map is created and also contours, lengths, & elevations are determined. The flow is calculated as per CPHEEO Manual. Assign the Trunk main and Sub main Sewer lines on the maps. The node no. and pipe no. are done on the road map. Sewer Network for the city is analyzed & designed with the help of SEWER Version 3.0 software.

Key words: LEACH, LEACH-C, K-LEACH, WSN

I. INTRODUCTION

A. *Sewerage Network*

Sewerage networks are an important part of the infrastructure of any society. The main purpose of providing the sewer network is to carry away sanitary waste from a municipal area in such a way that it does not cause any public health related problems. It is known that urban sewerage system provide one of the basic infrastructure facilities to transport sanitary waste to sewage treatment plant. Sewerage network infrastructure conveys wastewater used by individuals, commercial and industrial establishments to wastewater treatment facilities, ultimately to be returned to the natural environment. A sewerage network is just a reverse action of water supply network. The cost of laying a sewerage system is appreciably high compared to the water supply system. It involves a large cost with need for daily maintenance, and the operational coast is one of the major expenditures. In respect of this view, many research works are being done to design a cost effective sewerage network with the given constraints and guidelines. These difficult problems can be solved by using the computer software package SEWER Version 3.0.

B. *SEWER Version 3.0*

The computer program "SEWER Version 3.0" uses the manning's equation for the heuristic design of sanitary sewer system. It is suitable for the design of small bore sewers as well as large diameter conventional sewers and can handle up 800 pipes. The program assists in the design of bedding and also calculate slope. The program also gives the cost abstract for the designed sewer system. In heuristic methodology the constraints are less. Hence, in this study the computer program software package "SEWER Version 3.0" based on heuristic approach making use of dynamic programming also has been made use of for the design of sewer system. The sewer network consists of link (pipes) and nodes (manholes). The pipes are connected by manholes. One or more links come and join at a node and the sewage is discharged through a downs stream link which goes into another manhole. Thus the sewer network consists of links and nodes as if they are connected to a branch of a tree. The design of sewer network involves section of appropriate size and slope of a link so as to connect the succeeding node to transport the sewage while meeting the requisite hydraulic parameters. Identification of suitable size of pipe and the corresponding slope from an important part in the sewer network design. An estimate can be made to select each available commercial diameter for a link so that it will meet the constraint of design velocity, Quantity of flow, depth of flow, minimum velocities etc.

II. GENERAL INFORMATION ABOUT VIJAYAPUR CITY

A. *Vijayapur City*

Vijayapur District (Karnataka state) is situated on the South Central Railway line 213 km north of Hubballi and 96 km south of Sholapur city (in Maharashtra State). It is situated in the Belgaum Division of Indian Railways and is 192 km from Belgaum, the Divisional Headquarters. It has a population of 2,45,946 as per the 2001 Census.

B. *Existing Water Supply and Sewerage arrangement*

Vijayapur City has three piped water supply systems. Bhutnal Tank was the first water supply system constructed in 1914 on a local nalla. The total storage capacity is 1,848.75 ft spread over 50 ha. Krishna River First Stage Water Supply System was constructed in 1971 near Baluthi (now shifted to Kolhar Village in 1976 due to submergence), with back water of Almatti Irrigation dam is the source of water. The Krishna River Second Stage Water Supply System is designed to supply 27.24 MLD water to a population of 270,000 expected in year 2006 and 45.40 MLD water to a population of 350,000 expected in year 2021 at the rate of 135 lpcd. Together, the supply to the town during the summer months works to 27 MLD at 121 litres per capita per day (lpcd), gross supply – it is estimated that 30 -40 percent of water supplied is lost through transmission and distribution, with consumers receiving a net supply of 80 lpcd. The town population is served through 23,430 domestic, 1,261 non-domestic connections, and 352 public stand posts – all house service connections being unmetered. Sewerage system was provided in the old part of Vijayapur town in year 1976. It was designed to cover 1,50,000 population in the city within the fort wall and for sewage flow of 13.50 MLD. The sewer network covers about 40 percent of the CMC area and only 224 km out of a total of 565 km of roads.

C. Necessity of the Project

Vijayapur city had a UGD (Underground Drainage System) system since 1976, which covers 40% of the town's area. Survey results indicate that 77% of households have UGD connection, 22% have septic tank connectivity while the remaining one percent avail the services of public convenience. For wastewater disposal, approximately 40 percent of the surveyed households are connected to UGD while the remaining 60 percent dispose the sewage and sullage into roadside drains. As the development of city is very fast and hence 100% UGD connection is needed.

D. Design Proposal for Sewer Network

The preliminary work for a design engineer is to carry out field investigation and further to study carefully the characteristics of the study area pertaining to the road network pattern, projected population, land topography, natural barrier, existing and proposed land use, tentatively proposed site for sewage treatment plant and the outfalls etc. The master plan in "Fig.1." shows various housing unit sizes, street orientation and other civic amenities for the study area. Trunk sewer alignment has been proposed by considering the topography of the city and major obstacles like National Highway and railway track. Zoning has been done in such a way that trunk sewer line has to cross NH and Railway line at very minimal points. Based on this, entire Vijayapur CMC is divided into three main sewerage districts. A separate nomenclature has been given to Manholes as EMH for Existing Manholes, IMH for Newly Inserted Manholes in between two existing manholes and PMH for Proposed new Manholes at uncovered areas. Similarly for trunk sewers pipe number will start with T1, T2 etc, for sub mains S1, S2…S11 etc and for laterals it is P. Based on this zonal plan the pipeline corridor survey for the trunk sewers have been done and designed.

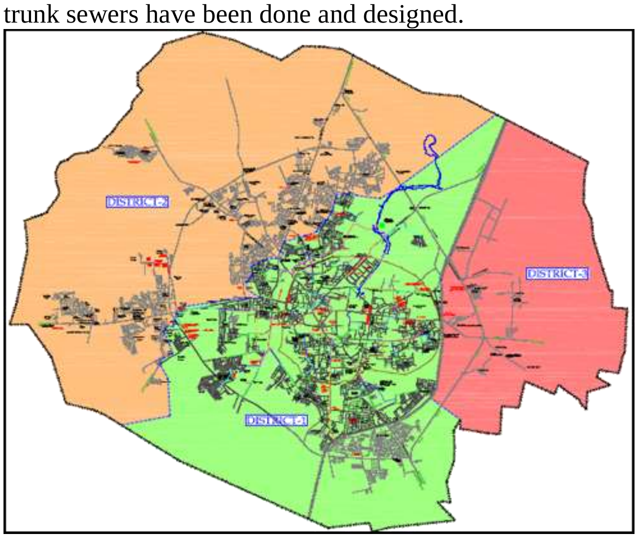

Fig. 1: Master plan for Vijayapur city

III. MATERIALS AND METHODS

A. Data Collection

For design a Sewer network of Vijayapur city, the following data were obtained from Karnataka Urban Infrastructure Development and Finance Corporation (KUIDFC).

1) Collection of the population of last 6 decades of Vijayapur city.
2) Collection of the existing work data of head work, sewer pipeline.
3) Road map of Vijayapur city.
4) Data of previous existing Sewer network.

B. Population Forecast

Vijayapur population has grown from 1, 93,131 in 1991 to 2, 45,946 in 2001 indicating a growth rate of 27.35 percent. The highest and lowest population growth rates recorded were 41.74 percent during 1971-1981 and 15.98 percent during 1901-1911. The projected populations for the design horizons for 2011, 2026 and 2041 are 318624, 452665 and 624515 respectively.

C. Total Sewage Contribution

The design flows are essentially the peak flows, which is the average weather flows multiplied by a peak factor. It is agreed that the design per capita water supply shall be 100 lpcd. As per CPHEEO norms, about 80 of water supply finds its way as wastewater into sewers i.e. 80 lpcd. In addition to that 5% of domestic flow is added to account for non-domestic flows. Thus a per capita flow of 84 lpcd, including provisions for infiltration (500 litre/km/day) has been considered for the design.

Table 1: Population projection and Sewage flow calculations

Design Year	No of Decades	Design Population	LPCD	Sewage Flow Generation (MLD)		
				Domestic	Non domestic/Infiltration	Total
2011	12.0	318624	80	25.49	1.27	26.76
2016	12.5	359406	80	28.75	1.44	30.19
2021	13.0	404026	80	32.32	1.62	33.94
2026	13.5	452665	80	36.21	1.81	38.02
2031	14.0	505504	80	40.44	2.02	42.46
2036	14.5	562727	80	45.02	2.25	47.27
2041	15.0	624515	80	49.96	2.50	52.46

D. Design Criteria

The major design criteria adopted for this project are as listed below. The per capita sewage generation is taken as 80 lpcd i.e. 80% of water supply level as suggested by CPHEEO. 5% provision is added over this to account for ground water infiltration and any other unaccounted for non domestic addition. The minimum diameter of sewer adopted is 150 mm. Materials used are Glazed Stoneware (GSW) up to 250 mm dia and depth 3 m and RCC NP3 thereafter. In crossings and where minimum cover is not possible, encasing with RCC NP4 of higher diameter is suggested. The minimum velocity is 0.6 mps at present peak flow and peaking factor from 2.25 to 3.00 based on cumulative population as suggested in CPHEEO manual. However since it is practically not possible to ensure this in starting laterals, the sewers have been designed to have minimum slopes suggested in CPHEEO manual. Minimum cover ensured is 1.0 m (though at starting stretches with less traffic it is restricted to 0.80 m to avoid uneconomical depth subsequently) and maximum is restricted to 6 m.

E. Zones and Subzones

Based on the topography of peripheral areas in each main district, sub-zones have been demarcated district-wise, areas which are not draining sewage by gravity to the corresponding main district. Vijayapur city has been divided into three drainage districts. As shown in "Fig. 2."

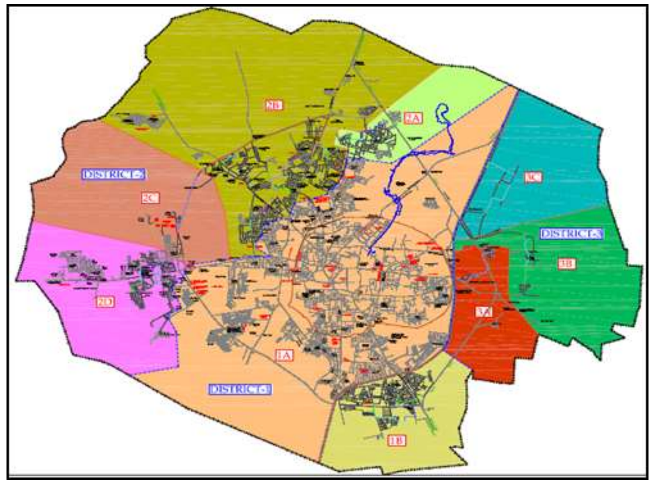

Fig. 2: Zones and Subzones

IV. RESULT AND DISCUSSION

SEWER Version 3.0 software saves the time and manpower. For each link of network the program finds a set of feasible diameter out of the commercially available set subject to the constraints imposed on the velocity and depth of flow in pipes. It also calculates the least cost of Sewer network. The optimal cost is also given by the software. Since the total cost of the sewer network is a function of both the sizes of pipes and depths and quantity to excavation. The program is run several times so that an appropriate pipe network is obtained.

The presented results are based on the SEWER Version 3.0 software. Since it is large sewer network only District 2C results can be tabulated below.

TABLE II: Results obtained from SEWER Version 3.0

Pipe No.	From Node	To Node	Peak Flow lps	Length m	Dia mm	Velocity m/sec	Excavation depth M
1	1	2	0.013	70	150	0.04	2.3
2	2	3	0.05	54.5	150	0.09	3.8
3	3	4	0.113	58	150	0.12	2.6
5	5	4	0.038	26.5	150	0.09	2.2
4	4	7	0.275	15	200	0.01	3.3
6	6	7	0.038	26.5	150	0.09	3.3
7	7	8	0.488	38	200	0.02	3.3
8	9	8	0.038	28.5	150	0.09	2.6
9	8	10	0.788	29	250	0.02	3.1
10	10	11	1.063	54	300	0.61	2.9
11	12	11	0.025	83.5	150	0.08	4.8
12	13	14	0.025	30	150	0.08	3.2
13	11	14	1.563	7.5	300	0.72	2.3
14	14	16	2.076	45.5	450	0.7	3.1

15	15	16	0.038	26	150	0.09	3.9
16	16	17	2.676	34.5	500	0.73	3
18	18	19	0.025	26	150	0.08	2.3
19	19	21	0.088	39.5	150	0.11	2.6
20	20	21	0.025	21.5	150	0.08	2.2
21	21	22	0.275	29	200	0.01	3.1
22	23	22	0.038	31	150	0.09	2.2
23	22	24	0.575	30.5	250	0.01	3.6
17	24	17	0.863	30	300	0.01	4.3
24	17	27	4.452	14	700	0.62	3.1
26	26	27	0.038	32	150	0.09	4.5
27	27	28	5.465	28.5	700	0.76	3.7
25	25	28	0.025	29	150	0.08	4
28	28	29	6.516	38	800	0.69	2.9
29	30	31	0.025	24	150	0.08	2.7
30	31	32	0.075	30.5	150	0.11	2.2
31	32	33	0.163	24	200	0.01	4.2
32	33	35	0.324	54.5	200	0.01	2.6
33	34	35	0.05	30	150	0.09	2.4
34	35	36	0.312	42	200	0.01	4.1
35	37	36	0.038	29.5	150	0.09	2.3
36	36	38	0.424	53.5	200	0.02	2.3
40	42	41	0.025	79.5	150	0.08	2.2
39	41	38	0.138	32	200	0.01	3.3
37	38	40	0.674	11.5	250	0.02	3
38	39	40	0.025	19.5	150	0.08	2.2
41	40	43	0.624	177	250	0.19	2.9
42	44	45	0.025	37.5	150	0.08	2.3
43	45	47	0.075	38	150	0.11	2.9
44	46	47	0.025	32	150	0.08	2.6
45	47	49	0.175	40.5	200	0.01	3.1
46	48	49	0.025	28	150	0.08	2.6
47	49	50	0.263	126	200	0.01	3.4
48	50	51	0.6	188	200	0.02	3.2
50	51	52	1.026	30.5	200	0.04	3.1
49	53	52	0.025	85.5	150	0.08	2.3
51	52	43	0.574	39	250	0.01	3.1
52	54	56	0.013	164	150	0.04	3.7
53	55	56	0.013	65.5	150	0.04	2.2
54	57	58	0.038	17.5	150	0.09	2.6
55	58	56	0.088	40.5	150	0.11	2.4
56	56	59	0.213	109	200	0.01	5

57	60	63	0.038	73	150	0.09	2.9
58	61	62	0.1	76	150	0.13	3.3
59	62	63	0.288	40	200	0.01	4.1
60	63	59	0.353	46	200	0.01	2.8
61	59	64	0.743	138.5	250	0.62	4.3
62	29	64	7.566	26.5	800	0.61	3.2
63	65	69	0.038	115.5	150	0.09	4
64	66	68	0.088	95.5	150	0.26	2.2
65	67	68	0.038	30.5	150	0.09	2.9
66	68	69	0.363	39	200	0.01	2.3
67	69	70	0.913	23.5	400	0.01	3.6
68	70	64	6.861	38.5	700	0.73	3.6
69	64	71	16.998	82.5	800	0.44	4.6
71	72	73	0.038	96	150	0.09	2.2
72	73	75	0.175	32	200	0.01	4.6
73	74	75	0.05	94.5	150	0.09	2.2
74	75	812	0.625	39.5	200	0.02	4.1
75	76	812	0.025	91.5	150	0.08	2.2
76	78	77	0.013	33	150	0.04	2.2
77	812	77	1.213	24	250	0.66	2.3
78	79	81	0.025	36.5	150	0.08	2.9
79	80	81	0.025	52	150	0.08	3.9
80	81	83	0.248	94.5	200	0.01	4.6
81	82	83	0.025	30	150	0.08	2.9
82	83	84	0.711	43	200	0.03	3.9
83	77	84	1.813	126	450	0.61	6.2
84	84	85	3.698	47.5	500	0.77	2.6
85	86	87	0.038	51.5	150	0.09	5
86	89	88	0.025	27	150	0.08	2.2
87	88	87	0.1	50.5	150	0.13	2.6
88	87	85	0.3	22.5	200	0.01	3.2
89	85	70	5.41	112	600	0.62	2.9
90	91	92	0.025	29	150	0.08	3.1
91	90	92	0.05	64	150	0.09	3.5
92	92	94	0.15	40.5	200	0.01	3.1
93	93	94	0.025	33.5	150	0.08	2.6
94	94	71	0.3	50	200	0.01	2.3
95	43	95	2.472	56.5	250	0.27	4.1
96	95	96	3.845	111	600	0.73	5.9
70	71	97	19.327	49.5	800	0.45	3.9
99	99	100	0.05	89	150	0.09	4.5
98	98	100	0.05	43.5	150	0.09	3.1

100	100	97	0.313	98.5	200	0.01	2.5
97	97	96	21.956	16	800	0.46	3.1
101	101	102	0.063	111	150	0.11	3.7
102	102	103	0.213	66.5	200	0.01	5.3
103	103	104	0.438	58	200	0.02	3.4

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