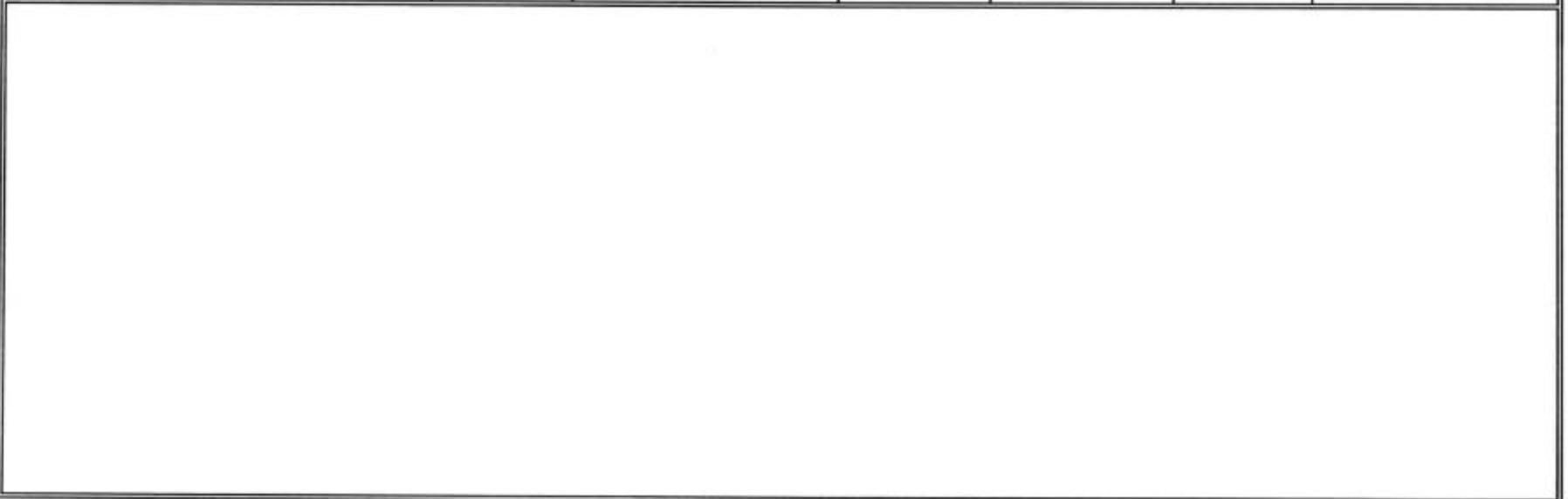


Life Cycle Cost Modeling							
SI	Factors considered :	INPUT VALUES	DEFAULT VALUES	REHAB	(DEFAULT)	Reference	Comments
	SEPARATE SANITARY SEWER SYSTEM:						
1	<b>POPULATION</b>	260,000					
2	<b>Establishments</b>						
	Housing Units(person per housing unit)	2.5	2.6 (US Average)			Ref 4	
	Industrial Est(% of total population)	0.10%	0.1% of population			Assumed	
	Business Est(% of total population)	1.50%	1.5% of population			Assumed	
	Education Institutes(% of total pop)	0.025%	0.025% of population			Assumed	
	Recreation and other facilities(% of total pop)	0.15%	0.15% of population			Assumed	
3	<b>Percent of Populatioin Associated with</b>						
	Industrial Est	10%	10% of the populaton			Assumed	
	Business Est	40%	40% of the populaton			Assumed	
	Education Institutes	20%	20% of the populaton			Assumed	
	Recreation and other facilities	5%	5% of the populaton			Assumed	
4	<b>Percent Population Increase per Year:</b>						
	Population increase for first 5 years	5%	1 % per Year(5% for 5 years)			Assumed	
	Population increase for 5 - 10 years	5%	1 % per Year(5% for 5 years)			Assumed	
	Population increase for 10 - 15 years	5%	1 % per Year(5% for 5 years)			Assumed	
	Population increase for 15 - 20 years	5%	1 % per Year(5% for 5 years)			Assumed	
	Population increase for 20 - 25 years	5%	1 % per Year(5% for 5 years)			Assumed	
	Population increase for 25 - 30 years	5%	1 % per Year(5% for 5 years)			Assumed	
5	<b>Length of sewer(Main line) per Unit(in Miles)</b>						
	Housing:	0.008	0.008 miles/unit			Assumed	
	Industrial est :	0.015	0.015 miles/unit			Assumed	
	Business Est:	0.015	0.015 miles/unit			Assumed	
	Education institutes	0.02	0.02 miles/unit			Assumed	
	Recreation and other facilities	0.04	0.04 miles/unit			Assumed	
	Sewer Trunk	10%	10 % of Main Lines			Assumed	
6	<b>Piping classification(by size)</b>						
	Street laterals	4 inches	34%	34% of total is 4 inches			Assumed
		6 inches	33%	33% of total is 6 inches			Assumed
		8 inches	33%	33% of total is 8 inches			Assumed
	Main Lines	8 inches	34%	34% is 8 inches	\$8	\$8/inch-dia/foot	Assumed
		10 inches	33%	33% 10 inches	\$8	\$8/inch-dia/foot	Assumed
		12 inches	33%	33% 12 inches	\$8	\$8/inch-dia/foot	Assumed
	Sewer Trunk	24 inches	20%	20% is 24 inches	\$9	\$9/inch-dia/foot	Assumed
		30 inches	20%	20% is 30 inches	\$9	\$9/inch-dia/foot	Assumed
		36 inches	20%	20% is 36 inches	\$9	\$9/inch-dia/foot	Assumed
		42 inches	20%	20% is 42 inches	\$9	\$9/inch-dia/foot	Assumed
		48 inches	20%	20% is 48 inches	\$9	\$9/inch-dia/foot	Assumed

<b>7</b>	<b>Pipe Joint-Specing</b>					
	Street laterals-Main Lines					
	Housing:	20	20 feet/joint	\$120	\$120/inch-dia	Assumed
	Industrial est :	20	20 feet/joint	\$120	\$120/inch-dia	Assumed
	Business Est:	20	20 feet/joint	\$120	\$120/inch-dia	Assumed
	Education Institutes	20	20 feet/joint	\$120	\$120/inch-dia	Assumed
	Recreation and other facilities	20	20 feet/joint	\$120	\$120/inch-dia	Assumed
	Joints(Main Lines)	20	20 feet/joint	\$6	\$6/inch-dia	Assumed
	Joints(Trunk Sewer)	20	20 feet/joint	\$6	\$6/inch-dia	Assumed
<b>8</b>	<b>Manhole-Specing in feet</b>					
	Main lines	300	1 per 300 feet			Reference 1
	Trunk Sewer	400	1 per 400 feet			Reference 1
<b>9</b>	<b>Manhole(Sizes) in feet</b>					
	For pipe sizes 8 to 12 inches	4	4 feet dia	\$150	\$150/foot-dia	Assumed
	For pipe sizes 24 inches	5	4 feet dia	\$150	\$150/foot-dia	Assumed
	For pipe sizes 30 inches	6	4 feet dia	\$150	\$150/foot-dia	Assumed
	For pipe sizes 42 inches	8	5 feet dia	\$150	\$150/foot-dia	Assumed
	For pipe sizes 48 inches	8	6 feet dia	\$150	\$150/foot-dia	Assumed
<b>10</b>	<b>Infiltration</b>					
10-A	Infiltration Percentage	0.0%				
	Manhole	0	0 gpid per manhole			
	Pipe line	0	0 gpidpf			
	Street laterals-Main Joints(6 to 8 inches)	0	0 gpid			
	Sewer Main Joints	0	0 gpid			
	Sewer Trunk Joints	0	0 gpid			
10-B	Infiltration Percentage	10%				
	Manhole	1	1 gpid per manhole			Assumed
	Pipe line	0.005	0.005 gpidpf			
	Street laterals-Main Joints(6 to 8 inches)	0.2	0.2 gpid			Assumed
	Sewer Main Joints	0.2	0.2 gpid			Assumed
	Sewer Trunk Joints	0.2	0.2 gpid			Assumed
10-C	Infiltration Percentage	31%				
	Manhole	2.5	2.5 gpid per manhole			
	Pipe line	0.015	0.015 gpidpf			
	Street laterals-Main Joints(6 to 8 inches)	0.7	0.7 gpid			
	Sewer Main Joints	0.7	0.7 gpid			
	Sewer Trunk Joints	0.7	0.7 gpid			
10-D	Infiltration Percentage	61%				
	Manhole	3.5	3.5 gpid per manhole			
	Pipe line	0.04	0.04 gpidpf			
	Street laterals-Main Joints(6 to 8 inches)	1.5	1.5 gpid			

	<i>Sewer Main Joints</i>	1.5	1.5 gpid			
	<i>Sewer Trunk Joints</i>	1.5	1.5 gpid			
				<b>Default</b>		
11	<b>Rainfall per Year</b>	<b>Days</b>	<b>% Infiltration</b>	<b>Days</b>	<b>% Infiltration</b>	
	Number of Days with % Infiltration	245	0%	245	0%	
	Number of Days with % Infiltration	100	10%	100	10%	
	Number of Days with % Infiltration	20	31%	20	30%	
12	<b>Average per Capita daily flow</b>					
	Residential:	60	60 gpcd			Reference 2
	Industrial:	60	60 gped			Reference 2
	Business	25	25 gped			Reference 2
	Educational	20	20 gped			Reference 2
	Recreational	10	10 gped			Reference 2
12	<b>Transportation Cost(O &amp; M, repair, pumping station)</b>	\$0.0000040	\$ .000004gpm			Reference 2
13	<b>Treatmen Cost</b>					
	<i>Plant 1 upto 3 mgd</i>	\$0.0008	\$ 0.0008 /gallon			Assumed
	<i>Plant 1 3 - 4 mgd</i>	\$0.0007	\$ 0.0007 /gallon			Assumed
	<i>Plant 1 4 - 5 mgd</i>	\$0.0009	\$ 0.0009/gallon			Assumed
	<i>Plant 2 5 - 6 mgd</i>	\$0.0010	\$ 0.001 /gallon			Assumed
	<i>Plant 2 6 - 8.5 mgd</i>	\$0.0009	\$ 0.0009 /gallon			Assumed
	<i>Plant 2 8.5 - 10 mgd</i>	\$0.0011	\$ 0.0011 /gallon			Assumed
	<i>Plant 3 10 - 11 mgd</i>	\$0.0012	\$ 0.0012 /gallon			Assumed
	<i>Plant 3 11 - 13.5 mgd</i>	\$0.0013	\$ 0.0013 /gallon			Assumed
	<i>Plant 3 13.5 - 15 mgd</i>	\$0.0014	\$ 0.0014/gallon			Assumed



**Conversions Used:**

gpmd: Gallons per mile per day  
gped: Gallons per employee per day  
gpcc: Gallons per capita per day  
gpid: Gallons per inch diameter per day  
gpidpf: Gallons per inch dia per foot per day

**Reference :**

Ref 1 : EPA Manual

Ref 2 : National Conference on Sanitary Sewer

Overflows(SSOs)  
April 24 - 26, 1995  
Washington ,DC

Ref 3 : Computer Applications of Hydraulic

Engg ; Haestad Method

Ref 4 : Census report

**Basic Model**

	Units	Per capita daily flow 35 - 60 gpcd	Sewer Length per unit in miles	MANHOLES 1 per 300 feet	Pipe Joints Main-lateral 1 per 20 feet	Pipe Joints Main line 1 per 20 feet	INFILTRATION				Total Infiltration Lateral+manhole Mainlines+joints	Total distance travelled	Transportation cost \$0.000004 gpm
							Manhole 1 gpid	Pipe Joints Main-lateral 0.2 gpid	Pipe Joints Main line 0.2 gpid	Pipe Line 0.005 gpidpf			
1 AREA(acres)	not available												
2 POPULATION	260,000												
3 POP DENSITY													
4 HOUSING UNITS	104,000												
H1(fixed)	2,000	300,000	16.0	282	4,238	4,238	13,514	5068	8458	4216	31256	80	106
H2(fixed)	2,000	300,000	16.0	282	4,238	4,238	13,514	5068	8458	4216	31256	62	82
H3(varying)	50,000	7,500,000	400.0	7,039	105,940	105,940	337,856	126704	211456	105389	781405	436	14458
H4(varying)	50,000	7,500,000	400.0	7,039	105,940	105,940	337,856	126704	211456	105389	781405	418	13854
5 INDUSTRIAL EST	260	1,560,000	3.9	69	1,033	1,033	3,294	1235	2062	1028	7619	31	196
6 BUSINESS EST	3,900												
B1	75	50,000	1.1	20	298	298	950	356	595	296	2198	65	14
B2	75	50,000	1.1	20	298	298	950	356	595	296	2198	47	10
B3	1,875	1,250,000	28.1	495	7,449	7,449	23,756	8909	14868	7410	54943	65	337
B4	1,875	1,250,000	28.1	495	7,449	7,449	23,756	8909	14868	7410	54943	46	242
7 Education institutes													
E1	1	20,000	0.0	0	7	7	21	8	13	7	49	64	5
E2	1	20,000	0.0	0	7	7	21	8	13	7	49	46	4
E3	31	500,000	0.6	11	166	166	528	198	330	165	1221	37	74
E4	31	500,000	0.6	11	166	166	528	198	330	165	1221	19	38
8 Recreation and other facilities													
R1	8	2,500	0.3	5	79	79	253	95	159	79	586	64	1
R2	8	2,500	0.3	5	79	79	253	95	159	79	586	46	1
R3	188	62,500	7.5	132	1,986	1,986	6,335	2376	3965	1976	14651	44	14
R4	188	62,500	7.5	132	1,986	1,986	6,335	2376	3965	1976	14651	26	8
10 24 to 48 inches Trunk			91.1	1,203		24,136	127,028		173778	86610	387416	46	71

20,930,000      1002      17,239      241,358      896,748      288,664      655,528      326,712      2,167,652      \$29,512

Population( X 1000)	260
Total flow (mgd) =	23
Infiltration (mgd)=	2.2
Sewer length(miles)	1,002
Main Lines(Miles)	911
Manholes	17,239
Pipe Joint(lateral)	241,358
Pipe Joints(Main line)	241,358

Actual flow treatment cost/day	\$29,302	Transportation Cost(\$)=	\$1.28	per 1000 gallons
Infiltration treatment cost/day	\$3,035	Treatment cost(\$)=	\$1.40	per 1000 gallons
Transportation cost/day	\$29,512	Per Capita Treatment Cost(\$)=	\$0.24	per Day
Total treatment cost/day	\$61,848	Infiltration =	10.36%	

Transportation Cost =Collection and Conveyance of Waste water ( Minor sewer repair + sewer maintenance + pumping station + O&M + miscellaneous administration)

## Capital Cost

**Data from Model**

	Total (Miles)	Main Line(Mile)	Trunk sewer(Miles)
Pipe Details	1002	911	91
Manholes	17,643	10,746	1,604
	Capacity(Mgd)		
WWTP	42		
Lift Station	84		

Population : 260,000

**1**

**2**

**3**

Pipe Material Cost				Pipe Installation Cost			Manhole Cost			
Pipe Dia	Length(Feet)	Length(Miles)	Material(VCP)	Installation Depth(Feet)	Cost per foot	Total Installation Cost	Manhole Dia(Feet)	Numbers	Costs\$/Manhole	Total Cost(\$)
8	1,635,966	310	\$49,078,973	10	\$75	\$122,933,712	4	5,453	3053	16,649,360
10	1,587,849	301	\$59,116,571	10	\$87	\$138,216,306	4	5,293	3053	16,159,673
12	1,587,849	301	\$60,338,267	10	\$99	\$157,114,597	4	5,293	3053	16,159,673
24	96,233	18	\$10,585,661	15	\$180	\$17,356,535	5	321	5389	1,728,619
30	96,233	18	\$10,975,185	20	\$226	\$21,754,921	6	321	7725	2,477,864
36	96,233	18	\$13,215,924	20	\$262	\$25,190,974	6	321	7725	2,477,864
42	96,233	18	\$15,463,803	20	\$297	\$28,627,027	8	321	12396	3,976,353
48	96,233	18	\$17,717,813	20	\$333	\$32,063,080	8	321	12396	3,976,353
5,292,830		1002	\$236,492,196	\$543,257,152			17,643		63,605,759	

**A**

**Wastewater Treatment Plant(WWTP)(Assumed 2 times Dry weather flow)**

Total Capacity (Mgd)	Cost \$Millions/Mgd	Total Cost \$millions
42	\$5.2	\$218

**B**

**Lift Stations(Assumed 4 times Dry weather flow)**

Total Capacity (Mgd)	Cost \$Millions/Mgd	Total Cost \$millions
84	\$0.7	\$59

**C**

**Total Cost:**

Description		Total Cost (\$Millions)
A1) Pipe Material	VCP	\$236
A2) Pipe Installation(Length-Miles)	1002	\$543
A3) Manhole(Number)	17,643	\$64
B) WWTP(Mgd)	42	\$218
C) Lift Station(Mgd)	84	\$59
Other Major Costs**	30 % of A, B, C	\$336
Miscellaneous Cost ***	7.5 % of A, B, C, D	\$109

Grand Total (\$ Millions)     **\$1,565**

Data in Red indicate data from LCC Model

\* Manholes are assumed to be at a depth of 14 feet

\*\*Includes major cost components like trench system design, mobilization of manpower and machinery, repair existing roads, Traffic control etc.

\*\*\*Includes minor cost components like site preparation, taxes etc.