

BALLENGER SUBDIVISION

Pump Station and Force Main Design

1 Design Criteria

Flow Generation

		av daily flow	
Single residence	107	25680	gpd
Club House	4	960	gpd
Infiltration 4416 feet	0.84 x2000	1673	gpd
Total Average Daily flow		28313	gpd
		19.67	gpm
Equivalent EDU		111	
Peak 1 hr flow factor		4	
Design Flow		78.6	gpm

2 Wetwell sizing

Circular diameter	8	ft
Wet well area	50.27	sf
Ave Daily inflow	19.67	gpm
Design Flow Rate	78.6	gpm
volume per 1 ft	376	gal
Max Storage Vol reqd for selected cycle	147.8	gal
change in elevation on to off	0.39	ft
peak 1 hour factor	4	
pump on minutes	2.5	min

pump off minutes	7.5	min
pipe velocity	2.01	fps
Top elevation	24.50	ft
Influent elevation	8.75	ft
HW Alarm	8.25	ft
Lagg Pump On	7.75	ft
Lead Pump On	7.25	ft
Pumps Off	6.85	ft
Low Level Alarm	6.35	ft
Bottom Wetwell	5.00	ft
Depth wet well (top slab to bottom ww)	19.50	ft

3 Pump Cycle

No starts per hour	6	per hour
Pump Cycle	10	min
Average inflow	19.67	gpm
Design Flow Pump Rate	78.6	gpm
pump run time (min)	2.50	min
Fill Time Pump Off (min)	7.50	min

4 Force Main Analysis

Effective pipe lengths	L	d
4 inch DIP in wetwell and enclosure	268	ft 4.22
	equiv. Lng per each	4 " dip # units
Straight pipe	1	Equiv. Length 66
B 90 deg	11.1	6 66.6
B45 deg	5.1	0 0

B22.5 deg	2.7	0	0
Tee	30.3	2	60.6
Reducer	14	1	14
Valve	2.7	4	10.8
Check Valve	33.6	1	33.6
ARV /cleanout	7.9	1	7.9
trans. /adaptor	9 or 14	1	9
Total Length			268

5 System Curve

Hazen Williams analysis

Ignore losses in PVC pipe as it flows by gravity below the ARV highpoint

Discharge to gravity manhole

Static head: PS pump off to high point in FM $29.-7.25=21.75\text{ft}$

Input data DIP 4" CI 52

d int. dia.	4.22
C factor Best Case	140
C factor Worst Case	120
Length	268

Best Case

Flow	Static Head	Friction Loss 4" DIP	TDH (C+D+E)	
0	21.75	0	21.75	
10		0.019	21.77	
20		0.070	21.82	
40		0.252	22.00	
60		0.533	22.28	
78.6		0.879	22.63	0.55
80		0.908	22.66	

100	1.37	23.12
120	1.98	23.73
140	2.56	24.31
160	3.28	25.03
180	4.08	25.83
200	4.96	26.71

Worst Case

Flow	Static Head	Friction Loss 4" DIP	TDH (C+D+E)
0	21.75	0	21.75
10		0.026	21.78
20		0.093	21.84
40		0.335	22.09
60		0.709	22.46
78.6		1.17	22.92
80		1.21	22.96
100		1.83	23.58
120		2.56	24.31
140		3.41	25.16
160		4.36	26.11
180		5.43	27.18
200		6.60	28.35

6 Pump Curves

Curves as provided by Flygt

Pump

Motor

Impeller

N 3085 MT 3~ Adaptive 4p

0N3085MT3Adaptive4p-3085.930 15-10-4AS-W 2.7hp

463 135mm FPSTXZ

Flow [US g.p.m.]

0

Head [ft]

26.93

Overall Efficiency [%]

0.01

22.94	26.08	6.79
45.88	25.23	13.36
68.82	24.38	19.27
91.76	23.52	24.48
114.70	22.66	29.07
137.64	21.80	33.12
160.58	20.93	36.67
183.52	20.06	39.69
206.46	19.19	42.21
229.40	18.32	44.19
252.35	17.45	45.71
275.29	16.57	46.80
298.23	15.69	47.54
321.17	14.80	47.98
344.11	13.92	48.15
367.05	13.03	48.04
389.99	12.14	47.58
412.93	11.25	46.72
435.87	10.35	45.40
458.81	9.45	43.67

Pump capability at reduced frequency and speed

Flow (gpm)	Head @ 60 Hz	Overall Eff. %	Head @ 55 HZ	Overall Eff. %	Head @ 50HZ	Overall Eff. %	Head @ 45 Hz	Overall Eff. %
0.00	26.93	0.01	22.63	0.02	18.70	0.02	15.15	0.02
22.94	26.08	6.79	21.85	8.31	17.99	9.14	14.51	10.14
45.88	25.23	13.36	21.07	16.26	17.28	17.74	13.87	19.50
68.82	24.38	19.27	20.29	23.29	16.57	25.22	13.23	27.46
91.76	23.52	24.48	19.50	29.40	15.85	31.62	12.58	34.16
114.70	22.66	29.07	18.71	34.72	15.14	37.11	11.94	39.80
137.64	21.80	33.12	17.92	39.33	14.41	41.76	11.29	44.41
160.58	20.93	36.67	17.12	43.25	13.69	45.59	10.63	47.99
183.52	20.06	39.69	16.33	46.49	12.97	48.59	9.98	50.59

206.46	19.19	42.21	15.53	49.04	12.24	50.80	9.32	52.32
229.40	18.32	44.19	14.73	50.96	11.51	52.32	8.66	53.37
252.35	17.45	45.71	13.92	52.32	10.77	53.29	8.00	53.85
275.29	16.57	46.80	13.11	53.22	10.03	53.79	7.33	53.75
298.23	15.69	47.54	12.30	53.74	9.30	53.84	6.66	52.95
321.17	14.80	47.98	11.49	53.88	8.55	53.36	5.99	51.33
344.11	13.92	48.15	10.68	53.60	7.81	52.25	5.32	48.85
367.05	13.03	48.04	9.86	52.84	7.06	50.43	4.57	45.33
389.99	12.14	47.58	9.04	51.51	5.65	45.33		

7 Emergency Storage

Per Artesian guide lines emergency storage computed per 40.541814

Volume for ease of analysis is composed of 3 elements. Wetwell, manholes and pipe. Laterals are ignored.

Pipe top one ft considered 50 % full. All others elevations considered full. MH 94 gal/ft Wetwell 376 gal /ft Pipe 2.64 gal

Minimum storage required is 12 hrs x ave daily flow AV Daily Flow 19.67 gpm

Max elev: 2 ft below lowest MH rim lowest MH rim elev 21.23 use 21 as highest elev for an

Stored Wastewater Elevation	Cumulated wetwell storage 376 g/ft	# MH impact	Cum # MH	MH volume 94 gal	Cum MH Vol	pipe length initially 50% flooded	total length sewer fully flooded	accumulated pipe vol gal 2.64 g/ft
5	0	0	0	0	0	0	0	0
6	376	0	0	0	0	0	0	0
7	752	0	0	0	0	0	0	0
8	1128	0	0	0	0	0	0	0
9	1504	2	2	188	188	175	88	232
10	1880	1	3	282	470	362	356	940
11	2256	1	4	376	846	223	649	1713
12	2632	2	6	564	1410	253	887	2342
13	3008	2	8	752	2162	689	1358	3585

14	3384	3	11	1034	3196	200	1802	4757
15	3760	2	13	1222	4418	544	2174	5740
16	4136	3	16	1504	5922	875	2884	7614
17	4512	2	18	1692	7614	600	3621	9560
18	4888	4	22	2068	9682	498	4170	11009
19	5264	2	23	2162	11844	0	4419	11666
20	5640	0	23	2162	14006	0	4419	11666
21	6016	0	23	2162	16168	0	4419	11666

8 Wetwell Bouyancy Computation

Assumption and data

Assume groundwater at surface .

Equipment in wetwell not considered.

Wetwell entirely dry

Min Reqd FOS 1.5

Wetwell Dia 8 ft
 wall thickness 8 inches
 floor slab thickness 18 Inches
 floor slab projection 20 inches
 roof slab 10 inches
 depth 21.00 ft

Uplift

weight of water displaced

uplift = $62.4 \times (22/7 \times 9.34 \times 9.34/4) \times 21.00 = 89818 \text{ lbs}$

Counter Weight

floor slab $130 \times (22/7 \times 12.67 \times 12.67/4) \times 1.5 = 24595 \text{ lbs}$

walls $130 \times (22/7 \times 1/4) \times (9.34 \times 9.34) - (8.0 \times 8.0) \times 18.67 = 44310 \text{ lbs}$

roof slab $130 \times (22/7 \times 9.34 \times 9.34/4) - (3 \times 6) \times 0.83 = 5454 \text{ lbs}$

earth backfill	$100 \times (22/7 \times 1/4) \times (12.67 \times 12.67) - (9.34 \times 9.34) \times 19.5 =$	112,295	lbs
	Total	186654	lbs
Counter required	1.5x 89818	134727	lbs
Actual FOS	186,654/89,818	2.07	

Head @ 40Hz	Overall Eff. %
11.97	0.02
11.40	11.38
10.83	21.62
10.26	30.11
9.69	37.11
9.11	42.80
8.53	47.19
7.95	50.31
7.36	52.32

6.78	53.46
6.19	53.88
5.59	53.54
5.00	52.25
4.40	49.87
3.61	45.33

l/ft

analysis

Total vol. stored C+G+J	Time (hours)
0	0
376	0.32
752	0.64
1128	0.96
1924	1.63
3290	3.23
4815	4.08
6384	5.41
8755	7.42

11337	9.61
13918	11.79
17672	14.97
21686	18.37
25579	21.67
28774	24.38
31312	26.53
33850	28.68

Stored Wastewater Elevation	Cumulated wetwell volume	Cumulated MH Vol (gal)	Cumulated pipe vol (gal)	Total vol. stored (gal)	Time (hours)
5	0	0	0	0	0
6	376	0	0	376	0.32
7	752	0	0	752	0.64
8	1128	0	0	1128	0.96
9	1504	188	232	1924	1.63
10	1880	470	940	3290	3.23
11	2256	846	1713	4815	4.08
12	2632	1410	2342	6384	5.41
13	3008	2162	3585	8755	7.42
14	3384	3196	4757	11337	9.61
15	3760	4418	5740	13918	11.79
16	4136	5922	7614	17672	14.97
17	4512	7614	9560	21686	18.37
18	4888	9682	11009	25579	21.67
19	5264	11844	11666	28774	24.38
20	5640	14006	11666	31312	26.53
21	6016	16168	11666	33850	28.68

Best Case	Static Head	Friction Loss 4" DIP	TDH (C+D+E)
Flow			
0	21.75	0	21.75
10		0.0193	21.77
20		0.0697	21.82
40		0.252	22
60		0.533	22.28
80		0.908	22.66
87.6		1.07	22.82
100		1.37	23.12
120		1.98	23.73
140		2.56	24.31
160		3.28	25.03
180		4.08	25.83
200		4.96	26.71

FLOW GENERATION

Single family residence 240 ε	107	25680 gpd
Clubhouse 4 EDU	4	960 gpd
Infiltration 4416 ft	0.83x2000	1673 gpd
Average Daily flow		28313 gpd
Equivalent EDU		111
Design Flow Peak 4.0		78.6 gpm

Stored Water Elevation	wetwell storage	MH Vol	Pipe volume	Total Vol stored	Time (hours)
4.5	0	0	0	0	0
5	106	0	0	106	0.09
6	321	0	0	321	0.27
7	533	0	0	533	0.45
8	745	188	232	1165	0.98
9	957	470	940	2367	2.00
10	1169	846	1713	3728	3.16
11	1381	1410	2342	5133	4.35
12	1593	2162	3585	7340	6.22
13	1805	3196	4757	9758	9.27
14	2017	4418	5740	12175	10.31
15	2229	5922	7614	15765	13.36
16	2441	7614	9560	19615	16.62
17	2653	9682	11009	23344	19.78
18	2865	11844	11666	26375	22.35
19	3077	14006	11666	28749	24.39
20	3289	16168	11666	31123	26.37
21	3501	18330	11666	33494	28.28

System Curve

Flow	Best Case	Worst Case
	TDH	TDH
0	21.75	21.75
10	21.77	21.78
20	21.82	21.84
40	22.00	22.09
60	22.28	22.46
78.6	22.63	22.92
80	22.66	22.96
100	23.12	23.58
120	23.73	24.31
140	24.31	25.16
160	25.03	26.11
180	25.83	27.18
200	26.71	28.35

Pump Curves

Flow (gpm)	Head @ 60 Hz	Head @ 55 HZ	Head @ 50HZ	Head @ 45 Hz	Head @ 40Hz
0.00	26.93	22.63	18.70	15.15	11.97
22.94	26.08	21.85	17.99	14.51	11.40
45.88	25.23	21.07	17.28	13.87	10.83
68.82	24.38	20.29	16.57	13.23	10.26
91.76	23.52	19.50	15.85	12.58	9.69
114.70	22.66	18.71	15.14	11.94	9.11
137.64	21.80	17.92	14.41	11.29	8.53
160.58	20.93	17.12	13.69	10.63	7.95
183.52	20.06	16.33	12.97	9.98	7.36
206.46	19.19	15.53	12.24	9.32	6.78
229.40	18.32	14.73	11.51	8.66	6.19
252.35	17.45	13.92	10.77	8.00	5.59
275.29	16.57	13.11	10.03	7.33	5.00
298.23	15.69	12.30	9.30	6.66	4.40
321.17	14.80	11.49	8.55	5.99	3.61
344.11	13.92	10.68	7.81	5.32	

367.05	13.03	9.86	7.06	4.57
389.99	12.14	9.04	5.65	
412.93	11.25			
435.87	10.35			
458.81	9.45			