Dibble Engineering

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Memorandum

To:	Adrian Carvajal, PE	**Date:**	3/23/16
Copy:		**Client Project:**	2014.057
From:	Jeremy Laipple, PE	**Project No:**	101438
			27th Avenue Composting Station
Subject:	Raw water well and hydropneumatic tank sizing		

INTRODUCTION AND PURPOSE

This technical memorandum will serve as the basis for design for the proposed raw water well pump and hydropneumatic tank for the new composting facility at the 27th Avenue landfill complex.

SIZING EVALUATION

Water Demand:

Due to the very specific nature of the demands on this water system, the system was analyzed by looking at each of the individual demands, and then at each combination of the demands to determine the critical flow scenarios. The demands are as follows:

Table 1 – Flow Demands

Demand	Required Pressure (PSI)	Demand Flow Rate (GPM)	Run Time
1 Blower-Mister	70	12	Continuous (24/7)
2 Grinder	70	140	Work Day (7am-4pm)
3 Turned Compost	70	59	Work Day (7am-4pm)
4 Active Compost	70	70	Work Day (7am-4pm)
5 Bio Filter	45	175	Evening
6 Irrigation	45	50	Evening
7 Dust Control	30	67	Continuous (24/7)

These individual flow demands were provided to Dibble by Green Mountain Technologies.

Well Pump Capacity:

The well pump was sized based on the demand scenario with the highest demand flow rate and dynamic head (Scenario 1). Under this scenario, the well pump must provide 348 gallons per minute (GPM) at a total dynamic head of 281 feet.

System Operating Point:

Once the pump design operating point was selected, the total dynamic head and total demand flow rate was determined for each flow scenario, and the system operating point was determined. The system model assumes that excess capacity from the pump (the difference between the pump capacity and the scenario system demand) contributes to filling and pressurizing the hydropneumatic tank. The rate at which the tank fills is estimated from a straight-line average between the pumping rate at the total dynamic head of the demand scenario and the total dynamic head of the hydropneumatic tank at pump shutoff point of 120 pounds per square inch (PSI). The system calculations are included as Attachment 1.

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Hydropneumatic Tank Sizing:
The hydropneumatic tank is sized based on the time of operation of the well, modeled using the following calculations.

First, the hydropneumatic tank efficiency was determined using Drawing No. 2600556 from the Peerless Pump Company Technical Information Bulletin Number 101. Using an operating range of 70-100 psi, and a minimum fill volume of 30%, the tank efficiency is read as 18%. The hydropneumatic tank efficiency calculations are included as Attachment 2.

Next, the well run time and backspin time (the time from when the pump turns off to the next pump start) are calculated. The well run time is calculated by dividing the available tank volume (total tank volume times the tank efficiency) by average tank fill rate, which is the difference between the pump flow rate and the scenario demand flow rate. The well backspin time is calculated by dividing the available tank volume by the scenario demand flow rate.

The tank size was then iterated, until the minimum backspin time was 10 minutes. The backspin time is critical for proper functionality of the well pump. As the pump turns off, the column of water in the riser pipe falls back through the pump, returning to the aquifer. The time it takes for this operation to occur is typically on the order of five to ten minutes. If the well pump were to start while the water column was still falling through the pump, the torque placed on the pump shaft would cause extreme stress and premature failure of the pump driveshaft. Common practice sets the minimum backspin time on well pumps as ten minutes to ensure that this situation does not occur.

RECOMMENDATIONS

Well Pump:
The well pump shall be a vertical turbine pump coupled with a 40-hp motor. Well pump set points shall be as follows:

- Pump on: 70 psi
- Pump off: 100 psi
- Backspin Timer: 10 minutes

Hydropneumatic Tank:
The hydropneumatic tank shall be a 16,000 gallon tank, with the following set points:

- Low Water Level: 30% volume at 70 psi
- High Water Level: 48% volume at 100 psi
- Pressure Relief: 120 psi

Due to the large size of the hydropneumatic tank, a larger than typical air compressor is required. The air compressor shall meet the following requirements:

- Minimum of 22 cubic feet per minute of free air capacity at 100 psi
- 7.5 horsepower, single phase, 230 volt electric motor
- Automatic pressure switch with adjustable set range from 100 – 120 psi

DEMAND SCENARIOS

ID	Demands	Demand Flowrate	Dynamic Head	Pump Flow Rate	Delta	Average Pump Rate	Average Tank Fill Rate	Well Run Time	Well Off Time	Well Cycle Time	
1	1, 2, 3, 4, 7	348 gpm	281.4	325 gpm	-23 gpm	275 gpm	0 gpm				
2	2, 3, 4, 7	336 gpm	279.3	329 gpm	-7 gpm	277 gpm	0 gpm				
3	1, 3, 4, 7	208 gpm	261.7	362 gpm	154 gpm	293 gpm	85 gpm	33:56	13:51	47:47	
4	1, 2, 4, 7	289 gpm	272.1	343 gpm	54 gpm	284 gpm	0 gpm				
5	1, 2, 3, 7	278 gpm	270.4	346 gpm	68 gpm	285 gpm	7 gpm	6:50:42	10:22	7:01:04	
6	1, 2, 3, 4	281 gpm	272.8	342 gpm	61 gpm	283 gpm	2 gpm	23:37:56	10:15	23:48:11	
7	1, 2, 3	211 gpm	263.6	359 gpm	148 gpm	291 gpm	80 gpm	35:47	13:39	49:26	
8	1, 2, 4	222 gpm	265.0	356 gpm	134 gpm	290 gpm	68 gpm	42:19	12:58	55:17	
9	1, 2, 7	219 gpm	263.1	360 gpm	141 gpm	292 gpm	73 gpm	39:28	13:09	52:37	
10	1, 3, 4	141 gpm	256.5	368 gpm	227 gpm	296 gpm	155 gpm	18:34	20:26	39:00	
11	1, 3, 7	138 gpm	255.4	370 gpm	232 gpm	297 gpm	159 gpm	18:08	20:52	39:00	
12	1, 4, 7	149 gpm	256.2	368 gpm	219 gpm	296 gpm	147 gpm	19:33	19:20	38:53	
13	2, 3, 4	269 gpm	271.1	345 gpm	76 gpm	284 gpm	15 gpm	3:05:49	10:42	3:16:32	
14	2, 3, 7	266 gpm	268.8	349 gpm	83 gpm	286 gpm	20 gpm	2:21:12	10:50	2:32:01	
15	3, 4, 7	196 gpm	260.4	363 gpm	167 gpm	294 gpm	98 gpm	29:30	14:42	44:11	
16	1, 2	152 gpm	257.6	367 gpm	215 gpm	295 gpm	143 gpm	20:05	18:57	39:02	
17	1, 3	71 gpm	252.0	375 gpm	304 gpm	300 gpm	229 gpm	12:36	40:34	53:10	
18	1, 4	82 gpm	252.6	374 gpm	292 gpm	299 gpm	217 gpm	13:16	35:07	48:23	
19	1, 7	79 gpm	252.0	375 gpm	296 gpm	300 gpm	221 gpm	13:03	36:27	49:31	
20	2, 3	199 gpm	262.2	361 gpm	162 gpm	293 gpm	94 gpm	30:47	14:28	45:15	
21	2, 4	210 gpm	263.6	359 gpm	149 gpm	291 gpm	81 gpm	35:20	13:43	49:03	
22	2, 7	207 gpm	261.7	362 gpm	155 gpm	293 gpm	86 gpm	33:33	13:55	47:28	
23	3, 4	129 gpm	255.6	369 gpm	240 gpm	297 gpm	168 gpm	17:10	22:20	39:30	
24	3, 7	126 gpm	254.5	371 gpm	245 gpm	297 gpm	171 gpm	16:48	22:51	39:39	
25	4, 7	137 gpm	255.3	370 gpm	233 gpm	297 gpm	160 gpm	18:01	21:01	39:02	
26	1	12 gpm	250.4	378 gpm	366 gpm	301 gpm	289 gpm	9:58	4:00:00	4:09:58	
27	2	140 gpm	256.6	368 gpm	228 gpm	296 gpm	156 gpm	18:27	20:34	39:02	
28	3	59 gpm	251.5	376 gpm	317 gpm	300 gpm	241 gpm	11:57	48:49	1:00:46	
29	4	70 gpm	252.0	375 gpm	305 gpm	300 gpm	230 gpm	12:33	41:09	53:41	
30	7	67 gpm	251.5	376 gpm	309 gpm	300 gpm	233 gpm	12:22	42:59	55:21	
31	1, 5, 6, 7	304 gpm	260.8	363 gpm	59 gpm	293 gpm	0 gpm				
32	5, 6, 7	292 gpm	260.0	364 gpm	72 gpm	294 gpm	2 gpm	1:09:32	9:52	1:19:23	Critical Scenario
33	1, 6, 7	129 gpm	252.7	374 gpm	245 gpm	299 gpm	170 gpm	16:56	22:20	39:16	
34	1, 5, 7	254 gpm	257.8	367 gpm	113 gpm	295 gpm	41 gpm	1:09:43	11:20	1:21:03	
35	1, 5, 6	237 gpm	258.8	365 gpm	128 gpm	295 gpm	58 gpm	49:57	12:09	1:02:06	
36	1, 5	187 gpm	256.1	369 gpm	182 gpm	296 gpm	109 gpm	26:20	15:24	41:44	
37	1, 6	62 gpm	251.9	375 gpm	313 gpm	300 gpm	238 gpm	12:07	46:27	58:34	
38	5, 6	225 gpm	258.1	366 gpm	141 gpm	295 gpm	70 gpm	41:05	12:48	53:53	
39	5, 7	242 gpm	257.1	367 gpm	125 gpm	296 gpm	54 gpm	53:37	11:54	1:05:31	
40	6, 7	117 gpm	252.4	374 gpm	257 gpm	299 gpm	182 gpm	15:48	24:37	40:25	
41	5	175 gpm	255.6	369 gpm	194 gpm	297 gpm	122 gpm	23:40	16:27	40:07	
42	6	50 gpm	251.6	376 gpm	326 gpm	300 gpm	250 gpm	11:32	57:36	1:09:08	
43	-	0 gpm	336.0	224 gpm	224 gpm	224 gpm	224 gpm				

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