Pump Analysis

Helix Design Build Mercer Island
6922 SE 33rd Street
Mercer Island, WA 98040

October 2022

bcradesign.com

bcra

2106 Pacific Avenue, Suite 300
Tacoma, WA 98402

PUMP ANALYSIS

October 2022

PROJECT:
Helix Design Build Mercer Island
6922 SE 33rd Street
Mercer Island, WA 98040

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I hereby state that this report for the Helix Design Build Mercer Island has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers.

10/05/2022

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Section A – Introduction

The new Helix Design Build Residence on Mercer Island, WA will include 4,650 sq ft of new and replaced hard surfaces, consisting of a single-family home and driveway. The project is eligible to use the Mercer Island Standard On-site Detention System Worksheet to meet Minimum Requirement #5: Low Impact Development standards. Initial design iterations using the Standard On-site Detention System Worksheet have proven the project site does not have sufficient elevation drop between the below grade driveway elevation of the new home and the municipal storm system to utilize the recommended detention tanks through gravity alone. To meet Minimum Requirement 5 a pump system will be used to convey the water from these lower locations (the driveway, the window well, and roof drains on the west side of the building) into the recommended detention tanks.

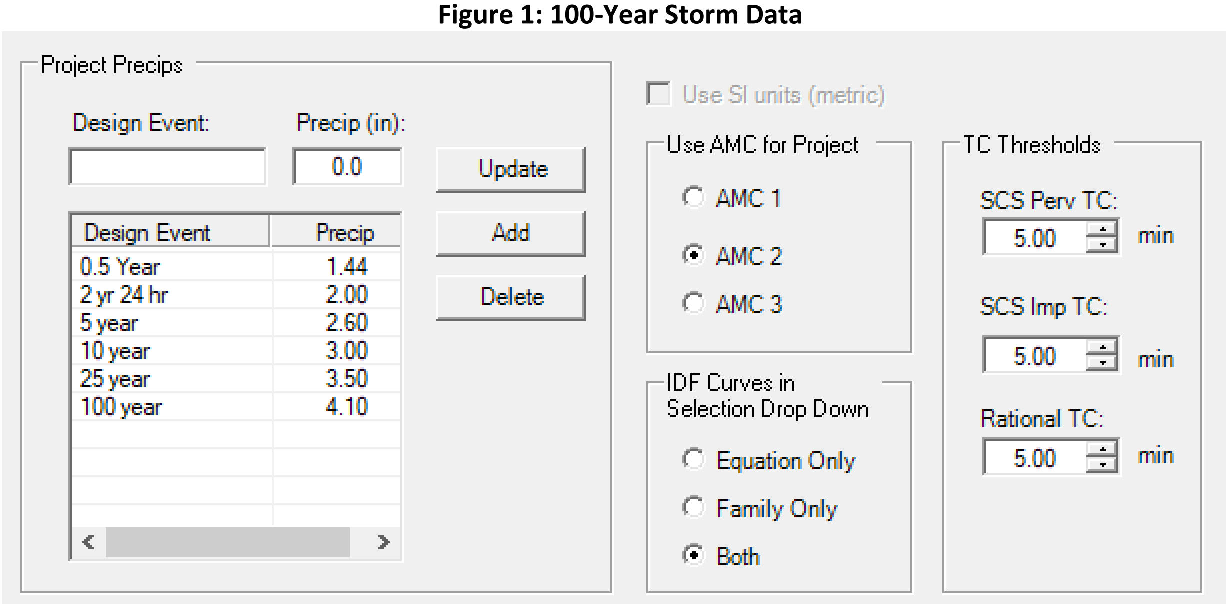
Section B – Pump Information

The pump system is an alternating duplex design to increase reliability and provide redundancy in the event of pump failure. Additionally, the house will have a backup generator to supply the pumps in case of loss of power service to the house. The pumps chosen are two Zoeller N57s which will be located in a 48” diameter type 2 catch basin and be controlled by a Zoeller 10-1041 control panel. In the event of pump failure, the Zoeller 10-1041 control panel features an external alarm that will sound and flash if the high-water level is reached. This external alarm is being paired with an APak Z Control Indoor Alarm that will alert occupants of the house via noise and notifications to their phones or other paired internet connected devices.

Section C – Flow to Pumps

These pumps where chosen using the flow received from the tributary areas during a 100-year storm. To find the flows the 100-year storm data from the Western Regional Climate Center’s isopluvial maps was entered into StormShed 3G, as can be seen in Figure 1.

Figure 1: 100-Year Storm Data



Using an assumed 5-minute time of concentration this storm data was the applied to the approximately 1,200 sf of roof, driveway, and window well (as can be seen in Figure 2) to result in flows of 0.0353 cfs, as can be seen in Figure 3. This flow is used to calculate the pump cycle lengths, as can be seen in Section D.

Figure 2: Pump Basin Area

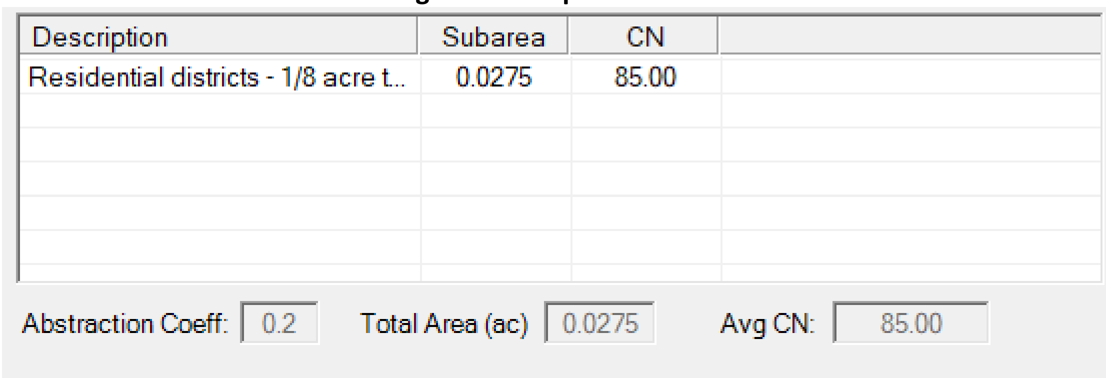
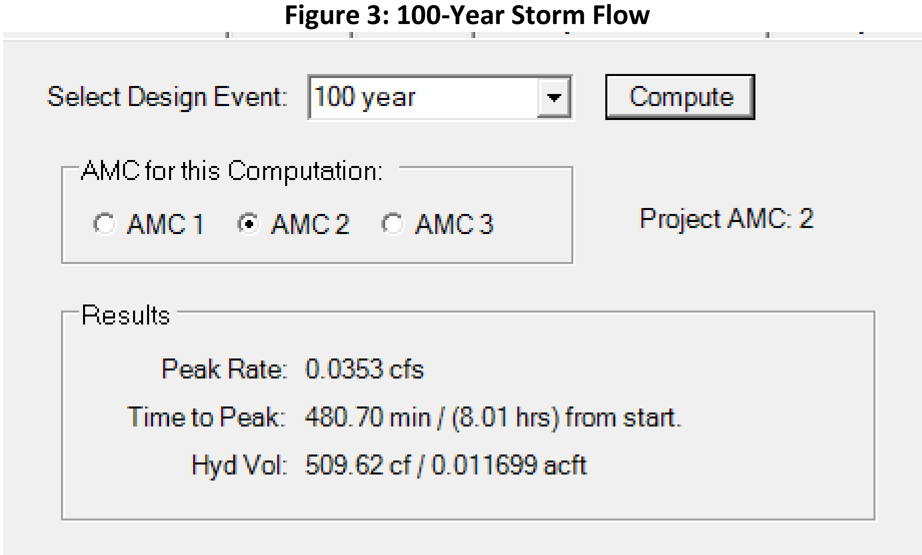


Figure 3: 100-Year Storm Flow



Section D – Pump Sizing

To check that the Zoeller N57s would work for this site, a system curve had to be calculated to compare to the pump curve supplied by Zoeller. The system curve was calculated using the Hazen-Williams Equation. This calculation was done via Excel and can be seen in Figure 4. (Yellow highlighted areas are where information was entered from the pipe design/site plan. The site plan can be found under a separate document within this submittal).

Figure 4: Hazen-Williams Spreadsheet

System Analysis Calculations

Variable:	d	A	L	K	DE	PE	h_s
	Pipe Size (in)	Cross-Sectional Area (in^2)	Length of Pipe (ft)	Total Minor Loss Coefficient	Discharge Elevation (ft)	Pump Elevation (ft)	Static Head (ft)
	2	3.14	45	5.0	263.59	253.26	10.33

$$A = \frac{d^2\pi}{4} \qquad v = 0.3208\frac{Q}{A} \qquad h_s = DE - PE$$

$$h_{maj} = \frac{3.022\, v^{1.85} L}{C^{1.85} \left(\frac{d}{12}\right)^{1.17}}$$

$$h_{min} = K\frac{v^2}{2g}$$

$$h_f = h_{maj} + h_{min}$$

$$TDH = h_s + h_f$$

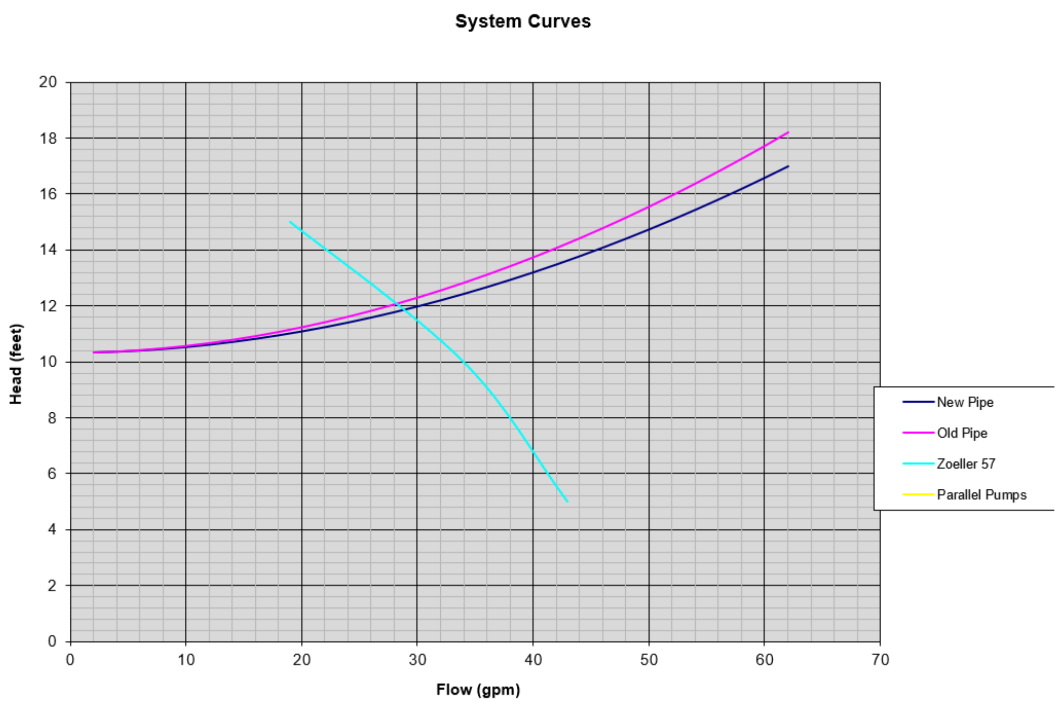
Minor Loss Coefficient Calculations

Fitting	Swing Check Valve	Ball Valve	Flanged Tee	Flanged 90° Elbow	Flanged 180° Return Bend	Expansion (3x4)	Contraction (4x3)	Exit	Total K
K	2.00	0.05	1.00	0.30	1.50	0.56	0.22	1.00	
Number	1	1	1	3	0	0	0	1	4.95

	New Pipe	C =	140				**Old Pipe**	C =	120			
Variable:	Q	v	h_{maj}	h_{min}	h_f	TDH	Q	v	h_{maj}	h_{min}	h_f	TDH
	Flow (gpm)	Velocity (fps)	Major Head Loss (ft)	Minor Head Loss (ft)	Total Head Loss (ft)	Total Dynamic Head (ft)	Flow (gpm)	Velocity (fps)	Major Head Loss (ft)	Minor Head Loss (ft)	Total Head Loss (ft)	Total Dynamic Head (ft)
	2	0.20	0.01	0.00	0.01	10.34	2	0.20	0.01	0.00	0.01	10.34
	4	0.41	0.02	0.01	0.04	10.37	4	0.41	0.03	0.01	0.04	10.37
	6	0.61	0.05	0.03	0.08	10.41	6	0.61	0.06	0.03	0.09	10.42
	8	0.82	0.08	0.05	0.13	10.46	8	0.82	0.11	0.05	0.16	10.49
	10	1.02	0.12	0.08	0.20	10.53	10	1.02	0.16	0.08	0.24	10.57
	12	1.23	0.17	0.12	0.29	10.62	12	1.23	0.23	0.12	0.34	10.67
	14	1.43	0.23	0.16	0.39	10.72	14	1.43	0.31	0.16	0.46	10.79
	16	1.63	0.29	0.21	0.50	10.83	16	1.63	0.39	0.21	0.60	10.93
	18	1.84	0.37	0.26	0.62	10.95	18	1.84	0.49	0.26	0.75	11.08
	20	2.04	0.44	0.32	0.76	11.09	20	2.04	0.59	0.32	0.91	11.24
	22	2.25	0.53	0.39	0.92	11.25	22	2.25	0.70	0.39	1.09	11.42
	24	2.45	0.62	0.46	1.08	11.41	24	2.45	0.83	0.46	1.29	11.62
	26	2.65	0.72	0.54	1.26	11.59	26	2.65	0.96	0.54	1.50	11.83
	28	2.86	0.83	0.63	1.46	11.79	28	2.86	1.10	0.63	1.73	12.06
	30	3.06	0.94	0.72	1.66	11.99	30	3.06	1.25	0.72	1.97	12.30
	32	3.27	1.06	0.82	1.88	12.21	32	3.27	1.41	0.82	2.23	12.56
	34	3.47	1.18	0.93	2.11	12.44	34	3.47	1.58	0.93	2.50	12.83
	36	3.68	1.32	1.04	2.36	12.69	36	3.68	1.75	1.04	2.79	13.12
	38	3.88	1.46	1.16	2.61	12.94	38	3.88	1.94	1.16	3.09	13.42
	40	4.08	1.60	1.28	2.88	13.21	40	4.08	2.13	1.28	3.41	13.74
	42	4.29	1.75	1.41	3.17	13.50	42	4.29	2.33	1.41	3.74	14.07

The results of the Hazen-Williams Equation where graphed against the Zoeller N57's pump curve to result in the system curve seen below in Figure 5. Where the curves cross is the operation point of the system, this operating point is also shown in the green highlighted area in Figure 4.

Figure 5: System Curve



Since the operating point is not in an extreme area of the pump curve (it is close to the middle) the Zoeller N57 pump will be able to meet the head and flow requirements of the system. The last element of the pumps that had to be checked was the cycle length of the pumps (how long they would run for and how long they would be off). To check this the flow found in Section C (0.0353 cfs) was plugged into the formulas seen below in Figure 6.

Figure 6: Pump Cycle Calculations

Wetwell Volume and Pump Cycle Calculations

Base Elev. (ft)	Top of Sump Elev. (ft)	Pump OFF Elev. (ft)	Lead ON Elev. (ft)	Lag ON Elev. (ft)	Alarm ON Elev. (ft)	Invert In Elev. (ft)	Top Elev. (ft)
252.76	NA	253.26	253.61	NA	253.94	253.94	256.44

Sump Depth (ft)	Base - Pump OFF (ft)	Pump OFF - Lead ON (ft)	Lead ON - Lag ON (ft)	Pump ON - Alarm ON (ft)	Alarm ON - Invert In (ft)	Invert In - Top (ft)	Storage Freeboard (ft)
NA	0.50	0.35	NA	0.33	0.00	2.50	0.00

Wetwell Diameter (ft)	Sump Diameter (ft)	Wetwell Area (ft^2)	Sump Area (ft^2)	Dead Storage Volume (gal)	Working Volume (gal)	Emergency Storage* (gal)
2.50	NA	4.91	NA	18	13	117

Total Capacity (ft^3)	Total Capacity (gal)	2-Year Cycle ON (min)	2-Year Cycle OFF (min)	100-Yr Cycle ON (min)	100-Yr Cycle OFF (min)	2-Year Cycles/Day	100-Yr Cycles/Day
18	135	0.51	2.71	1.02	0.74	92.6	296.6

$$PeakCycleON(\text{min}) = \frac{WorkingVolume(gal)}{PumpFlow\left(gal/\text{min}\right) - PeakInflow\left(gal/\text{min}\right)}$$

$$PeakCycleOFF(\text{min}) = \frac{WorkingVolume(gal)}{PeakInflow\left(gal/\text{min}\right)}$$

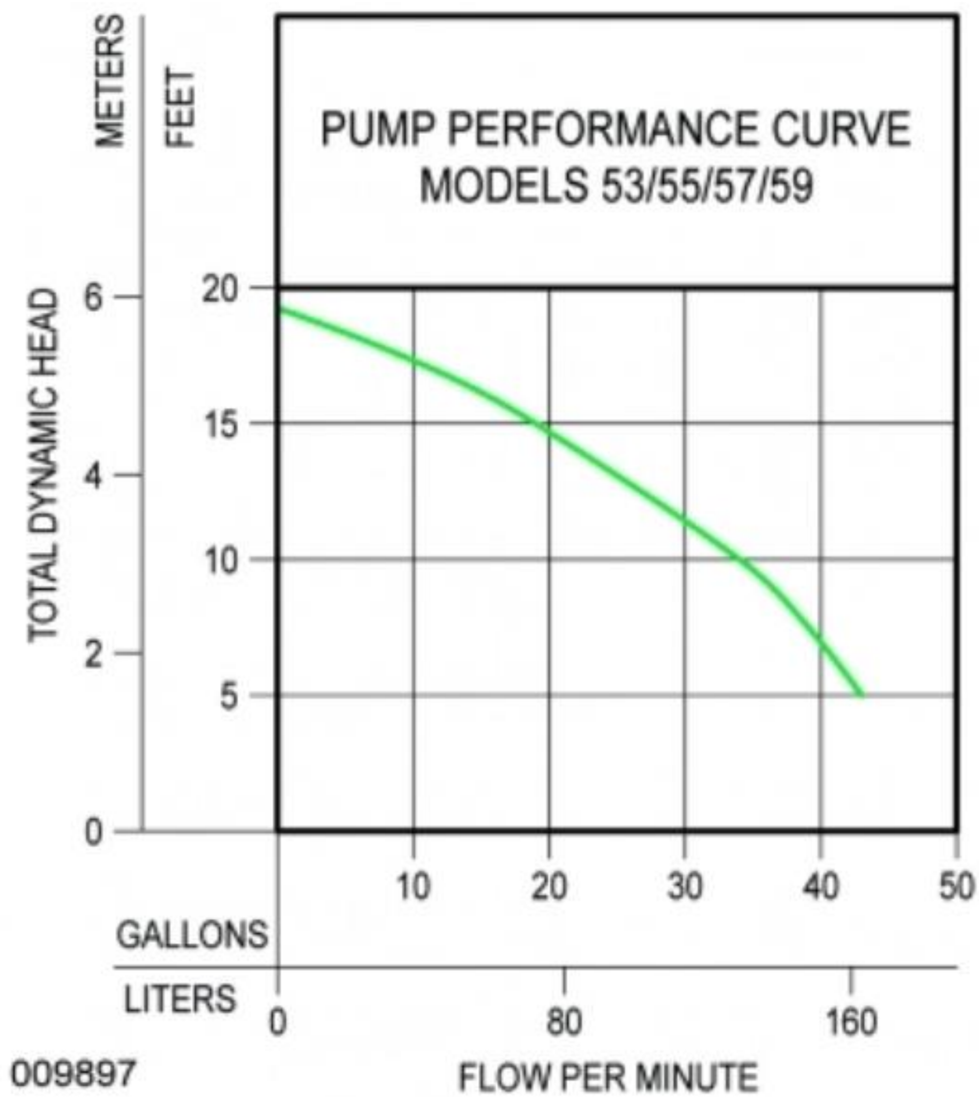
$$AvgCycleON(\text{min}) = \frac{WorkingVolume(gal)}{PumpFlow\left(gal/\text{min}\right) - AvgInflow\left(gal/\text{min}\right)}$$

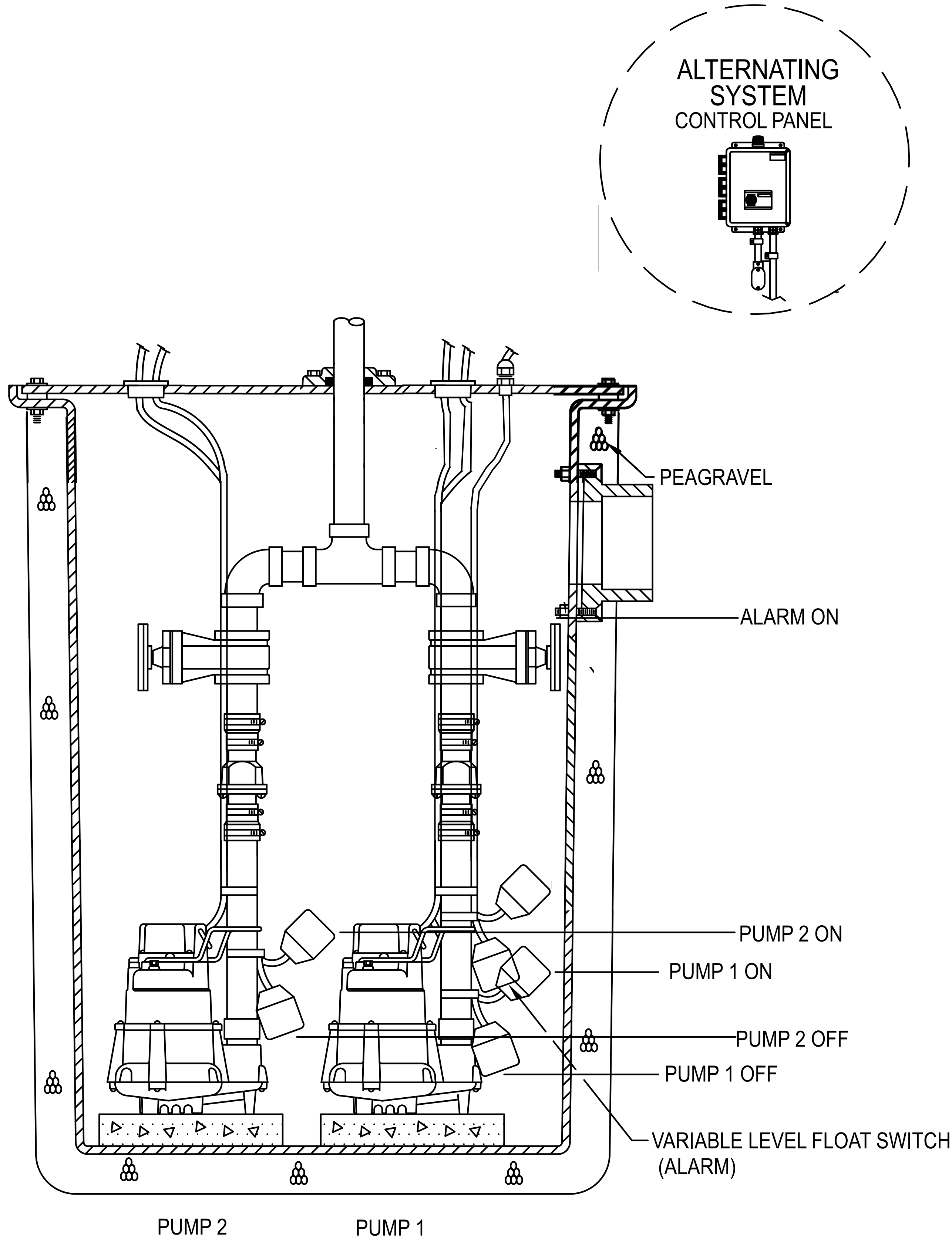
$$AvgCycleOFF(\text{min}) = \frac{WorkingVolume(gal)}{AvgInflow\left(gal/\text{min}\right)}$$

*Emergency storage defined as volume between Pump Off and top of wetwell per DOE

These cycle lengths are reasonable for the Zoeller N57 pumps, especially since the will be alternating with each cycle.

Appendix A – Pump Information





ALTERNATING SYSTEM
CONTROL PANEL
PEAGRAVEL
ALARM ON
PUMP 2 ON
PUMP 1 ON
PUMP 2 OFF
PUMP 1 OFF
VARIABLE LEVEL FLOAT SWITCH (ALARM)
PUMP 2
PUMP 1

Product information presented here reflects conditions at time of publication. Consult factory regarding discrepancies or inconsistencies.

ZOELLER® PUMP COMPANY

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SHIP TO: 3649 Cane Run Road • Louisville, KY 40211-1961
TEL: (502) 778-2731 • 1 (800) 928-PUMP • **FAX**: (502) 774-3624

Visit our web site: zoellerpumps.com

DUPLEX CONTROL PANEL RECOMMENDED APPLICATIONS

PUMP					CONTROL PANEL	
MODEL #	VOLT	PHASE	AMPS	HP	NEMA 1	NEMA 4X
N53	115	1	9.7	0.3	10-1039	10-1041
E53	230	1	4.8	0.3	10-0092	10-1043
N55	115	1	9.7	0.3	10-1039	10-1041
E55	230	1	4.8	0.3	10-0092	10-1043
N57	115	1	9.7	0.3	10-1039	10-1041
E57	230	1	4.8	0.3	10-0092	10-1043

PUMP					CONTROL PANEL	
MODEL #	VOLT	PHASE	AMPS	HP	NEMA 1	NEMA 4X
E188	230	1	14.0	1.5	10-0092	10-1044
F188	230	3	8.9	1.5	10-1110«	10-1110
I188	200	1	16.8	1.5	10-0092	10-1045
J188	200	3	10.3	1.5	10-1111«	10-1111
G188	460	3	4.6	1.5	10-1108«	10-1108
BA188	575	3	3.5	1.5	10-1156«	10-1156

Pumps are N57

Control Panel is 10-1041

Basin is a 48" type 2 catch basin

Alarm is APak Z Control Indoor Alarm

According to the Zoeller representative you can ask for all the fittings, wires, and pipes required for the internal basin pluming while ordering and from there it is essentially a plug and play system.

PUMP					CONTROL PANEL	
MODEL #	VOLT	PHASE	AMPS	HP	NEMA 1	NEMA 4X
E140	230	1	6.0	1.0	10-0092	10-1044
N145	115	1	13.0	0.75	10-1039	10-1041
N151	115	1	6.0	0.3	10-0092	10-1043
E151	230	1	3.2	0.3	10-0092	10-1043
N152	115	1	8.5	0.4	10-1039	10-1041
E152	230	1	4.3	0.4	10-0092	10-1043
N153	115	1	10.5	0.5	10-1039	10-1041
E153	230	1	5.3	0.5	10-0092	10-1043
N161	115	1	15.5	0.5	10-1040	10-1042
E161	230	1	7.5	0.5	10-0092	10-1044
F161	230	3	5.2	0.5	10-1108«	10-1108
I161	200	1	8.8	0.5	10-0092	10-1044
J161	200	3	6.4	0.5	10-1110«	10-1110
G161	460	3	2.9	0.5	10-1106«	10-1106
BA161	575	3	2.4	0.5	10-1154«	10-1154
N163	115	1	15.0	0.5	10-1040	10-1042
E163	230	1	7.5	0.5	10-0092	10-1044
F163	230	3	4.8	0.5	10-1108«	10-1108
I163	200	1	8.5	0.5	10-0092	10-1044
J163	200	3	6.0	0.5	10-1110«	10-1110
G163	460	3	2.9	0.5	10-1106«	10-1106
BA163	575	3	2.4	0.5	10-1154«	10-1154
E165	230	1	10.2	1.0	10-0092	10-1044
F165	230	3	7.4	1.0	10-1110«	10-1110
I165	200	1	12.6	1.0	10-0092	10-1044
J165	200	3	7.5	1.0	10-1110«	10-1110
G165	460	3	3.7	1.0	10-1106«	10-1106
BA165	575	3	3.0	1.0	10-1156«	10-1156
E185	230	1	9.8	1.0	10-0092	10-1044
F185	230	3	7.4	1.0	10-1110«	10-1110
I185	200	1	11.5	1.0	10-0092	10-1044
J185	200	3	7.5	1.0	10-1110«	10-1110
G185	460	3	3.7	1.0	10-1106«	10-1106
BA185	575	3	3.3	1.0	10-1156«	10-1156
E186	230	1	13.7	1.5	10-0092	10-1044
F186	230	3	9.2	1.5	10-1110«	10-1110
I186	200	1	17.2	1.5	10-0092	10-1045
J186	200	3	10.3	1.5	10-1111«	10-1111
G186	460	3	4.6	1.5	10-1108«	10-1108
BA186	575	3	3.6	1.5	10-1108«	10-1108

PUMP					CONTROL PANEL	
MODEL #	VOLT	PHASE	AMPS	HP	NEMA 1	NEMA 4X
F267	230	3	2.6	0.5	10-1106«	10-1106
G267	460	3	1.5	0.5	10-1104«	10-1104
J267	200	3	2.6	0.5	10-1106«	10-1106
I267	200	1	6.2	0.5	10-0092	10-1043
N268	115	1	10.4	0.5	10-1039	10-1044
E268	230	1	5.5	0.5	10-0092	10-1043
F268	230	3	2.6	0.5	10-1106«	10-1106
G268	460	3	1.5	0.5	10-1104«	10-1104
J268	200	3	2.6	0.5	10-1106«	10-1106
I268	200	1	6.2	0.5	10-0092	10-1043
N270	115	1	15.0	1.0	10-1040	10-1045
E270	230	1	7.5	1.0	10-0092	10-1044
N282	115	1	10.3	0.5	10-1039	10-1044
E282	230	1	5.0	0.5	10-0092	10-1043
F282	230	3	3.0	0.5	10-1106«	10-1106
I282	200	1	6.1	0.5	10-0092	10-1043
J282	200	3	3.6	0.5	10-1106«	10-1106
G282	460	3	1.7	0.5	10-1104«	10-1104
BA282	575	3	1.4	0.5	10-1152«	10-1152
E284	230	1	8.9	1.0	10-0092	10-1044
F284	230	3	5.0	1.0	10-1108«	10-1108
I284	200	1	9.3	1.0	10-0092	10-1044
J284	200	3	5.5	1.0	10-1108«	10-1108
G284	460	3	2.6	1.0	10-1106«	10-1106
BA284	575	3	2.2	1.0	10-1154«	10-1154
N292	115	1	15.0	0.5	10-1040	10-1045
E292	230	1	7.5	0.5	10-0092	10-1044
I292	200	1	8.8	0.5	10-0092	10-1044
F292	230	3	5.2	0.5	10-1108«	10-1108
J292	200	3	6.4	0.5	10-1110«	10-1110
G292	460	3	2.9	0.5	10-1106«	10-1106
BA292	575	3	2.4	0.5	10-1154«	10-1154
E293	230	1	10.2	1.0	10-0092	10-1044
F293	230	3	7.6	1.0	10-1110«	10-1110
I293	200	1	12.0	1.0	10-0092	10-1044
J293	200	3	8.2	1.0	10-1110«	10-1110
G293	460	3	4.0	1.0	10-1108«	10-1108
BA293	575	3	3.3	1.0	10-1156«	10-1156