MEMORANDUM
To: Chief Engineer Phanikumar Mantha
From: Devin Powers
Date: May 2, 2019
Subject: Hydraulics, Project 2

Introduction

Powers Worldwide, the first word in water slide park design has been directed to perform a feasibility study for the ending slide of a new proposed water slide at the Cedar Point amusement park in Sandusky, Ohio. The water slide will consist of a series of large circular rafts, each containing approximately 10 persons and will be towed around a canal. At the end of the ride, each raft is to be released from a towing mechanism, and will be guided down a chute, where it will pass through several transitions, finally ending in a quiescent pool. The client provided the following design constrain and requirements:

1. The channel is to be constructed of unfinished concrete, is rectangular in cross-section, and is approximately 10 ft wide. The channel width should support a raft that holds 10 people.
2. The steep slope produces a relatively high velocity (10 feet vertical maximum)
3. The raft will float down the chute until the depth becomes too shallow for its draft, so that for the reminder of the traverse the raft will be transported on rollers built into the bottom of the chute.
4. A hydraulic jump is to be located at the bottom of the chute, but not beyond the tailwater reach B-C. The maximum height of the jump should not exceed 2.0 ft. for safety reasons.
5. The channel should transition to a low velocity area of 0.5 to 1.0 ft/s for loading and unloading rafts.

Assumptions

- Water depth at the entrance of the ride is 3 ft.
- Discharge in the beginning of the waterslide is found by using the weir formula $Q=0.4*(2g)by^{3/2}$

Results Summary

The final design of the ride will extend 161 ft. and will include 4 sections. The width of the ride is 12 ft., for the 131 ft. of the ride, then the width is increased to 60 ft. to allow for passengers to safely exit the ride. The 4 sections and their excel calculations are shown in the appendix. The first section (A-B) of the waterslide, the entrance, will include an elevation of 10 ft., slope of

0.13, critical depth of 2.39 ft., and a discharge of 252.22 cfs. The first section, will be 36 ft. long. The Y value will be 1.25 ft. at point B. The initial slope portion of the water slide was found to be a S2 profile because Yo<Y<Yc. The second section of the ride (from B-C) will have no slope, and extend for a distance of 24 ft. and will be an H profile. The Hydraulic jump occurred at the end of section B-C, as riders will experience a jump of 1.95 ft. The waterslide extends another 101 feet until passengers are able to safely exit the ride.

Along every point of the ride, the water level is kept above 1 foot, allowing for the large tubes to stay off the bottom of the ride. Although there is no need for rollers in the water slide design, they will be added to ensure that the ride operates consistently. The water slide ride is a practical design for Cedar Point. The nearly two feet hydraulic jump will be a hit for all ages. A rendering of the actual water slide is shown in figure 8, was constructed in Rollercoaster Tycoon. Most riders enjoyed the ride.

Appendix:

Steep				
	Depth [Ft]	Residual		
Critical	2.393942	For a rectangular Channel		
Normal	1.210231	1.3794E-06		

Entrance Condtions		
b	12	ft
Q	252.22	cfs
n	0.014	
S0	0.13	
Normal y	1.21	ft
yc	2.39	ft
Y Weir	3	ft

Station	y [ft]	A [ft2]	V [ft/s]	E [ft]	ym [ft]	Sf-bar (@ym)	Δx [ft]	Δx (rounded)	x [ft]	Fr1	ycj
1	2.39	28.68	8.794281729	3.59092					0	1.002475	2.397888
2	2.3	27.6	9.138405797	3.59675	2.345	0.011691301		0	0	1.061888	2.490407
3	2.2	26.4	9.553787879	3.61731	2.25	0.013216022	0.176096532	1	1	1.135106	2.598965
4	2.1	25.2	10.00873016	3.65551	2.15	0.015130473	0.332515596	1	2	1.217142	2.714142
5	1.9	22.8	11.0622807	3.80022	2	0.018784107	1.301170067	2	4	1.414295	2.967162
6	1.8	21.6	11.67685185	3.91722	1.85	0.023751498	1.101194165	2	6	1.533775	3.106741
7	1.7	20.4	12.36372549	4.07363	1.75	0.02810041	1.534947702	2	8	1.671079	3.25648
8	1.69	20.28	12.43688363	4.0918	1.695	0.0309611	0.183497509	1	9	1.685933	3.272063
9	1.67	20.04	12.58582834	4.12968	1.68	0.031809334	0.385705515	1	10	1.71631	3.303581
10	1.6	19.2	13.13645833	4.2796	1.635	0.034550692	1.570776625	2	12	1.830166	3.417756
11	1.5	18	14.01222222	4.54879	1.55	0.040668751	3.013390857	4	16	2.016199	3.592265
12	1.45	17.4	14.4954023	4.71268	1.475	0.047345505	1.982794731	2	18	2.121379	3.685122
13	1.4	16.8	15.01309524	4.89989	1.425	0.052640049	2.419989402	3	21	2.236033	3.782119
14	1.35	16.2	15.5691358	5.11394	1.375	0.058763943	3.004829276	4	25	2.361401	3.88361
15	1.32	15.84	15.9229798	5.25698	1.335	0.064372419	2.179457848	3	28	2.442359	3.946825
16	1.3	15.6	16.16794872	5.35905	1.31	0.068247918	1.652892719	2	30	2.498937	3.989993
17	1.28	15.36	16.42057292	5.46688	1.29	0.071577231	1.845790074	2	32	2.557734	4.034017
18	1.25	15	16.81466667	5.64026	1.265	0.076052991	3.21393146	4	36	2.650363	4.101727

Figure 1: Section A to B

Conditions From B to C		
b	12	ft
Q	252.22	cfs
n	0.014	
S0	0	

y [ft]	A [ft2]	V [ft/s]	E [ft]	ym [ft]	Sf-bar (@ym)	Δx [ft]	Δx (rounded)	x [ft]	Fr1	ycj	Δy
1.25	15	16.814667	5.64026421					0	2.6503628	4.1017268	2.8517268
1.35	16.2	15.569136	5.113943938	1.3	0.069885948	7.531131572	8	8	2.3614007	3.8836097	2.5336097
1.4	16.8	15.013095	4.899891749	1.375	0.058763943	3.64257704	4	12	2.2360334	3.7821193	2.3821193
1.45	17.4	14.495402	4.712681488	1.425	0.052640049	3.556422615	4	16	2.1213793	3.6851222	2.2351222
1.5	18	14.012222	4.54879459	1.475	0.047345505	3.461509138	4	20	2.0161993	3.5922653	2.0922653
1.55	18.6	13.560215	4.405270688	1.525	0.042744452	3.357720048	4	24	1.9194323	3.503236	1.953236
1.6	19.2	13.136458	4.27960462	1.575	0.038726853	3.244933591	4	28	1.8301655	3.4177565	1.8177565
1.65	19.8	12.738384	4.169664951	1.625	0.035202956	3.123023784	4	32	1.7476096	3.3355785	1.6855785
1.7	20.4	12.363725	4.073629006	1.675	0.032099064	2.991861238	3	35	1.6710789	3.2564799	1.5564799

Figure 2: Section B to C

Conditions After Jump		
b	12	ft
Q	252.22	cfs
n	0.014	
S0	0	

Station	y [ft]	A [ft2]	V [ft/s]	E [ft]	ym [ft]	Sf-bar (@ym)	Δx [ft]	Δx (rounded)	x [ft]	Fr1	ycj
1	3.50324	42.03888	5.999684	4.062187					0	0.564892	1.549998
2	3.4	40.8	6.181863	3.993407	3.45162	0.003805125	18.07564573	19	19	0.590816	1.61064
3	3.3	39.6	6.369192	3.929916	3.35	0.004143525	15.3229452	16	35	0.617873	1.672257
4	3.2	38.4	6.568229	3.869901	3.25	0.004518715	13.28144753	14	49	0.647061	1.736875
5	3.1	37.2	6.780108	3.813818	3.15	0.004942691	11.34674971	12	61	0.678622	1.804674
6	3	36	7.006111	3.762199	3.05	0.005423786	9.517157611	10	71	0.712834	1.875853

Depths			
Y4	3.05		
Y5	3.54	Alternative Depth	

Figure 3: Section C to D

Unloading Wier	
Y	1
Q	252.22
b2 (Unloading)	60
S0	0

Station	y [ft]	A [ft2]	V [ft/s]	x(ft)
1	1	60	4.203667	30

Figure 4: Unloading of the Water Slide

Summary of Waterslide		
		Units
Wier (1)	3	ft
Critical Yc	2.39	ft
Normal Y	1.21	ft
Y1	1.25	ft
Y2	1.55	ft
Y3	3.503	ft
Y4	3.05	ft
Y5	3.54	ft
EGL at Yc	3.59	ft
EGL at Y1	5.64	ft
EGL at Y3	4.405	ft
EGL at Y4	3.76	ft
EGL at Y5	3.76	ft
Wier (2)	1	ft
Elevation A	25	ft
Elevation B	15	ft
Elevation C	15	ft
b	12	ft
Q	252.22	cfs
n	0.014	
S0 (Steep)	0.13	
S0 (flat)	0	
b2 (Unloading)	60	Ft

Figure 5: Summary of the Waterslide

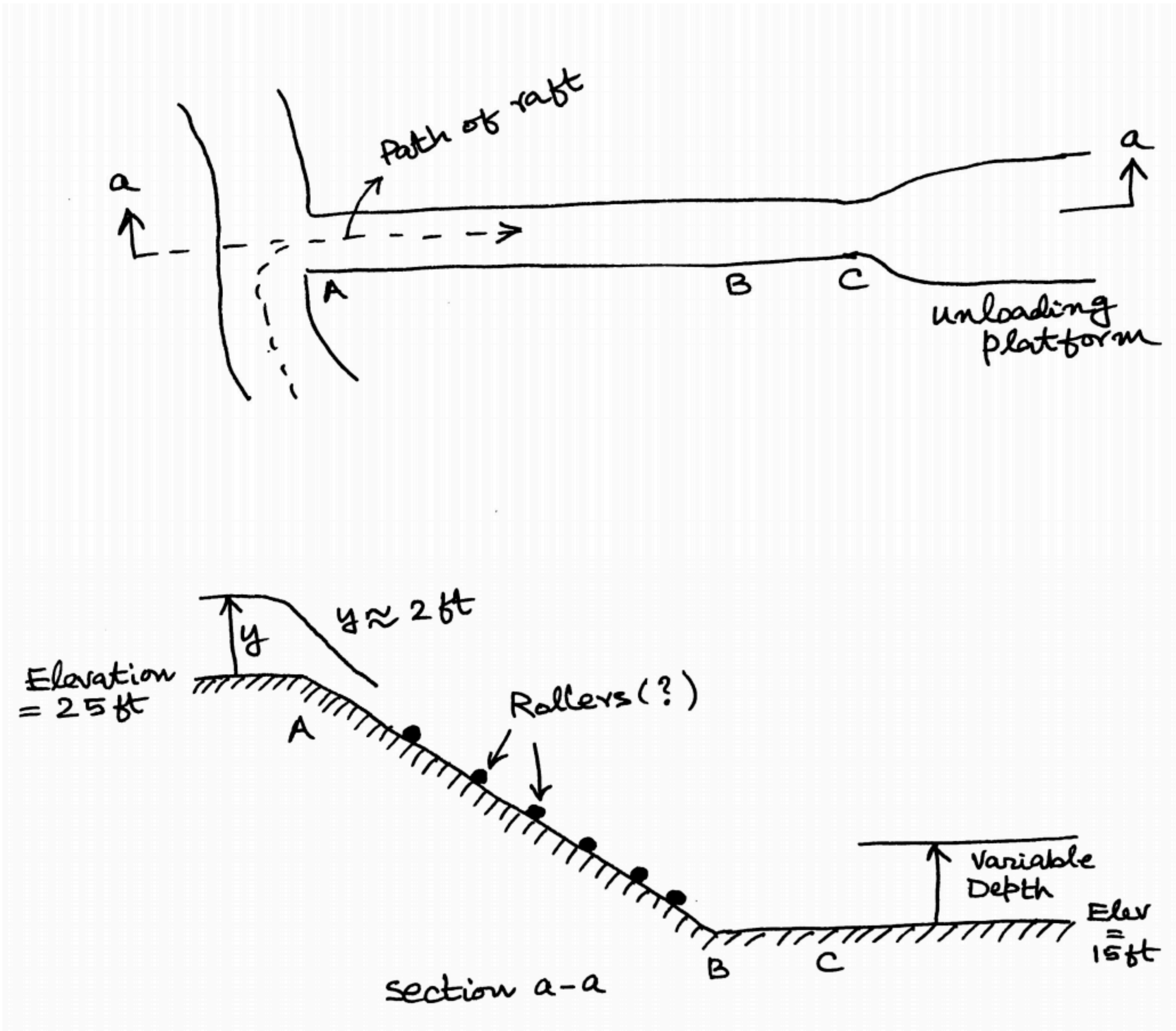

Figure 6: Initial Drawing of the Water Slide

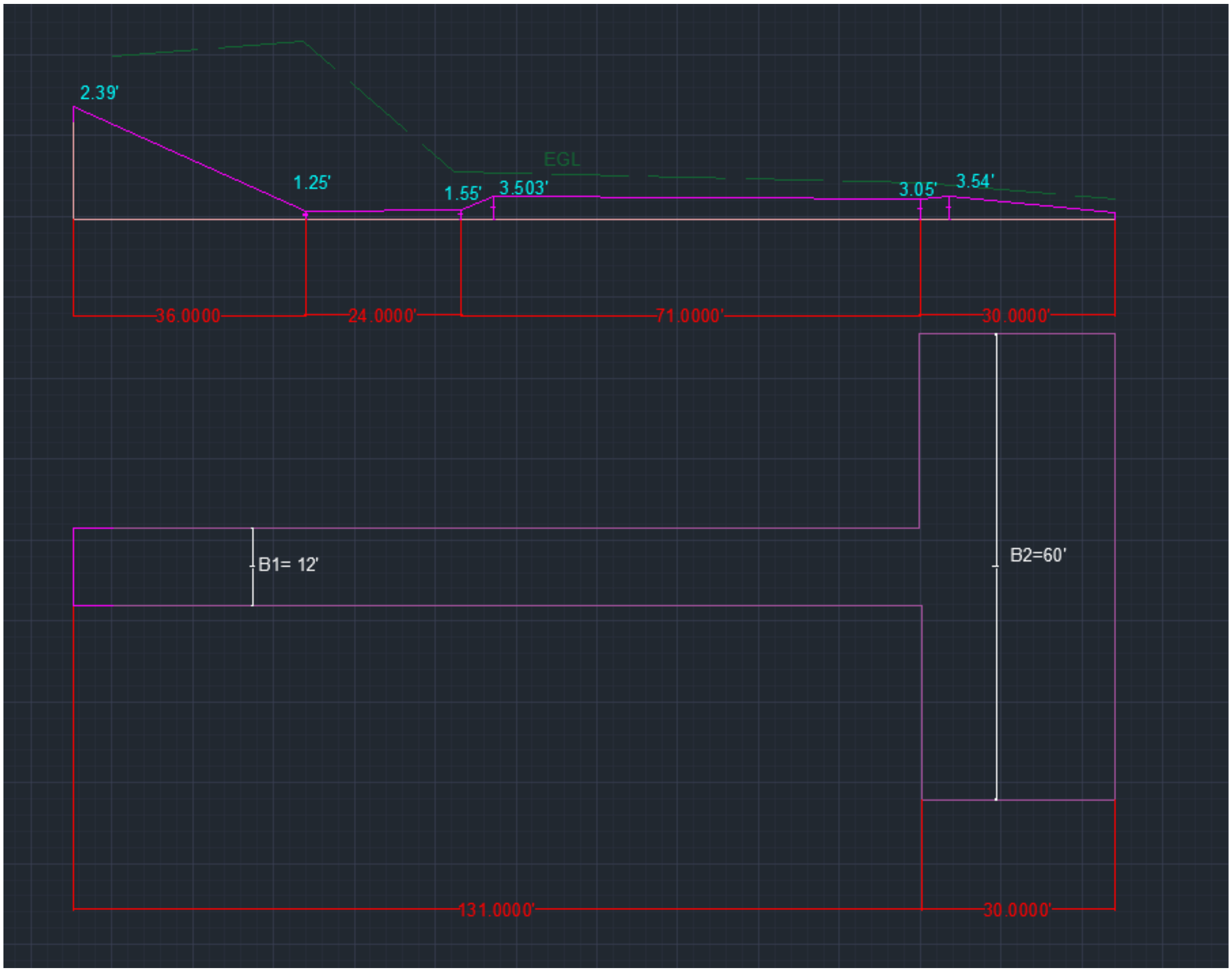

Figure 7: AutoCAD Drawing of the Water Slide

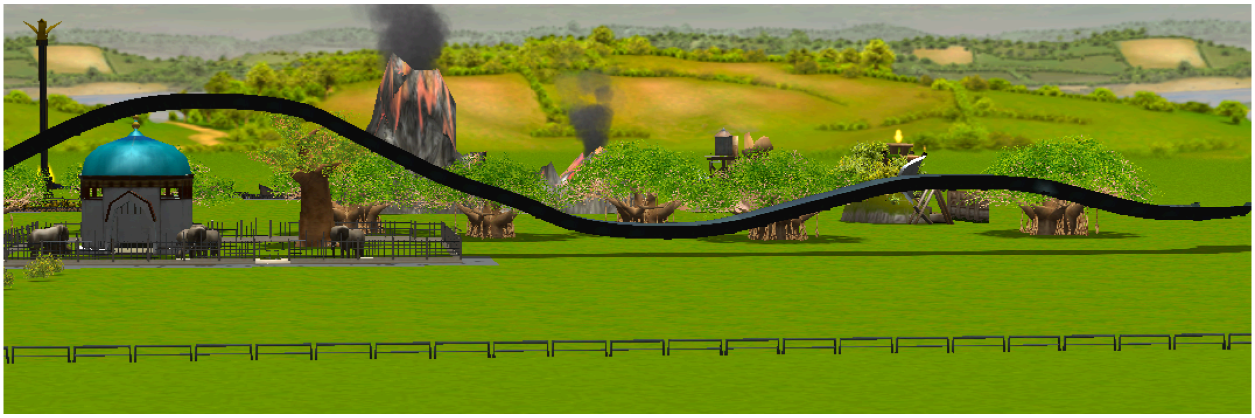

Figure 8: Water Slide Preview