Phone (231) 893-7177 DavidLSchultz@Charter.net

June 25, 2013

Chip May, Executive Director Camp Arcadia 3046 Oak Street, P.O. Box 229 Arcadia, MI 49613

Re: SandGrabber Report

Dear Mr. May;

This letter is intended to serve as the final report on the SandGrabber (SG) system placed on your beach over the last two years. Placement of the SG modules was permitted by the State of Michigan as an experimental system, with its removal mandated after a three-year trial. Five surveys were performed to quantify the gains and losses that occurred during the study period. Since then, SandGrabber has changed its name to SandSaver, so any reference to SG is intended to mean either name.

Shore protection at Camp Arcadia beach goes back to at least 1978, when the existing wooden walls and groins were installed. Most of the substantial additions and maintenance took prior to 1987. The continued deterioration of these structures initiated a deliberate search for solutions to their vulnerability, being situated so close to the Lake Michigan shore. Due to the camp's previous shore protection efforts, they are not in a high risk erosion zone. However, immediately north and south of the camp, the state has measured the 60 year recession rates to be 105' and 85' respectively. This amount of beach and bluff recession at Camp Arcadia would result in the loss of their most essential buildings.

After soliciting proposals from a number of consultants and contractors, the camp's beach committee selected SandGrabber, who was willing to install a limited number of SG modules at no cost, in an effort to gain positive data to be used for future marketing. Ledy Design Group (now LSG) performed the initial topographic survey used to facilitate design, layout and permitting efforts. The State of Michigan issued a permit on 11/20/09 and the US Army Corps of Engineers issued a permit on 11/29/10. The extra 1 year to obtain the federal permit created a time crunch that forced removal of the SG modules in April, 2013 after only five surveys, instead of the 7 originally contemplated.

In retrospect, the SG system should have been left in place longer, in order to witness its response to the rising Lake Michigan water levels we are now experiencing. Instead the modules were in place during historically low water levels. This would have given all parties additional information regarding SG performance over a larger range of conditions that can be expected over a standard service life.

Attachments to this report illustrate the changes that occurred, and consist of overlapping survey profiles and a spreadsheet that quantifies these changes into square feet at each cross-section and cubic yards between each section. Additionally, I broke the beach into 4 quadrants to assist in visualizing trends based upon proximity to the SG installation.

The results of the shoreline in response to the SG system are unambiguously positive. Of the 2,567 cubic yards (cy) of beach volume gain from April 2011 to April 2013, 37% of the gain (954 cy) occurred at the SG installation, which constituted only 25% of the surveyed beach length. This equates to a gain of 6.4 cy per foot of beach front at the SG location, compared with a gain of 3.6 cy/ft over the rest of the study area.

Beach volume gains did not just occur behind the SG modules, as some had anticipated. Tangible gains in bottom elevation were witnessed as much as 50' in front of the SG system into the lake. This benefit was also visited upon the beach immediately north of the installation, which is downdrift at this location on Lake Michigan. This portion of the beach gained 6.1 cy/ft, when standard expectations were it would lose profile if the SG system was successful at "grabbing" any sand. This result appears to show that, at the very least, the SandGrabber design does not generate adjacent negative impacts associated with shore-normal and impermeable structures. The SG modules' permeability and placement in a shore-parallel orientation demonstrated no negative impacts to adjacent stretches of beach.

Quadrant	Location	Δ Vol.	Average $\Delta Vol.$
1	Sta 5+00 to 6+75	+329 cy	1.9 cy/ft
2	Sta 6+75 to 8+25	+522	3.5
3	Sta 8+25 to 9+75	+954	6.4 ← location of SandGrabber system
4	Sta 9+75 to 11+00	+761	6.1
Total	Sta 5+00 to 11+00	+2567 cy	4.3 cy/ft

Summary of Monitoring Surveys at Camp Arcadia's Lake Michigan Beach

It has been a distinct pleasure to work for you and your colleagues in the interest of protecting Camp Arcadia and preserving its beach. Please feel free to contact me when further discussion or action becomes warranted.

Respectfully, David L. Schultz, P.E.

cc: Barry Peterman, MDEQ James Kohlenberg, Sand Saver

YOUNGS CONSULTING

14154 RUBY LANE BIG RAPIDS, MI. 49307 TELEPHONE 231-510-4216 FAX 231-832-1947

Date: June 16, 2013

To Whom It May Concern:

From: Cliff Youngs, P.E.

Subject: Survey equipment and procedures

To Whom It May Concern::

Please find listed below the information you have requested regarding the hydrographic surveying equipment used by Youngs Consulting:

- Innerspace 455 XPe 200KHZ sounder put into service in 2006
- 208KHz 3 degree XDCR transducer put into service in 2006
- Raven Invicta 210 GPS receiver put into service fall of 2005
- Hypack Max Hydrographic Survey Version 2012a

Please find below the methodology and equipment used by LCM Surveying and Engineering:

LCM Surveying & Engineering performed the upland portion of the topographic survey by utilizing Leica System 1200 GNSS GPS Receivers. We used a Base/Rover system referenced to the Michigan CORS GPS Network. We established the baseline, stationing and control for this project by using previous survey control established by LEDY Survey Group, who had previously completed a survey for the Lutheran Camp Association.

This survey control was used to establish reference lines at 25' intervals along the established baseline. Survey data was collected along said reference lines for each monitoring survey. Since data was collected along a common reference line the data could be compared with previous surveys looking for any variations.

Please contact me for any questions.

Camp	Arcadia	Volumetr	ics												
	Change, 4	4/13/11 to	9/1/11	Change, 9	9/1/11 to 4	4/17/12	Change, 4	/17/12 to	9/6/12	Change, 9	9/6/12 to 4	4/12/13	4/13/11 to 4/	12/13	
	c.s. area	change	volume	c.s. area o	change	volume	c.s. area c	hange	volume	c.s. area o	change	volume	Cum. volume	change	
Station	loss (sf)	gain (sf)	change (cy)	loss (sf)	gain (sf)	change (cy)	loss (sf)	gain (sf)	change (cy)	loss (sf)	gain (sf)	change (cy)	cubic yards		
5+00	0.7	90.0		70.7	8.8		1.9	151.8		147.0	4.0				
5+25	0.0	98.4	86.9	39.4	10.4	-42.1	4.7	134.9	129.7	104.0	38.0	-96.8	77.7		
5+50	6.2	67.0	73.7	9.9	21.4	-8.1	3.2	119.5	114.1	159.0	12.0	-98.6	81.1		
5+75	9.1	51.2	47.6	15.7	32.8	13.2	1.8	105.6	101.9	125.0	9.0	-121.8	41.0	329.3	5+00 to 6+75
6+25	24.9	4.9	20.5	8.3	64.5	67.9	56.9	24.6	66.2	11.0	37.0	-83.3	71.2	1.88 cy/lf	
6+50	42.8	17.7	-20.9	0.8	75.8	60.7	68.8	22.0	-36.6	22.0	38.0	19.4	22.7		
6+75	42.2	20.6	-21.6	2.0	67.8	65.2	56.2	24.7	-36.3	10.0	55.0	28.2	35.6		
7+00	54.9	19.2	-26.5	5.8	56.1	53.8	47.9	31.8	-22.0	18.0	57.0	38.9	44.1		
7+25	36.3	102.4	14.1	11.4	56.3	44.1	55.8	38.0	-15.7	17.0	49.0	32.9	75.3		
7+50	76.3	27.2	7.9	15.4	67.1	44.7	37.3	34.4	-9.6	8.0	64.0	40.7	83.8	522.4	6+75 to 8+25
7+75	58.6	6.2	-47.0	0.4	95.8	68.1	22.6	38.6	6.1	22.0	41.0	34.7	61.9	3.48 cy/lf	
8+00	20.6	48.4	-11.4	15.6	95.1	81.0	23.5	13.6	2.8	18.0	70.0	32.9	105.3		
8+25	13.8	36.3	23.3	7.2	43.7	53.7	3.0	39.1	12.1	16.0	100.0	63.0	152.1		
8+50	23.5	28.6	12.8	15.0	30.2	23.9	52.4	9.1	-3.3	11.0	114.0	86.6	120.0		
8+75	59.7	34.4	-9.4	9.9	48.7	25.0	0.0	95.5	24.2	50.0	75.0	59.3	99.1		
9+00	32.6	57.9	0.0	20.6	46.8	30.1	8.8	78.2	76.3	19.0	113.0	55.1	161.5		
9+25	67.1	35.1	-3.1	10.6	89.2	48.5	27.3	56.0	45.4	4.0	146.0	109.3	200.1	954.0	8+25 to 9+75
9+50	51.2	28.0	-25.6	7.7	30.3	46.9	18.3	47.6	26.9	0.0	187.0	152.3	200.5	6.36 cy/lf	
9+75	92.1	23.6	-42.5	12.0	52.5	29.2	18.3	51.0	28.7	1.0	154.0	157.4	172.9		
10+00	87.1	20.7	-62.5	15.4	51.9	35.6	34.4	54.1	24.3	0.0	182.0	155.1	152.5		
10+25	64.3	10.2	-55.8	1.1	51.2	40.1	38.9	37.9	8.7	5.0	186.0	168.1	161.0		
10+50	61.7	24.6	-42.2	20.2	49.8	36.9	47.1	45.1	-1.4	8.0	138.0	144.0	137.3	761.2	9+75 to 11+00
10+75	59.0	9.6	-40.0	15.3	78.7	43.1	61.5	34.5	-13.4	1.0	208.0	156.0	145.6	6.09 cy/lf	
11+00	46.7	19.7	-35.4	29.3	32.7	30.9	53.2	40.7	-18.3	4.0	202.0	187.5	164.8		
			-157.0			892.4			510.7			1320.8	2566.9		

Red stations and values are at SandGrabber installation location



-100				-50
574.5				578.0'
575.3'				578.8'
		END AREA (SQ FT)	VOLUME (CYD)	
5+00.	00 EX			

		5010	•
5+25.00 EX	Excavation	0.0	0
	Fill	98.4	87

-100	-50
574.6'	576.7'
575.1'	578.0'



-100	-50
574.5'	576.3'
574.9'	577.0'

		END AREA (SQ FT)	VOLUME (CYD)
5+50.00 EX	Excavation	6.2	3
	Fill	67.0	77
5+75.00 EX	Excavation	9.1	7
	Fill	51.2	55



		END AREA (SQ FT)	VOLUM (CYD)
6+25.00 EX	Excavation	24.9	31
	Fill	4.9	52
6+50.00 EX	Excavation	42.8	31
	Fill	17.7	10

		END AREA (SQ FT)	VOLUME (CYD)
7+25.00 EX	Excavation	36.3	42
	Fill	102.4	56
7+50.00 EX	Excavation	76.3	52
	Fill	27.2	60

		END AREA (SQ FT)	VOLUME (CYD)	
7+75.00 EX	Excavation Fill	58.6 6.2	62 15	
8+00.00 EX	Excavation Fill	20.6 48.4	37 25	

-100	-50
574.4'	576.1'
574.5'	576.0' 577.5'

			VOLUML
		(SQ FT)	(CYD)
8+25.00 EX	_		
	Excavation Fill	13.8 36.3	16 39
8+50.00 EX			
	Excavation Fill	23.5 28.6	17 30

				VOLUME
			(SQ FT)	(CYD)
8+75.0	00 EX	Excavation Fill	59.7 34.4	39 29
9+00.0	00 EX	Excavation Fill	32.6 57.9	43 43

TOO	50		
		BASE: W.	Ε.
574.4'	575.4'	NO DATA	
574.5'	576.5'	576.9'	577.

		END AREA (SQ FT)	VOLUME (CYD)
9+75.00 EX	Excavation	92.1	66
10+00.00 EX	F1	23.6	24
	Excavation Fill	87.1 20.7	83 21

		END AREA (SQ FT)	VOLUME (CYD)
10+75.00 EX	Excavation	59.0	56
	Fill	9.6	16
11+00.00 EX	Excavation	46.7	49
	Fill	19.7	14

575.3' 574.3'					578.8' 578.8'
			END AREA (SQ FT)	VOLUME (CYD)	
	5+00.00 EX	Excavation Fill	70.7 8.8	0 0	
	5+25.00 EX	Excavation Fill	39.4 10.4	51 9	

-100			-50

				577.0' 577.3'
		END AREA (SQ FT)	VOLUME (CYD)	
5+50.00 EX	Excavation Fill	9.9 21.4	23 15	
5+75.00 EX	Excavation Fill	15.7 32.8	12 25	
	5+50.00 EX 5+75.00 EX	5+50.00 EX Excavation Fill 5+75.00 EX Excavation Fill	5+50.00 EX Excavation 9.9 5+75.00 EX Excavation 21.4 5+75.00 EX Excavation 15.7 Fill 32.8	$\begin{array}{c} & \qquad $

		END AREA (SQ FT)	VOLUME (CYD)	
6+25.00 EX	Excavation Fill	8.3 64.5	22 90	
6+50.00 EX	Excavation Fill	0.8 75.8	4 65	

574.5' 574.9'					575.8' 575.9'
			END AREA (SQ FT)	VOLUME (CYD)	
	6+75.00 EX	Excavation Fill	2.0 67.8	1 66	
	7+00.00 EX	Excavation Fill	5.8 56.1	4 57	

		END AREA	VOLUME
		(SQ FT)	(CYD)
7+25.00 EX	Excavation	11.4	8
	Fill	56.3	52
7+50.00 EX	Excavation	15.4	12
	Fill	67.1	57

		END AREA (SQ FT)	VOLUME (CYD)	
7+75.00 EX	Excavation Fill	0.4 95.8	7 75	
8+00.00 EX	Excavation Fill	15.6 95.1	7 88	

574.5'	576.0
574.8'	577.5

574.8'					576.1'	BASE: W.
574.7'					5//.5	576.9'
			END AREA (SQ FT)	VOLUME (CYD)		
	8+25.00 EX	Excavation Fill	7.2 43.7	11 64		
	8+50.00 EX	Excavation	15.0	10 34		

		END AREA (SQ FT)	VOLUME (CYD)	
9+75.00 EX	Excavation	12.0	9	
	Fill	52.5	-38	
10+00.00 EX	Excavation Fill	15.4 51.9	13 48	

		END AREA (SQ FT)	VOLUMI (CYD)
10+25.00 EX	Excavation	1.1	8
	Fill	51.2	48
10+50.00 EX	Excavation	20.2	10
	Fill	49.8	47

		END AREA (SQ FT)	VOLUME (CYD)
10+75.00 EX	Excavation	15.3	16
	Fill	78.7	59
11+00.00 EX	Excavation	29.3	21
	Fill	32.7	52

G R A N Material N	DSUI Iame	M A R Y Unadjusted Volumes (cu. yd.)
	Excavation Fill	297 1188

574.3' 575.6'			END AREA (SQ FT)	VOLUME (CYD)	578.8' 579.7'
	5+00.00 EX	Excavation Fill	1.9 151.8	0 0	
	5+25.00 EX	Excavation Fill	4.7 134.9	3 133	

574.9' 575.8'					577.3' 578.6'
			END AREA (SQ FT)	VOLUME (CYD)	
	5+50.00 EX	Excavation Fill	3.2 119.5	4 118	
	5+75.00 EX	Excavation Fill	1.8 105.6	2 104	

75.0'	575.9
74.1'	576.0

574.9' 574.4'			END AREA (SQ FT)	VOLUME (CYD)	575.9' 576.1'
	6+75.00 EX	Excavation Fill	56.2 24.7	58 22	
	7+00.00 EX	Excavation Fill	47.9 31.8	48 26	

575.0'	575.9'
574.4'	576.3'

		END AREA (SQ FT)	VOLUME (CYD)
7+75.00 EX	Excavation	22.6	28
	Fill	38.6	34
8+00.00 EX	Excavation	23.5	21
	Fill	13.6	24

574.8'	577.5
574.6'	577.9

		END AREA (SQ FT)	VOLUME (CYD)
8+25.00 EX	Excavation	3.0	12
	Fill	39.1	24
8+50.00 EX	Excavation	52.4	26
	Fill	9.1	22

575.0'	575.8'	576.6	577
574.8'	577.6'	5/0.2	57

575.0' 574.6'			END AREA (SQ FT)	575.7' VOLUME 577.2' (CYD)	576.3'	576
	9+25.00 EX	Excavation Fill	27.3 56.0	17 62		
	9+50.00 EX	Excavation Fill	18.3 47.6	21 48		

574 5'	575 9'	576.8'	577.5
574.3'	576.9'		

		END AREA (SQ FT)	VOLUME (CYD)
9+75.00 EX	Excavation	18.3	17
10+00.00 EX	Excavation Fill	34.4 54.1	40 24 49
		5111	

574.8' 574.2'				576.3' 577.1'
			END AREA (SQ FT)	VOLUME (CYD)
	10+75.00 EX	Excavation Fill	61.5 34.5	50 37
	11+00.00 EX	Excavation Fill	53.2 40.7	53 35

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Т	00

575.6' 574.3'			END AREA (SQ FT)	VOLUME (CYD)	579.7' 579.3'
	5+00.00 EX	Excavation Fill	147 4	0 0	
	5+25.00 EX	Excavation Fill	104 38	116 19	

-100	-50

575.8' 574.2'			END AREA (SQ FT)	VOLUME (CYD)	578.6' 578.2'
	5+50.00 EX	Excavation Fill	159 12	122 23	
	5+75.00 EX	Excavation Fill	125 9	131 10	

-100				-50	
574.1' 574.1'		END AREA (SQ FT)	VOLUME (CYD)	576.2' 577.4'	
6+25.00 EX	Excavation Fill	11 37	126 43		
6+50.00 EX	Excavation Fill	22 38	15 35		

-100					-50
574.4' 574.1'			END AREA (SQ FT)	VOLUME (CYD)	576.1' 580.0'
	6+75.00 EX	Excavation Fill	10 55	15 43	
	7+00.00 EX	Excavation Fill	18 57	13 52	

-100	-50
574.4' 574.0'	576.3' 578.4'

-100	-50
	577.5'
574.6'	577.9'
574.0'	578.4'

 1	Λ	Λ
Т	U	U

574.8' 574.3'			END AREA (SQ FT)	VOLUME (CYD)	578.0'
	8+25.00 EX	Excavation Fill	16 100	16 79	
	8+50.00 EX	Excavation Fill	11 114	13 99	

		BASE: W.	Ε.
574.8' 574.7'	577.6' 579.1'	578.2'	578.

-100	-50	
	BASE: W.	

574.7'			END AREA (SQ FT)	VOLUME (CYD)	579.1'
		Excavation Fill	7 146	12 120	
	9+50.00 EX	Excavation Fill	0 187	3 154	

574.3'	576.9'
574.9'	579.2'

-100				-50
574.2' 574.6'				576.4' 579.0'
		END AREA (SQ FT)	VOLUME (CYD)	
9+75.00 EX	Excavation Fill	1 154	0 158	
10+00.00 EX	Excavation Fill	0 182	0 156	

-100

-50

574.2' 574.9' <mark>577.0'</mark> 579.0'

-100	-50

574.3' 575.0'			END AREA (SQ FT)	VOLUME (CYD)	577.2' 579.4'
	10+25.00 EX	Excavation Fill	5 186	2 170	
	10+50.00 EX	Excavation Fill	8 138	6 150	

-100	-50
574.1' 574.4'	577.0' 578.8'

574.3'			END AREA (SQ FT)	VOLUME (CYD)	579.3'
	5+00.00 EX	Excavation Fill	31 65	0 0	
	5+25.00 EX	Excavation Fill	14 148	21 99	

-100	-50
574.6'	576.7'
574.8'	579.6'

574.2'			END AREA (SQ FT)	VOLUME (CYD)	578.2'
	5+50.00 EX	Excavation Fill	48 92	29 111	
	5+75.00 EX	Excavation Fill	55 102	48 90	

574.1'		END AREA (SQ FT)	VOLUME (CYD)	
6+25.00 EX	Excavation Fill	46 75	94 164	
6+50.00 EX	Excavation Fill	62 81	50 72	

574.1'			END AREA (SQ FT)	VOLUME (CYD)	580.0'
	6+75.00 EX	Excavation Fill	49 109	51 88	
	7+00.00 EX	Excavation Fill	60 97	50 95	

574.1'			END AREA (SQ FT)	VOLUME (CYD)	578.5
	7+25.00 EX	Excavation Fill	52 175	52 126	
	7+50.00 EX	Excavation Fill	49 104	47 129	

574.2'					580.6'
			END AREA (SQ FT)	VOLUME (CYD)	
	7+75.00 EX	Excavation Fill	16 94	30 92	
	8+00.00 EX	Excavation Fill	13 163	13 119	

574.4'	576.1'
	577.5'
574.0'	578.4'

574.3'			END AREA (SQ FT)	VOLUME (CYD)	578.0'
	8+25.00 EX	Excavation Fill	12 191	12 164	
	8+50.00 EX	Excavation Fill	37 117	23 143	

		END AREA (SQ FT)	VOLUME (CYD)
8+75.00 EX	Excavation	37	34
	Fill	170	133
9+00.00 EX	Excavation	11	22
	Fill	227	184

574.2'	575.5'	BASE: W. NO DATA	E.

574.7'			END AREA (SQ FT)	VOLUME (CYD)	579.1'
		Excavation Fill	21 236	15 214	
	9+50.00 EX	Excavation Fill	18 233	18 217	

		END AREA (SQ FT)	VOLUME (CYD)
9+75.00 EX	Excavation	30	22
	Fill	188	195
10+00.00 EX	Excavation	20	23
	Fill	191	175

575.0'			END AREA (SQ FT)	VOLUME (CYD)	579.4
	10+25.00 EX	Excavation Fill	24 200	20 181	
	10+50.00 EX	Excavation Fill	44 166	31 169	

5.2				
			END AREA	VOLUME
			(SQ FT)	(CYD)
10+75.	00 EX	Excavation	10	20
		Fill	214	176
11+00.	00 EX	_	21	10
		Excavation Fill	182	19 183

	G R A N D Material Name	SUM	MARY Unadjusted Volumes (cu.yd.)	TOTAL Adjusted Volumes (cu.yd.)	S Mult Factor
EX	E	cavation Fill	753 3319	753 3319	1.00 1.00