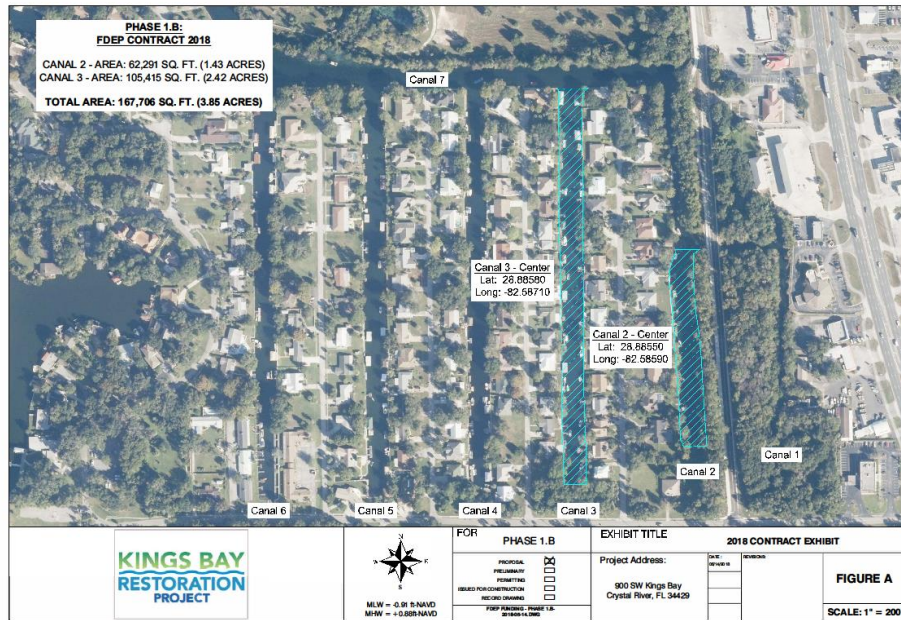


BENTHIC ASSESSMENT OF CANALS 2S, 3, and 6 PHASE 1 B/C IN KING'S BAY REPORT

February 18, 2019

prepared for:

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SCOPE OF WORK:

The purpose of this study is to document the conditions of the benthos prior to the habitat restoration in Canals 3 and 6 and after the de-mucking and restoration of Canal 2 South. This report presents the results of the first round of core samples from all three canals and post-restoration core sampling results from Canal 2 (south) and Canal 3. The post-restoration core sampling of Canal 2 was conducted on October 16 and Canal 3 on December 6, 2018. The core sampling of Canal 6 was postponed until restoration activities can be completed by Gator Dredging/Sea and Shoreline LLC following manatee season in April 2019.

METHODS:

On August 13, 2018 Johnson Engineering's senior aquatic ecologist and an environmental specialist collected core samples from Canals 3 and 6 in the King's Bay Restoration area prior to de-mucking (flocculent and *Lyngbya* removal) operations by Gator Dredging to obtain a baseline of five benthic samples from each canal from the terminus on the South to the confluence with Canal 7 on the North. Recognizing the time constraints for obtaining this data, Johnson Engineering proceeded to collect core samples from Canals in August 2018, prior to final approval of the pending agreement(s) with Save Crystal River. Canal 2 was also to be sampled but de-mucking activities had already commenced and post-restoration core samples would be collected at the appropriate time at a later date. On October 16, 2018, restoration activities were completed on Canal 2 South and post-restoration core samples were collected and analyzed at that time. Water depth and GPS location was recorded at each sampling site. Core samples from the benthos were collected using a customized vacuum core sampler developed by Florida Gulf Coast University for limnological studies and characterizing sediment types. The core sampler consists of a 3.1 meter-long section of 3.8 cm diameter schedule 40 PVC pipe, with a one-way ball valve, rubber coupler, and 7.6 diameter x 0.75 meter clear Plexiglas™ cylinder at the base for collecting and viewing benthic samples (Figure 1). Post-restoration core samples were collected from Canal 3 on December 6, 2018 from the same five locations using GPS coordinates recorded during the pre-restoration sampling event. Photographs of core samples collected in December 2018 are included in the Appendix.



Figure 1. Core sampling device ready to be deployed pre-restoration in Canal 3, August 13, 2018.

RESULTS:

For purposes of this study we define “Floc” is as the unconsolidated organic material floating above the surface of the benthos that is unsuitable substrate for *Vallisneria* growth and root establishment. This layer of floc was first identified inside the clear plastic cylinder by gently agitating the cylinder back and forth to see what organic material is loosely aggregated and mostly liquid. To measure the depth of the floc layer and lower layers of sediment, a plunger was used to slowly extract the floc and sediment and each layer was measured with a meter stick. Preliminary The floc layer often contained live and dead *Lyngbya* which was to be removed by the contractor, Gator Dredging prior to planting and enclosure cage installation by Sea and Shoreline LLC. Results from core samples from Canal 2 South (post-restoration) are presented in Table 1. The post-restoration core samples were collected from water depths of 1.8 to 4.9 meters (average depth of 3.4 meters). Floc layers ranged from <0.01 to 0.8 cm with an average of 0.6 cm. Lower sediment layers consisted mostly of mixed mud, sand and shell with occasional gravel and limestone deposits. Sediment quality overall appeared to be well suited for

establishment of *Vallisneria americana* but water depths and light attenuation may become a limiting factor for growth in some deeper pockets of Canal 2. Photographs of the core samples collected from Canal 2 South are included in the Appendix.

Table 1. Canal 2 South: Post Restoration Results of Core Samples collected on October 16, 2018						
King's Bay Core Sample Locations			Core Sample Constituents in cm (top to bottom).			
Site	Latitude	Longitude	Water Depth (m)	Floc (cm)	Mud/Sand/Shell	Overall (cm)
C2S-1	28.884504	-82.585862	4.9	< 0.01	19.0	19.0
C2S-2	28.884772	-82.585887	3.7	0.8	9.7	10.5
C2S-3	28.885261	-82.585913	4.1	<0.01	18.0	18.0
C2S-4	28.885717	-82.585976	2.4	0.3	18.7	19.0
C2S-5	28.886195	-82.585970	1.8	0.8	11.7	12.5
		Mean Value =	3.4	0.6	15.4	15.8

Core samples from Canal 3 were collected prior to floc/*Lyngbya* removal and planting of *Vallisneria americana*. Water depths ranged from 1.6 to 3.1 meters with an average depth of 2.5 meters (Table 2). The floc (and *Lyngbya*) layer in Canal 3 ranged from 1.0 cm to 11.5 cm in depth with the largest deposits toward the southern dead end at site C3-1. Average floc depth was 5.2 cm with deep deposits of mud/sand, shell layers and deposits of clay in some locations. It will be imperative to remove the deep floc deposits from Canal 3 to reach suitable sediments for *Vallisneria* growth and establishment. The post-restoration core sampling identified Floc/*Lyngbya* layer ranged from 0.1 cm to 0.8 cm with an average of 0.3 cm. This indicates that demucking resulted in a 94.3% removal of the floc/*Lyngbya* layer (Table 2). Sediment profiles collected post-restoration on December 6, 2018 indicate that the sediments consisted of consolidated mud and sand with scattered shell and clay layers, and suitable for growth and establishment of *Vallisneria* and other species of SAV.

King's Bay Core Sample (Approximate) Locations				Core Sample Constituents in cm (top to bottom)					
Site	Latitude	Longitude	Water Depth (m)	Pre-restoration Profile (cm)					Overall (cm)
				Floc	Shell	Mud/Sand	Clay		
C3-1	28.5305	-82.3522	2.5	11.5		10.5	10.0		32.0
C3-2	28.5307	-82.3523	2.5	7.0		21.0			28.0
C3-3	28.5309	-82.3523	3.0	1.0	7.5	24.0	14.5		47.0
C3-4	28.5315	-82.3523	3.1	3.0		19.0			22.0
C3-5	28.5325	-82.3523	1.6	3.5		28.5			33.0
		Mean Value =	2.5 (m)	5.2		20.6			32.4
				Post-restoration Profile (cm)					
Site	Latitude	Longitude	Water Depth (m)	Floc	Shell	Mud/Sand	Clay		Overall (cm)
C3-1	28.5305	-82.3522	2.5	0.1	2.5	12.5	11.6		26.7
C3-2	28.5307	-82.3523	2.5	0.1		10.2	2.5		12.8
C3-3	28.5309	-82.3523	3.0	0.3		11.5			11.8
C3-4	28.5315	-82.3523	3.1	0.8		23.0	1.2		25.0
C3-5	28.5325	-82.3523	1.6	0.3		15.2			15.5
		Mean Value =	2.5 (m)	0.3		14.5			18.3
				Floc removal of 94.3%					

Samples collected from center of canal at equal distances from terminus to mouth. Post-restoration samples were collected from the approximate same locations.

The results of baseline core samples collected from Canal 6 are summarized in Table 3. Water depths ranged from 1.1 to 2.7 meters with an average depth of just 1.96 meters. Floc layers ranged from 0.5 cm to 6.0 cm with an average of 2.3 cm. The underlying sediments consisted mostly of deep mud and muddy sand with shell fragments from snails. Canal 6 was inspected on December 6, 2018 and preliminary core sampling indicated no discernable difference from the October sampling event. Canal 6 will be core sampled at the same five locations with results presented in a letter report to Save Crystal River when restoration activities are completed following the manatee season in 2019.

King's Bay Core Sample Locations			Core Sample Composition in cm (top to bottom)			
Site	Latitude	Longitude	Water Depth (m)	Floc (cm)	Mud/Sand/Shell	Overall (cm)
C6-1	28.883928	-82.590384	2.1	0.8	26.2	27.0
C6-2	28.885563	-82.589967	1.1	0.5	25.0	25.5
C6-3	28.886058	-82.590520	1.5	1.0	27.0	28.0
C6-4	28.886517	-82.590425	2.4	3.0	39.0	42.0
C6-5	28.887494	-82.590424	2.7	6.0	20.0	26.0
		Mean Value =	1.96	2.3	27.4	29.7

CONCLUSION:

Post-restoration core samples collected from Canals 2S indicate that only 0.6 cm of floc and *Lyngbya* remain post-restoration and sediments are suitable for SAV establishment. Canal 2 South has very little floc remaining post restoration but water depths, light attenuation, and sedimentation rates may become limiting factors in deeper holes in the Canal.

Core samples collected on December 6, 2018 from Canal 3 had an average of 0.3 cm of floc/*Lyngbya*, representing a 94.3% average removal efficiency from the pre-restoration condition of 5.2 cm of floc/*Lyngbya*. Consolidated mud/sand dominate the sediment profiles with scattered pockets of shell and clay layers. Sediments are suitable for the establishment of *Vallisneria* and other species of SAV.

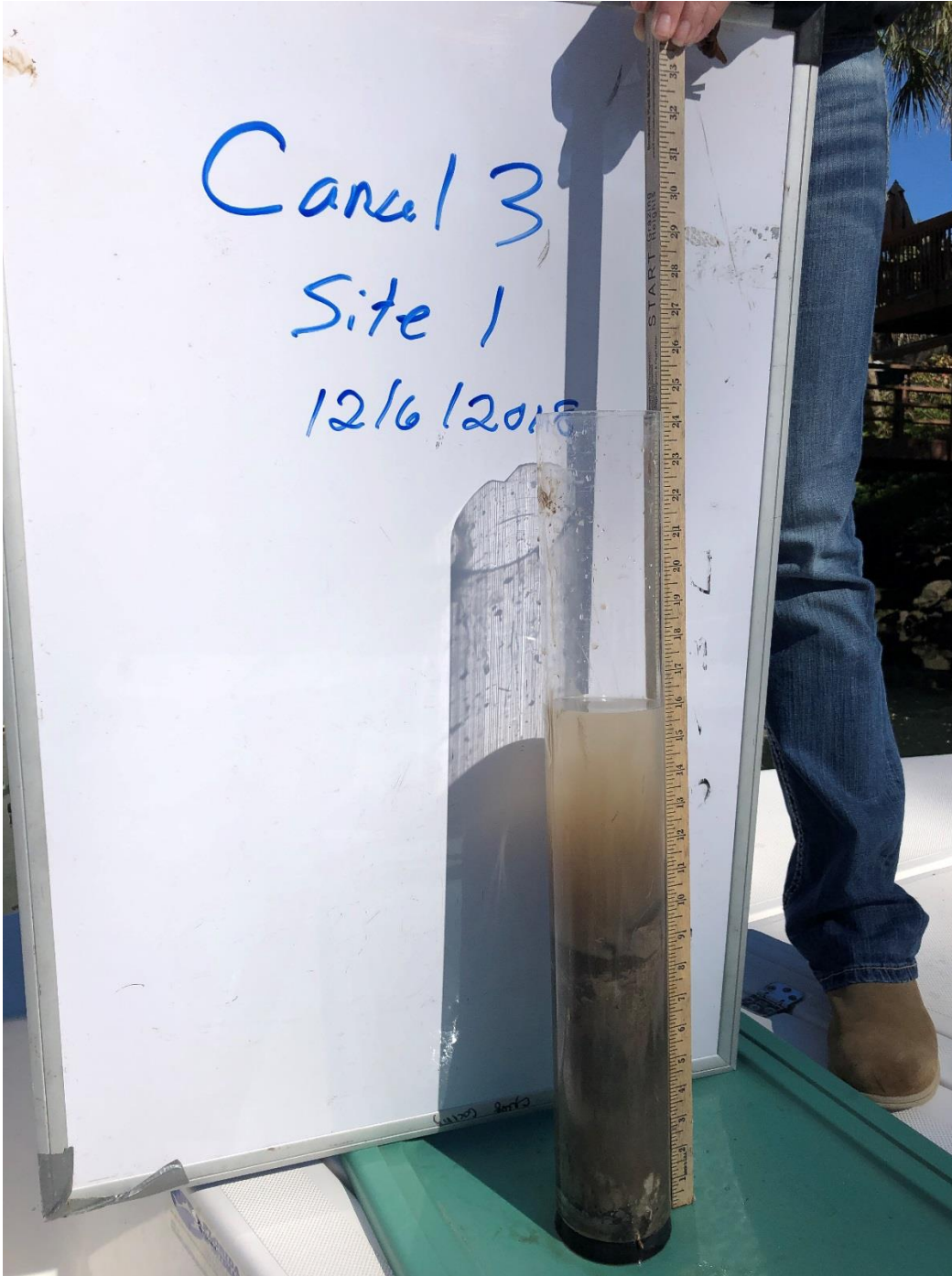
Core sampling of Canal 6 was halted after being informed that the restoration process was incomplete and will be restarted following manatee season in April 2019. Sediments in Canal 6 consisted mainly of mud/sand/shell, averaging 27.4 cm deep with a top layer of floc/*Lyngbya* ranging from 0.5 to 6.0 cm deep.

The customized core sampler with clear Plexiglas™ cylinder proved to be an effective sampling tool for sampling and identifying soft sediment profiles in each of the three canals surveyed in this project study area. Sediment profiles can be extracted and examined in the field for rapid assessment of benthic habitat conditions pre and post-restoration. This core sampler is not suitable for hard bottom sampling or in areas with gravel, large shell fragments, oysters or dense woody debris.

APPENDIX A
Core Sample Photographs

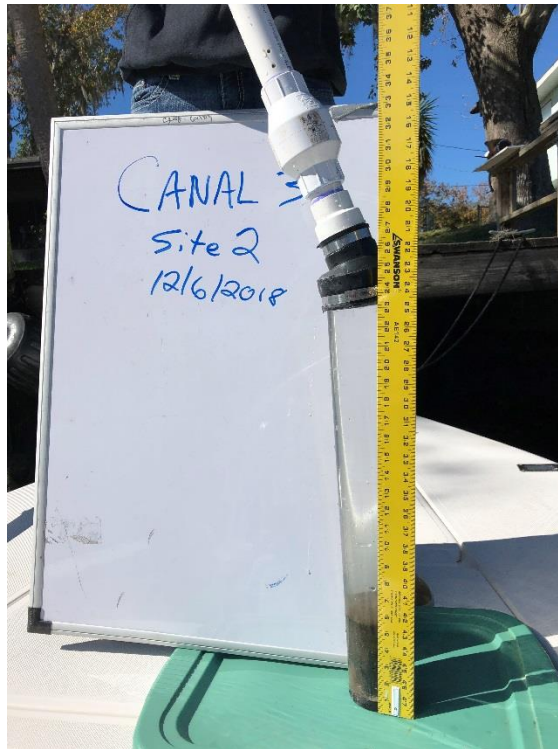


Johnson Engineering ecologist deploying customized core sampler in Canal near Three Sisters Spring, Kings Bay, Citrus County Florida.



Canal 3; Core Sample 1 near southern terminus of canal with 12.5 cm of mud/sand mix, 11.6 cm clay, 2.5 cm shell layer and 0.1 cm flocculent material (floc/*Lyngbya*).

Note that yardstick is in inches and values were converted to metric for reporting



Canal 3; Core Sample 2 with 10.2 cm mud/sand, 2.5 cm clay, and ≤ 0.1 cm floc.

Note that yardstick is in inches and values were converted to metric for reporting



Canal 3; Core Sample 3 with 11.5 cm mud/sand mix with 0.3 cm floc.

Note that yardstick is in inches and values were converted to metric for reporting



Canal 3; Core Sample 4 with 23.0 cm of mud/sand, 1.2 cm clay, and 0.8 cm floc.

Note that yardstick is in inches and values were converted to metric for reporting



Canal 3; Core Sample 5 with 15.2 cm mud/sand mix and 0.3 cm flocculent material.

Note that yardstick is in inches and values were converted to metric for reporting