

Memorandum

November 13, 2019

To: Joyce Mercuri, Washington State Department of Ecology
From: Eli Patmont, John Laplante, Greg Brunkhorst, and Clay Patmont, Anchor QEA, LLC
cc: Jerry Enslow and Dave McEntee, Simpson Timber Company

Re: Shelton Harbor Interim Action: Season 2 Water Quality and Cap Thickness Monitoring

This memorandum summarizes water quality and cap thickness monitoring completed as part of Season 2 sediment cleanup interim actions in the Shelton Harbor Sediment Cleanup Unit (SCU). Season 2 included capping sediment management area (SMA)-3 (Figure 1; southwest harbor) and completing capping in the remaining portion of SMA-1 Cap B (Figure 2; northern harbor), left uncapped in Season 1 to facilitate SMA-3 construction. Season 1 monitoring results are summarized in a memorandum: "Northern Shelton Harbor Interim Action: Water Quality Monitoring and Cap Construction Status" (Anchor QEA 2019a). Season 2 work concludes the interim action.

All in-water construction activities during Season 2 were performed during the period from July 15, 2019 to September 12, 2019. Water quality and cap thickness verification monitoring were conducted consistent with the *Water Quality Monitoring Plan (WQMP)* and the *Construction Quality Assurance Plan (CQAP)*, respectively, approved by the Washington State Department of Ecology (Ecology), and included as appendices to the September 2018 *Shelton Harbor Interim Action Basis of Design Report (BODR)* (Anchor QEA 2018). An addendum to the BODR, BODR Addendum No. 1 (Anchor QEA 2019b; BODR Addendum), was submitted to Ecology in early May 2019 summarizing the engineering design for SMA-3, as well as SMA-3 water quality monitoring locations; Ecology approved the BODR Addendum on May 22, 2019.

All Season 2 construction activities were performed in accordance with the BODR (Anchor QEA 2018), CQAP (Appendix D of the BODR), and technical specifications. Water quality monitoring was performed during the in-water construction period (Table 1); there were no measurements that exceeded the turbidity standard, as described in the WQMP (Appendix E of the BODR).

Post-placement cap thickness was measured using complementary lines of evidence:

- Electronic tracking (bucket maps) combined with total quantity calculations to calculate average material thickness and coverage across the placement area
- Comparison of bathymetric surveys before and after material placement
- Cap thickness probing

Taken together, the three lines of evidence confirmed that minimum cap thicknesses set forth in the BODR Addendum (Anchor QEA 2019b) and CQAP (Appendix D of the BODR; Anchor QEA 2018) were

successfully achieved in SMA-3 and the SMA 1 Cap B Season 2 area. Confirmation that the rest of SMA-1 Cap B (i.e., the area capped in Season 1) achieved cap thickness was documented in “Northern Shelton Harbor Interim Action: Water Quality Monitoring and Cap Construction Status” (Anchor QEA 2019a).

Water Quality Monitoring

In accordance with the WQMP (Appendix E of the BODR; Anchor QEA 2018), water quality monitoring was performed along transects radiating from in-water construction operations. Monitoring stations were selected based on the tide, current, and visual observations of turbidity. Each monitoring event consisted of measuring turbidity at background, early warning, and compliance stations at designated depths below the water surface. The schedule of water quality monitoring during in-water work periods was as follows:

- **Intensive:** Turbidity measurements were collected twice daily for 4 days at the start of in-water capping. Because no confirmed exceedances were measured during the intensive monitoring period, the schedule shifted to routine monitoring.
- **Routine:** Turbidity measurements were collected twice daily for 1 day per week during in-water work.

During Season 2, water quality monitoring was conducted during 8 days of in-water construction, with four intensive monitoring events and four routine monitoring events (Table 1). The construction schedule included frequent nighttime work, because shallow water restricted construction access and higher tides occurred primarily at night. For safety reasons, consistent with the WQMP (Appendix E of the BODR; Anchor QEA 2018), water quality monitoring was only performed in the daylight and was not performed on days that construction was performed entirely in the dark. For this reason, there were some required deviations in the monitoring schedule (e.g., the 4 days of intensive monitoring were performed in two 2-day segments, and 2 days of monitoring were canceled due to unsafe work conditions during routine monitoring). Ecology was notified of all water quality monitoring schedule modifications during construction.

As noted above, no exceedances of the water quality standard were measured during Season 2 water quality monitoring.

Cap Placement Verification

As discussed in the BODR (Anchor QEA 2018) and BODR Addendum (Anchor QEA 2019b), a minimum cap design thickness of 1.5 feet (18 inches) accounts for the following:

- A 6-inch thickness to provide chemical isolation and filtering
- An overlying 12-inch thickness to provide armoring

The project specifications also provide an additional 6 inches to account for the potential for mobilization and winnowing of finer grained cap material, and another 6 inches to account for equipment accuracy, resulting in a minimum post-construction thickness of 2.0 feet and a maximum placed thickness of 2.5 feet. In addition, caps in SMAs-1 and -2 included thickened edges (post-construction placed cap thickness of 3.0 to 3.5 feet) to help protect edge areas that may be subject to greater erosive forces.

Season 2 cap construction was initiated on July 19, 2019, and was completed on September 9, 2019. As discussed above, the cap placement thickness was evaluated based on complementary lines of evidence including electronic tracking (bucket maps) combined with volume estimates, hydrographic survey comparisons, and probing measurements.

Contractor bucket maps demonstrated complete coverage throughout the capping areas (Figures 3 through 5). The average thickness in the capping areas was estimated by dividing the volume placed by the placement area. The total volume of material placed was estimated based on bucket map counts and a calibrated bucket volume of 3.5 cubic yards (5.9 tons). Note that material delivery tickets to the upland transload facility were approximately 14% higher than the calibrated bucket volume, so the bucket volume is considered a minimum estimate. The placement surface area was calculated based on the area covered by the bucket maps. From this method, SMA-3 had an average placement thickness of 2.3 feet, above the minimum post-construction thickness of 2.0 feet (Table 2). SMA-1 Cap B had an average placement thickness of 2.6 feet, above the minimum cap placed thickness of 2.3 feet in the area (SMA-1 Cap B had a thicker average cap than SMA-3 because of thickened edge features in the area).

The comparison of pre- and post-construction bathymetric survey data is shown in Figures 1 and 2 within Season 2 placement areas covered by both surveys. As observed in Season 1, due to soft native sediments, significant settlement occurred in the subgrade as a result of cap material placement, resulting in an average apparent thickness from bathymetric surveys that was less than the actual placed thickness. Based on the cap thickness monitoring lines of evidence, the subgrade settled 0.4 to 0.5 foot on average, consistent with BODR estimates (Anchor QEA 2018).

As set forth in the BODR (Anchor QEA 2018) and CQAP (Appendix D of the BODR), the minimum cap design thickness of 1.5 feet must be achieved across at least 95% of the cap surface area. This performance criterion was assessed based on direct cap thickness probing measurements, which account for subgrade settlement below the cap. Because probe refusal was encountered at some cap locations, probing measurements were supplemented with pre- versus post-construction bathymetric survey data. As depicted in Figures 1 and 2, the combined probing data and bathymetric surveys verified that at least 2.0 feet of cap material was successfully placed across more than 95% of the cap areas, exceeding the minimum cap design thickness of 1.5 feet.

Interim Action Summary

Following Season 2 construction, the Shelton Harbor Interim Action is complete. Table 3 provides a summary of the project during the two seasons of construction.

A draft Interim Action Operations, Maintenance, and Monitoring Plan for the SMA-1, -2, and -3 caps will be submitted to Ecology in February 2020.

References

Anchor QEA (Anchor QEA, LLC), 2018. *Shelton Harbor Interim Action Basis of Design Report*. Oakland Bay and Shelton Harbor Sediments Cleanup Site. Prepared for Washington State Department of Ecology. September 2018.

Anchor QEA, 2019a. "Northern Shelton Harbor Interim Action: Water Quality Monitoring and Cap Construction Status." Oakland Bay and Shelton Harbor Sediments Cleanup Site. Prepared for Washington State Department of Ecology. March 2019.

Anchor QEA, 2019b. *Shelton Harbor Interim Action Basis of Design Report Addendum No. 1*. Oakland Bay and Shelton Harbor Sediments Cleanup Site. Prepared for Washington State Department of Ecology. May 2019.

Tables

Table 1
Water Quality Monitoring Summary – Season 2

Date	Activity	Monitoring Round	Station	Time	Water Depth (feet)	Actual Distance from Active Work (feet)	Coordinates (Degree decimal minutes)		Turbidity Reading (NTU)			Turbidity Elevation at EW	Turbidity Exceedance at CS	Confirmed Exceedance at CS	Elevation/ Exceedance Discussed with Client and Contractor	Notes	Response Actions Taken and Best Management Practices Applied
							Latitude	Longitude	Surface	Mid-depth	Bottom						
7/19/2019	Material Placement	1	BG-1	19:50	19	1170	47.207549	-123.089113	2.0	2.9	4.1	--	--	--	--	Unable to collect second Early Warning reading because of low light conditions (sunset).	NA
			500EW-1	20:25	20	491	47.207606	-123.091833	2.6	2.6	5.8	No	No	No	No		
			900C-1	20:10	20	893	47.207394	-123.090277	2.9	3.4	4.1	No	No	No	No		
		2	BG-2	20:48	22	1420	47.207360	-123.088192	1.8	2.6	4.9	--	--	--	--		
			500EW-2	--	--	--	--	--	--	--	--	--	--	--	--		
900C-2	21:03	21	902	47.207752	-123.090145	2.1	2.2		No	No	No	No					
7/20/2019	Material Placement	1	BG-1	19:58	17	1221	47.207837	-123.088929	1.3	2.7	4.1	--	--	--	--	Water quality monitoring ended because of low light conditions (sunset).	NA
			500EW-1	20:35	18	494	47.207907	-123.091908	2.7	2.4	3.7	No	No	No	No		
			900C-1	20:20	17	895	47.207953	-123.090236	1.2	4.4	2.3	No	No	No	No		
		2	BG-2	20:42	20	1187	47.207360	-123.088192	1.5	2.0	4.0	--	--	--	--		
			500EW-2	20:50	21	505	47.207564	-123.091832	2.1	2.0	6.1	No	No	No	No		
900C-2	20:58	18	897	47.207528	-123.090237	1.6	2.2	7.5	No	No	No	No					
7/29/2019	Material Placement	1	BG-1	17:37	16	1301	47.207507	-123.087913	3.2	3.5	4.6	--	--	--	--	NA	NA
			500EW-1	16:08	21	504	47.207664	-123.091112	2.9	5.4	8.7	No	No	No	No		
			900C-1	17:50	20	904	47.207698	-123.089516	3.7	3.8	6.0	No	No	No	No		
		2	BG-2	19:47	16	1246	47.207592	-123.087986	4.4	6.0	6.0	--	--	--	--		
			500EW-2	19:57	18	506	47.207922	-123.090961	4.8	4.0	5.9	No	No	No	No		
900C-2	20:20	16	908	47.207791	-123.089320	4.3	4.6	3.2	No	No	No	No					
7/30/2019	Material Placement	1	BG-1	18:23	16	1250	47.207349	-123.087679	4.6	4.6	16.8	--	--	--	--	NA	NA
			500EW-1	18:34	21	499	47.207367	-123.090664	3.8	5.7	5.8	No	No	No	No		
			900C-1	18:40	22	897	47.207412	-123.089379	4.4	4.2	5.7	No	No	No	No		
		2	BG-2	19:17	20	1217	47.207275	-123.087917	3.7	3.7	6.9	--	--	--	--		
			500EW-2	19:39	20	503	47.207164	-123.090260	4.3	4.2	9.0	No	No	No	No		
900C-2	19:45	23	896	47.207326	-123.089493	4.5	7.3	6.2	No	No	No	No					
8/12/2019	Material Placement	1	BG-1	17:45	17	1250	47.207500	-123.087700	4.3	4.0	3.9	--	--	--	--	NA	NA
			500EW-1	18:08	22	500	47.207317	-123.090112	3.8	4.1	5.4	No	No	No	No		
			900C-1	17:55	25	895	47.207372	-123.088482	3.6	3.7	4.0	No	No	No	No		
		2	BG-2	19:47	18	1159	47.207435	-123.087350	2.9	2.5	3.6	--	--	--	--		
			500EW-2	20:16	19	498	47.207129	-123.089953	5.2	6.2	9.1	No	No	No	No		
900C-2	19:59	21	895	47.207366	-123.088358	3.0	4.4	3.2	No	No	No	No					
8/19/2019	Material Placement	1	BG-1	19:12	17	1262	47.207748	-123.088880	1.7	1.8	3.4	--	--	--	--	NA	NA
			500EW-1	19:42	20	500	47.207418	-123.089712	1.5	2.0	6.0	No	No	No	No		
			900C-1	19:29	17	903	47.207473	-123.088178	1.7	1.5	3.4	No	No	No	No		
		2	BG-2	19:51	15	1152	47.207184	-123.087161	1.0	1.5	3.6	--	--	--	--		
			500EW-2	20:06	20	502	47.207393	-123.089701	1.4	4.6	6.5	No	No	No	No		
900C-2	19:57	16	902	47.207308	-123.088117	1.6	1.5	3.6	No	No	No	No					

Table 1
Water Quality Monitoring Summary – Season 2

Date	Activity	Monitoring Round	Station	Time	Water Depth (feet)	Actual Distance from Active Work (feet)	Coordinates (Degree decimal minutes)		Turbidity Reading (NTU)			Turbidity Elevation at EW	Turbidity Exceedance at CS	Confirmed Exceedance at CS	Elevation/ Exceedance Discussed with Client and Contractor	Notes	Response Actions Taken and Best Management Practices Applied
							Latitude	Longitude	Surface	Mid-depth	Bottom						
8/27/2019	Material Placement	1	BG-1	15:18	23	1144	47.213170	-123.084724	3.1	3.0	9.2	--	--	--	NA	NA	
			500EW-1	16:05	12	501	47.212480	-123.086994	2.5	4.2	5.6	No	No	No			
			900C-1	15:54	14	896	47.212528	-123.085412	2.1	2.8	3.4	No	No	No			
		2	BG-2	18:11	25	1134	47.213092	-123.084655	2.1	1.5	1.8	--	--	--			
			500EW-2	18:28	13	500	47.212647	-123.087031	5.7	3.5	3.9	No	No	No			
			900C-2	18:22	16	897	47.212846	-123.085475	2.7	1.9	2.4	No	No	No			
9/9/2019	Material Placement	1	BG-1	16:06	30	1170	47.213359	-123.084748	0.8	0.7	1.9	--	--	--	The first background reading was performed prior to a storm squall. The early warning and compliance measurements were compared to the second background reading (all measured following the storm squall). The EW station turbidity reading was elevated.	Contractor informed Anchor QEA they believe they are done placing material. Anchor QEA asked contractor to reduce placement rate should they need to return and place additional material.	
			500EW-1	18:13	12	506	47.213255	-123.087531	21.8	4.2	3.0	Yes	No	No			
			900C-1	17:37	24	896	47.213523	-123.085897	11.2	0.8	4.7	No	No	No			
		2	BG-2	17:56	29	1169	47.213368	-123.084746	7.1	0.6	5.8	--	--	--			
			BG-3	18:33	28	1343	47.213254	-123.084174	5.5	0.9	3.7	--	--	--			
			500EW-2	18:55	11	501	47.213194	-123.087577	10.0	3.7	4.2	No	No	No			
900C-2	18:43	19	891	47.213571	-123.086006	11.7	6.7	7.2	No	No	No						

Notes:
 Acceptable turbidity measurements
 -- : No applicable comparison
 BMP: best management practice
 CS: Compliance Station
 EW: Early Warning Station
 FL: Field Lead
 NA: not applicable
 NTU: nephelometric turbidity unit

Table 2
Cap Placement Thickness Calculation

Item	Unit of Measurement	SMA-3	SMA-1 Area B (Season 1 and Season 2)
Design Criteria			
Placement Volume ¹	cy	14,366	14,074
Volume Completed During Season 1	cy		11,424
Cap Area (including side-slopes)	sy	21,548	18,374
Minimum Placed Thickness	ft	2.0	2.3
Construction Quantities			
Construction Time	days	29	34
Average Mass Per Bucket Load	tons/bucket	5.9	5.9
Bucket Volume	cy/bucket	3.5	3.5
Bulk Density	tons/cy	1.68	1.68
Total Buckets	ea	4,897	4,388
Total Tonnage Placed	tons	28,843	25,845
Total Volume Placed	cy	17,140	15,358
Daily Production Rate	cy/day	591	452
	tons/day	995	761
Construction Calculations			
Area Covered in Bucket Maps ²	sf	197,531	164,626
	sy	21,948	18,292
Average Placed Thickness	ft	2.3	2.5

Notes:

1. Volume to achieve a 2-foot minimum thickness for cap area plus a 3-foot minimum thickness for thickened edges on SMA-1.

2. See Figures 3 through 5.

cy: cubic yards

ea: each

ft: feet

sf: square feet

SMA: sediment management area

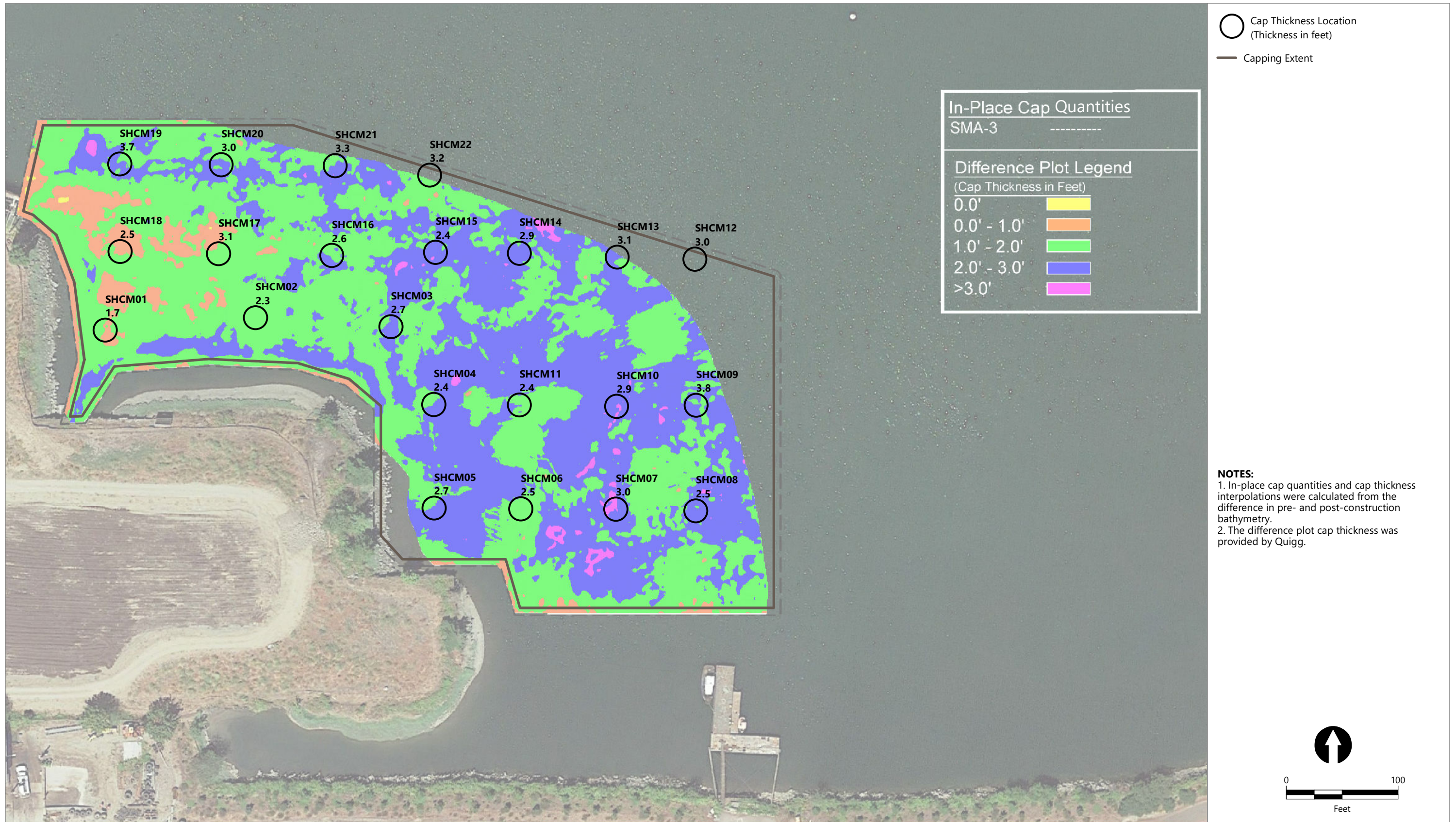
sy: square yards

Table 3
Shelton Harbor Interim Action Project Summary

	Unit of Measurement	Season 1 SMA-1 Cap A	Season 1 SMA-1 Cap B (89% Complete)	Season 1 SMA-1 Cap C	Season 1 SMA-2 Cap D	Season 2 SMA-3	Season 2 SMA-1 Cap B (Final 11%)	Totals
Design Criteria								
Cap Area (excluding side slopes)	sy	19,568	11,935	582	1,191	20,146	4,417	57,840
	ac	4.04	2.47	0.12	0.25	4.16	0.91	12
Cap Area (including side slopes)	sy	20,954	13,411	1,278	2,163	21,548	4,963	64,317
	ac	4.33	2.77	0.26	0.45	4.45	1.03	13
Estimated Volume Placed (based on bucket counts)	cy	17,931	11,424	1,470	1,838	17,140	3,934	53,736
Estimated Tonnage Placed (based on 1.68 ton/cy)	tons	30,123	19,192	2,470	3,087	28,794	6,609	90,276
Construction Quantities								
Construction Time (in-water work)	days	28	23	3	4	29	11	98
Average Daily Production Rate	cy/day	640	497	490	459	591	358	548
	tons/day	1,076	834	823	772	993	601	921

Notes:
 cy: cubic yards
 ea: each
 ft: feet
 sf: square feet
 SMA: sediment management area
 sy: square yards

Figures



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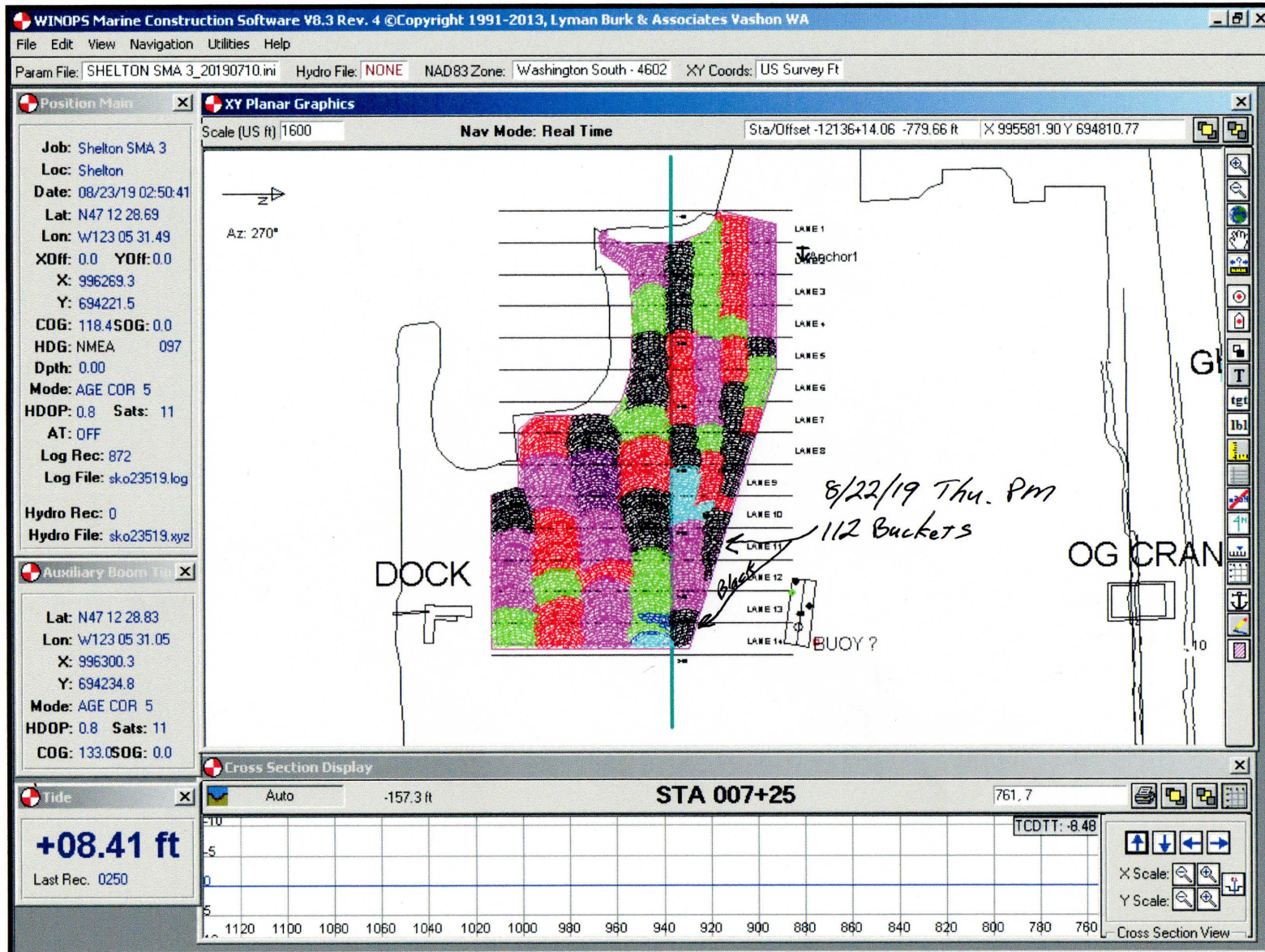
Figure 1
Cap Thickness and Probing Locations – SMA-3
Shelton Harbor Interim Action: Season 2 Water Quality and Cap Thickness Monitoring
Oakland Bay and Shelton Harbor Sediments Cleanup Site



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Figure 2
Cap Thickness and Probing Locations – SMA-1 Cap B
 Shelton Harbor Interim Action: Season 2 Water Quality and Cap Thickness Monitoring
 Oakland Bay and Shelton Harbor Sediments Cleanup Site

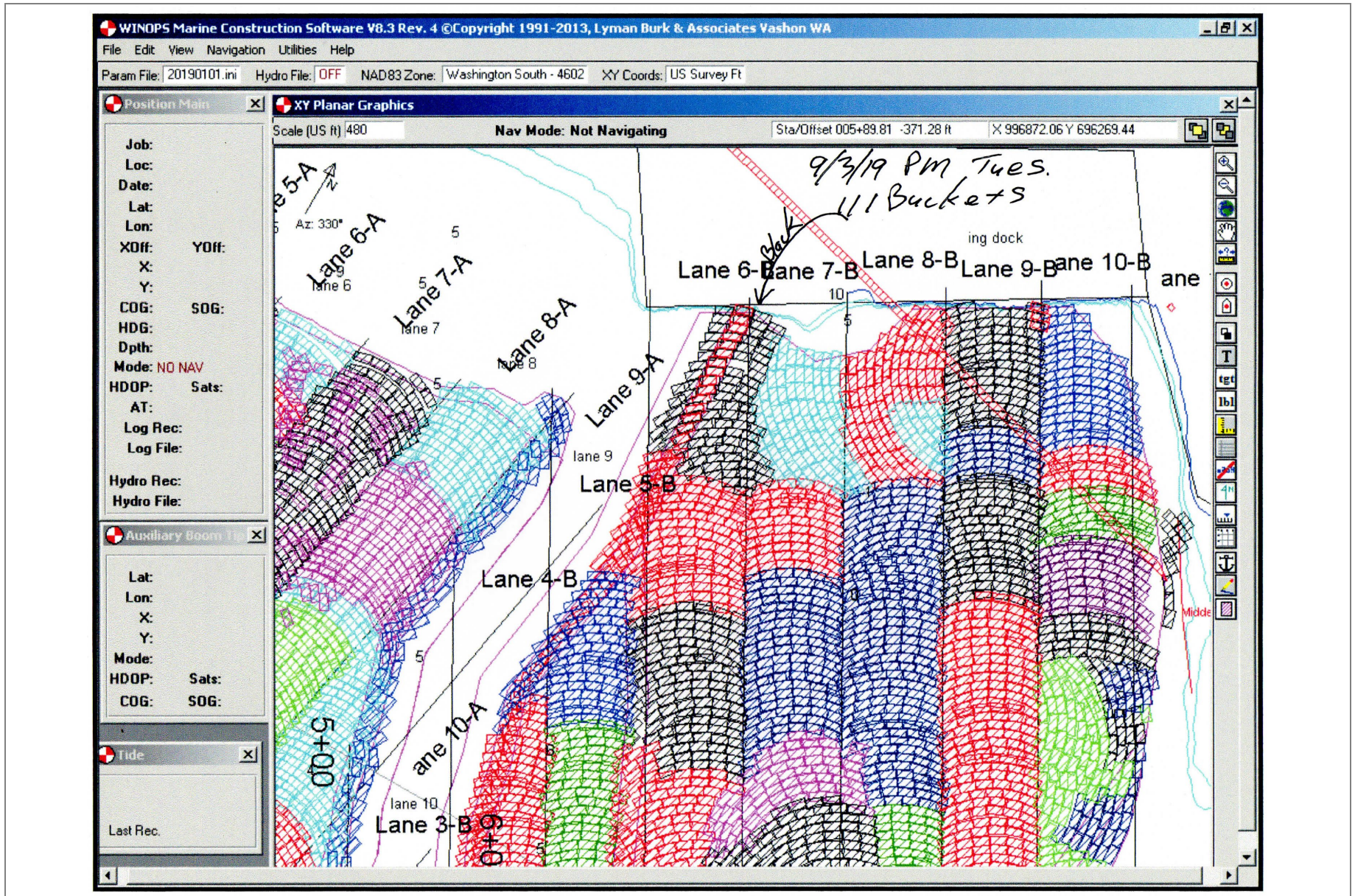


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Figure 3
Contractor Bucket Map – SMA-3

Shelton Harbor Interim Action: Season 2 Water Quality and Cap Thickness Monitoring
 Oakland Bay and Shelton Harbor Sediments Cleanup Site

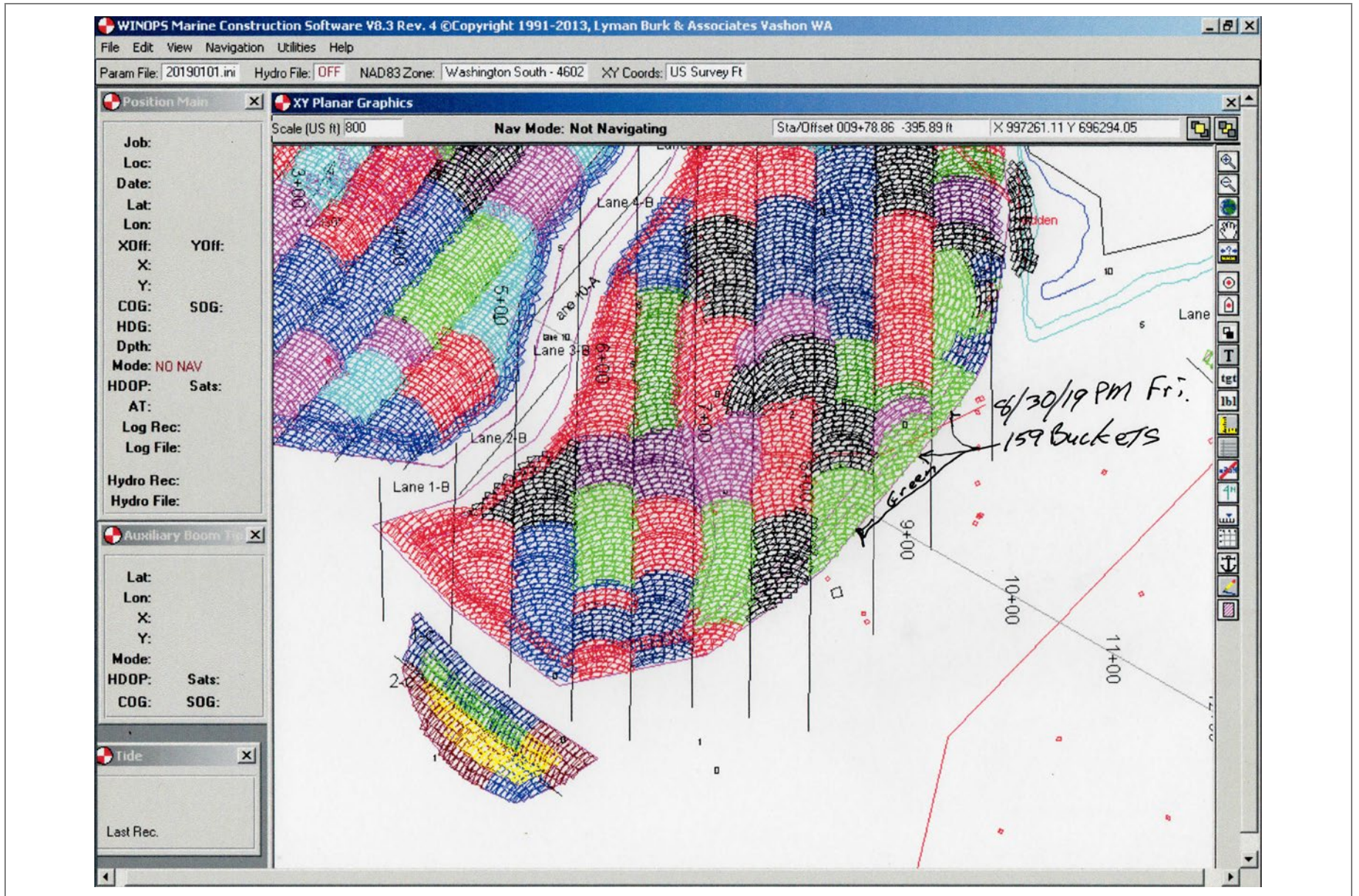


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Figure 4
Contractor Bucket Map – SMA-1 Cap B – North

Shelton Harbor Interim Action: Season 2 Water Quality and Cap Thickness Monitoring
Oakland Bay and Shelton Harbor Sediments Cleanup Site



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Figure 5
Contractor Bucket Map – SMA-1 Cap B – South

Shelton Harbor Interim Action: Season 2 Water Quality and Cap Thickness Monitoring
Oakland Bay and Shelton Harbor Sediments Cleanup Site