Enhanced Sediment Sampling for Lead near the St. Sebastian River Railroad Bridge

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Introduction.

After the possibility of lead contamination due to lead paint flaking from the St. Sebastian River Railroad (SSRR) Bridge was identified [1] and subsequently confirmed by the Florida Department of Environmental Protection (DEP) [2], the DEP sent a warning letter to the Florida East Coast Railroad (FECR) advising them that "a potential non-compliance item was identified" and that a hazardous waste determination was required. FECR hired a consultant (ARCADIS USA, Inc) to prepare [3] and execute [4] a sediment sampling study to quantify lead in river sediments.

Sampling locations and resulting lead concentrations in the ARCADIS sediment study are illustrated in Figure 1. Eight sampling sites were upstream from the SSRR bridge; the closest being 2300 feet upstream. Two stations were downstream in the immediate vicinity of the US 1 bridge, approximately a mile downstream of the SSRR bridge. Four stations were in close vicinity to the SSRR bridge; 2 were under the bridge near the northern end of the bridge, and 2 were in the shallows near the south extent of the bridge at approximately 50 and 100 feet downstream of the bridge.

Seven of the eight upstream samples did not show lead concentration above the laboratory's practical quantification level. The one sample above the practical quantification level showed very low lead concentration (1.2 mg/kg). All samples at and downstream of the SSRR bridge showed quantifiable lead concentrations higher than the highest upstream sample. Highest lead concentration samples (13 mg/kg) were found at the SSRR bridge and at US 1 bridge. None of the samples exceeded the FL DEP Sediment Quality Assessment Guidelines (SQAG), discussed later, of 30 mg/kg dry wgt for Threshold Effect Level, or the higher Probable Effect Level of 112 mg/kg dry wgt. Consequently, the DEP concluded that lead contamination was not a valid concern and the complaint was closed.

A copy of the ARCADIS study plan [3] was received on February 8, 2021, six days after the sampling had been performed, thus there was no opportunity to comment on the plan. Concerns about the plan were sent to the DEP, not knowing the study had already been performed. These concerns relates to the selection of sampling stations (Figure 1). With the exception of 4 sites immediately adjacent to the SSRR bridge all other sites were at least 2000

feet away from the bridge, either upstream or downstream. Areas around the bridge most likely to exhibit high lead contamination were not sampled at all. This was the motivation to conduct a spatially-enhanced sediment sampling scheme, described here, to better delineate lead concentrations in closer proximity to the bridge.

Procedures.

Procedures used and described in the ARCADIS reports [3, 4] were used in this study. This includes sample collection, handling, storage, and analyses techniques. The only significant difference is sampling locations. Our sampling scheme called for collecting sample along 3 transects running roughly perpendicular to the SSRR bridge. One transect (designated N) ran close to the Brevard County side of the river. A second transect (designated M) was roughly mid-channel. The third transect (designated S) ran close to the Indian River County side of the river. Transects were further designated as upstream (U) or downstream (D) of the SSRR bridge. Finally, the approximate intended distance from the bridge, in feet, was added to the location name. Intended locations were 0, 50, 100, 250, 500, and 1000 feet away from the bridge. Samples immediately under the existing RR bridge were designated N_0, M_0, and S_0. Wind and tidal flow conditions made it difficult to exactly match the intended sample coordinates, but the exact location of each sample was recorded with a WAAS-enabled handheld GPS (Garmin Oregon 700) with typical horizontal accuracy of 10 ft.

A Petite Ponar sampler was used. This sampler has a 6-inch x 6-inch sampling area and will typically penetrate at least 3 inches in soft to medium sediments. In the few hard sediment locations encountered several Ponar drops were made to accumulated sufficient sample volume. Station depth was noted by the approximated drop distance of the sampler. Each sample was placed in a plastic dish pan (purchased for the project). Sediment characteristics were determined visually and tactilly. Samples were stirred with a plastic kitchen spoon (purchased for project) and ladled into plastic Zip Lock bags, labeled, and placed in a cooler. Sample volume was at least one cup. After each sample, the sampler, bucket, and ladle were washed in river water, then rinsed in distilled water. All samples were stored in a cooler in the dark and delivered to the lab within 7 days of collection.

Analyses for lead was performed by ENCO Laboratories, Inc., Orlando, FL. , using US EPA method 6010D. All results are expressed in mg/kg dry wgt.

Results and Discussion.

All information on the sampling location and samples is contained in Table 1. Sampling locations are illustrated in Figure 2. The complete report from ENCO Laboratories in contained in the Appendix.

Actual sampling locations (Figure 2) show some deviation from intended distances from the bridge, nonetheless sampling provided a good coverage in close proximity to the SSRR bridge. Samples from deeper stations (5+ ft) were almost entirely unconsolidated black organic muck. Shallower stations under and near the bridge, and the mid-channel stations upstream of the bridge (M_0 to MU_1000) consisted of hard sand and shell fragments. Submersed samples immediately under the bridge (N_0 and S_0) consisted of sand and inorganic debris, which appeared to be from the bridge.

Lead concentrations varied with sediment type. The black muck samples contained the highest lead concentration, averaging 29.5 mg/kg (n = 14, standard deviation {SD} = 11.0). Six of the 14 black muck samples exceeded the SQAG Threshold Effect Level of 30 mg/kg. These 6 samples were located along the S transect close to the Indian River county shoreline. Sand samples without evidence of inorganic debris (apparently from bridge) exhibited extremely low lead concentration, averaging 1.63 mg/kg (n = 12, SD = 0.83). All of these samples were below the Practical Quantification Limit, i.e. effectively undetectable. Sandy samples with inorganic debris averaged lead concentration of 12.6 mg/kg (n = 4, SD = 6.6). Oyster shell collected under the SSRR bridge (by station M_0) exhibited very low in lead concentration, averaging 2.3 mg/kg (n = 2) with only 1 sample above the Practical Quantification Limit. No samples of oyster flesh were collected for analysis.

Sediment lead concentrations found in the present study are markedly different from those reported in FL ECR study performed by ARCADIS. The highest lead concentrations found in the present study were more than 3 times those reported by ARCADIS. No samples reported by ARCADIS were near the Threshold Effect Level while almost a 20% of the samples in the present study exceeded this level. Most of this can be explained by differences in sampling locations and sediment types sampled. ARCADIS had relatively few samples in the immediate proximity of the bridge, and of these samples none were described as unconsolidated black muck, which we found to contain the highest lead concentration.

The distribution of sediment lead concentrations found in this study and the ARCADIS study leaves little doubt that the bridge is the source of the elevated lead levels. This is based on the following:

1. There are no commercial or industrial activities in the Sebastian River within the vicinity of the SSRR bridge or the sampling stations found to contain high lead levels.
2. All upstream samples more than 2,000 ft of the bridge were near or below analytical detection limits. This suggests that upstream agricultural land use (cited by ARCADIS as a source of lead) does not contribute to detectable amounts of lead in sediments.
3. Samples in the near vicinity of the bridge and downstream all contained measureable amounts of lead.
4. Paint from the SSRR bridge is a known source of lead. Paint flakes tested by DEP [2] showed lead leaching from the flakes to exceed safe levels by 30 times. A calculation of paint flaking from the SSRR bridge [1] estimated 15,500 pounds which contained 1,700 pounds of lead using the earlier assay of 11% lead.

The Florida Department of Environmental Protection developed the Sediment Quality Assessment Guidelines (SQAG) [5] for determining the environmental/ecological risk of various concentrations of key pollutants, including lead. Two threshold points were picked for each pollutant. A lower Threshold Effect Level (TEL) and a higher Probable Effect Level (PEL). Concentrations below the TEL were found to rarely exhibit any biological responses. Concentrations above the PEL usually resulted in a biological response. Concentrations between the two levels sometimes exhibited biological responses. These levels are used as a guide to assessing contamination severity and are not used as a hard and fast limit for administrative action or remediation.

However, when FL DEP reviewed the results of the ARCADIS sediment study [4] that showed no samples exceeding the lead TEL of 30 mg/kg, they concluded that the complaint was not valid and was dismissed. Based on the updated information presented here it is apparent that FL DEP drew an incorrect conclusion and the lead contamination complaint needs to be assessed further since potential environmental harm may occur due to the lead levels found in the river and potential for further contamination by flaking lead paint during the removal of the existing railroad bridge.

Figure 1. ARCADIS sampling site map with results.

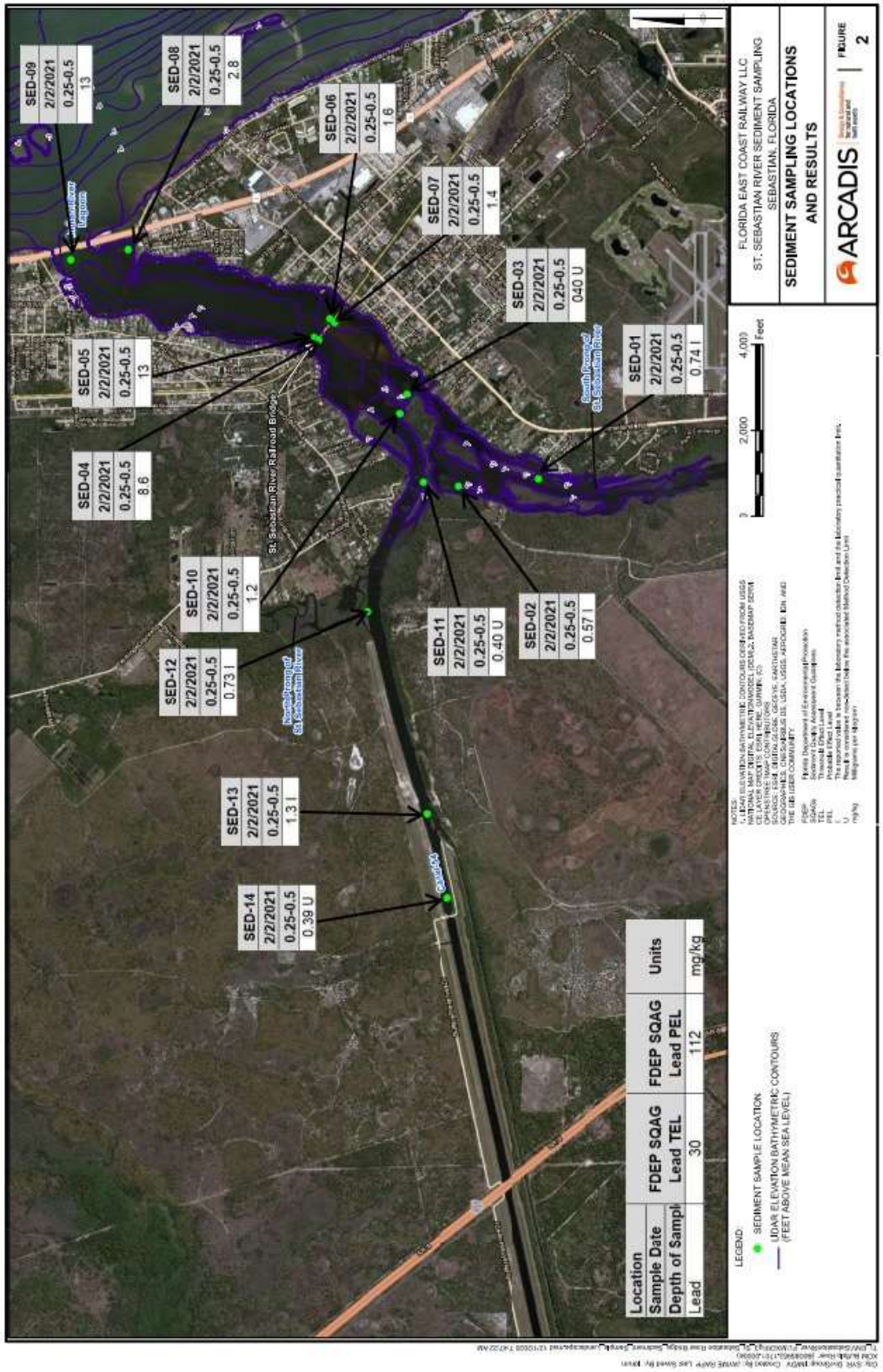

Figure 2. Sediment sampling stations locations.

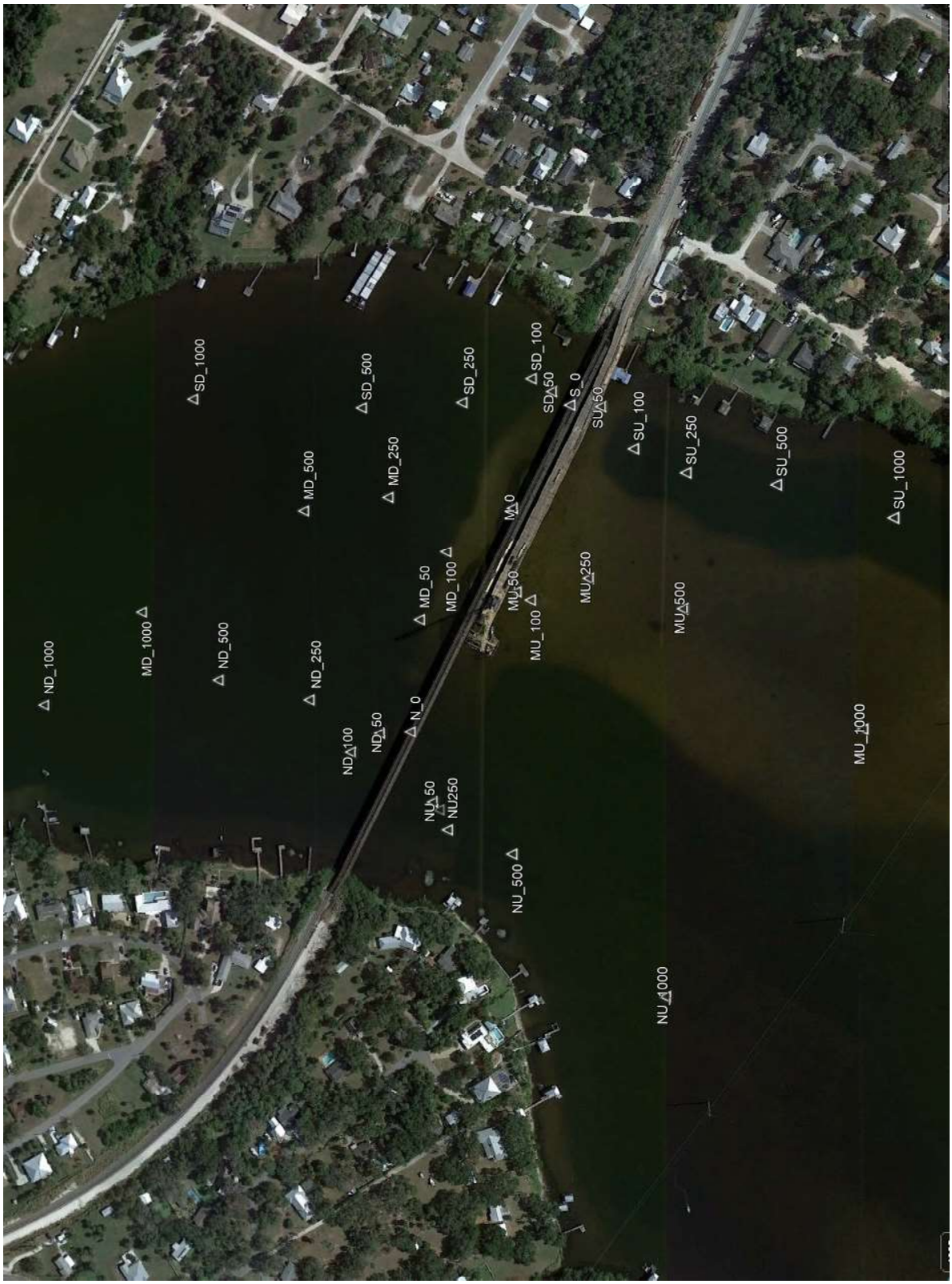

Table 1. Sample location and information

Sample ID	Latitude N[A]		Longitude W[A]		Collected		Approx. Depth (ft)	Sediment description	Lead concen. mg/kg dry wgt	Note
	Deg.	Min.	Deg.	Min.	Date (2021)	Time (EDT)				
SD_1000	27	50.403	80	29.692	07/08	1009	>6	black muck w/ shells	16.7	
SD_500	27	50.331	80	29.716	07/08	1001	6	black muck	**32.5**	
SD_250	27	50.289	80	29.725	07/08	1016	5	black muck	**36.7**	
SD_100	27	50.259	80	29.722	07/08	1025	5	black muck	29.1	
SD_50	27	50.252	80	29.730	07/09	0840	4	sand w/ trace muck & debris	4.56	
S_0	27	50.246	80	29.738	07/09	0834	3	sand w/ shell & debris	9.79	
SU_50	27	50.234	80	29.742	07/09	0829	3	sand	2.55[B]	
SU_100	27	50.225	80	29.764	07/09	0823	5	black muck	**45.0**	
SU_250	27	50.207	80	29.780	07/09	0818	5	black muck	**42.8**	
SU_500	27	50.174	80	29.794	07/09	0812	5	black muck	**42.4**	
SU_1000	27	50.134	80	29.819	07/09	0807	5	black muck	**41.3**	
MD_1000	27	50.446	80	29.787	07/08	1100	>6	black muck	28.5	
MD_500	27	50.365	80	29.757	07/10	0930	6	black muck	25.1	
MD_250	27	50.328	80	29.760	07/08	1045	5	black muck	26.6	
MD_100	27	50.309	80	29.791	07/09	0850	4	sand & muck	3.56	
MD_50	27	50.326	80	29.819	07/09	0859	5	sand & shell	1.35[B]	
M_0	27	50.278	80	29.778	07/10		0	oyster shells	0.910[B]	
MU_50	27	50.284	80	29.816	07/09	1004	1	Silty sand w/ shell frag	1.24[B]	
MU_100	27	50.279	80	29.821	07/09	1008	1	Sand & plant debris	0.818[B]	
MU_250	27	50.254	80	29.817	07/09	1014	2	Sand, shell frag	0.700[B]	
MU_500	27	50.220	80	29.839	07/09	1019	2	Sand, silt, shell frag, plant debris	1.27[B]	
MU_1000	27	50.163	80	29.906	07/09	1025	3	Sand, silt, muck	1.33[B]	
ND_1000	27	50.500	80	29.821	07/08	1110	>6	black muck	21.8	
ND_500	27	50.418	80	29.827	07/08	1118	6	black muck w/ shells	12.8	
ND_250	27	50.380	80	29.845	07/08	1126	6	black muck w/ shells	23.4	
ND_100	27	50.367	80	29.873	07/08	1132	5	black muck w/ shells and plant material	14.6	
ND_50	27	50.353	80	29.867	07/09	0906	5	sand, debris, shells	18.2	
N_0	27	50.340	80	29.869	07/09	0913	4	Debris & shell	17.9	

Sample	Latitude N[A]		Longitude W[A]		Collected		Approx.	Sediment	Lead	Note
NU_50	27	50.337	80	29.903	07/09	0920	4	Sand, shell, & organic debris	1.82[B]	
NU_100	27	50.335	80	29.907	07/09	0957	4	Sand, shell frag, organic debris	2.11[B]	
NU_250	27	50.333	80	29.917	07/09	0952	5	Sand, shell frag.	1.33[B]	
NU_500	27	50.309	80	29.933	07/09	0946	6	Black muck	29.4	
NU_1000	27	50.260	80	30.008	07/09	0938	>6	Silty sand & muck	2.00[B]	
Paint flakes	27	50.246	80	29.740	07/10	1000	-	Paint flakes	**20900**	Sampled from bridge
Oyster shell #1	27	50.278	80	29.787	07/10	1015	0	Dry oyster shell	3.73	Location M_0
Oyster shell #2	27	50.278	80	29.787	07/10	1025	0	Dry oyster shell	0.912[B]	Location M_0

A. Coordinates in WGS84
B. Measured lead concentration below Practical Quantifiable Limit
Concentrations in a bold red font exceed the SQAG Threshold Effect Level established for lead (30 mg/kg).

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References.

[1] Sabol, B., May 19,2020. Preliminary estimate of lead entering the St. Sebastian River from flaking lead-based paint on the St. Sebastian River railroad bridge. 8 pp. white paper

[2] ARCADIS, Inc., Augut 21, 2020. Letter to FL DEP DEP confirming high Pb levels in paint flakes.

[3] ARCADIS, Inc., December 2, 2020. Riverbed Sampling Work Plan presented to FL DEP

[4] ARCADIS, Inc., March 5, 2021. Riverbed Sediment Sampling Completion Report

[5] Florida Department of Environmental Protection. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters, Volume 2 Application of the Sediment Quality Assessment Guidelines. 52 pp.

Appendix

ENCO Laboratory Results Report