

Supplementary Material

Using Mixed Active Capping to Remediate Multiple Potential Toxic Metal Contaminated Sediment for Reducing Environmental Risk

Meng-Yuan Ou ¹, Yu Ting ¹, Boon-Lek Ch'ng ¹, Chi Chen ¹, Yung-Hua Cheng ¹, Tien-Chin Chang ², and Hsing-Cheng Hsi ^{1,*}

¹ Graduate Institute of Environmental Engineering, National Taiwan University, No. 1, Sec. 4, Roosevelt Rd., Taipei 10671, Taiwan; auanlie@outlook.com (M.Y.O.); yuting821216@gmail.com (Y.T.); r06541135@ntu.edu.tw (B.L.C.); q2461015@gmail.com (C.C.); r08541121@ntu.edu.tw (Y.H.C.)

² Institute of Environmental Engineering and Management, National Taipei University of Technology, No. 1, Sec. 3, Zhongxiao E. Rd., Taipei 10608, Taiwan; tcchang@ntut.edu.tw (T.C.C.)

* Correspondence: hchsi@ntu.edu.tw (H.C.H.); Tel.: +886-2-33664374

Table S1. Oxidation reduction potential (ORP) during operation.

Oxidation Reduction Potential (ORP) (mV)						
day	1	2	3	4	5	control
1	264.6	202.4	139.5	182.0	215.6	240.6
9	79.2	106.7	82.5	88.7	85.3	148.3
15	20.1	20.1	-135.5	-153.9	-112.6	78.2
22	19.2	5.5	-67.8	-142.8	-108.1	100.8
29	120.6	265.0	100.2	88.0	116.0	318.5
36	0.9	-2.9	-196.0	-179.6	-176.9	26.2
44	23.0	-86.8	-275.0	-257.8	-239.5	-36.4
51	-169.4	-133.2	-248.5	-218.6	-231.0	-48.1
58	-176.6	-93.2	-219.7	-229.0	-247.5	-56.0
65	-48.5	-145.2	-192.0	-240.8	-253.3	14.7
72	30.2	-105.2	-195.4	-220.9	-210.8	65.2
79	2.8	-92.5	-176.7	-203.7	-182.9	69.9
86	-70.4	-140.9	-166.0	-126.0	-124.7	64.4
93	-35.9	-116.4	-148.5	-184.1	-176.9	-167.2
101	-27.5	-97.0	-115.1	-178.8	-170.4	-175.1
107	13.9	-20.3	-19.2	-19.4	29.3	-70.3
114	-60.6	-84.2	-115.4	-140.0	-168.5	-59.2
122	-18.5	98.2	-38.6	-41.1	-12.8	26.7
128	-28.1	13.5	-65.8	-80.9	-20.2	-17.0
135	-68.5	-50.7	-96.4	-103.2	-45.0	-49.1

Table S2. pH values of microcosm during operation.

Day	pH					Control
	1	2	3	4	5	
1	6.13	5.99	6.19	6.02	6.24	6.24
9	5.79	5.81	5.94	5.92	6.03	4.70
15	7.79	7.82	7.78	7.71	7.79	6.70
22	7.64	7.63	7.59	7.36	7.58	6.51
29	7.61	7.65	7.52	7.33	7.61	6.56
36	7.52	7.70	7.52	7.31	7.56	6.49
44	7.21	7.61	7.29	7.13	7.29	6.45
51	6.91	7.44	7.11	7.02	7.20	6.69
58	7.26	7.52	7.33	7.12	7.23	6.56
65	7.40	7.57	7.44	7.24	7.39	6.93
72	7.65	7.59	7.47	7.25	7.39	6.97
79	7.60	7.52	7.42	7.24	7.32	6.90
86	7.58	7.48	7.40	7.27	7.31	6.77
93	7.63	7.44	7.37	7.26	7.30	6.95
101	7.51	7.33	7.29	7.23	7.24	7.05
107	7.45	7.35	7.32	7.36	7.28	7.05
114	7.29	7.29	7.22	7.01	7.11	6.86
122	7.38	7.28	7.29	7.26	7.31	6.85
128	7.48	7.30	7.14	7.20	7.30	6.95
135	7.39	7.30	7.29	7.26	7.20	6.96

Table S3. Dissolved oxygen (DO) (mg L⁻¹) of the overlying water in the microcosm.

Dissolved Oxygen (DO) (mg L⁻¹)						
Day	1	2	3	4	5	Control
1	1.15	0.87	3.80	1.40	2.59	1.77
9	1.02	0.88	1.38	1.58	1.46	1.99
15	1.25	1.22	1.21	0.86	1.10	1.29
22	0.57	1.12	1.47	1.63	1.25	1.63
29	1.46	1.33	0.86	1.23	1.21	0.91
36	1.20	2.18	2.06	1.86	1.65	1.60
44	1.24	1.19	1.28	1.11	1.31	1.04
51	0.61	0.64	0.61	0.66	0.63	0.63
58	1.53	1.32	0.76	0.57	0.70	0.94
65	0.38	0.48	1.10	0.83	0.97	1.29
72	0.61	0.54	0.82	0.62	0.70	0.62
79	0.54	0.66	0.62	0.65	0.77	0.83
86	0.53	0.70	0.80	0.72	0.63	0.56
93	0.46	0.94	0.97	0.54	0.55	0.47
101	0.32	0.75	0.38	0.35	0.53	0.36
107	0.26	0.86	0.19	0.16	0.12	0.28
114	0.28	0.27	0.27	0.28	0.30	0.17
122	0.27	0.70	0.80	0.28	0.49	0.54
128	0.33	0.25	0.48	0.25	0.45	0.41
135	0.46	0.35	0.71	0.53	0.29	0.28

Table S4. Electrical conductivity (EC) of the overlying water in the microcosm.

Electrical Conductivity (EC) ($\mu\text{s cm}^{-1}$)						
Day	1	2	3	4	5	Control
1	70	70	80	80	70	70
9	300	350	350	340	340	270
15	430	420	420	390	370	290
22	70	60	60	60	40	40
29	20	20	20	20	20	20
36	60	100	70	60	50	50
44	80	120	130	130	140	160
51	410	370	400	380	370	260
58	50	60	50	50	50	40
65	70	70	100	90	70	70
72	200	200	230	200	210	190
79	260	250	260	360	320	310
86	360	370	350	350	340	330
93	410	440	420	420	420	500
101	380	420	440	430	430	480
107	420	440	440	420	420	440
114	490	550	530	530	550	510
122	420	390	380	390	400	380
128	430	440	420	430	430	400
135	420	410	410	410	400	380

Table S5. THg concentration of the overlying water in the microcosm.

Day	THg ($\mu\text{g L}^{-1}$)					Control
	1	2	3	4	5	
1	0.448	1.389	0.708	1.426	0.810	0.533
9	0.057	1.337	0.144	ND	0.012	0.718
15	0.014	0.206	0.031	ND	0.035	0.810
22	0.026	0.085	0.149	0.032	0.104	0.220
29	0.259	0.437	0.350	0.155	0.147	0.403
36	0.146	0.854	0.374	0.237	0.269	0.590
42	0.133	0.125	0.278	0.161	0.095	0.568
49	0.138	0.123	0.207	0.245	0.157	0.625
51	0.201	0.153	0.235	0.313	0.070	0.913
58	0.147	0.178	0.185	0.587	0.221	0.261
65	0.141	0.138	0.203	0.537	0.177	0.172
72	0.133	0.127	0.154	0.148	0.150	0.369
86	0.067	0.065	0.065	0.068	0.101	0.408
93	0.118	0.136	0.183	0.128	0.146	0.360
101	0.089	0.081	0.069	0.113	0.096	0.588
107	0.119	0.054	0.089	0.077	0.088	0.259
114	0.324	0.499	0.041	0.028	0.215	0.648
121	0.192	0.145	0.040	0.137	0.046	0.158
128	0.073	0.187	0.070	0.321	0.108	0.213
135	0.108	0.127	0.293	0.051	0.126	0.733

ND < 0.00026 $\mu\text{g L}^{-1}$.

Table S6. MeHg concentration of the overlying water in the microcosm.

Day	MeHg (ng L⁻¹)					control
	1	2	3	4	5	
23	ND	ND	ND	0.121	ND	ND
30	1.459	1.770	2.423	1.625	1.353	1.163
36	1.108	0.677	11.257	4.355	3.014	1.139
41	0.302	ND	9.339	5.177	2.307	0.471
48	7.197	1.439	11.350	26.421	6.155	2.219
51	7.543	ND	5.623	25.158	8.026	0.331
58	2.221	0.943	6.977	18.428	1.884	1.599
65	3.703	0.960	20.278	20.228	9.485	1.078
72	0.147	ND	1.269	3.729	0.124	ND
79	0.319	ND	1.687	2.006	0.560	ND
86	0.712	0.216	1.192	1.528	0.720	0.452
93	0.404	0.413	1.291	1.343	0.557	10.324
101	0.371	0.533	1.111	1.074	0.272	18.990
107	0.422	0.089	1.422	1.198	0.533	20.544
114	1.525	1.864	2.672	2.112	1.000	9.543
122	0.133	0.744	0.908	1.253	1.130	5.398
128	0.043	0.039	0.599	0.845	0.666	1.777
135	0.223	0.363	1.017	2.059	0.723	2.532

ND: < 0.02 ng L⁻¹.

Table S7. Ni concentration of the overlying water in the microcosm.

Day	Ni (mg L ⁻¹)					control
	1	2	3	4	5	
1	0.718	0.694	0.459	0.725	0.623	0.664
9	0.179	0.181	0.175	0.223	0.177	0.465
15	0.111	0.116	0.086	0.176	0.092	0.441
22	0.089	0.107	0.077	0.273	0.077	0.412
29	0.095	0.126	0.085	0.285	0.080	0.426
36	0.016	0.044	ND	0.174	0.011	0.383
44	ND	0.061	ND	0.034	ND	0.308
51	ND	0.124	ND	ND	ND	0.285
58	ND	0.106	ND	ND	ND	0.281
65	ND	0.151	ND	ND	ND	0.104
72	0.012	0.144	0.010	ND	ND	0.108
79	0.025	0.140	ND	0.022	0.010	0.137
86	0.014	0.138	ND	0.032	0.021	0.175
93	0.016	0.134	ND	0.022	0.013	0.215
101	0.056	0.135	0.014	0.010	0.015	0.050
107	0.016	0.118	ND	0.011	0.016	0.031
114	0.024	0.142	ND	ND	0.013	0.041
122	0.045	0.062	0.013	0.036	0.023	0.041
128	0.015	0.036	ND	0.015	0.010	0.018
135	0.017	0.050	0.024	0.023	0.012	0.028

ND: < 0.01 mg L⁻¹

Table S8. Cr concentration of the overlying water in the microcosm.

Day	Cr (mg L ⁻¹)					Control
	1	2	3	4	5	
1	ND	0.0732	0.0694	0.0743	0.0690	0.0682
9	ND	0.0663	0.0676	0.0725	0.0688	0.0693
15	ND	0.0234	0.0235	0.0253	0.0247	0.0275
22	ND	0.0242	0.0236	0.0235	0.0221	0.0245
29	ND	0.0230	0.0263	0.0234	0.0273	0.0267
36	ND	ND	ND	ND	ND	ND
44	ND	ND	ND	ND	ND	ND
51	ND	ND	ND	ND	ND	ND
58	ND	ND	ND	ND	ND	ND
65	ND	ND	ND	ND	ND	ND
72	ND	ND	ND	ND	ND	ND
79	ND	ND	ND	ND	ND	ND
86	ND	ND	ND	ND	ND	ND
93	ND	ND	ND	ND	ND	ND
101	ND	ND	ND	ND	ND	ND
107	ND	ND	ND	ND	ND	ND
114	ND	ND	ND	ND	ND	ND
122	ND	ND	ND	ND	ND	ND
128	ND	ND	ND	ND	ND	ND
135	ND	ND	ND	ND	ND	ND

ND: < 0.01 mg L⁻¹.

Table S9. Cu concentration of the overlying water in the microcosm.

Day	Cu (mg L ⁻¹)					Control
	1	2	3	4	5	
1	0.119	0.095	0.078	0.084	0.099	0.107
9	0.069	0.069	0.068	0.084	0.068	0.090
15	ND	ND	ND	ND	ND	ND
22	ND	ND	ND	ND	ND	ND
29	ND	ND	ND	ND	ND	ND
36	ND	ND	ND	ND	ND	0.017
44	ND	ND	ND	ND	ND	0.011
51	ND	ND	ND	ND	ND	ND
58	ND	ND	ND	ND	ND	ND
65	ND	ND	ND	ND	ND	ND
72	ND	ND	ND	ND	ND	ND
79	ND	ND	ND	ND	ND	0.012
86	ND	ND	ND	ND	ND	0.016
93	ND	ND	ND	ND	ND	ND
101	ND	ND	ND	ND	ND	ND
107	ND	ND	ND	ND	ND	ND
114	ND	ND	ND	ND	ND	ND
122	ND	ND	ND	ND	ND	ND
128	ND	ND	ND	ND	ND	ND
135	ND	ND	ND	ND	ND	ND

ND: < 0.01 mg L⁻¹.

Table S10. Zn concentration of the overlying water in the microcosm.

Day	Zn (mg L ⁻¹)					Control
	1	2	3	4	5	
1	1.366	1.139	0.713	1.467	1.202	0.981
9	0.154	0.144	0.063	0.098	0.113	0.710
15	0.037	0.047	0.050	0.018	0.028	0.776
22	0.049	0.061	0.021	0.020	0.018	0.695
29	0.055	0.047	0.051	0.020	0.103	0.722
36	0.037	0.047	0.050	0.018	0.028	0.776
44	0.038	0.087	0.131	0.065	0.159	0.548
51	0.014	0.019	0.013	ND	0.019	0.471
58	0.086	0.083	0.032	0.006	0.015	0.407
65	0.013	0.023	0.052	0.019	0.013	0.192
72	0.049	0.051	0.061	0.022	0.045	0.179
79	0.186	0.048	ND	0.053	0.018	0.291
86	0.013	0.065	ND	0.014	0.118	0.182
93	ND	0.101	0.029	0.024	0.024	0.040
101	0.016	0.015	0.026	0.017	0.054	0.016
107	ND	0.057	ND	0.011	0.011	0.097
114	0.015	0.017	0.016	0.046	0.016	0.115
122	0.099	0.023	ND	0.021	0.022	0.100
128	ND	0.021	0.057	ND	0.110	0.084
135	0.011	0.064	ND	0.201	0.015	0.056

ND: < 0.01 mg L⁻¹.