

APPENDIX N
BUCKET DECANT WATER IMPACT ON
RIVER PCB LOAD

APPENDIX N
BUCKET DECANT WATER IMPACT ON RIVER PCB LOAD

The total polychlorinated biphenyl (PCB) concentration in the decant water, which includes dissolved PCBs as well as the PCBs on the suspended solids (i.e., particulate PCBs), can be estimated from the particulate PCB concentration by using conventional partitioning theory as expressed in the following equation:

$$c_t = c_d + c_p = \frac{r}{K_d} + rm \quad (1)$$

in which:

c_t	=	total PCB concentration (ng/L)
c_d	=	dissolved PCB concentration (ng/L)
c_p	=	particulate PCB concentration (ng/L)
r	=	particulate PCB per unit suspended solids (ng/kg) = PCB concentration of the sediment in the bucket
K_d	=	sorption partition coefficient (L/kg)
m	=	TSS concentration (kg/L)

Equation 1 may be simplified by combining terms to yield:

$$c_t = \left(\frac{1}{K_d} + m \right) r \quad (2)$$

The decant data provide a basis to estimate m and K_d . K_d is the ratio of the particulate PCB concentration (r) to the dissolved concentration (c_d). The particulate PCB concentration is calculated as the difference between the total PCB and dissolved PCB concentrations divided by the total suspended solids (TSS). Thus:

$$K_d = \frac{r}{c_d} = \frac{(c_t - c_d)/m}{c_d} \quad (3)$$

The decant data yield the K_d values shown in Table 5.4-1. The average of these values was used in Equation 2. The average of the measured TSS values was also used in Equation 2.

With K_d and m fixed, c_t was calculated from Equation 2 using r , as the average PCB concentration of sediment dredged by each dredge each day. The total PCB mass (M) in the decant waters of all dredges operated within a day was calculated as:

$$M = \sum(C_{ti} \times V_i \times D) \times E \quad (4)$$

in which:

- c_{ti} = daily-averaged total PCB concentration in the decant water of dredge i
- V_i = total daily bucket volume of dredge i
- D = fraction of water within a bucket
- E = fraction of bucket water decanted to the river

The daily total PCB mass (M) in the bucket decant water was calculated using Equation 2 with the following values and assumptions:

- Mean sediment PCB concentration from the Sediment Sampling and Analysis Program (SSAP) data mapped over the dredge areas using Thiessen polygons
- Total daily bucket volume was calculated as bucket volume (Table N-1) multiplied by numbers of daily bucket cycles recorded in the Hypack data
- Daily total dredge volume was calculated using the available Hypack data from May 15, 2009 through August 22, 2009 (Table N-2)
- Fraction of water volume (D) was calculated as the difference of total bucket volume and total dredge volume over the total dredge volume for a given day
- All CUs were used to compute daily dredge volume and the associated daily mean sediment PCB concentration being dredged for the upper bound calculation. This includes CUs 01 through 04 located in the East Rogers Island where flow rates were low, and areas within the sheet piling at CU18.
- While a portion of the bucket water decanted to the river, the rest of the bucket water was collected in the barge. Therefore, the fraction of bucket water decanted to the river (E) could be estimated by using the recorded liquid volume pumped out of the barge when it reached the processing facility (Table N-3). Approximately 27 million gallons (133,000 cy) of water were pumped out of the barge up to August 22, 2009. Compared with 167,000 cy of total bucket water accumulated over the same period (Table N-2), a long-term average of E was estimated to be 20%.

-
- The estimate of 20% is supported by a field test conducted on August 27, 2009 to estimate decant rates for different type of bucket. It took 41 and 90 seconds to completely drain 1 cy and 5 cy water-full buckets, respectively. As the average bucket cycle time for 385 dredges (i.e., the dredges using 5 cy buckets) is around 80 seconds of which approximately 15 seconds is from the point the bucket breaks water surface to being hoisted into the scow, approximately 17% of bucket water would be decanted to the river.
 - Depending on various field instructions and dredge operations, E could vary from 100% to near zero (i.e., few seconds air time). Thus in the current analysis, E values of 10% (half of the average value) and 60% (three times of the average value) were considered to account for the uncertainty.

From the above information, during the period of May 15, 2009 through August 22, 2009, the total PCB mass in the bucket water was estimated to be approximately 13.1 kg. Depending on E, the total PCB mass decanted to the river was in the range of 1.3 and 7.9 kg, with 2.6 kg associated with 20% of water decanted to the river. The daily values are shown in Table N-2.

TABLES

Table N-1
Summary of Bucket Volume by Dredge

Dredge Name	Dredge Type	Bucket Volume (cy)
320-09	320	1
320-10	320	1
320-11	320	1
320-12	320	1
320-13	320	1
320-14	320	1
320-16	320	1
345-07	345	2
385-02	385	5
385-03	385	5
385-04	385	5
385-05	385	5
385-06	385	5

Table N-2
Calculated Daily Total PCB Mass in Bucket Decant Water

Date ¹	Dredged Volume (cy)	Total Bucket Volume (cy)	Total Bucket Water Volume (cy)	PCB Mass in Bucket Water (g)	PCB Mass in Decant Water (g)		
					E = 10%	E = 20%	E = 60%
5/15/2009	137	465	328	16	2	3	10
5/16/2009	180	675	495	22	2	4	13
5/21/2009	53	448	395	2	0	0	1
5/22/2009	98	676	578	2	0	0	1
5/23/2009	85	900	815	18	2	4	11
5/26/2009	210	2,011	1,801	119	12	24	72
5/27/2009	177	1,725	1,548	9	1	2	6
5/28/2009	245	2,242	1,997	138	14	28	83
6/1/2009	641	1,995	1,354	185	19	37	111
6/2/2009	800	2,155	1,355	48	5	10	29
6/3/2009	799	2,251	1,452	29	3	6	17
6/4/2009	1,177	2,799	1,622	17	2	3	10
6/5/2009	1,492	2,847	1,355	21	2	4	12
6/6/2009	1,034	2,037	1,003	14	1	3	8
6/8/2009	1,331	2,816	1,485	9	1	2	5
6/9/2009	1,366	2,770	1,404	62	6	12	37
6/10/2009	1,107	2,615	1,508	20	2	4	12
6/11/2009	713	2,031	1,318	16	2	3	10
6/12/2009	791	1,663	872	17	2	3	10
6/13/2009	1,040	1,960	920	11	1	2	6
6/15/2009	1,146	2,190	1,044	14	1	3	9
6/16/2009	1,471	2,720	1,249	68	7	14	41
6/17/2009	1,478	2,420	942	33	3	7	20
6/18/2009	1,978	3,587	1,609	124	12	25	74
6/19/2009	1,316	2,130	814	32	3	6	19
6/20/2009	1,346	2,064	718	10	1	2	6
6/22/2009	1,939	3,092	1,153	72	7	14	43
6/23/2009	1,894	3,173	1,279	32	3	6	19
6/24/2009	1,311	2,437	1,126	49	5	10	30
6/25/2009	1,539	2,783	1,244	59	6	12	36
6/26/2009	1,558	3,256	1,698	16	2	3	9
6/27/2009	1,784	4,505	2,721	67	7	13	40
6/29/2009	1,786	5,113	3,327	62	6	12	37
6/30/2009	1,279	4,227	2,948	31	3	6	19

Table N-2
Calculated Daily Total PCB Mass in Bucket Decant Water

Date ¹	Dredged Volume (cy)	Total Bucket Volume (cy)	Total Bucket Water Volume (cy)	PCB Mass in Bucket Water (g)	PCB Mass in Decant Water (g)		
					E = 10%	E = 20%	E = 60%
7/1/2009	1,035	3,585	2,550	49	5	10	30
7/2/2009	1,621	5,463	3,842	121	12	24	73
7/6/2009	1,652	5,775	4,123	247	25	49	148
7/7/2009	1,333	4,506	3,173	761	76	152	457
7/8/2009	2,637	5,977	3,340	297	30	59	178
7/9/2009	3,154	6,918	3,764	117	12	23	70
7/10/2009	3,820	7,086	3,266	528	53	106	317
7/11/2009	2,211	6,354	4,143	379	38	76	228
7/13/2009	2,720	6,205	3,485	504	50	101	303
7/14/2009	3,393	6,563	3,170	338	34	68	203
7/15/2009	3,353	5,512	2,159	330	33	66	198
7/16/2009	2,800	4,890	2,090	282	28	56	169
7/17/2009	2,522	4,981	2,459	427	43	85	256
7/18/2009	2,267	4,965	2,698	376	38	75	226
7/20/2009	2,501	4,902	2,401	494	49	99	297
7/21/2009	2,804	6,264	3,460	131	13	26	78
7/22/2009	2,936	5,263	2,327	184	18	37	111
7/23/2009	3,517	6,196	2,679	53	5	11	32
7/24/2009	2,780	5,920	3,140	100	10	20	60
7/25/2009	2,569	5,384	2,815	237	24	47	142
7/27/2009	3,710	7,539	3,829	339	34	68	204
7/28/2009	2,817	5,744	2,927	162	16	32	97
7/29/2009	3,540	7,016	3,476	283	28	57	170
7/30/2009	2,665	6,048	3,383	318	32	64	191
7/31/2009	2,826	5,589	2,763	217	22	43	130
8/1/2009	2,116	4,361	2,245	211	21	42	127
8/3/2009	1,649	4,576	2,927	146	15	29	88
8/4/2009	3,213	6,426	3,213	325	32	65	195
8/5/2009	3,178	6,820	3,642	288	29	58	173
8/6/2009	2,424	5,073	2,650	112	11	22	67
8/7/2009	2,028	3,883	1,855	203	20	41	122
8/11/2009	569	1,790	1,221	49	5	10	29
8/12/2009	1,624	3,820	2,196	21	2	4	12
8/13/2009	1,984	4,214	2,230	21	2	4	12

Table N-2
Calculated Daily Total PCB Mass in Bucket Decant Water

Date ¹	Dredged Volume (cy)	Total Bucket Volume (cy)	Total Bucket Water Volume (cy)	PCB Mass in Bucket Water (g)	PCB Mass in Decant Water (g)		
					E = 10%	E = 20%	E = 60%
8/14/2009	2,667	5,810	3,143	77	8	15	46
8/15/2009	1,201	1,681	480	15	2	3	9
8/17/2009	2,159	4,008	1,849	48	5	10	29
8/18/2009	2,655	6,685	4,030	197	20	39	118
8/19/2009	3,070	5,484	2,414	49	5	10	29
8/20/2009	2,979	5,834	2,855	24	2	5	14
8/21/2009	2,354	5,365	3,011	168	17	34	101
8/22/2009	3,090	6,716	3,626	125	12	25	75

Note:

¹ Days with no dredge activities were not shown in the table.

Table N-3
Summary of Weekly Liquid Volume from the Barge

Week Ending	Est. Vol. Liquids (Gal)
05/23/09	129,800
05/30/09	80,000
06/06/09	667,600
06/13/09	935,800
06/20/09	1,271,000
06/27/09	1,192,700
07/04/09	2,080,800
07/11/09	2,912,400
07/18/09	2,788,600
07/25/09	2,875,200
08/01/09	2,487,300
08/08/09	3,015,700
08/15/09	2,468,325
08/22/09	4,034,600
Total	26,939,825