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TECHNICAL MEMORANDUM **CH2MHILL**

Ecological Evaluation of SWMU 15 Biopile Soils, Naval Air Station, Oceana, Virginia Beach, Virginia

PREPARED FOR: NAS Oceana Partnering Team

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DATE: March 27, 2000

The purpose of this Technical Memo is to document final assessment of SWMU 15 biopile soils at NAS Oceana, Virginia Beach, Virginia. This memo is being prepared in place of a full Ecological Risk Assessment for the biopile soils as agreed to by the Partnering Team for NAS Oceana. A full discussion of the SWMU 15 Biological Treatment Project is contained in the *Final SWMU 15 Biological Soil Remediation Project Close-Out Report and Technical Memorandum for the SWMU 15 Confirmatory Soil Sampling* (CH2MHILL, dated March 2000).

Samples of the biopile soil were collected in October 1988 and analyzed for Volatile Organic Compounds (VOCs) Total Petroleum Hydrocarbons (TPH), and Polynuclear-Aromatic Hydrocarbons (PAHs). Those results showed that VOCs and TPH had dropped significantly from pre-treatment levels. Although this confirmatory sampling determined that the cleanup goal of 10 ppm for total BTEX had been achieved for all the biopile soils, soil at the bottom of the biopiles remained at levels exceeding the 50 ppm for TPH cleanup goal. The detected levels of PAHs in the bottom of the biopiles were also elevated. Soil in the upper portion of the biopiles with TPH concentrations below the cleanup goals were determined to meet the state clean fill requirements. Subsequently, the upper 6 feet of soil was stripped from the biopiles and set aside for future use as clean fill in the NAS Oceana "tarmac restoration" project. The remaining soils, with TPH levels exceeding the state's requirements for clean fill, were spread on poly at the site and disked to aerate the soils. This additional treatment enhanced the biological degradation of the remaining VOC and TPH constituents to achieve the cleanup goal levels.

Samples from the retreated biopile soil were collected in August 1999 and analyzed for metals and TPH. These sample results demonstrated that TPH had decreased markedly in the treated soil from October 1998 levels. Although the majority of soils were found to meet the established cleanup goal of 50 ppm for TPH, a portion of the retreated soils did not. Therefore, an additional confirmatory sampling event was conducted in October 1999 to verify that the continuing biological activity had successfully treated these soils to below the 50 ppm for TPH. The August 1999 metals data was collected for use in the planned human health and ecological risk assessments for the SWMU 15 site. In October 1999, the NAS Oceana Partnering Team's Ecological Subgroup reviewed the proposed technical approach to conducting ecological risk assessments at NAS Oceana SWMUs. The subgroup recommended that an ecological risk assessment be conducted on the SWMU 15 biopiles soils prior to its use in the station's tarmac restoration project.

Inadvertently, the station used a portion of the staged biopile soils in the facility's tarmac restoration project prior to the completion of the planned ecological risk assessment on the soils. At the November 10th Ecological Subgroup meeting, the team evaluated the results from the August 1999 (metals data) and the October 1998 (VOC and PAH data) sampling events of the SWMU 15 biopile soils, Tables 1 and 2. From this evaluation the subgroup determined that the concentrations of the inorganic compounds were not an issue in the biopile soils as the detected concentrations were consistent with documented inorganic background concentrations in regional soils. The subgroup also reviewed the VOC and PAH data which was collected for use in the human health risk assessment for the biopile soil, and found the PAH compounds to be of potential concern. However, because the sampling that generated this data was conducted prior to the deconstuction of the biopiles and the additional biological treatment of selected soils, the subgroup determined that the PAH concentrations in the biopile soil were unknown and that additional sampling was required to demonstrate that PAH concentrations had decreased along with TPH concentrations.

The team agreed that the Navy would collect ten additional surface soil samples from the top three inches of the biopile soils remaining at SWMU 15 and from the biopile soil already spread in the tarmac restoration area, and collect five background surface soil samples adjacent to the tarmac restoration area; the samples would be analyzed for PAHs using Method 8310, to determine whether or not PAHs were still a concern. The team further agreed that, rather than continuing with a full Ecological Risk Assessment of the biopile soil, the results from the additional PAH sampling event would be evaluated and the need for or lack of need for further action would be documented in a technical memorandum. The attached meeting minutes of the November 10th Ecological Subgroup meeting were distributed to the NAS Oceana Partnering Team members as Attachment E to the December 1999 Tier I meeting minutes.

Table 3 contains the PAH results of biopile soil and background samples from the December 1999 sampling event. These results were presented to the NAS Oceana Partnering Team at the February 2000 Tier I partnering meeting. Analytical results from the ten biopile samples showed that levels of the PAHs analyzed for dropped significantly between the October 1998 and the December 1999 sampling events, demonstrating that the PAHs decreased in conjunction with the TPH. A comparison of the PAH data from the two sampling events is provided as Table 4. This table also compares the sampling data to ecological screening values.

Concentrations of the PAHs benzo(a)pyrene, benzo(k)fluoranthene, fluoranthene, and pyrene were elevated in a small portion of the samples, but when compared to equally high levels of the same PAHs in background soil samples, these are not seen as a concern. Summing the maximum detected concentration of each PAH compound as a worst case exposure scenario (all maximum contaminant detections being co-located in a single sample) yields a concentration of 6215 ug/kg for total PAHs. An action level for total PAHs equal to or greater than 40,000 ug/kg was agreed to by the NAS Oceana Partnering Team. Thus, the total maximum PAH concentration, even when calculated as a worst case exposure scenario, is well below the team's agreed upon action level. The drop in PAHs and TPH was due to the retreatment of the soil. Since the soil is being spread thinly within the tarmac restoration area, further enhancements in the biodegradation process is anticipated.

In summary, the team reached consensus that based on the December sampling results, PAHs are not considered to be of ecological concern in the biopile soils and that no further action is warranted.

TABLE 1: SWMU 15 Sampling Su[illegible] Statistics and COPC Selection

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Arithmetic Mean	BTAG Screening Values	Frequency of Exceedence	Maximum Hazard Quotient	COPC?	Alternate Screening Values	Frequency of Exceedence	Maximum Hazard Quotient	COPC?	Background Values [1] Maximum	Background Values [1] Mean	Background Values [2] Maximum	Background Values [2] Mean
Inorganics (mg/kg)	Collected August 1999															
Aluminum	4.4 - 5.8	13 / 13	19,200	16,569	1	13 / 13	19,200	YES	600	13 / 13	32.00	YES			100000	66000
Antimony	0.36 - 0.49	0 / 13	--	0.44	0.48	1 / 13	1.021	YES	5	0 / 13	0.10	NO				
Arsenic	0.45 - 0.6	13 / 13	3.2	2.71	328	0 / 13	0.010	NO	60	0 / 13	0.05	NO				
Barium	0.03 - 0.04	13 / 13	69.5	59.13	440	0 / 13	0.158	NO	3000	0 / 13	0.02	NO			5000	554
Beryllium	0.02 - 0.02	13 / 13	0.5	0.40	0.02	13 / 13	25	YES	10	0 / 13	0.05	NO	0.40	0.3225	7	1
Cadmium	0.05 - 0.07	0 / 13	--	0.03	2.5	0 / 13	0.028	NO	20	0 / 13	0.004	NO				
Calcium	5 - 6.8	13 / 13	1,950	971	NB	-	NB	YES	NB	-	NB	YES			320000	24000
Chromium	0.1 - 0.13	13 / 13	26.6	21.72	0.0075	13 / 13	3,547	YES	0.4	13 / 13	66.50	YES	19.5	15.65	1500	53
Cobalt	0.08 - 0.11	13 / 13	3.9	3.35	200	0 / 13	0.0195	NO	130	0 / 13	0.03	NO			70	10
Copper	0.1 - 0.13	13 / 13	28.9	10.65	15	1 / 13	1.927	YES	50	0 / 13	0.58	NO			300	25
Cyanide	0.24 - 0.29	4 / 13	0.48	0.32	0.005	13 / 13	96	YES	27.5	0 / 13	0.02	NO				
Iron	3.2 - 4.2	13 / 13	11,400	9,079	12	13 / 13	950	YES	200	13 / 13	57.00	YES			100000	25000
Lead	0.27 - 0.36	13 / 13	44.7	25.42	0.01	13 / 13	4,470	YES	500	0 / 13	0.09	NO	8.9	6.8	700	20
Magnesium	4.7 - 6.4	13 / 13	1,280	1,177	4,400	0 / 13	0.29	NO	NB	-	NB	YES			100000	9200
Manganese	0.03 - 0.04	13 / 13	46	38.87	330	0 / 13	0.139	NO	500	0 / 13	0.09	NO			7000	560
Mercury	0.02 - 0.02	13 / 13	0.05	0.04	0.06	0 / 13	0.862	NO	0.1	0 / 13	0.50	NO	0.12 (ND)	0.115 (ND)		
Nickel	0.22 - 0.29	0 / 13	--	2.91	2	13 / 13	0.145	NO	200	0 / 13	0.001	NO			700	20
Potassium	2 - 2.7	13 / 13	684	611.23	NB	-	NB	YES	NB	-	NB	YES			70000	23000
Selenium	0.45 - 0.6	0 / 13	--	0.54	1.8	0 / 13	0.333	NO	NB	-	NB	YES				
Silver	0.12 - 0.16	0 / 13	--	0.14	0.00001	13 / 13	16,327	YES	50	0 / 13	0.003	NO				
Sodium	27 - 36.2	10 / 13	78.3	46.66	NB	-	NB	YES	NB	-	NB	YES			100000	12000
Thallium	0.63 - 0.85	4 / 13	0.93	0.79	0.001	13 / 13	930	YES	1	0 / 13	0.93	NO				
Vanadium	0.13 - 0.18	13 / 13	28.1	23.99	58	0 / 13	0.484	NO	20	13 / 13	1.41	YES			500	76
Zinc	0.18 - 0.24	13 / 13	31.3	25.85	10	13 / 13	3.13	YES	200	0 / 13	0.16	NO			2000	54
Semivolatile Organics (ug/kg)	Collected October 1998															
Acenaphthene	160 - 8000	26 / 34	10,000	951.62	100	23 / 34	100	YES	20000	0 / 34	0.50	NO				
Acenaphthylene	380 - 40000	0 / 34	--	6351.76	100	34 / 34	400	YES	NB	-	NB	YES				
Anthracene	79 - 4000	30 / 34	3,400	753.85	100	27 / 34	34	YES	2050	4 / 34	1.66	YES				
Benzo(a)anthracene	7.9 - 400	33 / 34	2,200	193.82	100	8 / 34	22	YES	2050	1 / 34	1.07	YES				
Benzo(a)pyrene	79 - 4000	0 / 34	--	693.47	100	20 / 34	40	YES	2050	4 / 34	NB	YES				
Benzo(b)fluoranthene	310 - 16000	9 / 34	9,900	2629.12	100	34 / 34	99	YES	NB	-	NB	YES				
Benzo(g,h,i)perylene	160 - 8000	33 / 34	21,000	1970.29	100	34 / 34	210	YES	2050	7 / 34	10.24	YES				
Benzo(k)fluoranthene	620 - 32000	0 / 34	--	5428.24	100	34 / 34	320	YES	2050	9 / 34	NB	YES				
Chrysene	7.9 - 400	33 / 34	4,300	365.18	100	10 / 34	43	YES	2050	3 / 34	2.10	YES				
Dibenz(a,h)anthracene	160 - 8000	0 / 34	--	1384.41	100	34 / 34	80	YES	NB	-	NB	YES				
Fluoranthene	790 - 40000	0 / 34	--	6934.71	100	34 / 34	400	YES	2050	9 / 34	NB	YES				
Fluorene	310 - 16000	30 / 34	140,000	10564.12	100	34 / 34	1,400	YES	30000	4 / 34	4.67	YES				
Hexachlorobutadiene	6 - 30	0 / 34	--	8.22	100	0 / 34	0.34	NO	NB	-	NB	YES				
Indeno(1,2,3-cd)pyrene	150 - 16000	7 / 34	410	1853.56	100	31 / 34	4.1	YES	2050	3 / 34	0.20	NO				
Naphthalene	6 - 38000	16 / 34	560	1272.06	100	7 / 34	5.6	YES	2050	2 / 34	0.27	NO				
Phenanthrene	41 - 2100	31 / 34	4,900	641.06	100	18 / 34	49	YES	2050	4 / 34	2.39	YES				
Pyrene	4.1 - 210	33 / 34	400	35.89	100	4 / 34	4	YES	NB	-	NB	YES				
Volatile Organics (ug/kg)	Collected October 1998															
1,1,1,2-Tetrachloroethane	6 - 30	0 / 32	--	8.22	300	0 / 32	0.1	NO	NB	-	NB	YES				
1,1,1-Trichloroethane	6 - 30	0 / 34	--	8.41	300	0 / 34	0.1	NO	NB	-	NB	YES				
1,1,2,2-Tetrachloroethane	6 - 30	0 / 34	--	8.41	300	0 / 34	0.1	NO	NB	-	NB	YES				
1,1,2-Trichloroethane	6 - 30	0 / 34	--	8.41	300	0 / 34	0.1	NO	NB	-	NB	YES				
1,1-Dichloroethane	6 - 30	0 / 34	--	8.41	300	0 / 34	0.1	NO	NB	-	NB	YES				
1,1-Dichloroethene	6 - 30	0 / 34	--	8.41	NB	-	NB	YES	NB	-	NB	YES				
1,1-Dichloropropene	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	NB	-	NB	YES				
1,2,3-Trichlorobenzene	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	NB	-	NB	YES				
1,2,3-Trichloropropane	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	NB	-	NB	YES				
1,2,4-Trichlorobenzene	6 - 30	0 / 32	--	8.22	100	0 / 32	0.3	NO	1500	0 / 32	0.02	NO				
1,2,4-Trimethylbenzene	6 - 30	26 / 32	6,031	386	NB	-	NB	YES	NB	-	NB	YES				
1,2-Dibromo-3-chloropropane	6 - 30	0 / 32	--	11.41	NB	-	NB	YES	NB	-	NB	YES				
1,2-Dibromoethane	6 - 30	0 / 32	--	8.22	5,000	0 / 32	0.01	NO	NB	-	NB	YES				
1,2-Dichlorobenzene	6 - 30	0 / 32	--	8.22	100	0 / 32	0.3	NO	1500	0 / 32	0.02	NO				

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1,2-Dichloroethane	6 - 30	0 / 34	--	8.41	870,000	0 / 34	0.00003	NO	2005	0 / 34	0.01	NO				
1,2-Dichloroethene (total)	11 - 12	0 / 2	--	11.50	300	0 / 2	0.04	NO	NB	-	NB	YES				
1,2-Dichloropropane	6 - 30	0 / 34	--	8.41	NB	-	NB	YES	70000	0 / 34	0.0004	NO				
1,3,5-Trimethylbenzene	6 - 30	26 / 32	1,300	122	NB	-	NB	YES	NB	-	NB	YES				
1,3-Dichlorobenzene	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	1500	0 / 32	0.02	NO				
1,3-Dichlorpropane	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	NB	-	NB	YES				
1,4-Dichlorobenzene	6 - 30	0 / 32	--	8.22	100	-	NB	NO	20000	0 / 32	0.002	NO				
2,2-Dichloropropane	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	NB	-	NB	YES				
2-Butanone	11 - 12	0 / 2	--	11.50	NB	-	NB	YES	NB	-	NB	YES				
2-Hexanone	11 - 12	0 / 2	--	11.50	NB	-	NB	YES	NB	-	NB	YES				
4-Methyl-2-pentanone	11 - 12	0 / 2	--	11.50	100,000	0 / 2	0.00012	NO	10000	0 / 2	0.001	NO				
Acetone	11 - 12	0 / 2	--	11.50	NB	-	NB	YES	NB	-	NB	YES				
Benzene	6 - 30	3 / 34	103	12.56	100	1 / 34	1.03	YES	525	0 / 34	0.20	NO				
Bromobenzene	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	NB	-	NB	YES				
Bromochloromethane	6 - 30	0 / 32	--	8.22	3,000,000	0 / 32	0.00001	NO	300000	0 / 32	0.0001	NO				
Bromodichloromethane	6 - 30	0 / 34	--	8.41	450,000	0 / 34	6.667E-05	NO	45000	0 / 34	0.001	NO				
Bromoform	6 - 30	0 / 34	--	8.41	NB	-	NB	YES	NB	-	NB	YES				
Bromomethane	6 - 30	0 / 34	--	8.41	NB	-	NB	YES	NB	-	NB	YES				
Carbon disulfide	11 - 12	0 / 2	--	11.50	NB	-	NB	YES	NB	-	NB	YES				
Carbon tetrachloride	6 - 30	0 / 34	--	8.41	300	0 / 34	0.1	NO	1000000	0 / 34	0.00003	NO				
Chlorobenzene	6 - 30	0 / 34	--	8.41	100	0 / 34	0.3	NO	40000	0 / 34	0.001	NO				
Chloroethane	6 - 30	0 / 34	--	8.41	NB	-	NB	YES	NB	-	NB	YES				
Chloroform	6 - 30	1 / 34	1	7.48	300	0 / 34	0.00333	NO	5000	0 / 34	0.0002	NO				
Chloromethane	6 - 30	0 / 34	--	8.41	NB	-	NB	YES	NB	-	NB	YES				
cis-1,2-Dichloroethene	6 - 30	0 / 32	--	8.22	300	0 / 32	0.1	NO	NB	-	NB	YES				
cis-1,3-Dichloropropene	6 - 30	0 / 34	--	8.41	300	0 / 34	0.1	NO	NB	-	NB	YES				
Cumene	6 - 30	6 / 32	890	65.81	NB	-	NB	YES	NB	-	NB	YES				
Dibromochloromethane	6 - 30	0 / 34	--	8.41	NB	-	NB	YES	NB	-	NB	YES				
Dibromomethane	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	NB	-	NB	YES				
Dichlorodifluoromethane	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	NB	-	NB	YES				
Ethylbenzene	6 - 30	18 / 34	791	88.03	100	4 / 34	7.91	YES	25025	0 / 34	0.03	NO				
Gasoline	110 - 120	13 / 13	2,100	1,231	NB	-	NB	YES	NB	-	NB	YES				
Methylene chloride	6 - 30	16 / 34	109	21.78	300	0 / 34	0.363	NO	5005	0 / 34	0.02	NO				
n-Butylbenzene	6 - 30	4 / 32	160	15.50	NB	-	NB	YES	NB	-	NB	YES				
n-Propylbenzene	6 - 30	16 / 32	330	33.91	NB	-	NB	YES	NB	-	NB	YES				
o-Chlorotoluene	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	NB	-	NB	YES				
o-Xylene	6 - 30	16 / 32	1,200	85.22	NB	-	NB	YES	12525	0 / 32	0.10	NO				
p-Chlorotoluene	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	NB	-	NB	YES				
p-Isopropyltoluene	6 - 30	15 / 32	157	24.69	NB	-	NB	YES	NB	-	NB	YES				
sec-Butylbenzene	6 - 30	8 / 32	97	14.50	NB	-	NB	YES	NB	-	NB	YES				
Styrene	6 - 30	1 / 34	15	8.68	100	0 / 34	0.15	NO	50050	0 / 34	0.0003	NO				
tert-Butylbenzene	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	NB	-	NB	YES				
Tetrachloroethene	6 - 30	0 / 34	--	8.41	300	0 / 34	0.1	NO	2005	0 / 34	0.01	NO				
Toluene	6 - 30	2 / 34	1,754	67.21	100	2 / 34	17.54	YES	65025	0 / 34	0.03	NO				
trans-1,2-Dichloroethene	6 - 30	0 / 32	--	8.22	300	0 / 32	0.1	NO	NB	-	NB	YES				
trans-1,3-Dichloropropene	6 - 30	0 / 34	--	8.41	300	0 / 34	0.1	NO	NB	0 / 34	NB	YES				
Trichloroethene	6 - 30	5 / 34	7	8.06	300	0 / 34	0.023	NO	30000	0 / 34	0.0002	NO				
Trichlorofluoromethane	6 - 30	0 / 32	--	8.22	NB	-	NB	YES	NB	-	NB	YES				
Vinyl chloride	6 - 30	0 / 34	--	8.41	300	0 / 34	0.1	NO	300	0 / 34	0.10	NO				
Xylene, total	6 - 30	21 / 34	11,035	600	100	8 / 34	110.35	YES	12525	0 / 34	0.88	NO				

NB - No Benchmark

ND - Not Detected

1 -IT Corporation. 1997. Final Closeout Report. Closure of the Former Hazardous Waste Storage Compound, NAS Oceana, Virginia Beach, VA. Background data.

2 - USFWS. 1990. Evaluating Soil Contamination. Biological Report 90(2).

TABLE 2: Maximum and Mean Concentration NOAEL/LOA for Terrestrial Receptor Species, SWMU 15 Biopile Soils

COPC	Robin				Kestrel				Vole				Shrew				Fox			
	NOAEL HQ		LOAEL HQ		NOAEL HQ		LOAEL HQ		NOAEL HQ		LOAEL HQ		NOAEL HQ		LOAEL HQ		NOAEL HQ		LOAEL HQ	
	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean
Inorganics (mg/kg) Collected August 1999																				
Aluminum	49.420	7.974	4.942	0.797	18.099	0.978	1.809	0.098	510.737	3.497	51.074	0.350	1227.259	107.647	122.726	10.765	496.330	55.572	49.633	5.557
Antimony	NA	NA	NA	NA	NA	--	NA	--	0.201	0.037	0.020	0.004	0.484	0.434	0.048	0.043	0.196	0.235	0.020	0.024
Arsenic	0.367	0.083	0.122	0.028	0.134	0.000	0.045	0.00001	1.304	0.048	0.130	0.005	3.133	0.791	0.313	0.079	1.267	0.007	0.127	0.0007
Barium	0.943	0.249	0.471	0.124	0.345	0.016	0.172	0.008	1.802	0.235	0.180	0.024	4.330	1.454	0.433	0.145	1.751	0.085	0.175	0.009
Beryllium	NA	NA	NA	NA	NA	--	NA	--	0.039	0.000	0.004	0.000	0.093	0.076	0.009	0.008	0.038	0.013	0.004	0.001
Cadmium	0.060	0.017	0.006	0.002	0.022	0.004	0.002	0.0004	0.156	0.040	0.016	0.004	0.375	0.179	0.038	0.018	0.005	0.001	0.000	0.0001
Chromium	7.511	1.053	1.502	0.211	2.749	0.211	0.550	0.042	54.625	0.509	5.463	0.051	131.260	6.838	13.126	0.684	53.085	4.172	5.308	0.417
Cobalt	1.101	0.519	0.110	0.052	0.403	0.009	0.040	0.001	0.200	0.004	0.020	0.0004	0.481	0.413	0.048	0.041	0.195	0.005	0.019	0.0005
Copper	34.725	3.538	3.472	0.354	12.710	0.937	1.271	0.094	1.484	0.220	0.148	0.022	3.565	0.394	0.357	0.039	1.442	0.107	0.144	0.011
Iron	32.190	4.696	3.219	0.470	11.782	0.114	1.178	0.011	11.705	0.074	1.171	0.007	28.127	2.065	2.813	0.207	11.375	0.131	1.138	0.013
Lead	42.072	4.202	4.207	0.420	15.399	0.649	1.540	0.065	15.299	0.424	1.530	0.042	36.763	1.532	3.676	0.153	14.868	0.645	1.487	0.065
Manganese	0.013	0.002	0.001	0.000	0.005	0.0005	0.000	0.00005	0.027	0.006	0.008	0.002	0.064	0.005	0.020	0.002	0.026	0.005	0.008	0.002
Mercury	1.177	0.758	0.118	0.076	0.431	0.026	0.043	0.003	0.080	0.064	0.016	0.013	0.193	0.203	0.039	0.041	0.249	0.015	0.025	0.002
Nickel	0.001	0.003	0.001	0.002	0.0004	0.001	0.0003	0.001	0.0004	0.0002	0.0002	0.0001	0.001	0.003	0.0004	0.001	0.0002	0.001	0.00002	0.0001
Selenium	0.424	0.516	0.212	0.258	0.155	0.038	0.078	0.019	0.154	0.004	0.093	0.002	0.370	0.996	0.224	0.604	0.150	0.037	0.091	0.022
Silver	NA	NA	NA	NA	NA	--	NA	--	0.005	0.002	0.0005	0.0002	0.011	0.010	0.001	0.001	0.004	0.006	0.0004	0.0006
Thallium	NA	NA	NA	NA	NA	--	NA	--	6.452	0.043	0.645	0.004	15.504	13.157	1.550	1.316	6.270	0.603	0.627	0.060
Vanadium	0.696	0.109	0.070	0.011	0.255	0.012	0.025	0.001	6.870	0.055	0.687	0.006	16.507	1.299	1.651	0.130	6.676	0.677	0.668	0.068
Zinc	0.636	0.129	0.064	0.013	0.233	0.101	0.023	0.010	0.043	0.054	0.004	0.005	0.104	0.017	0.010	0.002	0.062	0.027	0.006	0.003
Semivolatile Organics (ug/kg) Collected October 1998																				
Acenaphthene	0.282	0.008	0.028	0.001	0.103	0.003	0.010	0.0003	0.395	0.008	0.197	0.004	0.949	0.031	0.474	0.015	0.384	0.019	0.192	0.010
Acenaphthylene	1.129	0.046	0.113	0.005	0.413	0.013	0.041	0.001	1.580	0.042	0.790	0.021	3.796	0.158	1.898	0.079	1.535	0.100	0.768	0.050
Anthracene	0.096	0.006	0.010	0.001	0.035	0.002	0.004	0.0002	0.134	0.003	0.067	0.001	0.323	0.026	0.161	0.013	0.130	0.014	0.065	0.007
Benzo(a)anthracene	0.062	0.001	0.008	0.0001	0.023	0.0004	0.002	0.00004	0.087	0.0002	0.043	0.0001	0.209	0.006	0.104	0.003	0.084	0.003	0.042	0.001
Benzo(a)pyrene	0.113	0.006	0.011	0.001	0.041	0.002	0.004	0.0002	0.158	0.0004	0.079	0.0002	0.380	0.025	0.190	0.012	0.154	0.013	0.077	0.006
Benzo(b)fluoranthene	0.280	0.018	0.028	0.002	0.102	0.004	0.010	0.0004	0.391	0.001	0.195	0.001	0.939	0.063	0.470	0.032	0.380	0.032	0.190	0.016
Benzo(g,h,i)perylene	0.593	0.013	0.059	0.001	0.217	0.002	0.022	0.0002	0.829	0.001	0.415	0.0003	1.993	0.037	0.996	0.018	0.806	0.019	0.403	0.009
Benzo(k)fluoranthene	0.904	0.041	0.090	0.004	0.331	0.022	0.033	0.002	1.264	0.214	0.632	0.107	3.037	0.130	1.518	0.065	1.228	0.172	0.614	0.086
Chrysene	0.121	0.003	0.012	0.0003	0.044	0.001	0.004	0.0001	0.170	0.0003	0.085	0.0002	0.408	0.016	0.204	0.008	0.165	0.008	0.083	0.004
Dibenz(a,h)anthracene	0.226	0.014	0.023	0.001	0.083	0.004	0.008	0.0004	0.316	0.001	0.158	0.0003	0.759	0.068	0.380	0.034	0.307	0.034	0.154	0.017
Fluoranthene	1.129	0.061	0.113	0.006	0.413	0.018	0.041	0.002	1.580	0.013	0.790	0.006	3.796	0.266	1.898	0.133	1.535	0.139	0.768	0.070
Fluorene	3.953	0.074	0.395	0.007	1.447	0.020	0.145	0.002	5.529	0.061	2.764	0.030	13.285	0.244	6.643	0.122	5.373	0.153	2.686	0.076
Hexachlorobutadiene	0.001	0.0001	0.0001	0.0000	0.0003	0.0001	0.00003	0.00001	0.001	0.00002	0.001	0.00001	0.003	0.001	0.001	0.0004	0.001	0.0004	0.001	0.0002
Indeno(1,2,3-cd)pyrene	0.012	0.017	0.001	0.002	0.004	0.005	0.0004	0.001	0.016	0.001	0.008	0.0003	0.039	0.078	0.019	0.039	0.016	0.039	0.008	0.020
Phenanthrene	0.138	0.005	0.014	0.001	0.051	0.001	0.005	0.0001	0.194	0.002	0.097	0.001	0.465	0.019	0.232	0.010	0.188	0.011	0.094	0.005
Pyrene	0.011	0.0003	0.001	0.00003	0.004	0.0001	0.0004	0.00001	0.016	0.0001	0.008	0.00003	0.038	0.001	0.019	0.001	0.015	0.001	0.008	0.0004

NA- NOAEL/LOAEL values not available

Shaded Cells Indicate a HQ > 1.0

Italicized Cells Indicate HQs Calculated Using Mean Concentrations

TABLE 3: SWMU 15 Biopile Soils, December 1999 PAH Sampling Results

SWMU 15 and Tarmac Resoration Area Biopile Surface Soil Sample Results

	OW15-SS10	Q.L.	OW15-SS11	Q.L.	OW15-SS12	Q.L.	OW15-SS13	Q.L.	OW15-SS14	Q.L.	OW15-SS16	Q.L.	OW15-SS18	Q.L.	OW15-SS19	Q.L.	OW15-SS20	Q.L.	OW15-SS21	Q.L.	Average Concentration	Minimum Detected Concentrtaion	Maximum Detected Concentration	Arithmetic Mean of Detected Concentrations
1-Methylnapthalene	18	U	19	U	19	U	19	U	19	U	18	U	18	U	19	U	20	U	19	U	18.8	18.0	20.0	18.8
2-Methylnapthalene	18	U	19	U	19	U	19	U	19	U	18	U	18	U	19	U	240		19	U	40.8	18.0	240.0	40.8
Acenaphthene	18	U	19	U	19	U	220		19	U	18	U	18	U	19	U	20	U	19	U	38.9	18.0	220.0	38.9
Acenaphthylene	35	U	38	U	37	U	37	U	38	U	36	U	36	U	37	U	39	U	37	U	37.0	35.0	39.0	37.0
Anthracene	49		7.5		6.1		130		5.2		14		2.8		4.9		17		9.4		24.6	2.8	130.0	24.6
Benzo(a)anthraceme	350		54		69		600		52		110		22		48		140		57		150.2	22.0	600.0	150.2
Benzo(a)pyrene	460		110		78		680		66		130		26		45		190		50		183.5	26.0	680.0	183.5
Benzo(b)fluoranthene	360		78		93		600		36		120		35		47		210		47		162.6	35.0	600.0	162.6
Benzo(g,h,i)perylene	400		72		100		640		37		150		3.9		67		250		57		177.7	3.9	640.0	177.7
Benzo(k)fluoranthene	150		2	U	40		220		25		46		13		23		78		25		62.2	2.0	220.0	62.2
Chrysene	400		85		86		510		48		130		27		53		170		51		156.0	27.0	510.0	156.0
Dibenzo(a,b)anthracene	11		3.8	U	3.7	U	33		3.8	U	160		3.6		3.7	U	3.9	U	3.7		23.0	3.6	160.0	23.0
Floranthene	390		56		69		800		65		150		42		73		210		100		195.5	42.0	800.0	195.5
Fluorene	18		4.3		3.7	U	57		3.8	U	9.4		3.7		6.7		11		3.7	U	12.1	3.7	57.0	12.1
Indeno(g,h,i)perylene	270		42		57		440		35		86		23		35		140		35		116.3	23.0	440.0	116.3
Naphthalene	18	U	19	U	19	U	19	U	19	U	18	U	18		19	U	20	U	19	U	18.8	18.0	20.0	18.8
Phenthrene	160		26		23		500		36		72		23		26		88		44		99.8	23.0	500.0	99.8
Pyrene	430		70		84		860		70		160		43		80		240		96		213.3	43.0	860.0	213.3
TOTAL PAHs (per sample)	**3555.0**		**724.6**		**825.5**		**6384.0**		**596.8**		**1445.4**		**376.0**		**625.3**		**2086.9**		**691.8**					

Background Location Surface Soil Sample Results

	OW15-SS15	Q.L.	OW15-SS17	Q.L.	OW15-SS22	Q.L.	OW15-SS23	Q.L.	OW15-SS23P	Q.L.	OW15-SS24	Q.L.	Average Concentration	Minimum Detected Concentrtaion	Maximum Detected Concentration	Arithmetic Mean of Detected Concentrations
1-Methylnapthalene	26	U	24	U	21	U	24	U	23		21	U	23.2	21	26.0	23.2
2-Methylnapthalene	26	U	24	U	21	U	24	U	23	U	21	U	23.2	21	26.0	23.2
Acenaphthene	26	U	24	U	21	U	24	U	23	U	21	U	23.2	21	26.0	23.2
Acenaphthylene	52	U	48	U	42	U	48	U	46	U	42	U	46.3	42	52.0	46.3
Anthracene	3	U	2	U	2	U	2	U	3.9		2	U	2.5	2	3.9	2.5
Benzo(a)anthraceme	220		79		3.1		17		14		4.5		56.3	3.1	220.0	56.3
Benzo(a)pyrene	340		95		4.7		9.5		43		7.6		83.3	4.7	340.0	83.3
Benzo(b)fluoranthene	270		58		4.1	J	10		31		5		63.0	4.1	270.0	63.0
Benzo(g,h,i)perylene	180		57		6.4		9.6		29		7.8		48.3	6.4	180.0	48.3
Benzo(k)fluoranthene	270		44		11		2	U	2	U	6.6		55.9	2	270.0	55.9
Chrysene	320		97		5.8		16		29		5.5		78.9	5.5	320.0	78.9
Dibenzo(a,b)anthracene	5.2	U	4.8	U	4.2		4.8	U	6.2		4.2	U	4.9	4.2	6.2	4.9
Floranthene	580		160		5.8		27		30		12		135.8	5.8	580.0	135.8
Fluorene	5.2	U	4.8	U	4.2	U	4.8	U	4.6	U	4.2	U	4.6	4.2	5.2	4.6
Indeno(g,h,i)perylene	97		40		3.2		19		23		8.5		31.8	3.2	97.0	31.8
Naphthalene	26	U	24	U	21	U	24	U	23	U	21	U	23.2	21	26.0	23.2
Phenthrene	200		53		3.9		16		12		4.7		48.3	3.9	200.0	48.3
Pyrene	430		150		7.1		21		22		6.7		106.1	6.7	430.0	106.1
TOTAL PAHs (per sample)	**3076.4**		**988.6**		**191.5**		**302.7**		**387.7**		**205.3**					

TABLE 4: SWMU 15 PAH Summary Statistics, December 1999 vs. October 1998

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected (12/99)	Maximum Concentration Detected (10/98)	Arithmetic Mean (12/99)	Arithmetic Mean (10/98)	BTAG Screening Values	Frequency of Exceedence	Maximum Hazard Quotient	COPC?	Alternate Screening Values	Frequency of Exceedence	Maximum Hazard Quotient	COPC?	Background Values[1]	
															Maximum	Mean
1-Methylnapthalene	18 - 39	0 / 5	*39*		11.3		NB	-- / --	NB	YES	NB	-- / --	NB	YES	26	23
2-Methylnapthalene	18 - 39	0 / 5	*39*		11.3		NB	-- / --	NB	YES	NB	-- / --	NB	YES	26	23
Acenaphthene	18 - 90	1 / 6	120	10,000	29.4166667	951.62	100	1 / 6	1.20	YES	20000	0 / 6	0.01	NO	26	23
Acenaphthylene	36 - 77	0 / 5	*77*	***40000***	22.3	6351.76	100	-- / --	NB	YES	NB	-- - --	NB	YES	52	46
Anthracene	2 - 20	9 / 10	120	3400	25.24	753.85	100	1 / 10	1.20	YES	2050	0 / 10	0.06	NO	3.9	2
Benzo(a)anthracene	2 - 20	10 / 10	450	2200	156.8	193.82	100	5 / 10	4.50	YES	2050	0 / 10	0.22	NO	220	56
Benzo(a)pyrene	2 - 20	10 / 10	720	***4000***	235.5	693.47	100	5 / 10	7.20	YES	2050	0 / 10	0.35	NO	340	83
Benzo(b)fluoranthene	3.6 - 37	10 / 10	490	9900	193.8	2629.12	100	5 / 10	4.90	YES	NB	-- - --	NB	YES	270	63
Benzo(g,h,i)perylene	3.6 - 37	10 / 10	610	21000	209	1970.29	100	6 / 10	6.10	YES	2050	0 / 10	0.30	NO	180	48
Benzo(k)fluoranthene	2 - 20	9 / 9	240	***32000***	70	5428.24	100	2 / 9	2.40	YES	2050	0 / 9	0.12	NO	270	56
Chrysene	2 - 20	10 / 10	490	4300	190.5	365.18	100	5 / 10	4.90	YES	2050	0 / 10	0.24	NO	320	79
Dibenz(a,h)anthracene	3.6 - 37	3 / 7	160	***8000***	32.6214286	1384.41	100	1 / 7	1.60	YES	NB	-- - --	NB	YES	6.2	5
Fluoranthene	3.6 - 37	10 / 10	810	40000	217.9	6934.71	100	6 / 10	8.10	YES	2050	0 / 10	0.40	NO	580	136
Fluorene	3.6 - 37	7 / 8	41	140000	14.26875	10564.12	100	0 / 8	0.41	NO	30000	0 / 8	0.001	NO	5.2	5
Hexachlorobutadiene				30		8.22										
Indeno(1,2,3-cd)pyrene	2 - 20	10 / 10	410	***16000***	131.1	1853.56	100	4 / 10	4.10	YES	2050	0 / 10	0.010	NO	97	32
Naphthalene	18 - 39	0 / 5	*39*	***38000***	11.3	1272.06	100	-- / --	0.39	NO	2050	0 / 5	0.02	NO	26	23
Phenanthrene	2 - 20	10 / 10	470	4900	106.8	641.06	100	3 / 10	4.70	YES	2050	0 / 10	0.23	NO	200	48
Pyrene	2 - 20	10 / 10	890	400	243.3	35.89	100	5 / 10	8.90	YES	NB	-- - --	NB	YES	430	106

100 - Upper Detection Limit used as MAX

NB - No Benchmark

U - Not Detected

1 - CH2MHILL, December 1999