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MOFFETT FIELD
SSIC NO. 5090.3

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MEMORANDUM

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Human and Ecological Risk Section (HERS)

DATE: January 16, 1996

SUBJECT: Moffet Field, Site Wide Ecological Assessment - PCB congeners
PCA = 14740, Site = 200068/45

This memorandum is a follow-up to our HERS memorandum, dated December 8, 1995, on the Moffett Field Phase II Site Wide Ecological Assessment (SWEA). As part of the assistance HERS is providing to the Navy contractors in the development of wildlife toxicity reference values, the contractors requested that HERS clarify our recommendations for using the polychlorinated biphenyl (PCBs) congener-specific data collected for Phase II.

Background

1. The analytical methods for PCB mixtures (e.g. Aroclor 1254, 1260, etc.) are based on visual recognition of patterns of peaks in the sample and a comparison to the pattern of peaks in a standard Aroclor. The peaks do not necessarily correspond to individual PCB congeners; one or more congeners may elute under the same peak. When these methods are applied to samples of weathered environmental material (e.g. sediments) or biota, they become semi-quantitative because the patterns of the originally spilled Aroclors have changed through biodegradation or metabolism. These changes make the comparison to the standard Aroclor mixtures problematic. There is evidence to indicate that the PCB congeners with toxicity similar to 2,3,7,8-tetrachlorodibenzo-p-

dioxin (TCDD) are among those enriched or retained. These congeners include the non-ortho, di-ortho, and mono-ortho substituted PCB congeners (Refs. 1,2,6,7,9).

Therefore, Aroclor analytical methods may not identify a biological sample as containing an Aroclor mixture, when in fact the biota contain PCB congeners. Another consideration is the detection sensitivity of the PCB congener analysis is better, by a few orders of magnitude, than the Aroclor analytical methods. Therefore, a sample of soil, sediment, or biota may not detect the presence of Aroclor mixtures, while the same sample analyzed using the PCB congener methods may detect the presence of PCBs. For these reasons, reliance on the Aroclor data alone is insufficient in evaluating the PCB toxicity to wildlife, in particular when food-chain transfer may be a dominant pathway.

An example of this phenomenon is the pickleweed and sediment data collected at Moffett at locations SSRP-34. The Aroclor analysis failed to detect any of the Aroclor mixtures in either sediment or pickleweed. Nonetheless, several PCB congeners were found in the pickleweed, and sediment using congener-specific analysis. One reason is the Aroclor analysis has detection limits of about 10 to 26 ppb, while the congener specific analysis has detection limits considerably lower at about 1 x 10^{-3} ppb. Another possible reason is the issue of degradation or biological uptake resulting in the selective enrichment of the higher chlorinated congeners.

2. It is widely reported in the literature that the non-ortho, mono-ortho, and di-ortho PCB congeners exhibit effects similar to TCDD in a variety of birds and mammals. The PCB congeners which are most potent TCDD-mimics include PCB 77, 126 118, 153, 180, 156. (Refs. 1, 2, and 3). Several authors indicate that the evaluation of PCB toxicity based on the Aroclor mixture alone can underestimate toxicity compared to that determined by accounting for the selective enrichment of the more toxic PCB congeners. (Refs. 9, 10)

3. Due to the selective retention of certain PCB congeners, including congeners which have TCDD-like toxicity, several authors have used a toxicity equivalency factor (TEF) approach for those PCB congeners which exhibit TCDD-like toxicity. (Refs. 3, 4, 5, 8, 10, 12). One drawback to the TEF approach is that additivity of the toxicity is assumed. There is some evidence that there may be antagonistic interactions between nonTCDD-like PCBs and the TCDD-like congeners (Ref. 3). Other authors suggest that there may be synergistic (greater than additive) effects among combinations of the di-, mono, and non-ortho-substituted PCBs (Ref. 12). Therefore, the TEF approach may overestimate, or perhaps even underestimate, the toxicity of PCBs.

Recommendations

It is for the reasons stated above that OSA originally requested that congener-specific PCB analysis be conducted in Phase II, in addition to the Aroclor analysis. Due to the higher cost of the congeners specific analysis versus the Aroclor method, the Navy was reluctant to conduct congener-specific analysis on all Phase II SWEA samples. So, it was agreed that all Phase II samples would have Aroclor analysis, while a limited subset of samples would be analyzed using congener-specific methods. The congener-specific data would then be extrapolated to other locations where only Aroclor data were available. HERS has the following recommendations for evaluating the PCB congener-specific data in the Phase II SWEA:

A. Determine ratios of toxicologically/environmentally important congeners to the Aroclor data, and apply these ratios to estimate these congener concentrations at locations where only Aroclor data are available. Refer to Dr. Mryto Petreas memorandum for specific details and examples, dated January 10, 1996 (attached). In this manner, congener concentrations for the most relevant TCDD-like congeners can be estimated. As Dr. Petreas points out, the limited data set for congener-specific analysis means that there will be uncertainties in the congener-specific estimates. However, as the summary data presented by Dr. Petreas indicates, reliance on the Aroclor data alone does not provide a full description of the nature of PCB contamination at Moffett Field.

There is a matched set of congener-specific and Aroclor data for sediments and polychaetes at Moffett Field. However, for the pickleweed data, sample location SSRP-34 did not detect Aroclors, while congener-specific PCBs were detected. Because of this, ratios of congener-specific PCBs to Aroclor concentrations can not be developed for pickleweed . Thus, the congener-specific data for pickleweed cannot be extrapolated to other locations at Moffett. We suggest that the SSRP-34 congener-specific data for pickleweed be used to estimate incidental sediment ingestion and food-chain dioxin-like PCB doses to the salt marsh harvest mouse, and uncertainties and data gaps be discussed in the SWEA. This will underestimate toxicity from dioxin-like PCBs since other areas of pickleweed habitat have detected Aroclors.

While it is true that different Aroclor mixtures can vary in the congener concentrations, the source to the wetlands at Moffett Field has been from the release of contaminants in stormwater drains at select locations and subsequent deposition in sediments. Apparently, this discharge has occurred over a number of years. This manner of deposition could be expected to result in a more homogeneous mixture than if the release where discreet spills or disposal directly to different locations in the wetlands. Nevertheless, there is uncertainty in extrapolating from the limited number of

congener-specific analysis, which can be reduced only by taking more congener-specific samples.

B. Choose TEFs from applicable references (e.g. Refs. 3,5 for mammals; Ref. 4 for birds). While the data for bird species indicates a wide number of species are sensitive to the TCDD-like effects of these PCB congeners, to date only TEFs based on chicken data are available in the open literature. However, not all the representative bird species chosen at Moffett have been tested using the TCDD-like PCB congeners. Therefore, use of the TEFs for birds cited in Bosveld et al. (1995) may be conservative since there is some indication in the literature that chickens are among the most sensitive species tested for TCDD-like toxicity.

C. Use the TEFs chosen in B., along with the PCB congener concentrations determined in A., to calculate a toxicity equivalency concentration (TEQ). This TEQ is a single value which represents the relative contribution, based on TCDD-like potency, in a sample. This is very similar to what is typically done to estimate the relative contribution to toxicity of polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran mixtures (PCDD/Fs). This TEQ can then be used in the dose calculations. Depending on the data analysis in A., a separate TEQ may be needed for sediment, pickleweed, and polychaetes.

D. Use wildlife toxicity reference values (TRVs) based upon TCDD toxicity data and uncertainty factors presented in U.S. EPA (Ref. 13). Separate data are presented for birds and mammals. This follows a similar recommendation we have made for Moffett Field TRVs for DDTr and mercury. The TCDD TRVs, along with the TEQ dose estimates made in C. above, can be used to develop hazard quotients for vertebrate species at Moffett Field.

Summary

Due to the selective retention of PCB congeners by biota, and because certain PCB congeners are potent TCDD-mimics, reliance on the Aroclor data alone would provide a misleading representation of the potential PCB hazards to wildlife, and may underestimate toxicity. The approach recommended above for select PCB congeners, in addition to the evaluation of the Aroclor toxicity already proposed by the Navy and their contractors, will provide a fuller description of potential hazards to wildlife from PCB to the remedial managers for their consideration in evaluating possible remedial actions. OSA is well aware that the approach suggested for PCB congeners has uncertainties. However, in the absence of additional congener-specific samples, these are the only data available at Moffett Field.

If you have any questions, please contact me at (916)327-2513.

Attachment (1)

Peer Reviewed: Gerald Chernoff, Ph.D.,
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To: Laura Valoppi, OSA

From: Myrto Petreas, HML MP

Date: January 10, 1996

Re: PCB data at Moffet

Following our meeting last week, I reviewed in more detail the PCB data contained in the Draft Phase II Report for Moffet. My task was to assess:

1 How congener-specific PCB data and Aroclor data for the same samples compared;

2 Whether Aroclor data could be used to estimate congener-specific PCB data for sediments and biota.

The attached table summarizes data for the sediment/pickleweed (SSRP-34) and the sediment/polychaete (SSWL-22) sets. Please note that all measurements are in the same units (pg/g). Also note that the value for Total PCB for sediment SSWL-22 in the report is incorrect. The correct value (calculated by summing the total mono- to deca-PCB) is in the table. Of all individual congeners I chose to show only the 3 coplanars (77, 126, 169) which are the most toxic; and PCB 105 and 118 as examples of prevalent and toxic mono-orthos. The table could be expanded to include all other PCB congeners reported, particularly those with an assigned TEF value.

Please note that I have not received any reply to the comments I had submitted to Joseph and, therefore, I have no information on the methodology used in the congener analysis in order to judge its quality. For the purpose of this task I will assume that the congener PCB data are accurate and valid. I will also assume that the samples bearing the same ID are homogeneous, i.e., the two labs who performed the analyses (Aroclor and congeners) did so on the same homogeneous (or previously homogenized) sample.

This brings up the first striking observation. Looking at sediment SSWL-22 (the only sample with complete data), PCB 118 is 58% of Aroclor 1254. This is very irregular, given that PCB 118 is usually ~10% of 1254. Even more irregular is the comparison of PCB 118 with Aroclor 1260, where PCB 118 appears to be over twice the concentration of 1260. Usually, PCB 118 is 5-10% of 1260. There is clearly some big error here. One explanation may be the semiquantitative nature of Aroclor analysis on weathered or metabolised materials. A review of the Aroclor chromatograms may reveal lack of fit to assumed patterns. Such inaccuracies are the basic reasons that congener-specific PCB analysis is such a breakthrough. Similar conclusions can be drawn by observing the ratios of PCB 105 and Aroclors.

It is unfortunate that we only have one sample with complete data.

However, we could use that sample as a crude tool to translate Aroclor data to congener data in sediments. Using the ratios shown in the table, all maps showing Aroclor data could generate maps showing estimated PCB 118, 105, etc. I feel more confident about such prevalent and abundant congeners than I do about the coplanar PCBs. The reason is that the latter are present at very low levels and any extrapolation may introduce great error. Of course, one could estimate coplanar PCBs, keeping this caveat in mind as long as these concentrations are considered crude estimates. TEFs could then be applied and toxic equivalents (TEQs) calculated for each sediment sample. I would suggest you calculate TEQs with and without the coplanars to determine a range of TEQs. This could serve as a screening tool by which one could evaluate the potential toxicity of sediments.

To go from sediments to biota, we are again limited to SSWL-22 sediment/polychaete pair. BAFs can be calculated for each congener SEPARATELY. It makes no sense to obtain specific congener data only to lump them all together in calculating "Total PCB BAFs".

We have no information on whether this sediment/polychaete pair is representative of sediments and polychaetes, or whether BAFs in polychaetes could be used as BAFs in pickleweed. Nevertheless, unless more congener-specific data are generated, I cannot see any other way to salvage the data.

cc: Joseph Chao, OMF
Bart Simmons, HML

MOFFET

CONCENTRATION (pg/g) OF SPECIFIC PCB CONGENERS AND AROCLORS

SAMPLE #	TYPE	#77	#126	#169	#105	#118	TOTAL PCB	AR 1254	AR 1260
SSRP-34	SEDIMENT	34	9.7	1.2 U	250	570	11,900	26,000 U	26,000 U
SSWL-22	SEDIMENT	33,000	6,700	120	500,000	1,400,000	75,585,148	2,400,000	680,000
SSRP-34	PICKLEWD	6.8	1.3 U	0.2 U	49	120	2,720	10,000 U	10,000 U
SSWL-22	POLYCH	3200	470	28 U	46,000	80,000	1,392,070	3,000 U	330,000
RATIOS									
CONG/AROCLOR 1254		0.014	0.003	0.000050	0.21	0.58	31.5		
CONG/AROCLOR 1260		0.049	0.010	0.000176	0.735	2.06	111.2		

NOTE: Entries with a "U" suffix indicate measurements below the detection limit. The shown number is the detection limit