March 15, 1999

MEMORANDUM

TO: Roland B. Hemmett, Ph.D.
Science Advisor
Region II

FROM: Philip M. Cook, Ph.D
Research Chemist

SUBJECT: Scientific Peer Review Comments for Region II/CENAN Framework for Evaluating Dredged Material for the Proposed Placement at the HARS

I was asked to address questions 4B (for PCBs and DDT only), 5A, 5B, 9, 11, and 12 in the peer review charge. The framework document, which I received on March 15, 1999, is a hypothetical example of a completed testing memo. I needed it in order to understand the complex process used to determine the category of dredged material on the basis of bioaccumulation information. Due to your immediate need for comments, I am restricting my comments in this memorandum to question 5 only. Thus, the major focus of my review is for dioxin bioaccumulation and toxicity risk assessment. This includes concern for the contribution of co-planar PCB congeners to dioxin toxicity.

Figure 1 in the peer review hypothetical memo diagrams the framework for evaluating bioaccumulation test results. I am particularly concerned about the process (a) if chemical "X" is bioaccumulated less from the test sediment than from the reference sediment. I recognize that it is likely that reference sediments will be cleaner than test sediments for dioxins, but what if they aren't? One would like to see a clear and comprehensive definition of the approach used here. If the same principle was applied to Lake Ontario, would it make sense? That is, if the reference area is highly contaminated, is it ok to dispose of dredge spoils as long as they have a lower concentration of dioxin-like chemicals? I think the answer is no because the disposal increases the chemical mass in a system in which it already exceeds safe levels. Figure 1 seems to indicate that if chemical "X" is greater from the reference sediments, no risk evaluation is needed and one goes on to (d) the integrated effects evaluation. It is unclear from the framework whether the a value greater than the regional dioxin values (1 ppt for TCDD and 4.5 ppt for TEQ) would result in a decision that the material is not Category 1. According to figure 1 this could only happen in step "d" but the description of step "d" is ambiguous on this point.

**Question 5A:**

In candor, I must state my reservations for the perpetuation of an unnecessary and potentially inaccurate basis for bioaccumulation assessment of dredge spoils. A basic scientific problem often occurs when methods evolve over many years without a fresh look, in the context of the present state of science, at the fundamental models, data, and assumptions that were incorporated into them in the beginning. Perhaps this is happening in this case with a method predicated on the need to test each

sediment for bioaccumulation. The use of a 28 day benthic invertebrate test of bioaccumulation, especially for assessing human health risks, seems to me to be a clumsy and scientifically indefensible approach. The result of the test is a concentration in the organism that may be influenced by test conditions and has little relevance to human or wildlife dietary exposures. More importantly, what factors other than sediment organic carbon content are likely to cause a significant difference in TCDD bioavailability from different sediments to the test organisms? Most food chain models are successful with an assumption of equilibrium partitioning to a benthic invertebrate species. Bioaccumulation potential can be better determined on the basis of the sediment organic carbon normalized concentration of the chemical and some standard condition assumptions for the magnitude of food chain transfer from the sediments to the fish or other organism that is either the subject of the risk assessment or the diet of the subject.

Another complication is that TCDD and the other congeners included in the TEQ analysis all have different bioaccumulation potentials in food chains. Bioavailabilities differ in proportion to hydrophobicities ($K_{ow}$) and once accumulated by fish, they are subject to varying degrees of metabolism. The framework uses reference 89 to document the calculations used to arrive at categories 1, 2, and 3 for dioxin risks. A trophic transfer factor of 1.0 is used for TCDD and, presumably, for all other congeners. The Great Lakes Water Quality Initiative/Guidance Technical Support Document for the Procedure to Determine Bioaccumulation Factors contains bioaccumulation equivalency factors (BSAF ratios) that reveal lower bioaccumulation potential in comparison to TCDD for all PCDDs and PCDFs except 1,2,3,7,8-PeCDD and 2,3,4,7,8-PeCDF. Perhaps more importantly, this EPA dioxin criterion document provides BSAFs for fish that would be **far better estimates of the $EMFC_{ss}$** used in the Region 2 dioxin risk evaluation than the benthic invertebrate test values. The equation for calculating the $EMFC_{ss}$ on a TEQ basis is:

$$EMFC_{ss} = \sum_{i=1}^{n} (C_{soc})_i \ (BSAF)_i \ (f_R) \ (TEF)_i$$

where:

$(C_{soc})_i$ is the concentration of congener i in sediment normalized to organic carbon
$(BSAF)_i$ is the fish biota sediment accumulation factor for congener i
$f_R$ is the fraction lipid in the fish
$(TEF)_i$ is the toxicity equivalence factor for congener i (WHO human health/mammal, fish, or bird TEF depending on species at risk)
for TCDD alone: n = 1, TEF = 1, BSAF = 0.06

The use of BSAFs from the Great Lakes may seem ridiculous, but they are probably no more than slightly conservative (slightly over-predictive of bioaccumulation) for fish living on a disposal site and may actually predict lower dioxin risk than the present procedure while allowing for a more accurate and straightforward TEQ analysis. The Great Lakes BSAFs are typical for sediment/benthic food chain-driven bioaccumulation with small contribution from chemicals in the overlying water, as one would expect to be the case for dredge spoil disposal area conditions. One additional complication is

that a TEQ analysis that ignores the contributions of PCBs assumes that a significant underestimation of risk is acceptable.

**Question 5B:**

The Region 2 memo to file by Alex Lechich on 3/15/97 summarizes the dioxin risk evaluation approach. The use of a different toxicity equivalence concentration (TEqC) of 4.5 ppt than the 1 ppt TCDD concentration limit for category 1 seems inconsistent but may be the result of congener detection limits - is 4.5 ppt the theoretical detection limit for TEqC?

The human health criterion used by Region 2 for TCDD is 10 ppt in fish tissue. The TEqC is not defined so one assumes it is also 10 ppt. At a consumption rate of 6.5 g fish for 70 years the cancer risk is about $10^{-4}$, a not very conservative risk factor. I believe the World Health organization recently established a daily human dose limit of 1-4 pg TEQ/Kg/day. For a 70 Kg person consuming 6.5 g fish/day, this would amount to TEqC = 10 - 40 ppt in fish. The questions asked of the peer reviewer under 5B are primarily risk management issues (population subgroups; target species differences; definition of significant undesirable effects) and thus are not within the expertise of this reviewer.

The comparison of human health risks and ecological risks is complicated by differences in definitions of risks (individual versus population) and differences in end points (cancer versus early life stage survival). Both the human and ecological risk criteria in this case involve exposure concentrations which are not intended to be exceeded. Implicitly, if one is exceeded and the other is not, the exceeded criterion should determine the classification. If not, there is no need for the ecological risk criterion.

The only definition of an ecological risk criterion is reference to Cook et al. 1993 for low risk to fish at 50 ppt. Based on data reported since 1993, early life stage survival of the most sensitive species would require TEqC in eggs/embryos to be less than 10 ppt. This is based on finding a more sensitive species than lake trout and recognition that developmental effects and growth reduction at sub-lethal exposure concentrations likely compromise survival in the environment. On the other hand, it is unlikely that fish species inhabiting disposal sites are the most sensitive species. The potentially greater sensitivity of some birds and mammals to TCDD does not infer greater risks due to the decreased potential for site-specific exposures of free ranging species.