HOUSATONIC RIVER MODEL CALIBRATION
PRELIMINARY PEER REVIEW COMMENTS BY E. JOHN LIST

On the face of it the models appear to be satisfactorily calibrated but on closer inspection I have come reluctantly to the opinion that the EFDC model, in its application to predicting the fate and transport of PCB's in the Housatonic Valley, is most probably flawed.

The basic problem is not with the EFDC model *per se* but in its specific application to the sediments in the Housatonic Valley. The difficulty arises in part because the PCB concentrations within the sediments show an extreme spatial variability. This variability exists on a very small length scale (see slides Number 3 and 4 of the presentation by Dick McGrath to the Peer Review Panel on April 13) and, what is even more important, it seems that this small-scale spatial variability is carried over essentially uniformly to the large scale, as is evident on Figure 5-26 of the calibration report[1]. These figures show that PCB concentrations in the top six inches of sediment range almost uniformly from 0.5 mg/kg to 200 mg/kg (approximately three orders of magnitude) over 11 miles of the river valley. There is no explanation for this essentially uniform distribution of extreme variability in the calibration report. When Ed Garland (presumptive leader of the modeling team) was directly asked for an explanation for this variability at the Peer Review Panel Meeting he responded that he did not know, and nobody from the EPA consulting team volunteered an explanation. In the absence of any explanation for why this variability is present it is difficult to believe that the modeling exercise, which deals only in spatial averages, can properly represent the fate and transport of the PCB.

The key point here is that there is no reason to believe that this extreme variability in the sediment concentration of PCB has not existed for many years; for it seems unreasonable to believe that it is a recent phenomenon. It is also unlikely that it is a mere sampling artifact. In other words, all of the sediment erosion and deposition during the past thirty some or more years since major PCB releases occurred has not caused the concentration of PCB's to average out, even over relatively short scales of a few meters. The importance of this observation is that the EFDC fate and transport model uses *spatially-averaged* PCB concentration data and therefore cannot possibly hope to reproduce either the observed current spatial variability or predict any future variability. A long term application of the model is therefore simply going to smooth everything out to produce an average concentration; something that has not occurred naturally, at least so far. In some respects, it is somewhat analogous to trying to model tidal currents with a model that uses flows temporally-averaged over a time scale of 12 hours. Here it is a model that uses spatial averages over a relatively large spatial element that incorporates almost three orders of magnitude change in concentration. Since the output of the model provides concentration averages there can be no hope of it reproducing the observed spatial variation. In fact, since it is not known exactly what process sustains the spatial variability it is seems entirely possible that the EFDC model does not even have that transport process properly represented. It may well be that the spatial variation is a

[1] Model Calibration: Modeling Study of PCB Contamination in the Housatonic River, Volume 1, Section 5, PCB Fate and Transport Modeling.

legacy of the manner in which PCB releases occurred in the past and will not occur in the future; in the absence of any explanation we simply do not know.

Regardless of the reason for the concentration variations this failure of the model to directly address the essentially uniformly distributed spatial variability in PCB concentration is a serious problem. It is highlighted by the fact that all of the calibration exercises performed to date simply address the prediction of *averages* and the comparison of *averages* of field data and *averages* of model output. The ability of a model to predict the *variance* in a distribution can be just as important as predicting the mean, especially where substances with potentially acute toxicity are concerned. There is nowhere (at least nowhere that I could find) in the PCB fate and transport calibration presentation that addresses the predicted *variance* in PCB concentration and calibrates this prediction with field data. Furthermore, the use of spatially-averaged input data is ultimately going to produce a reduction in the variance of concentration that is solely an artifact of the modeling process. This will occur because averaged sediment that is eroded and redeposited cannot regain its spatial variance.

In addition to these failings of the model application there appears to be a distinct lack of recognition of the statistical significance of the averaging process that has been used in EFDC. With reference to Figure 5-26 it is difficult to believe that the spatial fluctuations in the mean tPCB profile shown in that figure have any statistical significance. What is lacking from the figure is any indication of the confidence levels on the estimates of the mean tPCB concentration profiles that are plotted. Without this information it is not possible to conclude that there is any real difference in mean concentration over the 11 mile stretch of river. To see how the size of the averaging element can have an effect on the estimate of the mean refer to slide 5 of the GE presentation, where the averages are over one mile segments of the river, and compare this to Figure 5-26.

Given that the modeling exercise is chartered with predicting the outcome of remediation strategies it is my opinion that this fate and transport modeling process, which focuses only on spatially-averaged concentrations in a situation where there is extreme spatial variability, is inappropriate. The failure of the study team to investigate and understand the basis for this extreme, and apparently temporally sustained, spatial variability in concentration, is somewhat bewildering, especially when it is clearly of such importance to understanding the fate and transport of the PCB.

The overall strategy of producing a synthetic stream flow record from a rainfall record is a well-founded technique in hydrology and this work appears to have been done well. The food chain modeling seems also to be appropriate, although I am not a food chain expert. However, the primary concern is again that the variance of the concentration of PCB's in the valley sediments is so high that it is difficult to see how the concentration in organisms is driven by the mean PCB concentration, unless the organisms feed at random. For a lipidophilic compound such as PCB, one can imagine that an organism would likely reflect the highest concentration ingested rather than the average. The Monte Carlo analysis process proposed would therefore seem to be appropriate, if it reflects the inherent variation in the PCB concentration. However, if the EFDC modeling

is going to result in a long-term reduction in the variance that is simply an artifact of the modeling, then the Monte Carlo approach may require some adjustment.