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US Environmental Protection Agency
Hudson River PCBs Reassessment Remedial Investigation/Feasibility Study
Community Interaction Program

Joint Liaison Group Meeting
February 19, 1997
Albany, NY

On February 19, 1997 a Joint Liaison Group meeting was held at The Marriott in Albany to present the findings of the Data Evaluation and Interpretation Report (DEIR). The DEIR is the third of six volumes of the total Phase II investigation report. The agenda for the meeting is Attachment 1. Sign-in sheets are found in Attachment 2. The Executive Summary of the DEIR is Attachment 3.

Ann Rychlenski, United States Environmental Protection Agency (USEPA) Public Affairs Specialist and Community Relations Coordinator for the project, opened the meeting with introductions: Doug Tomchuk, USEPA Project Manager; Dr. Ed Garvey, TAMS; and Marion Olsen, USEPA Environmental Scientist and Human Health Risk specialist. Presentations by Mr. Tomchuk and Dr. Garvey followed. Attachment 4 contains hard copies of key slides. The presentations are summarized below, followed by a synopsis of questions and answers.

Doug Tomchuk began by recapping the objectives of Phase 2 of the Reassessment. The purpose of the reassessment, he stated, is to evaluate whether a remedy of any type is required to address the PCB-contaminated sediments in the upper Hudson River, to be protective of human health and the environment. EPA will look at risks involved, and then determine what the most effective remedy would be, if any at all.

Mr. Tomchuk reviewed the basic questions to be answered in determining appropriate actions to take:

- When will PCB levels in fish meet health criteria without any action?
- Will no action alleviate the problem?
- Can implementing a remedy reduce the time required to reach acceptable levels?
- If the PCB problem is being reduced by burial in the sediments, could a major flood event make those PCBs available again?

As part of a review of the Phase 2 report schedule, Mr. Tomchuk stressed that the DEIR was "number three of six" Phase 2 investigation reports. Any findings presented in connection with this report are not decisions for a remedy. EPA must still do baseline modeling work to project PCB concentrations found today into the future, and also will prepare ecological and human health risk

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- 1993 conditions. Dr. Garvey emphasized the importance of this finding, stating that this area of the Hudson is the primary source of PCBs in the entire freshwater river.

  - The PCB load from the Thompson Island Pool is a readily identifiable one. It has a distinct homologue pattern (homologues are groups of PCBs "organized" according to the number of chlorine atoms per molecule. The 209 individual PCB congeners fall into ten different homologue groups, mono meaning a molecule with one chlorine atom, di having two chlorine atoms, and so on). The homologue pattern in the water column from the signal at Rogers Island is dominantly tri and tetra. Samples taken at the Thompson Island Dam show not only that the PCB load jumps in size but also that the homologue pattern changes from tri- and tetra-dominant to di-dominant. Both the increase in load and the change in homologue pattern are attributed to the TIP.

  - The PCB load from the Thompson Island Pool originates from the sediments within the pool. Nothing else within the pool is responsible for generating the source.

  - The fourth finding has to do with the long-term fate of PCBs within the sediments: dechlorination is not going to remediate the problem of PCBs in the sediments. On average, about a 10 percent mass loss was observed due to dechlorination.

Dr. Garvey proceeded to present information that supports the four major findings, using graphics and illustrations from the DEIR itself. Some of those are included in Attachment 3. Key points are summarized in the following sections.

Water Column Results

- PCB load is the concentration of PCBs in the water column at the time a measurement is taken multiplied by the flow of the water at the same time [of collection]. It was found that the PCB load at the Thompson Island Dam is carried through downstream to Waterford. Graphs and graphics in the DEIR indicate the PCB load gain as a result of water traversing the TIP. The pie chart in Attachment 3 entitled *Loading at Waterford Based on Phase 2 Data* illustrates that the net load gain in the river as a result of the river traversing the TIP represents approximately three-fourths of the total load to the lower Hudson.

- In addition to total load, data were also analyzed on a homologue basis. The tri/tetra-dominated PCB homologue mixture entering the Thompson Island Pool changes to a mono/di/tri-dominated mixture leaving the TIP. The transition takes place as a result of the additional input [of PCBs] that occurs as the river traverses the pool. The same di-dominant homologue mixture appears at Waterford, 30 miles downstream.

- The fact that the load and the homologue mixture are carried as far as Waterford indicates that the river is serving as "a pipeline delivering this load to the lower

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- The fact that the load and the homologue mixture are carried as far as Waterford indicates that the river is serving as "a pipeline delivering this load to the lower river....Once the load is set at the Thompson Island Dam, that is basically what is delivered to the lower river."

- GE data also shows an offset between the [PCB] loading [in the water column] at the Thompson Island Dam and the loading at Rogers Island, the result of the river traversing the TIP.

- Post-June of 1993, the TIP has continued to input more PCBs into the system, based on GE's data, which also indicates that the TIP represents more than 50 percent of the di homologue loading to the water column. The TIP has in fact dominated the water column [PCB] load for the last three years. (See also the graphic entitled *Thompson Island Pool Contributions* in Attachment 3. The difference in the width of the pie slice representing background conditions - called "PCB Loading Originating Above Bakers Falls" - that is very narrow on the Phase 2 pie chart and wider on the GE pie chart, as indicated by arrows, is due to the fact that GE's detection limit is higher than the one used in Phase 2. For clarification, the main point of the diagram is that the proportion of the total load at the TI Dam originating within the TIP relative to the Rogers Island load has remained roughly constant since June 1993.)

Sediment Coring

Radionuclides, specifically cesium-137 and berillium 7, were used as markers to identify sediment age. The study first established the rate of deposition to a given core, then assigned an approximate year of deposition to a given core slice. Going down, or deeper into the core, is going back in time. Profiles of the cores showed relatively low surface concentrations and most of the cores showed extensive high concentrations at depth.

One of the considerations of studying PCBs in the Hudson is that PCBs have a great affinity for fine-grained sediments. They adhere to fine-grained sediments because fine-grained sediments tend to be very rich in organic matter, which provides a good adsorbant for PCBs. When sediment collects in the river, the amount of fine-grained material varies, depending upon the hydrologic conditions. Cores of comparable deposition rate can contain varying amounts of fine-grained sediments. Cesium is also a good marker for fine-grained sediments, and was used to as a normalizing factor to account for variations among cores in the amount of fine-grained sediment present, which set all cores as near as possible to identical deposition environments. Then comparisons made across cores should be comparing differences among stations as a result of PCB loads or gains of sinks or sources between stations, not as a result of differences in deposition types between locations.

On a display of river mile vs. PCB to cesium ratio, Dr. Garvey illustrated evidence of a steady decrease in PCBs relative to the amount of cesium in cores beginning with Core 19 at the Thompson Island Dam and continuing at subsequent locations southward, indicative of the fact that there are no significant PCB loadings in that portion of the river. He did not discuss the lower portion of the river, as the geochemistry of cesium changes below the salt front. As a further illustration, Dr. Garvey pointed out that using a dilution model, given the threefold increase in flow rate between the TI Dam and Kingston, the [PCB] concentration should be one-third: by increasing the flow by a factor of three, the concentration should decline by a factor of three. In fact, however, the TI Dam was too concentrated in PCBs in sediment to account for the decline. The implication is that PCBs are probably being stored preferentially in this portion of the Hudson sediments relative to points downstream.

Dr. Garvey displayed a graph showing a simple dilution model that began with the Thompson Island Pool [PCB] concentration and accounted for the drainage basin area, showing how the PCB to cesium ration should decline if all that occurs is the addition of clean tributary water. This trend overestimated downstream sediment inventories. Starting at Stillwater, however, sediment inventory [of PCBs] could be predicted as far downstream as Indian Point to within 25 percent of the [measured] inventory. The water column load as recorded at Stillwater is an excellent predictor for the entire freshwater Hudson. Resulting indications are that PCBs that are in the upper river are being transported to the lower river, and indicative that there are not any other significant PCB sources in the freshwater Hudson.

Dr. Garvey also was able to illustrate [PCB transport] on congener basis. First, to establish that the sediments in the bottom of the river were good reflectors of what was in the water column, core tops from the Albany Turning Basin just below the confluence of the Mohawk River and suspended matter collected at Troy were compared. Results indicated a very good match of suspended matter congener pattern and core top congener pattern. This indicates that the sediments are storing the suspended matter that the river is carrying, and that the cores are a good basis on which to assess the stored PCB transport: what is in the water column is what is stored in the sediment.

The next assessment is how the PCB load varies over time. Dr. Garvey illustrated a comparison within two core slices at Stillwater: surface sediment from approximately 1991-1992 and sediments that are approximately ten years older. Evidence showed that by and large, congener patterns in the sediment over time proved to be identical, indicating that 1) the sediments are recording the water column patterns and 2) the sediment [and water column] patterns are not changing very much over time.

An across-core congener pattern comparison done with cores from Stillwater and from Kingston, 90 miles downstream, indicated that congeners present at Stillwater were still present and in the right proportions at River Mile 88.5.

These findings all indicate that the sediments are recording the fact that the upper Hudson is the dominant source [of PCBs] to the river, has been the dominant source over time, and is dominant all the way down the freshwater reach. Another finding is that the congener pattern of the Mohawk River is quite different from the upper Hudson, which eliminates the Mohawk River and its entire drainage basin as a significant PCB source. Also, the evidence indicates that total contribution of

PCBs by other sources is less than 25 percent.

PCB Inventory and Long-term Fate Within the Sediments

Four data sets were used for this analysis. Geostatistical analysis showed lower estimates of metric ton PCB inventory in the TIP than previously recorded. A method called polygonal declustering yielded an estimate of 19.6 metric tons, while kriging analysis yielded an estimate of 14.5. Further, the areas previously defined by NYSDEC as hot spots were borne out by the Phase 2 analysis. The original NYSDEC estimate was 23.3 metric tons.

A congener-specific analysis was used to provide a detailed picture of what was happening in the sediments. Dr. Garvey pointed out that dechlorination does not destroy PCBs until the last chlorine is removed from the molecule. In looking at dechlorination in the Hudson, the study found that dechlorination did not remove the last chlorine from the molecules. The ortho positions were left untouched.

Two measures of PCB characteristics were used to examine dechlorination. The first measure was based on average molecular weight of PCBs in a sample. To summarize results of 126 congeners, the molecular weight of the PCB mixtures found in the sediment was calculated, and that was compared to an Aroclor 1242 standard to determine relative change in molecular weight. Given that dechlorination does not destroy the PCB molecule but rather cleaves the chlorine atoms, the number of PCB molecules stays the [largely] same as a result of dechlorination, even though mass is removed because chlorine atoms are removed. Because the number of molecules stays the [approximately] same, one can use the molecular weight as a means of tracking the mass loss.

[The second measure examined the fraction of final dechlorination products relative to the sample's total PCB content. If the dechlorination is occurring, and is only removing the outer chlorines, increases in four specific congeners should be observable in Hudson River sediment cores: BZ 1, 4, 10, and 19, which have exclusively ortho chlorines. In fact, BZ 8 also increased in the sediment, probably representing an important intermediate dechlorination product. These congeners can be used to track the extent of dechlorination. Dr. Garvey showed that change in molecular weight in Hudson River sediments relative to Aroclor 1242 moved in direct proportion to the increase in the final dechlorination product ratio. The consistency of these two measures indicates that either can be used to track the extent of dechlorination. He demonstrated that simple meta and para dechlorination is occurring. There is no loss, to speak of, of chlorines in the inner positions; there is a build-up of congeners containing ortho chlorines. Because dechlorination is limited to the outer chorine positions, meta and para dechlorination, it [dechlorination] can produce no more than a 26 percent mass loss. Dechlorination does not occur in the water column; it is limited to sediments where anaerobic conditions exist.

Dr. Garvey presented a graph showing the relationship among all the freshwater sediment cores collected, both datable and non-datable from river mile 88 to river mile 197 using both dechlorination measures. [PCBs in the] mainstem Hudson are derived from a 1242-like mixture that undergoes some dechlorination and perhaps some weathering but not much else. Dr. Garvey illustrated that tributary results were clearly different from the mainstem Hudson, indicating that the tributaries cannot be a major contributor to the Hudson River contamination since they are so unlike anything measured in the Hudson. There is no indication of any other significant sources, no other non-1242 sources, to the river.

Dr. Garvey stated that another important finding from the sediments is that the degree of dechlorination is not a function of depth of the core but rather is proportional to the total PCB concentration: the higher the PCB concentrations in the sediments, the higher the level of dechlorination. Above a concentration of 30 ppm there is some dechlorination, but even for these sediments, maximum level of dechlorination is still under 26 percent mass loss. The vast majority of the sediments in the lower river are seeing something on a scale of under 10 percent mass loss. Below a concentration of 30 ppm, there were as many sediments showing no dechlorination as there were sediments showing some level of dechlorination. Below 30 ppm, dechlorination can occur but not predictably and not extensively.

Dr. Garvey demonstrated that in looking down into Core 18 (just below TI Dam), a dated core, the extent of dechlorination increases going down into the core to peak concentration points at about slices 7 and 6, and then the level of dechlorination decreases with depth, basically in proportion to the [PCB] concentration in the sample. The fact that there is not more dechlorination is because the core's PCB concentration is under 30 ppm. If dechlorination were time-dependent, then dechlorination would increase in a straight line from top to bottom of the core.

Dr. Garvey showed a histogram of datable core samples showing several time horizons and rates of dechlorination. What the histogram demonstrated is that in each time segment, some of the sediments showed dechlorination, and some did not. The indication again is that the level of dechlorination is proportional to the [PCB] concentration, not to the age of the sediments.

Among the results Dr. Garvey reviewed in concluding this section was the fact that extensive dechlorination has been limited to the region above RM 180 because that is the part of the river that is most concentrated [in PCBs]. Also, dechlorination appears to occur rapidly on a scale of years and then stops when it reaches a certain level of [PCB] concentration. Dechlorination is not a continuing process and cannot be relied upon to continue to reduce the PCB mass, even to the 26 percent level.

Integration of Sediment and Water Column Results

Dr. Garvey displayed a graph with both sediment samples and water column samples illustrating that water column [PCB] loads are tied to the sediments. The Rogers Island signal, comprised of integration of Hudson Falls, Ft. Edward, and remnant deposits area input, closely resembles Aroclor 1242. The Thompson Island Pool signal is very distinct from that of Rogers Island and looks very much like the relatively altered sediments found in the TIP.

The water column PCB load at Rogers Island was compared to the load at the Thompson Island Dam. The properties of the net addition by the TIP to the water column at the Thompson Island Dam and are very similar to the very altered sediments of the TIP. Dr. Garvey illustrated that the fact that bot the TI Dam load and the net TIP addition lie on the same line as all the sediments is indicative of the fact that they are all derived from the starting material (i.e., the GE releases). The PCBs found in the tributaries are shown on the graphics to be clearly not part of this domain. A comparison of homologue patterns in the sediments and water column indicates the same relationship. The Rogers Island signal has a 1242-like homologue pattern, while the pattern at the TI Dam looks distinctly different, unlike Aroclor 1242 but very similar to sediment properties found in the TIP.

The implication overall is that the sediments in the TIP are the driving force for the TIP load, either directly by resuspension mechanism or by pore water (water in between grains of sediments in the river bed) exchange. A comparison of water column inventory and pore water from various sediment samples showed that water column loads and pore water types are compatible. It is likely that both mechanisms, resuspension and pore water exchange, are important to varying degrees at different times of year. Regardless of the mechanism, the sediments themselves are responsible for the loading across the TIP.

A summary of Dr. Garvey's findings can be found on pages 14-16 of Attachment 3.

Following are highlights of the question and answer period.

1. **Question** regarding low-molecular weight dechlorinated PCB products having low potential for bioaccumulation in fish or for adsorption to sediments to lower Hudson. Could we conclude that those PCBs would move as a pipeline through the Hudson and out to the Atlantic?

   Answer. Defer issue of bioaccumulation until we get to that part of analysis, so defer answer regarding fish. Lightest congeners in the water column are primarily in dissolved phase; safe to say they are traveling out to the Narrows. Important to note that although the TIP signal is dominantly mono and di, there is still a significant amount of tri and tetra; approximately one-third of tri loading to lower Hudson 1991-1995 came from TIP.

2. **Question:** Prior understanding was that dechlorination meant stripping away of any chlorine atoms. Are we now saying dechlorination does not occur unless the PCB molecule is gone?

   Answer: The report does not state dechlorination does not occur. It states dechlorination does not occur to an extent sufficient to serve as a remediation of the sediments. Dechlorination does occur to about ten percent of the concentration of PCBs within the sediment, but the theoretical limit is 26 percent because only the chlorines in the outside positions are removed. The same number of PCBs themselves remain. In fact, because dechlorination is occurring, "fingerprinting" of the PCBs from TIP sediments is possible compared to water column loads at Rogers Island. Sediments having concentrations sufficient to drive dechlorination will reach the extent of dechlorination within a couple of years. Once at that threshold, they will not dechlorinate further. The only dechlorination occurring is in the upper, surficial layers.

3. **Question: a.** Doesn't dechlorination start anaerobically but subsequently require aerobic conditions to be complete? **b.** [If the process is two part,] wouldn't you expect the PCBs in the sediments not to be totally dechlorinated?

Answer: a. There is a distinction between dechlorination and biodegradation. Degradation is the aerobic process. Dechlorination is a biological degradation process; but only one part. The other portion is the aerobic degradation. If the anaerobic sediment is reintroduced to an aerobic, oxygenated condition, dechlorination stops because the bacteria responsible for dechlorination do not live in an aerobic condition. **b.** Dechlorination is limited exclusively to anoxic sediment. Resuspending sediments to the water column for an aerobic degradation process is another degradation mechanism that is possible, but it is independent of dechlorination. Dechlorination is the cleavage of chlorine atoms; aerobic degradation involves destruction of the PCB molecule (breaking of the [biphenyl] rings).

4. **Question:** At what point in the Reassessment will we take information re concentration of monos and dis and show that they are less toxic?

Answer: First, the computer modeling will be done so that bioaccumulation of [current levels of] PCBs found in sediments and water column can be figured. This will be done in the ecological risk assessment and in the computer model. Then that information can be projected into the future so that the human health risk assessment can be done.

5. **Question: a.** What is average PCB concentration of surface sediments in Thompson Island Pool? **b.** Did you look at GE data from 1991? **c.** GE analysts' look at that data suggests surface concentrations at about 20 ppm; from TI Dam to Schuylerville, using the same data set, concentrations appear to be 10 to 12 ppm. [EPA's] data suggests there is a large flux coming from the TIP, and very little coming from the next lower reach of the river. Why do we not see the same kind of fluxes coming out of the TIP?

Answer: a. NYSDEC data, most extensive surficial calculations at one-foot intervals, indicates concentrations of about 60 ppm as of 1984. **b.** Dr. Garvey stated he was not certain he would accept the fact that concentrations in the next reach of river south to Schuylerville are 20 to 30 percent less, even a factor of two less. Also, there is a question of what the likely mechanism is for driving the inventory. We can say the inventory of PCBs in TIP is larger than in the next reach down; Dr. Garvey indicated he would argue that the inventory itself rather than the surficial concentration is a more likely key to why that source is there. At this point we do not have a good constraint as to why the TIP is so efficient at releasing its PCBs. Understanding the exchange mechanism is important.

6. **Follow-on Question: a.** In the case of either exchange mechanism, resuspension or porewater exchange, wouldn't that be off the surface sediments? **b**. Wouldn't it be reasonable to look at it based on the ratios of surface level concentrations?

Answer: a. Dr. Garvey said yes, but did not believe GE had enough data below TI Dam to assess surface concentration. **b.** The 1984 data gives a good feeling for [characterization of] the TIP; there isn't any data set that comes close to that one in terms of surface concentration inventory.

7. **Question: a.** Clarification of understanding: was 1984 data used in recalculating the mass in the TIP? **b.** What was the purpose? **c.** Did you adjust with more current data? **d.** What was the anticipated utility of the calculation?

Answer: a. Yes. **b.** There was an initial question as to whether NYSDEC's inventory as originally estimated was statistically rigorous, whether it could be defended from a statistical perspective, because there were some subjective judgements involved. It was decided that it would be valuable to do a more statistically objective analysis to see if the NYSDEC numbers would be comparable to those results. **c**. Adjusting for more current data will be done in the future. A series of cores was collected from the TIP and areas downstream to see if inventories measured now would be comparable to inventories measured in 1984. That analysis is being done currently and will be reported as part of the analysis of the low resolution coring program. **d.** The intent was to collect enough samples in 1994 at 80 or 90 reoccupied NYSDEC 1984 sites to see how that data compared to the 1984, and then, if results were comparable on average, be able to extrapolate the results to the remainder of the thousand or so 1984 sampling sites. The NYSDEC study was so extensive, time-consuming, and expensive, it was not thought to be warranted to explore the sediments on the same context again. The side scan sonar located fine-grained sediments in the same areas defined by the previous surveys, so [EPA] had other information to use in support of this approach.

8. **Question: a.** What role have GE data and any of GE's suggestions as to methods of study played in the current findings? **b.** How consistent are GE data with Reassessment Phase 2 data? **c.** Are those data consistent with [EPA's] conclusions?

Answer: The Reassessment method has been primarily based on the NYSDEC method: a dual column gas chromatograph technique originally developed at NYSDEC and New York State Department of Health, evolved and modified to suit [the Reassessment's] purposes. Within the analytical field, the columns chosen were relatively standard columns for GC analysis for PCBs; one of [the Reassessment's] columns and GE's primary capillary column happen to be the same. This would imply similar responses to the same contaminants in both data sets, and in fact there is relatively good agreement between [Reassessment and GE] samples collected close in time and space (e.g., from the same stations at around the same time). Also, the phenomena [EPA] sees within the Phase 2 data appears to be borne out by [EPA's] interpretation of GE data.

In terms of the scale of GE's data, GE has been collecting data from April 1991 on a bi-weekly basis from Bakers Falls, Rogers Island and the TID as part of the remnant deposit monitoring program, so it is a huge, extremely detailed, largely congener-specific, very useful monitoring data set. The data set is important to [EPA's] interpretation because it allows extrapolation of [the Reassessment's] very detailed analysis 1993 water column analysis to years prior and subsequent. There are some differences, but [EPA's] review of the data indicates it is of very good quality.

[EPA] has made a very conscious effort to remain objective throughout the entire study. [EPA] has used a lot of GE's data, but has used a lot of data from other sources as well. Regarding concerns about GE's affect on the study, some of the conclusions presented [at the meeting] would probably be contrary to what GE has said over the last seven years; that is a good indication of how objective [EPA] is being in the study. In the future, if any party contributes information that would enhance the project, it would be accepted and used just as other data has.

9. **Follow-on comment:** Speaker stated his point was more that the data seemed to contradict some of the main hypotheses put forth by GE, in the sense that their own data do not seem to support some of [GE's] long-standing contentions.

Responses: Issue was taken to this comment by a representative of GE. Mr. Tomchuk intervened to emphasize that [EPA's] analysis is separate from GE's analysis; some of the same data bases were used, information has been shared along the way, but the work is separate.

10. **Discussion on question of misinterpretation by the press:** Concern was expressed that the Executive Summary [of the DEIR] to the untrained eye would appear to say that dechlorination is not occurring; that all PCBs that were there in the late 1970s are still there; and that the appearance was a "case for dredge-and-dump."

Responses: Concern about misinterpretation was one key reason for holding the press briefing in the afternoon. Mr. Tomchuk reiterated that this report is still only one piece of the overall "jigsaw puzzle" of this study. Also, he said, this report is the first that has presented any conclusions, or findings. The Phase 2 report was divided into six parts to enable the information to be presented in segments that could be followed and understood. One of the problems with that approach is that some conclusions come out before the entire process is completed. [EPA] is taking every effort to emphasize that this is not a remedy decision, not steering toward a remedy. A lot of steps remain in the analysis before any decision is made regarding a remedy.

11. **Question:** Based on this statement, does that mean some of the conclusions here could change?

Answer: Dr. Garvey said that he does not foresee any change. The toxicity assessment has not been done, so although there is understanding of the PCB geochemistry, the issue of the relationship of the geochemistry to toxicity remains.

12. **Follow-on question:** Speaker stated there would need to be a "reconciliation" between the conclusions [of the DEIR] and the mechanistic explanations that come out of the model; felt there is the potential the [DEIR] conclusions could change in an attempt to reconcile a mechanistic description of what's going on in the Hudson with an observational description of the data.

Answer: There is no question about the fact that [EPA] will alter as things develop; it is an interactive process. It is important that any model put forth would have to reproduce the patterns [EPA] sees, but [EPA] is not fixed on being right about anything at this point.

13. **Question:** When [EPA] finishes the report, will [EPA] be taking a look at the economic impact that this project will have on the dairy industry in Washington County if it does in fact become a dredge project? There is a need to know what kind of economic impact there will be on the Ft. Edward area.

Answer: To the extent that [EPA] can, impact on the dairy industry will be looked at, but it is not a full-blown economic analysis. It is one of the considerations in the evaluation criteria of "acceptance by the community." It is unfortunate that economic impact is not specified as a consideration under Superfund.

14. **Question: a.** Are you comfortable that you have sufficient data to be able to finish your effort, make projections as to future conditions, so that the Feasibility Study can be done? **b.** If you don't understand the mechanism and the origins of PCBs in the river, how are you going to project future conditions in the river? **c.** What are you going to do to get that understanding between now and the time you make that decision? **d.** Is it reasonable to go out and try to verify the postulation that porewater is contributing PCBs to the water column?

Answer: a. Yes. The data [EPA] has would support a Feasibility Study for selection of a remedy. **b.** The numerical rigors of the model would provide ability to extrapolate. Regarding mechanisms for transfer of PCBs from sediments to water column, the congeners themselves will allow [EPA] to say that 'this' or 'that' or some combination is. **c.** At this point understanding the mechanisms would be a research project, not a Superfund investigation. **d.** It is reasonable to suggest verifying [the porewater postulation]. There is always a data gap; no one is ever 100 percent certain. GE intends to collect additional data, and [EPA] will look at that. [EPA] does not feel it needs any additional data collection at this point.

Follow-on discussion: Question to speaker (GE representative): are there other data gaps speaker sees? Answer: yes, and those are in [GE's] comments to the modeling report. At this point [GE feels] any projections based on modeling report are very uncertain. Response by EPA: EPA addressed those comments in a meeting with GE; explained that the modeling report was a preliminary report; many of GE's comments have been considered already in plan for future work.

15. **Question: a.** To clarify: is it EPA's position that dechlorination is going on in the upper Hudson, that it is extensive, and there is removal of most of the chlorines on the PCBs. **b.** Do we agree that the reduction in chlorines reduces risk?

Answer: a. Dechlorination is only removing about 10 percent mass, and is primarily driven by the concentration. Everywhere there was sufficient concentration, dechlorination was found. Sediments from 1965 to "1980-ish" would be the prime dechlorination horizons. Dechlorination was not extensive in sediments pre "1975-ish" and "post-1980-ish." **b.** No, not at all. There is not a clear cut correspondence between the reduction in toxicity because of reduced chlorination levels. EPA has issued a new toxicity factor for cancer assessments based on recent studies of various aroclors, which indicated that the presence of animal tumors. Risk still uses the highest slope factor, based on bioaccumulation [of PCBs] in fish. There is also non-carcinogenic risk to be considered, which the agency will evaluate as part of the Reassessment.

16. **Comment:** Clearwater representative expressed support for EPA's willingness to "draw a line in the sediment" after so many years of study. Requested an explanation of the reference to a [PCB] depletion horizon of approximately a decade found in the Executive Summary."

Answer: It is a rough non-numerical estimate based on the fact that post-June 1993 one sees no variation in the Thompson Island [PCB] load from June 1993 to February 1996. Given there is additional load from Hudson Falls 1991-1992 plus inventory already in the TIP, if the there has been no change in load from the TIP during the last three years, [the load] will not go away in the next three years. Based on three years of flat data, there is no decline rate from which to extrapolate. In reality, the depletion rate could be a decade, or it could be decades. It is unknown.

17. **Follow-on comment:** Based on a one-pound-per-day constant level of depletion, the timeframe [for depletion] is a century.

18. **Question:** Is the congener pattern during high flow events different that what is seen at the Thompson Island Dam?

Answer: During April 1993 spring event the signal was a large water column load occurring between Bakers Falls and Rogers Island, upstream of the TIP. The signal was substantial and distinct, very much like an aroclor 1242 mixture and attributed to PCBs flushing through the Allen Mills facility or a large release from a GE facility in the Bakers Falls area. It is unlike the TIP signal seen post-1993 to the present.

19. **Question:** There are several anaerobic microbial systems in the Hudson River carrying out dechlorination and giving different products. EPA is looking at one predominant in heavily contaminated sediments in the upper Hudson. There are others predominant further down river giving different congener pattern. They will not change the sediment inventory very much but [the microbial systems] are very effective in removing the coplanar toxic congeners. This could affect the ecological risk assessment. Will [EPA] be looking at other measures of dechlorination?

Answer: Dr. Garvey does not see extensive further analysis of the dechlorination process. That does not mean [EPA] will not examine congener patterns (presence or absence of coplanar congeners, for example) within sediments in and of themselves, for consideration in overall analysis. The goal is to capture how PCBs are working in the [river] system on a large scale, to gain an understanding of the most predominant congeners so as to be able to extrapolate findings to congeners more important toxicologically, or present at such low levels as to preclude their availability for analysis. The sediment data will help explain the food chain model, as congener patterns can be followed up the chain.

Follow-on comment: These patterns can be useful in assessing age of PCBs. A paper published by SETAC [indicate that patterns in fish suggest that fish in TIP are seeing very recently deposited PCBs, not heavily dechlorinated ones. PCBs in lower Hudson fish seem to have been there a long time.

20. **Question:** [EPA] appears to be looking at correlations and not cause and effect relationships. Are you intending to do that? A concern is that some sampling was done at or prior to Allen Mills event, a large PCBs release. What would you expect the water column to look like if there were no Allen Mills event vs a continuing Allen Mills event. Is there any alternative hypothesis that might also fit your model?

Answer: Processes here are quite complex and one could spend years looking at them. [EPA] has proposed a simple set of mechanisms to try to keep the process as simple as possible and to avoid being buried in permutations and still not understand the system. The fact that one can look down the Hudson and see the same [congener] pattern [throughout the sediments] for 15 years is not just happenstance. There are not very many scenarios that can produce that effect. The likelihood of doing that if additional external sources were to be introduced is small; such sources would have to match the GE source exactly. Further, the river is integrating all processes [affecting PCBs]; [EPA doesn't have to] try to piece all of them together. The congener-specific models for a suite of congeners will tie down the mechanisms and represent them directly. One can propose many mechanisms that may be involved in PCB transport and fate, but laboratory and field studies are not available to tie them down.

21. **Discussion on responses to comments and questions:** Speaker expressed a feeling that citizen participants did not have a clear idea about their direction. Could GE set up a meeting

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to answer questions and discuss issues? Can people who offer comments receive responses [from EPA] to know whether issues have been resolved, etc.?

Answer: Interested parties can attend the STC [Scientific and Technical Committee] meeting [3/25 and 3/26] where observers can learn a lot about the model calibration report and this [DEIR]. The original plan was to submit a Responsiveness Summary at the end of Phase 2. EPA has recently requested that a response be provided to the public in writing to comments on the Preliminary Calibration Report in a relatively short timeframe. EPA pointed out that the request for detailed response at this time extends the project. What EPA has said previously is that responses will be issued on some items, and in other cases, subsequent reports and/or plans will take comments into account.

22. Request from GE to make a presentation at STC meeting.

Answer: The purpose of the STC meeting is for scientists to comment on [EPA] reports. If the GE representative wants to comment during that meeting and there is room on the agenda, he could do that. [Presentations] are not the point of the STC meeting. GE has already requested a list of STC members with the intention of holding its own meeting.

23. Question: a. Is the comment period for our [citizens'] benefit to enjoy having made the comment, and not for your [EPA's] direction?

Answer: The comment period is entirely for direction. EPA takes the comments, reads them, and interprets direction after that, so that the next works can be addressed correctly. The record [of responsiveness] over the last seven years speaks for itself.

24. Question: Was the remedial work done by GE a non-event with respect to effect on the river?

Answer: Peaks [of PCBs] in the water column load were greatly reduced after GE's remedial effort. The levels decreased greatly. After that there has not been a decrease in the levels emanating from the TIP.

Addendum: Mr. Tomchuk explained that the intent of the JLG meeting was to present the DEIR in much the same way as a classroom, with explanation preceding the actual reading in the hopes that the explanation would aid understanding. Other opportunities for questions and comments would be through phone-in sessions, and all interested parties are able to observe at the STC meeting scheduled for March 25 and 26.

Attachment 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

U.S. EPA HUDSON RIVER PCBs REASSESSMENT COMMUNITY INTERACTION PROGRAM

JOINT LIAISON GROUP MEETING
PHASE 2 DATA EVALUATION AND INTERPRETATION REPORT

Wednesday, February 19, 1997
7:30 p.m.
Albany, New York

AGENDA

Welcome & Introduction	Ann Rychlenski Community Relations Coordinator, U.S. EPA
Phase 2 Objectives, Investigation and Sampling Program	Doug Tomchuk Project Manager, U.S. EPA
Conclusions of Report, Supporting Evidence, Summary	Dr. Ed Garvey TAMS Consultants, Inc. (EPA's contractors)

Questions & Answers

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
HUDSON RIVER PCBs REASSESSMENT REMEDIAL INVESTIGATION/FEASIBILITY STUDY
COMMUNITY INTERACTION PROGRAM

Joint Liaison Group Meeting
Albany, New York
February 19, 1997

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Judy Schmidt Dean	1 Fern St Schuylerville NY	Ag+Liaison Comm
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Susanne Crump	1104 London Rd Cohoes, NY 12047	Schuylerville, Adirondack School
Mel Schweiger	1 Computer Drive Albany, NY 12205	GE-CEP
Roger Mooney	1418 B-W H Rd BUSKIRK NY 12028	RCFB
John Santacrose	46 Ranck Rd Selkirk, NY 12158	The Audubon Society of New York State, Inc.

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John Connolly	HydroQual, Inc. Mahwah, NJ	HydroQual, Inc.
Tom Borden	Washington Co. Farm Bureau	
Andy Mele	112 Market St, Poughkeepsie, NY 1260[illegible]	Clearwater
BRADFORD CUSHING	16 CHESTER COUNTY COMMONS MALVERN, PA 19355	APPLIED ENVIRONMENTAL MANAGEMENT, INC.
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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JOSH CLELAND	9 VASSAR ST POUGHKEEPSIE NY 12601	Scenic Hudson
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Eleanor Brown	1479 Dean St Schenectady NY 12309	Citizens Liaison Group
Ron Sloan	NYSDEC 50 Wolf Rd	State
Lee Coleman	DAILY GAZETTE Schenectady	Reporter 374 Broadway Saratoga Springs NY 12866

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EXECUTIVE SUMMARY
DATA EVALUATION AND INTERPRETATION REPORT

The U.S. Environmental Protection Agency is conducting a study of the Hudson River PCBs Superfund site, reassessing the interim No Action decision the Agency made in 1984. The goal of the Reassessment study is to determine an appropriate course of action for the PCB-contaminated sediments in the Upper Hudson River in order to protect human health and the environment.

During the first phase of the Reassessment, EPA compiled existing data on the site, and conducted preliminary analyses of the data. As part of the second phase, EPA conducted field investigations to characterize the nature and extent of the PCB loads in the Upper Hudson and the importance of those loads to the Lower Hudson. EPA also conducted analyses of data collected by the New York State Department of Environmental Conservation, the U.S. Geological Survey, and the General Electric Company (GE), as well as other private and public agencies.

This report is the third of a series of six volumes that make up the Phase 2 Report. This volume, the Data Evaluation and Interpretation Report, provides detailed descriptions and in-depth interpretations of the water column and dated sediment core data collected as part of the Reassessment. The report helps to provide an improved understanding of the geochemistry of PCBs in the Hudson River. The report does not explore the biological uptake and human health impacts, which will be evaluated in future Phase 2 volumes.

The conclusions presented herein are based primarily on direct geochemical analyses of the data, using conceptual models of PCB transport and environmental chemistry. The geochemical analyses will be complemented and verified to the extent possible by additional numerical analysis via computer simulation. Results of the numerical simulations will be reported in subsequent reports, primarily the Baseline Modeling Report.

Major Conclusions - The analyses presented in the Data Evaluation and Interpretation Report lead to four major conclusions as follows:

1. The area of the site upstream of the Thompson Island Dam represents the primary source of PCBs to the freshwater Hudson. This includes the GE Hudson Falls and Ft. Edward facilities, the Remnant Deposit area and the sediments of the Thompson Island Pool.

2. The PCB load from the Thompson Island Pool has a readily identifiable homologue pattern which dominates the water column load from the Thompson Island Dam to Kingston during low flow conditions (typically 10 months of the year).

3. The PCB load from the Thompson Island Pool originates from the sediments within the Thompson Island Pool.

4. Sediment inventories will not be naturally "remediated" via dechlorination. The extent of dechlorination is limited, resulting in probably less than a 10 percent mass loss from the original concentrations.

A weight of evidence approach provides the support for these conclusions, with several different lines of investigation typically supporting each conclusion. The subordinate conclusions and findings supporting each of these major findings are discussed below.

1. The area of the site upstream of the Thompson Island Dam represents the primary source of PCBs to the freshwater Hudson. This includes the GE Hudson Falls and Ft. Edward facilities, the Remnant Deposit area and the sediments of the Thompson Island Pool. Analysis of the water column data showed no substantive water column load increases (*i.e.*, load changes were less than ten percent) from the Thompson Island Dam to the Federal Dam at Troy during ten out of twelve monitoring events. These results indicate the absence of substantive external (*e.g.*, tributary) loads downstream of the Thompson Island Dam as well as minimal losses from the water column in this portion of the Upper Hudson. These results also indicate that PCB transport can be considered conservative over this area, with the river acting basically as a pipeline (*i.e.*, most of the PCBs generated upstream are delivered to the Lower Hudson). Some PCB load gains were noted during spring runoff and summer conditions, which were readily attributed to Hudson River sediment resuspension or exchange by the nature of their homologue patterns. These load gains were notable in that they represent sediment-derived loads which originate outside the Thompson Island Pool, indicating the presence of substantive sediment inventories outside the Pool. The Mohawk and Hoosic Rivers were each found to contribute to the total PCB load measured at Troy. The loading from each of these rivers during the 1993 Spring runoff event could be calculated to be as high as 20 percent of the total load at Troy. However, these loads represent unusually large sediment transport events by these tributaries since both rivers were near or at 100-year flood conditions.

A second line of support for the above conclusion comes from the congener specific analyses of the water column samples which show conformity among the main stem Hudson samples downstream of the Thompson Island Dam and distinctly different patterns in the water samples from the tributaries. These results indicate that the tributary loads cannot be large relative to the main stem load since no change in congener pattern is found downstream of the tributary confluences.

This conclusion is also supported by the results of the sediment core analyses which showed the PCBs found in the sediments of the tributaries to be distinctly different from those of the main stem Hudson. As part of this analysis, two measurement variables related to sample molecular weight and dechlorination product content were shown to be sufficient to clearly separate the PCB patterns found in the sediments of the freshwater Hudson from those of the tributaries, indicating that the tributaries were not major contributors to the PCBs found in the freshwater Hudson sediments and by inference, to the freshwater Hudson as a whole.

When dated sediment core results from the freshwater Hudson were examined on a congener basis, sediment layers of comparable age obtained from downstream cores were shown to contain similar congener patterns to those found in a core obtained at Stillwater, just 10 miles downstream of the Thompson Island Dam. Based on calculations combining the homologue patterns found at Stillwater with those of other potential sources (*e.g.*, the Mohawk River) it was found that no less than 75 percent of the congener content in downstream cores was attributable to the Stillwater core. This suggests that the Upper Hudson is responsible for at least 75 percent of the sediment burden, and by inference, responsible for 75 percent of the water column load at the downstream coring locations. Only in the cores from the New York/New Jersey Harbor was substantive evidence found for the occurrence of additional PCB loads to the Hudson. Even in these areas, however, the Upper Hudson load represented approximately half of the total PCB load recorded by the sediments.

The last line of evidence for this conclusion was obtained from the dated sediment cores wherein the total PCB to cesium-137 (^{137}Cs) ratio was examined in dated sediment layers. Comparing sediment layers of comparable age from Stillwater (10 miles downstream of the Thompson Island Dam) to Kingston (100 miles downstream of the Thompson Island Dam), the data showed the sediment PCB to ^{137}Cs ratios at downstream cores to be readily predicted by those at Stillwater, implying a single PCB source (*i.e.*, the area above the Thompson Island Dam) and quasi-conservative transport between Stillwater and locations downstream. These calculations showed downstream ratios to agree with those predicted from Stillwater to within the limitations of the analysis (± 25 percent).

2. The PCB load from the Thompson Island Pool has a readily identifiable homologue pattern which dominates the water column load from the Thompson Island Dam to Kingston during low flow conditions (typically 10 months of the year). Evidence for the first part of this conclusion stems largely from the Phase 2 water column sampling program which provided samples above and below the Thompson Island Pool. In nearly every water column sampling event, the homologue pattern of the water column at the Thompson Island Dam was distinctly different from that entering the Thompson Island Pool at Rogers Island. In addition, the Phase 2 and GE monitoring data both showed increased water column PCB loads at the downstream station, relative to the upstream station, particularly under low flow conditions. Based on the monitoring data collected from June 1993 to the present, water column concentrations and loads typically doubled and sometimes tripled during the passage of the river through the Pool. Thus, a relatively large PCB load originating within the Thompson Island Pool is clearly in evidence in much of the Phase 2 and GE data. This load was readily identified as a mixture of less chlorinated congeners relative to those entering the Pool.

The importance of this load downstream of the Thompson Island Dam is demonstrated by the Phase 2 water samples collected downstream of the Dam. These samples indicate the occurrence of quasi-conservative transport of water column PCBs (*i.e.*, no apparent net losses or gains) throughout the Upper Hudson to Troy during much of the Phase 2 sampling period. This finding is based on the consistency of homologue patterns and total PCB load among the downstream stations relative to the Thompson Island Dam load. Thus, the region above the Thompson Island Dam is responsible for setting water column concentrations and loads downstream of the Dam to Troy. During the low flow conditions seen in the Phase 2 sampling period, as well as in most of the post-June 1993 monitoring data collected by GE, the Thompson Island Pool was responsible for the majority of the load at the Dam. Thus, the Thompson Island Pool load represents the largest fraction of the water column load below the Dam during at least 10 months of the year, corresponding to low flow conditions.

The importance of this load for the freshwater Lower Hudson is derived from a combination of the water column and the sediment core results discussed above. Specifically, the water column results show the Thompson Island Pool to represent the majority of the water column load during much of the year throughout the Upper Hudson to Troy. The dated sediment core results show the Upper Hudson to represent the dominant load to the sediments of the Lower Hudson and, by inference, to the water column of the Lower Hudson. Since the majority of the Upper Hudson load is derived from the Thompson Island Pool, the Thompson Island Pool load represents the majority of the PCB loading to the entire freshwater Hudson as well.

3. The PCB load from the Thompson Island Pool originates from the sediments within the Thompson Island Pool. The PCB homologue pattern present in the water column at the Thomson Island Dam is distinctly different from that which enters the Thompson Island Pool at Rogers Island. This change in pattern was nearly always accompanied by a doubling or tripling of the water column PCB load during the Phase 2 sampling period and subsequent monitoring by GE. This pattern change and load gain occurred as a result of passage through the Pool. With no known substantive external loads to the Pool, the sediments of the Pool were considered the most likely source of these changes. Upon examination of the PCB homologue and congener patterns present in the sediment cores collected from the Thompson Island Pool and elsewhere it became clear that the sediment PCB characteristics closely matched those found in the water column at the Thompson Island Dam and sampling locations downstream during most of the Phase 2 sampling period. On the basis of this PCB "fingerprint" it was concluded that the Thompson Island Pool sediments represented the major source to the water column throughout much of the year as discussed above.

Two possible mechanisms for transfer of PCBs to the water column from the sediment were explored and found to be consistent with the measured water column load changes. The first mechanism involved porewater exchange, *i.e.*, the transport of PCB to the water column via the interstitial water found within the river sediments. This mechanism was examined using sediment-to-water partition coefficients developed from the Phase 2 water column samples. These coefficients were used to estimate the homologue patterns found in porewater from the Thompson Island Pool sediments. These patterns were then compared with the measured water column patterns at the Thompson Island Dam. On this basis it was demonstrated that this mechanism is generally capable of yielding the water column homologue patterns seen. This analysis suggested that if porewater exchange is the primary exchange mechanism, then sediments with relatively low levels of dechlorination are the likely candidates for the Thompson Island Pool source.

The alternate mechanism, resuspension of Thompson Island Pool sediments, was also shown to be capable of yielding the water column patterns seen. Since this mechanism works by directly adding sediments to the water column, sediment homologue patterns were directly compared to those of the water column at the Thompson Island Pool. The close agreement seen between the sediment and water column homologue patterns demonstrated the viability of this mechanism. If resuspension is the primary sediment-to-water exchange mechanism, then the responsible sediments must have comparatively high levels of dechlorination, since the water column homologue pattern at the Thompson Island Dam contains a relatively large fraction of the least chlorinated congeners.

As part of the investigation of Hudson River sediments, a relationship between the degree of dechlorination and the sediment concentration was found such that sediments with higher PCB concentrations were found to be more dechlorinated than those with lower concentrations, regardless of age. This relationship had important implications for the nature of the sediments involved in the sediment-water exchange mechanisms. For porewater exchange, which indicated a low level of dechlorination in the responsible sediments, the sediment concentrations had to be relatively low, although no absolute concentration could be established. For resuspension, the sediment concentrations had to be relatively high (*i.e.*, greater than 120,000 μg/kg (120 ppm)) in order to attain the level of dechlorination necessary to drive the Thompson Island Pool load. This in turn suggested that older sediments, particularly the relatively concentrated ones found in the previously identified *hot spots*, are the likely source for the Pool load via the resuspension mechanism. Given the complexities of sediment-water column exchange, it is probable that the current Thompson Island Pool load is the result of some combination of both mechanisms.

Recent large releases from the Bakers Falls area may have also yielded sediments with sufficient concentration so as to undergo substantive alteration and potentially yield some portion of the measured load via resuspension. However, the mechanism for rapid burial and subsequent resuspension is unknown. It is also conceivable that these materials could be responsible for a portion of the load if porewater exchange is the driving mechanism. However, the presence of such deposits is undemonstrated and must still be viewed in light of the prior, demonstrably large PCB inventory.

In this assessment, neither porewater exchange nor resuspension was evaluated in terms of the scale of the flux required to yield the measured Thompson Island Pool load. Such an evaluation will be completed as part of the Baseline Modeling Report.

4. Sediment inventories will not be naturally "remediated" via dechlorination. The extent of dechlorination is limited, resulting in probably less than a 10 percent mass loss from the original concentrations. Evidence for this conclusion is principally derived from the dated sediment core data obtained during the Phase 2 investigation. These data show that dechlorination of PCBs within the sediments of the Hudson River is theoretically limited to a net total mass loss of 26 percent of the original PCB mass deposited in the sediment. This is because the dechlorination mechanisms which occur within the sediment are limited in the way they can affect the PCB molecule, thus limiting the effectiveness of the dechlorination process. In fact, although theoretically limited to 26 percent , the actual estimated mass loss is much less, in the range of only

10 percent based on the sediment core results (the mean mass loss for the high resolution sediment core results was eight percent).

A second finding was obtained from the core data which supports this conclusion as well. In core layers whose approximate year of deposition could be established, no correlation was seen between the degree of dechlorination and the age of the sediment. If dechlorination were to continue indefinitely, such a correlation would be expected, with the oldest sediments showing the greatest degree of dechlorination. Instead, a relationship was found between the degree of the dechlorination and the PCB concentration in the sediment, such that the most concentrated samples had the greatest degree of dechlorination. Also, sediments below 30,000 μg/kg (30 ppm) showed no predictable degree of dechlorination, suggesting that the PCBs in sediments with less than 30 ppm are largely left unaffected by the dechlorination process. These findings indicate that the dechlorination process occurs relatively rapidly, within perhaps five to ten years of deposition but then effectively ceases, leaving the remaining PCB inventory intact. These results also indicate that the dechlorination process is generally limited to the areas of the Upper Hudson where concentrations are sufficient to yield some level of dechlorination. For those areas characterized by concentrations less than 30 ppm, dechlorination is not expected to have any effect at all. Thus, dechlorination cannot be expected to yield further substantive reductions of the Hudson River PCB inventory beyond the roughly ten percent reduction already achieved.

An important related finding concerning the Upper Hudson sediments was obtained from the geophysical survey completed during the Phase 2 investigation. This survey showed a general correlation between areas of fine-grained sediment and the *hot spot* areas previously defined by NYSDEC. Since PCBs have a general affinity for fine-grained sediments, it can be assumed that the fine-grained sediment areas mapped by the geophysical survey represent the same PCB-contaminated zones mapped by NYSDEC. This indicates that the *hot spot* areas previously mapped by NYSDEC are largely still intact and have not been completely redistributed by high river flows.

Ancillary Conclusions

In addition to the conclusions described above there are several additional findings which have important implications for the understanding of PCB transport in the Hudson River. These are discussed briefly below. More extensive discussions of these conclusions can be found in the summary discussions contained within each chapter.

- Erratic releases of apparently unaltered PCBs above Rogers Island, probably from the GE Hudson Falls facility, dominated the load from the Upper Hudson River during the period September 1991 to May 1993. The load at Rogers Island now represents about a third of the total load at the Thompson Island Dam.

- The unaltered PCB load originating above Rogers Island is predominantly Aroclor 1242 with approximately 4% Aroclor 1254 and 1% Aroclor 1260.

- The annual net Thompson Island Pool load ranged from 0.36 to 0.82 kg/day over the period April 1991 to October 1995, representing between 20 to 70% of the total load at the Thompson Island Dam based on data obtained by GE. During the period of June 1993 to October 1995, the net Thompson Island Pool load varied between 50 to 70% of the total load at the Thompson Island Dam.

- The Upper Hudson area above the Thompson Island Dam, *i.e.*, the Hudson Falls and Fort Edward facilities, the Remnant Deposit area, and the Thompson Island Pool, has represented the largest single source to the entire freshwater Hudson for the past 19 years, representing approximately 77 to 91% of the load at Albany in 1992 - 1993 based on water column measurements.

- While the homologue pattern in the freshwater Hudson is dominated by the homologue pattern from the Thompson Island Pool, minor changes in the PCB pattern downstream of the Thompson Island Dam have been observed. The resulting water column patterns resemble those seen in downstream sediments and associated porewater. However, it is unclear whether this change is the result of subsequent downstream sediment-water exchange or in situ water column processes (*e.g.*, aerobic degradation), given the temporal dependence. In particular, the congener pattern seen at the Thompson Island Dam is preserved throughout the Upper Hudson during winter and spring but appears to undergo modification during summer conditions when biological activity is high but energy for sediment-water exchange is low. Porewater exchange may be important under these conditions.

- Water-column PCB transport occurs largely in the dissolved phase, in the Upper Hudson, representing 80% of the water-column PCB inventory during 10 to 11 months of the year.

- Dissolved-phase and suspended-matter PCB water-column concentrations at the Thompson Island Dam and downstream appear to be at equilibrium as defined by a two-phase model dependent on temperature and the particulate organic carbon content.

- Evidence suggests that the Upper Hudson River PCB load can be seen as far downstream as RM -1.9. The contribution is estimated to represent about half of the total PCB loading to the New York/New Jersey Harbor.

- Two estimates were made of the PCB inventory sequestered in the sediments of the Thompson Island Pool, based on the 1984 NYSDEC data. The first estimate, based on a technique called polygonal declustering, yielded an estimate of 19.6 metric tons (the original NYSDEC estimate was 23.2 by M. Brown et al., 1988). The second, based on a geostatistical technique called kriging, yielded an estimate of 14.5 metric tons.

- An analysis of the side-scan sonar 500 kHz signal and the 1984 NYSDEC sediment PCB survey indicated that the acoustic signal could be used to predict the level of sediment PCB contamination. Acoustic data can be used to separate areas of assessed low PCB levels (mean concentration of 14.6 mg/kg) from areas of relatively high PCB contamination (mean concentration of 48.4 mg/kg). Based on this correlation and corresponding changes in river cross-sectional area, maps were created delineating the likely distribution of contaminated sediments within the region of the river surveyed.

- The extent of dechlorination in the sediments was found to be proportional to the log of the total PCB concentration and had no apparent time dependence. Sediments as old as 35 years were found where little or no dechlorination was present.

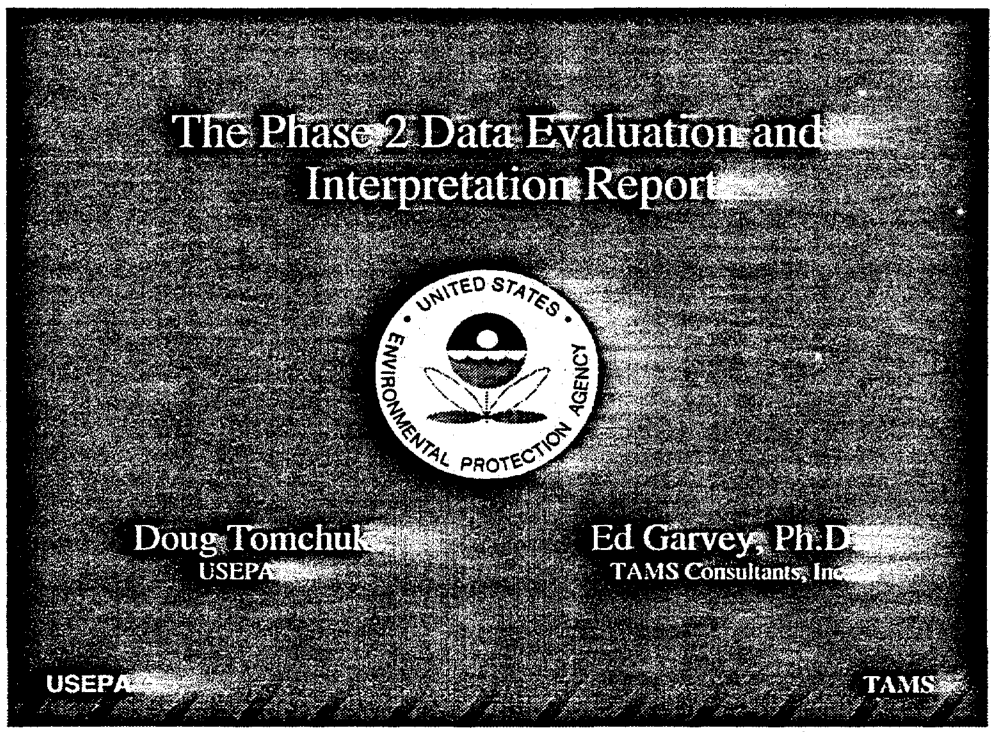
- Below a concentration of 30,000 µg/kg, dechlorination mass loss did not occur predictably and was frequently 0%. Dechlorination mass loss of greater than 10% of the original total PCB concentration was limited to sediments having greater than 30,000 µg/kg of total PCBs.

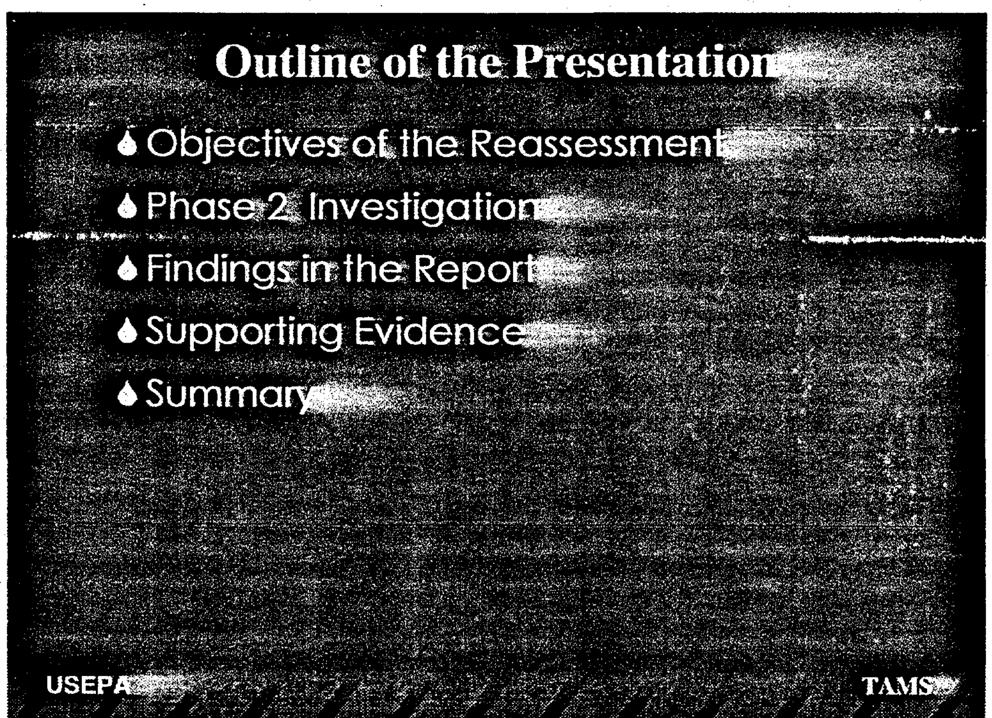
- Some sediments, particularly those in the freshwater Lower Hudson, show substantively higher molecular weights and lower fractions of BZ#1, 4, 8, 10 and 19. These conditions may be the result of aerobic degradation during transport from the Upper Hudson.

- Regardless of the sediment type or mechanism, the sediments of the Thompson Island Pool have historically contributed to the water column PCB load and will continue to do so for the foreseeable future. It is unlikely that the current loading levels will decline rapidly in light of their relatively constant annual loading rates over the last three years.

In conclusion, the sediments of the Thompson Island Pool strongly impact the water column, generating a significant water column load whose congener pattern can often be seen throughout the Upper Hudson. The Phase 2 investigation has also found a number of sediment structures via the geophysical investigation which closely resemble the *hot spot* areas defined previously by NYSDEC. These *hot spot*-related structures appear to be intact in spite of the time between the Phase 2 and NYSDEC studies. Given the strong linkage between sediment and water, the large inventory of PCBs in the Upper Hudson, and the apparent lack of significant reduction in PCB concentrations via in situ degradation, it is unlikely that the water column PCB levels downstream of the Thompson Island Dam will substantially decline beyond current levels until the active sediments are depleted of their PCB inventory or remediated. The time for depletion appears to be on the scale of a decade or more and will be investigated further through the planned computer simulations.

Presentation to the Joint Liaison Group Feb. 19, 1997





Purpose of the Reassessment

- To evaluate whether any action is required for the PCB-contaminated sediments in the Upper Hudson River in order to be protective of human health and the environment

USEPA TAMS

Goal of Contaminant and Transport Analysis

Reassessment designed to answer the basic questions

- When will PCB levels in fish meet human health criteria without any action?
- Can implementing a remedy significantly reduce the time required to reach acceptable levels?
- Could a major flood event make PCBs in buried sediments available to the food chain?

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10.9604

Phase 2 Reports

- Database Report — Nov 95
  - Database CD-ROM — Mar 96
- Preliminary Model Calibration Report — Oct 96
- Data Evaluation and Interpretation Report
- Baseline Modeling Report — Sept 97
- Ecological Assessment — Nov 97
- Human Health Risk Assessment — Dec 97

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Phase 3 Report - Feasibility Study

- Detailed analysis of alternatives
- Models to be run for each remedial scenario
- Calculate risk reduction for each scenario

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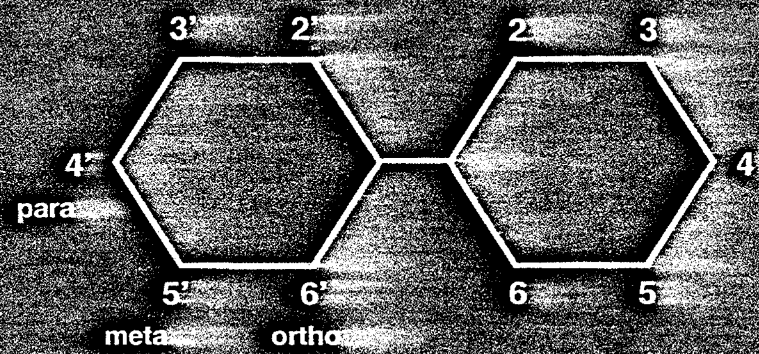
Polychlorinated Biphenyl



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Sampling Programs Reported in DEIR

- Water Column Sampling
  - Time-of-Travel (Transect) Sampling
  - Flow-Averaged Sampling
  - Daily TSS Monitoring
- Sediment Sampling
  - Dated Sediment Cores (High Resolution Coring)
- Geophysical Investigation
  - Acoustic Mapping
  - Confirmatory Sediment Sampling

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Water Column Sampling

- Six time-of-travel surveys of the Upper Hudson from Glens Falls to Waterford
- Six flow-averaged sampling events of the Upper Hudson
- Samples were separated into suspended matter and dissolved fractions prior to PCB analysis

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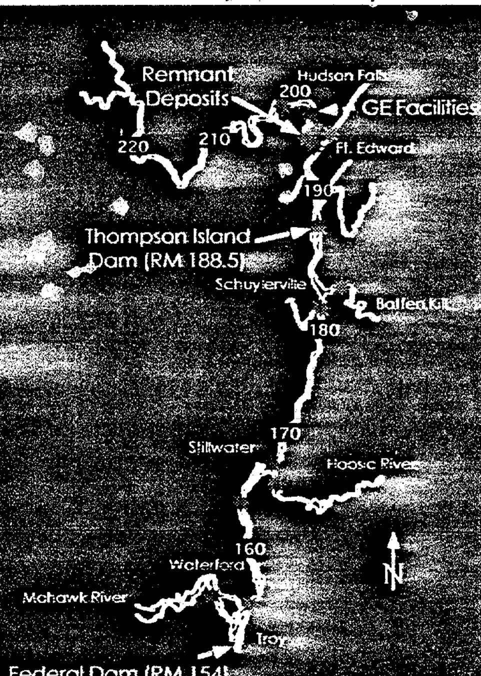
Upper Hudson Water Stations



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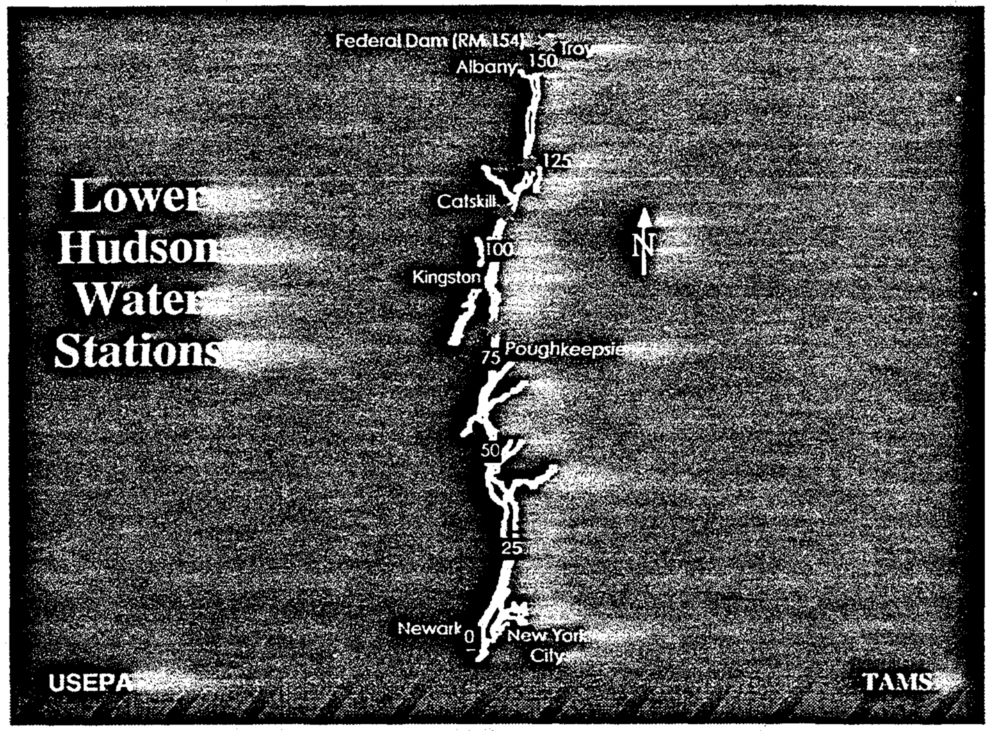
10.9607



Sediment Investigation

- High resolution sediment cores were obtained from 28 locations from the Upper and Lower Hudson
- Sediment cores were sliced into thin layers to examine historical PCB transport as recorded by the sediments

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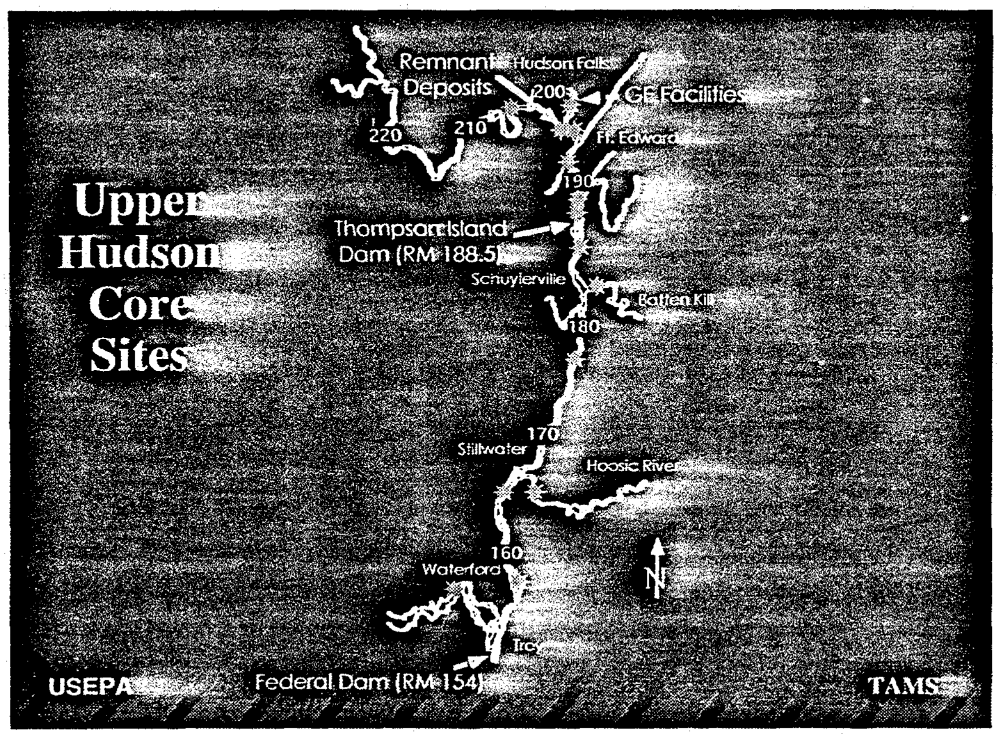
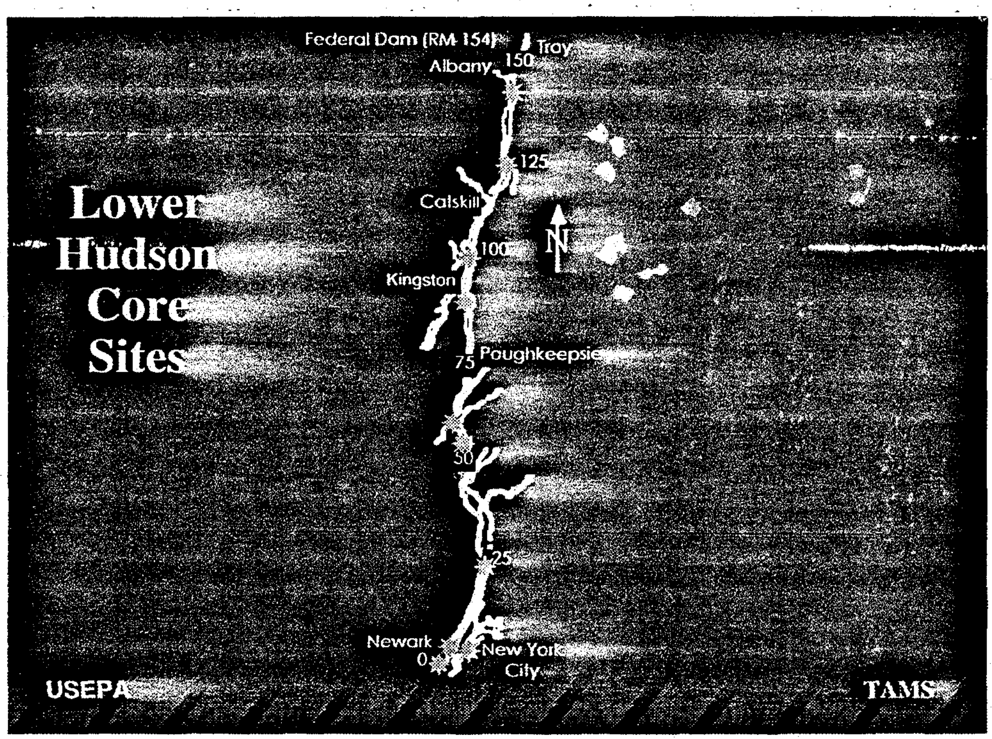
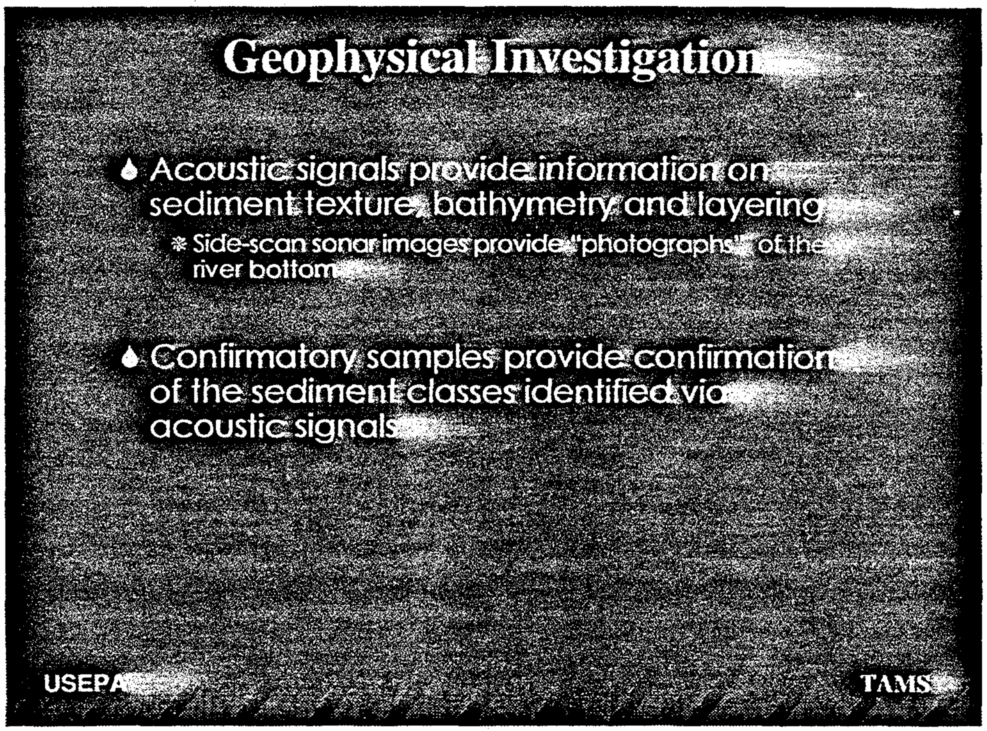

Upper Hudson Core Sites
Remnant Deposits
Hudson Falls
200
GE Facilities
220
210
Ft. Edward
190
Thompson Island Dam (RM 188.5)
Schuylerville
Batten Kill
180
170
Stillwater
Hoosic River
160
Waterford
N
Troy
Federal Dam (RM 154)
USEPA
TAMS


Lower Hudson Core Sites
Federal Dam (RM 154)
Troy
Albany
150
125
Catskill
N
100
Kingston
75
Poughkeepsie
50
25
Newark
0
New York City
USEPA
TAMS

10.9609


Geophysical Investigation
Acoustic signals provide information on sediment texture, bathymetry and layering
Side-scan sonar images provide "photographs" of the river bottom
Confirmatory samples provide confirmation of the sediment classes identified via acoustic signals
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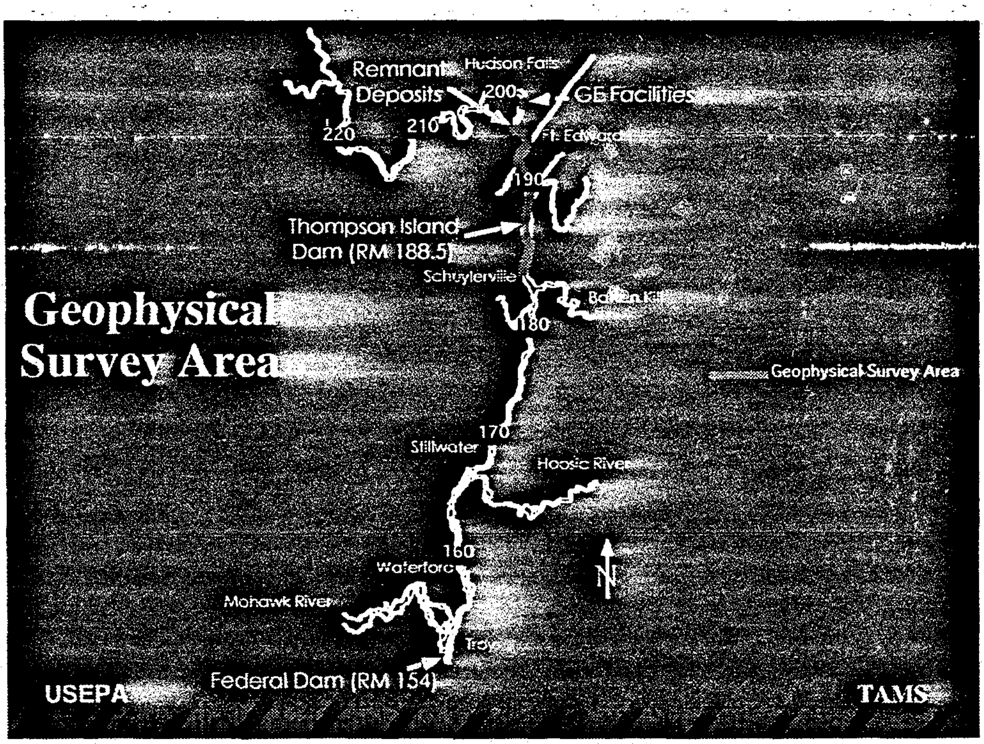
Geophysical Survey Area
Remnant Deposits
Hudson Falls
GE Facilities
220
210
200
Ft. Edward
190
Thompson Island Dam (RM 188.5)
Schuylerville
Batten Kill
180
Geophysical Survey Area
170
Stillwater
Hoosic River
160
Waterford
Mohawk River
Troy
Federal Dam (RM 154)
N
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10.9610

The Phase 2 Data Evaluation and Interpretation Report

Ed Garvey, Ph.D.
TAMS Consultants, Inc.

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Data Evaluation and Interpretation Report

- Examines the geochemistry of PCBs in the Hudson River
  - PCB transport mechanisms
  - PCB sources
  - Fate of PCBs within the water column
  - Fate of PCBs within the sediments
- Examines the entire Hudson River with an emphasis on Upper Hudson conditions

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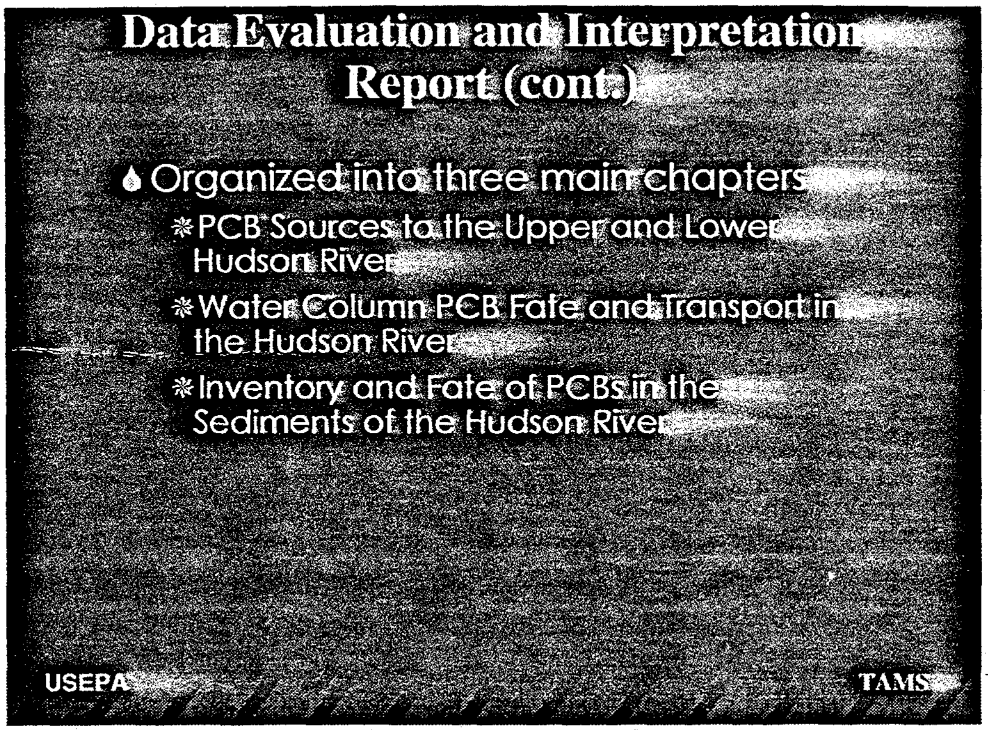
Data Evaluation and Interpretation Report (cont.)
Organized into three main chapters
PCB Sources to the Upper and Lower Hudson River
Water Column PCB Fate and Transport in the Hudson River
Inventory and Fate of PCBs in the Sediments of the Hudson River
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Findings in the DEIR
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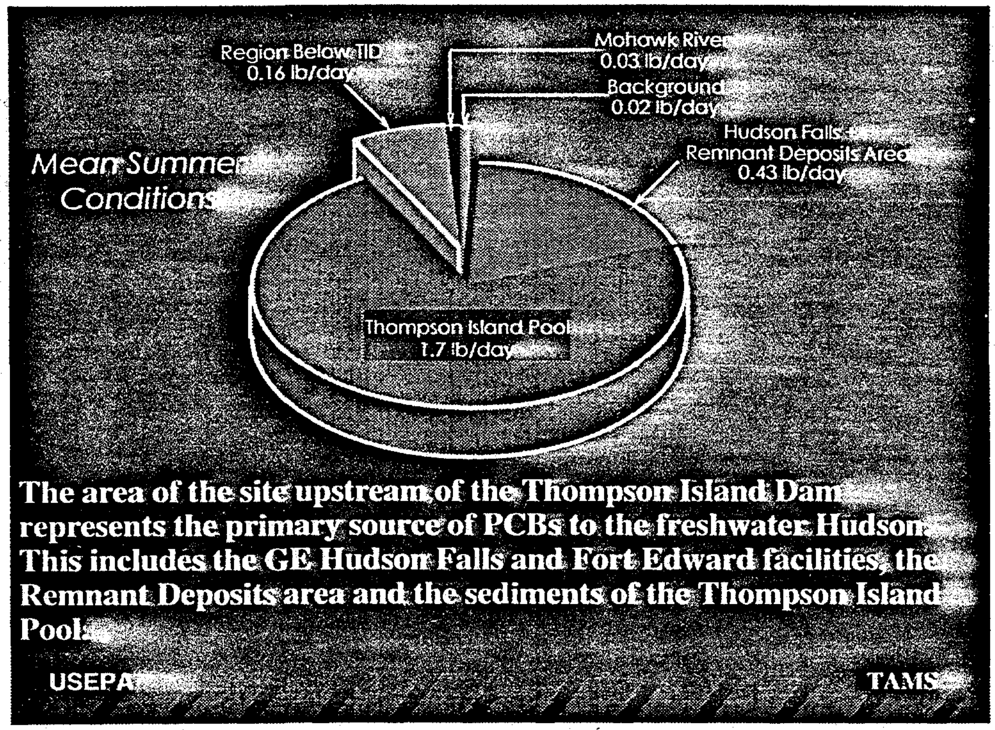
Region Below TID
0.16 lb/day
Mohawk River
0.03 lb/day
Background
0.02 lb/day
Hudson Falls
Remnant Deposits Area
0.43 lb/day
Mean Summer
Conditions
Thompson Island Pool
1.7 lb/day
The area of the site upstream of the Thompson Island Dam represents the primary source of PCBs to the freshwater Hudson. This includes the GE Hudson Falls and Fort Edward facilities, the Remnant Deposits area and the sediments of the Thompson Island Pool.
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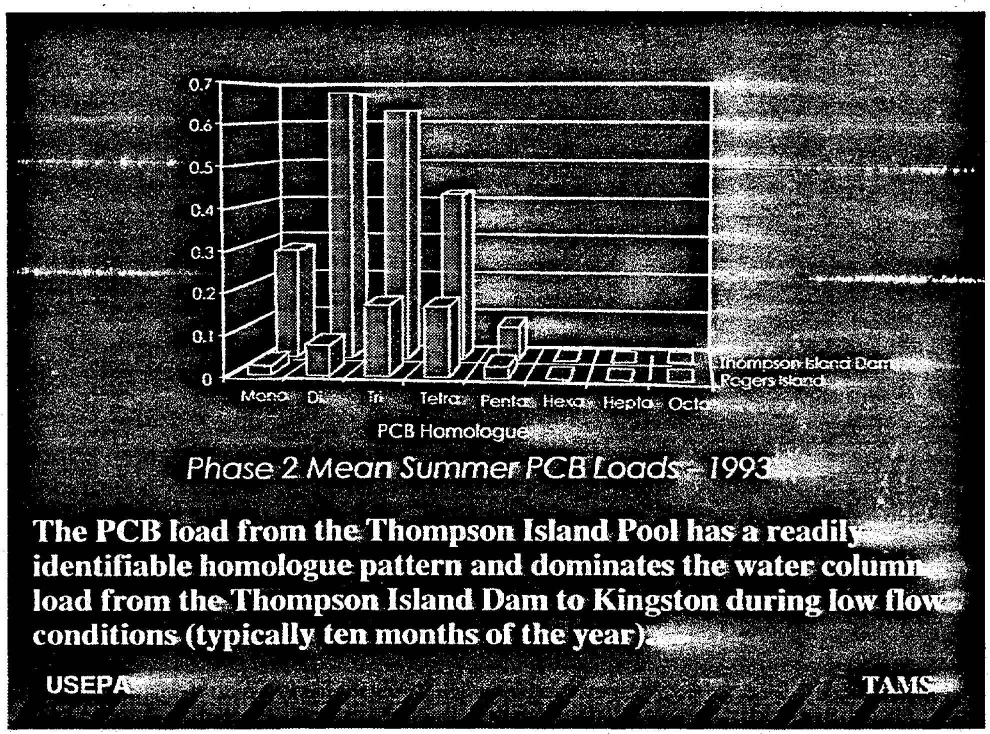
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Mono
Di
Tri
Tetra
Penta
Hexa
Hepta
Octa
PCB Homologue
Thompson Island Dam
Rogers Island
Phase 2 Mean Summer PCB Loads - 1993
The PCB load from the Thompson Island Pool has a readily identifiable homologue pattern and dominates the water column load from the Thompson Island Dam to Kingston during low flow conditions (typically ten months of the year).
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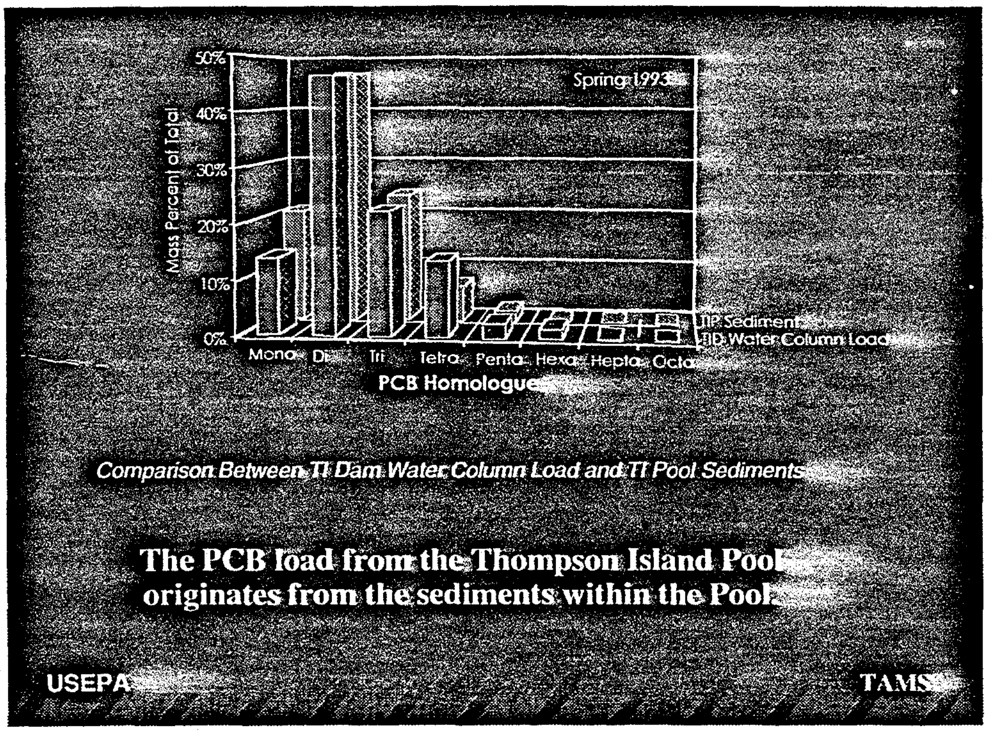
10.9613


Spring 1993
Mass Percent of Total
50%
40%
30%
20%
10%
0%
Mono
Di
Tri
Tetra
Penta
Hexa
Hepta
Octa
PCB Homologue
TIP Sediment
TID Water Column Load
Comparison Between TI Dam Water Column Load and TI Pool Sediments
The PCB load from the Thompson Island Pool originates from the sediments within the Pool.
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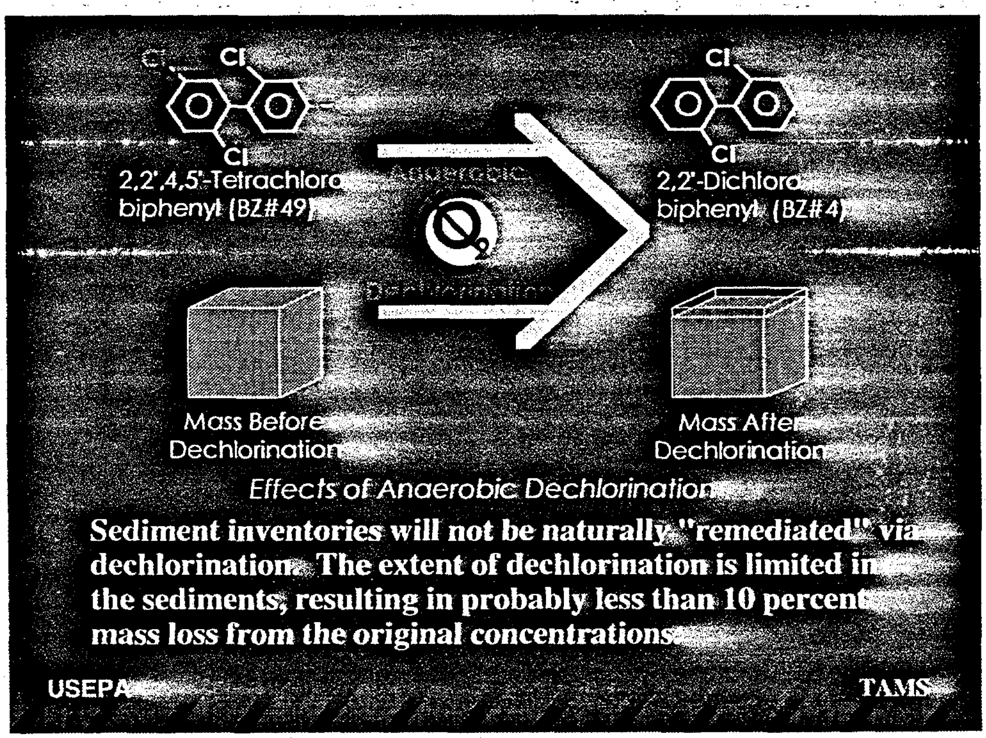
TAMS


Cl
Cl
Cl
2,2',4,5'-Tetrachloro biphenyl (BZ#49)
2,2'-Dichloro biphenyl (BZ#4)
Mass Before Dechlorination
Mass After Dechlorination
Effects of Anaerobic Dechlorination
Sediment inventories will not be naturally "remediated" via dechlorination. The extent of dechlorination is limited in the sediments, resulting in probably less than 10 percent mass loss from the original concentrations.
USEPA
TAMS

Supporting Evidence

- Water Column Results
  - Phase 2
  - GE
  - USGS
- Dated Sediment Core Results
- Geophysical Investigation
- Sediment Inventory and PCB Fate
- Sediment-Water Column Link

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Overheads from DEIR

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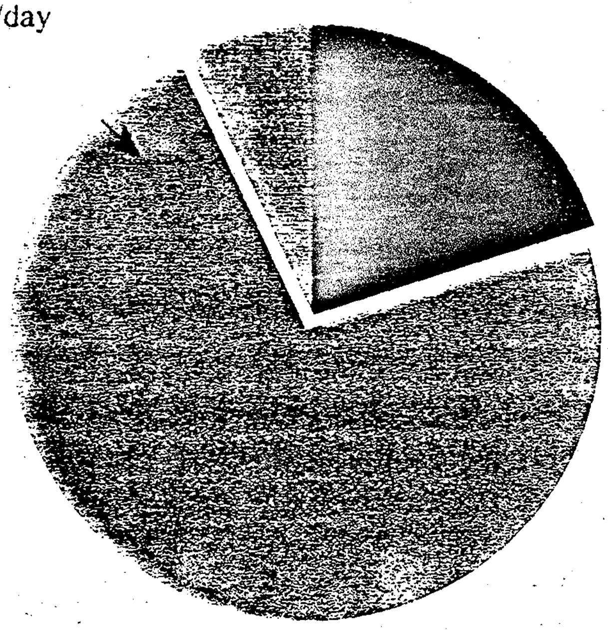
Thompson Island Pool
0.75 kg/day



Summer Mean
July to September, 1993
1.0 kg/day

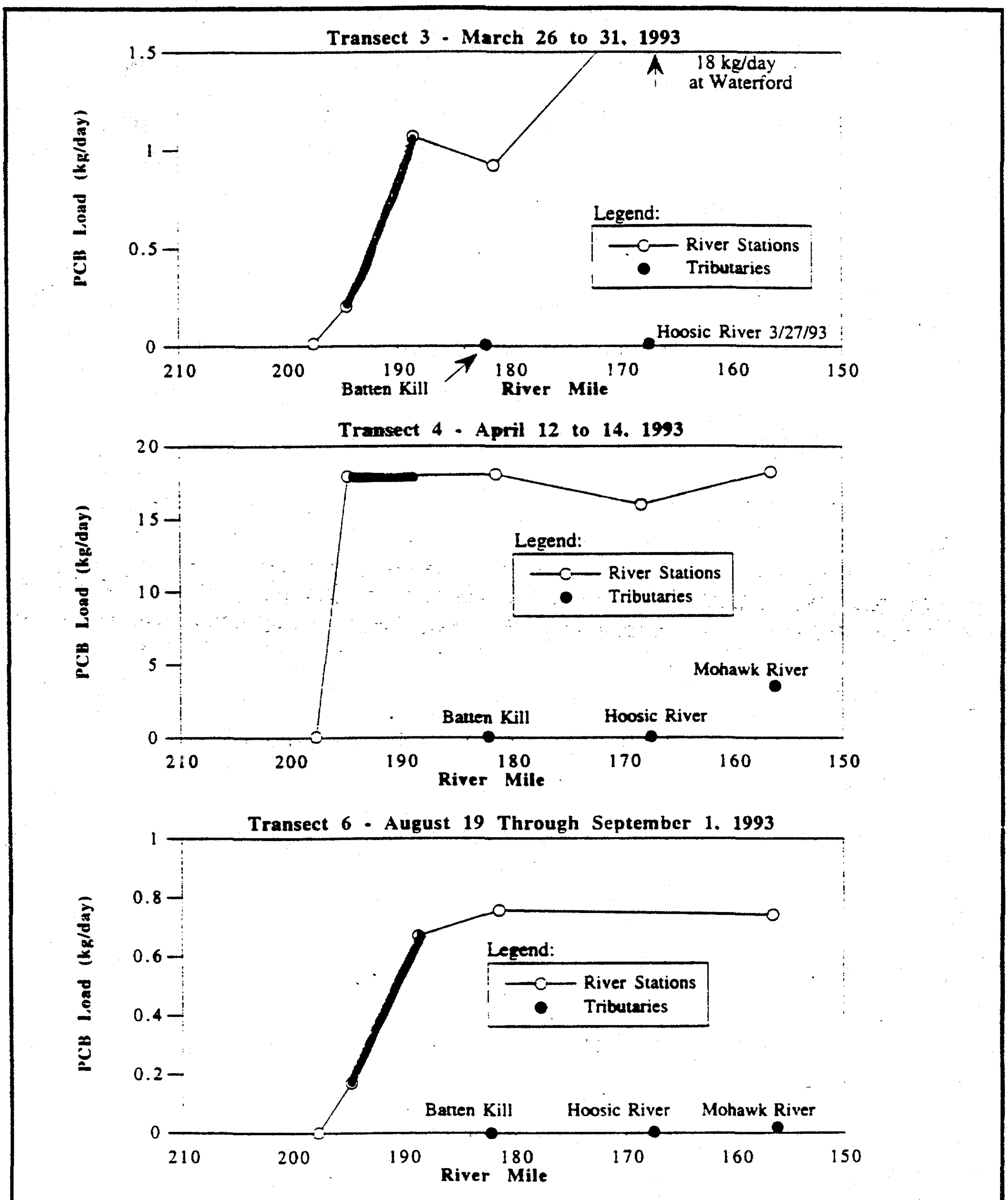
Legend:

- PCB Loading Originating Above Bakers Falls
- Incremental PCB Loading between Bakers Falls and Rogers Island
- Incremental PCB Loading from Thompson Island Pool
- Incremental PCB Loading between Thompson Island Dam and Waterford

Source: TAMS/Gradient Database

TAMS/Cadmus/Gradient

Loading at Waterford based on Phase 2 Data



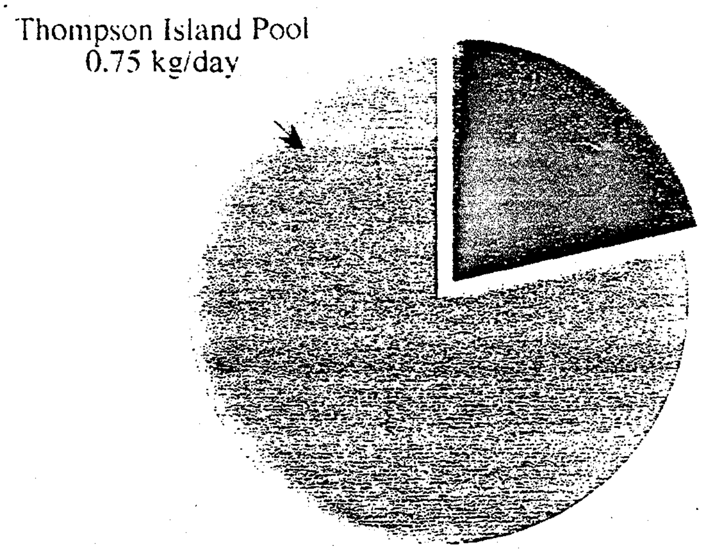
Source: TAMS/Gradient Database

TAMS/Cadmus/Gradient

PCB Load vs. River Mile for Three Phase 2 Water-Column Transects

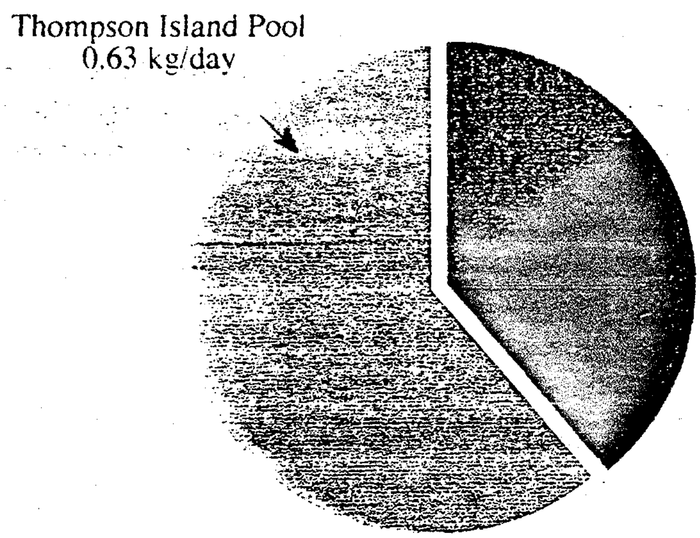
10.9617

Phase 2



July to September, 1993
1.0 kg/day

GE



July 1993 to October 1995
1.0 kg/day

- PCB Loading Originating Above Bakers Falls
- Incremental PCB Loading between Bakers Falls and Rogers Island
- Incremental PCB Loading from Thompson Island Pool

Source: TAMS Gradient Database | TAMS/Cadmus/Gradient

Thompson Island Pool Contributions

Water Column Results

- TI Pool generates the majority of the water column load during low flow conditions
- After June 1993, the TI Pool represents 50 to 70 % of the annual water column load
- The Upper Hudson acts as a "pipeline" delivering the PCB load from the TI Dam to the Lower Hudson
- The TI Pool load has a large fraction of lighter congeners and is distinct relative to other inputs

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Results for Dated Sediment Cores

- Congener pattern of suspended matter well recorded by sediments
- Total PCB levels decrease steadily downstream of TI Dam
- Below Stillwater, PCB concentrations in sediment can be predicted based on drainage basin area only, implying no significant other PCB sources between TIP (RM 188.5) and the salt front (~RM 60) for the period 1975 to the present.
- Congener patterns can be used to roughly estimate percent contributions
  - Mohawk River cannot a be a significant contributor based on its congener pattern
  - Other sources must be minor as well above salt front (total contribution less than ~25%)
  - In NY/NJ Harbor, local inputs roughly equal to upriver load
- Core results are consistent with those of the water column program

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Sediment Investigations

- Four data sets
  - 1992 Phase 2 geophysical survey of the Upper Hudson
  - Phase 2 confirmatory sediment samples
  - 1984 NYSDEC sediment survey of the TIP
  - 1992 Phase 2 high resolution sediment core data
- Sediment characteristics
- PCB fate in the sediment

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Geostatistical Analysis Results

- Polygonal declustering yields an estimate of 19.6 metric tons for the total PCB inventory of the TI Pool
- Kriging analysis yields an estimate of 14.5 metric tons
- M. Brown et al (1988) original analysis suggested 23.2 tons for this inventory
- All Phase 2 interpretations yield spatial distributions similar to those demarcated by NYSDEC

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PCB Fate in the Sediments

- Congener-specific analysis permits the examination of individual degradation products.
- Dechlorination does not destroy PCBs until the last chlorine is removed. Prior steps simply reduce mass but not molecules.
- Sediment processes are examined using two measures:
  - Change in molecular weight relative to Aroclor 1242
  - Variation in the presence of dechlorination products relative to Aroclor 1242

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Sediment Results

- PCB contamination throughout the freshwater Hudson is derived from Aroclor 1242.
- Dechlorination within the sediments appears limited to meta- and para-chlorines.
- Meta and para-dechlorination can produce no more than a 26% mass loss.
- Dechlorination results in the buildup of BZ#1,4,8,10 and 19, which can be used to track the extent of dechlorination.
- The degree of dechlorination is proportional to the log of the PCB concentration in the sediments.
- The majority of the sediments have estimated mass losses less than 10%.
- Dechlorination mass loss greater than 10% was limited to sediments higher than 30,000 µg/kg (30 ppm).
- Extensive dechlorination has been limited to the region above RM 180 due to its dependence on concentration, not location.

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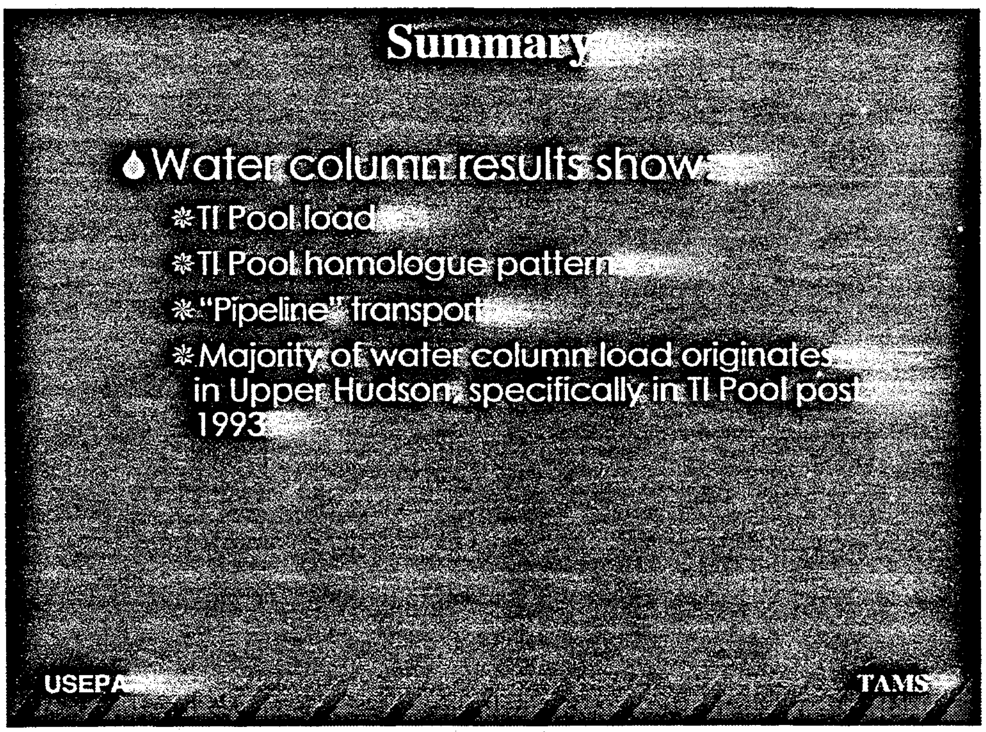
Summary
Water column results show:
TI Pool load
TI Pool homologue pattern
"Pipeline" transport
Majority of water column load originates in Upper Hudson, specifically in TI Pool post 1993
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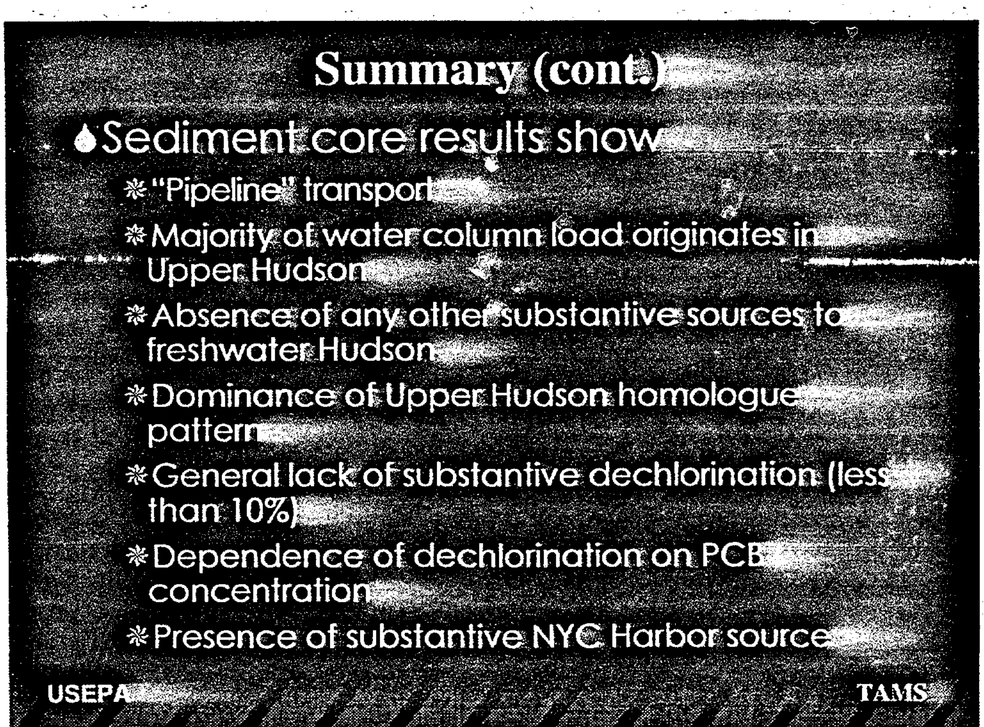
TAMS


Summary (cont.)
Sediment core results show
"Pipeline" transport
Majority of water column load originates in Upper Hudson
Absence of any other substantive sources to freshwater Hudson
Dominance of Upper Hudson homologue pattern
General lack of substantive dechlorination (less than 10%)
Dependence of dechlorination on PCB concentration
Presence of substantive NYC Harbor source
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Summary (cont.)

- Geophysical investigation shows
  - Correlation of acoustic signal and sediment texture
  - Continued presence of fine-grained sediments in NYSDEC hot spots indicating sediment structures intact
- Geostatistics analysis yields
  - Lower PCB mass estimates for TI Pool inventory
  - Maps of sediment PCB inventory

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Summary (cont.)

- Combined water & sediment analysis shows
  - Close correlation between water and sediment homologue patterns throughout freshwater Hudson
  - Possibility of two exchange mechanisms
  - Likelihood of older sediments as drivers for a resuspension flux

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Findings

- The area of the site upstream of the Thompson Island Dam represents the primary source of PCBs to the freshwater Hudson. This includes the GE Hudson Falls and Fort Edward facilities, the Remnant Deposits area and the sediments of the Thompson Island Pool.
- The PCB load from the Thompson Island Pool has a readily identifiable homologue pattern and dominates the water column load from the Thompson Island Dam to Kingston during low flow conditions (typically ten months of the year).
- The PCB load from the Thompson Island Pool originates from the sediments within the Pool.
- Sediment inventories will not be naturally "remediated" via dechlorination. The extent of dechlorination is limited in the sediments, resulting in probably less than 10 percent mass loss from the original concentrations.

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