

**California Water Resources Control Board
Bay Protection and Toxic Cleanup Program:
Problems with the Weight of Evidence Triad Approach**

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January 8, 1997

John Caffrey, Chairman
State Water Resources Control Board
P.O. Box 100
Sacramento, CA 95812-2100

Dear Chairman Caffrey:

I wish to provide the State Board with comments on the Bay Protection and Toxic Cleanup Program issues that are scheduled to be addressed by the Board at their January 8, 1997 workshop. As you and the other Board members may recall, I have been concerned about the technical validity of some of the approaches that are being used by the State Board staff in developing, implementing, and now reporting on the Bay Protection and Toxic Cleanup Program (BPTCP). I have also been concerned about the technical validity of some of the WRCB staff BPTCP proposed policies.

This discussion is based on my review of Item 3 to the January 8, 1997 workshop concerned with the consensus policy regarding the use of a weight of evidence triad approach for interpretation of sediment quality characteristics. **I strongly recommend that the State Board not support the consensus recommendation set forth on the first page of the staff's Item 3 Consensus Recommendations of the BPTCP Advisory Committee:**

"The recommendations call, in part, for the SWRCB to adopt a policy outlining the approach for identifying polluted sites in a consistent manner throughout coastal waters using a weight-of-evidence approach (a triad of sediment chemistry, toxicity and benthic community analysis) which is being currently used by the BPTCP."

with respect to the final phrase "...which is being currently used by the BPTCP." As discussed herein, the currently used approach in the BPTCP for the weight of

evidence triad is technically invalid with respect to incorporating chemical information into the triad. The basis for this recommendation is provided below.

Background

I have been involved for over 35 years in contaminated sediment evaluation and management issues. This involvement has included conducting over two million dollars in research on this topic and publishing over one hundred professional papers and reports on various aspects of it. Further, I have provided invited lectures and several day short courses on sediment quality evaluation and management issues at several locations in the US and in other countries. These presentations include presenting a short course at the Texas A&M University Dredging Engineering Workshop that is held the second week of January of each year. Again this year as I have done over the past 20 years, I will present a short course on the relative merits of various sediment quality evaluation approaches at this workshop.

As I have previously documented, I have found that some of the approaches being used by the State Board staff in the BPTCP lack technical validity. My views on this issue are not alone. Several years ago the State Board staff released for public review the proposed approaches that it had formulated for designating and ranking "toxic hot spots" in the state's waters. This led to a large scale resounding condemnation of the State Board staff's approaches by the technical community based primarily on the lack of technical validity of many of these approaches for designating and ranking toxic hot spots.

Associated with this issue was the development of sediment quality objectives. In the early 1990s the State Board staff proposed to use the geometric mean of three unreliable approaches for assessing the water quality significance of chemical constituents in sediments. One of the components of this approach was co-occurrence based sediment quality guidelines. Specifically, the issue of concern was the Long and Morgan-AET co-occurrence based sediment total chemical concentration based so-called "effects" concentrations. When this approach for developing sediment quality criteria was first proposed in the early 1990s, Dr. Jones-Lee and I, as well as others, provided the State Board with detailed discussions of why the proposed approach was technically invalid. We pointed out that at that time there was substantial literature by a number of professional organizations and governmental agencies which had reviewed the Long and Morgan-AET approach and concluded that it was not technically valid.

Because of the comments received by the State Board on this matter, the Board under chairman Maughan, ordered the State Board staff to work closely with the public in the further development of the sediment quality objectives as part of implementing the BPTCP for designating and ranking toxic hot spots. The State Board staff, however, chose to ignore the Board's recommendations and continued to develop the BPTCP without public review.

Finally, this situation became of sufficient concern to the regulated community and others including BPTCP fee payers that they contacted the state legislature and as part of

renewal of the BPTCP legislation forced the State Board to appoint a public advisory committee in order to attempt to gain some accountability on how the several million dollars per year that were being spent by the State Board staff in BPTCP activities were being used and the technical validity of the approaches being followed by this staff in developing and implementing the BPTCP.

The legislature supported the development of a public advisory committee to serve as a watchdog of the WRQCB BPTCP activities. I have attended many of the BPTCP Public Advisory Committee (PAC) meetings and have on several occasions provided the State Board, as well as the committee, with comments on details of technical issues that need to be addressed in order to stop the further development of technically invalid approaches for toxic hotspot designation and ranking as well as sediment quality objectives development. This effort has been conducted without support based on Dr. Jones-Lee's and my interest in seeing that the State of California adopt the most technically valid, cost effective approaches for assessing the real water quality problems in the state waters caused by chemical constituents in the waters or sediments.

Finally under pressure from the PAC and others, the State Board staff, at least superficially, abandoned the obvious technically invalid approaches that were being proposed for designating toxic hot spots and the development of sediment quality objectives. With respect to the latter, the State Board staff announced that it was abandoning the geometric mean of the three unreliable approaches for characterizing sediment quality in favor of a "narrative" approach. As of yet, now two years later, this narrative approach has still not been defined. Those concerned about this issue, however, cannot be certain that this narrative approach is not an attempt by the State Board staff to implement the technically invalid approach that it has proposed previously under the guise of a narrative approach. This is an important issue that must be watched until this narrative approach is defined and implemented.

In January 1995, Dr. Jones-Lee and I were shocked to find that the State Board staff was proposing to continue using what were technically invalid approaches for designating and ranking toxic hotspots. Dr. Jones-Lee and I, as well as others, have provided the PAC, with copies to the State Board, detailed comments on the lack of technical validity of the toxic hotspot designation process as part of our comments on the draft Functional Equivalent Document: Development of the Water Quality Control Policy for Implementation of the Bay Protection and Toxic Cleanup Program which was reviewed by the PAC. Eventually the comments made by the PAC and others caused the BPTCP management staff to unofficially terminate the proposed approaches in favor of what, superficially, is a far more technically valid approach, namely the Weight of Evidence Triad approach.

Characteristics of Weight of Evidence Triad Approach

The weight of evidence triad approach is an approach that we have supported for many years. It should be based on a best professional judgement, non-numeric evaluation of biological effects based testing, such as toxicity tests, in place aquatic organism

assemblage information and chemical information. It is the chemical component of the triad that is prompting me to contact the State Board on this matter in connection with the January 8, 1997 Board review of it.

The staff statement downloadable from the Board's web site states under Item 3, Consensus Recommendations of the BPTCP Advisory Committee:

"The recommendations call, in part, for the SWRCB to adopt a policy outlining the approach for identifying polluted sites in a consistent manner throughout coastal waters using a weight-of-evidence approach (a triad of sediment chemistry, toxicity and benthic community analysis) which is being currently used by the BPTCP."

While this statement, superficially to those who do not have a good understanding of aquatic chemistry issues with regard to the chemical component of a weight of evidence approach and the current activities based on released BPTCP reports, appears to be appropriate, a review of the chemical component of the weight of evidence approach that is currently being used in the BPTCP shows that the current BPTCP weight of evidence approach is using, as its primary chemical component, the technically invalid Long and Morgan co-occurrence based approaches. It appears, therefore, that the State Board staff, by wording this matter as they have for the PAC, is attempting to gain State Board approval of use of Long and Morgan methods as a legitimate basis for incorporating chemical information into a weight of evidence based triad. **The State Board should fully understand this issue so that at a later date, when this matter is reviewed by the public and others as part of implementing the BPTCP results into public policy, the Board understands the error that it made in supporting the Consensus Recommendations of the PAC with respect to incorporating current BPTCP approaches in triad development at it's January 8, 1997 workshop.**

Adequacy of Review of the Weight of Evidence Triad Approach by PAC. It should be pointed out that the BPTCP PAC did not want to address the technical issues associated with the specific components of the triad as part of their development of the "consensus statement". When I raised this issue at the PAC meeting, one of the members made it clear that he did not want to become involved in detailed discussions of the triad components. It, therefore, should not be concluded by the Board that the PAC has properly reviewed the current use of chemical information by the BPTCP staff and concluded that it is technically valid. In fact, this has not been addressed by PAC. It has been clear since PAC was organized that there is need for an independent technical advisory committee who would report to the BPTCP PAC and the Board on policy issues pertinent to the BPTCP.

Comments on the BPTCP Lab Scientists December 23, 1996 Letter

At the time that this PAC consensus recommendation was being developed, I provided comments at the PAC meeting on the significant deficiencies with the chemical aspects of the weight of evidence triad as being implemented by the State Board staff. I also followed up my discussion of these issues at the committee meeting with a letter dated

November 7, 1996 providing a detailed discussion with appropriate references of the deficiencies in continuing to use the current BPTCP approach for incorporating chemical information into the weight of evidence triad. In yesterday's mail, I received a copy of a letter addressed to the Chair BPTCP Public Advisory Committee, dated December 23, 1996 and signed by Russell Fairey, Max Puckett, Brian Anderson and John Hunt, which attempts to discredit my comments on the highly significant technical deficiencies on the way in which chemical information is being incorporated into the WRCB BPTCP weight of evidence triad. Mr. Puckett is with the California Department of Fish and Game Granite Canyon Marine Pollution Studies Laboratory. Mr. Fairey is part of the research staff of the Moss Landing Marine Laboratories and Mr. Anderson and Mr. Hunt are part of the University of California, Santa Cruz research staff at the Granite Canyon Marine Pollution Studies Laboratory.

In the first paragraph of their letter they characterize themselves as the "*chief scientists at the laboratories conducting the analyses and interpreting the resulting data for the Bay Protection and Toxic Cleanup Program (BPTCP)*" (BPTCP lab scientists). I am providing the PAC with a detailed set of comments on the distortions and the unreliable information provided by the BPTCP lab scientists. As will be discussed in these comments and summarized below, the BPTCP lab scientists have taken significant liberties in reliably discussing issues that I raised in my November 7, 1996 letter. They have also chosen to ignore, if they were aware of it, the long history that still prevails today with technically invalid approaches being advocated by the WRCB BPTCP management staff located in Sacramento on these issues. Further, they have deliberately distorted information pertinent to review of these issues in their December 23, 1996 letter.

Inappropriate Use of Chemical Information in Triad. It would be highly inappropriate for the State Board to rely, in any way, on the BPTCP lab scientists letter as a credible technical discussion of the chemical component of the triad approach that is being used in today's BPTCP. While the BPTCP lab scientists claim that my review of this issue does not accurately portray what is actually being done in the BPTCP triad with respect to providing chemical information, as I have pointed out in my November 7, 1996 letter and in the comments that I will soon be sending PAC and as has been documented in previous correspondence, the BPTCP staff have been allowed to spend from 2 to 3 million dollars per year of public/private funds for seven years without any accountability. I and others have repeatedly tried to obtain a detailed budget breakdown on how the funds that were budgeted each year for BPTCP activities were being spent. The PAC tried to obtain this information and were told that it is State Board staff policy to not make detailed budget information available to the public even though the funds being spent are substantially derived from fees collected from various dischargers.

I have also repeatedly pointed out that except for a couple reports, much of what has been generated from the BPTCP expenditures through support of these various laboratories within the Department of Fish and Game and the University of California, Santa Cruz, etc. has not been made available for public review. It is, frankly, unbelievable that over 15 million dollars in public funds have been spent with essentially no accountability.

While the State Board staff in their various documents such as the June 1996 draft Status of the Bay Protection and Toxic Cleanup Program: A Legislative Report, attempt to portray the BPTCP as having accomplished the development of significant information, when in fact little of this information has been made available for public review. A review of the Draft Staff Report: Status of the Bay Protection and Toxic Cleanup Program dated October 1995 shows under the References section, numerous reports in preparation, yet it is now over a year and a half later since that October 1995 report was developed and, with few exceptions, the reports are still not available for public review.

This past spring in connection with a SPARC meeting, the State Board staff released an "Internal Draft Report Do Not Cite or Reproduce," "Chemistry, Toxicity and Benthic Community Conditions in Sediments of the San Diego Bay Region" dated February 1996. This coupled with the discussions at the SPARC meeting held at Moss Landing last spring alerted me and others that the BPTCP staff responsible for incorporation of the chemistry component information into the BPTCP triad were relying almost exclusively if not totally exclusively on co-occurrence based values.

For example, on page 148 of the San Diego Bay studies, Item 1 under Conclusions states:

"Two sets of sediment quality guidelines were useful in demonstrating chemical pollution: The ERL/ERM thresholds developed by NOAA (Long and Morgan, 1990; Long et al.1993) and the NOEL/TEL/PEL thresholds used in Florida (MacDonald, 1993, MacDonald, 1994)."

The above quoted section indicates that co-occurrence based values were judged by the authors (R. Fairey, C. Bretz, S. Lamerdin, J. Hunt, B. Anderson, S. Tudor, C. Wilson, F. Le Caro, M. Stephenson, M. Puckett and E. Long) as useful in demonstrating "chemical pollution." However, a critical review of the San Diego Bay sediment report shows that the Long and Morgan based co-occurrence values do not predict pollution where pollution is defined in accord with current California regulatory requirements: Porter-Cologne Water Quality Control Act, January 1989 as:

"(l) 'Pollution' means an alteration of the quality of the waters of the state by waste to a degree which unreasonably affects (1) such waters for beneficial uses, or (2) facilities which serve such beneficial uses. 'Pollution' may include 'contamination'."

It is clear that the authors of this report do not understand or certainly do not properly use the term "pollution" as it is used in water pollution evaluation management programs in the state. While this program is still in draft form, hopefully someone who does understand this issue will rewrite this report so that it properly incorporates chemical information into sediment quality and more importantly properly interprets the sediment results in terms of San Diego Bay **pollution**. Unless this is done, the public and private entities associated with San Diego Bay could readily find themselves of having to spend many millions of dollars in remediating San Diego Bay sediments and current chemical constituent input arising from the fact that BPTCP management and lab scientists have

failed to properly incorporate chemical information into the triad and properly evaluate the pollution of the Bay by constituents in the sediments and tributary waters.

I have done extensive work on San Diego Bay sediment copper issues and have found that Long and Morgan so-called effects based values are highly unreliable in predicting copper toxicity in San Diego Bay sediments. In one area near National City, copper concentrations on the order of 50,000 mg/kg were present in the sediments which were non-toxic to nine different test organisms.

In the July 1994 Final Report, San Francisco Estuary Pilot Regional Monitoring Program: Sediment Studies, which was conducted under the BPTCP, the primary approach used for interpretation of chemical information was the Long and Morgan co-occurrence based values. Examination of page 3-12 under Preliminary Conclusion lists four items where Long and Morgan ER-L and ER-M values are discussed. No discussion is provided in the preliminary conclusions on other chemical information.

I have also had the opportunity to recently review the data that was developed in the BPTCP studies of sediments in Upper Newport Bay in Orange County and have found that from the information available, Long and Morgan co-occurrence based values are the important if not the most important chemical characterization tool for interpreting sediment toxicity data.

As discussed in my November 7, 1996 letter, at the SPARC meeting of last spring, a couple of SPARC members specifically informed the BPTCP lab scientists and administration that Long and Morgan co-occurrence based values are not reliable for use as a chemical component of the triad. While the BPTCP lab scientists in their December 23, 1996 letter claim on page 3 that I am not familiar with what is actually being done in the BPTCP with respect to incorporating chemical information into the triad, I wish to point out that I have reviewed all of the documents that have been made available thus far and have yet to find a single BPTCP document where the primary so-called chemical characterization tool was other than the Long and Morgan co-occurrence values.

It is for this reason that when the State Board staff urged the Board to support a recommendation that calls for the use of "*...a weight-of-evidence approach (a triad of sediment chemistry, toxicity and benthic community analysis) which is being currently used by the BPTCP.*" that I find that I must point out to the State Board that based on what has been produced thus far in the BPTCP, that the incorporation of chemistry into the BPTCP weight of evidence has been and continues to be fundamentally flawed. Those who organize and have implemented this program which has now spend over \$15 million failed to properly review the literature and gain sufficient expertise in aquatic chemistry and water quality issues to incorporate appropriate chemical measurements as part of the field studies that could have provided the information needed to discern whether heavy metals in the sediments are potentially toxic through the measurement of acid volatile sulfides.

While the BPTCP lab scientists and the BPTCP lab management may attempt to claim that they did not incorporate appropriate sulfide measurements in the program because this was a new issue that has only been recently developed, such claims are totally inappropriate. I had graduate students working on sediment sulfide issues in the early 1960s. In every sample of sediments from over 100 sites studied in the 1970s as part of the Corps of Engineers Dredged Material Research Program, I had my graduate students measure sulfides in the sediments. It is obvious to anyone with an elementary knowledge of aquatic chemistry and water quality that total sulfides in sediments must be measured if there is an attempt to relate the toxicity found to heavy metals in the sediments.

Appropriateness of Weight of Evidence Approach. The BPTCP lab scientists assert that I do not understand weight of evidence approaches. The basic problem is not a lack of understanding. It is a detailed understanding of these issues that is causing me to raise the concerns about the technical validity of the chemistry component of the triad that the State Board staff are recommending that the State Board support. While the BPTCP lab scientists attempt to portray the Long and Morgan values as having technical validity and that my review of the co-occurrence based approach is invalid, this is clearly a self serving statement on their part in an attempt to try to justify an ill-conceived, implemented and now, based on what has been reported thus far, BPTCP program that, evidently, they together with the State Board staff are responsible for developing without allowing the public the opportunity to review the program until it is essentially over.

The statements I have made on the lack of technical validity of the co-occurrence based values as an unreliable tool for interpreting chemical data pertinent to sediment quality are not based solely on my assessment of the situation. Dr. Robert Engler and Dr. Tom Wright as well as several others who have worked and held leadership roles for over 20 years in the Corps of Engineers research and management program at the Waterways Experiment Station in Vicksburg, Mississippi, are strongly opposed to the use of Long and Morgan and other co-occurrence based values to assess sediment quality. Dr. Engler is the US representative to the "London" International Dumping Convention concerned with contaminated sediment issues in international waters.

Dr. Tom O'Connor who heads up the NOAA National Status and Trends Program for marine environmental quality has found that Long and Morgan based values are not reliable for predicting sediment toxicity for the US EPA EMAP data for the east coast of the US. Further, Dr. Peter Chapman, who the BPTCP lab scientists attempt to assert in their December 23, 1996 letter holds different views than myself on these issues, is also strongly opposed to the use of Long and Morgan co-occurrence based values as the primary tool for incorporating chemical characteristics data into a triad. It was Dr. Chapman who as part of his organizing the Society for Environmental Toxicology and Chemistry (SETAC) Learned Discussions section who asked me to write a short review for publication in the Learned Discussions section of the SETAC news devoted to why co-occurrence based values should not even be used for screening purposes for assessing chemical contamination. I also know that the Chemical Manufacturers Association and other groups have reviewed this issue and determined that the co-occurrence based values are not a valid basis for characterizing sediment quality.

Further, from information provided by Ray Whittemore of the National Council of the Paper Industry for Air & Stream Improvement that the Council is strongly opposed to the use of Long and Morgan based values for characterization of sediment quality because of their unreliability. Further, as I discussed in my November 7, 1996 letter two members of SPARC, Drs. Suffet and Swartz cautioned the BPTCP management and BPTCP lab scientists about the use of Long and Morgan co-occurrence based values as a chemical component of the triad. I know from my recent discussions of this issue with Dr. Swartz that he is strongly opposed to this approach. Also, Dr. B. Thompson of the San Francisco Estuary Institute has recently reported that Long and Morgan co-occurrence based values were unreliable for predicting sediment toxicity in San Francisco Bay sediments. This is a small number of the scientists, engineers and various professional organizations and public agencies that have concluded that Long and Morgan co-occurrence based values are not valid for judging sediment characteristics.

Bioaccumulation Issues. The BPTCP lab scientists attempt to criticize my evaluation of bioaccumulation issues in the November 7, 1996 letter by asserting that I have presented contradictory statements in this letter on this issue. This is one of the several significant distortions of information presented by the BPTCP lab scientists. As I discussed at the PAC meeting and in my November 7, 1996 letter, the BPTCP has, after spending over \$15 million, failed to address in a meaningful way the bioaccumulation of hazardous chemicals issue which is one of the, if not the most important, toxic water quality problem in the state. Contrary to the BPTCP lab scientists, Mr. Puckett at the PAC meeting did say that the triad approach being used in the BPTCP does not include bioaccumulation issues. The failure to address bioaccumulation issues with these funds will become recognized as one of the most significant deficiencies in which the BPTCP program was developed and implemented. If this program had received public review as it should have there is a substantial probability that bioaccumulation issues would have been incorporated into it where some of the \$15 plus million would have been devoted to supplementing some of the WRCB TSM data to properly define where excessive bioaccumulation occurs and the potential sources of the constituents responsible for this problem.

Participation in SPARC Meeting. The BPTCP lab scientists attempt to assert, on page 4 of their December 23, 1996 letter that my failure to discuss the significant deficiencies that I have raised in the BPTCP program was a deficiency on my part where they state:

"His [Dr. Lee] comments in a [sic] open professional forum would have been welcomed and we regret he did not chose to participate and open his comments to debate. This response letter would probably not be needed now, had he chosen to do so.

The BPTCP lab scientists have failed to reliably report on the situation governing public participation in that SPARC meeting. Had they reliably reported on this issue they would have pointed out that the reason that other members of the public and I did not discuss many of the technical deficiencies in the program was that we were instructed not to do so by Craig Wilson at the beginning of the meeting. He made it clear at this meeting was that this meeting was for BPTCP staff and management to discuss technical issues with

the SPARC members. The public was allowed to be there as an observer. Why did Mr. Anderson and Mr. Hunt not state in the December 23, 1996 letter that they signed, with reference to my participation in the meeting that during break periods I specifically discussed with both of them the significant technical deficiencies in their use of chemical information in interpretation of sediment quality data?

Further, why did they not discuss that I have repeatedly provided PAC and the State Board with detailed comments with references to the literature on why Long and Morgan co-occurrence based values are not a valid basis for interpreting sediment composition data? Either through a lapse in memory, ignorance, or a deliberate distortion of information, the BPTCP lab scientists have failed to properly discuss the issues pertinent to the ability of the members of the public like myself to actively participate in the SPARC meetings. Further, I believe that if the State Board will review previous correspondence they will find that I have requested on several occasions that the State Board hold a full public forum so that the significant problems on how this program is being developed and implemented could be addressed while there was still time to make mid-course corrections which would address the invalid approaches that were being followed in the BPTCP program before the funds were exhausted.

Conclusions and Recommendation

I will be providing the PAC and the State Board with detailed comments on the significant deficiencies and distortions in the December 23, 1996 letter. For now it suffices to conclude that that letter is a non-credible discussion of issues that raises further questions about the ability of the BPTCP management in Sacramento and now the BPTCP lab scientists who have acknowledged that they are responsible for conducting analyses and interpreting resulting data for the BPTCP to properly implement and report on BPTCP results.

It is my recommendation that the State Board support a technically valid triad approach without tying it to what the current BPTCP lab scientists are doing in the way of BPTCP data interpretation. Basically, the recommendation should include deletion of the words, "*...which are currently being used by the BPTCP.*" from the first page of the Item 3 discussion for the January 8, 1997 workshop. Failure to do so could give license to BPTCP management that the current data approaches being used with respect to incorporating chemistry into the current triad interpretation are supported by the State Board. If the State Board has any questions about the validity of this recommendation it should convene a panel of experts who are knowledgeable in this topic who would critically review, as I have done, the various BPTCP reports that have been released thus far on how chemical data is interpreted relative to sediment quality.

As mentioned above, I will not be available to attend the January 8, 1997 Board workshop as a result of presenting my annual contaminated sediment short course at the Texas A&M University Dredging Engineering Workshop. I will, however, be happy to answer any questions that the Board members may have on these issues.

Sincerely yours,

Fred

G. Fred Lee, PhD, DEE

copy to: Governor Wilson
W. Pettit
PAC members through S. Folwarkow
BPTCP lab scientists

GFL:djc

Reference as: "Lee, G. F., 'California Water Resources Control Board Bay Protection and Toxic Cleanup Program: Problems with the Weight of Evidence Triad Approach,' Letter to J. Caffrey, State Water Resources Control Board, Sacramento, CA, January (1997). "