Cleanup Objectives For TMDL-Based Mercury Control Program

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At the last meeting of the Cache Creek Mercury Group there was discussion about the need to review appropriate goals for control of mercury under the current Central Valley Regional Water Quality Control Board mercury control TMDL process. Presented below is a discussion of issues relative to establishing TMDL goals for mercury control in Cache Creek, Putah Creek, Sacramento River, Yolo Bypass, Delta, and San Francisco Bay.

Water Quality Criterion for Mercury

In the current TMDL process the goal for the TMDL is mandated by regulations to be a water quality standard (objective). By Clean Water Act regulations the water quality standard can be no less stringent than the US EPA water quality criterion. The US EPA (1987) Gold Book criterion for mercury is 12 ng/L total recoverable mercury. While California does not have water quality standards (objectives) at this time, the regional boards typically are using US EPA water quality criteria as state standards. While there are questions about the legality of this approach, it is the approach that has been used and will likely continue to be used until California develops water quality standards.

The 12 ng/L water quality criterion is based on a worst-case-based situation where it was believed by the US EPA that in certain waterbodies from some mercury sources under certain conditions some fish would bioaccumulate mercury to excessive levels when the total mercury content of the water exceeded 12 ng/L. However, it has been well known that there are many situations where total recoverable mercury well in excess of 12 ng/L is present in a waterbody's water column that does not result in fish in the waterbody bioaccumulating mercury in excess of the concentrations that are considered safe for human consumption.

The worst-case approach used by the US EPA for establishing water quality criteria is part of the Agency's attempt to simplify the aqueous environmental chemistry of mercury where the issues of bioavailability, methylation, etc., are largely ignored. It has been understood since the 12 ng/L criterion was first promulgated that it could cause large scale expenditures for mercury control with little or no impact on the amount of bioaccumulatable mercury present in fish in the receiving waters for a mercury discharge. This situation has occurred in a number of areas where the US EPA has found that public owned treatment works (domestic wastewater treatment plants) are in violation of their NPDES discharge permit because the concentrations of mercury in the discharge exceed 12 ng/L. However, the fish in the receiving waters for the discharge did not have excessive mercury in their edible tissue.

California Toxics Rule

Several years ago, as a result of the California Water Resources Control Board having not developed water quality standards for the state, the US EPA Region 9 was required, as per Clean Water Act regulations, to develop standards for the state. This resulted in the US EPA (1997) Region 9 promulgating the Draft California Toxics Rule (CTR) in August 1997. The US EPA Region 9, as part of promulgating the CTR, proposed to adopt a water quality standard for mercury in California of about 50 ng/L. The raising of the standard from 12 ng/L to 50 ng/L does not reflect an understanding that mercury is less hazardous than originally thought. It reflects an adjustment in the approach that the US EPA is using to develop the mercury criterion which becomes the mercury standard.

In the spring of 1998 the US Fish and Wildlife Service and the National Marine Fisheries objected, as part of their role in implementation of the Endangered Species Act, to the US EPA Region 9 raising the mercury criterion in the CTR from the existing 12 ng/L based on total recoverable mercury to about 50 ng/L based on total recoverable mercury. The US EPA and the Services have not yet resolved this issue and other CTR criterion issues such as dissolved metals vs. total recoverable metals.

New Mercury Water Quality Criterion

Discussions with US EPA water quality criteria officials lead to the conclusion that the 50 ng/L criterion is a temporary criterion that will almost certainly be adjusted downward to about 5 ng/L as part of the current US EPA's national mercury review. The 5 ng/L total recoverable mercury reflects a US EPA assessment that mercury is more hazardous than was thought at the time the 12 ng/L value was adopted in the mid 1980s. It is uncertain at this time when the US EPA will promulgate a new mercury criterion reflecting the agency's current position on the hazards of mercury in fish. It is my assessment that, based on current US EPA policy, any TMDL development program should consider as one of the TMDL goal would be 5 ng/L total recoverable mercury.

There is considerable controversy between the US EPA, Food and Drug Administration, and the Agency for Toxic Substances and Disease Registry on the hazardous of mercury in human food where the FDA and ATSDR have concluded that the US EPA is over estimating these hazards. It is unlikely that the US EPA's assessment of mercury hazards will be changed. It is therefore recommended, that the US EPA guideline values for excessive mercury in edible fish tissue be used as a basis for regulating mercury for protection of public health.

Regulating Mercury Based on Site Specific Bioaccumulation Factors

As part of the US EPA's Clean Water Action Plan, promulgated in the spring of 1998, the US EPA has proposed to possibly adopt a tissue residue based site specific water quality standards approach where the discharges and regulatory agency would have the opportunity to determine the relationship between mercury discharges to a waterbody and the excessive bioaccumulation that occurs within the

waterbody. While this approach is an approach that I have advocated in general for over 30 years as the approach that should be used to regulate bioaccumulatable substances, the way in which the US EPA proposes to implement this approach involving translating the tissue residues to a chemical specific numeric discharge limit is fraught with significant technical problems. This is especially true for constituents like mercury where there is a sediment based methylation process that influences/controls the rate of conversion of mercury into a tissue accumulatable form and, therefore, the tissue residues that occur in fish and other forms of aquatic life in a waterbody. While this approach has considerable merit for situations in which the current discharge of mercury controls the tissue residues, the situations such as those that occur in the Sacramento River, Cache Creek, Putah Creek, Yolo Bypass, the Delta and other waterbodies in the Sacramento/San Joaquin River system where there is large amounts of mercury accumulated in the sediments, the current mercury load - fish tissue response relationship may have no meaning since the tissue residues could be controlled, to a large part if not exclusively, by historical inputs of mercury to the system.

Need to Understand the Role of Current Mercury Inputs to Excessive Mercury Bioaccumulation in Fish and Other Aquatic Life

Ultimately, in geological time, i.e., thousands to tens of thousands/hundreds of thousands of years, the historical and current mercury inputs to the deeper sediments in waterbodies of concern will, to a considerable extent if not totally, become part of the historical sediments which are not interacting with the overlying waters. Under these conditions there would be a decrease in the mercury content of fish tissue. It could be, however, that in the shallow water system of the Sacramento/San Joaquin River watershed, Delta, and San Francisco Bay, there is enough reworking of sediments so that the fish in the system will never have a significant decrease in their mercury content. It is extremely important that these situations be understood, otherwise, large amounts of money could be spent in controlling mercury inputs that have little or no impact on excessive mercury bioaccumulation in fish and other aquatic life.

While it is asserted that the CALFED sponsored research program that is developed by the Cache Creek Mercury Work Group will develop the information needed to develop a more technically valid, cost effective mercury control program, I have serious reservations as to whether the current research program will yield the kinds of information within the time frame that is allowed for TMDL development to enable the regulatory agencies to formulate what would be considered technically valid approaches for managing mercury inputs. The research program that is needed will need to be carried out over ten to twenty years. Certainly no two-year program will provide definitive results that will put the development of a mercury control strategy on a significantly better technical base than exists now.

The basic problem is that the coupling between mercury loads, mercury concentrations in sediments, mercury tissue concentrations and rates of methylation in various parts of the Sacramento/San Joaquin River system, the Delta and San Francisco Bay is so poorly understood and sufficiently complex that it is highly doubtful that the relationship between mercury inputs to a waterbody and the tissue residues that result from these inputs under conditions where there is substantial mercury already in the sediments, will not be achieved in the time frame allowed. In the early 1990s, when I first became involved in

assessing information on mercury methylation, there was limited understanding of the factors controlling methylation. In the last half a dozen years or so considerable information has been gained which shows that there is not a single simple pathway, but there are multiple pathways and control factors that can lead to methyl mercury formation and accumulation within fish tissue.

These comments on the expected deficiencies on the CALFED sponsored Cache Creek, Yolo Bypass, Delta, Bay research program should not be interpreted that I feel that an intensive research program should not proceed as part of developing technically valid cost-effective mercury control program. However, it is important that this research program focuses a significant part of the funding available on understanding the relative roles of historical mercury inputs (i.e., existing sediment residues) and current mercury inputs as a cause of the current excessive mercury tissues residues in aquatic life in each of the waterbodies of concern, Cache Creek, Putah Creek, Sacramento River, the Delta, and San Francisco Bay.

Development of Mercury TMDL Goals

At the recent Cache Creek Mercury Work Group meeting there was discussion about the need to define mercury TMDL control goals. While there is need to define the goals of the TMDL process, I suggested that, rather than focusing considerable amounts of group time on goal definition, what should be done is to assume that if this group had to make a decision tomorrow on the implementation of a five to ten million dollar control program what would this group recommend be the initial phase of the control program. Where should the money first be spent? What is the basis for selecting the initial expenditures? What additional information is needed to justify such expenditures? Basically, I am suggesting that rather than approaching this as a scientific curiosity issue it should be approached as an engineering problem where you as "engineers" have to develop a mercury control program within a short period of time based on what is known and can readily be obtained within a two year period.

Another issue that should be assessed is how sensitive is the implementation of the initial mercury control program to the range of TMDL goals. It is suggested that the group should establish a set of data covering the range of the type that will likely be encountered as a result of research results. Given this data, how would it be used to make decisions about the control program? The group will likely find, if they conduct this exercise, that much of the research that is being done under the CALFED project will provide little in the way of definitive information that will influence the control programs that are to be implemented within a short period of time. It appears, from review of the CALFED proposal, that the research efforts that have been initiated is a result of a collection of projects without a well defined plan on how the data generated from the projects will be used to implement public policy for mercury control within the TMDL process and especially the severe time limitations allowed by this process.

It is suggested that the TMDL goals for mercury control cover the range of what is expected now to be the worst case situation of 5 ng/L of total recoverable mercury that is not to be exceeded more than once every three years through a tissue residue based TMDL goal where the US EPA Region 9 guideline value for one meal of fish per week be used to establish an excessive concentration of mercury in edible

fish flesh. With respect to the latter goal, it will be necessary to implement this goal based on developing an understanding of the relationship between existing/historical mercury inputs that are now present as residues in waterbody sediments and the current inputs that principally occur each year during the high winter flows where large amounts of particulate mercury are mobilized into the watercolumn in Cache Creek, Sacramento River, Putah Creek, Yolo Bypass, the Delta, and San Francisco Bay.

Each of the waterbodies of concern should be critically examined with respect to whether there are local populations who are consuming more than one meal of fish per week taken from the waterbody. If such populations are found, then the excessive tissue residue goal should be adjusted accordingly to protect the health of unborn and nursing young children from the hazards of mercury.

If it is found that the mercury content of fish and other aquatic life, that is considered "safe" for human consumption based on a one meal per week consumption rate, is hazardous to higher trophic level fish eating birds and mammals then a goal designed to protect fish eating birds and mammals could be considered for development. I would not attempt to develop at this time a TMDL goal for mercury control in the Cache Creek, Putah Creek, Yolo Bypass, Sacramento River, Delta, and San Francisco Bay based on attempting to protect fish eating birds and mammals from the hazards of mercury. These issues should be investigated to determine if there is evidence for aquatic life mercury tissue residues being significantly adverse to fish eating bird and mammal populations. Initial efforts of the TMDL process should be focused on protection of human health. The information on adverse impacts to wildlife can be incorporated into the revision of the TMDL goal that could be considered in five to ten years.

In area that has apparently not been considered is the potential impacts on mercury on aquatic life. The US Army Corps of Engineers (US COE/EPA 1998) and the US EPA (Jarvinen and Ankley, 1999) have recently developed tissue residue aquatic life impact reviews that provide information on what elevated concentrations of potentially hazardous chemicals mean to the aquatic life host organism.

Additional information on the TMDL process is available from the US EPA Region 9 website at www.epa.gov/region09/water/tmdl/fact.html

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July 30, 1999

To: Sacramento/San Joaquin River Delta Watershed Mercury Council

From: G. Fred Lee

Re: Mercury TMDL Control Goals

TMDL Goal Based on Mercury Tissue Residues

Prior to the last Sacramento/San Joaquin River Delta Watershed Mercury Council meeting I distributed a discussion devoted to establishing TMDL goals for mercury. That discussion, (Lee, G.F., "Cleanup Objectives For TMDL-Based Mercury Control Program," July (1999).) is available from my web site, www.gfredlee.com, in the Sacramento River Watershed section. I wish to follow up on the last Delta Watershed Mercury Council meeting discussions on TMDL goals for mercury and my e-mail discussion of this issue to indicate that before large amounts of effort are made in trying to establish a rational approach based on acceptable tissue residue concentrations as a goal for mercury control TMDL development, the US EPA Region 9 and US EPA headquarters, Washington, D.C., should be contacted to gain approval for this approach. It is important to understand that the tissue residue approach for establishing TMDL goals, while technically valid, is contrary to current US EPA TMDL policy and the approach that the US EPA is using for implementation of the Clean Water Act involving independent application of chemically-based criteria/standards.

While, as I discussed, the Agency is discussing the possibility of modifying the independent application approach and the possibility of using tissue residue-based approaches for controlling bioaccumulatable substances, there is no assurance that the Agency will be able to follow through with these efforts. The Agency has been discussing these issues for about ten years with little progress thus far. A number of environmental groups are strongly opposed to any approach other than the most simplistic numeric chemical worst-case-based criteria/standards regulatory approach. They were successful in blocking the US EPA from even reviewing the independent application policy for many years. I know that they are vigorously opposed to any modifications of current regulatory approaches as a "weakening" of the Clean Water Act. The Agency, as it has done in the past, may, in the future, yield to their pressures with a result that it may not be able to carry through with a more technically valid, cost-effective approach for regulating chemical constituents in aquatic systems as they may impact public health and the environment.

Before the, what is apparently proposed, detailed extended discussions of TMDL goals are undertaken by the Delta Mercury Council, an attempt should be made to obtain a clear written definition from the US EPA Region 9 Regional Administrator (F. Marcus) and the US EPA headquarters Assistant Administrator for Water (C. Fox) on the appropriateness of using a tissue residue-based approach for establishing a TMDL for mercury control. I wish to point out that this issue is under review by the US EPA Region 9 in connection with an Arizona Indian tribe's proposal for mercury control. While a tissue residue-based approach is a logical approach, and is an approach that some of us have been advocating for over

25 years, the US EPA administration has consistently refused to adopt this approach in favor of the bureaucratically simplistic worst-case-based single chemical concentration approach for establishing water quality criteria/standards and TMDLs.

The participants in the "Delta Mercury Council" should understand that if they spend large amounts of time trying to develop a more technically valid, cost-effective but equally protective approach for controlling mercury inputs to the Sacramento/San Joaquin River systems and the Delta, that this time may be of limited utility since the US EPA could follow its current approach of basing TMDLs on achieving numeric water quality standards. While there are no standards now, likely within a few months there will be a California Toxics Rule standard of 50 ng/L for total recoverable mercury that cannot be exceeded by any amount more than once every three years. This standard will also likely be decreased to around 5 ng/L within a couple of years. Based on past approaches I do not feel that the 1 ng/L value that is sometimes used as a protective level for aquatic birds and animals will be adopted by the US EPA as the water quality criterion/standard that would be used as a TMDL goal.

Great Lakes as a Model for Mercury Control

There were suggestions at the recent Council meeting about trying to gain experience from the Great Lakes on these issues. As an individual who conducted research on Great Lakes water quality for 15 years, served as an advisor to the International Joint Commission for the Great Lakes for many years, and who has continued to follow Great Lakes water quality issues since then, I can unequivocally state that the Great Lakes are not a good model for Cache Creek, Putah Creek, the Sacramento River and the other tributaries of the Delta for mercury. The aqueous environmental chemistry of various potential pollutants in the Upper Great Lakes is quite different from that of most other waterbodies.

Site Specific Mercury Water Quality Objectives

There were also suggestions at the last Council meeting about trying to establish a site specific numeric objective for mercury based on the bioaccumulation factor that results from the water column mercury concentration and an acceptable tissue residue. As I indicated, this is the approach that the US EPA has used. At the time that it was adopted in the early 1980s it was a plausible worst-case approach for developing a chemically based criterion. Today, however, it is known that this approach is not valid because of the sediment coupling in formation of bioaccumulatable mercury. It is now well established that there is no relationship between water column concentrations and sediment concentrations of total recoverable mercury. There is also no relationship between sediment concentrations of mercury and bioaccumulation. While it would be possible to develop a numeric criterion/standard that could serve as a TMDL goal for mercury control, such an approach will almost certainly have no technical validity and, most importantly, no predictive capability between changing the load of total recoverable mercury to a waterbody and the tissue residues that are present in various aquatic organisms within the waterbody.

If there are questions or comments on these comments, please contact me.

Air and Waste Management Association Meetings on Mercury

The national annual meeting of the Air and Waste Management Association that was held in June, 1999, St. Louis, MO included eight sessions devoted to "Emission Controls for Mercury and Area Sources." There was also a session devoted to "State, Regional and National Mercury Control Strategies."

The Air and Waste Management Association will also hold a specialty conference, "Mercury and the Environment," September 15-17, 1999 in Minneapolis/St. Paul, MN. This conference is indicated to cover "...mercury and its relationships with ecosystem impacts, health effects, measurement and control, transport and deposition, and regulation and policy." For more information on these conferences, contact A&WMA at (412) 232-3444, ext. 3142, or visit www.awma.org/awma/confs/confs.htm.

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