California Regional Water Quality Control Board
San Francisco Bay Region

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ATTACHMENT

TO: Tom Howard
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FROM: Bruce Wolfe
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Regional Water Quality Control Board

DATE: May 13, 2005

SUBJECT: STATE WATER BOARD RESOLUTION NO. 2005-0026 REGARDING THE PROPOSED SAN FRANCISCO BAY MERCURY TMDL

We appreciate the opportunity to present the following response to the State Water Board's March resolution regarding the proposed San Francisco Bay Mercury TMDL. We hope that the Board will consider this response sufficient to address the complexities associated with this TMDL such that the Board may consider approving it. In the following discussion, we provide a summary response (in bold) to each applicable element of the Resolution, followed by a more detailed rationale and documentation.

RESOLVED 2

The San Francisco Bay Water Board staff and the Central Valley Water Board staff shall work with State Water Board staff to develop integrated TMDLs for the Sacramento/San Joaquin Delta, the San Francisco Bay, and the Guadalupe River to address mercury pollution.

Our current approach is already founded on integrated TMDLs, and San Francisco Bay and Central Valley Water Board staff will continue to work together to integrate these mercury TMDLs. The San Francisco Bay TMDL's allocations applied to the Guadalupe River and to the Central Valley were developed with full consideration of the work under way in those watersheds. By its adaptive implementation design, the San Francisco Bay TMDL will be reviewed at least every five years and revised if and when new information becomes available. We do not see anything in the Guadalupe River Watershed, Cache Creek, and Delta mercury TMDLs that would affect the San Francisco Bay TMDL in the short term (i.e., less than five years) that otherwise cannot be accounted for within the current implementation plan of the San Francisco Bay TMDL.

The San Francisco Bay TMDL implementation plan for the Guadalupe River allocation was crafted with the recognition that attainment of the allocation within 20 years as prescribed will depend on development and implementation of a plan of action that would also meet the TMDL and its associated allocations for mercury in the Guadalupe River, now under development. By adopting the San Francisco Bay TMDL, the San Francisco Bay Water Board expressed its commitment to meet the Guadalupe River allocation through the Guadalupe River Watershed TMDL. The San Francisco Bay TMDL implementation plan for the Guadalupe River allocation specifically states:

> "In the near term, the effort underway to develop the Guadalupe River Watershed Mercury TMDL will be the mechanism used to implement and track progress toward achieving the load allocation. Ultimately, the Water Board expects the implementation plan for the Guadalupe River Watershed Mercury TMDL to integrate implementation efforts relative to that TMDL with those implementation efforts for the San Francisco Bay Mercury TMDL."

A Preliminary Project Report for the Guadalupe River Watershed TMDL that will be completed by July 2005 will further demonstrate this ongoing integration. This report is not expected to contain any new information that would affect the San Francisco Bay TMDL.

San Francisco Bay Water Board staff developed the Central Valley watershed allocation with direct input from Central Valley Water Board staff. Central Valley staff confirmed that the allocation is reasonable and that Central Valley TMDLs will be designed to meet this allocation. Central Valley staff is incorporating the San Francisco Bay TMDL load allocation into the Delta TMDL currently under development. Central Valley staff is using the San Francisco Bay suspended sediment target as a goal for the Delta and the required mass load reduction to help it develop its own mercury load allocations. The Central Valley Water Board's fish target is comparable to the fish tissue target in the San Francisco Bay TMDL, and Central Valley staff recommend adopting the tissue target as a water quality objective.

We do not anticipate any new information related to the Sacramento/San Joaquin Delta and Guadalupe River Watershed TMDLs that would affect the San Francisco Bay TMDL in the short term. Since San Francisco Bay is downstream from the Guadalupe River watershed and the Sacramento/San Joaquin Delta watershed, these TMDLs are unlikely to raise issues that need to be integrated into the San Francisco Bay TMDL. By its adaptive implementation design, however, the San Francisco Bay TMDL will be periodically reviewed and revised, as necessary, when new information becomes available. The Delta TMDL (and all Central Valley mercury TMDLs) will include similar language about reviewing new data and making revisions as necessary. The State Water Board could, when it reviews the Central Valley TMDLs, call for any further coordination deemed necessary, and could specifically direct the San Francisco Bay Water Board to address any concerns when the San Francisco Bay mercury TMDL comes up for review.

In addition to coordinating development of TMDL targets and allocations, San Francisco Bay and Central Valley Board staff are closely coordinating other actions associated with implementation. There are some distinct differences in the TMDLs such as all discharges in the Central Valley are to freshwaters where all San Francisco Bay discharges are to marine/estuarine waters. As such, there are significant differences in receiving water chemistry and biology, and mercury and methylmercury fate and transport. On the other hand, wastewater treatment systems in the Central Valley and San Francisco Bay regions are very similar. Central Valley Board staff has asked wastewater dischargers to monitor for methylmercury. Rather than asking all San Francisco Bay dischargers to conduct the same monitoring, we will await the Central Valley's results, since it is reasonable to assume the results will apply to San Francisco Bay dischargers. In the meantime, we have asked one discharger to conduct a detailed pilot study on methylmercury throughout its treatment system. We intend to use the results from the latter study along with the Central Valley dischargers' results in the design of the local effects studies called for in the San Francisco Bay TMDL's implementation plan. This is one example of how a staggered TMDL schedule and implementation schedule is proving beneficial.

RESOLVED 3

The integrated TMDLs shall build upon the work already completed in the proposed San Francisco Bay mercury TMDL, and not duplicate that work unless it is necessary to achieve the intent of this resolution.

At this time we see no need to duplicate or change the proposed San Francisco Bay mercury TMDL to achieve the intent of the resolution.

RESOLVED 4

The integrated TMDLs shall ensure attainment of all applicable mercury standards within a reasonable period of time. The staff reports shall include a rationale for the proposed implementation and compliance time schedules, and the appropriateness of the length of time it will take to restore the water bodies to standards.

The existing staff report for the proposed San Francisco Bay mercury TMDL adopted by the Water Board included this rationale. The 120-year time frame for full recovery included in that staff report is a byproduct of the analysis demonstrating that allocations are sufficient to meet targets. In actuality, the TMDL implementation plan has an explicit implementation schedule not to exceed twenty years. Faster implementation is not feasible. The recovery period of the Bay was considered when developing the implementation plan and schedule. However, the dominant factors that affect the recovery time of the Bay are not controllable. We commit to inclusion of the required rationale in all future TMDLs.

Rationale for Time Schedules and Recovery Time. To determine what time period is reasonable and appropriate requires balanced judgment. It requires implementing the mandates of applicable laws and regulations in a manner that is protective, reasonable and achievable. These issues are considered below:

TMDL allocations must be sufficient to attain water quality standards. The Clean Water Act requires TMDL allocations, if implemented, to eventually result in standard attainment. This mandate is our first priority. The Clean Water Act does not necessarily require that TMDL allocations be technically or economically feasible.

- *TMDL implementation must be technically and economically feasible.* While allocations need not be feasible, the TMDL implementation plan must be technically and economically feasible. U.S. EPA guidance instructs that allocations must be technically feasible and reasonably assured of being implemented within a reasonable period of time. The California Environmental Quality Act requires that economic factors be considered.

- *The Clean Water Act does not dictate a specific time frame for meeting water quality standards.* Without question, the intent of the Clean Water Act is that all waters should meet standards. Waters that do not meet standards should be brought into attainment as soon as possible. However, assuming that allocations are set such that standards will eventually be attained, the Clean Water Act does not require that they be set lower, simply to speed recovery, if doing so ignores technical and economic feasibility.

Accordingly, we must prudently balance the need to comply with the Clean Water Act with the need to do so using available information and resources. The speed at which we seek to implement the TMDL must be commensurate with available information regarding our ability to implement the TMDL, the likely effectiveness of our actions, and the ability of the citizens of California to pay for such actions.

We selected allocations necessary to meet the proposed targets throughout San Francisco Bay (and therefore water quality standards) and then sought to demonstrate that San Francisco Bay would indeed meet the targets if the allocations were implemented. The projected 120-year recovery period is simply the byproduct of this demonstration and should not be over-interpreted. It should be only be used to study target attainment and the relative effects of different allocation and implementation schemes. It should not be taken too literally. Unfortunately, many observers take the recovery projection out of this context, suggesting that we arbitrarily selected it with disregard for environmental protection. They neglect to recognize the limitations of the model and the constraints that limit a faster recovery.

The actual TMDL implementation schedule is very aggressive. The TMDL calls for all "controllable" allocations to be phased in within 20 years (not 120 years). (Bed erosion is considered "uncontrollable" and is discussed below.) This will be very challenging since meeting the allocations will require monumental actions throughout the Bay Area and Central Valley and Guadalupe River watersheds. Nevertheless, reductions are necessary to reach water quality standards throughout San Francisco Bay, and the TMDL calls for dischargers to face these challenges on an aggressive schedule.

Alternative Implementation Scenarios. When concerns are expressed regarding the projected recovery time for San Francisco Bay, the underlying assertion is often that the TMDL does not require fast enough implementation or large enough load reductions. We considered an alternative to the Basin Plan Amendment whereby the allocations would be phased in faster (over 10 years instead of 20 years). However, this alternative would shave only about 10 years from the projected recovery period. Unfortunately, faster implementation is almost certainly infeasible, particularly for the Central Valley and Guadalupe River watersheds, where so much additional work is needed. Adopting a faster implementation time frame does not necessarily guarantee faster implementation, especially when the real world work cannot be completed faster.

We also explored an alternative that would lower the allocations and thereby reach the targets faster. We considered the most extreme scenario: all allocations would immediately be set at zero (this is clearly impossible), except for bed erosion, which is essentially uncontrollable. In this scenario, meeting the targets would still take at least 40 years. We also considered a less extreme (but no less impossible) scenario: immediately setting the allocations for the Central

Valley and Guadalupe River watersheds and urban storm water runoff at pre-mining conditions, and assuming that wastewater and atmospheric deposition allocations could be zero. Even in this scenario, reaching the targets would take more than 70 years. These analyses clearly demonstrate that substantially speeding San Francisco Bay's recovery would require achieving allocations well below those proposed. Since implementing lower allocations is likely infeasible, if the TMDL called for such allocations, it would be a mere paper exercise prposing a fictional recovery.

During the public comment period, it was suggested that the TMDL should reduce wastewater allocations to accelerate San Francisco Bay's recovery. In reality, wastewater is a small portion of the total mercury load (about 2%). Assuming that all other allocations would remain as proposed, we estimate that allowing no wastewater load (zero allocation) would cut only about three years from the predicted recovery time (and given the limitations of the analysis, this scenario's 118-year recovery is indistinguishable from the proposed TMDL's 121-year recovery—both are essentially about 120 years). However, wastewater treatment plants already remove almost all mercury from their influent; reducing wastewater loads further would require substantial additional pollution prevention, reclamation, and treatment. To the extent that lower loads are technically feasible, these efforts could be unreasonably costly to California ratepayers for limited environmental benefit. Substantially further reducing mercury in Bay Area wastewater discharges could cost from $87 million to almost $1 billion per year.

Physical Constraints. Evidence in the record does not support the notion that substantially lower allocations or more aggressive implementation can speed San Francisco Bay's recovery. The sheer mass of mercury already in San Francisco Bay places a very real constraint on the time it will take to attain standards. San Francisco Bay already contains so much mercury (roughly 64,000 kilograms) that, even if most mercury sources could be eliminated immediately, it would take decades to reach the 50% reduction called for. More to the point, the largest source of mercury, bed erosion, cannot be controlled based on our existing understanding of the Bay's physical system.

Mercury-laden sediment buried below the floor of San Francisco Bay during mining times is now coming to the surface as sediment as the floor erodes. This process cannot continue forever, but we expect it to continue for some time and have no practical way of reducing its effects. We propose no implementation actions targeting bed erosion because there are no reasonable actions to pursue. Given the scale of bed erosion, addressing this source could require substantial dredging of the San Francisco Bay floor, capping the floor with erosion-resistant material, or causing extreme sediment flows to ensure deposition. All these options would be phenomenal engineering feats, none is feasible, and none is reasonable in light of the severe environmental harm that would be posed to San Francisco Bay's beneficial uses.

To illustrate the significance of this source, we have used our simple model to estimate the projected recovery time if we could actually control bed erosion within 20 years (the same time frame we propose for the "controllable" sources). Implementing this allocation within 20 years instead of the 110 assumed in the TMDL staff report allows target attainment within about 70 years. Thus, the fact that we cannot control bed erosion adds roughly 50 years to the projected recovery time. To suggest that we could arbitrarily select a shorter recovery period promotes a fantasy that ignores the essential physical constraints of the Bay that limit how fast we can expect to meet water quality standards. We must face the reality that the mercury problem took over a century to develop, and the solution may require a similar length of time to implement. In view of the Bay's physical constraints, the proposed allocations and the implementation time schedules are aggressive, reasonable, and appropriate.

RESOLVED 5(a)

The integrated TMDLs shall include a consideration and documentation of the complexities of the Sacramento/San Joaquin Delta and San Francisco Bay hydrology and whether or not mixing and flushing of sediments will actually occur as San Francisco Bay Water Board staff has indicated....

In developing the TMDL, we reviewed all available information and considered San Francisco Bay's complexities to the extent possible. The scientific peer reviewers evaluated this issue and concurred with our approach. Improved understanding of the system and model improvements are part of the adaptive implementation plan.

San Francisco Bay is the largest estuary in western North America. Its watershed encompasses about 60,000 square miles, or 40% of California. Water and sediment circulation patterns are especially complex as a result of its elongated shape, the large volume of water that passes through its northern reach, its narrow connection to the Pacific Ocean at the Golden Gate, and the relatively low freshwater inputs from local tributaries, especially those in South San Francisco Bay.

Mercury fate and transport processes within San Francisco Bay vary significantly throughout time and space, and available data are insufficient to support more detailed analyses without over-interpreting the limited data. Therefore, we have relied on simple models to represent San Francisco Bay and some of its basic processes. The advantages of simplicity—the ability to identify and prioritize reasonable actions without over-interpreting available data—outweigh the apparent realism that might be attainable with more complex models.

The proposed adaptive approach to TMDL implementation requires that new information be collected and reviewed as it becomes available. Such information would be incorporated into the TMDL, as appropriate, through future Basin Plan amendments. The TMDL staff report already acknowledges the system's complexities and documents the information needed to address these complexities. Specifically, the TMDL calls for working to answer the following specific questions:

- *Will erosion of buried mercury-laden sediment affect water quality?* The TMDL assumes that mercury buried below the active layer is introduced into the system via erosion. If this source continues for many decades as anticipated, it will continue to impede progress toward TMDL targets because of its magnitude.

- *What is the mercury and sediment export out the Golden Gate?* The TMDL estimates mercury and sediment export out the Golden Gate indirectly. Better estimates of sediment and mercury export may enable us to refine estimates of the time it will take to attain targets.

- *What is the timeframe for recovery of the system and attainment of targets?* The simple model we used is based on the following simplifications:

    - *The system is composed of two compartments—waters and active sediment.* The active sediment is the topmost layer of Bay sediment subject to routine re-suspension by wind, waves, currents, and tides.

    - *The depth of the active sediment layer is 0.15 meters.* Although the active sediment layer depth may vary by location, salinity, season, and a number of other factors, since the TMDL is concerned with long-term changes and consequences, it is reasonable to summarize this process through an overall average.

    - *Mercury below the active sediment is not considered part of the system, but it can enter the system when overlying sediment erodes.* This process does not occur everywhere, but it is well documented.

    - *Active sediment is completely mixed.* This is a reasonable assumption given that, by definition, the sediment in this layer is subject to re-suspension and mixing.

    - *The mass of sediment leaving San Francisco Bay balances the mass of sediment entering.* Although some parts of San Francisco Bay appear to be eroding, the active layer is assumed to neither lose nor gain sediment. Assuming that the depth of the active layer is constant, the sediment mass in the active layer is also constant.

  Refining these assumptions as we collect new information will allow a better estimate of the recovery time frame. Refinement of the projected recovery time would not, however, change the actual recovery time, but the information could provide clues as to what steps might exist to speed recovery.

  What are the implications of the residence time of mercury from different sources? Water and sediment entering San Francisco Bay from different locations likely have different residence times, and a better understanding of hydrodynamics and sediment transport could be useful. Mercury that has a very short residence time may be less likely to undergo methylation and bioaccumulation.

Mercury cycling in the environment, coupled with San Francisco Bay's complexity, make solving the mercury problem a serious challenge. Studies of mercury transport, fate, and effects are underway, and we expect significant new information to become available within five to ten years. Such research, however, will continue for decades. Nevertheless, our problem-solving approach is based on available information and is adequate to identify and prioritize measures to attain water quality standards today, while seeking better information to inform our future actions.

A team of external scientists has reviewed the TMDL with the charge of ensuring that the proposed Basin Plan Amendment is based on sound scientific knowledge, methods, and practices. Upon concluding his review, Professor James Kirchner of U.C. Berkeley wrote:

> *To my knowledge, the data used in the report are the best currently available. There are several important information gaps, which are clearly identified in the report. The treatment of the data is appropriate; the report neither over-interprets the available data, nor overlooks important data bearing on the matters of interest....*
>
> *The report recognizes that there are key information gaps, but these do not justify indefinite delay in implementing a plan of action. Enough is known about the sources, fate, and effects of mercury in San Francisco Bay to justify the proposed TMDL allocations and the proposed implementation plan. The implementation plan proposed in the report is a reasonable approach to managing mercury in San Francisco Bay, while simultaneously working to fill the critical information gaps, and allows for changes to be made as new information becomes available.*

Professor David Sedlak of U.C. Berkeley wrote:

> *The development of a TMDL for mercury in San Francisco Bay is very challenging and I believe that the authors of the report should be commended for their efforts. In my opinion, the report articulates the state of the science with respect to mercury in San Francisco Bay and the various approaches that can be used to ameliorate the risks that mercury poses to humans and wildlife. The authors have done a good job identifying uncertainties in the data and designing a TMDL that can be adapted as additional information becomes available. Although certain elements of the report could be improved* [staff addressed these issues], *I believe that the plan should be adopted in a timely manner. The report makes it clear that mercury really is a problem in San Francisco Bay and that a modest allocation of resources can help solve the problem.*

On the basis of existing information, the TMDL assumptions regarding mixing and flushing of San Francisco Bay sediment are reasonable and can be revised as new information becomes available through adaptive implementation.

RESOLVED 5(b)

The integrated TMDLs shall include a consideration and documentation of...the impacts, if any, resulting from mercury discharges from the San Francisco Bay to marine waters outside the Golden Gate....

There is no evidence of adverse impacts to marine waters outside the Golden Gate resulting from mercury discharges from the San Francisco Bay. This is consistent with our understanding of the marine food web outside the Golden Gate, which is different that that in the Bay.

The TMDL focuses on San Francisco Bay because the Bay is a §303(d)-listed impaired water body. The TMDL need not account for the Pacific Ocean; nevertheless, since most San Francisco Bay mercury will eventually end up in the Ocean, concern regarding the potential impacts of mercury discharges from San Francisco Bay to marine waters outside the Golden Gate is understandable. The San Francisco Bay Water Board expressed similar concern during its November 2002 meeting.

Many typically consumed commercial fish (e.g., some tuna) live in the ocean and are known to contain elevated mercury concentrations. Far more people consume commercially available ocean fish than consume San Francisco Bay fish. San Francisco Bay fish consumers are primarily anglers and subsistence fishers. To understand how mercury leaving San Francisco Bay relates to ocean fish consumption requires an understanding of the differences between mercury's fate in San Francisco Bay versus its fate in the ocean.

Most mercury is bound to sediment. Because San Francisco Bay is relatively shallow (its depths are typically less than 50 feet), San Francisco Bay sediment is easily re-suspended. Therefore, mercury in San Francisco Bay sediment moves readily from place to place. Eventually, some of this mercury moves to locations where it is converted to methylmercury, which enters San Francisco Bay's benthic food web primarily through bottom-dwelling organisms.

In contrast, the Pacific Ocean is very deep. Just offshore, depths quickly become greater than 8,000 feet. Sediment settling at these depths is not easily re-suspended. More importantly, the ocean floor is not known to be a region of efficient methylmercury production. Although large predatory ocean fish are known to contain mercury, they do not accumulate it through a benthic food web. They obtain their mercury through a pelagic (water column) food web, which is less affected by sediment-bound mercury from San Francisco Bay. Dissolved mercury, such as mercury deposited on the ocean's surface from the atmosphere, enters phytoplankton and subsequently bioaccumulates through the food web. Because large ocean fish live for so many years, they are able to bioaccumulate high concentrations of mercury.

The TMDL calls for reductions in incoming mercury loads. As incoming loads decrease, outgoing mercury loads will also decrease. Therefore, the TMDL will reduce mercury loads exiting through the Golden Gate. The resulting reductions would benefit the Pacific Ocean environment. However, the magnitude of the benefit would be moderated by the fact that existing San Francisco Bay mercury is believed to have relatively little effect on the Pacific Ocean food web.

RESOLVED 5(c)

The integrated TMDLs shall include a consideration and documentation of...the degree to which point source additions of mercury are causing or contributing to violations of water quality standards....

Available total mercury data documented in our source analysis indicate that wastewater sources make up about 1.6% of the total load to the Bay, and there is no evidence of locally elevated levels due to these sources. Available data are insufficient to allow any meaningful documentation of relative responsibility other than what already appears in the TMDL. The relative potential for bioaccumulation is too uncertain to determine source by source.

Narrative Bioaccumulation Objective. The potential for wastewater sources to cause or contribute to violations of the narrative bioaccumulation objective requires consideration of the relative potential for these mercury discharges to bioaccumulate within the food web.

Bioaccumulation is not well understood in a quantitative sense. Several observers have noted recent studies suggesting that wastewater discharges could supply organic carbon and nutrients that enhance the potential for mercury methylation. They also point to evidence that wastewater often contains a relatively higher fraction of dissolved mercury and methylmercury, which could be more bioavailable than mercury from non-point sources. Factors such as particle size of mercury-containing sediment as well as mineral composition of the sediment may influence biological uptake.

Unfortunately, available information does not allow us to quantitatively distinguish the bioavailability of mercury from different sources. For example, the available research merely offers speculation, without evidence, that mercury from wastewater treatment plants is more bioavailable than mercury from other sources. While this could be the case, it could also be less bioavailable if wastewater mercury forms very stable complexes with other wastewater constituents. Well-oxygenated wastewater effluent discharged into or near potentially methylating areas may even inhibit methylation. Also, nearly all wastewater discharges receive rapid dilution and mixing via discharge through diffusers, rendering waters in the vicinity of these discharges essentially indistinguishable from other Bay waters. More to the point, there is currently no quantitative way to weight the allocations to account for relative bioaccumulation potential.

The TMDL implementation plan requires dischargers to study the relative availability of wastewater mercury for methylation and biological uptake. Dischargers are expected to study mercury fate, transport, and biological uptake in San Francisco Bay and tidal areas. They are specifically called upon to answer the question, "What is the relative bioavailability of mercury from different sources to San Francisco Bay?" The answer is important to guide our efforts to control the most bioavailable mercury. If sources differ substantially in bioavailability, then allocations can be adjusted by reducing the allocation for the most bioavailable sources. This question will be addressed through field studies and laboratory investigations, some of which CALFED, dischargers, and others will undertake through a variety of ongoing research efforts. We anticipate having a preliminary answer to this question within about five years of TMDL adoption.

Numeric Objectives. From a legal perspective, the TMDL is not intended to ensure that the numeric mercury objectives will be met. San Francisco Bay appears on the §303(d) list because mercury bioaccumulation is detrimental to human health and wildlife, thus it fails to meet the narrative bioaccumulation objective. The water quality impairment does not specifically relate to aquatic life and the numeric objectives. In fact, as discussed below, available monitoring data do not necessarily suggest that San Francisco Bay fails to meet the numeric mercury objectives. Therefore, evidence does not clearly suggest that wastewater sources cause or contribute to violations of numeric water quality standards.

In accordance with wastewater permits, dischargers monitor San Francisco Bay conditions and evaluate their potential to cause or contribute to violations of water quality standards primarily through the Regional Monitoring Program for Trace Substances, which has collected water and sediment samples for over 10 years and tested them for mercury. These data provide a technical basis for much of the TMDL analysis.

The Regional Monitoring Program collects instantaneous grab samples. Because most mercury is sediment-bound, and sediment concentrations in the water column vary significantly throughout each day in San Francisco Bay, some interpretation is required to compare Regional Monitoring Program data with numeric water quality objectives for which specific averaging periods are specified. The California Toxics Rule objective of 0.051 µg/l total mercury in water applies south of the Dumbarton Bridge and applies as a long-term average. It is often evaluated as a 30-day average. In the Regional Monitoring Program data set for Lower South San Francisco Bay from 1993 through 2002, only about 6% of the instantaneous grab samples exceeded 0.051 µg/l. Therefore, it is unlikely that Lower South San Francisco Bay frequently, if ever, exceeds the California Toxics Rule mercury objective as a 30-day average.

The Basin Plan contains a numeric objective of 2.1 µg/l total mercury in water with a one-hour averaging period. This objective applies north of the Dumbarton Bridge. Instantaneous grab samples may approximate one-hour averages. In the Regional Monitoring Program data set for portions of San Francisco Bay north of the Dumbarton Bridge from 1993 through 2002, no instantaneous grab samples ever exceeded 2.1 µg/l.

The Basin Plan also contains a numeric objective of 0.025 µg/l total mercury in water with a four-day averaging period. This objective applies north of the Dumbarton Bridge. In the Regional Monitoring Program data set for portions of San Francisco Bay north of the Dumbarton Bridge from 1993 through 2002, about 15% of the instantaneous grab samples exceeded 0.025 µg/l. The data are unclear regarding whether the four-day average objective is ever exceeded, but we do know that this particular objective is somewhat dubious. We propose to remove the objective from the Basin Plan, as discussed below.

RESOLVED 5(d)

The integrated TMDLs shall include a consideration and documentation of...the appropriateness of the selected margin of safety, which shall be set at a level not less stringent than necessary to ensure that standards are met.

TMDL analyses must incorporate a margin of safety to address potential uncertainties. The margin of safety is intended to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality. It can be explicit, implicit, or both. The model used for the San Francisco Bay TMDL allows calculation of an explicit margin of safety, but we did not formally adopt this explicit margin of safety because the model it is based on is very simple. Further, we believe that because the TMDL relies on numerous conservative assumptions, the implicit margin of safety within the analysis is sufficient. The TMDL relies on several conservative assumptions to derive the targets that serve as the basis of the TMDL allocations and implementation actions. Also, the TMDL implementation plan includes a number of measures that could improve water quality beyond simply meeting the allocations.

Explicit Margin of Safety. For load-based TMDL's, an explicit margin of safety can be expressed in relation to the total maximum load and allocations as follows:

total maximum load =
wasteload allocations (point sources) + load allocations (nonpoint sources) + margin of safety

As shown in the table below, the TMDL (as proposed) sets forth a total maximum load of 706 kg/yr, allocations that sum to 706 kg/yr, and no explicit margin of safety. The suspended sediment target of 0.2 ppm is conservatively projected to be met in roughly 120 years. Given more time, the final San Francisco Bay sediment mercury concentration is projected to drop to 0.015 ppm. We developed this scenario by first setting allocations to ensure that San Francisco Bay suspended sediment would meet the proposed target at all discharge locations. Larger allocations could result in target attainment throughout San Francisco Bay as a whole, but would not necessarily prevent local target exceedences.

	Total Maximum Load (kg/yr)	Total Allocations (kg/yr)	Explicit Margin of Safety (kg/yr)	Projected Recovery Time (years)	Final Overall San Francisco Bay Mercury Concentration (ppm)
TMDL as proposed	706	706	0	120	0.15
Alternative #1	886	886	0	190	0.20
Alternative #2	886	706	180	120	0.15

We could have used an alternative approach, shown in the table above as Alternative #1. In this case, we could have determined the total maximum load first based on what would be necessary to eventually meet the suspended sediment target. The total maximum load would then be about 886 kg/yr. If we were to allocate this entire load among the sources and reserved nothing for an explicit margin of safety, San Francisco Bay would be projected to achieve the suspended sediment target in about 190 years. This would be less desirable than the proposed TMDL.

Alternative #2 would use the total maximum load from Alternative #1 and the allocations from the TMDL as proposed. Because the allocations would be the same as those of the proposed TMDL, the recovery time and eventual sediment mercury concentration would also be the same. However, 180 kg/yr would be left over as an explicit margin of safety. Since this alternative would be materially the same as the TMDL as proposed (in terms of allocations and recovery time), the TMDL can be considered to already include a tangible margin of safety. However, we did not formally adopt this explicit margin of safety because (1) the model it is based on is very simple, and this use may stretch the model too far beyond its intended purpose; (2) we have no way of knowing whether this margin of safety adequately accounts for any uncertainty in the relationship between allocations and water quality; and (3) we believe the implicit margin of safety within the analysis is sufficient.

Implicit Margin of Safety. The TMDL relies on enough conservative assumptions to ensure an implicit margin of safety. The TMDL relies on several conservative assumptions to derive the targets that serve as the basis of the TMDL allocations and implementation actions. The proposed adaptive implementation strategy offers an additional margin of safety.

The proposed fish tissue target is based on conservative assumptions. We derived the target using the method U.S. EPA used to develop its fish tissue criterion. U.S. EPA made several conservative assumptions, including the incorporation of a factor of ten that accounts for uncertainties related to mercury's health effects and its metabolism within the body. Our fish tissue target is more conservative than U.S. EPA's fish tissue criterion because it is also based on a more conservative fish consumption assumption. We used the 95th percentile of local fish consumption (i.e., not including the vast majority of Bay Area residents that do not eat San Francisco Bay fish), whereas U.S. EPA used the 90th percentile of national consumption estimates and included data for non-consumers.

The proposed wildlife targets are also conservative. The bird egg target refers to a concentration where no observable adverse effects occur. Establishing a target more conservative than "no effects" would be meaningless. The TMDL also includes a prey fish tissue target developed by the U.S. Fish and Wildlife Service to protect wildlife. The prey fish target reflects safety factors to account for interspecies variability and information gaps concerning exposure levels expected to cause no observed adverse effects.

The suspended sediment target is more conservative than both the fish tissue and wildlife targets. Whereas a 40% reduction in striped bass mercury concentrations is needed to meet the fish tissue target and a greater than 25% reduction in California least tern egg mercury concentrations is needed to meet the bird egg target, the suspended sediment target calls for a 50% reduction in sediment mercury concentrations. This additional measure of protection (an extra 25% protection, when comparing the 50% suspended sediment mercury reduction with the necessary 40% fish tissue mercury reduction) is important because we based the allocations on the suspended sediment target, and therefore incorporated this margin of safety within the TMDL.

The TMDL implementation plan includes a number of measures that could improve water quality beyond simply meeting the allocations. Most importantly, the plan calls for investigating ways to control mercury methylation and bioaccumulation. The allocation scheme assumes that all methylmercury reductions in fish and wildlife must come from total mercury reductions in sediment. However, to the extent that methylmercury production and bioaccumulation can be controlled, we can reduce mercury concentrations in fish tissue and wildlife, and meet the proposed targets, more quickly. Together with the margins of safety implicit within the targets, the implementation plan for the TMDL provides an adequate implicit margin of safety for TMDL purposes.

RESOLVED 6

If any parts of the applicable standards require review, staff shall propose any needed modifications either before or with the TMDLs.

The standard requiring review is the SF Bay Basin Plan aqueous mercury water quality objective (0.025 µg/l as a 4-day avg.). While commenters assert otherwise, the TMDL implements this objective. As such, it is an issue of burden of proof and certainty. The TMDL is designed to meet numeric targets that are five times more stringent than this objective. Nevertheless, this is an archaic objective that was based on a federal water criterion that no longer exists, and alternatives to review and revise the objective are underway.

Aqueous Mercury Water Quality Objective The standard in question is the San Francisco Bay Basin Plan aqueous mercury water quality objective (0.025 µg/l as a 4-day avg.). While we content the TMDL implements this objective, the issue becomes one of burden of proof and certainty. The TMDL is designed to meet numeric targets that are five times more stringent than this objective. U. S. EPA has taken a position that the TMDL does not meet this objective based on the results of a simple simulation that predicts a possibility that the objective may be infrequently not met in a few areas of the Bay once the TMDL sediment target is attained. The same simulation would predict that even if all sediments had only mercury levels from no human influence, there would be areas where the numeric objective would not be met.

We did another calculation based on the proposed fish tissue target, and, using the same model on which the numeric objective was based, we predict that when the fish tissue target is met, levels of mercury in Bay waters will be five times lower than the objective.

There is no way to modify the TMDL to demonstrate without question that the numeric objective will be attained. It has been suggested that we could impose more restrictive wasteload allocations on wastewater discharges; however, it would be fairly easy to demonstrate with a high degree of certainty that this would have no measurable affect on the Bay. This is not a water quality issue, and even U. S. EPA agrees that the numeric objective is archaic.

Standards Review and Revision If it remains necessary to revise this objective, the standards review and revision options we see include:

~~2.~~1. Vacating the existing Basin Plan objective by the Water Board, such that the CTR mercury objective would apply. We feel we could complete the necessary staff work such that the Water Board could consider such action by fall 2005.

2. Vacating the existing Basin Plan objective, and proposing that the Water Board adopt the TMDL methylmercury fish tissue target as an objective. We feel we could complete the necessary staff work such that the Water Board could consider such adoption by the beginning of 2006.

3. Vacating the existing Basin Plan objective and proposing the State Board adopt the federal methylmercury criterion as a statewide objective.