

**STATE OF CALIFORNIA
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION
895 Aerovista Place Suite 101
San Luis Obispo, CA 93401-7906**

**March 15, 2012, Item 18
Staff Report Attachment 5**

SCIENTIFIC PEER REVIEW COMMENTS AND STAFF RESPONSE

The following comments address the external scientific review of (1) the Total Maximum Daily Loads (TMDLs) for fecal coliforms in Cuyama River, Santa Maria River, Orcutt-Solomon Creek, Oso Flaco Creek Watersheds and for Total Coliform in the Santa Maria River Estuary, and (2) the Domestic Animal Waste Discharge Prohibition. The reviewer was Stefan Wuertz, Ph.D. of the University of California at Davis, who completed his review on May 15, 2009.

Central Coast Water Board staff asked the reviewer to determine whether the scientific portion of the TMDLs was based upon sound scientific knowledge, methods, and practices. Staff requested the reviewer make this determination for several issues that constituted the scientific basis of the TMDLs. The issues are presented below, with the reviewer's comments and staff's response.

The reviewer provided overall positive assessments of the work as typified by the following statement:

Taken in their entirety the proposed measures as outlined in the Draft TMDL Project Report for the targeted watersheds should reduce the levels of fecal microbial indicators in creeks, rivers and the estuary by improvements to storm water drainage systems as well as human and domestic animal discharges, onsite sewage disposal systems and controllable wildlife sources.

Additionally, the reviewer acknowledged that one of the chief uncertainties the release of "naturalized" FIB [fecal indicator bacteria] from non-fecal (or not recently fecal) sources. These sources represent natural, uncontrollable sources and cannot be subjected to implementation actions as mentioned in the Project Report.

I. State of Scientific Knowledge about Pathogens and Microbial Indicators in Recreational Waters

- I. Reviewer's comment: (paraphrased by staff). Fecal indicator bacteria (FIB) measured close to a point source release of fecal pollution correlates well with the incidence of illness or disease in humans, however, FIB measured in the absence of a point source release of fecal pollution does not have a strong correlation with the incidence of illness or disease in humans. In fact, there is a large amount of scientific data that suggests that FIB can survive and propagate in the environment.

Direct pathogen measurements rarely correlate with elevated FIB counts. Scientists are increasingly calling for regulations and standards that target rapid monitoring of relevant

indicator organisms including disease causing agents, such as *Cryptosporidium* spp., *Giardia lamblia*, Adeno- and Enteroviruses, and a variety of bacterial pathogens. Technological advances, along with decreases in costs should allow for this type of testing in the near future.

Against this scientific backdrop the overarching question is how to best develop Pathogen (or Fecal/Total Coliform) TMDLs that are still based on microbial indicator standards (fecal coliforms, *E. coli*, *Enterococcus*) and yet allow for more advanced pathogen monitoring methodology and science-based decisions to be applied should classical FIB measurements prove inadequate at predicting public health risks for recreational uses. Scientific knowledge regarding the persistence of FIB in the environment has evolved substantially in the past 5 years. It is, therefore, important to insert language into the Final TMDL Project Report that explicitly acknowledges uncertainties regarding the environmental sources of fecal indicator bacteria.

Taken in their entirety the proposed measures as outlined in the Draft TMDL Project Report for the targeted watersheds should reduce the levels of fecal microbial indicators in creeks, rivers and the estuary by improvements to storm water drainage systems as well as human and domestic animal discharges, onsite sewage disposal systems and controllable wildlife sources. As TMDLs are being implemented and monitored additional studies may be conducted by the Central Coast Regional Water Quality Control Board to analyze sources of FIB that cannot be attributed to controllable sources as component of site-specific objectives. One of the chief uncertainties is the release of “naturalized” FIB from non-fecal (or not recently fecal) sources. These sources represent natural, uncontrollable sources and cannot be subjected to implementation actions as mentioned on page 49 in the report. Unpublished studies in progress in California would suggest that these in-stream sources can be significant. Specific suggestions for the calculation of TMDLs and load allocations are included in section 2.

Staff response: Staff agrees with the reviewer’s comment. Staff inserted language into the report that acknowledges uncertainties regarding the environmental sources of FIB (see section 4.1 Influence of Channel Characteristics on Bacteria Concentrations). Taking part in additional studies to analyze sources of FIB that cannot be attributed to controllable sources may be difficult due to lack of funding.

II. Problem Statement

- Reviewer’s comment: The beneficial uses identified in the Central Coast Water Quality Control Plan (Basin Plan) for waterbodies of the Cuyama River, Santa Maria River, Orcutt-Solomon Creek, and Oso Flaco Creek watersheds that are associated with pathogen concentrations are body contact recreation (REC-1) and non-body contact recreation (REC-2). Additional beneficial use of shellfish harvesting (SHELL) is identified for the Santa Maria Estuary. Current levels of fecal coliforms (FC) and total coliforms (TC) are not supportive of these beneficial uses for any of the four watersheds.

The amendments address fecal coliform TMDLs for these impaired waterbodies, not all of which are included in the 303(d) list. Whether the Cuyama River is already listed as impaired for FC or is intended to be listed is not quite clear as staff report attachment 1 (page 2, finding 7, “listed”) and attachment 2 (page 8, problem statement, “not listed”) are inconsistent in this matter.

Also addressed are the new domesticated animal waste discharge prohibition and the human waste discharge prohibition.

Staff response: Any uncertainties regarding impairment or intention to be listed have been clarified in the Project Report.

III. Source analysis

3. Reviewer's comment: Source analysis was based on data collected by several entities or programs. Water quality data collected via the Central Coast Ambient Monitoring Program (CCAMP) provided detailed information about the different waterbodies particularly in terms of seasonal trends, because the CCAMP locations comprise multiple locations per watershed. Selected locations were later also assigned for the TMDL monitoring plan. The reviewer agrees with the conclusion that because in some cases fecal coliform levels are elevated year-round, allocations and implementation need to be implemented year-round to resolve impairment, rather than based on seasonality.

Staff response: Staff agrees.

4. Reviewer's comment: The source analysis in the Draft TMDL Project Report is balanced and sound in terms of amount and variety of data used. Most likely sources that contribute to the impairment of the waterbodies are identified as municipal runoff, cattle, livestock, and natural/background. Reviewer finds the assessment of the relative importance of all sources listed by staff to be logical and conclusive. However, the reviewer can only partially agree with the conclusion that no substantial information would be gained from additional sample analyses or data collection methods to confirm specific animal sources. While this is a reasonable conclusion for large watersheds with a multitude of land uses, especially for small watersheds with low volume flow, such studies could help to isolate main sources. For example, several creeks are referred to in the report as running dry during the summer. Sediments could be collected during that time and analyzed for FIB. The report mentions related sediment sampling conducted by the water board staff in May 2005 in Bradley Channel and Oso Flaco Creek. Conclusions about natural, uncontrollable background sources could be gained if multiple sediment sampling were conducted over the dry period with dry river/creek beds.

Staff response: Staff generally agrees with reviewer's comments. With regards to source tracking, if numeric targets are not achieved at the end of the implementation time period, staff will re-evaluate whether it is necessary to use any source tracking methods in order to isolate sources dependent upon resources and priorities. As stated in staff's response #1, taking part in additional studies to analyze sources of FIB that cannot be attributed to controllable sources may be difficult due to lack of funding.

IV. Numeric targets

5. Reviewer's comment: The fecal coliform water quality objective of a log mean fecal coliform concentration of 200 per 100 mL, based on a minimum of not less than five samples for any 30-day period, and a limitation of not more than ten percent of total samples during any 30-

day period with fecal coliform concentration above 400 per 100 mL is proposed as numeric target for Cuyama River, Santa Maria River, Orcutt-Solomon Creek, and Oso Flaco

The numeric target for the Santa Maria Estuary, an area where shellfish may be harvested for human consumption, is that the median total coliform concentration throughout the water column for any 30-day period shall not exceed 70/100 mL, nor shall more than ten percent of the samples collected during any 30-day period exceed 230/100 ml for a five-tube decimal dilution test or 330/100 ml when a three-tube decimal dilution test is used.

In the absence of real pathogen data or sufficient scientific knowledge about the public health risks associated with FIB in recreational waters impacted by NPS pollution, this target is reasonable. Improvements in the controllable sources as outlined in the Draft Project Report should provide load reductions of human and domestic animal fecal pollution.

Staff response: Staff included load duration curves as an appendix to the Project Report (Appendix E) which includes percent reduction goals. The percent reduction should not be viewed as the TMDL but rather a goal to work towards in the implementation phase of the TMDL process with the ultimate goal being the restoration and maintenance of in-stream water quality so that beneficial uses are met.

V. TMDL and allocations

6. Reviewer's comment: TMDLs are proposed for six different waterbodies within the four watersheds (report section 7). It seems that for the Santa Maria River, the reach to Bull Canyon Road is being proposed rather than the "Bull Creek Road" as no Bull Creek Road can be found along the river. A Total coliform TMDL is proposed for the Santa Maria Estuary only.

Staff response: Staff corrected the discrepancy as noted above. The reach now correctly says "Bull Canyon Road."

7. Reviewer's comment: Reviewer does not follow the rationale presented by the Water Board to set TMDLs as the same set of concentrations as the numeric targets. The EPA Protocol for Developing Pathogen TMDLs (2001) states that "... fecal indicators, however, TMDLs can be expressed in terms of organism counts (or resulting concentration)" also referring to 40 CFR 130.2(i) (First Edition, page 7-1). However, the EPA also recommends in the Draft document "Options for the Expression of Daily Loads in TMDLs" from June 2007 that "As with load-based TMDLs, if the established concentration-based TMDL is not on a daily time step, the TMDL should also include a daily expression representing the non-daily allocation." (p47). In the same document an approach is presented for identifying a daily expression corresponding to the non-daily allocations developed in concentration-based TMDLs. Reviewer considers this approach advisable in case of concentration-based TMDLs. While it is stated in the Draft Project Report that public health risks are based on organism concentration and that pathogens are not readily controlled on a mass basis, health risks emerge from variations in concentrations at the time of contact and not from long-term means.

Staff response: Staff modified the Project Report (see Appendix E: Load Duration Curves) to provide for mass-based daily load expressions in accordance with 2007 USEPA draft guidance. The USEPA draft guidance was explicitly produced to address the legal issues arising from the Anacostia Decision by the U.S. District of Columbia

Circuit Court of Appeals (see Transmittal Letter and Executive Summary in USEPA, 2007). USEPA continues to recognize the validity of concentration based TMDLs, where appropriate, in accordance with 40 CFR 122.45(f). Indeed, in the draft 2007 guidance, USEPA explicitly recognizes that TMDLs may be expressed as a concentration of a pollutant, but that it would be possible to supplement the TMDL with a daily load expression:

*“For TMDLs that are **expressed as a concentration of a pollutant**, a possible approach would be to use a table and/or graph to **express the TMDL as daily loads for a range of possible daily stream flows**. The in-stream water quality criterion multiplied by daily stream flow and the appropriate conversion factor would translate the applicable criterion into a daily target.”**

-- USEPA, 2007 “Options for Expressing Daily Loads in TMDLs”, Office of Wetlands, Oceans and Watersheds, June 22, 2007.

** emphasis added*

In the modified Project Report, staff provides interpretations of our concentration-based allocations and TMDLs as a daily load expression in MPN/per day in accordance with the draft 2007 USEPA guidance (see attachment E: Load Duration Curves); however, we intend to implement the concentration-based TMDLs and allocations. A daily or average daily TMDL is inappropriate for the proposed allocations and TMDLs due to both (1) the temporal component embedded in the applicable water quality objective for bacteria; and (2) the episodic and highly variable nature of FIB transport and loading in streams, which make daily fecal coliform loads inappropriate for this TMDL project.

Expressing the TMDL as a concentration equal to the water quality objective ensures that the water quality objective will be met under all flow and loading conditions. The density (concentration) of fecal indicator organisms in a discharge and in the receiving waters is the technically relevant criterion for assessing the impact of discharges, the quality of the affected receiving waters, and the public-health risk. Concentration-based allocations are deemed more straightforward since they only require measuring concentrations in the waterways and do not require extensive flow monitoring and loading calculations. Therefore, staff established concentration-based TMDLs and pollutant load allocations, expressed in terms of indicator bacteria concentrations.

8. Reviewer’s comment: Perhaps the reluctance to employ loads instead of cell concentrations of fecal coliforms is rooted in the belief that bacteria are emitted from a particular fecal source (like a storm drain or wild animal) and then undergo rapid decay in the environment without leaving a trace, unlike many chemical constituents, for example, heavy metals which are persistent. Bacterial (fecal coliform) cells can also persist in the environment and attach to particulates, either in the water column or in the benthos; they can even grow and divide given the right conditions and finally detach. Further, it seems important to design Fecal Coliform TMDLs that are flexible enough to allow for the use of real pathogen data or microbial source tracking data during the implementation and monitoring stages and that can pinpoint the predicted effects of variations in flow conditions (stormwater, drought) or effect of reductions in specific load allocations.

Staff response: Staff agrees with the reviewer. As mentioned above, staff included a daily load expression. Additionally, staff crafted language to allow the TMDL Project Report to be flexible enough to allow for the use of real pathogen data or microbial source tracking data during implementation and monitoring stages should it become necessary and feasible depending on funding opportunities and priorities.

9. Reviewer's comment: The main advantage, however, of expressing Fecal Coliform TMDLs in terms of organism loadings is that the effect of various source load reductions can be estimated and allocation scenario loadings calculated. The Water Board has proposed that the load allocations for non-natural sources will be equal to the TMDL. This intention can also be realized by simply multiplying the flow rate associated with that load by the water quality standard and incorporating a sediment sink and source term. Reviewer believes that natural (uncontrollable) sources may contribute a sufficiently high load so that the FIB levels will remain high in the watershed. Simulating the effect of various controllable load reductions can help predict the outcome of improvements in wastewater collection systems and stormwater systems. The Water Board may wish to anticipate how direct pathogen measurements can be used to meet TMDL targets by allowing for alternate expression of mass loadings once quantitative pathogen data become available on a more routine basis. Fifteen years planned for achieving the TMDL is a long enough period to envision a mechanism for incorporating other pathogen indicators (such as concentrations of actual pathogens) into the calculations intended to estimate public health risk.

Staff response: As mentioned in the previous comment (no. 8), staff included daily load expressions. Staff agrees that natural sources may be a large contributor in this watershed. Dependent upon priorities and resources, staff may incorporate direct pathogen measurements during the implementation phase.

10. Reviewer's comment: EPA recommends Load Duration Curves (An Approach for Using Load Duration Curves in the Development of TMDLs, EPA 841-B-07-006, August 2007), a type of cumulative distribution function. The approach involves plotting observed flow rates against the percent of time those values have been met or exceeded. Existing and allowable loads are calculated by multiplying flow values with the measured concentration of FIB and the numerical target, respectively. The method does not lend itself easily to estimating loads from specific sources within watersheds. Mass balance methods, on the other hand, require more data but can be used in situations where a differentiation between direct (e.g. failing septic tanks, sewers, livestock) and diffuse (runoff from land uses) nonpoint sources is not easily made or when there are no pronounced seasonal (flow-related) fluctuations.

Additional models developed by EPA are in-stream models that can account for spatial and temporal variation of bacterial loading. A numerical target for a TMDL may be exceeded at certain times and in many cases it is useful to refer to modeling techniques that give a reasonable estimate of the frequency distribution of projected receiving water quality. USEPA has listed continuous simulation, Monte Carlo simulation, and lognormal probability modeling as useful approaches to calculate receiving water concentrations. References are in Protocol for Developing Pathogen TMDLs (2001) and more recent information is available from the EPA TMDL website (<http://www.epa.gov/owow/tmdl/techsupp.html>).

Another reason for expressing TMDLs in terms of mass loadings is that exceedances of natural (uncontrollable) sources do not automatically lead to additional required action in terms of source monitoring and TMDL modifications if at the same time controllable sources

are lowered sufficiently. In other words, the receiving water quality in segments of the watershed or estuary that contains discharge from both controllable and natural sources may be qualified and controllable sources can compensate for exceedances elsewhere. As a result the watershed is still in compliance with the TMDL.

Staff response: Staff has modified the Project Report to empirically assess spatial variability of FIB loading with USEPA recognized methodologies. Staff has utilized Load Duration Curves and mass balance modeling, to develop mass-based daily load expressions and allocations. The TMDL and allocations will be concentration based, but for planning and implementation purposes, the aforementioned assessments are included in the Project Report.

VI. Implementation Plan

11. Reviewer's comment: The proposed approach to first target controllable sources of anthropogenic origin is feasible and supported by previous monitoring and source identification studies in the watershed. The proposed Implementation Plan and evaluation of implementation progress takes into account that additional measures may be necessary based on site-specific objectives.

Staff response: Staff agrees.

VII. Monitoring Plan

12. Reviewer's comment: The proposed general monitoring plan is feasible and includes specific stormwater outfalls. Water board staff recommends specific CCAMP sampling locations; these are reasonable with the exception that neither location 312BSR (Oso Flaco Creek) nor 312SMA (Santa Maria River Estuary) is explained in the report.

Staff response: Staff included a map that shows where the abovementioned sampling sites are. Additionally, Appendix A provides a description of the location of these sampling sites.

13. Reviewer's comment: There is also one remaining uncertainty for the adaptation of monitoring plans in case of continuing exceedances of WQO after controllable sources have been reduced or eliminated. The potential for re-growth of microbial indicators in the watershed is largely unknown. It is uncertain that mere monitoring of water quality using FIB could address this possibility. Such a monitoring program may involve a research component ("Feasibility of re-growth of microbial indicators in situ") and would benefit tremendously if real pathogen data were collected at the same time.

It is, therefore, recommended to include measurements for pathogens in monitoring activities whenever feasible and especially when a presumptive hotspot of WQO exceedance has been identified. Such monitoring activity can use PCR-based methods for detection of pathogens as long as proper QA/QC procedures are followed. Further, the Water Board is advised that microbial source tracking (MST) methods have undergone significant developments since 2002, when the cited Morro Bay Estuary study was completed. In addition to ribotyping methods there are available library-independent approaches, which have been widely used in California and have been shown to be

geographically independent in the state. Selected monitoring of watersheds with MST methods that target animal host-specific genetic fecal markers with fast decay rates in the environment can identify fecal contamination that is of recent origin. In other words, it may be more beneficial to combine fecal coliform monitoring with MST to verify that exceedances truly reflect a recent fecal contamination event. Costs for quantitative PCR assays on extracted DNA from water can be lower than 100 USD per assay, depending on sample volume filtered and method used. Generally, the individual assay rates decrease when several assays are performed on the same DNA extract. Consequently, costs for MST analysis are almost comparable to those of FIB tests for implementation and monitoring purposes.

Staff response: Staff acknowledges there is the potential for regrowth in this situation. Dependent upon priorities and resources, staff may consider different types of monitoring (e.g. MST, PCR, etc.) in order to determine if some of the elevated levels of FIB may be coming from “naturalized” bacteria during the implementation phase. Staff will also look at the implementing parties’ implementation measures and use that information in our evaluation of where sources may be coming from.

VIII. Time schedule for achieving the TMDLs

14. Reviewer’s comment: The proposed timeline is reasonable.

Staff response: Staff agrees.

IX. Domestic Animal Prohibition

15. Reviewer comment: The Water Board intends to adopt a Cuyama River, Santa Maria River, Orcutt-Solomon Creek, and Oso Flaco Creek Watersheds domestic animal prohibition. Reviewer finds the proposed prohibition as planned by the Water Board appropriate and scientifically sound.

Staff response: Staff agrees.

X. General comments

16. Reviewer comment: As mentioned before the watersheds are mostly discussed together and a clear separation or definition of each watershed is missing throughout the whole report. That makes it difficult to separate these watersheds. The reviewer understands well that waterbodies of these watersheds are connected and the Santa Maria River (Estuary) is a receiving body of the other three, but while fecal coliform TMDLs and allocations are the same for each of the watersheds later review of monitoring results might lead to changes of individual TMDLs.

Staff response: Staff included a clear description of each of the separate watersheds that make up the larger Santa Maria River Watershed. Staff also included a map to show this visually. In addition, staff based load duration curves and loading from specific fecal sources by these distinct watersheds. Staff concludes the reviewer’s comment is adequately addressed in the current Project Report.

17. Reviewer comment: The term watershed is often used differently. While individual TMDLs are addressed for the Cuyama River and Orcutt-Solomon Creek watersheds, Table 9 (page 39), for example, lists both as subwatersheds of the Oso Flaco and Santa Maria Watersheds without clear allocation or separation into watersheds. The Orcutt-Solomon Creek watershed, for example, is not even mentioned in the watershed description (section 2 of the report).

Staff response: *Staff clarified these issues in the Project Report.*

18. Reviewer comment: Despite lacking detail and clear separation in some parts of the report the overall rationale is sound and assessments are fully justified by the available data.

Staff response: *Staff acknowledges the comment.*

XI. Conclusions

19. Reviewer comment: It is recommended that Fecal and Total Coliform TMDLs be defined on a mass basis (e.g. number of cells per day) for fecal indicator bacteria or human pathogens and that EPA approved models be employed.

Staff response: *Staff included a mass basis for this TMDL Project Report and employed USEPA approved methods (see above responses 7 and 10).*

20. Reviewer comment: There is substantial uncertainty as to the ability to distinguish between natural and controllable sources of fecal pollution. Microbial source tracking techniques should be employed alongside FIB measurements whenever feasible.

Staff response: *Staff agrees that there is uncertainty distinguishing between natural and controllable sources of fecal pollution. Staff will work with implementing parties during the implementation phase of the TMDL and determine the best approach to take regarding separating out these sources dependent upon resources and priorities.*

21. Reviewer comment: The proposed measures to reduce allocations from controllable sources are supported scientifically and may be adequate to achieve necessary load reductions and compliance with a mass-based TMDL.

Staff response: *Staff agrees.*