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Responses to the CALFED Low-DO Directed Action Project External Peer Review Panel's Overall Comments

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On June 11 and 12, CALFED conducted an external peer review of the CALFED Low-DO Directed Action Project of the 2001 studies and the previous two years' studies. On July 11, 2002, the Peer Review panel's (PR) July 1, 2002, report was made available for review. In accord with the CALFED/NFWF contract, the component project PIs are to provide a written response to each of the PR comments. Also the overall project PI (G. F. Lee) is to address the general PR comments. This report provides the responses to the PR general comments.

The Peer Reviewers are to be thanked for the time and effort they made in conducting this peer review. Their comments reflect a critical review of the large amount of information that has been developed for the approximately $3 million of CALFED support that has been made available over the past three years. The Peer Reviewers comments are presented below in italics with the responses following the PR comments.

Appropriate DO Target

The PR comments, *"… it is important to identify an appropriate DO target that would be protective of aquatic organisms in the SJR DWSC system. First it is necessary to determine the ecological groups and life stages that may be impacted by low DO concentrations (just migrating fish or also benthic/aquatic invertebrates?). The next step would be to determine protective DO thresholds, and how compliance should be defined spatially and temporally."*

This is an important recommendation that has been of concern over the past three years. The issue of appropriate DO water quality objectives for solving the low-DO problem in the DWSC is an issue that has been discussed extensively amongst several of the participants in the studies. The Lee and Jones-Lee (2000) "Issues" report contains considerable discussion of this issue. This discussion is based on Dr. Lee's experience in developing water quality criteria, including specifically being involved in DO criteria. There are appropriate questions about the need for the 6 mg/L DO objective for protection of Chinook salmon migration that has been established by the State Water Resources Control Board for the reach of the DWSC between Channel Point and Turner Cut during September 1 through November 30. In developing the original recommended peer review panel members, a proposed panel member, Dr. Alan Mearns, was selected and initially agreed to be a participant in this peer review effort. His PhD dissertation and professional work since then has included considerable attention on the effect of DO on Chinook salmon physiology. Unfortunately, Dr. Mearns found that he could not participate in this peer review, with the result that this left a gap in the peer review process. Efforts are being undertaken to correct this situation through supplemental review of the low-DO project target objectives by Dr. Chris Foe and Mark Gowdy of the CVRWQCB. The issues that need to be addressed include:

- The appropriateness of the 6 mg/L DO objective adopted by the State Water Resources Control Board and the CVRWQCB for the DWSC to protect Chinook salmon homing migration during the fall.
- The need for a 5 mg/L DO objective that is applied without averaging with respect to time of day and location within the DWSC. Of particular concern are excursions which lead to low-DO concentrations in the near-surface waters that occur only in the early morning, related to the diel photosynthetic cycle, and the excursions below 5 mg/L in the near-bottom waters.
- With respect to the proposed interim DO concentration target for Phase I of the TMDL, there is concern that the minimum 3 mg/L specified in the draft target may not be protective, where this value should be raised to at least 4 mg/L as the minimum that can occur at any time and location. It is recommended that the CVRWQCB organize a review of the DO objective for Phase I and overall, and that this review include the preparation of a report on these matters, which would be available by February 2003.

Data Gaps and Need for Improved Teamwork

The PR makes the recommendation that, *"A comprehensive analysis of all current data has not yet been completed. The investigators need the opportunity to exploit historical and new data to:*

- *Refine conceptual models of sources and causes of the DO problem*
- *Identify high priority data gaps*
- *Design a road map for filling those data gaps*

This can best be accomplished by extending contracts and funding expressly for this purpose. In addition, the hiring of a facilitator to improve teamwork and help all parties understand where the data needs are will assist the investigators to fully exploit the data."

Data Gaps. The peer review panel's primary recommendations, as represented by the three bulleted items above, are all important issues that need to be addressed in the near future. Considerable discussion has already taken place on these issues with regard to further defining the sources and causes of the DO problem, identifying high-priority data gaps, and designing appropriate programs to fill the necessary data gaps to develop a technically valid, cost-effective program for solving the low-DO problem in the DWSC. As discussed in the Synthesis Report (Lee and Jones-Lee, 2002), the timeframe governing the development of reports for the peer review panel precluded a comprehensive review of the large amount of data that have been collected. It is concluded, however, that simply extending all current PI contracts and adding funding may not be the appropriate approach to follow in filling data gaps.

The approach that is planned involves first identifying the major data gaps for which there is immediate need for additional data as part of the implementation of Phase I of the TMDL. Next, there is need to determine how best to proceed to fill these data gaps. This is a decision that will be made by the Steering Committee and CALFED. While there are a number of interesting scientific issues associated with the low-DO problem in the DWSC, many of these are not considered high priority to solving the low-DO problem. It is important to focus CALFED's

financial resources on the highest priority items needed to proceed with the Phase I TMDL. As it stands now, there are few data gaps that need to be immediately filled in order to proceed with the Phase I TMDL. Many of the key data gaps can, in fact, be addressed during Phase I. The key data gap issues are discussed below.

As a followup to the peer review workshop, and in response to a request made by Barbara Marcotte, G. F. Lee has developed a draft write-up of the overall monitoring/evaluation approach that should be developed for each of the major areas in which there is need for additional information. This write-up is being made available for review by all interested parties, and will become the mechanism for defining the existing data gaps and the roadmap for filling them.

Improving Teamwork. Considerable effort has been devoted to correcting the lack of teamwork and the lack of responsiveness to contractual requirements by component project PIs as required by CALFED, by the Steering Committee, the overall project PI, and the CVRWQCB staff. The inability to achieve an integrated teamwork approach has been a serious problem throughout the three years of study. Considerable efforts were made as part of developing the 2001 Directed Action project to address this problem. While some improved teamwork was achieved through these efforts, a variety of factors have prevented achieving a highly coherent investigative team. Hiring a facilitator, *per se*, as recommended by the peer review panel, will not solve this problem.

One of the key issues that played a major role in failing to achieve an integrated team approach was CALFED's problems with issuing contracts in a timely manner. Another factor that played a role was CALFED's approach toward funding the modeling effort. As originally designed in the CALFED proposal, the primary integrating effort for the 2001 studies was the realtime forecasting modeling approach, where all data were to be fed into the model as it was generated. This, in turn, was to lead to an integrated team approach for review and recommendations for modifications of the study program. Unfortunately, CALFED chose not to support this approach, with the result that the binding component (the model) of the 2001 studies was lost, and still has not been effectively started.

PR Response to Question 1 on Adequacy of Existing Understanding

"There was general agreement among the reviewers that the data have established that there is a strong correlation between flow rates and dissolved oxygen levels. However, the roles of loadings of various types and sources of oxygen-demanding materials are not well understood. Dr. Chapra suggests that an analysis of Stockton discharge records be performed to construct a multi-year time series of flow and discharge concentrations of several key variables."

As discussed in the Synthesis Report (Lee and Jones-Lee, 2002) and by Dr. Foe in the Strawman analysis (Foe, *et al*., 2002), the overall aspects of the relationship between types and sources of oxygen demand loads to the DWSC are understood with respect to the role of upstream planktonic algae and the city of Stockton's ammonia loads. How flow affects these loads in the 500 to 1,200 cfs range of SJR flow through the DWSC is not well understood at this time. It is concluded, however, that further studies of the type that have been conducted in the past will not

likely provide the information needed, and that an experimental aeration approach, coupled with appropriate modeling and monitoring, will provide this information.

Following the peer review workshop, G. F. Lee prepared a preliminary proposal to CALFED and the CVRWQCB devoted to supporting the PR's comments of using the Chen model to further elucidate the DO depletion issues in the 500 to 1,200 cfs range of SJR flow through the DWSC. This proposal specifically focused on evaluating the ability of the existing Chen model, without additional coefficient tuning, to predict the characteristics of the DWSC for each of the 43 monitoring runs that the city of Stockton made in 1999, 2000 and 2001, relating the oxygen demand load in the form of algae/BOD at Mossdale and ammonia loads from the city of Stockton to DO depletion at Channel Point, Rough and Ready Island and near Turner Cut. Thus far, no response has been received to this preliminary proposal.

If the current Chen model can properly track the results of the 43 monitoring runs without coefficient adjustment, then considerable confidence will be gained in the use of this model to evaluate the effects of flow and various load types and sources on DO depletion at various times and locations within the DWSC. If the model cannot make these predictions reliably, then there is need for further work on the model before any refinements can be made in the understanding of DO depletion versus oxygen demand load types and sources.

PR-Identified Data Needs

"Preliminary identification of data needs includes:

- *Continuous measurements of flow, DO, and representative measurements of phytoplankton, zooplankton, nutrients and other oxygen-affecting substances. These should be collected within the DWSC, upstream of the DWSC at Mossdale, and far upstream from one or more significant tributaries. These are critical for new modeling work as well as for quantifying the driving forces into the SJR and on to the DWSC."*

G. F. Lee's monitoring/evaluation program guide that is currently being developed specifically addresses these issues.

- *"Information on critical levels of DO in water (and location) for various organisms of interest, both aquatic and benthic."*

The recommended DO target and objectives review mentioned above will address these issues.

- *"Information on the importance of thermal stratification in the DWSC."*

G. F. Lee's monitoring/evaluation program guide that is being developed will address this issue.

- *"Information on flow augmentation resulting from permanent tidal barriers in the Delta. These would factor into a major hydrodynamic change in the SJR/DWSC system. There is a need for a better hydrologic budget for better modeling of the upper SJR system."*

Further studies on the low-head pumping as a means of supplementing the SJR flow through the DWSC are being planned. These studies will include an expansion of the current South Delta modeling to include water quality issues. Further, G. F. Lee's monitoring/evaluation program guide discusses the characteristics of the South Delta monitoring program that will be needed to provide the information needed to gain approval for the low-head, across-the-barriers pumping program.

- *"Data on certain high-priority watersheds within the upper watershed (to support development of control actions). This should include data on BOD loading from upstream wetlands."*

The characteristics of the specific upstream watershed monitoring are being developed in G. F. Lee's monitoring/evaluation program guide.

- *"Data to resolve disagreement on the causes of DO depletion in the DWSC (upstream algae versus local ammonia inputs)."*

The specific program to address the conflict between Lehman and the other investigators on the importance of city of Stockton ammonia discharges as a cause of low DO in the DWSC, even when the city's ammonia load is low, will first be addressed in the review of the Chen model's ability to predict the DWSC conditions during the 43 city of Stockton monitoring runs. Follow-up studies will be defined at that time.

- *"Characterization of the dynamics between Mossdale and the DWSC, including the effects of zooplankton and especially macrobenthic grazing on algae levels."*

The oxygen demand dynamics in the reach of the SJR between Mossdale and Channel Point is a specific study area in the G. F. Lee monitoring/evaluation program guide.

- *"Information on species variation of the algal load along the SJR, which will demonstrate whether upstream algal inputs act as a seed population, or whether a new algal community develops. This distinction has a large impact on the eventual algal load into the DWSC."*

Algal dynamics in the SJR upstream of Mossdale and between Mossdale and Channel Point are proposed to be examined by G. F. Lee during the follow-up monitoring/evaluation program.

PR Monitoring Recommendations

PR comment:

"General additional monitoring recommendations include the following:

- *Extend monitoring upstream*
- *Install more probes to adequately define temporal and spatial variation in DO, conductivity, temperature, turbidity, and pH*
- *Continue "synoptic surveys" (Hayes cruises, etc.)"*

All of these issues are being addressed in the G. F. Lee proposed monitoring/evaluation program guide.

PR comment:

> *"It is important to coordinate all data collection activities with modeling needs. If the monitoring and research proceed without input from the modelers, there would be a risk of obtaining information that could be incompatible with the model structure (i.e., its kinetic representation, as well as it's temporal and spatial resolution)."*

The peer review panel support of the approach that was originally proposed in the CALFED Directed Action proposal submitted in January 2001 to closely integrate monitoring/evaluation with modeling is important to achieving this integration. If the realtime forecasting modeling approach that was proposed in January 2001 had been supported by CALFED, it is believed that a much better understanding of the processes responsible for DO depletion in the DWSC would be available now. With CALFED funding, it is planned, through the experimental aeration studies, to closely integrate modeling with monitoring and evaluation. These issues are being discussed by G. F. Lee in his monitoring/evaluation program guide that is under development at this time.

The monitoring/evaluation program guide that G. F. Lee is developing specifically addresses the need to establish a monitoring program that will provide the HydroQual modeling effort with the necessary data. It will be important for CALFED to establish a framework where an integration of the monitoring/evaluation with the modeling can be achieved. This framework does not exist at this time. The modeling that is being planned is still not integrated with the CALFED-supported monitoring and evaluation that has been conducted over the past three years on the DWSC and its tributaries.

PR Comments on Future Monitoring and HydroQual Modeling

> *"This is particularly critical if the actual allocations in the TMDL will be generated by the HydroQual model. Considering the short time frame, the team cannot afford unnecessary research or data collection that (1) measures the wrong processes or variables, and (2) do not address the proper space and time scales."*

Those responsible for working with CALFED and the Steering Committee in organizing future studies are keenly aware of the need to focus on data collection needed to support the HydroQual model with specific studies designed to provide the information needed to properly develop this model. As discussed above, a key component of this will be CALFED's ability to integrate the current HydroQual modeling with Phase I monitoring and evaluation. The G. F. Lee monitoring/evaluation program guide specifically addresses this issue.

PR Comments on Question 2 on Modeling

> *"The 1-D model or other suitable model can and should be used to obtain a version of the oxygen mass balance for the DWSC that accounts for all of the different information*

(primary productivity, respiration, sedimentation rates and SOD) and resolves the ammonia controversy or better exposes basis for differing opinions. Use of the 1-D model can accomplish this in a relatively short period of time."

As discussed above, G. F. Lee's proposal to use the Chen model to address these issues is being planned. The first phase, which can be initiated as soon as CALFED support is available, will be devoted to an evaluation of the ability of the Chen model to properly track the conditions that were found in the 43 city of Stockton monitoring runs.

PR comment:

"The application of a statistical model to long term data is promising and should be pursued. There are problems with the existing statistical model that must be resolved to make it a valuable tool for analysis."

Discussions will be held with E. Van Nieuwenhuyse and CALFED about refining the statistical modeling as an independent approach.

Ammonia Issues

PR comment:

"Ammonia concentrations in the DWSC are high. This deserves serious attention. Analysis of Stockton Regional Wastewater Control Facility (RWCF) effluent data needs to be performed to verify the occurrence and completion of nitrification."

The issue of the importance of the city of Stockton ammonia as a cause of low DO is an issue that has been of concern. One of the primary issues that will be addressed with future funding is the potential benefits of the CVRWQCB's requirements of limiting the city of Stockton's wastewater discharges to a monthly average of no more than 2 mg/L ammonia nitrogen in affecting DO depletion in the DWSC. As it stands now, if the State Board does not support the appeal by the city of Stockton of this recently-received, revised domestic wastewater NPDES permit, the high ammonia loads that have been discharged by the city in the past will, eventually, with the construction of adequate treatment, not occur in the future. The issue that needs to be resolved is whether the 2 mg/L ammonia discharge limit, which was based on toxicity issues and not DO depletion issues, is adequate to control significant oxygen depletion due to the ammonia discharged by the city to the DWSC.

Upstream Oxygen Demand Source Issues

PR comment:

"The evidence identifies Mud and Salt Sloughs as the primary subwatersheds for examining possible load reduction. However, the ultimate worth of any such reductions needs to be considered more thoroughly. There might be gains in water quality, but it is not clear at this point that they would be significant with respect to the ultimate goal."

One of the primary areas of emphasis discussed in G. F. Lee's draft proposed monitoring/evaluation program guide is the need for detailed watershed studies of Mud and Salt

Sloughs, as well as the SJR upstream of Lander Avenue, to understand algal growth dynamics and, especially, whether there is any potential for controlling the algal biomass generated within these watersheds that reaches the SJR at the tributary mouths. In addition, as part of the HydroQual modeling, it is proposed that an evaluation be conducted of how altering the algal loads that are discharged by these three watersheds to the SJR influences the oxygen demand loads that reach the DWSC. Through these studies, it should be possible to understand the coupling between upstream algal/BOD loads and DO depletion in the DWSC. Based on this understanding, it should be possible then to evaluate the cost-effectiveness of any upstream nutrient/algal control programs on the DO depletion problem within the DWSC.

Further DO Objective Compliance Issues

PR comment:

> *"It is likely that the interim DO objective can be achieved, but a variety of control measures may be required rather than a single one. In addition, the feasibility of achieving this objective depends on how compliance is defined spatially and temporally."*

The experimental aeration program that was proposed by the CVRWQCB/Steering Committee that will be conducted during Phase I will provide information on the ability of aeration, alone or in combination with other control programs that are needed, to achieve the interim, as well as the final, DO target/objective.

PR comment:

> *"The relationship between flow and DO conditions has been described in general terms. Further statistical analysis of historical data, as well as refinement of the Systech model would be useful, as stated in Dr. Jassby's comments (Appendix E)."*

The experimental aeration studies are specifically designed to gain further insight into the relationship between SJR flow through the DWSC and DO depletion for a given oxygen demand load. By conducting the aeration/monitoring studies at different flows, it will be possible to gain insight into this relationship. Further, it may be possible to alter the flow through the DWSC, through discharges down Old River, to help in gaining this understanding.

PR comment:

> *"There is a need to develop information on various aeration schemes/technologies, including performance of science-based demonstrations at pilot scale. Cost/benefit data are also needed."*

Task 5 of G. F. Lee's component project for the current CALFED Low-DO Directed Action project, which has recently been approved by CALFED/NFWF, provides funds that will enable URS, Corp., to develop an overall plan that is acceptable to the Steering Committee and CALFED for conducting the experimental aeration studies. As planned now, these studies will provide the information suggested by the PR that will enable CALFED and the Steering Committee/CVRWQCB to determine the appropriate use of aeration as a means of controlling the low-DO situation in the DWSC. It should be noted that, while the focus of the Phase I TMDL will be on aeration, considerable additional information will be gathered during Phase I

on other means of controlling the low-DO problem. There seems to be general agreement that it will be a combination of approaches (such as aeration, load control from the City and upstream, and supplemental flow) that will ultimately solve the low-DO problem.

PR comment:

> *"The Systech model results show that the channel deepening has had a strong influence on DO conditions. There is some question as to how the geometry of the DWSC affects the settling and resuspension of sediments and oxygen demanding particulate matter. There is also a question as to the thermal stratification that occurs in the DWSC and what effect this has on the DO at various depths."*

The issue of how depth of the channel influences DO is an issue that will be addressed as further work with the Systech (Chen) model is undertaken, once it has been verified that the model can reliably track DO depletion under various conditions. There will be need for CALFED to better integrate its modeling efforts with the DWSC studies than have been done thus far if there is going to be a better understanding of how thermal stratification and depth of channel affects settling and resuspension within the channel, as they relate to DO depletion.

Comments on Dr. J. Cloern's "Minority View" on Structural Solutions for the DO Problem in the DWSC

J. Cloern, in his discussion as a "minority view," has misinterpreted the US EPA's Clean Water Act requirements for DO depletion for controlling water quality problems. The US EPA (2002) Region 9 has indicated in recent communications that solving the problem does not necessarily mean that there has to be a load reduction. Solving the problem can be accomplished by other means. While, typically, TMDLs are solved through pollutant load reductions, this does not mean that other approaches (such as flow, etc.) are not equally acceptable. It is believed that there are some on the Steering Committee and others who take the position that oxygen demand load reduction should be accomplished where it is technically and economically feasible. This approach especially needs to be supported with respect to future agricultural and urban development within the SJR DWSC watershed. Aeration should ultimately be used to control DO depletion problems where load control is not feasible. As planned now, the initial focus on aeration represents a learning process that has substantial promise for controlling low-DO situations in the DWSC. While aeration is being evaluated, work will be done on controlling oxygen demand loads to the DWSC.

Dr. Chapra

Dr Chapra's Specific Comment:

> *"Action Item: An analysis of Stockton discharge records should be performed to construct a multi-year time series of flow and discharge concentrations of several key variables including nitrogen species (not only ammonia, but also organic nitrogen), $CBOD_u$ and dissolved oxygen. One goal of this analysis would be to accurately characterize the seasonal trends of ammonia discharge from the pond* [city of Stockton wastewater effluent pond]. *In particular, the analysis should establish the timing of the rise in ammonia discharge that occurs in the fall and the subsequent reductions that would occur in the spring."*

The nitrogen dynamics in the City's wastewater effluent ponds needs to be better understood, although this situation is likely to change with the Regional Board's revised NPDES permit, which limits the ammonia discharge to a monthly average of 2 mg/L ammonia nitrogen. Before any substantial work is done on the nitrogen dynamics in the City's effluent ponds, the issue of whether the city of Stockton will gain support for its appeal of this permit needs to be resolved.

Dr. Chapra's Specific Comment:

> *"Action Item: Available time series data collected with data sondes should be systematically analyzed to ascertain the magnitude and frequency of low dissolved oxygen conditions during the winter. The first goal would be to evaluate whether winter low oxygen episodes are a significant recurring phenomenon. If so, an initial evaluation of possible causes should be performed. For example, the correlation of low oxygen with low flow should be analyzed."*

While it has been understood that there are low-DO problems in the DWSC at other times of the year, the initial emphasis in the TMDL is on the Chinook salmon fall run situation. Recently, Dr. Foe and Mr. Gowdy have indicated that the TMDL issues will need to be expanded to include other times of the year when DO depletion below the water quality objective occurs. This will include the need to conduct studies in the winter and spring. Further work will need to be done to begin to plan the necessary studies to understand the low-DO conditions that occur during the winter and spring.

During the course of the current studies, it was realized that low-DO concentrations were occurring throughout the summer. This caused the investigators to expand their work to include sampling during June and July.

Dr. Chapra's comment:

> *"Study and observation are needed in a number of areas:*
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> *Further rate experiments should be conducted to quantify the rate constants for nitrification, plant growth and respiration. In particular, there is a major discrepancy between model and bottle estimates of productivity (Chen and Tsai, Lehman). As Chen and Tsai point out, bottle rates can reflect artifacts due to the enclosure process. On the other hand, the order of magnitude discrepancy that presently exists seems too large. A simple test of Lehman's rate would be developed by using her rate in the Chen and Tsai model to assess the impact on the oxygen calibrations. Another approach would be to compare model predictions of diurnal oxygen swings with measurements on the river. HydroQual should be consulted to solicit there ideas for process studies to strengthen their model development."*

Discussions will be held to determine how best to proceed to resolve the differences between the Chen and Tsai estimates of productivity, and those of Lehman.

Dr. Chapra's comment:

> *"I was surprised at how little the Systech model was referenced during our workshop. Although it could certainly be improved (by improved data and rate measurements), it is a technically sound tool for making initial assessments."*

As discussed above, the lack of use of the Systech (Chen) model during the 2001 studies, related to CALFED's decision not to fund the proposed use of this model during these studies, has left a substantial gap in the information base, which hopefully can now be corrected.

Dr. Ritter

Dr Ritter's comment:

> *"Based upon what is known and what the uncertainties are in what is causing the oxygen depletion it is recommended*
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> *a. Further research be conducted on more accurately delineating the major sources of oxygen demanding material that are causing the oxygen depletion in the DWSC.*
>
> *b. A more detailed analysis of historical data from the DWCS, San Joaquin River and Stockton wastewater treatment plant discharges."*

Dr. Ritter's recommendations are in line with what is being planned in further work on the low-DO problem in the DWSC. This work includes more accurately delineating the major sources of oxygen demand and, if funds are made available, a more detailed review of the existing database. The approach to these issues has been summarized above.

Dr Ritter's comment:

> *"It is important to go ahead with the development of the more sophisticated models. This should give us a better understanding of the dynamics of the system and be able to evaluate management alternatives more accurately. In order for the more complex models to be of any use, it is very important to collect more data."*

Dr. Ritter's comments that there is need to go ahead with the more sophisticated modeling effort, and that this will require collection of additional data, are in line with what is planned. However, as discussed above, the integration of the "more sophisticated modeling" and additional data collection will need to be achieved, since at this time this approach is not well defined.

Dr. Ritter's comment:

> *"There is disagreement among the scientists as to the major causes of DO depletion in the DWSC. There is a need to reduce the uncertainty in the causes and sources of DO depletion before load reduction studies are conducted. To reduce the uncertainty, the principal investigators need to collect more data and do a more thorough analysis and synthesis of historical data."*

Dr. Ritter's comment about the disagreement among the scientists as to the major causes of DO depletion in the DWSC needs to be reviewed in terms of the situation. While, based on the peer review workshop, it is possible for a peer review panel member to come away with the conclusion that this issue is a major issue that needs to be resolved, the facts are that Drs. Brown,

Litton, Foe, Mr. Gowdy and Dr. Lee all are in agreement that algae from upstream sources are a major cause of oxygen depletion in the DWSC. At times, when the City's ammonia discharges are significantly elevated, the City's ammonia can contribute significantly to the DO depletion problem. On the other hand, Lehman asserts, based on a statistical evaluation rather than a deterministic evaluation used by the others, that ammonia is the dominant factor causing DO depletion. The data do not support her position. There is no question that ammonia is an important factor when the flows of the SJR through the DWSC are low, and especially in the fall when the algal BOD load is reduced. As discussed in the Synthesis Report (Lee and Jones-Lee, 2002), great caution must be exercised in using statistical approaches to try to determine cause and effect. This has and can readily lead to erroneous conclusions on the importance of a particular situation. The proposed use of the Chen model to establish the impact of ammonia versus algal loads on the DO depletion problem should provide considerable information pertinent to resolving the relative significance of ammonia versus algae as a cause of the DO depletion problem in the DWSC.

Dr. Ritter's comment:

> *"There is enough data available to determine which of the tributaries are the major sources of oxygen demanding material that is transported into the San Joaquin River channel. What is not known with certainty is what are the causes of the oxygen demanding material in the subwatersheds of the tributaries."*

Dr. Ritter's comments about there being enough data to show that the oxygen demand materials are derived from certain tributaries of the SJR and that we do not understand the sources of oxygen demand within the tributary watersheds, where he supports the need for further studies, is in accord with the planned activities.

Dr Ritter's comment:

> *"There is a need to collect more data in this flow range with continuous DO, temperature and flow rate at various points within the system and to obtain accurate measurements of BOD loads to determine the relationship between flow rate, DO and BOD loads to the DWSC with more certainty."*

Dr. Ritter's recommendations regarding the need to collect more data on various parameters in the flow range of greatest interest are in accord with what is being planned. As indicated above, an overall monitoring/evaluation program guide is being developed. This will be presented to CALFED for support. This work will likely be done during the Phase I TMDL.

Dr. Ritter's comment:

> *"CALFED should go ahead with a pilot scale aeration demonstration. It is recommended an RFP be developed for the aeration demonstration and the proposals be evaluated by a peer group of scientists and engineers. There is also a need to develop detailed cost/benefit data for different aeration schemes."*

Dr. Ritter's recommendation for CALFED to go ahead with the support of a pilot aeration demonstration is in accord with the planned approach. The pilot (or experimental) aeration program will be a key component of the Phase I TMDL.

Dr. Ritter's comment:

> *"It is fairly clear how the DWSC increases the hydraulic residence time and affects the DO conditions in the DWSC. There is some question how the geometry of the DWSC affects the settling and resuspension of sediments and oxygen demanding particulate matter. There also is a question to the thermal stratification that occurs in the DWSC and what effect this has on the DO levels at various depths."*

Dr. Ritter's comments regarding how the geometry of the DWSC affects settling and resuspension of the sediments and oxygen-demanding particulate material is an important issue that will need to be considered in future studies, especially as it relates to the potential for deepening the DWSC that the Port of Stockton has recently proposed. His recommendation on thermal stratification is in accord with planned studies.

Dr. Jassby

Dr. Jassby did not attend the Peer Review workshop or participate in the PR discussion of issues. He provided specific comments on several of the component project reports. The issues raised in these comments will be addressed by the component project PIs. He comments,

> *"c) Information gaps*
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> - *There is still much uncertainty on the fate of river loads downstream of Mossdale but upstream of the DWSC. It would still be helpful, as suggested in the last review panel, to establish stations between Mossdale and Channel Point that evaluated changes in both the total BOD load and the relative role of different constituents (algal-derived materials, ammonium, other refractory and labile detrital organic matter). This would also help to address Dr. Lehman's contention that river loads are much more refractory than expected.*
> - *A better estimate of river loads into the DWSC is necessary. At the very least, a station several miles upstream of the RWCF outfall would be more appropriate than Channel Point or Mossdale when using discrete measurements. For chlorophyll, continuous flow and fluorescence monitoring should enable load estimates at any point."*

Dr Jassby's recommendations on adding additional monitoring stations between Mossdale and Channel Point will be considered in the development of the Phase I TMDL. Sampling in this area is much more expensive. The reason that sampling has not been conducted in this area in the past is based on funding limitations.

> - *"A related issue is the role of primary consumers. It is still important, as noted in the last review panel, to find out what role primary consumers are playing in the DWSC as well as between Mossdale and Channel Point. Because primary producers are so variable (especially Corbicula fluminea, a major macrobenthic filter-feeder in the Delta), this information is essential to calibrating a reliable simulation model, as well as to understanding BOD changes downstream of Mossdale."*

Consideration is being given to quantification of zooplankton and macrobenthic organism grazing as a factor in controlling phytoplankton populations as part of the future monitoring/evaluation program guide that is being developed.

- *"There is a very large body of historical evidence (DWR, DFG, and USBR datasets) that can be brought to bear on some of the questions here and that remains unexploited. Historical data analysis and time series or other statistical models offer a cost-effective addition to this project that could produce results in a timely manner with respect to the TMDL timelines. Moreover, they offer a long-term, data based perspective to the results generated by other types of analyses and models. Agreement between such different approaches gives us a much higher degree of confidence in the conclusions. Disagreement subjects all approaches to a more rigorous examination."*

To the extent that Dr. E. Van Nieuwenhuyse is involved in these studies in the future, he could address these issues. Note: Dr. E. Van Nieuwenhuyse was not part of the CALFED-supported team of investigators. He has followed closely the reporting on the studies that have been done and, on his own initiative without CALFED support, provided a statistical evaluation of the IEP database pertinent to the DO depletion problem. His future involvement will be dependent on the arrangements that he makes with his employer – USBR and CALFED, for support if needed, as well as the time he has available for activities of this type.

Dr. Jassby's comment:

"I do, however, feel that it would be worthwhile to emphasize a few of the points that bear on future research and mitigation strategies:

1. *The role of river loading from upstream in controlling DWSC DO levels is uncertain. The research to date has made a strong case for the role of channel dredging, RWCF wastewater discharge and river flow. But some of the best guesses that have been brought to bear on the importance of river loading are contradictory. Resolving the relative importance of river loading should be a research priority, whether it involves additional field measurement or analysis of existing data."*

The statement with respect to the uncertainty in the role of river loading only relates to Lehman. The other investigators, who have all independently examined this issue, are in agreement with respect to the relative significance of upstream river loading versus city of Stockton ammonia. Basically, the issue focuses on the use of a questionably reliable statistical approach to infer cause and effect, versus a deterministic approach based on measured rates and concentrations of constituents. This issue will be addressed and resolved as part of the future studies.

"2. Given the uncertainty regarding river loading, the most important known load is from RWCF wastewater. Even if river loading proves to be relatively important, wastewater contributions will remain significant. Improving wastewater effluent quality is therefore at this point the most likely way to reduce TMDLs to the system, and at any time an effective way to reduce TMDLs to the system."

As discussed above, the issue of the future City's ammonia discharges is under review. As now currently required under the recently-adopted NPDES permit for the City's wastewater discharges to the SJR just upstream of the DWSC, the ammonia loads to the SJR during times of elevated concentrations in the effluent will be reduced by a factor of about 10.

Dr. A. Horne

Dr. Alex Horne was unable to attend the Peer Review panel workshop. He provided comments that focused on his recommended approach to solve the low-DO problem in the DWSC. He strongly supports channel aeration as the initial means of controlling low DO in the DWSC. He also supports the use of constructed wetlands to control upstream nutrient loads. G. F. Lee's proposed monitoring/evaluation program guide includes exploratory studies on the potential to use naturally occurring and/or constructed wetlands in the Mud and Salt Slough watersheds to remove the nitrogen loads to the SJR upstream of where the Merced River enters the SJR.

References

Foe, C.; Gowdy, M. and McCarthy, M., "Draft Strawman Source and Linkage Analysis for Low Dissolved Oxygen in the Stockton Deepwater Ship Channel," Report prepared for San Joaquin River DO TMDL Steering Committee and TAC by California Regional Water Quality Control Board, Central Valley Region, Sacramento, CA, April (2002). Available from www.sjrtmdl.org.

Lee, G. F. and Jones-Lee, A., "Issues in Developing the San Joaquin River Deep Water Ship Channel DO TMDL," Report to Central Valley Regional Water Quality Board, Sacramento, CA, August (2000).

Lee, G. F. and Jones-Lee, A., "Synthesis of Findings on the Causes and Factors Influencing Low DO in the San Joaquin River Deep Water Ship Channel Near Stockton, CA," Report Submitted to SJR DO TMDL Steering Committee/Technical Advisory Committee and CALFED Bay-Delta Program, G. Fred Lee & Associates, El Macero, CA, May (2002).

US EPA, "Total Maximum Daily Loads for Toxic Pollutants, San Diego Creek and Newport Bay, California," US Environmental Protection Agency, Region 9, San Francisco, CA, June 14 (2002).