San Joaquin River Dissolved Oxygen Total Maximum Daily Load Technical Working Group Meeting

Tuesday, March 23, 2010
9:00 a.m. – 12:00 p.m.

ICF International
(formerly known as Jones & Stokes Associates)
630 K Street, #400, Sacramento, CA 95814

Attendees

Name	Agency
Ameri, Khalid	DWR Bay-Delta Office
Brown, Russ	ICF International
Brunell, Mark	UOP Stockton
Domagalski, Joe	USGS
Fong, Stephanie	Central Valley Regional Water Board
Grimes, Russ	ICF International
Goldberg, John	CA Department of Mental Health
Joab, Christine	Central Valley Regional Water Board
Johnson, Mike	MLJ-LLC
Kendall, Carol	USGS
Lee, Gene	US Bureau of Reclamation
Lee, Petra	CA Department of Water Resources
Litton, Gary	UOP Stockton
Martin, Sara	ICF International (Note-taker)
McLaughlin, Bill	DWR Bay-Delta Office
Montgomery, Amanda	Central Valley Regional Water Board
Parlin, Larry	City of Stockton
Pedlar, Bob	CA Department of Water Resources
Reeves, Ryan	CA Department of Water Resources
Stringfellow, Will	University of the Pacific
Turner, Melissa	MLJ-LLC
Westcot, Dennis	SJRGA
Wilson, Danielle	ICF International (Facilitation)
Wong, Henry	US Bureau of Reclamation

Introductions and Agenda Review

Danielle Wilson convened the meeting at 9:05 a.m. and observed that it has been quite a while since the SJR DO TMDL TWG has met (the last meeting was held on June 19, 2008). Danielle asked phone participants to e-mail her their name and affiliation for the official record. She noted that the agenda for the meeting is primarily focused on what's been happening with the aeration facility over the past two years, but pointed out that the meeting is also a chance to revisit the goals of the group and discuss what types of presentations the group would like to

see over the coming year. Danielle also requested that the TWG members take a look at the newly improved website and provide feedback regarding its utility. The PowerPoint presentations from the meeting will be posted on the SJR DO TMDL TWG website.

Updates

San Joaquin River Water Quality Management Group
No update was given, as no one from SJRWQMG was in attendance.

CVRWQCB—Christine Joab
Christine Joab announced that the Central Valley Regional Water Quality Control Board has undergone a substantial reorganization. For the TWG, it means that there will be a new face from the Regional Board—Stephanie Fong. She will be taking over from Amanda Montgomery as the CVRWQCB Senior for the SJR DO TMDL.

Christine also announced that there will be an open-forum TWG meeting in April during which issues related to the aeration device as well as the prohibition of discharge can be discussed. She encouraged the members of the TWG to call her or send her an e-mail with any thoughts or ideas for the April open-forum discussion.

Danielle noted that future agendas will feature updates from DWR.

Presentations

***City of Stockton Wastewater Nitrification Process Upgrade and Benefit to San Joaquin River Dissolved Oxygen*—Larry Parlin, Deputy Director, Department of Municipal Utilities, City of Stockton**
Larry Parlin opened his presentation by explaining that the City of Stockton Regional Wastewater Control Facility installed two nitrifying biotowers in 2007 to remove ammonia during the tertiary wastewater treatment process. He outlined his presentation, stating his intention to provide some background information on the treatment facility, describe the nitrification process improvements that came online in 2007, provide performance data and show how the new nitrification process might be benefiting the dissolved oxygen problem in the San Joaquin River.

Larry displayed some photos of the facility, showing the facility's layout and proximity to the San Joaquin River, as well as a treatment process flow chart showing all the stages of wastewater treatment. He explained that the treatment process is fairly typical. Almost all of the flow is pumped through the treatment plant six times, and that the tertiary-treated water is discharged directly into the San Joaquin River. This tertiary-treated wastewater is high-quality and could be used for landscape irrigation. Sludge is hauled offsite and land-applied in Sacramento County.

Though the treatment plant is in close proximity to the San Joaquin River, the plant has not flooded yet. The entire City of Stockton Municipal Utilities Department is headquartered at the site. Most of the structures onsite are 35 years old; and the City is in the process of undertaking some capital improvements to the treatment facilities.

The new nitrifying towers are located at the tertiary treatment portion of the plant. The City monitors water quality at nine sites upstream and downstream of the plant's outfall, with the furthest monitoring site approximately nine miles downstream from the outfall.

After the nitrification facilities came online in 2007, the City obtained a new NPDES discharge permit limiting them to 2 mg/L of effluent ammonia concentration and 10 mg/L for $CBOD_5$. The City typically removes almost all of the ammonia in the wastewater, then adds a little ammonia back in during the chlorination process to ensure disinfection byproducts are not left behind. The City is considering moving to a UV disinfection treatment process. The City monitors effluent ammonia concentrations every day.

The operation of the wastewater treatment plant was contracted out to a private company from 2004 to 2008. This company designed and built the nitrifying biotowers. They also built some wetlands to assist in the nitrification process, though the City does not always use them for nitrification because the wetlands pose a maintenance challenge and are a major mosquito vector.

Larry then went on to describe the nitrification process biotowers. The wastewater gets trickled down through the towers, where a thin film of bacteria oxidizes the ammonia to nitrates. The biotowers sustain only enough bacteria growth to treat the inflowing ammonia load. Balancing the amount of bacteria with the ammonia load can be tricky because the ammonia load changes seasonally. However, the City has the ability to adjust how much secondary effluent is pumped through the nitrifying towers based on the ammonia load, keeping the amount of ammonia going through the towers constant.

Larry's next slides showed the monitoring results for ammonia and $CBOD_5$ from before the installation of the nitrifying biotowers through December 2009. The chart showing monthly average effluent ammonia load clearly shows that since the operation of the nitrifying towers, ammonia treatment has been very successful—never even approaching the NPDES permitted amount. The treatment process has performed very well, and this is due entirely to the nitrifying biotowers; the wetlands alone would not have done as well. In the summer months, the City sometimes bypasses the wetlands completely.

The nitrifying biotowers had a similar effect on the BOD_5 levels as well, and the effluent biological oxygen demand has remained low ever since. The BOD_5 levels are already low when the effluent comes out of the secondary treatment process, and the City has to ensure that they don't add too much BOD_5 to the nitrifying biotowers.

Larry then presented two slides showing the overall benefits of the nitrifying biotowers to the San Joaquin River. The City feels it is benefiting the river significantly at this time.

City of Stockton Nitrifying Biotowers Benefits to Dissolved Oxygen Levels in the San Joaquin River:

- The NPDES permit allows NH3N load of approximately 28,000 lbs/month;
- Nitrification process reduces oxygen demand approximately 650,000 lbs/month at the current 32 mgd Flow;
- NPDES permit allows CBOD5 load of 137,610 lbs/month;
- Actual discharge CBOD5 load of <15,000 lbs/month;
- Actual discharge reduces oxygen demand approximately135,000 lbs/month.

Larry then opened up the discussion to questions from the TWG.

Questions, Comments, and Discussion

Question: How tall are the towers?
Answer: The towers are approximately 35 feet tall with 22 feet of plastic media. The media intake openings are very small, so the City has to be careful that the openings don't get blocked or clogged. The wetlands do cause some tules and bulrushes to enter the towers, which is part of the reason why the City is considering modifying the wetlands.

Question: Why is monitoring site R1 so far upstream (approximately 8 miles upstream of the effluent outfall)?
Answer: As a municipal discharger, the City of Stockton must be able to provide data about the receiving waters to regulators.

Question: Is there a tidal influence of your effluent?
Answer: The City's effluent is affected by the tides. Sometimes it stays in place for a brief period, and sometimes it moves upstream, but generally heads downstream.

Question: Are the City's monitoring data online?
Answer: Larry said that the monitoring results are not available online, but that he would be happy to provide the data to anyone who would like to look at it.

Question: Are the monitoring results presented in a report?
Answer: Not yet. For now the data are just presented in monthly discharge monitoring reports.

Question: It looks like the discharge levels of ammonia are well below the permitted level. When you chose the new treatment system, did you select the nitrifying biotowers in order to get you closer to that permitted amount?
Answer: The private company that was contracted to operate the plant between 2003 and 2008 selected the nitrifying biotowers. Usually, if nitrification processes are operated properly, they result in close to zero levels of ammonia in the effluent. Once the ammonia levels are close to zero, the plant operator has to worry about the chlorination process.

Question: Since the City is looking to move on to a UV disinfection system, how would that change operations at the plant?

Answer: Installation of a UV disinfection system would eliminate the chlorination process and allow the City to stop worrying about disinfection byproducts. Concern about disinfection byproducts is the reason the City now adds ammonia back into the effluent after it's been through the nitrifying biotowers. A UV disinfection system would probably be very effective, but it is an energy hog, so it might put the City in conflict with its goal to be energy neutral. However, on the other hand, with the current process, the City stores 90-ton cars of chlorine on-site. There is a chance that a UV disinfection system may be a requirement of the next NPDES permit.

Question: How much does the sulfate concentration change from upstream of the outfall to downstream of the outfall?

Answer: Larry responded that he has not looked at the sulfate numbers, since not much sulfate is used in the treatment process.

Question: How much did the nitrifying biotowers cost to install?

Answer: It was a $43 million project with approximately $18 million for the biotowers and wetlands; but the water quality benefits are clear.

Question: Is the City monitoring nitrate concentration of the effluent?

Answer: Yes, the City monitors nitrate concentration in the effluent and in the river. Nitrates are currently running from 10-20 mg/L, depending on time of year. Some denitrification does occur in the filtration process; however, it can't be fully denitrified because there is not enough BOD_5 left in the effluent. The City is considering rerouting the flow from the towers back to the wetlands in the future to further denitrify.

***Stockton DWSC Demonstration DO Aeration Facility 2008 Experimental Testing Overview*—Bill McLaughlin, Department of Water Resources**

Bill McLaughlin, the Project Manager for the Stockton Deep Water Ship Channel (DWSC) aeration facility, opened his presentation by acknowledging that he gave the same presentation at the January Central Valley Regional Water Quality Control Board meeting, and apologized to anyone who might have been at that meeting as well. He explained that his presentation provides an overview of the following, and serves as a preview of Dr. Russ Brown's more detailed upcoming presentation:

- Aeration facility;
- Experimental area;
- 2008 operations of the facility;
- Historical and recent DO levels in the DWSC; and
- 2008 operations monitoring results.

The basic principle of the aeration facility's operation is that it pumps up to 50 CFS of river water out of the San Joaquin River, injects it with oxygen gas, then discharges it back into the river through a diffuser to increase dissolved oxygen levels in the DWSC.

Bill showed some photos of the facility and provided a virtual tour to the TWG. He showed a map of the area, with the diffuser location and monitoring stations called out. He explained that the discharge location for the facility was selected by choosing the historically worst area of dissolved oxygen sag in the DWSC. At mean tide, the diffuser is located at an approximately 12-15 foot depth. There are five monitoring stations between Turner Cut (downstream of the facility) and Channel Point (upstream of the facility). The Rough & Ready Island monitoring station (RRI) is 1,000 feet downstream of the discharge location; NA 43 is approximately ¾ mile upstream of the RRI, and NA 48 is approximately 1 ½ miles upstream of the RRI. NA 42 is located approximately ¾ mile downstream of the RRI, and NA 40 is located approximately 1 ½ miles downstream of the RRI.

Bill then reviewed the aeration facility's operational dates for 2008. The facility was in operation during June, July, August, and September of 2008. For the first seven weeks, the facility was operated on a four-days-on, three-days-off cycle. For the next two weeks, it was operated on a seven-days-on, seven-days-off cycle, and the final cycle was one ten-days-on, ten-days-off cycle.

As background information, Bill shared some plots of dissolved oxygen levels at the Rough & Ready Island monitoring station during 2001, 2004, and 2007. All of those years were dry years, and 2007 was a critically dry year. The dissolved oxygen levels for both 2001 and 2004 often fell below CVRWQCB objectives during the summer months, and even into the fall in 2004. Although 2007 was a critical dry year, and the dissolved oxygen levels did fall below CVRWQCB objectives, the results were not nearly as bad as in 2001 or 2004. Bill believes this can likely be attributed to the City of Stockton's newly operating nitrifying biotowers.

2008 was another critically dry year. Bill showed a plot of dissolved oxygen levels at the Rough & Ready Island monitoring station during 2008, with the addition of data points showing when the aeration facility was operating and when it was not. The plot clearly shows how the dissolved oxygen levels were elevated during operation of the facility, and how the levels dropped after the facility was shut off. From the initial monitoring results at Rough & Ready Island, it looks like the dissolved oxygen levels in the DWSC are pretty responsive to operation of the aeration facility.

Bill's next slide showed the dissolved oxygen level results from each of the 5 monitoring stations during the 2008 summer/fall seasons. He pointed out that the Rough & Ready Island monitoring station is located at a 1-meter depth; and the other four monitoring stations are located at a 12-foot depth. At all of the monitoring stations (except NA 48), the dissolved oxygen levels were kept above CVRWQCB objectives for the four-day-on, three-day-off and

seven-day-on, seven-day-off aeration facility operation schedules most of the time. For future measurements, the monitoring station at NA 48 is going to be moved to a 9-foot depth because the area is not as deep as originally thought. This should provide some more constant readings at that location.

Rough costs for the experimental operation of the aeration facility (not including maintenance) ran at approximately $1,200 per day for liquid oxygen and approximately $1,200 per day for power. The facility operated for 58 days in 2008. Bill hopes that through additional efficiency testing the costs can be brought down. Because 2008 was a critically dry year, this cost estimate represents a worst-case operational scenario of daily operational costs.

The data from a NMFS-required fisheries study related to oxygen effects is currently being analyzed at the UC Davis Bodega Marine Laboratory. A draft report is expected in early summer 2010. So far, the results look good, but there is still a lot of analysis left to do before the results are finalized.

Bill then reviewed some of the reports that are available online at http://baydeltaoffice.water.ca.gov/sdb/af/index_af.cfm. The "Initial Testing of Aeration Facility Capacity and Efficiency, August 2008" report provides the results of an efficiency study performed at the aeration facility in early 2008. This study assessed the percentage of oxygen that gets dissolved into the river water versus the percentage that is lost to the atmosphere. The aeration facility currently is able to dissolve 65% of the oxygen into the water (with most of the remaining 35% lost to the atmosphere). Bill noted that they would like to improve efficiency to 80% if possible.

The report "Effects of the Head of Old River Barrier on Flow and Water Quality in the San Joaquin River and Deep Water Ship Channel—March 2010" presents an evaluation of the influence of the Head of Old River Barrier on water quality and biological characteristics of the San Joaquin River flows as they enter the DWSC. Results from this study are intended to improve operational management of the DWR demonstration aeration facility by enhancing the understanding of the DO response in the DWSC to changes in San Joaquin River flow and quality.

The monthly monitoring reports for the five monitoring stations from 2008 through the present are also available at the same website.

The aeration facility study should be completed in 2010. Additional work remaining to be done includes:

- Additional operational tests;
    - 2008 Operations Testing report in April 2010
- Additional efficiency tests;
- Fishery Study final report;

    - Summer/Fall 2010
- Demonstration study final report;
    - Fall 2010
- Long-term operational agreement.

So far, from the initial study results, the aeration system looks promising as far as its ability to improve dissolved oxygen conditions in the DWSC. However, as highlighted in the final bullet point above, there is no agreement in place as of yet that identifies a long-term operator of the aeration facility. DWR would like to start a discussion with the TWG and others who may be potentially interested in operating the facility.

Bill then opened up the presentation to discussion and comment, and noted that Dr. Russ Brown would get into more detail about the results of the 2008 aeration facility operations in his presentation later in the meeting.

Questions, Comments, and Discussion

Question: Instead of operating on a predetermined schedule, have you considered developing an operational plan based on monitoring, and turning on the system only when the dissolved oxygen levels near critical levels?

Answer: A monitoring-based operation system is being considered and will be discussed in the 2008 final report. Dr. Brown is able to estimate how much dissolved oxygen in the channel comes from the aeration facility and how much is natural. He is working on developing a predictive model, but that work is not part of the current study, so it may not be finished this year.

Question: Dennis Westcot asked if the aeration facility will be operated differently in 2010.

Answer: Bill anticipates that the facility will be run in 2010 to meet the CVRWQCB objectives at the five monitoring stations during July and August after operational and efficiency testing is completed. They are considering operating the facility in April and May for additional effectiveness testing. Dennis requested that he and Bill speak offline about spring operation of the facility, as the San Joaquin River Group Authority will be performing VAMP testing during that time.

Question: What can be done to improve efficiency of the system? Are increased pressure or a smaller diffuser orifice options?

Answer: There are many factors that affect efficiency of the system, including water flow, oxygen rate, the ratio of oxygen to water that's being discharged, and the compressor's physical abilities. A range of different spargers were tried, but none of them seemed to make a difference. They plan to text oxygen ratios and flow rates in 2010.

Question: The facility is located on property that belongs to the Port of Stockton. Does DWR have a lease agreement with the Port?

Answer: DWR has a temporary entry and use agreement with the Port of Stockton. The current agreement is good through the end of 2010. The only cost associated with the agreement is paying for power from the Port of Stockton for facility operations.

Question: What is the ability of the aeration facility to accommodate another diffuser line, or to do more than what it's doing now? Could the facility be expanded? Could it provide oxygen at different locations?

Answer: The facility is physically able to pump up to 45 CFS. Currently, there is a 1,000-foot long pipeline leading to the diffuser. There is a limit to how far this pipeline can be extended. The final report will include some discussion of how the facility could be used to its fullest extent.

Question: How many pounds of oxygen are pumped per day?

Answer: 7,500 pounds of effective (dissolved) oxygen were injected per day in 2008 when the most efficient operation was utilized, which occurred for most of the operations. However, over 10,000 pounds of oxygen were fed into the system on a daily basis, with most of the 30-35% of unutilized oxygen lost to the atmosphere.

Question: Are any other water quality data (like ammonia) being collected as part of the study?

Answer: No ammonia or water quality data has been collected at the monitoring stations. The questioner mentioned that a big question relating to dissolved oxygen levels in the San Joaquin River has to do with how much dissolved oxygen loss can be attributed to ammonia versus algae growth. Bill mentioned to the group that Dr. Brown is looking into the ammonia issue to some degree and will address it in the final report.

***Demonstration Aeration Facility 2008 Operations Performance Report*—Dr. Russ Brown, ICF International**

Dr. Russ Brown, with ICF International, provided a preview of the performance of the aeration facility during its demonstration operations in 2008. Capacity and efficiency testing showed that the aeration facility basically was able to meet expectations regarding the amount of dissolved oxygen (DO) it is physically able to dissolve and discharge to the Deep Water Ship Channel (DWSC). The focus of this presentation, however, is to show the results of various monitoring and data-gathering efforts to provide an idea of the Aeration Facility performance at increasing the DO levels in the DWSC.

The aeration facility itself is located at the north end of the docks at the Port of Stockton. Although the intake of the facility is near the Rough & Ready Island (RRI) monitoring station, the diffuser was sited 1,000 feet upstream so that the newly oxygenated water would not overwhelm the monitoring station. The diffuser location was also carefully selected (between Docks 19 and 20) so that it would not usually be blocked by any ships.

Russ then briefly summarized the objectives of the overall aeration facility demonstration in 2008:

- Determine how well the existing RRI DO monitoring station represents natural DO conditions in the DWSC.
- Determine whether the Aeration Facility diffuser location is appropriate for adding DO to the DWSC to alleviate the low DO conditions.
- Determine how much DO can be added to the DWSC from the Aeration Facility under a variety of flows (i.e., 250 cfs to 1,000 cfs) at maximum Aeration Facility capacity (7,500 lb/day).
- Determine how the added DO will be distributed along the DWSC at high tide and low tide.
- Determine the effects of natural surface reaeration on the downstream DO and added DO increments.
- Determine the ability of the Aeration Facility to maintain DWSC DO above the Basin Plan objectives of 5 mg/l during December–August, and 6 mg/l during September–November.

The methods used to assess aeration facility performance were as follows:

- Evaluate tidal movement and spreading of added DO from the Aeration Facility diffuser (there are good tidal flow meters all along the San Joaquin River),
- Evaluate DWSC DO measurements from the DWR San Carlos boat surveys (the San Carlos boat surveys started in July of 2008. They measured surface and bottom dissolved oxygen for the entire study stretch, as well as downstream of the study area),
- Evaluate measured DO at the five DWR DO monitoring stations (RRI and 4 DWSC stations) during the pulsed operations (these monitoring stations, located at depths between 10 and 15 feet, depending on the tides, provided 15-minute records),
- Evaluate UOP boat survey measurements of DO profiles from three depths in the DWSC (these dissolved oxygen readings were taken at the surface, at mid-depth, and at 25-foot depth, every 10 feet), and
- Combine UOP boat surveys and DO monitoring station data to determine the distribution of the added DO in the DWSC.

Russ then introduced a series of slides showing tidal elevation and movement, tidal velocity, tidal flows, and river flows for the San Joaquin River near the aeration facility, concluding that the distance of “tidal excursion” (difference between high-high tide and low-low tide) is about 1.5 to 2.5 miles each day. This is the distance that the oxygenated water from the diffuser will be mixed into during a given day. Flows were relatively steady throughout July, August, and September of 2008; at approximately 250 cfs. Russ used the estimated tidal movement in the DWSC to determine how much DO from the aeration facility should be reaching each monitoring location at any given time.

Diffuser mixing is rapid and the added DO concentration (of 30 mg/l) is mixed with twenty times that amount of DWSC water at RRI, so the incremental DO is about 1.5 mg/l (5%). A set of dye studies (dye injected into the diffuser) performed by Dr. Gary Litton indicate that vertical and lateral mixing is nearly complete and that longitudinal spreading is about 3 miles after one tidal day (25 hours).

The next set of slides featured charts showing DO levels in the DWSC between San Joaquin River miles 25 and 40 for various dates during the 2008 demonstration operations of the aeration facility. These charts included data related to natural DO in the channel, DO levels with the Aeration Facility, saturated DO, and the increment by which DO levels in the channel were increased by the Aeration Facility. The charts showed that the aeration facility increased DO levels in the DWSC by about 2 mg/l just downstream of the diffuser. However, the charts also show that the DO levels just 5 miles downstream from the diffuser remain unchanged by the Aeration Facility.

The level of natural DO in the DWSC is based on historical surveys performed by DWR's *San Carlos* boat during times when no aeration was occurring. The longitudinal dissolved oxygen profile is determined by the flow (cfs) and the initial biochemical oxygen demand (BOD) (mg/l). The DWR *San Carlos* DWSC dissolved oxygen surveys also determined that surface reaeration is about 20% of the dissolved oxygen deficit (saturated dissolved oxygen – actual dissolved oxygen) per day. The incremental effects of the added dissolved oxygen from the Aeration Facility will decrease downstream because of reduced surface reaeration—most of the DO increment will be gone within about 5 days.

Based on tidal movement, Dr. Litton's dye study, and the San Carlos dissolved oxygen studies, the expected dissolved oxygen increments from the Aeration Facility can be predicted as follows:

- The fully-mixed added dissolved oxygen increment should be observed at the Light 42 monitoring station, which is a ½ mile downstream from the diffuser.
- The daily added dissolved oxygen (7,500 lb/day) will tidally mix with 3 miles of DWSC water (5,000 acre-feet) and produce a daily dissolved oxygen increment of about 1 mg/l.
- The added dissolved oxygen increment would be 1.25 mg/l with a flow of 1,000 cfs, 2.5 mg/l with a flow of 500 cfs, and 5 mg/l with a flow of 250 cfs.

Russ then presented two graphs showing dissolved oxygen data gathered at the aeration facility monitoring site (RRI) in 2004 and 2008 compared to dissolved oxygen data gathered by the City of Stockton. The data matches up and serves as independent confirmation that the data gathered at the RRI monitoring site is accurate. The data from 2008 also shows that there may not be as much of a BOD problem in the DWSC as there was before the City of Stockton installed its nitrifying biotowers (in 2007). Specifically, changes in DWSC dissolved oxygen levels from the City of Stockton's Regional Wastewater Control Facility new nitrification facility are as follows:

- Comparison of 2004 and 2008 data suggests that the summer inflow BOD was reduced from 15-20 mg/l to 5-10 mg/l.
- The periods and severity of dissolved oxygen deficits (below DWSC dissolved oxygen objectives) will likely be less frequent and smaller in magnitude.
- The current Aeration Facility capacity of 7,500 lb/day should be sufficient to maintain the DWSC DO above the objectives most of the time.

Russ explained that early on, the project team realized that it would be difficult to tell the difference between natural dissolved oxygen in the channel and the oxygen that was added because of the aeration facility. This is the reason that the facility was operated on a pulsed or on-off interval schedule during 2008—to effectively reset the study after each "off" period. A chart entitled "Measured DO in the DWSC for July 2008" showed how quickly measured dissolved oxygen levels responded to the aeration facility's operations. The monitor at RRI registered the most immediate changes. Because the San Joaquin River (with high BOD) enters the DWSC near the Light 48 monitoring station, this station generally measured the lowest dissolved oxygen levels.

The chart showing dissolved oxygen levels at RRI during July 2008 testing reveals that the measured dissolved oxygen at RRI spikes in the afternoon, whether or not the facility was operating, though it spiked to a higher level during operations than it did when the facility was not operating. The difference between spike levels shows what part of the measured dissolved oxygen is added versus what part is natural, with consideration of tidal influence.

The data also shows that natural surface reaeration in the channel is about 20% per day, which means that only 80% of the injected oxygen increment from any given day is present in the channel the next day. The day after that, there would only be 60% of the injected oxygen increment left in the channel. This natural surface reaeration rate is higher than expected. It can't be measured, but must be determined by comparing the data from the pulsed operations.

The tidal movement measured at the RRI tidal flow meter was used to track the 15-minute dissolved oxygen increments upstream and downstream of the diffuser, past the five DWSC dissolved oxygen monitoring stations. A spreadsheet model was developed to estimate these dissolved oxygen increments compared to the measured dissolved oxygen data. Because the DWSC flow was low (250 cfs) during operations, several days are required for the added dissolved oxygen to reach the monitoring stations at Lights 42 and 40 (approximately 0.5 and 1.5 miles downstream of the diffuser, respectively), and several days are required after aeration stops before the natural dissolved oxygen is measured at Lights 42 and 40. The DWSC surface reaeration of about 20% per day reduces the downstream "wedge" of added dissolved oxygen and limits the added dissolved oxygen increment in the DWSC to about 4 days of aeration capacity (4 x 7,500 = 30,000 lbs).

In summary, the monitoring efforts and studies show that the aeration facility works very well, increasing dissolved oxygen levels over three miles of the DWSC, but that it has a diminishing effect as one looks downstream. About 20% of the injected oxygen increment is lost per day, but the aeration facility still provides a considerable amount of increased dissolved oxygen levels in the DWSC that can be observed 3 miles downstream at low tide.

The next steps are to finish testing and prepare the demonstration study final report, and turn the Aeration Facility over to another entity for long-term operation. Russ then presented the group with a final set of recommendations:

- Adjustments in the aeration facility are needed to improve the oxygen gas transfer efficiency and increase the capacity.
- Testing of tidal operations (during flood tide) are needed to shift the distribution of added dissolved oxygen upstream toward Light 48.
- A long-term DWSC dissolved oxygen monitoring plan should be developed to track natural dissolved oxygen and the added dissolved oxygen from the aeration facility.
- An operational strategy for the aeration facility should be developed to maintain the DWSC dissolved oxygen objectives, using upstream flow and water quality data from Mossdale.
- The integration of the Port of Stockton aeration facilities at Dock 13 with operation of the DWR aeration facility should be evaluated as part of the SJR DO TMDL implementation plan.

Questions, Comments, and Discussion

Question: How do you differentiate between reaeration (degassing) as opposed to respiration?
Answer: We assumed that our added oxygen does not affect other natural processes like respiration. The aeration facility doesn't change the amount of BOD in the channel; it's still there no matter what, with the same demand for respiration. Russ encouraged the group to read the final report and consider whether that question is answered adequately.

Question: It seems that, if you're adding dissolved oxygen to the channel, you're causing the channel to lose the natural reaeration process.
Answer: Correct. The added dissolved oxygen never causes the total dissolved oxygen in the channel to rise above saturation level, so it is not degassing. Under natural conditions, the oxygen would have increased as it moved downstream through natural reaeration. However, by adding dissolved oxygen, the DO is increased, reducing the amount of natural reaeration downstream of the diffuser.

Question: To clarify, you argue that although photosynthesis adds oxygen to the water, respiration does not cause any oxygen to be lost?

Answer: No, we agree that there is a lot of respiration going on in the water that is reducing the DO, but it is a more constant process that occurs all the time. The added DO does not change the respiration rate.

Question: You argue that the most efficient length of time to operate the aeration facility is four days at a time; however, if you operated the facility for eight days, wouldn't you get twice as much oxygen into the channel downstream than if you operated for four days?

Answer: No, because of the natural surface reaeration rate, the oxygen added in four or five days of operations was the maximum amount of oxygen we detected in the channel, even when we operated for 10 days straight. After four or five days, we weren't seeing all of the dissolved oxygen that we were putting into the ship channel, and it wasn't moving as far downstream as we were expecting.

Question: Does the reaeration effect depend on how much dissolved oxygen is already in the channel?

Answer: No, it does not depend on the amount of natural oxygen in the system. Our added oxygen will still go away at 20% no matter how much natural oxygen is already in the channel. It is a natural process with a steady rate. Because of the steady reaeration rate, the oxygen only adds up over four or five days, so we are limited in the total amount of oxygen that can be added, and we would have to continue operating to maintain this maximum amount of added DO in the DWSC.

Question: It sounds like you could cut costs by operating the facility for three days, and then turning it off.

Answer: Yes, that is what you'd call an operational strategy. If the goal is to keep the dissolved oxygen levels at the objective or above, an operational strategy like that would work well as a routine. During 2009, we tried the idea of only operating on flood tide to keep the injected oxygen upstream where the lowest dissolved oxygen levels were occurring. There are other similar ideas for performance efficiency. For example, if the measurements of natural dissolved oxygen showed that the channel was only 2 mg/l below the objective, we could run just one of the aerator tubes (since it is a dual-tube facility) to put out a smaller increment of oxygen but over the same distance, to avoid aerating above saturation. Those are the types of operational strategies we'll be considering as we start planning for long-term operations.

Russ encouraged the attendees to discuss any additional questions with him in person after the meeting. Danielle announced that the 2008 Operations Testing report should be available in April 2010, close to the same time that all presentations and meeting minutes will be posted online.

DO TMDL website update

Danielle noted that the DO TMDL website is being updated; and she apologized for the time that the website was down. The site is now up and running, and ICF is developing special pages for each of the following:

- Upstream Studies
- Downstream Studies
- Modeling
- Aeration Device
- TMDL
- Other Studies

Additional improvements are also being made to the site. Danielle asked the group to let her know if any links are broken or if there are any other issues with the site.

General Discussion on future TWG meetings

Danielle informed the group about the dates for the rest of the 2010 TWG meetings. They are as follows:

- Tuesday, April 20
- Tuesday, May 18
- Tuesday, July 20
- Tuesday, September 21
- Tuesday, November 16

Danielle observed that the funding for this effort will run out at the end of 2010. She posed a question to the group in order to focus the efforts of the TWG between now and the end of the year: If the November 16 meeting were to be the last meeting of the TWG, what story would the group like to be able to tell at that point? The website is a great tool for sharing that story.

The group responded with the following suggestions:

- *Focus on the results from the aeration facility demonstration.*
- *Look at new developments over the last few years (like how the flow regime is changing) and how DO levels may be affected; for example, the OCAP BO and changes to the Head of Old River Barrier.*
- *Assess likelihood of additional changes to the San Joaquin River, like the flood management program proposed by the Army Corps of Engineers and discussed in the Lower San Joaquin River Feasibility Study.*
- *Revisit the WARMF model that is now in wide use in the Central Valley. Provide an update on WARMF and make it clear that it was initially developed by the TWG.* Danielle pointed out that Russ Brown just wrote a white paper on the different models

that have been explored by the TWG. Danielle will ask him if he wouldn't mind presenting to the TWG on the paper, and include a discussion of WARMF. She will also ensure the TWG's modeling webpage is updated with that white paper.

Danielle asked the group if they would be interested in using the TWG to discuss longer-term plans for the aeration facility. The discussion was first approached in the early 2000's and was last discussed by the Steering Committee in 2003. Considering that the Steering Committee doesn't exist anymore, Danielle wanted to know if the TWG felt comfortable taking up the issue. Will Stringfellow suggested that the TWG stick to the technical side of the issue, by developing efficiency plans and so forth. Gary Litton agreed and pointed out that in past attempts to combine the stakeholder and technical groups, the meetings always deteriorated into political discussions.

Danielle reiterated her desire for the TWG to have some meaningful discussions during the next several meetings, and to be able to demonstrate a clear picture of what the TWG has accomplished by the end of the year. If the group suggests that at the end of the year, it would like to be able to demonstrate the functionality of the aeration facility, then that can be the goal. Danielle noted several heads nodding in agreement. Gary Litton agreed, saying that he feels focusing on the aeration facility would be a good way to proceed.

Gary also suggested that over the next few meetings, the TWG should make some recommendations for further studies. Danielle mentioned again that ICF is in the process of building specific webpages for upstream studies, downstream studies, modeling, the aeration device, the DO TMDL, and other studies. She suggested that the TWG could set a goal of developing future recommendations for each of those categories; providing a record of where the group has been and what it recommends.

Danielle agreed to tentatively plan for a modeling presentation from Dr. Russ Brown at the May TWG meeting.

April 20 Open-Forum Discussion

Danielle pointed out that the meeting proposed for April 20 falls out of the normal, every-other-month schedule of TWG meetings. This meeting is proposed as an open-forum discussion to which stakeholders who are involved in the DO TMDL process and DWSC issues but do not normally attend the TWG meeting will be invited. The meeting will be an opportunity to discuss topics that do not normally get brought up during regular TWG meetings.

For purposes of this round-table discussion, Danielle asked the group for suggestions of other stakeholders who might like to participate in the open-forum discussion, and are interested in what's happening on the subject of the DO TMDL. Russ Grimes suggested inviting policy folks who will be involved in deciding on the final DO TMDL, including the State water contractors and the Port of Stockton. He felt that it would be a good idea to get them involved in the discussion

again—show them the tools and the data and maybe start a discussion about long-term operation. Will recalled that, a few years ago, it seemed like if the TWG could prove that the aerator worked, there would be buy-in on long-term operation. Russ agreed, and said that he thinks long-term operation needs to be discussed because the upstream dischargers are already limited, and the City of Stockton has made strides on the ammonia issue. He argued that the group needs to get those folks in the room and talk about the Aeration Facility's ability to assist in meeting DO objectives.

Mike Johnson warned that it might be a hard sell if the Port and the water contractors are invited to the meeting and immediately asked to pay for long-term operation of the Aeration Facility. He agreed that informing them of the new data is important, but felt that it might be premature to talk about who's going to pay for long-term operations at the same meeting, especially since farming has had such a bad year. The group should definitely focus on getting these groups' buy-in first.

Christine agreed that those groups need to be brought into the conversation, but she asked whether the TWG is the right forum for that. She suggested bringing those groups in initially to update them on the technology, but then letting them meet separately with the Regional Board. Russ responded that wherever the subsequent discussions take place, those groups definitely need to be brought in to learn about the current DO levels and what the aeration device can do to improve those levels.

Danielle pointed out that the benefit of holding the round-table discussion in April is that it is not a part of the regular TWG schedule. If, after the round-table meeting, there is a desire to reinstate the steering committee or policy group, then that could happen, allowing the TWG to remain focused on the science. She pointed out that it is also important to find out how those groups view their role in the process. The TWG should make sure that the discussions started at the round-table do not end up in a dead-end. If the discussion demonstrates that the Steering Committee needs to be reinstated, then it needs to happen and not be left unresolved.

The group committed to sending Danielle e-mails containing the names of people/groups that should be invited to the round-table discussion to talk about TWG accomplishments, changes in policy, and to get updates from different groups on what's new and what their concerns are. Some discussion regarding possibly rescheduling the April meeting ensued. TWG members agreed to begin reaching out to folks who should be invited to the round-table discussion, and to get back to Danielle with potential date conflicts by March 31. Danielle said she would get back to the TWG by April 1 with a date confirmation for the round-table meeting and a list of agenda topics. However, Danielle encouraged the group to stick with the April 20 date, as it would give the group more time to deal with any issues that may arise out of that discussion.

Identify Next Steps

Danielle said she would get back to the TWG with a proposal for the next meeting date. The meeting was adjourned at 12:20 p.m.