
# Municipal Water Quality Investigations Program
# 2011-2012 Workplan

**4/27/11**
**Final**

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# 1 Potential Municipal Water Quality Investigations Program Impacts Associated with the State's Budget Crisis

At the time of this workplan's approval, the Governor, the State Legislature and the State Employee Unions had not finalized a new contract for Environmental Scientists or a State budget for Fiscal Year (FY) 2011-2012. Given the volatility of contract and budget negotiations, this workplan approaches staffing resources conservatively. This section identifies the Municipal Water Quality Investigation Program's (MWQI) core elements that will be maintained as planned during this FY and program elements that could either be delayed or eliminated depending on how the State's 11-12 budget impacts State workers and the Department. To accommodate any reductions in staff resources and to meet routine and unforeseen demands of core Program elements, staff resources will potentially be shifted away from new program elements (as needed). Staff time may also become limited to participate in multiple meetings (both MWQI and outside agencies) and to attend non-mandatory training and conferences.

MWQI core elements that will receive the highest priority during the term of this workplan include;

a) Water quality monitoring (both real time and discrete) at existing stations and sites.
b) Modeling duties associated with real time forecasting used in the Real Time Daily Forecasting (RTDF) daily and weekly reports.
c) Production and dissemination of daily and weekly RTDF reports.
d) Data management activities pertaining to database infrastructure enhancement and development to improve long term storage and retrieval of RTDF data.
e) Program management activities listed in the MWQI funding agreement and those mandated by DWR required for health and safety of MWQI staff. This includes monthly MWQI TAC meetings and quarterly budget updates.
f) Other required Program activities that are mandated by DWR and/or essential to the MWQI Program (i.e. 2011 Department Environmental Scientist Workshop, training, specific meetings and conferences, purchasing, contracts, budgeting, etc).
g) Special studies that are fully developed, already underway, or that only require minimal staff time in the office to complete the initial phase. These studies will continue as planned unless it becomes apparent that additional staff resources are needed for monitoring, forecasting and reporting tasks. Adjustments to timelines will be made to accommodate delays as opposed to eliminating studies.

Work on specific program elements and/or tasks that could be delayed pending budget negotiations and/or potential extension of furloughs include:

a) Report production deadlines and timelines associated with some tasks.
b) Cross-training of MWQI staff on modeling and GIS functions.
c) Delay of RTDF data management tasks when assistance is needed from either Division of Technology Services or MWQI staff. The MWQI Data Management Consultant (Dennis Huff) can continue to work regularly scheduled hours.
d) If needed, implementation of special studies will be delayed to accommodate core Program elements.
e) Implementation of recommendations in the MWQI Emergency Response document will be delayed based on the timing of input from various DWR groups and the requirement of DWR Executive Management review and approval.
f) To ensure that core functions are not affected, staff may curtail participation in MWQI related meetings.
g) If necessary, with the consent of the MWQI TAC, face to face meetings may be reduced to one/year for the current FY.

# 2 MISSION STATEMENT

The mission of the Municipal Water Quality Investigations Program (MWQI Program) is to a) support the effective and efficient use of the State Water Project (SWP) as a source water supply for municipal purposes through monitoring, forecasting, and reporting of SWP water quality; b) provide early warning of changing conditions in source water quality used for municipal purposes; c) provide data and knowledge based support for operational decision-making on the SWP; d) conduct scientific studies of drinking water importance; and e) provide scientific support to DWR, the State Water Project Contractors Authority-MWQI Specific Project Committee (SPC), and other governmental entities.

**MWQI Core Competencies**

- Continuous long-term water quality monitoring (grab samples) in the Delta.
- Real time water quality monitoring (automated, high frequency data collection stations) in the Delta.
- Scientific support on Delta and SWP drinking water issues.
- Analysis of Delta drinking water quality monitoring data.
- Primary source of Delta drinking water quality historical data.
- SWP drinking water quality early warning (RTDF-CP).
- SWP drinking water quality forecasting (RTDF-CP).
- Provide drinking water quality support (data, expertise) to Delta Stewardship Council and other agencies.

**Customers/Regulators utilizing MWQI Program data**

- State Water Project Contractors Authority-MWQI Specific Project Committee
- Contra Costa Water District
- State government
- Bay Delta Conservation Plan
- Central Valley Regional Water Quality Control Board
- California Department of Public Health (DPH)
- US EPA
- DWR's Operation Control Office
- DWR's Bay Delta Office

# 3 INTRODUCTION

## 3.1 Background and Workplan Structure

This is a workplan for work to be performed under the California Department of Water Resources (DWR) Municipal Water Quality Investigations Program (MWQI) for the FY 2011-12 (July 1, 2011 to June 30, 2012). The total MWQI Program budget for FY 2011-12 is $3.1 million. Of this total, $2.9 million is allocated directly to the MWQI Program and $200,000 is kept as part of the State Water Project Contractors Authority (SWPCA), MWQI-SPC fund to cover consultants and other expenses.

The contract agreement between MWQI, SWPCA and the 16 State Water Project (SWP) contractors who purvey drinking water expired in December 2010. A new 3 year Funding Agreement, covering 2011-2013 was executed in February 2011. Under this renewed agreement, work to be performed is identified, prioritized, and approved annually by the MWQI Technical Advisory Committee (MWQI TAC). The TAC is composed of technical representatives of the participating SWP contractors, DWR, SWPCA, Contra Costa Water District, (which is an invited participant associated with the TAC), and other invited members of outside agencies. Approval of the annual workplan is provided by "voting members" of the MWQI TAC, which include DWR and the 16 SWP contractors and constitutes a commitment of funding to the planned work. Some of the tasks outlined in the annual workplan may be completed using funds from a supplemental account provided under the MWQI Agreement and managed by SWPCA. Expenditures using this fund are approved annually by the MWQI SPC, which is made-up of representatives from 15 of the 16 participating SWP contractors. Representatives serving on the MWQI-SPC can differ from those serving on the MWQI TAC.

This workplan continues the format agreed upon between DWR and the MWQI SPC. Budget information for FY 2011-12 in section 4 is followed by the workplan elements in the MWQI program. The workplan elements are:

- Water Quality Assessment
- The Real Time Data and Forecasting Comprehensive Program (RTDF-CP) which includes
    - Real Time Water Quality Monitoring
    - Real Time Forecasting
    - Real Time Data Dissemination
- Special Studies
- Emergency Response

- Other Water Quality Program Related Activities
- Program Management
- Other Required Program Costs

Detailed deliverables are provided for each workplan element along with estimated start and completion dates and the lead organization. Many of the workplan elements either incorporate or overlap with action items identified in the 2006 Sanitary Survey Update. Some of the tasks identified in the 2006 Sanitary Survey Update are associated with groups outside of MWQI. These tasks are included in this workplan under RTDF-CP Sections 6.1 to help gauge their progress (for example pump-in activities in the SWP, or streamlining equipment throughout the department), but they are not necessarily related managerially to the MWQI program. Unless there is a direct connection to the MWQI program through BCP positions, accomplishments associated with these projects are as a result of the ongoing efforts of the group outside of MWQI.

In addition to the workplan, a series of stand alone appendices complement the workplan by providing more in-depth information. These appendices are:

- Appendix 1-an itemized explanation of the MWQI-SPC fund expenditures (information also appears in section 4).
- Appendix 2-a Gantt chart detailing the tasks and timelines associated with the RTDF forecasting section of the RTDF-CP (as of April 2011, currently undergoing updating).
- Appendix 3- detailed information on MWQI Special Studies
- Appendix 4-detailed description of the program's discrete and real time monitoring.
- Appendix 5- detailed information on the history of the MWQI program.

These appendices allow interested parties to learn more about other aspects of the program while keeping the basic workplan document concise.

## 3.2 Program Accomplishments

Although, due to a 15% reduction in staff time the previous FY continued to be challenging, the MWQI Program has accomplished a number of goals listed in the FY 2010-11 workplan. These include:

- Completion of a draft feasibility report on the installation of a water quality station at the Gianelli Pumping/Generating (P/G) plant. Draft report approved, station logistics approved based on reort

and final report completed in FY 2010-11

- Installation of temporary EC/temperature sondes at key points within the channel of O'Neill forebay.
- Initiation of construction of a real time water quality station at the Gianelli P/G plant.
- Installation of a Metrohm anion analyzer at the Jones Pumping Plant. Publication of data to CDEC began March 2011.
- Installation of a Streamsplitter device allowing both Total and Dissolved Organic Carbon (TOC and DOC, respectively) measurements from one, field-based oxidation instrument.
- Software deployment at the Penitencia water treatment plant allowing water treatment operators to see important, ambient, real time water quality data on a dedicated monitor.
- Ability to conduct historical simulations for hydraulics, EC and bromide for both the DSM2 and Aqueduct models.
- Establishment of a $300,000 contract for the completion of the State Water Project Sanitary Update. Work on the update began January 2011.
- Completion of a report on DOC sampling for the DSM2 Boundary Improvement/Model Calibration special study. Report was included in the Annual Modeling Report published by the Bay Delta Office. Data from this study is now being used by both the Department and outside consultants on various modeling studies.
- Completion of a draft report of the SWP particle tracking study.
- Completion of a draft MWQI Summary Report on the history of the program and important study results.
- Creation and installation of Quality Control software allowing field personnel to more easily predict, track and diagnose issues associated with real time instrument QC.
- Completion of Field Station Real Time Monitoring Standard Operating Procedures.
- Provided Department comments on the impacts of the Delta Wetlands EIR to drinking water source water.
- Provided Department comments on the NPDES permit renewal for the Sacramento Regional County Sanitation District wastewater treatment plant.

## 3.3 Changes/Updates From the 2010-11 Workplan

The MWQI workplan continues to evolve to meet the changing water quality, regulatory, and State budget landscape. In this workplan cycle, a number of projects are ongoing and continue forward from the FY 2010-11 workplan. These include many of the tasks associated with the RTDF-CP as well as several special studies. Changes from the last workplan or changes approved in monthly MWQI TAC meetings include:

- Approval by the MWQI TAC to continue the Lathrop Urban Runoff study for another year.
- Approval by the MWQI TAQ to remove the Update on a Water Quality Compendium from the 2011-12 Workplan. Similar tasks are being conducted by the Regional Board and the Legislatively mandated Water Quality Monitoring Council
- Approval by the MWQI TAC to continue the Feasibility Study of a Portable Water Quality Station into the 2011-12 Workplan, with the understanding that field staff will work on this special study as time allows from their regular field duties.
- Addition of Eastside streams Watershed Assessment Risk Management Framework (ESS WARMF) monitoring sites midway through the FY 2010-11 workplan cycle. Data from these sites will be used in the ESS WARMF model funded by the SWPCA.
- Authorization to increase the funding allocated towards Crypto/Giardia monitoring to include Cryptosporidium genotyping and infectivity analyses.
- Approval by the MWQI-TAC to only use Gantt charts for the RTDF forecasting section of workplan. GANTT charts not needed for all other MWQI sections.
- Agreement to continue production of MWQI Biennial Reports.

# 4 PROGRAM FUNDING NEEDS

## 4.1 MWQI and SWPCA Funds

For Fiscal Year 2011-12, the MWQI Program Budget is $3.1 M. Funding is subdivided into a $2,900,000 MWQI DWR baseline budget and a $200,000 SWPCA managed fund. The $2,900,000 fund covers MWQI staff salaries, benefits, DWR operating expenditures, etc. The $200,000 SWPCA fund is used to acquire student assistants, hire consultants, and to purchase certain goods and services deemed necessary and desirable for station operation and Special Studies by both the MWQI TAC and the Specific Project Committee.

For FY 2011-12, there are no grant funds tied to other agencies. The contract between MWQI and the San Luis Delta Mendota Water Authority expires in December 2011. However, remaining funds in this contract will be rolled over into a no-cost extension to continue to provide supplemental support of the MWQI water quality monitoring equipment installed at the Jones Pumping Plant. In FY 2010-11, a consultant was hired to complete the 2006-2010 SWP Sanitary Survey Update. The funds associated with this $300,000 contract were encumbered in FY 2010-11. Because of the year they were encumbered, these funds are not shown in Table 1, however expenditures associated with this contract will be tracked and provided to the MWQI-TAC as part of MWQI's normal FY 2011-12 quarterly budget updates.

The FY 2011-12 MWQI and SWPCA budget is presented below in Table 1 followed by an explanation of SWPCA expenditures. All SWPCA expenditures are also included in Appendix 1. Table 1 reflects current DWR accounting assumptions available to the Program Manager. However, line management assessments provided by the Department to the Program appeared to be in error. To generate the budget shown in Table 1, program management used an estimated correction factor to calculate line management assessments. MWQI will work with DWR's Budget Office to determine if erroneous overhead charges can be removed from the SAP numbers supplied by the Department. If corrections are possible, the budget in this workplan will be updated to reflect the true cost of MWQI labor. As of April, using an estimate of the correct overhead charges, there was an unallocated reserve of $167,428 to cover unanticipated equipment costs, etc. Partner staffing in this budget reflects 1 FTE for both the Bay Delta Office and the Operations Control Office and 0.6 FTE for O&M Water Quality.

Table 1. Program Element Costs FY 2011-12 (MWQI and SWPCA Funds)

| Workplan Element | Program Element | IO # | | | MWQI Funds | | | | SWPCA Funds | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total Labor Hrs. | Labor PYs | Labor | Equipment/Supplies | Contracts | Total | Labor | Equipment/Supplies | Contracts | |
| 5 | **Water Quality Assessment** | | | | $ - | $ - | $ - | | | $ - | $ - | $ - |
| | Grab Samples Collection | V20833701010 | 832 | 0.4 | $ 52,575 | $ - | $ 23,664 | $ 76,239 | $ 20,000 | $ - | $ - | $ 20,000 |
| 6.1 | **Real Time Water Quality Monitoring** | | - | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| | * MWQI Real Time Stations | V10093000000 | 1984 | 0.95 | $ 128,640 | $ 35,000 | $ 29,225 | $ 192,865 | $ 10,280 | $ 32,500 | $ - | $ 42,780 |
| | Field Unit Office Duties | V20833703010 | 4480 | 2.15 | $ 313,076 | $ 9,000 | $ 1,400 | $ 323,476 | | | $ - | $ - |
| | Gianelli Feasibility Study | V20833704010 | 1800 | 0.87 | $ 105,795 | $ 25,600 | $ - | $ 131,395 | | $ - | $ - | $ - |
| | O & M WQ other duties | V20833705010 | - | - | $ - | $ - | $ - | $ - | | $ - | $ - | $ - |
| 6.2 | **Real Time Forecasting** | | - | - | $ - | $ - | $ - | $ - | | $ - | $ - | $ - |
| | BDO-Bay Delta Office-Modeling | V10387600000 | 2080 | 1.00 | $ 199,416 | $ - | $ - | $ 199,416 | | $ - | $ - | $ - |
| | OCO-Operations Control Office Modeling | V20833706010 | 2080 | 1.00 | $ 215,250 | $ - | $ - | $ 215,250 | | $ - | $ - | $ - |
| | MWQI-Trends Analysis, modeling and reporting | V20833707010 | 2304 | 1.11 | $ 156,877 | $ - | $ - | $ 156,877 | | $ - | $ - | $ - |
| 6.3 | **Real Time Data Dissemination** | | - | - | $ - | $ - | $ - | $ - | | $ - | $ - | $ - |
| | RTDF Data Dissemination & Reporting. | V10387700000 | 776 | 0.37 | $ 60,256 | $ - | $ - | $ 60,256 | $ 8,100 | $ - | $ - | $ 8,100 |
| | Administration and Database Activities | | - | - | $ - | $ - | $ - | $ - | $ 62,400 | $ - | $ - | $ 62,400 |
| 7 | **Special Studies** | | - | - | $ - | $ - | $ - | $ - | | $ - | $ - | $ - |
| 7.1 | Urban Sources and Loads | V10092500000 | 2120 | 1.02 | $ 177,699 | $ 500 | $ 63,667 | $ 241,867 | $ 1,620 | $ - | $ - | $ 1,620 |
| 7.2 | NDMA/Crypto/Giardia Study | V20833708010 | 196 | 0.09 | $ 39,816 | $ - | $ 69,000 | $ 108,816 | | $ - | $ - | $ - |
| 7.3 | O'Neill Forebay Circulation Study | V20833710010 | 112 | 0.05 | $ 78,452 | $ 52,246 | $ - | $ 130,698 | | $ - | $ - | $ - |
| 7.4 | FDOM Study | CDOMxxxx12 | 112 | 0.05 | $ 23,036 | $ 2,800 | $ - | $ 25,836 | $ - | $ - | $ - | $ - |
| 7.5 | Spectrofluorometry Study | V20833713010 | 196 | 0.09 | $ 115,682 | $ 2,000 | $ 50,460 | $ 168,142 | $ 6,000 | $ - | $ - | $ 6,000 |
| 7.6 | Sacramento WARMF Study | V10093500011 | 640 | 0.31 | $ 14,130 | $ - | $ - | $ 14,130 | | $ - | $ - | $ - |
| 7.7 | Portable Water Quality Study | V10093100011 | 1231 | 0.59 | $ 35,393 | $ - | $ - | $ 35,393 | | $ - | $ - | $ - |
| 7.8 | MWQI Summary Report | V10093300011 | 360 | 0.17 | $ 11,744 | $ - | $ - | $ 11,744 | | $ - | $ - | $ - |
| 7.9 | Tidal Marsh Report | V10093400011 | 1344 | 0.65 | $ 115,021 | $ - | $ - | $ 115,021 | | $ - | $ - | $ - |
| 7.10 | 2006-2010 Sanitary Survey (Contract & mgmt) | V10093200011 | 208 | 0.10 | $ 24,800 | $ - | $ - | $ 24,800 | | $ - | $ - | $ - |
| 8 | **Emergency Response** | V10387400000 | 480 | 0.23 | $ 7,138 | $ - | $ - | $ 7,138 | | $ - | $ - | $ - |
| 9 | **Other Water Quality Program Activities** | V10093600011 | 240 | 0.12 | $ - | $ - | $ - | $ - | | $ - | $ - | $ - |
| 10 | **Program mngt/Status Reporting** | V10092200000 | 2193 | 1.05 | $ 204,332 | $ - | $ - | $ 204,332 | $ 53,100 | $ - | $ 6,000 | $ 59,100 |
| 11 | **Misc. Program Costs (Training, travel, TECS)** | V10092700000 | 288 | 0.14 | $ 169,183 | $ 119,700 | $ - | $ 288,883 | | $ - | $ - | $ - |
| | | | | | | | | | | | | |
| | Subtotal | | **26,056** | **12.53** | **$2,248,312** | $ 246,846 | $ 237,416 | $ 2,732,574 | $ 161,500 | $ 32,500 | $ 6,000 | $ 200,000 |
| | **Funds not assigned to specific Program Element** | | | | | | | $ 167,426 | | | | $ - |
| | **Total Funding** | | | | $2,248,312 | $ 246,846 | $ 237,416 | **$ 2,900,000** | $ 161,500 | $ 32,500 | $ 6,000 | **$ 200,000** |

‡All labor and salary calculations assume no furloughs in FY 11-12.

* Includes contract with San Luis Delta Mendota Water Authority at Jones PP and Maintenance contracts for anion analyzers.

**Specific tasks to be implemented using SWPCA Funds**

Program Element 5.1: Water Quality Assessment

a. Continue to employ student assistants for miscellaneous tasks. Annual cost for a student will be approximately **$20,000** and will utilize a new contract between the SWPCA and the CSUS Hornet Foundation.

Program Element 6.1: Real time monitoring

b. Continue to employ student assistants for miscellaneous tasks. Annual cost for a student will be approximately **$10,280** and will utilize a new contract between the SWPCA and the CSUS Hornet Foundation.

c. Reserve **$32,500** for real-time station and special study equipment and/or rental needs.

Program Element 6.3: RTDF-CP Information Dissemination

a. Consultant's time to assist with continuing progress on the RTDF database, updating of the MWQI Website, assisting field staff with remote data relay and assisting with all areas of data management. Annual salary cost associated with this task is **$62,400**.

f. Potentially employ student assistant for miscellaneous tasks. Annual cost for a student will be approximately **$8,100** and will utilize a new contract between the SWPCA and the CSUS Hornet Foundation.

Program Element 7.1: Urban Sources and Loads Study

g. Potentially employ student assistant for miscellaneous tasks. Annual cost for a student will be approximately **$1,620** and will utilize a new contract between the SWPCA and the CSUS Hornet Foundation.

Program Element 7.5: Spectrofluorometer Study

h. Consultant's time for special assignments such as assistance with spectrofluorometer study or collaboration on a paper assessing the impacts of agricultural conversion to urban land use using Staten island and NEMDC MWQI data. Annual salary cost associated with this task is **$6,000**.

Program Element 10: Program Management

i. Costs for semi-annual MWQI offsite meetings. Costs may include rental fees for facility, AV equipment and technical assistance, refreshments, deposit for facilities reservation, and other miscellaneous meeting package elements. Estimated cost for offsite meeting is **$6,000.**

j. MWQI Technical Consultant to provide administrative and technical expertise on program tasks related to water quality assessment, RTDF-related activities, special studies, and serving as a member of the MWQI Technical Advisory Committee. Cost for FY 2011-12 is **$50,000**.

k. All other Program Management expenses including SWC staff services, Legal, and misc. expenses. Annual cost associated with these functions are: **$3,100.**

# PROGRAM ELEMENTS
# 5 WATER QUALITY ASSESSMENT

Water quality monitoring has been a key feature of the MWQI Program since its inception in 1982. Data from the Program are used extensively by DWR, State Water Project Urban Contractors, non-governmental organizations, the public, and numerous other federal, State, and local agencies, for drinking water supply planning studies. Data from this program are used to identify long-term trends of drinking water quality changes in the Delta region and the SWP. Monitoring data also helps DWR and other agencies develop research and mitigation measures to reduce drinking water contaminants in Delta waters. In collaboration with the Department's Bay Delta Office (BDO), and DWR's Division of Operations and Maintenance, Operation Control Office (OCO), monitoring data from the Delta and California Aqueduct are being used to develop an "early warning" system having the potential to provide advance notice to Delta water users of possible drinking water quality problems.

Water quality assessment consists of two different monitoring strategies, 1) discrete, grab samples, and 2) continuous real time monitoring via remote instrumentation. This section focuses on discrete grab sample monitoring for FY 2011-12. Section 6.1 focuses on continuous remote real-time instrumentation monitoring.

## 5.1 Discrete Sample Collection and Analysis

The MWQI program currently collects monthly grab samples from 19 sites within the Delta (Northern District is currently collecting one sample for the MWQI program in the upper Sacramento Watershed). Sites shown in Table 2 are long-term stations with data available over a number of years. Sites shown in Table 3 are associated with short-term modeling studies. Figure 1 presents a map of all (grab and real time) sampling sites for FY 2011-12. A detailed description of the MWQI program's discrete and in-situ monitoring can be found in Appendix 4.

The frequency of collection at long term monitoring sites remains unchanged from FY 2010-11, but additional analytes and sampling locations have been added to meet the monitoring needs of the WARMF, Spectrofluorometer, and an internal MWQI THMFP/HAAFP comparison special study. Monthly, discrete, sample collection will remain at current levels through the end of October 2011. At that time, the Sacramento WARMF and THMFP/HAAFP comparison special studies will finish. The THMFP/HAAFP comparison study is a year long comparison between trihalomethane and haloacetic acid formation potential (THMFP and HAAFP, respectively) methodologies. Samples are being collected at

several key locations and analyzed for THMFPs and HAAFPs using DWR's modified method and Standard Methods (SM) 5710B (also modified by first filtering the sample). The Department's Bryte Laboratory is no longer providing the analytical support for THMFP and HAAFP analyses, therefore, in the future, if the MWQI program needs to analyze THMFP or HAAFP, analyses will have to be conducted by outside contract labs using standard methods. Currently split samples are being analyzed by Bryte laboratory, using DWR methodology and by a contract laboratory, using SM 5710b. If a robust relationship between the 2 methods exists, then MWQI's historical formation potential data can still be used to examine changes in FP over time and reasonably be used in conjunction with data collected in the future. Monthly sampling for this comparison study commenced in October 2010 and will continue through October 2011. The Eastside Streams WARMF and Spectrofluorometer monitoring will continue throughout the FY 2011-12 workplan period.

As part of real-time instrument quality control, grab samples are also collected bi-weekly at, the Banks Pumping Plant, the Jones Pumping Plant, and the Hood and Vernalis stations. These river and canal samples are used by the discrete monitoring program to examine instrument effectiveness. These biweekly grabs increase the resolution of data available at real-time stations. Monthly grab sample data is available through the Department's Water Data Library (WDL).

Deliverables and timelines associated with discrete sample collection are shown in Table 4.

Table 2. MWQI routine, discrete, sampling stations.

| Station # | Stations | WDL Stations (ID) | Analytes Collected | Frequency |
|---|---|---|---|---|
| 1 | Natomas East Main Drainage Canal | Natomas EMDC @ El Camino Rd (A0V83671280) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, bromide, metals | Monthly |
| 2 | American River at EA Fairbairn WTP Intake | American River W.T.P. (A0714010) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, and bromide | Monthly |
| 3 | Sacramento River at West Sacramento WTP Intake | Sacramento River at W. Sac Intake Structure (A0210451) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, and bromide | Monthly |
| 4 | Sacramento River at Hood | Sacramento R @ Hood (B9D82211312) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, and bromide | Once every two weeks |
| 5 | Sacramento River at Mallard Island | Sacramento River @ Mallard Island (E0B80261551) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, and bromide | Monthly |
| 6 | San Joaquin River near Vernalis | San Joaquin R. nr. Vernalis (B0702000) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, and bromide | Once every two weeks |
| 7 | Old River at Bacon Island | Old River at Bacon Island (B9D75811344) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, and bromide | Monthly |
| 8 | Old River at Station 9 | Old R. nr. Bryon (st9) (Near HWY 4 Bridge) (B9D75351342) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, and bromide | Monthly |
| 9 | ‡ Banks Pumping Plant at Headworks | Delta P.P. Headworks at H.O. Banks PP (KA000331) | Std. Mineral, Turbidity, UVA, TOC, DOC, Bromide, Total Phosphorous, Total Suspended Solids, Phytoplankton, Purgeable Organics, Taste and Odor, Asbestos, and Radiological, Pesticides and herbicides. | Depending on analyte, Bi-weekly, Monthly, or Quarterly |
| 10 | Contra Costa at Rock Slough | Contra Costa @ Rock Slough (B9D75861368) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, and bromide | Monthly |
| 11 | Middle River @ Union Point | Middle River A Union Point (B9D75351292) | Std. Mineral, Turbidity, UVA, TOC, DOC, Bromide, nutrients | Monthly |
| 12 | Jones Pumping Plant at DMC Headworks | Delta Mendota Canal at Jones Headworks (B9C74701355)) | Anions, TOC, DOC | Once every two weeks |
| 13 | Gianelli Pumping/Generating Plant (proposed) | N/A | N/A | N/A |

‡ Samples collected by DWR's Operations and Maintenance (O&M)

- Physical Parameters collected at all sites: Temperature, pH, Turbidity, Dissolved Oxygen, and Specific Conductance
- Standard Mineral analysis includes: Ca, Mg, Na, K, S, Cl, B, Alkalinity, Nitrate, Dissolved Solids, Specific Conductance
- Standard Nutrient analysis includes: Nitrate + Nitrite, Ammonia, Organic Nitrogen and Ammonia, Total Phosphorus (unfiltered)

Table 3. MWQI discrete sampling stations for short-term modeling studies.

| Station # | Stations | WDL Stations (ID) | Analytes Collected | Frequency |
|---|---|---|---|---|
| 14 | Feather River near Garwood - Sacramento WARMF station | Feather River nr Garwood Road ( A0510250) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity bromide, Suspended Solids | Monthly/Storm Event |
| 15 | Colusa Main Drain near. Sacramento River- Sacramento WARMF station | Ag Drain on Colusa Basin Main Drain (A0294500) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, bromide, THMFP/HAAFP, Fluorescence, Suspended Solids | Monthly/Storm Event/Rice Drainage Event |
| 16 | Shag Sl. @ Liberty Island Sacramento WARMF station | Shag Slough @ Liberty Island Bridge (B9S81841416) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, bromide, Suspended Solids, Chlorophyll, CBOD | Monthly/Storm Event |
| 17 | North Fork Mokelumne River @ Wimpy's Marina<br>Eastside Streams WARMF station | NF Mokelumne @ Wimpy's Marina (B9D81371295) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, bromide, Suspended Solids, Chlorophyll, CBOD, THMFP/HAAFP, Fluorescence | Monthly/Storm Event |
| 18 | Calaveras River @ UOP Footbridge Eastside Streams WARMF station | Calaveras River @ Footbridge (B9D75851208) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, bromide, Suspended Solids, chlorophyll, CBOD | Monthly/Storm Event |
| *19 | Sacramento River at Red Bluff- Sacramento WARMF station | Sac R bl Red Bluff (A0275890) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, bromide, Suspended Solids | Monthly/Storm Event |
| 20 | Sutter Bypass at Kirkville Road - Sacramento WARMF station | Sutter BP @ Kirkville Rd (A049163000) | Std. Mineral, nutrients, TOC, DOC, UVA, turbidity, bromide, Suspended Solids | Event Based |

*Samples collected by DWR Division of Integrated Regional Water Management-Northern Region Office

- Physical Parameters collected at all sites: Temperature, pH, Turbidity, Dissolved Oxygen, and Specific Conductance
- Standard Mineral analysis includes: Ca, Mg, Na, K, S, Cl, B, Alkalinity, Nitrate, Dissolved Solids, Specific Conductance
- Standard Nutrient analysis includes: Nitrate + Nitrite, Ammonia, Organic Nitrogen and Ammonia, Total Phosphorus (unfiltered)

Figure 1. MWQI Discrete ("Grab") & Real time Sampling Locations, FY 2011-12

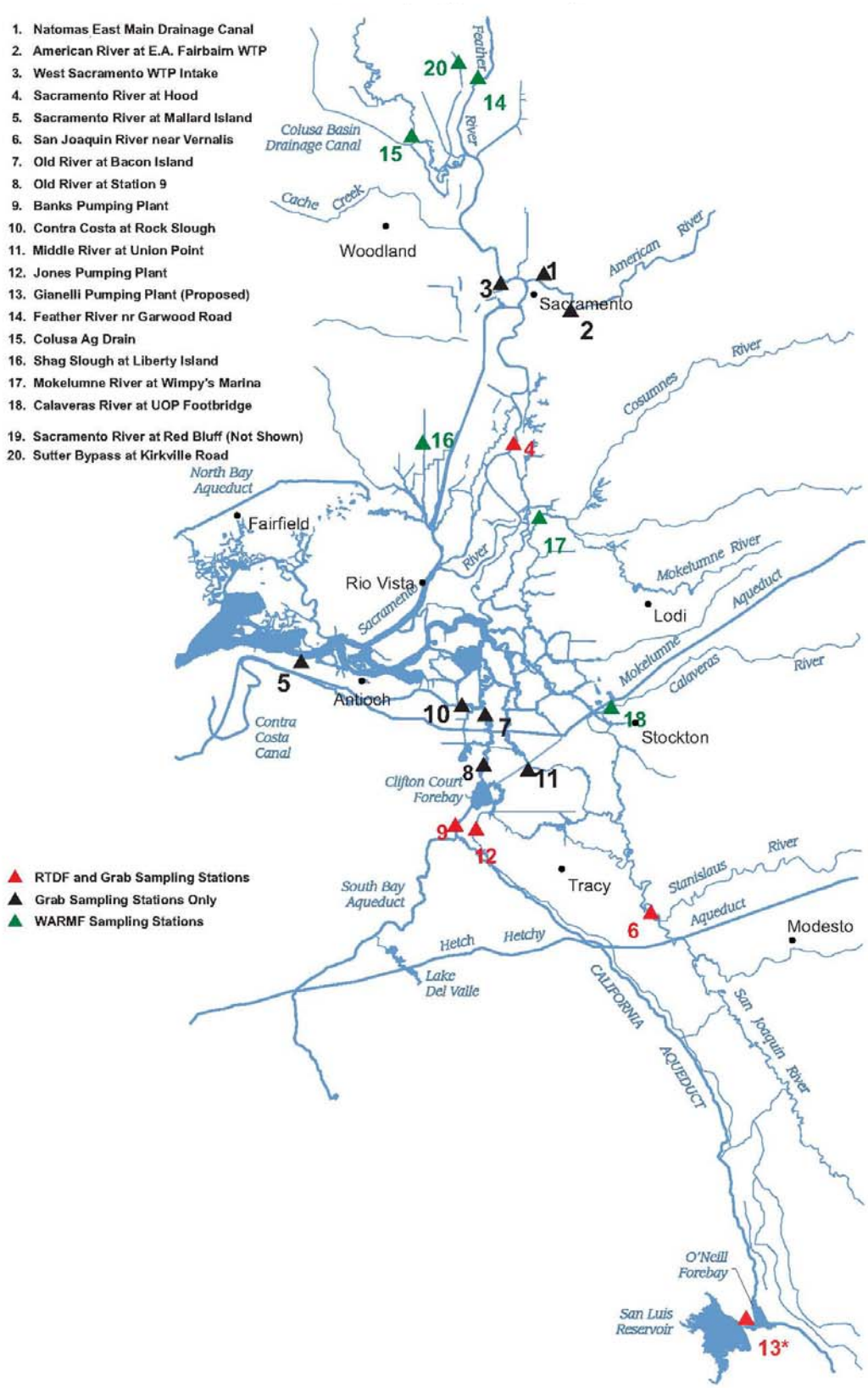


Table 4. Discrete Grab Sample Deliverables and Timelines

| Deliverable | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Records of monthly and bi-weekly, monitoring data. | **MWQI** | na | Currently available upon request |
| Records of periodic calibration of field monitoring equipment | **MWQI** | na | Currently available upon request |
| Records demonstrating consistent and timely application of QA/QC procedures | **MWQI** | na | Currently available upon request |
| Timely analysis and posting of results to the Water Data Library | **MWQI** | na | Monthly Available on-line |

na = not applicable or available

# 6 REAL TIME DATA AND FORECASTING COMPREHENSIVE PROGRAM

The RTDF-Comprehensive Program (RTDF-CP) focuses on providing a single location that compiles and disseminates real-time drinking water quality data gathered across agencies to enable water managers to make operating decisions based on upcoming changes in water quality. The RTDF-CP includes a network of real time water quality monitoring stations and a modeling component intended to allow greater predictive ability of water quality in real time and the future.

The RTDF-CP crosses organizational boundaries within DWR and reaches out to other agencies to gather the necessary data and information. Historically, the geographic scope of the MWQI Program was confined to the Delta. However, the scope of real time monitoring and forecasting encompasses not only the watersheds of the Delta, but also the SWP, and portions of the federal Central Valley Project that are interconnected to the Delta and SWP. As a result, this element includes MWQI funded positions within DWR's Bay Delta Office (BDO), the Operations Control Office (OCO), and the Division of Operations and Maintenance, Water Quality Section (O & M WQ) as well as a contract with the San Luis Delta Mendota Water Authority (SLDMWA).

The RTDF-CP consists of:

1. Remote instrumentation that provides real-time water quality data
2. Mathematical modeling to provide water quality forecasting
3. Information management and dissemination of real-time data to interested parties

Emergency response is also part of the RTDF-CP, but is treated separately in this workplan.

Real time monitoring, forecasting and data dissemination activities are guided by the RTDF Steering Committee, a group of technical experts composed of MWQI staff, Contra Costa Water District and participating SPC agencies. The RTDF Steering Committee reports to the MWQI TAC.

In December 2009, the MWQI program reached an important RTDF goal, publishing daily web-based summaries of water quality and flow at key locations in the Delta. This is a significant milestone toward providing an early warning forecasting system for water quality. At this point, the RTDF program has in place both a robust real-time monitoring system and a data dissemination platform that automates data retrieval and data posting on MWQI's website. With these two components functioning fairly efficiently, the next step is to couple daily summaries of water quality and flow with modeling to provide the early warning system envisioned in the 5-year strategic plan. Although still requiring several years of

development, the capability being built to enable on-demand short term forecasts of Aqueduct water quality should provide the ability to provide weekly forecasts, or if needed, daily forecasts. The RTDF-CP moved closer to this goal in FY 2010-11 with completion of historical simulations for hydraulics, EC and Br for both the DSM2 and Aqueduct Model.

## 6.1 RTDF-CP-Real Time Monitoring

Real time water quality data are used to: a) make informed operational decisions affecting the Delta and SWP; b) support development of water quality forecasting tools for better management of SWP water supplies; c) provide early warning of changing water quality conditions for users downstream; and d) provide information for water quality and water supply planning studies. In addition to DWR and the urban SWP contractors, this information is used by many federal, state, and local agencies, non-governmental organizations, and the public.

This program element is comprised of a) instrumentation installed at key remote locations, b) field operations which ensure proper operation and maintenance of all automated sampling equipment, c) the timely transmission of real-time data, d) the documentation of Standard Operating Procedures, e) the implementation and documentation of QA/QC of the data, and f) Field Unit Office Duties. Field unit office duties encompass all of the components listed above as well as additional office tasks not directly related to real time monitoring. All staff in the field unit work on field office tasks. Task assignments are determined by the Field Unit Supervisor, and the Field Supervisor also spends the majority of his time coordinating and conducting Field Unit Office duties. Field office labor associated with real time monitoring (RTM) includes: ordering RTM supplies, phone consultation with instrument manufacturers, creation of RTM QC sampling runs, creation of instrument specific standards, solutions and reagents, in-office repairs to station peripheral components (pumps, compressors, etc.), cleaning of equipment used on RTM runs, data entry and analysis of RTM QC data, and working on instruments remotely via Remote Desktop and datalogger telemetry programs. Labor charges to Field Unit Office Duties also reflect in-office tasks associated with the discrete monitoring program as well as other office specific tasks required to keep the field unit operational. For example; the discrete monitoring program's requires generation of field run paperwork and sample labels, preparation of sampling containers for field runs, calibration of field monitoring instruments, purchase of discrete field sampling supplies, clean-up of sampling equipment, vehicle related preparations and maintenance, monitoring planning activities, restocking of supplies, etc. The Field Unit may also be asked to handle some of the purchasing and maintenance issues associated with the Field Trailer buildings. In addition the Field Unit routinely holds field office meetings

to coordinate different projects and tasks so that sampling, maintenance and repairs can proceed with as little down time as possible. The one area of office time not charged to Field Unit Office Duties is the time related to special studies. In-office time devoted to special studies is charged to the appropriate special study.

Table 5 summarizes station locations, water quality parameters, and automated analyzer equipment used by the MWQI Real time Monitoring Program. Figure 1 shows the location of real-time monitoring stations.

Currently there are 4 remote real-time stations located throughout the Delta. It is anticipated that in FY 2010-11, the Gianelli feasibility report will be completed by O&M WQ and that construction of the station will begin in the spring of 2011. Final station installation is expected to finish in FY 2011-12.

Deliverables in the FY 2010-11 workplan focused on efficient operation of existing water quality monitoring sites and refining the operation of instrumentation at the Jones Pumping Plant (PP). This workplan continues that goal. Real time organic carbon data is available from all real time stations which fulfills one RTDF-CP objective; to provide organic carbon baseline concentrations and allow visualization of carbon timing and loading for water entering the Delta and the State Water Project. A similar goal has been set for anions, specifically bromide and nutrients. In November 2010, with the installation of a Metrohm anion analyzer at the Jones PP, real-time anion data became available at 3 of the 4 real time stations. Data from this station became available to the public via CDEC in March 2011. The Metrohm is currently operational and will be evaluated to determine if it is a more cost effective alternative to the current Dionex anion analyzers.

Table 6 summarizes the deliverables and timelines associated with real-time monitoring. Note that in FY 2010-11, South Bay Contractors (SBC) indicated a need for a bromide analyzer on the South Bay Aqueduct (SBA) at Vallecitos. The SBC agreed that the first step in the process would be to study the site and alternatives prior to installation of any station. Prior to any feasibility study undertaken by DWR, the Department has asked the South Bay Contractors to justify their need for station expansion. In April 2011, the SBC and the Department will meet to begin this process. It is anticipated that a discussion of the contractor's justification and a decision on whether to move forward with a feasibility report will be made sometime in FY 2011-12. The production of a feasibility report will be predicated on the Department accepting the justification from the SBC that an expansion of the Vallecitos station is required. It is also anticipated that the draft report on long-term trends of organic carbon and bromide

data will be finished in FY 2011-12. Staff will also focus on publishing this data so the results are available to a wider audience.

As mentioned previously in section 3.1, some of the tasks associated with the 2006 Sanitary Survey Update are associated with groups outside of MWQI. In table 6, these tasks are included in this workplan as a guide to their progress but are not related managerially to the MWQI program. These projects are indicated with a (SS) in the column labeled "participants." Unless there is a direct connection to the MWQI program through the BCP positions, accomplishments associated with these projects are as a result of the ongoing efforts of the group outside of MWQI.

Table 5. MWQI Real Time station locations, parameters, and equipment

| Station | MWQI Parameters & Instruments | Non-MWQI Parameters |
|---|---|---|
| Sacramento River at Hood (HOOD) | TOC, DOC (Sievers 900-oxidation) | Water: chlorophyll, EC, DO, pH, temperature and turbidity.<br>Atmospheric: solar radiation, temperature, wind speed and direction. |
| San Joaquin River near Vernalis (VERNALIS) | TOC, DOC (Shimadzu 4110-combustion), bromide, chloride, nitrate, sulfate, fluoride (Dionex DX 800) | Water: chlorophyll, DO, EC, pH, river flow and stage, temperature and turbidity. |
| Delta P.P. Headworks (BANKS) | TOC, DOC (Shimadzu 4110-combustion),, bromide, chloride, nitrate, sulfate, fluoride (Dionex DX 800) | Water: EC, fluorescence, pH, pump discharge, temperature, turbidity, UVA 254.<br>Atmospheric: temperature, wind speed and direction. |
| Jones Pumping Plan (JONES) | TOC, DOC, Shimadzu 4100 – (combustion),<br>bromide, chloride, nitrate, sulfate, fluoride (Metrohm IC 850) | Water: EC, pump discharge, temperature. |
| Gianelli P/G Plant (in process) | TOC, DOC (Sievers 5310), EC, temp, turbidity (YSI 6600) | N/A |

Table 6. Real Time Monitoring Deliverables and Timelines

(Lead organization(s) are shown in bold)

| Deliverable | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Continue operation of automated stations at Hood, Banks, Jones and Vernalis. Identify critical data gaps. | **MWQI** | na | Ongoing |
| **A)** As needed, update SOPs documenting maintenance, operation and quality assurance/quality control of all in-situ equipment.<br><br>**B)** Work towards standardizing, streamlining, and consolidating DWR's in-situ: equipment, data quality control, and data dissemination. | **MWQI/ O&M Water Quality (SS)**<br><br>**B) MWQI O&M Water Quality (SS)** DPLA IEP | July 2008<br><br>July 2008 | **A)** For MWQI, final documents completed. Updates completed on an "as needed" basis.<br><br>**B)** Ongoing-Note that O&M has completed a datalogger upgrade project and MWQI's real-time instruments are unique to the Department. This task requires upper management support to direct water quality instrument uniformity across divisions. |
| As needed, request SLDMWA staff to repair water system and instrumentation at Jones PP. | **MWQI/SLDMWA** | February 2009 | Ongoing . FY 2010-11 no cost extension of current contract expires 12/31/11. Anticipate a 2nd no-cost extension for remaining funds. |
| Installation of real time monitoring instruments at DMC at McCabe Rd. (inlet to O'Neill Forebay). | MWQI | na | Identified by MWQI-TAC as having a low priority compared to Gianelli real-time station. Work on hold pending Gianelli's installation. |
| Gianelli Real-time water quality station.<br><br><u>Evaluation Phase</u> | **O&M Water Quality**/SLFD/ MWQI | | |

| Deliverable | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| **A)** Produce a final report on feasibility of installing a water quality station at Gianelli<br><br><u>Construction Phase</u><br><br>**A)** Site preparation and building installation<br><br>**B)** Installation of water intake line.<br><br>**C)** Station providing data on-line to CDEC and daily MWQI RTDF water quality reports | | **A)** July 2010<br><br>**A)** March 2011<br><br>**B)** Sept. 2011<br><br>**C)** Dec. 2011 | **A)** April 2011<br><br>**A)** August 2011<br><br>**B)** Sept. 2011<br><br>**C)** June 2012 |
| Begin process to determine if expansion of the Vallecitos station on the South Bay Aqueduct is justified.<br><br>If Department feels station expansion is justified, produce a feasibility report on the installation of a real time WQ station at Vallecitos on the South Bay Aqueduct. | **O&M Water Quality**/DFD/ MWQI<br><br>**O&M Water Quality** | April 2011<br><br>August 2011 | July 2011<br><br>June 2012 |
| Evaluate the need, and planning for, other installations per the RTDF-CP (together with RTDF Steering Committee). | **RTDF SC** MWQI TAC | July 2008 | Ongoing |
| Provide readily accessible data and fill in TDS/EC data gaps on pump-in activities. | **O&M WQ (SS)** | July 2008 | Ongoing (TDS data posted on WDL for:<br>Check 13 = KA007089<br>Check 21 = KA017226<br>Check 23 = KA019705<br>Check 29 = KA024454<br>Check 39 = KA029021<br>Semi Tropic 2 = GKA02098<br>Semi Tropic 3 = GKA02070<br>CVC = GKA02380<br>Kern Water Bank Canal = GKA02382<br>Arvin Edison Canal = GKA02773), however see Cindy Garcia for current TDS status and |

| Deliverable | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| | | | sampling frequency by station. |
| Pursue alternative strategies for debris removal at Vernalis station. | **MWQI** | na | Low priority |
| Long term trends of organic carbon and bromide.<br>**A)** Produce DWR report on organic carbon and bromide LT trends<br><br>**B)** Submittal of organic carbon and bromide LT-trends report in peer reviewed journal | **MWQI** | **A)** April 2010<br><br>**B)** March 2011 | **A)** Sept. 2011<br><br>**B)** Dependent on journal revisions. |
| Feasibility study on portable water quality station-see Special study 7.7 | **MWQI** | | |

na = not applicable or available

## 6.2 RTDF-CP-Water Quality Forecasting

Water quality monitoring using in-situ instrumentation provides information on current and past water quality conditions, however, it is of limited value for assessing the water quality effects of future, or proposed, changes in the Delta and SWP. To enable future conditions to be forecasted and analyzed, this work plan element combines the use of monitoring data, with mathematical modeling techniques, to develop water quality forecasting tools. MWQI collaborates with the OCO and the BDO to accomplish forecasting tasks. Objectives of this enhanced effort are to better incorporate Delta modeling needs with water quality monitoring and maximize the use of modeling results by water quality managers.

In December 2009, the RTDF steering committee and MWQI TAC approved a detailed Gantt chart consisting of tasks, critical paths, and estimated timelines. This Gantt chart and its prioritization of tasks represented a significant leap forward toward guiding modeling efforts over the next few years. The full Gantt chart is available in Appendix 2. Timelines result from identifying task interdependencies and the time required to complete various tasks. Although the group strove to identify dependencies and sequences correctly, due to potential competition of staff time for tasks outside MWQI's control, etc actual time durations may still differ from Gantt chart estimates.

In March 2011, MWQI, BDO, and OCO began updating the Gantt chart timeline. It is anticipated that by the beginning of the new FY, a revised Gantt chart will be in place. Tentative forecasting tasks for FY

2011-12 are shown in tables 8 through 11, however these may be subject to revision based on current discussions between RTDF modelers and MWQI TAC committee members. The tasks in this section require numerous steps and do not lend themselves to the task/deadline formats used in other sections of the workplan. Therefore, forecasting tasks were taken directly from the Gantt chart in Appendix 2, however tasks and deadlines could change based on the new Gantt chart updates. The group responsible for task completion is shown in bold after each task item.

During the previous fiscal year, forecasting tasks focused on two of the four main subject areas (Historical Conditions 1990-present and short-term forecasting). In this FY, OCO and MWQI will continue to work on Historical and Short Term forecasts, however both groups may also begin working on tasks associated with Seasonal Forecasts and Planning Studies. As shown in Tables 8 and 9, tasks associated with modeling historical hydraulics, EC and DOC conditions from 1990-present have been completed for both the DSM2 and the Aqueduct models.

The Gantt chart working group focused on four subject areas in the development of improved modeling capabilities. In order of priority these are:

- **Historical Simulations (1990-present)-** This requires collecting, processing and filling in missing flow data, water quality data, and data on project operations, running the simulation, comparing results to field data, and investigating sources of error in the results.

- **Short-term (2 week) forecasts**-Meaningful short-term forecasts require an accurate description of initial water quality throughout the system and higher resolution time series of boundary water quality input.
- **Seasonal forecasts-** Seasonal forecasts extend out up to one year and require establishing boundary water quality conditions and projecting future operations at points along the SWP.
- **Planning studies-** A planning study requires the generation of boundary conditions and project operations under an assumed hydrology, water demands, institutional constraints, and project operation goals.

To produce the Gantt chart and the task list associated with integrating the DSM2 Delta and Aqueduct model, required integration according to the above 4 subject areas. For each subject area, modeling capabilities were further subdivided into hydrology/hydraulics, EC, Br, and DOC components (Table 7).

When creating the Gantt chart, subject areas and subtasks were prioritized to provide at least minimal coverage or capability. The goal was to achieve working coverage under all subject headings, with refinement of coverage coming later. In most cases, priorities focused first on enabling modeling of Delta water quality, then on modeling Aqueduct water quality. With most subject areas, the ultimate goal is to link the Delta and Aqueduct models to enable on demand water quality forecasts for the Contractor's use. Note that as the DSM2 model is improved by upgrades or new calibrations, the most current, vetted, supported version of the model will be used for forecasting purposes.

Table 7. Example of two subject areas and associated subtasks.

Note that a capability may already exist for some subareas.

| Historical, 1990-Present | | | | | | | | Short term (2 week) forecasts | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Delta (DSM2) Component | | | | Aqueduct Component | | | | Delta (DSM2) Component | | | | Aqueduct Component | | | |
| Hydro-logy | EC | Br | DOC | Hydro-logy | EC | Br | DOC | Hydro-logy | EC | Br | DOC | Hydro-logy | EC | Br | DOC |

In FY 2009-10, one goal was to produce weekly DOC forecasts for the Delta and the Aqueduct. However achieving this was dependent on the development of the Sacramento WARMF model by the California Urban Water Authority. Due to State budget shortfalls, funding for the WARMF model was delayed. Resumption of work on the development of the WARMF model began again in 2011. When completed, there is the potential to again address the FY 09-10 goal to produce weekly DOC forecasts for the Delta.

### 6.2.1 RTDF Forecasting Special Study-Delta Salinity Constituent Analysis

In addition to integrating watershed, Delta, and Aqueduct modeling capabilities, a new modeling-related task was approved by the MWQI TAC for FY 2011/12. This task consists of using grab sample data and modeled fingerprints to develop conversions from electrical conductivity to other constituents in Delta waters. These relationships will be included in an official document intended to guide and standardize methods for deriving EC-based estimates of other water quality constituents in Delta waters entering the State Water Project.

The only official document concerning relationships between Delta water quality constituents was published in 1986 by DWR as an interoffice memo. This memo only covered EC, TDS, and chloride and did not take into account Delta mixing patterns when the grab samples were taken. Accounting for

mixing is important because the relationship between any two conservative constituents in a water sample can vary significantly based on the relative proportions of different source waters in the sample.

This study would be conducted over one fiscal year and is divided into 3 phases (see below). Tasks associated with this special study are divided between the BDO and a consultant. This division of labor ensures that timelines associated with BDO's development of the Aqueduct model are not impacted. Of the 3 phases associated with this project, the first phase would be handled by BDO. Phase I consists of data acquisition by BDO from the WDL at key locations in the Delta. Grab sample data would be retrieved for: EC, TDS, sodium, sodium bicarbonate, calcium, magnesium, potassium, bromide, chloride, sulfate, and nitrate. Data acquisition would extend back to 1975, however, the BDO would determine if all historical data was suitable for further regression analysis. Assembled data would then be provided to the consultant to handle regression analyses and report generation. Note that a $4^{th}$ phase has also been identified for future study, but is not included in this workplan. The phases of this special study consist of:

**Phase I: Data acquisition and determination of data use for subsequent analyses.—**This first phase consists of acquiring and assembling WDL grab sample data for the constituents of concern. It also includes BDO determination on the suitability of using all data back to 1975.

**Phase II. Development of regression analysis at discrete monitoring sites without fingerprint information –** Using data assembled by BDO, a consultant would run statistics without fingerprint information. This analysis will show that some locations tend to have a consistent water source (as indicted by good relationships) and some locations have variable water sources (as indicated by poor relationships). As part of this task, consultant would be required to conduct checks on accuracy using one or more of the following techniques.

- Mass Balance (in mg/l): sum of anions & cations approximately equals TDS
- Charge balance (in meq/l): sum of anions approximately equals sum of cations
- Additional check: sum of cations (in meq/l) times 100 approximately equals EC (in uS/cm)

**Phase III: Regression analysis at regional or Delta-wide scale with fingerprint information –** Provide statistical justification for aggregating data at a regional or Delta-wide scale. If statistics suggest a regional aggregation, provide a physical justification for such an aggregation. Fingerprinting would be used to help bin the data for regression analysis. Regression accuracy would be checked using one or more of the techniques outlined in phase II above.

**Phase IV: Regression analysis at regional or Delta-wide scale without fingerprint information –** This phase will require additional exploratory work; therefore, this phase is not proposed to be undertaken as part of the 2011 MWQI special study.

In addition to completing phases II and III, the outside consultant would also be responsible for producing a report which would potentially include:

- Executive Summary
- Purpose
- Data Description
  - Measurement locations in the Delta
  - Data sources
  - General discussion of analyte characteristics
  - Importance of other analytes not evaluated in project – e.g. importance of silica as a TDS component in low-salinity Delta inflows
  - General discussion of measurement techniques, measurement error
  - Influence of hydrodynamics on water quality
  - DSM2 fingerprint data
- Data Analysis
  - Phase 1
  - Phase 2
  - Phase 3
- Recommended Equations
- Next Steps
- Bibliography

Table 12 lists individual tasks and estimated deadlines associated with this special modeling-related work. Note that the tools to quickly generate individual regressions at all discrete locations has already been developed. A preliminary simulation of Delta conditions back to 1975 has also been completed.

Table 8. Deliverables for Simulation of Historical Conditions, 1990 – present

| | Delta (DSM2) Component | Aqueduct Component |
|---|---|---|
| **Hydraulics** | Tasks either completed or not scheduled for this workplan cycle. | Assemble and synthesize data including system operations needed to conduct simulation of Aqueduct hydraulics for 1990 - present **(OCO)** |
| | | Conduct hydraulic simulation of historical Aqueduct hydraulics **(BDO)** |
| | | Assemble historical hydraulic data within Aqueduct system for validation **(OCO)** |
| | | Finalize simulation of historical Aqueduct hydraulics **(BDO)** |
| | | Document simulation of historical Aqueduct hydraulics, including validation **(BDO)** |
| **EC** | Tasks either completed or not scheduled for this workplan cycle. | Assemble and synthesize EC data as needed to define boundary conditions using field EC at Banks and Jones PP (MWQI) |
| | | Assemble measured data within the Aqueduct system for model validation **(MWQI)** |
| | | Produce DSM2 Aqueduct EC simulation for period 1990 to present using field EC at Banks and Jones PP **(BDO)** |
| | | Finalize historical simulation-phase 1 **(BDO)** |
| | | Document phase 1 simulation of historical EC, including validation **(BDO)** |
| | | Simulate Aqueduct EC using DSM2-simulated EC at Jones and Banks PP based on measured Delta boundary conditions **(BDO)** |
| | | Finalize historical simulation-phase 2 **(BDO)** |
| | | Document phase 2 simulation of historical EC, including validation of model **(BDO)** |
| **Bromide** | Assemble measured data at diversions and in-Delta locations **(MWQI)** | Assemble and synthesize bromide data as needed to define boundary condition, including measured or calculated bromide at Jones and Banks PP **(MWQI)** |
| | Calculate historical bromide based on EC simulation **(BDO)** | Assemble measured bromide data within Aqueduct system for validation **(MWQI)** |
| | Document validation of estimating bromide using simulated EC **(BDO)** | Produce DSM2 Aqueduct bromide simulation for period 1990 to present **(BDO)** |
| | Assemble and synthesize bromide data as necessary to define boundary conditions **(MWQI)** | Finalize historical simulation **(BDO)** |
| | | Document simulation of historical bromide, including validation **(BDO)** |
| **DOC** | Assemble DOC data to define boundary condition **(MWQI)** | Assemble and synthesize DOC data as needed to define boundary conditions, Including DOC at Jones and Banks PP **(MWQI)** |
| | Synthesize DOC data as needed to define boundary condition **(MWQI)** | Assemble historical DOC data within Aqueduct system for validation **(MWQI)** |
| | Assemble measured data at diversions and in-Delta locations for model validation **(BDO)** | Develop ability to gather data for near immediate update of aqueduct conditions **(OCO)** |

| | Delta (DSM2) Component | Aqueduct Component |
|---|---|---|
| | Produce first DSM2 Delta DOC simulation for period 1990 to present **(BDO)** | Produce first DSM2 Aqueduct DOC simulation for period 1990 to present **(BDO)** |
| | Finalize historical simulation and document validation of simulation of DOC **(BDO)** | Calibrate model DOC kinetic parameters along the Aqueduct and in reservoirs **(BDO)** |
| | | Finalize historical simulation **(BDO)** |
| | | Document simulation of historical DOC, including validation **(BDO)** |
| | | Simulate Aqueduct DOC using DSM2-simulated DOC at Jones and Banks PP based upon measured Delta boundary DOC **(BDO)** |
| | | Finalize historical simulation **(BDO)** |
| | | Document simulation of historical DOC, including validation **(BDO)** |
| **Tools** | | **Develop tool to enable near immediate update of historical simulation of EC, Bromide, and DOC (BDO)** |

Yellow highlight =s task completed in 10/11
Tasks carried over from 2010-11 workplan to 2011-12 workplan
New tasks for FY 2011-2012

Table 9. Deliverables for Short-Term Forecast of Water Quality Conditions

| | Delta (DSM2) Component | Aqueduct Component |
|---|---|---|
| **Hydraulics** | Phase 3—Develop method of short-term forecast of operations from O&M, USBR sources (**OCO)**—Note that this was scheduled for completion for 11-12 but was completed ahead of schedule in 10-11. | Use study of historical SWP operations to refine assumptions of operations **(OCO)** |
| | | |
| **EC** | Tasks either completed or not scheduled for this workplan cycle. | Develop method to estimate Aqueduct EC boundary conditions including pump-in **(MWQI)** |
| **Bromide** | Develop methods to generate Delta bromide boundary conditions based on EC generated by existing methods**(BDO)** | Develop and test methods to generate Aqueduct boundary bromide conditions other than Banks and Jones PP bromide, including pump-in bromide**(MWQI)** |
| **DOC** | Tasks either completed or not scheduled for this workplan cycle. | Develop methods to generate DOC conditions at other Delta boundaries **(BDO)** |

Table 10. Deliverables for Seasonal Forecasts of Water Quality Conditions

| | Delta (DSM2) Component | Aqueduct Component |
|---|---|---|
| **Hydraulics** | | Use study of historical SWP operations to refine assumptions of operations **(OCO)** |
| | | Develop method for assuming pump-in amounts **(OCO)** |
| **EC** | | Develop method for estimating Aqueduct EC boundary conditions **(MWQI)** |
| | | Develop method for assuming pump-in EC **(MWQI)** |
| **Bromide** | Develop methods to generate Delta bromide boundary conditions based on EC generated by existing methods **(BDO)** | Develop and test methods to generate Aqueduct boundary (Kern River and San Luis) bromide conditions other than Banks and Jones PP bromide **(OCO)** |
| | | Develop method for assuming pump-in bromide **(MWQI)** |
| **DOC** | | |

Yellow highlight =s task completed in 10/11
Tasks carried over from 2010-11 workplan to 2011-12 workplan
New tasks for FY 2011-2012

Table 11. Deliverables for Planning Studies of Water Quality Conditions

| | Delta (DSM2) Component | Aqueduct Component |
|---|---|---|
| **Hydraulics** | | |
| | | |
| **EC** | | Develop method for estimating Aqueduct EC boundary conditions **(MWQI)** |
| | | Develop method for assuming pump-in EC **(MWQI)** |
| **Bromide** | Develop methods to generate Delta bromide boundary conditions based on EC generated by existing methods **(BDO)** | |
| | | |
| **DOC** | | Develop and test methods to generate Aqueduct boundary DOC conditions other than Banks and Jones PP DOC **(MWQI)** |

Table 12. Timelines and Deliverables for RTDF Forecasting Special Study- Delta Salinity Constituent Analysis

| Deliverable | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Phase I<br><br>**A)** Extension of historical DSM2 HYDRO and QUAL simulation back to 1975 | **BDO** | February 15, 2011 | May 2011 |
| **B)** Assemble and organize all analyte and location data from the WDL. Determine if data back to 1975 is suitable for use in regression analysis. | **BDO** | May 2011 | June 2011 |
| Phase II<br><br>**A)** Production of regressions for each constituent at discrete locations using grab samples without simulated fingerprints | **SPC Consultant** | July 2011 | Sept. 2011 |
| Phase III<br>**A)** Production of regressions for each constituent at discrete locations using grab samples with simulated fingerprints | **SPC Consultant** | Oct. 2011. | December 2011. |
| Report generation | **SPC Consultant** | January 2012 | April 2012 |

## 6.3 RTDF-CP-Information Management and Dissemination

This program element includes the information management and data dissemination tasks associated with grab sample and real time data. It involves the synthesis of real time data from a variety of federal, State and local agency water quality monitoring programs, and the rapid data quality control, analysis, and dissemination of results. For the Department, grab sample data, including data collected by MWQI, is stored in the California Water Data Library (WDL) (http://wdl.water.ca.gov/). The website is administered through DWR's Division of Planning and Local Assistance. Real time data from MWQI's real time monitoring stations are stored on a MWQI server and posted on DWR's California Data Exchange Center (CDEC) (http://cdec.water.ca.gov/), and the MWQI web site (http://water.ca.gov/waterquality/drinkingwater/rtdf_rprt.cfm).

Information management and dissemination tasks are associated with mechanisms that allow real time analytical data and modeled forecasting data to be packaged into a user friendly product. Tasks under this program element include: a) continued refinement of the California Water Data Library (i.e. fully accessible historical MWQI data, and repository for current O&M Water Quality and MWQI water quality data), b) database management for delivery of real-time data to users, c) continued development and enhancement of online tools for evaluating and interpreting MWQI water quality data (scientific visualization), d) development of means to distribute daily and weekly water quality reports via the Internet, and e) database development for storage and management of real time data.

Many of the tasks associated with the FY 2010-11 workplan, as well as additional tasks that required resolution during FY 2010-11 have been completed. These include:

- Developed a desktop application for the Santa Clara Valley Water District to continuously monitor and display plots of CDEC sensors on the South Bay Aqueduct.
- Developed and installed procedures to transfer data from the new Metrohm anion analyzer at Jones to the central database on Einstein.
- Developed and installed procedures for transferring digital data captured from OC analyzers to Einstein and CDEC. This included specialized new procedures for ftp transfers through the new wireless modems at Jones and Hood.
- Established procedures for monitoring and reporting the status of the Streamwalker sampling controller alternating between TOC an DOC for the Sievers at Hood.
- Assisted the field unit in testing and setting up wireless modems for providing internet connections at Hood and Jones.
- Completed an initial version of a QA/QC database and related application for managing data and analyzing and displaying results. Imported all data from the Field Unit's spreadsheets. Made the application available for use by staff.

- Developed a field journal system providing the ability to make entries at each of the field computers. Also developed the infrastructure needed to send copies of the entries to Einstein, and a database repository on Einstein. This allows Journal entries created by the application to be transferred routinely to the central database from where it will be linked with both the real-time and QA/QC data.
- Supported BDO modeling efforts with development of a time series interpolation routine for creating model datasets from grab sample data.
- Continued improvements to the MWQI Program Management application, website and database. This application produces the MWQI monthly status report.
- Added new sensors to the database, the RTDF website, and, selectively, to the daily summary table: EC for Victoria Canal; EC and water temperature for the California Aqueduct Check 13; and pumping flows for the Dos Amigos pumping plant

In FY 2010-11, the new real time data station (Jones PP) was added to the CDEC website and incorporated into MWQI's daily/weekly report. As new stations are established (for example the Gianelli, P/G plant), they will also be incorporated into the system. Note that the task involving the use of Aquarius software for the post processing of water quality data was discontinued after further evaluating the software. The software developed in-house was judged adequate for QA/QC and would not involve the radical overall revisions to the database and other applications in use that would be required with the use of Aquarius.

Tasks and deadlines for the data dissemination portion of the RTDF program are shown below in Table 13.

Table 13. Information Management and Data Dissemination Deliverables and Timelines

(Lead organization(s) are shown in bold)

| Task | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Import selected contract lab data into the WDL. | O & M WQ Northern Region Office MWQI Program | July 2008 | For O& M, June 2011. |
| Improve/Upgrade database infrastructure<br>This task includes:<br><br>**A**) Continue to develop, implement and test backup and restoration capabilities for both the server and the SQL Server database. Apply service packs and patches as appropriate.<br><br>**B)** Enhance routine, automated QA/QC processes to the database (takes the place of Aquarius). Note that initial screening tools have been completed. Continued calibration is needed to eliminate questionable data. Also need capability to test and apply to historic data.<br><br>**C)** Continue to develop and enhance the QA/QC database in collaboration with staff.<br><br>**D)** Continue to develop the station journal database and applications, including creation intranet browsing tools.<br><br>**E)** Continue to develop desktop data management tools. Enhance plotting capabilities. Link time series and QA/QC and Station Journal databases. | **MWQI Program** | **A)** January 2009<br><br>**B)** January 2009<br><br>**C)** July 2008<br><br>**D)** January 2010<br><br>**E)** January 2010 | **A)** Ongoing<br><br>**B)** Ongoing<br><br>**C)** Ongoing<br><br>**D)** Ongoing<br><br>**E)** Ongoing |

| Task | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| **F)** Continue to document and maintain infrastructure.<br><br>**G)** Add new sensors to the database as needed | | **F)** July 2009<br><br>**G)** January 2010 | **F)** Ongoing<br><br>**G)** Ongoing |
| Improve Field Data Communications. This task includes:<br><br>**A)** Work to eliminate use of Corsica and transfer its functions to Einstein/Heisenberg.<br><br>B) Continue to develop, test and enhance intranet/ internet components.<br><br>**C)** Develop and implement as feasible procedures, practices and standards for supporting the reliability of field system data systems. | **MWQI Program** | **A)** February 2009<br><br>**B)** January 2011<br><br>**C)** July 2011 | **A)** June 2011<br><br>**B)** Ongoing<br><br>**C)** June 2012 |
| Provide timely access to current QA/QC'd SWP operations data i.e. conduct QA/QC on historical data and remove inconsistencies and gaps. | **OCO**/Office of Reconciliations | na | Ongoing |
| Development and enhancement of MWQI data dissemination products,<br><br>**A)** As needed, add new sensors to the website or daily summary table.<br><br>**B)** As needed, enhance the website presentation.<br><br>**C)** Enhance procedures for emailing the daily summary report. | **MWQI Program** | **A)** na<br><br>**B)** na<br><br>**C)** na | **A)** Ongoing as needed<br><br>**B)** Ongoing as needed<br><br>**C)** Ongoing as needed |

na = not applicable or available

# 7 SCIENCE SUPPORT (SPECIAL STUDIES)

The many natural and anthropogenic processes that affect drinking water quality in the Delta, its tributaries, and the State Water Project remain poorly understood. To further improve DWR's ability to measure and forecast drinking water quality of water delivered to its customers, MWQI engages in special studies that focus on specific aspects of source waters, including contaminant loading, newly emerging contaminants of concern (COCs), and assessing the application of new instrumentation. Results of these studies inform subsequent cycles of the MWQI workplan by improving the RTDF and discrete sampling programs.

At the January 2011 MWQI TAC meeting, the Special Studies subcommittee presented their recommendations of special studies for inclusion in this current workplan. The MWQI TAC agreed with the subcommittee's recommendations and several new special studies have been added, These are: 1) an examination of the relationship between colored dissolved organic matter and measurements of organic carbon using traditional real-time instruments, and 2) expanding and refining relationships between Delta EC and specific ions such as bromide. This second study involves modeling personnel and is discussed in detail in the RTDF-forecasting section of this workplan.

The MWQI-TAC also agreed with the Special Studies subcommittee to extend or modify 2 Special Studies. The MWQI TAC agreed that the Lathrop Urban Runoff study should be extended for a third storm sampling season to allow for the collection of a first flush event and the collection of 2 solid years of stormwater runoff data. The deadlines associated with a Portable Station Feasibility Report have been modified to allow field staff to complete the Gianelli Station as well as accommodate field staff's first priority which is to operate and maintain all real-time stations.

Finally, two studies were either removed from this workplan or will finish in this FY. In the first case, the MWQI TAC agreed to remove the Compendium Special Study from the workplan. The TAC agreed that the compilation of water quality sampling programs throughout the Delta, had already been completed by the Aquatic Sciences Center through a contract with the Central Valley Regional Water Quality Control Board. Secondly, sampling for the Sacramento WARMF model will end in Oct. 2011. This one year special study began in Oct. 2010. Cessation of sampling at all sites (except Shag Slough) was first verified with BDO modelers (Bob Suits, pers. comm. 2/11). Sampling at Shag Slough will continue for another 3-5 years to collect carboneous biological demand data (CBOD). Note that per the FY 10/11 workplan, the only deliverable associated with this special study was data accessible in the WDL.

In addition to new special studies, there are a number of continuing special studies in this workplan. Besides the investigation of stormwater runoff from Lathrop mentioned above, sampling for the NDMA/Cryptosporidium/Giardia began in January 2011 as did sample analysis with the scanning spectrophotometer. The MWQI-TAC agreed to increase the budget of the NDMA/Cryptosporidium/Giardia study to allow genotyping and infectivity analysis. A paper study examination of EC dynamics in the O'Neill forebay was also initiated at the end of the FY 10/11 work-cycle.

Summaries of the different studies within the Special Studies Element are discussed below. Budget requirements for each study are listed in Section 4 of this workplan under Program Funding Needs. When appropriate, more detailed or modified proposals are presented in Appendix 3.

## 7.1 Urban Sources and Loads Investigation—Lead Investigator: Rachel Pisor

This is an ongoing study that began in the FY 2008-09 workplan. The study duration was extended for a third year to allow for 2 full years of stormwater sampling using flow weighted sampling and to ensure that a first flush event was captured. Appendix 3 contains the detailed proposal for the FY 2011-12 workplan, the modified FY 2009-10 proposal and the original FY 2008-2009 proposal for this study.

Urban stormwater is an issue of increasing focus and concern for the SWP drinking water contractors. As urbanization of the Delta and its tributary watersheds continues, the volume of stormwater discharged is expected to increase, potentially causing increased water quality degradation. In February 2008, MWQI published a report that summarized their multi-year study quantifying a significant portion of Delta urban loading to the Sacramento River (http://www.wq.water.ca.gov/docs/mwqi_pubs/Steelhead%20Creek%20rpt%20FINAL.pdf). This current study examines Delta urban loading to the San Joaquin River, by evaluating stormwater discharge from the city of Lathrop. Lathrop, though small (approximate population of 17,000), was a rapidly growing city prior to the recession, with agricultural land being converted for urban uses. Land conversion, from agricultural to urban, will likely continue once the economy and housing market recover. Quantifying Lathrop's current effects on the water quality of the San Joaquin River will provide valuable information on the impacts of similar urban areas and will provide a baseline for further study.

Significant changes to autosampler triggering and sample locations were begun in the FY 2010-11 sampling season. Prior to the 10-11 season, autosamplers were programmed to collect samples at set time intervals. In the 10-11 sampling season, autosamplers were fully wired into the SCADA system. This enabled the SCADA to automatically trigger the autosamplers to start sampling by flow during a storm event.

Analysis of first year and early second year pump data showed that the total stormwater discharge by the City into the San Joaquin River, comprised no more than ~ 2% of the total volume to the San Joaquin River. Therefore, since impacts to river loads would potentially not be detected downstream of the City, and to streamline sampling, several river stations downstream of the City of Lathrop were removed from 10-11 sampling. Stations removed were located at: the San Joaquin River at Lathrop, and at Brandt Bridge. Samples continued to be collected upstream of the City at Mossdale.

The first samples of the 2$^{nd}$ season were collected in November (11/17/10). Due to complications with furloughs and the weather forcasts, the first flush storm event in late Oct. was not captured. The MWQI

TAC, at its January 2011 meeting agreed with the Special Studies subcommittee recommendations that this Special Study should continue for a third year to capture a first flush and also have 2 full years of flow weighted concentration data.

As this study continues into its third year, storm event samples will be taken at one site along the San Joaquin River and in the pumping stations within Lathrop. Constituents monitored include minerals, metals, organic pesticides, pyrethroids, total and dissolved organic carbon, bromide, bacteria, turbidity, total dissolved and suspended solids, $UVA_{254}$, total trihalomethane formation potential and haloacetic acid formation potential. Due to costs, pyrethroid samples will be collected twice a season whereas all other constituents will be collected during each sampling event. Additional samples for metals, nutrients, DOC and TOC will be collected for comparison with autosampler samples. Pyrethroid samples will be sent to Weck Laboratory for analysis and bacteria samples will be sent to FGL Laboratory for analysis through a subcontract with Weck Laboratory. Additionally, replicate samples for total trihalomethane formation potential and haloacetic acid formation potential will be collected and sent to Weck Laboratory for analysis using the standard method (SM 5710B). This data will be used for a comparison study of the 2 methodologies. A baseline GIS analysis will determine current land use patterns. This baseline will be used in future analyses of land use and water quality to correlate changes in land use with changes in water quality. Tasks and deadlines for urban sources and loads study are shown below in Table 14.

Table 14. Urban Investigations Deliverables and Timelines

| Deliverables | Participants | Estimated Start Date | *Estimated Completion Date |
|---|---|---|---|
| Storm event sampling at 11 sites in the Lathrop study area | **MWQI Program MWQI Field Group** | Winter 2009 | July 2012 |
| Analysis of samples as indicated above by DWR | **Bryte Laboratory** | Winter 2009 | August 2012 |
| Analysis of pesticide samples as indicated above through contract with Weck | **FGL Laboratory** | Winter 2009 | August 2012 |
| Analysis of bacteria samples as indicated above through contract with Weck | **Weck Laboratory** | Winter 2009 | August 2012 |
| Final Report | **MWQI Program** | September 2013 | April 2014 |

* Note that based on potential summer storm events, sample completion dates are tentative. The estimated sample completion date of August 2012 includes the possibility of rare summer storm events. Final deadlines will be adjusted based on when actual storm events end in water year 2012.

## 7.2 Nitrosamines, their Precursors and Cryptosporidium /Giardia Occurrence from Waste Water Treatment Plant Facilities in the Delta—Lead Investigator: Joe Christen and MWDSC

This is an ongoing study from the FY 2010-11 workplan. Sampling for this study began in January 2011. Appendix 3 contains the detailed study plan for FY 2011-12 and the original FY 2010-11 studyplan. In January 2011, the MWQI TAC agreed that the study constituents should be expanded to include cryptosporidium infectivity and genotyping.

A joint MWQI/MWD 2year special study of occurrences of N-Nitroso-dimethylamine (NDMA) and nitrosamines and their precursor in the Sacramento-San Joaquin Delta was completed in July 2010. Based on the Special Subcommittee's recommendation, an extension and augmentation of this study was approved by the MWQ TAC. The new, 2 year study, included examining the occurrence of Cryptosporidium and Giardia from WWTP discharges and conducting additional NDMA and precursor monitoring around 2 WWTPS in the Delta. Additionally, the 2 agencies began preparing the results of the earlier NDMA study for publication, however, publication of the first 2 years of results is dependent on freeing up staff time from duties associated with completion of other projects.

Based on 2010 sample reconnaissance, and trials of different riverine sampling designs, sample collection and design has been refined over the previous workplan. As before, sampling efforts will focus on the 2 largest wastewater treatment plant (WWTP) discharges into the Delta--the Sacramento Regional Wastewater Treatment Plant, which discharges disinfected secondary treated effluent immediately below the Freeport Bridge, and the City of Stockton Regional Wastewater Control Facility, which discharges tertiary treated wastewater into the San Joaquin River. Results of the previous 2 year study illustrated that NDMA precursors increase downstream of these WWTPs. Unlike the previous study, this study will collect samples by boat to enable sampling at locations that more appropriately bracket WWTP discharges and better quantify nitrosamines, their precursors and WWTP tracers from discharged effluent. Trend analysis will continue to be examined by collecting samples upstream and downstream of the discharge point. The City of Stockton WWTP has agreed to supply MWQI with their final, treated effluent.

Study design for both the nitrosamine and pathogen portions of the study are still evolving, therefore some of these approaches may be revised, however, currently it is anticipated that sampling frequency for the NDMA portion of the study will, at a minimum, occur quarterly. During late summer/early fall, Delta outflows decrease and WWTP discharges are proportionally a larger percentage of total river flow, therefore quarterly sampling will be timed to capture changing volumetric impacts of WWTP discharges

with seasonal changes in river outflow. If sampling frequency can be increased, nitrosamine sampling would increase to monthly sampling from July through September. Pathogen sampling would be scheduled to occur approximately bimonthly. Additional event sampling would be scheduled to capture the first storm event of the season. It is anticipated that offsite movement of terrestrially deposited pathogens should be at its highest during first flush storm events.

To provide background concentrations and assess possible WWTP impacts, samples will be collected upstream and downstream of the WWTPs. A composite midwater trawl sample will be collected for nitrosamines, their precursors, and some WWTP pharmaceutical tracers. A surface trawl will be collected for pathogens. Composite trawl samples will be collected perpendicular to river flow. Cryptosporidium and Giardia (oo)cysts are expected to occur at, or slightly below, the surface, therefore the composite surface water trawl will be collected no more than 1 meter below the surface. This approach should potentially maximize collection of (oo)cysts with a non-homogeneous distribution. The midwater trawl will be conducted at mid-depth to limit photolysis of NDMA and other nitrosamines,.

Sample collection of WWTP effluent depends on the site. At the Sacramento Regional WWTP, samples will be collected approximately one foot from the substrate, adjacent to the downstream face of the diffuser pipe, using an intake-pump to pump the water from depth. EC readings from a probe attached at the sampling system intake will be used as a signal for the presence of the effluent plume. The Stockton Municipal Utilities District has agreed to provide final effluent for all constituents; therefore boat sampling at the WWTP outfall in the San Joaquin River will not be conducted. Study design is detailed in appendix 3.

For this study, MWQI and MWD will continue a cost sharing agreement, with MWQI providing sample collection via boat and MWD analyzing samples for nitrosamines, their precursors, and WWTP pharmaceutical tracers. Sample analyses for Cryptosporidium and Giardia will be conducted by BioVir, a contracted outside laboratory. Additionally, American Water of New Jersey will be contracted to perform genotyping and infectivity analyses for Cryptosporidium. A tentative outline of sampling frequency, etc. is provided below in Table 15. Table 16 outlines deliverables and timelines.

Table 15. Sample design and sample frequency for nitrosamines, their precursors and protozoan pathogens.

| **Sampling information** | **Sacramento River** | | **San Joaquin River** | |
|---|---|---|---|---|
| | **Nitrosamines, precursors and WWTP tracers** | **Pathogens** | **Nitrosamines, precursors and WWTP tracers** | **Pathogens** |
| Sampling frequency | At least quarterly | Bimonthly | At least quarterly | Bimonthly |
| Upstream of WWTP | One composite, midwater trawl | One composite, sub surface trawl, 1 meter below surface | One composite midwater trawl | One composite, sub surface trawl, 1 meter below surface |
| At WWTP | One sample of the effluent plume collected by submerged intake.<br><br>Effluent sample provided by WWTP may be substituted for diffuser sample. | One sample of the effluent plume collected by submerged intake line | Effluent sample provided | Effluent sample provided |
| Downstream of WWTP | One composite midwater trawl sample | One composite, sub surface trawl, 1 meter below surface | One composite midwater trawl sample | One composite, sub surface trawl, 1 meter below surface |

Table 16. NDMA/Crypto/Giardia Deliverables and Timelines

| Deliverables | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Final Report (2008-2010 NDMA study) (note due to time constraints, a journal article may be substituted for final report). | MWQI staff<br>MWDSC staff | August 2010 | December 2011 |
| Paper for Publication (2008-2010 NDMA study) (note due to time constraints, this may be substituted for final report). | MWQI staff<br>MWDSC staff | January 2012 | Submit March 2012 |
| Quarterly and monthly sampling at up to 9 sites in the Sacramento-San Joaquin Delta | MWQI staff<br>MWQI Field Group | January 2011 | January 2013 |
| Analysis of samples | Bryte Laboratory<br>MWDSC Laboratory<br>BioVir Laboratory<br>American Water | January 2011 | February 2013 |
| Final Report (s)<br>Nitrosamine and Pathogen studies will have separate reports. | MWQI staff<br>MWDSC staff | February 2013 | July 2013 |
| Paper(s) for Publication<br>Nitrosamine and Pathogen studies will have separate papers. (note this may be substituted for final report). | MWQI staff<br>MWDSC staff | August 2013 | Submit Nov. 2013 |

## 7.3 Investigation of O'Neill Forebay water circulation--Lead Investigator: Jason Moore/Ted Swift

This study replaces an ongoing study of the same title begun in the FY 2008-09 workplan. Although forebay circulation patterns are of interest, one key question this study will focus on is the extent of mixing between forebay water and water discharged into the forebay from the Delta Mendota Canal (DMC). Photographic evidence, provided by the San Luis Field Division, suggests that, at times, water discharged from the DMC may hug the forebay shoreline, flowing directly downstream to Check 13 and short circuit mixing in the forebay.

To examine this question, this study has adopted a phased approach. The first phase uses available historical data to analyze forebay mixing using EC readings at input and output locations to the Forebay. Depending on the outcome of the first phase, second and third phases may include direct measurements of short-circuiting via a boat in the forebay, or examining real-time data using EC sensors at the Gianelli water quality station. Although a rough sample design for phase 2 is provided below, a consultant may be hired to help direct the sampling design of the second phase.

**Phase 1**

The first phase of the study uses available historical data to begin to address the question of DMC short circuiting in the forebay. EC data will be analyzed to find any patterns and correlations between the Banks PP, the Jones PP, the O'Neill Intake EC station (this Central Valley Project (CVP) station is located on the DMC, downstream of the O'Neill pumping/generating facility) and SWP Check 13. Operations data from the O'Neill pumping/generating facility are available since 2004. This data indicates whether the plant was pumping, generating or idle on any given day.

To examine the concept of short-circuiting, historical EC data from the Jones PP will be compared to the EC of SWP water entering the forebay from Banks PP. A mass balance will be calculated to determine the contribution of these 2 end members to the EC of water leaving the forebay at SWP Check 13 and of water passing O'Neill Intake EC Station. If there is a large difference in EC between CVP and SWP waters, then these differences could be reflected proportionally in the EC observed at SWP Check 13 and O'Neill Intake EC Station. For example, if, source water from the CVP, proportionally, have a greater influence on EC at SWP Check 13 than SWP water, then this may indicate that CVP water is hugging the shoreline of the forebay and being transferred preferentially into the aqueduct at check 13 (i.e. bypassing or short-circuiting thorough mixing in the forebay). Conversely, on the days when O'Neill

pumping/generating facility is generating, if SWP water is shown to have the greatest influence on EC at the O'Neill Intake EC Station, then it would indicate that thorough mixing is not occurring in the forebay and SWP water is being routed directly to the CVP.

It is important to note that the phase I study cannot definitively answer the question of whether short-circuiting is occurring in the forebay. In order to do this, EC from San Luis reservoir, the third input to the system is needed. Flow data is available for the P/G plant, but not EC. Using a simple mass balance approach, EC differences noted at SWP check 13 could be assigned to EC contributions from the reservoir. Therefore, if noticeable changes in EC are observed at SWP check 13, they cannot be definitively traced to one of the known end members to the forebay. To solidly confirm circulation dynamics in the forebay, a repeat of this study would required once MWQI's real time station is on-line (see phase 3 below) and/or confirmation of circulation patterns conducted via a boat study (see phase 2 below).

**Phase 2**

Phase 2 is directed towards the validating phase 1 results using actual measurements in the forebay. In keeping with the phased approach, following the completion of phase 1, MWQI staff and TAC members will reconvene to determine if the results of the paper study answer the question of short-circuiting and whether further studies are necessary. Some questions to be answered include, if short-circuiting occurs, would its time-step affect the accuracy of current models, and based on the paper results, should real world verification be included? If the TAC agrees that real world validation of phase 1 results are necessary, then funding for specialized consultants may be required to examine the best approach to validate O'Neill Forebay hydrodynamics

One approach might include conducting transects in the Forebay using a boat and two GPS linked YSI sonde units with EC probes. A GIS interface would be used to provide a graphical representation of the sources and patterns of water throughout the Forebay. Sharp changes in EC during certain operations would confirm the short-circuiting effect. A study plan would be created detailing sampling design, but potentially boat transects would occur monthly for 12 months. In addition, EC sensors like those used for the Gianelli PP feasibility study, would potentially be installed at the former Check 12 water quality station, on the DMC between Jones and the O'Neill P/G plant and the stretch between the O'Neill P/G plant and the junction with the DMC. Because of the numerous discharges into the DMC between the Jones PP and the O'Neill P/G plant, these sensors would provide more accurate EC data than EC data

from Jones or the O'Neill EC station, while the EC sensor at check 12 would eliminate time delay calculation of EC between Banks and when the water enters O'Neill. If possible, EC sensors would be reused from the Gianelli Feasibility Study. This study would require funding for boat time and a boat operator and would be dependent on DWR O&M allowing a boat in off-limit areas of the forebay. If this approach was a viable option, MWQI would summarize the dollar amounts involved and discuss with the MWQI-TAC the feasibility of using funding for this project.

**Phase 3**

The third phase of this study would be dependent on the placement of a real-time EC sensor in the new Gianelli real-time station and an evaluation of whether data from sensors placed at Gianelli would provide the information required to examine short-circuiting. If the historical data analysis indicated short-circuiting, then, once the Gianelli P/G real-time station was operational, at a minimum, one year of real time EC data would be analyzed from the Gianelli P/G real-time station, Banks PP, the Jones PP, O'Neill EC station and SWP Check 13. Data would be analyzed in a manner similar to the phase 1 historical data analysis. Results of the first phase of this study would help inform the chances of success of this approach. Tasks and deadlines for this circulation study are shown below in Table 17.

Table 17. O'Neill Forebay Circulation Deliverables and Timelines

| Deliverables | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Phase 1<br><br>Analyze historical EC patterns at Banks PP, Delta Mendota Canal station, O'Neill Intake, and SWP Check 13. Complete paper study report of short circuiting. | **MWQI Program** | March 2011 | May 2011 |
| Hold briefings with MWQI TAC and MWQI to determine next phase of study. Hiring of independent contractor may be necessary to help guide next phase of study. | **MWQI Program/MWQI TAC** | June 2011 | July 2011 |
| Phase 2<br><br>Depending on outcome of briefings, investigate feasibility of sonde study of the O'Neill Forebay and develop study and safety plans. | **MWQI Program** | Start date dependent on outcome of meetings between staff and TAC. | |
| Depending on outcome of briefings, conduct boat transect sonde study of the O'Neill Forebay | **MWQI Program** | Start date dependent on receiving OK of safety plan by SLFD, ~ August or September 2011 | Approximately 1 year after the acceptance of the safety plan. |
| Phase 3<br><br>Monitor and analyze real-time data from Gianelli P/G, Banks PP, Jones PP and Check 13 | **MWQI Program** | Start date dependent on installation of EC meter at Gianelli P/G Plant | Completion date dependent on installation of EC meters at Gianelli Pumping Plant, however, after 1 year of data collection, determine if a report on new findings is warranted, or if previous studies have quantified this issue sufficiently. |

na = not applicable or available

## 7.4 In-situ FDOM Proof of Concept-Lead Investigators: Joe Christen/Arin Conner.

This is a new special study for the 2011-12 Workplan.

Dissolved organic carbon (DOC) remains a constituent of concern to water treatment plant operators. In addition to its role as a DBP precursor, the concentration of organic matter determines the amount of chemicals used in the water treatment process. To help water treatment operators, and provide data for modeling and forecasting, MWQI currently uses laboratory instruments, situated in remote locations, to measure organic carbon in real time. These instruments, however, are labor intensive and costly to maintain. Therefore it could be cost effective to identify an inexpensive instrument that is easy to maintain and can indirectly measure DOC concentrations. This could aid studies of DOC concentrations in the environment and enhance monitoring of DOC concentrations in remote source waters.

Fluorometers have the potential to be an inexpensive and reliable surrogate measure for DOC. In-situ fluorometers have been used to vertically profile DOC in a reservoir, measure tidal changes of DOC on a Delta Island, and to profile storm flow DOC concentrations in a stream in Yolo County.

This study will evaluate the application of fluorometer measurements for dissolved organic matter as an indirect measure of dissolved organic carbon (FDOM). A Turner Designs Cyclops-7 fluorometer, tuned to a custom FDOM excitation/emission pair of 350nm/450nm, will be installed in the MWQI Banks Pumping Plant water quality monitoring station for one year. The fluorescence data collected will be compared to the MWQI Shimadzu's DOC data and to grab samples. A correlation between FDOM and DOC will be compared to the UVA and DOC relationship. Initial results will be made available six months into the study and a final report will be produced after one year of data collection. Tasks and deadlines are shown below in Table 18.

Table 18. FDOM Deliverables and Timelines

| Deliverables | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Fluorometer installation | **MWQI** | June 2011 | July 2011 |
| Mid-study Progress Report | **MWQI** | November 2011 | December 2011 |
| Final Report | **MWQI** | July 2012 | October 2012 |

## 7.5 Spectrofluorometer Study—Lead Investigator: Ted Swift

This is an ongoing study that began in the FY 2009-10 workplan. This research was identified as an area of expertise needed by the MWQI Program. The full proposal is given in Appendix 3.

In the Sacramento-San Joaquin River Delta, sources of dissolved and particulate natural organic matter (NOM) include tributary river flows from distinct watersheds, algae, submerged vegetation growth and decay, and organic-rich peat soils. NOM concentrations and characteristics in source waters, ultimately bound for municipal drinking water use, is of great interest to water contractors and water treatment operators because of the disinfection byproducts (DBPs) resulting from water treatment.

In 2007, the DWR QA/QC group acquired a high-performance FluoroMax 4 spectrofluorometer. One purpose was to investigate the usefulness of spectrofluorometric analysis of Delta and Delta source waters. An extensive and growing body of literature strongly suggest that this approach may provide a rapid method for accurately quantifying multiple constituents of concern (COCs), such as DBP precursors in a single measurement.

This study evaluates the utility of spectrofluorometry as a method of rapidly quantifying COCs such as DOC, algae, and organic nitrogen as a source of DBP precursors. This study also seeks to identify distinctive characteristics of Delta source waters to provide "fingerprints" that could be used to validate Delta water quality models. It will examine the feasibility of configuring a spectrofluorometer instrument to operate unattended in a real-time monitoring setting. A more detailed description appears in Appendix 3.

To capture a wide range of water quality conditions and source water types, while minimizing staff labor and travel costs, samples for analysis are being collected in parallel with other existing field sampling programs and also supplemented with specific sampling and lab-prepared samples with known contents. UV254 absorbance is also being measured photometrically and subsamples are also being analyzed by Bryte Laboratory for TOC, DOC and nutrients. Subsamples are being sent to Weck Laboratories for trihalomethane and haloacetic acid formation potential (THMFP and HAAFP, respectively). Both whole and filtered fractions of water samples are being analyzed spectrofluorometerically to distinguish dissolved sources from particulate sources such as algae. Subsamples from the NDMA special study are being analyzed spectrofluorometerically to examine fluorescence features that correlate with nitrosamine

formation potential and potential organic nitrogen precursors (to date, nitrosamines, themselves, have not been found in detectable concentrations in field samples).

Results from this study will be compared to laboratory analyses of COCs to identify distinctive features in the excitation emission matrix that are highly correlated with characteristics such as DOC and TOC concentration, THMFP, UV254 absorbance, algal biomass, and organic nitrogen species. Analytical tools will include multiple regression, parallel factor analysis, and principle component analysis. Once the methods are well characterized, its efficacy as part of the routine monitoring will be presented to the TAC with recommendations. Tasks and deadlines for the spectrofluorometer study are shown below in Table 19.

Table 19. Spectrofluorometer Deliverables and Timelines

| Deliverables | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Approximately monthly sampling at sites in the Delta study area | **MWQI Staff**<br>**MWQI Field Unit** | Sept. 2010 | Dec. 2012 |
| Spectrofluometric analysis of raw and filtered water samples | **MWQI Staff** | Sept. 2010 | Dec. 2012 |
| Laboratory analysis of samples | **Bryte Laboratory**<br>**MWD Laboratory**<br>**Weck Laboratory** | Sept. 2010 | Dec. 2012 |
| Interim report | **MWQI Staff** | Nov. 2011 | Feb. 2012 |
| Final Report | **MWQI Staff** | Feb. 2013 | June 2013 |

## 7.6 Monitoring of the Upstream Sacramento River and Eastside Streams for the Systech WARMF models-Lead Investigator: Joe Christen

This Sacramento WARMF special study was approved by the MWQI TAC for inclusion in the FY 10-11 workplan and will be completed in October 2011. This will conclude 1 year of monthly sampling, 1 year of weekly sampling at the Colusa Basin Drain during the rice drainage season, and collection of stormwater samples during storm events. Per BDO, Department modelers only required one year of monitoring, with the final product being access to the data in the Water Data Library. Due to its importance as potential Delta Smelt habitat, monthly samples will continue to be collected at Shag Slough. Note that cessation of this study was first checked with BDO modelers before deciding on the end date.

During FY 10-11, the Eastside stream sampling was approved and added to MWQI's duties, however, due to the workplan production cycle, it was not included in the FY 2010-11 workplan. Sample locations for this monitoring effort and the continuation of Yolo Bypass data is shown below.

- Mokelumne River at Wimpy's Marina
- Calaveras River near the University of the Pacific
- Shag Slough at Liberty Island Bridge

The Mokelumne River station lies below the confluence with the Cosumnes Rivers and is thus representative of both rivers. The Calaveras River station has been moved approximately 1.6 river miles upstream of its original location for better accessibility; there are no major inputs between the locations. Shag Slough is representative of the Yolo Bypass. The Yolo Bypass is outside the domains of the WARMF models, however, the location is of interest as a modeled boundary in DSM2 simulations.

Sampling at the East Side Streams and Yolo Bypass is scheduled to continue monthly for three years. Additionally storm event samples will be taken during peaks in runoff flow. Similar to the Sacramento WARMF deliverables, modelers only need access to the monitoring data on CDEC. No written report is required. Tasks and approximate deadlines are shown below in Table 20.

Table 20. WARMF Model Monitoring Deliverables and Timelines

| Deliverables | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Conduct monthly monitoring and up to 4 stormwater sampling events in the Upstream Sacramento | **MWQI, Northern District** | August 2010 | October 2011 |
| Provide upstream Sacramento River data to BDO | **MWQI** | November 2011 | November 2011 |
| Conduct monthly monitoring and stormwater sampling in the East Side Streams and Yolo Bypass | **MWQI** | August 2010 | September 2013 |
| Provide ESS and Yolo Bypass data to BDO | **MWQI** | November 2013 | November 2013 |

## 7.7 Feasibility Study for Portable Water Quality Monitoring Station—Lead Investigator: Arin Conner

This is an ongoing study from the FY 10-11 workplan.

At the January 2011 MWQI TAC meeting, the TAC agreed that the timelines associated with this study needed to be flexible to accommodate the rapid and unexpected changes in priorities associated with field work. Therefore, it was agreed that the field staff person assigned to this special study would work on this special study as time allowed from other field duties. During 2010-11, focus of staff assigned to this study, was diverted to providing design specifications for the Gianelli permanent station, conducting the Gianelli field study, and other field monitoring duties. While construction and initial installation of the Gianelli station in FY 2011-12 will continue to be the highest priority, it is anticipated that a station will be fully established at Gianelli by late 2011. It is anticipated that staff time would then become more available as Gianelli duties became more routine. Since some of the design specifications used on Gianelli could be used for a portable station, it is anticipated that staff can use the lessons learned from Gianelli, in conjunction with new research specific to a portable station, to produce a final report at the end of the 11-12 FY. However, deadlines associated with this special study need flexibility to accommodate field staff's primary responsibilities associated with real-time station operation and maintenance. The write-up from the 2010-11 workplan is provided below. New estimated timelines for this study are provided in Table 21.

Permanent water quality monitoring station are not always needed, or cost effective. Using a self-contained, portable monitoring station could allow for the collection of real-time water quality data without committing to construction costs normally associated with a permanent facility. Moreover, a portable station could potentially be used as a semi-permanent installation with the addition of security devices and some simple preparations. Such a station could also be used in an emergency response situation (similar to the Jones Tract levee breach) in which water quality data can be gathered and distributed even before pump-out begins. It is also anticipated that a portable station would be more cost and labor efficient to build because it could be constructed at the Bryte field office rather than at a remote location and because material costs should be lower.

This study will investigate the design and costs of constructing a portable water quality station. It is anticipated that the portable station would use analyzers and pumps that have a low power draw, and would use batteries, solar panels, and a small generator for power while data is transferred through a

cellular connection to eliminate any hardwires. The HVAC, main pump, and other support systems would be on a direct current (DC) system to reduce power loss through conversion to alternating currents (AC). Organic carbon concentrations would be gathered using an oxidation-based analyzer (such as Sievers) and physical data (EC, DO, pH, temp., turbidity.) would be determined by a sonde unit (such as YSI) in a flow-through chamber. Depending upon the performance of the power system and the specification of the analyzer, an anion analyzer or at least a bromide probe can also be added. A simple tank built into the bypass stream of the pump can indicate the presence of mussels. All of these instruments would be housed inside a small cargo trailer that can be towed on site and secured. The intake apparatus would be customized to the site/application, and the QA/QC procedures and maintenance would be similar to the current MWQI real-time monitoring stations.

This phase of this study would consist of an investigation and report on the feasibility construction of a portable station. Actual construction of a portable station would be dependent on MWQI TAC approval.

Table 21. Monitoring Upstream Sacramento River Deliverables and Timelines

| Deliverables | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Feasibility and cost analysis report on portable station construction. | **MWQI** | Late Fall 2011 (Depends upon MWQI Field Unit schedule) | Early Spring 2012 (Depends upon MWQI Field Unit schedule) |

## 7.8 MWQI Program Summary Report—Lead Investigator: Sonia Miller

This is an ongoing special study from the FY 10-11 workplan.

The bulk of this report has been completed in draft form, however there is the potential that edits and comments from outside reviewers may extend report completion into FY 2011-12.

As discussed in the FY 2010-11 workplan, the year 2010 will mark the 20-year anniversary for the MWQI program. By 2012, DWR will have been conducting studies of Delta drinking water quality for 30 years. This special study is developing a document summarizing the accomplishments of the MWQI program (and DWR efforts pre-dating the MWQI program) over the last 30 years. This report could provide an introductory resource for new MWQI and water agency staff, provide water agency managers with justification for continued program funding, and potentially provide a clear context for future program workplans. The report could include, but would not necessarily be limited to the following key elements:

1. History of the program, including the evolution of program goals and objectives
2. Data
    a. Data collection network – grab samples and continuous stations
    b. Large historical database
    c. Key findings from data
        i. Long term trends analysis
        ii. Delta Island Drainage Investigations
        iii. Etc.
3. Special Studies – summarize findings from key special studies
4. Model Development – summarize key accomplishments and status
5. RTDF Program – describe formation, goals and status

    Bibliography – all program reports and publications

Tasks and deadlines for a MWQI summary report are shown below in Table 22.

Table 22. MWQI Program Summary Report Deliverables and Timelines

| Deliverables | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Convert all MWQI reports to pdf, | **MWQI,** | June 2010 | Completed |
| Compile bibliography and begin outline of program accomplishments and key findings. | **MWQI** | August 2010 | Completed |
| Prepare draft report and send out for comments. | **MWQI** | September 2010 | Completed |
| Prepare final report | **MWQI** | March 2011 | Depending on the extent of reviewer comments, between June 2011 and September 2011. |

## 7.9 Tidal Marsh Restoration Literature Review—Lead Investigator: Sonia Miller

This is an ongoing special study from the FY 10-11 workplan.

The exact start date of this study is dependent on completion of a draft MWQI Summary Report. Completion of the draft summary report will allow staff resources to then be directed towards this special study. For this special study, workplan products were deliberately left vague. This was to allow for discussion and development of studies suggested by the literature review. In early 2011, MWQI management and interested contractors will meet to begin to brainstorming the scope of the literature review and potential future research. It is anticipated that when the literature review is complete, that this group will again meet and begin determining the final products that will emerge from this particular workplan special study. The summary of this special study that appeared in the FY 2010-11 workplan is reproduced below.

Currently state, federal, and local agencies are interested in adding thousands of acres of tidal marsh to the Sacramento – San Joaquin Delta. Several examples include the most recent draft of the Bay Delta Conservation Plan (BDCP) which proposes creation or restoration of 65,000 acres of tidal wetland in the Delta, including the Suisun Marsh. The recent Delta Smelt Biological Opinion also calls for the restoration of 8,000 acres of intertidal and subtidal wetlands.

One negative impact from wetland restoration is the production of dissolved organic carbon (DOC) which at high concentrations can cause disinfection by products (DBPs) during the chlorination process of water treatment. DBPs are carcinogenic, highly regulated, and can lead to increased scrutiny and regulation of water treatment plant operations. The purpose of this study would be to review, compile, and summarize existing research on the impact of tidal wetlands in the Delta and better quantify production rates and seasonality of tidal marsh DOC. A few important components of the study are outlined below.

- Literature review and follow up of existing USGS research on DOC production in the Delta.
- Determine what areas of the Delta are likely to be restored first and would allow for a good study area.
- Provide recommendations on restoration activities that could affect drinking water quality and suggestions for future study.

This literature search and its recommendations would serve as a foundation for future studies, if necessary, for future workplans. Tasks and deadlines for the tidal marsh restoration literature review are

shown below in Table 23. Specific tasks and deadlines will be delineated as staff finish once staff have finished tasks associated with the MWQI summary report special study.

Table 23. Tidal Marsh Restoration Literature Review Deliverables and Timelines

| **Deliverables** | **Participants** | **Estimated Start Date** | **Estimated Completion Date** |
|---|---|---|---|
| Gather literature for all Tidal Marsh/DBP production journal articles. | **MWQI,** | TBD | TBD |

## 7.10 2006-2010 State Water Project Sanitary Survey Update—Lead Investigator: Carol DiGiorgio

This is an ongoing special study from the FY 10/11 workplan.

The contract for this work was signed in December 2010 between MWQI and Archibald Consulting. Archibald Consulting and their subcontractors will produce the Sanitary Survey Update report with MWQI serving as the contract manager and point person for activities associated with the report. The consultant provided a detailed task list and timeline which was approved by the Sanitary Survey Subcommittee and DPH (these groups also serve as the reviewers of the Sanitary Survey). Archibald Consulting and subcontractors began work on this project in December 2010. The deadline for final publication and submittal to DPH is June 2012. All funds for this $300,000 contract were encumbered in FY 2010-11, therefore while expenditures for this item will be tracked in FY 2011-12, this study will not impact the FY 2011-12 MWQI budget.

In addition to the Update, an Action Plan, similar to the one that was developed for the previous Sanitary Survey Update will also be created. This will help guide future work of MWQI and the SWPCA. The July 2012 face to face meeting between the SWPCA, MWQI and Archibald Consulting will be used as one of the forums to formalize the development of an Action Plan. The Action plan will be finalized in September 2012. The summary of this special study that appeared in the FY 10/11 workplan is reproduced below.

Sanitary Surveys are a federally mandated program which survey surface water and ground water under the direct influence of surface water drinking water systems to evaluate: 1) the capability of a drinking water system to consistently and reliably deliver an adequate quality and quantity of safe drinking water to the consumer, and 2) the system's compliance with federal drinking water regulations (EPA, 1999). Sanitary surveys provide a comprehensive inspection of an entire water delivery system and its operation and maintenance. The surveys determine whether a system's source, facilities, equipment, operation, maintenance, and management are effective in producing safe drinking water. Sanitary surveys also evaluate a system's compliance with federal drinking water regulations, as well as state regulations. Additionally, it evaluates water quality data, administrative issues and draws conclusion about the system's integrity and its capability to consistently and reliably deliver and adequate supply of safe drinking water.

Although the Department does not provide finished drinking water directly to consumers, as the supplier of drinking water for approximately 25 million Californians, an assessment of the Department's State Water Project and the watershed that provides project water is an important element for indentifying and preventing contamination of drinking water supplies and ensuring that the quality and delivery of surface water delivered to utilities and wholesalers is maintained. The completed survey will be used by MWQI drinking water agencies to meet their regulatory requirements for a Sanitary Survey of their SWP source waters. In California the California, Department of Public Health oversees the State's sanitary survey program. By law, non-community water systems and community water systems with outstanding performance based on prior sanitary surveys must be surveyed every 5 years.

Because of the size of the undertaking, the MWQI TAC agreed that the 2006-2010 Sanitary Survey (SS) Update would be contracted out to a consultant. MWQI will serve as the project lead in securing a consultant and overseeing the consultant's progress. All contracting and consulting costs will be paid through DWR's MWQI baseline funding.

Tasks and deadlines for the SS update are shown below in Table 24. Specific tasks and deadlines will be further delineated as timelines are defined by the Sanitary Survey Subcommittee.

Table 24. Sanitary Survey Update Deliverables and Timelines. (Note that all tasks up to the actual completion of the Report were completed in FY 2010-11).

| Deliverables | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Determine SS update topics drinking water contractors want in the update | **MWQI/Sanitary Survey Subcommittee** | February 2010 | Completed |
| Meet with DPH to propose contractor topics and determine topics DPH wants investigated in update. | **MWQI/Sanitary Survey Subcommittee/CADPH** | March 2010 | Completed |
| Sanitary Survey Subcommittee determine format for RFP or RFQ | **MWQI/Sanitary Survey Subcommittee** | April 2010 | Completed |
| Prepare RFP or RFQ | **MWQI**/Sanitary Survey Subcommittee | April/May 2010 | Completed |
| Send out RFP or RFQ | **MWQI**/Sanitary Survey Subcommittee | July 2010 | Completed |
| Selection process | **MWQI**/Sanitary Survey Subcommittee | August 2010 | Completed |
| Contract negotiation (if RFQ) and contract initiation | **MWQI/Sanitary Survey Subcommittee** | October 2010 | Completed |
| Consultant prepares SS update | **Archibald Consulting/MWQI/Sanitary Survey Subcommittee** | December 2010 | June 2012 |
| Consultant submits publication to CDPH | **Archibald Consulting/MWQI/Sanitary Survey Subcommittee** | na | June 2012 |
| Preparation of Action Plan Items | **Archibald Consulting/MWQI/Sanitary Survey Subcommittee/All interested SWC** | Spring 2011 | July 2012 |
| Finalization of Action Plan | **Archibald Consulting/** | July 2012 | September 2012 |

# 8 EMERGENCY RESPONSE ACTIVITIES

Although a component of the RTDF-CP, this element is broken out separately because its scope goes beyond the program and includes tasks identified in the 2006 Sanitary Survey Update. The goals of this element are to: 1) develop and encourage policies to define the role of drinking water quality in DWR's Emergency Response (ER) actions; 2) incorporate drinking water quality components, (including monitoring and involving the MWQI Program), into DWR's established ER plans; and 3) improve dissemination of drinking water quality information between DWR and other stakeholders (i.e. State Water Project contractors, Department of Public Health, State and Regional Water Boards, Office of Spill Prevention Response, etc.) during emergency events (Sanitary Survey Action Item). One of the key preliminary staff draft findings from the Delta Stewardship Council's draft Delta Plan pointed out that "There is no comprehensive state or regional emergency response plan for the Delta." If these findings become final, there is the potential that MWQI may become more involved with the Department's Emergency Response activities to develop a true comprehensive emergency response plan.

Currently MWQI has fulfilled the tasks originally set-forth in the FY 2008-09 workplan. An internal document has been prepared that assesses the effectiveness of DWR's Emergency Response plans in addressing drinking water quality protection during emergency events. MWQI staff have performed a review of the Department's existing emergency response documents to: 1) identify how drinking water quality is addressed by the Department during an emergency; 2) make recommendations as to how drinking water quality can better be addressed within the Department during emergency events; and 3) make recommendations for more effective lines of communication between the Department's emergency response managers, drinking water quality experts, and affected stakeholders during emergency events.

The first draft of the emergency response document was returned to MWQI staff from upper DES management in November 2009. New information warranted an investigation into the role of SWRCB during emergencies. Investigations showed that the Regional Board, not DWR, is the primary agency responsible for water quality sampling during an emergency. However, the boards have the discretion to ask other agencies for monitoring help. In late 2010, MWQI met with the Central Valley Regional Water Quality Control Board Emergency Response coordinators to gain a better understanding of their role in emergency response.

The second draft of the emergency response document was prepared in early 2010 and was resubmitted for internal review in March 2010. MWQI received DES upper management comments in late 2010.

Edits were returned for final DES upper management approval in early 2011. It is anticipated that following upper management approval, this document will be resubmitted to affected divisions within the Department for final approval. Once this document completes the second round of internal editing/approval process, an implementation strategy has been established for moving the ideas in this document forward for consideration by Departmental executive management. MWQI staff have also created 4 stocked emergency kits for gathering drinking water quality data during an emergency. A manual of how to use the kits was completed in the FY 2008-09. In March of 2010 a training demonstration for MWQI staff illustrated the use of these kits. The O&M WQ section have reviewed the SWP emergency response plans (Red Binders) and with the assistance of Bryte Lab have also developed emergency response kits to be kept in water technician vehicles from each field division. O&M WQ staff will provide onsite training on the use of these kits.

Many of the recommendations presented in the MWQI document cannot move forward without approval from DWR upper management to direct the Department's Emergency Management Committee (EMC) to implement these recommendations. Therefore, until there is approval from DWR upper management, ongoing efforts under this element will include: emergency response meeting attendance, restocking of drinking water quality ER kits, providing emergency assistance for drinking water quality monitoring as requested by emergency responders and assisting the Department's EMC as needed in the development of a Department Drinking Water Quality Emergency Response Plan. Tasks and deadlines for Emergency Response are shown below in Table 25.

Table 25. Emergency Response Deliverables and Timelines

| Deliverable | Participants | Estimated Start Date | Estimated Completion Date |
|---|---|---|---|
| Identify and review all DWR emergency response plans and processes that should consider potential drinking water quality impacts during an emergency. | **MWQI Program**<br>O&M WQ<br>O&M Field Divisions<br>DPLA | November 2008 | Original Draft completed Dec 2008. Management reviewed and returned to staff Oct 2009. During 2nd revision new information was found. An inquiry into SWRCB roles during emergencies started in Dec 2009. 2nd revision draft sent to DES upper management end of Mar. 2010. Following re-submittal and approval by DES upper management, report will be resubmitted to affected divisions. Following all internal review, recommendations will be submitted for consideration of Executive Management. |
| Identify water quality staff and material resources for responding to various emergency scenarios. | DWR Emergency Management Committee (EMC) | November 2008 | Ongoing-Dependent on DWR EMC contacting appropriate division heads to direct the assignment of their staff and resources to this effort |
| Participate in emergency response meetings (i.e. CUWA emergency spill taskforce). | **MWQI program** | November 2008 | Ongoing |

# 9 OTHER WATER QUALITY PROGRAM-RELATED ACTIVITIES

As necessary, MWQI management and staff will continue to attend outside meetings of the following groups to provide technical input and stay current on issues and activities that could affect drinking water. These groups may include but are not limited to;

Central Valley Regional Board's Drinking Water Policy Work Group

CUWA Sewage Spills Work Group

Delta Stewardship Council

Delta Watershed Monitoring Council (as needed. Note that Rich Breuer has been assigned this task by the Department)

Bay-Delta Conservation Plan

Pelagic Organism Decline Workgroup

San Joaquin River Basin Monitoring Partnership

South Bay Aqueduct Task Force (quarterly meetings)

State Water Resources Control Board

Delta Conveyance

DWR and other agency climate change activities

Special Aquatic Species Workgroups or Meetings (Delta Smelt, Splittail Smelt, Salmon, etc.)

MWQI will continue to coordinate its activities in these areas with the MWQI SPC members as it has done in the past. MWQI will achieve this through the tasks detailed in this and future workplans and participation in both internal and public forums that are focused on drinking water quality issues. As necessary, MWQI management and staff will also attend meetings associated with storm water and wastewater treatment plant discharge permit renewals and will review EIR/EIS documents for projects with the potential to affect drinking water quality in the Sacramento-San Joaquin Delta.

For this fiscal year, MWQI assistance is not required to comment and assess the impacts of the proposed mercury TMDLs that affecting the Department. The responsibility for this issue has been moved to the Department's Environmental Studies and Compliance Section. In the future, MWQI may be asked to participate regularly and assist with the development of a monitoring plan and determination of possible sampling locations, however, at this point, monthly attendance and assistance for mercury TMDL meetings are not required.

## Sanitary Survey

As discussed in more detail in section 7.10, a consultant has been chosen and work has begun on the 2006-2010 Sanitary Survey update.

# 10 **PROGRAM MANAGEMENT**

**Specific MWQI management tasks for FY 2011-12 for this program element include:**

A. Conduct monthly program status teleconferences for members of the MWQI TAC. Provide appropriate program and budget updates and meeting minutes during these calls.

B. Coordinate the July MWQI/SWC face to face meeting for 2011. In general, duties include coordinating up to two comprehensive program conferences for MWQI TAC participants during the fiscal year, one of which may include a Delta or SWP facility tour for new TAC program participants. An update of MWQI's 5 year Strategic Plan may be the content of one of these comprehensive meetings.

C. Serve as Sanitary Survey liaison and coordinator between Archibald Consulting, the Sanitary Survey Subcommittee, the Department and DPH.

D. Serve as contract manager for the 2006-2010 Sanitary Survey Update

E. As needed, conduct Sanitary Survey and Special Studies Subcommittee meetings as well as other MWQI/contractor meetings. As needed, participate in technical meetings of the RTDF-CP Steering Committee, the New Technologies work group and other subcommittees or working groups as may be formed from time to time to address specific drinking water quality issues that arise.

F. Serve as overall workshop coordinator for the Division of Environmental Services, 3 day Environmental Scientist Workshop.

G. Along with MWQI staff, attend various technical and management meetings, conference and workshops related to drinking water quality issues.

H. Along with MWQI staff, attend relevant Delta Stewardship Council meetings and various workshops including the Bay-Delta Science Conference.

I. Ensure MWQI TAC members continue to receive all draft materials, and members of that committee continue to have the opportunity to participate in any technical meetings of interest.

J. Develop the FY 2012-13 MWQI Program Work Plan.

K. As data becomes available in SAP, finalize MWQI Program budget for FY 2011-12 including identifying needs for the SWPCA Fund. If information is available, begin rough estimates of FY 2012-2013 MWQI budget.

L. Coordinate implementation of the RTDF-CP.

M. Monitor progress on MWQI program elements outlined in workplans.

N. Address personnel and safety related issues for MWQI Program.

# 11 OTHER REQUIRED PROGRAM COSTS

**Description of costs**

There are numerous program costs for labor, supplies, equipment and services that are charged to the MWQI Program through SAP, but are not necessarily linked to specific program elements. These are costs that are often divided between all branches in the Division of Environmental Services. These costs often result from Department-required, job related or career advancement activities and tasks. Examples of miscellaneous labor costs include staff time to:

- Attend training
- Attend conferences, workshops, meetings
- Develop and track contracts, purchase orders, training requests, travel expense claims
- Conduct facility maintenance (West Sacramento Field Unit)
- Accommodate other high priority Departmental programs and outside programs with data collection and analysis as directed by management
- Personnel management including hiring, training, and taking disciplinary actions
- Write memos and other forms of non-technical communication
- Enter and approve time
- Develop Department's Program budget and other SAP-related tasks

Examples of miscellaneous costs associated with supplies, equipment, general facility maintenance and services include:

- IT support (DWR IT personnel maintaining staff computers, servers)
- IT hardware and software (purchasing staff computers, mandatory software)
- Office equipment maintenance (copy and fax machines)
- Office supplies
- Janitorial services
- Moving and general facility services
- Staff training (required and job related)
- Travel costs for meetings, conferences
- Registration and labor costs for mandatory conferences (Environmental Scientists workshop)

- Out-of-State travel costs for conferences, meetings, workshops
- Vehicle maintenance, operation, fuel
- Uniform allowance (shoes, sun glasses)

# 12 CHALLENGES AND OPPORTUNITIES

The following is a description of challenges and opportunities associated with management of the MWQI Program.

**DWR Staffing and State Budget Actions**

Between February 2009 and June 2009, all DWR employees were furloughed 2 days a month. Beginning July 2009, all state employees were furloughed 3 days a month with furloughs continuing through June 2010. In July 2010, furloughs were lifted, only to be reinstated in August 2010. Beginning April 1, 2011, staff returned to 1 furlough day per month, however at the time of this workplan, the legislature had not yet approved the final contract with the California Association of Professional Scientists which codifies the new furlough measures for staff. Additionally, since this workplan was completed prior to approval of the State's 2011-12 budget, it is difficult to anticipate how this fiscal's year's budget crisis will impact DWR personnel.

In 2010-11, the State operated without a budget until September, resulting in purchasing uncertainties and potential loss of supplies for the real-time stations. Fortunately, the SPC contractor's fund provided the necessary funding to keep the stations operational. In this FY, leadership in the Governor's office has changed and the budget approval process has changed to a simple majority vote (from the 2/3rds vote that was previously required to pass a budget). However given the 26 billion dollar deficit currently facing the State, it is unknown whether any of these changes will result in a speedier budget process, or the end of staff furloughs. Additionally, per the Governor's order, Departments will need to reduce the number of vehicles by 50%. Presently, it is unknown if MWQI's vehicles will be affected by the Governor's 50% vehicle reduction, however, if this is the case, it is expected that projects and maintenance of real time stations would be impacted.

Given the uncertainty surrounding the State budget and the impacts of Governor's order, there may be unforeseeable delays to some projects. Any impacts will require creative adjustments. Although there is no desire for delays, until the 2011-12 State budget is finalized, and its impacts fully vetted, deadlines may have to become more flexible, the number of meetings reduced and/or lengths expanded to meet several previously individual meeting requirements. DWR travel to and from meetings has also been severely curtailed, and several SWP contractors have indicated that travel is becoming an issue within their agencies. Until budget issues improve, this may necessitate fewer face to face meetings.

Currently, there is no Environmental Program Manager for the MWQI program. The position has been advertised and is theoretically exempt from the Governor's hiring freeze, however, if these conditions change, responsibilities for this position will continue to be rotated between staff. Staff assuming the responsibilities for 2 positions will potentially impact the turnaround time of different tasks. Additionally, because of the continuing need for a full-time IT person, MWQI will monitor the success of another DES unit's newly created IT position that organizationally resides within DWR's IT section but with duties associated with the DES unit providing funding. If this arrangement proves successful, it is anticipated that a future MWQI vacancy would be reclassified to an IT position operationally housed within the Department's IT section but with duties assigned by MWQI. The challenge of retention and future recruitment still remains, especially in light of salary discrepancies for State scientists.

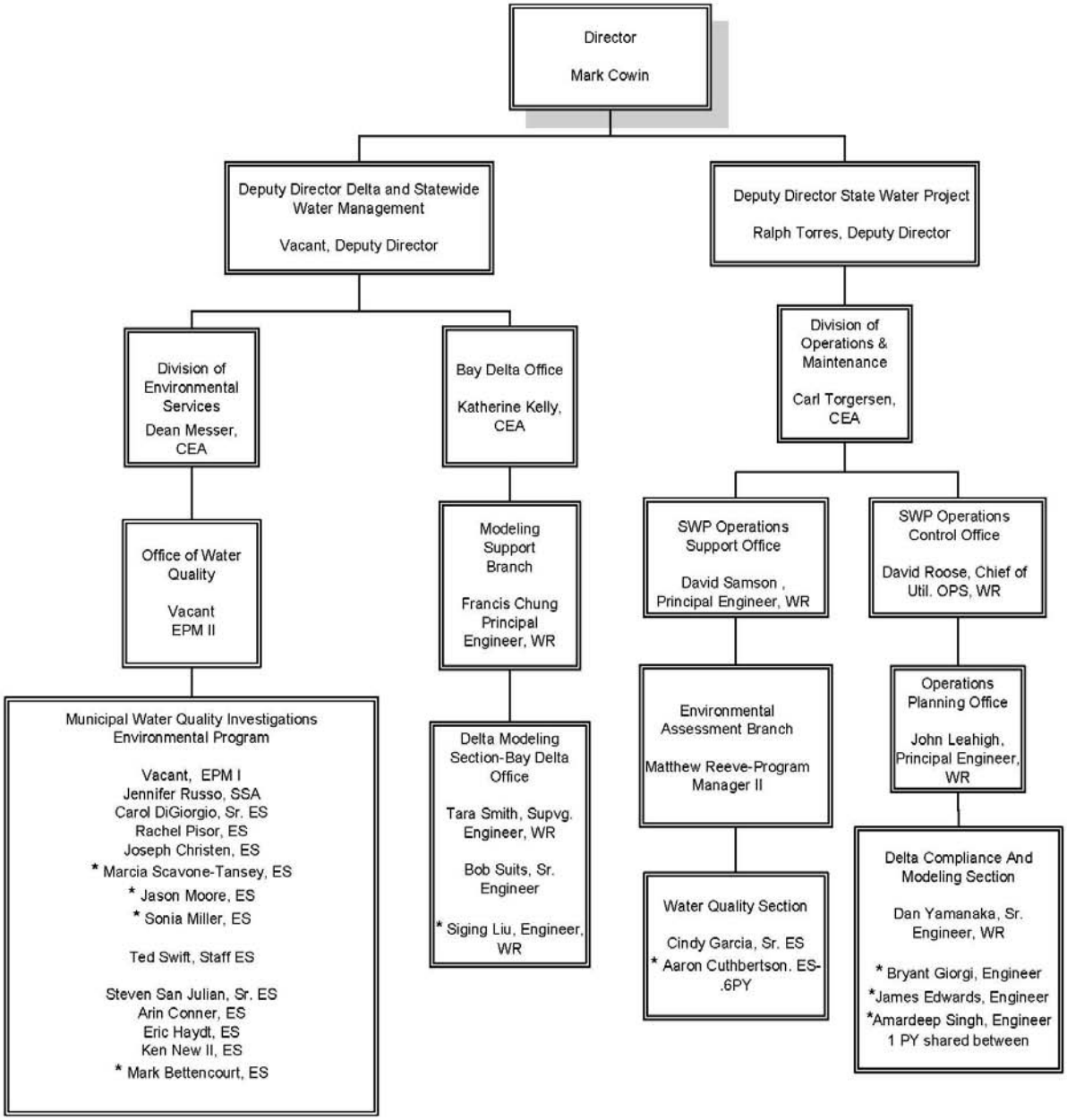
**DWR Overhead Rates**

Overhead rates for the Department continue to rise steadily with each new fiscal year. Hourly rates for permanent staff currently used in this workplan were an accurate reflection at the time that the budget was created, however, overhead rates change throughout the year, therefore final budget labor rates may not accurately reflect predicted increases for FY 2011-12. As overhead rates increase and the scopes of the MWQI Program and RTDF-CP broaden, adjustments to the overall program budget may need to be made on an annual cycle. Issues associated with overhead rates are discussed more fully in the budget section.

**Journal Submissions**

With the time and financial investment that has been dedicated to the MWQI program, it is important to create validated and referenced studies. The MWQI program will continue to use the DWR reports/publications process, but more emphasis will be put on publishing in scientific journals. This insures that the professional effort expended by the MWQI scientists is showcased in a peer-respected venue. Additionally this elevates the individual staff in their own professional career. With the evolution of more scientific entities in the Delta Stewardship, MWQI findings need to be presented on equal footing with other drinking water research project results.

# 13 **ORGANIZATION CHART**




* Indicates one of seven new positions authorized in 2007/08. All positions are for 1 PY unless otherwise indicated

# 14 GLOSSARY OF ACRONYMS AND TERMS

AMS Accelerated Mass Spectrometry

BCP Budget Change Proposal

BLM U.S. Bureau of Land Management

BMP Best Management Practices

Ca Calcium

CBDA California Bay Delta Authority

CBOD Chemical Biological Oxygen Demand

CCWD Contra Costa Water District

CDEC California Data Exchange Center

CDPH California Department of Public Health

CUWA California Urban Water Agencies

CVP Central Valley Project

DBP Disinfection by-product

DCC Dry Creek Conservancy

DDT Dichloro-Diphenyl-Trichloroethane (insecticide)

DFG California Department of Fish and Game

DMC Delta-Mendota Canal

DO Dissolved Oxygen

DOC Dissolved Organic Carbon

DOE DWR Division of Engineering

DPLA California Department of Water Resources, Division of Planning and Local Assistance

DSM2 Delta Simulation Model 2

DU Ducks Unlimited

DWR California Department of Water Resources

DWR EMC Department of Water Resources Emergency Management Committee

EC Specific Electric Conductivity

EPA U.S. Environmental Protection Agency

FSR Feasibility Status Report, used in information technology planning

FY Fiscal Year

GC-MS Gas Chromatography Mass Spectrophotometer

GIS Geographic Information System

HAA Haloacetic Acid

HAAFP Haloacetic Acid Formation Potential

IC Ion Chromatography, Inorganic Carbon (e.g., dissolved carbon dioxide)

IEP Interagency Ecological Program

IT Information Technology

KHP Potassium hydrogen phthalate

LC-MS Liquid Chromatography Mass Spectrometry

LLNL Lawrence Livermore National Laboratory

MWDSC Metropolitan Water District of Southern California

MGD Million Gallons per Day

MWQI Municipal Water Quality Investigations

Na Sodium

NEMDC Natomas East Main Drainage Canal

NDBA N-nitroso-di-n-butylamine

NDMA N-nitroso-dimethylamine

NDPA N-nitroso-di-n-propylamine

NMEA N-nitroso-methylethylamine

NMOR N-nitrosomorpholine

NPYR N-nitroso-pyrrolidine

NMR Nuclear Magnetic Resonance (analysis)

O&M Department of Water Resources Division of Operations and Maintenance

OC Organic carbon

OCO Operation Controls Office (DWR O&M)

OEE Operating Expenses and Equipment

PCB polychlorinated byphenyls

QA/QC Quality Assurance, Quality Control

QC Quality Control

RTD Real time Data

RTDF Real time Data and Forecasting Program

RTDF-CP Real time Data and Forecasting – Comprehensive Program

SBA South Bay Aqueduct

SDIP South Delta Improvement Program

SLDMWA San Luis Delta Mendota Water Authority

SOP Standard Operating Procedure

SPC Specific Project Committee

SUVA Specific ultraviolet absorbance

SWC State Water Contractors

SWP State Water Project

SWPCA State Water Project Contractors Authority

TBD To Be Determined

TDS Total Dissolved Solids

THM Trihalomethane

THMFP Trihalomethane formation potential

TKN Total Kjeldahl Nitrogen

TMDL Total Maximum Daily Load

TNC The Nature Conservancy

TOC Total (dissolved and suspended particulate) organic carbon

UCD University of California at Davis

UCSB University of California at Santa Barbara

UNO University of New Orleans

USBR U.S. Bureau of Reclamation

USGS United States Geological Survey

UVA *n* Ultraviolet absorbance at wavelength *n*

VAMP Vernalis Adaptive Management Program

WDL California Water Data Library

WWTP Waste Water Treatment Plants