Appendices for the Municipal Water Quality Investigations Program 2010-2011 Workplan

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Appendix 1-- Overview and Evolution-MWQI and Real Time Data and Forecasting Comprehensive Program

MWQI Program Background

In the early 1960's, the U.S. Public Health Service published drinking water criteria that consisted of only a few water quality parameters. These criteria remained largely unchanged for years, as the conventional wisdom of the day held that treatment of surface waters by filtration, and natural filtering of ground water by soils, along with disinfection, rendered these supplies safe for drinking. In the 1970's, improvements in scientific measurement techniques led to discovery of trihalomethanes (THMs) in U.S. drinking waters. Subsequent investigation indicated a possible link with increased incidence of cancer among exposed populations. With the creation of the U.S. EPA a process was set in motion that resulted in a new federal regulation in the early 1980's controlling THMs in drinking water.

In anticipation of the new regulation, DWR undertook a three-month investigation of organic carbon and bromide sources in Delta drinking water supplies. This study resulted in a preliminary finding that discharges from wastewater treatment plants and drainage from land surfaces contained elevated concentrations of organic carbon precursors of THMs, and that bromide was present in the system in concentrations sufficient to create bromine-containing THMs in treated drinking water. This finding led to the formation of a panel of recognized independent water quality and health scientists who were asked to evaluate information and make recommendations for further action as needed.

The panel report, published in 1981, found that most Delta water quality data then in existence was produced in support of ecological, rather than human health, concerns. The panel recommended institution of a program of monitoring for constituents of human health significance, namely THM precursors, sodium, and synthetic organic pollutants such as pesticides. In 1982, DWR implemented the Interagency Delta Health Monitoring Program (IDHAMP) in satisfaction of the panel's recommendations. The IDHAMP was created as an interagency effort, and its successor remains so today. Participants have included the U.S. Bureau of Reclamation, City of Stockton, City of Sacramento, Contra Costa Water District, and California Department of Health Services, along with SWC agencies that purvey drinking water.

Early information from the IDHAMP indicated drainage from Delta island peat soils is rich in organic carbon, therefore a separate study, the Delta Island Drainage Investigation (DIDI) was subsequently instituted. The DIDI was established to develop detailed information on the nature of this carbon source and to identify potential means of mitigating its impact on Delta drinking water supplies.

Meanwhile, advancements in analytical methodology continued, and as these were applied to environmental analysis, new water quality concerns emerged. Among these were the presence of DDT and PCB in fish and sediments of the Delta and its watersheds, selenium pollution in the San Joaquin River watershed, arsenic in the watersheds of the Delta and SWP, pesticide pollution by molinate and thiobencarb (rice herbicides) and insecticides such as diazinon, and waterborne pathogenic protozoa (*Giardia, Cryptosporidium*) that resist disinfection. Advancements in the analytical sciences have also led to discovery of previously unidentified disinfection by-products in drinking water supplies. Scientific data on all these and other potential water quality challenges were collected through the IDHAMP Program.

As scientific discoveries were made, there was a greater appreciation of the need for water quality information upon which to base management decisions affecting Delta water supplies. Accordingly, in 1985, the SWC requested DWR to propose a broad-based program that would provide information on known and emerging threats to drinking water quality. In 1986, DWR responded by implementing the Municipal Water Quality Investigations (MWQI) Program, that unified the IDHAMP and DIDI programs. The MWQI Program was founded on the principle that water quality concerns will continue to evolve as scientific understanding progresses, and that the program must be flexible and pro-active in order to address the new water quality challenges that will continually arise.

In search of practical means of eliminating or mitigating sources of undesirable constituents, the MWQI Program has supported numerous scientific investigations into underlying mechanisms of pollution. Years of monitoring effort have established a high quality, long-term base of data documenting the drinking water quality status of the Delta, and the phenomena that cause changes in Delta water quality. Data from the program have been, and continue to be used, extensively in water quality and water supply studies and planning. The continually evolving integration of MWQI's data with forecasting and information dissemination tools have made possible a future in which we will be able to not only better understand the consequences of changes that occur in the Delta and SWP, but also to anticipate, communicate and, in

some measure, control water quality conditions. It is toward this future that the MWQI program is focused.

The Real Time Data Forecasting Comprehensive Program Background

Past MWQI water quality assessments centered on periodic collection of discrete ("grab") samples followed by their laboratory analysis and retrospective data interpretation. The early years of the program were primarily devoted to surveying the status of THM precursors and other water quality constituents and identifying their sources. Information derived from this work was used for water supply planning. Today, new technology allows remote, near continuous, monitoring of water quality parameters such as organic carbon and bromide, along with instantaneous remote acquisition of the data. With these advances, the MWQI Program and the SWC realized that the tools were available to coordinate real time data acquisition and water quality forecasting to provide water agencies and municipal operators with the information to make operational decisions based on imminent changes in water quality. What was lacking was a coordinated mechanism to realize this capability. On June 7 and 8, 2006, representatives from SWC agencies who are participants of the MWQI Program, DWR management and staff, and select outside agencies, met to discuss the concept of a Real Time Data and Forecasting Comprehensive Program (RTDF-CP). The meeting focused on identifying the required program elements, possible collaboration and the resource sharing opportunities that would allow the RTDF-CP to become reality. It was determined that if MWQI and the SWC were to effectively harness the tools to improve the efficiency of water project operations, while protecting and improving drinking water quality, then the RTDF-CP must address the following considerations:

- The Delta and SWP must be more thoroughly instrumented to assure that real time water quality data are available at all critical locations.
- A forecasting system must be created that was capable of producing water quality simulations and providing early warning and notification on a daily production basis using the existing SWP water quality forecasting model. Primarily, this would entail developing the software mechanisms for efficiently channeling the necessary input data to the model, and producing a report output suitable for use by water managers.
- Improvement in the Coordination among various DWR and SWC organizations to enable smooth information flow and timely, appropriate action.

To address these needs the RTDF-CP was developed by the MWQI Program. A five-year strategic plan was developed to guide the RTDF-CP (see Appendix 4 for a copy of the 5 year strategic plan). The objectives of the 5-year strategic plan include:

- Create a cooperative organizational structure and identify the coordination and funding required for the RTDF-CP
- Develop and refine a SWP Early Warning System for water quality concerns to include:
    - Water quality monitoring and emerging concerns,
    - Water quality forecasting,
    - Water quality information management and data dissemination,
    - Scientific support studies, and
    - Emergency Response.

As envisioned, water quality sensors in the tributaries to the Delta (mainly Sacramento and San Joaquin rivers) would provide early warning of elevated concentrations of organic carbon, bromide, turbidity, algal growths, and other water quality constituents of concern to drinking water purveyors. Movement and concentrations of these constituents would be predicted using computer forecasting tools, and their actual movements tracked through other monitoring stations in the Delta. Water operations managers could be made aware of the conditions and could make operations decisions designed to mitigate water quality problems while maintaining water deliveries. Agencies using the Delta as a source of drinking water would be notified and status of the situation communicated on an ongoing basis. If elevated concentrations of constituents entered the SWP system, they could be tracked using computer forecasting and remote sensing tools, and drinking water agencies along the system could be notified when the material was expected to appear at their turnouts, and in what concentrations. Drinking water purveyors could alert water treatment plant managers who, in turn, would prepare for chemical addition or other process changes as warranted. Drinking water agencies would provide continuing feedback to SWP operators and water quality managers to enable the full consequences of operations decisions to be understood, and this information would be acted upon to improve the early warning and operational control processes.

The geographic scope of the MWQI Program has historically been confined to the Delta. However, the scope of real time monitoring and forecasting effort must, by necessity, encompass the watersheds of the Delta, the SWP, and portions of the federal Central Valley Project that are interconnected to the Delta and SWP. Implementing many of the RTDF-CP goals required coordination with staff outside of the MWQI

unit. Within DWR, several units have expertise and responsibilities that are necessary to operate an extensive real time early warning and response system, including: Division of Environmental Services (MWQI Program, Environmental Real Time Monitoring and Support), Division of Operations and Maintenance (Office of Water Quality, Operations Control Office, SWP Field Divisions), Bay Delta Office (Delta Modeling Section), and Division of Planning and Local Assistance (District Offices). Therefore, in 2006, the SWC began working with the Department to create additional positions needed to ensure that the goals of the RTDF-CP are accomplished. In FY 2007/08 seven new positions were created within the Department and were filled by February 2008. The FY 2008/09 work plan represented the first year where all RTDF-CP positions were filled and priority tasks associated with the RTDF-CP could be fully addressed. Currently, oversight is being provided by an RTDF Steering Committee with participation from each involved contractor of the SWP. It also includes DWR staff members from the various component divisions.

A major, but necessary, challenge has been to develop mechanisms to integrate and coordinate among DWR programs and other agencies to achieve effective communications, standardized information formats, provide funding, and periodically review and update programs to meet current needs. The DWR Office of Water Quality was established in recognition of the need for greater linkage among existing DWR water quality programs. Expansion of the Real time Data and Forecasting program illustrates the need and provides a mechanism to realize this coordination and integration. However, if a robust real time water quality data and forecasting capability is to be realized, it will require longer-term management commitment and funding from DWR and the SWC. Eventually the RTDF CP will need to reside organizationally where the integration of functions and resources can be best realized.

Today the MWQI Program, the RTDF-CP entails the following elements:

1. Coordination and collaboration between DWR monitoring and forecasting groups.
2. Real time data acquisition for the Delta and SWP through remote, high-frequency monitoring.
3. Enhancement of forecasting and fingerprinting of drinking water quality through use of computer models.
4. Centralized information management and dissemination.
5. Scientific support studies.
6. Emergency response preparedness as related to drinking water quality.

7. Coordination and collaboration within DWR and with outside agencies to enhance real time monitoring activities.

Besides the water quality monitoring, forecasting and data dissemination that makes up the "nuts and bolts" behind a real time early warning system, scientific special studies and emergency response elements are also necessary for an early warning system. In the case of special studies, the information collected is an integral part of the real time data collection and forecasting. Special studies are conducted to investigate the origins, fate and transport, and in some cases, loads of current and emerging contaminants of concern. Such studies help to determine where new instruments should be located. Special studies may also investigate seasonal patterns and trends of constituents or examine circulation patterns of contaminants. These studies can also be used to refine modeling assumptions. Special studies can also assess the impacts of increasing urbanization on levels of water quality constituents of concern. In addition, ensuring that Departmental emergency response mechanisms include consideration of drinking water constituents is vital to an early warning system. A mechanism that can quickly notify water purveyors and operators of emergency spills and analytes that aren't modeled or analyzed in real time will always be necessary.

Real Time Monitoring

Real time monitoring or in situ monitoring is defined as high frequency or continuous measurement of water quality and flow by remote equipment installed in locations within the Delta, its tributaries, and the SWP. Communication equipment transmits the resulting data to headquarters to be used shortly after measurements are made. Real time monitoring is comprised of two parts; a) field operations which ensure the operation and maintenance of all automated sampling equipment, timely transmission of real-time data to users and implementation and documentation of QA/QC of this data, and b) the synthesis of real time data from a variety of federal, State and local agency water quality monitoring programs, rapid data quality control, analysis, and dissemination of results. These results are currently provided as part of the RTDF CP via weekly electronic reports.

Real time results are used to: a) inform operational decisions affecting the Delta and SWP, b) support development of water quality forecasting tools for better managing of SWP water supplies, and c) for water quality and water supply planning studies. In addition to DWR and the SWC, this information is used by many federal, state, and local agencies, and the public.

Today, real time equipment is installed and maintained by MWQI at four critical Delta locations (Hood, Vernalis, Banks PP and Jones PP). Remote sensing technology allows real time operational decisions to be made that take into account water quality considerations. As water management has become vastly more complex, due to increasing environmental restrictions on water operations, it has become necessary to manage the Delta and SWP to increasingly finer degrees. This new water quality sensing technology offers a tool for better and quicker "tuning" of water operations.

Within the RTDF-CP, real time monitoring activities receive technical advice and guidance from the RTDF Steering Committee, a group of technical experts composed of staff from participating agencies. The RTDF Steering Committee serves as a subcommittee of the MWQI TAC, to which the Steering Committee reports.

Current objectives for the Real time Monitoring Program include:

- determining baseline concentrations of organic carbon, anions, nutrients and other drinking water quality constituents in Delta and SWP waters.
- determining loads, timing, and quality of carbon, nutrients, anions (i.e. chloride and bromide) entering the Delta from the Sacramento and San Joaquin Rivers, as well as in-Delta sources.
- identifying and quantifying water quality changes caused by land use changes from urbanization and population growth in the Delta and its watersheds, and by actions proposed or taken by CALFED or other entities that affect the Delta environment.
- providing water quality data relevant to SWP contractors and other users of Delta water supplies in a timely manner for decision making.
- providing water quality forecasts that assist SWP and other utilities in advanced planning efforts to optimize management of their water supplies while meeting increasingly stringent drinking water regulations.

Water Quality Forecasting

High frequency real time water quality data from multiple remote locations also provides the needed information base to develop and populate computer tools for fingerprinting and forecasting drinking water quality conditions in the Delta and SWP. Although water quality monitoring enables an understanding of current and past water quality conditions, it is generally inadequate to forecast and assess the water quality effects of future, or proposed, changes in the Delta and SWP. To enable future conditions to be

forecasted and analyzed, this component of the RTDF-CP uses monitoring data in conjunction with mathematical modeling techniques to develop and refine computer simulation tools. The geographic domain of DWR's Delta Simulation Model (DSM2) has been extended to include the newly developed DSM2-Aqueduct extension model. This new model includes the California and South Bay Aqueducts. A third model includes the Delta Mendota Canal. With these tools, water quality consequences of Delta and SWP-Central Valley Project operations can be forecasted, with the objective of incorporating this information into water operations decisions for the export facilities as well as downstream purveyor's facilities.

To achieve the tasks associated with modeling and forecasting requires the continued collaboration between the various DWR groups responsible for real time data collection and forecasting. These groups include the MWQI Program, O & M's OCO and the Bay Delta Office's Delta Modeling Section.

Objectives of this enhanced effort are to better tailor water quality monitoring to modeling needs and to maximize the use of modeling results by water quality managers.

RTDF Information Management and Dissemination

This component of the RTDF-CP integrates and delivers results of the real time monitoring, fingerprinting and forecasting elements of the forecasting aspect of the RTDF-CP. This is generally accomplished through the weekly water quality reports distributed via an E-mail subscription list to staff of agencies participating in the MWQI Program and to other interested parties. Both current and archived reports are available on the MWQI website. However, as additional needs arise that require real time data and forecasting tools, this information will also be disseminated to stakeholders through e-mail, reports, and meetings. The goals of this program element are:

- to continue to provide real time water quality data and forecasting information to stakeholders and utilities for source water management decisions,
- to continue to review and refine format of real time information based on stakeholder and utility needs,
- to continue to develop a program for acquisition, storage, assessment, and transfer of water quality data and processed information in a near-real time mode,
- to provide continuous, real time postings of relevant autoanalyzer, operations, hydrologic data, and water quality forecasts to stakeholders and utilities via the Internet in a "user friendly" format, and

- to continue updating and enhancing the MWQI Program website.

Within this component, there are information management and data dissemination tasks associated with grab sample data and with real time data. Grab sample data is stored in the California Water Data Library (WDL) which encompasses DWR programs beyond MWQI. 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) and the MWQI web site.

The database management associated with this component has gone through several evolutionary steps. Initially the data management system ("RTDF2") was used to generate weekly reports. Data was retrieved by MWQI staff from the California Data Exchange Center (CDEC). MWQI staff then reviewed the data for accuracy, and summarized the data in graphical and text forms in the weekly reports. In FY 2007/08, the RTDF2 data management system was replaced by RTDF3, consisting of a database platform that automatically received data from real time stations and/or CDEC as necessary. The final phase of data management evolution under this program element (RTDF4) will link the database with the Internet using a web-based interface. RTDF4 will establish an "on demand" capacity for users to query RTDF data such as TOC, DOC, EC, precipitation, hydrology, anion, and operations data.

Due to the great difficulty of trying to correct problems while the database is in use, it is important for the databases to be well designed from the outset, as opposed to being configured after deployment. It is anticipated that a Database Working Group, composed of DWR staff and Contractor representatives of the MWQI Committee, will need to be formed to oversee technical aspects of data dissemination tool development, especially with respect to RTDF 4. This group will report to the RTDF Steering Committee. This subcommittee will be expected to provide advice and recommendations on the appearance, format, and function of web pages, reports and related media that provide access to the information produced through the project.

Appendix 2--Science Support (Special Studies)

Background

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, contaminant loading, measurement methods and instrumentation, and climate and hydrology. Results of these studies inform subsequent cycles of the MWQI work plan by improving the RTDF and discrete sampling programs.

Generally strawman proposals of special studies are submitted to the Special Studies subcommittee for discussion and prioritization. Strawman proposals are evaluated on technical merit, how well they meet the needs of the MWQI mission, and funding available to conduct the study.

To keep the workplan concise, only short summary descriptions are provided in the 2010-11 workplan. This appendix contains the full project proposals for some of the special studies that appear in the workplan. In cases where a proposal does not appear in this appendix, the proposal in the workplan did not require further elaboration in this appendix. For some projects, project proposals from earlier workplans are also presented in this appendix. Their inclusion shows the changes and progression of the project from the original proposal to the current study.

2010-11 Workplan Proposal for Urban Sources and Loads Investigation--Lead Investigator: Rachel Pisor

Note that this study proposal updates the 2009-10 study proposal listed in this appendix.

Background/Introduction

The Sacramento/San Joaquin River Delta is a region that has been rapidly growing at a rate much faster than the rest of California and the United States. Because of the geographic location of this growth, there is a significant potential for negative effects to drinking water quality. The Delta provides drinking water to approximately 25 million Californians; therefore, the effects of municipal stormwater discharges on water quality are particularly important in this region.

Water quality impacts from urbanization are primarily due to increased urban drainage, increased wastewater discharge, and recreational uses. Increases in the volume of urban drainage are mainly due to increases in impervious cover. Agriculture and open space landscapes are pervious and generally allow for greater percolation of stormwater through the soil. Soils filter contaminants like heavy metals, oil and grease, pesticides, etc., as compared to compacted or developed areas which allows less percolation and more runoff. Urban land uses are mainly characterized by pavement and do not allow water infiltration. Instead, water flows as sheets over the impervious surface to the river. This typically results in higher runoff volumes, with shorter duration but larger magnitude peak flows in response to rainfall. Impervious and semi-impervious (e.g. commercial and residential landscapes) surfaces also catch and store urban contaminants between storm events. Typical urban contaminants include vehicle emissions, vehicle maintenance wastes, landscaping chemicals, household chemicals, pet wastes, and trash. Increases in impervious surfaces and installation of storm sewer systems provide a faster and more direct route for the transport of accumulated pollutants to nearby waterways.

The focus of this study is to analyze the effects of urban drainage on drinking water quality. This will involve analyzing both water quality and land use patterns. This study will be conducted for 2 years. At the end of this time, MWQI will determine whether additional sampling is necessary.

Background

MWQI began investigating the effects of urban runoff with a study of the Steelhead Creek watershed in the northern Sacramento metropolitan area. Results from that study showed that urban runoff can have significant impacts on drinking water quality and it demonstrated how important tracking this issue is as the Delta continues to urbanize. To further understand these effects, MWQI reviewed several geographic areas for investigation. We considered northern and southern Sacramento, Stockton, Brentwood, Lathrop and Mountain House, but selected the City of Lathrop based on accessibility, feasibility and data needs for the San Joaquin River.

Lathrop is a small municipality that was rapidly urbanizing prior to the housing market collapse of the late 2000's. Conversion of agricultural and open space land uses to urban land uses resulted in increased impervious cover. With the collapse of the housing market, this conversion stopped, however, it is anticipated that when the economy rebounds, land use conversion would continue. Therefore, when urbanization resumes, conducting this study today provides a baseline for future studies of the impacts of changing land use on water quality. Also because Lathrop is a small municipality, it is covered under the Phase II General NPDES Permit. This permit does not require Lathrop to monitor its stormwater runoff. In order to manage drinking water throughout the Delta effectively, however, it is necessary to understand the effects of stormwater on drinking water quality from all sizes of growing municipalities.

Objectives

This study will assess the effects of urban stormwater runoff from Lathrop on the San Joaquin River Watershed with special attention paid to first flush events. Because the population of Lathrop is small, this study may serve as a baseline of water quality conditions and land use patterns. As development continues to grow, we will be able to see at what population size urbanization negatively effects drinking water quality. This may be useful in management decisions regarding monitoring of stormwater and mitigation of negative effects on drinking water quality from urban runoff.

Specifically, this study will quantify background concentrations and loads in the river and loads of specific constituents discharged to the river from the City of Lathrop. Knowing both the background loads in the river and the urban load discharged to the river will provide a relative contribution of urban loading to the river. Using discharge rates and riverine flow measurements, urban and riverine loads will be calculated for nutrients and organic carbon. Concentration data will be collected for all other

constituents. Land use will be analyzed by quantifying the percentage of impervious cover. This will enhance our understanding of water quality effects from urban drainage by linking particular landuses to loads. By linking percent impervious cover to discharges from different landuses, stormwater discharge information from Lathrop may also prove useful in predicting loading from other urban areas.

Study Design

To accomplish the study objectives, we will be collecting water quality samples from Lathrop's stormwater pumping stations. The city's stormwater flows through these pumping stations immediately prior to being discharged to the San Joaquin River. We will also collect river samples upstream and downstream of Lathrop's discharge to evaluate the proportion of load in the river attributable to urban runoff. We will focus on first flush events because these events have the greatest potential to effect water quality. This will provide a better understanding of what the water quality conditions of the San Joaquin River are and how they are influenced by Lathrop's discharge. In addition, we will collect data from rain gauges to determine precisely how much precipitation occurred during each event.

To complement these analyses, we will use GIS to conduct a land use analysis. All the layers necessary to conduct the analysis will be obtained from the San Joaquin County Assessor's office.

Stormwater pumping stations

Lathrop handles its stormwater using detention basins and stormwater pumping stations. The detention basins impound the stormwater prior to being conveyed to stormwater pumping stations. Pump stations discharge to the river. Pumping stations are comprised of a wet well, a low-flow pump and up to three main pumps. When water rises to a certain level, the low flow pump turns on. If the water in the wet well continues to rise, and the low flow pump cannot accommodate the flow, the low flow pump will turn off and the main pumps will turn on.

Different regions in Lathrop handle stormwater in different ways. Historic Lathrop does not have a developed stormwater system. Runoff from this region is dealt with by detention basins which channel the water to the River station (figure 1). The Mossdale region of Lathrop has a developed storm drain system which utilizes 5 pumps which discharge to the river. The Stonebridge region utilizes a detention basin and a pumping station. The industrial region of Lathrop uses a detention basin and a pumping station (see figure 1).

Eight Lathrop stormwater pumping stations will be sampled (see figure 2). This includes all stations which pump directly to the river and encompasses all the regions of Lathrop. These stations are River Station, Stonebridge, KV, M1, M2, M3, M5, and M6. With the exception of pathogen samples, all pump station samples will be collected by autosamplers (ISCO 3700 or 6712). Because of holding times, pathogen samples will be collected as grab samples.

Frequency of autosampler sample collection will vary by storm size and duration, however samples will be collected as a single composite sample. This sample will be processed according to requirements of the laboratories to analyze the constituents. For further details in sample processing, see the methods section.

SCADA programming for Autosampler sampling

DWR has hired MCC Consulting to wire the autosamplers into the city's SCADA system at each pumping station. During a rainfall event, the SCADA system monitors the pumps and will trigger autosampler sampling after the pumps have run for a sufficient time to flush out any standing water. This ensures that the water collected by the autosampler reflects the water quality of stormwater runoff, and not the quality of the residual water that has sat in the pipes prior to discharge. The SCADA system will send a text message to a cell phone when the first signal has been sent to the autosampler to collect a sample. This will alert staff that sampling has begun and allow efficient staging for sample deployment.

Manual programming for Autosampler sampling

In the event that the SCADA system is not operational, autosamplers will be manually programmed to collect samples at pre-determined intervals. Prior to a rainfall event, weather will be closely monitored and the autosamplers manually programmed. Autosamplers will be programmed identically. To ensure that samples are collected after residual water has been flushed from the discharge system, autosamplers will be programmed to begin sampling after the storm has begun. At most stations a 10-15 minute delay is sufficient to ensure that residual water is flushed from the pipes. In addition to allowing residual flushing of standing water, delayed start times also ensures that enough water has collected in the stilling well to allow sample collected. Since the volume of water in the stilling well is dependent on the volume of stormwater runoff, delayed start times will also have to factor in the intensity of the storm to ensure that enough water has collected in the stilling wells to ensure adequate volume for sampling. If a storm is

predicted to last multiple days, the samples will be switched out every 24 hours. The whole suite of samples will be processed for each day of the storm.

Weather based Autosampling frequency and duration

The variation in the storm will determine how many samples are collected from each autosampler. If the storm only lasts 24 hours, samples will be taken for that 24 hours and then will be processed. If the storm is expected to last for multiple days, the processing will change. After the first 24 hours, the water will be collected and processed. If the storm is expected to continue for another full day, then the autosampler will be re-programmed to collect the samples for the next 24 hour period, after which they would be processed. This pattern will continue up to 3 days worth of samples. After that time it will be decided if it is reasonable to take more samples.

River Station Samples

To assess the load in the river, grab samples will be taken above and below Lathrop on the San Joaquin River. Sample will be collected at Mossdale (MSD), San Joaquin River at Lathrop (SJL), and Brandt Bridge (BDT) (see figure 2). Originally, samples were also scheduled to be collected from the Head of Old River (OH1), but this station has been removed for safety and logistical reasons.

This region of the Delta is tidally influenced and therefore it is necessary to consider tidal cycles when collecting and analyzing the data so that they are comparable. When there is an ebb tide, the water is flowing from the Delta out to sea. In this case, we would sample at MSD first, then SJL and finally BDT. The MSD sample would serve as the background condition and the BDT sample would serve as the background plus what Lathrop has contributed. If the tide is a flood tide, the water will flow from the sea into the Delta. In this case, we would first sample at BDT, then SJL, and finally MSD. In this case, BDT is the background condition and MSD is the background plus what Lathrop has contributed. Tide prediction software, Tides & Currents Pro, will be used to monitor the tides and will be used as a tool to help make decisions about sampling times for the river stations.

All river station samples will be taken as grab samples the day of the storm. These samples will be processed the same way as the autosampler samples.

Weather and River Station Samples

River samples, like autosampler samples, will be taken during storm events. These grab samples will be taken during the first day of the storm to catch first flush effects. Due to logistics and availability of staff, there will be only 1 set of river samples taken per storm.

Weather Monitoring and Precipitation Data

Precipitation will be monitored closely throughout the study's duration. Since the focus of this study will be on first flush events, a storm in which 0.5 inches of precipitation is predicted will be sampled if it follows a dry period of 30 days or more. If there is a major storm event within a 30 day dry period, sampling would also occur. For the purpose of this study, a major storm event is defined as storm producing1.5+ inches of precipitation over a 24 hour period. These are general guidelines for sampling protocol and it is possible that storm sampling may be modified.

At two of the stormwater lift stations, rain gauges are installed. These are RainWise 8 -inch diameter tipping bucket rain gauges equipped with dataloggers. One is located at the Stonebridge station and the other is at the River station. These rain gauges will store up to 365 days worth of data and record data every minute. The two gauges installed are geographically separated to account for regional differences in precipitation.

Flow Data

One of the focuses of this study will be to make a determination of carbon and nutrient load. Load is a function of concentration and flow. The river stations have continuous flow data; however, there is no continuous flow data at the autosampler stations. Flow data at these sites will be determined by the pump rating curves. By knowing the pump rates and duration of pumping, we will calculate the approximate flow during sampling events.

Methods

Processing of water quality samples

Physical parameters

Physical parameters will be taken in the field as soon as possible after collection. Physical parameters measured will include dissolved oxygen, pH, electrical conductivity, temperature and turbidity.

Samples prepared for Bryte Laboratory

All the samples prepared for Bryte laboratory will be processed in accordance with the laboratory's guidelines. This includes filtration, acidification, and agitation of the matrix when applicable. All samples will be put on ice until returned to the lab.

Pathogen samples

Pathogen samples will always be collected as grab samples and will be taken at the river sampling sites and autosampler stations. These samples cannot be collected from an autosampler due to the probability of bacteria death or reproduction during the time between collection and processing. Immediately after collection, pathogen samples will be put on ice and delivered to the FGL Laboratory within the 6-hour holding time. FGL Laboratory is subcontracted through Weck Laboratory which is contracted through the Department.

Replicate TTHMFP and HAAFP samples

Additional samples for total trihalomethane formation potential (TTHMFP) and haloacetic acid formation potential (HAAFP) will be collected and sent to Weck Laboratory the day after collection. The samples collected will be unfiltered, but they will be filtered using a 0.45 micron filter in laboratory prior to processing. The results of these additional samples will be used to compare Bryte lab's DWR modified TTHMFP and HAAFP method to Weck Laboratory's method, SM 5710B.

Duplicate and Replicate Samples

During each sampling event, replicate samples will be taken for all constituents at station M5 with the exception of pathogens. At M-5, the autosampler is outfitted with a 19-L glass jar. All other stations are outfitted with a 9-L glass jar. Nine liters is a sufficient volume to collect sample for all the analyses, but not sufficient to collect sample for replicates. Due to the large size of the 19-L jar and the set up at each of the stations, switching out this jar with other stations is not feasible. Both the regular sample and replicate sample will be collected from the same 19 liter container.

During each event, pathogen sample duplicates will be taken. The duplicate station will rotate among the autosampler stations. The duplicate is a second sample taken directly from the water source and sample method is identical to that of the parent sample. For a complete list of analyses and methods, see Table 1.

Analysis of Loads

Load calculations will be computed for nutrients and organic carbon. Loads are a function of flow and concentration and can be computed as the integral of the instantaneous discharge multiplied by the concentration for a defined time period (dt):

$$L=\int_0^t K \cdot Q_t \cdot C_t dt$$

Where L is load for interval 0 to t, K is a unit conversion factor, Q_t is the instantaneous discharge, C_t is instantaneous concentration (Coats, 2002). Because the data we will be collecting from the pumping stations is not in real time for all flows and concentrations, we will compute loads as the product of the average flow and the average concentration for a defined time period:

$$L_{0-t} = \overline{Q}_{0-t} \cdot \overline{C}_{0-t}$$

Where L_{0-t} is load from time interval 0 to t, $\overline{Q}_{0-t}$ is the average flow from 0 to t and $\overline{C}_{0-t}$ is the average concentration from 0 to t.

For the river stations, we be collecting a grab sample and therefore we will not be using averages to compute the load. For these stations, we will be computing an instantaneous load at time (t):

$$L_t = Q_t \cdot C_t$$

Where L_t is the load at time t, Q_t is the flow at time t and C_t is the concentration at time t.

Data Analysis

Load will be calculated for organic carbon and nutrients. For all other analytes, statistical comparisons using either concentration or load values will be used. Statistical comparisons will be used to examine significant differences in trends or seasonality between stations, storms and water years. Analyses will include examining differences between upstream and downstream points on the rivers, between grab samples from the river stations and the 8 pumping stations and between the individual storms. An ANOVA will be used for these analyses if the data is normally distributed. If the data is not normally

distributed, the non-parametric Kruskal-Wallis test will be used. A trends analysis will determine if there are statistically significant trends over the course of the wet season or between years. If the data follows a normal distribution, a regression based on time will be used. If the data is not normally distributed, a Mann-Kendall test will be used.

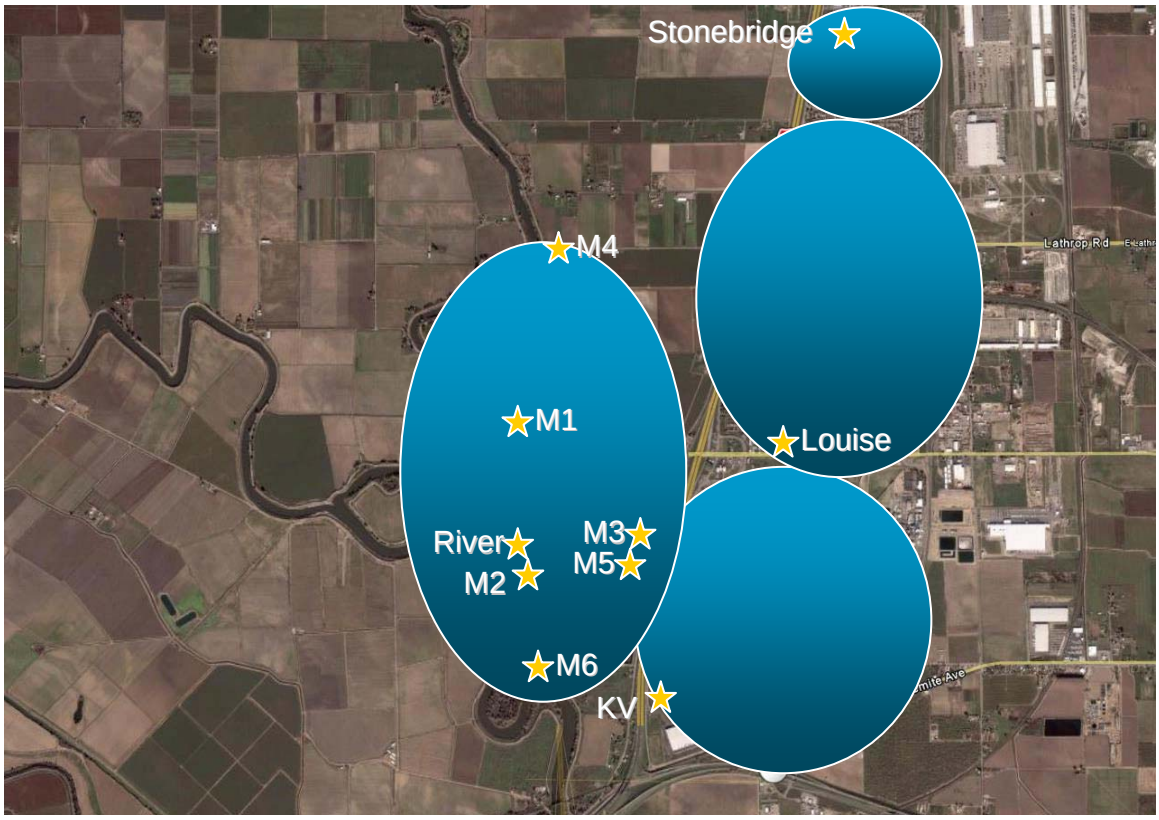


Figure 1. Approximate Regions of Lathrop handled by different stormwater pumping stations. Note that the Louise Station pumps water directly from historic Lathrop to the River Station.

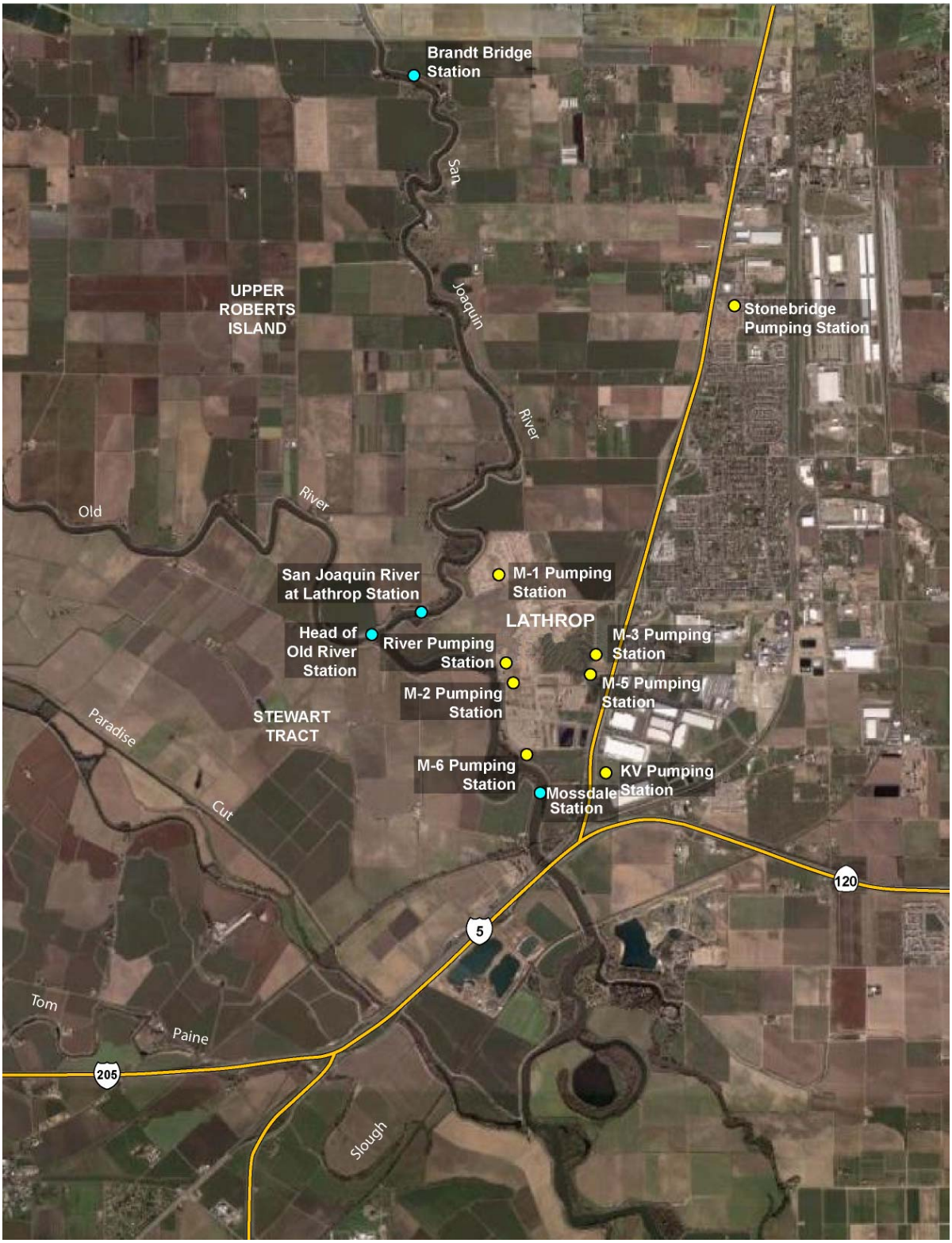


Figure 2. Location of sampling stations for Lathrop Urban Drainage Study. City discharge pump stations are in yellow. River sampling stations are in blue.

Table 1 Laboratory Analyses and Methods

Method	Analyte
Std Method 2340 B, Hardness By Calculation	All
EPA 200.7 (D), ICP Metals and Trace Elements (Dissolved)	Dissolved Calcium
EPA 200.7 (D), ICP Metals and Trace Elements (Dissolved)	Dissolved Magnesium
EPA 200.7 (D), ICP Metals and Trace Elements (Dissolved)	Dissolved Potassium
EPA 200.7 (D), ICP Metals and Trace Elements (Dissolved)	Dissolved Sodium
EPA 300.0 28d Hold, Inorganic Anions 28d hold	Dissolved Sulfate
EPA 300.0 28d Hold, Inorganic Anions 28d hold	Dissolved Chloride
EPA 200.7 (D), ICP Metals and Trace Elements (Dissolved)	Dissolved Boron
Std Method 2540 C, Total Dissolved Solids (TDS)	All
Std Method 2320 B, Alkalinity	All
Std Method 2510-B, Electrical Conductivity (EC)	All
EPA 300.0 28d Hold, Inorganic Anions 28d hold	Dissolved Nitrate
Std Method 4500-NO3-F (28Day), Nitrite, Nitrate (DWR Modified)	Dissolved Nitrate + Nitrite
EPA 350.1, Ammonia, Nitrogen (Dissolved)	All
EPA 351.2, Kjeldahl Nitrogen	All
EPA 365.1 (DWR Modified), DWR Othro-Phosphate (Dissolved)	All
EPA 365.4, Phosphorus (Total)	All
EPA 200.8 (D), ICP/MS Trace Elements (Dissolved)	Dissolved Silver
EPA 200.8 (D), ICP/MS Trace Elements (Dissolved)	Dissolved Aluminum
EPA 200.8 (D), ICP/MS Trace Elements (Dissolved)	Dissolved Antimony
EPA 200.8 (D), ICP/MS Trace Elements (Dissolved)	Dissolved Arsenic
EPA 200.8 (D), ICP/MS Trace Elements (Dissolved)	Dissolved Cadmium
EPA 200.8 (D), ICP/MS Trace Elements (Dissolved)	Dissolved Nickel
EPA 200.8 (D), ICP/MS Trace Elements (Dissolved)	Dissolved Zinc
EPA 200.8 (D), ICP/MS Trace Elements (Dissolved)	Dissolved Selenium
EPA 200.8 (D), ICP/MS Trace Elements (Dissolved)	Dissolved Molybdenum
EPA 200.8 (D), ICP/MS Trace Elements (Dissolved)	Dissolved Manganese
EPA 200.8 (D), ICP/MS Trace Elements (Dissolved)	Dissolved Lead
EPA 200.8 (D), ICP/MS Trace Elements (Dissolved)	Dissolved Copper
EPA 200.8 (T), ICP/MS Trace Elements (Total)	Total Iron
EPA 200.8 (T), ICP/MS Trace Elements (Total)	Total Lead
EPA 200.8 (T), ICP/MS Trace Elements (Total)	Total Copper
EPA 200.8 (T), ICP/MS Trace Elements (Total)	Total Chromium
EPA 200.8 (T), ICP/MS Trace Elements (Total)	Total Aluminum
EPA 415.1 (D) Ox, Organic Carbon (Dissolved) by Wet Oxidation	All
EPA 415.1 (T) Ox, Organic Carbon (Total) by Wet Oxidation	All
Std Method 5910B, UVA	All
EPA 608, Chlorinated Organic Pesticides	All
EPA 614, Phosphorus / Nitrogen Pesticides	All
EPA 160.2, Total Suspended Solids	Total Suspended Solids
DWR THMFP (Buffered), DWR THMFP (Buffered)	All
DWR HAAFP (Buffered), Haloacetic Acid Formation Potentials	All
Std Method 9221B,E, Total and Fecal Coliform[1]	All
Std Method 9223B, Total and E.Coli Coliform[1]	All
GC/MS NCI-SIM, Pyrethroid Pesticides[2]	All
Std Method SM 5710B, THMFP, HAAFP[2]	All

[1]Analysis conducted by FGL Laboratory, Stockton, Ca
[2]Analysis conducted by Weck Laboratory, City of Industry, Ca

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 2011
Analysis of samples as indicated above by DWR	**Bryte Laboratory**	Winter 2009	August 2011
Analysis of samples as indicated above through contract with Weck	**FGL Laboratory**	Winter 2009	August 2011
Analysis of samples as indicated above through contract with Weck	**Weck Laboratory**	Winter 2009	August 2011
Final Report	**MWQI Program**	September 2011	April 2012

* Note that based on potential summer storm events, sample completion dates are tentative. The estimated sample completion date of July 2011 includes the possibility of rare summer storm events. Final deadlines will be adjusted based on when actual storm events end in water year 2011.

Literature Cited

Coats, R.N., F. Liu, and C.R. Goldman. 2002 A Monte Carlo test of Load Calculation Methods, Lake Tahoe Basin, California-Nevada. Journal of the American Water Resources Association 38(3): 719-730.

Budget

See 2010/2011 Workplan

2009-10 Workplan Proposal for Urban Sources and Loads Investigation--Lead Investigator: Rachel Pisor

Note that this study proposal updates the 2008-09 study proposal listed in this appendix

Background/Introduction

As urbanization in the Delta increases, so does the potential for impacts to drinking water quality. MWQI began to investigate the effects of urban runoff with a study of the Steelhead Creek watershed. Results from that study showed that urban runoff can have significant impacts to drinking water quality and demonstrated how important tracking this issue is as the Delta continues to urbanize. To further understand these effects, MWQI reviewed several areas of concern for further investigation. Under consideration were northern and southern Sacramento, Stockton, Brentwood, Lathrop and Mountain House.

A northern Sacramento area study would revisit the Steelhead Creek study to assess changes in land use and water quality. Since the completion of that study, there has been a major collapse in the housing market; therefore, any further changes in land use and water quality are unlikely. In southern Sacramento, Morrison Creek flows to the Sacramento, Mokelumne, and Cosumnes Rivers. During storm events, water backs up into Beach Lake, preventing accurate calculations of the volume and quality of water that flows to the Sacramento, therefore, making this site infeasible.

There is much interest in focusing on the San Joaquin River watershed especially considering the current pumping restrictions. In Stockton, numerous creeks and sloughs drain into the San Joaquin River; however, they are geographically widespread, making this site logistically infeasible. Additionally, some of the sloughs drain both agriculture and urban land, making it impossible to differentiate between urban and agricultural runoff. Finally, not all Stockton runoffs flow to the San Joaquin River. Therefore, smaller municipalities of Brentwood, Mountain House and Lathrop were considered.

Brentwood's runoff flows northerly to Big Break and out to San Pablo Bay and does not influence drinking water quality. Mountain House was considered and was logistically sound, but due to current pumping schedules, runoff from Mountain House would flow more directly to the Central Valley Project through the Delta Mendota Canal than to the State Water Project. Lathrop was determined to be the best

choice for this study because its location is logistically the most feasible, and Lathrop has the potential to directly impact the State Water Project's drinking water quality.

Lathrop is a small municipality that was rapidly urbanizing prior to the housing market collapse. Being able to assess its impacts on drinking water quality now will give us the opportunity to revisit later and assess the changes in land use and water quality. Also because Lathrop is a small municipality, it is covered under the Phase II General NPDES Permit and is, therefore, not required to monitor its stormwater runoff. In order to manage drinking water throughout the Delta effectively, it is necessary to know what contributions small growing municipalities make to drinking water quality.

Objectives

This study will assess the effects of urban stormwater runoff from Lathrop on the San Joaquin River Watershed with special attention paid to first flush storm water events. Because the population of Lathrop is small, this study may serve as a baseline of water quality conditions and land use patterns. As development continues to grow, we will be able to see at what population size urbanization results in significant effects on drinking water quality. This may be useful in policy decisions regarding monitoring of stormwater and mitigation of negative impacts on drinking water quality for urban runoff.

Study Design

Sampling will start at the first storm event of the 2009-2010 wet season, and will continue for at least 2 years. Grab samples will be collected from the rivers, and composite samples collected by autosamplers will be collected from the city's stormwater pumping plants.

River samples will be collected on the San Joaquin River south of Lathrop at Mossdale, north of Lathrop at Brandt Bridge, and at Lathrop just downstream of the confluence of the San Joaquin and Old River. Grab samples will also be collected at the head of Old River. Grab samples from the rivers will be collected via boat or van and the timing of collection will be determined by the tide. The order in which the river stations will be sampled will depend on what stage in the tidal cycle the river is in at that time, such as flood or ebb, and samples will be collected within a timely manner to ensure all river station samples are collected at the same stage. For example, when the storm event occurs, if the tidal stage is flood, the Brandt Bridge station would be sampled first, and the Mossdale station would be sampled last, but all stations would be sampled during the flood tide. Because storm events can occur during any stage

in the tidal cycle, samples taken during separate storm events may not be comparable since samples taken at both flood and ebb tides are not comparable. Therefore, the focus of the analysis will be on what percent of the total load Lathrop contributes to the San Joaquin River.

Autosamplers will be used to collect samples from Lathrop's 8 pumping plants that discharge to the San Joaquin River. These stations are M1, M2, M3, M5, M6, KV, River and Stone Bridge pumping plants. These stations automatically pump discharge into the river once a pre-determined volume is reached in their stilling well. Figure 1 identifies both the cities' discharge stations and the river sites that will be sampled.

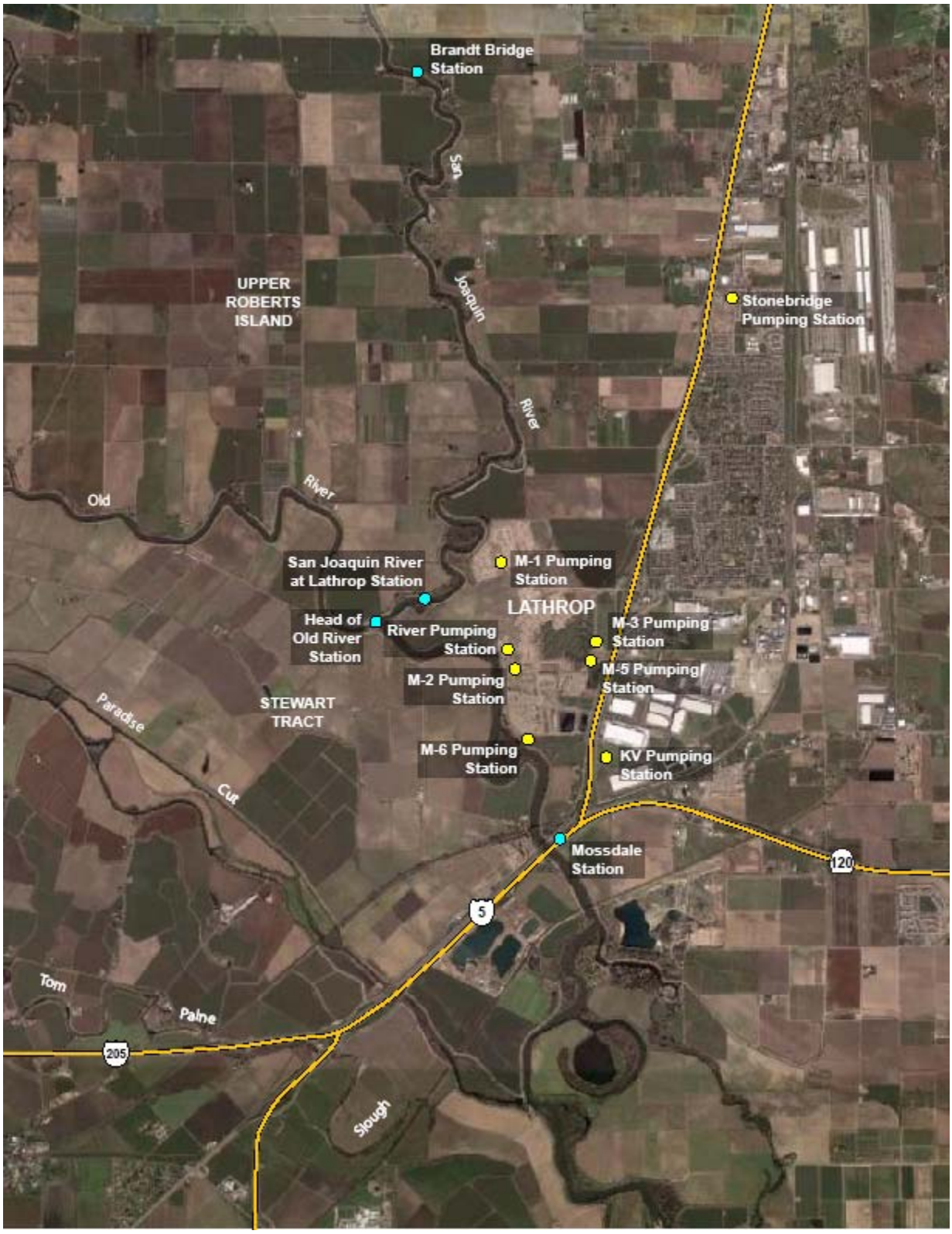


Figure 1. Location of sampling stations for urban runoff study. City discharge pump stations are in yellow. River sampling stations are in blue.

Sample analytes will include minerals (Calcium, Magnesium, Sodium, Potassium, Alkalinity, Sulfate, Chloride, Boron), metals (Aluminum, Antimony, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Mercury, Nickel, Manganese, Molybdenum, Selenium, Silver, Thallium, Zinc), nutrients (Nitrate+Nitrite, Ammonia, Organic Nitrogen and Ammonia, dissolved orthophosphate), pesticides (chlorpyrifos, diazinon, malathion, atrazine, simazine, cyanazine, prometryn), total and dissolved organic carbon, bromide, bacteria (total and fecal coliforms), turbidity, total dissolved and suspended solids, UVA_{254} and total trihalomethane formation potential.

A GIS analysis will assess the land use patterns in the study area. This analysis will be valuable in a future correlation between change in land use patterns and water quality.

Deliverables and Timelines

Deliverables	Participants	Estimated Completion Date
Storm event sampling at 12 sites in the Lathrop study area	MWQI Staff MWQI Field Group	September 2011
Analysis of samples as indicated above by DWR	Bryte Laboratory	October 2011
Final Report	MWQI Staff	April 2012

Budget

See 2009/10 Workplan

2008-09 Workplan Proposal for Urban Sources and Loads Investigation--Lead Investigator: Rachel Pisor

Background/Introduction

As Delta watersheds continue to urbanize, the impacts to drinking water quality from urban runoff is of concern. MWQI has already conducted one intensive urban loading study of the Natomas East Main Drainage Canal (NEMDC) watershed. The study found that, on a daily basis, NEMDC contributed up to 93 percent of the organic carbon load in the Sacramento River at Hood during the wet season. On a monthly basis, NEMDC contributed up to 8.2 percent of the organic carbon load, up to 19 percent of the nitrate plus nitrite load, and up to 14 percent of the orthophosphate load at Hood. These numbers emphasize the level of impacts that urban drainage can have on drinking water quality and the importance of tracking urban loading as the Delta continues to urbanize.

Objectives

The purpose of this study is to investigate where MWQI should focus its efforts for another urban load study in the FY 2009/10. Possible areas of investigation include:

a) examining the impacts from a Southern Sacramento urban watershed (ie. Morrisson Creek).

b) conducting a follow-up study to the previous NEMDC study, with the purpose of determining whether any water quality changes have occurred in the 4 years that have passed between studies and filling in data gaps associated with the first NEMDC study.

c) examining Stockton urban impacts to the San Joaquin River (identifying suitable sample areas).

d) evaluating the effectiveness of mandated in-place Best Management Practices (BMPs) from stormwater permits as they relate to drinking water constituents of concern.

e) quantifying urban runoff from Brentwood and/or Lathrop as their vicinity to the Banks Pumping Plant would have the immediate impact on water quality, and because of their size, no stormwater monitoring has been conducted by the cities.

During this fiscal year, staff will examine the feasibility of the above options (and any others that are uncovered). The goal of this research is to provide the background information required to begin the field

work or design of the project. Research conducted will determine the ideal location, feasibility and logistics.

Deliverables and Timelines

Deliverables	Associated Tasks	Participants	Estimated Completion Date
Conduct background research and investig study locations, feasibility and logistics.	A,	**MWQI Program**	June 2009

Budget

Labor Costs: Labor hours: 1595.5 Labor Cost: $118,128 Other Costs: 0 Total Cost: $118,128

2008-09 Workplan proposal for Sources, Fate, and Transport of Nitrosamines and their Precursors in the Sacramento-San Joaquin Delta and the State Water Project--Lead Investigator: Carol DiGiorgio and MWDSC

Note there are no changes between the 2008-09 study design and the 2009-10 study design. The latest study planned for 2010-11 is summarized in the 2010-11 Workplan.

Background/Introduction

Nitrosamines are highly carcinogenic compounds with cancer potentials much higher than that of trihalomethanes (THMs). Historically, nitrosamine concerns have centered on food products. More recently, interest has focused on drinking water—especially effluent-impacted supplies, as surface waters used for drinking water that are downstream of wastewater treatment plants (WWTPs) may contain the carcinogenic compounds themselves, or the precursors necessary to form nitrosamines. Depending on the level of nitrification and/or the use of advanced physical/chemical treatment at a WWTP, the discharge can be a major source of nitrosamines and/or their precursors. Treated wastewater used for groundwater recharge has been shown to contain N-nitrosodimethylamine (NDMA) at elevated levels (cited in Mitch and others, 2003). In an effluent-dominated river in Colorado, elevated levels of nitrosamines (i.e., NDMA and N-nitrosomorpholine [NMOR]) and nitrosamine precursors have been detected (Krasner and others, 2005). There is also evidence that some nitrogenous pesticides may react with chlorine or chloramines to form nitrosamines (for example, diuron) (Chen and Young, 2007). In addition, certain nitrosamines (e.g., NDMA) can be a chloramination by-product created during the drinking water disinfection process. If certain organic nitrogen precursors are present, drinking water facilities that have switched from chlorine to chloramines, to reduce THM formation in their distribution system, may find themselves in the untenable position of having reduced THMs only to have created more toxic nitrosamines.

Because it was first detected in drinking water wells, much of the attention has been directed at NDMA. However, as more information has become available, the California Department of Public Health has set notification levels of 10 ng/L each for NDMA, N-nitrosodiethylamine (NDEA), and N-nitroso-di-n-propylamine (NDPA), with a Public Health Goal for NDMA of 3 ng/L (http://www.cdph.ca.gov/certlic/drinkingwater/Pages/NDMAhistory.aspx, accessed 12/29/07). The EPA's Unregulated Contaminant Monitoring Rule 2 (UCMR2) has also listed 6 nitrosamines, NDEA,

NDMA, NDPA, N-nitroso-di-n-butylamine (NDBA), N-nitroso-methylethylamine (NMEA), and N-nitroso-pyrrolidine (NPYR), as contaminants to be monitored during 2008-2010 to support the Agency's determination of whether to regulate these contaminants in the interest of protecting public health (http://www.epa.gov/safewater/ucmr/ucmr2/basicinformation.html#list, accessed 12/29/07). Early indications suggest that nitrosamines will become the next set of contaminants regulated in treated drinking water by the EPA (Bruce Macler, EPA Region 9, Pers. Comm., Oct. 2007).

The largest municipal discharger to the Delta is the Sacramento Regional WWTP, with an average annual dry weather flow of 160 MGD. Depending on its treatment practices, Sacramento Regional WWTP may be a source to the Sacramento River of both nitrosamines and nitrosamine precursors. With the plant's discharge site located a few miles upstream of a potential peripheral canal location at Hood, understanding what concentrations of nitrosamines and/or nitrosamine precursors are present at this site is critical. The next largest WWTP discharge in the Delta is located in Stockton. Although discharge from this facility (36.7 MGD average annual dry weather flow) would not affect the water quality of a peripheral canal structure, water quality at the Banks Pumping Plant could be affected. Therefore, regardless of whether a dual conveyance, a through Delta conveyance or a peripheral canal is ultimately decided upon, understanding water quality contributions from both of these WWTPs to nitrosamines and nitrosamine precursors are important to the drinking water community that receives its water from the SWP.

The potential of agricultural inputs of nitrosamine precursors (e.g., from diuron) also needs to be examined. The Delta receives pesticide and herbicide inputs from the Sacramento and San Joaquin River's watersheds, as well as supporting an average annual farming industry of over $2.1 billion within the Delta itself (http://www.delta.ca.gov/pdf/Sacto-SanJoaqin_fact.pdf**,** accessed 12/29/07). Moreover, diuron is the third most heavily used herbicide in California.

Objectives

Because of their extreme toxicity, their likely potential to become regulated in the future, and the fact that no assessment of the occurrence of nitrosamines or the nitrosamine formation potential of Delta waters has ever been undertaken, MWQI proposes a cost share special study with Metropolitan Water District of Southern California that would 1) identify and quantify some of the potential sources of nitrosamines and their precursors at a number of key points in the Delta (i.e., sample upstream and downstream of potential

point sources), and 2) examine the fate and transport of nitrosamines (which can undergo photolysis depending on the depth of the photic zone) and their precursors (which can be biodegraded to some extent in a river) in the Delta. The study proposed would be a 2-year study, so that trends and seasonal patterns could be assessed. Because this is a cost share study, no large expenditures are anticipated for this study.

Study Design

To accomplish the project objectives, MWQI would sample quarterly, for 2 years, beginning in July 2008, from 7 sites (i.e., total of 8 sampling events). The sites sampled would be:

1. West Sacramento Drinking Water Intake: This sampling site would serve as the sampling point upstream of Sacramento Regional WWTP. Samples collected at this point would also capture most of the agricultural drainage impacts from the Sacramento River watershed.
2. Sacramento River at Hood: This sampling site would serve as the sampling point downstream of Sacramento Regional WWTP and is also one of the potential sites of a peripheral canal.
3. San Joaquin River at Mossdale: This sampling site would serve as the sampling point upstream of Stockton's WWTP.
4. San Joaquin River at Holt: This sampling site would serve as the sampling point downstream of Stockton's WWTP.
5. San Joaquin River at Vernalis: This sampling site would capture most of the agricultural drainage impacts from the San Joaquin river watershed.
6. Banks Pumping Plant: This sampling site integrates all of the Delta and riverine influences to the headworks of the SWP's California Aqueduct.
7. Twitchell Island ag drain: This sampling site would represent the in-Delta agricultural drainage inputs from a high-carbon peat island.

Three of these sites are already part of MWQI's discrete sampling program.

Along with standard field measurements, samples would be analyzed by Bryte Laboratory for total organic carbon, dissolved organic carbon, diuron, TKN, ammonia, nitrates + nitrites, total phosphate, UVA-254, THMFP, and HAAFP. A subset of each sample would be split and sent to Metropolitan Water District of Southern California (MWDSC)'s chemistry laboratory, where samples would be analyzed for eight nitrosamines (all nitrosamines with notification levels and all those listed in the UCMR2, as well as NMOR and N-nitrosopiperidine [NPIP]) and nitrosamine formation potential testing. If time and funding

permit, MWDSC would also analyze for the anticonvulsants primidone and carbamazepine, as well as caffeine, as conservative tracers of WWTP influences. This will help determine whether the sources of the nitrosamine precursors are from treated wastewater or other sources.

Deliverables and Timelines

Deliverables	Participants	Estimated Completion Date
Quarterly sampling at 7 sites in the Sacramento-San Joaquin Delta	MWQI staff MWQI Field Group	July 2010
Analysis of all samples as indicated above by both DWR and MWDSC	Bryte Laboratory MWDSC Laboratory	August 2010
Final Report	MWQI staff MWDSC staff	December 2010
Paper for Publication	MWQI staff MWDSC staff	Submitted March 2011

Literature Cited

Chen, W.-H., and T.M. Young. 2007. Potential transformation by-product and associated risk of diuron in the disinfection process. Presented at the 233rd American Chemical Society national meeting, Chicago, Ill.

Krasner, S.W., P. Westerhoff, B. Chen, G. Amy, and S. Nam. 2005. Contribution of wastewater to DBP formation: case study of an effluent-impacted river. In the proceedings of the 2005 American Water Works Association (AWWA) Water Quality Technology Conference. Denver, Colo.: AWWA.

Mitch, W. A., J. O. Sharp, R. Rhodes Trussell, R. L. Valentine, L. Alvarez-Cohen, and D. L. Sedlak. 2003. N-Nitrosodimethylamine (NDMA) as a drinking water contaminant: a review. Environmental Engineering Science (20)5: 389-404.

Budget.

DWR MWQI and MWDSC have agreed to a cost-sharing arrangement for this study.

2008/09 Labor Costs: Labor hours: 1144 Labor Cost: $ 91,347 Other Costs: $429.00 Total Cost: $91,776

2008-09 Workplan proposal for Investigation of O'Neill Forebay water circulation--Lead Investigator: Ron Melcer

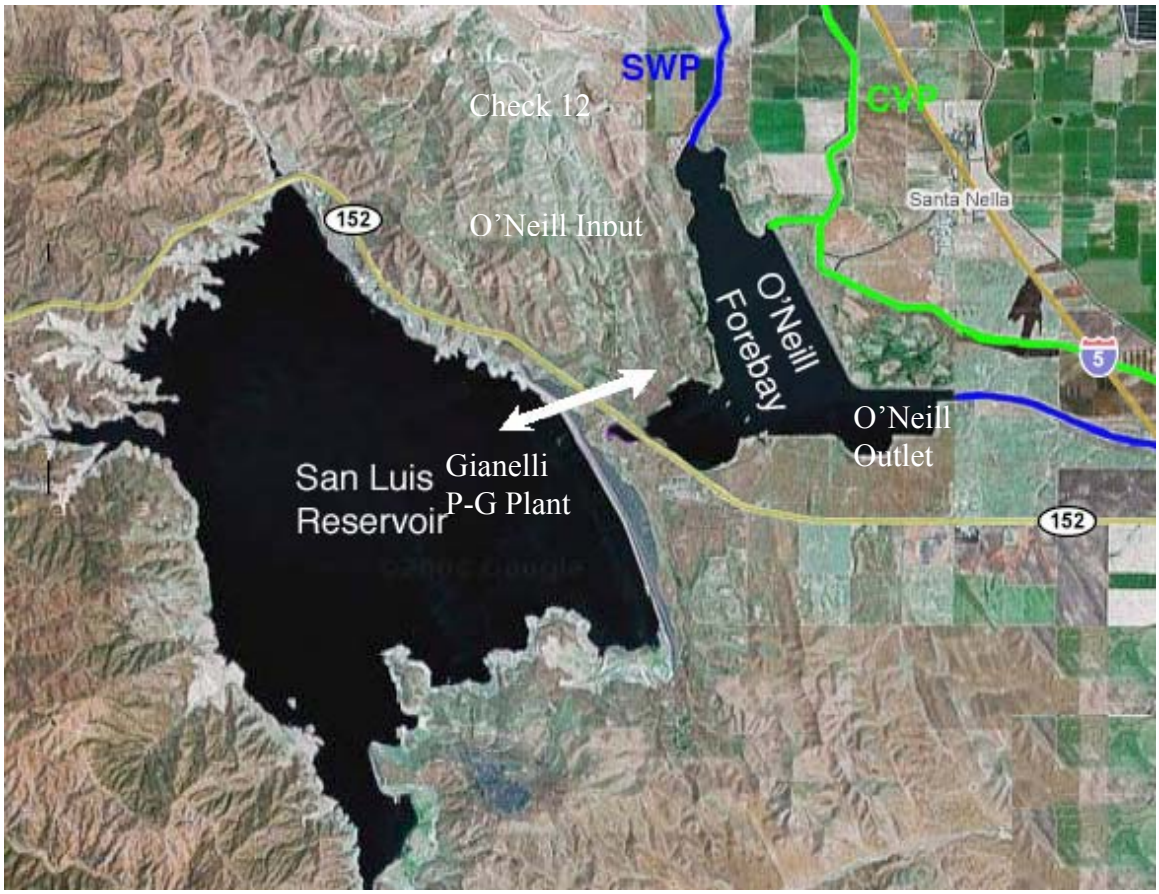
See the 2010-11workplan for modifications to this proposal.

Background/Introduction

Water from the State Water Project (SWP) and federal Central Valley Project (CVP) are pumped into O'Neill Forebay at the foot of Sisk Dam and San Luis Reservoir (Figure 2). The SWP and CVP waters are generally of differing water quality, containing different concentrations of bromide and other dissolved salts, organic carbon, and other constituents of concern. Water from the SWP enters O'Neill at its north end, at SWP Check 12. Water from the CVP enters O'Neill on the east side, at CVP O'Neill Intake. Depending on flow and pumping conditions at Gianelli Pumping-Generating Plant, the two waters may be transported south into the joint-use aqueduct at O'Neill outlet, or flow through a channel on the west side to Gianelli and thence into San Luis Reservoir. Observations suggest that the waters do not appreciably mix in O'Neill and, specifically, that CVP water tends to hug the east shore of O'Neill and travel directly to O'Neill Outlet.

Objectives

The behavior of water flows in O' Neill forebay has important implications for water quality modeling and forecasting. The objectives of this study are to: (i) better understand water flow patterns in O'Neill Forebay under a range of conditions, (ii) support more accurate numerical modeling of the O'Neill Forebay region of the DSM2 Aqueduct Extension model, and (iii) improve forecasting of water quality characteristics in subsequent parts of the State Water Project.

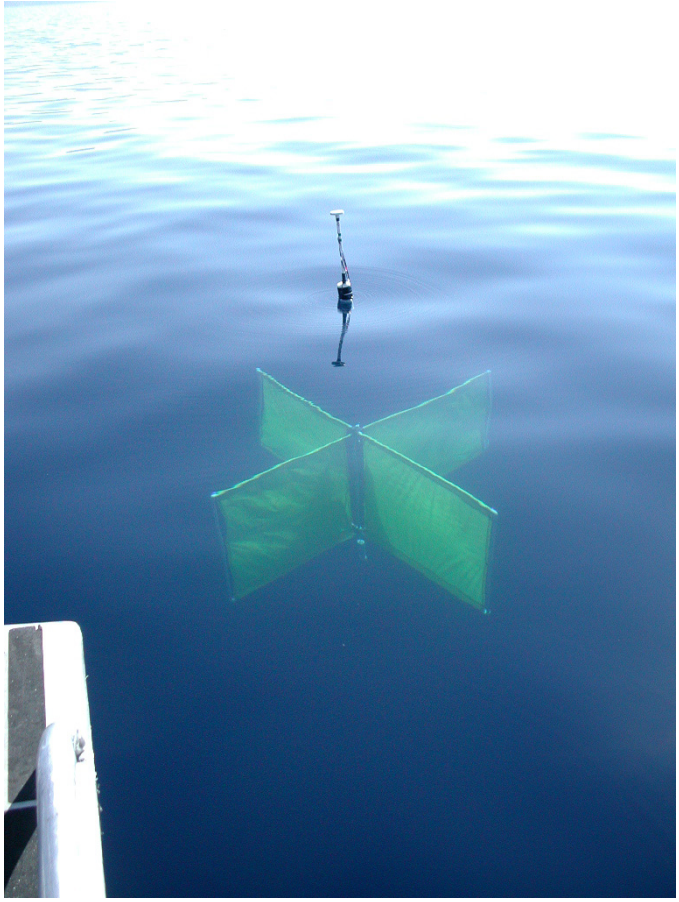


CVP water enters at O'Neill Input. The waters may not mix on their way to O'Neill Outlet.

Figure 1. Movement of SWP water into O'Neill Forebay

Study Design

Passively-drifting drogues are a proven tool in lake and ocean circulation studies (e.g., Austin and Atkinson 2004; Figure 3). A submerged "kite" moves with the water at a chosen depth, carrying a surface sensor along with it. In this application, the surface buoy would contain a small, battery-powered GPS receiver and logger. The logger would periodically record the drogue's location for later recovery and downloading.



Buoy is attached to drogue by short stainless steel cable. Each yellow panel is 1 m square. Drifters used in this study may be much smaller. (example picture taken on Lake Tahoe, CA-NV).

Figure 2. Example of a drifter surface buoy with a GPS location logger

Deliverables and Timelines

Deliverables	Participants	Estimated Completion Date
Purchase miniature logging GPS receivers materials to construct drifters.	**MWQI Program**	Sept 2008
Assemble and test drifters	**MWQI Program**	Oct 2008
Field studies at O'Neill Forebay	**MWQI Program**	Dependent on pumping. Nov 2008 - May 2009, with potential sampling in July 09 based on Wanger effects on summer pumping.
Data Analysis and preparation of report	**MWQI Program**	Dec 2008 – June 2009
Preparation of peer-reviewed manuscript for publication	**MWQI Program**	May 2009 – July 2009

Literature Cited

Austin, Jay and Sten Atkinson. 2004. The design and testing of small, low-cost GPS-tracked surface drifters. Estuaries and Coasts 27(6): 1026-1029.

Budget

Labor Costs: Labor hours: 1559.5 Labor Cost: $125,509 Other Costs: $10,000 Total Cost: $135,509

2010-11 Workplan Proposal for Spectrofluorometer Investigation--Lead Investigator: Ted Swift

Note that this study proposal updates the 2009-10 study proposal listed in this appendix.

Background/Introduction

Natural water sources contain a complex variety of dissolved and particulate organic materials, or natural organic matter (NOM). In the Sacramento-San Joaquin River Delta, primary sources include tributary river flows from, in-Delta algae and 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. Regulatory agencies such as the US EPA have put in place regulations on the concentrations of DBPs allowable in finished drinking water. Thus, it is of great interest to (a) understand the sources, chemical reactivity, and seasonal variations of NOM in Delta source waters and (b) identify ways of producing the most useful water quality information with the least effort and cost.

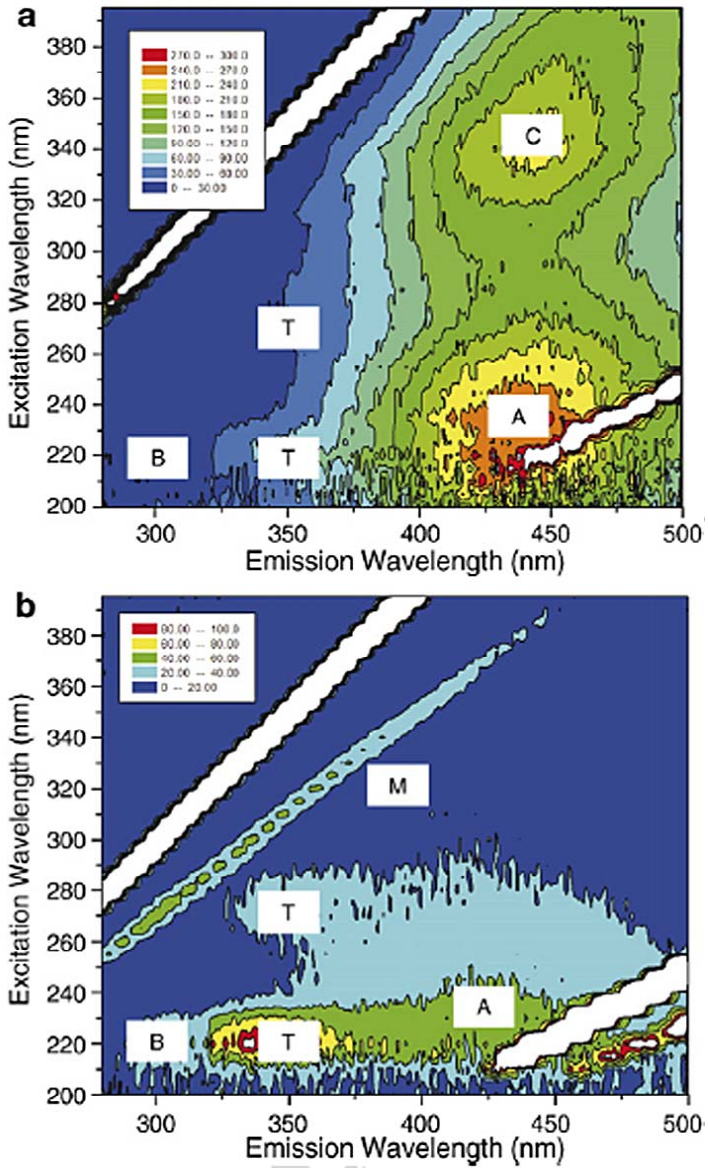
NOM can be evaluated through several surrogate measurements such as total organic carbon (TOC), dissolved organic carbon (DOC), absorbance spectroscopy (e.g., UVA254) and spectrofluorescence methods. For example, MWQI operates TOC and DOC analyzers at the two main tributary points (the Sacramento River at Hood and the San Joaquin River at Vernalis) and two export facilities (Banks Pumping Plant on the State Water Project and Jones Pumping Plant on the federal Central Valley Project). UVA254 is used by DWR Division of Operations and Maintenance (O&M) as a DOC surrogate at several points in the SWP. These have all proven to be quite useful in accurately measuring TOC or DOC as a bulk measurement. However, without other concurrent and relatively laborious analyses, such as trihalomethane formation potential (THMFP) or pigment analysis, these bulk measurements do not provide much insight into the sources, concentrations, and potential reactivity of NOM in a given water sample.

Measurement principles

Fluorescence occurs when a loosely held electron within an atom or molecule is excited to a higher energy level (electron orbit) by absorption of energy, e.g, a photon of light, and subsequently releases

energy as light as it drops to a lower energy level. Some energy is lost prior to emission, so the energy of the emitted photon is lower than the excitation energy. Shorter wavelengths of light correspond to higher photon energies. Thus, stated another way, the wavelength of the excitation light is shorter than the emission wavelength. The wavelength at which excitation and emission occur is specific to the molecule involved. Those compounds that absorb light (often pigments) are called chromophores and those that both absorb and re-emit light energy are called fluorophores. Aromatic organic compounds provide particularly good subjects for fluorescence analysis due to the electron structure of the carbon ring (Hudson *et al*., 2007).

A spectrofluorometer is an instrument that implements this principle by exciting the sample across a rapidly-scanned range of ultraviolet-to-visible light wavelengths, while simultaneously measuring light emission across another band of wavelengths. The result is an *excitation-emission matrix* (EEM), such as Figure12, where excitation wavelength is on one axis (most often vertical), emission wavelength is the second, and fluorescence intensity forms a third axis, often represented by color. Each matrix consists of hundreds of excitation-emission measurements of a single water sample. Water constituents of concern, such as DOC and algae, along with other characteristics that may be distinctive of each source water, can be resolved from features in the EEM (Yan, 2000). For example, pigments within living algae produce distinctive features characteristic of the algal family. Spectrofluorescence has also been used to distinguish wastewaters from pristine waters (e.g., Baker *et al.* 2004b, Hudson *et al.,* 2007).



Typical fluorescence EEMS showing the position of the principal fluorophores in optical space: (a) River Tyne, England (b) coastal North Sea. Note that the fluorescence intensity scale is different for (a, 0-300) and (b, 0-100). C=terrestrial humic/fulvic-like peak; M=marine humic/fulvic-like peak; A=humic-like peak; T=tryptophan-like, protein-like peak; B=tyrosine-like, protein-like peak. Fluorophores C and M are often referred to as H, humic/fulvic-like peak for comparison. The diagonal linear features are Rayleigh Tyndall and Raman scattering of water, respectively (from Spencer et al., 2007).

Figure: 1. Typical fluorescence EEMs observed in a study by Spencer et al., 2007

In 2007, the DWR QA/QC group acquired a high-performance FluoroMax 4 spectrofluorometer to investigate the usefulness of spectrofluorometric analysis to Delta and Delta source waters. An extensive and growing body of literature (e.g., Beggs *et al*., 2009, and references in Henderson *et al.* 2009 and Hudson *et al.* 2007), strongly suggest that this approach may provide a rapid method or methods of accurately quantifying multiple constituents of concern in a single measurement.

Objectives

This study will evaluate the usefulness of spectrofluorometry as a method of rapidly quantifying constituents of concern (COCs) such as DOC, algae and organic carbon, and as a method of fingerprinting source waters as they pass through the Delta. This study will examine the feasibility of configuring a spectrofluorometer instrument to operate unattended in remote real-time monitoring applications. It will also seek to identify distinctive characteristics of Delta source waters to provide a water "fingerprint" that would be used to, among other things, validate Delta water models.

Study Design

Field grab samples will be collected approximately monthly for two years at sites in the Delta study area and Delta source waters. Sites will be selected to reflect the individual tributary source waters, seasonal variations, and the likely sources of COCs in each source water. Sampling stations will include

- West Sacramento Drinking Water Intake. Samples from this site would represent the Sacramento River upstream of Sacramento Regional Wastewater Treatment Plant (WWTP). Samples here would also include most of the agricultural drainage impacts from the Sacramento River watershed.
- Sacramento River at Hood. Samples from this site would represent water downstream of Sacramento Regional WWTP
- Sacramento Water Intake on the American River.
- San Joaquin River at Vernalis. Samples from this site would capture the San Joaquin River as it enters the Delta. It would include most of the agricultural drainage impacts from the San Joaquin river watershed.
- Banks Pumping Plant. Samples from this site would represent water as it leaves the Delta at the beginning of the State Water Project's California Aqueduct.
- Other source waters further upstream of the Delta, such as the Colusa Basin Drain, tributaries to the Sacramento River, the Mokelumne and Cosumnes Rivers, and tributaries to the San Joaquin River.

Samples will be analyzed as soon as possible after collection to minimize changes. However, Yan *et al.* (2000) found in a study of sample stability that a sample that had been stored in a sealed dark-glass

container for 43 days had, within experimental error, same structure and intensity originally measured for those samples within 24 hours of collection.

Laboratory preparations of specific "end member" waters will include dissolved organic carbon from known Delta peat soil, pure cultured algae, and cultured algae that has been allowed to senesce.

In coordination with the MWQI standard field sampling program, samples will be analyzed by Bryte Laboratory for total organic carbon, dissolved organic carbon, pH, and UVA-254,. Subsamples from the ongoing collaborative investigation of nitrosamine sources by Carol DiGiorgio, Joe Christen (DWR), Stuart Krasner (MWD), and others, will be analyzed spectrofluorometerically to seek out fluorescence features that correlate with nitrosamine formation potential. To date, nitrosamines themselves have not been found in detectable concentrations in field samples. However, their precursors may be detectable using these methods.

The resulting data will be analyzed to identify distinctive features in the EEMs that are highly correlated with characteristics such as DOC and TOC concentration, THMFP, nitrosamine formation potential, and algal biomass. Analytical tools will include multiple regression, parallel factor analysis, and principle component analysis.

Deliverables and Timelines

Milestones / Deliverables	Participants	Estimated Start Date	Estimated Completion Date
Sampling at sites in the Delta study area, development of lab pure samples	MWQI Staff MWQI Field Unit	March2010	June 2012
Spectrofluometric analysis of raw and filtered water samples	MWQI Staff	March2010	June 2012
Analysis of samples by DWR Bryte Laboratory	Bryte Laboratory	March2010	June 2012
Interim report	MWQI Staff	May 2011	July 2012
Final Report	MWQI Staff	July 2012	October 2012

Literature Cited

Baker, Andy, David Ward, Shakti H. Lieten, Ryan Periera, Ellie C. Simpson, Malcolm Slater. 2004. Measurement of protein-like fluorescence in river and waste water using a handheld spectrophotometer. Water Research 38:2934–2938.

Beggs, Katherine M. H., R. Scott Summers, and Diane M. McKnight. 2009. Characterizing chlorine oxidation of dissolved organic matter and disinfection by-product formation with fluorescence spectroscopy and parallel factor analysis. J. Geophysical Research, 114, G04001, doi:10.1029/2009JG001009.

Cory, Rose M. and Diane M. McKnight 2005. Fluorescence Spectroscopy Reveals Ubiquitous Presence of Oxidized and Reduced Quinones in Dissolved Organic Matter. Environ. Sci. Technol. 39, 8142-8149.

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Hudson, Naomi A., Andy Baker, and Darren Reynolds. 2007. Fluorescence Analysis of Dissolved Organic Matter in Natural, Waste and Polluted Waters —A Review. River Research And Applications 23: 631–649

Marhaba, Taha F., Karim Bengraine, Yong Pu, and Jaime Arago. 2003. Spectral fluorescence signatures and partial least squares regression: model to predict dissolved organic carbon in water. J. Hazardous Materials B97:83–97.

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Yan, Yuan, Hong Li and M.L. Myrick. 2000. Fluorescence Fingerprint of Waters: Excitation-Emission Matrix Spectroscopy as a Tracking Tool. Applied Spectroscopy 54(10):1539-1542.

Budget
See 2010/11 Workplan

2009-10 Workplan Proposal for Spectrofluorometer Investigation--Lead Investigator: Ted Swift

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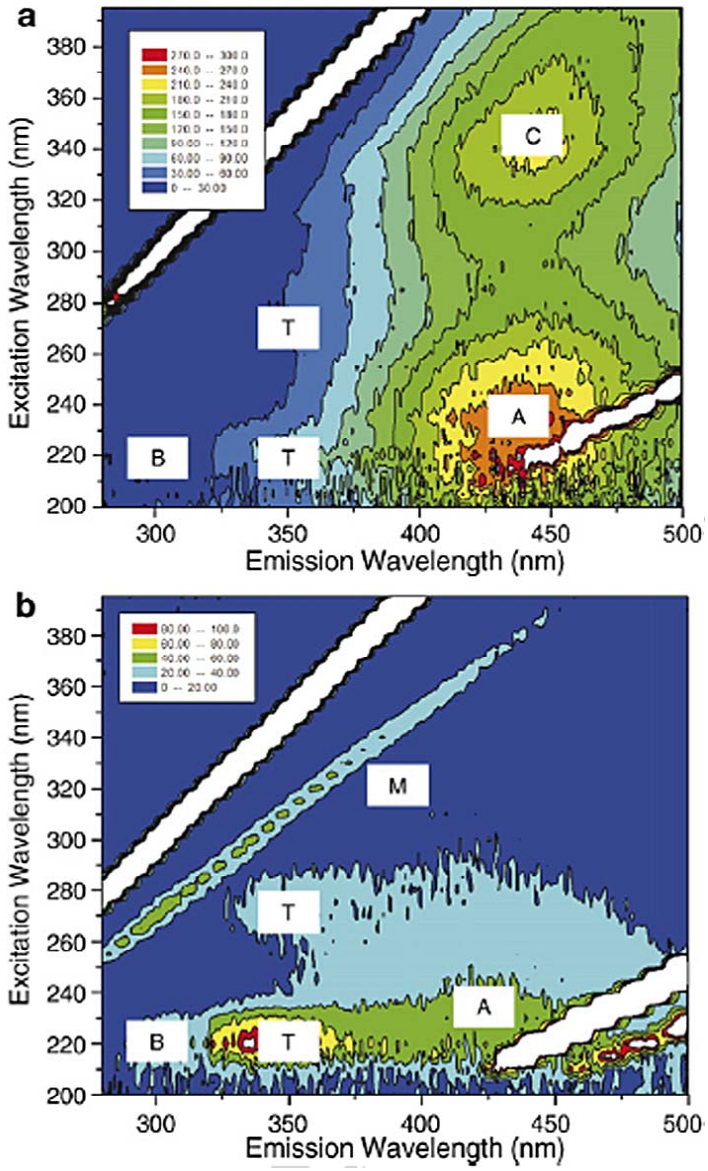

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The resulting data will be analyzed to identify distinctive features in the EEMs that are highly correlated with characteristics such as DOC and TOC concentration, THMFP, and algal biomass. Analytical tools will include multiple regression, parallel factor analysis, and principle component analysis.

Deliverables and Timelines

Milestones / Deliverables	Participants	Estimated Start Date	Estimated Completion Date
Approximately monthly sampling at sites in the Delta study area	MWQI Staff MWQI Field Unit	July 2009	June 2011
Spectrofluometric analysis of raw and filtered water samples	MWQI Staff	July 2009	June 2011
Analysis of samples by DWR Bryte Laboratory	Bryte Laboratory	July 2009	June 2011
Interim report	MWQI Staff		July 2010
Final Report	MWQI Staff		October 2011

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Budget
See 2009/10 Workplan

Appendix 3-MWQI 5 Year Strategic Plan

During 2006-07, the five-year strategic plan for the MWQI Program was updated and approved and adopted by the MWQI Technical Advisory Committee. This strategic plan will serve as the basis for the MWQI Program for completing development of program work plans for 2008-2009, and subsequent years. The plan that was approved is reproduced below.

MWQI Mission Statement

The mission of the MWQI Program is to collect and disseminate timely information to enable drinking water supplies taken from the Sacramento-San Joaquin Delta to be economically treated to produce safe and palatable drinking water. Information produced through this program will be used for:

1. Identifying and evaluating sources of drinking water contaminants.
2. Assisting MWQI Program participants in achieving their water quality objectives, meeting regulatory requirements, and planning for the future.
3. Supporting Delta and SWP water supply operations and assessing the water quality consequences of these operations.
4. Augmenting, in a cost-effective manner, the efforts of State and federal agencies mandated to monitor, protect, and improve drinking water.
5. Assessing impacts of actions by the California Bay Delta Authority and other entities on Delta and SWP drinking water quality.
6. Participating in public regulatory and funding processes to disseminate drinking water quality information and to assist in efforts to protect and improve drinking water sources.

Objectives for The Five-Year Plan

Organizational Structure, Coordination and Funding

- Develop an organizational structure that ensures staffing requirements for the MWQI Program are met on a timely basis through the retention of highly qualified personnel that have the expertise to meet MWQI Program objectives.
- Develop and implement the Real Time Data and Forecasting-Comprehensive Program (RTDF-CP) which will encompass tasks identified by the State Water Contractors, MWQI staff, other DWR units, outside agencies as high priority and achievable through cooperative effort.
- Work with the State Water Contractors to identify tasks that can most efficiently be performed through cooperative agreement, and participate in cooperative implementation of such tasks. These tasks will be described in detail and planned for on an annual basis in the RTDF-CP strategic plan.
- Work with the State Water Contractors to identify funding needs that will enable the MWQI Program to be adequately implemented, and to participate in acquiring, allocating, and accounting for, funds to accomplish needed work both directly, and through cooperative agreement.

- Coordinate MWQI Program activities with those of other DWR units under the RTDF-CP to enhance productivity, minimize duplication and overlap, and ensure effective coordination and communication among these units to enable joint implementation of water quality assessment and forecasting activities affecting the Delta and SWP as a whole.

Development and REfinement of a SWP "Early Warning System" for WAter Quality Concerns

- In conjunction with the Division of Operations and Maintenance and as one of the primary objectives of the RTDF-CP, develop and refine a "SWP Water Quality Early Warning" system that will alert MWQI Program participants of likely drinking water quality problems in a timely manner to enable preventative or corrective actions to be taken to avoid consumer impacts.
- Develop efficient communications among DWR units and MWQI Program participants to ensure early warning information is transmitted, received, and acted upon as appropriate.
- Tasks identified under the "Water Quality Monitoring", "Information Management and Dissemination", "Water Quality Forecasting", "Scientific Support" and "Emergency Response" program elements support the development of this early warning system.

Water Quality Monitoring and Emerging concerns

- Monitor water quality parameters relevant to drinking water at key locations in the Sacramento-San Joaquin Delta through periodic collection of discrete samples and their analysis by field and laboratory instruments, according to accepted methods.
- Maintain existing *in-situ* multi-parameter water quality monitoring stations on the Sacramento River at Hood, H.O. Banks Delta Pumping Plant Headworks, and San Joaquin River near Vernalis.
- As part of RTDF-CP work cooperatively with the State Water Contractors, other DWR units, and other agencies, to identify additional key locations in the Delta, its tributaries, and the State Water Project where additional *in-situ* water quality assessment equipment is needed. Work cooperatively with others to acquire needed permits, plan for and perform construction, acquire monitoring and communications equipment, bring new stations into operation, and assure the quality of data produced.
- Perform water quality assessments and evaluations to identify drinking water quality consequences of physical or operational changes in the Delta, its watersheds, and the State Water Project.
- With participation of the State Water Contractors, other MWQI Program participants, and DWR modelers, produce annual re-evaluations of the discrete and *in-situ* monitoring programs to identify and recommend needed changes to eliminate critical data gaps, provide valid data for the DSM2 model, improve program efficiency and minimize monitoring costs.
- Ensure timely and appropriate quality assurance/quality control of water quality and related information produced by the MWQI program. Take timely and effective action to identify and correct QA/QC problems. Include equipment/instrument maintenance and calibration as part of the annual QA/QC process.
- As part of the RTDF-CP work with other DWR units towards standardization of QA/QC procedures, especially for new stations.

- Continue to explore new and improved technologies for acquiring real time water quality data. Utilize new technology where possible to minimize monitoring costs and data gaps and to move towards standardization of monitoring methodology.
- Plan for emerging constituents of concern such as "Taste and Odor" issues that have been increasing with time. Respond to these emerging concerns in a timely manner as part of the RTDF-CP.
- As part of the RTDF-CP develop a comprehensive program of monitoring, early warning, and management for algal growths in the Delta and SWP having the potential for causing taste and odor in treated drinking water taken through the SWP. Governance of this program will be through a steering committee composed of DWR staff from relevant organizational units, and State Water Contractor representatives of affected agencies.

Information Management and Dissemination

- Provide timely analysis, interpretation, and dissemination of monitoring information to MWQI program participants and other identified stakeholders on key constituents of concern. Analyze and present monitoring results to program participants and in public proceedings.
- Continue to develop and refine capability for MWQI Program participants to rapidly acquire real time and other drinking water quality data and supporting information through the internet in user-friendly formats.
- Produce annual data and/or interpretative reports documenting program findings, as shall be determined by the MWQI Committee.
- Continue production of weekly water quality reports, with continuing improvements, as may be directed by the MWQI Committee.
- Provide technical assistance to MWQI Program participants in acquiring needed water quality data and supporting information.
- Research and develop new and innovative means of communicating MWQI Program work products to program participants and other interested parties.
- Encourage and promote actions by regulatory agencies necessary to ensure a high-quality and reliable water supply by disseminating information derived from the MWQI Program.
- Advocate drinking water quality protection by tracking new projects in the Central Valley, including operational planning activities, by alerting MWQI Program participants to projects having the potential to affect the quality of drinking water supplies taken through the Delta, reviewing and commenting on environmental documents, and participating in pubic hearings and workshops.
- Maintain awareness of findings from international, national, and regional research activities that have a bearing on the ability to meet future drinking water regulations, factor these findings into analyses of Delta water quality conditions and facilities options as appropriate, and communicate these findings to MWQI Program participants.

Water Quality Forecasting

- Complete development of, and implement, extension of the DSM2 Delta model to include the State Water Project.
- Produce timely water quality forecasts for SWP Contractors. MWQI Program staff will support DWR modeling efforts by providing water quality expertise needed to improve Delta models,

coordinating closely with modelers to collect data to support model development, and to improve the ability to interpret and apply model outputs.

- Pending full implementation of the extended DSM2 model, evaluate other existing models for the potential of providing interim water quality forecasts to SWP Contractors.

Scientific Support Studies

- In cooperation with MWQI Program participants and as part of the RTDF-CP, identify the need for, and implement, detailed studies to examine specific phenomena that affect, or may in the future affect, Delta drinking water quality. These studies may be generally classified as follows:
  - Detailed evaluations of problem areas or conditions identified as a result of monitoring activities.
  - Evaluations of drinking water quality consequences of proposed physical or operational modifications in the Delta and its tributaries, its inflows, internal flow patterns, or outflows.
  - Prediction of the drinking water quality consequences of population growth patterns.
  - Detailed evaluations of natural processes that have the potential to affect the quality of Delta drinking water sources.
  - Detailed evaluations of point and non-point pollutant discharges to the Delta (including tributaries to the Delta).

  Studies will be selected for implementation based on their significance to the quality of drinking water supplies taken through the Delta, and likelihood of being able to apply the information to attain higher quality of Delta drinking water sources. Outside expertise will be enlisted where necessary and feasible to conduct or collaborate on scientific studies.

Emergency Response

- Identify, to the extent possible, ahead of time specific concerns regarding these events and what constituents would need to be assessed.
- Develop scenarios for different emergency events using models to determine which areas in the Delta pose most significant DWQ issues
- Develop emergency response plans ahead of time (follow SIMS template), identifying funding and staffing needs, all participating groups and their roles
- Work with other DWR units (i.e. Div of Flood Management) to develop emergency response plans
- Encourage DWR Executive to treat these events similar to flood events
- Perform water quality assessments and evaluations in response to emergency situations, such as Delta levee breaks, supplying timely water quality information to emergency decision makers and public health authorities.
- During emergency circumstances, work cooperatively with emergency managers and rapidly communicate results of emergency water quality assessments the MWQI Program may be tasked to perform.