- **Board of Directors**
  Engineering and Operations Committee

March 12, 2002 Board Meeting

9-4

Subject

Authorize $3.511 million for an Alternative Disinfectant Evaluation to meet U.S. Environmental Protection Agency regulations and enhance the ability to treat higher blends of State Water Project supplies at the blend plants (Approp. 15390)

Description

The new Stage 1 Disinfectants/Disinfection By-Products (D/DBP) Rule issued by the U.S. Environmental Projection Agency (USEPA) became effective January 1, 2002. This rule reduces the allowable levels of certain DBPs and also requires a treatment technique to control DBP precursors. One way to control DBP precursors is through the use of elevated coagulant dosages (enhanced coagulation), which removes total organic carbon. Enhanced coagulation is undesirable for Metropolitan's facilities because it (1) greatly increases chemical and solids handling costs; (2) increases plant effluent total dissolved solids; and (3) offers no control of taste and odor problems.

The USEPA allows agencies to avoid enhanced coagulation if they use an alternative technology—such as ozone, chlorine dioxide, or other suitable method—which can reduce the DBPs to one-half of the new Stage 1 maximum contaminant levels.

Metropolitan is currently retrofitting the Jensen and Mills filtration plants with ozonation facilities to meet the alternative performance criteria of the treatment technique of the Stage 1 D/DBP Rule. These two plants exclusively treat State Water Project (SWP) supplies. Once the percentage of SWP supplies blended with Colorado River water exceeds 20-25 percent as a long-term average, the treatment technique at the three blend plants (Weymouth, Diemer, and Skinner) will need to be put into place. As such, ozonation facilities were also initially planned for the Weymouth, Diemer, and Skinner filtration plants. However, the Board has yet to approve the long-term compliance strategy for these facilities.

In order to determine the best treatment method, this proposed study—known as the Alternative Disinfectant Evaluation—will primarily study the feasibility of using chlorine dioxide as a replacement for pre-chlorination or ozonation at the Weymouth, Diemer, and Skinner filtration plants. The study will also determine the feasibility of using chlorine dioxide as a possible enhancement to ozonation at the Jensen and Mills filtration plants. Until recently, the use of chlorine dioxide was precluded in California because of the California Department of Health Services (CDHS) stringent action level for chlorite, a chlorine dioxide DBP. CDHS subsequently rescinded their action level and adopted a much higher federal maximum contaminant level for chlorite, which no longer precluded the possible use of chlorine dioxide. In January 2002, CDHS released an action level for another chlorine dioxide DBP—chlorate—which may again cause utilities to avoid using chlorine dioxide.

The Alternative Disinfectant Evaluation would evaluate the most cost-effective methods that

- comply with Stage 1 (and the recently negotiated Stage 2) of the D/DBP Rule;
- ensure reliable disinfection under all treatment conditions;
- meet CDHS action levels for DBPs;
- allow unrestricted blending of SWP supplies with Colorado River water at the three blend plants;

- allow Metropolitan to avoid the increased costs and increased total dissolved solids associated with enhanced coagulation;
- control selected taste and odor problems; and
- meet a proposed member agency goal of 50 µg/L for distribution system trihalomethane levels.

The Alternative Disinfectant Evaluation will also study some modifications of the free chlorine/chloramine process. Ultraviolet light disinfection is being studied under a separate capital program (the Desalination Research Innovation Partnership).

Major project steps to complete the Alternative Disinfectant Evaluation include:

- Bench- and demonstration-scale testing of chlorine dioxide and free chlorine/chloramine process performance;
- Pilot-scale testing of distribution system issues (e.g., microbial control and taste and odor formation) related to chlorine dioxide;
- Bench-, pilot-, and demonstration-scale testing of methods to minimize chlorine dioxide by-products;
- Bench-, pilot-, and demonstration-scale testing of methods to improve taste and odor control with chlorine dioxide.

The overall schedule for implementing this program is approximately 18 months. A detailed report is given in **Attachment 1**. A financial statement is shown in **Attachment 2**.

Policy

Metropolitan Water District Administrative Code § 5108: Capital Project Appropriation

California Environmental Quality Act (CEQA)

CEQA determination for Option #1:

The proposed action is categorically exempt under the provisions of CEQA. The proposed action involves the funding of a study, i.e., Alternative Disinfectant Evaluation and minor modifications to existing public facilities with no expansion of use and no possibility of significantly impacting the physical environment. In addition, the proposed action will consist of basic data collection, and resource evaluation activities which does not result in a serious or major disturbance to an environmental resource. This may be strictly for information gathering purposes, or as part of a study leading to an action which a public agency has not yet approved, adopted, or funded. As such, the proposed action qualifies for both Class 1 and Class 6 Categorical Exemptions (Sections 15301 and 15306 of the State CEQA Guidelines).

The CEQA determination is: Determine that pursuant to CEQA, the proposed action qualifies for both Class 1 and Class 6 Categorical Exemptions (Sections 15301 and 15306 of the State CEQA Guidelines).

CEQA determination for Option #2:

None required.

Board Options/Fiscal Impacts

Option #1

Adopt the CEQA determination and

a. Authorize funds for an Alternative Disinfectant Evaluation to meet U.S. Environmental Protection Agency regulations; and
b. Enhance the ability to treat higher blends of SWP supplies at the blend plants.

Fiscal Impact: $3.511 million of out-of-budget CIP funds under new Appropriation No. 15390. If the Board approves this recommendation, the fiscal year 2001/02 CIP expenditure plan will be adjusted.

Option #2

Do not authorize funds for the study. This option limits the most likely treatment technologies at the Weymouth, Diemer, and Skinner filtration plants to ozonation or enhanced coagulation.

Fiscal Impact: Potential increased costs of treatment that would not be necessary if chlorine dioxide were feasible.

Staff Recommendation

Option #1

Jill T. Wicke *Manager, Water System Operations*	2/20/2002 *Date*
Ronald R. Gastelum *Chief Executive Officer*	2/21/2002 *Date*

Attachment 1 – Detailed Report

Attachment 2 – Financial Statement

BLA #1485

DETAILED REPORT

Background

The Safe Drinking Water Act (SDWA) Amendments of 1996 require the U.S. Environmental Protection Agency (USEPA) to develop new and improved drinking water regulations. One set of regulations, known as the Disinfectants/Disinfection By-products (D/DBP) Rule, addresses key public health concerns related to chronic and acute exposure to disinfectant residuals and by-products formed during disinfection.

Stage 1 of the two-stage D/DBP Rule was promulgated in December 1998 and took effect January 1, 2002. Under Stage 1, the maximum contaminant level (MCL) for trihalomethanes (THMs) was lowered from 100 micrograms per liter (µg/L, or parts per billion) to 80 µg/L. A new MCL of 60 µg/L was established for the sum of five haloacetic acids (HAA5). New MCLs were also established for bromate (an ozone DBP) and chlorite (a chlorine dioxide DBP). In addition, the D/DBP Rule requires the use of a treatment technique (such as enhanced coagulation) to control DBP precursors. Alternatively, a plant that treats water with less than 4.0 mg/L of total organic carbon (TOC) and greater than 60 mg/L of alkalinity can comply with the treatment technique if THM and HAA5 levels are less than 40 and 30 µg/L, respectively.

Stage 2 of the D/DBP Rule was recently negotiated and is expected to be promulgated by USEPA in 2003 with compliance for large systems such as Metropolitan by 2010. In Stage 2, the current practice of determining compliance by averaging DBP results from all sampling sites within a distribution system will be eliminated. Instead, compliance will be determined at each sampling site within the distribution system. Under this negotiated compliance requirement, a violation at any sampling location would result in the entire system being out of compliance. Even though Stage 1 MCLs were negotiated to remain the same in Stage 2, the requirement to comply with DBP MCLs at each sampling site is expected to significantly reduce overall exposure to DBPs.

In order to comply with Stages 1 and 2 of the D/DBP Rule, Metropolitan is retrofitting plants that exclusively treat State project water (SPW) with ozone. Startup for ozone facilities at the Mills and Jensen plants is scheduled for 2003 and 2005, respectively. Metropolitan's Board has yet to authorize the long-term compliance strategy to be used at plants that treat blends of SPW and Colorado River water (CRW).

The Alternative Disinfectant Evaluation proposes to investigate possible alternatives to the current pre-chlorination practice at the three blend plants (Diemer, Skinner, and Weymouth). If approved, this project would investigate the most cost-effective chemical disinfection methods that:

- comply with Stage 1 (and the recently negotiated Stage 2) of the D/DBP Rule, in particular the alternative performance criteria to enhanced coagulation (i.e., THMs less than 40 µg/L and HAA5 less than 30 µg/L);
- ensure reliable disinfection under all treatment conditions;
- meet California's action levels for DBPs;
- allow unrestricted blending of SPW with CRW;
- allow Metropolitan to avoid the increased costs and increased total dissolved solids (TDS) associated with enhanced coagulation;
- control selected taste-and-odor problems; and
- meet a goal proposed by several member agencies of 50 µg/L for distribution system THM levels.

The Alternative Disinfectant Evaluation will study the use of chlorine dioxide as a possible replacement for pre-chlorination treatment. Until recently, the use of chlorine dioxide for drinking water treatment had not been feasible in California. A stringent action level for chlorite enacted in 1990 by California's Department of Health Service (CDHS) had precluded the use of chlorine dioxide. Based on recent short-term health effects data, CDHS revised its action level on chlorite (this inorganic compound is formed during the decomposition of chlorine dioxide and is considered a DBP). In November 1998, CDHS adopted the USEPA's promulgated MCL for chlorite ion (1.0 mg/L). Based on the lack of health effects data at this time, USEPA and CDHS have both indicated that chlorate ion (another chlorine dioxide DBP) would not be regulated by the D/DBP Rule for now. However, studies regarding the possible health effects of chlorate are being conducted. In January 2002, CDHS issued an action level for chlorate at 0.2 mg/L. This action level may again cause utilities in California to avoid the use of chlorine dioxide.

The use of chlorine dioxide for drinking water treatment is attractive in that it is a strong disinfectant and that its use with chloramines results in the formation of low concentrations of THMs and HAAs (less than 20 μg/L for either DBP). However, if chlorine dioxide cannot be used to meet all of the disinfection requirements, some chlorine disinfection is also needed which will result in higher THM and HAA5 formation. Based on these reported DBP levels, the use of chlorine dioxide may allow Metropolitan to avoid the use of enhanced coagulation at the Diemer, Skinner, and Weymouth plants. In contrast to chlorine and ozone, bromide ion does not typically react with chlorine dioxide. However, chlorine dioxide may react with bromide in open basins during the daylight. Unlike enhanced coagulation, pH adjustment and large coagulant dosages are typically not required to optimize chlorine dioxide treatment. As a result, chlorine dioxide treatment typically has little impact on TDS levels.

Capital costs for the design and installation of chlorine dioxide generating equipment are relatively inexpensive in comparison to other potential treatment options. The majority of cost associated with the use of chlorine dioxide is due to the cost of sodium chlorite, a key reactant in the formation of chlorine dioxide (chlorite ion is both a reactant and by-product during chlorine dioxide treatment). The generation of chlorine dioxide requires chlorination equipment similar to equipment already in place at Metropolitan's facilities. In addition, facilities for the storage, metered feeding, and containment of 25 percent sodium chlorite solution would be required.

One significant unknown factor at this time is whether the use of a chlorine dioxide reactor would be required to achieve disinfection, optimize treatment, or avoid reactions with sunlight. It is expected that if reactors were required to implement chlorine dioxide, construction costs would increase significantly and the time required to implement this alternative treatment would be extended.

Significant disadvantages to the use of chlorine dioxide relate to the presence of chlorite and chlorate in treated water. The MCL for chlorite is 1.0 milligram per liter (mg/L, or parts per million) and the action level for chlorate is 0.2 mg/L. The chlorite MCL requires daily compliance sampling and does not allow for averaging. As approximately two-thirds of the chlorine dioxide dose added to water decomposes to form chlorite and one-third decomposes to form chlorate, the 1.0 mg/L chlorite MCL would effectively limits the maximum chlorine dioxide dose in most waters to 1.25 mg/L in order to meet the MCL with a safety factor. The chlorine dioxide dose could be further limited to 0.5 mg/L because of the action level for chlorate. These maximum chlorine dioxide doses may not be sufficient to meet all disinfection requirements for waters containing high TOC levels and/or high chlorine dioxide demands. Alternatively, the use of ferrous salts (in addition to the coagulant) may reduce chlorite concentrations in the chlorine dioxide treated water. However, this reaction may be pH dependent, where pH-controlling chemicals could increase the TDS of the water. Also, the use of ferrous salt may adversely impact filtered water turbidity levels.

In addition, sub-optimal chlorine dioxide generation conditions may result in the addition of either excessive chlorite ion or free chlorine to the treated water. In general, optimal chlorine dioxide generation will require extensive operator training, frequent generator maintenance, and continuous monitoring by laboratory and operations personnel to avoid the addition of excessive amounts of unreacted chlorite ion or free chlorine.

The presence of chlorite in treated plant effluent may pose problems for member agencies that convert Metropolitan's chloramine residual to free chlorine within their distribution systems—even for relatively short durations. Free chlorine will react with residual chlorite ion to re-form chlorine dioxide. When opening water faucets in homes and office buildings, low concentrations of chlorine dioxide may volatilize and react with air-borne synthetic organic compounds. These reactions may form strongly objectionable odors that resemble kerosene and cat urine. Complaints regarding these odors are generally received from the occupants of newly-constructed homes or following the installation of new carpeting. These odors may dissipate over a period of several months. However, these odors can be avoided by removing chlorite ion or eliminating the use of free chlorine in the distribution system.

Another issue is the ability of chlorine dioxide to control taste- and odor-causing chemicals present in the source waters. Chlorine dioxide does not destroy 2-methylisoborneol (MIB) or geosmin, which cause earthy/musty odors. Alternatively, powdered activated carbon (PAC) can be used to control MIB or geosmin. However, PAC doses may be high and may require elevated coagulant doses to avoid carbon breakthrough. In addition, chlorine dioxide may not destroy certain chemicals that cause fishy, swampy or grassy odors, which are currently controlled with the use of pre-chlorination.

It should also be noted that the presence of chlorite in treated plant effluent may also have beneficial aspects. Initial studies suggest that low concentrations of chlorite ion can effectively control the growth of bacteria that degrade ammonia from chloramines within the distribution system (a process known as nitrification). This could benefit member agencies that have difficulties maintaining disinfectant residuals in portions of their distribution systems. The inhibitory effect that chlorite may have on microbial communities within the distribution system may reduce the need to maintain elevated chloramine residuals. This effect may also lessen the need to periodically use free chlorine in place of chloramines in many distribution systems.

This study will also evaluate the potential use of pre-chlorination contactors to provide disinfection and control THM levels. Under this treatment scenario, pre-chlorination contactors located at the head of the treatment plant would be used to minimize free chlorine contact and THM formation. After complying with mandated disinfection requirements, ammonia would be added to the chlorine contactor effluent to convert the remaining free chlorine residual to chloramines. A chloramine residual would then be maintained through the treatment plant and into the distribution system. This proposed treatment scheme differs from current treatment in which chlorine is added at the entrance to the treatment plant. Currently, a free chlorine residual is maintained through the flocculation and sedimentation basins to achieve required disinfection credit and ammonia is added after the filters. The primary limitation with current treatment is the inability to adequately control the free chlorine contact time prior to ammonia addition and optimize disinfection treatment. Moderate changes in plant flow rates may result in excessive free chlorine contact times and result in increased DBP formation.

Advantages to the proposed pre-chlorination contactor treatment scheme are similar to those found with chlorine dioxide treatment. If pre-chlorination treatment were capable of controlling THM formation to less than 40 μg/L, the use of enhanced coagulation could be avoided. Additionally, this treatment scheme would require no significant changes in plant operations, chemical handling, and require only moderate amounts of operator training. In contrast to chlorine dioxide treatment, there would be no significant increases in operator workload and no added complexities of chlorine dioxide generation.

A significant disadvantage to the pre-chlorination contactor option is that it does not allow unrestricted blending. Depending on the influent total organic carbon (TOC) and bromide levels, the use of pre-chlorination contactors may not significantly increase the SPW blend percentage that can be achieved at Diemer, Skinner, and Weymouth plants now. Additionally, this treatment scheme may require the construction of contactors with long detention times. Current hydraulic profiles at these treatment plants may not accommodate these contactors without the use of lift pumps.

Project Description

The Alternative Disinfectant Evaluation will evaluate the use of chlorine dioxide and pre-chlorination contactors as possible methods to replace current pre-chlorination treatment and comply with current and recently negotiated regulations concerning disinfection and DBP formation. These initial evaluations will incorporate combinations of bench-, pilot-, and demonstration-scale testing as required. Depending on the levels of chlorite and chlorate produced during the initial bench-scale studies, further testing may be curtailed

Project Schedule

If approved, the Alternative Disinfectant Evaluation would begin in March 2002. The projected schedule is:

- Begin Project: March 2002
- Initiate bench-scale chlorine dioxide demand testing: March 2002
- Initiate pre-chlorination contactor bench-scale testing: March 2002
- Conduct pre-chlorination contactor demonstration-scale tests: June 2002
- Chlorine contactor feasibility determination: July 2002
- Initiate pilot- and demonstration-scale chlorine dioxide testing: July 2002
- Initiate studies of impact of chlorite on distribution system bacteria: March 2003
- Determine chlorine dioxide reactor design criteria (if required): March 2003
- Evaluate ferrous chloride for chlorite control: March 2003
- Evaluate powdered activated carbon for taste-and-odor control: May 2003
- End Project: Sept. 2003

Financial Statement

A breakdown of the Board Action No. 1 for Appropriation No. 15390 to finance the funding for the Alternative Disinfectant Evaluation is as follows:

	Board Action No. 1
Labor, labor additives, and overhead	$2,086,000
Operating Equipment	$ 350,000
Materials and Supplies	$ 342,000
Outside Services – Professional	$ 250,000
Incidental Expenses	$ 25,000
Remaining funds	$ 458,000
Total	**$3,511,000**