Attachment A
Water Quality Evaluation

C-085118

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Attachment A. Water Quality Evaluation

This water quality evaluation has been prepared by EBMUD to provide an overview of EBMUD's current water supply and the water quality issues associated with the water supply sources considered for the Supplemental Water Supply Project Alternatives Screening Report. This evaluation is based on water quality data developed by EBMUD and other water suppliers and by state and federal agencies. It is divided into the following five general subjects:

- Water Quality Issues Common to All Water Utilities
- Current Water Supply Operation
- Regulatory Requirements for Drinking Water
- Water Quality of Alternative Sources
- Impacts of Alternative Water Sources on EBMUD

WATER QUALITY ISSUES COMMON TO ALL WATER UTILITIES

The quality of available sources of water supply is one of the most important issues that water utilities must address in choosing their supplies. Source water quality affects consumers in many ways, including risks to public health, treatment costs to meet drinking water standards, industrial production costs, and aesthetic acceptance. The importance of this issue is reflected in the "Statement of Policy on Water Supply Matters, Drinking Water Quality," by the American Water Works Association:

> All water utilities should deliver to the consumer an adequate supply of high-quality drinking water at a cost commensurate with the needs of each individual water system. To achieve this objective, the water should come from the highest quality source of supply available and be appropriately treated to meet regulatory and water supply industry criteria.

The following discusses several specific source water quality issues that are common to all water utilities. For each issue, industry responsibility/duty, industry general practice, and EBMUD's approach to the issue are discussed.

1. Public Health Protection

Industry Responsibility/Duty

Water purveyors are at the forefront of public health protection and have been for many years. Ever since public drinking water supplies were first implicated in the spread of disease in the late 1800s, public health protection has been one of their key concerns. The responsibility for public health protection extends from the source water through the treatment facilities and distribution system to the customer's tap. Federal and state agencies have played a significant role in protecting public health as well by enacting and enforcing drinking water standards. Health standards were first promulgated in the United States in 1914 and have become ever more stringent since then. Despite the agency involvement, the primary responsibility is still with the water purveyor. One of the most important lessons learned over the past hundred years is that the first and most important step for a water purveyor in protecting public health is to select and maintain a high-quality source with low risk of contamination.

In recent years, there have been increasing concerns regarding the impact of drinking water on public health, and minimizing public health risks has been reinforced as a key consideration for all water utilities. High quality drinking water for public health protection is demanded by the public and consumers, who are more informed and expect more now than ever before. This is evidenced by a 1993 Roper survey, sponsored by the *National Geographic Society,* which found that 83 percent of Americans rate upgrading of municipal water treatment systems as an excellent or good idea, and 76 percent support this measure even if it raises rates. A 1993 survey by the American Water Works Association Research Foundation found that 74 percent of water customers were willing to pay more to raise their water quality above the federal minimum standards, 82 percent were willing to pay more to meet existing federal standards, and water quality consistently rates high among "quality of life' indicators.

This information suggests that the responsibility of water utilities is not only to protect public health based on documented health effects research, but also to meet the demands of its customer base.

Industry General Practice

As a result of the 1996 Amendments to the Safe Drinking Water Act, source water protection has become a national priority. Accordingly, a source water protection goal is included in EPA's draft "Environmental Goals for America with Milestones for 2005." It is EPA's goal that by the year 2005, 60 percent of the population served by community water systems will receive their water from systems with source water protection programs in place. As a result of the Surface Water Treatment Rule, promulgated in 1989, every water utility drawing water from surface supplies is now required to conduct a sanitary survey of its watershed every five years. The sanitary surveys not only document contamination sources but also assess their impacts on drinking water quality and recommend steps to minimize or eliminate the sources of contamination. Similarly, wellhead protection programs are required for most groundwater recharge areas. The 1996 SDWA Amendments have been codified into environmental law and add a new prevention approach (e.g., source water assessment programs) that seeks to prevent problems by increasing each public water system's capacity to provide safe drinking water and to protect its source waters.

Water industry professionals have long recognized that higher source water quality is a key component of a multiple barrier approach to delivering a safe drinking water. This approach is an inherently better way to protect public health than trying to remove contaminants through a single barrier (i.e., treatment), particularly in light of the recently recognized need to balance the conflicting risks of microbial and chemical contaminants in the treatment of drinking water. Treatment technology is only capable of removing known contaminants and is still vulnerable to breakdown or human errors. Even the best monitoring and treatment technologies can sometimes fail to protect public health.

EBMUD Approach

EBMUD has a long history of public health protection through source water selection and protection. This began with its original selection of the Mokelumne River as its primary supply in the 1920s. The Mokelumne River above Pardee Reservoir, the point of diversion, is largely undeveloped and will remain so because much of its 575 square mile watershed is mountainous and held in public ownership.

To formalize this basic responsibility to provide a safe drinking water, EBMUD has adopted the following policy:

> It is EBMUD policy to "protect the public health of its customers by serving high quality water from the best available source in preference to reliance on additional treatment." (Policy 81)

In putting this policy into practice, EBMUD routinely monitors water quality and activities in the watersheds above its supply reservoirs. Additionally, EBMUD has prepared watershed master plans, conducted sanitary surveys and developed a subsequent action plan with recommendations for EBMUD-owned, publicly-owned and privately-owned lands. These activities comprise a strategic plan to address water quality protection throughout the watersheds.

EBMUD's pursuit of a supplemental water supply from the American River is consistent with this policy and with the opinion of state regulatory agencies. In the Lower American River Court Reference Report of Referee, the State Water Resources Control Board held, as a matter of water policy, that the "best available source" doctrine should govern the determination of drinking water source.

> EBMUD has a duty to ensure the quality of its supply...[A] public water supplier should obtain water from the *best available source* and provide treated water of the highest practical quality. Prudence dictates that a public water supplier should *minimize treatment uncertainties by seeking water from the best available source and as removed from the potential for degradation as possible.*" (Report of Referee at 14, emphasis added)

2. Protection from Future Health Risks

Industry Responsibility/Duty

A high quality water source not only provides public health protection in the present, it is a head start in ensuring future protection. The need for protection from future health risks is affirmed by the increasing public expectations for safer drinking water and by the fact that more pathogens and chemical contaminants have been identified and will be regulated in the future. For example, *Giardia*, a significant waterborne pathogen, and disinfection by-products have only been of concern for the past 25 years, and *Cryptosporidium*, the pathogen of most concern today, was first attributed to a waterborne disease outbreak only about 10 years ago. Even more recently, MTBE, a compound added to gasoline to reduce air pollution only for the past few years, has been found with alarming incidence in groundwater and surface water supplies. This recognition of the recent changes and continuing trend in water quality concerns obliges utilities to secure and maintain high quality sources and to protect them from future sources of contamination.

Industry General Practice

Water industry standard practice for ensuring high quality water supplies now and in the future includes three key aspects:

Watershed development/use/management - The more protected and less developed the watershed, the less potential there is for contaminant sources that present risks to public health. Because of greater access control and less commercial and industrial activity in undeveloped watersheds, there is less risk of accidental contamination from toxic spills and less risk of contamination from urban storm runoff, sanitation facilities and fuel lines.

Treatment capability (current) - Although there have been substantial advancements in treatment technologies to remove microbial and chemical contaminants, it is unrealistic and cost prohibitive to provide treatment technologies to protect customers from unknown future risks. Instead, treatment facilities are designed and operated to meet current health standards, and the majority of large water utilities, such as EBMUD, provide treatment to produce water quality better than that minimally required by regulation. Facilities are typically designed to reliably meet drinking water standards and protect public health under foreseeable operating conditions, but not for future and unknown regulatory requirements. For some utilities, this means providing additional processes or capacity in the design facilities. For others it means having alternate sources, treatment facilities, or distribution system components.

Adaptability/expansion of treatment - Over time, more contaminants of a public health risk will be identified as technology continues to evolve. EPA is presently developing a contaminant occurrence data base from which contaminants will be selected for future regulation. As more information becomes available, there will be greater need for expanded treatment should these contaminants be found in water supplies. With a lower quality source of supply, there are increased future risks. Those who have had to rely on poorer sources typically construct treatment facilities that can be adaptively managed and have the potential for process upgrades and additions in order to meet future regulatory requirements. However, it is not practical to design facilities adaptable to all possible changes, nor is it possible to build fail-safe facilities.

EBMUD Approach

As discussed above, EBMUD's primary approach is source water selection and protection. In the American River litigation (circa 1990), the Court determined that based on the evidence presented, "health risk concerns of EBMUD are well founded...It is the respect for the unknown which dictates the continuing validity of [source protection] as one of the legitimate bases for public health decisions." (Superior Court of California, Judge Hodge)

EBMUD's approach also includes flexibility to utilize multiple supply sources and use of appropriate treatment technologies. EBMUD's water treatment facilities that treat Pardee Reservoir water directly are designed with in-line filtration, a process that is applicable to treating a high quality water source. On the rare occasions, such as the winter of 1997, when the treatment system cannot meet production and water quality requirements because of high turbidity in the raw water, EBMUD can switch to other, local sources that are usually held in reserve.

If a poorer quality source than the American River is chosen as a supplemental supply, major capital improvements will be required to achieve the same quality that EBMUD customers expect. This is because EBMUD's treatment facilities were designed and built based on its high quality Mokelumne River source. A commitment to the continued high level of service to its customers led to the EBMUD Board of Directors establishing an objective to "maintain the high quality of EBMUD's water supply." (Updated WSMP FEIR, Vol. 1, pp 6-4). The resulting underlying assumption in the programmatic EIR/EIS is that all alternative sources of supply would be treated to achieve a quality comparable to the Mokelumne Supply (Updated WSMP FEIR, Response to Comment D14-3).

3. Consumer Acceptance

Industry Responsibility/Duty

Water utility customers are more informed and demand a better quality product than ever. In areas such as the San Francisco Bay Area, where drinking water quality can vary widely from one locale to another, this quality of life factor can be one of the bases for choosing a place of residence. just as quality of schools, distance to work, etc., are. Therefore, in addition to meeting health-related standards and criteria, most of which can be ascertained only by laboratory examination, water utilities must also address the aesthetic quality of their product.. This objective is embodied in AWWA's Statement of Policy on Water Supply Matters, Drinking Water Quality:

> Water delivered to the consumer for domestic purposes should...be free from biological forms that may be aesthetically objectionable. It should be clear and colorless and should have no objectionable taste or odor.

Industry General Practice

Consumer acceptance of water quality is a critical benchmark and objective of most utilities. Nearly all water utilities that treat water with even occasional taste and odor problems are equipped with facilities to treat for those problems. These facilities are typically aeration, chlorination or permanganate feed systems. Utilities with more severe problems often implement advanced technologies. In California, water utilities are required to report customer complaints to the Department of Health Services (DHS) each month. Utilities with poor records may be required to take steps to correct recurring problems. Furthermore, in California, secondary drinking water standards (based on aesthetic quality) are enforced in the same manner as primary, health-based standards.

EBMUD Approach

EBMUD has a duty and has made a historical commitment to provide its customers with a drinking water supply that is safe, reliable, and free from taste and odor problems. When EBMUD was formed in the 1920s, it secured a high quality source from the Mokelumne River. Less expensive sources from the Sacramento-San Joaquin Delta and groundwater were considered, but it was determined to be in the public's best interest to choose a source of higher quality. EBMUD's water treatment system has evolved over 70 years and has been optimized in reliance on a high quality water source. In its local sources, EBMUD has occasionally experienced taste and odor problems, and in response ozonation facilities were added at two of its water treatment plants to remove the compounds that cause the problems. EBMUD is also implementing a program to reduce the sources of compounds that result in taste and odor episodes in the raw water reservoirs.

Operationally, treating a supplemental supply which is similar to the Mokelumne source will minimize impacts to EBMUD's customers. They rely on a consistent, high quality water, and if that water quality is altered to accommodate a lower water quality source, there will be a perception that it is less healthful and their confidence in the water supply will diminish. This will lead to more frequent use of alternatives such as bottled water or point of use devices. The quality of these alternatives is less routinely monitored and they may be more expensive with no reduction in health risks. Thus, EBMUD considers aesthetic quality to be as important as health-related quality.

4. Compatibility with Existing Customer Use

Industry Responsibility/Duty

Whenever a water utility introduces a water source of different quality to its system, the impacts on existing customers and facilities must be considered. A common problem experienced in this regard is corrosion of piping and plumbing materials. An extreme example of this occurred in Tucson, Arizona, several years ago. When Tucson introduced Colorado River water to its system, red water complaints due to corrosion of iron pipes were widespread. The problem became so severe that a 150 MGD water treatment plant was removed from service indefinitely. Similarly, commercial and industrial enterprises expect specific levels of water quality and have developed their processes accordingly. Lowering this water quality may require substantial and expensive process modifications. It is the responsibility of the utility to protect the investment that residential, commercial and industrial customers have made in their own plumbing and treatment facilities as well as their investment in the water utility's infrastructure.

Industry General Practice

The industry general practice when introducing new water supplies is to make the supply compatible with existing supplies and improve water quality. It is necessary to evaluate the impacts on the existing customers based on one or more the following:

- Water quality monitoring
- Literature reviews

- Calculations and paper studies
- Surveys and/or inspections of existing customers
- Assessment of special customer needs
- Bench- or pilot-scale studies
- Full-scale trials

This information can then be used to select among water source alternatives and determine the type and level of treatment/conditioning needed for the selected source.

EBMUD Approach

EBMUD has conducted many of the specific activities cited above to evaluate the compatibility of alternative sources, including water quality monitoring, literature reviews, calculations and paper studies, assessments of special customer needs, and bench- and pilot-scale studies. The results indicate that it is in the customers' best interest to select a source that is comparable in quality to the existing Mokelumne River supply.

EBMUD's industrial and commercial customers have made significant capital investments based on Mokelumne River source water quality. The EBMUD service area has attracted industries such as high technology, food processing and biotechnology that are very sensitive to small changes in water quality. Delivery of a lower water quality supply would result in substantial increases in capital and operational costs for these commercial and industrial customers.

5. Avoid Water Quality Degradation and Re-directed Impacts

Industry Responsibility/Duty

The provisions of the California Safe Drinking Water Act place a significant responsibility upon drinking water suppliers in California to maintain existing high quality and to take actions to improve quality. This California statute is not simply an embodiment of federal law, but rather, it seeks "to improve upon the minimum requirements of the federal Safe Drinking Water Act Amendments of 1996" (California Health and Safety Code, Section 116300(e)). If a community which currently receives a higher quality drinking water supply is asked to accept a lower quality supply, the water supplier faces increased challenges and risks in providing a safe and reliable water supply to the community it serves, despite the increased investment in additional treatment facilities. Should the water utility abdicate its responsibility to protect its supplies from degradation in quality and pass the cost of treatment to the end users, it redirects significant negative impacts to its customers, both in public health protection and costs.

Industry General Practice

Consistent with the 1996 SDWA Amendments and the California Safe Drinking Water Act, water utilities are mandated to strive to seek the best available source of potable supply and protect that source from contamination. In assessing redirected impacts, if a water utility is faced with choosing between two available sources of supply, it is industry general practice to evaluate the *total* costs associated with that supply, both to the utility and the customer. For example, in comparing an inexpensive but highly mineralized groundwater source to a more expensive, high quality surface water supply, the long-term total cost to the customer may be substantially higher for the groundwater source. With a higher mineral content, industrial customers face higher treatment costs, and residential customers may face more frequent replacement of plumbing materials, water heaters and other appliances.

EBMUD Approach

Where there is an alternative, EBMUD's approach to minimizing degradation and redirected impacts is to develop a potable water supply from the best available source and to take aggressive measures to protect that source of supply. EBMUD's program of source protection includes implementation of sanitary surveys, a watershed master plan and watershed strategic plans to balance land uses and minimize the potential for contamination of its water supplies. In seeking a supplemental water supply from the American River, EBMUD has also taken an integrated resource management approach in assessing public health risks, water treatment costs, current and future regulatory requirements for drinking water quality and compatibility with its existing treatment facilities.

The water quality issues discussed above are common to all utilities. The differences and contrasts in choices made by each utility facing such issues are based on local conditions, constraints, historical development and customer preferences. All of the water sources being considered can be treated to meet drinking water standards. However, in EBMUD's case, the history of having a high quality source and the economic impacts associated with introduction of a lower quality source have led to the decision to seek American River water.

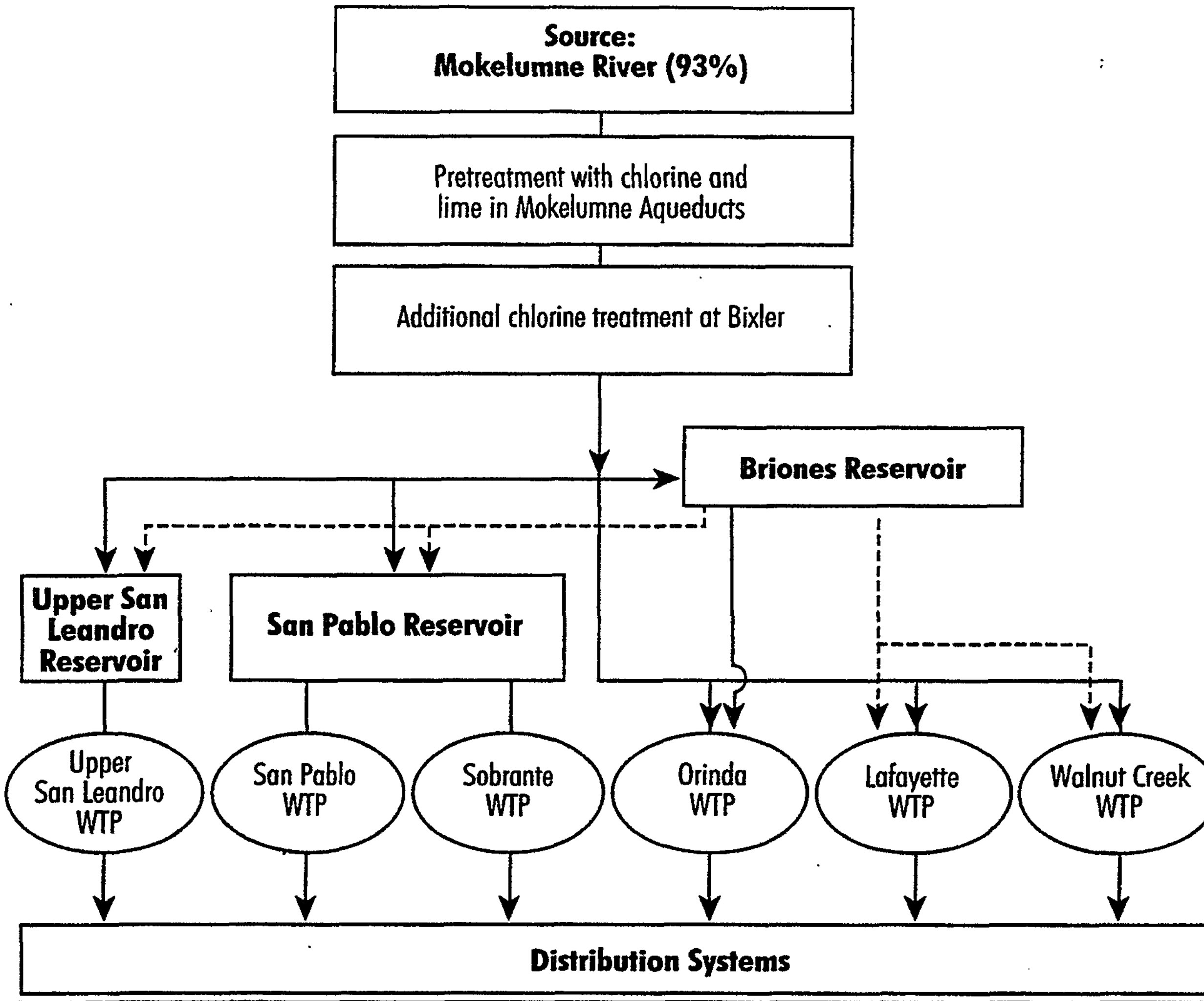
CURRENT WATER SUPPLY OPERATION

Water Sources

On a long-term average, EBMUD diverts approximately 93 percent of its current water from Pardee Reservoir which collects runoff and snowmelt from the Mokelumne River watershed. The drainage area above Pardee Reservoir is approximately 575 square miles of mostly undeveloped land on the western slope of the Sierra Nevada in Alpine, Amador, and Calaveras counties. Pardee Reservoir water is transported to the Bay Area via three parallel pipelines, the Mokelumne Aqueducts. The remainder of EBMUD's water supply is collected from local runoff draining into three terminal reservoirs (San Pablo, Upper San Leandro and Briones Reservoirs) in the Bay Area. The terminal reservoirs are also used to store excess Pardee Reservoir water. A schematic diagram of EBMUD's water supply system is shown in Figure A-1.

Water Treatment

The Pardee Reservoir supply is of extremely high quality, with low turbidity, mineral content and natural organic matter (NOM). In all but extreme storm events, this water requires only minimal treatment consisting of in-line filtration and chlorine disinfection to meet drinking water standards. EBMUD operates three in-line filtration plants (Orinda, Lafayette and Walnut Creek, WTPs) that treat water directly from the Mokelumne Aqueducts. The Orinda WTP also occasionally draws water from Briones Reservoir to supplement the Mokelumne supply during limited periods of the year to meet short-term increases in customer demand. If the Mokelumne



Water Treatment Plant	Source Water	Type of Treatment	Year of Construction	Capacity in MGD
Walnut Creek	Pardee Reservoir	In-Line Filtration	1967	80
Lafayette	Pardee Reservoir	In-Line Filtration	1953	35
Orinda	Pardee Reservoir/ Briones Reservoir	In-Line Filtration	1935	175
San Pablo	San Pablo Reservoir	Conventional Treatment	1921	55
Sobrante	San Pablo Reservoir	Conventional Treatment + Ozone	1965	60
Upper San Leandro	Upper San Leandro Reservoir	Conventional Treatment + Ozone	1961	65

Notes:
Chabot and Lafayette Reservoirs, small standby reservoirs, would be used for potable supply only during extreme emergencies.
Briones Reservoir can supply the entire system on an emergency basis.
WTP capacities are based on Partnership for Safe Water documentation.
San Pablo WTP is a standby facility.

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Figure A-1
EBMUD Water Supply and Treatment System

Aqueducts are out of service, Briones Reservoir can also supply the Lafayette and Walnut Creek WTPs.

Although water in the terminal reservoirs is also of high quality, it has higher levels of turbidity, dissolved minerals and NOM and requires complete or "conventional" treatment to meet drinking water standards. Two conventional treatment plants (Sobrante and San Pablo WTPs)[1] draw water from San Pablo Reservoir and one (Upper San Leandro WTP) treats water from Upper San Leandro Reservoir. The local sources are subject to occasional taste and odor episodes due to algal growth in the reservoirs. To eliminate the taste and odor, EBMUD installed ozonation facilities at the Sobrante and Upper San Leandro WTPs in the early 1990s.

REGULATORY REQUIREMENTS

Community water systems are required to meet specific state and federal water quality standards for a variety of constituents. Standards are set only for those constituents expected to be found in drinking water supplies and that pose a significant risk to public health. Constituents for which regulations have been established fall into the following basic categories:

- Microbial pathogens and their indicators such as turbidity and total coliforms
- Inorganic chemicals, including metals
- Organic chemicals, including synthetic organic chemicals and volatile organic chemicals
- Disinfection by-products

Primacy

The United States Environmental Protection Agency (EPA) has the primary responsibility for setting and enforcing drinking water standards on a national level. EPA may delegate primary enforcement responsibility to individual states. To gain and maintain primacy (authority to enforce drinking water standards) under the Safe Drinking Water Act (SDWA), the state must adopt drinking water regulations at least as stringent as the Federal regulations and meet other relevant criteria. State drinking water regulations may be more stringent than the Federal regulations, but not less stringent.

In California, the Department of Health Services (DHS) Office of Drinking Water (ODW) is the agency with primacy for drinking water standards for water purveyors with more than 200 connections.

Summary of Current Drinking Water Regulations

Under the 1974 SDWA, EPA established drinking water regulations for 23 contaminants. The SDWA Amendments of 1986 required EPA to set maximum contaminant levels (MCL) for 83 specific constituents and to set MCLs for an additional 25 constituents every 3 years, indefinitely. Under the 1986 SDWA Amendments, EPA was also required to specify an MCL goal (MCLG) for each contaminant regulated. The MCLG represents the concentration at which

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[1] San Pablo WTP is a standby facility.

no known or anticipated adverse health effects occur, including an adequate margin of safety. The enforceable MCLs were set as close to the MCLG as technically and economically feasible, specifying the best available technology for achieving each MCL. In some cases where it is impractical to measure the concentrations of specific contaminants, EPA has regulated them by establishing treatment techniques (TTs) in lieu of MCLs. Significant regulations promulgated after the 1986 SDWA Amendments are summarized in Table A-1.

There are now over 100 contaminants regulated by EPA and DHS. Nevertheless, EPA was not able to meet the schedule for setting MCLs mandated by the 1986 SDWA Amendments.

Table A-1
Federal Regulations Promulgated Following the 1986 SDWA Amendments

Regulation	Key Provisions	Date
Phase I Regulations	Set MCLs for 8 VOCs; requires monitoring for 51 additional VOCs	Final - 1987 Effective - 1989
Phase II Regulations	Set MCLs for 38 VOCs, IOCs, SOCs plus nitrate, nitrite. Established Standardized Monitoring Framework	Final - 1991 Effective - 1993
Phase V Regulations	Set MCLs for 23 VOCs, IOCs, SOCs	Final - 1992 Effective - 1994
Surface Water Treatment Rule	Requires filtration and disinfection of all surface water supplies	Final - 1989 Effective - 1993
Total Coliform Rule	Allows no more than 5% of monthly coliform samples to be positive	Final - 1989 Effective - 1992
Lead and Copper Rule	Limits the amount of lead and copper at customers' taps	Final - 1989 Effective - 1991
Information Collection Rule	Requires monitoring for microbial contaminants and DBPs for setting future regulations (D/DBPR and ESWTR)	Final - 1996 Effective - 1997

Therefore, when the SDWA was reauthorized in 1996, substantial amendments were passed to revise the law. The 1996 Amendments were developed to provide more flexibility, more state responsibility and more cooperative approaches. They eliminated the requirement for EPA to establish 25 MCLs every 3 years. Instead, EPA has until February 6, 1998, to develop a list of high priority contaminants for possible regulation. These contaminants must have adverse health effects that are known or likely to occur at levels of public health concern. EPA will select 5 contaminants from the list every 5 years and determine whether to regulate them. The regulations will be based on risk assessment and cost-benefit considerations and on minimizing overall risk. Regulations must be based on best available, peer-reviewed science and data from the best available methods.

Table A-2
Annual Water Quality Report for 1996
Water Supply Sources

WATER QUALITY CONSTITUENT	DLR	MCL	UNITS	PARDEE RESERVOIR	SAN PABLO RESERVOIR	USL RESERVOIR	BRIONES RESERVOIR
PRIMARY STANDARDS (Health-related)							
INORGANIC PARAMETERS (a)							
ALUMINUM (b, c)	50	1000	ug/l	59	377	297	NR
ANTIMONY	6	6	ug/l	NR	NR	NR	NR
ARSENIC	2	50	ug/l	NR	NR	NR	NR
ASBESTOS (d)	0.2	7	mf/l	ND	ND	ND	ND
BARIUM	100	1000	ug/l	ND	ND	55	NR
BERYLLIUM	1	4	ug/l	ND	ND	ND	NR
CADMIUM	1	5	ug/l	NR	NR	NR	NR
CHROMIUM	10	50	ug/l	NR	NR	NR	NR
CYANIDE: TOTAL	100	200	ug/l	NR	NR	NR	NR
FLUORIDE	0.1	1.4	mg/l	NR	NR	NR	NR
MERCURY	1	2	ug/l	NR	NR	NR	NR
NICKEL	10	100	ug/l	NR	NR	NR	NR
NITRATE AS NO_3	2	45	mg/l	ND	ND	ND	NR
NITRITE AS N	0.4	1	mg/l	NR	NR	NR	NR
SUM OF NITRATE + NITRITE AS N	0.4	10	mg/l	NR	NR	NR	NR
SELENIUM	5	50	ug/l	NR	NR	NR	NR
THALLIUM	1	2	ug/l	NR	NR	NR	NR
RADIOLOGICAL PARAMETERS (e)							
TOTAL RADIUM 226 &228	0.5	0	pCi/l	NR	NR	NR	NR
URANIUM	2	20	pCi/l	ND	ND	ND	ND
RADIONUCLIDES: ALPHA	1.5	15	pCi/l	ND	ND	ND	ND
RADIONUCLIDES: BETA	4	50	pCi/l	ND	ND	5	4
TRITIUM	1000	20000	pCi/l	ND	ND	ND	ND
STRONTIUM	2	8	pCi/l	ND	ND	ND	ND
VOLATILE ORGANIC PARAMETERS (f)							
BENZENE	0.5	1	ug/l	ND	ND	ND	ND
CARBON TETRACHLORIDE	0.5	0.5	ug/l	ND	ND	ND	ND
1,2-DICHLOROBENZENE	0.5	600	ug/l	ND	ND	ND	ND
1,4-DICHLOROBENZENE	0.5	5	ug/l	ND	ND	ND	ND
1,1-DICHLOROETHANE (1,1-DCA)	0.5	5	ug/l	ND	ND	ND	ND
1,2-DICHLOROETHANE (1,2-DCA)	0.5	0.5	ug/l	ND	ND	ND	ND
1,1-DICHLOROETHYLENE (1,1-DCE)	0.5	6	ug/l	ND	ND	ND	ND
CIS-1,2-DICHLOROETHYLENE (c-1,2-DCE)	0.5	6	ug/l	ND	ND	ND	ND
TRANS-1,2-DICHLOROETHYLENE (t-1,2-DCE)	0.5	10	ug/l	ND	ND	ND	ND
DICHLOROMETHANE (METHYLENE CHLORIDE)	0.5	5	ug/l	ND	ND	ND	ND
1,2-DICHLOROPROPANE	0.5	5	ug/l	ND	ND	ND	ND
1,3-DICHLOROPROPENE	0.5	0.5	ug/l	ND	ND	ND	ND
ETHYL BENZENE	0.5	700	ug/l	ND	ND	ND	ND
MONOCHLOROBENZENE (CHLOROBENZENE)	0.5	70	ug/l	ND	ND	ND	ND
STYRENE	0.5	100	ug/l	ND	ND	ND	ND
1,1,2,2-TETRACHLOROETHANE	0.5	1	ug/l	ND	ND	ND	ND
TETRACHLOROETHENE (PCE)	0.5	5	ug/l	ND	ND	ND	ND
TOLUENE	0.5	150	ug/l	ND	ND	ND	ND
1,2,4-TRICHLOROBENZENE	0.5	70	ug/l	ND	ND	ND	ND
1,1,1-TRICHLOROETHANE (1,1,1-TCA)	0.5	200	ug/l	ND	ND	ND	ND
1,1,2-TRICHLOROETHANE (1,1,2-TCA)	0.5	5	ug/l	ND	ND	ND	ND
TRICHLOROETHYLENE (TCE)	0.5	5	ug/l	ND	ND	ND	ND
FREON 11	5	150	ug/l	ND	ND	ND	ND
FREON 113	10	1200	ug/l	ND	ND	ND	ND
VINYL CHLORIDE	0.5	0.5	ug/l	ND	ND	ND	ND
XYLENES (TOTAL)	0.5	1750	ug/l	ND	ND	ND	ND
SYNTHETIC ORGANIC PARAMETERS							
ALACHLOR	1	2	ug/l	ND	ND	ND	ND
ATRAZINE	1	3	ug/l	ND	ND	ND	ND
BENTAZON	2	18	ug/l	ND	ND	ND	ND
BENZO(A)PYRENE	0.1	0.2	ug/l	ND	ND	ND	ND
CARBOFURAN	5	18	ug/l	ND	ND	ND	ND
CHLORDANE	0.1	0.1	ug/l	ND	ND	ND	ND
2,4-D	10	70	ug/l	ND	ND	ND	ND
DALAPON	10	200	ug/l	ND	ND	ND	ND
DIBROMOCHLOROPROPANE (DBCP)	0.01	0.2	ug/l	ND	ND	ND	ND
DI(2-ETHYLHEXYL) ADIPATE	5	400	ug/l	ND	ND	ND	ND
DI(2-ETHYLHEXYL) PHTHALATE	3	4	ug/l	ND	ND	ND	ND
DINOSEB	2	7	ug/l	ND	ND	ND	ND
DIQUAT	4	20	ug/l	ND	ND	ND	ND
ENDOTHALL	45	100	ug/l	ND	ND	ND	ND

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WATER QUALITY CONSTITUENT	DLR	MCL	UNITS	PARDEE RESERVOIR	SAN PABLO RESERVOIR	USL RESERVOIR	BRIONES RESERVOIR
ENDRIN	0.1	2	ug/l	ND	ND	ND	ND
ETHYLENE DIBROMIDE (EDB)	0.02	0.05	ug/l	ND	ND	ND	ND
GLYPHOSATE	25	700	ug/l	ND	ND	ND	ND
HEPTACHLOR	0.01	0.01	ug/l	ND	ND	ND	ND
HEPTACHLOR EPOXIDE	0.01	0.01	ug/l	ND	ND	ND	ND
HEXACHLOROBENZENE	0.5	1	ug/l	ND	ND	ND	ND
HEXACHLOROCYCLOPENTADIENE	1	50	ug/l	ND	ND	ND	ND
LINDANE	0.2	0.2	ug/l	ND	ND	ND	ND
METHOXYCHLOR	10	40	ug/l	ND	ND	ND	ND
MOLINATE	2	20	ug/l	ND	ND	ND	ND
OXAMYL	20	200	ug/l	ND	ND	ND	ND
PENTACHLOROPHENOL	0.2	1	ug/l	ND	ND	ND	ND
PICLORAM	1	500	ug/l	ND	ND	ND	ND
POLYCHLORONATED BIPHENYLS (PCBs)	0.5	0.5	ug/l	ND	ND	ND	ND
SIMAZINE	1	4	ug/l	ND	ND	ND	ND
THIOBENCARB (b)	1	70	ug/l	ND	ND	ND	ND
TOXAPHENE	1	3	ug/l	ND	ND	ND	ND
2,3,7,8-TCDD (DIOXIN)	5	30	pg/l	NR	NR	NR	NR
2,4,5-T SILVEX	1	50	ug/l	ND	ND	ND	ND
SECONDARY STANDARDS (Aesthetics)							
ALUMINUM (b)	*50*	*200*	*ug/l*	*N/A*	*N/A*	*N/A*	*N/A*
ALKALINITY: BICARBONATE AS $CaCO_3$	NS	NS	mg/l	NR	NR	NR	NR
ALKALINITY: CARBONATE AS $CaCO_3$	NS	NS	mg/l	NR	NR	NR	NR
ALKALINITY: HYDROXIDE AS $CaCO_3$	NS	NS	mg/l	NR	NR	NR	NR
CALCIUM	NS	NS	mg/l	3.5	17.8	32.6	NR
CHLORIDE	NS	500	mg/l	1	10	NR	11
COLOR	NS	15	units	NR	NR	NR	NR
CONDUCTIVITY	NS	1600	umho/ cm	NR	NR	NR	NR
COPPER	*50*	*1000*	*ug/l*	ND	ND	ND	NR
DETERGENTS (AS MBAS)	NS	0.5	mg/l	NR	NR	NR	NR
HARDNESS: TOTAL	NS	NS	mg/l	11	NR	NR	130
IRON	NS	300	ug/l	ND	395	250	NR
MAGNESIUM	NS	NS	mg/l	1.1	6.7	13.7	NR
MANGANESE	NS	50	ug/l	ND	74.5	55	NR
SILVER	NS	100	ug/l	NR	NR	NR	NR
SODIUM	NS	NS	mg/l	1.8	10.6	18	NR
SULFATE	NS	500	mg/l	1.3	21.4	33.1	NR
THIOBENCARB (b)	1	1	ug/l	NR	NR	NR	NR
THRESHOLD ODOR NUMBER	NS	3	TON	NR	NR	NR	NR
TOTAL DISSOLVED SOLIDS	NS	1000	mg/l	NR	NR	NR	NR
TURBIDITY (b)	NS	5	NTU	N/A	N/A	N/A	N/A
ZINC	NS	5000	ug/l	ND	ND	ND	NR

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WATER QUALITY CONSTITUENT	DLR	MCL	UNITS	SYSTEM-WIDE AVERAGE (A)	MIN	MAX	LAFAYETTE WTP	ORINDA WTP	SAN PABLO WTP	SOBRANTE WTP	USL WTP	WALNUT CRK WTP
PRIMARY STANDARDS (Health-related)												
BACTERIOLOGICAL PARAMETERS												
TOTAL COLIFORMS (B)	NS	5	% positive	0.26	0	0.74	N/A	N/A	N/A	N/A	N/A	N/A
TURBIDITY (C, E)	NS	1	NTU	0.06	0.03	0.1	0.04	0.07	0.07	0.05	0.06	0.05
INORGANIC PARAMETERS (D)												
ALUMINUM (E)	50	1000	ug/l	69	ND	97	56	97	ND	ND	72	ND
ANTIMONY	6	6	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
ARSENIC	2	50	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
ABSESTOS (F)	0.2	7	mf/l	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BARIUM	100	1000	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
BERYLLIUM	1	4	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
CADMIUM	1	5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHROMIUM	10	50	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
COPPER (E, G)	50	NS	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
CYANIDE: TOTAL	100	200	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLUORIDE	0.1	1.4	mg/l	0.8	ND	0.97	0.88	0.82	ND	0.86	0.91	0.8
LEAD (G)	5	NS	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
MERCURY	1	2	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
NICKEL	10	100	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
NITRATE AS NO_3	2	45	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
SUM OF NITRATE + NITRITE AS N	0.4	10	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
NITRITE AS N	0.4	1	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
SELENIUM	5	50	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
THALLIUM	1	2	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
VOLATILE ORGANIC PARAMETERS												
BENZENE	0.5	1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON TETRACHLORIDE	0.5	0.5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROBENZENE	0.5	600	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DICHLOROBENZENE	0.5	5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHANE (1,1-DCA)	0.5	5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHANE (1,2-DCA)	0.5	0.5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHYLENE (1,1-DCE)	0.5	6	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,2-DICHLOROETHYLENE (c-1,2-DCE)	0.5	6	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,2-DICHLOROETHYLENE (t-1,2-DCE)	0.5	10	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
DICHLOROMETHANE (METHYLENE CHLORIDE)	0.5	5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROPROPANE	0.5	5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DICHLOROPROPENE	0.5	0.5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,3-DICHLOROPROPENE	0.5	0.5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYL BENZENE	0.5	700	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
MONOCHLOROBENZENE (CHLOROBENZENE)	0.5	70	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
STYRENE	0.5	100	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-TETRACHLOROETHANE	0.5	1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
TETRACHLOROETHENE (PCE)	0.5	5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOLUENE	0.5	150	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-TRICHLOROBENZENE	0.5	70	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-TRICHLOROETHANE (1,1,1-TCA)	0.5	200	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-TRICHLOROETHANE (1,1,2-TCA)	0.5	5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHYLENE (TCE)	0.5	5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIHALOMETHANES		100	ug/l	77	72	79	N/A	N/A	N/A	N/A	N/A	N/A
FREON 11	5	150	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
FREON 113	10	1200	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
VINYL CHLORIDE	0.5	0.5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
XYLENES (TOTAL)	0.5	1750	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
SYNTHETIC ORGANIC PARAMETERS												
ALACHLOR	1	2	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
ATRAZINE	1	3	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENTAZON	2	18	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(A)PYRENE	0.1	0.2	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBOFURAN	5	18	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLORDANE	0.1	0.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-D	10	70	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
DALAPON	10	200	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBROMOCHLOROPROPANE (DBCP)	0.01	0.2	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
DI(2-ETHYLHEXYL) ADIPATE	5	400	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
DI(2-ETHYLHEXYL) PHTHALATE	3	4	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
DINOSEB	2	7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIQUAT	4	20	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND

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WATER QUALITY CONSTITUENT	DLR	MCL	UNITS	SYSTEM-WIDE AVERAGE (A)	MIN	MAX	LAFAYETTE WTP	ORINDA WTP	SAN PABLO WTP	SOBRANTE WTP	USL WTP	WALNUT CRK WTP
ENDOTHALL	45	100	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
ENDRIN	0.1	2	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLENE DIBROMIDE (EDB)	0.02	0.05	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
GLYPHOSATE	25	700	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEPTACHLOR	0.01	0.01	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEPTACHLOR EPOXIDE	0.01	0.01	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROBENZENE	0.5	1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROCYCLOPENTADIENE	1	50	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
LINDANE	0.2	0.2	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHOXYCHLOR	10	40	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
MOLINATE	2	20	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
OXAMYL	20	200	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENTACHLOROPHENOL	0.2	1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
PICLORAM	1	500	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
POLYCHLORONATED BIPHENYLS (PCBs)	0.5	0.5	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
SIMAZINE	1	4	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
THIOBENCARB [I]	1	70	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOXAPHENE	1	3	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,7,8-TCDD (DIOXIN)	5	30	pg/l	NR	NR	NR	NR	NR	NR	NR	NR	NR
2,4,5-T SILVEX	1	50	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
SECONDARY STANDARDS (Aesthetics) [H]												
ALUMINUM (E)	0.05	0.2	mg/l	0.15	ND	0.20	0.09	0.20	0.09	0.15	0.18	ND
ALKALINITY: BICARBONATE AS $CaCO_3$	NS	NS	mg/l	37	21	120	21	22	64	64	120	22
ALKALINITY: CARBONATE AS $CaCO_3$	NS	NS	mg/l	1	1	2	1	1	2	2	2	2
ALKALINITY: HYDROXIDE AS $CaCO_3$	NS	NS	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
CALCIUM	NS	NS	mg/l	10.0	5.3	34.0	5.8	7.3	18.2	18.8	32.2	5.7
CHLORIDE	NS	500	mg/l	7	4	20	5	5	12	11	20	4
COLOR	NS	15	units	3	3	4	3	3	4	4	4	3
CONDUCTIVITY	NS	1600	umho/cm	124	56	384	67	71	260	230	384	68
COPPER (G)	50	1000	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
HARDNESS: TOTAL	NS	NS	mg/l	42	20	140	20	27	73	72	140	20
IRON	NS	300	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
MAGNESIUM	NS	NS	mg/l	2.9	1.0	13.2	1.0	1.0	6.4	6.6	13.2	1
MANGANESE	NS	50	ug/l	ND	ND	ND	ND	ND	7	1	ND	ND
MBAS	NS	0.5	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	NS	NS	units	8.5	8.0	9.2	8.8	8.5	8.5	8.5	8.2	8.7
SILVER	NS	100	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
SODIUM	NS	NS	mg/l	7.7	2.2	25.2	4.6	2.2	21.4	18.8	25.2	4
SULFATE	NS	500	mg/l	16.5	1.7	46.0	3.2	12	35	38	46	1.7
THIOBENCARB (E)	1	1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
THRESHOLD ODOR NUMBER	NS	3	TON	1	ND	3.0	1.4	ND	3	1.4	1	1
TOTAL DISSOLVED SOLIDS	NS	1000	mg/l	73	41	220	41	43	140	140	220	41
TURBIDITY (E)	NS	5	NTU	0.06	0.04	0.07	0.04	0.07	0.05	0.07	0.06	0.05
ZINC	NS	5000	ug/l	11	10	14	10	10	14	11	14	12

Table A-2
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Notes

KEY TO ABBREVIATIONS:

DLR = Detection Level for Purpose of Reporting. Minimum levels of analytical sensitivity as determined by the State Department of Health Services.
MBAS = Methylene Blue Active Substances, a measurement of the presence of detergent compounds.
MCL = Maxmimum Contaminant Level
mf/l = million fibers per liter
mg/l = milligrams per liter
N/A = Not Appicable. See notes for applicable sampling locations and parameters.
ND = Not Detected in samples. Results below DLRs are treated as zero for averages.
NR = Not Required. Waivers were granted by the State Department of Health Services.
NS = No Standard
NTU = Nepholometric Turbidity Units as a measure of suspended material in the water.
pCi/l = picoCuries per liter
pg/l = picograms per liter
TON = Threshold Odor Number
ug/l = micrograms per liter
umhos/cm = micromhos per centimeter

WATER SUPPLY SOURCE NOTES:

a = Annual averages are shown for particular source water reservoirs.
b = Inorganics are based on routine water supply source sampling, not required by the State Department of Health Services. See Inorganics for the Treated Waters. Annual averages are shown for all results available.
c = Aluminum and Thiobencarb are regulated with both Primary and Secondary Standards. See Treated Waters for Aluminum and Turbidity.
d = Asbestos monitoring was completed in 1995 as required.
e = Radiological monitoring is required every four years. Results shown were last sampled in 1995.
f = Volatile Organic Chemical results were based on special sampling, not required by the State Department of Health Services. See Volatile Organic Chemical results for Treated Waters.

TREATED WATER NOTES:

A = Averages for total coliforms were based on straight monthly averages. All other averages were flow-weighted. Annual averages were used for particular treatment plants. Minima and maxima are lowest and highest values as applicable to State regulations.
B = Total coliform standards were based on presence-absence tests taken in the distribution system for compliance.
C = Turbidity (clarity) Primary standard was based on the highest five percent level of treated water samples for each treatment plant.
D = Inorganics was based on treated water sampling, except for lead and copper.
E = Aluminum, Copper, Turbidity and Thiobencarb are regulated with both Primary and Secondary Standards. The levels for Primary standard was based on the average annual level observed for each plant.
F = Asbestos samples were taken in 1995 as required. Samples are required every nine years.
G = Lead and copper results shown are average levels in treated water. Lead and copper are regulated with "Action Levels" based on customer worst-case tap sampling in 1992 instead of MCLs. District results in 1992 for both Lead and Copper complied with the "Action levels" of 15 and 1,300 ug/l, respectively based on the highest 10 percent of results. Customers should note that private plumbing and fixtures may add lead or copper levels above the level delivered by the District. Water from one's hot water system is known to contain elevated levels of lead and copper and its consumption is not advisable. Similarly, selection of faucets and plumbing materials should be based on the use of approved materials for potable consumption and installled according local building code practices.
H = Maximum individual levels are reported for Secondary Standards, except parameters without MCLs where average annual concentration are used.

The current primary and secondary drinking water standards are shown in Table A-2. This table also compares EBMUD water quality averages and ranges to the standards. Primary standards are those related to public health. The secondary drinking water standards are related to the aesthetic quality of water. EPA considers compliance with the secondary standards to be optional, but in California, secondary standards are mandatory unless the population served consents to lower quality.

Information Collection Rule

The Information Collection Rule (ICR) was created as part of the D/DBP Rule regulatory negotiation process when it became evident that there is a critical lack of information on the prevalence and concentration of microbial pathogens, especially *Giardia* and *Cryptosporidium*. For large utilities, such as EBMUD, it requires an 18-month monitoring program to gather data on plant design features, operations, microbial occurrence and DBP formation. It also requires testing of granular activated carbon (GAC) or membranes for DBP precursor removal.

Although the ICR did not create any MCLs, it indicates that EPA is gathering data to help establish MCLs for new constituents and more stringent MCLs for constituents already regulated. Therefore, any plans for future water supplies should maintain as much flexibility as possible.

Anticipated Regulations

The EPA is developing new regulations needed to maintain compliance with the SDWA and it's Amendments. The major anticipated regulations are shown in Table A-3. Of these anticipated regulations, only the Stage 1 and 2 D/DBP Rule, the Interim and Final ESWTR, and the Backwash Water Recycling regulations are likely to affect surface water supplies such as those being considered by EBMUD.

Table A-3
Anticipated Federal Regulations

Anticipated Regulation	Targeted Contaminants	Status
Arsenic Regulation	Arsenic	Proposed - January 1, 2000 Final - January 1, 2001
Sulfate Regulation	Sulfate	August 6, 2001
Radon Regulation	Radon	Proposed - August 6, 1999 Final - August 6, 2000
Stage 1 and 2 D/DBPs	Disinfectants Disinfection By-Products	Proposed - July 29, 1994 Stage 1- November 1998 Stage 2 - 2002
Interim and Final ESWTR	Microbial	Proposed - July 29, 1994

		Interim - November 1998 Final - 2002
Backwash Water Recycling	Microbial	August 6, 2000
Source Water Assessment Programs	All	Guidance - August 1997 Implementation - August 1999
Groundwater Disinfection	Microbial	Proposed - 1998 Final - 2001

Disinfectants/Disinfection By-Products Rule

The Disinfectants/Disinfection By-Products (D/DBP) Rule was published for public comment in the Federal Register in July 1994. The 1996 Amendments to the SDWA require the Stage 1 D/DBP Rule to be promulgated by November 1998. The main objectives of the anticipated Disinfectants/Disinfection By-Products (D/DBP) Rule include minimizing the formation of DBPs, minimizing the applied dose of disinfectant, and minimizing the level of TOC present at the point(s) of disinfection.

The Stage 1 D/DBP Rule proposed in 1994 originally included three items:

1. Establish MCLs for THMs, HAA5, bromate and chlorite at 80 μg/L, 60 μg/L, 10 μg/L and 1,000 μg/L, respectively.
2. Establish Maximum Residual Disinfectant Limits (MRDLs) for chlorine, chloramines and chlorine dioxide at 4.0 mg/L, 4.0 mg/L and 0.8 mg/L, respectively.
3. Require enhanced coagulation to remove DBP precursors.

The Stage 2 D/DBP Rule is expected to be promulgated 4 years after the Stage 1 Rule. The findings from the ICR will be used to develop appropriate regulations, but at this time it is considered very likely that the Stage 2 rule will be more stringent that the Stage 1 rule.

Enhanced Surface Water Treatment Rule

The Enhanced SWTR (ESWTR) was published in the Federal Register for public comment in July 1994. The 1996 SDWA Amendments require that an Interim ESWTR be promulgated by November 1998.

The purpose of the Interim ESWTR is to address the issue of *Cryptosporidium* outbreaks. Most likely, greater levels of *Cryptosporidium* reduction will be required than are now required for *Giardia* under the SWTR, and the disinfection (CT) criteria for *Cryptosporidium* will be increased compared to those for *Giardia*. The Final ESWTR is expected to be promulgated 4 years after the Interim Rule. The findings from the ICR will be used to develop appropriate regulations or correct existing regulations.

Backwash Water Recycling

The EPA must publish a regulation for recycling filter backwash water within a treatment plant. This regulation must be promulgated by August 6, 2000 and it is not anticipated to be addressed in the Enhanced Surface Water Treatment Rule.

WATER QUALITY OF ALTERNATIVE SOURCES

A considerable amount of water quality data exists for most of the alternatives considered in the screening report. As part of its water supply planning, EBMUD conducted monthly sampling from Pardee Reservoir, the American River at Nimbus Dam, the American River at the Highway 160 crossing, the Sacramento River at Greene's Landing, and the Delta at Indian Slough. That monitoring was done from 1983 through 1992. There are also data available from the City of Sacramento's Fairbairn WTP on the American River below Nimbus Dam and the Sacramento River WTP below the confluence of the American and Sacramento Rivers. Limited data are available from the lower American River just upstream of the confluence, one of the alternatives being considered.

As stated previously, all of the water sources can be treated to meet drinking water standards; other utilities are doing so at the present time. However, there are significant differences in water quality among the sources. The differences found are primarily in turbidity, microbial concentrations, mineral content, DBP precursors and taste and odor (T&O) episodes. Table A-4 summarizes the available data from the various alternatives.

Turbidity

Turbidity is a measure of water clarity and is affected by the amount of suspended matter in the water. High turbidity is typically the result of erosion in the watershed during runoff of rainfall or snowmelt. Following major storms, turbidity often increases dramatically as erosion of soil and plant matter carries these materials into the main water courses. It has been found in past research that the presence of suspended matter interferes with disinfection of microbial organisms. It has also been found that very low (e.g., less than 0.1 NTU) turbidities in treated water are generally necessary to assure the removal of many pathogens such as *Giardia* and *Cryptosporidium*. Based on this past research, turbidity has been used as a surrogate for microbial presence and disinfection. The current MCL for turbidity when using conventional or direct filtration is 0.5 NTU or less in 95 percent of WTP effluent samples in a monthly reporting period.

As can be seen in Table A-4, the average turbidity in Pardee Reservoir, EBMUD's primary source, is only 0.8 NTU. The average turbidity in the American River is 3.4 at Nimbus Dam, 3.5 NTU at the Fairbairn WTP and 4.6 NTU at Highway 160. The average turbidity in the Sacramento River is 9.7 NTU at the Sacramento River WTP and 12.5 at Greene's Landing. The average turbidity at Indian Slough is 13.1 NTU. The significance of the differences in turbidity is in the type of treatment needed. An average turbidity of about 5 NTU is normally considered the maximum that can be treated by direct filtration. Higher turbidities nearly always require full conventional treatment that includes a clarification process.

Table A-4
Overview of General Water Quality Parameters
Along the Mokelumne, American, and Sacramento Rivers

		MOKELUMNE RIVER AT PARDEE							AMERICAN RIVER AT NIMBUS							AMER. RIVER AT FAIRBAIRN WTP						
		source: EBMUD 1983-92 Alternate Source Study (approx. monthly data)							source: EBMUD 1983-92 Alternate Source Study (approx. monthly data)							source: City of Sacramento 1984-95 (daily to monthly data with sporadic gaps)						
CONSTITUENT	UNITS	AVG.	MEDN.	10%	90%	MIN	MAX	#SAM	AVG.	MEDN.	10%	90%	MIN	MAX	#SAM	AVG.	MEDN.	10%	90%	MIN	MAX	#SAM
Turbidity	NTU	0.8	0.51	0.27	1.0	0.22	10	102	3.4	1.2	0.6	4.1	0.38	130	108	3.5	2.0	1.2	4.4	0.5	234	3464
Temperature	degrees C	18.8	20.0	11.0	26.0	7.2	29.0	92	16.2	17.0	10.0	22.2	8.0	24.5	89	15.8	16.4	9.5	21.4	6.1	29.2	3455
Alkalinity, Total	mg/L	15.2	15	12	18	9	22	85	26.3	25	19.6	31	13	120	87	23.8	24	20	28	16	40	3456
pH	---	7.5	7.5	7.0	7.8	6.7	9.4	83	7.5	7.5	7.2	7.8	6.8	8.6	82	7.4	7.4	7.1	7.6	4.7	8.3	3444
Conductivity	micro-mhos/cm^2	38.6	39	30	47	2	52	100	63.1	62	47	80	35	99	101	64.2	64	51	78	37	89	103
TDS	mg/L	32.1	32	25	38	19	55	101	45.4	46	33	57	27	68	107	43.5	44	33	55	18	59	100
Chloride	mg/L	1.9	2.0	1	3	0.03	4	101	3.2	2.0	1.1	4	1	14	112	2.5	2.4	1.5	3.5	0.9	5.2	2060
Hardness, Total	mg/L	13.4	13	10	17	0.6	30	85	26.1	25	19	32	13	120	86	21.2	21	15	27	11	40.0	2045
Calcium	mg/L	3.5	3.4	2.6	4.4	1.3	8	85	6.5	6.2	4.8	8.7	3.2	13	90	5.5	5.3	3.8	7.3	2.3	8.8	103
Magnesium	mg/L	1.2	1.0	0.8	1.5	0.5	4.9	85	2.4	2.2	1.5	3.4	1	7.4	86	1.9	1.8	1.3	2.7	0.7	3.7	103
Iron	mg/L	0.033	0.03	0.01	0.06	0.01	0.12	24	0.09	0.07	0.041	0.18	0.01	0.25	22	0.07	0.04	0.01	0.12	0.01	1.5	103
Manganese	mg/L	0.0049	0.0043	0.0018	0.0088	0.0005	0.014	25	0.024	0.01	0.0064	0.060	0.0056	0.12	17	0.011	0.01	0.01	0.01	0.010	0.070	103
Arsenic	mg/L															0.005	0.005	0.005	0.005	0.002	0.005	102
Copper	mg/L	0.0019	0.002	0.001	0.003	0.001	0.005	25	0.076	0.003	0.0018	0.33	0.001	0.33	9	0.029	0.03	0.010	0.05	0.010	0.080	104
Lead	mg/L	0.0024	0.001	0.001	0.004	0.001	0.02	75	0.0031	0.002	0.001	0.0088	0.001	0.020	57	0.007	0.005	0.005	0.01	0.005	0.010	103
Phosphate	mg/L	0.045	0.005	0.003	0.0436	0.001	1.7	102	0.022	0.01	0.003	0.052	0.001	0.128	89	0.104	0.10	0.064	0.15	0.010	0.220	7
Nitrate	mg/L	0.016	0.009	0.001	0.0224	0.001	0.34	93	0.043	0.02	0.004	0.11	0.001	0.32	99							
NOx as N	mg/L															0.09	0.02	0.01	0.19	0.01	1.6	75
Ammonia	mg/L	0.11	0.008	0.005	0.0292	0.003	4.6	85	0.021	0.01	0.005	0.04	0.003	0.19	77							
TOC	mg/L	2.0	1.7	1.2	3.2	0.9	5.6	84	2.5	1.6	1.3	4.6	0.8	35	93	1.7	1.7	1.4	2.1	1.3	2.4	20
Total Coliforms	MPN/ 100 mL	58	8	2	68	2	3,000	102	377	125	30	800	2	3,500	112	1,214	430	75	2,400	9	24,000	473
Fecal Coliforms	MPN/ 100 mL	4	2	2	4	2	80	101	280	50	8	500	2	13,000	107	136	33	8	230	2	4,600	468

notes: "#SAM" = Number of samples taken.

for Pardee pH, two outliers of 15 and 17 were removed.

for Pardee TOC, three outliers of "<50,<50,100 mg/L" were removed.

for Pardee TCM, there is one outlier of 3000 MPN/100 mL. it was left in.

for Nimbus FCM, there is one possible outlier of 13,000 MPN/100 mL. it was left in.

for Nimbus iron, two outliers of "3.0, 3.1" were removed.

in all cases, when a value was below the detection limit, the detection limit was used as the value.

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Table A-4
Overview of General Water Quality Parameters
Along the Mokelumne, American, and Sacramento Rivers

AMER. RIVER - HWY 160 BRIDGE — source: EBMUD 1983-92, Alternate Source Study (approx. monthly data, some quarterly)

CONSTITUENT	UNITS	AVG.	MEDN.	10%	90%	MIN	MAX	#SAM
Turbidity	NTU	4.6	1.2	0.6	6.0	0.5	150	82
Temperature	degrees C	15.0	14.8	10.0	20.5	7.0	22.5	74
Alkalinity, Total	mg/L	26.1	25	19	30	14	130	67
pH	---	7.5	7.5	7.1	7.8	6.9	8.3	65
Conductivity	micro-mhos/cm^2	63.1	61	50	81	39	100	86
TDS	mg/L	44.9	45	33	56	28	69	82
Chloride	mg/L	2.7	2	1	4	1	12	85
Hardness, Total	mg/L	25.6	24	19	29	15	130	66
Calcium	mg/L	6.9	6.0	4.9	8.0	3.8	34	71
Magnesium	mg/L	2.1	2.0	1.5	2.8	1.0	3.8	66
Iron	mg/L	0.15	0.10	0.07	0.26	0.03	0.50.	23
Manganese	mg/L	0.014	0.010	0.010	0.021	0.010	0.030	19
Arsenic	mg/L							
Copper	mg/L	0.004	0.003	0.002	0.008	0.002	0.010	7
Lead	mg/L	0.005	0.002	0.001	0.020	0.001	0.020	31
Phosphate	mg/L	0.025	0.020	0.004	0.054	0.001	0.120	64
Nitrate	mg/L	0.06	0.04	0.01	0.16	0.01	0.26	92
NOx as N	mg/L							
Ammonia	mg/L	0.033	0.02	0.01	0.0804	0.006	0.17	69
TOC	mg/L	2.4	2.0	1.3	4.9	0.2	5.8	67
Total Coliforms	MPN/ 100 mL	4,360	790	170	3,340	50	170,000	89
Fecal Coliforms	MPN/ 100 mL	387	70	13	338	2	13,000	89

AMER. RIVER AT FAIRBAIRN WTP — source: City of Sacramento, 1989-92 (three years' sporadic data)

CONSTITUENT	UNITS	AVG.	MEDN.	10%	90%	MIN	MAX	#SAM
Turbidity	NTU	3.7	4.1	1.7	5.7	1.5	6.1	8
Temperature	degrees C	16.6	16.5	9.1	22.9	8.0	24.0	32
Alkalinity, Total	mg/L							
pH	---	7.2	7.2	7.0	7.4	7.0	7.5	7
Conductivity	micro-mhos/cm^2	66.0	66	56	75	51	78	21
TDS	mg/L							
Chloride	mg/L							
Hardness, Total	mg/L							
Calcium	mg/L							
Magnesium	mg/L							
Iron	mg/L	0.058	0.035	0.01	0.15	0.01	0.19	12
Manganese	mg/L	0.013	0.01	0.01	0.02	0.01	0.03	12
Arsenic	mg/L	0.005	0.005	0.005	0.005	0.005	0.005	12
Copper	mg/L	0.051	0.05	0.03	0.07	0.01	0.11	12
Lead	mg/L	0.005	0.005	0.005	0.005	0.005	0.005	12
Phosphate	mg/L							
Nitrate	mg/L							
NOx as N	mg/L							
Ammonia	mg/L							
TOC	mg/L							
Total Coliforms	MPN/ 100 mL							
Fecal Coliforms	MPN/ 100 mL							

AMER. RIV AT DISCOVERY PARK — source: City of Sacramento, 1989-92 (three years' sporadic data)

CONSTITUENT	UNITS	AVG.	MEDN.	10%	90%	MIN	MAX	#SAM
Turbidity	NTU	7.1	5.3	2.5	13.5	1.7	17.0	8
Temperature	degrees C	17.8	19.0	10.1	23.9	9.0	26.0	32
Alkalinity, Total	mg/L							
pH	---	7.4	7.3	7.2	7.8	7.1	7.9	7
Conductivity	micro-mhos/cm^2	75.7	68	57	89	53	182	21
TDS	mg/L							
Chloride	mg/L							
Hardness, Total	mg/L							
Calcium	mg/L							
Magnesium	mg/L							
Iron	mg/L	0.30	0.18	0.02	0.46	0.01	1.60	12
Manganese	mg/L	0.025	0.01	0.01	0.03	0.01	0.12	12
Arsenic	mg/L	0.005	0.005	0.005	0.005	0.005	0.005	12
Copper	mg/L	0.010	0.01	0.01	0.01	0.01	0.01	12
Lead	mg/L	0.005	0.005	0.005	0.005	0.005	0.005	12
Phosphate	mg/L							
Nitrate	mg/L							
NOx as N	mg/L							
Ammonia	mg/L							
TOC	mg/L							
Total Coliforms	MPN/ 100 mL							
Fecal Coliforms	MPN/ 100 mL							

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in all cases, when a value was below the detection limit, the detection limit was used as the value.

Table A-4
Overview of General Water Quality Parameters Along the Mokelumne, American, and Sacramento Rivers

SACTO RIV - SACTO RIVER WTP — source: City of Sacramento 1984-95 (daily to monthly data with sporadic gaps)

CONSTITUENT	UNITS	AVG.	MEDN.	10%	90%	MIN	MAX	#SAM
Turbidity	NTU	9.7	6.6	3.1	15	0.4	278	2897
Temperature	degrees C	19.2	20.5	12.0	23.8	7.0	27.5	2897
Alkalinity, Total	mg/L	49.7	50	35	63	20	83	2850
pH	---	7.6	7.6	7.4	7.8	6.7	8.5	2896
Conductivity	micro-mhos/cm²	128	130	98	153	55	200	85
TDS	mg/L	83.8	85	66	102	38	125	84
Chloride	mg/L	5.0	4.8	3.3	6.9	1.3	10	1643
Hardness, Total	mg/L	42.9	43	32	53	14.0	68	1710
Calcium	mg/L	9.7	9.8	7.5	12.0	1.7	15	84
Magnesium	mg/L	4.8	4.8	3.2	6.1	2.0	7.7	84
Iron	mg/L	0.16	0.11	0.01	0.29	0.01	1.6	85
Manganese	mg/L	0.012	0.01	0.01	0.01	0.010	0.080	84
Arsenic	mg/L	0.005	0.005	0.005	0.005	0.002	0.005	84
Copper	mg/L	0.015	0.01	0.01	0.02	0.010	0.080	85
Lead	mg/L	0.007	0.005	0.005	0.01	0.005	0.010	85
Phosphate	mg/L	0.09	0.10	0.06	0.11	0.01	0.12	7
Nitrate	mg/L							
NOx as N	mg/L	0.19	0.08	0.03	0.60	0.01	1.0	64
Ammonia	mg/L							
TOC	mg/L	2.2	1.7	1.5	3.3	1.2	5.1	19
Total Coliforms	MPN/ 100 mL	1,303	430	110	2,400	23	24,000	406
Fecal Coliforms	MPN/ 100 mL	281	43	9	230	2	24,000	400

SACTO RIV - GREENE'S LANDING — source: EBMUD 1983-92 Alternate Source Study (approx. monthly data, some quarterly)

CONSTITUENT	UNITS	AVG.	MEDN.	10%	90%	MIN	MAX	#SAM
Turbidity	NTU	12.5	5.5	2.2	23.3	1.4	140	92
Temperature	degrees C	16.4	17.5	9.1	22.5	5.0	24	82
Alkalinity, Total	mg/L	64.2	63.0	50.0	80.6	39	95	75
pH	---	7.7	7.7	7.5	7.9	7.0	8.2	74
Conductivity	micro-mhos/cm²	164	161	124	207	64	252	92
TDS	mg/L	104.6	100.0	80.0	130.0	45	160	93
Chloride	mg/L	7.5	7.0	5.0	10.7	2.0	19	94
Hardness, Total	mg/L	59.0	57.5	47.0	72.7	40.0	87	74
Calcium	mg/L	12.5	12.0	9.6	15.0	7.4	38.4	75
Magnesium	mg/L	6.9	6.9	5.2	9.1	1.2	10	74
Iron	mg/L	0.72	0.73	0.25	1.18	0.17	1.5	9
Manganese	mg/L	0.021	0.020	0.010	0.032	0.010	0.040	9
Arsenic	mg/L							
Copper	mg/L	0.010	0.010	0.010	0.010	0.010	0.010	1
Lead	mg/L	0.004	0.002	0.001	0.007	0.001	0.026	42
Phosphate	mg/L	0.107	0.100	0.060	0.161	0.011	0.21	90
Nitrate	mg/L	0.17	0.14	0.07	0.25	0.01	0.74	93
NOx as N	mg/L							
Ammonia	mg/L	0.29	0.25	0.11	0.54	0.01	0.90	76
TOC	mg/L	3.4	2.0	1.4	6.9	0.1	29	77
Total Coliforms	MPN/ 100 mL	10,902	500	75	5,150	20	900,000	96
Fecal Coliforms	MPN/ 100 mL	196	30	8	346	2	5,000	93

DELTA - INDIAN SLOUGH — source: EBMUD 1983-92 Alternate Source Study (approx. monthly data, some quarterly)

CONSTITUENT	UNITS	AVG.	MEDN.	10%	90%	MIN	MAX	#SAM
Turbidity	NTU	13.1	11	4	26	2.3	50	104
Temperature	degrees C	16.8	18	8.8	24	5	25	97
Alkalinity, Total	mg/L	72	72	58	86	36	180	89
pH	---	7.8	7.9	7.6	8.1	7.1	8.3	89
Conductivity	micro-mhos/cm²	551	552	231.5	930	76	1080	106
TDS	mg/L	329	325	140	546	55	650	106
Chloride	mg/L	102	87	22	206	14	260	105
Hardness, Total	mg/L	107	110	66	140	55	163	89
Calcium	mg/L	18	18	13	22	9.2	50	97
Magnesium	mg/L	15.0	15	7.8	22	1	38	96
Iron	mg/L	0.86	0.79	0.3	1.22	0.17	3.9	25
Manganese	mg/L	0.03	0.03	0.01	0.04	0.01	0.12	26
Arsenic	mg/L							
Copper	mg/L	0.05	0.004	0.0027	0.1083	0.002	0.34	8
Lead	mg/L	0.008	0.009	0.001	0.02	0.001	0.02	25
Phosphate	mg/L	0.09	0.08	0.06	0.12	0.02	0.18	108
Nitrate	mg/L	0.49	0.43	0.16	0.86	0.01	2.5	111
NOx as N	mg/L							
Ammonia	mg/L	0.07	0.05	0.02	0.13	0.01	0.5	87
TOC	mg/L	4.6	3	2.1	7.6	1.2	29	87
Total Coliforms	MPN/ 100 mL	4,077	265	50	1,300	2	280,000	108
Fecal Coliforms	MPN/ 100 mL	86	23	8	118	2	3,000	107

in all cases, when a value was below the detection limit, the detection limit was used as the value.

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Total Coliforms

Coliform bacteria, a class of organisms usually found in the intestines of warm-blooded animals, have been used for many years as an indicator of the presence of the pathogenic bacteria, such as those that cause typhoid fever and cholera, which are transmitted via the fecal-oral route. Total coliforms have been used as an indicator because they are always present when the pathogens are present, they occur in greater numbers, they are more resistant to disinfection, and they are easy to isolate and enumerate. It is generally assumed that if a water sample is free of coliforms, then it is also free of the bacterial pathogens. The presence of high concentrations of coliform bacteria in source waters can be an indication of fecal contamination. Therefore, a source with low concentrations of coliform bacteria is desirable.

The source water quality data for total coliforms shows a wide range of values among the sources. The median concentration in Pardee Reservoir was only 8 organisms (most probable number, or MPN)/100 mL, compared to 125 MPN/100 mL at Nimbus Dam, 430 MPN/100 mL at the Fairbairn WTP, 790 MPN/100 mL at Highway 160, 430 MPN/100 mL at the Sacramento River WTP, 500 MPN/100 mL at Greene's Landing, and 265 MPN/100 mL at Indian Slough. The high value at Highway 160 may be due to recreational use of the lower American River. The Indian Slough value is lower than the upstream values most likely because of die-off of the bacteria.

Giardia and Cryptosporidium

Giardia lamblia and *Cryptosporidium parvum* are pathogenic microorganisms that originate in the feces of humans and domestic and wild animals. Ingestion of these microorganisms can cause gastrointestinal disease of varying intensity (up to 30 percent of those infected are asymptomatic). *Cryptosporidium* was implicated in a disease outbreak in Milwaukee in 1993 in which 400,000 people, or half the population served by the water system, became ill. *Giardia* has also been implicated in many disease outbreaks since the early 1970s. *Giardia* can generally be treated by chemotherapy drugs, but it may still take up to two weeks to recover from the affliction. For *Cryptosporidium*, however, there is no known treatment, and those with depressed immune systems, such as persons on chemotherapy or with AIDS, often die from the disease. In Milwaukee, over 100 deaths have been attributed to the 1993 outbreak.

There is no MCL for *Giardia*. However, EPA has a treatment technique regulation, the federal Surface Water Treatment Rule (SWTR), which requires all public water systems using surface water or groundwater under the direct influence of surface water to filter and disinfect their supplies and achieve a minimum 99.9 percent (3-log) removal and/or inactivation of *Giardia*. DHS has issued a companion regulation to the federal SWTR, called the Surface Water Filtration and Disinfection Treatment Rule (SWFDTR). It has the same basic *Giardia* reduction requirements but also includes specific design, operation and monitoring requirements.

Cryptosporidium is not currently regulated but has been proposed for regulation under the Enhanced SWTR. Reduction of *Cryptosporidium* can be achieved through source water protection, particulate removal and disinfection. Many utilities have instituted programs (e.g., Partnership for Safe Water) to minimize the number of *Cryptosporidium* in treated water, and

DHS has developed a *Cryptosporidium* Action Plan to also address this threat. One of the major concerns about regulating *Cryptosporidium* is that it is much more difficult to disinfect than is *Giardia*, and chlorine, the most commonly used disinfectant, has little effect. If treatment technique standards, similar to *Giardia*, are promulgated, then utilities with sources vulnerable to substantial *Cryptosporidium* contamination may be forced to implement ozonation to achieve the required inactivation levels.

Minimal *Giardia* and *Cryptosporidium* monitoring data are available for the alternative sources. Current monitoring programs are underway by DWR and others to help quantify the incidence of these organisms in Delta tributaries. Despite the lack of monitoring data, the fact that these organisms emanate from fecal matter suggests that sources with higher levels of coliform bacteria are at greater risk. For public health protection, given the lack of monitoring data, the most important consideration is identification and elimination of sources of these organisms.

Total Dissolved Solids

Mineral content, as measured by total dissolved solids (TDS) is important for several reasons. For industrial processes that rely on demineralizers to prevent scaling, higher TDS levels lead to higher treatment costs. Water with higher TDS concentrations generally does not taste as good as lower TDS water. Also, higher TDS water is generally more corrosive to plumbing materials and fixtures, thus requiring more frequent replacement or more expensive treatment to reduce the corrosivity. Higher levels of TDS also reduce consumer acceptance because of the "saltiness" associated with it.

The TDS concentrations of the source waters are relatively low at all the sites except Indian Slough. The Pardee Reservoir average concentration is lowest at 32 mg/L compared to 45 mg/L at Nimbus Dam, 44 at the Fairbairn WTP, 45 mg/L at Highway 160, 84 mg/L at the Sacramento River WTP, and 105 mg/L at Greene's Landing. The TDS concentrations at these locations are generally very consistent. The average TDS concentration at Indian Slough is 329 mg/L, but it can vary from less than 200 mg/L to over 500 mg/L due to seawater intrusion during dry conditions. Research done by the University of California at Berkeley in the early 1970s indicated that consumer acceptance of drinking water is directly related to the TDS concentration. Those supplies with TDS concentrations under 100 mg/L were rated excellent by the customers. Higher concentrations of TDS led to progressively worse ratings from good to fair, and those with concentrations above 500 mg/L were rated poor.

Disinfection By-Products

Disinfection by-products (DBPs) are formed when disinfectants added to water react with other constituents, such as natural organic matter or bromide. The most common organic DBPs are trihalomethanes (THMs), and the most common THM is chloroform. THMs were discovered in drinking water supplies in the early 1970s and were linked by epidemiology studies to cancer in humans. Laboratory studies have shown that THMs cause cancer in rats and mice. Other DBPs, such as haloacetic acids (HAAs) and bromate have also been found to cause cancer in laboratory animals. The current MCL for total THMs (4 species) is 100 µg/L. However, as discussed under Anticipated Regulations, the standard is almost certain to be changed in Stage 1 of the D/DBP

Rule to 80 μg/L within the next five years, and a new MCL for HAA5 (5 species) will be set at 60 μg/L. Stage 2 of the D/DBP Rule may reduce the MCLs even further.

The D/DBP Rule is also likely to regulate bromate and chlorite, both inorganic DBPs. Bromate is primarily a concern for utilities that use ozone in their WTPs and have bromide in their water sources (e.g., the Delta during times of seawater intrusion). Chlorite is primarily a concern for utilities that use chlorine dioxide for disinfection or oxidation.

The primary surrogate for organic DBP precursors (the materials that react with the disinfectants to form DBPs) is total organic carbon (TOC). Although the types of organic matter in water affect the DBP formation rates and can vary considerably from source to source, waters with higher TOC concentrations tend to form higher levels of DBPs.

The concentrations of TOC in the alternative sources follow the same basic trends as the other major water quality parameters. The average TOC concentration in Pardee Reservoir was 2.0 mg/L during this sample period, compared to 2.5 mg/L at Nimbus Dam, 1.7 mg/L at the Fairbairn WTP, 2.4 mg/L at Highway 160, 2.2 mg/L at the Sacramento River WTP, 3.4 mg/L at Greene's Landing, and 4.6 mg/L at Indian Slough.

Another means of estimating the amount of DBP precursors is the THM Formation Potential (THMFP) analysis. The procedure for this analysis is to add chlorine to a water sample, hold the sample for a given time (e.g., 7 days), and then measure for THMs. The chlorine doses and hold times vary among laboratories, and the analysis usually shows more THMs formed than are actually measured in systems using the water sources, but THMFP gives a relative measure of the potential for forming THMs.

The THMFP data also show the same basic trend as TOC. There are a number of methods to determine THMFP in use, but when analyzed by the same method, Pardee Reservoir has the lowest value, followed by the American River, the Sacramento River and Indian Slough.

Taste and Odor

Objectionable taste and odor (T&O) in surface waters generally result from metabolic by-products of several species of algae and blue-green bacteria. Because these organisms grow and die off in cycles, the T&O compounds they release also tend to occur cyclically. Periods in which high concentrations of T&O compounds occur are referred to as episodes. Such episodes can occur during low river flows when algae growth is encouraged by sun exposure and high water temperatures. Although they have no known adverse health effects, T&O episodes can result in a loss of consumer confidence in the water supply, leading to purchase of bottled water or home treatment devices. Those T&O compounds classified as "earthy and musty" are most troublesome because they cannot be eliminated by addition of chlorine, which all surface water treatment facilities are required to use for disinfection. More expensive treatment processes such as ozonation or GAC filtration are needed to eliminate them.

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T&O episodes are difficult to quantify or to accurately determine their cause. The most widely used "analytical" method is call the threshold odor number (TON). It merely is a measure of the number of dilutions with odor-free water needed to eliminate the odor. A more precise tool, called the Flavor Profile Analysis (FPA) was borrowed from the food and beverage industry about 15 years ago and is much better able to characterize the odors and intensities. EBMUD began using the FPA technique about 10 years ago and has been able to roughly determine the number of customer complaints they will receive based on the intensity and type of odor. The FPA is judged by a panel on a scale of 0 to 4. An intensity of 1 means that the odor is barely detectable. A rating of 2 indicates that most of the population can at least detect the odor, 3 is much more intense, and 4 is the most severe intensity. EBMUD has found that an intensity of 3 for earthy-musty odors will lead to approximately 200 to 300 complaints, compared to a typical month of about 10 water quality complaints or less.

The T&O data from the various alternative water sources are sporadic and mostly consist of TON values. However, EBMUD has never experienced a T&O episode in Pardee Reservoir. The American and Sacramento Rivers occasionally experience T&O episodes. The City of Sacramento's 1995 annual water quality report indicated that T&O episodes were experienced at both WTPs in August and September. FPA analyses by EBMUD this summer from Nimbus Dam, the Fairbairn WTP and the confluence found odor intensities greater than 2, suggesting the possibility for the need to provide treatment to remove the odors.

Synthetic and Volatile Organic Chemicals

More than 100,000 organic compounds have been synthesized since 1940. Most of these compounds are not used widely, but some have become ubiquitous throughout the world (Tchobanoglous 1985). Any organic chemical that is manufactured is referred to as a synthetic organic chemical (SOC). Volatile organic chemicals (VOCs) are a subset of SOCs and are generally classified separately because of the type of analytical equipment needed to measure their concentrations. SOCs can enter the water supplies from a variety of sources such as industrial contamination and pesticide use. In surface waters, their presence tends to be intermittent because of the nature of their use. For example, pesticides are typically added at certain periods of crop growing seasons and are flushed into the water supplies during rainfall events or from agricultural drainage systems. For this reason, most monitoring programs have found few of these chemicals unless they were designed to sample and analyze for compounds known to be used in the watersheds above the sample sites and shortly after the times of application. Most SOCs dissipate quickly in surface waters either through evaporation or decomposition. Some, such as PCBs and DDT, however, can persist for years if adsorbed (attached) to sediment particles.

Both EPA and DHS have set primary MCLs and a limited number of secondary MCLs for individual SOCs and VOCs. The watershed surveys conducted in the past have shown significantly more SOC application in the Sacramento River and Delta watersheds than in the American River watershed, but the monitoring programs have found few of the chemicals in the water. The Interagency Delta Health Aspects Monitoring Program (DWR 1989) was designed to find specific chemicals based on application locations and times. Overall, about 4 percent of the analyses showed detectable concentrations of SOCs. In most cases, the concentrations were marginally above the laboratory detection limits, but considerably below health-based drinking water standards. Despite the infrequency of detection, the incidence was much greater in the Delta and Sacramento River than in the American River.

Prior to 1989, trichloroethylene (TCE) was detected in the American River above the Fairbairn WTP at concentrations of about 1 μg/L (McGuire 1993). The source was determined to be a "seep" from contaminated groundwater below the Aerojet General property near the river. Aerojet General has installed a treatment system to remove the TCE and return the groundwater to the aquifer. TCE has not been detected in the American River since then.

Except for molinate and thiobencarb, no SOCs have been detected at the Sacramento River WTP (Wilczak and Chen 1996). These two rice herbicides were routinely detected in the source water just below the confluence with the American River in the early 1980s during the spring at concentrations below the current MCL, but high enough to cause T&O complaints. The current secondary MCL for thiobencarb of 1 μg/L was exceeded on several occasions. An aggressive management program resulted in a significant reduction in these herbicides to levels typically below detection limits.

Benzo(a)pyrene, a regulated SOC, was detected in the American River at Discovery Park (near the confluence) at a concentration above the MCL once. This was during a storm event monitored as part of the Sacramento Stormwater Monitoring Program (Archibald & Wallberg 1995).

IMPACTS OF ALTERNATIVE SOURCES ON EBMUD

To meet the water quality criterion in the alternatives evaluation discussed in Chapter 5, an alternative must enable EBMUD to maintain the high quality of both its raw and treated water supplies, as described in Chapter 4. Maintenance of the high quality of EBMUD's water supply is a basic project objective and an ongoing planning objective of the updated Water Supply Management Program. Besides minimizing health risks associated with poor water quality, EBMUD's new supplemental water supply must be of high enough quality that it does not require treatment beyond that which can be reasonably provided by EBMUD. Limitations affecting the feasibility of providing additional treatment could include physical constraints to expansion of existing facilities, operational complexity, financial impacts, and other relevant factors.

The following paragraphs discuss each water supply alternative and describe the treatment improvements needed to meet the water quality criterion discussed above. This assessment of treatment needs is based on the water quality data discussed previously and on treatment evaluations conducted for EBMUD or other water utilities.

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American River Diversions

The water quality data indicate that the higher turbidity levels found in the American River alternatives would have the most impact on EBMUD. The in-line filtration process used by EBMUD is applicable only to sources with consistently very low turbidity. Because the filters provide all of the turbidity removal, the process is very sensitive to the source water turbidity. For this reason, DHS approves it for use only on a case-by-case basis.

In the fall of 1996, an evaluation of existing EBMUD treatment plant data was done to estimate the impacts of the higher turbidity values found in the American River on water production capacity. To meet water production requirements in July 2020, it is estimated that the Walnut Creek WTP must have a source water turbidity no greater than 1.2 NTU. In the period of record, even the American River at Nimbus Dam exceeded this value on a monthly average 7 years out of 10. It is likely that operational modifications combined with a strategy of not taking American River water during high turbidity conditions would enable EBMUD to treat American River water without making significant capital improvements..

An analysis done in 1996 based on projected operating conditions showed that DBPs formed in American River water delivered to the Bay Area would not be significantly different than those now formed in Pardee Reservoir water. Thus, no change in treatment would be needed.

The higher total coliform concentrations found in the alternative sources are not high by comparison with many sources nationally. However, they do suggest a higher microbial pathogen risk compared to the Pardee Reservoir source. The coliform organisms themselves can be readily inactivated by conventional disinfection.

Relative to turbidity, the other American River diversion points would have slightly greater impacts than those associated with a Nimbus Dam diversion, but the treatment requirements are likely to be the same.. However, downstream of Nimbus Dam, the river is more likely to experience T&O episodes and be more exposed to contamination by *Giardia* and *Cryptosporidium*. T&O episodes could be treated by GAC filtration or ozonation or an operational strategy of not taking the water during such episodes could be employed. The presence of significant concentrations of *Giardia* or *Cryptosporidium* would likely require ozonation. Treatment facilities to remove T&O or disinfect these pathogens could be installed at the existing EBMUD WTPs in the Bay Area. Alternatively, they could be installed near the conveyance facilities to treat the American River water before being put into the raw water aqueducts.

Sacramento River Diversions

Because the average turbidities of the Sacramento River alternatives are more than 10 times as high as in Pardee Reservoir, a clarification step would be required before treatment at EBMUD's in-line filtration plants. The DBP formation potential of Sacramento River water is slightly higher than the American River and Pardee Reservoir sources; however, clarification used for turbidity removal would reduce the TOC concentrations to approximately the same concentration as Pardee Reservoir. Thus, no additional treatment would be necessary for DBPs.

The vast size of the watershed clearly suggests a higher risk of *Giardia* and *Cryptosporidium* than in the American River, thus indicating a need for ozonation. The fact that Greene's Landing is downstream of the Sacramento Regional Wastewater Treatment Plant provides a further indication of the need for ozonation.

The higher incidence of samples containing SOCs and more frequent T&O episodes in Sacramento River water would lead to use of GAC filtration and/or ozonation.

To reduce the higher TDS concentrations in the Sacramento River, reverse osmosis (RO), forcing water through a semi-permeable membrane, would be the only feasible process. If used, RO would may eliminate the need for ozonation and GAC filtration required for the other contaminants discussed above. This would depend on RO's ability to remove certain SOCs and T&O compounds. RO does require pretreatment for turbidity removal, requiring either conventional treatment (clarification and filtration) or microfiltration, another membrane process.

Delta Diversion

A Delta diversion would require the same treatment processes as the Sacramento River alternatives for the same reasons, i.e., clarification for turbidity and TOC removal, GAC or ozonation for T&O removal, and ozonation for *Giardia* and *Cryptosporidium* inactivation. Because the average TDS concentration in Indian Slough is 10 times higher than that in Pardee Reservoir, the need for RO to meet the water quality criterion is unequivocal. Again, RO might eliminate some of the processes needed to treat for other contaminants, but RO does still require pretreatment for turbidity removal.

Conclusion

Based on this analysis, the American River sources would have the least impact on EBMUD. The ability to remove the slightly higher turbidity levels at the in-line filtration plants might require construction of additional treatment facilities such as flocculation and possibly clarification. If the incidence of T&O episodes and microbial contaminants is high, EBMUD will need to either:

- Not take American River water during T&O episodes or high microbial risk periods, or
- Install GAC or ozone facilities..

Use of the Sacramento River would definitely require addition of a clarification step and may require GAC or ozone for T&O control, ozone for disinfection and reverse osmosis for demineralization. The Delta source would definitely require demineralization (RO), in addition to the pretreatment steps discussed above, to meet the criterion of treating any alternative source to the quality of the Pardee Reservoir supply.