MTBE in California Drinking Water: An Analysis of Patterns and Trends

Pamela R. D. Williams, Sc.D.

Exponent

149 Commonwealth Drive

Menlo Park, CA 94025

650-688-1748 (phone)

650-688-1799 (fax)

pwilliams@exponent.com

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ABSTRACT

Over the past decade, there has been much publicity surrounding the impact of MTBE on drinking water supplies in the United States. In California, the presence of MTBE in groundwater and drinking water has led to a ban on the future use of MTBE in gasoline (ARB, 1999). Other states, such as those in the Northeast, are also seeking ways to reduce or eliminate the use of MTBE due to perceived threats to the environment and public health. Despite claims about the incidence of MTBE in drinking water, no comprehensive characterization has been conducted on the available drinking water monitoring data. This paper provides a detailed analysis of the MTBE drinking water data compiled by the California Department of Health Services (CDHS) from 1995 to 2000. We find that MTBE was detected in about 1.3% of all drinking water samples, 2.5% of drinking water sources, and 3.7% of drinking water systems in California over this 6-year period. Our analysis reveals that many drinking water sources are not routinely sampled for MTBE, and in those sources that appear to be affected by MTBE, the compound is not consistently detected. The majority of MTBE detections are also concentrated in several geographic areas, which contain about 9-21% of the total California population. Average detected MTBE concentrations have decreased significantly since 1995 and 1996, ranging from 5 to 15 ppb over the last three years depending on the outcome of interest. Of the samples in which MTBE was present above the analytical detection limit, the concentrations in approximately 73% of drinking water samples and 86% of drinking water sources and systems were below the State's primary health-based standard of 13 ppb. Our findings suggest that, although some drinking water supplies in California have been affected by MTBE, the majority of drinking water sources and systems either have not been affected at all or contain MTBE at concentrations below levels that are likely to be of health concern.

INTRODUCTION

Over the past decade, there has been much publicity surrounding the impact of methyl tertiary butyl ether (MTBE) on drinking water supplies in the United States. A Blue Ribbon Panel appointed by the Administrator of the U.S. Environmental Protection Agency (EPA) concluded that MTBE is "more likely to contaminate ground and surface water than the other components of gasoline" and that the use of MTBE has resulted in "growing detections of MTBE in drinking water" (USEPA, 1999). An interagency assessment by the Office of Science and Technology Policy also concluded that gasoline releases from storage tanks, pipelines, and refueling stations provide "point sources for entry of high concentrations of fuel oxygenate into ground water" (NSTC, 1997). In addition, a recent study by the U.S. Geological Survey (USGS) found that MTBE was one of the most frequently detected volatile organic compounds in untreated ambient ground water nationwide (Squillace et al., 1999). Other research by the USGS suggests that leaking underground storage tanks may pose a significant threat to drinking water for at least the next 10 years (Johnson et al., 2000).

In California, several highly publicized events have contributed to the perception that MTBE contamination of drinking water supplies is a widespread occurrence. Relatively high concentrations of MTBE were detected in some drinking water wells located in prominent areas, such as Santa Monica and South Tahoe (USEPA, 2000a; STPUD, 2000; NSTC, 1997), resulting in extensive litigation and clean-up activity (*City of Santa Monica v. Mobile Oil Company; South Tahoe Public Utility District v. Atlantic Richfield Company*). A study by the Lawrence Livermore National Laboratory also reported that 78% of monitored leaking underground fuel tank sites in California had detectable levels of MTBE, and concluded that more than 10,000 aquifers throughout the State could potentially be affected by this chemical (Happel et al., 1998).

In addition, sampling of six lake reservoirs in Southern California suggested that motorized watercrafts were a major point source of MTBE contamination of surface water supplies (Dale et al., 2000). A study conducted by the University of California, *Health & Environmental Assessment of MTBE*, further concluded that there were significant risks and costs associated with MTBE contamination of drinking water supplies, and recommended that MTBE be phased out of gasoline statewide (UC, 1998).

Various regulatory actions have occurred in response to growing concerns about the impact of MTBE on the nation's drinking water supplies. On a federal level, legislation has been introduced into Congress to ban the use of MTBE and Senate bill S.2962 was recently passed by the Committee on Environment and Public Works that would allow governors to waive the requirement that reformulated gasoline contain 2% oxygen by weight (Smith, 2000; BNA, 2000a, 1999). In addition, the EPA has taken regulatory action to eliminate MTBE as a fuel additive under the *Toxic Substances and Control Act* (BNA, 2000b,c; USEPA, 2000b). Many states in the Northeast have also sought individual waivers to opt out of the federal reformulated gasoline program and the oxygenate requirement (NESCAUM, 1999). In California, the Governor issued an Executive Order to eliminate the use of MTBE statewide no later than December 31, 2002, due to perceived threats to the environment and water quality (ARB, 1999).

Despite claims about the incidence of MTBE in drinking water, the available drinking water monitoring data have not been subjected to a comprehensive characterization. The California Department of Health Services (CDHS) provides an ongoing and updated summary of MTBE detections statewide, but does not provide a detailed analysis of the detection frequency or concentration of MTBE over time. CDHS (2000) estimates that 0.8% of drinking water sources and 1.9% of public water systems in California had detectable levels of MTBE as of

September 5, 2000. In a preliminary analysis of the CDHS database, we found that both the detection frequency and average concentration of MTBE in drinking water sources in California were fairly low, and did not change significantly from 1995 through 1999 (Williams et al., 2000). Our earlier analysis did not examine the impact of MTBE on individual drinking water sources in California, however, or assess whether MTBE detections were concentrated in any particular geographic location.

The purpose of this paper is to provide a more detailed analysis of the MTBE drinking water monitoring data in California using more recent data on MTBE detections in 2000. Specifically, we examine the following issues in regard to MTBE drinking water detections and concentrations over time:

- How has the detection frequency for MTBE in drinking water supplies changed over time, and does the detection rate vary by outcome (e.g., source versus system)?
- How often have individual drinking water sources and systems been sampled over the last six years?
- How consistent are MTBE detections in individual drinking water sources that are sampled for several consecutive years?
- How much are MTBE detections influenced by certain factors, such as changes in analytical detection limits or geographic location?
- How have average detected MTBE concentrations in drinking water changed over time, and how much variation is in these estimates?
- What is the distribution of detected MTBE concentrations in drinking water, and what percentage are below California's primary and secondary drinking water standards?

- What attributes are associated with drinking water sources that do have detectable MTBE levels above the state's health-based level?

We anticipate that the findings of this analysis will be informative for decision-makers in California, the United States, and abroad. This research may also serve as a template for future MTBE analyses in other states or regions. The remainder of this paper consists of the following four sections: (1) description of the MTBE drinking water monitoring database and data coding; (2) overview of MTBE detections in California drinking water by sample, source, system, and county; (3) analysis of detected MTBE concentrations in drinking water, and comparisons to state primary and secondary standards; and (4) discussion of findings and implications for future research and policy decisions about MTBE.

MTBE DRINKING WATER DATABASE

The current analysis examines available MTBE drinking water monitoring data compiled by the California Department of Health Services from April 12, 1995 to June 8, 2000 (CDHS 2000). All drinking water sources are included in the analysis, regardless of activity status. For example, 204 drinking water sources are labeled as inactive, 179 are on standby, and 78 have been abandoned or destroyed. Five samples were excluded from the analysis because they were labeled by the analytical laboratory as having a "false positive" result.

In the CDHS database, drinking water samples with nondetectable levels of MTBE are identified with a "<" sign in the XMOD field. For these samples, the detection limit for purposes of reporting (DLR) is listed in the "finding" field. Data at or above the DLR are required to be submitted to CDHS, and the state-mandated DLR for MTBE was reduced from 5 to 3 parts per billion (ppb) on May 17, 2000 (Collins, 2000). Some systems or analytical laboratories, however, submit data below (or above) the DLR (CDHS, 2000). Indeed, analysis of the database indicates that 35% of samples with nondetectable MTBE levels reported a DLR of 5 ppb, 30% reported a DLR of 3 ppb, 21% reported a DLR of 0.5 ppb, and 10% reported a DLR of 1 ppb. The remaining 4% of samples have detection limits ranging from 0.005 to 500 ppb, but it is unclear whether these represent reporting errors or actual detection limits. Records that are not clearly identified with a "<" sign in the database, but have a reported "finding" of zero or blank, are also coded as nondetect samples based on discussions with the CDHS database manager (Collins, 2000).

Drinking water samples with detectable levels of MTBE do not have any identification in the CDHS database (i.e., XMOD field is blank). For these samples, the "finding" field represents the measured MTBE concentration determined by each analytical laboratory. The DLR for samples with detectable levels of MTBE is not reported in the database. CDHS compares measured MTBE concentrations to the State's adopted Maximum Contaminant Levels (MCLs) for MTBE in drinking water. The primary MCL of 13 ppb became effective on May 17, 2000, while the secondary MCL of 5 ppb became effective on January 7, 1999.

Although CDHS considers MTBE to be detected only if it is present in at least two samples from the same source, the current analysis examines all MTBE detections, even if MTBE is present in only one sample. We also report findings separately for all drinking water samples, drinking water sources, and drinking water systems. The distinction between samples, sources, and systems is important, because statistical analyses based on these outcomes may yield different results, and various states may report their findings based on different outcomes. In general, drinking water systems tend to encompass more than one source, and drinking water sources often contain multiple samples

MTBE DETECTIONS IN DRINKING WATER

More than 29,000 drinking water samples were collected and tested for MTBE from 1995 to 2000, representing nearly 4,300 drinking water sources and about 1,700 drinking water systems (see Table 1). The overall detection rate for MTBE during 1995–2000 was estimated to be 1.3% for all drinking water samples, 2.5% for drinking water sources, and 3.7% for drinking water systems in California.[1] The detection frequency for MTBE was the highest in 1995, ranging from 3 to 6%, likely due to the sampling of drinking water sources or systems that were suspected of having MTBE contamination. The detection frequency for MTBE decreased 2- to 3-fold in 1996 and has remained relatively stable since then, despite increased sampling efforts in later years. MTBE detections in 1999 and 2000 may be influenced, in part, by the use of more sensitive analytical instruments and lower detection limits. For example, although the most frequently reported detection limit for nondetect samples was 5 ppb in 1998, the most frequently reported detection limit in 1999 and 2000 was 3 ppb (see Figure 1). It is difficult to interpret the observed decreased detection frequency for MTBE in 2000, because data have not yet been reported for the entire year.

According to CDHS (2000), sampled drinking water systems serve about 29.9 million people in California, or 88% of the total population. Approximately 55% of these systems' sources have been sampled. Reported findings are therefore not representative of all drinking water supplies in the state, and in particular, exclude private wells and small water systems that are regulated by local primacy agencies. CDHS (2000) estimates that the detection frequency for MTBE is greater for surface water sources (4.6%) than for groundwater sources (0.5%) in

[1] The CDHS database also includes 18 samples that were collected in 1990–1994. MTBE was detected in six of these samples (three sources and one system), with all detections occurring in 1990.

California. However, it is not clear from the database how to distinguish between surface and groundwater sources.

INSERT TABLE 1 ABOUT HERE

INSERT FIGURE 1 ABOUT HERE

A significant finding of our analysis was that the majority of drinking water sources and systems in California have been sampled for only one to two years (see Figure 2). About 36% of drinking water sources and 24% of systems were sampled for three or more years, while only 1% of sources and systems were sampled for all six years. Reported findings of MTBE drinking water detections over time may therefore be influenced by the number of years that drinking water sources or systems are sampled. For example, five contaminated drinking water sources that serve the city of Santa Monica (i.e., the "Charnock Wells") were sampled in 1995 and 1996 only, and it is unclear whether repeated sampling of these sources would result in continued detections of MTBE. Although these wells may not be representative of other distribution systems in California, if all affected drinking water sources are sampled only intermittently, the observed stability of MTBE drinking water detections over time may be an artifact of the sampling methodology. Depending on the persistence of MTBE in individual drinking water sources, limited sampling may result in an underestimate of the true detection rate for MTBE. On the other hand, past detections of MTBE may not be relevant for evaluating impacts on drinking water supplies over a longer time horizon.

INSERT FIGURE 2 ABOUT HERE

To further explore these issues, we examined the total number of samples collected and the number of MTBE detections in 104 individual drinking water sources that had detectable levels of MTBE at least once in 1995–2000. Table 2 presents the findings for those 59 sources with detectable levels of MTBE that were sampled for three or more consecutive years. This table reveals several interesting findings. First, MTBE is not detected consistently in drinking water sources that have been impacted by MTBE. Of those sources sampled for three or more consecutive years, 39% had detectable MTBE levels for only one year, 41% had detectable MTBE levels for two consecutive years, and 15% had detectable MTBE levels for three or more consecutive years. Only five drinking water sources that were sampled for three or more consecutive years had detectable levels of MTBE for every year it was sampled. These findings indicate that if MTBE is detected in drinking water sources at one point in time, it will not necessarily be detected in the same source at another point in time.

Second, many drinking water sources have only a few MTBE detections, despite a substantial number of samples collected. For example, 105 samples were collected in 1997–2000 from "Camanche Lake Intake-Raw," which provides drinking water for the Camanche South Shore area in Calaveras County. Only three of these samples, however, tested positive for MTBE. Similarly, MTBE was detected in only one out of 35–41 samples collected in 1996–2000 from two drinking water sources that serve the city of Los Angeles (i.e., "Tujunga Well-04" and "Tujunga Well-05"). Of the 311 drinking water samples collected in 1995-2000 from "Well-07," which serves the Yorba Linda Water District in Orange County, only three samples had detectable levels of MTBE and these occurred in a single year. Such findings raise questions about the reliability of reported findings, particularly when MTBE is detected in only one year or a very limited number of samples.

Third, it is unclear based on the available data whether MTBE drinking water detections are increasing or decreasing for sources sampled over several consecutive years. That is, the number of drinking water sources with detectable levels of MTBE in the early years only, closely approximates the number of drinking water sources with detectable levels of MTBE in the later years only. These findings suggest that, although the overall detection frequency for MTBE is not necessarily increasing over time, different drinking water sources may be affected by MTBE at alternating points in time.

Fourth, 46 drinking water sources with detectable MTBE levels were sampled for less than three consecutive years (not shown). As mentioned, it is unclear whether these sources would continue to have detectable levels of MTBE if sampled at a later date. Some of these sources were sampled only in the early years, while many sources were sampled only in the later years or for several non-consecutive years. These findings suggest that the limited sampling of drinking water sources for MTBE might not have an impact on the relative detection frequency over time, but could have an impact on the overall detection rate for MTBE. That is, if all of these sources were repeatedly sampled and tested positive for MTBE, this could result in a higher detection rate than what has been previously reported.

INSERT TABLE 2 ABOUT HERE

Additional analyses reveal that MTBE was detected in 31 out of 58 counties sampled in California in 1995–2000 (see Table 3). The detection frequency for the majority of counties is less than 5%, but can vary considerably by outcome of interest (e.g., sample, source, or system). The greatest detection rate for MTBE (i.e., ≥ 9%) appears to be concentrated in 5–9 different counties, which account for about 9–21% of the California population. For example, the greatest detection frequency of MTBE is concentrated in five counties, comprising 9% of the total population, based on drinking water samples. For drinking water sources and systems, the greatest detection frequency of MTBE is concentrated in six and nine counties, comprising 16% and 21% of the population, respectively. Since most counties have multiple sources and systems that might be used for public drinking water at any particular point in time, this does not imply that up to 21% of the population may have contaminated drinking water.

Interestingly, the detection rate for Los Angeles, which comprises about 28% of the population in California, is fairly low. Although specific communities such as Santa Monica may have been impacted by MTBE, drinking water supplies serving the city of Los Angeles have therefore generally not been affected. Other counties in California that account for over a million persons each (e.g., Orange, Riverside, Sacramento, Santa Clara, and San Bernadino), also have relatively low detection rates for MTBE. These findings reveal that MTBE contamination of drinking water supplies in California are not uniform throughout the state, and suggest that certain geographic areas may have higher risk factors for MTBE contamination.

INSERT TABLE 3 ABOUT HERE

DETECTED MTBE CONCENTRATIONS IN DRINKING WATER

For drinking water supplies with detectable levels of MTBE in 1995–2000, average detected MTBE concentrations were the highest in 1995 and 1996, ranging from 66 to 78 ppb for all drinking water samples, 37 to 58 ppb for drinking water sources, and 13 to 40 ppb for drinking water systems (see Figure 3). Average detected MTBE levels decreased significantly in 1997 and remained at 10 ppb or below from 1997 through 1999. There appears to be a slight increase in MTBE detected concentrations over the last three years, with average detected MTBE levels reaching 13 ppb for all drinking water samples, 12 ppb for drinking water sources, and 15 ppb for drinking water systems in 2000. These latter findings are difficult to interpret, however, given the lack of a complete data set for 2000. The smaller number of drinking water samples collected in 1995 and 2000 is reflected in the greater variability in average detected MTBE concentrations for these years.

It is important to recognize that the MTBE concentrations reported here are based only on drinking water supplies with detectable levels of MTBE. These concentrations are not representative of MTBE drinking water levels or exposures for the general population in California. Over 95% of drinking water supplies in California had nondetectable levels of MTBE in 1995–2000, and inclusion of these samples in the analysis would significantly reduce average MTBE levels. In the earlier assessment by Williams et al. (2000), average MTBE levels for all drinking water sources were estimated to range from <1 ppb to 6 ppb in 1995–1999, depending on whether nondetect samples were assumed to equal zero or the analytical detection limit, respectively.

INSERT FIGURE 3 ABOUT HERE

The distribution of MTBE concentrations among contaminated drinking water supplies in California in 1995–2000 is presented in Figure 4. Approximately 73% of drinking water samples and 86% of drinking water sources and systems with detectable levels of MTBE, contain MTBE at concentrations below the State's primary MCL (health-based standard) of 13 ppb. In addition, about 56% of all drinking water samples and 70% of drinking water sources and systems have detectable MTBE levels below California's secondary MCL (aesthetic-based standard) of 5 ppb. These estimates are greater than those reported by CDHS (2000), which found that only 0.2% of drinking water sources and 0.7% of public water systems have MTBE concentrations greater than 13 ppb, and 0.4% of sources and 1.1% of systems have MTBE concentrations greater than 5 ppb. These findings suggest that, although some drinking water supplies in California have been affected by MTBE, the majority of these sources or systems contain MTBE at concentrations that are unlikely to be of health (or aesthetic) concern.

INSERT FIGURE 4 ABOUT HERE

Further analysis reveals that there are a total of 19 drinking water sources (14 systems) that had detectable levels of MTBE above 13 ppb at least once in 1995–2000 (see Table 4). Of these, 11 sources (6 systems) are currently labeled as inactive or on standby, possibly due to MTBE contamination. Analyses based on the entire dataset may therefore overestimate MTBE drinking water exposures in California, since sources with relatively high MTBE levels may not be in public use. MTBE detections greater than 13 ppb do not appear to be concentrated in any one particular location or year, with the exception of the six drinking water sources that serve the city of Los Angeles (i.e., Arcadia and Charnock wells), which were sampled in 1995–1996. The highest reported MTBE concentrations occurred in two drinking water sources that serve the city of Los Angeles—"Charnock Well 19" (610 ppb) and "Charnock Well 13" (490 ppb)—and one source ("Well 03-01") that provides drinking water for Yuba County (234 ppb). These findings suggest that other site-specific characteristics or risk factors, such as proximity to a major spill or leaking underground storage tank, may be associated with particularly high MTBE concentrations in drinking water.

INSERT TABLE 4 ABOUT HERE

DISCUSSION

A great deal of discussion has centered around the possible public health hazards posed by the continued use of MTBE in gasoline. To a large extent, the claims have been that ground water and drinking water supplies in California, as well as nationwide, have become contaminated by this chemical. There is little doubt that some drinking water supplies have been impacted by MTBE or that the presence of MTBE in certain instances can make water nonpotable due to its taste and odor. However, the available evidence indicates that a limited number of drinking water supplies in California have been contaminated with MTBE, particularly at concentrations that would limit their use. From a public health standpoint, MTBE may actually serve as an "early warning system" for alerting users to the fact that a leaking underground tank is nearby. In some cases, this could prevent exposures to the more hazardous components of gasoline, such as benzene.

Interestingly, the corrective action that has been recommended is a ban on MTBE rather than implementation of an effective underground storage tank program. The majority of MTBE detections in drinking water have been attributed to leaking tank problems, and research suggests that such leaks could represent a significant threat to drinking water over the next decade (Johnson et al., 2000; Davidson and Creek, 1999; White, 1999). Implementation of an effective program, such as the one proposed by EPA to upgrade, replace, or close leaking underground storage tanks nationwide, would help prevent any gasoline constituent from entering the ground water or impacting drinking water supplies (NFGH, 1999).

To reach an informed decision about the impact of MTBE on drinking water supplies, decision makers will need to be presented with all the relevant information. In particular, a careful review of the available drinking water monitoring data is needed. This information can be used not only to evaluate trends in drinking water detections, but also to assess potential public health risks from MTBE drinking water exposures. In our preliminary analysis, MTBE detections and average concentrations in California drinking water were found to be fairly low, remaining relatively stable from 1995 through 1999 (Williams et al., 2000). Our current analysis, which consists of a more detailed review of the available data through 2000, yields similar results. However, we find that reported findings may differ significantly based on outcome of interest (i.e., sample, source, or system), and this distinction may be important in comparisons between different states or regions.

The key findings of our analysis are as follows:

1. Drinking water sources are not sampled routinely for MTBE. Our analysis reveals that many drinking water wells in California have not been sampled at all, or are not routinely sampled for MTBE. As a consequence, it is difficult to evaluate the actual impact of MTBE on drinking water supplies in California. Future monitoring efforts in California should be based on a comprehensive sampling protocol that will ensure the representativeness of the data, and will allow for an evaluation of trends over time.

2. MTBE detections may be influenced by sampling methods. The reliance on more sensitive analytical instruments and/or the lowering of statewide mandatory detection limits, may account for observed detections of MTBE in recent years. The CDHS monitoring database does not allow for a full investigation of this issue, however, since the DLR is only provided for select samples with nondetectable levels of MTBE (and is not provided for any of the samples with detectable MTBE levels). Requiring analytical laboratories to report their method detection limits for all samples would aid in the interpretation of the drinking water monitoring data.

3. MTBE is not detected consistently in affected drinking water sources. In California, drinking water sources that are impacted by MTBE at one point in time do not necessarily contain MTBE when sampled at another point in time. Although the reasons for these findings are unclear, analyses based on “snapshot” data may lead to misleading conclusions about the impact of MTBE on drinking water supplies. Time-series analyses based on individual drinking water sources or systems are therefore required to provide a more accurate characterization of the data.

4. MTBE detections are concentrated in several geographic areas. MTBE contamination of drinking water supplies in California is not uniformly distributed throughout the state. Certain geographical areas may therefore be more susceptible to MTBE contamination, particularly if underground storage tanks are nearby. Future analyses should attempt to identify likely “hot spots” or potential risk factors for MTBE contamination.

5. Average detected concentrations of MTBE are unlikely to cause a significant health risk. Although some drinking water sources in California have clearly been impacted by MTBE, the majority of affected sites have detectable concentrations below the State’s health-based standard for MTBE. In many

> instances, MTBE concentrations are also below levels likely to cause an aesthetic concern, even for sensitive individuals. The presence of MTBE in drinking water therefore does not imply a threat to human health or water quality, and future analyses should put the available data into perspective.

Our findings suggest that, although some drinking water supplies in California have been affected by MTBE, the majority of drinking water sources and systems have not been affected or they contain MTBE at concentrations that are below levels likely to be of health concern. Indeed, we found that human exposures to MTBE from all water-related activities in a household were unlikely to pose a significant health risk for the general population or more highly exposed individuals in California (Williams et al. 2000). These findings are in contrast to media reports that suggest MTBE contamination of public drinking water supplies is widespread and growing, or that MTBE in drinking water poses a risk to human health.

Decisions about how or whether to regulate MTBE based on perceived threats to water quality need to be based on an accurate characterization of the available data. The risks and benefits of MTBE should also be weighted against the potential environmental and health consequences of alternatives to MTBE. For example, substitution of MTBE with ethanol or a non-oxygenated blend could result in backsliding on air quality or contribute to greater water contamination by other gasoline constituents. A comprehensive risk-benefit analysis of alternative gasoline formulations is necessary to ensure the protection of drinking water supplies and public health.

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Table 1
MTBE Detection Frequency for Drinking Water Supplies in California in 1995–2000

Year	Number of Samples Collected	% MTBE Detection	Number of Sources Sampled	% MTBE Detection	Number of Systems Sampled	% MTBE Detection
1995	174	4.0	117	3.4	32	6.3
1996	4,519	1.3	1,698	1.3	402	3.0
1997	6,064	1.2	2,054	1.5	610	3.3
1998	7,553	1.6	2,481	1.8	814	3.3
1999	8,201	1.3	2,377	2.0	997	3.1
2000	2,765	0.6	1,144	1.0	440	2.0
All Years	***29,276***	***1.3***	***4,280***[a]	***2.5***	***1,718***[a]	***3.7***

[a]Does not equal total because some drinking water sources and systems were sampled for more than one year.

Table 2
MTBE Detections for Individual Drinking Water Sources in California in 1995–2000[a]

Source	1995	1996	1997	1998	1999	2000
AIR STRIPPING TOWER COMBINED INFLUENT						
Number of Samples Collected				8	60	19
Number of MTBE Detections				1	0	0
ALVARADO PLANT EFFLUENT - TREATED						
Number of Samples Collected			2	4	3	1
Number of MTBE Detections			0	2	1	0
ALVARADO PLANT INFLUENT - RAW						
Number of Samples Collected		1	2	4	3	1
Number of MTBE Detections		1	0	3	1	0
ANTIOCH MUNICIPAL RESERVOIR - RAW						
Number of Samples Collected				1	1	1
Number of MTBE Detections				1	0	0
ARROWHEAD WELL 02						
Number of Samples Collected		1	4	7	1	
Number of MTBE Detections		0	3	7	0	
CAMANCHE LAKE INTAKE - RAW						
Number of Samples Collected			4	41	45	15
Number of MTBE Detections			0	1	2	0
CANYON LAKE - RAW						
Number of Samples Collected		1	1	2	1	
Number of MTBE Detections		1	1	2	1	
CASITAS RESERVOIR RAW						
Number of Samples Collected				10	23	4
Number of MTBE Detections				3	0	0
CHERRY RESERVOIR-RAW						
Number of Samples Collected		3	4	4	1	1
Number of MTBE Detections		2	1	2	1	0
CLEAR LAKE INTAKE						
Number of Samples Collected			2	6	5	
Number of MTBE Detections			1	2	2	
CLEAR LAKE INTAKE - LAKESHORE BOOSTER						
Number of Samples Collected			1	3	3	1
Number of MTBE Detections			1	0	0	0
CONCERTO 01 - INACTIVE						
Number of Samples Collected		1	1	4		
Number of MTBE Detections		0	1	4		
CONCERTO 02						
Number of Samples Collected	1	7	4	5	4	2
Number of MTBE Detections	0	0	0	2	0	0
DEL VALLE CWE-TREATED WATER						
Number of Samples Collected			4	2	2	
Number of MTBE Detections			2	1	0	
DRAKE WELL						
Number of Samples Collected				1	11	3
Number of MTBE Detections				1	4	0
EL CAJON WELL 04						
Number of Samples Collected			1	9	6	2
Number of MTBE Detections			0	0	1	0
EL CAPITAN LAKE - RAW						

Source	1995	1996	1997	1998	1999	2000
Number of Samples Collected				3	3	1
Number of MTBE Detections				3	1	0
GARDNER MT. WTP - RAW						
Number of Samples Collected			10	17	4	
Number of MTBE Detections			7	7	0	
GARDNER MT. WTP - TREATED						
Number of Samples Collected			10	17	5	
Number of MTBE Detections			3	7	1	
HEAD WEIR TUNNEL						
Number of Samples Collected				4	8	4
Number of MTBE Detections				1	0	0
JULIE WELL (ANGORA WELL 11)						
Number of Samples Collected		2	3	5	7	1
Number of MTBE Detections		0	0	1	7	1
LAKE HODGES RESERVOIR						
Number of Samples Collected			1	1	1	
Number of MTBE Detections			0	0	1	
LAKE PERRIS (EFFLUENT OR SURFACE)						
Number of Samples Collected		3	3	4	4	
Number of MTBE Detections		3	2	2	3	
LAKE SKINNER OUTLET CONDUIT						
Number of Samples Collected		1	3	4	4	
Number of MTBE Detections		0	0	1	0	
MALONE						
Number of Samples Collected		1	1	6	14	1
Number of MTBE Detections		0	0	3	0	0
MIRAMAR LAKE - RAW						
Number of Samples Collected				2	3	1
Number of MTBE Detections				1	1	0
MIRAMAR PLANT EFFLUENT - TREATED						
Number of Samples Collected			2	4	3	1
Number of MTBE Detections			0	3	2	0
MIRAMAR PLANT INFLUENT - RAW						
Number of Samples Collected		2	2	3	3	1
Number of MTBE Detections		1	0	2	2	0
MURRAY LAKE - RAW						
Number of Samples Collected				2	3	1
Number of MTBE Detections				0	1	0
OTAY LAKE - RAW						
Number of Samples Collected				2	4	1
Number of MTBE Detections				1	2	0
OTAY PLANT EFFLEUNT - TREATED						
Number of Samples Collected			1	4	3	1
Number of MTBE Detections			0	0	3	0
OTAY PLANT INFLUENT - RAW						
Number of Samples Collected		1	2	4	3	1
Number of MTBE Detections		1	0	0	2	0
PATTERSON PASS CWE-TREATED WATER						
Number of Samples Collected			4	2	2	
Number of MTBE Detections			2	1	0	
SAN PABLO RESERVOIR-SOBRANTE INTAKE-RAW						
Number of Samples Collected		2	14	38	42	5
Number of MTBE Detections		2	4	0	0	0

Source	1995	1996	1997	1998	1999	2000
SAN VICENTE LAKE - RAW						
Number of Samples Collected				3	3	1
Number of MTBE Detections				3	3	1
SHASTA LAKE INTAKE - RAW						
Number of Samples Collected		1	4	1	4	
Number of MTBE Detections		1	1	0	0	
SOUTH SAN DIEGO CLEARWELL EFFLUENT - TRT						
Number of Samples Collected			1	4	3	1
Number of MTBE Detections			0	0	3	0
SOUTH Y CENTER WELL (ANGORA 06)						
Number of Samples Collected		1	1	1	7	1
Number of MTBE Detections		0	0	0	4	0
TATA LANE WELL 02						
Number of Samples Collected		1	1	2	7	1
Number of MTBE Detections		0	0	0	4	1
TATA LANE WELL 03						
Number of Samples Collected		1	1	2	7	1
Number of MTBE Detections		0	0	0	2	1
TATA WELL 04 (ANGORA WELL 10)						
Number of Samples Collected		2	9	8	1	
Number of MTBE Detections		2	9	7	1	
TUJUNGA WELL 04						
Number of Samples Collected		3	10	8	11	3
Number of MTBE Detections		0	1	0	0	0
TUJUNGA WELL 05						
Number of Samples Collected		4	13	9	12	3
Number of MTBE Detections		0	1	0	0	0
VERDUGO WELL 01						
Number of Samples Collected		1	11	9	10	2
Number of MTBE Detections		1	0	0	0	0
VERDUGO WELL 02						
Number of Samples Collected		3	8	2	9	
Number of MTBE Detections		3	3	0	0	
WAGNER WELL 03						
Number of Samples Collected				1	11	3
Number of MTBE Detections				1	1	0
WELL 01						
Number of Samples Collected	5	87	140	253	338	94
Number of MTBE Detections	0	0	0	12	9	0
WELL 01 - DESTROYED						
Number of Samples Collected	2	2	2	1	1	1
Number of MTBE Detections	0	1	1	0	0	0
WELL 02						
Number of Samples Collected		58	109	124	174	49
Number of MTBE Detections		0	0	0	1	0
WELL 029						
Number of Samples Collected	1	6	6	7	6	3
Number of MTBE Detections	1	0	0	0	0	0
WELL 03-01						
Number of Samples Collected			21	9	12	1
Number of MTBE Detections			16	0	3	0
WELL 04						
Number of Samples Collected	4	75	138	159	115	47

Source	1995	1996	1997	1998	1999	2000
Number of MTBE Detections	0	2	0	1	1	0
WELL 05A						
Number of Samples Collected		5	7	10	14	15
Number of MTBE Detections		0	0	0	0	1
WELL 07						
Number of Samples Collected	4	44	63	98	79	23
Number of MTBE Detections	0	0	0	3	0	0
WELL 075-01 - TREATED						
Number of Samples Collected		4	3	4	8	1
Number of MTBE Detections		0	0	0	2	0
WELL 09 GAC TREATED						
Number of Samples Collected				11	12	2
Number of MTBE Detections				0	1	0
WELL 11 - INACTIVE						
Number of Samples Collected		3	6	13	12	3
Number of MTBE Detections		0	0	8	5	2
WELL 15-01						
Number of Samples Collected		15	20	10	9	3
Number of MTBE Detections		0	0	0	1	0
WHISKEYTOWN LAKE - SPRING CREEK TUNNEL						
Number of Samples Collected		1	3	1	1	
Number of MTBE Detections		1	1	0	0	

[a]Includes only those sources that have at least one MTBE detection that are sampled for three or more consecutive years.

Table 3
MTBE Detection Frequency for Drinking Water Supplies in California by County[a]

County	Number of Samples Collected	% MTBE Detection	Number of Sources Sampled	% MTBE Detection	Number of Systems Sampled	% MTBE Detection
ALAMEDA	539	3.5	64	10.9	14	21.4
BUTTE	539	0.2	95	1.1	21	4.8
CALAVERAS	180	1.7	24	4.2	22	4.5
CONTRA COSTA	50	4.0	21	9.5	20	10.0
DEL NORTE	25	4.0	14	7.1	19	5.3
EL DORADO	477	16.6	61	14.8	14	7.1
KERN	1,429	3.2	388	1.5	175	2.9
LAKE	77	9.1	31	9.7	35	11.4
LOS ANGELES	8,475	0.8	839	2.6	214	3.7
MARIPOSA	27	3.7	15	6.7	14	7.1
MONO	26	3.8	14	7.1	5	20.0
NEVADA	69	1.4	32	3.1	28	3.6
ORANGE	3,327	0.3	200	2.0	52	5.8
PLACER	85	1.2	45	2.2	32	3.1
RIVERSIDE	1,697	0.4	296	0.7	54	3.7
SACRAMENTO	1,106	1.4	357	0.3	36	2.8
SAN BERNADINO	2,631	0.2	497	0.6	113	1.8
SAN DIEGO	383	12.0	72	19.4	19	10.5
SAN FRANCISCO	69	8.7	13	7.7	3	33.3
SAN LUIS OBISPO	284	0.4	117	0.9	31	3.2
SAN MATEO	317	2.8	54	7.4	10	20.0
SANTA CLARA	1,201	0.7	250	2.8	47	6.4
SANTA CRUZ	359	0.3	86	1.2	21	4.8
SHASTA	65	7.7	35	8.6	18	16.7
SOLANO	185	0.5	47	2.1	28	3.6
SONOMA	502	1.0	143	2.1	141	2.1
TRINITY	5	20.0	3	33.3	4	25.0
TULARE	637	0.5	210	1.0	39	2.6
TUOLUMNE	52	1.9	38	2.6	22	4.5
VENTURA	337	1.5	98	3.1	58	5.2
YUBA	119	16.0	31	3.3	23	4.3

[a]Includes samples from 1995–2000.

Table 4
Drinking Water Sources With Detectable Levels of MTBE Above California's Primary Standard of 13 ppb[a]

Source	System	County	Number of Samples	Year	Concentration (ppb)
ARCADIA WELL 04 - STANDBY	Santa Monica	Los Angeles	1	1996	20
ARCADIA WELL 05 - STANDBY	Santa Monica	Los Angeles	8	1995-1996	15-87
CANYON LAKE - RAW	Elsinore Valley	Riverside	1	1997	14
CHARNOCK WELL 13 - STANDBY	Santa Monica	Los Angeles	10	1995-1996	44-490
CHARNOCK WELL 15 – STANDBY	Santa Monica	Los Angeles	2	1996	53-73
CHARNOCK WELL 18 – STANDBY	Santa Monica	Los Angeles	5	1996	19-48
CHARNOCK WELL 19 – STANDBY	Santa Monica	Los Angeles	6	1995-1996	14-610
CONCERTO 01 - INACTIVE	Yorba Linda	Orange	4	1997-1998	16-41
LAKE PERRIS (EFFLUENT OR SURFACE)	So. California	Los Angeles	2	1997-1998	15
TATA WELL 04 (ANGORA WELL 10)	South Tahoe	El Dorado	15	1997-1999	13-68
TRAVIS WTP - TREATED	Vallejo	Solano	1	1999	22
VERDUGO WELL 02	Los Angeles	Los Angeles	1	1996	13
WELL 01	Gary Drilling	Kern	13	1998-1999	14-47
WELL 01 - SYSTEM INACTIVATED	Gaslite Mobile	Kern	2	1999	14-16
WELL 022-02 - STANDBY (MTBE>AL)	Bakersfield	Kern	4	2000	13-24
WELL 03-01	Marysville	Yuba	13	1997-1999	15-234
WELL 05 - INACTIVE	Union Pacific	Kern	3	1997-1998	22-46
WELL 05A	Atascadero	San Luis Obispo	1	2000	85
WELL 11 - INACTIVE	Fruitridge Vista	Sacramento	13	1998-2000	14-25

[a]Includes samples from 1995–2000.

Figure 1
Reported MTBE Detection Limits for Non-Detect Drinking Water Samples in California in 1995–2000

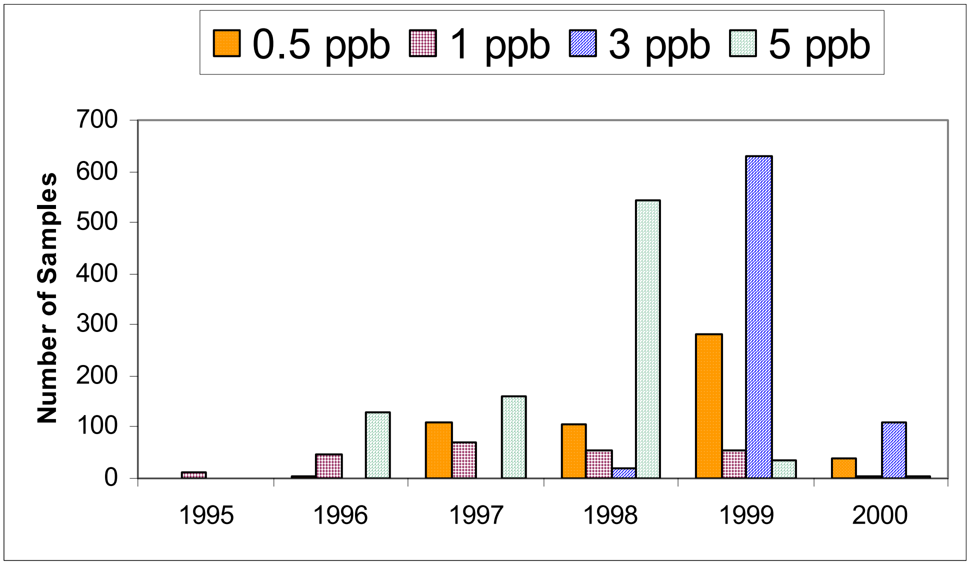


Figure 2
Frequency of Sampling of Drinking Water Supplies in California in 1995–2000

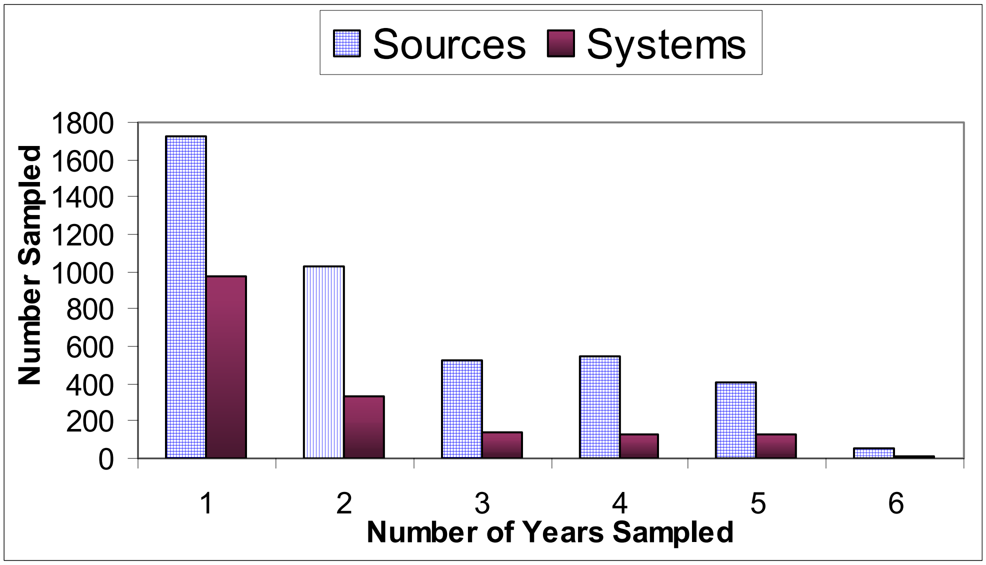


Figure 3
Average Detected MTBE Concentration for Drinking Water Supplies in California in 1995–2000

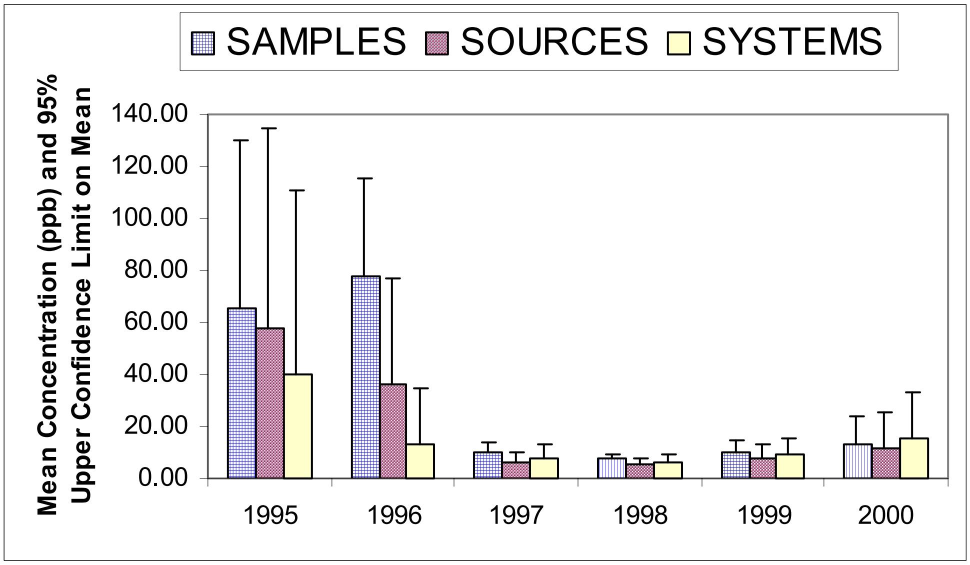
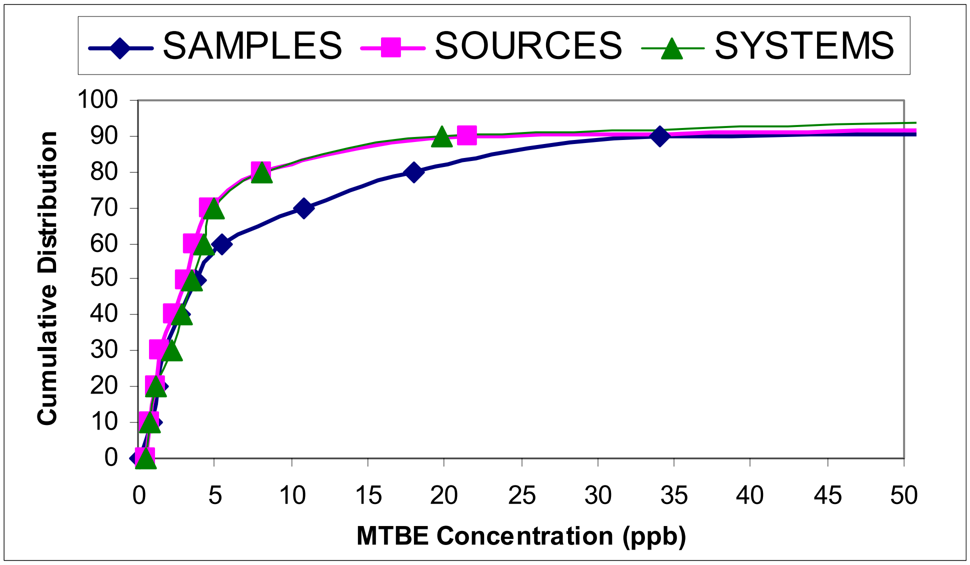


Figure 4
Distribution of Detected MTBE Concentrations for Drinking Water Supplies in California[a]



[a]Includes samples from 1995–2000.

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