A REVIEW OF THE POLICY FOR THE ELIMINATION OF MTBE AS A PETROLEUM ADDITIVE IN THE U.S.

By

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ABSTRACT

MtBE is used as a gasoline additive all over the United States; its use is associated with the reduction of atmospheric concentrations of carbon monoxide or ozone. MtBE has been used to great advantage since the seventies without society being aware of any adverse health effects, other than bad odor. Thus, when the U.S. Geological Survey reported in 1994 that MtBE was the most frequently found volatile organic chemicals (VOC) in shallow ground water from urban areas, concerns about potential inhalation health effects and water contamination were quickly raised. Yet, despite a multitude of studies, there remains considerable debate over what, if any, health effects result from exposure to MtBE.

Faced with a growing outcry on the part of the public about whether MtBE might be adverse to human health and the environment, the EPA appointed a Blue Ribbon panel in November 1998 to investigate the air and water quality concerns. The panel sought to explain any links between MtBE exposures and negative human health conditions, and the degree to which a cause-effect relationship might exist.

This master's paper reviews the steps associated with the policy development for MtBE including impact on air and water quality and public health. It summarizes available data on benefits and risks to support the need for a policy decision at the national level. It concludes by advocating for legislation which truly controls the use of MtBE. This may serve as a model for what to do or what not to do for other public health/environmental policy.
1. Introduction

Methyl tertiary-Butyl Ether (MtBE) is an ether compound made by combining methanol and isobutylene. The methanol is typically derived from natural gas; isobutylene can be derived as a byproduct of the petroleum refinery process. Since the 1970's, MtBE has been used in the United States as an octane-enhancing replacement for lead, primarily in mid- and high-grade gasoline at concentrations as high as 7% (by volume). MtBE was first introduced at levels of 15% by volume in Colorado in the winter of 1987 to help Denver reduce its smog problem. Now, however, MtBE is mainly used as a fuel oxygenate at higher concentrations (11% to 15% by volume) as part of the Federal reformulated gasoline programs (RFG) required by the 1990 Clean Air Act (CAA, 1990). The amendment requires that Federal RFG meet 2.0% oxygen content.

About 109 million people live in counties where fuel oxygenates are used to meet either one or both of the requirements of the Clean Air Act Amendments of 1990 (CAA, 1990) (fig. 1). MtBE also is used in many other undefined areas to enhance the octane of gasoline, but its use is not mandated in these areas. In 1994, fuel oxygenates were added to more than 30% of the gasoline in the United States (U.S. EPA, 1994) and by the year 2000 it was projected that fuel oxygenates would be added to 70% of the gasoline pool in the United States (Federal Register, 1994).
Figure 1. Location of areas using oxygenated or reformulated gasoline, U.S. Geological Survey National Water-Quality Assessment (NAWQA) Study Units, and Urban and Agricultural Land-Use Studies.
MtBE is on the Hazardous Air Pollutants List with 189 other chemicals to be regulated under the Air Toxics Program of the 1990 Clean Air Act Amendments (Article 211, CAA [1990]). Considerable public attention has been focused on MtBE in the atmosphere. Health complaints related to MtBE in the atmosphere were reported in Fairbanks, Alaska, in November 1992 (Mehlmann MA [1998a]) when residents reported headaches, dizziness, irritated eyes, burning of the nose and throat, coughing, disorientation, and nausea (Moolenaar and others, 1994). After MtBE had been added to gasoline, similar health complaints also have been registered across the country including Anchorage, Alaska; Missoula, Montana; Milwaukee, Wisconsin; and several cities in New Jersey (Health Effects Institute [HEI] 1995; Price, 1995). But the number of complaints in these areas varied.

A few epidemiological studies have been conducted in response to public concerns related to the health complaints listed above (Mannino and Etzel, 1996; Moolenaar and others, 1994; White and others, 1995), and a few laboratory studies of healthy adults have been conducted (U.S.EPA, 1994a). Controlled exposure to MtBE in laboratory air did not cause an increase in symptoms or in objective measures of irritation (U.S.EPA, 1994a). Although both of these types of studies have led to a better understanding of human exposures to MtBE, they can neither confirm nor dismiss the existence of acute health effects from exposure to MtBE alone or in gasoline (U.S.EPA, 1994a). MtBE is a potentially important ground-water contaminant because of its mobility and persistence (Garrett and Moreau, 1986), and because it is tentatively classified by the U.S.EPA as a possible human carcinogen. In non-oxygenated gasoline, the monocyclic aromatic hydrocarbons, which include benzene, toluene, ethyl benzene, and the three xylenes, m-, o-, and p- (BTEX compounds), are the most soluble and most mobile components in gasoline.
In oxygenated gasoline, MtBE is even more soluble and mobile than any of the BTEX compounds (Garrett and Moreau, 1986; Barker et al., 1990; Luhrs and Pyott, 1992; OSTP, 1998). In fact, evidence indicates that MtBE moves as rapidly as a conservative tracer (Barker et al., 1990; J.P. Malley, Jr., 1993).

MtBE persists in ground water under both aerobic and anaerobic conditions (Barker and others, 1990; Squillace, P.J. et al., 1997; J.P. Malley, Jr., 1993; Keller, Arturo, et al., 1999; Hurt, K.L., et al., 1999) because it resists physical, chemical, and microbial degradation. The U.S. EPA drinking-water lifetime health advisory for MtBE recommends keeping levels of contamination in the range of 20 to 40 ug/L or below to protect consumer acceptance of water (U.S. EPA, 1997). MtBE is on the U.S. EPA's Drinking Water Priority List, which means it is a possible candidate for future regulation under the Safe Drinking Water Act. MtBE is also used in conventional gasoline to boost the octane of gasoline. Octane is a measure of a fuel's resistance to uncontrolled combustion (engine knock). The Department of Energy estimates that approximately 12,000 barrels of MtBE are used per day as an octane enhancer in conventional gasoline (U.S. EIA, April 1999). There are no current Federal regulations that require municipalities to test for MtBE in drinking water.

One important purpose of this paper is to review potential health effects, including the benefits and risks associated with MtBE. It also will outline a plan for EPA to implement a policy response related to MtBE. First, relevant national environmental policies will be reviewed.
II. A Brief Policy History

This table documents the major policy developments that helped increase or control the utilization of MtBE in the United States of America.

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>The Clean Air Act (CAA)</td>
<td>Federal law that regulates air emissions from stationary and mobile sources</td>
</tr>
<tr>
<td>1974</td>
<td>Safe Water Drinking Act</td>
<td>Law to protect the quality of drinking water in the USA.</td>
</tr>
<tr>
<td>1976</td>
<td>Toxic Substances Control Act (TSCA)</td>
<td>Enacted by congress, this act prohibited manufacture, import, sale, storage, and transportation of MtBE for use in the U.S. as a gasoline additive</td>
</tr>
<tr>
<td>1976</td>
<td>Resource Conservation &amp; Recovery Act</td>
<td>EPA-program that requires that older, more leak prone tanks meet current standards for new tanks.</td>
</tr>
<tr>
<td>1990</td>
<td>Clean Air Act (CAA) - amendment</td>
<td>Amendments require geographic areas that do not meet certain air quality standards to incorporate oxygenates such as MtBE into gasoline to reduce emissions of carbon monoxide (CO) &amp; volatile organic compounds (VOC).</td>
</tr>
</tbody>
</table>
1970: **Clear Air Act (CAA)**. The Clear Air Act is the comprehensive Federal Law that regulates air emissions from area, stationary, and mobile sources. This law authorizes the U.S. Environmental Protection Agency to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. The goal of the Act was to set and achieve NAAQS in every state by 1975. The setting of maximum pollutant standards was coupled with directing the states to develop state implementation plans (SIP's) applicable to appropriate industrial sources in the state. The Act was amended in 1977 primarily to set new goals (dates) for achieving attainment of NAAQS since many areas of the country had failed to meet the deadlines.

1972: **Federal Water Pollution Control Act**. As amended in 1977, this law became commonly known as the **Clean Water Act (CWA)**. The Act established the basic structure for regulating discharges of pollutants into the waters of the United States. It gave EPA the authority to implement pollution control programs such as setting wastewater standards for industry. The Clean Water Act also continued requirements to set water quality standards for all contaminants in surface waters (CWA, 1977).

1974: **The Safe Drinking Water Act**. This Act was established to protect the quality of drinking water in the U.S. This law focuses on all waters actually or potentially designed for drinking use, whether from above ground or underground sources. The Act authorized EPA to establish safe standards of purity and required all owners or operators of public water systems to comply with primary (health-related) standards. State governments, which assume this power from EPA, also encourage attainment of secondary standards (nuisance-related)( SDWA, 1974).
1976: The Toxic Substances Control Act (TSCA). TSCA was enacted by Congress to give EPA the ability to track the 75,000 industrial chemicals currently produced or imported into the United States. EPA repeatedly screens these chemicals and can require reporting or testing of those that may pose an environmental or human-health hazard. EPA can ban the manufacture and import of those chemicals that pose an unreasonable risk and that might have unknown dangerous characteristics (TSCA, 1976).

1976: Resource Conservation & Recovery Act (RCRA). RCRA gave EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. RCRA focuses only on active and future facilities and does not address abandoned or historical sites. Under this program the EPA, requires that older, more leak-prone gasoline tanks meet current standards for new tanks. These include requirements for tank design, leak detection, spill control, and cleanup (The Resource Conservation and Recovery Act (RCRA); 42 U.S.C. s/s 321 et seq. (1976).

1990: Clean Air Act (CAA). The 1990 amendments to the Clean Air Act in large part were intended to meet unaddressed or insufficiently addressed problems such as acid rain, ground-level ozone, stratospheric ozone depletion, and air toxics. It requires fuel oxygenates, such as MTBE, to be added to gasoline used in some metropolitan areas to reduce atmospheric concentrations of carbon monoxide (CO) or ozone (O3). Areas that exceed the national ambient air-quality standard for carbon monoxide were required to use oxygenated fuels by November 1, 1992. It requires oxygenated fuels during the winter when the concentrations of carbon
monoxide are largest. Gasoline must contain no less than 2.7% oxygen by weight, which is equal to 15% MtBE by volume, to meet this oxygen requirement(CAA,1993)

2001: Federal Reformulated Fuels Act – Amends the Solid Waste Disposal Act to authorize the use of the Leaking Underground Storage Tank Trust Fund to: (1) carry out corrective actions regarding releases of methyl tertiary butyl ether (MTBE) that present a risk to human health, welfare, or the environment; and (2) conduct inspections, issue orders, or bring actions under the underground storage tank regulation program. Authorizes appropriations from the Trust Fund(Senate Rpt.107-131 – federal reformulated fuels Acts of 2001).
III. Stakeholders

There are three major stakeholders who influence MtBE policy:

- **U.S. producers of MtBE**: There are 27 companies producing Methyl Tertiary Butyl Ether (MtBE) at 32 facilities in the United States. In 1992, 9.1 billion pounds of MtBE were produced in this country. During that same year, capacity was estimated at 11.6 billion pounds (CE & N, 1992). However, MtBE is also being imported into the U.S. from Alberta Envirosfuels of Canada and by the parent company of Citgo in Argentina. A major production plant is under construction in Argentina.

- **The Oxygenated Fuels Association (OFA)**. This industry organization convinced the EPA, Congress, and some state and local officials (with the exception of a few states that have or are in the process of banning MtBE) that oxygenates such as MBTE are the answer to automotive exhaust smog problems and the health benefits associated with the use of MtBE in gasoline outweigh the health risks posed by its detection in groundwater (OFA, 1996). A letter written by the OFA went on to explain that “while MtBE may render water unpalatable at very low concentrations, it does not pose a significant health risk when used as intended in gasoline, because MtBE does not accumulate in the body. Its effects occur only at high doses not encountered by humans and despite extensive testing, no scientific consensus exists on whether the compound can cause cancer in a manner relevant to humans.” (OFA, 1996, p.1961).
Communities for a Better Environment (CBE): This 20-year old-California environmental health and justice group is a non-profit organization in promoting clean air, clean water and the development of toxin-free communities. CBE’s unique three-part strategy provides grassroots activism, environmental research and legal assistance within urban communities. In August 1998 CBE sued eight oil giants (Tosco, Chevron, shell, Exxon, Mobil, Arco, Unocal, and Texaco) that produced and distributed MtBE in California. CBE’s lawsuit is under California’s unfair Competition Act that prohibits any “unlawful, unfair or fraudulent business practice.” According to the lawsuit, the oil companies have violated the law by using MtBE in such a way that it has contaminated ground water and drinking water and alleges that the defendants knew of MtBE’s high mobility, solubility and probable carcinogenicity and nevertheless exposed California residents to this environmental disaster (http://cbeegal.org/alerts/alerts_MtBE_fs.htm).

In addition to these formal stakeholder organizations, is the public health workforce, whose role is to promote and protect the health of the public. This includes careful assessment of the benefits and risks associated with the use of environmental agents, such as MtBE.
IV. Public Health & Environmental Impacts

Methyl tertiary butyl ether (MtBE) is used as an octane enhancer to replace lead in gasoline. It also promotes more complete burning of gasoline, thereby reducing carbon monoxide and ozone levels in localities which do not meet National Ambient Air Quality Standards (ATSDR, 1996; USGS, 1996). Almost all of the MtBE produced is used as a gasoline additive; small amounts are used by laboratory scientists (ATSDR, 1996). In spite of these advances, vehicle controls did not improve air quality enough in certain severely-impacted metropolitan areas. So, the Clean Air Act Amendments of 1990 required the EPA to adopt regulations for reformulated gasoline (RFG) in the nation’s nine worst ozone no attainment areas. (“No attainment areas” are areas which do not meet one or more of the air quality standards established by the EPA.) If they choose, less severe ozone no attainment areas across the nation have the option to participate in the Federal RFG program. Currently, 32 areas in a total of 18 states are participating in the Federal reformulated gasoline program (RFG) and it accounts for about 30% of the gasoline nationwide.

About 40% of the U.S. population live in areas where MtBE is used (USGS, 1996). MtBE is a volatile chemical; therefore, in most areas, the major exposure to MtBE is from air. In some instances, drinking water sources may be contaminated. Leaking underground storage tank systems and pipelines for gasoline products are the cause of reported ground water contamination. According to the Toxic Chemical Release Inventory published in 1995, approximately 3% of the MtBE released from industrial sources enters surface water or publicly-owned treatment plants (ATSDR, 1996). Surface waters can also become contaminated as non-combusted MtBE in gasoline is released into air and precipitated by rain and snow. Unlike most gasoline components, MtBE is a small, highly water-soluble molecule. Therefore, it does not bind strongly to soils, but travels relatively rapidly to and through surface and
underground water. In addition, MtBE appears to be resistant to chemical and microbial decomposition in water (ATSDR, 1996).

MtBE has been reported in ground water and drinking water derived from ground water. Based on monitoring data collected by the U.S. Geological Survey (USGS), it appears that wells most susceptible to contamination are shallow ground water wells in urban areas (USGS, 1996). There is limited MtBE drinking water occurrence information. In air, MtBE may represent 5-10% of the volatile organic compounds that are emitted from gasoline-burning vehicles, particularly in areas where MtBE is added to fuels as part of an oxygenated fuel program (ARCO, 1995).

V(a). Water Quality Impacts.

The first Occurrence of MtBE in shallow ground water was demonstrated by the Urban Land Use study area conducted during 1993-1994 (fig. 2). Of the 210 urban wells and springs sampled, 28% contained chloroform; 27% contained MtBE; 18% contained tetrachloroethene; 10% contained trichloroethene; 7% contained cis-1,2 dichloroethene; 5% contained 1,1-dichloroethane; and 5% contained benzene. There are many potential sources for these other chemicals; however, 1,1-dichloroethane and benzene are found in gasoline. MtBE generally was not found with benzene, toluene, ethyl benzene, and xylenes (BTEX), which commonly are associated with point-source spills of gasoline (fig. 2). Of 210 urban wells and springs sampled 60 wells and 1 spring had concentrations of MtBE or BTEX. Among these 60 wells and 1 spring, 79% had MtBE only, 13% had MtBE and BTEX, and 8% had BTEX compounds only. Detectable concentrations of MtBE were found in 86% of the wells sampled in industrial areas (6 of 7 wells), 31% of the wells sampled in commercial areas (12 of 39 wells), 23% of the wells sampled in residential areas (14 of 61 wells and springs), and 23% of the wells sampled in areas of mixed urban land use, parks, and recreation areas (24 of 103 wells and springs).
MtBE was detected more frequently, and in larger concentrations, in shallow ambient ground water in urban areas. At a reporting level of 0.2 mg/L, MtBE was detected in 27% of 210 shallow urban wells and springs. MtBE was detected in shallow ground water in Denver, Colorado; New England (specifically urban areas within Connecticut, Massachusetts, and Vermont); Reno, Nevada; Albany, New York; Dallas/Fort Worth, Texas; Las Vegas, Nevada; Atlanta, Georgia; and Albuquerque, New Mexico (fig. 3).
**Figure 3.** Frequency of detection of MTBE in shallow ground water from Urban Land-Use Study areas, 1993-94.
A number of studies have been conducted on the concentration of MtBE in drinking water at which individuals can detect the taste and odor of the chemical (Prah, J.D et al., 1994). MtBE has been found at low levels in about 15% of the drinking water tested in the Northeast states of the U.S.A. The public health impacts, as well as taste and odor problems, are a concern where MtBE is present in drinking water at levels above 20 to 70 ppb. The chemical has a very unpleasant turpentine-like taste and odor which can render drinking water unacceptable for consumption even at low levels. The results from a group of studies (summarized in Table 2) show that between .5 and 1.5% of water supplies tested in the Northeast contained MtBE at concentrations above the 35 ppb public health drinking water standard used in Maine (the most restrictive standard in the region).

### Table 2. MtBE Concentration in Northeast Water Supplies

<table>
<thead>
<tr>
<th>Concentration Range (µg/L)</th>
<th>Maine (Private Wells)</th>
<th>Maine (Public Water)</th>
<th>USGS Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤0.2</td>
<td>N=946 (95% CI)</td>
<td>N=793 (95% CI)</td>
<td>N=576 (95% CI)</td>
</tr>
<tr>
<td></td>
<td>85%</td>
<td>85.1%</td>
<td>82.2%</td>
</tr>
<tr>
<td>2–5</td>
<td>12% (10–14%)</td>
<td>13% (11–16%)</td>
<td>16.2% (13–20%)</td>
</tr>
<tr>
<td>5–35</td>
<td>1.9% (1.1–2.3%)</td>
<td>1.3% (0.6–2.3%)</td>
<td>1% (0.3–2.7%)</td>
</tr>
<tr>
<td>&gt;35</td>
<td>1.1% (0.5–1.9%)</td>
<td>0.0% (0.0–0.5%)</td>
<td>0% (0.06–1.9%)</td>
</tr>
</tbody>
</table>

Source: Presence of MtBE and other Gasoline Compounds in Maine's Drinking Water Supply: A preliminary Report, 1998. N=Number of samples. 95% CI (Confidence Interval). The USGS study includes parts of CT, MA, NJ, NH, NY, PA, and VT.
MtBE concentrations above 2.0 ppb are typically associated with identifiable sources such as storage system releases or major accidental spills. However, an analysis conducted by the state of Maine suggests that relatively small spills of a few gallons can contaminate wells to levels near or above health guidelines (Maine dept of conservation, 1998). Table 3 shows that compared to MtBE, the BTEX compounds (with the possible exception of toluene) were infrequently detected and were typically well below health-based standards. In one study conducted by the United States Geological Survey (USGS) in the Northeast, MBTE was the most frequently detected compound of the twenty-five chemical sampled (USCG Fact Sheet 029-1997). A USGS study of seven streams in New Jersey detected MtBE in 87 of the 112 samples taken. However, the median concentration was .42 ppb and the maximum concentration 4.8 ppb (USGS report, 1998).

Table 3: Detection Frequency of Gasoline Compounds in Public and Private Drinking water in Maine.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Private wells</th>
<th>Public water supplies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xylene</td>
<td>.1%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Toluene</td>
<td>2.1%</td>
<td>13.1%</td>
</tr>
<tr>
<td>Ethyl benzene</td>
<td>.1%</td>
<td>.9%</td>
</tr>
<tr>
<td>Benzene</td>
<td>.5%</td>
<td>2.0%</td>
</tr>
<tr>
<td>MBTE</td>
<td>15.8%</td>
<td>16.0%</td>
</tr>
</tbody>
</table>

In a 1999 publication, the Proceedings of Water Resources Conference of the American Water Works Association, USGS assembled its early ambient groundwater data with additional data from urban and rural wells (USGS/USEPA joint study). For urban areas, the frequency of detection of MTBE in groundwater around areas of substantial MTBE use was about 27% (49 of 184 wells), whereas frequencies of detection in non-substantial use areas was about 5%. In rural areas, the frequency of detection of MBTE in groundwater around areas of substantial MTBE use was about 17% (50 of 298 wells), whereas the frequency of detection in non-substantial uses areas was about 2%. Overall, USGS found detections of MTBE in 21% of ambient groundwater in areas where MTBE is used in RFG compared with 2% of ambient groundwater in areas using conventional gasoline. Preliminary results from a joint USGS/EPA study of 12 northeastern States (with a detection limits of 1.0 g/L) show that MTBE was detected in 7% of drinking water supplies, with .8% of these detections above 20 g/L (Hitzig, Robert et al., 1998). The study also concluded that MTBE is detected five time more frequently in drinking water from community water systems in RFG areas than in non-RFG areas. An EPA-supported survey of 50 states and the District of Columbia in 1998 found that, of 34 states that acquire MTBE data from leaking underground storage tank (LUST) sites, 27 (79%) indicated that MTBE was present at more than 20% of their sites and 10 (29%) reported MTBE at more than 80% of their sites.
V(b). Human Health Effects

There are very limited data on the effects of MtBE in humans by any route of exposure and no data are available for the oral route. In two small studies (n=34 and n=43, where human volunteers were exposed to low levels of MtBE in air (1.39 or 1.7 ppm) for 1 hour (Cain et al., 1994; Prah et al., 1994), there was no significant increase in symptoms of eye, nasal, or pulmonary irritation when the results for periods of exposure to MtBE were compared to results from exposure to ambient air. There were also no significant effects on mood (determined by the Profile of Mood States test) or in the results from several performance-based neurobehavioral tests. In both studies, the females ranked the quality of the air containing MtBE lower than the control atmosphere. However, in the study by Cain et al. (1994), where the subjects were also exposed to an atmosphere containing a 7.1 ppm mixture of 17 volatile organic compounds (VOCs) that are frequent air contaminants in areas around gasoline stations, the air quality of the MtBE-containing atmosphere ranked higher than that with the VOC mixture. The results from studies of neurological effects (headache, dizziness, disorientation, fatigue, emotional distress, etc.), gastrointestinal problems (nausea, diarrhea), and symptoms of respiratory irritation in individuals exposed to MtBE vapors through MTBE-containing fuels are inconclusive (Hakkola et al., 1996; Moolenaar et al., 1994; White et al., 1995). The studies cited were different in their design and utilized slightly different parameters for monitoring effects.

The studies by Hakkola et al. (1996) and White et al. (1995) compared the effects in two groups exposed to different concentrations of MtBE from treated gasoline because of their lifestyles. The moderately-exposed individuals either drove a gasoline delivery truck, worked in a gasoline station or worked on car repairs. The minimally-exposed individuals merely used a gasoline-powered vehicle to go to and from work or as part of their job. Hakkola et al. (1996) found that there were no
statistically-significant differences between the signs and symptoms reported by 101 drivers of tanker trucks in Finland (where the gasoline contains 10% MtBE) and 100 milk truck drivers. Blood concentrations of MtBE or its metabolites were not monitored. In the study by White et al. (1995), the odds ratio was 8.9 (95% CI = 1.2-75.6) for the reporting of one or more symptoms when 11 individuals with blood MtBE levels of >2.4 g/L were compared with 33 individuals with lower levels. The odds ratio increased to 21 (95% CI = 1.8-539) when commuters were excluded from the population studied and 8 workers with blood levels of >3.8 g/L were compared to 22 individuals with lower blood MtBE levels. All individuals lived and worked in the area around Stamford, Connecticut.

A study in Alaska (Moolenaar et al., 1994) compared effects and blood levels of MtBE from a time period when oxygenated fuels were in use (Phase I) to those after the oxygenated fuels use had stopped (Phase II). The subjects were volunteers who were occupationally exposed to motor vehicle exhaust or gasoline fumes. Eighteen workers participated in Phase I and 22 in Phase II. Twelve of those that participated in Phase I of the study also participated in Phase II. A questionnaire was used to gather information on signs and symptoms and blood samples were collected for measurement of MtBE at the beginning and end of a typical work day. In Phase I, the median post-shift MtBE level was higher than the pre-shift value (1.80 vs. 1.15 g/L). During Phase II, the values were more comparable (0.25 vs. 0.21 g/L). Median post-shift blood measurements of TBA were higher during Phase I than in Phase II (5.6 vs. 3.9 g/L). Signs and symptoms that could be associated with MtBE exposure were reported more frequently during Phase I than Phase II (Moolenaar et al., 1994). During Phase I, 50% or more of the participants reported headaches, eye irritations and nose and throat irritations. Reporting of these symptoms occurred in less than 10% of the participants during Phase II. However, it is difficult to evaluate if psychosomatic factors and individual sensitivity had influenced these results.
The volunteers may have chosen to participate because of their sensitivity to contaminants in the atmosphere.

In comparison to other components of concern gasoline such as BTEX, the available information shows that MBTE may pose additional problems when it escapes into the environment through gasoline releases. MBTE is capable of traveling through soil rapidly and is very soluble in water (much more than BTEX). In addition, it is highly resistant to biodegradation. MBTE that enters groundwater moves at nearly the same velocity as the groundwater itself. As a result, it often travels farther than other gasoline constituents making it more likely to impact public and private drinking water wells. Most contamination enters the water supply from leaking underground storage tanks. Furthermore, percolation of MBTE-exhaust-contaminated rainwater and urban runoff into the soil can cause widespread low-level contamination (Siddiqui, Mohamed, et al., 1998).

The U.S. Geological Survey (USGS) has assessed the occurrence of MtBE contamination in twelve eastern states where its use is common and found that almost 8% of 721 community water supply systems are contaminated with as much as 20 parts per billion (ppb) MtBE (John Zogorski, et al., 1999). A joint EPA and university of Massachusetts national survey (Denise Leonard, UMass survey of States 1998) depicting leaking underground storage tank programs reported that 19 states had detected MBTE in public water supplies in 251 to 422 wells per state (John Zogorski, et al., 1997). Once MtBE pollutes the groundwater, it spreads out more quickly and is more difficult to remove than other gasoline components. The compound is slow to biodegrade, persists longer, and spreads up to twice as far in the environment as gasoline by itself does. It therefore threatens a larger volume of the water supply." An estimated 17 billion pounds of MBTE were produced in the United States in 1995, placing it 12th on a list of industrial chemicals based on column of production (CEC, 1998). This makes MBTE one of the highest volume chemicals with potential for human exposure in the United States.
The EPA classified MTBE as a "possible" human carcinogen under its 1986 cancer risk assessment guidelines on the basis of results of inhalation cancer tests and has suggested that it be regarded as posing a potential carcinogenic hazard and risk to humans. However, EPA has established no quantitative estimate of the cancer potency of MTBE because of limitations in the available data (U.S. EPA, Office of R&D, 1998).
VI. Benefits and Risk Consideration

This master's paper provides a review of the MTBE policy development with a goal to encourage the EPA to make a policy change to eliminate the use of MTBE in gasoline. But the policy response should not sacrifice the gains this country has made in trying to achieve cleaner air. EPA should ensure that there is no loss of current air quality benefits if reformulated gasoline formulation changes. Phasing out MTBE would greatly reduce the current threat to water quality, but it would also decrease some air quality benefits. Without oxygenates, about 25% of current carbon monoxide benefits from oxygenated fuels would also be lost. According to the U.S. Department of Energy, a ban on MTBE would result in a two cent per gallon refining cost increase (G.R. Hadder, 1999). Should MTBE be banned over a short time frame, it would result in visible price increases. But using ethanol to fill the MTBE void would further increase prices by an estimated six-tenths of a cent per gallon because increased demand would boost ethanol prices. Price increases would be higher if MTBE is eliminated or quickly banned. Despite these unexpected consequences, data from the U.S. Geological Survey indicates a strong relationship between MTBE use as a fuel additive and detections of low levels of MTBE in water supplies. Several states that originally participated in the RFG programs mandated by the CAA have already taken action to address concerns over growing MTBE contamination of their water resources. A number of those states have partially or totally banned the use of MTBE (table 4).

Thus for many states the decision has been made that the risks of MTBE greatly outweigh the benefits. Data used by those states to make their decisions need to be summarized in order to provide the most comprehensive information available to insure that a fair assessment of the benefit/risk ratio for MTBE is carried out in an objective manner. This information will provide a strong basis for enacting policy change at the national level.
<table>
<thead>
<tr>
<th>State (EPA region)</th>
<th>Phase out date</th>
<th>Complete or Partial</th>
<th>Others Oxygenates</th>
<th>Date of adoption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iowa</td>
<td>7/1/00</td>
<td>Partial (0.5%) MtBE</td>
<td>MtBE only</td>
<td>5/11/00</td>
</tr>
<tr>
<td>Minnesota</td>
<td>7/2/00 then 7/02/05</td>
<td>Complete 05</td>
<td>MtBE, EtBE and TAME</td>
<td>Early 2000</td>
</tr>
<tr>
<td>Nebraska</td>
<td>7/13/00</td>
<td>Partial 1% volume</td>
<td>MtBE only</td>
<td>4/11/00</td>
</tr>
<tr>
<td>South Dakota</td>
<td>1/01/01</td>
<td>Partial (0.5% volume)</td>
<td>MtBE only</td>
<td>2/28/01</td>
</tr>
<tr>
<td>Colorado</td>
<td>4/30/02</td>
<td>Complete by 4/30/02</td>
<td>MtBE only</td>
<td>5/23/00</td>
</tr>
<tr>
<td>California</td>
<td>12/31/02 delayed to 03</td>
<td>Complete by 12/31/02</td>
<td>MtBE only</td>
<td>10/9/99</td>
</tr>
<tr>
<td>Michigan</td>
<td>6/01/03</td>
<td>Complete by 6/01/03</td>
<td>MtBE only</td>
<td>6/26/00</td>
</tr>
<tr>
<td>Connecticut</td>
<td>1/01/04</td>
<td>Complete ban 1/01/04</td>
<td>MtBE only</td>
<td>6/01/00 ext 04</td>
</tr>
<tr>
<td>New-York</td>
<td>1/01/04</td>
<td>Complete as 1/01/04</td>
<td>MtBE only</td>
<td>5/24/00</td>
</tr>
<tr>
<td>Washington</td>
<td>1/01/04</td>
<td>Partial 0.06% Volume</td>
<td>MtBE only</td>
<td>5/10/01</td>
</tr>
<tr>
<td>Kansas</td>
<td>7/01/04</td>
<td>Partial (0.5% volume)</td>
<td>MtBE only</td>
<td>4/19/01</td>
</tr>
<tr>
<td>Illinois</td>
<td>7/24/04</td>
<td>Partial (0.5% or less)</td>
<td>MtBE only</td>
<td>7/24/01</td>
</tr>
<tr>
<td>Indiana</td>
<td>7/24/04</td>
<td>Partial, no &gt;5 % volume</td>
<td>MtBE Only</td>
<td>3/14/02</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>8/01/04</td>
<td>Partial, No &gt;5 %</td>
<td>MtBE only</td>
<td>8/11/03</td>
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<tr>
<td>Ohio</td>
<td>7/1/05</td>
<td>Partial, No &gt;5 %</td>
<td>MtBE only</td>
<td>5/29/02</td>
</tr>
<tr>
<td>Missouri</td>
<td>7/31/05</td>
<td>Partial no &gt;5% volume</td>
<td>MtBE only</td>
<td>7/11/02</td>
</tr>
<tr>
<td>Kentucky</td>
<td>1/01/06</td>
<td>Partial no &gt;5 % volume</td>
<td>MtBE only</td>
<td>4/25/02</td>
</tr>
<tr>
<td>Maine</td>
<td>1/01/04</td>
<td>Partial, no &gt;5 vol</td>
<td>MtBE only</td>
<td>4/14/04</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>1/01/07</td>
<td>Partial no &gt;5 % vol</td>
<td>MtBE, and TBA</td>
<td>5/27/04</td>
</tr>
</tbody>
</table>
IV. Recent Policy Initiative

In response to the growing concerns from State and federal officials about MtBE, the MTBE Blue Ribbon Panel was created in November 1998 by a Charter from the Clean Air Act Advisory Committee to provide independent advice and counsel to EPA on policy issues associated with the use of MTBE and other oxygenates in gasoline (CAAAC, 1999). The Panel members consisted of leading experts from the public health, scientific communities, and automotive fuels industry, and water utilities, local and state governments. The Panel was charged to: (1) examine the role of oxygenates in meeting the nation's goal of clean air; (2) evaluate each product's efficiency in providing clean air benefits and the existence of alternatives; (3) assess the behavior of oxygenates in the environment; (4) review any known health effects; and (5) compare the cost of production and use and each product's availability -- both at present and in the future. Further, the panel studied the causes of ground water and drinking water contamination from motor vehicle fuels, and explored prevention and cleanup technologies for water and soil. The members met six times from January – June, 1999, heard presentations in Washington, the Northeast, and California about the benefits and concerns related to RFG and the oxygenates; gathered the best available information on the program and its effects; identified key data gaps; and evaluated a series of alternative recommendations based on their effects on air quality, water quality and stability of fuel supply and cost.

Based on its review of the issues, the Panel made the following overall findings: (1) The distribution, use, and combustion of gasoline poses risks to our environment and public health. (2) RFG provides considerable air quality improvements and benefits for millions of US citizens. (3) The use of MTBE has raised the issue of the effects of both MTBE alone and MtBE in gasoline.
The panel was not constituted to perform an independent comprehensive health assessment and has chosen to rely on recent reports by a number of state, national, and international health agencies. What seems clear, however, is that MtBE, due to its persistence and mobility in water, is more likely to contaminate ground and surface water than the other components of gasoline. It is important to note the following facts and recommendations in the Blue Ribbon report:

- MtBE has been found in a number of water supplies nationwide, primarily causing consumer odor and taste concerns that have led water suppliers to reduce use of those supplies. Incidents of MtBE in drinking water supplies at levels well above EPA and state guidelines and standards have occurred, but are rare. The Panel believed that the occurrence of MtBE in drinking water supplies can and should be substantially reduced.

- MtBE is currently an integral component of the U.S. gasoline supply both in terms of volume and octane. As such, changes in its use, with the attendant capital construction and infrastructure modifications, must be implemented with sufficient time, certainty, and flexibility to maintain the stability of both the complex U.S. fuel supply system and gasoline prices (EPA, 1999).

These recommendations could be implemented by federal and state environmental agencies without further legislative action.
VII. Policy Changes

One purpose of this paper is to review the history of the policies that have been put in place and then to reexamine previous policy in order to re-stimulate debate over the benefits and risks of MtBE as a gasoline additive. A comprehensive policy response by the EPA administrator should include both regulatory actions as well as a concerted lobbying effort at the Federal level. The overriding goal should be to create a policy in a way which minimizes economic costs to states while maintaining environmental and economic benefits. Key items in the policy history of MtBE, which should be considered for future legislation include the following:

1. **Toxic Substances Control Act of 1976 (TSCA).**

This Act gave the EPA authority to ban, phase out, limit or control the manufacture of any chemical substance deemed to pose an unreasonable risk to the public or the environment. Data from the U.S. Geological Survey indicates a strong relationship between MTBE use as a fuel additive and detections of low levels of MtBE. A number of states have taken action to ban MtBE. Accordingly, EPA published in March, 2000 an Advance Notice of Proposed Rulemaking requesting comments on a phase down or phase out of MTBE from gasoline under Section 6 of the Toxic Substances Control Act (TSCA). This master paper believe that TSCA is the best regulatory process available for EPA to limit or eliminate any chemical substance deemed to pose an unreasonable risk to public health or the environment. Actions taken by a growing number of states to ban the use of MTBE as a gasoline additive are the single biggest factor that would allow the EPA to regulate this requirement around the country.
2. The "Reinforcement" of Resource Conservation and Recovery Act (RCRA).

Because a significant portion of MTBE contamination is from leaking underground storage tanks, an obvious prevention technique is to stop such leaks. EPA, under a program of the Resource Conservation and Recovery Act (RCRA), requires that older, more leak-prone tanks meet current standards for new tanks. These include requirements for tank design, leak detection, spill control, and cleanup. However, eight months after the deadline, 20% of tanks were noncompliant, in part because requirements had not been enforced. It is important to note that small underground and above-ground tanks, noncommercial farm and residential tanks, and some tanks involved with petroleum gathering and production are exempt from EPA regulations.


In January 2001, former President Clinton's EPA proposed a regulation that would ban MtBE use. The proposed regulation said that "The use of MtBE as an additive in gasoline present an unreasonable risk to the environment. The EPA document went on to say that "low levels of MtBE can render drinking supplies unpotable due to its offensive taste and odor," and the additive should be phase out over four year. During the markup of this legislation, the Senate Environment and Public Works Committee (EPW) voted to approve the phasing out of MtBE in reformulated gasoline (RFG) by 2004. Unfortunately, this legislation that looks promising was shelved quietly by the first term of George W. Bush administration. The current EPA administrator has the opportunity to work with different state congressional delegation to significantly raise the profile of MtBE, which still a very obscure issue on Capitol Hill by lobbying both Congress and the second term of George W. Bush administration for its reconsideration. Nonetheless, it will be useful for the EPA to send a clear signal to the White House that it support this legislation for its clean water benefits and it has the backing of the Senate EPW Committee.
An important reason for reviewing the policy history of MtBE is to provide a model for other public health initiatives that rely on complex legislative processes for their success. Thus the objectives of this review are not limited to MtBE policy alone, but also to providing a greater understanding of the approach that is needed for changing other health policies when there are numerous stakeholders and competing benefits and risks.
XII. Conclusion/Recommendation

It has been clearly demonstrated that there are both benefits and risks to the use of MtBE. Benefits are those related to a reduction in air pollution. Risks to the public health are related to several factors that are of concern in public health. There is significant concern about contamination of drinking water in many areas of the country. Current data on MtBE in ground and surface waters indicate widespread and numerous detections at low levels. Clearly, the EPA should be concerned about the presence of MtBE in ground and surface water. Based on the recommendations of EPA’s Blue Ribbon panel, some change in federal regulation of MtBE is justified. This master’s paper encourage the current EPA Administrator to consider the limitation of MtBE in gasoline as quickly as possible without sacrificing the gains we’ve made in achieving cleaner air. The EPA also need to provide technical assistance to Congress in order to work toward a targeted legislative solution that maintains the air quality benefits of RFG while allowing reductions in the use of MTBE.

An important recommendation of this paper is to form a working group that will review the benefits and risks of MtBE in simple manner that can aid legislation. It should include study findings and a summary of state-level legislature actions. An example of this approach is the Working Group that was assembled to study the suspected health effects of living near power lines. The program included a three day symposium with discussions and presentation by world wide experts. Their findings were then summarized for review in a concise document(NIEHS,1998). This approach may also be useful in regard to the MtBE controversy. With the appropriate documents in hand, the EPA will then need to embrace a policy that would limit MtBE in gasoline as quickly as possible without sacrificing the gains we’ve made in achieving cleaner air.
The EPA already has the authority under Section 211 of the Clean Air Act to regulate fuel formulation. Environmental implications of phasing out MTBE from gasoline and eliminating the oxygenate mandate would greatly reduce the current threat to water quality, but it might decrease some air quality benefits. Without oxygenates (MtBE is a major chemical component), current carbon monoxide benefits from oxygenated fuels may be lost. But this loss will become less critical in the next few years as vehicles conform to stricter tailpipe emissions standards. The last Senate session heard testimony on whether to phase out MtBE or ban it altogether. The senate bill which was sponsored under the “Federal Reformulated Fuels Acts of 2001” was quickly shelved by President Bush’s administration. EPA has listed MtBE as a potential candidate for regulation under the current Safe Drinking Act (SDWA). The three policy reviews suggested in this master’s paper, if embraced by the EPA will ensure at least that MtBE problem will be addressed. Thus it will demonstrate the administration’s commitment to preserving cleaner air. Legislative and regulatory action should be the priority and the best way for America to address this problem. The EPA also has the TASCA act that would allow it to ban, phase out, limit or control MtBE. This is a public health issue that can no longer be ignored by EPA. Delaying it will only exacerbate the problem. The time has come for the EPA to take action. We deserve both clean air and clean water but never one at the expense of the other.
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Figure (2). Concentration of MtBE versus total concentration of BTEX compounds in shallow ground water samples from Urban Land-Use Study areas, 1993-1994.
Figure(3) Frequency of detection of MtBE in shallow ground water from Urban

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Table (2). Presence of MBTE and others Gasoline Compounds in Maine's Drinking Water Supply: A preliminary Report, 1998. N=Number of samples. 95% CI (Confidence Interval). The USGS study includes parts of CT, MA, NJ, NH, NY, PA, and VT.


Table (4). http://www.epa.gov/ 

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The Safe Drinking Water Act (SDWA); 42 U.S.C. s/s 300F et seq. (1974)

The Toxic Substances Control Act (TSCA); 15 U.S.C. s/s 2601 et seq. (1976)


U.S. Environmental Protection Agency, Office of Water, Drinking Water.

