New Jersey Drinking Water Quality Institute

Maximum Contaminant Level Recommendations for Hazardous Contaminants in Drinking Water

September 26, 1994

SUBMITTED TO:

State of New Jersey
Department of Environmental Protection

Let's protect our earth

State of New Jersey
DRINKING WATER QUALITY INSTITUTE
DIVISION OF WATER RESOURCES
CN 029
TRENTON, NEW JERSEY 08625

Richard J. Sullivan, Chairman

16 February 1995

Commissioner Robert Shinn
Department of Environmental Protection
CN 402
Trenton, New Jersey 08625-0402

Dear Commissioner:

The members of the Institute are pleased to submit to you their recommendations for new and revised Maximum Contaminant Levels for hazardous contaminants in drinking water.

We have reexamined the MCL for each of the 22 contaminants specifically identified in the 1984 amendments to the New Jersey Safe Drinking Water Act (N.J.S.A. 58:12A-1 et seq.). Where recent credible epidemiological findings so indicate we have recommended revisions to MCLs previously adopted.

As provided in the statute we have also prepared a discretionary list of contaminants that may be found in our public water supplies. For each, based upon a review of all appropriate information, we have proposed a new Maximum Contaminant Level.

The Department is gifted with competent staff in the Bureau of Safe Drinking Water and in the Division of Science and Research whose review, analysis and presentation of epidemiological data provided the basis for our MCL recommendations.

Sincerely,

Richard Sullivan

Richard J. Sullivan
Chairman

RJS:jeb

INTRODUCTION

This is the second document written by the New Jersey Drinking Water Quality Institute (Institute) to address drinking water maximum contaminant level (MCL) issues. The first document was issued March 26, 1987 and provided MCL recommendations for 16 (plus isomers) of the 22 synthetic organic contaminants listed in the 1984 amendments to the New Jersey Safe Drinking Water Act (A-280) legislation. These MCL recommendations were adopted as final regulations by the N.J. Department of Environmental Protection (NJDEP) on January 3, 1989, with minor modifications to be consistent with the national regulations. This document presents the next phase of work that has been performed by the Institute.

A "triennial review" of all the 22 hazardous contaminants listed in the N.J. Safe Drinking Water Act was performed by the Institute. Recommendations for either maintaining or updating the current MCLs for 16 hazardous contaminants ((plus isomers) are discussed in this document. Also discussed are those "2a" list chemicals for which MCLs could not be derived in 1987 because of the lack of validated analytical methods. New health effects data were evaluated and new or modified analytical methods which have been developed and validated since the last Institute recommendation report are discussed. Treatment techniques are also evaluated as part of the development of the new MCLs.

This report discusses the development of the "2b" list, an additional list of drinking water contaminants of concern. The development of the list and the subsequent standard setting were required by the 1984 amendments to the N.J. Safe Drinking Water Act. The derivation of health-based levels, analytical methodologies and treatment techniques for these contaminants is reviewed and specific recommendations regarding MCLs for this list of selected hazardous contaminants are presented. The Institute's comments regarding proposed and final MCLs issued by USEPA are included in this report.

The Institute made specific recommendations for changes to the drinking water program to provide for legislative consistency between the State and Federal drinking water programs. The future use of the MCLs by NJDEP and the limitations in applying the MCLs to other media are presented.

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ACKNOWLEDGEMENTS

The New Jersey Drinking Water Quality Institute (Institute) would like to acknowledge the efforts of the staff of the New Jersey Department of Environmental Protection (NJDEP) and the New Jersey Department of Health (NJDOH) in the development of the Institute's recommendations.

The Institute would like to recognize the following NJDEP and NJDOH personnel who prepared this document: Sandra Krietzman, Environmental Scientist, Bureau of Safe Drinking Water (BSDW); Pat Bono, Principal Environmental Specialist, BSDW; Dr. Gloria B. Post, Research Scientist, Division of Science and Research (DSR); Stephen Jenniss, NJDOH Environmental and Chemical Laboratory Services (of the Institute); Dr. Lee Lippincott, Research Scientist, DSR and Paul Schorr, Research Scientist, BSDW.

Several other NJDEP personnel made significant contributions to the Institute. The health-based support documents and appendices prepared as part of the triennial review and included as appendices to this report were prepared by Dr. Gloria B. Post, Dr. Lubow Jowa, Shelley Hearne, Dr. Thomas Ledoux, and True-Jenn Sun all of the DSR and Dr. Perry Cohn, Drinking Water Project Manager, NJDOH Environmental Health Services. Contributors to the development of appropriate analytical techniques include John Jenks of the Bureau of Analytical Services, Mike Miller of the Office of Quality Assurance, Paul Sanders and Lee Lippincott of the DSR and Joan Kryak of the BSDW. The Institute would also like to recognize the contributions provided by Barker Hamill, Chief of the BSDW and Leslie McGeorge, Assistant Director of the DSR as well as the contributions provided by former Institute members Dr. Ronald Cohen, Dr. Robert Fischer, Mr. Frank Livelli, Dr. Kenneth Ruehl, Dr. Theodore Shelton and Dr. Gisela Witz. This document and appendices were typed by JoAnn Harris, Carole Klein, Lisa Brown and Megan Leadem of the BSDW and Gwen McClendon of the DSR.

EXECUTIVE SUMMARY

The New Jersey Drinking Water Quality Institute, established by the 1983 amendments to the New Jersey Safe Drinking Water Act (N.J.S.A. 58:12A-1 et seq., P.L. 1983, c. 443), is responsible for developing maximum contaminant levels (MCL) or standards for hazardous contaminants in drinking water and recommending these standards to the Commissioner of the N.J. Department of Environmental Protection and Energy (NJDEP). In 1987, the Institute recommended MCLs for 16 of the 22 hazardous contaminants listed in the amendments to the N.J. Safe Drinking Act. The 22 contaminants are commonly referred as "2a" list contaminants since these chemicals were listed in Section "2a" of the amendments to the N.J. Safe Drinking Water Act.

First, health-based standards were established based on specific methodology outlined in the legislation. For carcinogenic contaminants, health-based levels were established at levels which would not, within the limits of medical, scientific and technological feasibility, permit cancer in more than one in one million persons ingesting the contaminant over a lifetime. For noncarcinogens, health-based levels were established at levels which eliminate all adverse physiological effects following ingestion within the limits of practicability and feasibility. In addition, analytical capability and technological feasibility for treating and removing the "2a" list contaminants from drinking water were evaluated. The health-based levels were used as the bases for MCLs, and these levels were modified, where necessary, to reflect analytical or technological limitations. The MCLs developed in 1987 were adopted into regulation by the Commissioner of NJDEP in 1989.

The Institute completed a review of the 1987 recommended standards to ensure that the most current toxicological information, analytical methodology and treatment capability were being utilized in New Jersey's standard setting process. The "triennial review" included a review of all information developed for the 22 contaminants on the "2a" list. This review resulted in recommendations to change five health-based levels based on the availability of new health effects data or reinterpretation of previous data: chlorobenzene, cis-1,2-dichloroethy- lene, trans- 1,2-dichloroethylene, formaldehyde and xylenes. These new health-based levels were used to develop new MCLs for chlorobenzene, cis-1,2-dichloroethylene, trans-1,2- dichloroethylene and xylenes, but an MCL could not be established for formaldehyde because of the lack of adequate treatability data. U.S. Environmental Protection Agency (USEPA) analytical methodologies (with modifications) are available for nearly all "2a" list contaminants. Treatability data for ethylene glycol, formaldehyde, n-hexane and methyl ethyl ketone are incomplete. The Institute could not set standards for these contaminants, however, the Institute recommended the adoption of guidance numbers until new treatability data becomes available.

The Institute developed a list of additional contaminants in drinking water for standard setting. The six contaminants included on the "2b" list, named after the section of the amendments to the N.J. Safe Drinking Water Act which outlined the basis for developing this list, were chosen based on the presence of these contaminants in New Jersey waters and the frequency of occurrence. MCLs for these "2b" list contaminants were established using the same principles as used for setting MCLs for the "2a" list contaminants. The health-based levels developed for these contaminants were included in the triennial review. MCLs were recommended for five of the six "2b" list contaminants: 1,1-dichloroethane, methyl tertiary butyl ether, naphthalene, 1,1,2,2-tetrachloroethane and 1,1,2-trichloroethane. These contaminants can be removed from drinking water by either granular activated carbon and/or air stripping. Analytical difficulties precluded the establishment of an MCL for 2,4,6-trichlorophenol at this time.

Recommendations:

1. The Institute recommends the following new MCLs for lifetime exposure to contaminants in potable water to NJDEP:

Contaminant	New MCL (ug/l)		Former MCL (ug/l)	
1. Chlorobenzene	50		4	
2. para-Dichlorobenzene	75	(a)	6	
3. 1,1-Dichloroethane	50		-	(b)
4. cis-1,2-Dichloroethylene	70		10	
5. trans-1,2-Dichloroethylene	100		10	
6. Methyl tertiary butyl ether	70		-	(b)
7. Naphthalene	300		-	(b)
8. 1,1,2,2-Tetrachloroethane	1		-	(b)
9. 1,1,2-Trichloroethane	3		5	(b)
10. Xylenes	1000		44	

(a) The Institute recommended a health-based level of 150 ug/l after the 1987 recommendation document was issued. This contaminant is regulated at the more stringent USEPA MCL.

(b) This contaminant was not included on the "2a" list of contaminants for standard development in the A-280 law, but was selected for standard development based on occurrence in New Jersey waters and toxicity and is on the "2b" list of contaminants. A Federal standard for 1,1,2-trichloroethane was adopted on January 17, 1994.

2. The Institute recommends the following lifetime exposure guidance numbers:

Contaminant	Guidance Level (ug/l) (a)
1. Ethylene glycol	290
2. Formaldehyde	100
3. n-Hexane	33
4. Methyl ethyl ketone	270
5. 2,4,6-Trichlorophenol	1

(a) These guidance numbers are health-based levels. Approved drinking water analytical methods are available for all of these contaminants except 2,4,6-trichlorophenol. Existing treatment technology cannot effectively remove these five contaminants from drinking water. MCLs for these contaminants will be proposed when analytical methods and/or treatment technology data become available.

3. The Institute recommends that the risk assessment for PCBs be reviewed by a NJDEP work group representing different environmental media. The occurrence of PCBs in drinking water is not significant based on the lack of detectable levels in treated water from public community water supplies during the past ten years, yet PCBs remain an important contaminant in other media such as soil. Because of the large amount of data available and the difficult issues and controversies that must be resolved, the review of the risk assessment for PCBs will take considerable time and effort. The Institute has chosen not to reassess this chemical at this time as it is not being detected in finished drinking water.

4. The Institute recommends that the New Jersey Safe Drinking Water Act be amended to include language that exempts the Institute from being required to set standards for naturally occurring carcinogenic contaminants based on a carcinogenic risk assessment goal of one in one million excess cancer risk.

5. The Institute recommends that the N.J. Safe Drinking Water Act regulations be modified so that the A-280 sample locations are equivalent to USEPA sample locations. The A-280 samples are currently required to be taken from the water distribution system during periods of representative demand. The new Federal monitoring requirements require sampling at the point-of-entry to the water distribution system. The NJDEP should evaluate the new Federal monitoring requirements to insure that test results from the point-of-entry and the distribution system are equivalent.

6. Kerosene cannot be monitored in drinking water because it is a mixture of both water soluble and insoluble components that varies among manufacturers. The Institute recommends that naphthalene, for which an MCL of 300 ug/l has been developed, serve as an indicator of petroleum and/or kerosene contamination in drinking water and that kerosene be removed from the "2a" list.

Triennial Review of A-280 Contaminants

Contaminant	Health Based Level (ug/l)	Practical Quantitation Level (ug/l)	Best Available Technology	Institute Recommended MCL (ug/l)
"2a" list				
Benzene	0.15	1	AS/GAC	1
Carbon tetrachloride	0.39	2	AS/GAC	2
Chlordane	0.013	0.5	GAC	0.5
Chlorobenzene	50	2	AS/GAC	50
m-Dichlorobenzene	600	5	GAC/AS	600
o-Dichlorobenzene	600	5	GAC/AS	600
p-Dichlorobenzene	150	5	GAC/AS	75 (a)
1,2-Dichloroethane	0.29	2	AS/GAC	2
1,1-Dichoroethylene	1	2	AS/GAC	2
cis-1,2-Dichloroethylene	70	2	AS/GAC	70
trans-1,2-Dichloroethylene	100	2	AS/GAC	100
Ethylene glycol	290 (b)	NA	NA	NA
Formaldehyde	100 (b)	41	NA	NA
n-Hexane	33 (b)	5	NA	NA
Kerosene	NA	NA	NA	NA
Methyl ethyl ketone	270 (b)	20	NA	NA
Methylene chloride	2.5	2	AS/GAC	3
Polychlorinated biphenyls	0.024	0.5	GAC	0.5
Tetrachloroethylene	0.44	1	AS/GAC	1
1,2,4-Trichlorobenzene	8.6	5	GAC/AS	9
1,1,1-Trichloroethane	26	1	GAC/AS	30
Trichloroethylene	1.2	1	GAC/AS	1
Vinyl chloride	0.084	5	AS	5 (a)
Xylenes	1000	2	AS/GAC	1000
"2b" list				
1,1-Dichloroethane	46	1	AS	50
Methyl tertiary butyl ether	70	1	AS/GAC	70
Naphthalene	300	2	GAC	300
1,1,2-Trichloroethane	3	2	AS/GAC	3
1,1,2,2-Tetrachloroethane	1	1	AS	1
2,4,6-Trichlorophenol	1 (b)	NA	GAC (c)	NA

KEY:

New health-based values and new Institute recommended MCLs are underlined.

NA = not available.

(a) NJDEP adopted the more stringent USEPA MCL for this contaminant.

(b) Guidance level to be used until analytical or treatment issues allow the development of an MCL.

(c) Partial removal (<90% possible).

LIST OF ABBREVIATIONS AND DEFINITIONS

Act	1983 Amendments to the New Jersey Safe Drinking Water Act, N.J.S.A.58:12A-1 et seq. (P.L. 1983, c. 443). The Act was signed into law on January 9, 1984.
AS	Air Stripping (also called Packed Tower Aeration or PTA).
A-280	Assembly Bill 280 (1983 Amendments to the New Jersey Safe Drinking Water Act, N.J.S.A. 58:12A-1 et seq. (P.L. 1983, c. 443)).
BSDW	Bureau of Safe Drinking Water of the New Jersey Department of Environmental Protection.
DSR	Division of Science and Research of the N.J. Department of Environmental Protection.
GAC	Granular Activated Carbon Adsoption.
Institute	New Jersey Drinking Water Quality Institute.
MCL	Maximum Contaminant Level-the maximum permissible level of a contaminant allowed in drinking water.
MDL	Method Detection Limit - the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.
NJDEP	New Jersey Department of Environmental Protection.
NJDOH	New Jersey Department of Health.
Noncommunity water system	A public water system that serves at least 25 people a day for at least 60 days a year that are not year-round residents.
Nontransient noncommunity water system	A public water system that regularly serves at least 25 of the same persons over six months of the year.
Public community water system	A water system that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents.

LIST OF ABBREVIATIONS AND DEFINITIONS (cont'd.)

PCBs	Polychlorinated biphenyls
PQL	Practical Quantitation Level - the level above the MDL at which quantitation can be achieved by most laboratories within acceptable levels of uncertainty.
RTI	Research Triangle Institute
USEPA	United States Environmental Protection Agency
VOC	Volatile organic chemical
"2a" list	The 22 hazardous contaminants listed in N.J.S.A. 7:12A-13a. This list originally appeared in Section "2a" of Assembly Bill 280 which eventually became the law.
"2b" list	A list of pesticides and related compounds, metals and base/neutral extractable organic compounds and acid extractable compounds believed to be found in drinking water developed by the Drinking Water Quality Institute according to N.J.S.A. 7:12A-13b.
ug/l	micrograms per liter or parts per billion (ppb).

I. INTRODUCTION

A. BACKGROUND

In 1984, the Governor of New Jersey signed landmark legislation requiring that public community drinking water systems test for a specific list of 22 synthetic organic contaminants. This legislation also mandated that standards be set for these contaminants as well as any others that were found or believed to be of concern in New Jersey drinking water supplies. These amendments to the N.J. Safe Drinking Water Act were passed because of both state-wide and nation-wide volatile organic contamination detected in groundwater supplies by several surveys conducted in the early 1980's (Tucker, 1981; Westrick, et al., 1984). Examples of volatile organic chemicals (VOCs) are solvents used in industrial processes such as trichloroethylene, 1,1,1-trichloroethane and 1,2-dichloroethane as well as substances found in gasoline such as benzene and xylenes. Although the State and Federal governments had required monitoring of public community water systems for microbiological parameters, inorganics, radiological contaminants and certain disinfection by-products since the 1970's and there were maximum contaminant levels (MCL) or standards developed for these parameters, there were no enforceable standards available at the State or Federal level for the VOCs being detected in groundwater. In 1983, the U.S. Environmental Protection Agency (USEPA) indicated its intent to regulate 13 VOCs (USEPA, 1983). However, USEPA did not promulgate standards for several years.

B. A-280 AMENDMENTS

The amendments to the New Jersey Safe Drinking Water Act, adopted in 1983 by the Legislature (N.J.S.A 58:12A-1 et seq.), are commonly called the "A-280 amendments." This legislation outlined several new drinking water programs for the protection of public health. The legislation required semi-annual monitoring of public community water systems for 22 synthetic organic contaminants; selection of additional contaminants for future regulation in drinking water; mandated timeframes for the correction of contamination problems in public community water systems and required MCLs be established based on specific risk assessment, analytical capability and treatability criteria specified in the legislation. Another important aspect of the legislation allowed the New Jersey Department of Environmental Protection (NJDEP) "to conduct drinking water research relating to the causes, effects, extent, prevention and control of contaminants in drinking water." The law also established the New Jersey Drinking Water Quality Institute (Institute), a 15 member advisory group to NJDEP. Specific responsibilities of the Institute are outlined in the A-280 legislation and are discussed in the next section.

Mandatory semi-annual monitoring of all public community water systems for the synthetic organic contaminants listed in the legislation began within one year of passage of the bill. When this monitoring began in late 1984, USEPA approved drinking water analytical methods were not available for these contaminants. NJDEP adopted the USEPA "600 series" analytical methods, commonly used for wastewater analyses, in June 1984 for 16 of the 22 contaminants. NJDEP has developed and continues to develop analytical methodologies for the contaminants that do not have applicable promulgated methods. Table 1 lists the 22 synthetic organic contaminants in the A-280 legislation and the current status of monitoring.

TABLE 1

A-280 CONTAMINANT LIST

(Commonly known as the "2a" list)

COMPOUNDS FOR WHICH MONITORING IS PRESENTLY REQUIRED

1. Benzene
2. Carbon tetrachloride
3. Chlordane
4. Chlorobenzene
5. Dichlorobenzene(s)
    - o-Dichlorobenzene
    - m-Dichlorobenzene
    - p-Dichlorobenzene
6. 1,2-Dichloroethane
7. 1,1-Dichloroethylene
8. cis-1,2-Dichloroethylene (a)
9. trans-1,2-Dichloroethylene
10. Methylene chloride
11. Polychlorinated biphenyls
12. Tetrachloroethylene
13. Trichlorobenzene(s)
14. 1,1,1-Trichloroethane
15. Trichloroethylene
16. Vinyl chloride
17. Xylene(s)
    - o-Xylene
    - m-Xylene
    - p-Xylene

COMPOUNDS FOR WHICH MONITORING IS NOT PRESENTLY REQUIRED (b)

1. Ethylene glycol
2. Formaldehyde
3. n-Hexane
4. Kerosene
5. Methyl ethyl ketone

(a) Monitoring for cis-1,2-dichloroethylene was not possible until the USEPA "500 series" methods became available in 1988.

(b) Monitoring for these contaminants has not been possible because of the lack of appropriate analytical techniques. Current information regarding analytical methodologies as well as toxicological data and treatment capability are discussed in detail in other sections of the document.

C. NEW JERSEY DRINKING WATER QUALITY INSTITUTE

The fifteen member Institute was established by the A-280 legislation. Six members serve ex officio and 9 members are appointed - three each by the Governor, the President of the Senate, and the Speaker of the Assembly. The appointed members are from the academic scientific community, the public or the regulated public water supply systems. The first meeting of the Institute was held in March 1985. A list of current Institute members appears in Table 2.

The Institute is responsible for making recommendations to NJDEP for the implementation of the drinking water quality program. Three subcommittees were established to address the main areas of concern outlined in the legislation. The Lists and Levels Subcommittee is responsible for recommending health-based levels for the contaminants listed in the legislation ("2a" list) and for developing an additional list of drinking water contaminants based on occurrence in New Jersey drinking waters ("2b" list). The Testing Subcommittee is responsible for developing appropriate analytical methods to measure levels as close to the health-based levels as possible and developing appropriate monitoring frequencies. The Program Subcommittee is responsible for evaluating best available treatment technologies for removal of the hazardous contaminants from drinking water, as well as overall program review.

D. REVIEW OF RECOMMENDATIONS FROM THE 1987 INSTITUTE DOCUMENT

The first task of the newly-formed Institute was to develop health-based levels for the contaminants listed in the A-280 amendments. The legislation stated that MCLs for carcinogens must be set, within the limits of medical scientific and technological feasibility, at a level which would not permit cancer in more than one in one million persons ingesting the chemical for a lifetime. Also, MCLs for noncarcinogens must be set at levels that eliminate, within the limits of practicability and feasibility, all adverse physiological effects resulting from ingestion. The Institute and NJDEP worked together in developing these health-based levels based on review of the primary scientific literature, following USEPA risk assessment guidance (USEPA, 1986). Adequate health effects data were available for all the contaminants except kerosene so that the Lists and Levels Subcommittee could determine health-based levels in accordance with the A-280 legislation. Since kerosene is a mixture of many different components and the amounts of these components vary among manufacturers, no specific endpoint for toxicity can be reliably determined that would adequately protect consumers of drinking water.

TABLE 2

MEMBERS OF THE NEW JERSEY DRINKING WATER QUALITY INSTITUTE

Currently serving the Institute (1994)

Appointed Members	***Affiliation***
Richard Sullivan (Chairman)	Public
Thomas Cawley	Purveyor
Bruce Chorba	Academic/scientific
Ella Filippone, Ph.D.	Public
Joseph Hunter, Ph.D.	Academic/scientific
Wendell Inhoffer	*Purveyor*
Paul LaPierre, P.E., P.L.S., P.P.	Public
David Marino	Purveyor
Tavit Najarian, Sc.D.	Academic/scientific

Ex Officio Members

Commissioner of Environmental Protection: Robert C. Shinn, Jr., Commissioner
Alternate: Barker G. Hamill, Chief, Bureau of Safe Drinking Water

Commissioner of Health: Len Fishman, Commissioner
Designee: S.I. Shahied, Ph.D. Laboratory Administrator
Alternate: Stephen Jenniss, M.S., Director, Environmental and Chemical Laboratory Services

Chairman of the Water Supply Advisory Council: Eugene Golub, Ph.D.

Director of the Division of Water Resources:
Designee: Steven Nieswand, Administrator, Water Supply Program

Director of the Division of Science and Research:
Designee: Leslie McGeorge, M.S.P.H., Assistant Director

Director of the Office of Occupational and Environmental Health:
Designee: Perry Cohn, Ph.D., M.P.H., Drinking Water Project Manager

During the development of the MCLs, the Institute identified two critical issues: the lack of adequate analytical testing procedures and the inability of the current testing technology to identify and quantify some of the A-280 contaminants at the health-based level. Legal interpretation of the legislation determined that the ability of current analytical testing technology to reliably quantitate these contaminants should be considered when MCLs are developed.

The ability of available treatment technology to remove the contaminants from drinking water should also be considered when establishing MCLs for noncarcinogenic contaminants.

NJDEP adopted the USEPA "600 series" methods for the initial monitoring of the A-280 contaminants. In 1985, the USEPA published "500 series" drinking water test methodologies that were designed specifically for the low level drinking water analysis of 17 (plus isomers) of the 22 listed chemicals (USEPA, 1985). These "500 series" analytical methods were evaluated and subsequently adopted for usage in monitoring for the A-280 chemicals. The Institute recommended that NJDEP research and develop new analytical methods for the remaining A-280 contaminants for which no validated analytical protocols existed. These contaminants are: ethylene glycol, formaldehyde, n-hexane, kerosene and methyl ethyl ketone.

In the case of the carcinogenic contaminants, it was determined that most of the health-based levels were at or below the respective method detection limit (MDL) of the test procedure. The MDL is defined by the USEPA as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero (40 CFR 136 Appendix B). Since the regulation of drinking water contamination at MDL levels is not possible because of analytical variability among instrumentation and among analysts at these low concentrations, the Institute agreed to proceed with the USEPA approach of establishing a "practical quantitation level" (PQL), defined as the level above the MDL at which quantitation can be achieved by most laboratories within acceptable levels of uncertainty (USEPA, 1985). PQLs were developed by the Institute for those contaminants having analytical methods with MDLs at or above the health-based levels by conducting interlaboratory analytical performance evaluations. The Institute later recommended that in these situations the PQL would be used as the MCL with the understanding that as the testing technology improves, PQLs would be lowered until the MCL became equivalent to the health-based level.

Best available treatment removal technologies were also evaluated. It was determined to be "technologically feasible and practicable" to remove the "2a" list contaminants from drinking water with the exception of ethylene glycol, formaldehyde, n-hexane, kerosene and methyl ethyl ketone using air stripping and/or granular activated carbon treatment. The conclusion regarding treatment for the five remaining contaminants listed above was that there was insufficient treatment efficiency data to recommend air stripping and/or granular activated carbon as a removal technology for these contaminants in drinking water and that alternate treatment technologies may have to be investigated.

The Institute recommended the adoption of 18 MCLs representing 16 of the 22 hazardous contaminants (plus isomers) listed in the A-280 amendments to NJDEP in a document issued March 26, 1987 (New Jersey Drinking Water Quality Institute, 1987). The Institute's recommendation document included:

* an extensive discussion of the risk assessment methods used for developing health-based levels for the "2a" list chemicals;

* derivation of health-based levels for the "2a" list contaminants according to the requirements of the A-280 amendments;

* identification of available USEPA test methodologies;

* derivation of analytical levels of acceptable precision and accuracy called a practical quantitation level or PQL; and,

* an evaluation of the effectiveness and economic impact associated with the implementation of treatment technologies.

The MCL recommendations by the Institute were adopted by NJDEP into regulations with two exceptions, vinyl chloride and para-dichlorobenzene, effective January 1989. The Institute recommended an MCL for vinyl chloride of 5 micrograms per liter (ug/l) in March 1987, however, the USEPA in July 1987 promulgated an MCL of 2 ug/l (USEPA, 1987). This difference is the result of different analytical limits determined by the two agencies. Since NJDEP is required to adopt the more stringent standard, an MCL of 2 ug/l was included in the New Jersey regulations adopted in January 1989. For para-dichlorobenzene, new data on health effects became available between the time that the Institute made its recommendations (March, 1987) and the time that the N.J. MCLs were proposed (December, 1987). NJDEP agreed with the USEPA interpretation of this new data and derived a health-based level of 150 ug/l based on New Jersey risk assessment procedures (see Appendix A). By not proposing and adopting an MCL for para-dichlorobenzene, NJDEP adopted the more stringent USEPA MCL of 75 ug/l for para-dichlorobenzene by reference.

The Institute set forth several drinking water program recommendations in the original 1987 document. First, the Institute recommended that the MCLs proposed in the 1987 document be reviewed every three years to insure that the most recent scientific information has been incorporated into the drinking water standards in New Jersey. Section II.A represents this effort.

Secondly, although the A-280 amendments state that the Institute is not required to develop an MCL for a "2a" list contaminant that has not been detected in drinking water, in the 1987 document the Institute stated that they may choose to develop MCLs for those contaminants not yet detected in drinking water.

If any of these undetected "2a" list contaminants were detected in drinking water, an MCL would be available so that NJDEP could take appropriate action.

Thirdly, in 1987 the Institute recommended that the legislation be changed so that kerosene be removed from the "2a" list of contaminants.

II. MCL RECOMMENDATIONS FOR THE 22 CONTAMINANTS IN SECTION "2A" OF THE A-280 AMENDMENTS

In March 1987, the Institute submitted a report to the Commissioner of NJDEP establishing MCLs for a list of 16 of 22 specific hazardous contaminants (plus isomers). The Institute recommended that the MCLs developed in 1987 be reviewed every three years to ensure that the most current information is used for the evaluation of drinking water quality. The MCLs developed by the Institute were adopted into regulation by the Commissioner in January 1989. The Institute recommendations set forth in this document will be referred to as the "triennial review" of the synthetic organic contaminant health effects, analytical and treatability data in drinking water used to establish MCLs.

A. TRIENNIAL REVIEW OF HEALTH-BASED MCLs

In 1987, health-based levels for all 22 of the contaminants (with the exception of kerosene) were adopted by the Lists and Levels Subcommittee and subsequently the Institute. For four contaminants on the original list of A-280 hazardous contaminants, health-based levels were developed, but MCLs were not promulgated by NJDEP in 1989 because of the lack of standardized analytical methodologies: ethylene glycol, formaldehyde, n-hexane and methyl ethyl ketone. The Institute recommended that kerosene be deleted from the legislation due in part to the fact that kerosene is actually a mixture of a variety of hydrocarbon compounds. The health-based levels have been reevaluated as part of the "triennial review."

The Division of Science and Research (DSR) of the NJDEP has conducted database and literature searches in order to locate any new toxicological data not considered previously in the MCL development process for the A-280 contaminants. Table 3 provides an update of the status of the "2a" list health-based levels. Individual changes to health-based levels are discussed below and in Appendix A.

Based on the completion of the review of scientific literature, it is recommended that the health-based levels remain at their current values for the following chemicals: benzene, carbon tetrachloride, meta-dichlorobenzene, ortho-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethylene, n-hexane, methyl ethyl ketone, methylene chloride, tetrachloroethylene, 1,2,4-trichlorobenzene, 1,1,1-trichloroethane, trichloroethylene and vinyl chloride.

TABLE 3

"2A" LIST HEALTH-BASED LEVEL CHANGES

Contaminant	1987 Health-Based Level (ug/l)	Current Health-Based Level (ug/l)
Chlorobenzene	4	50
para-Dichlorobenzene	6.1	75 (a)
cis-1,2-Dichloroethylene	10	70
trans-1,2-Dichloroethylene	10	100
Formaldehyde	0.65	100
Xylenes	44	1000

(a) The Institute calculated a health-based level of 150 ug/l since the 1987 health-based level was recommended. The more stringent USEPA MCL for this contaminant is presented since this is the level at which this contaminant will be regulated.

The following chemicals are still under consideration by the Lists and Levels Subcommittee: chlordane and ethylene glycol. The remaining group of contaminants, polychlorinated biphenyls (PCBs), is not being evaluated by the Institute at this time. PCBs are not detected in drinking water but are detected in soil. Because of the large amount of data available and the controversies that must be resolved, the Institute recommends that the risk assessment for PCBs be reviewed by a NJDEP work group representing different environmental media. No changes are recommended for chlordane, ethylene glycol and PCBs at this time.

Changes in the health-based levels are recommended for chlorobenzene, para-dichlorobenzene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, formaldehyde and xylenes. A more thorough review of the National Toxicology Program data used for the classification of chlorobenzene as a Group C carcinogen by the USEPA Science Advisory Board Halogenated Organics Subcommittee resulted in a Group D classification for this contaminant and a higher health-based level. The risk assessment for para-dichlorobenzene was modified after a study demonstrated that the mechanism for tumor production in male rat kidneys was not relevant to humans. The health-based levels for cis- and trans-1,2-dichloroethylene were previously based on the risk assessment for 1,1-dichloroethylene because of the lack of data for the 1,2-dichloroethylene isomers.

The new health-based levels for cis- and trans-1,2-dichloroethylene were developed based on subchronic oral studies conducted using cis-1,2-dichloroethylene and trans-1,2-dichloroethylene. New oral data for formaldehyde allowed the derivation of a health-based level based on a route more closely related to the ingestion of drinking water instead of the inhalation route. The xylene health-based MCL was recalculated because of questions regarding the study on which the original health-based level was based. Additional information regarding the bases for these changes are discussed in Appendix A.

B. DEVELOPMENT OF ANALYTICAL METHODS AND PQLS FOR THE HAZARDOUS CONTAMINANTS NOT CURRENTLY MONITORED

NJDEP initiated a contract with Battelle, a research laboratory, to develop analytical methods for ethylene glycol, formaldehyde, n-hexane, and methyl ethyl ketone (Hertz, et al., 1990). As part of this contract, Battelle was required to assess the precision and accuracy of their draft methods, as well as the methods' MDL.

From this study, Battelle proposed three analytical procedures:

* a gas chromatographic method using a packed column and a flame ionization detector for the analysis of ethylene glycol;

* a purge and trap gas chromatographic method using a capillary column and a flame ionization detector for the analyses of n-hexane and methyl ethyl ketone; and

* a high performance liquid chromatography method for the analysis of formaldehyde (Eaton, et. al., 1991).

Battelle reported MDLs of 3 ppb for both n-hexane and methyl ethyl ketone, 20 ppb for ethylene glycol and 30 ppb for formaldehyde. They also reported that spiked sample recoveries, a measure of the method's accuracy, were generally in the range of 70 to 110 percent with the relative standard deviations in the range of 1 to 15 percent. NJDEP then contracted with Research Triangle Institute (RTI) to further evaluate and validate the three analytical methods proposed by Battelle (Warner, et. al., 1989; Hertz, et.al., 1990).

Table 4 shows a comparison of the draft analytical method MDLs and the health-based levels. The PQLs listed on the table were calculated by multiplying the MDLs for the approved USEPA analytical method listed by five and are included to demonstrate that PQLs do not appear to be limiting factors for MCL development for formaldehyde, n-hexane and methyl ethyl ketone. A more complete discussion of the MDLs and PQLs that appear on this table follows.

TABLE 4

COMPARISON OF "2A" LIST HEALTH-BASED LEVELS TO THE MDLs AND PQLs

Contaminant	Health-Based Levels (ug/l)	Study MDLs (ug/l)	PQLs (ug/l)
Ethylene glycol	290	20 (Battelle)	
		21 (RTI)	
		18 (DSR)	NA (a)
Formaldehyde	100	30 (Battelle)	
		17 (RTI)	1
		8.1 (554)	41
n-Hexane	33	3 (Battelle)	
		4 (RTI)	
		1 (524.2)(b)	5
Methyl ethyl ketone	270	3 (Battelle)	
		8 (RTI)	
		4 (524.2)(b)	20

(a) Not available due to technical problems with the analytical method.

(b) Method 524.2 modified to include target analyte. MDLs reported are from NJDEP's Bureau of Organic Analytical Services laboratory.

Ethylene glycol

The analytical method proposed by Battelle for the analysis of ethylene glycol utilizes packed column testing technology rather than the newer capillary column technology. Their data also suggested a potential problem with sample holding times due to sample degradation. The NJDEP's DSR compared the proposed packed column method to a new bonded phase capillary column. In addition, it was decided that the sample holding time issue should be more closely evaluated.

The capillary column study performed by DSR had superior precision and accuracy compared to the packed column method (Lippincott, 1992). DSR was also able to demonstrate a stable sample holding time of up to 14 days, sufficient for the application of this test procedure. Lastly, the study findings confirmed the MDLs of Battelle and RTI. The researchers found that although the method showed good percent recoveries at the low concentration ranges, as the sample concentration increased to higher levels approaching that of the health-based level, the percent recoveries dropped off yielding poor results. This conflicts with the findings of the original two studies and raises a question concerning the clarity of the written method description as compared to the actual analytical steps performed by the first two research laboratories. DSR in-house research will address improvements in the recovery of ethylene glycol in drinking water and initiate an interlaboratory method performance evaluation. This project will also gather a limited amount of occurrence data from drinking water sources in New Jersey.

Formaldehyde

The analytical method developed by Battelle for the analysis of formaldehyde was found by RTI to give relatively good results. They suggested that some additional work be conducted to clarify the description of the protocol and improve upon the procedure's relatively high background levels of formaldehyde detected in the blank. This is due to the ubiquitous nature of formaldehyde. At the time of the Testing Subcommittee's review of this procedure, it was brought to their attention that the USEPA was in the process of proposing a test method for formaldehyde analysis, USEPA Method 554. A review of the procedure found the method to be feasible and in order to avoid duplicating the USEPA efforts, the Subcommittee decided to consider the USEPA procedure and have one of the two State laboratories evaluate the test protocol.

n-Hexane and Methyl Ethyl Ketone

Battelle proposed a single method for the analysis of both n-hexane and methyl ethyl ketone (Eaton, et. al, 1991). This gas chromatographic procedure was found to yield acceptable precision and accuracy, while providing a sufficiently low MDL. This method however, uses a non-selective detector which will require the reanalysis of all positive samples by a second confirmatory technique. Because of this concern, NJDEP's Bureau of Organic Analytical Services (BOAS) was asked to evaluate the addition of two compounds to USEPA Method 524.2, the current federally approved method for the analysis of volatile organics in drinking waters using gas chromatography/mass spectroscopy. BOAS reported the successful addition of these two compounds into USEPA Method 524.2. This method could be used in conjunction with Battelle's method, a screening test, as the confirmatory analysis or as a stand alone procedure for the analysis of n-hexane and methyl ethyl ketone. The Testing Subcommittee developed mandatory language to incorporate these two analyses into USEPA Method 524.2, and therefore the Testing Subcommittee recommended that these two test procedures be used for the analysis of n-hexane and methyl ethyl ketone.

PQLs

PQLs are defined as the level above the MDL at which quantitation can be achieved by most laboratories within acceptable levels of uncertainty. This approach to standard setting, using PQLs instead of MDLs, was first recommended by the Institute in 1987. At that time an interlaboratory study was conducted to determine at which levels above the MDLs the PQLs could be established. However, data collection and analysis for an interlaboratory study is very time consuming and labor intensive.

NJDEP conducted a research project to determine if the MDL multiplied by a certain factor could yield a supportable PQL value. Based on the results of this research, it was determined that a multiplier between four and six could be used to derive a PQL (Eaton, et. al., 1993). The Testing Subcommittee chose to use a multiplier of five to determine the PQL. This is consistent with the multiplier approach outlined in NJDEP's recently promulgated Ground Water Quality Standards (N.J.A.C. 7:9-6). The ground water quality standards PQLs were calculated by multiplying the median interlaboratory MDLs from the drinking water methods by five. Since interlaboratory MDL data were not available because of the lack of standardized analytical methodologies until recently, published MDL data were used here to determine the PQLs. A PQL is not listed on Table 4 for ethylene glycol because of questions regarding analytical recovery. The PQLs for the remaining three contaminants appear on Table 4 and in Appendix B.

Since PQLs were developed in 1987 for chlorobenzene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, and xylenes and proposed changes to the health-based levels will result in higher values, the PQLs developed in 1987 are still applied for these "2a" list contaminants.

C. TREATABILITY ISSUES

Ethylene glycol, formaldehyde, n-hexane and methyl ethyl ketone are considered to be noncarcinogenic by the ingestion route. According to the A-280 statute, treatability is an issue to be considered as part of the MCL development process for noncarcinogens. Table 5 provides treatment information regarding these four chemicals. Research data on removal efficiencies are available for higher concentrations of these contaminants than are thought to be found in drinking water in New Jersey. As can be seen in Table 5, three of these chemicals can be partially removed from drinking water with packed tower aeration and/or granular activated carbon adsorption: formaldehyde, n-hexane and methyl ethyl ketone. Ethylene glycol cannot be removed using conventional technology such as packed tower aeration and granular activated carbon adsorption. The Program Subcommittee reviewed the treatability data and recommended that MCLs not be established for these four "2a" list contaminants based on the lack of available treatability data in drinking water (USEPA, 1989).

TABLE 5

RELATIVE EASE OF REMOVING "2A" LIST CHEMICALS FROM DRINKING WATER USING TREATMENT TECHNIQUES (a)

CHEMICAL NONCARCINOGENS	PACKED TOWER AERATION	GAC ADSORPTION
Ethylene glycol	N	N
Formaldehyde	N	P
n-Hexane	P	P
Methyl ethyl ketone	N	P

Key:
P = PARTIAL REMOVAL < 90% POSSIBLE
N = NOT REMOVED

(a) USEPA, 1989.

Economic analysis of removing these four contaminants from drinking water cannot be performed at this time. Although analytical methods for monitoring drinking water to determine the presence and concentrations of these contaminants are now available, no comprehensive survey of water supplies has been performed in New Jersey to determine the number of supplies where these chemicals are present.

Since these contaminants had not yet been detected in drinking water, the Program Subcommittee recommended that no MCL be developed until such time that these contaminants are detected in drinking water. This conforms to the A-280 legislation which states that no maximum contaminant level need be established for any substance until the presence of the substance in drinking water is established.

Treatability data developed in 1987 for chlorobenzene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene and xylenes are still valid. The Program Subcommittee does not foresee any treatability issues associated with raising the MCLs to reflect the new health-based levels developed by the Lists and Levels Subcommittee.

D. MCL RECOMMENDATIONS

The Institute voted on June 15, 1993 to adopt new health-based levels for chlorobenzene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, formaldehyde and xylenes. These health-based levels were based on new information or on reinterpretation of previous data and resulted in higher health-based levels for all five contaminants. Risk assessment procedures used to derive these new health-based levels were outlined in the previous Institute document (New Jersey Drinking Water Quality Institute, 1987). PQL and treatability data developed in 1987 for chlorobenzene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene and xylenes are still adequate. New MCLs were developed and adopted by the Institute based on new health-based levels for four of these contaminants. An MCL was not adopted for formaldehyde because of the lack of treatability data. A list of health-based levels, PQLs, Institute recommended MCLs and USEPA MCLs for all "2a" list contaminants appears in Table 6.

MCLs are not presently available for ethylene glycol, formaldehyde, n-hexane and methyl ethyl ketone and will not be proposed as part of this document because of the lack of adequate treatability data. The analytical method developed for ethylene glycol also precluded the development of an MCL for this contaminant because of product recovery problems in the method. The Institute recommended the health-based levels that are listed in Table 6 for ethylene glycol, formaldehyde, n-hexane and methyl ethyl ketone be used for guidance should these contaminants be detected in New Jersey drinking waters.

TABLE 6

"2A" LIST OF HEALTH-BASED LEVELS, PQLS, INSTITUTE RECOMMENDED MCLS AND USEPA MCLS (ug/l)

Contaminant	Health-Based Level	PQLs	Treatment	Institute Recommended MCLs	USEPA MCLs
1. Benzene	0.15	1	AS/GAC (a)	1	5 (b)
2. Carbon tetrachloride	0.39	2	AS/GAC	2	5 (b)
3. Chlordane	0.013	0.5	GAC	0.5	2 (c)
4. Chlorobenzene	50 (d)	2	AS/GAC	50 (d)	100 (c)
5. o-Dichlorobenzene(e)	600	5	GAC/AS	600	600 (c)
m-Dichlorobenzene(e)	600	5	GAC/AS	600	NA (f)
p-Dichlorobenzene(e)	- (g)	5	GAC/AS	- (g)	75 (b)
6. 1,2-Dichloroethane	0.29	2	AS/GAC	2	5 (b)
7. 1,1-Dichloroethylene	1.0	2	AS/GAC	2	7 (b)
8. cis-1,2-Dichloroethlene	70 (d)	2	AS/GAC	70 (d)	70 (c)
9. trans-1,2-Dichloroethylene	100 (d)	2	AS/GAC	100 (d)	100 (c)
10. Ethylene glycol	290 (h)	NA	NA	NR (i)	NA
11. Formaldehyde	100 (h)	41	NA	NR	NA
12. n-Hexane	33 (h)	5	NA	NR	NA
13. Kerosene(j)	-	NA	NA	NR	NA
14. Methylene chloride	2.5	2	AS/GAC	3	5 (k)
15. Methyl ethyl ketone	270 (h)	20	NA	NR	NA
16. Polychlorinated biphenyls	0.024	0.5	GAC	0.5	0.5(c)
17. Tetrachloroethylene	0.44	1	AS/GAC	1	5 (c)
18. Trichlorobenzene(s) (e)	8.6	5	GAC/AS	9	70 (k)
19. 1,1,1-Trichloroethane	26	1	AS/GAC	30	200 (b)
20. Trichloroethylene	1.2	1	AS/GAC	1	5 (b)
21. Vinyl chloride	0.084	5	AS	5	2 (b)
22. Xylenes	1000 (d)	2	AS/GAC	1000 (d)	10,000 (c)

(a) AS = air stripping or packed tower aeration; GAC = granular activiated carbon adsorption. The preferred treatment technique is listed first.

(b) 52 FR 25718, July 8, 1987.

(c) 56 FR 3593, January 30, 1991.

TABLE 6 (Cont'd)

"2A" LIST OF HEALTH-BASED LEVELS, PQLS, INSTITUTE RECOMMENDED MCLS AND USEPA MCLS (ug/l)

(d) The health-based level was updated as part of the triennial review process. The MCL also changed as a result of the new health-based level. See Section II.A. and II.D.

(e) For those contaminants listed as single chemicals in the A-280 legislation, yet have multiple isomers, NJDEP developed separate MCLs when adequate toxicological information was available. For trichlorobenzene(s), the isomer 1,2,4-trichlorobenzene was used as a basis for the MCL.

(f) NA = Not available.

(g) USEPA adopted an MCL of 75 ug/l shortly after the publication of the 1987 Institute document. The Institute agreed with the USEPA approach and developed a health-based level of 150 ug/l for para-dichlorobenzene based on N.J. risk assessment criteria. Since this health-based level is greater than the Federal MCL and the N.J. Safe Drinking Water Act directs NJDEP to adopt the most stringent number (75 ug/l), the New Jersey MCL regulations do not include an MCL for para-dichlorobenzene. The USEPA standard of 75 ug/l was adopted into N.J. Safe Drinking Water Act regulations by reference in 1989.

(h) The Institute adopted this health-based level as a guidance number pending the development of additional treatability data. The analytical methodology allows for analysis of this health-based level.

(i) NR = No recommendation.

(j) No MCL recommendation for kerosene was developed by the Institute. See Section II.D.

(k) 57 FR 31846, July 17, 1992.

III. MCL RECOMMENDATIONS FOR THE LIST OF CONTAMINATIONS IDENTIFIED IN ACCORDANCE

A. SELECTION OF CONTAMINANTS

A working group comprised of representatives of NJDEP and NJDOH was established in 1986 to "...develop, within the limits of medical, scientific,and technological feasibility, a list of those pesticides and related compounds, metals, and base/neutrals extractable organic compounds which...may be found in drinking water...." These additional chemicals are commonly referred to as the "2b" list contaminants.

The working group evaluated several sources of information in order to determine additional chemicals for possible future regulation. Recommendations for candidate chemicals for the "2b" list from Institute members were also considered. Each contaminant was evaluated for availability of toxicity data and for analytical data. Information on occurrence in potable water was also evaluated in order to determine its suitability for regulation in drinking water.

Although volatile organics as a group were not specifically mentioned in the A-280 legislation, the BSDW had been receiving test results and had historical information that showed that certain VOCs for which there were no state or federal MCLs were being detected in drinking water. The following four main databases were reviewed to determine appropriate VOC candidate chemicals.

The first list of chemicals reviewed was the list of 23 analytes that were detected by USEPA method 624. The second source of information was a list provided by USEPA that contained the contaminants that USEPA was considering for monitoring regulation (USEPA, 1984). This list contained 36 contaminants. The third source of information was the Ground Water Supply Survey conducted in 1981 by USEPA (Westrick, 1984). There were 30 chemicals analyzed as part of that survey. The fourth source was historical data collected by the BSDW between 1978 and 1984 from the 25 largest public community water systems. These data were collected in response to known or suspected contamination in the raw or delivered water.

From the comprehensive list formed from the four databases, a working list of 23 VOCs was chosen for additional screening for the preliminary "2b" list. These chemicals are listed in Appendix C. The preliminary "2b" list was formulated by eliminating those chemicals that already appeared on the "2a" list as well as those that were determined to be laboratory contaminants, such as 1,4-dichlorobutane. After careful evaluation of the toxicological properties of these chemicals, six VOCs were identified for possible future regulation: 1,1-dichloroethane, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, 1,2-dichloropropane, toluene and ethylbenzene. As this screening work for volatile organics was being completed, USEPA published final recommended MCLs or MCL goals for eight VOCs (USEPA, 1987) and proposed recommended MCLs for a list of 38 inorganic and synthetic organic parameters (USEPA, 1989).

Three of the six VOCs being considered by the working group were being considered for regulation by USEPA and final MCLs for the three were adopted by USEPA on January 30, 1991 (USEPA, 1991a). The remaining three contaminants - 1,1-dichloroethane, 1,1,2-trichloroethane, and 1,1,2,2-tetrachloroethane were included on the "2b" list. An MCL for 1,1,2-trichloroethane was subsequently adopted by USEPA on July 17, 1992 with an effective date of January 17, 1994 (USEPA, 1992).

A list of potential inorganic substances for the "2b" list was compiled by NJDOH. Major sources of information used to generate the inorganic list included documents from the National Academy of Sciences, the World Health Organization, USEPA regulations and the USEPA Office of Drinking Water Health Advisory series. A comprehensive list of 42 contaminants was compiled. The following screening criteria were used to narrow down the list of 42 inorganic contaminants to those "2b" list contaminants of most concern: elimination of those inorganics of aesthetic concern only, elimination of those without sufficient data for standard development, and elimination of those with current standards that are considered to be protective. The remaining contaminants for consideration based on the screening criteria as well as comments made by the Lists and Levels Subcommittee were cadmium, lead, arsenic and asbestos; nitrite would be reviewed in more detail for possible future consideration as a "2b" list contaminant. Subsequently, these contaminants were included in USEPA's schedule for standard development and were dropped from consideration by the Institute to avoid duplication of work effort. This information is listed in Appendix C.

Three sources of occurrence information were reviewed to determine if any phthalates or phenolic compounds had been detected in New Jersey waters: a survey of drinking water supplies for the priority pollutants conducted in the early 1980's, a USEPA report on the fate and transport of priority pollutants in publicly owned treatment works and a survey of the fate and occurrence of toxic substances in New Jersey sewage treatment facilities. Of the five phthalates and ten phenols evaluated, only pentachlorophenol and 2,4,6-trichlorophenol were considered to be likely candidates for inclusion on the "2b" list based on known toxic effects, occurrence and analytic capability.

At the request of the Institute, four trihalomethanes - chloroform, bromoform, dichlorobromomethane and dibromochloromethane - were considered for the "2b" list but were not included. USEPA indicated that in order to successfully reevaluate the current standards for these chemicals, an evaluation of alternative disinfectants, by-products and microbial contaminants must be performed. The Institute agreed that USEPA should perform this extensive undertaking and the Institute should review this work upon completion. The proposed regulations for disinfectants and disinfection by-products were published by USEPA in 1994.

The Institute determined early in the MCL development process that there was a problem with conducting a risk assessment for the contaminant kerosene listed in the A-280 amendments. Kerosene cannot be classified as to human carcinogenicity because it is a mixture of many different hydrocarbons and chronic toxicity associated with kerosene is not well-defined. The Institute recommended that an MCL be developed based on the most toxic and abundant components of kerosene. Since benzene, a carcinogenic component of kerosene, already appears on the "2a" list, the Institute recommended that naphthalene, the most abundant component of kerosene that can be found in water, be added to the "2b" list.

NJDEP submitted a request to the Institute that an MCL for methyl tertiary butyl ether (MTBE) be developed because of increasing numbers of reports of occurrences of MTBE using drinking water methods 502.2 and 524.2 in both public and domestic drinking water.

Table 7 provides a final list of the "2b" chemicals.

B. HEALTH-BASED LEVELS

Health-based levels were developed for the contaminants on the "2b" working list. Risk assessment procedures used were the same as those used for the development of the "2a" list health-based levels in 1987 (New Jersey Drinking Water Quality Institute, 1987). The health-based levels developed for each "2b" contaminant appear in Table 7. These health-based values that had been developed over several years were reevaluated as part of the triennial review process so that the most recent data available were used for the derivation of the health-based levels. Support documents containing contaminant specific information, such as studies evaluated for risk assessment purposes and safety factors, appear in Appendix A.

C. ANALYTICAL METHODS

Existing analytical methodology was also a consideration in determining MCLs. Testing techniques are available to detect, quantify and identify each analyte of interest. The analytical issues that needed to be addressed were:

1. What are all the specific testing protocols that could be used?

2. Are these methods standardized and fully validated for drinking water?

3. What MDLs can be expected from these testing techniques and how do these MDLS compare to the health- based levels?

TABLE 7

COMPARISON OF "2B" LIST HEALTH-BASED LEVELS TO THE MDLs AND PQLs (ug/l)

Contaminant	Health Based Levels (ug/L)	MDLs (ug/L)		PQLs
1,1-Dichloroethane	460	0.002	(502.1)	
		0.07	(502.2)	
		0.04	(524.2)	1
Methyl tertiary butyl ether(MTBE)	70	0.3	(502.2)(a)	
		0.1	(524.2)(a)	1
Naphthalene	300	0.06	(502.2)	
		0.04	(503.1)	
		0.1	(524.2)	2
1,1,2,2-Tetrachloroethane	1	0.004	(502.1)	
		0.02	(502.2)	
		0.04	(524.2)	1
1,1,2-Trichloroethane	3	0.007	(502.1)	
		0.1	(502.2)	
		0.1	(524.2)	2
2,4,6-Trichlorophenol	1	0.022	(552)	
		2.7	(625)	-(b)

(a) Method modified to detect the additional target compound MTBE. Recent revisions to USEPA method 524.2 include MTBE as a target analyte.

(b) No PQL derived because methods for the analysis of 2,4,6-trichlorophenol need further investigation. See additional discussion in the text.

All of the proposed "2b" list contaminants, except for MTBE, are listed analytes in at least one of the USEPA "500 series" methods. NJDEP's BOAS laboratory found that MTBE could be successfully incorporated into USEPA Method 524.2 and 502.2. Table 7 compares the MDLs for the "2b" list contaminants with the proposed health-based levels. These chemicals each have at least two USEPA approved analytical methods. Table 7 also includes the PQLs that the Testing Subcommittee developed for the "2b" list contaminants.

Three main sources of information were used when determining PQLs for the "2b" list contaminants. The first source of PQL information is the Ground Water Quality Standards (N.J.A.C. 7:9-6) adopted February 1, 1993. The adopted ground water quality standard PQLs were derived using median interlaboratory MDLs for drinking water methods, when available, multiplied by a factor of five. The interlaboratory MDLs were derived from verified MDL data from laboratories certified by NJDEP for the USEPA 500 (drinking water) or 600 (wastewater) series analytical methods. The analytical methodologies, MDLs, PQLs and health-based levels for the "2b" list contaminants are presented in Appendix B.

The second source of information for the development of PQLs was obtained from a DSR-sponsored research project (Eaton, 1993). The purpose of the project was to develop a rapid, standardized method for calculating PQLs without utilizing interlaboratory studies. PQLs were developed using this method for three "2b" list contaminants included in the research study.

The third source of PQL information was obtained by multiplying the median interlaboratory MDL data gathered from 13 laboratories certified by New Jersey for USEPA method 524.2 by a factor of five. The factor of five had been used to develop ground water quality standards and was the average multiplier recommended in the DSR research project. PQLs could be derived using the multiplier times the median interlaboratory MDL for five of the contaminants: 1,1-dichloroethane, methyl tertiary butyl ether, naphthalene, 1,1,2,2-tetrachloroethane and 1,1,2-trichloroethane.

The PQLs from the groundwater standards are the preferred source of PQL data for the drinking water program. These PQLs were developed using drinking water methods when available and these PQLs have already been reviewed by the public and adopted into regulation. Adopted PQLs are available for 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, and 2,4,6-trichlorophenol. For 1,1-dichloroethane, MTBE, 1,1,2-trichloroethane and 1,1,2,2-tetrachloroethane, the PQL was calculated using the interlaboratory MDL data gathered from 13 N.J. certified laboratories multiplied by five. The PQLs for the "2b" list contaminants are rounded off to one significant figure.

The Testing Subcommittee does not recommend a PQL for 2,4,6-trichlorophenol at this time for the following reasons:

(1) The MDL for method 625 is higher than the health-based MCL,

(2) proposed changes to method 552 will result in this analyte being eliminated from the methodology (USEPA, 1993) and

(3) the PQLs from the ground water quality standards and the DSR research project are substantially higher than the health-based level.

The Testing Subcommittee will continue to monitor changes to method 552.

D. TREATABILITY ISSUES

The "2b" list contaminants 1,1-dichloroethane, MTBE and naphthalene are considered to be noncarcinogenic by the ingestion route. According to the A-280 statute, treatability must be considered as part of the MCL development process for noncarcinogens. Table 8 provides treatment information regarding all six of the "2b" list chemicals. Two of the noncarcinogenic chemicals, 1,1-dichloroethane and MTBE, can be completely removed from drinking water with packed tower aeration and the other, naphthalene, can be completely removed by granular activated carbon (GAC) adsorption. The air to water ratio for the removal of 1,1-dichloroethane is about twice that needed for the removal of trichloroethylene to achieve the same percent reduction. The cost of packed tower aeration operation is estimated to be higher than the conventional GAC because the chemical is weakly strippable. Packed tower aeration also removes 1,1,2-trichloroethane and 1,1,2,2-tetrachloroethane from drinking water and GAC removes 1,1,2-trichloroethane as well. The contaminant 2,4,6-trichlorophenol can be partially removed from water by GAC adsorption. The Program Subcommittee recommends that treatment techniques for 2,4,6-trichlorophenol be further investigated.

TABLE 8

RELATIVE EASE OF REMOVING SIX "2B" LIST CHEMICALS FROM DRINKING WATER USING TREATMENT TECHNIQUES (a)

CHEMICAL	PACKED TOWER AERATION	GAC ADSORPTION
NONCARCINOGENS		
1,1-Dichloroethane	C	P
Methyl tertiary butyl ether	C	P
Naphthalene	N	C
CARCINOGENS		
1,1,2,2-Tetrachloroethane	C	P
1,1,2-Trichloroethane	C	C
2,4,6-Trichlorophenol	N	P

Key:
C = COMPLETE REMOVAL > 90 % POSSIBLE
P = PARTIAL REMOVAL < 90 % POSSIBLE
N = NOT REMOVED

(a) USEPA, 1989.

E. OCCURRENCE OF THE "2B" LIST CONTAMINANTS IN NEW JERSEY DRINKING WATER

The chemicals selected for the "2b" list have been found in the waters of New Jersey. Appendix D contains two tables summarizing occurrence data for the "2b" list contaminants in drinking water. Table D-1 of Appendix D summarizes historical occurrence data for those contaminants that were selected for the "2b" list. This table includes VOC data collected from the 25 largest purveyors between 1978 and 1984 prior to the A-280 monitoring program. This data was collected in response to suspected contamination. The only "2b" chemicals that were detected during this period were 1,1-dichloroethane and 1,1,2-trichloroethane. The 25 largest purveyors in N.J. mainly utilize surface water sources which usually have lesser quantities of VOCs.

Table D-2 of Appendix D also summarizes occurrence data for the "2b" list contaminants. Beginning January 1, 1988, all public community water systems and nontransient water systems were required to monitor for a list of 36 unregulated contaminants. Included on the mandatory list of chemicals are 1,1-dichloroethane, 1,1,2-trichloroethane and 1,1,2,2-tetrachloroethane. An optional list of 15 contaminants includes naphthalene. The

MTBE data presented on Table D-2 were collected in response to known contamination incidents from both public community and public noncommunity water systems.

Occurrence data for 2,4,6-trichlorophenol was obtained from two surveys that were conducted in New Jersey. The first survey was designed to analyze the operations of major surface water treatment plants in New Jersey (Special Water Treatment Study Phase II, 1988). USEPA method 625, an approved wastewater method available at the time of the survey, was conducted as part of the analyses of the treatment process; 2,4,6-trichlorophenol is one of the listed analytes in USEPA method 625. The second survey was conducted to determine the presence of disinfection by-products in raw, finished and distribution system samples at selected water utilities (Disinfection By-Products Project, unpublished). USEPA method 552 was used for the analysis of 2,4,6-trichlorophenol in this study. 2,4,6-Trichlorophenol was not detected in New Jersey drinking waters as part of these two studies.

E. ESTIMATED STATEWIDE COSTS FOR THE "2B" LIST CONTAMINANTS

As can be seen from the data presented in Table D-2 of Appendix D, 1,1-dichloroethane, methyl tertiary butyl ether, naphthalene, 1,1,2-trichloroethane and 2,4,6-trichlorophenol have not been detected in N.J. public water supplies at concentrations that exceed the health-based numbers of 46 ppb, 70 ppb, 300 ppb, 3 ppb and 1 ppb, respectively. . Therefore there would be no economic impact of treating drinking water to the health-based levels since there were no exceedances.

One sample taken in 1988 exceeded the health-based level of 1 ppb for 1,1,2,2-tetrachloroethane. This water system had MCL exceedances for tetrachloroethylene as well, a regulated "2a" list contaminant, which has resulted in the water utility installing treatment. 1,1,2,2-Tetrachloroethane has not appeared in the most recent samples submitted by the water utility. In this instance no additional cost was incurred by the water utility because of the presence of 1,1,2,2-tetrachloroethane.

An analysis of MTBE occurrence data and estimated statewide costs to achieve an MCL of 70 ppb appears in Appendix E. The Institute requested that an analysis of the occurrence of MTBE in both public and nonpublic water systems be performed and the costs of regulating this contaminant to the health-based level be evaluated prior to recommending an MCL to NJDEP. Of particular concern was the economic impact of applying an MCL developed for public community water systems to nonpublic water systems in New Jersey.

Although occurrence data indicate that concentrations of MTBE in public water supplies presently do not exceed the proposed drinking water standard, MTBE concentrations in nonpublic water supplies more often exceed the proposed drinking water standard of 70 ppb. Projected costs are based on the assumption that a water supplier may find MTBE in the drinking water and decide to remediate the supply.

Estimated statewide costs to achieve an MCL of 70 ppb for MTBE range from $6,000,000 to $50,000,000. This expenditure would provide treatment for between 2000 and 4000 private (nonpublic) wells and from 3 to 6 public community systems. Statewide estimates assume that between 0.5% and 1% of private (nonpublic) wells and public community systems would have concentrations of MTBE greater than 70 ppb in their raw water.

These costs are based on available occurrence and treatability data. Occurrence estimates are based on BSDW databases for nonpublic wells and public systems. Neither database is representative because neither USEPA nor NJDEP have approved an analytical method for MTBE and MTBE reports are not routinely filed. Therefore an estimated range of statewide costs is provided.

Treatability costs assume the use of air stripping and granular activated carbon adsorption. Treatability data is derived from actual costs in New Jersey at nonpublic and public water supply systems that use air stripping and granular activated carbon.

Because MTBE is a gasoline additive, the presence of other gasoline components such as benzene may indicate the presence of MTBE. However, reports of MTBE at concentrations less than 100 ppb may not indicate the presence of benzene. There are two reasons: one, there is less benzene in gasoline than MTBE and two, MTBE is much more soluble in water than benzene. Benzene may be no more than 1% by volume of gasoline, whereas MTBE may vary from 3 % to as much as 11% of gasoline. During winter the concentration of MTBE may be as high as 15%. MTBE is about 25 times more soluble in water than benzene.

Concentrations of MTBE in nonpublic wells and public supplies are usually less than 5 ppb and except for a handful of instances, MTBE concentrations are almost always less than 70 ppb. Furthermore, in most instances when MTBE concentrations are greater than 70 ppb, other gasoline components such as benzene have been reported.

NJDEP and USEPA have legislated the clean up of petroleum/gasoline spills and the protection of drinking water supplies. Consequently many spills have been cleaned up and many contaminated nonpublic wells and some public community systems have been treated or replaced by water main extensions. To date, at least six public community water systems and about 600 nonpublic wells with MTBE or petroleum have been remediated.

Presently the BSDW considers MTBE an unregulated organic; as such, a health effects level of 50 ppb is provided for guidance.

Because of these past actions, future statewide costs to comply with an MTBE drinking water standard of 70 ppb may be at the lower end of the estimated range.

G. MCL RECOMMENDATIONS

The analytical methodologies for the volatile "2a" list A-280 contaminants also detect 1,1-dichloroethane, naphthalene, 1,1,2-trichloroethane and 1,1,2,2-tetrachloroethane. These contaminants usually occur with regulated A-280 contaminants, therefore, the treatment system designed to remove the A-280 contaminant also removes the "2b" volatile chemicals. It is important to establish an MCL for these contaminants since the presence of one of these contaminants, especially 1,1,2-trichloroethane and 1,1,2,2-tetrachloroethane which are carcinogenic and therefore have low MCLs, could be important in designing a treatment system. Recent revisions to USEPA method 524.2 include MTBE as a target analyte.

Table 9 provides a summary of the health-based levels, PQLs, treatment techniques, Institute recommended MCLs and USEPA MCLs for the "2b" list contaminants.

The Institute voted on June 15, 1993 to adopt MCLs for 1,1-dichloroethane, naphthalene, 1,1,2,2-tetrachloroethane and 1,1,2-trichloroethane and on March 11, 1994 to adopt an MCL for MTBE. Health-based levels, PQLs, treatability and occurrence data are available for these contaminants. An MCL will be developed for 2,4,6-trichlorophenol when analytical and treatability issues are resolved.

TABLE 9

"2B" LIST
HEALTH-BASED LEVELS, PQLS, INSTITUTE RECOMMENDED MCLS AND USEPA MCLS (ug/l)

Contaminant	Health-Based Level	PQL	BAT	Institute Recommended MCLs	USEPA MCLs
1,1-Dichloroethane	46	1	AS	50	NA(a)
Methyl tertiary butyl ether (MTBE)	70	1	AS	70	NA
Naphthalene	300	2	GAC	300	NA
1,1,2,2-Tetrachloroethane	1	1	AS/GAC	1	NA
1,1,2-Trichloroethane	3	2	AS/GAC	3	5(b)
2,4,6-Trichlorophenol	1(c)	-	-	-	NA

KEY: AS = Air Stripping
GAC = Granular Activated Carbon

(a) Not available.

(b) 57 FR 31846, July 17, 1992.

(c) The Institute recommended this health-based level as a guidance number pending the development of a PQL and treatment techniques capable of removing 2,4,6-trichlorophenol from drinking water.

IV. REVIEW OF PROPOSED AND FINAL USEPA MCLs

The Lists and Levels Subcommittee reviewed USEPA's Phase II regulations proposed May 22, 1989. These standards have since been finalized by the USEPA. The review was conducted to compare the proposed standards with New Jersey's regulatory mandate under the A-280 law. The contaminants of interest were chromium, ethylbenzene, trans-1,2-dichloroethylene, tetrachloroethylene, and toluene. The contaminants were selected for review by the Lists and Levels Subcommittee based on (1) frequency of occurrence in N.J. drinking waters, (2) new interpretations of USEPA's risk assessment policy in the development of these Federal Standards, (3) prior drinking water guidance number development requests by NJDEP preceding publication of the proposed Federal Standard and/or (4) the endpoints selected by USEPA that resulted in different MCLs than those calculated by New Jersey.

NJDEP reviewed USEPA's carcinogenicity classifications and MCL setting process for these contaminants for the Lists and Levels Subcommittee. This review did not result in any recommended changes to USEPA MCLs. However, it did result in a reevaluation of the New Jersey standard for trans-1,2-dichloroethylene. This is discussed in Section II.B. of this document.

V. MAXIMUM CONTAMINANT LEVEL APPLICATION

A. USE OF THE MCLS BY NJDEP

In 1984, amendments to the NJ Safe Drinking Water Act authorized the Institute to recommend MCLs to the Commissioner of NJDEP for adoption into rules and regulations. The definition of maximum contaminant level set forth in the Act is the "maximum permissible level of a contaminant in water which is delivered to the free-flowing outlet of the ultimate user of a public water system." The monitoring for the contaminants listed in the law is required of public community water supply systems although the MCLs are also used as appropriate to assess the water quality of noncommunity and domestic water systems.

On July 8, 1987, USEPA published final rules regulating eight organic contaminants, all of which were already regulated by the A-280 amendments. Up to this time, all monitoring (except for turbidity) under State and Federal regulations was required to be taken from the water distribution system. These new Federal rules changed the monitoring location to "point-of-entry." Instead of one sample required at each public community water system, each point-of-entry, or place at which water enters the water distribution system after treatment, was required to be monitored. For the larger water systems in New Jersey, this represents a substantial increase in the number of samples required during each monitoring period. The effective date of this rule was January 9, 1989. This rule applied to nontransient noncommunity water systems as well.

Beginning in 1993, monitoring for additional organic contaminants is required under Federal regulation. Some of these contaminants are also regulated by the A-280 statute. In order to provide consistent monitoring requirements, the Institute supports consistent sampling locations for the Federal and State drinking water programs. The State regulations must also be reevaluated for consistency of sampling frequency. This will be discussed in more detail in Section VI.

When a Federal MCL and State MCL have been developed for the same contaminant, the more stringent MCL is applicable. The State MCLs are more stringent for most of the contaminants for which MCLs have been developed.

The MCLs will continue to be used to assess drinking water quality. The MCLs were derived based on the ingestion of drinking water over a lifetime of exposure. The application of the risk assessments derived for drinking water to other environmental media must be carefully evaluated.

B. CHEMICAL-SPECIFIC MCL CONSIDERATIONS

As discussed in the Institute document published in 1987, many of the 22 A-280 hazardous contaminants are listed in the law as single contaminants and others are listed as multiple isomers of the same contaminants. When information was available, risk assessments were performed for as many of the isomers as possible. The following is an update of the information presented in 1987:

1. The PCB health-based number was based on a risk assessment of one of the six PCB mixtures currently monitored. There was insufficient information available for calculating risk assessments for each mixture. The compliance test result data from each of these six mixtures of PCBs should be totaled, and this total compared to the MCL to determine if there is a violation of the MCL.

2. The 1,2,4-trichlorobenzene isomer was chosen for derivation of a health-based MCL for "trichlorobenzene(s)" because it is the only isomer used commercially and the only one with any toxicology data available. It is also being used more extensively than in the past as a substitute for PCBs in electrical transformers. Therefore, the MCL for "trichlorobenzene(s)" will be measured by this isomer.

3. Risk assessments for each of the three dichlorobenzene isomers were calculated separately. The isomers should be reported as total dichlorobenzenes, however, since the isomers are difficult to separate. If the total dichlorobenzene(s) concentration exceeds the MCL for the isomer with the lowest health effect number,para-dichlorobenzene, a resample to quantify the separate isomers should be taken as soon as possible.

4. The xylene health-based number is based on the total xylene concentration because there is no information to justify separate risk assessments for the three isomers. The laboratory community, however, has been separating the three isomers according to the laboratory certification regulations. NJDEP should compare the total of the three isomers to the MCL to determine the water quality of the drinking water supply.

VI. OTHER INSTITUTE RECOMMENDATIONS

In addition to recommending MCLs, the Institute identified other program areas where changes are recommended. First, the Institute is interested in setting forth a policy regarding how to regulate naturally occurring contaminants in drinking water. Second, in order to provide consistency with the Federal Safe Drinking Water Act and regulations, provisions of the A-280 regulations should be modified regarding sampling locations and the frequency of sampling. Enforcement powers at the local level, and removal of kerosene from the "2a" list are two modifications to the A-280 amendments that have been targeted by the Institute.

A. NATURALLY OCCURRING CONTAMINANTS

Naturally occurring contaminants, in particular radiological contaminants, have been of great concern for certain N.J. water utilities. For radon, in particular, it is not meaningful to set standards in the same manner as for other contaminants since it is also naturally present in the outdoor air at levels which result in a much larger total exposure than by the use of water. The MCL proposed for radon by USEPA is 300 picocuries per liter. If adopted, this standard will significantly impact many public community water systems in New Jersey. The A-280 amendments require that New Jersey develop standards based on a one in one million excess cancer risk. The Program Subcommittee wishes to amend N.J.S.A. 58:12A-13(b) to include language that allows that standards for naturally occurring carcinogenic contaminants, such as radon, be based on a risk assessment other than one in one million. A recommended way to accomplish this is to amend the N.J. Safe Drinking Water Act to read as follows: "...with respect to other chemicals or chemical compounds on the list and those carcinogens resulting from compounds with public health benefits or are naturally occurring in groundwaters, eliminate...all physiological effects resulting from ingestion." This amendment would allow risk assessments for naturally occurring contaminants to be based on different risk levels than required for other contaminants.

B. SAMPLING LOCATIONS AND FREQUENCY

The A-280 amendments were signed into law in January, 1984 and by late 1984, A-280 testing regulations were adopted. These regulations predated any Federal monitoring requirements or Federal MCL proposals for volatile organic contaminants. The sampling location and frequency requirements for New Jersey were established based on general guidelines provided in the A-280 amendments with additional sampling guidelines from Federal drinking water programs.

The A-280 law states that testing must begin within one year of passage of the legislation and be conducted semiannually thereafter during periods of representative demand unless the Commissioner of NJDEP determined that a greater or lesser frequency of testing is necessary or sufficient to ensure public health and safety (N.J.S.A. 58:12A-12). USEPA regulations, on the other hand, require that VOC samples be drawn at the point-of- entry into the water distribution system and be taken on a quarterly basis for a year during the first sampling period (1993-1995) and repeated every three years if no contamination is detected. These two sets of sampling requirements were established to achieve the same goals. However, these requirements are conflicting and confusing to the regulated community.

The Program Subcommittee has recommended that the A-280 regulations be amended to conform with the Federal monitoring frequency and location requirements. Until the regulation revisions are finalized, the Program Subcommittee recommends that A-280 monitoring continue on an annual basis in the distribution system for systems serving more than 10,000 people in addition to the point-of-entry Federal sampling requirements. The relationship between distribution system data and point-of-entry data will be evaluated.

C. REMOVAL OF KEROSENE FROM THE "2A" LIST

In 1987, the Institute recommended that the "2a" list contaminant, kerosene, be removed from the A-280 legislation because it is a mixture of many variable contaminants in different proportions and cannot be classified as to human carcinogenicity. The Institute strongly recommends that kerosene be removed from the A-280 amendments and naphthalene be used as a surrogate compound for regulation. This recommendation resulted in the placement of naphthalene on the "2b" list as discussed in Section III.A. Benzene, a carcinogenic component of kerosene, is already on the "2a" list and has been monitored in public community water systems in New Jersey since 1984. The Institute recommended that NJDEP adopt the MCL developed for naphthalene of 300 ug/l to protect water supplies from contamination by kerosene.

D. ENFORCEMENT AUTHORITY AT THE LOCAL LEVEL

In New Jersey, counties with delegated health departments have the responsibility of enforcing the Federal monitoring requirements for noncommunity, nontransient water systems. Legal counsel has informed NJDEP that Federal VOC enforcement should be handled in the State court system, not local or municipal court. In order to facilitate the enforcement of drinking water laws in New Jersey, the Institute recommends that the A-280 legislation be amended so that the local court system can be utilized by the county health departments.

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APPENDIX A

SUMMARY OF HEALTH-BASED MAXIMUM CONTAMINANT LEVEL (MCL) SUPPORT DOCUMENTS AND ADDENDA

"2A" LIST

CHLOROBENZENE

The current New Jersey health-based MCL is 4.5 ug/l. The risk assessment is based on the No Observed Adverse Effect Level (NOAEL) for effects observed in a subchronic study in dogs. In 1989, USEPA revised its carcinogenicity classification from Group C (possible carcinogen) to Group D (no evidence for carcinogenicity) based on close reexamination of the data on neoplastic liver nodules in male rats. The Lists and Levels Subcommittee concluded that the data on rat liver lesions in male rats did not warrant a classification in Group C and recommended that the contaminant be reclassified as Group D. The Lists and Levels Subcommittee, therefore, recommended that the current health-based MCL for chlorobenzene be increased by a factor of 10. Application of the policy for rounding to one significant figure results in a health-based MCL of 50 ug/l.

PARA-DICHLOROBENZENE

The current NJ MCL for para-dichlorobenzene (p-DCB) is 75 ug/l. The NJ Drinking Water Quality Institute recommended a health-based MCL of 6.1 ug/l in 1987, but NJDEP chose not to propose this number and instead adopted the Federal MCL of 75 ug/l because of controversies regarding the carcinogenicity classification. The carcinogenicity classification of p-DCB was changed by USEPA from Group B-2, probable human carcinogen, to Group C, possible human carcinogen in 1987. The Lists and Levels Subcommittee reviewed the study that USEPA used and agreed with the recommendation of a change in carcinogenicity classification.

The kidney tumors produced by p-DCB in male rats appear to result from the accumulation of the protein alpha-2-microglobulin. Unlike other species, the male rat has difficulty excreting this protein which is exacerbated further in the presence of this tumorigenic compound. Since kidney tumors develop only in male rats, the significance to possible human carcinogenesis is questionable. The presence of this tumor type cannot contribute to the weight-of-evidence of p-DCB carcinogenicity. Therefore, the Lists and Levels Subcommittee concurred with USEPA in classifying p-DCB as a possible human carcinogen (Group C). The Lists and Levels Subcommittee utilized a study which shows an increase in hepatocellular degeneration, necrosis and cell size alteration in male and female B63F1 mice exposed to 300 mg/kg p-DCB for two years. As a result, the health-based MCL for p-DCB is 150 ug/l based on liver toxicity in mice. (Note: The USEPA MCL of 75 ug/l will be used by New Jersey since this value is more stringent than New Jersey's health-based value).

CIS-1,2-DICHLOROETHYLENE

The current health-based MCL for cis-1,2-dichloroethylene is 10 ug/l. The health-based MCL was calculated based on the toxicity of the isomer 1,1-dichloroethylene since inadequate toxicity data was available. A three-month study was subsequently completed for cis-1,2-dichloroethylene; decreased hematocrit and hemoglobin are the endpoints of concern. USEPA used this study to calculate the MCLG as part of the MCL proposal of 70 ug/l in 1991. The Lists and Levels Subcommittee concurred with the USEPA risk assessment and derivation of a health-based MCL of 70 ug/l.

TRANS-1,2-DICHLOROETHYLENE

The current health-based MCL for trans-1,2-dichloroethylene is 10 ug/l. The health-based MCL was calculated based on the toxicity of the isomer 1,1-dichloroethylene since inadequate toxicity data was available. Two studies of the effects of trans-1,2-dichloroethylene have been conducted since the health-based MCL for trans-1,2-dichloroethylene was calculated. One study reported significant dose-dependent increases in kidney weights and kidney weight ratios in female rats. However the effects of trans-1,2-dichloroethylene are less severe than the 1,1-dichloroethylene isomer. The Lists and Levels Subcommittee concurred with USEPA's MCLG of 100 ug/l and recommended that the health-based MCL be raised to 100 ug/l.

FORMALDEHYDE

The current health-based MCL for formaldehyde is 0.65 ug/l based on nasal cancers in rodents. Chronic oral studies on formaldehyde have since been conducted. A chronic bioassay in rats was used to develop a NOAEL. The Lists and Levels Subcommittee changed the carcinogenicity classification from Group B to Group C based on the new oral studies. A Group C classification was chosen since formaldehyde is a probable human carcinogen via the inhalation route and had reported tumor promoting effects by oral exposure. A health-based MCL of 100 ug/l is recommended.

XYLENE

The current xylene health-based MCL is 44 ug/l. Additional studies were subsequently completed which were not able to replicate the findings of the study which was used to derive the health-based MCL. Minimal chronic nephropathy in female rats was used as the basis for the oral LOAEL. The Lists and Levels Subcommittee recommended a health-based MCL at 1.0 mg/l.

"2B" LIST

1,1,-DICHLOROETHANE

1,1-Dichloroethane is a chlorinated aliphatic hydrocarbon which has been detected in drinking water supplies. It has been used as a chemical intermediate and as a solvent for extraction and degreasing. 1,1-Dichloroethane is used in relatively small quantities unlike its isomer 1,2-dichloroethane. This compound is one of the less toxic of the chlorinated aliphatics. The Lists and Levels Subcommittee classified 1,1-dichloroethane in Group D. Exposure of cats to 1,1-dichloroethane by inhalation was found to produce kidney damage. A health-based MCL of 46 ug/l was derived to protect against renal damage.

METHYL TERTIARY BUTYL ETHER

MTBE is used to increase the octane rating of gasoline and more recently has been added to gasoline to meet the requirements of the Clean Air Act. MTBE production increased the fastest of any chemical in the 1980's and it is anticipated to continue through the 1990's. The 1991 US supply was 100 million barrels per day and it is anticipated that both supply and demand will more than double by 1997. MTBE has been identified in the potable water in NJ at concentrations ranging from 1 to 81 ppb in a survey conducted from 1985-1986. It has been found at concentrations up to 10,000 ppb in private wells in New Jersey.

MTBE is classified as a Group C, possible human carcinogen, by the Lists and Levels Subcommittee. This is based on the results of chronic inhalation studies in rats and mice. The development of the health-based MCL was based on increased kidney weight seen in a subchronic gavage study. A health-based MCL of 70 ug/l was derived to protect from health effects from lifetime exposure.

NAPHTHALENE

Naphthalene is a white crystalline solid recovered during the processing of petroleum or coal tar. It is released into the environment by industrial processes. In experimental animals, the principal target tissues have been identified as the nonciliated bronchiolar epithelial (Clara) cells and eye tissues. A chronic inhalation study completed by NTP in 1992 concluded that there was some evidence of carcinogenic activity for naphthalene in female mice and no evidence of carcinogenicity in male mice.

Naphthalene has been shown to selectively accumulate in the Clara cells after exposure by routes other than inhalation (intraperitoneal injection) in some species. Clara cells are the site of high levels of mixed function oxidases which are activated by naphthalene. Human lung tissue contains high levels of mixed function oxidases which metabolize naphthalene to naphthalene oxide. The Lists and Levels Subcommittee has classified this compound as Group C, possible carcinogen, and has derived a health-based MCL of 300 ug/l.

1,1,2,2-TETRACHLOROETHANE

1,1,2,2-Tetrachloroethane was once used extensively as an industrial solvent and intermediate but it presently has limited use since less toxic substitutes are available. The compound has been detected in NJ surface water and ground water supplies. Tetrachloroethane is a known toxicant to the liver, kidney and central nervous system in both humans and laboratory animals. It is classified by USEPA as a possible human carcinogen (Group C) since there is limited animal and no human evidence for carcinogenicity. A health-based maximum contaminant level of 1 ug/l was derived by the Lists and Levels Subcommittee for 1,1,2,2-tetrachloroethane to protect from liver damage and possible carcinogenicity.

1,1,2-TRICHLOROETHANE

1,1,2-Trichloroethane is primarily used as a feedstock intermediate in the production of 1,1-dichloroethylene. Human exposures to 1,1,2-trichloroethane occur from ambient air and drinking water. Possible damage to kidney, lung, and gastrointestinal tract may result from long-term exposure. The Lists and Levels Subcommittee classified 1,1,2-trichloroethane as a Group C carcinogen. A health-based MCL of 2.7 ug/l is proposed for 1,1,2-trichloroethane to protect from liver damage and depressed immune status.

2,4,6-TRICHLOROPHENOL

2,4,6-Trichlorophenol is prepared by the direct chlorination of phenol and was used as an intermediate for dyestuffs and pesticides. It is often contaminated with other toxic chlorinated phenol products including dibenzo-dioxins and dibenzo-furans. Water contamination by 2,4,6-trichlorophenol results from chlorination of phenol in natural waters or secondary effluents in wastewater plants, direct addition of chemicals to waterways, degradation products of chemicals in water, wet and dry atmospheric fallout or as metabolic by-products of pesticides such as lindane. Workers have been exposed to 2,4,6-trichlorophenol in hospitals, the leather tanning and finishing industry, and treated lumber industries.

Trichlorophenol is classified as a probable human carcinogen (USEPA Group B2) and has been shown to induce lymphomas and leukemias in male F344 rats and hepatocellular carcinomas and adenomas in both sexes of B6C3F1 mice. A health-based MCL of 1 ug/l in drinking water was determined by the Lists and Levels Subcommittee to result in an excess cancer risk of no more than one in one million.

APPENDIX B

"2A" AND "2B" LIST CONTAMINANTS
ANALYTICAL METHODOLOGIES, METHOD DETECTION LIMITS, PRACTICAL QUANTITATION LEVELS AND HEALTH-BASED LEVELS (a)

	Method	Method Detection Limit	GW Std PQL	DSR PQL	IMDL	IMDL x5	PQL	Health Based Level
"2a" List Contaminant								
1. Ethylene Glycol	NA (b)	-	-	-	-	-	-	290
2. Formaldehyde	554	8.1	-	-	-	-	41	100
3. n-Hexane	524.2 (c)	1	-	-	-	-	5	33
4. Methyl Ethyl Ketone	524.2 (c)	4	-	-	-	-	20	270
"2b" List Contaminant								
5. 1,1-Dichloroethane	502.1 502.2 524.2	0.002 0.07 0.04	-	-	0.17	0.85	1	46
6. Methyl t-Butyl Ether	502.2 524.2	0.3 0.1	-	-	0.26	1.3	1	70
7. Naphthalene	502.2 503.1 524.2	0.06 0.04 0.1	-	-	0.40	2.0	2	300
8. 1,1,2,2-Tetrachloroethane	502.1 502.2 524.2	0.004 0.02 0.04	1	1.2	0.25	1.3	1	1
9. 1,1,2-Trichloroethane	502.1 502.2 524.2	0.007 0.1 0.10	2	1.0	0.26	1.3	2 (d)	3
10. 2,4,6-Trichlorophenol	552 625	0.022 2.7	20	11	-	-	- (e)	1

APPENDIX B (cont'd.)

"2A" AND "2B" LIST CONTAMINANTS
ANALYTICAL METHODOLOGIES, METHOD DETECTION LIMITS, PRACTICAL QUANTITATION LEVELS AND HEALTH-BASED LEVELS (a)

(a) Method detection limits, health-based levels and practical quantitation levels are expressed in micrograms per liter (ug/l).

(b) Not Available: The Testing Subcommittee does not recommend a method for ethylene glycol at this time because of inconsistent recovery data utilizing recently developed methods. A DSR inhouse project will address improvements in the recovery of ethylene glycol in drinking water.

(c) Method 524.2 modified to include target analyte.

(d) This PQL is based on the PQL derived according to procedures in the Groundwater Quality Standards.

(e) The Testing Subcommittee needs to further investigate possible methods for the analysis of 2,4,6-trichlorophenol.

APPENDIX C

CHEMICALS REVIEWED FOR THE "2B" LIST

Volatile Organic Contaminants

1. Bromobenzene (a)(b)
2. Bromodichlorobenzene (c)
3. Bromodichloromethane (a)(d)
4. Bromoform (a)(d)
5. 2-Chloroethylvinyl ether (d)
6. Chlorodibromomethane (d)
7. Chloroform (a)(d)
8. o-Chlorotoluene (b)
9. p-Chlorotoluene (b)
10. p-Cymene (c)
11. 1,2-Dibromo-3-chloropropane (a)(b)
12. 1,2-Dibromoethane (a)
13. Dibromomethane (a)
14. 1,4-Dichlorobutane (c)
15. 1,1,-Dichloroethane (a)-(e)
16. Dichlorodifluoromethane (a)
17. Dichlorofluoromethane (c)
18. 1,2-Dichloropropane (a)-(d)
19. 1,3-Dichloropropane (a)
20. 1,3-Dichloropropylene (d)
21. Ethylbenzene (a)-(d)
22. Isopropylbenzene (b)
23. Propylbenzene (c)
24. n-Propylbenzene (b)
25. Styrene (a)(b)
26. 1,1,1,2-Tetrachloroethane (b)
27. 1,1,2 ,2-Tetrachloroethane (a)(b)(d)(e)
28. Toluene (a)-(d)
29. 1,1,2-Trichloroethane (a)(b)(c)(e)
30. Trichlorofluoromethane (a)(c)(d)
31. 1,1,2-Trichloro-1,2,2-trifluoroethane (c)

APPENDIX C

CHEMICALS REVIEWED FOR THE "2B" LIST (cont'd)

Inorganics (f)

1. Aluminum (g)
2. Antimony (i)
3. Arsenic (i)(j)
4. Asbestos (i)(j)
5. Barium (i)
6. Beryllium (i)
7. Boron (g)
8. Cadmium (i)(j)
9. Calcium (g)
10. Chloride (g)
11. Chromium (i)
12. Cobalt (g)
13. Copper (i)
14. Cyanide (i)
15. Fluoride (i)
16. Iron (g)
17. Lead (i)(j)
18. Lithium (g)
19. Magnesium (g)
20. Manganese (g)
21. Mercury (i)
22. Molybdenum (g)
23. Nickel (i)
24. Nitrate (i)
25. Nitrite (i)(j)
26. Phosphate (g)
27. Potassium (g)
28. Selenium (i)
29. Silica (h)
30. Silver (g)
31. Sodium (g)
32. Sulfate (g)
33. Sulfide (g)
34. Tellurium (g)
35. Thallium (i)
36. Thorium (h)
37. Tin (g)
38. Titanium (g)
39. Tungsten (g)
40. Uranium (i)
41. Vanadium (g)
42. Zinc (g)

APPENDIX C

CHEMICALS REVIEWED FOR THE "2B" LIST (cont'd)

Phenols/Phthalates (k)

1. Butyl benzyl phthalate (l)
2. 2-Chlorophenol (m)
3. Di(2-ethyl hexyl)phthalate (l)(n)
4. 2,4-Dichlorophenol (m)
5. Diethyl phthalate (l)
6. 2,4-Dimethylphenol (m)
7. Dimethyl phthalate (l)
8. Di-n-butylphthalate (l)
9. 4,6-Dinito-o-cresol (m)
10. 2,4-Dinitrophenol (m)
11. 4-Nitrophenol (m)
12. Phenol (m)
13. 2,4,5-Trichlorophenol (m)
14. Pentachlorophenol (n)
15. 2,4,6-Trichlorophenol

Other

1. Methyl tertiary butyl ether (o)
2. Naphthalene (p

(a) This contaminant was reviewed for the "2b" list because of USEPA's intention to monitor and possibly regulate this contaminant as per 10/4/84 correspondence.

(b) This contaminant was monitored in the Groundwater Supply Survey conducted in 1981 at 1000 sites nationwide.

(c) This contaminant was found in New Jersey drinking water test results from the 25 largest water suppliers collected between 1978-1983.

(d) This contaminant was able to be detected using USEPA analytical method 624, the method used by NJDOH laboratory in the early 1980's.

CHEMICALS REVIEWED FOR THE "2B" LIST (cont'd)

(e) This contaminant was chosen for standard development based on occurrence in New Jersey drinking waters, availability of reliable analytical methodology, toxicity data and the lack of a USEPA standards. NJDEP commenced standard development for 1,1,2 - trichloroethane prior to USEPA's standard development process.

(f) These contaminants were chosen from a list that was developed based on recommendations from the World Health Organization, USEPA regulations and the USEPA Health Advisory series.

(g) These contaminants were eliminated due to consistently being listed as "no action" or they are only of aesthetic concern and without current health-based standards.

(h) These contaminants were eliminated due to being consistently judged to have insufficient data for standard development.

(i) These contaminants were eliminated because they have either primary or secondary MCLs developed by USEPA.

(j) These contaminants were chosen for the "2b" list, however NJDEP did not pursue development of MCLs for these contaminants to avoid duplication of USEPA work.

(k) These recommendations were chosen from several databases: drinking water survey of priority pollutants, fate and transport of priority pollutants in publicly owned treatment facilities, and fate and occurrence of toxic substances in New Jersey sewage treatment facilities.

(l) Chronic health effects have been reported for a number of the phthalates. Analytical difficulties at low concentration levels need to be investigated further and have eliminated these contaminants from consideration for the "2b" list at this time.

(m) These phenolic compounds were eliminated from consideration because they did not meet the criteria of known adverse toxic effects and significant occurrence.

(n) These contaminants are regulated by USEPA.

(o) Methyl tertiary butyl ether was recommended to the "2b" list due to its increasing prevalence in groundwater contamination cases in the vicinity of gasoline stations.

(p) Naphthalene was recommended to the "2b" list since it is a water soluble component of kerosene, a "2a" list contaminant mixture that cannot be regulated according to the methods described in the A-280 statute.

APPENDIX D

OCCURRENCE DATA FOR THE "2B" LIST CONTAMINANTS

TABLE D-1

SUMMARY OF "2B" LIST CONTAMINANTS FOUND IN THE TOP 25 PURVEYORS 1978-1984 (a)

Contaminant	# of Occurrences	# of Water Supplies	Min	Max	Mean
1,1,2-Trichloroethane	8	3	1.9	22	9.9
1,1-Dichloroethane	29	4	1.1	13	4.8

(a) This data was collected from the 25 largest water purveyors in the state in response to suspected or known problems with volatile organic chemicals. This data was collected beginning in 1978 and is current through December 1984. This data is taken only from the top 25 public community water supplies in the State.

TABLE D-2

SUMMARY OF "2B" LIST CONTAMINANTS FOUND IN PUBLIC COMMUNITY WATER SYSTEMS 1988-1993

Contaminant	# of Detections	# of Water Syst.	Min	Max	Mean	# of Samples	Health Based Level
1,1-Dichloroethane (a)	63	24	0.14	4.4	1.1	3046	46
Methyl Tertiary Butyl Ether (b)	88	46	0.3	47.5	-	-	70
Naphthalene (c)	4	3	0.15	3.6	1.2	1846	300
1,1,2,2-Tetrachloroethane (a)	4	4	0.6	2.8	1.4	2984	1
1,1,2-Trichloroethane (a)	6	6	0.22	1.03	0.7	3010	3
2,4,6-Trichlorophenol (d)	0	5	<0.2	-	-	42	
		4	<2.8	-	-	88	1

(a) Since 1988, public community water supplies have been required to monitor for a list of 36 unregulated contaminants (40 CFR 141.40).

(b) MTBE was not included on the list of unregulated contaminants for federal reporting (40 CFR 141.40). A detailed presentation of MTBE data from other sources appears in Appendix E.

(c) Naphthalene is listed as one of the federal "optional" unregulated contaminants (40 CFR 141.40). New Jersey did not require, but recommended, that water systems test for the "optional" list of 15 additional unregulated contaminants.

(d) 2,4,6-Trichlorophenol was not included on the list of unregulated contaminants for federal reporting (40 CFR 141.40). However, two surveys were conducted that looked for 2,4,6-trichlorophenol in potable water. The first survey was conducted at four treatment plants using USEPA method 625 (Special Water Treatment Study Phase II, 1988). The second was conducted between 1989 and 1991 at five treatment plants using USEPA method 552 (Disinfection By-Products Project, unpublished).

APPENDIX E

OCCURRENCE, TREATABILITY AND ESTIMATED STATEWIDE COSTS TO ACHIEVE A PROPOSED MAXIMUM CONTAMINANT LEVEL OF 70 PPB FOR METHYL TERTIARY BUTYL ETHER IN PUBLIC AND NONPUBLIC DRINKING WATER SYSTEMS IN NEW JERSEY

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Staff in the Bureaus of Site Management-Wellfield Remediation Section (BSM-WR), Underground Storage Tanks, Environmental Claims, and Communication provided most of the occurrence, treatability and cost data for nonpublic wells. Shane Michael of the Bureau of Wellfield Remediation critically reviewed the text. Kristi Tallone and Sam Patel conducted the database search in the Bureau of Safe Drinking Water files.

OCCURRENCE, TREATABILITY AND ESTIMATED STATEWIDE COSTS TO ACHIEVE A PROPOSED MAXIMUM CONTAMINANT LEVEL OF 70 PARTS PER BILLION FOR METHYL TERTIARY BUTYL ETHER IN PUBLIC AND NONPUBLIC DRINKING WATER SYSTEMS IN NEW JERSEY

SUMMARY

This report summarizes available occurrence data of methyl tertiary butyl ether (MTBE) in drinking water and evaluates the economic impact of setting a drinking water standard or maximum contaminant level (MCL) of 70 parts per billion (ppb) for MTBE in drinking water.

Although occurrence data indicate that concentrations of MTBE in public water supplies presently do not exceed the proposed drinking water standard, MTBE concentrations in nonpublic water supplies more often exceed the proposed drinking water standard of 70 ppb. Projected costs are based on the assumption that a water supplier may find MTBE in the drinking water and decide to remediate the supply.

The estimated Statewide costs to achieve an MCL of 70 ppb range from $6,000,000 to $50,000,000. This expenditure would provide treatment for between 2000 and 4000 private (nonpublic) wells and from 3 to 6 public community systems. Statewide estimates assume that between 0.5% and 1% of private (nonpublic) wells and public community systems would have concentrations of MTBE greater than 70 ppb in their raw water.

These costs are based on available occurrence and treatability data. Occurrence estimates are based on Bureau of Safe Drinking Water (BSDW) databases for nonpublic wells and public systems. Neither database is representative because neither the United States Environmental Protection Agency (USEPA) nor New Jersey Department of Environmental Protection (NJDEP) have approved an analytical method for MTBE and MTBE reports are not routinely filed. Therefore an estimated range of Statewide cost is provided.

Treatability costs assume the use of air stripping and granular activated carbon adsorption. Treatability data is derived from actual costs in New Jersey at nonpublic and public water supply systems that use air stripping and granular activated carbon.

Because MTBE is a gasoline additive, the presence of other gasoline components such as benzene may indicate the presence of MTBE. However, reports of MTBE at concentrations less than 100 ppb may not indicate the presence of benzene. There are two reasons: one, there is less benzene than MTBE in gasoline and two, MTBE is much more soluble in water than benzene. Benzene may be no more than 1% by volume of gasoline, whereas MTBE may vary from 3 % to as much as 11% of gasoline. During winter the concentration of MTBE may be as high as 15%. MTBE is about 25 times more soluble in water than benzene.

Concentrations of MTBE in nonpublic wells and public supplies are usually less than 5 ppb and except for a handful of instances, MTBE is almost always less than 70 ppb. Furthermore, in most instances when MTBE is greater than 70 ppb, other gasoline components such as benzene have been reported. However, because MTBE is more difficult to remove than other gasoline components, water treatment plants may have to be designed to meet the MTBE standard.

The number of nonpublic or public supplies reporting MTBE or petroleum related compounds is noted below:

	Number of Wells/Systems from 1989-1993 Reporting:	
	MTBE	petroleum
Water Supplies:		
Nonpublic wells	120	530
Public noncommunity	50	
Public community	60	

New Jersey and USEPA have legislated the clean up of petroleum/gasoline spills and protection of drinking water supplies. Consequently many spills have been cleaned up and many contaminated nonpublic wells and some public community systems have been treated or replaced by water main extensions. To date, at least six public community water systems and about 600 nonpublic wells with MTBE or petroleum compounds have been remediated.

Presently the BSDW considers MTBE an unregulated organic; as such, a health effects level of 50 ppb is provided for guidance.

Because of these past actions, future Statewide costs to comply with an MTBE drinking water standard of 70 ppb may be at the lower end of the estimated range.

GASOLINE IS THE MOST PROBABLE SOURCE OF MTBE

MTBE became commercially available in the United States after 1979. MTBE is used almost exclusively as an additive in gasoline production to reduce carbon monoxide and hydrocarbon emissions during combustion. The concentration of MTBE in gasoline may vary by manufacturer, region and season from 3 % to 15% by volume. A concentration of 11% by volume corresponds to 110,000 parts per million (ppm) or 110,000,000 parts per billion (ppb).

MTBE has been found in groundwater and associated most frequently with leaking underground gasoline or industrial storage tanks rather than surface spills or contaminated air. Since underground storage tanks have been regulated for a number of years, the worst contamination cases are believed to have been found.

MTBE SOLUBILITY IN GROUNDWATER

MTBE is very soluble in water. The solubility limit in water is 43,000 ppm or 43,000,000 ppb. This is much more than benzene, toluene, xylenes or other gasoline components. In addition, MTBE increases the solubility of these other components in water.

Solubility of Selected Gasoline Components In Water (a)

Component	mg/l or ppm
Benzene	1,780
Toluene	515
m-Xylene	170
MTBE	43,000

(a) Garrett, 1986.

In New Jersey, concentrations of MTBE in wells have been reported as high as 40,000 ppb. This is 1000 times less than the solubility limit. Most of the reported concentrations of MTBE in wells were less than 10 ppb. In almost all instances, when MTBE was greater than 70 ppb, other gasoline constituents such as benzene, toluene and xylene or other regulated solvents such as trichloroethylene were also present.

DATABASE DESCRIPTION

The databases searched for MTBE are not representative and may be skewed for a variety of reasons. There is no approved USEPA analytical method for MTBE in drinking water and no USEPA MCL. Consequently, purveyors and laboratories do not routinely report MTBE data. MTBE, however can be detected using USEPA method 524.2. If MTBE had been detected, a laboratory would have been required to report it. Only two private laboratories in addition to the NJDOH (New Jersey Department of Health) and NJDEP laboratories have reported MTBE. This could contribute to underreporting occurrence.

On the other hand, MTBE data was typically reported as part of an investigation of a gasoline/fuel spill or leak. If a number of wells had been affected by the spill, the occurrence would appear to be higher than in other areas. Consequently, MTBE data has not been collected uniformly nor at a required frequency.

BSDW PUBLIC AND NONPUBLIC WATER SUPPLY DATABASE

BSDW routinely collects compliance monitoring reports from all public water systems. In addition, on occasion since 1989, BSDW received reports of MTBE. All of this data has been entered into a public drinking water quality database.

BSDW has also collected nonpublic water supply data. On occasion, since 1984, outside agencies such as local health departments have submitted laboratory reports of private (nonpublic) well tests to the BSDW. Recently, these laboratory reports have been compiled and entered into a nonpublic drinking water database.

DATABASE ANALYSIS

Occurrence was estimated to develop statewide treatment costs. Both databases were searched and the results analyzed. Table E-2 and Addendum Tables 2a and 2b summarize the results and identify counties and municipalities where MTBE was reported. MTBE was reported in the nonpublic database in about 10% of wells sampled and 10% of those wells or 1% of the total had concentrations greater than 70 ppb. Similarly, about 60 public community supplies reported MTBE. There are an estimated 400,000 nonpublic (private) wells and 630 public community supplies in New Jersey. By extrapolation, one percent of the total or about 4000 nonpublic wells and 6 public community supplies might have more than 70 ppb MTBE.

Since these databases may not be representative, other sources of information were checked. Staff from Atlantic and Ocean County Health Departments and from NJDEP's Bureaus of Underground Storage Tanks, Environmental Claims Administration, Wellfield Remediation and Communications in the Hazardous Site Remediation element were consulted. Table E-3, E-4 and E-5 summarize data made available to us from Ocean County, Environmental Claims and Wellfield Remediation.

A random check of BSDW and Bureau of Site Remediation-Wellfield Remediation (BSM-WR) entries indicates that as much as 10% of data reports in those two files may be duplicative. However, sufficient time was not available to check each entry. For all these reasons, the number of wells that might have been affected by MTBE was estimated to be between 0.5% and 1% of all wells.

OTHER SOURCES OF DATA

N.J. regulates discharges more stringently than the Federal government. Any discharge of a regulated chemical of any quantity by any person must be reported. The New Jersey Spill Compensation and Control Act (N.J.S.A. 58:23.11 et seq.), the Discharge Control and Containment Act, the N.J. Pollution Discharge Elimination System and Clean Air statutes generally require that releases be reported to the NJDEP Hotline, 609-292-7172. Staff at the Bureau of Communications and Support Services report that between 750 and 1000 incidents are reported each month.

All information is data managed but only stored for about 1 year. Incidents involve possible discharge of hazardous chemicals to air, water or land. Of the 9000 to 12,000 releases per year that are reported, petroleum or gasoline products are likely to be involved in many of those incidents.Not all reports are significant. Between one quarter and one half of these incidents have been forwarded to the NJDEP Site Remediation Program or to a local health department and one fourth have had no action taken. Incident reports are not specific as to the source, quantity or type of contamination. It could involve spills, traffic accidents or underground tanks. Therefore one can not readily determine the type of incident or if MTBE might be involved.

In comparison a recent Federal report on hazardous material releases from transportation spills recorded a total of about 60,000 incidents from 1981 to 1989.

Staff at the Bureau of Underground Storage Tanks report that the number of gas stations in New Jersey has decreased from an estimated 75,000 to about 35,000. Of those, about 8,000 to 9,000 gas stations are undertaking some type of remediation because of leaks. There are an estimated 900 active cases. Monitoring results are not data managed.

Staff in the Environmental Claims Administration report that about 2600 claims have been filed in 1993. About 25% are for contamination with petroleum products. Another 25% of the claims have reported both hazardous and petroleum products. The remainder of the claims have hazardous wastes without petroleum products. For many of these claims a responsible party has not been determined. Therefore the source has not been identified. Specific chemicals are not data managed. Monitoring results are not data managed.

Staff in the BSM-WR have been involved in about 140 contaminated wellfield clusters with an estimated 2800 contaminated wells. Benzene, MTBE, or petroleum have been associated with approximately 30 of those clusters where an estimated 380 wells were affected. Sources of contamination have ranged from leaking underground gasoline storage tanks to backyard spills of undetermined amounts of gasoline. Monitoring results are data managed. Tables E-6, E-7, E-8 and E-9 selectively summarize monitoring data at specific sites. BSM-WR maintains lists of Current, Potential and Closed cases in New Jersey.

MTBE ATTENUATION IN GROUNDWATER

The attenuation of MTBE by a factor of as much as 1,000,000 seems to occur. Concentrations of MTBE in groundwater have been reported as high as 40,000 ppb and as low as 0.5 ppb. If the solubility limit in water is 43,000 ppm or 43,000,000 ppb, then a groundwater concentration of 43 ppb is equivalent to attenuation by 99.9999% or a factor of one million. This attenuation may be attributed to dilution, volatility, adsorption, chemical reaction or biological degradation. Movement of MTBE in groundwater seems to be controlled by its high solubility. It has been suggested that a groundwater plume of

MTBE may move differently than a plume of other gasoline components.

MTBE TREATABILITY

MTBE is treatable with air stripping and granular activated carbon. However the high solubility of MTBE in water makes treatment difficult. Tables E-6, E-7, E-8, and E-9 provide treatability data derived from NJDEP operations for air strippers and GAC units. Both techniques have been used in public and nonpublic supplies.

If gasoline constituents such as benzene or other regulated solvents are found, then the raw water concentration and the MCL will determine which component is the most difficult to remove. Because MTBE solubility is greater and the volatility is less than benzene, MTBE concentrations are likely to control design criteria.

The following findings are based on data from NJDEP BSM-WR files. BSM-WR presently monitors point of entry granular activated carbon canisters, "Lowry" and shallow tray air strippers.

Air Strippers

Actual MTBE removal efficiencies for air stripping are comparable to manufacturer's predictions. A typical treatment unit may have water cascading down at 10 gallons per minute and air blown up at about 150 cubic feet per minute. The air to water ratio is about 120:1. See Figure 1 and 2 for manufacturers' equipment and treatment specifications. An average of 50% to 60% MTBE reduction may be achieved after one pass through a single tray aerator. Four trays are needed to achieve a 90% reduction in MTBE. In comparison, benzene reductions of 90% can be achieved with a single tray aerator.

Granular Activated Carbon Adsorption

The solubility and size of the MTBE molecule make it more difficult to adsorb especially when smaller and more volatile organics are present. Granular activated carbon can adsorb 100% of influent MTBE. However "breakthrough" which is considered a change from none detectable to detectable concentrations, may occur after several weeks in standard GAC contactors that are designed to last 6 months to a year. Breakthrough can occur when the fixed volume of carbon in the canister becomes saturated with organics. The rate of flow, the raw water concentration of MTBE, the presence of other adsorbable compounds and the amount of carbon will determine the time to breakthrough. Monthly monitoring results in Tables E-6, E-7, and E-8 show if breakthrough has occurred.

If raw water concentrations of MTBE exceeded 1000 ppb, a single tray air stripper followed by two 1.5 cubic feet granular activated carbon canisters would not be sufficient to prevent MTBE from increasing above 70 ppb within one month. Additional air strippers and GAC canisters would be needed.

If raw water concentrations of MTBE were less than 90 ppb then two GAC canisters in series have been used successfully to reduce MTBE to nondetectable levels. Once detectable concentrations were observed after the first canister, it would be removed and the second canister would take its place. A new virgin carbon GAC canister would become the second canister. In residential applications breakthrough could occur in weeks or months.

Packed Tower Aeration (PTA)

Packed tower aeration systems are used at public community water supplies and have been designed to reduce concentrations of MTBE from 200 ppb to none detectable. Table E-9 summarizes data at one New Jersey public community water supply. Figures 3 and 4 provide monthly data for reductions for MTBE and other organics at that facility.

UNIT COSTS

The design of a treatment system considers both construction and operating costs. An air stripper will have higher construction costs and lower operating costs than granular activated carbon canisters. An air stripper followed by two carbon canisters in series appears to be economical for raw water concentrations from 50 to 150 ppb. Treatment can achieve nondetectable levels, presently less than about 0.5 ppb. If raw water concentrations are greater, then air strippers providing greater contact time are recommended. If raw water MTBE concentrations are lower, then GAC canisters may suffice.

The following cost estimates are based on experience of the NJDEP BSM-WR and the BSDW. Cost estimates assume a 10 gpm point of entry (POET) device for a nonpublic well, 50 to 100 gpm POET for a noncommunity system and 694 gpm (1 mgd) PTA for a public community system.

Point of Entry Treatment (POET): Air Stripper

The estimated cost of purchasing a one tray POET air stripping unit is about $4000 to $6000 (1993 dollars). If this unit cannot be installed in an existing building, such as a basement, shed or garage, then the total estimated cost to house the unit may be as high as $10,000. Operating costs for a stripper are about $0.35/day for blowers. If the unit is housed outdoors then operating costs for heat, light and fans may come to $2/day.

Point of Entry Treatment (POET):
Granular Activated Carbon Canister

A granular activated carbon treatment system is likely to consist of two GAC canisters in series with a monitoring tap in between. The estimated cost of installing the system is about $1500 (1993 dollars). Each canister would have about 1.5 to 2 cubic feet of granular activated carbon. Carbon replacement would cost a minimum of about $165 and would include disposal. Monitoring costs could be as much as $400 per year if samples were taken quarterly at a cost of $100/sample. These systems are most economical if canisters can last at least six months.

Water Main Extensions

POETS have been considered interim treatment solutions until a water line is extended to the area. Water line extension costs may range from $20,000 to $90,000 per well (1993 dollars). These estimates are based on NJDEP costs to install mains to several of the contaminated wellfield areas. A typical project would be designed and bid by a municipality according to NJDEP specifications.

Packed Tower Aeration (PTA)

Packed aeration towers to remove volatile organics have been installed by more than 30 public community water supplies in New Jersey. Some have been in operation for more than ten years. Estimated costs (1993 dollars) provided by the BSDW and BSM-WR range from $300,000 to about $1,000,000 dollars per million gallons of treatment capacity. PTA can reduce MTBE influent concentrations as high as 200 ppb to nondetectable concentrations in treated water.

Related POET Processes

If a POET air stripper or a GAC unit is installed, the BSM-WR may provide an ultraviolet light or a chlorinator to disinfect the water. This will increase the installation cost between $650 and $2000 (1993 dollars). The operating costs will also increase by as much as $35/month for a chlorinator.

STATEWIDE COST ESTIMATES

Table E-1 presents the statewide high and low conceptual cost estimates to achieve a 70 ppb MTBE standard. Site specific studies would refine concept costs and provide feasibility cost estimates.

The unit costs combined with occurrence data provide high and low cost statewide estimates. The high cost estimate (1993 dollars assumes):

1. 4000 nonpublic wells with an air stripper and 2 GAC canisters at a cost of $11,500 each;

2. 13 noncommunity public systems with several air strippers and GAC canisters at a cost of $50,000 each;

3. 6 public community supplies with a packed tower aerator at a cost of $1,000,000 each.

The low cost estimate (1993 dollars) is for:

1. 2000 nonpublic wells with 2 GAC canisters at a cost of $1500 each;

2. 6 noncommunity public systems with several air strippers and GAC canisters at a cost of $30,000 each;

3. 3 public community supplies with a packed tower aerator at a cost of $1,000,000 each.

CONCLUSION

Estimated statewide costs for removing MTBE from public and nonpublic potable wells range from 6 to 50 million dollars. This would remediate an estimated 2,000 to 4,000 nonpublic wells serving an estimated 6,000 to 16,000 people and not more than 6 public community supplies each serving about 10,000 people.

Because the state and counties have been addressing the most significant source of MTBE, that is leaking underground gasoline storage tanks, the number of additional public and nonpublic wells found to contain MTBE is likely to be less than the high estimate.

As of 1993 there were between 50 and 400 nonpublic wells that had reported MTBE alone or in combination with regulated organics. Five of these wells use air stripping and GAC systems to treat raw water MTBE concentrations greater than 1000 ppb. Additional treatment would be needed at each of those sites. The remaining sites may not need additional treatment since raw water MTBE levels are less than 70 ppb in most instances.

Public community wells are not likely to be impacted, since MTBE levels are likely to be less than 70 ppb and the presence of regulated organics would have triggered a regulatory response. To date, one public community system has been designed specifically for MTBE. Up to six other public community systems are removing MTBE along with other regulated organics.

However, if a public community water supply has only MTBE, the owner of that supply may abandon the well rather than treat, since treatment costs may appear to be prohibitive. In that instance the decrease in overall availability of water supply for that area should be taken into account.

TABLE E-1

STATEWIDE CONSTRUCTION COST ESTIMATES FOR TREATING MTBE TO 70 PPB

HIGH COST ESTIMATE

Nonpublic wells	4000	x	$11,500	=	$46,000,000.
(air stripper & 2 GAC canisters)					
Nontransient noncommunity wells				=	not known
Public noncommunity systems	13	x	$50,000	=	$650,000.
Public community systems	6	x	$1,000,000	=	$6,000,000.
HIGH ESTIMATED TOTAL					$52,650,000.
ROUNDED					$50,000,000.

LOW COST ESTIMATE

Nonpublic wells	2000	x	$1,500	=	$3,000,000.
(2 GAC canisters)					
Nontransient noncommunity wells				=	not known
Public noncommunity	6	x	$30,000	=	$180,000.
Public community	3	x	$1,000,000	=	$3,000,000.
LOW ESTIMATED TOTAL					$6,180,000.
ROUNDED					$6,000,000.

TABLE E-2

BUREAU OF SAFE DRINKING WATER

PUBLIC and NONPUBLIC WATER SUPPLY SYSTEMS

REPORTING METHYL TERTIARY BUTYL ETHER

System	Number of Systems with Reported Concentrations of MTBE, ppb			
	>1000	<1000 &>70	<70 >10	<10
Public Community (a)	0	0	2	44
Public Noncommunity (a)	0	0	0	53
NonPublic Wells (b)	0	6	17	35

(a) There are approximately 630 public community systems and about 1300 public nontransient noncommunity systems in New Jersey. In addition to the file maintained by the BSDW for compliance with the Safe Drinking Water Act, the BSDW maintains a file that contains data collected by BSDW personnel. The data presented on this table was collected between 1984 to 1993 and also includes this noncompliance data. There are about 58,000 entries for specific chemicals in this database. Most of the entries are from compliance monitoring. MTBE data were input whenever it was reported. The database can not be considered representative for statistical purposes. Table E-2a lists locations and reported concentrations.

(b) There are an estimated 400,000 nonpublic wells in New Jersey in 1993. These wells serve private residences. This database contains only results of special investigations of the BSDW or results submitted to the BSDW for evaluation from 1982 to 1993. There are about 11,000 entries for specific chemicals in this database. NJDOH and NJDEP laboratories and two private laboratories have reported MTBE results. At this time there is no certified method or MCL for MTBE. The database can not be considered representative for statistical purposes. Table E-2b summarizes locations and reported concentrations.

KEY:
< is the symbol for LESS THAN
> is the symbol for GREATER THAN

TABLE E-2A

PUBLIC WATER SYSTEMS REPORTING MTBE (a)

	NUMBER OF REPORTS			CONCENTRATION MTBE (ppb)		
COUNTY MUNICIPALITY	TOTAL ANY CHEM-ICAL	MTBE &ANY CHEM ICAL	ONLY MTBE	HIGH W/ OTHER	HIGH ONLY MTBE	LOW
BERGEN						
MAHWAH	1	1		2.0		
CAMDEN						
CAMDEN CITY	1	1		0.8		
CUMBERLAND						
MILLVILLE	1	1		0.4		
ESSEX						
LIVINGSTON	1	1		1.0		
MONTCLAIR	1	1		3.0		
SO.ORANGE	1		1		0.7	
GLOUCESTER						
GREENWICH	1	1		1.0		
HUNTERDON						
CALIFON						
Beginnings	1		1		0.5	
CLINTON	2		2		16.4	1.0
Edna Mahan	1		1		2.5	
LEBANON						
First Step	1		1		0.5	
Dominick's	1		1		0.5	
FLEMINGTON						
Presco Foods	1		1		0.8	
Trenegar	1		1		0.5	
Darts Mill D	1		1		0.5	
HAMPTON						
Hunterdon HI	1		1		0.5	

TABLE E-2A (cont'd.)

PUBLIC WATER SYSTEMS REPORTING MTBE (a)

	NUMBER OF REPORTS			CONCENTRATION MTBE (ppb)		
COUNTY MUNICIPALITY	TOTAL ANY CHEM-ICAL	MTBE &ANY CHEM ICAL	ONLY MTBE	HIGH W/ OTHER	HIGH ONLY MTBE	LOW
READINGTON						
Readington Farm	1		1		0.5	
STOCKTON	1		1		0.5	
TEWKSBURY						
Oldwick Unit	1		1		0.5	
MERCER						
HAMILTON						
GARDEN STATE	1	1		0.4		
HOPEWELL	1	1		0.2		
MIDDLESEX						
CRANBURY						
RhonePoulenc	11		11		0.5	
OLD BRIDGE						
Jacoma	3		3		0.5	
PERTH AMBOY						
N.J. Bell	1		1		0.5	
SOUTH RIVER						
Harris Steel	3		3		0.5	
MONMOUTH						
ROOSEVELT	1	1		0.1		
MORRIS						
CHESTER						
N.J.Bell	2		2		0.5	
DENVILLE	1		2		1.2	

TABLE E-2A (cont'd)

PUBLIC WATER SYSTEMS REPORTING MTBE (a)

	NUMBER OF REPORTS			CONCENTRATION MTBE (ppb)		
COUNTY MUNICIPALITY	TOTAL ANY CHEM-ICAL	MTBE &ANY CHEM ICAL	ONLY MTBE	HIGH W/ OTHER	HIGH ONLY MTBE	LOW
FLORHAM PK. Exxon R & E	3		3		0.5	
JEFFERSON	1		1		1.1	
MADISON	2	2		9.0		2.0
MENDHAM Sister	1		1		0.5	
MONTVILLE	3		3		3.5	1.9
MT.ARLINGTON	1	1		0.8		
MT.OLIVE	1	1		0.4		
ROCKAWAY B	2		2		8.7	7.
ROCKAWAY TWP	1		1		47.5	
ROXBURY TWP	1		1		3.8	
WASHINGTON	2		2		0.5	
Long	2		2		0.5	
OCEAN						
DOVER Raymor	1	1		0.5		
POINT PLEAS	1	1		0.9		
SOMERSET						
BERNARDS St.Johns Wat	1		1		0.5	

TABLE E-2A (cont'd.)

PUBLIC WATER SYSTEMS REPORTING MTBE (a)

	NUMBER OF REPORTS			CONCENTRATION MTBE (ppb)		
COUNTY MUNICIPALITY	TOTAL ANY CHEM-ICAL	MTBE &ANY CHEM ICAL	ONLY MTBE	HIGH W/ OTHER	HIGH ONLY MTBE	LOW
BRANCHBURG	1		1		0.3	
Wilson Fiber	1		1		0.5	
Wilson	1		1		0.5	
BRIDGEWATER						
Bridgewater	1		1		0.5	
Health	1		1		0.5	
FAR HILLS						
Country Club	2		2		0.5	
FRANKLIN						
Little Learn	1		1		0.5	
HILLSBOROUGH						
Bridgewater	1		1		0.5	
SUSSEX						
ANDOVER						
LAKE LENAPE	1		1		2.0	
HOPATCONG						
HIGHCREST WT	2	2		0.8		0.7
SPARTA	1	1		1.0		
SPARTA	1	1		4.5		
UNION						
MOUNTAINSIDE						
Echo Lanes	2		2		0.6	
MURRAY HILL						
Electrical	3		3		0.5	
RAHWAY	8	8		35		0.4

TABLE E-2A (cont'd.)

PUBLIC WATER SYSTEMS REPORTING MTBE (a)

	NUMBER OF REPORTS			CONCENTRATION MTBE (ppb)		
COUNTY MUNICIPALITY	TOTAL ANY CHEMICAL	MTBE &ANY CHEMICAL	ONLY MTBE	HIGH W/ OTHER	HIGH ONLY MTBE	LOW
WARREN						
WHITE						
Lamplighter	1	1		0.3		

(a) This database consists of all compliance data from community and noncommunity public water supplies from 1984 to 1993 for all required monitoring. Noncompliance data including MTBE reports provided since 1989 have been entered into the database. Private lab #20071 has reported most of the data along with NJDOH lab and private lab# 20044. There are about 58,000 chemical entries for 630 public community and about 1300 public noncommunity systems.

TABLE E-2B

NONPUBLIC WELLS REPORTING MTBE (a)

	NUMBER OF WELL REPORTS			CONCENTRATION MTBE (ppb)			
COUNTY MUNICIPALITY	TOTAL ANY CHEM-ICAL	MTBE &ANY CHEM ICAL	ONLY MTBE	HIGH MTBE >70 PPB	HIGH W/ OTHER	ONLY MTBE	LOW
MIDDLESEX							
SO.PLAINFIELD	99	7	3	0	4	2	1
MORRIS							
JEFFERSON	2	2	2	0	<1	<1	<1
ROXBURY	139	3	0	0	1		<1
WASHINGTON	189	17	11	0	7	5	0.1
PASSAIC							
WAYNE	14	1	0	1	600		
WEST MILFORD	128	28	21	5	800	600	<1
	---	--	--	-	---	---	--
	571	58	37	6			

(a) The data was collected by the BSDW or by local health departments as part of contamination investigations. None of the data was collected as part of compliance monitoring. The database contains reports from 1982 to 1993 from 18 counties. It includes about 4500 wells and 11,000 chemical results. The MTBE results were reported by four laboratories (lab # 20044, #11149, 77166, 14116). All MTBE sample results were collected between 1989 and 1992. All MTBE samples results outside of Passaic County were <10 ppb. About half of those samples with MTBE only reported <1 ppb.

KEY:
< is the symbol for LESS THAN
> is the symbol for GREATER THAN

TABLE E-3

OCEAN COUNTY HEALTH DEPARTMENT

NONPUBLIC WELL COMPLIANCE DATA

	Estimated Number of Wells with Estimated Concentration of MTBE, ppb (a)			
	>1000	<1000 &>70	<70 >10	<10
NonPublic wells estimated*		97	65	

OCEAN COUNTY COMPLIANCE DATA: 1986 TO 1991

	Number of Wells with Concentrations of Benzene, ppb			
	>1000	<1000 & >70	< 70 > 10	<10
NonPublic Wells Benzene			97	65

(a) There are an estimated 30,000 nonpublic wells in Ocean County as of 1993. These wells serve private residences for potable and irrigation purposes. Ocean County requires that wells be tested for 29 parameters when the title to a house changes or when a new well is constructed. There was no requirement to report MTBE. Results for benzene have been taken from a summary table in a report prepared by Camp, Dresser & McKee for the County. The report summarizes results from 1986 to 1991. The estimated number of wells with MTBE, presumes that each detection of benzene was at a unique location; and that MTBE was present in concentrations between 10 ppb and 70 ppb. Results of locations with suspected contamination are also included. There are about 22,800 tests for 8,700 unique (nonincident) locations and 3,500 tests for 2,500 unique (incident) locations in this database. The database can not be considered representative for statistical purposes for MTBE.

TABLE E-4

ENVIRONMENTAL CLAIMS ADMINISTRATION

NONPUBLIC (PRIVATE) WATER SUPPLY WELLS

Estimated Number of Wells with
Estimated Concentration of MTBE, ppb (a)

	>1000	**<1000 & >70**	**< 70 > 10**	**<10**
NonPublic Wells estimated			363	

(a) In fiscal year 1993 the Environmental Claims Administration compensated more than 2600 claims for damages from petroleum and hazardous chemicals at a cost of 11 million dollars. This included a backlog of claims presented prior to 1987. Between July 1993 and the end of November 1993 there were 363 claims related to petroleum discharges, 352 claims related to petroleum and hazardous discharges, and 1027 claims for hazardous discharges. There have been approximately 860 claims for new wells. Environmental Claims presently pays monitoring and maintenance costs for 646 GAC POETs. Water line extensions have been provided for 713 claims.

Specific chemical data which is the basis for the claim is not data managed. Claims are paid only if health guidance levels are exceeded. As an unregulated organic, MTBE had a health guidance level of 50 ppb. Because MTBE is associated with gasoline spills, the number of petroleum claims is used as the number of MTBE cases. This database summary is not representative.

TABLE E-5

BUREAU OF WELLFIELD REMEDIATION

CLOSED AND CURRENT CASE LIST

NONPUBLIC (PRIVATE) WATER SUPPLY WELLS

Estimated Number of Wells with
Estimated Concentration of MTBE, ppb (a)

	>1000	<1000 & >70	< 70 > 10	<10
	-----	-----	-----	-----
NonPublic wells estimated	5	65		
	-----	-----	-----	-----

(a) As of January 1, 1994 the NJDEP BSM-WR listed 400 wells "affected" with contamination of which 60 were related to fuel including 39 specifically identified with MTBE. In addition BSM-WR has a "closed" list of approximately 2000 wells that have been remediated of which 196 had fuel contamination including 26 specifically identified with MTBE. However, this database represents only those wells with known contamination.

TABLE E-6

MTBE REMOVAL EFFICIENCY

POINT OF ENTRY TREATMENT UNITS (POETS)

AIR STRIPPER & GRANULAR ACTIVATED CARBON CANISTER (a)

year month	raw ppb	after air stripper ppb	% red.	after first granular activated carbon ppb	% red.
1992					
4	5,800	2,500	57	nd	100
5	10,200	3,600	64	nd	100
6	3,300	1,200	64	2500	B
7	12,200	2,100	78	1800	B
8	8,500	4,800	43	3500	B
9	14,400	4,900	65	nd	100
10	21,800	7,700	64	nd	100
11	11,000	5,100	54	1200	B
12	21,700	23,000	na	na	na
1993					
1	25,500	25,500	3	nd	100
2	15,600	16,200	na	7,100	B
3	10,100	9,900	2	nd	100
4	11,900	6,000	49	200	B
5	5,200	8,000	na	5,400	B
6	5,500	3,800	30	10,300	B
7	5,000	3,500	30	2,700	B
8	18,500	6,600	64	1,700	B
9	39,000	11,800	70	na	na

(a) Branchburg Twp. Shallow Tray Aeration and GAC by North East Environmental Products. The BSM-WR collects monthly data for regulated and unregulated organics including MTBE. The typical per cent reduction (% red) for MTBE was from 40% - 70%. Concentrations reported in January, February and March 1993 may reflect operations when the air stripper was bypassed. Concentrations in June and July 1993 may reflect operations when the air stripper blower was off. BSM-WR follows air stripping with 2 GAC canisters in series. The first canister is replaced after breakthrough (B) of that unit is detected.

TABLE E-7

MTBE REMOVAL EFFICIENCY

POINT OF ENTRY TREATMENT UNITS (POETS)

AIR STRIPPER & GRANULAR ACTIVATED CARBON CANISTER (a)

date	raw ppb	after air stripper ppb	% red.	after granular activated carbon ppb	% red.
1992					
4	160	85	47	nd	100
5	210	75	64	nd	100
8	150	26	83	1	B
9	60	19	68	40	B
10	67	11	84	nd	100
11	150	17	89	nd	100
12	150	35	77	nd	100
1993					
1	200	52	74	nd	100
2	34	32	6	nd	100
3	73	74	-	nd	100
4	89	81	8	nd	100
5	31	30	3	nd	100
6	n/a	n/a	n/a	-	-
7	26	24	8	2	B
8	16	3	81	nd	100
9	10	1	90	nd	100
10	27	4	84	-	-

(a) Wanamaker, Stillwater, Shallow Tray aerator by North East Environmental. The BSM-WR monitors results monthly.

TABLE E-8

MTBE REMOVAL EFFICIENCY

GRANULAR ACTIVATED CARBON

POETS: WEST MILFORD TWP MOBIL/ 3-4 FT3 GAC

date	raw ppb	after GAC 1 ppb	% red.	after GAC#2 ppb	% red.
1991					
4	47	nd	100	nd	---
5	23	nd	100	nd	---
6	32	1.5	95	nd	100
7	9	nd	100	nd	---
8	31	nd	100	nd	---
9	na	na	na	na	na
10	20	2.2	90	nd	100
11	na	na	na	na	na
12	19	nd	100	nd	---
1992					
1	na	na	na	na	na
2	na	na	na	na	na
3	19	nd	100	nd	---
4	na	na	na	na	na
5	17	nd	100	nd	---
6	34	nd	100	nd	---
6	24	nd	100	nd	---
7	26	nd	100	nd	---
8	41	nd	100	nd	---
9	24	nd	100	nd	---
10	28	15	50	10	80
11	5	nd	100	nd	---
12	12	nd	100	2	neg
1993					
1	89	nd	100	nd	---
2	22	nd	100	nd	---
3	20	nd	100	nd	---

(a) Mobil Oil as the responsible party monitored and maintained 48 GAC units at 48 wells. From 1991 to 1993 they took 567 samples. The above results are at one well. They typify reductions achieved. When breakthrough occurred the GAC cartridge was replaced. There were no detectable concentrations of other volatile organics.

TABLE E-9

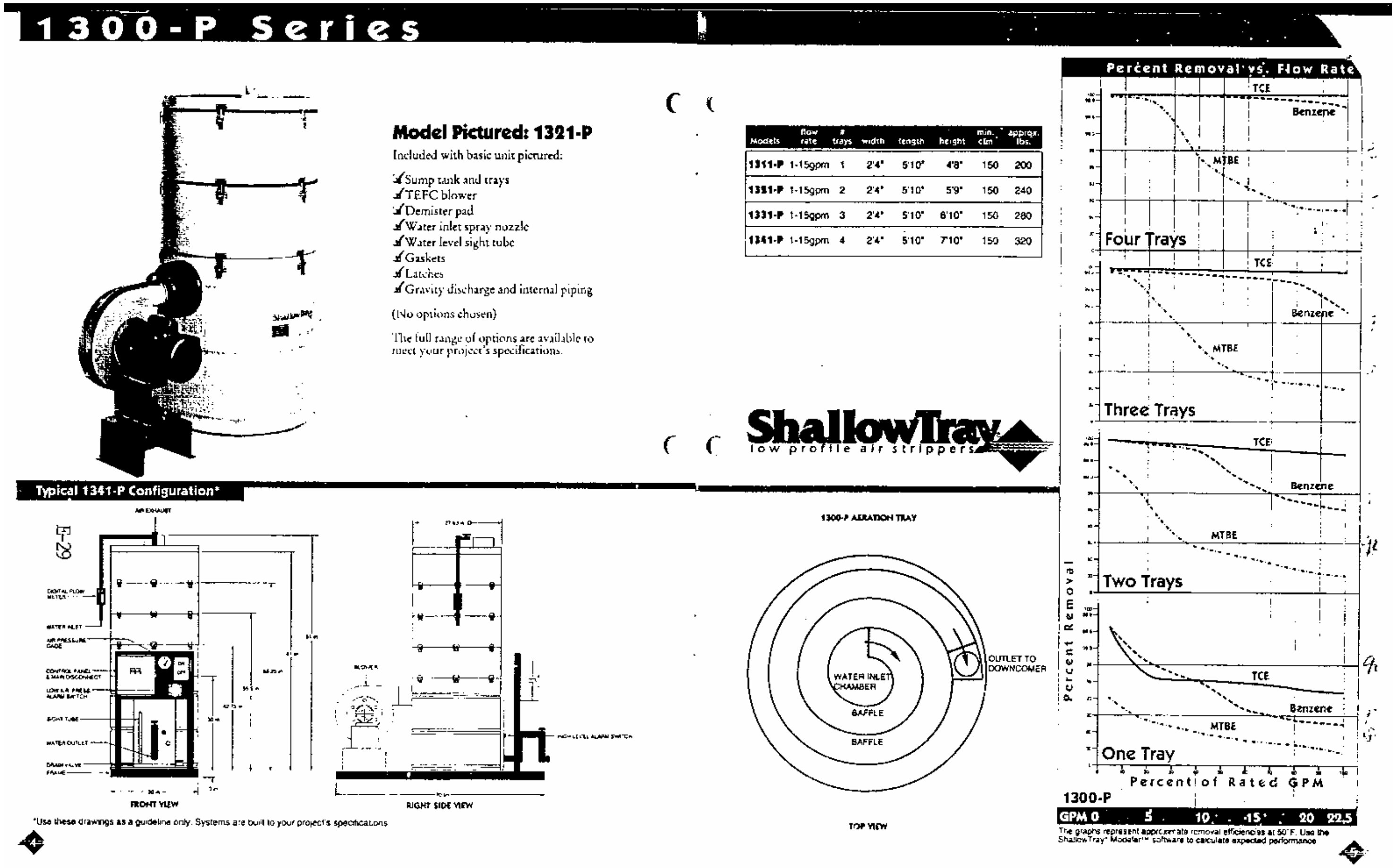
MTBE REMOVAL EFFICIENCY (a)

PACKED AERATION TOWERS

FAIRLAWN: CADMUS & WESTMORELAND WELLFIELDS

NUMBER OF SAMPLES	NUMBER OF WELLS	CONCENTRATION OF MTBE(ppb) BEFORE PTA	AFTER PTA	PERCENT REDUCTION
24		0.5 TO 300	ND	100

(a) See Figures 3 and 4 for additional data on removals achieved for all organics present. This data was reported by a public community water supply system to comply with permit conditions for its packed aeration tower.



1300-P Series

Model Pictured: 1321-P

Included with basic unit pictured:

- ✓Sump tank and trays
- ✓TEFC blower
- ✓Demister pad
- ✓Water inlet spray nozzle
- ✓Water level sight tube
- ✓Gaskets
- ✓Latches
- ✓Gravity discharge and internal piping

(No options chosen)

The full range of options are available to meet your project's specifications.

Models	flow rate	# trays	width	length	height	min. cfm*	approx. lbs.
1311-P	1-15gpm	1	2'4"	5'10"	4'8"	150	200
1321-P	1-15gpm	2	2'4"	5'10"	5'9"	150	240
1331-P	1-15gpm	3	2'4"	5'10"	6'10"	150	280
1341-P	1-15gpm	4	2'4"	5'10"	7'10"	150	320

ShallowTray
low profile air strippers

Typical 1341-P Configuration*

*Use these drawings as a guideline only. Systems are built to your project's specifications

1300-P AERATION TRAY

Percent Removal vs. Flow Rate

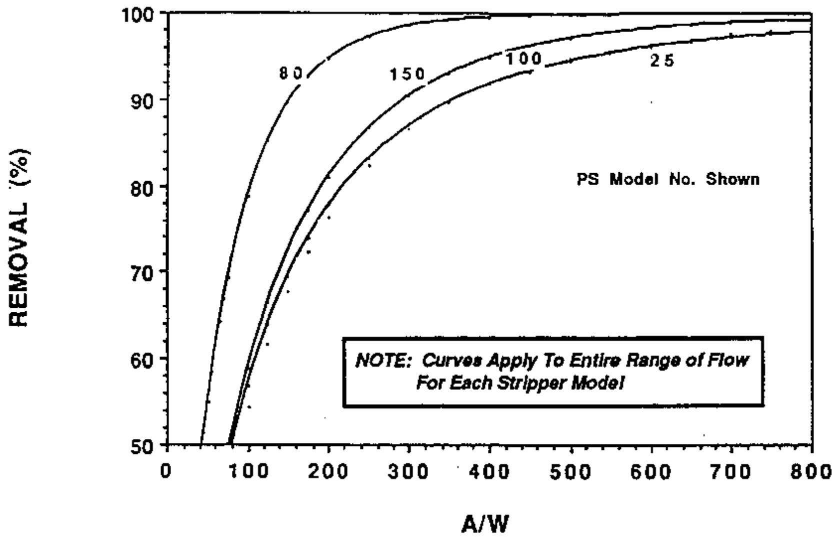
The graphs represent approximate removal efficiencies at 50°F. Use the ShallowTray® Modeler™ software to calculate expected performance

FIGURE 1
FROM MANUFACTURER'S DATASHEETS

FIGURE 2

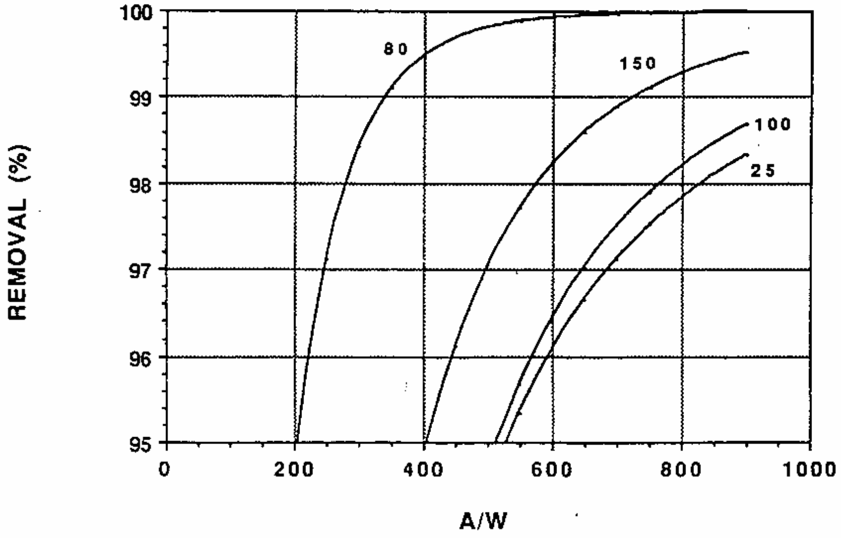
LEI Stripper DESIGN CHART **10/89**

MTBE —— MTBE —— MTBE



NOTE: Curves Apply To Entire Range of Flow For Each Stripper Model

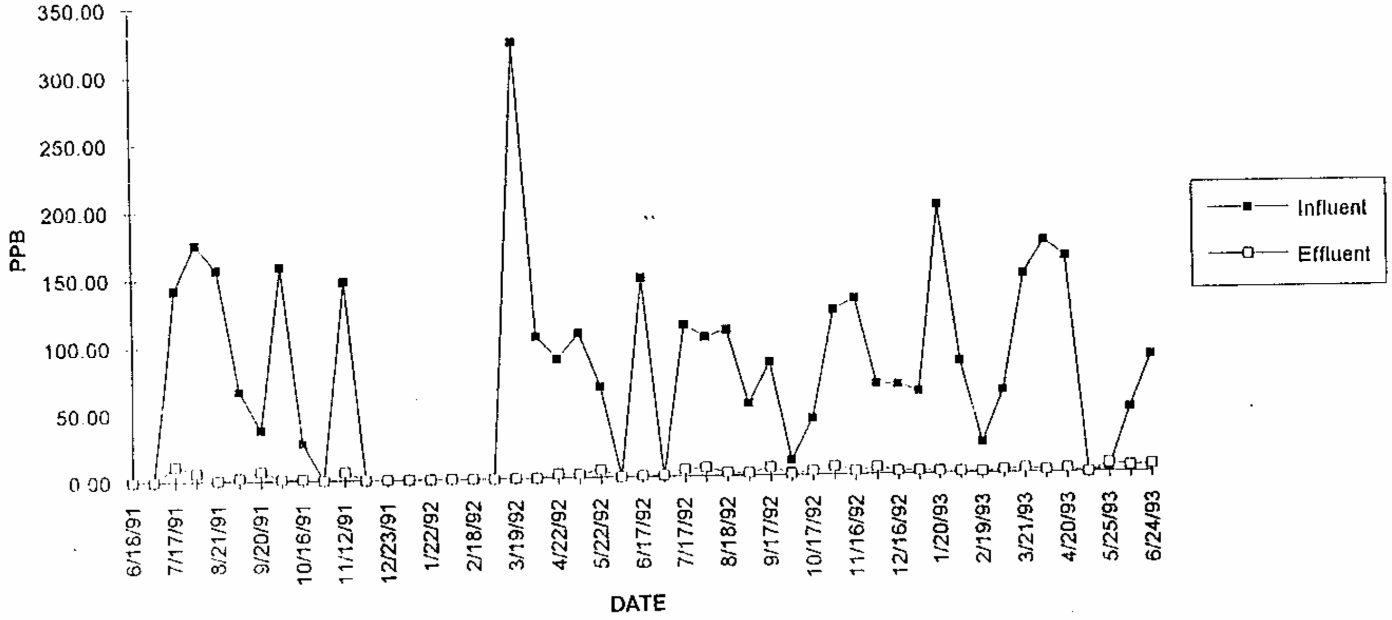
EXPANDED SCALE



Refer to the APPLICATION GUIDE SHEET for the proper use of these DESIGN CURVES

FROM MANUFACTURER'S DATASHEETS

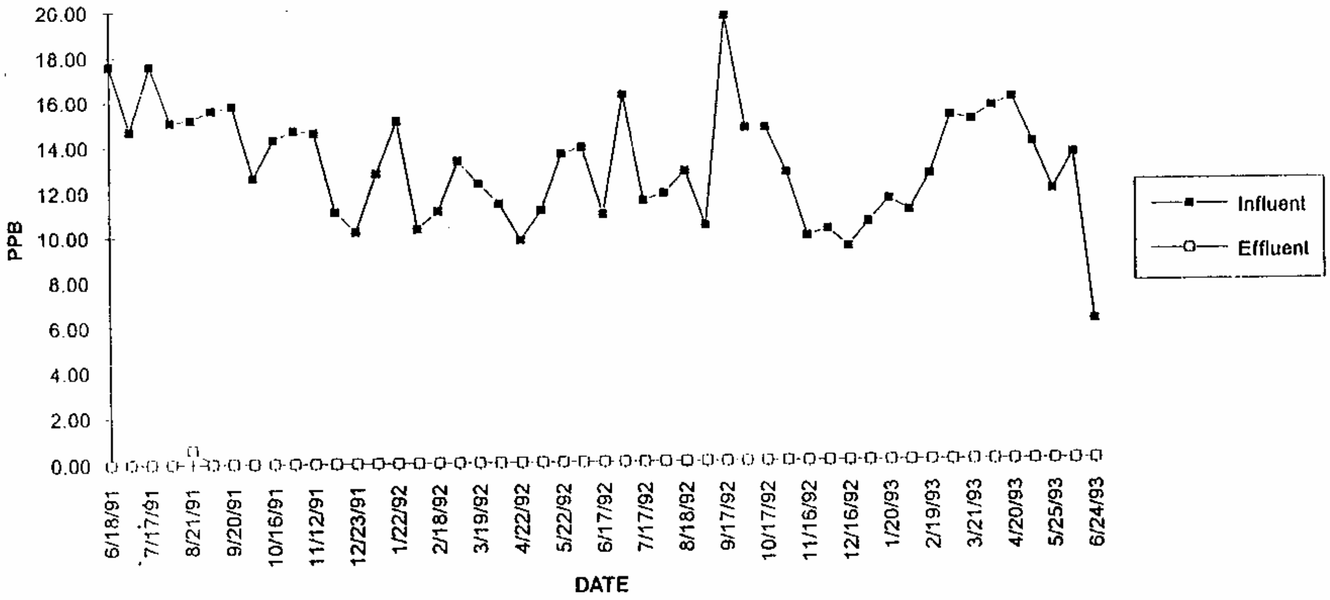
FIGURE 3
MTBE



* Influent and Effluent Concentrations Before and After The Packed Aeration Tower

FIGURE 4

Tetrachloroethylene



* Influent & Effluent Concentrations Before and After The Packed Aeration Tower

7/21/93

REFERENCES

1. Garrett, Peter, Marcel Moreau and Jerry D. Lowry. MTBE as a Ground Water Contaminant. Second Annual Conference on Petroleum Hydrocarbons and Organic Contaminants in Ground Water, November 1986.