

ENVIRONMENTAL PROTECTION AGENCY**40 CFR Parts 141 and 142**

[OW-FRL-2819-4a]

National Primary Drinking Water Regulations; Volatile Synthetic Organic Chemicals**AGENCY:** Environmental Protection Agency (EPA).**ACTION:** Proposed rulemaking.

SUMMARY: This action under the Safe Drinking Water Act (42 U.S.C. 300f, *et seq.*) proposes National Drinking Water Regulations and Maximum Contaminant Levels (MCLs) for the following eight volatile synthetic organic chemicals (VOCs) in drinking water: trichloroethylene, carbon tetrachloride, 1,1,1-trichloroethane, vinyl chloride, 1,2-dichloroethane, benzene, 1,1-dichloroethylene, and p-dichlorobenzene. In addition, monitoring, reporting and public notification requirements for these eight VOCs and 51 other VOCs are proposed.

MCLs are *enforceable standards* and are to be set as close to the Recommended Maximum Contaminant Levels (RMCLs) (health goals) as is feasible and are based upon treatment technologies, costs (affordability) and other feasibility factors, such as availability of analytical methods, treatment technology and costs for achieving various levels of removal.

EPA proposed RMCLs for these eight VOCs and tetrachloroethylene. RMCLs for the eight VOCs are promulgated elsewhere in today's *Federal Register*. New data on the toxicology of tetrachloroethylene has recently become available and the public comment period on the RMCL for tetrachloroethylene has been reopened for 45 days for public consideration of the new data. This action is officially announced elsewhere in today's *Federal Register*. When the RMCL for tetrachloroethylene is promulgated, the MCL will be proposed.

EPA is also proposing best technology generally available for use by public water systems that receive variances under the Act. The proposal specifies criteria by which EPA and States with primary enforcement responsibility shall issue variances and compliance schedules to systems under the Act.

DATES: Written comments should be submitted on or before February 11, 1985. A public hearing will be held in Washington, D.C., on Tuesday, January 13 and 14, 1986, beginning at 9:00 a.m. in

Room 3906 Mall, EPA, 401 M St. SW., Washington, D.C.

ADDRESSES: Send written comments on this proposed rule to Comment Clerk, Criteria and Standards Division, Office of Drinking Water (WH-550), Environmental Protection Agency, 401 M Street, SW., Washington, D.C. 20460. Comments are not solicited on the RMCLs. A copy of the comments and supporting documents will be available for review during normal business hours at the EPA, Room 2904 (rear), 401 M Street, SW., Washington, D.C. 20460. Anyone planning to attend the public meeting (especially those who plan to make statements) should register in advance by calling or writing Ms. Arnetta Davis at 202/382-7575, EPA, WH-550, 401 M St., SW., Washington, D.C. 20460. Persons planning to make statements at the meeting are encouraged to submit written copies of their remarks at the time of the hearing.

Supporting documents cited in Section IX will be available for inspection at the Drinking Water Supply Branches in EPA's Regional Offices.

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Copies of the treatment and costs document, the analytical methods/monitoring document, and the analytical methods documents, are available for a fee from the National Technical Information Service (NTIS), U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161. The toll free number is 800/336-4700; local: 703/487-4650.

FOR FURTHER INFORMATION CONTACT: Joseph A. Cotruvo, Ph.D., Director, Criteria and Standards Division, Office of Drinking Water (WH-550),

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I. Statutory Requirements and Regulatory Framework

The Safe Drinking Water Act (42 U.S.C. 300f, *et seq.*) ("SDWA" or "the Act") requires the EPA to establish primary drinking water regulations which (1) apply to public water systems; (2) specify contaminants which in the judgment of the Administrator, may have any adverse effect on the health of persons; (3) specify for each contaminant either (a) maximum contaminant levels (MCLs) or (b) treatment techniques. See Section 1401(1), 42 U.S.C. 300f. A treatment technique requirement would only be set if "it is not economically or technologically feasible" to ascertain the level of a contaminant in drinking water.

The SDWA includes provisions for interim and revised primary drinking water regulations. See Section 1412, 42 U.S.C. 300g-1. Interim regulations were to be established within 180 days of enactment of the SDWA. Revised regulations are to be developed in two steps: the Agency is to establish RMCLs and then establish MCLs as close to the RMCLs as feasible. MCLs are to be proposed at the time of promulgation of the RMCLs.

RMCLs are non-enforceable health goals. RMCLs are to be set at a level which, in the Administrator's judgment, "no known or anticipated adverse effects on the health of persons occur and which allows an adequate margin of safety". Section 1412(b)(1)(B).

MCLs are the enforceable standards. MCLs must be set as close to RMCLs as is feasible. Feasible means "with the use of the best technology, treatment techniques and other means, which the Administrator finds are generally available (taking costs into consideration)." Section 1412(b)(3). The legislative history suggests that MCLs should be based upon performance of technologies affordable by large systems and relatively clean intake waters. H.R.

93-1185, 93rd Cong. 2d Sess. at 4-5 (1974).

Variances and exemptions are available for systems, including small systems, that cannot meet the MCL due to their raw water quality or compelling factors, including economic factors. Sections 1415 and 1416.

Primary drinking water regulations under the Act are to include monitoring requirements. Section 1401(1)(D). Specifically, primary regulations are to contain "criteria and procedures to assure a supply of drinking water which dependably complies with such maximum contaminant levels; including quality control and testing procedures to insure compliance with such levels * * *". In addition, section 1445 states, "every person who is a supplier of water * * * shall establish and maintain such records, make such reports, conduct such monitoring and provide such information as the Administrator may reasonably require by regulation to assist him in establishing regulations, * * * in evaluating the health risks of unregulated contaminants or in advising the public of such risks".

The SDWA provides that if a State determines that, because of raw water sources, a system cannot meet an MCL despite installation and/or use of the "best technology, treatment techniques, or other means which the Administrator finds to be generally available," taking costs into consideration, it may grant a variance to the MCL. Section 1415(a)(A), 42 U.S.C. 300g-4(a)(1)(A). A variance, if granted, would insulate the system not in compliance from enforcement actions for exceeding an MCL. The system, however, would be required to install and/or use the best generally available treatment methods identified that are available and effective for that system in reducing levels of VOCs. In addition, pursuant to section 1414(c)(2), 42 U.S.C. 300g-3(c)(2), any system that receives a variance, must give public notice of such variance to the persons served by it.

Exemptions, under section 1416, are available to systems (including small systems) who are unable to comply with the MCLs due to compelling factors which may include economic factors. To be eligible, a system must have been in operation on the effective date of the MCL or if not, only if no reasonable alternative source of drinking water is available. The granting of the exemption must not result in an unreasonable risk to health. Unlike a variance, a system need not install and/or use the best treatment generally available as a condition of receiving a variance.

Public notification requirements (section 1414(c)) require that any violation of a maximum contaminant

level, failure to comply with an applicable testing or monitoring provision, and the failure to comply with the requirements of a variance or exemption be reported to the persons served by the water system.

States may assume primary enforcement responsibility (primacy) for public water systems under SDWA § 1413. To assure primacy, States must adopt drinking water regulations that are no less stringent than EPA's National Primary Drinking Water Regulations and other supporting authority. See SDWA section 1413(a). States which grant variances must also issue such variances in a manner no less stringent than EPA's issuance of variances. States must, therefore, adopt EPA's primary MCLs and associated monitoring requirements but need not adopt the RMCLs, or variances to assume or retain primacy.

II. Background: RMCLs for VOCs

RMCLs were promulgated for the following eight VOCs in drinking water: trichloroethylene, carbon tetrachloride, 1,1,1-trichloroethane, vinyl chloride, 1,2-dichloroethane, benzene, 1,1-dichloroethylene and p-dichlorobenzene. For background on the RMCLs and information/data on the occurrence of these VOCs in drinking water and potential health effects of human exposure, see the preamble to the final rule on RMCLs and supporting documents listed in that notice and published elsewhere in today's Federal Register. RMCLs for substances considered to be probable human carcinogens were set at zero and RMCLs for substances not treated as probable human carcinogens were set based upon chronic toxicity or other data. Table 1 summarizes the final RMCLs for the VOCs.

An RMCL was proposed for tetrachloroethylene at zero at the same time as RMCLs were proposed for the above eight VOCs. New toxicological data has recently become available and thus the public comment period has been reopened for public consideration. The RMCL will be promulgated after consideration of the public comments; the MCL for tetrachloroethylene will be proposed at that time. Information and data on analytical methods, treatment technologies and costs are presented in this preamble on tetrachloroethylene along with the other VOCs. However, an MCL for tetrachloroethylene is not proposed today.

TABLE 1.—FINAL RMCLs FOR THE VOCs

Compound ¹	RMCL
Benzene.....	Zero.
Vinyl chloride.....	Zero.
Carbon tetrachloride.....	Zero.
1,2-Dichloroethane.....	Zero.
Trichloroethylene.....	Zero.
1,1-Dichloroethylene.....	0.007 mg/l.
1,1,1-Trichloroethane.....	0.20 mg/l.
p-Dichlorobenzene.....	0.75 mg/l/1.

¹ The RMCL for tetrachloroethylene was proposed at zero. New toxicological data appear to confirm that zero is appropriate but the public comment period is reopened today for public comment on the new data.

III. Proposed MCLs and Best Technology Generally Available

MCLs are to be set "as close to" the RMCLs "as is feasible". The term "feasible" means "feasible with the use of the best technology, treatment techniques, and other means, which the Administrator finds are generally available (taking costs into consideration)". Section 1412(b)(3).

The general approach to setting MCLs is to determine feasibility of controlling contaminants. This requires an evaluation of: (1) The availability and cost of analytical methods, (2) the availability and performance of technologies and other factors relative to feasibility and identifying those that are "best" and, (3) an assessment of the costs of the application of technologies to achieve various concentrations. Key factors in the analyses include the following:

- Technical and economic availability of analytical methods: precision/accuracy of analytical methods that would be acceptable for accurate determination of compliance, limits of analytical detection, laboratory capabilities, and costs of analytical techniques.

- Concentrations attainable by application of best generally available treatment technologies.

—Levels of VOC contamination in drinking water supplies.

—Feasibility/reliability of removing VOCs to specific concentrations.

- Other feasibility factors relating to the "best" means of treatment such as air pollution and waste disposal and effects on other drinking water quality parameters.

- Costs of treatment to achieve contaminant removal.

Proposed MCLs for the eight VOCs are presented in Table 2; the MCLs were determined based upon the following key factors:

- Best technologies generally available are packed tower aeration and granular activated carbon (GAC) adsorption.

- Raw water VOC removal of 90 to 99 percent (and 90–99.9% for vinyl chloride) is a reasonable expectation of performance by packed tower aeration and GAC adsorption.

- The Practical Quantitation Level (PQL) for the VOCs is 5 µg/l except for vinyl chloride which has a PQL of 1 µg/l. The PQL is defined as the lowest achievable level of analytical quantitation during routine laboratory operating conditions within specified limits of precision and accuracy.

Provided below are summaries of the availability of analytical methods, treatment technology performance and costs, and the rationale used to determine the proposed MCLs. A more complete explanation is found in the Cost and Technologies document and the Analytical Methods/Monitoring document listed in the end of this notice.

TABLE 2.—PROPOSED MCLs

Compound ¹	MCL mg/l
Trichloroethylene.....	0.005
Carbon tetrachloride.....	0.005
Vinyl chloride.....	0.001
1, 2-Dichloroethane.....	0.005
Benzene.....	0.005
1,1-Dichloroethylene.....	0.007
1,1,1-Trichloroethane.....	0.20
p-Dichlorobenzene.....	0.75

¹ The MCL for tetrachloroethylene will be proposed later—see text, Section II—Background.

A. MCL vs. Treatment Technique Regulation

The SDWA specifies in section 1401 that an MCL is to be set for contaminants in drinking water if "it is economically and technologically feasible to ascertain the level of such contaminant in water in public water systems." If it is not, a treatment technique regulation is to be set.

For the purposes of making the finding regarding the feasibility of monitoring for any given contaminant, EPA must first determine, with respect to a given contaminant, what effective analytical techniques, if any, are technologically available. Next EPA must determine at what frequencies those techniques should be employed to assure detection of any violation prior to the time the violation will actually cause or contribute to any significantly increased health hazard. Then EPA must determine whether monitoring at that frequency is economically feasible. H.R. 93-1185, 93rd Cong. 2d Sess. at 11-12 (1974).

In this proposal, three analytical techniques have been identified and are clearly technologically available. As discussed in Section IV, EPA is proposing to require monitoring quarterly where VOCs are detected.

This monitoring frequency will detect violations of the MCL before there is any significantly increased health hazard, as VOCs present only potential long-term risks at the concentrations normally found in drinking water.

Quarterly reporting is also proposed to account for the data which suggest that VOC raw water concentrations may vary under some circumstances. At \$150 to \$200 per sample, quarterly monitoring is economically feasible for public water systems. For example, monitoring costs for a system serving 100 people with two wells would be a total of \$1 per month per person for one year. For a system of 25 people with one well, costs would be \$2 per month per person for one year. Costs for larger systems would be much less. Monitoring on a daily or weekly basis might not be economically feasible in all cases. Monthly monitoring might be economically feasible for larger communities but would not generally be necessary to detect significantly increased health hazards given the long-term risks from VOCs.

Although VOCs can sometimes be reduced below the practical quantitation level using best generally available technology (BGAT), EPA does not believe a treatment technique should be required instead of an MCL. First, Congress requires EPA to set a treatment technique instead of an MCL when monitoring is not economically and technologically feasible. EPA believes that Congress intended EPA to require use of treatment techniques whenever a method was substantially infeasible across a broad range of contamination levels. In this case, monitoring is economically and technologically feasible across a very broad range of contamination levels.

Second, if a treatment technique were proposed for the VOCs, it would have to be based on a treatment performance measurement parameter which is more sensitive than the analytical test methods for VOCs. There is no known parameter and its development is not foreseeable in the near future. Similarly, if EPA were to prescribe a treatment technique for VOCs, there would still remain the question of whether an individual system would have to implement the prescribed technique. EPA can only identify those systems that need the treatment technique by having the systems monitor for the VOCs. Obviously, monitoring data are only valid above the verifiable level of quantitation, and only those systems with VOC contamination at or above the verifiable level would have to install the technique. Therefore, setting the MCL at the limit of quantitation provides

essentially the same level of protection as a treatment technique and provides the added advantage of allowing compliance monitoring. Standard design and operating procedures would result in treated water concentrations somewhat below the MCL. This allows a margin of safety during periods of changing water quality, ambient temperature conditions or other unanticipated conditions.

EPA requests comment on whether a treatment technique or an MCL should be set for these VOCs.

B. Analytical Methods

The analytical methods used for compliance monitoring must be "economically and technologically feasible to ascertain the level of such contaminant in water in public water systems" (SDWA, section 1401(1)(C)).

The reliability of analytical methods used for compliance monitoring is critical at the maximum contaminant level. Therefore, the analytical methods have been evaluated with respect to the accuracy or recovery (lack of bias) and precision (good reproducibility) at the range of MCLs being considered for all nine VOCs. The primary purposes of these evaluations is to determine:

- Whether analytical methods are technically available to measure VOCs in drinking water, and
- What are reasonable expectations of technical performance by analytical laboratories at levels considered for MCLs.
- What are the costs of analysis for VOCs.

1. Availability of Methods

Numerous analytical techniques have been developed for the determination of volatile chemicals in drinking water. The selection of analytical methods for compliance with these regulations includes consideration of the following factors:

- (a) Reliability (i.e., precision/accuracy) of the analytical results,
- (b) Specificity in the presence of interferences,
- (c) Availability of enough equipment and trained personnel to implement a national monitoring program (i.e., laboratory availability),
- (d) Rapidity of analysis to permit routine use, and
- (e) Cost of analysis to water supply systems.

These methods involve the use of gas chromatography (GC) with either conventional detectors or a mass spectrometer (GC/MS).

The EPA has developed three analytical methods based on these techniques that it has determined are

"economically and technologically feasible" for compliance with one or more of the proposed MCLs. The methods are specified below.

1. Method 502.1, "Volatile Halogenated Organic Compounds in Water by Purge and Trap Gas Chromatography".

2. Method 503.1, "Volatile Aromatic and Unsaturated Organic Compounds in Water by Purge and Trap Gas Chromatography".

3. Method 524.1, "Volatile Organic Compounds in Water by Purge and Trap Gas Chromatography/Mass Spectrometry". These analytical methods use the purge and trap technique for the extraction of volatile constituents from the aqueous phase and concentration in a column containing a sorbent. The compounds are thermally desorbed from the column and backflushed onto the head of a GC column. This is followed by separation of constituents in the GC column and measurement with a specific detection system.

a. *Precision and Accuracy.* Method 502.1 recommends the use of a column containing 1 percent SP-1000 on Carbowack-B for the separation of constituents that are detected with a halide specific detector (HSD). An electrolytic conductivity detector (EICD) or a microcoulometric detector are recommended for this purpose. This method may be used for the determination of eight VOCs (it does not measure benzene). The single laboratory accuracy and precision have been determined by analysis of replicate samples of finished drinking water and raw source water spiked at levels of 0.2 or 0.4 $\mu\text{g/l}$ for these compounds. The results show an accuracy, expressed as percent average recoveries, ranging from 88 to 110 percent, and a precision, expressed as percent relative standard deviations, ranging from 6 to 15 percent for the eight VOCs.

Method 503.1 recommends the use of a column containing 5 percent SP-1200 + 1.75% Bentone 34 on Supelcoport for the separation of constituents that are then detected with a photoionization detector (PID). This method may be used for the determination of benzene p-dichlorobenzene, vinyl chloride, 1,1-dichloroethylene, trichloroethylene, and tetrachloroethylene. The single laboratory accuracy and precision have been determined by analysis of replicates of finished drinking water and raw source water spiked at levels of 0.40 and 0.5 $\mu\text{g/l}$ for benzene and p-dichlorobenzene, respectively. The results show an average percent recovery of 100 percent and a relative standard deviation of 2.8 percent for

benzene and an average percent recovery of 95 percent and a relative standard deviation of 6.4 percent for p-dichlorobenzene.

Method 524.1 recommends the use of a column containing one percent SP-1000 on Carbowack B for the separation of constituents, which are detected with a mass spectrometer. VOCs are identified by comparing their mass spectra to the spectra of standards analyzed under identical conditions. All nine VOCs may be determined using this method. The single laboratory accuracy and precision have been determined for the nine VOCs by analysis of seven aliquots of reagent water spiked at levels of 1 or 5 $\mu\text{g/l}$. The results show average recoveries ranging from 88 to 109 percent, and relative standard deviations ranging from 3.6 to 13.6.

The precision and accuracy results summarized above for Methods 502.1, 503.1 and 524.1 are from a highly experienced single laboratory and they would not be expected to be achieved in routine practice in typical laboratories.

EPA has conducted single-laboratory evaluations for Methods 502.1, 503.1 and 524.1. The objective of these evaluations was to determine the precision and accuracy of the method under practical and routine laboratory conditions. Some multi-laboratory data have been collected from PE studies conducted by EPA, and EPA believes that sufficient data are available from these studies that demonstrate that the methods are available for use in monitoring for VOCs. Public comments are requested on the availability of these methods for VOC monitoring and if these methods are sufficiently validated to be used for compliance monitoring.

b. *Specificity.* The analytical methods selected for compliance must be specific in the presence of interferences. That is, the method must specifically and correctly identify the contaminant of concern and not confuse it with another chemical. Separations by gas chromatography techniques are not always complete, particularly in complex (multi-contaminant) mixtures. Several compounds within a mixture which have similar chemical and/or physical properties may coelute from the column along with the compounds of interest. Conventional gas chromatography detectors are not always able to discriminate between the compounds of interest and the interfering compounds. The proposed GC methods recommend that when conventional detectors are used, a second column containing a different stationary phase should be used, to provide additional assurance that the

qualitative identifications are indeed the compounds of interest. However, since some VOCs are amenable to both photoionization and halogen specific detectors, the second detector may provide the same degree of confirmation as a second column analysis.

A mass spectrometer usually is able to discriminate between the compounds of interest and interfering compounds. Thus, it is the preferred detection system to provide unequivocal identification in such cases.

c. *Laboratory Availability.* There are approximately 60 laboratories which participate regularly in EPA's Water Pollution performance evaluation studies for VOCs. In addition, there are approximately 200 laboratories which participate regularly in EPA's Water Supply performance evaluation studies for trihalomethanes (THMs). The principles of sample collection and analysis for VOCs are similar to those used for the determination of the four regulated THMs except that the THM MCL (0.10 mg/l) is about 2 orders of magnitude higher than the limits being proposed for the VOCs. The selected procedures use equipment and skills available in many drinking water laboratories. Therefore, EPA feels that there are analytical laboratories available with the expertise required to conduct VOC analysis on a routine basis.

Vinyl chloride, however, presents special analytical problems in the analysis, especially at concentrations near 1 $\mu\text{g/l}$. Reliable preparation and analysis of samples for vinyl chloride is expected only from the most experienced laboratories. Thus, few laboratories are available to measure vinyl chloride at concentrations near 1 $\mu\text{g/l}$ routinely. Since the proposed monitoring regime (see Section V) would require fewer analyses for vinyl chloride on the most experienced laboratories would be expected to be used for vinyl chloride analysis.

d. *Rapidity.* Estimated analysis time including sample preparation and quality assurance is about one hour per sample. This is comparable to the analysis time required for THM analysis. The selected methods are sufficiently rapid to permit routine use in the examination of a large number of samples.

e. *Costs.* EPA conducted an assessment of analytical costs associated with the analysis of VOCs in drinking water. This assessment included 28 commercial laboratories chosen from those participating in EPA's performance evaluation sample program and which are performing VOC analyses by methods consistent with the

proposed methods. The cost comparison below summarized the findings.

COST COMPARISON OF VOC ANALYSES

	GC/MS	GC ¹
Average cost	\$197	\$187
Range	50-300	75-500
Number of laboratories	23	13

¹Includes both halocarbons and aromatics by HSD and PID, separately.

The average quote for the sum of separate VOC analyses using GC with halogen-specific and photoionization detection for halocarbons and aromatics, respectively, was \$187 per sample and ranged from \$75 to \$500 per sample. The average cost of VOC analysis using GC/MS was \$197 per sample, and ranged from \$50 to \$300 per sample. The range in prices quoted by the laboratories may be due to differences in the number of samples analyzed routinely by these laboratories and the amount of quality assurance associated with the analyses. These costs were quoted for analysis for all VOCs listed in the methods or about 60 VOCs. When asked for quotes for just 10 VOCs, the laboratories generally stated it would be the same quote; 2 of the 13 GC laboratories quoted \$28 per sample less and 3 of the 23 GC/MS laboratories quoted \$50 per sample less. These quotes took into account that analysis of all nine VOCs may require two analyses depending upon the equipment in a particular laboratory. In addition, a confirmatory secondary column analysis might be needed for some VOCs in cases where GC/MS is not used.

The analysis of VOCs using the photoionization and electrolytic conductivity detectors in series has been reported by some laboratories. Methods 502.1 and 503.1 include use of detectors in series as an alternate. Simultaneous analysis of volatile halocarbons and aromatic hydrocarbons most likely will result in lower analytical costs (total cost estimated at about \$150 per sample). EPA expects that many analytical laboratories will opt to use detectors in series or GC/MS, and that the analytical costs will thereby be reduced.

2. Method Detection Limits and Practical Quantitation Levels

In general, EPA defines the method detection limit (MDL) as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the true value is greater than zero. The specification of such a concentration is limited by the fact that MDLs are a variable affected by the performance of a given measurement system. MDLs are not necessarily

reproducible over time in a given laboratory, even when the same analytical procedures, instrumentation and sample matrix are used.

The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions is the Practical Quantitation Level (PQL). The PQL thus represents the lowest level achievable by good laboratories within specified limits during routine laboratory operating conditions. The PQL is determined through inter-laboratory studies, such as the PE studies. Differences between MDLs and PQLs are expected since the MDL represents the lowest achievable level under ideal laboratory conditions whereas the PQL represents the lowest achievable level under practical and routine laboratory conditions.

If data are unavailable from inter-laboratory studies, PQLs are estimated based upon the MDL and an estimate of a higher level which would represent a practical and routinely achievable level with relatively good certainty that the reported value is reliable. Traditionally, this level has been estimated at 5 to 10 times the MDL. EPA believes that setting the PQLs in a range between 5 and 10 times the MDL achieved by the best laboratories is a fair expectation for most State and commercial laboratories. Public comment are specifically requested on the expectation that 5 to 10 times the MDL is a good general rule as to what levels can be expected to be measured by commercial laboratories with reliability.

A recent survey of seven U.S. EPA laboratories and contract laboratories serving the EPA reported MDLs averaging from 0.2 to 0.5 $\mu\text{g/l}$ for the nine VOCs in this proposed regulation. The approximate MDLs of 0.2 to 0.5 $\mu\text{g/l}$ are the result of measurement made by a few of the most experienced laboratories under non-routine and very controlled conditions. These levels are not expected to be representative of the capabilities of a cross-section of good laboratories performing compliance VOC measurements on a routine basis.

The PQLs for the VOCs have been determined based primarily upon the results of performance data from EPA and non-EPA sources, multi-laboratory method validation studies and performance evaluation studies. Table 3 provides a summary of recent WP performance evaluation studies by EPA and State laboratories (WP studies #8-11). This table summarizes the result if the limits of precision and accuracy were set at $\pm 20\%$ and $\pm 40\%$ of the reference "true" value for VOC

concentrations of 20 µg/l and below. These result are considered to be optimum since they were drawn from experienced laboratories operating under conditions where they knew they were being tested with standard samples in distilled water and without matrix interferences. Actual day to day operations in a wide variety of laboratories using "real" samples in natural water would be expected to produce poorer results, i.e., wider performance ranges especially at the lower concentration levels. Similar multi-laboratory data are not available for 1,1-dichloroethylene and vinyl chloride.

TABLE 3.—PERFORMANCE EVALUATION STUDIES

	TV (µg/l)	No. of labs	No. of labs out-side ±20% TV	No. of labs out-side ±40% TV
Benzene	7.10	31	12	6
	9.4	32	5	2
	14.1	26	5	1
	18.8	28	8	4
Carbon tetrachloride	6.02	31	10	5
	10.5	35	6	2
	12.0	40	12	3
	16.9	37	7	2
1,2-dichloroethane	6.43	35	11	3
	15.9	29	5	3
	17.1	34	3	0
	19.1	38	7	3
Trichloroethylene	4.99	30	6	3
	8.32	38	8	2
	12.0	36	8	2
	16.8	35	5	2
Tetrachloroethylene	6.08	38	11	5
	11.0	36	4	1
	12.2	30	6	4
1,1,1-trichloroethane	1.61	39	16	9
	6.42	31	6	3
	7.96	35	8	2
p-Dichlorobenzene	15.9	35	6	0
	5.5	18	5	2
	11.0	18	5	4
	13.7	14	8	1

TV = "true" value or reference concentration.

The available data demonstrate that the number of laboratories producing unacceptable data generally increases as the concentration decreases. In the 5 to 20 µg/l range, the failures rates appear among the better laboratories under known test conditions to fall between 10 and 30% (some exceptions) using the ±20% of the true value acceptance limit. From 0 to 20 percent of the laboratories fail to meet the ±40% of the true value acceptance limit at concentrations of 5 to 20 µg/l. It is emphasized that these are EPA and States laboratories, many of which are certified for THM analysis and have extensive experience, proper laboratory instruments, and trained analytical chemists. Illustrating the difficulty of attaining accuracy by laboratories using these methods, after four years of experience analyzing THMs, 15% of those laboratories still fall outside the

acceptance limits using ±20% at 0.10 µg/l (100 µg/l) for THMs. While specific data are unavailable at this time, the percentage of private commercial laboratories expected to be able to meet specified performance limits when compared to EPA and State laboratories will likely be lower.

The data in Table 3 suggest that 5 µg/l would be achievable by most laboratories within ±40%. A value of ±40% was determined to be appropriate based upon the desire to set the smallest interval on precision and accuracy (i.e., ± some percentage) that could be achieved by most good laboratories (e.g., 80-100%). Thus, a limit of ±20% would have been more desirable than ±40% but the data in Table 3 showed that fewer laboratories would be able to achieve that level. The PQLs are therefore being proposed at 5 µg/l for the VOCs in Table 3. While data at levels less than 5 µg/l are limited, use of the general rule of "5 to 10 times the MDL" for estimating feasible detection limits for commercial laboratories shows that a PQL of 5 µg/l is reasonable for these compounds. The PQL for 1, 1-dichloroethylene is based upon its similarity in analysis (e.g., same analytical method, similar chemical structures and similar GC retention times) to the VOCs in Table 3 and is also reasonable to be set at 5 µg/l.

Vinyl chloride poses a greater analytical challenge than for the other VOCs because it is gaseous at ambient conditions.

In view of the analytical difficulties and the observation that vinyl chloride consistently occurs in ground waters in the presence of other halogenated two-carbon VOCs, monitoring for vinyl chloride will only be required for ground water systems when the systems detect other VOCs (see discussion below in *Compliance Monitoring Requirements*). EPA believes that is reasonable to use a more conservative approach in setting the PQL for vinyl chloride than described for the other eight VOCs for several reasons. There are: (1) A much smaller number of systems would be required to monitor for vinyl chloride as opposed to other VOCs in this proposal, (2) vinyl chloride analysis will be carried out on a sample which has already been characterized for a number of related VOC compounds, which would in effect improve a laboratory's measurement efficiency, and (3) vinyl chloride analysis requires special handling resulting in what can be more focused attention and careful analysis procedures. Because multilaboratory performance data are unavailable at this time at relatively low concentrations

(i.e., 1-5 µg/l), the determination of the proposed PQL for vinyl chloride has been made by taking the low end of the MDL range given earlier (0.2 µg/l) and multiplying by a factor of 5. These choices reflect the fewer and more focused expert analyses required of this chemical.

3. Laboratory Performance Requirements

The question of reasonable expectations of performance by analytical laboratories for the determination of VOCs at or around the proposed MCLs suggests that EPA should establish performance requirements for laboratories analyzing compliance samples for VOCs.

EPA recognizes that the effectiveness of the proposed regulations is dependent upon the ability of analytical laboratories to produce reliable data at relatively low levels for these contaminants. It is important to apply the concepts of quality assurance (QA) to all aspects of data gathering activities, i.e., collection, transport and storage of samples, analytical procedures, and manipulation and storage of data. The existing drinking water laboratory certification program (LCP) provides guidance for the establishment of minimum QA and quality control (QC) criteria for those analytical laboratories conducting compliance monitoring measurements. Today EPA is proposing criteria of ±40% at concentrations less than 10 µg/l and ±20% above 100 µg/l as mandatory requirements. Additional criteria will be developed later.

The LCP has established the use of external checks of performance to evaluate the ability of laboratories to analyze samples for specific contaminants and to produce data within specific limits. For this purpose, EPA provides performance evaluation (PE) samples to laboratories on a regular basis; participation in this program is a prerequisite for a laboratory to achieve certification and to remain certified for analyzing compliance samples (EPA's laboratory certification program is not mandatory). Achieving acceptable performance in these studies of known test samples provides some indication that the laboratory is following proper practices, and assures that the same practices are also followed under routine conditions. Unacceptable performance may be indicative of problems that could impact on the reliability of all data generated for specific contaminants. Unacceptable performance should trigger an investigation to establish the possible

cause(s) and to take corrective action. EPA recognizes that even a superior analytical laboratory would occasionally produce data that are outside the acceptable limits for statistical reasons rather than any actual analytical problems. A provision for follow-up analysis is necessary if a laboratory fails the initial determination to decrease the likelihood of statistical error and to determine if a real problem exists.

In the present program, the Quality Assurance Branch of EPA's Environmental Monitoring and Support Laboratory in Cincinnati (EMSL-CI) sends laboratories a set of stable sample concentrates in sealed glass ampules with instructions for dilution of the samples with reagent water and a report form to report the analytical results. The Quality Assurance Branch determines if the concentrations reported are within certain acceptance limits and a detailed analysis of the reported analytical results is returned to the laboratories. Annual participation and acceptable performance in these studies is mandatory for retaining certification. Two studies are conducted every year; the second study is intended as a follow-up for those laboratories failing the primary study.

Acceptable laboratory performance in analyzing drinking water samples have historically been set by EPA using two different approaches; regressions from performance of pre-selected laboratories or specified accuracy requirements. EPA is evaluating these two and other approaches in the development of laboratory performance requirements for the VOCs.

The approach used for contaminants included in the Interim Regulations (except for trihalomethanes) has been to determine acceptance limits from regressions analyses on historical data (Britton and Lewis, 1984). Data obtained under known testing conditions (PE studies) from the most capable of participating laboratories are used (after outlier testing to exclude extreme data points) to derive regression equations, i.e., linear relationships between a reference "true" concentration and the mean reported value and between the reference concentration and the standard deviation. These linear relationships developed from a select group of highly experienced laboratories are then used to determine acceptance limits for all participating laboratories based upon a 95 percent confidence level. In other words, a good laboratory is expected to produce data within the acceptable limits approximately 95 percent of the time. For these VOCs,

approximately 90 percent of laboratories would be expected to be within $\pm 40\%$ of the true value for concentrations less than $10 \mu\text{g/l}$ and within $\pm 20\%$ for levels above $100 \mu\text{g/l}$. These are the proposed performance criteria for VOCs.

If historical statistics are not available, acceptance limits are set from the data generated from current PE studies. Acceptance limits based on study statistics result in limits which vary with time and depend on the overall performance of the pre-selected participating laboratories. Thus, these limits could vary with time in either direction as a function of the performance of a given group of laboratories in a particular study. The resulting acceptance limits take into consideration that the accuracy and precision of the measurement are usually related to the concentration of the analyte, i.e., the acceptance range is wider at lower concentration levels since the expected performance is generally poorer at low concentrations. This approach also considers any bias inherent in the analytical procedure used since the acceptance limits are set around the mean reported value and not around the reference "true" value. They would also reflect variability in the performance of the participating laboratories.

The other approach has been applied to the trihalomethanes where the acceptance limits were set at $\pm 20\%$ of the reference "true" value in the range of $0.10 \mu\text{g/l}$. This second approach requires that each laboratory demonstrate its ability to perform within certain pre-defined limits. Laboratory performance is evaluated using a constant yardstick independent of the performance achieved by other laboratories participating in the same PE study. A fixed criterion based on a percent error around the "true" value reflects the experience obtained from numerous laboratories and includes relationships of the accuracy and precision of the measurement to the concentration of the analyte and it assumes little or no bias in the analytical methods that may result in average reporting values different from the reference "true" value. This concept assures that reported results can be related to a percentage of variance from the MCL. Precision and bias are considered in setting the MDL, PQL and MCL, and no further introduction of variance due to highly variable performance is acceptable. This approach (setting a $\pm 40\%$ and $\pm 20\%$ limit) would be used to certify laboratories under the LCP to perform

analyses that would be required by this proposed rule.

EPA has also considered the use of other alternative approaches to setting acceptable limits for laboratory performance. One such approach is the use of a percentage around the mean reported value instead of the reference value. This approach could be used to account for bias in the analytical procedure.

EPA has previously used the following performance criteria with contractor laboratories for the VOCs:

- The reported value must be within $\pm 20\%$ of the reference value for concentrations of $100 \mu\text{g/l}$ or above, and
- The reported value must be within $\pm 40\%$ of the reference value for concentrations below $10 \mu\text{g/l}$. Table 3 summarized available data using these criteria.

EPA proposes to use the "plus or minus percent of true value" approach (i.e., $\pm 40\%$, $\pm 20\%$) in setting MCLs and in certifying laboratories conducting compliance analyses for the VOCs. These performance criteria would be applicable at concentrations at or near the MCL.

- EPA is continuing to conduct additional data-gathering activities for the VOCs, particularly at levels below $10 \mu\text{g/l}$. One such effort involves the inclusion of PE samples for the VOCs to an upcoming water supply performance evaluation study scheduled for the fall of 1985.

4. Request for Public Comments on Analytical Methods

Public comment and information on all aspects of the issues presented in this section are requested to assist EPA in making a final choice of monitoring methods and the specific performance requirements in the final rule. Supporting data/information is requested for any comments provided. Specifically, public comment is requested on the following questions..

- Are the proposed analytical methods technically and economically available?
- What is the precision/accuracy of the analytical methods at the proposed MCL levels? Can lower levels of VOCs be measured with reasonable accuracy and precision? Are other precision and accuracy data available on these methods?
- Are the estimated analysis costs accurate and reasonable?
- Are there sufficient qualified laboratories capable of monitoring at concentrations such as the proposed MCLs?

• Is EPA's selection of a plus or minus percent range of true value approach reasonable?

• What specific acceptance limits should be set for laboratory performance in the LCP? Are the following performance criteria which EPA has previously used for its contract laboratories reasonable (i.e., ±20% of the expected value for concentrations at or above 100 µg/l and ±40% of the value for concentrations below that level)? How many laboratories would be able to meet these performance criteria?

• Is the MDL-PQL concept reasonable and acceptable? Is a PQL at 5-10 times the MDL a reasonable expectation for most State and commercial laboratories? Must EPA have single laboratory data or multi-laboratory validation data on precision and accuracy at low levels before it can establish PQLs?

• Are PQLs of 5 µg/l for eight VOCs and a PQL of 1 µg/l for vinyl chloride reasonable? Should the PQL for vinyl chloride be set at a higher level?

• Have the methods been sufficiently demonstrated to be reliable and accurate to be available for VOC monitoring? Is the EPA plan to complete formal method multi-laboratory validation studies prior to implementation of the regulations reasonable?

C. Technologies and Costs

A number of technologies have been used for the removal of VOCs in drinking water, as shown in Table 4. A more detailed discussion of applicable technologies and their costs are included in the cost and technology document. By definition, VOCs are compounds with a tendency to move from liquid phase to gas phase or, simply stated, evaporate. These chemicals also tend to have limited solubility in water. Engineers have designed treatment systems taking advantage of these physical-chemical properties.

Aeration and adsorption technologies have been shown to be effective. In certain cases, both technologies can be applied in series. Aeration or the introduction of air into water has been used routinely to remove gases from water, oxidize iron and hydrogen sulfide, and less frequently to remove objectionable tastes and odors. Most recently, aeration has been successfully applied in the removal of VOCs.

Another available technology is adsorption. Adsorption is the collection of a material at an interface or surface. Activated carbon in granular and

powdered form has been used extensively for taste and odor control and most recently for the removal of VOCs from drinking water. All nine VOCs considered here can be removed from drinking water using aeration or activated carbon adsorption.

TABLE 4.—TREATMENT TECHNOLOGIES FOR VOC REDUCTION

	Estimated removal efficiency (percent)	Number of installations currently in operation in the U.S. for VOC removal
Aeration:		
a. Packed tower aeration	90-99.9	27
b. Multiple tray aeration	40-90	6
c. Diffused aeration	70-92	1
d. Spray aeration	75-90	1
e. Air lift pumping	40-97	2
f. Cascade aeration	(*)Unknown	1
Adsorption:		
a. Granular activated carbon	>99	4
b. Powdered activated carbon	50-90	1
c. Synthetic resins	>99	0
Other Treatment Options		
a. Point-of-use GAC	90->99	1
• Ultraviolet-ozone	(*)Unknown	(*)Unknown

1. Aeration.

When water containing a dissolved volatile or semivolatile compound is in contact with air, an equilibrium of molecules of the compound migrating from the water to the air (evaporating) and from the air to the water (dissolving) is established. Henry's Law describes the equilibrium relationship by stating that the concentration of a substance in the liquid phase (dissolved in water) is directly proportional to the partial pressure of the compound in the vapor phase (concentration in air). The coefficient of proportionality is known as Henry's Law Coefficient. By providing an environment where the concentration in air is low (for example, by continuously replacing semi-saturated air with fresh air) the system will tend toward an equilibrium condition of low concentration in water.

Because of their relatively low solubilities and high vapor pressures, VOCs have a natural tendency to migrate from water to the air; that is, they have relatively high Henry's Law Coefficients. This tendency can be put to use in aeration treatment systems which enhance the migration, or transfer, by providing large water/air interfacial areas, large volumes of air relative to the volume of water treated and sufficient contact time for the transfer to occur.

Although many types of aeration devices are available, the packed column is the one which has been most widely applied for removal of VOCs from contaminated drinking water. In a packed column, contaminated water is pumped to the top of the column and cascades down through a bed of inert packing material. Uncontaminated air enters the bottom of the column and is driven or drawn upward through the packing, exiting at the top of the column. VOCs are transferred from the water to the air, resulting in treated water with very low VOC concentrations leaving the column at the bottom and air with elevated levels of VOCs discharged from the top of the column. Packing media are fabricated of various geometrical shapes or continuous elements, and are all designed to maximize the air/water contact opportunity while minimizing the frictional resistance to the air flow (air pressure drop). Key design parameters are depth and type of packing, liquid loading and air loading.

Because of the countercurrent flow pattern of air and water, very high removal efficiencies are possible. Rational design techniques are available which indicate, together with field data, that 90-99 percent removal of most VOCs can be obtained at reasonable depths of packing and moderate air to water ratios.

Other methods of aeration to remove VOCs are available, but they are generally less cost effective than packed tower aeration when high removal efficiencies are required. These methods include: spray aeration, diffused aeration, mechanical aeration, in-well aeration, multiple tray aeration, and cascade aeration. The nine VOCs listed here can be removed using aeration. Normally, a pilot-scale study is recommended to determine the proper operating conditions under each set of circumstances. Other factors which affect performance and suitability of aeration include water temperature, concentration of contaminants, maintenance of a chlorine residual, and the presence of iron or other unoxidized mineral contaminants. Good design practice would take these and other factors into consideration.

a. Performance Potential of Aeration.
A number of successful applications of aeration have been documented in the literature and by EPA investigators as shown in Table 5.

TABLE 5.—EXAMPLES OF PACKED TOWER AERATION PERFORMANCE

Location	Major contaminant (raw water concentration range in µg/l)	Air: water ratio	Per- cent re- moval	Treated water conc. (µg/l)
Wurthsmith, AFB MI.	TCE (50-8000)	25:1	99.9	4-8
Liberty, MO	TCE (36-69) 1,1-DCE (11-22)		80	7-4
Fairfield, NJ	Total VOCs TCE (26-400) 1,1,1-TCA (17-291) PCE (<2-172) 1,2-DCA (<1-51)		96	<10 1-16 <1-12 <1-7 <1-2
Rockaway, NJ	TCE (50-220)	144:1	99+	<1-2
Rockhill, NJ	TCE (45-95)	83:1	<99	<1
Brewster, NY	PCE (420-470) TCE (30-48)	33:1	90	4-5 <1 <1-1.2
Upper Merion, PA	TCE (3-20)	11:1	94	<1-1.2
Warrington, PA	TCE (130)	40:1	97	4
Tacoma, WA	TCE (54-130) 1,2 DCE (30-100) PCE (1.6-5.4)	62:1	95	7 2-5 <1
Hartland, WI	TCE (175)	50:1	99	<2

Source: Love, O.T. Jr., Fege, W.A., Carswell, J.K., Milner, R.J., Clark, R.R., and Frank, A., "Aeration to Remove Volatile Organic Compounds from Ground Water," Draft Report, U.S. EPA Drinking Water Research Division, Cincinnati, Ohio, March 1984.

TCE: trichloroethylene
PCE: tetrachloroethylene
1,1,1-TCA: 1,1,1-trichloroethane
1,2-DCA: 1,2-dichloroethane

Love, et al. (1984) conducted a survey and reported that of the three dozen or so aeration systems installed, two-thirds used packed tower aeration. Table 5 displays some performance data from those systems in the survey using packed tower aeration. These data show that at least half of the systems were achieving greater than 99% removals at least part of the time, with treated water VOC concentrations in the low µg/l range. The variability of the raw water concentrations is also apparent in this data. Recent EPA studies using a pilot-scale packed tower aeration showed greater than 99 percent removals to be achievable at the over 30 sites which were studied.

Although removals of greater than 99.99 percent are theoretically achievable through physical/chemistry textbook calculations, maximum removal efficiency over a wide range of compounds using the best technology currently available under optimum conditions is approximately 99.9 percent for the compounds under consideration. Further, almost all information EPA has obtained on the performance of packed tower aeration indicates that 90 to 99+ percent removal has been achieved in actual practice. Unlike traditional concepts of pollutant removal, design of aeration for 99 percent removal is considered reasonable engineering practice; the incremental cost to achieve

95 to 99 percent as opposed to 90 percent is small when compared to the traditional concepts of biological oxygen demand (BOD) removal by biological treatment (i.e., it may cost X dollars to remove 90 percent and 2X dollars to remove an additional 5%). Thus, 99 percent removal of the nine VOCs using packed tower aeration is considered reasonable design and is possible under most circumstances. However, vinyl chloride is so easily removed by aeration that up to 99.9 percent reduction is considered achievable. The calculated Henry's Law Coefficient for vinyl chloride is about ten to one hundred times higher than any of the other eight VOCs. This is because it has a high vapor pressure (it's a gas at ambient temperatures) and it has relatively low solubility in water. For these reasons, the removal of 99.9 percent of vinyl chloride is considered to be achievable using packed tower aeration.

The above data and removal efficiencies are for ground water systems. Minimal data are available for removal of VOCs by packed tower aeration for surface water systems. Removal of VOCs from surface water might be more complex due to higher total organic carbon, colloidal particles, other matrix effects, and wider water temperatures variations. However, aeration would be expected to be an acceptable means of control; the different operating conditions would have some impact on the costs of operating the system.

b. Feasibility/Reliability of Attaining Specific Levels. Since packed tower aeration provides a fixed percent removal under a given set of conditions, variations in raw water concentrations will be accompanied by similar variations in treated water concentrations. While one would expect raw water concentrations of VOCs in ground water to be relatively constant or slow to change, actual data show that variations are not uncommon. Pumping patterns of the contaminated well and other wells in a well field can also have significant effects on VOC concentrations. There is little long term data available to judge how large a fluctuation in raw water VOC concentrations can be expected. This can be a particularly difficult problem in contaminated ground water since the cause and severity of the contamination are usually undefined. Large variations in concentrations have been experienced in some cases, while other water sources show concentration variations of only a few percent. This can be seen by examining the range of

raw water concentrations in Table 5. In one case, the concentration of trichloroethylene ranged from 50 to 8000 µg/l.

Accounting for variations in monitoring the performance of packed tower aeration or GAC adsorption is a significant consideration for EPA is selecting best technology generally available and for any system considering such technology. As noted above, since packed tower aeration will provide a fixed percent removal of VOCs in the raw water; it follows that as the raw changes, so will the treated water. Some factor would need to be incorporated into the design to allow for these fluctuations. Monitoring treated or raw water is not considered economically feasible daily or weekly basis as commercial analyses at \$150 to \$200 per sample would result in significant costs. Moreover, some of the variation in the treated water concentration can be provided for in the design of the aeration system even though the actual variation in concentration is difficult to predict. Designs would almost likely be based upon measured concentrations of occurrence plus a presumed variability factor of 50 to 100 percent unless sufficient water quality data were available. In any event, public water systems must consider variations in designing their system and will be held accountable for meeting the MCL, despite variation in raw water.

c. Secondary Effects of Aeration.

Transfer of VOCs from water to air might be a concern depending on the proximity to human habitation, treatment plant worker exposure, local air quality, local meteorological conditions, daily quantity of processed water and contamination level. In the example in Table 6, 500,000 gallons per day of water contaminated with trichloroethylene is treated using packed tower aeration. An air to water ratio of 33:1 is used to remove trichloroethylene from 50 µg/l in the raw water to 5 µg/l in the treated water. For purposes of air modeling, one hundred percent transfer from water to air is assumed. The stack height is five meters with an exit velocity of 0.4 meters per second and a stack gas temperature of 10°C. The site chosen was one described in Table 5 and all meteorological conditions are those for the geographic area of concern. The same model was run for a variety of geographic, meteorological conditions and water treatment parameters. The results for other examples were comparable to those presented here.

It is possible to consider the example shown in Table 6 in terms of projected

human cancer risks from inhalation exposure to vaporized VOCs. The individual risk of drinking two liters of water per day containing 50 µg/l of trichloroethylene would be calculated as 1.4×10^{-5} for a seventy year lifetime using a conservative multi-stage model (EPA, Health Effects Criteria Document for Trichloroethylene, see Final RMCLs). In Table 6 the highest air concentration projected is 0.1 µg/cubic meter and

occurs 0.2 kilometers south of the source. The individual lifetime risk of breathing 20 cubic meters of air per day at this location (assuming a 50 percent air to blood transfer of trichloroethylene) is 1.3×10^{-7} . Since the concentration in air decreases rapidly as the distance from the source increases, the individual risk from air exposure also rapidly diminishes. Other examples were examined and EPA has

determined that the risk resulting from exposure to VOCs in air from aeration of VOC contaminated water was lower than that resulting from drinking contaminated water. It was also apparent that in the cases examined, the amounts of VOCs added to air did not significantly increase risks from airborne contaminants.

TABLE 6.—AIR DISPERSION MODEL RESULTS FOR TRICHLOROETHYLENE EMISSIONS FROM A TYPICAL PACKED TOWER INSTALLATION

Wind direction	Air concentration (micrograms/cubic meter) of trichloroethylene at downwind distance (kilometers)				
	0.2	0.5	1.0	5.0	10.0
South.....	1.0×10^{-3}	2.2×10^{-3}	6.7×10^{-3}	4.9×10^{-4}	1.7×10^{-4}
West.....	6.5×10^{-3}	1.4×10^{-2}	4.4×10^{-2}	3.3×10^{-3}	1.1×10^{-3}
North.....	1.0×10^{-3}	2.2×10^{-3}	6.8×10^{-3}	5.0×10^{-4}	1.7×10^{-4}
East.....	4.1×10^{-3}	8.6×10^{-3}	2.6×10^{-2}	1.9×10^{-3}	6.4×10^{-4}

If necessary, control of VOC air emissions from packed tower aerators is possible using air phase GAC adsorption. Generally, air pollution control using GAC adsorption will roughly double the cost of packed tower aeration. This technology has been applied at a few installations in the United States, but is still considered to be in the developmental stages. It is necessary to reduce the relative humidity of the stack emissions to allow efficient adsorption of VOCs. This can be accomplished by heating the air prior to contact with the GAC. It should be

noted that most applications of this technology are currently in use in industrial air pollution control where VOC concentrations are much higher than those being emitted from a packed tower operation.

d. *Cost of Packed Tower Aeration.* The estimated cost (in 1983 dollars) of 99 percent removal (e.g., from 500 µg/l to 5 µg/l) of the VOCs using packed tower aeration, is presented in Table 7 (cost for p-dichlorobenzene and 1,1,1-trichloroethane are based upon lesser removals as shown in the Table). These cost estimates are based on the size of

equipment designed to provide the indicated removal efficiency and all material, electrical power and other items necessary to construct and operate the system. Comparisons with costs of actual installations have shown that the estimating procedure results in estimates which are generally higher than comparable actual cost. These costs are presented by system size category and include capital cost, annual operation and maintenance (O&M) cost, and total cost per thousand gallons (including annual O&M and amortized capital cost).

Table 7.—Cost for 99 Percent Removal (From 500 µg/l to 5 µg/l) of the Nine VOCs Using Packed Tower Aeration in August 1983 Dollars

Compound	Costs by system size category ¹		
	100-500 (0.037 mgd)	3,300-10,000 (0.95 mgd)	100,000- 500,000 (36.8 mgd)
<i>Trichloroethylene:</i>			
Capital cost.....	69,000	264,000	4,789,000
Annual O&M cost.....	1,400	18,000	617,000
Total cost (cents per 1,000 gal).....	79.0	15.5	9.4
<i>Tetrachloroethylene:</i>			
Capital cost.....	67,000	252,000	4,607,000
Annual O&M cost.....	1,200	15,000	513,000
Total cost (cents per 1,000 gal).....	75.0	14.2	8.4
<i>Carbon tetrachloride:</i>			
Capital cost.....	66,000	249,000	4,536,000
Annual O&M cost.....	1,200	15,000	509,000
Total cost (cents per 1,000 gal).....	75.0	14.0	8.3
<i>1,2-Dichloroethane:</i>			
Capital cost.....	84,000	461,000	10,221,000
Annual O&M cost.....	2,400	37,000	1,149,000
Total cost (cents per 1,000 gal).....	101.0	28.5	18.7
<i>Vinyl chloride:</i>			
Capital cost.....	60,000	201,000	3,453,000
Annual O&M cost.....	900	11,000	377,000
Total cost (cents per 1,000 gal).....	66.0	11.0	6.2
<i>1,1-Dichloroethylene:</i>			
Capital cost.....	64,000	229,000	3,975,000
Annual O&M cost.....	1,000	13,000	428,000
Total cost (cents per 1,000 gal).....	71.0	12.6	7.1
<i>Benzene:</i>			
Capital cost.....	74,000	325,000	6,536,000
Annual O&M cost.....	1,700	23,000	781,000
Total cost (cents per 1,000 gal).....	86.0	19.2	12.3
<i>p-Dichlorobenzene (1,000 µg/l to 750 µg/l)</i>			
Capital cost.....	51,000	146,000	2,489,000
Annual O&M cost.....	700	8,000	283,000
Total cost (cents per 1,000 gal).....	56.0	8.1	4.6

Table 7.—Cost for 99 Percent Removal (From 500 µg/l to 5 µg/l) of the Nine VOCs Using Packed Tower Aeration in August 1983 Dollars—Continued

Compound	Costs by system size category ¹		
	100-500 (0.037 mgd)	3,300-10,000 (0.95 mgd)	100,000- 500,000 (36.8 mgd)
1,1,1-Trichlorobenzene (500 µg/l to 200 µg/l)			
Capital cost.....	52,000	150,000	2,500,000
Annual O&M cost.....	700	8,500	280,000
Total cost (cents per 1,000 gal).....	57.0	8.2	4.7

¹ Number of persons served and million gallons per day.

The raw water concentration of 500 µg/l as the basis for costs was chosen as an approximate 95th percentile worst case example of VOC contamination. Nearly all known contamination incidences are considerably less than this and actual costs would also be less. While the SDWA legislative history states that MCLs are to be based upon technologies affordable to large systems using relatively clean waters (H.R. Rep. 93-1185, 93rd Cong. 2d Sess. at 12-13 (1974)), the costs for the worst case situation presented in Table 7 are affordable to large systems; thus, costs of reducing VOCs from a lower concentration in the raw water would be less and similarly affordable. Costs do not increase proportionally if a system is designed for 99 percent compound removal compared to 90 percent removal. For example, costs for TCE removal at 90 percent would be 6.1 cents/1000 gallons compared to 9.4 cents/1000 gallons for 99 percent removal. This is roughly a 50 percent increase in costs for reaching a treated water concentration which is one-tenth that at 90 percent removal (i.e., 50 µg/l versus 5 µg/l).

2. Adsorption (Granular Activated Carbon)

Activated carbon removes organic contaminants from water by the mechanism of adsorption. Contaminant molecules migrate to the external surface of the carbon and then into the extensive pore structure in the interior of the carbon particle, where they are effectively removed from solution.

The capacity of activated carbon of a particular compound is a function of the type of carbon, the molecular structure of the compound, the concentration of the compound in the water, the presence of competing organic substances and a number of other factors. Because the effect of all factors on the adsorption capacity cannot be well defined, capacity is determined empirically,

usually from laboratory equilibrium tests known as adsorption isotherms. Adsorption isotherms and other equilibrium tests permit the development of an equilibrium equation which relates the concentration of adsorbate (VOC) in the liquid phase to the concentration of adsorbate on the solid phase (concentration of VOC adsorbed per unit weight of activated carbon). This allows an estimation of the amount of carbon necessary to treat water with a given concentration of VOC under ideal circumstances.

Adsorption of VOCs from contaminated water is most likely and practically done by passing the water through a bed of granular activated carbon (GAC). As water passes downward through the bed, the GAC in the upper portions of the bed reach their equilibrium capacity and provide no further removal. Contaminant molecules penetrate deeper into the bed until they appear in the water leaving the bed. The appearance of detectable concentrations of VOCs in the treated water is known as breakthrough. When the concentration of the VOC in the treated water reaches an unacceptable level, the GAC in the bed is removed and replaced with either virgin carbon or reactivated carbon.

Critical design parameters are the empty bed contact time and throughput to exhaustion. Empty bed contact time (EBCT) is the volume of carbon in the bed divided by the hydraulic flow rate. Throughput to exhaustion signifies the specific volume treated at the point at which the bed is taken out of service (volume of water treated per unit volume of GAC in the bed). Throughput is expressed as bed volumes. The reciprocal of the throughput to exhaustion is the volume of carbon to be replaced per unit volume of water treated, or carbon usage rate.

Operating a carbon bed with short EBCT (e.g., 3-4 minutes) can result in rapid breakthrough and frequent

removal and replacement or reactivation of the carbon with attendant high operating costs. Very long EBCT (30-45 minutes) allows long time periods between carbon replacement or regeneration cycles. A carefully designed pilot study can provide data which allow an engineering determination of the optimum GAC design parameters.

The majority of published carbon usage rates for VOC removal are for waters with low total organic carbon (TOC) concentrations. The data used in developing treatment and cost data for this proposed rule were also for low TOC waters. This was because VOC contamination has been characterized as predominately a ground water problem. The majority of ground water in the U.S. has low TOC content with south Florida being a notable exception. The significance of total organic carbon is that it competes with the VOCs for adsorption sites or the GAC. This leads to more rapid exhaustion of the GAC. Some studies have shown exhaustion for certain VOCs as early as three weeks when high levels of naturally occurring organic carbon are present. Carbon usage rates for high TOC water versus low TOC water have been estimated to be two to six times higher. Carbon replacement costs could be at least as much as six to eight times higher for surface water systems compared to ground water systems.

Table 8 illustrates some pilot data for various locations where time to breakthrough was reported. In these cases, carbon was removing VOCs for at least 12 months before the first trace of VOC was seen in the treated water. There is some limited evidence that backwashing of GAC beds can disrupt the adsorption wave front and permits premature breakthrough, although the ultimate capacity is not diminished. This problem should be considered in the design and operation of GAC adsorption systems.

TABLE 8.—BREAKTHROUGH PERFORMANCE OF GRANULAR ACTIVATED CARBON ADSORPTION

Location	Raw water concentration	Empty bed contact time (minutes)	Treated water concentration ($\mu\text{g/l}$)	Approx. time to breakthrough (i.e., detection)(months)
New Jersey.....	194 $\mu\text{g/l}$ PCE.....	10.5	<1	22
Pennsylvania.....	20-30 $\mu\text{g/l}$ TCE.....	7.5	<1	20
New Hampshire.....	120-276 $\mu\text{g/l}$ TCE.....	9	<1	18.
New Jersey.....	23 $\mu\text{g/l}$ 1,1,1-TCA.....	18	<1	13
Connecticut.....	1-214 $\mu\text{g/l}$ 1,1,1-TCA.....	8.5	<1	12

After VOCs begin to appear in the treated water and the concentration is approaching the MCL, the GAC must be replaced or regenerated. Small systems will probably find that replacement is more economical. GAC replacement services are available from activated carbon suppliers. Large systems may determine that on-site reactivation is cost-effective. In these situations the carbon may be regenerated by the supplier or disposed of at an approved disposal site. Various types of equipment are available to accomplish thermal reactivation of GAC.

Two other methods of adsorption include the use of powdered activated carbon (PAC) and synthetic resins. PAC has limited applicability due to low adsorption; however, PAC may be useful for temporary application or cases where the standard is only marginally exceeded. Low rates of removal occur because PAC moves along with the water column and comes to equilibrium with the effluent concentration. Synthetic resins have shown promise in experimental use, but they are not available on the commercial market and are currently very expensive to produce. For these reasons, these two methods are not applicable to the wide varieties of VOC contamination anticipated that would be encountered.

a. *Performance Potential/Feasibility of GAC.* There are published performance data for VOC removal rates from pilot studies. All the VOCs except vinyl chloride can be removed using GAC adsorption. GAC should lower the concentrations of the other eight VOCs to below the limits of detection for a period of time which will depend primarily upon the EBCT, the influent concentration and the adsorption characteristics of the individual compound. The carbon usage rates for benzene and 1,2-dichloroethane

are significantly higher than the other six compounds, but it is still feasible to remove them using carbon adsorption. Engineering studies can generate data to determine the EBCT which will provide the optimum balance between capital and operating costs. When the treated water VOC concentration approaches the MCL, the spent carbon must be removed and replaced with either virgin or reactivated carbon. GAC can be used to remove VOCs from surface water supplies, but the background organics in many surface waters could result in earlier breakthrough of VOCs resulting in slightly higher costs. GAC might be especially applicable when a water supply is or may potentially be contaminated with non-volatile organics as well as VOCs as GAC does remove a wide variety of organic compounds.

GAC performance should be monitored carefully to detect the breakthrough of VOCs and to determine when the GAC should be removed from service.

b. *Secondary Effects of GAC Adsorption.* Thermal reactivation of GAC in a gas or oil fired unit may result in the discharge of particulates and combustion products of both the fuel and adsorbed organics. Reactivation can also be accomplished using electrical resistance furnaces with steam injection, which decreases potential air pollutants. In either case, reactivation systems are always supplied with air pollution control equipment, such as afterburners, cyclone dust collectors, and wet scrubbers. For this reason, emissions from reactivation operations were not considered significant enough to be of major concern in developing this proposal.

Systems must properly dispose of spent GAC and backwash from contactors. Disposal of spent GAC is not anticipated to be a problem, since a

number of disposal methods are available for similar wastes (e.g., GAC used in wastewater treatment). Backwash water from contactors can be treated like sand filter backwash. These methods include recycling of backwash water, discharge to a sanitary sewer, or treatment and disposal to surface waters (NPDES requirements must be met). Both solid and liquid waste disposal requirements of GAC treatment can be met with existing technology and should not present a significant problem for affected utilities.

Systems must also maintain the microbiological quality of water treated with GAC. Properly designed and operated disinfection facilities should be provided in all cases as a barrier to microbial contaminants entering the distribution system. With proper operation of GAC contactors (including backwashing) and proper post disinfection, microbiological quality degradation should not occur.

c. *Cost of Controlling VOCs using GAC.* The costs of removing VOCs using GAC adsorption were estimated assuming steel pressure vessel contactors for system sizes with less than two million gallons average daily flow and concrete gravity flow contactors for larger systems. EBCT used for all design calculations was 10 minutes. The construction cost of the steel pressure vessels were developed using manufacturer's quotes for equipment and standard cost estimating procedures for installation, buildings, electrical, and instrumentation. The construction costs for concrete gravity flow contactors were developed using an EPA cost estimating equation. Capital cost were then calculated using the following mark up factors: 12 percent for sitework, 15 percent for engineering, 15 percent for contractor overhead and profit, and 15 percent for contingencies. Carbon usage rates were determined by extrapolating the data of Love and Miltner, 1983 (Environmental Science and Engineering, 1984). Operation and maintenance costs were then determined using the EPA cost estimating equations. Costs are presented in Table 9 below for 99% removal except for 1,1,1-trichloroethane, and p-dichlorobenzene which are costed at lesser percentage removals because of their higher RMCLs/MCLs.

TABLE 9.—COST FOR 99 PERCENT REMOVAL (FROM 500 µG/L TO 5 µG/L) OF THE NINE VOCs USING GRANULAR ACTIVATED CARBON ADSORPTION IN AUGUST 1983 DOLLARS

Compound	Costs by system size category ¹		
	100-500 (0.037 mgd)	3,300-10,000 (0.95 mgd)	100,000- 500,000 (36.8 mgd)
Trichloroethylene:			
Capital cost.....	24,000	240,000	9,000,000
Annual O&M cost.....	4,500	86,000	710,000
Total cost (cents per 1,000 gal).....	57.0	34.0	14.0
Tetrachloroethylene:			
Capital cost.....	24,000	240,000	7,700,000
Annual O&M cost.....	2,800	45,000	400,000
Total cost (cents per 1,000 gal).....	45.0	22.0	11.0
Carbon tetrachloride:			
Capital cost.....	24,000	240,000	9,800,000
Annual O&M cost.....	5,700	85,000	930,000
Total cost (cents per 1,000 gal).....	66.0	34.0	17.0
1,2-Dichloroethane:			
Capital cost.....	24,000	249,000	11,000,000
Annual O&M cost.....	9,400	150,000	1,500,000
Total cost (cents per 1,000 gal).....	93.0	52.0	23.0
Vinyl chloride:			
Capital cost.....	NA	NA	NA
Annual O&M cost.....	NA	NA	NA
Total cost (cents per 1,000 gal).....	NA	NA	NA
1,1-Dichloroethylene:			
Capital cost.....	24,000	240,000	9,100,000
Annual O&M cost.....	4,600	90,000	740,000
Total cost (cents per 1,000 gal).....	58.0	35.0	15.0
Benzene:			
Capital cost.....	24,000	236,000	17,200,000
Annual O&M cost.....	15,700	258,000	2,800,000
Total cost (cents per 1,000 gal).....	150	83.3	37.6
p-Dichlorobenzene (1000 ug/l to 750 ug/l)			
Capital cost.....	24,000	240,000	5,100,000
Annual O&M cost.....	1,900	22,000	230,000
Total cost (cents per 1,000 gal).....	38.0	15.0	6.9
1,1,1-Trichloroethane (500 µg/l to 200 µg/l):			
Capital cost.....	24,000	240,000	10,000,000
Annual O&M cost.....	6,600	100,000	1,100,000
Total cost (cents per 1,000 gal).....	73.0	38.0	18.0

¹ Number of persons served and million gallons per day.

3. Other Technologies

Other technologies can be considered for possible control of VOCs in drinking water. These include ultraviolet radiation and ozone, non-treatment alternatives such as regionalization, alternate source, well field management, and point-of-use/entry treatment (single tap/whole house). They are discussed in more detail in the Cost and Technology document.

4. Best Technology Generally Available

For purposes of determining the appropriate levels for MCLs, EPA must identify the best technology generally available (BTGA). The SDWA provides in section 1412(b)(3):

The maximum contaminant level specified in a revised national primary drinking water regulation for a contaminant shall be as close to the recommended maximum contaminant level . . . as feasible . . . [T]he term "feasible" means feasible with the use of the best technology, treatment techniques, and other means, which the Administrator finds are generally available (taking costs into consideration).

In addition, as discussed in Section IV below, one of the purposes of the rule being proposed today is to identify pursuant to section 1415(a)(1)(A) of the SDWA, the best technologies, treatment

techniques or other means that the Administrator of EPA has determined to be generally available, taking costs into consideration. The analysis in this section supports both sections 1412 and 1415 findings of best technology generally available.

The determination of BTGA is essentially a two step process:

(1) Engineering assessment of technologies and other means that may be used for removing the pertinent contaminants.

(2) Assessment of the costs of the technology to determine their affordability to public water systems and consumers and the levels of contaminants removed.

The first step in this process is to list all technologies which are commercially available for removal of the contaminants. The performance potential of these technologies can then be determined in terms of relative removal efficiencies. Table 10 lists those technologies identified for VOC removal.

From this list, the best technologies generally available were determined by a thorough review of existing data to evaluate which technologies have the highest efficiencies of removal, are designed specifically for VOC removal,

are compatible with other types of water treatment processes, are available as manufactured items or components, are not limited to application in a particular geographic region, have integrity for a reasonable service life as a public work are reasonably affordable by large metropolitan or regional systems. Also, EPA must consider "all technology that can be mass produced and put into operation in time for implementation of (the revised) regulations."

From the list in Table 10, packed tower aeration and GAC adsorption were determined to meet the engineering criteria for BGAT. Detailed cost assessments were then made of capital, O&M, and total annual costs of installation and operation of GAC and packed tower aeration. The costs to public water system and consumers in medium and large systems were then assessed and determined to be reasonable (see Tables 8, 9 and 12). EPA is also aware that a number of small systems have already installed these technologies and found them to be affordable. Because these technologies are affordable by small systems, economies of scale would also make them affordable to medium to large size systems. The increased cost is expected

to be passed to the consumer either as a water rate increase or as a tax increase.

It has been suggested that EPA should specify different BTGA for small systems. In the case of the technologies available for VOC removal, EPA does not feel this is necessary. The technologies (aeration and adsorption) are effective and appropriate for any size of system, both from a design and an operational perspective. Of course, a system may choose any means of compliance; it need not use aeration or adsorption.

Table 10

Unit Processes and Other Means Considered in Determining BTGA

Aeration

Waterfall Aeration

- Packed tower aeration
- Multiple tray aeration
- Cascade aeration
- Spray aeration

Diffused Aeration

- In existing vessels or tanks
- In well (includes air-lift pumping)

Mechanical Aeration

Adsorption

- Granular Activated Carbon
- Powdered Activated Carbon
- Strong Base Anion Exchange Resins
- Ultraviolet-Ozone Oxidation
- Reverse Osmosis

Home Treatment Devices (Point-of-entry or Point-of-Use)

- Reverse Osmosis
- GAC Adsorption
- Aeration

Non-Treatment Alternatives

- Well Field Management
- Regionalization Alternate Source
- Bottled Water

a. *BTGA: Packed Tower Aeration; GAC Adsorption.* Packed tower aeration is considered BTGA because: (1) It can achieve a high level (99%) or more of VOCs removal under all anticipated conditions, (2) its application is not limited by climatic conditions such as temperature or geographic conditions such as space, (3) it is compatible with other forms of water treatment, (4) it can be installed either at the well head or in a central treatment plant, (5) technologies are available to handle any side effects (e.g., air pollution or increased corrosivity), (6) the equipment is commercially available and typical of that used by the water industry, (7) it can be designed for operation for a reasonable number of years before replacement would be needed, (8) it is reasonably affordable by large public water systems, (9) it does not require any pre-existing structures (e.g., basins for diffused aeration), and (10) it has been successfully applied to the removal of VOCs in at least twenty-four full-scale plants in the U.S.

GAC adsorption is considered BTGA because: (1) It can achieve a high level (up to 99.9%) of removal of several VOCs (except, e.g., vinyl chloride, and to lesser extents benzene and 1,2-dichloroethane), under all anticipated conditions, (2) its application is not limited by climatic or geographic considerations, such as space, (3) it is compatible with other forms of water treatment, (4) it can be installed either at the well head or in a central treatment plant, (5) technologies are available to regenerate used carbon or dispose of it and any potentially adverse side-effects (i.e., bacteria) can be controlled using existing technology, (6) the equipment is commercially available and typical of that used in the water industry, (7) it can be designed for economical life, (8) it is reasonably affordable by large public water systems, (9) it does not require preexisting structures (e.g., basins and filters for PAC), and (10) it has been successfully applied to the removal of VOCs in at least five plants in the U.S.

Certain of the other technologies listed in Table 11 may be appropriate for use in specific circumstances but do not meet the above criteria. These include:

b. *Other Technologies: Ultraviolet—Ozone Oxidation.* There is some limited experimental data on the usefulness of ultraviolet radiation-ozonation systems to remove VOCs from drinking water. This technology is available, but is quite new and is not in general use in the water industry. Insufficient data are available upon which to judge the performance and the costs of treatment.

c. *Other Technologies: Reverse Osmosis.* There are limited data on this technology's application for removing VOCs. Membrane fouling is a real concern that limits the potential use of this technology. Some membrane materials are also rapidly permeated by the VOCs and rapidly become ineffective. Only limited cost data could be developed on the use of reverse osmosis and reliability of the process is questionable.

d. *Other Technologies: Non-Treatment Alternatives.* These include well field management, alternate source, and regionalization. Since these depend on local geology and geography, EPA cannot say they are generally available to most systems with VOC contamination.

e. *Other Technologies: Point-of-Use/Point-of-Entry Treatment Devices.* Point-of-use devices treat the drinking water in the home, providing treated water at a single tap. They are installed as faucet mounted devices or under-the-sink line bypass devices. Point-of-entry devices treat the water as it enters the home and provide treated water

throughout the entire home. Two types of treatment have been investigated and reported in the literature as applicable to point-of-use/entry treatment to remove VOCs. These types of treatment are reverse osmosis and granular activated carbon (GAC) adsorption.

The effectiveness of point-of-use devices has been studied for reverse osmosis (Sorg, Thomas J. and Love, O. Thomas, "Reverse Osmosis Treatment to Control Inorganic and Volatile Organic Contamination, *Proceedings, Preconference Seminar: "Experiences with Ground Water Contamination," Annual AWWA Conference and Exposition, Dallas, Texas, June 1984*) and granular activated carbon adsorption (Bellen and Gottler, "Point of Use Reduction of Volatile Halogenated Organic Contaminants from Drinking Water," First Report, U.S. EPA, MERL, Cincinnati, Ohio, 1984). Reverse osmosis using cellulose, nylon amide, and thin film membranes was found to have limited effectiveness due to permeation of the membranes by a variety of VOCs. Based on this preliminary study, reverse osmosis cannot be considered an effective technology for VOC removal. On the other hand, studies of GAC adsorption point-of-use devices have found that a number of commercially available devices effectively removed some of the VOCs of concern. These VOCs included trichloroethylene, tetrachloroethylene, carbon tetrachloride, 1,1,1-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethylene, and chloroform. Breakthrough (defined as detectable concentrations of VOCs) was not observed in some devices in use for up to 24 months. This study also confirmed an increase in total bacterial plate count in the treated water previously described by other authors. However, it was noted that flushing the GAC unit reduced the bacterial concentration to near background.

GAC adsorption point-of-use/entry treatment devices are not BTGA but could be considered acceptable technology to meet MCLs under certain conditions as specified below. These devices are not BTGA because it is difficult to monitor the reliability of treatment performance in a manner comparable to central treatment. In addition, point-of-use devices only treat the drinking water at the single tap.

The SDWA provides authority for EPA to establish the conditions under which treatment devices may be used, if necessary to assure protection of public health. Section 1401(1) of the Act states that primary drinking water regulations are to contain "criteria and procedures to assure a supply of drinking water

which dependably complies with . . . maximum contaminant levels; including quality control and testing procedures to insure compliance with such levels and to insure proper operation and maintenance of the system." The legislative history also makes clear that EPA has authority to prescribe operating requirements where necessary to assure safe drinking water and that these requirements should be as limited as possible. H.R. Rep. No. 93-1185, 93rd Cong. 2d Sess. at 14-15 (1974).

EPA believes that because point-of-use/point-of-entry devices are different from central treatment alternatives, and present a potential that public health will not be protected to the same degree as central treatment it is important to establish minimum criteria for operation, maintenance, and testing of these devices. Therefore, EPA is proposing to establish the conditions listed below as the minimum requirements for systems using point-of-use/point of entry devices. These requirements are limited to those necessary to assure that the water supplies dependably complies with the MCL.

If point-of-use/entry devices are to be considered as an acceptable technology, to meet the proposed VOC MCLs, the approving primacy agency (State or EPA) would have to assure that the following conditions are met:

(1) Central Ownership and Control. It would be the responsibility of the public water system to own, operate, and maintain all parts of the treatment system (i.e., the treatment device). This appears appropriate and necessary to ensure adequate control of the treatment device so that it is working properly.

(2) Effective Monitoring and Surveillance. The utility would develop a plan and obtain State approval for a monitoring scheme before point-of-use/entry devices are installed for compliance. This monitoring scheme must provide health protection equivalent to a monitoring scheme for central water treatment.

Monitoring and surveillance would also include physical measurements and observations such as total flow treated and the mechanical condition of the treatment equipment. Monitoring and surveillance are a central part of the NPDWRs to ensure that MCLs are complied with. Because point-of-use/entry schemes are fundamentally different, a unique monitoring scheme must be developed.

(3) Effective Technology Must Be Property Applied. There are no generally accepted standards for the design and construction of these devices. The State would have to

require adequate certification of performance, field testing, and a rigorous engineering design review. This condition is needed because of the variety of devices that might be employed.

(4) The Microbiological Safety of the Water Must be Maintained. The design and application of these devices must consider the tendency for increases in bacterial concentrations in water treated with activated carbon. It may be necessary to use frequent backwashing, post-contactor disinfection, and monitoring to ensure that the microbiological safety of the water is not compromised. This condition is believed necessary to protect health from any bacterial threat the devices may present.

(5) All Consumers are to Be Protected. Every building connected to the system must have the device installed, maintained, and adequately monitored. The State must be assured that every building is covered by treatment and monitoring, and that the rights and responsibilities of the utility customer convey with title upon sale of property. Individual public water fountains not in or connected to a building need not have a point-of-use/entry device.

(6) There Must Be No Significant Increase in Risk Over Centrally Treated Water. Under the plan approved by the State, point-of-use/entry devices must provide health protection equivalent to central treatment. This would include determination if the VOC concentrations are high enough to create a significant risk from dermal and respiratory exposure and any other sources of exposure except individual public water fountains.

These last two conditions [i.e., (5) and (6)] are central to the criteria under which point-of-use/entry devices could be approved for use: there is to be adequate protection of human health from the treatment devices.

If a primacy State wishes to allow systems to use point-of use devices to comply with an MCL, it must adopt regulations which are no less stringent than EPA's regulations. Of course, States may be more stringent and not allow systems to comply using point-of-use/entry devices. (These States must adopt regulations prohibiting point-of-use/entry devices; this decision will not jeopardize primacy.)

5. Bottled Water. EPA has rejected use of bottled water as best technology generally available. Bottled water does not provide the same level of protection as central treatment, as persons often choose not to drink bottled water. In addition, there could be problems with access to delivery of bottled water.

Thus, bottled water is also not an acceptable permanent means of meeting the MCL requirements. EPA is proposing that bottled water not be considered an acceptable means of meeting MCLs on a permanent basis. However, bottled water meeting the MCLs may be considered as an emergency or interim measure to prevent an unreasonable risk during the time between detection of an MCL violation and compliance through other means.

Public comments and information/data are requested on the availability of technologies and costs of these technologies for control of VOCs. Specific comments are requested on the question of considering: (1) Point-of-use/treatment devices, (2) point-of-entry treatment devices, and (3) bottled water as BGAT or as acceptable technologies. Are these appropriate under the SDWA to use in achieving MCL compliance by public water systems?

D. Selection of MCLs

Provided below is a brief summary of the pertinent factors considered in determining the proposed MCLs.

1. Analytical Methods

As noted above, three methods are available for the determination of VOCs in drinking water. The EPA approved methods involve the use of gas chromatography (GC) with either a conventional detector or a mass spectrometer (GC/MS). These analytical methods have the required scope, sensitivity and reliability, and these are experienced laboratories available to conduct the analyses. The technology employed is similar to that used for the analysis of trihalomethanes, however it is being applied to levels about 1 or 2 orders of magnitude below the TTHM MCL. The costs of sample analysis appear to be about \$150-\$200 per sample.

For purposes of this proposal, the PQL for the VOCs is 5 μ g/l, except for vinyl chloride for which the PQL of 1 μ g/l. These PQLs represent the lowest level achievable by about 90% of good laboratories under routine operating conditions. The level measured would be expected to be within \pm 40% of the true value at levels less than 10 μ g/l and \pm 20% above 10 μ g/l. These PQLs are primarily based upon PE studies. Reliability of analytical results is expected to decrease as laboratories attempt to measure lower and lower concentrations. Data on day to day performance in most commercial laboratories are not available, but it would be expected in many cases to be poorer than the EPA and State (or

commercial) laboratories participating in the PE studies.

2. Availability/Performance of Treatment Technologies

Two technologies, packed tower aeration and granular activated carbon (GAC) adsorption, are specifically suitable for VOC control, have high theoretical and empirically determined removal efficiencies (90-99% or more), have been used by drinking water systems in the U.S., and their costs are reasonably affordable when used by large systems. These technologies are thus considered best technologies generally available for determination of the MCLs.

Reasonable removal efficiencies for packed tower aeration are up to 99 percent for eight of the VOCs and up to 99.9 percent for vinyl chloride. In most cases, GAC can achieve VOC levels below detection until breakthrough which could be 12 months or longer. Consideration include: (1) The variability of VOCs in the raw water (\pm 50-100% variation in raw water concentration is a reasonable estimate); and (2) the feasibility of performance monitoring at \$150 to \$200 per sample.

3. Levels of VOC Occurrence

As stated above, application of the available technologies will either achieve a concentration lower than the analytical detection limit (e.g., via GAC) or remove up to 99 percent of the raw water concentration. Legislative history suggests that MCLs should be based upon treatment affordable by large systems using relatively clean intake water. In order to project an estimate of expected VOC contamination, positive occurrence results from EPA and State VOC surveys have been pooled (Table 11) and for each VOC, the median and 95th percentile concentrations determined. The latter concentration represents the concentration below which 95 percent of the positive sample results would occur. For example, about 238 or 95% of 251 selected positive samples were contaminated with tetrachloroethylene at concentrations between the MDL (probably 0.5 μ g/l) and 175 μ g/l. Median levels are usually well below 5 μ g/l. If the median level were considered to represent the "relatively clean intake water" suggested in the legislative history, application of aeration technology (i.e., 99% removal) would result in levels below the PQLs.

The surveys included both public water systems samples and a few ground water samples not necessarily used for drinking water; the latter were often collected near suspected spill or

contamination sites. The information in Table 11 represents only the positive portion of the samples measured. This provides a way to project an upper bound on the maximum contamination that 95 percent of the community water systems could expect before applying treatment.

TABLE 11.—VOC RAW WATER LEVELS

VOC	No. of contamination incidences	Median: 50th percentile μ g/l	95th percentile μ g/l
Trichloroethylene.....	257	4.6	300
Tetrachloroethylene.....	251	3.3	175
Carbon Tetrachloride.....	134	2.6	40
1,2-Dichloroethane.....	59	3.2	100
1,1-Dichloroethylene.....	47	3.5	50
Benzene.....	61	1.8	30
Vinyl chloride.....	15	4.3	70
p-Dichlorobenzene.....	57	0.3	4
1,1,1-Trichloroethane.....	195	3.5	143

4. Other Technical Feasibility Factors

Air pollution due to aeration does not appear to be a problem in the vast majority of cases. Assessments of air emissions of VOCs have shown potential levels in the air to be negligible. Some States have indicated that aeration of VOCs without air pollution control is not a viable alternative in their State. Air pollution control using gas phase carbon adsorption is available, but total production costs would approximately

double. In these cases, the systems would probably choose GAC adsorption as the mode of water treatment.

5. Costs of Treatment

The costs for the removal of the nine VOCs are considered reasonable for medium and large systems; costs vary from 5 to 15 cents/1000 gallons for aeration and from about 10 to 85 cents/1000 gallons for GAC adsorption. The annual cost per family is presented in Table 12. Costs for small systems are high (38-150 cents/1000 gallons) but again costs are worst case scenarios and actual costs would probably be less. In addition, a number of small systems have installed aeration or GAC for control of VOCs which would indicate that these technologies are affordable.

Total national costs are also shown in Table 12 which is based upon the use of all occurrence data and projecting the number of systems that would need to install treatment at three alternate levels for the MCLs. The increase in total national costs becomes larger if MCLs are set at 1 μ g/l as opposed to 5 μ g/l or 10 μ g/l. At MCLs of 1 μ g/l, many more groundwater systems would need to install treatment. In addition, many surface water systems would also need to install treatment because when surface water systems have VOCs, they are generally at concentrations less than 5 μ g/l.

TABLE 12.—COSTS IMPACTS OF MCLs AT VARIOUS LEVELS

MCL Opts. μ g/l	Estimated # systems impacted	National cost (\$ millions)		Annual cost per family per size of system (dollars per year)			
		Total capital	Annual	Very small	Small	Medium	Large
1.....	3,800	1,300	100	96	47	12	8
5.....	1,300	280	21	91	41	12	3
10.....	800	150	11	90	42	11	1

E. Proposed MCLs

EPA is proposing to set the MCLs based upon: (1) 99+ percent removal by packed tower aeration (99.9% for vinyl chloride) and granular activated carbon and (2) the capabilities of laboratories to measure VOCs within reasonable limits of prevision and accuracy (i.e., the PQL is 5 μ g/l for eight VOCs and 1 μ g/l for vinyl chloride). Doubling the median values in Table 11 to allow for 100 percent raw water variability and reducing that amount by 99% would result in MCLs below the PQLs in every case. In this analysis, median and lower values would represent the SDWA requirement to set MCLs based upon relatively clean intake waters. Looking at a worst case scenario, sample

calculations are shown below based upon raw water levels corresponding to the 95th percentile of the positive EPA and State occurrence data in Table 11 for each VOC. An assumed raw water concentration fluctuation of 100 percent was factored into the calculations below (i.e., the 95th percentile of the occurrence data was increased by 100% to determine the appropriate raw water concentration).

	μ g/l
Benzene:	
95th percentile.....	30
plus 100% variation.....	60
99% removal.....	0.6
PQL.....	5
MCL.....	5

	µg/l
Vinyl chloride:	
95th percentile.....	70
plus 100% variation.....	140
99.9% removal.....	0.14
PQL.....	1
MCL.....	1
1,1-Dichloroethylene:	
95th percentile.....	50
plus 100% variation.....	100
99% removal.....	1.0
PQL.....	5
RMCL.....	7
MCL.....	7
Trichloroethylene:	
95th percentile.....	300
plus 100% variation.....	600
99% removal.....	6
PQL.....	5
MCL.....	5

EPA is proposing to set the MCLs equal to the RMCLs for 1,1-dichloroethylene, 1,1,1-trichloroethane and p-dichlorobenzene as the RMCLs are higher than the PQL and levels achievable by BTGA. The remaining MCLs are set based on the levels achievable by BTGA and the PQL. The levels of 5 µg/l and 1 µg/l (for vinyl chloride) are clearly achievable on the basis of treatment technologies and limits of analytical detection, taking precision/accuracy into account. The 95th percentile occurrence data were used to demonstrate that even in the worst case situations, the BTGA could achieve the PQL or the RMCL. Aeration and GAC adsorption are effective at any range of concentration anticipated in drinking water. Engineering design could certainly remedy the situation such as in the above example for trichloroethylene; that is, the treatment methods could be altered within their design parameters to remove the additional 1 µg/l. The proposed MCLs for the VOCs are presented Table 2.

F. Applicability to Certain, Non-community Water Systems

MCLs in the Interim Regulations that posed chronic (long-term) health risks do not apply to non-community water systems. MCLs, such as total coliforms and nitrate, that posed acute (short-term) health risks did apply to non-community systems. Non-community water systems are those that serve transient populations, such as campgrounds, parks, restaurants, gas stations and schools.

The basis for regulating non-community systems in this manner was that transient populations used these types of systems and thus, long-term health risks would not exist. However, since implementation of the Interim Regulations, experience has shown that certain types of non-community systems serve the same consumers over long periods of time, such as schools and factories. The chronic health risks to

consumers in these types of systems would be similar to residential populations. Therefore, EPA is considering amendment of the definition of community water systems such that non-community systems serving such populations are included. While regulatory language is not proposed in the back of this notice, EPA may include in the final regulations. The effect of this amended definition would be that the Revised Primary Drinking Water Regulations would apply to such systems as schools, factories, and day care centers; MCLs monitoring, reporting and public notice would apply for the VOCs and other contaminants that will be included in the Revised Regulations. The definition of community water systems would include non-community systems that serve at least 25 non-transient people over 6 months a year, and it is estimated that 10 to 15 percent of 158,000 non-community water systems would be included. In definition of a community water system would be amended to read as follows:

Community Water Systems means a public water system which serves as least 15 service connections used by year-round residents or regularly serves at least 25 of the same persons over six months per year.

Six months would be included as a reasonable projection of what period could represent a long-term health risk; EPA requests comment on this specific time period and this definition. Public comments are requested on this approach that would include such systems as schools and factories in the definition of community water systems in the Revised Primary Drinking Water Regulation, and the specific definition of what would constitute this kind of system.

IV. Best Technology Generally Available for Section 1415 Variances

Today's rule proposes a new section 142.61, "Variances from the maximum contaminant level for volatile organic chemicals." This section implements section 1415(a)(1) of the SDWA for VOCs. Under this section of the Act, EPA or the primacy State may grant variances from national primary drinking water regulations if certain conditions are met. These conditions include: (1) An inability to meet the MCLs despite application of best technology which the Administrator finds are generally available, (2) a finding that the variance will not result in an unreasonable risk, (3) a compliance schedule, (4) implementation of such additional control measures as may be required, and (5) public notice of

the proposed variance and opportunity for a hearing.

The purpose of today's proposed regulation under Section 1415 is to identify the "best technologies, treatment techniques, or other means that the Administrator finds are generally available (taking costs into consideration)." SDWA section 1415(a)(1)(A). These are the technologies that the system must install or agree to install as a condition of receiving the variance. This regulation is modeled on the variance rule promulgated for trihalomethanes in 40 CFR 142.60 (48 FR 8406, February 28, 1983).

EPA believes that packed tower aeration and granular activated carbon adsorption are best technologies generally available, considering costs under section 1415. EPA reached this conclusion based on the analysis in section III of this notice. Subsection (a) and (b) of proposed § 142.61 specify the two best technologies generally available and that they must be used unless they are not technically appropriate or technically feasible for the system. In any event, systems shall be required to evaluate alternative treatment methods specified in subsection (c) as part of the schedule of compliance. These treatment alternatives are discussed in section III. If a method is technically feasible, economically reasonable, and will achieve removals commensurate with the costs incurred, the Administrator or primary State will require use of that method (see subsection (d)).

If a State intends to grant variances to the VOC regulations, it must issue variances that are no less stringent than those issued under this section. States intending to issue these variances would have to adopt comparable authority to receive or retain primary enforcement authority under section 1413 of the Act.

EPA invites comment on all aspects of this proposed variance regulation. In particular, EPA solicits comment on the findings of best technology generally available under section 1415 and the specification of alternate technologies.

V. Compliance Monitoring Requirements

Compliance monitoring requirements are being proposed for the purpose of determining if public water systems are distributing drinking water that meets the MCLs. As a class of chemicals, VOCs are included in the second tier of the three tiered approach presented in the Phase II ANPRM published on October 5, 1983 (48 FR 45502). The tiers are as follows:

Tier I—Those which occur with sufficient frequency and which are of sufficient concern to warrant national

regulation (MCLs) and consistent monitoring and reporting.

Tier II—Those which are of sufficient concern to warrant national regulation (MCLs) but which occur at limited frequency, justifying flexible national minimum monitoring requirements to be applied by State authorities.

Tier III—Those which would not warrant development of a regulation but for which non-regulatory health guidance could be provided to States or water systems.

The three tiered approach was developed to provide a framework for developing MCLs and monitoring requirements according to the significance of the contaminants in drinking water, the extent of contamination, and the predictability of occurrence or potential occurrence in drinking water.

Tier II includes those contaminants which may sometimes be predictable in drinking water based upon a multiplicity of factors such as geological conditions, type of source, historic record, or proximity of sources of drinking water contamination such as industries and hazardous waste sites. Cases such as these appear to warrant conferring discretion on States so that activities can be tailored to regional conditions. Thus, although compliance with the MCL would be required in all cases, States are being provided flexibility in establishing monitoring requirements within minimum federal requirements.

In the development of VOC compliance monitoring requirements, EPA considered: (1) The differences between ground and surface water systems, the (2) collection of samples which are representative of consumer exposure, the economic burden associated with the sampling and analytical costs, and (4) the limited occurrence of VOCs and the need for States to take an active role in requiring increased monitoring over the federal minima. EPA has determined that the sampling and analytical costs are reasonable and that there are sufficient analytical laboratories capable of handling sample analyses in the scheme proposed if the initial monitoring requirements are phased-in over a period of several years.

Surface and ground waters have been considered separately because: (1) The sources and mechanisms of contamination for these systems are different, (2) the overall quality of ground waters tends to change more slowly with time than does the quality of surface waters, and (3) ground water contamination is usually a localized problem confined to one or several wells within a system. For ground water

systems, sampling will be done at entry points to the distribution system since VOC contamination of the water reaching the consumer is not expected to increase within the distribution system. However, source monitoring results may be used to decrease the number of samples taken at entry points to the distribution system or to reduce the frequency of monitoring for the determination of compliance with the MCL. Reductions in the number of samples or frequency of monitoring, if appropriate, will be determined by the primacy agency.

EPA has identified situations where monitoring should be more frequent. The probability of contamination of a water supply increases when one or more of the following conditions exist: (1) Proximity to large population areas, (2) nearby commercial or industrial use of VOCs, and (3) lack of protection of the water source by natural factors or land use control. It is important to identify industrial, commercial or municipal facilities that handle wastes or use solvents and to locate abandoned waste sites. Surface water systems may be protected by land use restrictions or by remoteness of the sources from VOC-based activities. Ground water systems may be protected naturally by geological formations above the aquifers that are impermeable to VOCs used or stored near the surface, or by strict management practices.

A. Proposed Monitoring Requirements

The fundamental questions that were considered in developing the proposed compliance monitoring requirements are the following:

- How can monitoring regulations be developed to provide States with an active role such that resources are efficiently utilized?
- What minimum requirements should be set?
- What distinctions should be made between ground and surface water systems?
- What locations for sampling?
- Number of samples per system?
- One-time monitoring or monitoring over a period of time? Should minimum repeat frequency be established? What frequency and upon what basis?
- How much time should be allowed for public water systems to complete the monitoring requirements?
- What is the cost of monitoring per system?
 - What sampling requirements should be set?
 - What follow-up actions may be needed to assist the public water

systems and the States when positives are reported?

—Follow-up confirmation sampling?

—Health and treatment advisories?

• What reporting and public notice requirements should be set?

Public comments are requested on each question above as they relate to the proposed requirements discussed below and the other alternatives presented.

EPA believes that all systems should conduct at least one initial round of monitoring to determine the extent of contamination of water supplies and to provide maximum consumer knowledge of the quality of their drinking water. EPA also believes that there should be minimum requirements for repeat sampling since the vulnerability of a system to VOC contamination may change with changing land and water use and waste disposal practices. The repeat sampling requirements should reflect the potential for contamination of the system (i.e., the most vulnerable systems should monitor the most frequently). The States should recertify the vulnerability status of each system on an annual basis. Systems should notify the State whenever a significant change takes place that could affect the vulnerability of the system (e.g., change in water source, new VOC-based industry nearby or a positive VOC analysis).

Several approaches to monitoring requirements have been considered by EPA. Three specific options are outlined below with additional details provided in Appendix B. Appendix B contains Table B-1 a detailed description of the monitoring options considered; further explanation is provided in the analytical methods/monitoring document. In each option, requirements are displayed for: (1) An initial round of monitoring and (2) repeat monitoring. In addition, different requirements are set within each option for ground water systems (about 45,000) and surface water systems (about 15,000). These requirements would also apply to those water systems previously considered non-community systems such as schools and factories. The primary differences between the options relate to the extent of specific sampling requirements and the opportunity for State discretion. In each option, monitoring for vinyl chloride would not be required for all systems. Ground water systems would be required to analyze for vinyl chloride only when other chlorinated 2-carbon VOCs (trichloroethylene, tetrachloroethylene, 1,2-dichloroethane, 1,1,1-trichloroethane, and 1,1-dichloroethylene) had been

detected; this is because EPA has concluded that the most likely explanation for vinyl chloride detection in ground waters is from *in situ* transformation; no requirements would be set for vinyl chloride monitoring in surface water systems because vinyl chloride is not expected to be found due to its high volatility.

In each option, monitoring requirements are proposed to be phased in depending upon the size of the systems. Phasing in requirements over four or five years allows public water systems laboratories and States sufficient time to efficiently allocate the necessary resources to conduct the monitoring and analysis. Systems that are most vulnerable to VOC contamination should sample first; while EPA studies have not shown a clear distinction between potential sources of contamination and actual VOC contamination that could be used to pinpoint specific systems that would be vulnerable to VOC contamination, the GWSS found the best correlation was between the size of systems and VOC contamination. In general, this could be expected since large population centers are located in areas of large commercial or industrial activity (users and producers of VOCs). However, smaller systems have also detected contamination by VOCs. Therefore, monitoring requirements are proposed to be phased in by system size with the largest systems sampling first.

EPA has also gathered occurrence data from several State surveys. These data are generally consistent with nationally based occurrence information in the GWSS. Although no additional projection can be made from these State surveys, they provide additional support for the initial monitoring requirements in this proposal. The regional surveys also provides such support; specifically, these data support the decision to phase in the monitoring requirements for VOCs based on population since frequency of VOC occurrence generally increases with increasing population served by the community water systems. These data also support the decision that all systems be required to monitor for VOCs since small and large systems have detected VOCs at relatively high concentrations, without apparent sources of contamination.

EPA is proposing that Option 2 be selected as the minimum federally enforceable monitoring requirements (Option 2 is described in Appendix Table B-1). Option 2 provides for reasonable minimum federal requirements and also provides for State discretion in their application. While the

requirements are phased in by size of system, States are encouraged to sample vulnerable systems as early as possible. EPA requests comments on these three options; final monitoring requirements may be modified based on public comments.

1. *Option 1.* This option would require all systems to monitor at least once over a four year period. The federally mandated monitoring requirements would be relatively stringent under this option. The monitoring requirements would be phased-in based on the size of the population served by the system, as follows:

System size	Completed by
> 10,000.....	End of 1 year.
3,300 to 10,000.....	End of 2 years.
< 3,300.....	End of 4 years.

- Ground water systems would be required to sample at entry points to the distribution system. The minimum number of samples would be one sample per entry point to the distribution system per quarter and confirmation samples would be required.

- Surface water systems would be required to sample in the distribution system. The minimum number of samples would be one sample per source per month and confirmation samples would be required.

Ground and surface water systems would sample at least quarterly or monthly, respectively, for one year and would be required to resample any positive result. Sample locations for ground water systems are at entry points to the distribution system in order that contamination of any single well could be detected. Sampling in the distribution system might not detect contamination due to factors such as sample location and pumping patterns. It is thought that representative samples can be obtained within the distribution system for surface waters since there are usually fewer entry points.

Repeat monitoring would be based on prior monitoring results and the vulnerability of the system to VOC contamination. The repeat monitoring frequency would be as follows:

Status	Frequency
VOCs not detected in any one sample and not vulnerable.	Repeat in 5 years. ¹
VOCs not detected in any one sample and vulnerable.	Repeat in 3 years. ²
VOCs detected.....	Monthly.

¹ States would annually recertify the vulnerability status of systems. Vulnerability criteria are discussed in Appendix A of this notice.

² Surface water systems sample during four consecutive quarters.

The estimated costs of this option at \$150 per sample are as follows:

Initial round, \$25 million/year (average) for 4 years

Repeat monitoring, \$64 million/year

2. *Option 2.* The federally mandated monitoring requirements would be less stringent under this option than in Option 1. Like Option 1, all systems would monitor at least once over a four year period but fewer samples would be required than in Option 1. The monitoring program would be the same as in Option 1, phased-in based on the size of the population served by the system, i.e.:

System size	Completed by
> 10,000.....	End of 1 year.
3,300 to 10,000.....	End of 2 years.
< 3,300.....	End of 4 years.

- Ground water systems would be required to sample at entry points to the distribution system. The minimum of samples for ground water systems would be one sample per entry point to the distribution system, per quarter for one year. However, if a system was not considered vulnerable to contamination and the first quarterly sample did not detect VOCs, States would have discretion to reduce the sampling requirements to that one sample. In other words, that one sample in that quarter would complete monitoring for that year (and the next 5 years).

- Surface water systems would sample at points representative of each source. The minimum number of samples would be one sample per source, per quarter for one year.

States would have discretion on requiring confirmation samples for positive results.

All systems would be required to conduct repeat monitoring except for surface water systems that were not vulnerable and did not detect any VOCs in the first round of sampling. The frequency of such monitoring would be based on prior monitoring results and the vulnerability of the system to VOC contamination. The monitoring frequency would be as follows:

Status ¹	Ground water	Surface water ²
VOCs not detected and not vulnerable.	Repeat in 5 years.	State discretion.
VOCs not detected and vulnerable.	Repeat in 3 years.	Repeat in 3 years. ²
VOCs detected.....	Quarterly.....	Quarterly.

¹ States would annually recertify the vulnerability status of systems.

² Surface water systems sampled during four consecutive quarters.

States could reduce the repeat monitoring requirements for systems detecting VOCs but at levels less than the MCL from quarterly sampling to no less than yearly sampling after a baseline of data is developed. A minimum of three years of quarterly sampling is considered an adequate time span for gathering these data.

The estimated costs of this option of \$150 per sample are as follows:
Initial round, \$9.3 million/year (average) over 4 years

Repeat monitoring, \$17 million/year

3. *Option 3.* More State discretion is provided under this option than the previous options. All ground water systems would monitor at least once over a five year period. Monitoring of surface water systems would be at State discretion based upon vulnerability. The monitoring program would be phased-in based on the size of the population served by the system as described in the previous options except that systems serving less than 500 people would have five years from the date of promulgation to complete the initial monitoring, i.e.:

Size of system	Complete by
> 10,000.....	End of 1 year.
3,300 to 10,000.....	End of 2 years.
500 to 3,300.....	End of 4 years.
> 500.....	End of 5 years.

Ground water systems would be required to sample at entry points to the distribution system at points representative of each well at least once during the initial monitoring period. States would have discretion on requiring confirmation samples. Specific requirements for surface water systems would be up to State discretion based upon a vulnerability assessment. Repeat compliance monitoring requirements would only be for those systems that detected VOCs in the initial monitoring round. States would have discretion in the frequency of monitoring for those systems where VOCs were not found. The monitoring frequency would be as follows:

Status ¹	Ground water	Surface water
VOCs not detected and not vulnerable.	State discretion.	State discretion.
VOCs not detected and vulnerable.	State discretion.	State discretion.
VOCs detected.....	Annually.....	State discretion.

¹ States would annually recertify the vulnerability status of systems.

The estimated costs of this option at \$150 per sample are as follows:
Initial round, \$3.8 million/year (average) over 5 years

Repeat monitoring, \$2.9 million/year

4. *Selection of Monitoring Requirements.* EPA is proposing Option 2. The phase-in period is shorter than Option 3, as EPA believes that such monitoring should begin and be completed as quickly as feasible given laboratory capacity. Given the variability of VOCs and their long-term risks, quarterly monitoring is deemed to be frequent enough to provide a reasonable representation of contamination and provide adequate health protection. The monitoring requirements are thought to be economically feasible. As an example, a system of 25 people with one well would have annual costs of \$600 or \$2 per month per person. Large system costs per person would be less. The monitoring frequency includes sampling for four consecutive quarters during the monitoring period for surface water systems since variability of surface waters is expected to be influenced more by seasonal and weather conditions. Ground water systems would be required to take four quarterly samples unless the first sample did not detect VOCs and the system was not considered vulnerable; in these cases States could waive the additional three samples. States have the option to reduce the repeat monitoring requirements for vulnerable systems that have detected VOCs at levels less than the MCLs to no less frequent than once a year after a baseline of data is developed. EPA expects that the States will have a major role in implementing these monitoring requirements. Assessments of vulnerability, extent of contamination, and individual system factors will determine the amount of monitoring properly conducted at each system. General guidance on the determination of vulnerability of systems is provided in Appendix A.

B. Determination of Compliance with MCLs

All compliance samples shall be collected on the same day and analyzed according to EPA approved procedures. Compliance with the MCL shall be computed by arithmetically averaging the quarterly values for each sampling point at the end of one year for each source of water. If the average for any source is above the MCL, that system shall be considered out of compliance. This approach is proposed because of the large variations of raw and finished water quality that may occur in a year. In addition, ground water or surface water systems with multiple sources and treatment plants could serve some consumers high levels of VOCs in a

portion of the system over a period of many years. Determination of compliance by averaging the results from various sampling points across the system could mask the higher exposure of these consumers.

C. Public Comments

Public comments are requested on the proposed monitoring requirements and specifically on each of the fundamental questions that address monitoring listed previously. In addition:

- Are the proposed requirements affordable by public water systems, especially small systems?
- Are the frequencies proposed adequate to measure variability of VOCs in the drinking water?
- Is the active role of the States in the proposal a reasonable expectation?
- The proposal for determination of compliance would provide that parts of a system could be out of compliance (and public notice required). This is a distinct change from the Interim Regulations which measured compliance for the entire public water system. Is this approach reasonable to provide maximum protection of the consumers?

VI. Monitoring for Unregulated Contaminants

This section addresses other VOCs for which MCLs and compliance monitoring requirements have not been proposed. Monitoring requirements are being proposed in this notice for these other, "unregulated" VOCs. The discussion below provides background information, describes statutory authority, and explains the proposed requirements.

A. Summary Statement of the Problem

Contamination of drinking water by organic pollutants is recognized as a serious problem across the country. Contamination has been detected through limited federal, State and local monitoring actions. Only a small percentage of systems have actually sampled their water to assess water quality for organic contaminants. Monitoring is currently not being conducted in a comprehensive manner by public water systems which would serve to alert the public to potential health risks in their drinking water and the need for remedial action. Results of compliance monitoring for drinking water standards would provide additional information but implementation of these standards are several years away and will not cover all possible contaminants in drinking water. Moreover, monitoring is necessary to identify additional contaminants which may require

National Primary Drinking Water Regulations.

B. Statutory Authority

The establishment of monitoring regulations is authorized by section 1445(a) of the SDWA which states:

Every person who is a supplier of water, . . . shall establish and maintain such records, make such reports, conduct such monitoring, and provide such information as the Administrator may reasonably require by regulation to assist him in establishing regulations, . . . in evaluating the health risks of unregulated contaminants or in advising the public of such risks.

C. Background

In recent years, numerous organic chemical contaminants have been found in drinking water including volatile synthetic organic chemicals, pesticides, disinfection by-products and other synthetic organic chemicals.

Assessment of the quality of drinking water in the U.S. has been accomplished through various monitoring activities including: (1) Compliance monitoring for the drinking water standards, (2) EPA conducted national statistically designed surveys of selected drinking water supplies, (3) State surveys, (4), responses to contamination, and (5) research studies.

These monitoring activities have been partially successful in determining the quality of the nation's drinking water:

- Widespread contamination potential of public water supplies has been determined to exist through these monitoring efforts. For example:

- About 20 percent of public water systems detected at least a trace of VOCs in the 1000 city ground water survey.
- Sampling of ground waters around hazardous waste sites has identified many synthetic organic chemicals (SOCs) that threaten public water supplies.
- Pesticides in ground and surface waters are the most recent concern as various pesticides have been detected in water supplies across the country; e.g., aldicarb, dibromochloropropane (DBCP), ethylene dibromide (EDB), and alachlor.

However, most small (and many large) public water systems are unaware of possible contamination of their supplies. Except for certain large systems and those in aggressive States, public water systems are not taking initiatives in monitoring for organics in their drinking water. Besides the chemicals that are known, it seems that every few months a new chemical is detected in drinking water that draws

much public attention resulting in a wide variety of responses.

What appears to be needed is a systematic and comprehensive monitoring program that would determine the quality of drinking water in public water systems across the country. This would enhance public awareness of drinking water quality, encourage control actions (when appropriate, before standards could be implemented) and provide the basis for standard setting for additional contaminants.

Major interest in a monitoring program is being shown by Congress in legislation that would require monitoring for unregulated organic chemicals. Congressional debate has focused on the need for more occurrence data for standard setting and for widespread monitoring of unregulated contaminants. The intent of the monitoring requirements discussed by the Congress was: (1) Elevate public awareness regarding the quality of their drinking water, (2) identify problems of gross contamination for immediate remedial action by State and local authorities, and (3) identify additional contaminants for regulation. In Congress' view, requiring monitoring would stimulate interim measures for public health protection until drinking water regulations could be promulgated.

Given the apparent need for a monitoring program, EPA sponsored a public workshop in November 1984, to discuss the need for and specific aspects of possible monitoring regulations for unregulated contaminants in drinking water. Representatives of States, utilities, public interest groups, analytical laboratories and consultants attend the workshop. The universe of organic chemicals considered potential drinking water contaminants was split into two groups for evaluation by the workshop participants:

(a) *VOCs*. Available analytical procedures with modifications can measure up to 50 to 60 VOCs at a cost of about \$150 to \$200 per sample. Depending upon laboratory capabilities (e.g., GC vs. GC/MS) and other requirements such as quality assurance (QA) and confirmation of positives, costs could range up to a maximum of \$400 to \$500 per sample for 50 to 60 VOCs. The analytical capabilities of laboratories have improved over the last few years and laboratories are generally more aware of QA aspects of trace contaminant analyses. Most public water systems serving over 10,000 people are already monitoring for trihalomethanes (TTHMs) using similar analytical procedures.

(b) *Pesticides and other higher molecular weight SOCs*. While some pesticides/SOCs can be measured together, separate analytical techniques are generally required for analysis of pesticides and SOCs. Presently, analytical methodologies and laboratory capabilities are very limited for widespread use. Costs would be in the range of \$1500 to \$2000 per sample.

Workshop participants also carefully reviewed the recent experience in California in which the State legislature enacted legislation requiring monitoring for a large number of VOCs, SOCs and pesticides by public water systems serving greater than 200 service connections. Serious problems have been found in analytical methodology and laboratory capability for many of the pesticides and SOCs required for analysis.

Workshop participants concluded that EPA should develop regulations for monitoring for unregulated contaminants. General recommendations are provided below: (specific recommendations of the workshop are provided in Table 13).

- EPA should initially proceed with development of monitoring regulations for 40 to 50 VOCs at all public water systems.
- Before regulations are set for pesticides and SOCs, EPA should develop additional analytical capabilities, background occurrence and information or vulnerability of systems. Participants felt that because of the expense of monitoring, EPA should develop monitoring regulations such that they apply only to areas vulnerable to pesticide/SOC contamination. The National Pesticide Survey, now in planning, would assist in providing some of this data.
- The workshop did recommend, however, that monitoring could be initiated right away for a limited number of pesticides for which sufficient information is available.

Table 13.—Recommendations of Monitoring Workshop

VOCs

- Require monitoring by all community systems for at least 50 VOCs.
- Sample each well or surface water source in distribution system.
- Repeat monitoring every 3 years for all systems.
- Repeat annually for positives above an action level.
- State can modify based upon vulnerability assessment.

- Positive results: confirm by follow-up sample.

- Report to public all confirmed results. Report all results to State and EPA.

- Provide Health Advisories to enable public to understand the potential health risks.

SOCs/Pesticides

- Conduct national survey prior to development of monitoring regulations

- Costs of all systems to do all SOCs/Pesticides prohibitive (\$1500 to \$2000 per sample)

- Sensible approach: directed monitoring for those SOCs/Pesticides most likely to be present

- Survey should be conducted to collect data on occurrence and vulnerability to contamination

Alternate Approach to SOCs/Pesticides

- Set monitoring regulations where States have great flexibility to design program

- Require a number of screening tests (4 to 6) and evaluate unidentified peaks

- States can add/delete chemicals from list based on previous monitoring experience, usage and production patterns

- One sample per system (composites from different wells-OK)

- Phase in over 4 years

- Surface water systems: quarterly for 1 year. Composite sample for seasonal variations

- Sufficient laboratory capability exists

- Confirmed positives along with Health Advisories should be reported to the public in press releases or reports. Not in water bills.

The National Drinking Water Advisory Council (NDWAC) considered this issue in its December 1984 meeting and recommended that a systematic national monitoring program for unregulated VOCs and pesticides/SOCs be implemented. The NDWAC emphasized the need for VOC monitoring and monitoring for a limited number of pesticides for which sufficient analytical capabilities exist. Monitoring regulations for other pesticides/SOCs would follow as analytical methods and occurrence and health data become available.

D. Summary of Proposal

Because similar analytical procedures for the nine VOCs can also measure numerous other VOCs at relative small additional costs, monitoring regulations are being proposed for other VOCs in this notice. Monitoring for most pesticides and other SOCs is more costly and additional time is needed to

develop analytical methods and baseline occurrence data (i.e., which pesticides should be monitoring for and in what locations) such that directed monitoring requirements can be developed (i.e., only those systems vulnerable to contamination would be required to monitor). The National Pesticides Survey will provide much of this preliminary data.

1. Selection of Contaminants

Two approaches have been considered in the selection of specific VOCs to be included in a monitoring regulation. The first and most comprehensive approach is to include all VOCs that can be detected (without complicating analytical problems) using the purge and trap gas chromatography techniques described in Section III of this proposal. Table 14 provides a list of the VOCs that can potentially be included as part of this proposal. The second approach considered is to include only those VOCs which have been detected in drinking water supplies to date and which have known and potential adverse health effects of human exposure. EPA believes that the monitoring efforts should include all chemicals: (1) That have been detected or are likely to occur in drinking water, (2) that have not been ruled out as posing no adverse health risk, and (3) that can be measured with little additional analytical effort. EPA is proposing that the VOCs listed in Table 14 be included in monitoring requirements as part of this proposal. The compounds included are:

- Four trihalomethanes (identified in the November 29, 1979 Federal Register and regulated in CWS serving more than 10,000 persons);

- Additional VOCs being considered for later phases of the Revised Regulations;

- VOCs not included above but detected in the Ground Water Supply Survey and various federal and State surveys.

- Other VOCs based upon their potential for occurrence in drinking water: VOCs detected in waste waters, surface or ground waters or have widespread dispersive use patterns and high production; and

- Other VOCs based upon ease of analytical determinations. The VOCs in Table 14 can be measured in a single analysis by GC/MS or by two separate analyses using GC. Estimated costs are \$150 to \$200 for the GC/MS, and for the two GC analyses \$100 per GC analysis is a useful rule for estimating costs. Some cost savings are expected by laboratories if detectors are used in

series, thus requiring only one GC analysis. The two analyses include:

- Purgeable halogenated hydrocarbons

- Purgeable aromatics

The analysis of highly volatile substances can be accomplished using the procedures for the purgeable hydrocarbons through minor adaptations (e.g., change the trapping device).

EPA requests comments on the specific contaminants listed in Table 14 and whether additional contaminants besides the 51 in this proposal should also be included, such as synthetic organic chemicals or pesticides. Development of Health Advisories for each of the VOCs is planned to coincide with the implementation of the monitoring requirements. Health Advisories are non-regulatory guidance on the health risks of exposure to contaminants in drinking water for various durations of exposure.

Monitoring for EDB and DBCP (compounds requiring low limits of detection) requires special analysis estimated to cost an additional \$50 per sample. Monitoring for EDB and DBCP will only be required for systems considered to be vulnerable to EDB or DBCP contamination. Procedures are currently being used by EPA, State and contract laboratories to nominally analyze for EDB and DBCP to 20 ng/l. These procedures are based on co-distillation or liquid-liquid extraction followed by GC analysis using electron capture detection. A draft method now available for EDB and DBCP analyses is Method 504, Measurement of 1,2-Dibromomethane (EDB) and 1,2-Dibromo-3-chloropropane (DBCP) in Drinking Water by Microextraction and Gas Chromatography, August 1985, available from the Environmental Monitoring and Support Laboratory, U.S. EPA, Cincinnati, Ohio 45268. Public comments are requested on the availability and adequacy of procedures for routine monitoring for EDB and DBCP. Also, public comments on analytical costs and precision and accuracy of analysis at these levels are requested.

Table 14.—VOCs Proposed in Monitoring Regulations for Unregulated VOCs

Chloroform
Bromodichloromethane
Chlorodibromomethane
Bromoform
trans-1,2-Dichloroethylene
Chlorobenzene
m-Dichlorobenzene
Dichloromethane

cis-1,2-Dichloroethylene
 o-Dichlorobenzene
 1,2,4-Trichlorobenzene
 Fluorotrichloromethane
 Dichlorodifluoromethane
 Dibromomethane
 1,2-Dibromoethane (EDB)
 1,2-Dibromo-3-chloropropane (DBCP)
 Toluene
 p-Xylene
 o-Xylene
 m-Xylene
 1,1-Dichloroethane
 1,2-Dichloropropane
 1,1,1,2-Tetrachloroethane
 Ethylbenzene
 1,3-Dichloropropane
 Styrene
 Chloromethane
 Bromomethane
 Bromochloromethane
 1,2,3-Trichloropropane
 1,2,3-Trichlorobenzene
 n-Propylbenzene
 1,1,1,2-Tetrachloroethane
 Chloroethane
 1,1,2-Trichloroethane
 Pentachloroethane
 bis-2-Chloroisopropyl ether
 sec-Dichloropropane
 1,2,4-Trimethylbenzene
 n-Butylbenzene
 Naphthalene
 hexachlorobutadiene
 o-Chlorotoluene
 p-Chlorotoluene
 1,3,5-Trimethylbenzene
 p-Isopropyltoluene
 1,1-Dichloropropane
 iso-Propylbenzene
 tert-Butylbenzene
 sec-Butylbenzene
 Bromobenzene

Analysis for unregulated contaminants must be conducted in laboratories certified by the State. Because the monitoring for unregulated contaminants will be required before full certification programs can be implemented, interim certification will be provided to those laboratories that are: (1) Presently certified for trihalomethane analyses and, (2) able to analyze performance evaluation samples for additional VOCs within acceptable limits ($\pm 20\%$, $\pm 40\%$).

2. Proposed Monitoring Requirements for Unregulated VOCs

Three options for the establishment of minimum monitoring requirements were considered for unregulated VOCs. These options are similar to those described for VOC compliance monitoring (Section IV of this proposal). The options range from an extensive federally mandated specific monitoring program to monitoring program whose specifics (e.g., repeat monitoring frequencies)

would be largely determined by the States. The second option below is being proposed because EPA considers that such a monitoring program provides reasonable minimum federal requirements and allows for State discretion in their application. Of course, systems need not monitor for unregulated contaminants as frequently.

Insofar as possible, the monitoring requirements for unregulated VOCs will be similar to those proposed for compliance monitoring under the NPDWR so that systems will be allowed to use the same samples for analysis of both the VOCs in Table 14 and the VOCs for which MCLs are proposed. In addition provisions for "grandfathering" previous data for acceptable quality are included. The three options for minimum federally mandated monitoring requirements outlined below generally correspond to the three options described earlier for compliance monitoring for the VOCs in this proposal. Appendix B provides additional details on each of the options.

a. Option 1. This option proposes relatively stringent monitoring requirements and includes minimum repeat monitoring for all systems. The monitoring program would be phased-in over a four year period based on the size of the population served by the water system in a similar manner as described under Option 1 of the proposed compliance monitoring requirements. Ground water systems would be required to sample once at the well head. Surface water systems would be required to sample quarterly for one year in the distribution system at points representative of each source. All systems would be required to resample positive samples. All systems would be required to repeat monitoring every 10 years.

b. Option 2. This option is the same as Option 1 above except that it provides for State discretion on resampling positive results; repeat monitoring requirements would not be required but would be at State discretion.

c. Option 3. Under this option all systems would monitor once over a five-year period. Monitoring would be phased-in by the size of population served by the water system as described under Option 3 of the compliance monitoring requirements. Ground water systems would be required to randomly sample only 25 percent of their wells and the sampling would be done at the well head. The State would have discretion on whether to require confirmation samples. Also, States would have discretion on whether to require surface water systems to monitor based upon a vulnerability

assessment. There is no repeat monitoring requirement under this option.

Estimated additional monitoring costs for the three options are shown in Table 15. These costs are based on the assumption that water supply systems will opt to monitor for compliance with MCLs and for unregulated VOCs simultaneously. Details are presented in the Methods/Monitoring Document referenced in Section IX.

TABLE 15.—COSTS FOR MONITORING OF UNREGULATED VOCs
 (In millions of dollars)

	Option 1	Option 2 ¹	Option 3 ²
Initial Round.....	\$2.7	\$2.3	\$0.5
Repeat Monitoring.....	2.7	0	0

¹ Over 4 years.
² Over 5 years.

d. Selection of Monitoring Requirements. Option 2 is being proposed and Table 16 summarizes the proposed monitoring requirements. As discussed above, one sample for every well is felt to be needed to collect representative data; geologic conditions, pumping patterns, and other factors are known to result in variations between wells in the same well field (e.g., certain wells are contaminated but another close by well is not). The variability in concentration levels is also known to vary but it is felt that one sample should determine if the well is contaminated by VOCs; the levels may vary but the VOC analysis will detect if VOCs are present. Confirmatory analyses and follow-up actions by the State would be expected to determine the more precise nature of the contamination.

TABLE 16.—PROPOSED MONITORING REQUIREMENTS FOR UNREGULATED VOCs

Initial Monitoring

- All systems monitor once over four years
- Requirements are by system size:

Size of System	Complete by End of
> 10,000.....	1 year.
3,300 to 10,000.....	2 years.
< 3,300.....	4 years.

- Ground Water Systems: One sample entry point to distribution system.
- Surface Water Systems: Quarterly samples per each source for one year at points in distribution system representative of each source.

Repeat Monitoring

- State discretion for repeat sampling; dependent upon vulnerability and results of first round of monitoring.

EPA is proposing to implement this option through a new regulation to be codified at 40 CFR 141.40. EPA would delete existing § 141.40, "Special monitoring for organic chemicals". This regulation was adopted in 1975 to allow

the Agency to require designated systems to conduct monitoring for specified organic chemicals. Because the new regulation provides a comprehensive scheme for monitoring for VOCs, old § 141.40 will be deleted. EPA intends to propose more monitoring requirements for other organic and inorganic contaminants which will appear as a subsection to § 141.40 or as a new section in Subpart E of Part 141.

States are expected to play a major role in implementation of these monitoring requirements especially in activities following the first round of sampling. Depending upon the vulnerability of systems and results of the first sampling, States are encouraged to require confirmation of contamination and assist in remedial measures for removal of these contaminants from drinking water.

Public comments are requested on the need for monitoring for unregulated contaminants and on specific aspects of the proposed requirements. For example, public comments are specifically requested on if repeat monitoring requirements should be set at every 10 years or some other period or if State discretion is sufficient for repeat monitoring.

VII. Reporting Requirements

The Interim Regulations currently require public water systems to report monitoring data to States within specified time periods. No changes are being proposed in those requirements for the Revised Regulations. Public comments are requested on those requirements and whether they should be changed.

For monitoring unregulated VOCs, requirements are proposed such that public water systems will report the analytical results of the unregulated contaminants to either: (a) The State, if the State has adopted the monitoring requirements for the unregulated contaminants, equivalent to those required by the federal regulations, or (b) to EPA if the State has not adopted equivalent monitoring requirements. Any State which adopts equivalent monitoring requirements will be asked to submit all of the information to EPA so that EPA can compile a nationwide file on the occurrences and levels of these unregulated contaminants. EPA intends to use the analytical results to evaluate the health risks of the contaminants and believes it is necessary to have all available results.

The data collection approach proposed here is believed to be the most reasonable one available as it is the least burdensome on the water systems. It assumes, however, that States which

have adopted monitoring requirements for the unregulated contaminants will provide all of the collected analytical results to EPA.

An option to this proposal in order to insure that EPA receives all such analyses, is to establish regulations to require system to submit these monitoring results to EPA regardless of whether the State has adopted the equivalent regulations. Water systems in a State which had adopted monitoring requirements for unregulated contaminants could thus be required to submit such results twice: once to the State and once to EPA. Public comments are requested on these two options.

VIII. Public Notice Requirements

Current regulations at 40 CFR 141.32 require that any violation of a maximum contaminant level, failure to comply with an applicable monitoring provision, or failure to comply with any monitoring required pursuant to section 1445(a) of the Act be reported to the persons served by the water system. No change to those requirements are being proposed for the VOCs. The regulations are very specific in when, where, and who, and how the public notification is to be made. These requirements were based upon very specific directions in the SDWA, Section 1414. Some problems with effective notification have been experienced primarily because of the specificity of the requirements. Added flexibility appears to be needed and is currently under consideration in reauthorization of the SDWA. If the SDWA is amended in the area of public notification, the regulations would be modified as appropriate.

Section 1413 provides authority for EPA to require public notification of the results of monitoring for unregulated contaminants. It also gives the Agency the authority to prescribe the form and content of the public notification. Under this section and sections 1445(a) and 1450(a), EPA has the authority to direct to whom monitoring results should be sent.

Regulations are proposed today (proposed § 141.34) for unregulated VOCs and include a provision which would require the supplier to notify his/her consumers of the availability of the analytical results of the unregulated contaminant monitoring. The proposed regulations would also require the supplier to submit a representative copy of each public notification to either the State (if it has adopted the monitoring requirements for the unregulated contaminants), or EPA (if the State has not adopted equivalent monitoring requirements). These requirements

would meet the SDWA objective of providing information on drinking water contamination to consumers of that water. Public comment is requested on the following:

- Should the notification tell the users that monitoring was conducted and that the results are available to interested parties?
- Should the notification give specific detail on the contaminants monitored, the results and the anticipated health significance of the presence of the contaminants?
- Who should be notified of the monitoring program and the analytical results, and how should the notification, be conducted (i.e., newspaper or media notification, written notice with water bill)?
- How much time should elapse between the supplier's receipt of the analytical results and the notification of the users that the results are available?
- How frequently should the notification occur?

IX. Economic Impact Assessment

An impact assessment has been prepared and is entitled "Economic Impact Analysis of Proposed Regulations to Control Volatile Synthetic Organic Chemicals (VOCs) in Drinking Water" (see section X). The assessment was prepared in response to Executive Order (E.O.) No. 12291 which requires the Agency to consider costs and benefits for all regulations. It was determined that this regulation was not a major regulation, that a Regulatory Impact Analysis was not needed, and that only an economic impact analysis was needed. The analyses in the report are based on the documents prepared by the Agency which present information on health effects, contamination occurrence, the cost and technology of contaminant removal and analytical methods. As required by E.O. 12291, this information was evaluated to permit estimation of the benefits and costs of regulatory alternatives. Also included are analyses required by the Regulatory Flexibility Act and the Paperwork Reduction Act.

E.O. 12291 does not distinguish between the legislative authority of various statutes but requires the same kinds of information in each analysis. Therefore as a result, some of the information and analyses presented in the analysis have been conducted to meet the specific requirements of E.O. 12291 regarding cost/benefit analysis and were not used in determination of the MCLs. The SDWA requires setting MCLs with use of best generally available technology (taking costs into

consideration); according to legislative history, costs are to be determined by what is reasonably affordable for large metropolitan water systems. However, in many instances, drinking water regulations will provide net benefits, despite the fact that the MCLs are not required to be set using a cost-benefit approach. Information on costs and benefits required by E.O. 12291 is useful to EPA and the public in estimating the impact of the drinking water regulations. The data presented below summarize the impact assessment.

A. Alternatives Examined

The impact assessment examines several regulatory alternatives. Those presented in this notice reflect the viable alternatives which received serious consideration throughout the decision-making process. The MCL alternatives evaluated reflect drinking water concentrations of 1, 5 and 10 $\mu\text{g}/\text{l}$ for each of the potential carcinogenic contaminants. While none of these alternatives is identical to the proposed rule, the 5 $\mu\text{g}/\text{l}$ alternative is considered essentially the same. The analysis presents further data on alternatives from 0.5 $\mu\text{g}/\text{l}$ to 100 $\mu\text{g}/\text{l}$, and also includes alternatives based on risk rather than feasibility.

B. Economic Impacts

Table 17 presents the economic impacts associated with three alternatives. Approximately 1,300 community water supplies would be expected to exceed the proposed standards. If nearly all these systems took action to comply with the proposed regulations, the total cost to the nation for treatment would be about \$280 million. On an annual basis the cost of treatment would be about \$21 million per year. As presented in Table 17, the "total social cost" is the present year value-constant dollar cost of the proposals over a twenty year period and includes both capital and annual costs. Imbedded in these estimates are the assumptions that capital costs are all incurred in the first year, and an inflation free discount rate of 4.4 percent (applied to annual operation and maintenance costs).

The "annualized costs" is a constant dollar estimate of the capital cost (amortized at 4.4%) plus the annual operation and maintenance costs. These costs are also inflation free.

The cost impacts on water systems and consumers affected by volatile organic contamination vary depending upon the size of the utility. Very small systems which serve from 25 to 500 people could be expected to increase their water rates by less than 60 cents

per 1,000 gallons of water. As a result of economies of scale, large systems serving more than 50,000 people could be expected to increase their rates only about 2 cents per thousand gallons. These increases would only affect systems with contaminant levels above the proposed standard.

A typical family served by a very small water system could expect to spend about \$91 more each year in order to receive safer drinking water. A family living in a large community would pay only about \$3 more each year. Again, these costs would only affect families receiving water that is not contaminated at levels above the proposed standard.

Examination of Table 17, and the Economic Impact Assessment, shows that the cost to the system or the family is not significantly different for the various regulatory alternatives. If a system does take action to reduce volatile organic contamination in its drinking water, the basic cost of implementing a change in water treatment or supply is not very sensitive to the treatment removal efficiency. The reason the national costs vary is that with lower concentration alternatives there are more systems who would have to implement treatment. This analysis of national costs only reflects the economic impacts of selected MCL ranges and was not used to determine the MCLs.

The cost impacts on State governments are also presented in the assessment. While the cost to any particular State of managing the proposed regulations would depend on the number of systems in the State, the total cost to all States would be approximately \$4 million in the first year and \$2 million in each succeeding year. On average, this is less than \$100,000 per State in the first year and less than \$50,000 per State in the following years.

This notice also proposes a monitoring program which will be used to determine compliance with the regulation as well as examine whether other volatile organic contaminants are present. The cost of the compliance monitoring is shared by all water systems in the nation. For those which find at least one of the nine regulated chemicals additional follow-up monitoring will be required. In addition, all systems will look for unregulated volatile contaminants as well, but no follow-up monitoring will be required. The initial round of compliance monitoring will be phased in over a period of four years.

The total cost of the initial round will be about \$9.3 million per year. The follow-up monitoring will cost about \$19 million per year for the first few years. Monitoring for unregulated

contaminants will be done simultaneously with the initial round of compliance monitoring and will cost about \$2.3 million per year.

C. Benefits

The risk posed by certain volatile organic contaminants found in drinking water is, in the main, cancer; other chronic toxic effects are also posed. Drinking water standards will ensure that water systems react to contamination properly. It will require action on contaminated water systems and provide appropriate targets for clean-up of contaminated drinking water supplies. The impact assessment presents information on the level of benefits associated with the various alternatives as well as comparisons of the benefits and costs of each.

The proposed regulation is expected to reduce the amount of new cancer that might arise each year by about 32 cases in the worst case scenario. Much of this benefit (about 29 cases) is attributable to control of the potentially extremely potent carcinogen vinyl chloride. It should be remembered that vinyl chloride appears only to be found with other contaminants, and may result from the *in situ* biodegradation of some of them. Therefore, control of the risk posed by vinyl chloride may require control of the potential precursor contaminants, especially since significant benefits arise from control of vinyl chloride even when it is present only at very low levels. In the absence of standards for the other volatile contaminants, many of the benefits of vinyl chloride removal probably would not arise.

The Economic Impact Assessment devotes significant attention to the issue of costs of controlling volatile organic contaminants and the benefits of control. As one would expect, when only a few people are served by a contaminated system, the cost per case of disease avoided can be quite large. Table 17 presents the average cost per case of disease for each alternative regulation, broken out by system size. The cost per case for the proposed regulation varies from \$200,000 to \$5 million per case, depending on system size.

D. Uncertainty

Computations of the benefits or costs associated with a proposal are subject to error from many sources. The result depends on estimates of a number of contributing factors, each of which is imperfectly known to a greater or lesser degree. More importantly, some contribute significantly to uncertainty in

estimates while others are relatively unimportant. Risk calculations can vary over orders of magnitude depending upon which risk extrapolation model is used. As discussed in the June 12, 1984 proposal, while the uncertainties are large (i.e., orders of magnitude), risk models are the best available scientific means for estimating risk of human exposure. When computing benefits, if the uncertainties in the risk extrapolation calculation are not included, the uncertainty was found to be dominated by the errors in the exposure data; i.e., there is a 95 percent likelihood that the true value of the benefits of the proposed MCL is within the range of 10 to 60 cases per year.

In like measure a major contribution to the uncertainty in cost estimates is error in the occurrence data. However, other factors such as the probability of treatment selection also contribute significantly. Much like the benefits calculation computation of the national costs followed a specific mathematical equation. The Economic Impact Assessment describes both equations as well as the importance of each element on the resultant uncertainty. The resulting analysis suggests there is a 95 percent likelihood that the true value of annual national costs of the proposed MCL is within the range of \$0 to \$45 million.

E. Major Rules

Under Executive Order 12291, EPA must judge whether a regulation is "major" and therefore subject to the requirements of a Regulatory Impact Analysis. This proposed action does not constitute a "major" regulatory action because it will not have a major financial or adverse impact on the community. However, an Economic Impact Analysis was prepared during the regulation development and this regulation was submitted to the Office of Management and Budget for review.

F. Regulatory Flexibility Analysis

The Regulatory Flexibility Act requires EPA to explicitly consider the effect of proposed regulations on small entities. If there is a significant effect on a substantial number of small systems, means should be sought to minimize the effects.

Under the Regulatory Flexibility Act, 5 U.S.C. 601 *et seq.*, I certify that this proposed rule will not have a significant effect on a substantial number of small entities. The Small Business Administration defines a small water utility as one which serves fewer than 50,000 people. There are about 58,500 systems which, for the purposes of this analysis, are considered small systems.

Of course, this analysis under the Regulatory Flexibility Act is to portray the regulated community against other U.S. entities. In this regard, most public water systems are considered small. Of the 58,500 small systems fewer than 1,300 are likely to have contamination levels greater than the proposed MCL. This proposal would regulate less than 3 percent of the "small" systems and this does not constitute a substantial number of small systems. In addition, the cost impacts on systems will lead to increases in water rates of no more than 20 percent, and more typically less than 10 percent.

G. Paperwork Analysis

The Paperwork Reduction Act seeks to minimize the reporting burden on the regulated community as well minimize the cost of federal information collection and dissemination. The information collection proposed by this rule is of two types. Monitoring is proposed which will indicate if a water utility is in compliance with the proposed standard. There is no way to determine if a water is safe to drink without such monitoring.

The second type of information collected is monitoring data on contaminants which are not now regulated. This proposal would provide all of the people in the nation served by community water systems information on whether there are important chemical pollutants in their water. The importance of this monitoring is described in the section on monitoring for unregulated contaminants. The cost of the proposed monitoring is shown in Table 17.

TABLE 17.—SUMMARY OF IMPACTS OF THE REGULATORY OPTIONS

	Regulatory options		
	1 µg/l	5 µg/l	10 µg/l
Systems Impacted, National			
Cost of Control.....	3,800	1,300	800
Total social cost (dollar in millions).....	\$1,300	\$280	\$150
Annualized cost (dollar in millions).....	100	21	11
National Cost of Monitoring:			
Compliance (dollar in millions/year—4 years).....		\$9.3	
Unregulated Contaminants (dollar in millions/year).....		2.3	
Annual Cost per Family (dollar per year) System Size (people served):			
Very Small (25-500).....	\$96	\$91	\$90
Small (501-3,300).....	47	41	42
Medium (3,301-50,000).....	12	12	11
Large (over 50,000).....	8	3	1
Typical Rate Increases (dollar per 1,000 gal):			
Very Small (25-500).....	\$0.58	\$0.54	\$0.58
Small (501-3,300).....	0.33	0.29	0.29
Medium (3,301-50,000).....	0.07	0.07	0.07
Large (over 50,000).....	0.04	0.02	0.01
Annual Cancer Cases Avoided:			
Total.....	42	32	31
Attributable to Vinyl Chloride.....	37	29	27

TABLE 17.—SUMMARY OF IMPACTS OF THE REGULATORY OPTIONS—Continued

Average Cost/Case Avoided (dollar in millions):	Regulatory options		
	1 µg/l	5 µg/l	10 µg/l
Very Small (25-500).....	\$10	\$5	\$4
Small (501-3,300).....	7	3	2
Medium (3,301-50,000).....	2	0.6	0.4
Large (over 50,000).....	2	0.2	0.04

X. Public Docket/References

Public comments, supporting documents and the index to the public docket are maintained at EPA in Room 2904 (rear). All other supporting materials pertinent to the development of this proposal are included in the public docket located at EPA headquarters, Washington, D.C. The public docket is available to the public and the public should contact the Drinking Water Regulations Docket Manager (Ms. Kitty Miller, 202/382-3022) for access. Materials in the public docket include such documents as the following:

- Public comments on the ANPRM and Proposed Rulemaking for RMCLs
- Transcript of public meetings
- Report and background material for the four public workshops, Summer 1982
- Transcripts and meetings of NDWAC meetings
- Summaries of meetings, telephone calls from outside EPA
- Letters to/from the public
- Technical reports
- Other supporting materials

The following supporting documentation for this proposal is available on request from the address (NTIS) listed at the beginning of this notice.

Environmental Science and Engineering. Technologies and Cost for the Removal of Volatile Organic Chemicals from Potable Water Supplies. May 1985.
 EPA, Criteria and Standards Division, Analytical Methods/Monitoring for VOCs in Drinking Water. October 1985.
 EPA, Summary of Available Information Related to the Occurrence of Vinyl Chloride in Ground Water as a Transformation Product of other Volatile Organic Chemicals. October 1985.

Other pertinent references available in the public docket include the following:

EPA, EMSL. "Volatile Aromatic and Unsaturated Organic Compounds in Water by Purge and Trap Gas Chromatography. Method 503.1". September 1984.
 EPA, EMSL. "Volatile Organic Compounds in Water by Purge and Trap Gas Chromatography/Mass Spectrometry. Method 524.1". May 1985.

EPA, EMSL. "Volatile Halogenated Organic Compounds in Water by Purge and Trap Gas Chromatography. Method 502.1". September 1984.

EPA, Office of Program Development and Evaluation, Economic Impact Analysis of Proposed Regulations to Control Volatile Synthetic Organic Chemicals (VOCs) in Drinking Water. October 1985.

XI. Request for Public Comment

EPA requests public comments and relevant information on all aspects of the proposed regulations. The questions for which comment is being specifically solicited have been provided in the above discussion; several additional questions are listed below. Comment will be of great assistance to EPA in formulating a protective and practical approach to reducing human exposure to VOCs in drinking water.

- Do the MCLs represent a level "as close to the RMCL as feasible"?
- Is the methodology for determining the MCLs appropriate?
- Are the levels set for the MCLs feasible?
- Are the costs of meeting the MCLs reasonable?
- Should packed tower aeration and granular activated carbon be considered best available technologies for determination of the MCLs?
- Is it reasonable to assume up to 99 percent removal for packed tower aeration for the nine VOCs (up to 99.9% for vinyl chloride)?
- Are the costs of treatment sufficiently accurate? Do they reasonably represent what could be expected in real-world situations?
- Should point-of-use or point-of-entry GAC adsorption devices be considered as available technology suitable for meeting the proposed MCLs?
- Are the proposed criteria adequate for protection of public health?
- Can the utility and primary agency assure that point-of-use/entry treatment will afford protection equivalent to central treatment?
- Bottled water has been rejected as an acceptable means of meeting MCLs on a permanent basis. Is this reasonable under the SDWA?
- Is the approach to setting PQLs reasonable?
- Is the use of $\pm 40\%$ acceptance limits a useful and valid criterion to set PQLs for VOCs.
- In the absence of sufficient information/data on inter-laboratory studies, is the use of 5 to 10 times the MDL a reasonable approach to determine the PQL?
- Are PQLs of 5 $\mu\text{g}/1$ for eight of the VOCs and a PQL of 1 $\mu\text{g}/1$ for vinyl chloride reasonable?

- Are the monitoring costs (\$150–\$200/sample) representative of actual costs?

- Do the proposed compliance monitoring requirements serve the purpose of insuring that high quality water is available?

- Is the proposal for monitoring for unregulated VOCs reasonable? Should pesticides and other SOCs be included at this time? Should repeat monitoring be established at 10 year intervals or should repeat monitoring be left to State discretion?

- Is there any information to suggest that there is a significant occurrence of vinyl chloride in ground water that is not the result of *in situ* transformation?

A public meeting will be held for the interested public to comment and provide information and data on the proposed MCLs, compliance monitoring, reporting and public notice requirements and monitoring for unregulated VOCs. The date and location of the meeting are provided in the Dates section of this notice.

List of Subjects

40 CFR Part 141

Chemicals, Intergovernmental relations, Radiation protection, Reporting and record keeping requirements, Water supply.

40 CFR Part 142

Administrative practice and procedure, Chemicals, Radiation protection, Reporting and recordkeeping Requirements, Intergovernmental relations, and Water supply.

Dated: October 10, 1985.

Lee Thomas,
Administrator.

For the reasons set out in the preamble, Parts 141 and 142 of Title 40, Code of Federal Regulations is proposed to be amended as set forth below.

PART 141—[AMENDED]

1. The authority citation for Part 141 continues to read as follows:

Authority: 42 U.S.C. 300g-1, 300g-3, 300j-4, and 300j-9.

§ 141.2 [Amended]

2. In § 141.2, new paragraphs (v) and (w) are proposed to be added to read as follows:

* * * * *

(v) A point of use treatment device is a treatment device applied to a single tap used for the purpose of reducing contaminants in drinking water at that one tap.

(w) A point of entry treatment device is a treatment device applied to the

drinking water entering a house or building for the purpose of reducing contaminants in the drinking water distributed throughout the house or building.

3. It is proposed that a new paragraph (g) be added to § 141.24 to read as follows:

§ 141.24 Organic Chemicals Other than total trihalomethanes, sampling and analytical requirements.

* * * * *

(g) Analysis of the contaminants listed in § 141.61(a)(1)–(9) for purposes of determining compliance with the maximum contaminant levels shall be conducted as follows:

(1) Surface water systems shall sample at points in the distribution system representative of each source. The minimum number of samples is one sample every three months for one year per source. Sampling must be conducted at the same location or a more representative location each quarter.

(2) Ground water systems shall sample at points of entry to the system representative of each wells. Sampling must be conducted at the same location or a more representative location each quarter. The minimum number of samples is one sample every three months for one year per entry point to the distribution system. If VOCs listed in § 141.61(a) or in § 141.40(e) are not detected in the first sample and the system is not considered vulnerable, as defined in paragraph (g)(6)(iv) of this section the State may waive further sampling but may not waive the requirements of (g)(6) of this section.

(3) Systems that detect the VOCs listed in § 141.61(a)(1)–(8) or in § 141.40(e) following the procedures listed in paragraphs (g)(9) and (g)(10) of this section in any sample must commence monitoring following the requirements of paragraphs (g)(1) and (g)(2) of this section.

(4) All community water systems serving more than 10,000 people, shall analyze all distribution or entry-point samples, as appropriate representing all source waters within one year of the date of promulgation of this regulation. All community water systems serving from 3,300 to 10,000 people, shall analyze all distribution or entry-point samples as appropriate, representing source waters within two years of the date of promulgation of this regulation. All other community water systems shall analyze distribution or entry-point samples, as appropriate, representing all source waters within four years of the date of promulgation.

(5) The State may require confirmation samples for positive or

negative results, on written notice to the system by regulation.

(6) Analysis for vinyl chloride is required only of ground water systems that have detected one or more of the following VOCs: Trichloroethylene, tetrachloroethylene, 1, 2-dichloroethane, 1, 1, 1-trichloroethane, cis-1, 2-dichloroethylene, trans-1, 2-dichloroethylene, or 1, 1-dichloroethylene. Surface water systems may be required to analyze for vinyl chloride at the discretion of the State.

(7) All ground water systems and surface water systems shall conduct repeat monitoring.

(i) The repeat monitoring frequency for ground water systems is as follows:

- VOCs not detected and system not vulnerable—Repeat in 5 years
- VOCs not detected and system vulnerable—Repeat in 3 years
- VOCs detected—Quarterly, as required under (g)(1) of this section

(ii) The repeat monitoring frequency for surface water systems is as follows:

- VOCs not detected and not vulnerable—State discretion
- VOCs not detected and vulnerable—Repeat in 3 years
- VOCs detected—Quarterly, as required under (g)(2) of this section

Surface water supplies shall monitor four consecutive quarters during the monitoring period.

(iii) States may reduce to once per year the repeat monitoring requirements for systems detecting VOCs at levels consistently less than the MCL for three consecutive years.

(iv) Vulnerability shall be determined by the State based upon an assessment of the following factors:

- (A) Previous monitoring results.
- (B) Number of persons served by public water system.
- (C) Proximity of a smaller system to a larger system.
- (D) Proximity to commercial or industrial use of VOCs.
- (E) Protection of the water source.

(v) A system is deemed to be vulnerable for a period of three years after any positive measurement of one or more VOCs listed in either § 141.61(a) or § 141.40(e) except for trihalomethanes or other demonstrated disinfection by-products.

(8) Compliance with § 141.61(a) shall be determined by arithmetically averaging the results of quarterly sampling over a one-year period for each sampling location. If one location's average is greater than the MCL then the system shall be deemed to be out of compliance.

(9) Analysis under this paragraph shall be conducted using EPA methods 502.1, "Volatile Halogenated Organic Chemicals in Water by Purge and Trap Gas Chromatography"; 503.1, "Volatile Aromatic and Unsaturated Organic Compounds in Water by Purge and Trap Gas Chromatography"; or 524.1, "Volatile Organic Compounds in Water by Purge and Trap Gas Chromatography/Mass Spectrometry." These methods are contained in "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water," June 1985, available from Environmental Monitoring and Support Laboratory (EMSL), EPA, Cincinnati, Ohio.

(10) Analysis under this section shall only be conducted by laboratories that have analyzed Performance Evaluation samples provided by EMSL to within ±40% of the reference value at concentrations below 100 µg/l and within ±20% of the reference value at concentrations at 100 µg/l and above.

(11) States have the authority to use monitoring data collected up to three years prior to the effective date of this regulation for purposes of determining compliance with the MCLs provided that requirements in this paragraph are met.

(12) States may increase monitoring where necessary to detect variations within the system.

(13) The State has the authority to determine compliance or initiate enforcement action based upon analytical results and other information compiled by their sanctioned representatives and agencies.

4. It is proposed that § 141.32 be amended by *revising the first clause of paragraph (a)* as follows:

§ 141.32 Public notification.

(a) If a community water system fails to comply with an applicable maximum contaminant level established in Subpart B or G, . . . * * *

5. It is proposed that a new § 141.34 be added to Subpart D of Part 141 to read as follows:

§ 141.34 Reporting and public notification for certain unregulated contaminants.

(a) The requirements of this section only apply to the contaminants listed in § 141.40.

(b) Public water systems required to monitor under § 141.40 shall send a copy of the results of such monitoring within 30 days of receipt and any public notice under paragraph (c) of this section to the State, if the State has adopted regulations equivalent to § 141.40 and

this section or to EPA if such regulations have not been adopted.

(c) The supplier of water shall notify persons served by the system of the availability of the results by including a notice in the first set of water bills issued by the system after the receipt of the results, and in any event by written notice within three months. If the system issues water bills less frequently than quarterly, or does not issue water bills, the notice shall be made by or supplemented by another form of direct mail. The notice shall specify a person to contact for information on the monitoring results.

6. It is proposed that 40 CFR 141.40 be revised to read as follows:

§ 141.40 Special monitoring for organic chemicals.

(a) All community water systems shall monitor for the contaminants listed in paragraph (e) in this section as follows:

Number of persons served	Monitoring completion date
Over 10,000.....	Within 1 year of promulgation.
3,300 to 10,000.....	Within 2 years of promulgation.
Less than 3,300.....	Within 4 years of promulgation.

(b) Surface water systems shall sample in the distribution system at entry points representative of each water source. The minimum number of samples is four quarterly samples per water source.

(c) Ground water systems shall sample at points of entry to the distribution system representative of each well. The minimum number of samples is one sample per entry point to the distribution system.

(d) The State may require confirmation samples for positive or negative results by written notice to the system or by regulation.

(e) Community water systems shall monitor for the following contaminants except as provided in paragraph (f) of this section:

- (1) Chloroform
- (2) Bromodichloromethane
- (3) Chlorodibromomethane
- (4) Bromoform
- (5) trans-1,2-Dichloroethylene
- (6) Chlorobenzene
- (7) m-Dichlorobenzene
- (8) Dichloromethane
- (9) cis-1,2-Dichloroethylene
- (10) o-Dichlorobenzene
- (11) 1,2,4-Trichlorobenzene
- (12) Fluorotrichloromethane
- (13) Dichlorodifluoromethane
- (14) Dibromomethane
- (15) 1,2-Dibromoethane (EDB)
- (16) 1,2-Dibromo-3-chloropropane (DBCP)

- (16) Toluene
- (17) p-Xylene
- (18) o-Xylene
- (19) m-Xylene
- (20) 1,1-Dichloroethane
- (21) 1,2-Dichloropropane
- (22) 1,1,2,2-Tetrachloroethane
- (23) Ethylbenzene
- (24) 1,3-Dichloropropane
- (25) Styrene
- (26) Chloromethane
- (27) Bromomethane
- (28) Bromochloromethane
- (29) 1,2,3-Trichloropropane
- (30) 1,2,3-Trichlorobenzene
- (31) n-Propylbenzene
- (32) 1,1,1,2-Tetrachloroethane
- (33) Chloroethane
- (34) 1,1,2-Trichloroethane
- (35) Pentachloroethane
- (36) bis-2-Chloroisopropyl ether
- (37) sec-Dichloropropane
- (38) 1,2,4-Trimethylbenzene
- (39) n-Butylbenzene
- (40) Naphthalene
- (41) hexachlorobutadiene
- (42) o-Chlorotoluene
- (43) p-Chlorotoluene
- (44) 1,3,5-Trimethylbenzene
- (45) p-Isopropyltoluene
- (46) 1,1-Dichloropropane
- (47) iso-Propylbenzene
- (48) tert-Butylbenzene
- (49) sec-Butylbenzene
- (50) Bromobenzene

(f) Analysis for EDB and DBCP shall only be required for community water systems considered vulnerable to contamination by these two VOCs. Vulnerable is defined for this paragraph as those systems potentially contaminated by DBCP and EDB, including surface water systems where these two compounds are applied, manufactured, stored, disposed of or shipped upstream and for ground water systems where the compounds are applied, manufactured, stored, disposed of or shipped in the ground water recharge basin.

(g) Analysis under this subsection shall be conducted using EPA methods 502.1, "Volatile Halogenated Organic Compounds in Water by Purge and Trap Gas Chromatography," 503.1; "Volatile Aromatic and Unsaturated Organic Compounds in Water by Purge and Trap Gas Chromatography," or 524.1; "Volatile Organic Compounds in Water by Purge and Trap Gas Chromatography/Mass Spectrometry". These methods are contained in "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water," June 1985, available from Environmental Monitoring and Support Laboratory (EMSL), EPA, Cincinnati,

Ohio 45268. Vinyl chloride shall be measured using only methods 502.1 or 503.1. Analysis of 1,2-dibromoethane (EDB) and 1,2-dibromo-3-chloropropane (DBCP) shall be conducted by Method 504, "Measurement of 1,2-Dibromoethane (EDB) and 1,2-Dibromo-3-chloropropane (DBCP) in Drinking Water by Microextraction and Gas Chromatography," August 1985, available from EMSL, Cincinnati, Ohio 45268.

(h) Analysis under this section shall only be conducted by laboratories that have been certified for THM analysis and have analyzed Performance Evaluation samples provided by EMSL to within ±40% of the reference value.

(i) States have the authority to use monitoring data collected up to three years prior to this regulation provided that the requirements of this section are met.

7. It is proposed that a new Subpart G (§§ 141.60 through 141.69) be added to read as follows:

* * * * *

Subpart G—National Revised Primary Drinking Water Regulations: Maximum Contaminant Levels

- 141.60 Effective dates.
- 141.61 Maximum contaminant levels for organic contaminants.
- 141.62-141.68 [Reserved]
- 141.69 Criteria and procedures for public water systems using point-of-use devices and point-of-entry devices; use of bottled water.

Subpart G—National Revised Primary Drinking Water Regulations: Maximum Contaminant Levels

§ 141.60 Effective dates.

(a) For § 141.61(a) (1)-(8), the effective date is [insert date 18 months after publication date of Final Rule].

(b) [Reserved]

§ 141.61 Maximum contaminant levels for organic contaminants.

(a) The following maximum contaminant levels for organic contaminants apply to community water systems.

Contaminant	Maximum contaminant level in mg/l
(1) trichloroethylene.....	0.005
(2) carbon tetrachloride005
(3) vinyl chloride.....	.001
(4) 1,2-dichloroethane.....	.005
(5) benzene.....	.005
(6) 1,1-dichloroethylene.....	.007
(7) 1,1,1-trichloroethane.....	.20
(8) p-dichlorobenzene.....	.75

(b) [Reserved.]

§§ 141.62-141.68 [Reserved]

§ 141.69 Criteria and Procedures for Public Water Systems using Point-of-Use Devices and Point-of-Entry Devices; Use of Bottled Water.

(a) Public water systems may use point-of-use/point-of-entry devices to comply with maximum contaminant levels only if they follow the requirements of this section.

(b) It is the responsibility of the public water system to own, operate, and maintain the point-of-use/point-of-entry treatment system.

(c) The utility must develop a plan and obtain State approval for a monitoring scheme before point-of-use/point-of-entry devices are installed for compliance. This monitoring scheme must provide health protection equivalent to a monitoring scheme for central water treatment.

(d) Effective technology must be properly applied under a plan approved by the State and the microbiological safety of the water must be maintained.

(1) The State must require adequate certification of performance, field testing, and a rigorous engineering design review of the point-of-use/point-of-entry devices proposed.

(2) The design and application of the proposed point-of-use/point-of-entry devices must consider the tendency for increase in heterotrophic bacteria concentrations in water treated with activated carbon. It may be necessary to use frequent backwashing, post-contactor disinfection, and Heterotrophic Plate Count monitoring to ensure that the microbiological safety of the water is not compromised.

(e) All consumers shall be protected. Every building connected to the system must have the point-of-use/point-of-entry device installed, maintained, and adequately monitored. The State must be assured that every building is covered by treatment and monitoring, and that the rights and responsibilities of the utility customer convey with title upon sale of property.

(f) Under the plan approved by the State, point-of-use/point-of-entry devices must provide health protection equivalent to central water treatment.

(g) Bottled water shall not be used to achieve compliance with an MCL except in emergency situations to avoid unreasonable risk.

PART 142—[AMENDED]

8. The authority citation for 40 CFR Part 142 is revised to read as follows:

Authority: 42 U.S.C. 300g-2, 300g-3, 300g-4, 300g-5, 300j-4 and 300j-9.

9. It is proposed that a new § 142.61 be added to Part 142 of Title 40 to read as follows:

§142.61 Variances from the maximum contaminant level for volatile organic chemicals.

(a) The Administrator, pursuant to Section 1415(a)(1)(A) of the Act, hereby identifies the following as the best technology, treatment techniques, or other means generally available for achieving compliance with the maximum contaminant level for volatile organic chemicals (§ 141.12(a) (1)-(9)): Removal using packed tower aeration; removal using granular activated carbon adsorption.

(b) The Administrator, in a State that does not have primary enforcement responsibility or a State with primary enforcement responsibility (primacy State) that issues variances, shall require community water systems to install and/or use any treatment method identified in § 141.61(a) as a condition for granting a variance unless the Administrator or primacy State determine that such treatment method identified in § 142.61 is not available and effective for VOC removal for the system. A treatment method shall not be considered to be technically "available and effective" for an individual system if the treatment method would not be technically appropriate and technically feasible for that system or would only result in a marginal removal of VOCs for that system. If, upon application by a system for a variance, the Administrator or primacy State that issues variances determines that none of the treatment methods identified in paragraph (a) of this section is technically available and effective for the system, that system shall be entitled to a variance under the provisions of Section 1415(a)(1)(A) of the Act. The Administrator's or primacy State's determination as to the availability and effectiveness of such treatment methods shall be based upon studies by the system and other relevant information. If a system submits information intending to demonstrate that a treatment method is not available and effective for VOC removal for that system, the Administrator or primacy State shall make a finding whether this information supports a decision that such treatment method is not available and effective for that system before requiring installation and/or use of such treatment method.

(c)(1) Pursuant to § 142.43 (c)-(g) or corresponding State regulations, the Administrator or primacy State that issues variances shall issue a schedule of compliance that requires the system being granted the variance to examine

the following treatment methods: (i) To determine the probability that any of these methods will significantly remove VOCs from the water of that system, and (ii) if such probability exists, to determine whether any of these methods are technically feasible and economically reasonable, and that the VOC removals obtained will be commensurate with the costs incurred with the installation and use of such treatment method for that system:

(c)(2) Removal using other waterfall aeration technologies, such as:

(i) Multiple tray aeration, spray aeration, or cascade aeration.

(ii) Removal using diffused or mechanical aeration.

(iii) Removal using powered activated carbon adsorption.

(iv) Use of an alternate source of water.

(d) If the Administrator or primacy State that issues variances determines that a treatment method identified in paragraph (c) of this section is technically feasible, economically reasonable, and will achieve VOC removals commensurate with the costs incurred with the installation and/or use of such treatment method for the system, the Administrator or primacy State shall require the system to install and/or use that treatment method in connection with a compliance schedule issued under the provisions of section 1415(a)(1)(A) of the Act. The Administrator's or primacy State's determination shall be based upon studies by the system and other relevant information.

(e) Use of bottled water under paragraphs (c) and (d) of this section shall not be allowed under a variance except in emergency conditions to avoid unreasonable risk to health.

Appendix A.—Guidance To Determine Vulnerability of Public Water Systems to Contamination by VOCs

Note.—Appendix A will not appear in the Code of Federal Regulations.

EPA's evaluation of available occurrence data has shown that no single factor can perfectly predict the presence or absence of volatile organic chemicals (VOCs) in a water supply. However, size and proximity of a water source to VOC use increases the probability of contamination. If VOCs have been detected in the water source from previous monitoring, the system is considered vulnerable. Other criteria briefly mentioned below may be used by the States and EPA as vulnerability criteria to prioritize systems in implementing the monitoring schedule

and to determine the frequency of repeat monitoring. The three general criteria of population, nearby use of VOCs, water source protection, are suggested for developing more specific guidelines to classify community water systems (CWS) as vulnerable.

1. Population

The number of persons served by the CWS has been strongly linked to occurrence in many drinking water sources. Large CWS's, serving populations of 3300 or more are considered vulnerable. To rank the remaining CWS serving populations smaller than 3300, the following information should be considered:

(1) Previous measurements of VOCs in non-potable water samples.

Occurrences in non-potable wells or streams may indicate a presence of VOCs in a source that may later contaminate potable water supplies.

(2) Proximity of a smaller system to a larger community may increase the vulnerability of the smaller system because nearby discharges into surface waters, or into ground water recharge areas, can contaminate local drinking water supplies.

(a) Proximity of a surface water system to a larger community can be defined in terms of the flow rates between the monitoring points.

(b) Proximity is harder to define for ground water systems; possibilities include:

(i) Determining hydraulic gradients and travel times between the smaller CWS well(s) and the contamination source. Ground water modeling can be useful, especially when the geology or the well field pumping patterns are complex or uncertain.

(ii) Defining "nearby" statistically, by means of Standard Metropolitan Statistical Areas.

2. Nearby Use of VOCs

A hierarchy of use can be established for a State or regional watershed area or ground water basin.

High volume use: metal fabricators, solvent producers, electroplating plants, airfields, military bases, Superfund sites, closed wells, and a history of large spills are all indicators of the potential for significant presence of VOCs in or near drinking water sources.

Light volume use: electronic component, dry cleaner and small commercial users, protected surface impoundments are examples.

It is likely that more than one of these use categories will apply to the area

served by a single CWS. The combined effect of all on the nearby drinking water sources will have to be evaluated carefully.

3. Protection of the Water Source

The source may be protected by natural factors or discharge controls.

For surface water sources, a sanitary survey and an examination of upstream waste water dischargers (NPDES permittees) can indicate the nature and extent of pollution activities that affect the vulnerability of a surface water system. Some watersheds are protected by strict access and land use laws. Surface water systems could be ranked according to the extent of watershed protection afforded by either these land use restrictions or the remoteness of the source from VOC-based activities.

Ground water sources can be protected naturally by geological formations above the aquifer that are impermeable to VOCs used or stored near the surface, or by strict aquifer management practices. Two problems exist. First, even geologically invulnerable formations can be polluted by improper well construction or discharging into existing wells. Second, because of the complex nature of ground water hydrogeology, it is difficult to regulate and monitor land-use as effectively as for surface water sources.

Rating the vulnerability of ground water systems will often require simultaneously considering aquifer protection and nearby use of VOCs. It is important to characterize the recharge areas by:

- locating all industrial, commercial or municipal facilities that handle wastes or use solvents,
- identifying geological materials that are porous, fractured or have solution openings near VOC sources that overlap the cones of influence of drinking water wells, and
- locating abandoned wells, which can be a sign of faulty well construction, an opportunity for improper dumping, or the existence of a contaminated well.

These three criteria should be used by individual States to devise specific guidelines for the classification of their CWS for the initial round of monitoring. These criteria, along with initial monitoring results, may also be applied to setting a repeat monitoring frequency. Although the regulations specify when systems are to complete the initial monitoring, States are encouraged to accelerate monitoring for the most vulnerable systems.

Appendix B

Options

VOCs: Compliance Monitoring and Monitoring for Unregulated VOCs

Note.—Appendix B will not appear in the Code of Federal Regulations.

Provided below are three options for regulations for compliance monitoring and monitoring for unregulated VOCs. These options are summarized in Table B-1.

In each option, requirements are displayed for (1) an initial round of monitoring and (2) repeat monitoring. In addition, different requirements are set within each option for ground water systems (about 45,000) and surface water systems (about 15,000). The primary differences between the options relate to the extent of specific sampling requirements and the provision of State discretion.

Option 1

This option would require all ground and surface water systems to monitor at least once over four years. Relatively stringent federally mandated sampling requirements would be set. Monitoring for unregulated VOCs would be repeated in 10 years.

Initial Monitoring

- All systems monitor once over 4 years
- Phase in by size:
 - >10,000; complete by end of 1 year
 - 3300-10000; complete by end of 2 years
 - <3300; complete by end of 4 years

- Ground water systems:

—Sample locations

- Compliance monitoring: sample at each entry point to the distribution system.
- Unregulated VOCs: sample at each entry point to the distribution system.

—Number of samples

- Compliance monitoring: quarterly sampling for one year (i.e., 4 samples). Require resample of any positive result.
- Unregulated VOCs: one sample and require resample of any positive result.
- Surface Water Systems.

—Sample locations: sample in distribution system at points representative of each source.

- Number of samples: monthly for one year, require resample of any positive result.

- Costs for initial monitoring.
- Compliance: \$25 million per year for four years (total \$100 million)
- Unregulated: \$2.7 million per year for four years (total \$10.8 million)

Repeat Monitoring

All systems would be required to remonitor for the nine VOCs on a frequency based upon the results of the first monitoring and their vulnerability to VOC contamination. All systems would be required to repeat the monitoring for unregulated VOCs in 10 years (for unregulated VOCs that were detected in the initial monitoring it would be anticipated that States would require follow-up investigative monitoring).

Status ¹	Frequency
Compliance Monitoring: VOCs not detected and invulnerable.	Repeat in 5 years
VOCs not detected and vulnerable.	Repeat in 3 years.
VOCs detected.....	Monthly.
Monitoring for unregulated.....	Repeat in 10 years.

¹ States would recertify annually vulnerability status.
² Any system installing aeration or GAC would be required to monitor monthly to assure treatment effectiveness. After a baseline of data was generated States could decrease the frequency to quarterly.

- Costs for repeat monitoring.
- Compliance monitoring: \$64 million/year
- Unregulated monitoring: \$2.7 million/year

Option 2

This option would require all ground and surface water systems to monitor at least once over four years. Fewer samples would be required during the first round of monitoring than in Option 1. Ground water systems would be required to repeat compliance monitoring at a frequency based upon vulnerability and monitoring results. Repeat monitoring by surface water systems would be at State discretion. No repeat monitoring for unregulated VOCs would be federally mandated.

Initial Monitoring

- All systems monitor once over 4 years.
 - Phase in by size:
 - >10,000; complete by end of 1 year.
 - 3300-10000; complete by end of 2 years.
 - <3300; complete by end of 4 years.
 - Ground water systems:
- #### —Sample locations
- Compliance monitoring: sample at each entry point to the distribution system.
 - Unregulated VOCs: sample at each entry point to the distribution system.
- #### —Number of samples
- Compliance Monitoring: quarterly sampling for one year; if first sample detects no VOCs, State can reduce

monitoring to that one sample. State discretion on confirmation sample.

- Unregulated VOCs: one sample; State discretion on confirmation sample.
 - Surface Water Systems.
- Sample locations: Sample in distribution system at points representative of each source.
- Number of samples: Quarterly for one year; State discretion on confirmation samples.
- Cost for initial monitoring.
- Compliance: \$9.3 million per year over four years (total \$37 million)
- Unregulated: \$2.3 million per year over four years (total \$8 million)

Repeat Monitoring

Repeat compliance monitoring would be based upon vulnerability and if VOCs were detected, similar to Option 1. Repeat compliance monitoring for surface water systems would be at State discretion. Repeat monitoring for unregulated VOCs would be at State discretion.

Status ¹	Frequency
Compliance Monitoring: VOCs not detected and invulnerable.	Repeat in 5 years.
VOCs not detected and vulnerable.	Repeat in 3 years.
VOCs detected.....	Quarterly.
Monitoring for unregulated.....	State discretion.

¹States would recertify annually vulnerability status.

- Cost for repeat monitoring.
- Compliance: \$17 million per year
- Unregulated: \$0

Option 3

This option would require all ground water systems to monitor at least once over five years. Monitoring of surface waters would be at State discretion based upon vulnerability. Monitoring for unregulated VOCs would only require samples representing 25% of the wells in each ground water system. State discretion would be provided for repeat sampling frequencies for systems not detecting VOCs in the first round. No repeat monitoring would be required for unregulated VOCs.

Initial Monitoring

- All systems monitor once over five years
 - Phase in by size:
<10,000; Complete by end of 1 year.
3300-10000; Complete by end of 2 years.
500-3300; Complete by end of 4 years.
<500; Complete by end of 5 years.
 - Ground Water Systems.
- Sample locations.
- Compliance monitoring: sample entry points to the distribution system.
 - Unregulated VOCs: sample at entry points to the distribution system.
- Number of Samples
- Compliance monitoring: one sample; State discretion on confirmation sample.
 - Unregulated VOCs: number representing 25% of wells in each system. State discretion on confirmation sample.
 - Surface Water System: State discretion based upon vulnerability assessment.
 - Costs for initial monitoring.

- Compliance: \$3.8 million over 5 years (total \$20 million)
- Unregulated: \$0.5 million over 5 years (total \$1.5 million)

Repeat Monitoring

Repeat compliance monitoring would only be for those systems that detected VOCs in the first round. Other systems would be at State discretion. No federally required repeat monitoring for unregulated VOCs.

Status ¹	Frequency
VOCs not detected and invulnerable.	State discretion.
VOCs not detected and vulnerable.	State discretion.
VOCs detected.....	Annually.

¹States recertify annually vulnerability status.

- Costs of repeat monitoring
- Compliance: \$2.9 million/year
- Unregulated: \$0

Other Factors for Reduction in Monitoring

- Require sampling for vinyl chloride only in ground water systems that had detected other chlorinated 2-carbon VOCs.
- Systems with recent valid monitoring data would not be required to conduct the monitoring; i.e., "grandfather" waiver. Minimum QA requirements would have to be met.
- States could reduce monitoring for ground and surface water systems that detected VOCs below the MCL after a baseline period of data are generated.
- States would reduce monitoring for systems that took a well out of service that had detectable levels of VOCs.

TABLE B-1.—SUMMARY: MONITORING OPTIONS

	Option 1	Option 2	Option 3
Initial Round:			
Time to Complete.....	4 years.....	4 years.....	5 years.
Ground Water Systems:			
Compliance ¹	Quarterly: 4 samples/confirmation 1 sample/confirmation.....	Quarterly: State can reduce to 1 sample, 1 sample/State discretion on confirmation,	1 sample. 1 sample at 25% of wells.
Unregulated.....			
Surface Water Systems:			
Compliance and Unregulated	Monthly for one year.....	Quarterly for one year.....	State Discretion.
Costs:			
Compliance.....	\$25 million/year.....	\$9.3 million/year.....	\$3.8 million/year.
Unregulated.....	\$2.7 million/year.....	\$2.3 million/year.....	\$0.5 million/year.
Repeat Monitoring:			
Compliance ¹			
VOCs ND/Invulnerable.....	5 years.....	5 years.....	State Discretion.
VOCs ND/Vulnerable.....	3 years.....	3 years.....	State Discretion.
VOCs detected.....	Monthly.....	Quarterly.....	Annually (State Systems), State Discretion. (Surface Water Systems).
Unregulated.....	10 years.....	State discretion.....	None.
Costs:			
Compliance.....	\$64 million/year.....	\$17 million/year.....	\$2.9
Unregulated.....	\$2.7 million/year.....	\$0.....	\$0

¹ Vinyl chloride would only be required for systems that had detected other chlorinated 2-carbon VOCs. No requirements for vinyl chloride in surface water systems.