

**Possible Monitoring Requirements for the
Disinfectants and Disinfection by-Products
(D/DBP) Regulations**

**POSSIBLE MONITORING REQUIREMENTS FOR THE DISINFECTANTS AND
DISINFECTION BY-PRODUCTS (D/DBP) REGULATIONS**

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Introduction

The monitoring requirements presented in this report were developed by EPA before a negotiated D/DBP rule was considered. The framework described herein may substantially change as a result of the negotiated rulemaking process. Nevertheless, the monitoring strategies described herein, particularly as they pertain to reduced monitoring for smaller systems and systems less vulnerable to exposure from DBPs, may be useful to consider in developing various monitoring options during the negotiated rulemaking process.

Monitoring requirements for four trihalomethanes (THMs) were promulgated in 1979 [44 FR 68264]. They apply to all systems serving 10,000 or more people that disinfect the drinking water source. All four regulated THMs must be measured. Depending on certain system criteria and prior monitoring results, each system must collect from one to sixteen samples each year. The requirements discussed in this report parallel the THM monitoring requirements, but differ in two important ways. First, some systems may not have to measure all of the disinfectants and disinfection by-products that may be regulated under the D/DBP rule. Second, monitoring frequencies may be longer than one year (i.e., less than one sample per year) for some small or very small systems.

The last draft of these possible monitoring requirements was prepared in June 1991 by combining the trihalomethane monitoring requirements with certain features of the 1991 Standardized Monitoring Framework [56 FR 3526 and 30266] and with a consideration of how to measure residual disinfectant concentrations and other indicators of disinfection by-product formation potential. This draft of the requirements factors in suggestions received on the 1991 draft from EPA, State, and other commenters. Although the Agency is considering ways to improve the Standardized Monitoring Framework, the requirements in this paper have not tried to anticipate the effect these changes may have, nor the effect the negotiated rulemaking process may have.

Background

The Disinfectants and Disinfection By-Products Rule may have monitoring requirements for disinfectants and for organic and inorganic by-products of disinfection. The requirements may

apply to over 50,000 public water systems that use disinfection - including those that purchase water from other systems.

EPA estimates that about 90% of the systems affected may be very small ground-water systems that serve less than 500 people. Because of characteristics unique to most of these systems (low variability of the already low organic content in the source water and small distribution systems), EPA may require fewer samples to characterize disinfectant and disinfection by-product (DBP) occurrence at very small systems. In addition, some of these systems that demonstrate low probability of significant by-product formation may qualify for monitoring waivers for some by-products.

Approximately 80% of the U.S. population is currently served by about 3000 large systems that disinfect. These systems must comply with the monitoring requirements of the trihalomethane rule [40 CFR 141.30]. To do so, they have selected sample collection points, designed compliance monitoring procedures, and are now paying about \$65 per sample for measurement of THMs. The monitoring requirements as presented here would result in additional analytical costs for these systems. Most of the new costs are anticipated to result from measurement of haloacids (\$200), chloral hydrate (\$75), and chlorine dioxide (\$50) (prices are per sample). Costs for measurement of other by-products, disinfectants, and some surrogates also have been estimated (Table 1). In addition to absorbing the same per sample analytical costs as large systems, small systems (serving populations of less than 10,000) may have to set up sample collection and data reporting procedures to meet the new monitoring requirements.

Possible Conditions of the Monitoring Requirements

1. The D/DBP rule will specify minimum monitoring requirements, but EPA may allow systems to ask to sample more frequently or at more locations to determine compliance. To obtain approval for this, the system must submit a map of all sampling locations, reasons for the frequency selected, and the formula that will be used to calculate a running annual average concentration for each organic by-product and an annual average concentration for each disinfectant and inorganic by-product. This plan, when approved by the State, must be used to measure all disinfectants and by-products for which the system must monitor.
2. A system using ground water under the direct influence of a surface water may have the same requirements as a surface water system.

TABLE 1. APPROXIMATE ANALYTICAL COSTS - 1992 DOLLARS

ANALYTE OR PARAMETER	COST(\$)/SAMPLE
<u>Source Water Quality Indicators</u>	
Total Organic Carbon (TOC) (nonpurgeable)	\$ 35 - 45
Ultraviolet (UV) Absorption	< 10
Bromide	20 - 30
Total Organic Halogen (TOX)	65 - 100
Formation Potential Studies (FP)	150 - 500
<u>Organic & Inorganic By-Products</u>	
Trihalomethanes (THMs)	\$ 65
Haloacetic Acids (HAAs)	200
Chloral Hydrate (CH)	75
Bromate, Chlorate, Chlorite (\$25 each)	75
<u>Disinfectants</u>	
Chlorine	\$ 10 - 25
Chloramines	< 10
Chlorine Dioxide (includes Chlorite & Chlorate)	50

3. When monitoring is less frequent than quarterly or less than four samples are collected per sampling period, the system may be able to select a sample point and time that are expected to produce the highest concentration of by-product, which is defined as at remote points in the distribution system during the month of warmest water temperature.
4. A ground-water system may (unless the State objects) elect to determine compliance for organic disinfection by-products with one annual formation potential sample.

Summary of Compliance Monitoring Requirements

A. STANDARDIZED MONITORING

Despite some comment to the contrary, EPA is not planning to adopt the Standardized Monitoring Framework (the Framework) per se for this rule, since to do so would delay initial monitoring until January 1999 for systems that now disinfect. Instead EPA is considering phasing-in initial monitoring beginning on January 1, 1997. Although the Framework does not apply to the disinfectants and disinfection by-products, the monitoring requirements described herein fit relatively well within it. Features of the Framework that are compatible with (and have been incorporated into) the monitoring requirements presented in this paper include:

1. Monitoring is a system responsibility unless the State accepts responsibility.
2. Waivers (by Rule, by Use and by Susceptibility) are granted by the State. They are used to permit no or reduced monitoring.
3. There are always base monitoring requirements that a system must comply with whenever a waiver is not obtained or renewed.
4. The initial monitoring period begins on a January 1st.
5. States submit to EPA a sampling schedule to phase-in the initial monitoring requirements; phase-in by system size is not required.

Another feature of the Framework included in this draft of the D/DBP monitoring requirements is the adoption of the three-year cycle for phasing-in initial monitoring, and for setting repeat and reduced monitoring frequencies.

B. WAIVERS

- 1. In general, all systems using a chemical disinfectant may be required to monitor for the disinfectant and possible by-products. A system cannot receive a waiver from disinfectant monitoring but may obtain waivers from some or all by-product monitoring. Possible exceptions to the prohibitions on waivers for disinfectant monitoring are that systems using ozone may not be required to measure ozone residuals under the monitoring requirements discussed herein. Groundwater systems that use only ultraviolet (UV) radiation may not be subject to any monitoring requirements. Instead, these systems may have monitoring requirements to characterize the effectiveness of UV disinfection under the Ground-Water Disinfection Rule.**
- 2. Systems that annually conduct monitoring of total organic carbon (TOC), bromide, and UV absorbance (all relatively inexpensive), or other indicators of by-product formation potential, may be able to obtain a waiver from some by-product measurements.**
- 3. Systems with certain types of pH control, or that can demonstrate predictable by-product formation correlations with other by-products or parameters, may receive a waiver from some or all by-product monitoring.**
- 4. Systems with compliance samples that are reliably and consistently below a "trigger" percentage of the maximum contaminant level (MCL) for certain disinfection by-products may be able to obtain a waiver from some by-product measurements.**
- 5. Waivers to allow reduced monitoring frequencies may be required to be renewed regularly. They are not automatically granted when prior monitoring data show levels below the trigger concentration. To qualify for reduced monitoring, the State must not object, and there must be no significant change in source water quality or treatment during the waiver period.**
- 6. Possible waiver criteria that would allow systems to avoid monitoring for some or all disinfection by-products are listed in Table 2. Possible criteria for reduced frequency monitoring waivers for chloral hydrate, haloacetic acids and trihalomethanes are shown in Tables 3 and 4.**

TABLE 2. FOUR POSSIBLE WAIVER CRITERIA

Systems may be allowed to avoid measuring some DBPs if one or more of the following criteria are met, subject to State approval. A waiver generally must be renewed every year or at the end of the reporting period.

1. Raw water quality. If the source water (or water prior to disinfection) falls below certain levels x, which are to be determined for certain combinations [to be determined] of the following parameters:

TOC < "x"

UV absorbance < "x"

then monitoring for certain DBPs may be waived.

2. Other water quality criteria. If the criteria below [to be determined] are met for any of the DBPs specified, then monitoring for those DBPs is not required.

Waiver For	Raw Water Criteria	Finished Water Criteria
Haloacetic Acids		[Acids] < T% MCL
Bromate	Bromide < "x"	No use of ozone
Chloral Hydrate		[Chloroform] < T% MCL

The quantities "x" and "T%" are currently unspecified.

3. Surrogates in finished water. If the ratio of THM/TOX is [required relationship to be determined] and pH and temperature are within [range to be determined] and [range to be determined], respectively, then DBP monitoring is not required.

4. Membrane treatment. If certain membrane processes are used, no DBP monitoring is required.

**TABLE 3. POSSIBLE MONITORING REQUIREMENTS:
ORGANIC BY-PRODUCTS**

(Based on 1979 THM Rule)

System Size: Population > 10,000

Water Source:	Surface Water	Ground Water
Sample Location:	All samples taken at the 40 FR 141.30 THM locations	
Sample Frequency:	4/quarter	4/qtr, or one FP^a/qtr
Reduction Criteria^b:	Annual average <X% MCL	Annual average <X% MCL or FP^a < X% MCL
Reduced^b Frequency:	1 smpl/quarter worst-case sample)	1 smpl/quarter (worst-case sample)
Compliance:	See text and Figure 1.	

^a This is a formation potential (FP) sample with criteria as yet unspecified.

^b Assumes no significant change in treatment or source water quality, and that the State does not demur. "Significant" is a term and X% a quantity yet to-be-determined.

**TABLE 4. POSSIBLE MONITORING REQUIREMENTS:
ORGANIC BY-PRODUCTS**

System Size: Population < 10,000

Water Source:	Surface Water	Ground Water
Sample Location/Time:	Worst-case sample from distribution system	Worst-case sample from distribution system
Sample Frequency:	1 sample/quarter	1 sample/year
Reduction Criteria^a:	Annual average < 50% MCL or < 25% MCL	Each sample < 50% MCL for 3 yrs or one sample < 25% MCL for 1 yr
Reduced^a Frequency:	1/yr or 1/3 yrs, respectively	1/3 yrs or 1/9 yrs, respectively
Compliance:	See text and Figures 2 and 3.	

^a Assumes no significant change in treatment or source water quality, and that the State does not demur. "Significant" is a term yet to-be-determined.

C. MONITORING FOR ORGANIC BY-PRODUCTS

The monitoring requirements for the organic by-products - chloral hydrate, haloacetic acids and trihalomethanes - have been divided first by population served, and second by type of source water used (ground or surface water).

1. Initial monitoring at large systems is at the same frequencies and sample points used for trihalomethane compliance sampling. Large systems are defined as serving a population of 10,000 or more people (Table 3 and Figure 1).
2. Initial monitoring at small systems requires only one sample per sampling period, which is quarterly for surface water systems and annually for ground water systems (Table 4 and Figures 2 and 3).
3. Reduced monitoring eligibility is predicated on worst-case samples. Since most systems are very small ground-water systems (the majority with populations less than 500) with low and relatively constant concentrations of precursors in the source water, they are likely to meet this eligibility requirement.

D. MONITORING FOR DISINFECTANTS AND INORGANIC BY-PRODUCTS

The disinfectants are chlorine, chlorine dioxide and chloramines; the inorganic by-products are bromate, chlorate and chlorite (Table 5).

1. Disinfectant residuals are measured at least monthly at representative locations in the distribution system under the Surface Water Treatment Rule (SWTR). The same monitoring is expected to be required under the Ground-Water Disinfection Rule (GWDR) for those systems that must disinfect distribution systems. If a system is not using a chemical disinfectant under the GWDR, these monitoring requirements may not apply.
2. Monitoring requirements for inorganic by-products are identical to those for the disinfectants.
3. Measurements of free chlorine may be required to determine compliance with the chlorine MCL; however, total chlorine measurements may be used instead. Many systems measure total chlorine residual under the SWTR.
4. Total chlorine measurements may be used to determine compliance with the chloramines MCL.

MONITORING FOR DISINFECTION BY-PRODUCTS

SYSTEM SIZE: POPULATION $\geq 10,000$

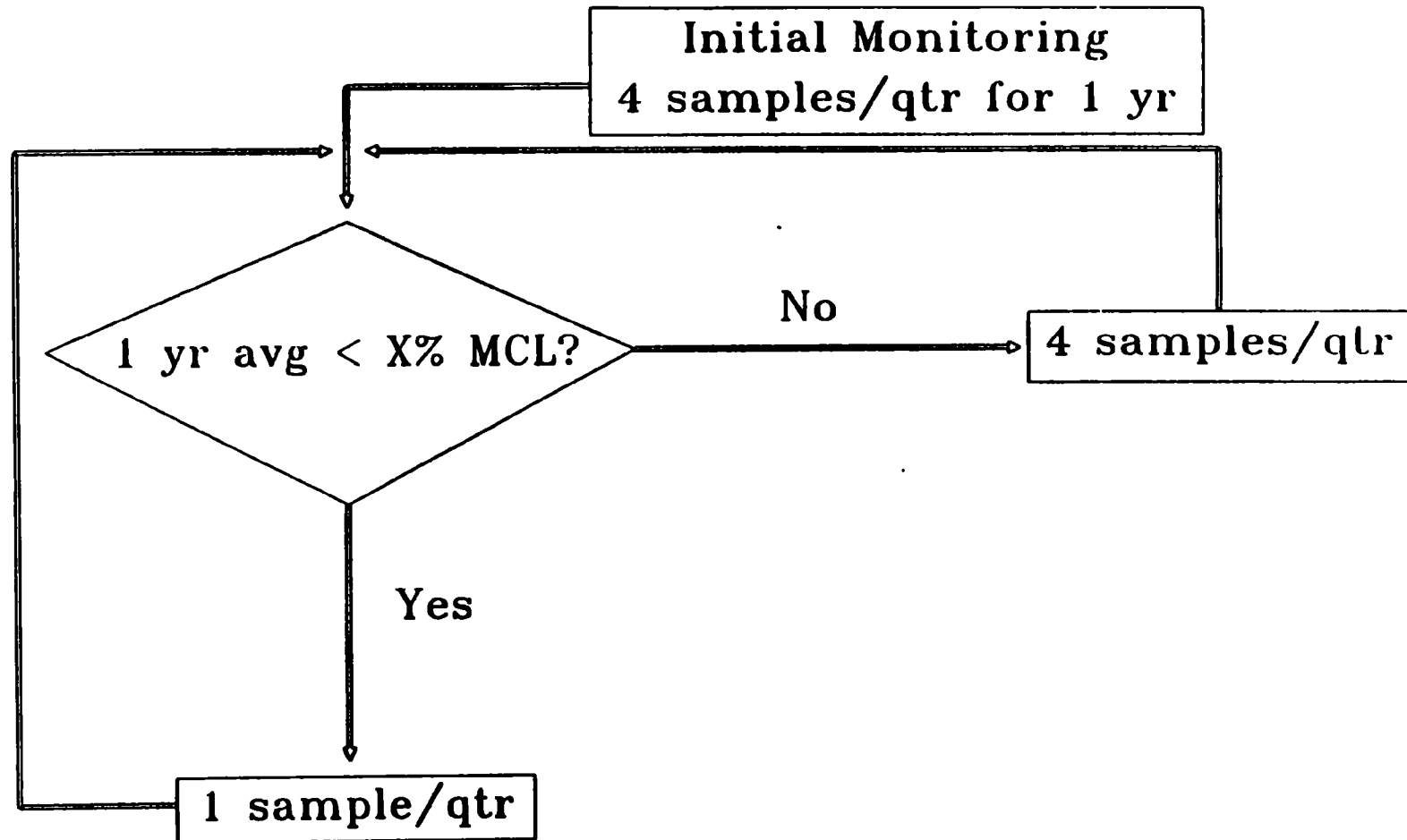


Figure 1

MONITORING FOR DISINFECTION BY-PRODUCTS
SYSTEM SIZE: POPULATION < 10,000
WATER SOURCE: SURFACE WATER

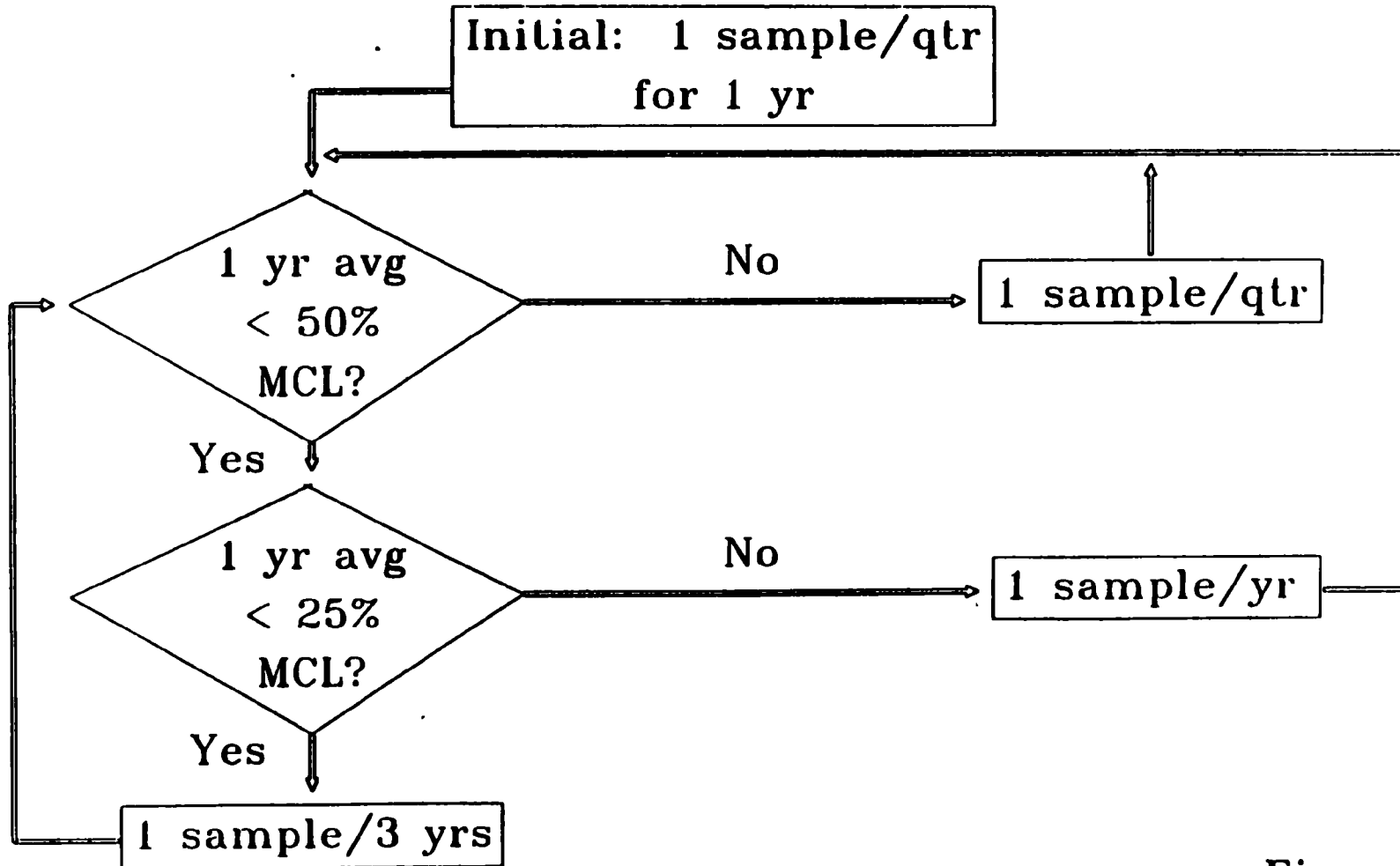


Figure 2

MONITORING FOR DISINFECTION BY-PRODUCTS
SYSTEM SIZE: POPULATION < 10,000
WATER SOURCE: GROUND WATER

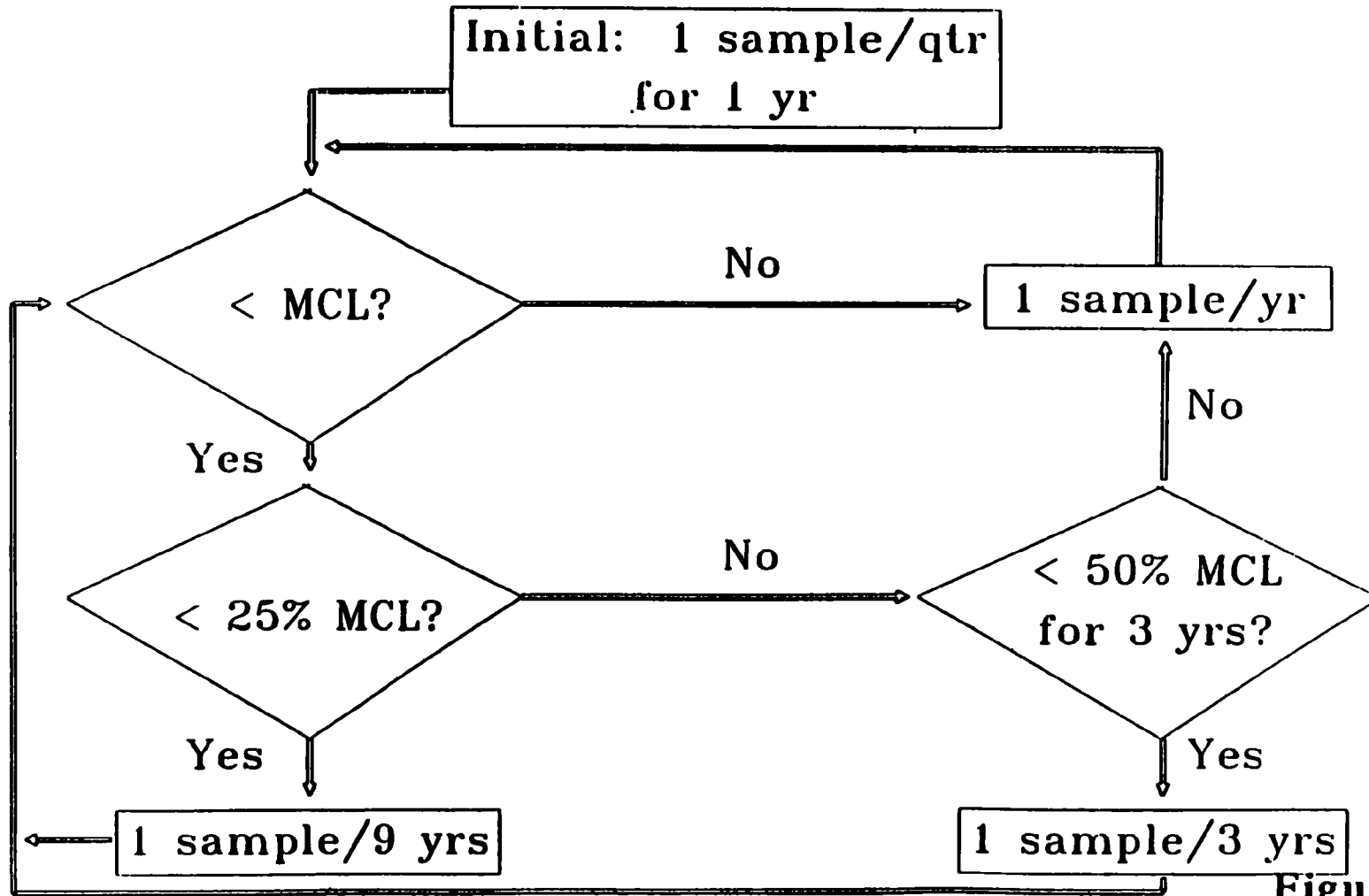


Figure 3

**TABLE 5. POSSIBLE MONITORING REQUIREMENTS:
CHLORINE^a CHLORAMINES^b CHLORINE DIOXIDE, BROMATE AND CHLORITE**

Water Source and System Size:	Pertinent systems^c
Sample Location: the distribution system^d	Representative locations in
Sample Frequency:	1/month^d
Compliance:	Running annual average of monthly values must be < MCL. If more than 1 sample is taken per month, the monthly mean values are averaged.

^a As free chlorine - analysis performed at water system. Compliance may also be determined using total chlorine measurements.

^b Compliance determined using combined chlorine measurements.

^c To be defined; possibilities include - only systems using ozone will monitor for bromate; only systems using chlorine dioxide will monitor for chlorine dioxide or chlorite.

^d Monitoring for disinfectant residuals is already required under the surface water treatment rule, and is anticipated under the ground-water disinfection rule.

5. Sampling location, minimum sampling frequency, and calculations required for determining compliance with the disinfectant and inorganic by-product MCLs are specified in Table 5.

E. POSSIBLE TIMING OF INITIAL MONITORING REQUIREMENTS

1. The possible dates of the disinfectant and disinfection by-product monitoring requirements and the anticipated actions under the GWDR (Table 6) assume promulgation by June 30, 1995, for the D/DBPR and August 31, 1996, for the GWDR.
2. For systems that are disinfecting at the time of promulgation, the initial D/DBP monitoring period may be complete by December 31, 1998, if the SMF is not followed, and December 31, 2001, if the SMF is followed completely. For the GWDR, the initial monitoring period may begin on March 1, 1998, for monitoring only and January 1, 1999, for compliance with performance requirements.

Monitoring data for by-products collected up to twelve months before monitoring is required may be accepted provided the State does not object, and treatment and source water quality have not significantly changed.

3. Phase-in periods for systems that begin disinfection after promulgation may be as follows.
 - a. For community water systems, initial D/DBP monitoring may be complete by December 31, 2001, if the SMF is not followed, and December 31, 2004, if SMF is followed.
 - b. For non-transient, noncommunity water systems, initial monitoring may be complete by December 31, 2004, if the SMF is not followed. If the SMF is followed, the initial monitoring period would be complete by December 31, 2007.
4. These monitoring requirements can accommodate any combination of regulatory MCL options. Regulatory options include, but are not limited to, setting MCLs for each contaminant, setting MCLs for total THMs and total haloacetic acids, or setting a combination of single-contaminant and multiple-contaminant MCLs.

TABLE 6. POSSIBLE TIMING OF INITIAL MONITORING FOR DISINFECTANTS AND BYPRODUCTS FOR GROUND WATER SYSTEMS COORDINATED WITH POSSIBLE DEADLINES UNDER THE GROUND-WATER DISINFECTION RULE (GWDR)

	<u>D/DBP Rule</u>	<u>GWDR</u>
<u>Promulgation:</u>	June 30, 1995	August 31, 1996 (1)
<u>Effective Date:</u>	January 1, 1997	March 1, 1998
<u>Systems Currently Disinfecting:</u>		
Comply with disinfection performance requirements	NA	January 1, 1999 (4)
Complete initial D/DBP Monitoring	December 31, 1998 (2)	NA
	December 31, 2001 (3)	
<u>Systems That Begin Disinfection After 7/1/95:</u>		
<u>Community Systems:</u>		
Begin Disinfection:	NA	March 1, 2001
Complete initial D/DBP Monitoring:	December 31, 2001 (2)	NA
	December 31, 2004 (3)	
<u>Noncommunity Systems:</u>		
Begin Disinfection:	NA	March 1, 2003
Complete initial D/DBP Monitoring:	December 31, 2004 (2)	NA
	December 31, 2007 (3)	

(1) - Assumes promulgation date of August 31, 1996, and certain requirements in rule. Dates and requirements may be changed.

(2) - Schedule applicable if Standardized Monitoring Framework (SMF) not followed (i.e., if initial D/DBP monitoring must be completed less than three years after rule becomes effective). Date is first SMF period final date after rule becomes effective.

(3) - Schedule applicable if SMF followed fully (i.e., if initial D/DBP monitoring must be completed during first complete three year SMF period following effective date of rule).

(4) - Ground water systems disinfecting when GWDR promulgated will have until January 1, 1999, to meet disinfection performance requirements, although GWDR monitoring will begin March 1, 1998.

F. POSSIBLE COMPLIANCE DETERMINATIONS FOR ORGANIC BY-PRODUCTS - THE HALOACIDS, CHLORAL HYDRATE AND FOUR TRIHALOMETHANES

Compliance may be determined by comparing the running annual average of prior sample measurements to each MCL. The running annual average requirement may apply to whatever combination of single-contaminant MCLs or group MCLs (e.g., total haloacids) that EPA adopts in the final rule.

Therefore, for systems serving less than 10,000 people, EPA may consider determining compliance for trihalomethanes, chloral hydrate, and haloacids as follows. A sample is collected in the first year that a system qualifies for a reduction in sampling frequency to less than quarterly. Depending on the result of this measurement, one of three repeat sampling schedules applies:

1. If the result is less than the MCL but above one or more of the trigger concentrations, the sampling frequency stays at or increases to the next higher frequency (Table 4), depending on whether the system was at a lower frequency prior to the sample result.
2. If the result is less than the MCL and meets the trigger concentration criteria, the next sample is collected at the reduced monitoring frequency (Table 4).
3. If any measurement exceeds the MCL, the system must immediately increase its monitoring to at least quarterly to compute a running annual average. If appropriate, the state may require the system to take more immediate corrective action to assure compliance. The system is not in violation until two quarterly annual average calculations exceed the MCL (Figure 4). If any sample concentration exceeds 4 times the MCL, a violation may be considered to have occurred.

Note that compliance with disinfection requirements (Table 5) is always checked by monthly monitoring of both disinfectants and inorganic disinfection by-products except for bromate.

Future Issues and Problems

To further develop and improve the compliance monitoring requirements for this rule, EPA believes the following issues and problems will require attention.

1. EPA has suggested several parameters or correlations with treatment processes or with occurrence of other disinfection by-products as ways to waive a system from some by-product monitoring.

**SAMPLE FREQUENCY < QUARTERLY;
SAMPLE ≥ MCL**

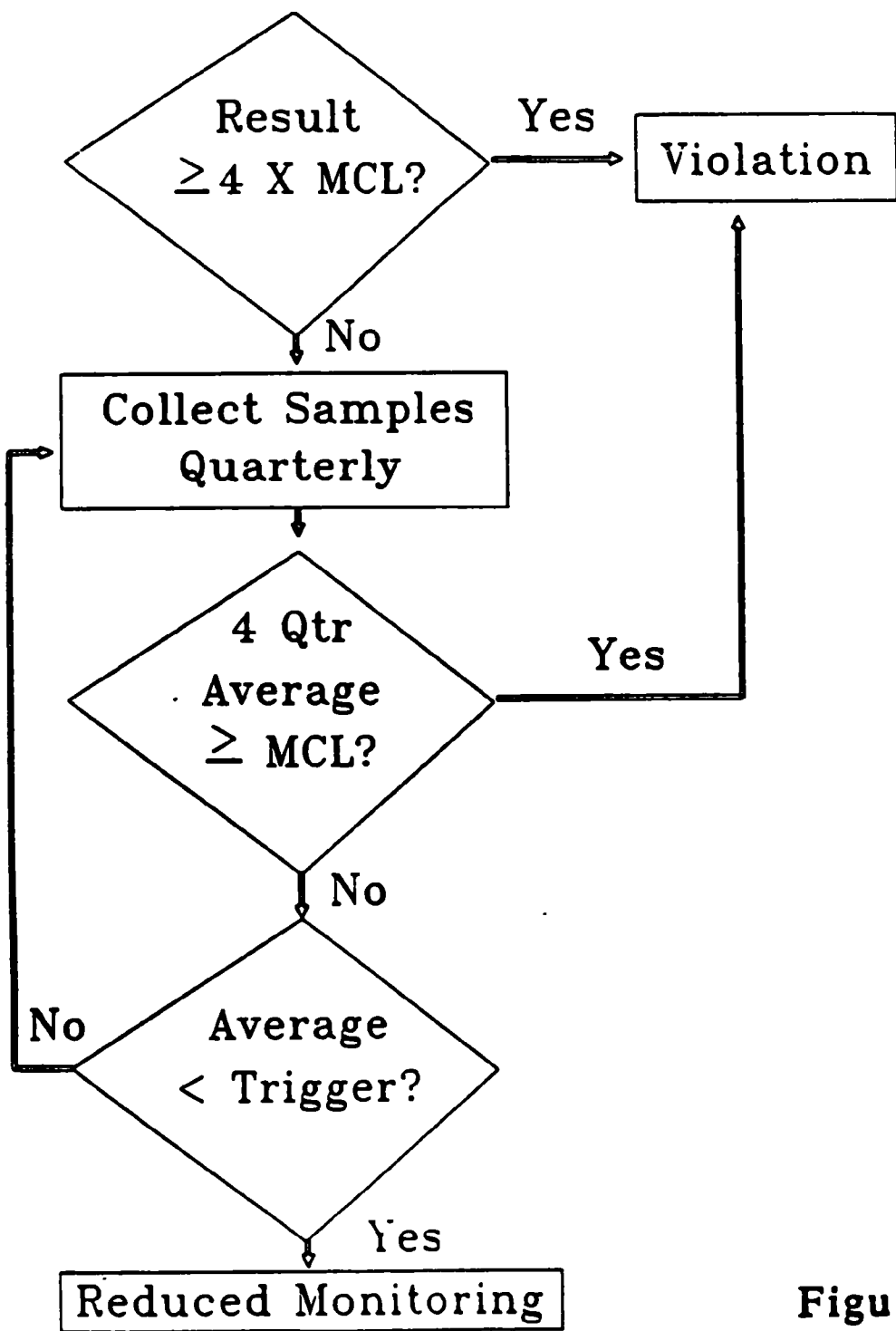


Figure 4

- a. We need to carefully discuss and determine the reasonableness of this approach.
 - b. Information must be obtained so that cutoffs can be proposed:
 - i. for the indicators of source water quality listed in Table 2, and
 - ii. for the reduced monitoring trigger concentrations in Tables 2, 3 and 4.
 - c. We must determine whether EPA can obtain enough data to support use of surrogate indicators to grant monitoring waivers.
 - d. We should consider whether EPA should offer systems the option of performing simulated distribution system studies to support waiver applications.
2. For large systems, the monitoring requirements presented here for all by-products are identical to the requirements of the 1979 THM Rule.
- a. EPA must determine whether this amount of monitoring is sufficiently predictive, and yet economical.
 - b. We must consider whether EPA should modify these monitoring requirements to permit more flexibility in initial or repeat monitoring. Specifically:
 - i. for initial monitoring EPA might consider allowing a range of 2-4 samples per quarter rather than requiring 4 samples per quarter; and
 - ii. for repeat or reduced monitoring, EPA could allow less frequent monitoring when a system is reliably and consistently below some percentage of the MCL. For example, if for three years a system is below a trigger percentage of the MCL, the sampling frequency could be reduced to once every three years.
3. When less than four samples per sampling period are collected, or when the sampling frequency is less than quarterly, EPA may require that compliance with an MCL be based on a worst-case sample.
- a. EPA must determine whether it is cost-effective for a system to select a worst-case site and time for monitoring.

- b. EPA could consider limiting the options of collecting only one sample per sampling period, or permitting less than quarterly monitoring to only small or very small systems.
 - c. In Table 4, EPA defined the small system group as those serving populations of less than 10,000 people. Three other ways in which EPA might define this group are: only nontransient, noncommunity systems; only systems serving fewer than 500 people; or only systems serving fewer than 3,300 people. There are other possibilities for defining this class of "small" systems, and the merits of each must be carefully considered.
 - d. EPA should consider whether it is reasonable to ever permit less than one sample per year per PWS under any conditions. Requiring at least one sample per year would increase the monitoring load at small systems from that presented in Table 4.
4. If EPA fully adopted the Standardized Monitoring Framework (SMF) nine-year compliance cycle, initial monitoring for systems that currently disinfect would occur from 1999 to 2001. Initial monitoring for community water systems that begin disinfection under the GWDR would occur from 2002 to 2004. Conformance with the SMF rather than the dates shown earlier in this paper would result in a two-year delay for systems now disinfecting, with a 10 month delay for others. Non-transient noncommunity systems would begin disinfection in March 2003, and initial D/DBP monitoring under SMF would run from 2005 until 2007. This represents almost a two year delay. We should carefully consider whether the monitoring requirements should fully conform to the Framework's nine-year compliance cycles, given that this may give systems the option to delay monitoring two years after an MCL becomes effective.
5. For small systems that are monitoring the organic by-products - chloral hydrate, trihalomethanes or haloacetic acids - less frequently than quarterly, EPA is suggesting that one sample exceeding an MCL is not a violation until the average of this sample plus the next three quarterly samples exceeds the MCL. This proposal would treat small systems more like large systems in that an MCL violation would not be based on a single, worst-case sample.
- a. All parties must consider whether this is a reasonable approach.
 - b. We could consider other options such as allowing

this approach only for some of the organic by-products listed above, based on the relative health risk.

6. Compliance determinations need to be more thoroughly developed so that the conditions are complete, clear and reasonable. The conditions for determining MCL-compliance need to cover cases when worst-case samples are collected, and when sampling is less frequent than quarterly.

References

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=== END ===