United States
Environmental Protection Agency

Office of Water
(WH-550)

EPA 811/R-92-007
November 1992

EPA

ANALYSIS OF POTENTIAL TRADE-OFFS IN REGULATION OF DISINFECTION BY-PRODUCTS

EXHIBITS AND APPENDIX MATERIAL

Analysis of Potential Trade-offs In Regulation of Disinfection By-Products

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Stig Regli & Bruce Macler
U.S. Environmental Protection Agency

Exhibits & Appendix Material

Exhibit 1

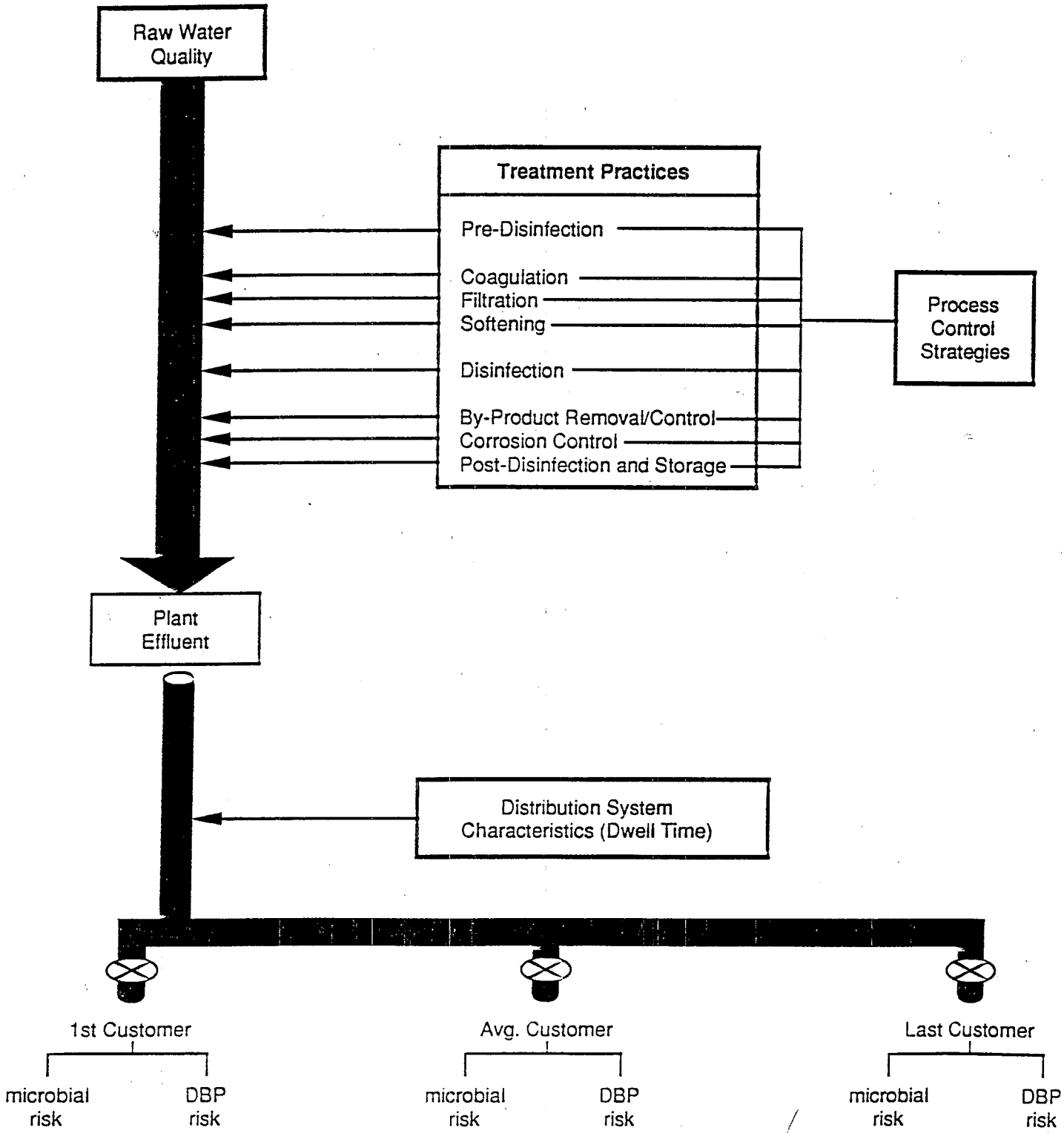

Raw Water Quality
Treatment Practices
Pre-Disinfection
Coagulation
Filtration
Softening
Disinfection
By-Product Removal/Control
Corrosion Control
Post-Disinfection and Storage
Process Control Strategies
Plant Effluent
Distribution System Characteristics (Dwell Time)
1st Customer
Avg. Customer
Last Customer
microbial risk
DBP risk
microbial risk
DBP risk
microbial risk
DBP risk

Exhibit 2

Influent Giardia vs. Total Log Reduction (Winter) From LeChevallier

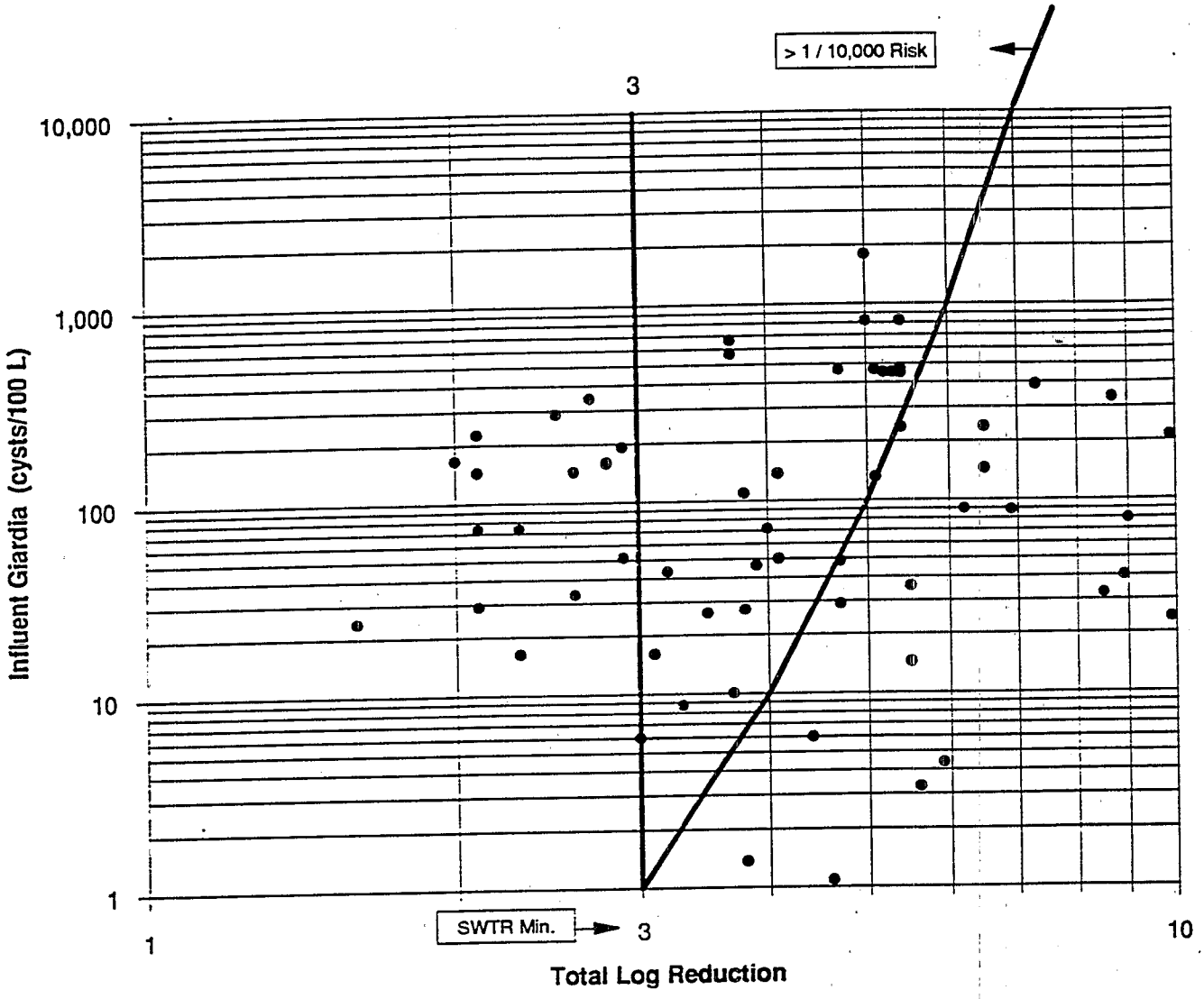


Exhibit 3

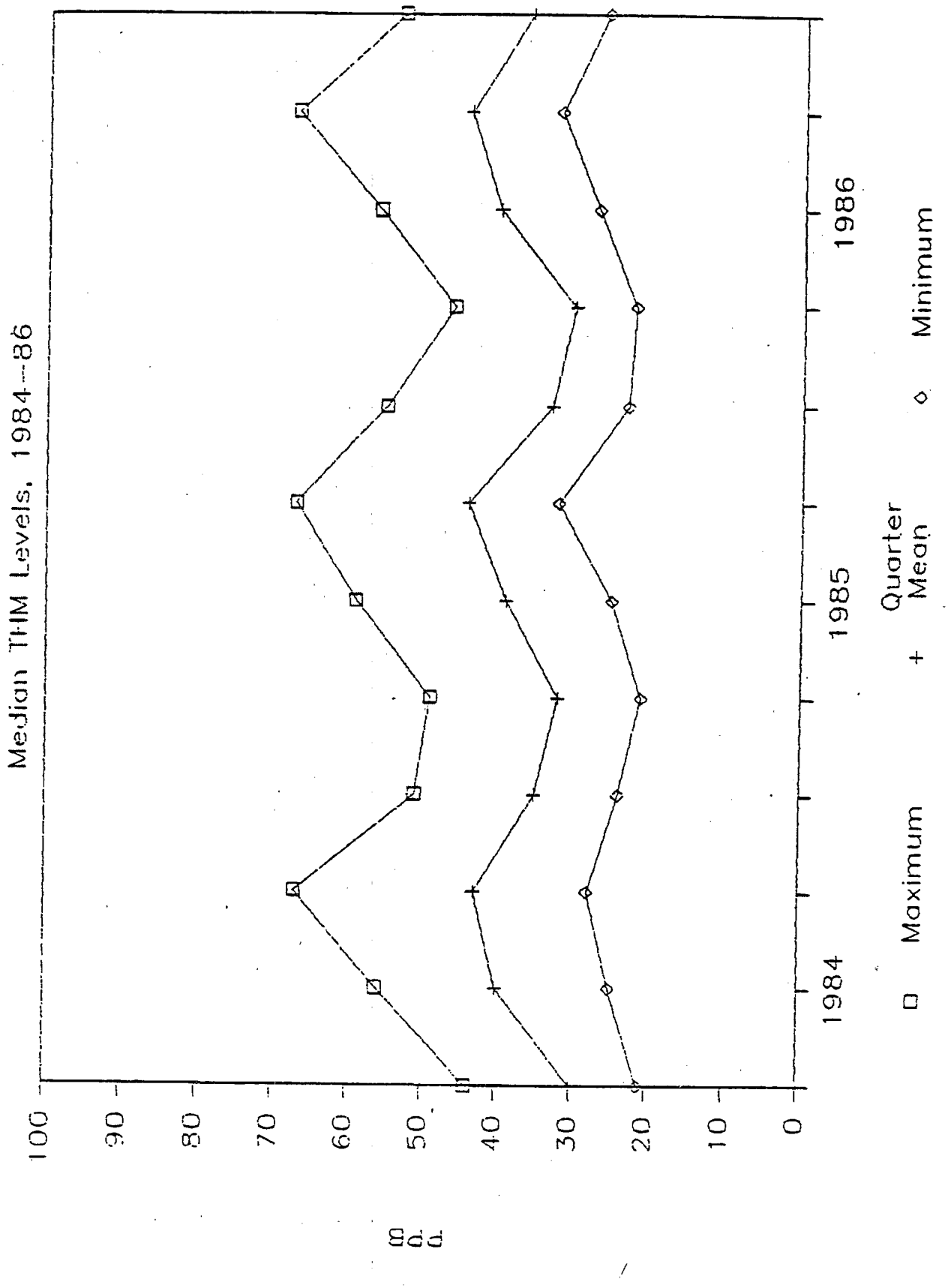

Median THM Levels, 1984--86
PPB
100
90
80
70
60
50
40
30
20
10
0
1984
1985
1986
Quarter
Maximum
Mean
Minimum

Exhibit 4

Disinfection By-Products Regulatory Analysis
Baseline Cancer Incidence -- Based on Occurrence Data
(Surface Water Systems)

Annual Cases = Population Exposed (persons) x DBP Concentration (μg/l) x Annual Risk Factor (cases/persons/year/μg/l)

	High Case Estimate [1]		Low Case Estimate [2]	
	<10,000 people	≥10,000 people	<10,000 people	≥10,000 people
Total Population (million persons) [3]	17	145	17	145
Average Concentrations (μg/l)				
Chloroform	77.2	59.7		14
Bromodichloromethane	24.8	17.4		6.6
Dibromochloromethane	10.4	6.3		3.6
Bromoform	1.4	0.8		0.57
TTHMs	114	84		25
Dichloroacetic Acid	27.7	22.1		6.4
Tichloroacetic Acid	16.6	17.00		5.5
THAAs	44	39		12
MLE Annual DW Risk Factors [4]				
Chloroform	1.43E-10	1.43E-10		1.43E-10
Bromodichloromethane	3.33E-10	3.33E-10		3.33E-10
Dibromochloromethane	3.33E-10	3.33E-10		3.33E-10
Bromoform	1.79E-10	1.79E-10		1.79E-10
Dichloroacetic Acid	3.59E-08	3.59E-08		3.59E-08
Tichloroacetic Acid	8.68E-09	8.68E-09		8.68E-09
Cancer Incidence based on MLE (cases/yr.)				
Chloroform	0.19	1.24		0.29
Bromodichloromethane	0.14	0.84		0.32
Dibromochloromethane	0.06	0.30		0.17
Bromoform	0.00	0.02		0.01
TTHMs	0.4	2.4		0.8
Dichloroacetic Acid	17.3	115.0		33.3
Tichloroacetic Acid	2.5	21.4		6.9
THAAs	20	136		40
Total				
Upper 95% CI Annual DW Risk Factors [5]				
Chloroform	2.49E-09	2.49E-09		2.49E-09
Bromodichloromethane	1.02E-08	1.02E-08		1.02E-08
Dibromochloromethane	1.02E-08	1.02E-08		1.02E-08
Bromoform	3.22E-09	3.22E-09		3.22E-09
Dichloroacetic Acid	1.13E-07	1.13E-07		1.13E-07
Tichloroacetic Acid	2.57E-08	2.57E-08		2.57E-08
Cancer Incidence Based on 95% CI (cases/yr.)				
Chloroform	3.3	21.6		5.1
Bromodichloromethane	4.4	25.7		9.8
Dibromochloromethane	1.8	9.3		5.3
Bromoform	0.1	0.4		0.3
TTHMs	10	57		20
Dichloroacetic Acid	54.3	361.0		104.5
Tichloroacetic Acid	7.4	63.4		20.5
THAAs	62	424		125
Total				

[1] Based on occurrence data from: disinfection by-products field studies data (EPA,OGWDW,TSD)
[2] Based on occurrence data from Krasners et.al., 1989
[3] Source: Federal Reporting Data System (FRDS)
[4] maximum likelihood estimate (MLE)
[5] upper 95% confidence interval

Population Served By Community Water Systems

(Total = 242 million)

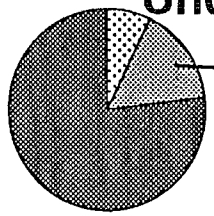
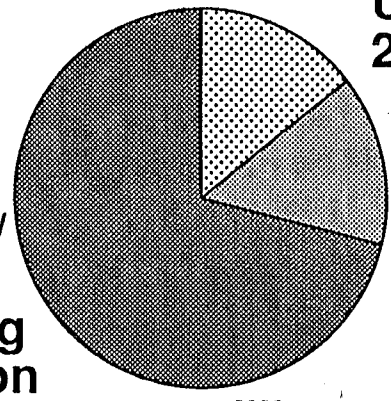
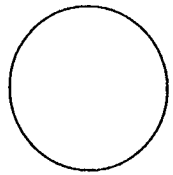
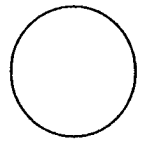
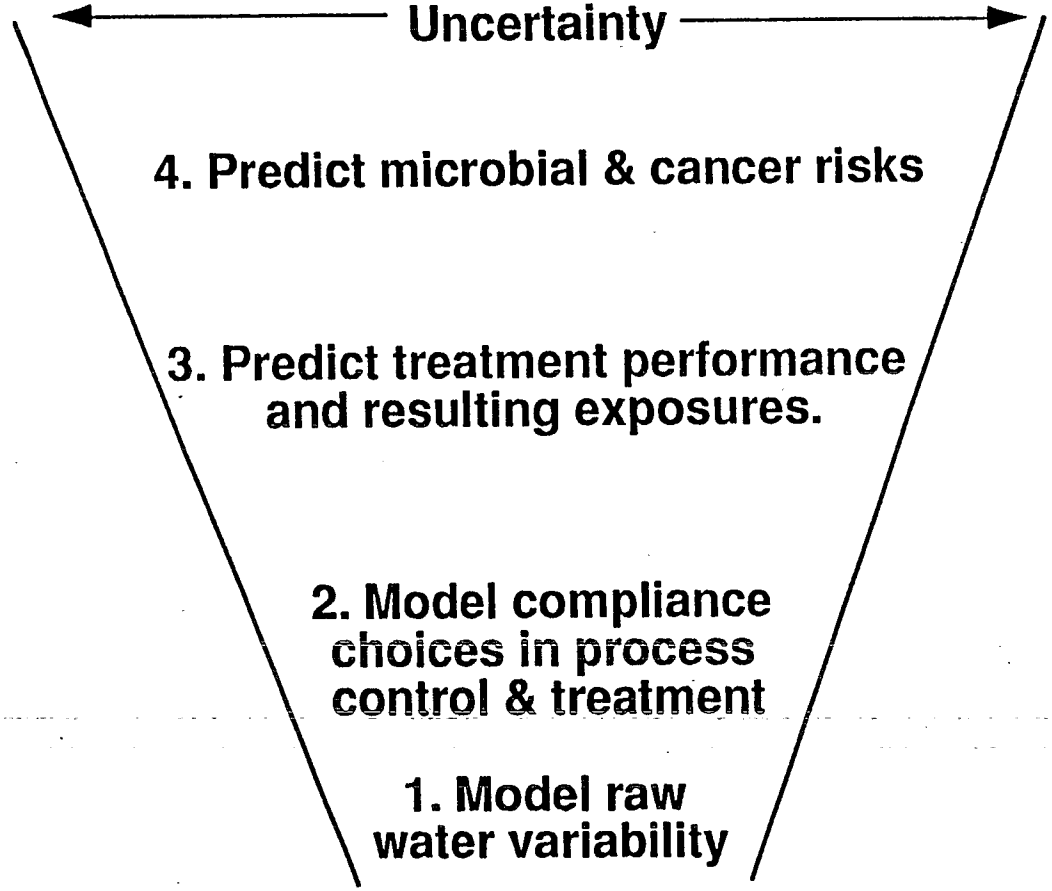
	GW (80 million)	SW (162 million)
Large Systems (serving 710,000)	 Undisinfected, 3.5 mil. Disinfected & Softened 7.5 mil. Disinfected No Softening 37 million 48 million	 Unfiltered 21 million Filtered & Softened 21 million Filtered/ No Softening 103 million 145 million
Small Systems (serving <10,000)	 32 million	 17 million

Exhibit 5

Major Steps in DBP Analysis



Analytical Tools:

Present cancer & giardia risk models

WTP model:
DBP equations &
CXT equations

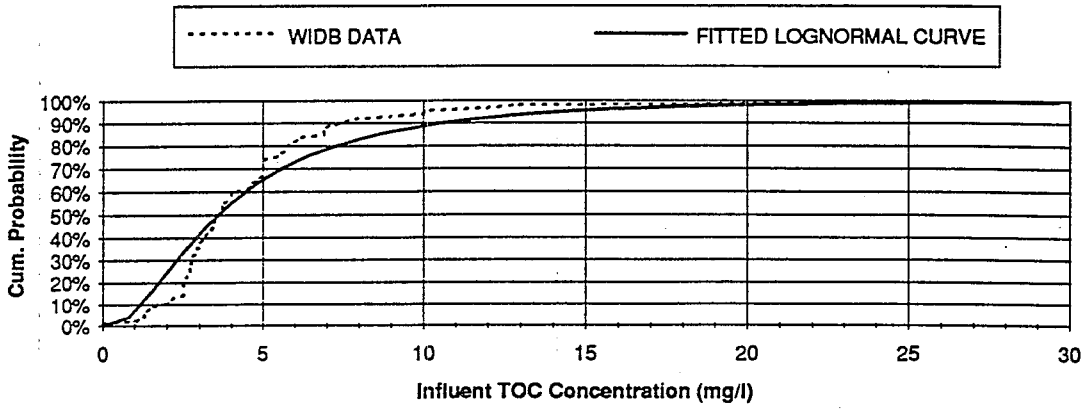
WTP model assumptions

Monte Carlo simulation

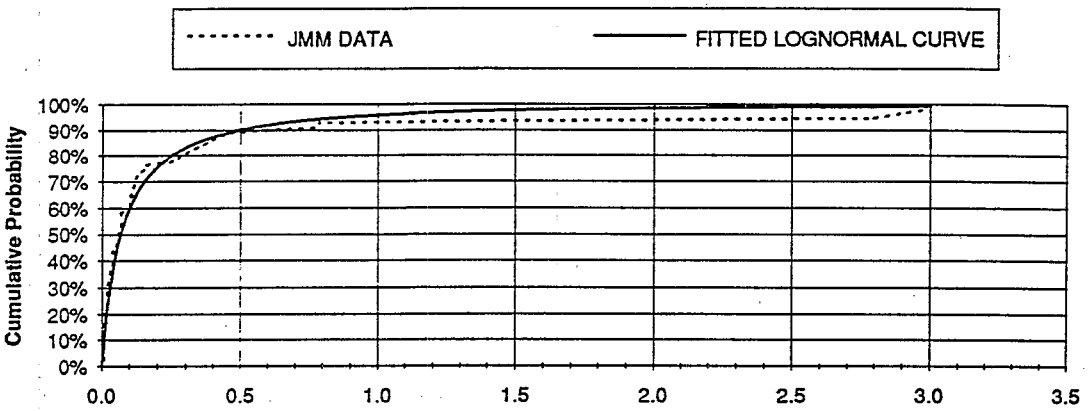
Exhibit 6

SURFACE WATER WITHOUT FILTRATION/SOFTENING CUMULATIVE PROBABILITY DISTRIBUTIONS

Actual and Model-predicted Influent TOC Concentration



Actual and Model-predicted Bromide Concentration



Actual and Model-predicted Influent Giardia

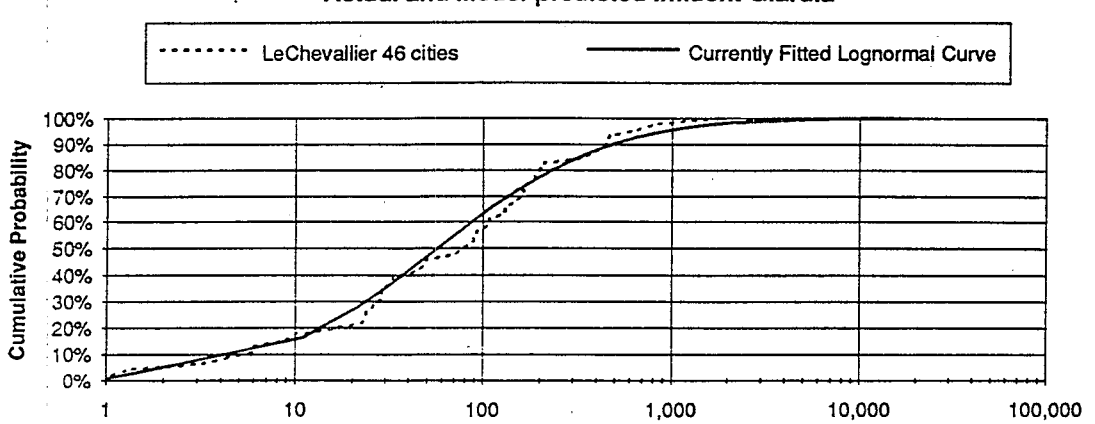
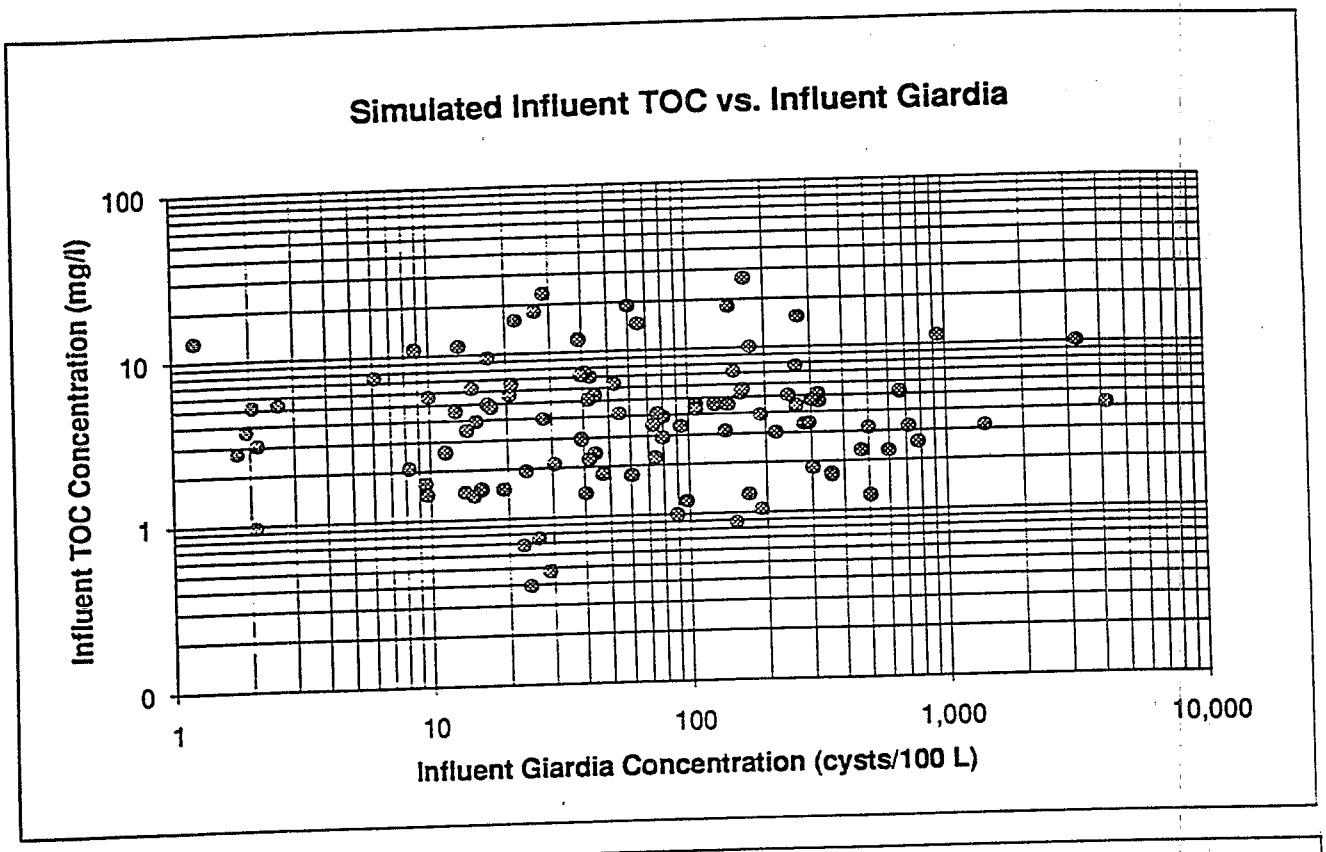
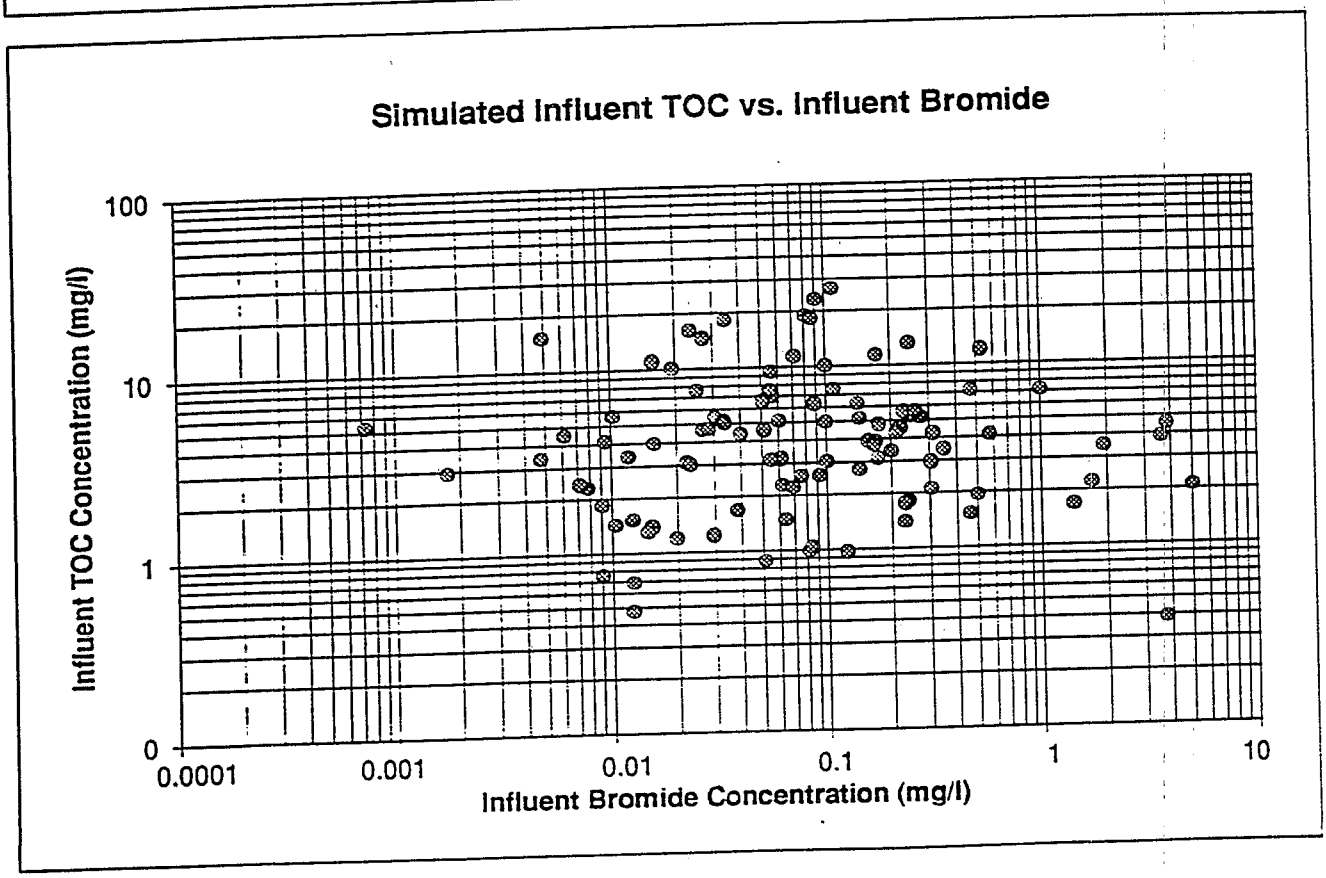


Exhibit 8


Simulated Influent TOC vs. Influent Giardia
Influent TOC Concentration (mg/l)
100
10
1
0
1
10
100
1,000
10,000
Influent Giardia Concentration (cysts/100 L)


Simulated Influent TOC vs. Influent Bromide
Influent TOC Concentration (mg/l)
100
10
1
0
0.0001
0.001
0.01
0.1
1
10
Influent Bromide Concentration (mg/l)

Compliance Decision Tree

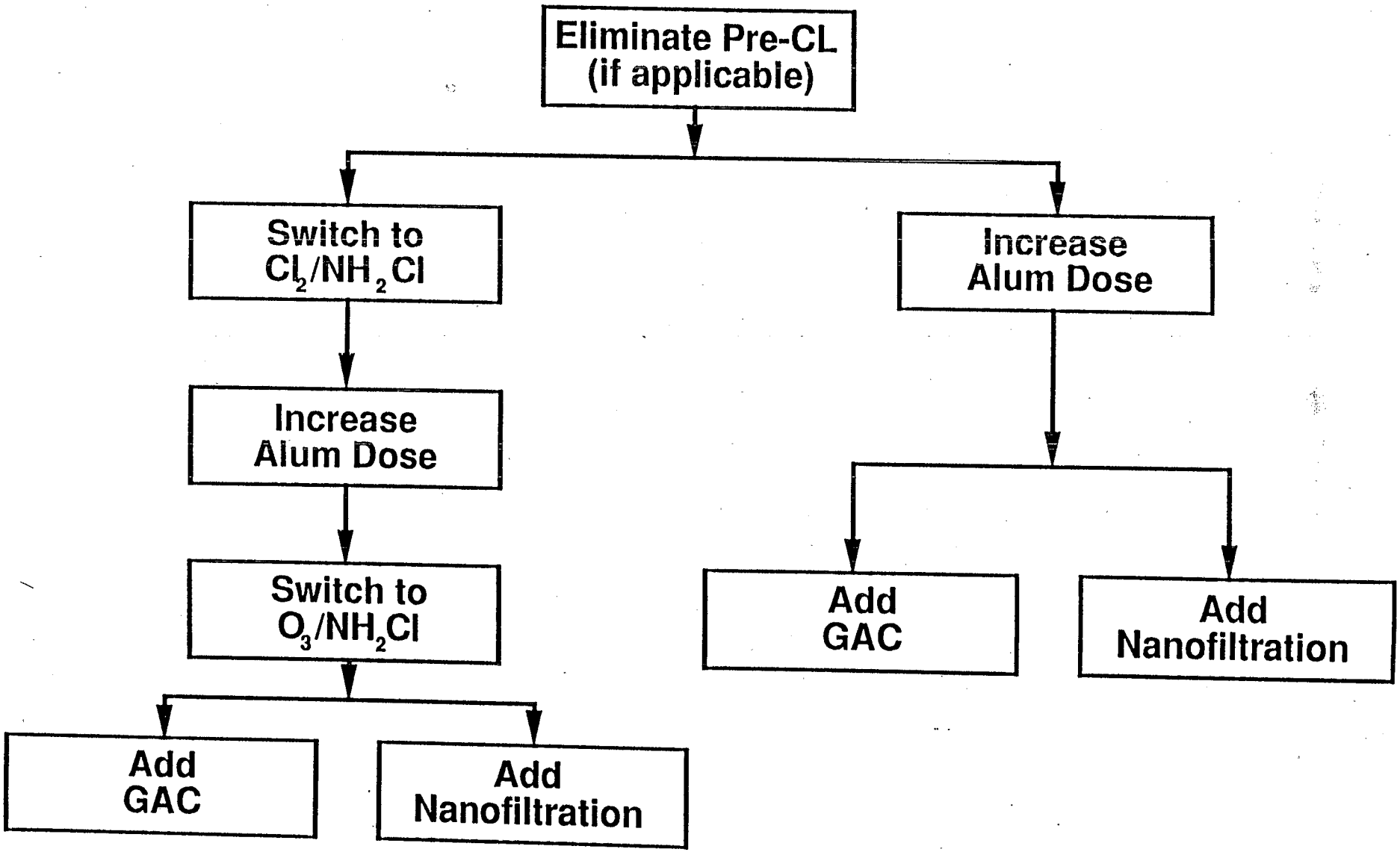


Exhibit 9

Exhibit 10

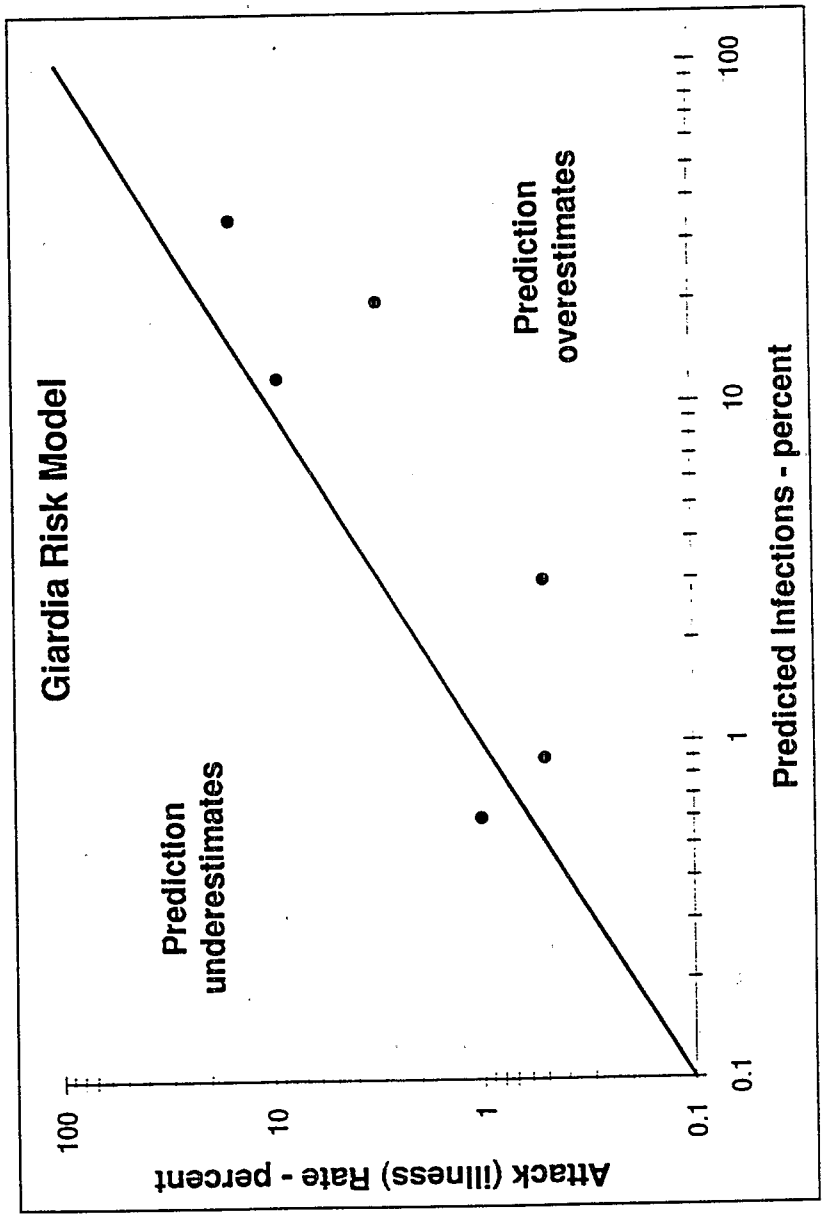

Giardia Risk Model
Prediction underestimates
Prediction overestimates
Attack (Illness) Rate - percent
Predicted Infections - percent
100
10
1
0.1
0.1
1
10
100

Exhibit 11

Overview of *Giardia* Modelling

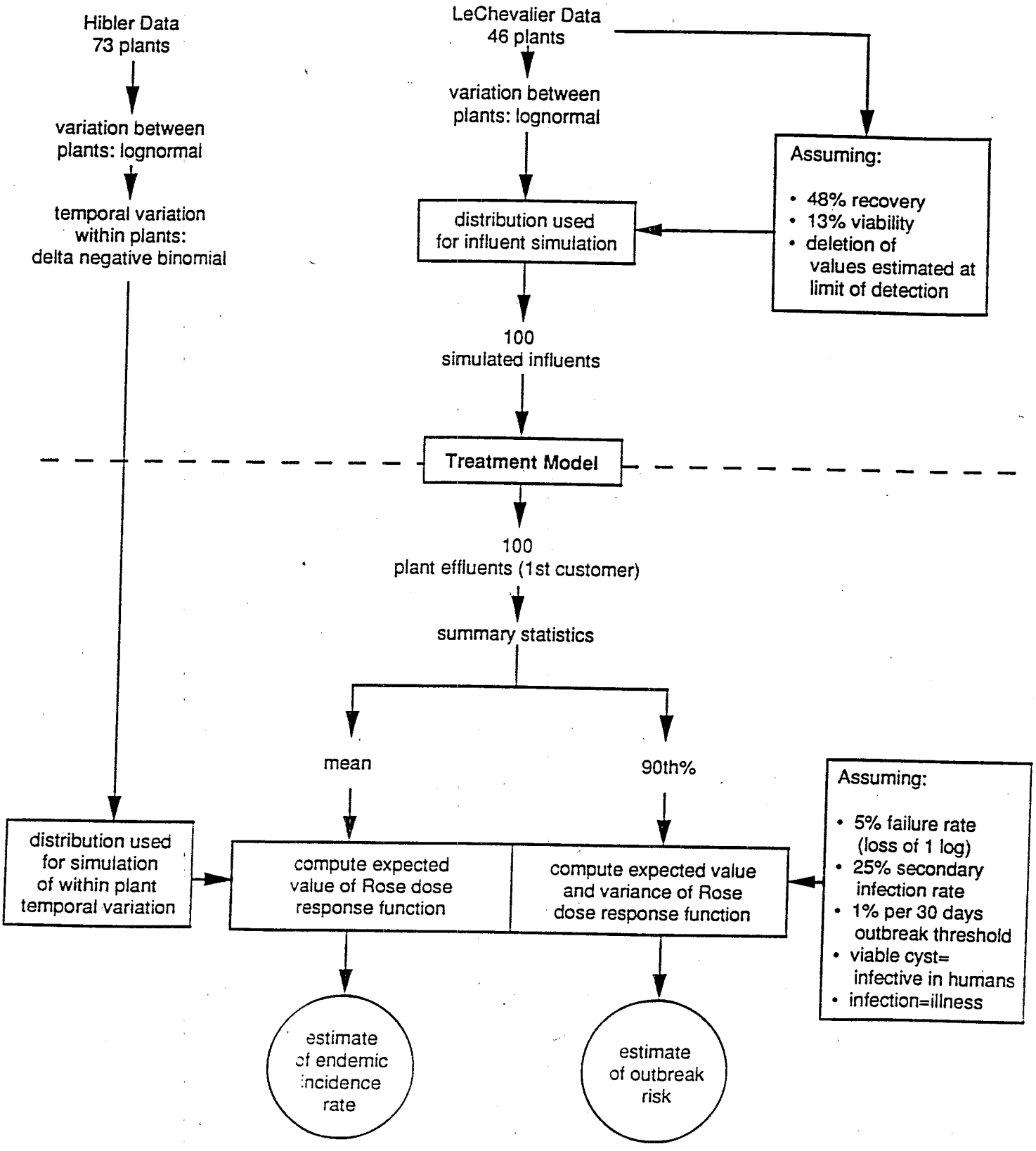


Exhibit 12

Overview of National-Level Model

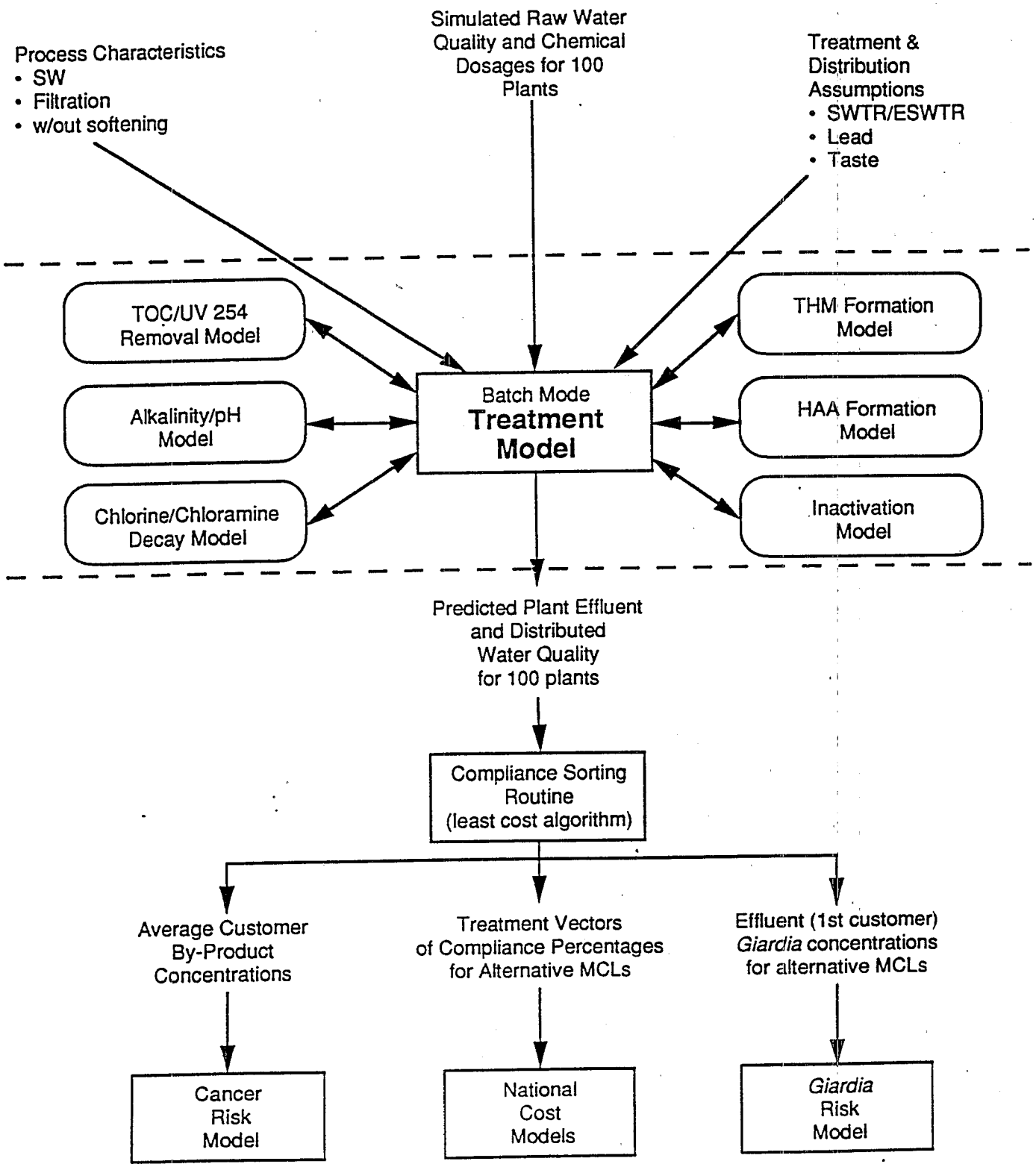
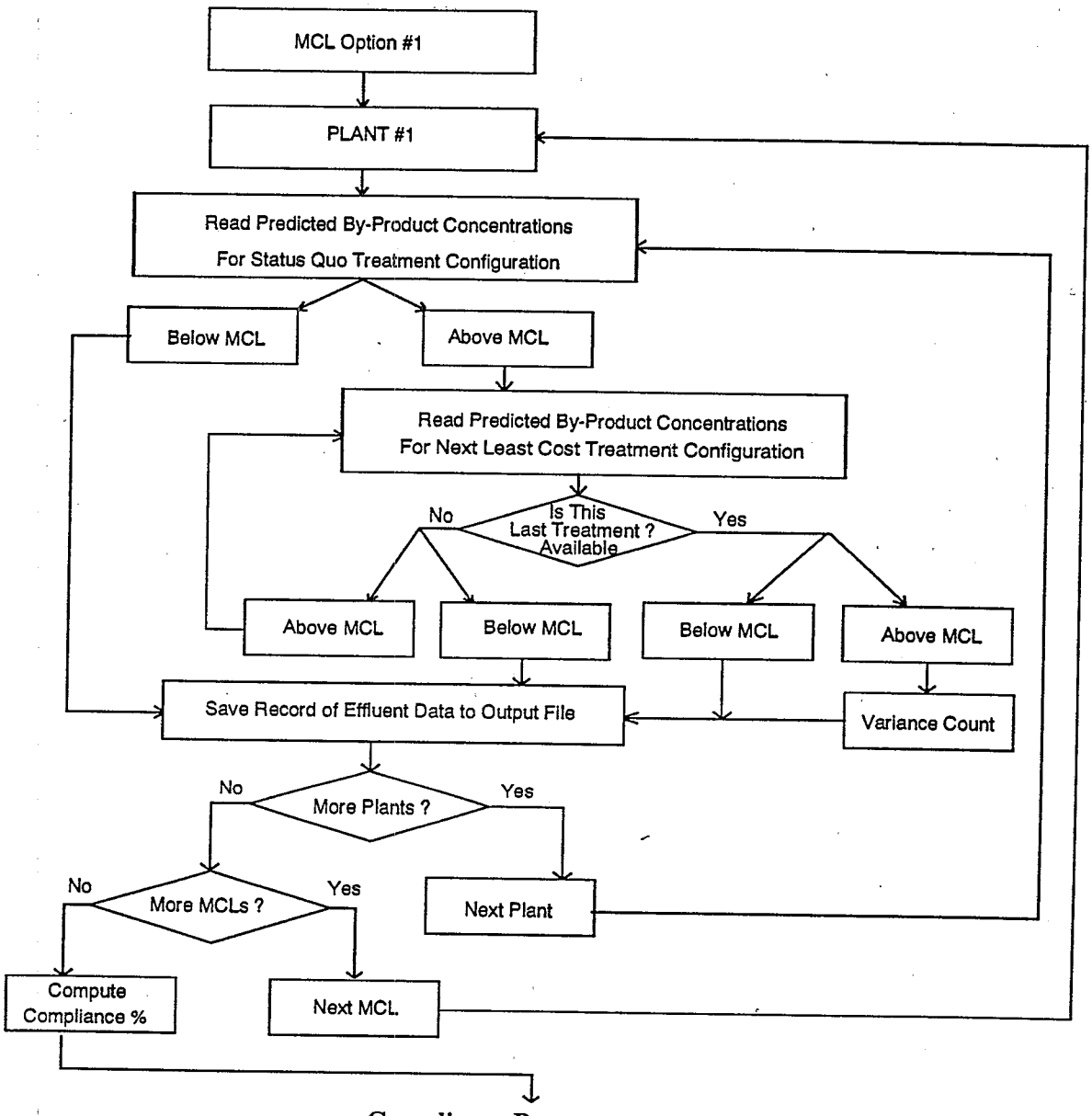


Exhibit 13

Compliance Sorting Routine



Compliance Percentages

SWTR Scenario W/ Alt. Disinf.	TTHM MCLs (ug/l) 100	75	50	25
No further treatment	61	49	33	17
Eliminate per-chlorination	21	25	23	10
Eliminate per-chlor & add ammonia	18	23	34	30
pre-chlor + ammonia + alum dose	0	3	9	27
pre-chlor + ammonia + alum + ozone	0	0	1	13
pre-chlor + ammonia + alum + ozone + GAC	0	0	0	3

Exhibit 14

The Core Problem

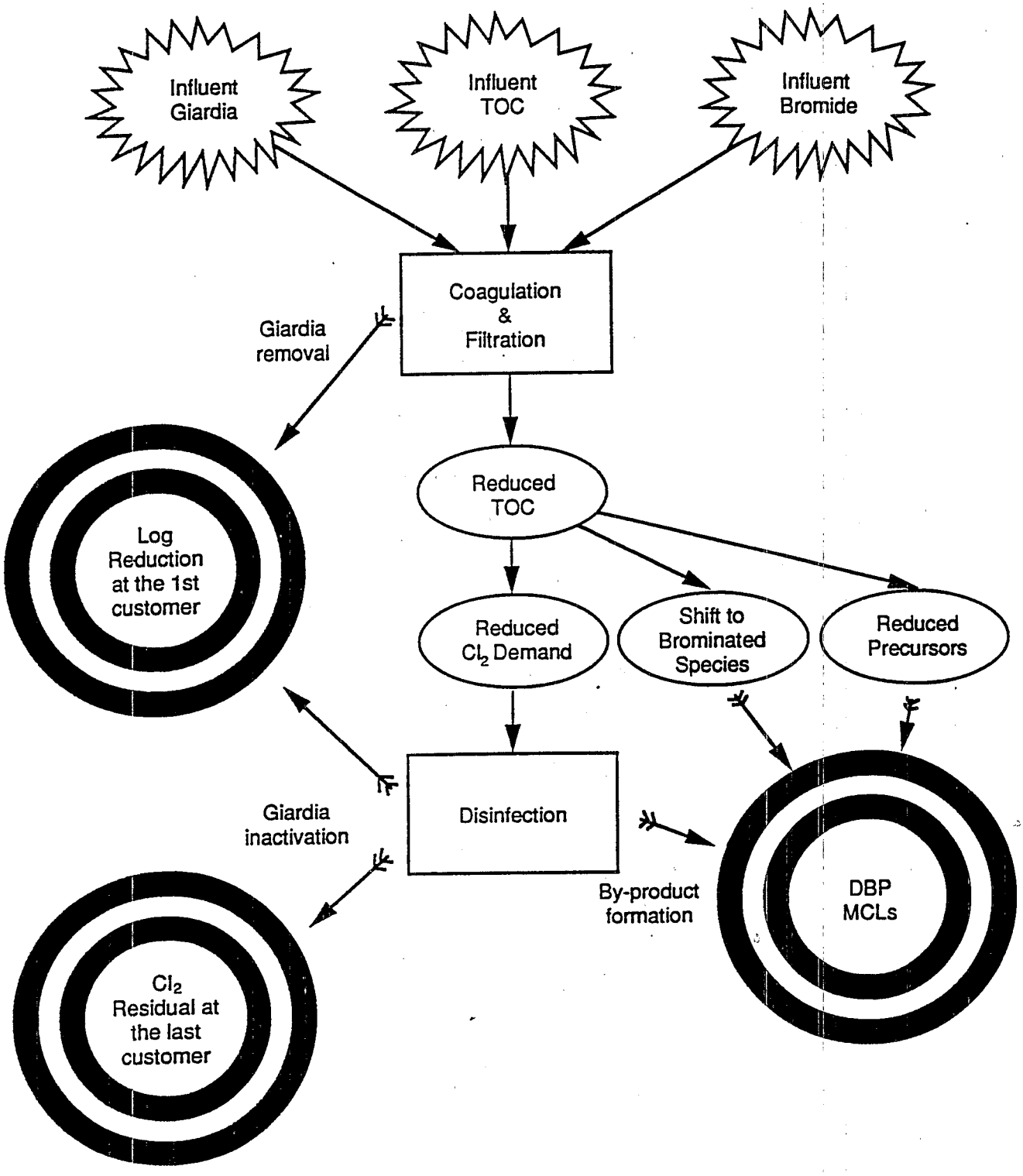


Exhibit 15

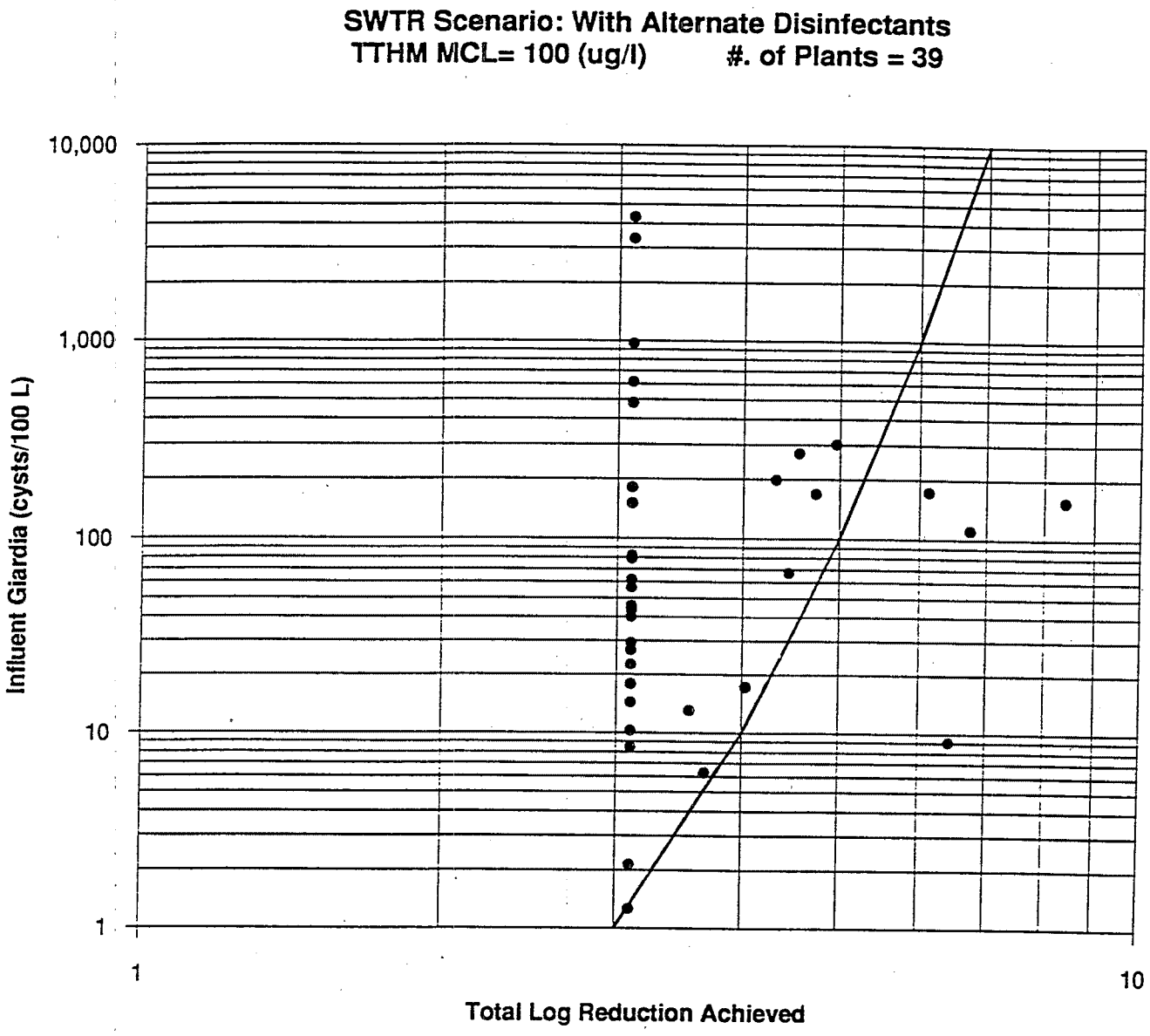

SWTR Scenario: With Alternate Disinfectants
TTHM MCL= 100 (ug/l) #. of Plants = 39
10,000
1,000
100
10
1
Influent Giardia (cysts/100 L)
1
10
Total Log Reduction Achieved

Exhibit 16

SWTR Scenario: With Alternate Disinfectants

TTHM MCL = 25 (ug/l) **#. of Plants Treating = 83**

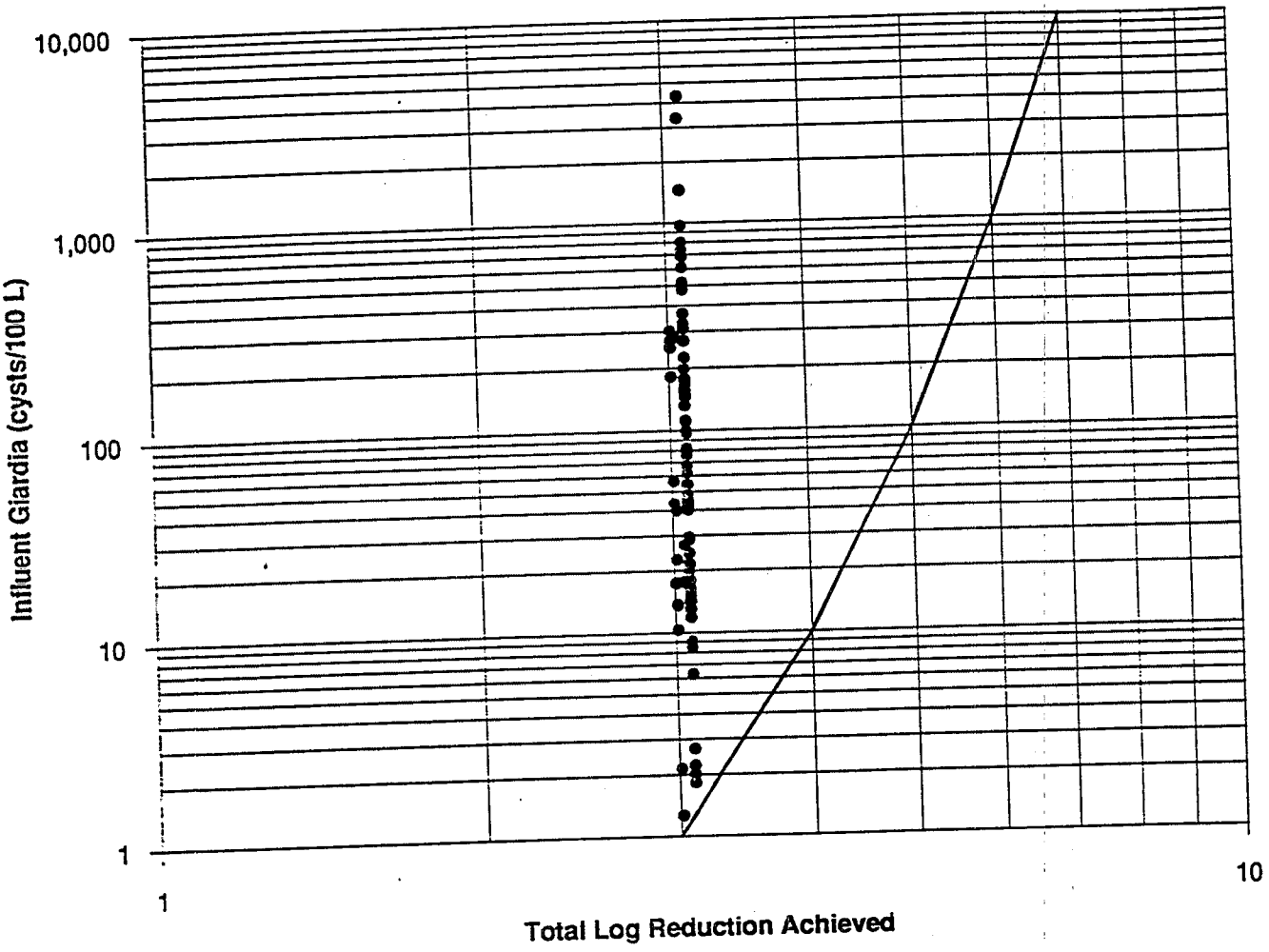


Exhibit 17

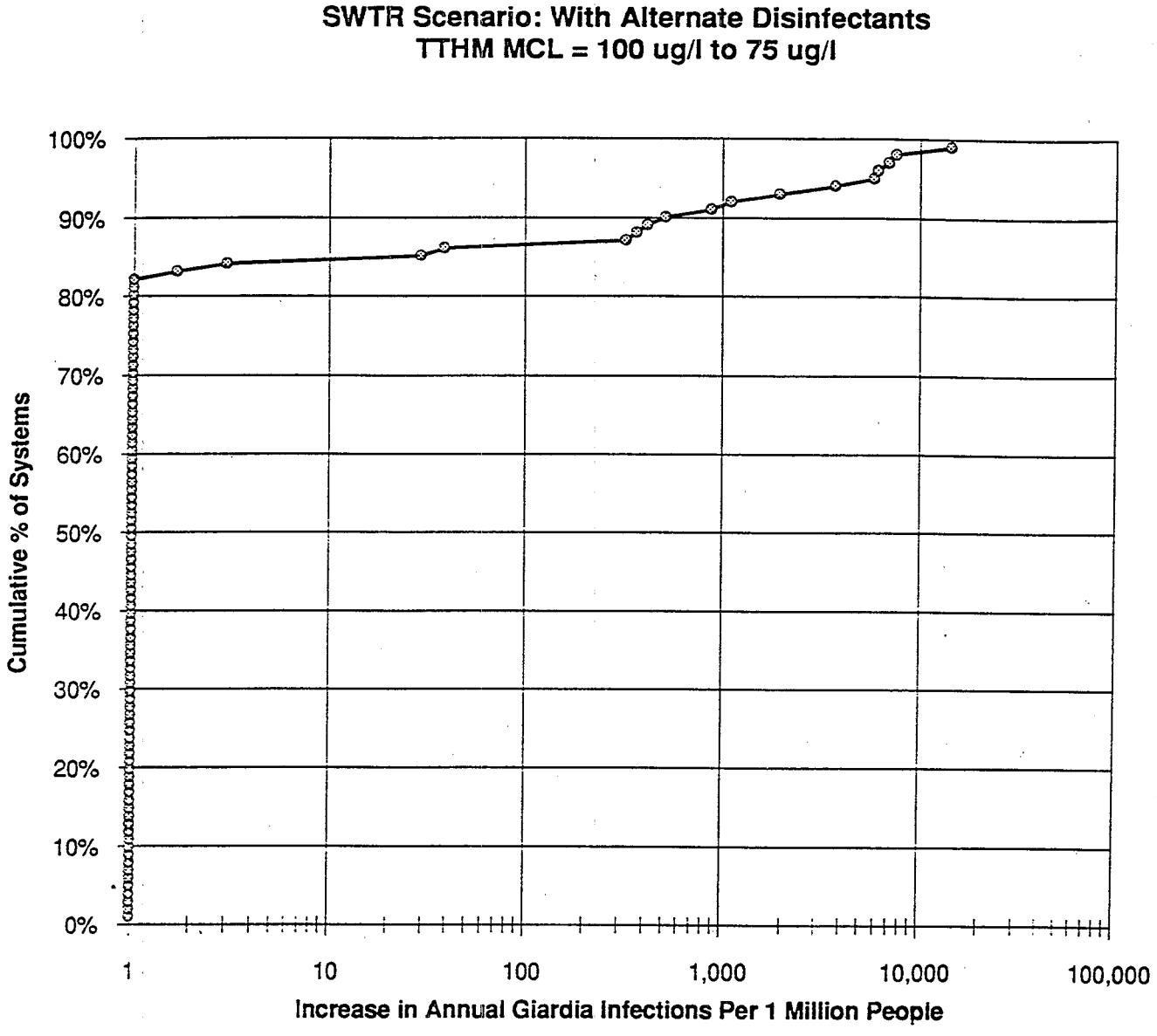

SWTR Scenario: With Alternate Disinfectants
TTHM MCL = 100 ug/l to 75 ug/l
Cumulative % of Systems
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1,000
10,000
100,000
Increase in Annual Giardia Infections Per 1 Million People

Exhibit 18

SWTR Scenario: With Alternate Disinfectants
TTHM MCL = 100 ug/l to 25 ug/l

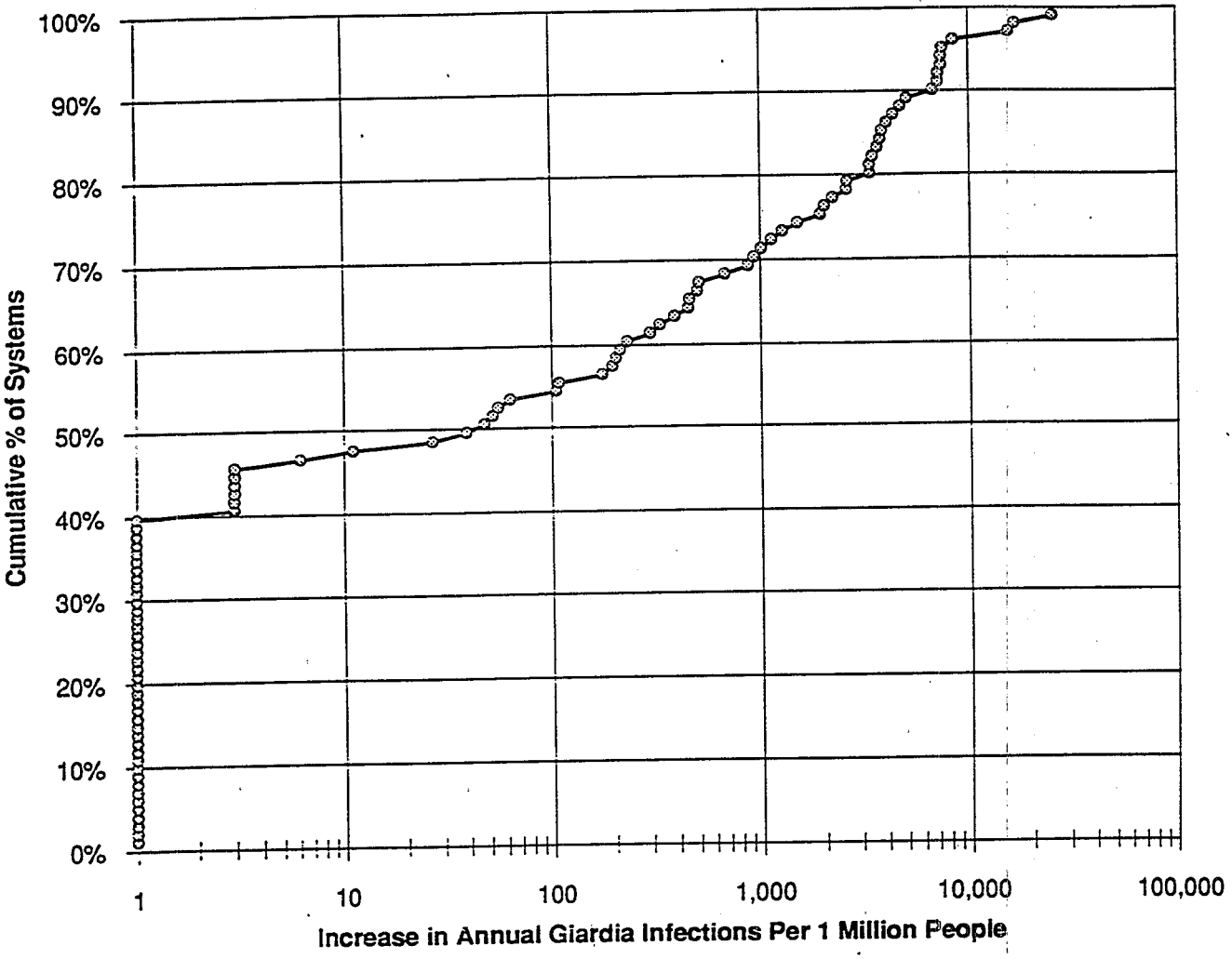


Exhibit 19

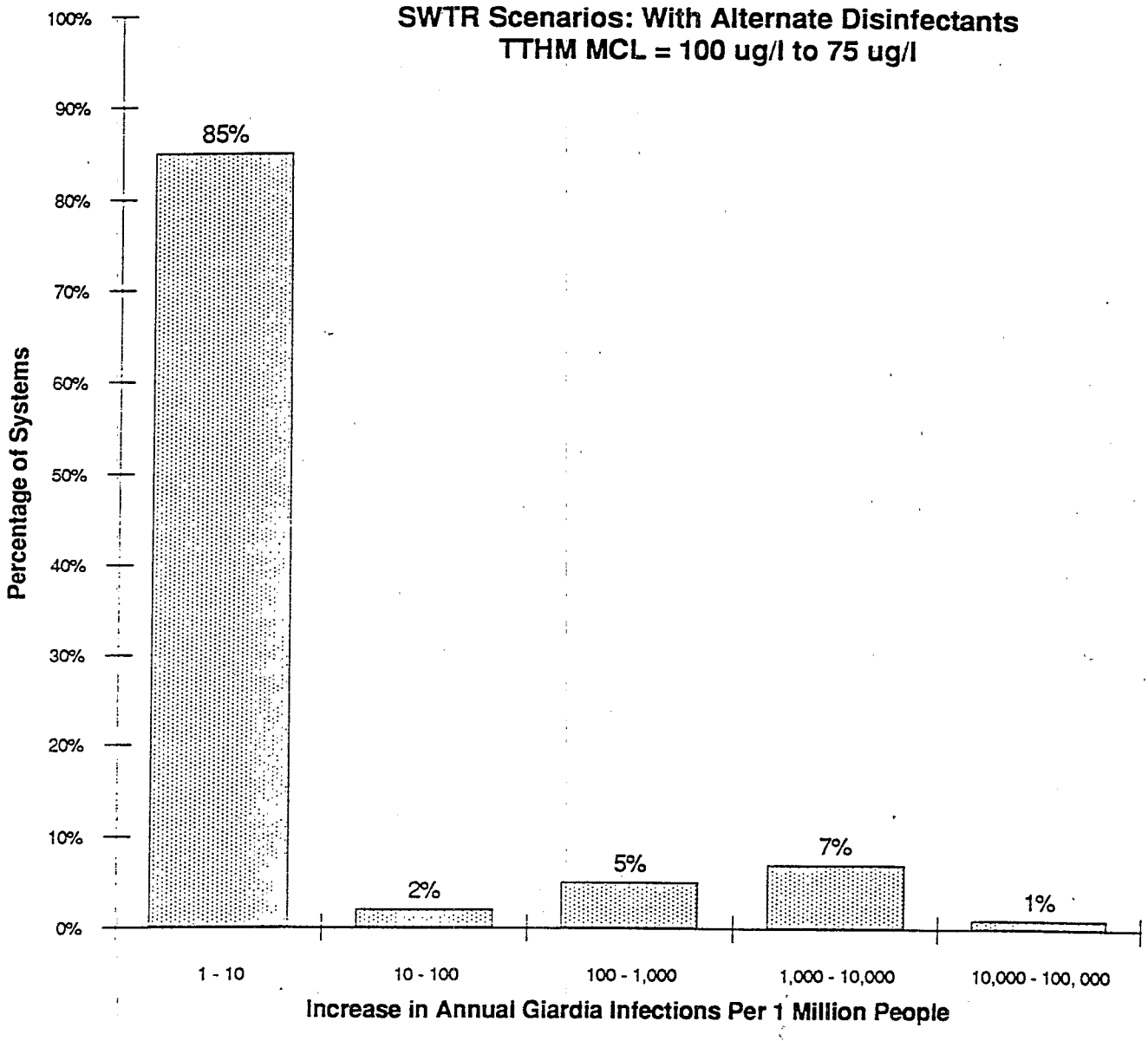

SWTR Scenarios: With Alternate Disinfectants
TTHM MCL = 100 ug/l to 75 ug/l
Percentage of Systems
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
85%
2%
5%
7%
1%
1 - 10
10 - 100
100 - 1,000
1,000 - 10,000
10,000 - 100, 000
Increase in Annual Giardia Infections Per 1 Million People

Exhibit 20

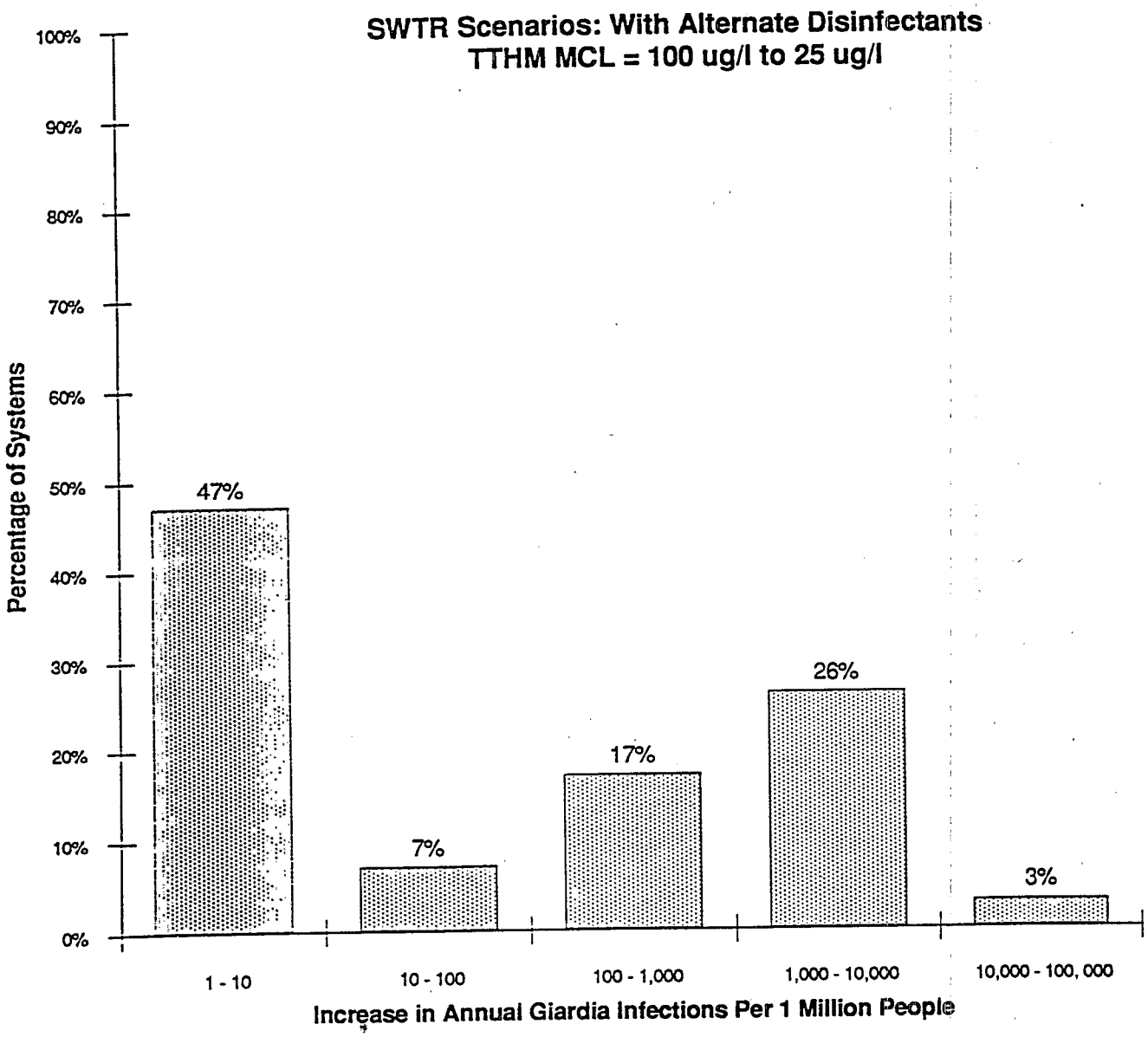

SWTR Scenarios: With Alternate Disinfectants
TTHM MCL = 100 ug/l to 25 ug/l
Percentage of Systems
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
47%
7%
17%
26%
3%
1 - 10
10 - 100
100 - 1,000
1,000 - 10,000
10,000 - 100, 000
Increase in Annual Giardia Infections Per 1 Million People

Exhibit 21

SWTR Scenario: With Alternate Disinfectants

From TTHM MCL = 100 ug/l to 75 ug/l
Change in Risks Per 1 Million People

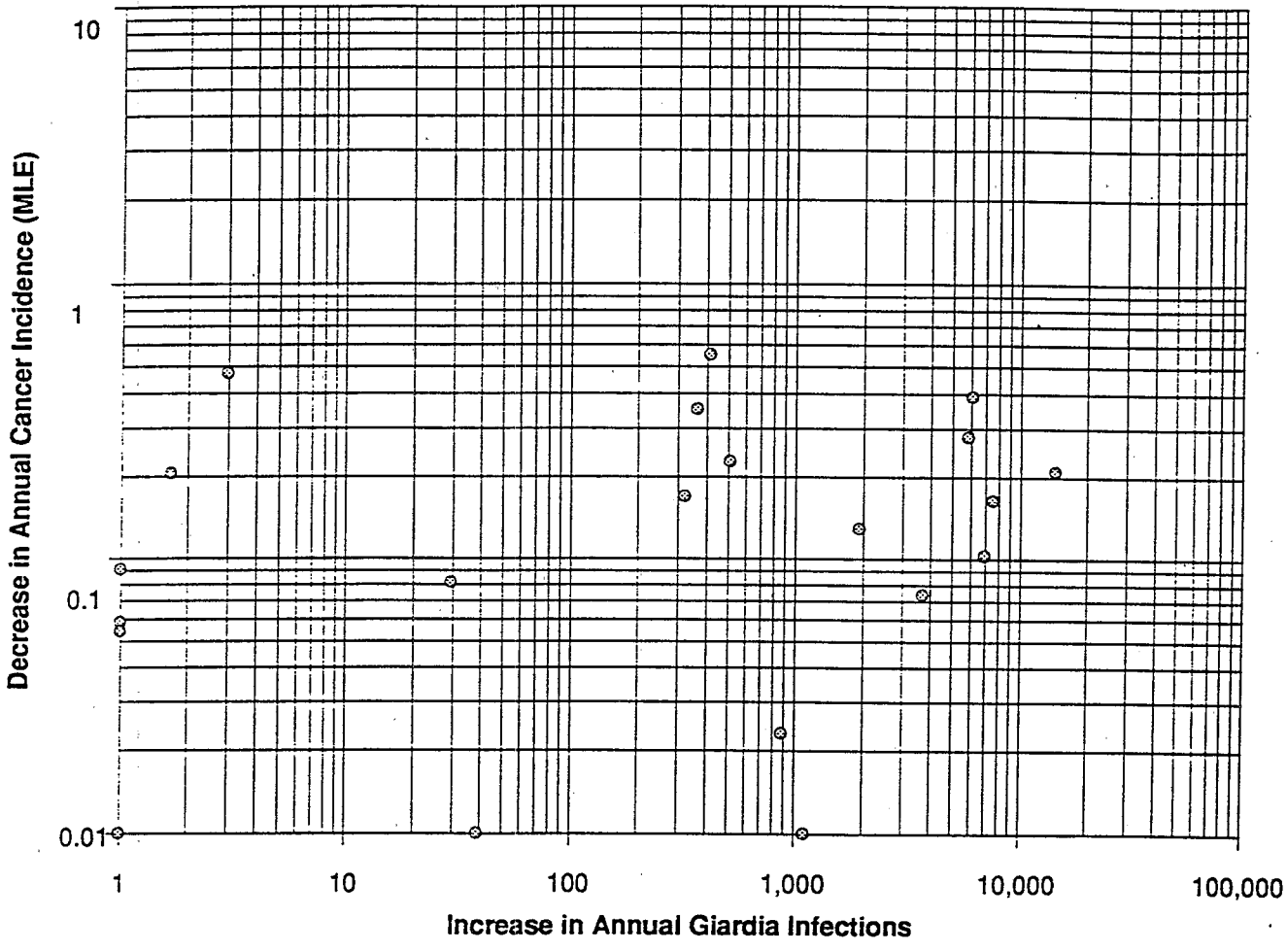


Exhibit 22

SWTR Scenario: With Alternate Disinfectants

From TTHM MCL = 100 ug/l to 25 ug/l
Change in Risks Per 1 Million People

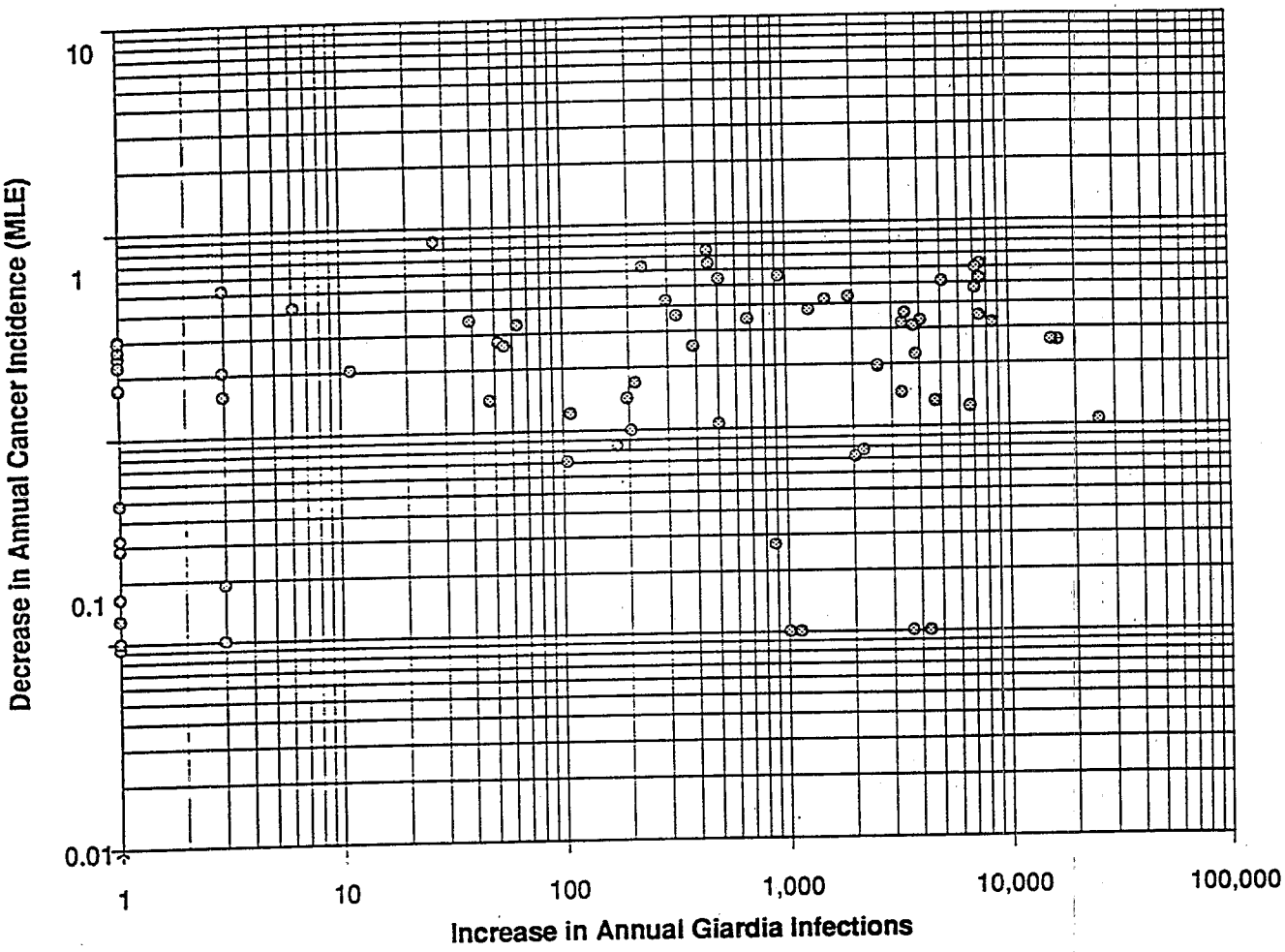


Exhibit 23

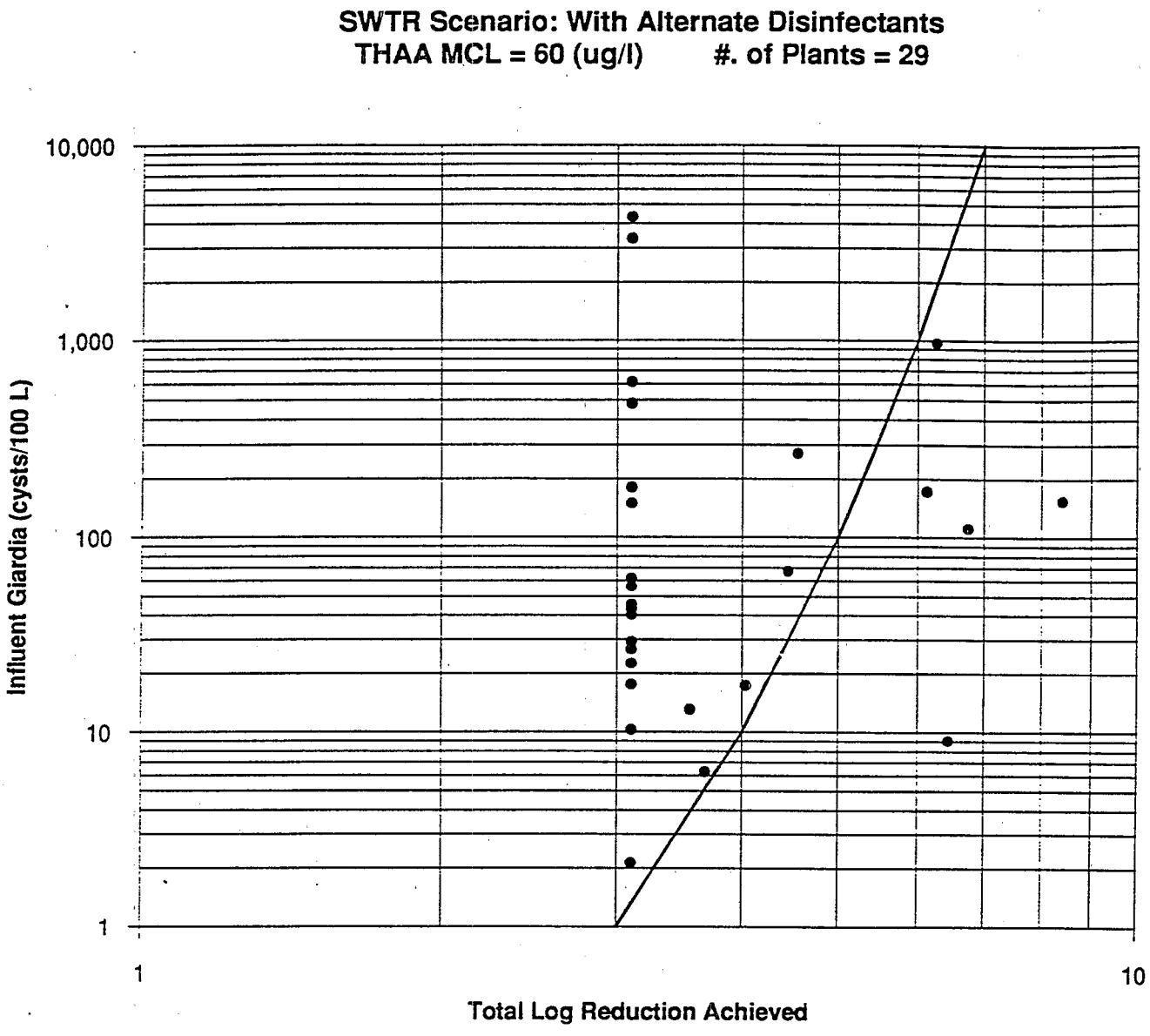

SWTR Scenario: With Alternate Disinfectants
THAA MCL = 60 (ug/l) #. of Plants = 29
10,000
1,000
100
10
1
Influent Giardia (cysts/100 L)
1
10
Total Log Reduction Achieved

Exhibit 24

SWTR Scenario: With Alternate Disinfectants

THAA MCL = 10 (ug/l) #. of Plants Treating = 80

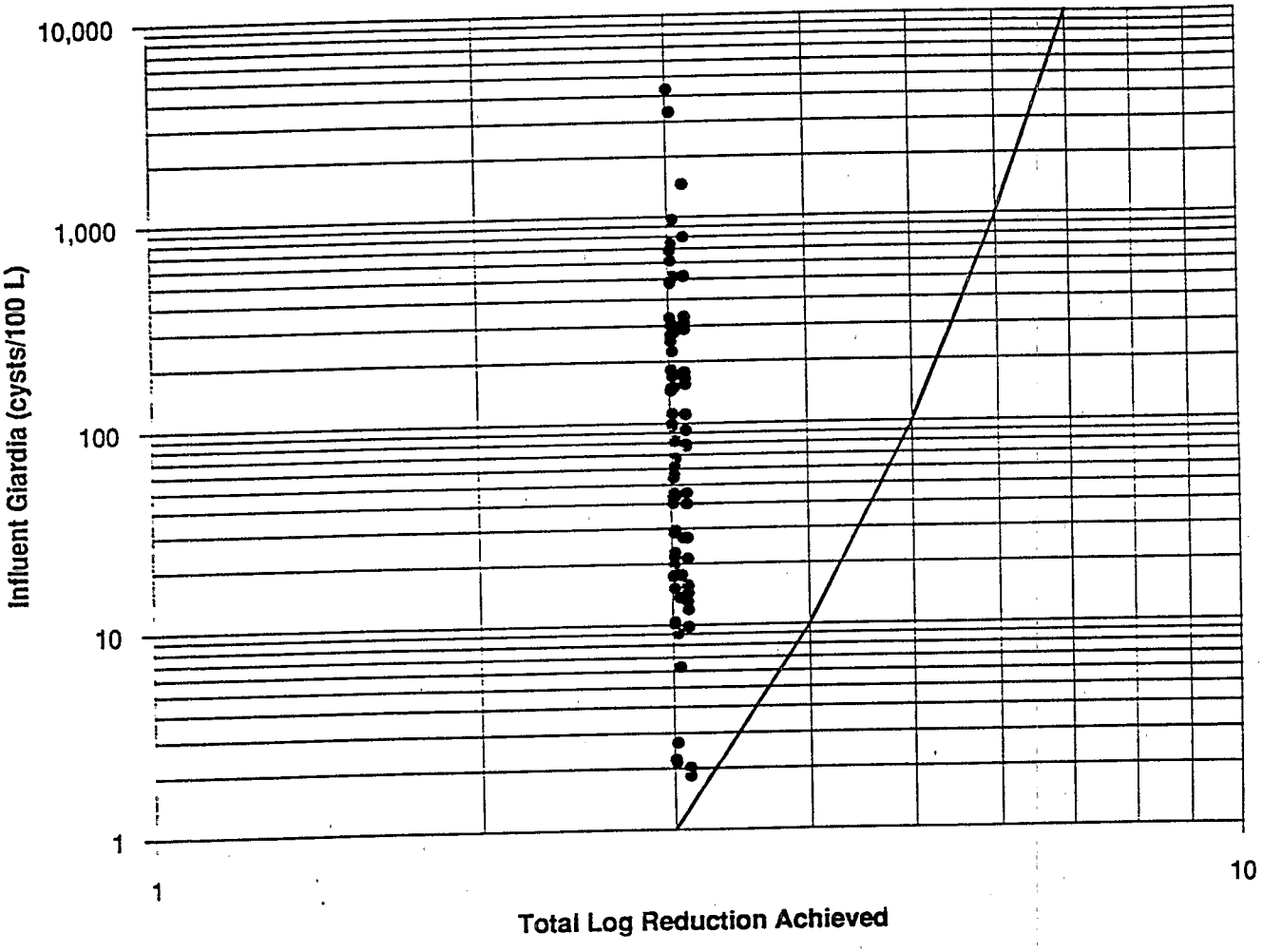


Exhibit 25

SWTR Scenario: With Alternate Disinfectants
THAA MCL = 60 ug/l to 50 ug/l

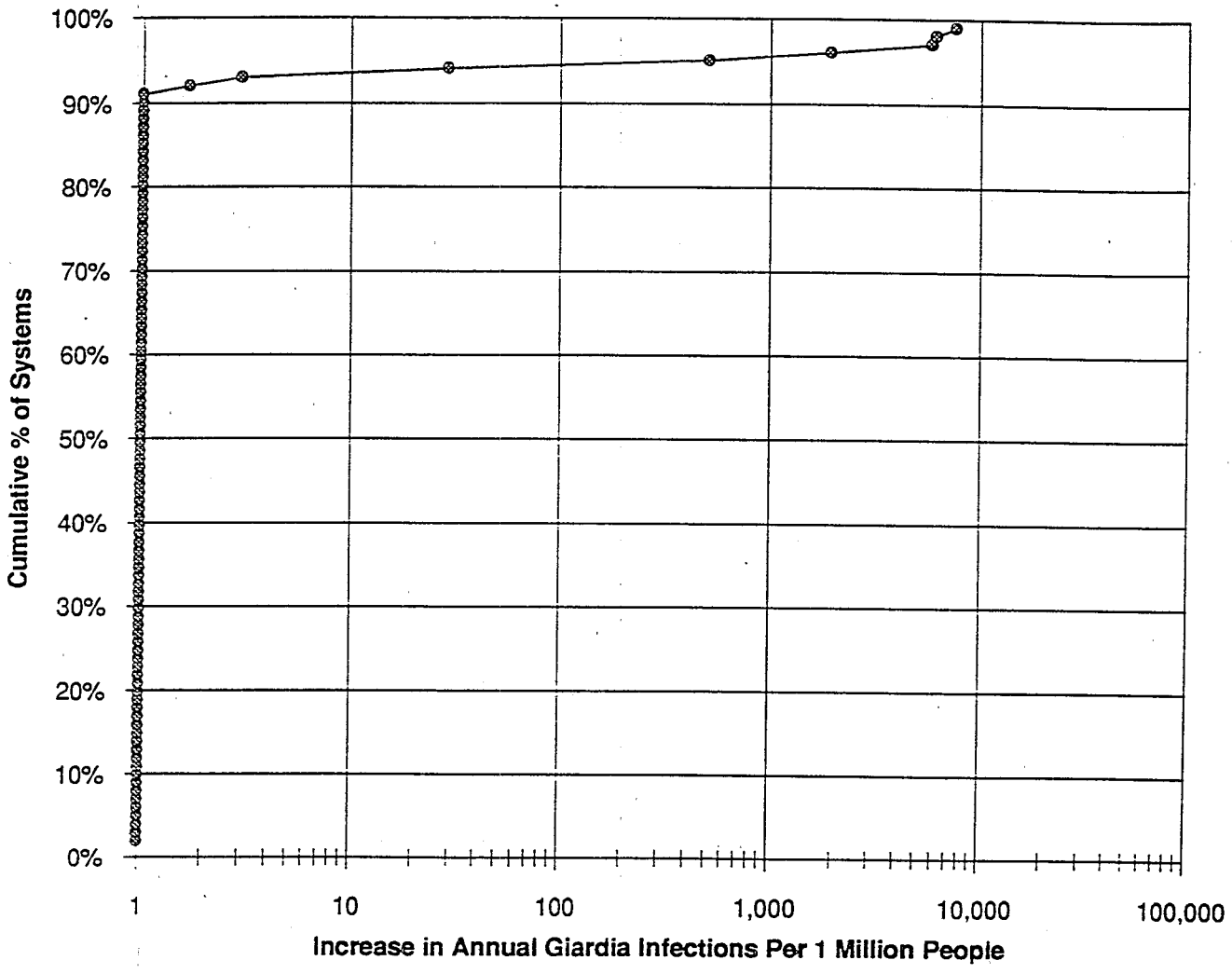


Exhibit 26

SWTR Scenario: With Alternate Disinfectants
THAA MCL = 60 ug/l to 10 ug/l

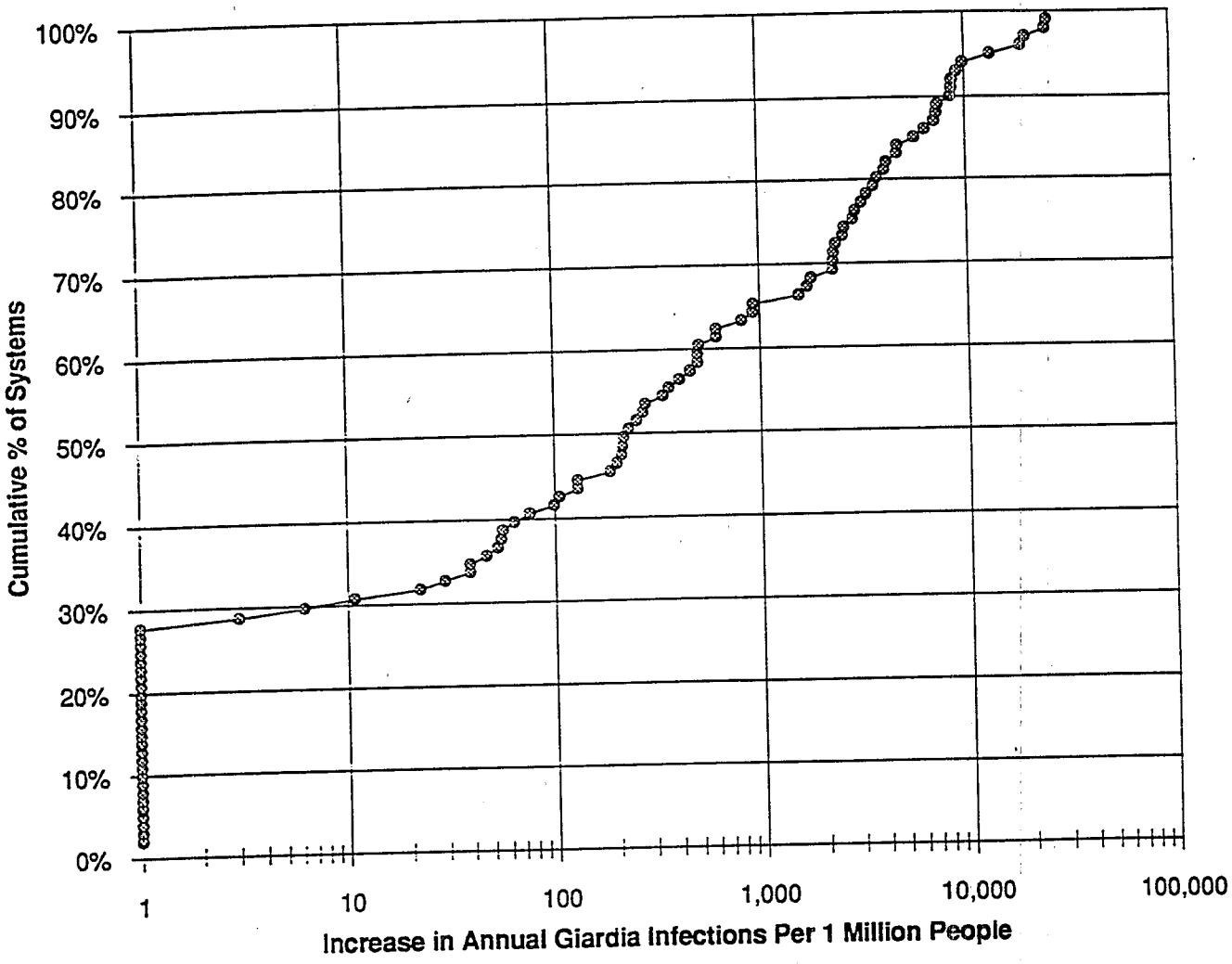


Exhibit 27

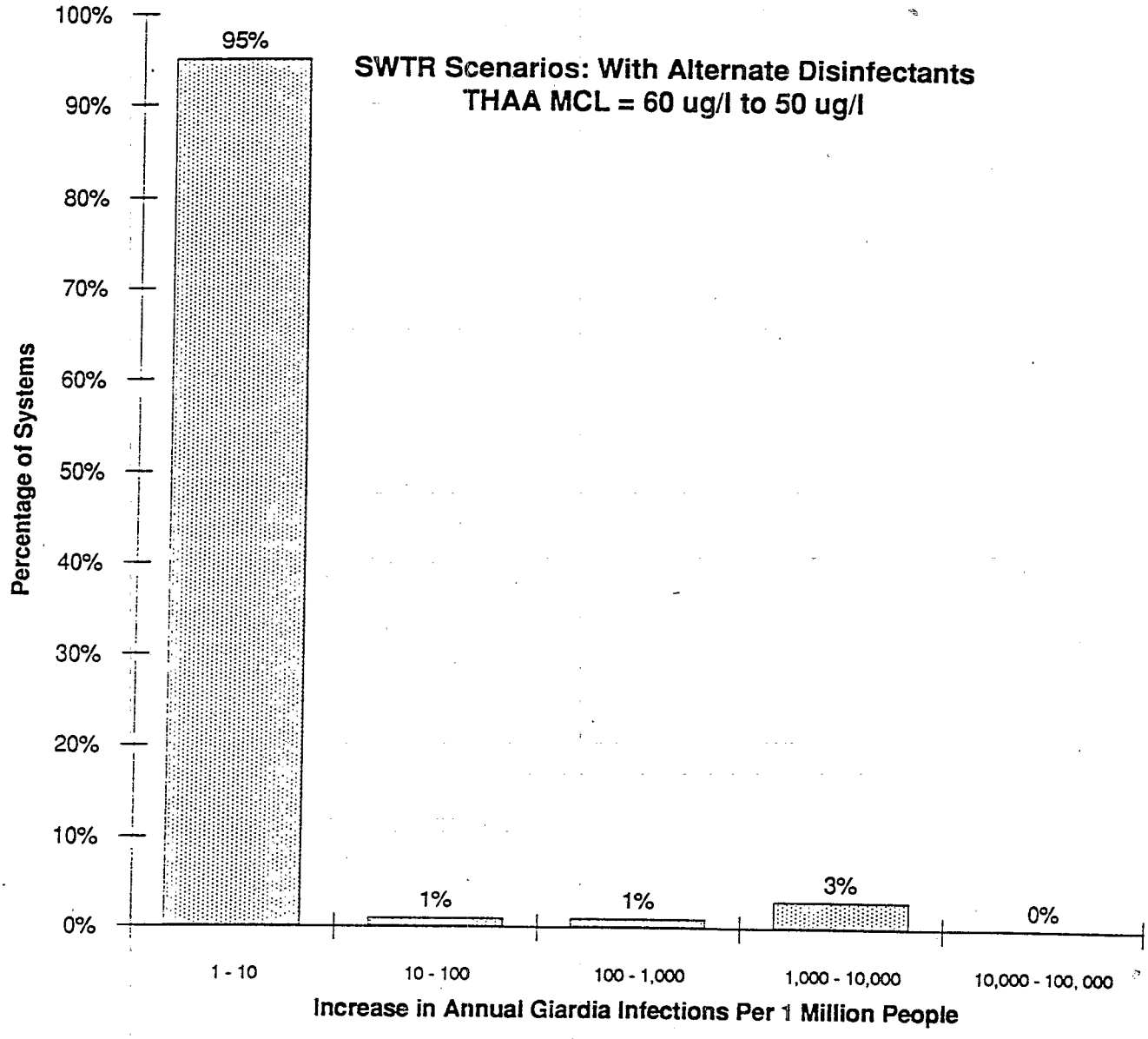

SWTR Scenarios: With Alternate Disinfectants
THAA MCL = 60 ug/l to 50 ug/l
Percentage of Systems
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
95%
1%
1%
3%
0%
1 - 10
10 - 100
100 - 1,000
1,000 - 10,000
10,000 - 100, 000
Increase in Annual Giardia Infections Per 1 Million People

Exhibit 28

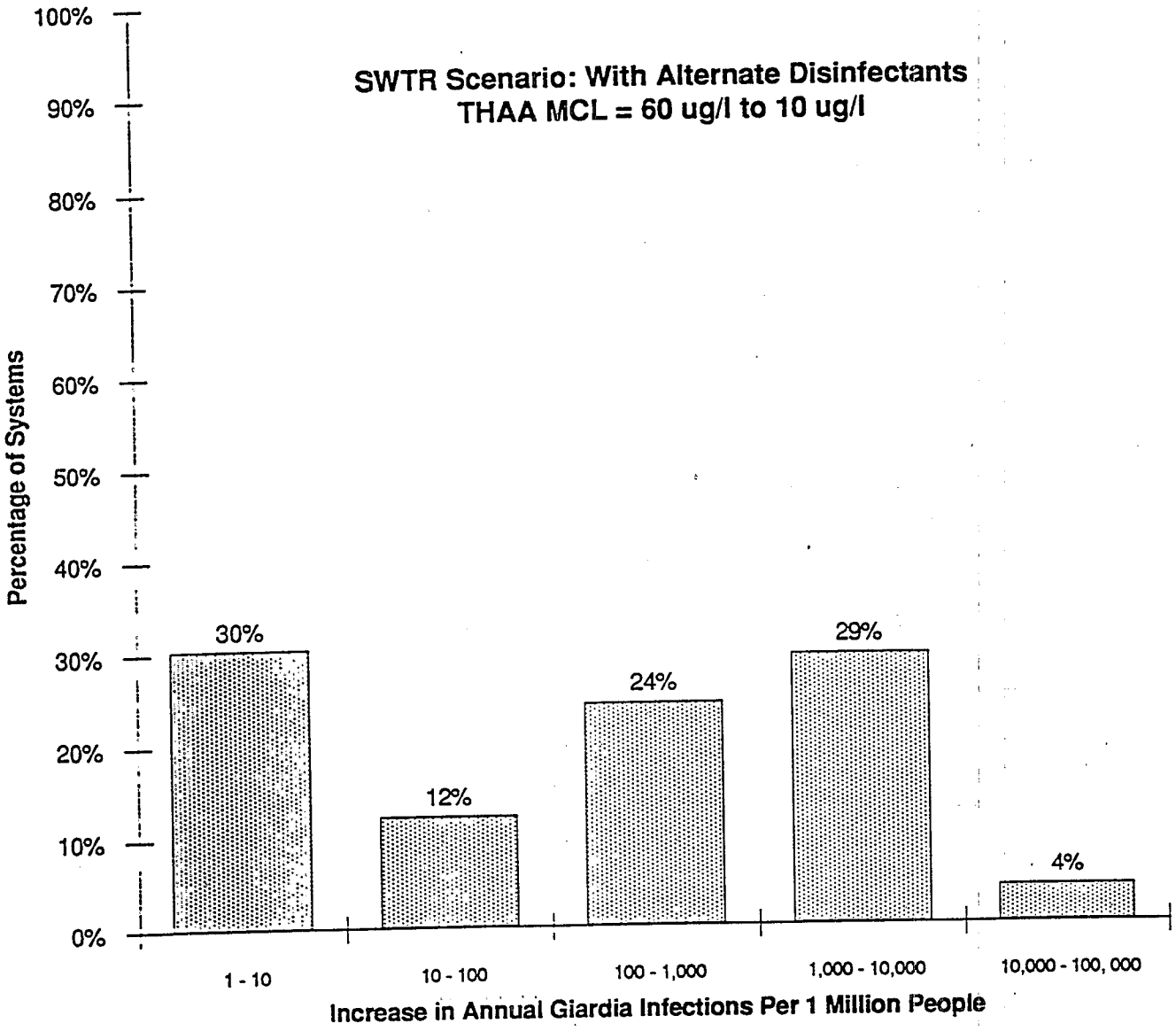

SWTR Scenario: With Alternate Disinfectants
THAA MCL = 60 ug/l to 10 ug/l
Percentage of Systems
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
30%
12%
24%
29%
4%
1 - 10
10 - 100
100 - 1,000
1,000 - 10,000
10,000 - 100, 000
Increase in Annual Giardia Infections Per 1 Million People

Exhibit 29

SWTR Scenario: With Alternate Disinfectants

From THAA MCL = 60 ug/l to 50 ug/l
Change in Risks Per 1 Million People

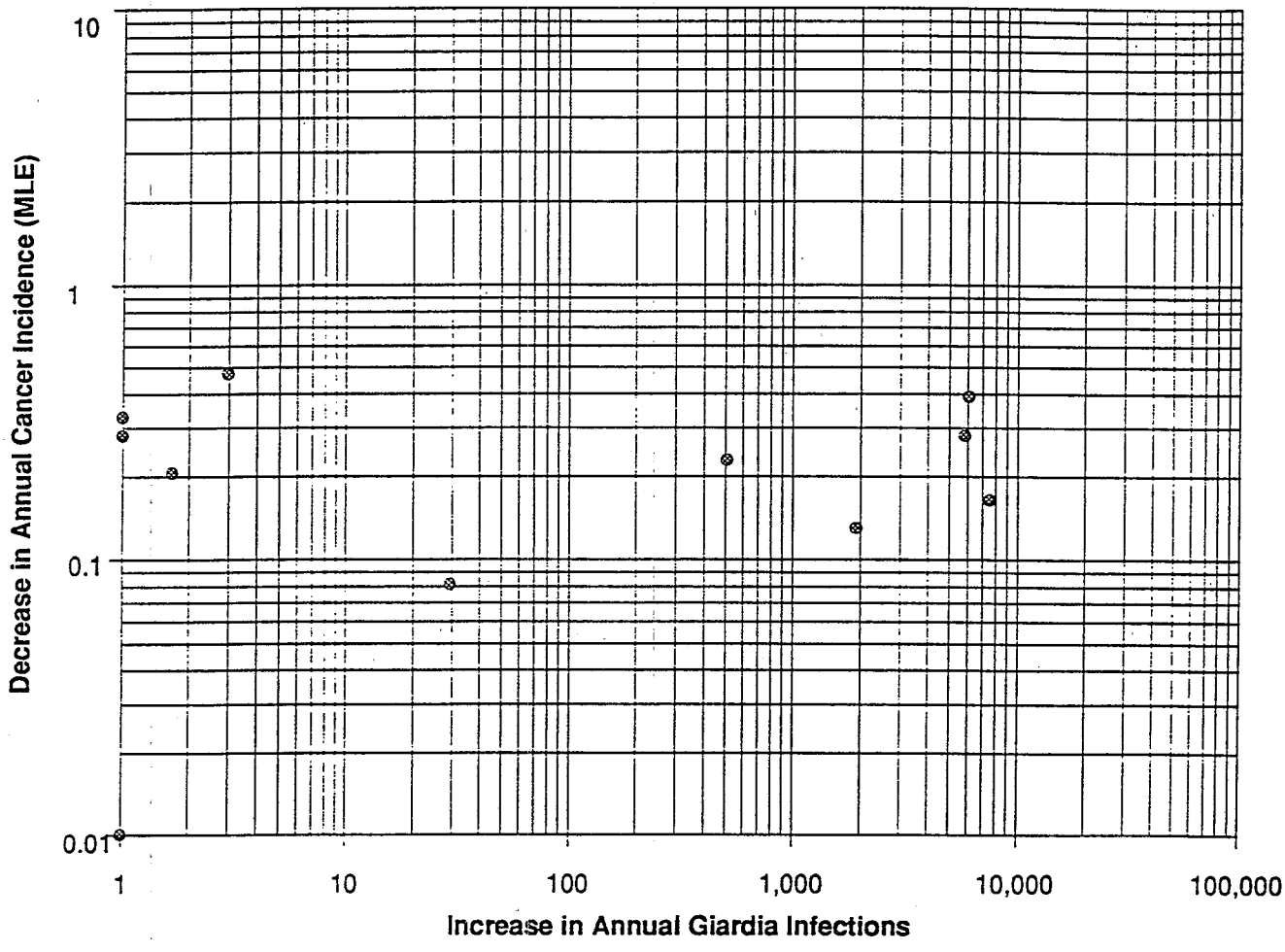
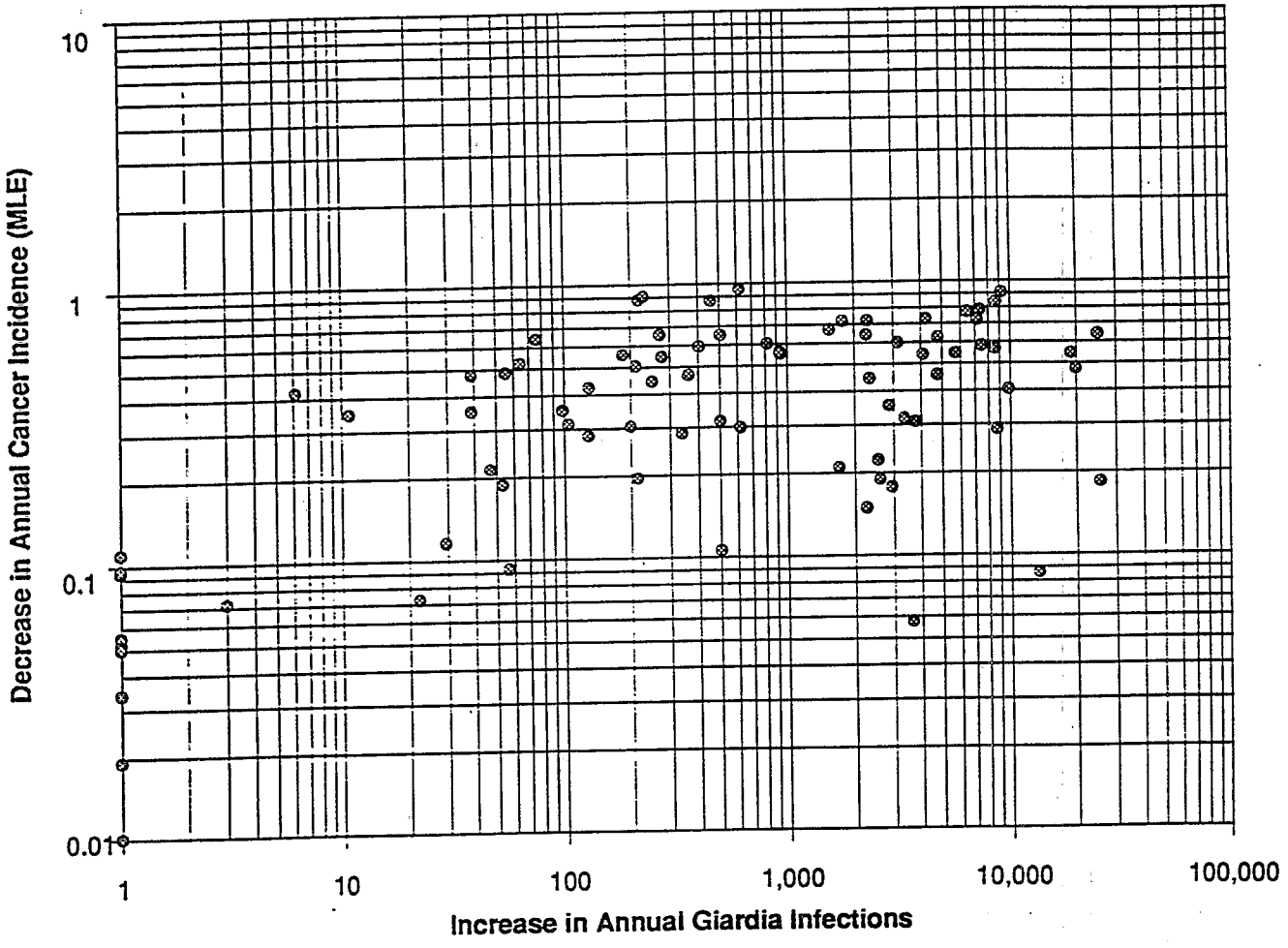


Exhibit 30

SWTR Scenario: With Alternate Disinfectants

THAA MCL = 60 ug/l to 10 ug/l
Change in Risks Per 1 Million People



W/ Alternate Disinfectants

SWTR Scenario	Total Annual Treatment Cost ($M/Yr.) *	Total Capital Cost ($M)	Number of Cancer Cases Remaining/Yr.		Incremental Annual Treatment Cost ($M/Yr.)	Incremental Cost Per Case of Cancer Avoided ($M/case)		Incremental Number of Cancer Cases Avoided/Year	
			95%	*MLE*		*95%*	*MLE*	*95%*	*MLE*
THAA MCLs									
60	2	17	139	45	–	–	–	–	–
50	12	20	131	42	10	1	4	8	3
40	21	61	118	38	9	1	2	13	4
30	71	266	101	32	50	3	9	17	6
20	383	2,433	69	22	312	10	30	32	10
10	922	6,547	35	11	539	16	50	34	11

ESWTR Scenario	Total Annual Treatment Cost ($M/Yr.) *	Total Capital Cost ($M)	Number of Cancer Cases Remaining/Yr.		Incremental Annual Treatment Cost ($M/Yr.)	Incremental Cost Per Case of Cancer Avoided ($M/case)		Incremental Number of Cancer Cases Avoided/Year	
			95%	*MLE*		*95%*	*MLE*	*95%*	*MLE*
THAA MCLs									
60	7	18	143	46	–	–	–	–	–
50	16	55	135	43	8	1	3	8	3
40	38	94	122	39	22	2	5	14	4
30	120	504	101	32	82	4	12	21	7
20	422	2,737	69	22	302	10	30	31	10
10	963	6,887	35	11	541	16	50	34	11

*** Costs are annualized at 10% interest rate over 20 years.**

Exhibit 31

W/out Alternate Disinfectants

SWTR Scenario	Total Annual Treatment Cost ($M/Yr.) *	Total Capital Cost ($M)	Number of Cancer Cases Remaining/Yr. 95%	MLE	Incremental Annual Treatment Cost ($M/Yr.)	Incremental Cost Per Case of Cancer Avoided ($M/case) 95%	MLE	Incremental Number of Cancer Cases Avoided/Year 95%	MLE
THAA MCLs									
60	104	788	130	42	–	–	–	–	–
50	118	889	124	40	13	3	8	5	2
40	202	1,524	105	34	84	4	13	19	6
30	353	2,668	80	26	151	6	19	25	8
20	588	4,446	55	18	235	9	28	26	8
10	957	7,240	31	10	369	15	48	24	8

ESWTR Scenario	Total Annual Treatment Cost ($M/Yr.) *	Total Capital Cost ($M)	Number of Cancer Cases Remaining/Yr. 95%	MLE	Incremental Annual Treatment Cost ($M/Yr.)	Incremental Cost Per Case of Cancer Avoided ($M/case) 95%	MLE	Incremental Number of Cancer Cases Avoided/Year 95%	MLE
THAA MCLs									
60	118	889	131	42	–	–	–	–	–
50	118	889	124	40	0	0	0	7	2
40	218	1,651	105	34	101	5	16	19	6
30	336	2,541	82	26	118	5	16	23	8
20	588	4,446	55	18	252	9	29	27	9
10	974	7,368	30	10	386	15	47	25	8

*** Costs are annualized at 10% interest rate over 20 years.**

Exhibit 32

Exhibit 33

Compliance Percentages

SWTR Scenario W/ Alt. Disin.	THAA MCLs (ug/l) 60	50	40	30	20	10
No further treatment	70	64	56	48	37	19
Eliminate pre-chlor	12	15	16	12	8	3
Eliminate pre-chlor & add NH3	18	17	22	22	8	1
pre-chlor + NH3 + alum dose	0	4	5	14	23	22
pre-chlor + NH3 + alum + Oz	0	0	1	3	7	5
pre-chlor + NH3 + alum + Oz + GAC	0	0	0	1	17	50

Compliance Percentages

Enhanced SWTR Scenario W/ Alt. Disin.	THAA MCLs (ug/l) 60	50	40	30	20	10
No further treatment	70	62	56	47	35	17
Eliminate pre-chlor	11	16	16	12	10	3
Eliminate pre-chlor & add NH3	17	18	16	12	4	0
pre-chlor + NH3 + alum dose	2	3	10	18	18	15
pre-chlor + NH3 + alum + Oz	0	1	2	10	16	15
pre-chlor + NH3 + alum + Oz + GAC	0	0	0	1	17	50

Exhibit 34

Compliance Percentages

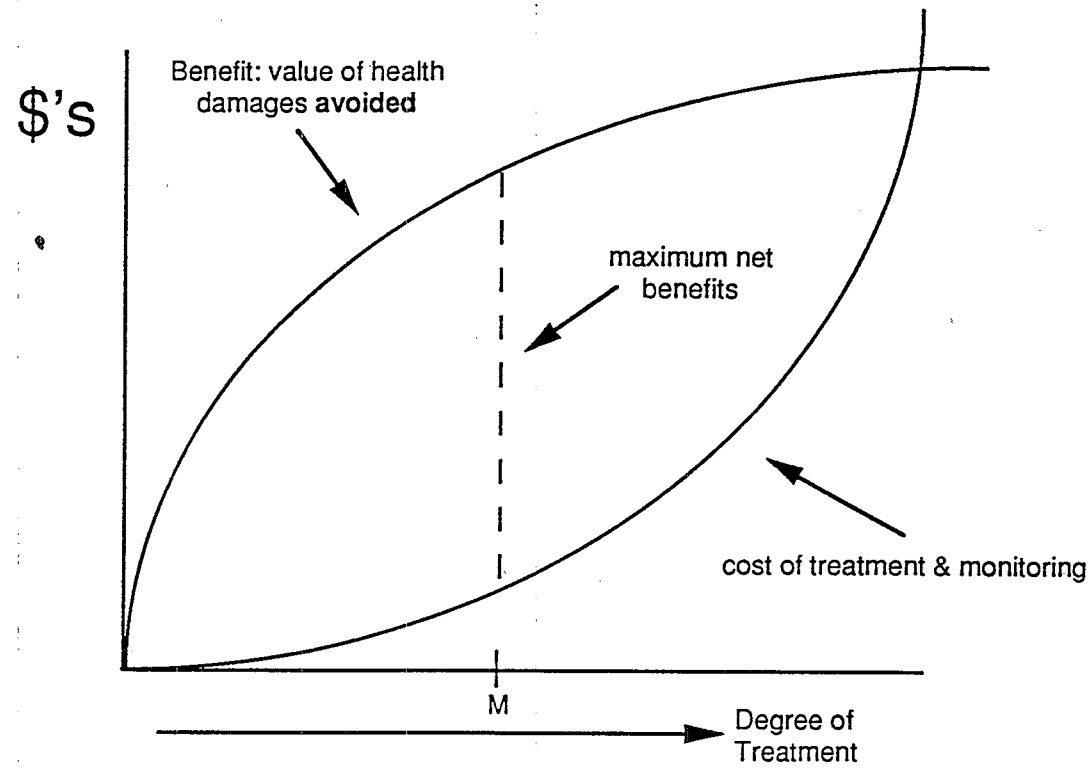
SWTR Scenario W/out Alt. Disin.	THAA MCLs (ug/l) 60	50	40	30	20	10
No further treatment	70	64	56	48	37	19
Eliminate pre-chlor	12	15	16	12	8	3
Eliminate pre-chlor & modify alum	11	14	16	19	20	21
Eliminate pre-chlor + alum + GAC	7	7	12	21	35	57

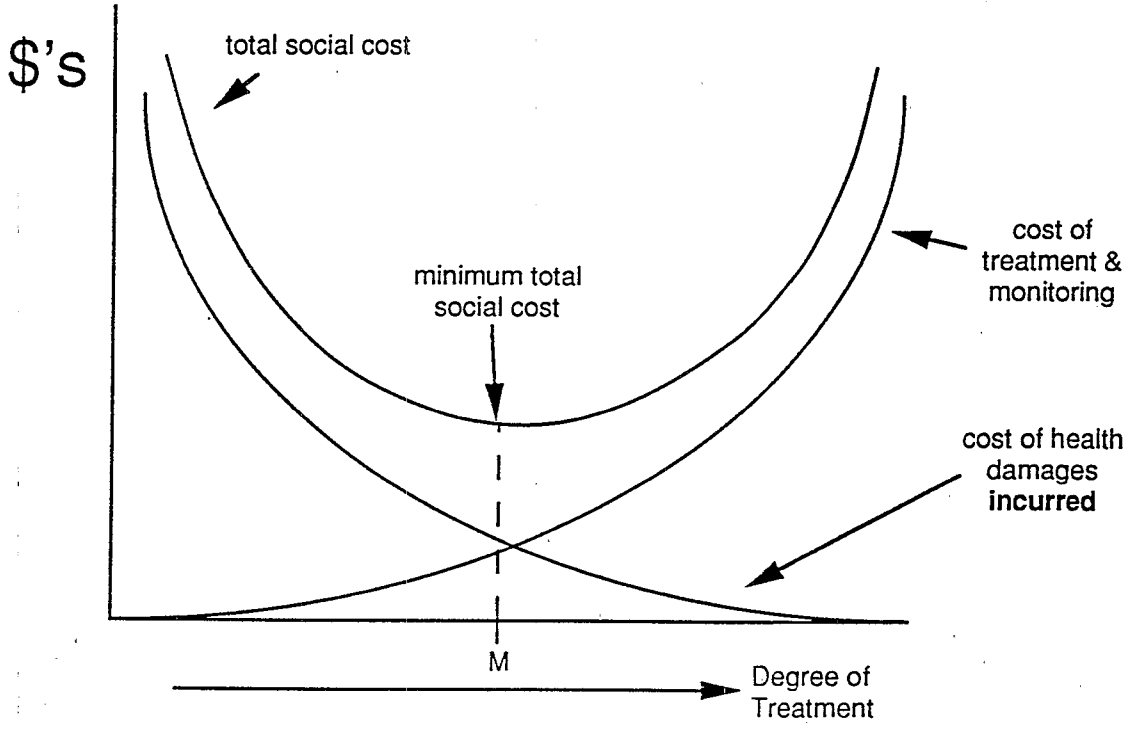
Compliance Percentages

Enhanced SWTR Scenario W/out Alt. Disin.	THAA MCLs (ug/l) 60	50	40	30	20	10
No further treatment	70	62	56	47	35	17
Eliminate pre-chlor	11	16	16	12	10	3
Eliminate pre-chlor & modify alum	12	15	15	21	20	22
Eliminate pre-chlor + alum + GAC	7	7	13	20	35	58

Exhibit 35

Equivalence of "Maximum Net Benefit" and "Minimum Total Social Cost" Objectives





Maximizing Health Damages Avoided Per Dollar of Treatment Expenditure = Minimizing Health Damages Incurred Per Dollar of Treatment Expenditure

Exhibit 36

MODEL OUTPUT (surface w/o softening): SWTR W/ ALTERNATIVE DISINFECTION

Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre–chlorination
3 – eliminate pre–chlor + add ammonia
4 – pre–chlor + ammonia + alum dose
5 – pre–chlor + ammonia + alum + ozone
6 – pre–chlor + ammonia + alum + ozone + GAC

Population = *103,000,000* *(persons)*

THAA MCL (µg/l)	Annual Treatment Cost * ($M)	Cost of Cancer** @ $8m/case ($M)	Cost of Giardia @ $3,000/case ($M)	Total Costs ($M)
60	2	358	639	1,000
50	12	338	714	1,064
40	21	304	849	1,174
30	71	259	974	1,304
20	383	177	1,239	1,798
10	922	91	1,729	2,742

* Capital costs are annualized at 10% interest rate over 20 years.
** MLE of cancer incidence from HAAs.

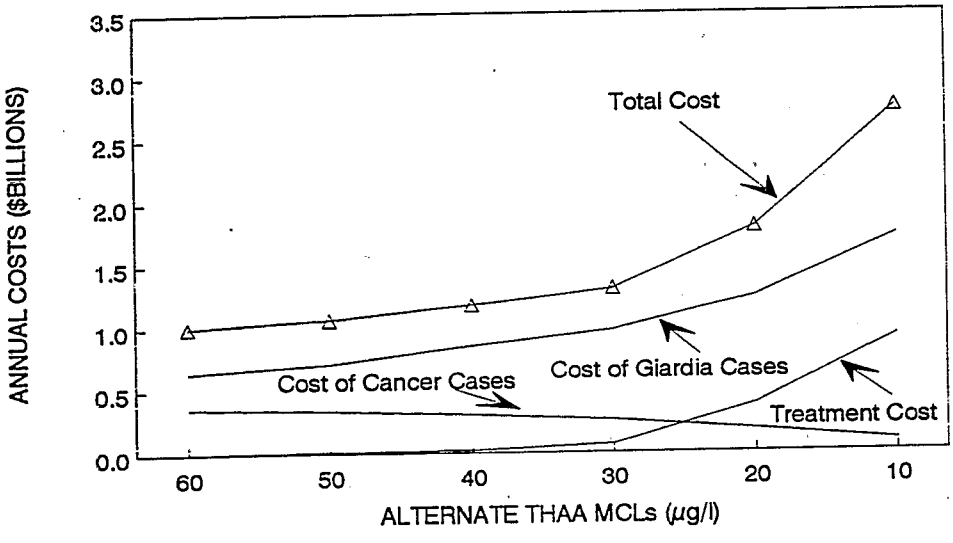


Exhibit 37

Draft: 13–May–92

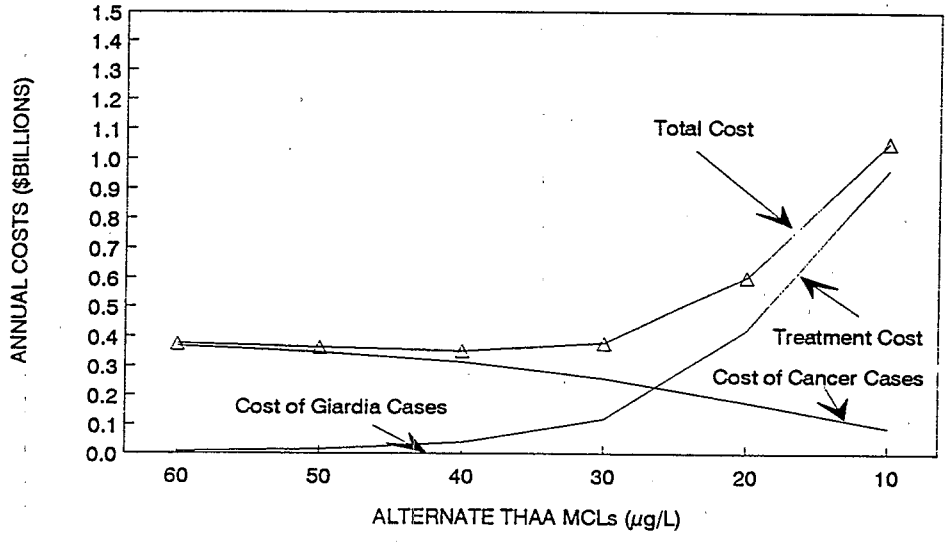
MODEL OUTPUT (surface w/o softening): ENHANCED SWTR W/ ALTERNATIVE DISINFECTION

Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre–chlorination
3 – eliminate pre–chlor + add ammonia
4 – pre–chlor + ammonia + alum dose
5 – pre–chlor + ammonia + alum + ozone
6 – pre–chlor + ammonia + alum + ozone + GAC

Population = *103,000,000* *(persons)*

THAA MCL (µg/l)	Annual Treatment Cost * ($M)	Cost of Cancer** @ $8m/case ($M)	Cost of Giardia @ $3,000/case ($M)	Total Costs ($M)
60	7	369	0.8	377
50	16	348	0.8	364
40	38	313	0.9	351
30	120	258	1.0	379
20	422	178	1.0	601
10	963	91	1.0	1,055

* Capital costs are annualized at 10% interest rate over 20 years.
** MLE of cancer incidence from HAAs.



MODEL OUTPUT (surface w/o softening): SWTR W/O ALTERNATIVE DISINFECTION

Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre–chlorination
3 – eliminate pre–chlor + modify alum dose
4 – pre–chlor + alum dose + GAC

Population = *103,000,000* *(persons)*

THAA MCL (µg/l)	Annual Treatment Cost * ($M)	Cost of Cancer** @ $8m/case ($M)	Cost of Giardia @ $3,000/case ($M)	Total Costs ($M)
60	104	334	740	1,177
50	118	320	772	1,210
40	202	270	831	1,303
30	353	206	972	1,531
20	588	140	1,212	1,940
10	957	79	1,519	2,555

* Capital costs are annualized at 10% interest rate over 20 years.
** MLE of cancer incidence from HAAs.

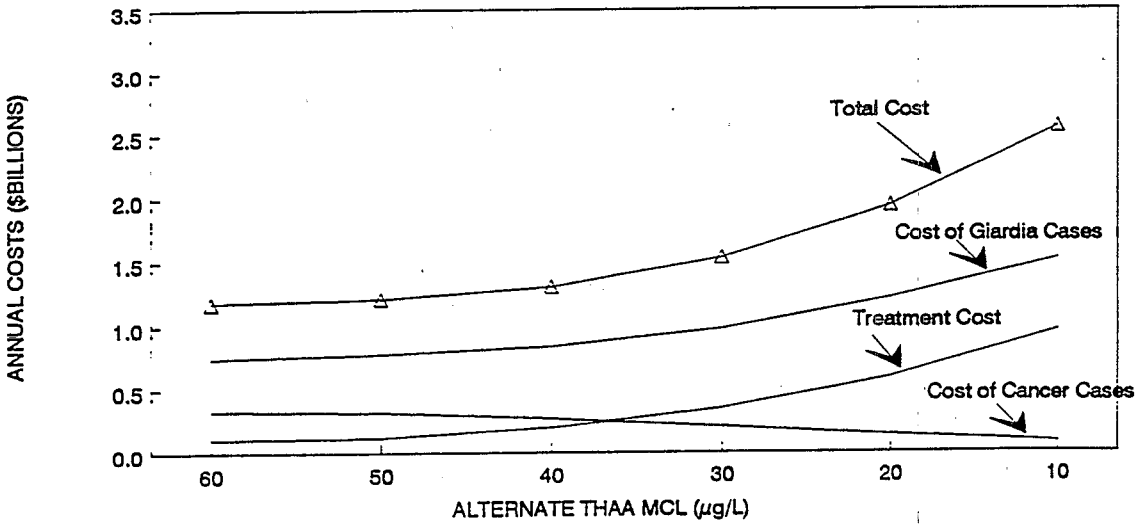


Exhibit 39

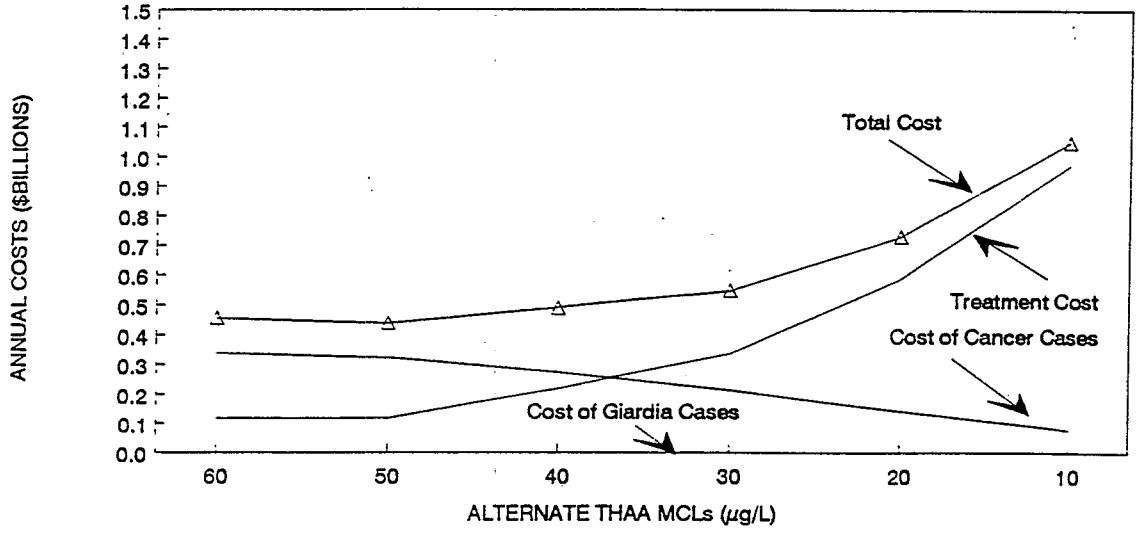
MODEL OUTPUT (surface w/o softening): ENHANCED SWTR W/O ALTERNATIVE DISINFECTION

Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre–chlorination
3 – eliminate pre–chlor + modify alum dose
4 – pre–chlor + alum dose + GAC

Population = ***103,000,000*** ***(persons)***

THAA MCL (µg/l)	Ann.Trt.* Cost ($M)	Cost of Cancer** @ $8m/case ($M)	Cost of Giardia @ $3,000/case ($M)	Total Costs ($M)
60	118	337	0.8	455
50	118	320	0.8	438
40	218	271	0.8	490
30	336	211	1.0	548
20	588	142	1.0	731
10	974	77	1.0	1,052

* Capital costs are annualized at 10% interest rate over 20 years.
** MLE of cancer incidence from HAAs.



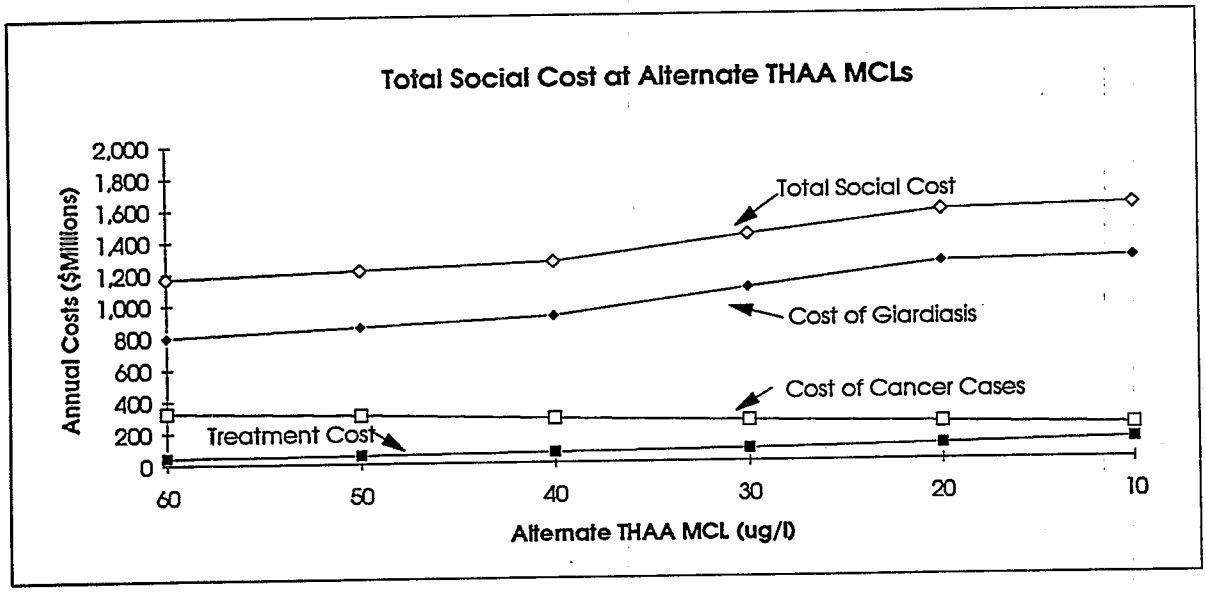
Model Output (surface water systems w/o softening) : SWTR w/ MODIFYING ALUM DOSE

Treatment Tier Code:
1 - not requiring further treatment modification
2 - eliminating prechlorination + modifying alum dose

Population = *103,000,000 (persons)* *Number of Systems =* *977*

THAA MCL (ug/l)	Treatment Code	% of Systems Modifying Alum Dose*	Cumulative % of Systems <= MCL*	Annual Treatment Cost ($M) **	Cost ($M) of Cancer *** @$8M/Case	Cost ($M) of Giardiasis @$3K/Case	Total Social Cost ($M)
				(1)	(2)	(3)	(1)+(2)+(3)
60	2	30	93	45	326	796	1,167
50	2	36	93	54	303	853	1,210
40	2	44	88	66	275	917	1,258
30	2	52	79	78	254	1,086	1,418
20	2	63	65	95	234	1,237	1,565
10	2	81	43	122	215	1,261	1,597

* Includes 20% over-design factor.
** Maximum Likelihood Estimates (MLE) of cancer incidence associated with HAAs.
*** Capital costs are annualized at 10% interest rate over 20 years.



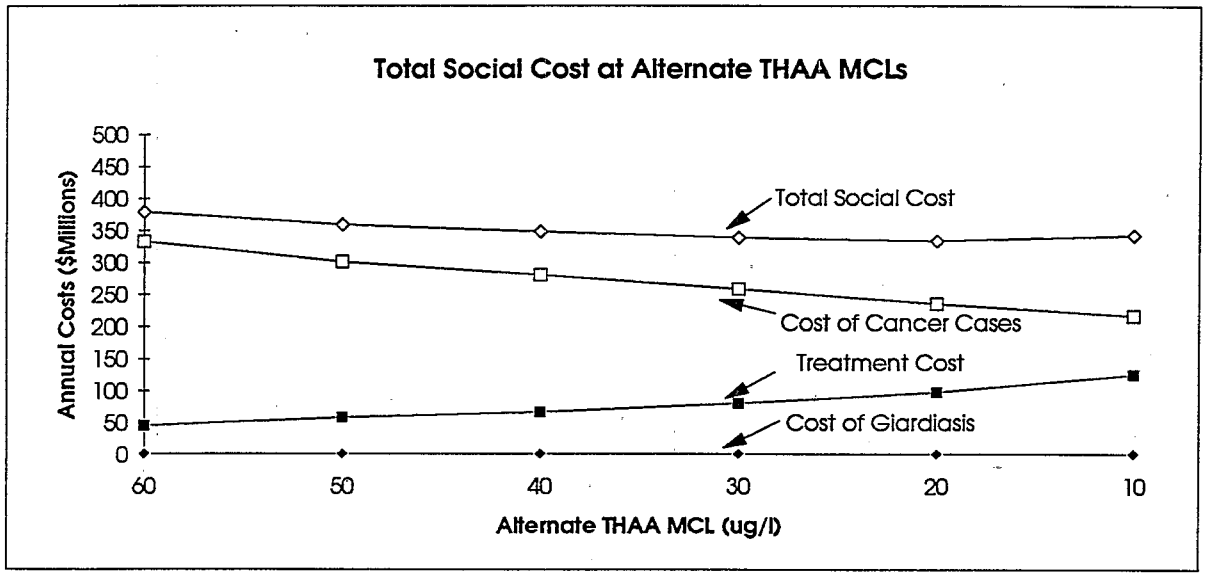
Model Output (surface water systems w/o softening) : Enhanced SWTR w/ MODIFYING ALUM DOSE

Treatment Tier Code:
1 - not requiring further treatment modification
2 - eliminating prechlorination + modifying alum dose

Population = *103,000,000* ***(persons)*** ***Number of Systems =*** *977*

THAA MCL (ug/l)	Treatment Code	% of Systems Modifying Alum Dose*	Cumulative % of Systems <= MCL*	Annual Treatment Cost ($M) **	Cost ($M) of Cancer *** @$8M/Case	Cost ($M) of Giardiasis @$3K/Case	Total Social Cost ($M)
				(1)	(2)	(3)	(1)+(2)+(3)
60	2	30	93	45	332	0.8	378
50	2	38	93	57	300	0.8	358
40	2	44	87	66	280	0.9	348
30	2	53	80	80	258	1.0	339
20	2	65	65	98	235	1.0	333
10	2	83	42	125	216	1.0	342

* Includes 20% over-design factor.
** Maximum Likelihood Estimates (MLE) of cancer incidence associated with HAAs.
*** Capital costs are annualized at 10% interest rate over 20 years.



Appendix A

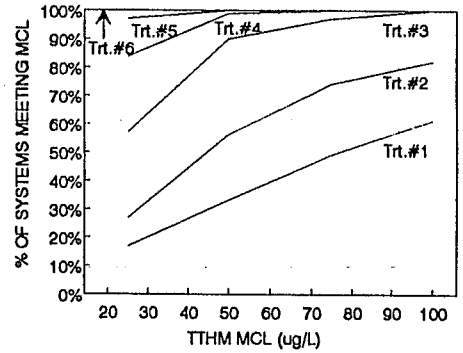
Exhibit A-1

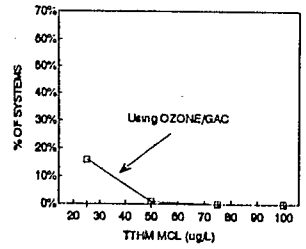
MODEL OUTPUT (surface w/o softening): SWTR W/ ALTERNATIVE DISINFECTION

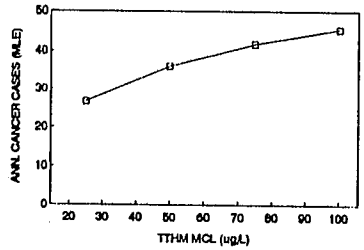
Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + add ammonia
4 – pre-chlor + ammonia + alum dose
5 – pre-chlor + ammonia + alum + ozone
6 – pre-chlor + ammonia + alum + ozone + GAC

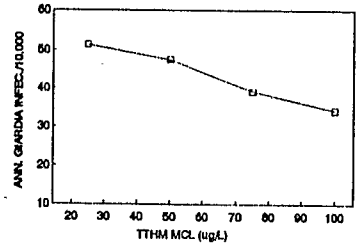
Population = *103,000,000* *(persons)*

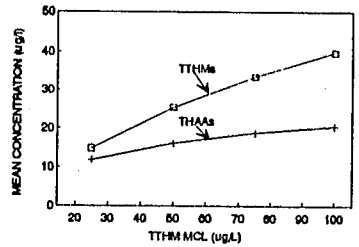
MCL (TTHMs)	Trt. Code	% of Sys. Ending[1]	Cumulative % of Sys. < MCL[2]	Mean Concentrations of By-Products (Avg Cus.)[3]		Cancer Incidence				Giardia Infections	
						THMs		HAAs		Endemic[4]	Epidemic[5]
				TTHMs	THAAs	95%	MLE	95%	MLE	Infections	(90%) #.Yrs. to Outbreak
100	1	61	61	55	24	33.8	1.3	153.3	49.4		
100	2	21	82	42	20	27.0	1.0	136.1	43.7		
100	3	18	100	40	20	24.6	0.9	138.7	44.6		
100	4	0	100	40	20	24.6	0.9	138.7	44.6		
100	5	0	100	40	20	24.6	0.9	138.7	44.6		
100	**6**	**0**	**100**	**40**	**20**	**24.6**	**0.9**	**138.7**	**44.6**	**340,992**	**2.99**
75	1	49	49	55	24	33.8	1.3	153.3	49.4		
75	2	25	74	39	19	25.0	1.0	132.1	42.5		
75	3	23	97	34	19	21.0	0.8	129.8	41.7		
75	4	3	100	33	19	20.7	0.8	127.5	41.0		
75	5	0	100	33	19	20.7	0.8	127.5	41.0		
75	**6**	**0**	**100**	**33**	**19**	**20.7**	**0.8**	**127.5**	**41.0**	**390,216**	**0.16**
50	1	33	33	55	24	33.8	1.3	153.3	49.4		
50	2	23	56	37	18	23.9	0.9	126.6	40.7		
50	3	34	90	28	17	17.4	0.7	116.8	37.5		
50	4	9	99	26	16	16.0	0.6	110.4	35.4		
50	5	1	100	25	16	15.9	0.6	109.9	35.3		
50	**6**	**0**	**100**	**25**	**16**	**15.9**	**0.6**	**109.9**	**35.3**	**474,985**	**0.04**
25	1	17	17	55	24	33.8	1.3	153.3	49.4		
25	2	10	27	36	18	23.2	0.9	124.9	40.1		
25	3	30	57	23	16	14.1	0.5	107.7	34.6		
25	4	27	84	17	13	10.6	0.4	88.5	28.4		
25	5	13	97	15	12	9.9	0.4	84.6	27.2		
25	**6**	**3**	**100**	**15**	**12**	**9.6**	**0.4**	**81.7**	**26.2**	**513,146**	**0.006**











[1] percent of systems installing each treatment tier (includes 20% over-design factor)
[2] cumulative percent of systems able to meet MCL at each treatment tier (includes 20% over-design factor)
[3] mean concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL
[4] assumes 10% of population exposed at first customer
[5] estimate for 90th percentile

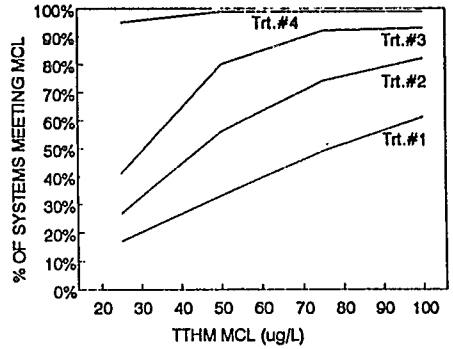
Exhibit A-2

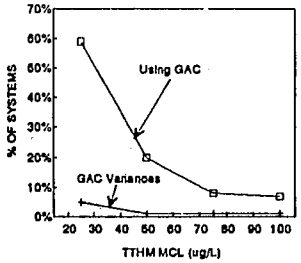
MODEL OUTPUT (surface w/o softening): SWTR W/O ALTERNATIVE DISINFECTION

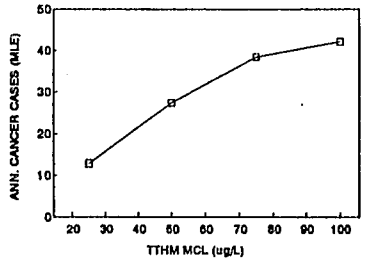
Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + modify alum dose
4 – pre-chlor + alum dose + GAC

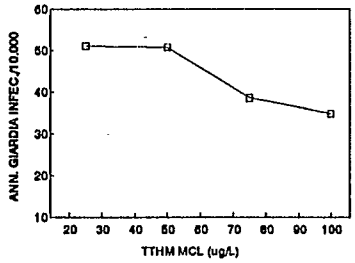
Population = 103,000,000 *(persons)*

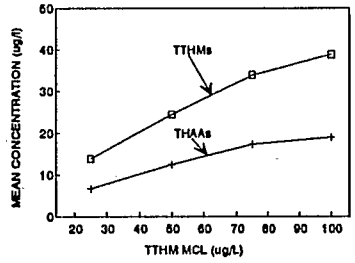
MCL (TTHMs)	Trt. Code	% of Sys. Ending[1]	Cumulative % of Sys. < MCL[2]	Mean Concentrations of By-Products (Avg.Cus.)[3]		Cancer Incidence				Giardia Infections	
						THMs		HAAs		Endemic[4]	Epidemic[5]
				TTHMs	THAAs	95%	MLE	95%	MLE	Infections	(90%) #.Yrs. to Outbreak
100	1	61	61	55	24	33.8	1.3	153.3	49.4		
100	2	21	82	42	20	27.0	1.0	136.1	43.7		
100	3	11	93	40	20	25.4	1.0	132.6	42.6		
100	4	7	99	30	19	24.7	0.9	128.4	41.3	347,110	1.091
75	1	49	49	55	24	33.8	1.3	153.3	49.4		
75	2	25	74	39	19	25.0	1.0	132.1	42.5		
75	3	18	92	35	18	22.5	0.9	122.1	39.2		
75	4	8	99	34	17	21.5	0.8	117.3	37.7	385,220	0.182
50	1	33	33	55	24	33.8	1.3	153.3	49.4		
50	2	23	56	37	18	23.9	0.9	126.6	40.7		
50	3	24	80	29	15	19.1	0.7	102.6	33.0		
50	4	20	99	24	13	16.4	0.6	83.3	26.8	507,790	0.035
25	1	17	17	55	24	33.8	1.3	153.3	49.4		
25	2	10	27	36	18	23.2	0.9	124.9	40.1		
25	3	14	41	26	13	17.3	0.6	88.5	28.4		
25	4	59	95	14	7	10.1	0.4	39.0	12.5	510,880	0.008











[1] percent of systems installing each treatment tier (includes 20% over-design factor)
[2] cumulative percent of systems able to meet MCL at each treatment tier (includes 20% over-design factor)
[3] mean concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL
[4] assumes 10% of population exposed at first customer
[5] estimate for 90th percentile

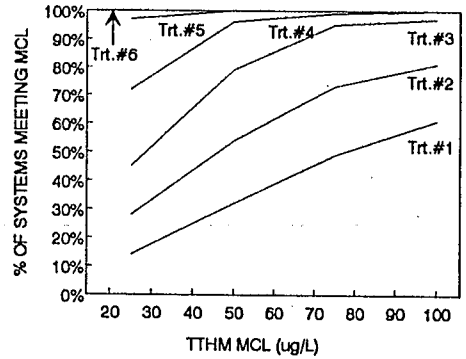
Exhibit A-3

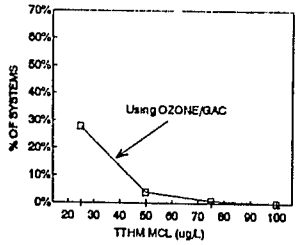
MODEL OUTPUT (surface w/o softening): ENHANCED SWTR W/ ALTERNATIVE DISINFECTION

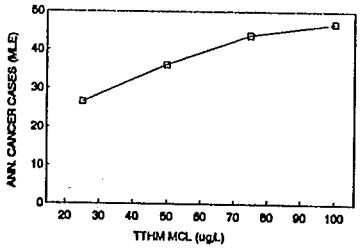
Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + add ammonia
4 – pre-chlor + ammonia + alum dose
5 – pre-chlor + ammonia + alum + ozone
6 – pre-chlor + ammonia + alum + ozone + GAC

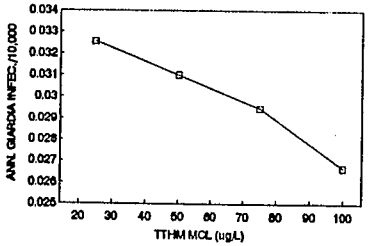
Population = *103,000,000* *(persons)*

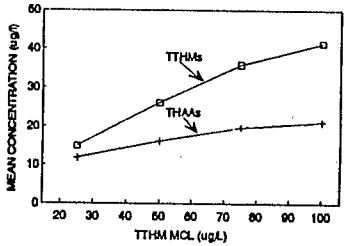
MCL (TTHMs)	Trt. Code	% of Sys. Ending[1]	Cumulative % of Sys. < MCL[2]	Mean Concentrations of By-Products (Avg.Cus.)[3]		Cancer Incidence				Giardia Infections	
						THMs		HAAs		Endemic[4]	Epidemic[5]
				TTHMs	THAAs	95%	MLE	95%	MLE	Infections	(90%) #.Yrs. to Outbreak
100	1	61	61	57	25	34.8	1.3	156.3	50.3		
100	2	20	81	44	21	28.0	1.1	139.6	44.9		
100	3	16	97	43	22	26.2	1.0	145.3	46.7		
100	4	3	100	41	21	25.8	1.0	142.6	45.8		
100	5	0	100	41	21	25.8	1.0	142.6	45.8		
100	**6**	**0**	**100**	**41**	**21**	**25.8**	**1.0**	**142.6**	**45.8**	**287**	**infinity**
75	1	49	49	57	25	34.8	1.3	156.3	50.3		
75	2	24	73	41	20	26.0	1.0	135.9	43.7		
75	3	22	95	38	20	23.2	0.9	137.6	44.2		
75	4	4	99	36	20	22.2	0.9	134.3	43.2		
75	5	1	100	36	20	22.1	0.9	133.5	42.9		
75	**6**	**0**	**100**	**36**	**20**	**22.1**	**0.9**	**133.5**	**42.9**	**295**	**infinity**
50	1	32	32	57	25	34.8	1.3	156.3	50.3		
50	2	22	54	39	19	24.9	0.9	130.4	41.9		
50	3	25	79	33	19	20.0	0.8	126.1	40.5		
50	4	17	96	27	17	16.9	0.6	112.6	36.2		
50	5	4	100	26	16	16.4	0.6	110.4	35.5		
50	**6**	**0**	**100**	**26**	**16**	**16.4**	**0.6**	**110.4**	**35.5**	**310**	**infinity**
25	1	14	14	57	25	34.8	1.3	156.3	50.3		
25	2	14	28	37	19	24.0	0.9	128.0	41.1		
25	3	17	45	29	18	17.4	0.7	119.9	38.5		
25	4	27	72	19	14	12.4	0.5	93.9	30.2		
25	5	25	97	15	12	10.0	0.4	84.4	27.1		
25	**6**	**3**	**100**	**15**	**12**	**9.8**	**0.4**	**81.5**	**26.2**	**325**	**infinity**











[1] percent of systems installing each treatment tier (includes 20% over-design factor)
[2] cumulative percent of systems able to meet MCL at each treatment tier (includes 20% over-design factor)
[3] mean concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL
[4] assumes 10% of population exposed at first customer
[5] estimate for 90th percentile

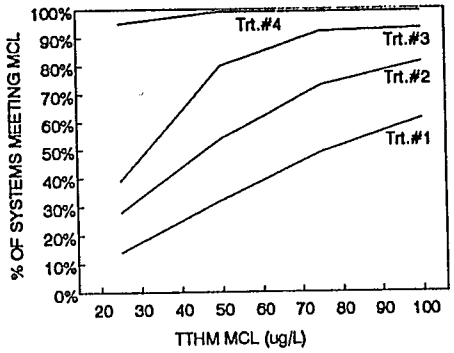
Exhibit A-4

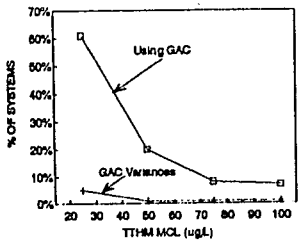
MODEL OUTPUT (surface w/o softening): ENHANCED SWTR W/O ALTERNATIVE DISINFECTION

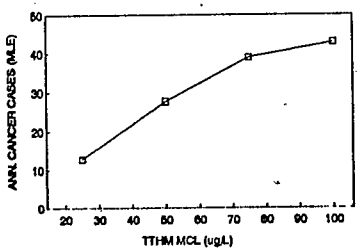
Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + modify alum dose
4 – pre-chlor + alum dose + GAC

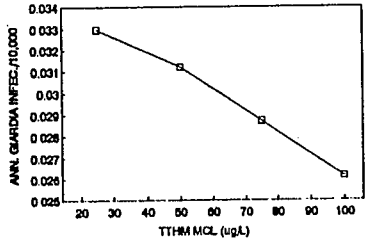
Population = *103,000,000* *(persons)*

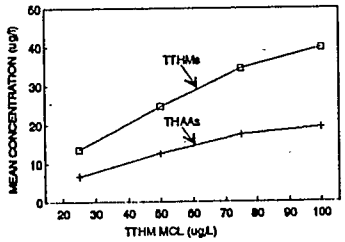
MCL (TTHMs)	Trt. Code	% of Sys. Ending[1]	Cumulative % of Sys. < MCL[2]	Mean Concentrations of By-Products (Avg.Qus.)[3]		Cancer Incidence				Giardia Infections	
						THMs		HAAs		Endemic[4]	Epidemic[5]
				TTHMs	THAAs	95%	MLE	95%	MLE	Infections	(90%) #.Yrs. to Outbreak
100	1	61	61	57	25	34.8	1.3	156.3	50.3		
100	2	20	81	44	21	28.0	1.1	139.6	44.9		
100	3	12	93	41	20	26.0	1.0	134.8	43.3		
100	4	7	99	40	19	25.2	1.0	130.5	41.9	262	Infinity
75	1	49	49	57	25	34.8	1.3	156.3	50.3		
75	2	24	73	41	20	26.0	1.0	135.9	43.7		
75	3	19	92	36	18	22.8	0.9	123.6	39.7		
75	4	8	99	34	18	21.8	0.8	118.6	38.1	287	Infinity
50	1	32	32	57	25	34.8	1.3	156.3	50.3		
50	2	22	54	39	19	24.9	0.9	130.4	41.9		
50	3	26	80	30	15	19.3	0.7	104.2	33.5		
50	4	20	99	25	13	16.5	0.6	84.5	27.1	312	Infinity
25	1	14	14	57	25	34.8	1.3	156.3	50.3		
25	2	14	28	37	19	24.0	0.9	128.0	41.1		
25	3	11	39	26	13	17.5	0.7	89.6	28.8		
25	4	61	95	14	7	9.9	0.4	38.8	12.5	330	Infinity











[1] percent of systems installing each treatment tier (includes 20% over-design factor)
[2] cumulative percent of systems able to meet MCL at each treatment tier (includes 20% over-design factor)
[3] mean concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL
[4] assumes 10% of population exposed at first customer
[5] estimate for 90th percentile

Exhibit A-5

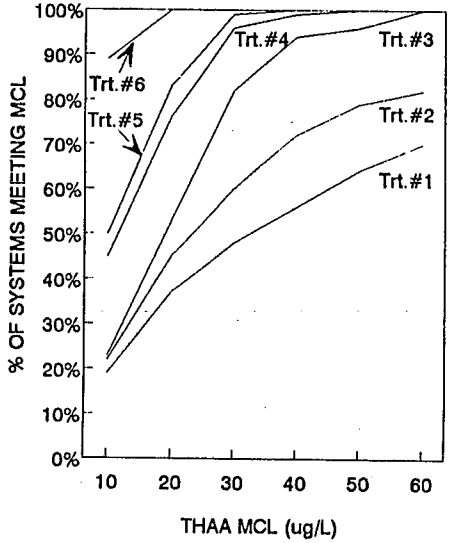
MODEL OUTPUT (surface w/o softening): SWTR W/ ALTERNATIVE DISINFECTION

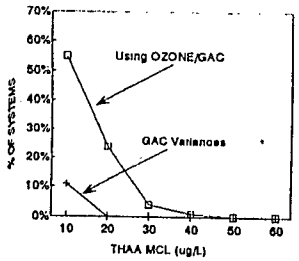
Treatment Code:

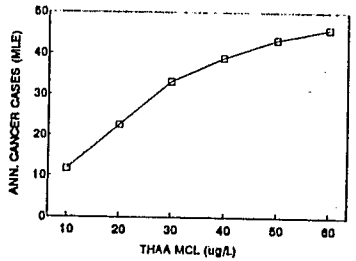
1 – not requiring further treatment modification	4 – pre-chlor + ammonia + alum dose
2 – eliminate pre-chlorination	5 – pre-chlor + ammonia + alum + ozone
3 – eliminate pre-chlor + add ammonia	6 – pre-chlor + ammonia + alum + ozone + GAC

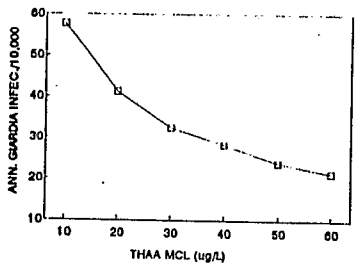
Population = *103,000,000* *(persons)*

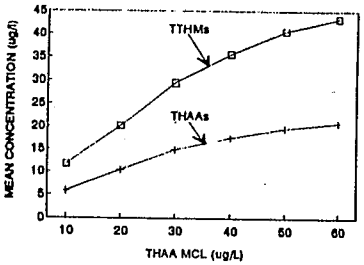
MCL (THAAs)	Trt. Code	% of Sys. Ending[1]	Cumulative % of Sys. < MCL[2]	Mean Concentrations of By-Products (Avg.Cus.)[3]		Cancer Incidence				Giardia Infections	
						THMs		HAAs		Endemic[4]	Epidemic[5]
				TTHMs	THAAs	95%	MLE	95%	MLE	Infections	(90%) #.Yrs. to Outbreak
60	1	70	70	55	24	33.8	1.3	153.3	49.4		
60	2	12	82	46	21	30.2	1.1	139.9	45.0		
60	3	18	100	43	21	27.9	1.1	139.3	44.8		
60	4	0	100	43	21	27.9	1.1	139.3	44.8		
60	5	0	100	43	21	27.9	1.1	139.3	44.8		
60	**6**	**0**	**100**	**43**	**21**	**27.9**	**1.1**	**139.3**	**44.8**	213,045	3,089,000
50	1	64	64	55	24	33.8	1.3	153.3	49.4		
50	2	15	79	45	20	29.9	1.1	137.3	44.1		
50	3	17	96	42	20	27.3	1.0	134.8	43.3		
50	4	4	100	41	20	26.9	1.0	131.4	42.3		
50	5	0	100	41	20	26.9	1.0	131.4	42.3		
50	**6**	**0**	**100**	**41**	**20**	**26.9**	**1.0**	**131.4**	**42.3**	237,889	2.496
40	1	56	56	55	24	33.8	1.3	153.3	49.4		
40	2	16	72	42	19	28.0	1.1	131.5	42.3		
40	3	22	94	38	18	25.1	0.9	123.9	39.8		
40	4	5	99	36	18	24.5	0.9	118.7	38.1		
40	5	1	100	36	17	24.4	0.9	118.2	38.0		
40	**6**	**0**	**100**	**36**	**17**	**24.4**	**0.9**	**118.2**	**38.0**	283,003	0.658
30	1	48	48	55	24	33.8	1.3	153.3	49.4		
30	2	12	60	40	19	27.0	1.0	128.9	41.4		
30	3	22	82	34	17	22.7	0.8	115.2	37.0		
30	4	14	96	30	15	21.6	0.8	103.4	33.2		
30	5	3	99	30	15	21.5	0.8	101.8	32.7		
30	**6**	**1**	**100**	**29**	**15**	**21.4**	**0.8**	**100.8**	**32.4**	324,821	0.174
20	1	37	37	55	24	33.8	1.3	153.3	49.4		
20	2	8	45	39	18	25.9	1.0	126.1	40.5		
20	3	8	53	29	16	19.5	0.7	108.9	35.0		
20	4	23	76	23	13	17.4	0.6	88.0	28.2		
20	5	7	83	22	12	16.8	0.6	82.5	26.5		
20	**6**	**17**	**100**	**20**	**10**	**16.1**	**0.6**	**68.9**	**22.1**	412,980	0.018
10	1	19	19	55	24	33.8	1.3	153.3	49.4		
10	2	3	22	38	18	25.2	0.9	124.2	39.9		
10	3	1	23	26	16	17.1	0.6	108.6	34.9		
10	4	22	45	18	12	13.6	0.5	78.4	25.1		
10	5	5	50	15	10	12.1	0.4	67.6	21.7		
10	**6**	**50**	**89**	**12**	**6**	**10.4**	**0.4**	**35.3**	**11.3**	576,460	0.006











[1] percent of systems installing each treatment tier (includes 20% over-design factor)
[2] cumulative percent of systems able to meet MCL at each treatment tier (includes 20% over-design factor)
[3] mean concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL
[4] assumes 10% of population exposed at first customer
[5] estimate for 90th percentile

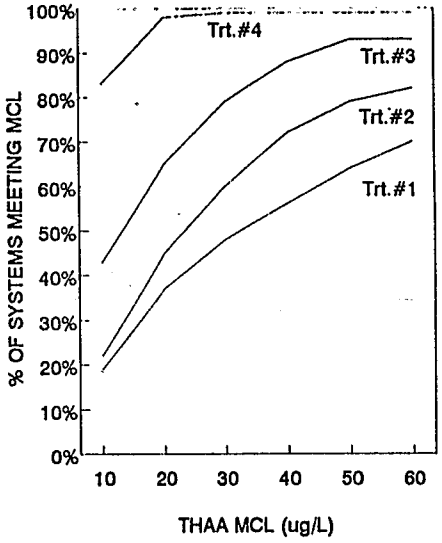
Exhibit A-6

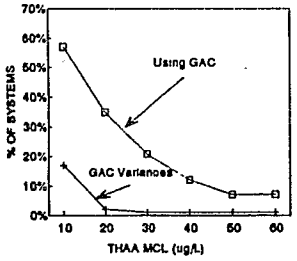
MODEL OUTPUT (surface w/o softening): SWTR W/O ALTERNATIVE DISINFECTION

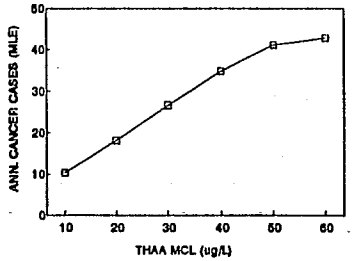
Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + modify alum dose
4 – pre-chlor + alum dose + GAC

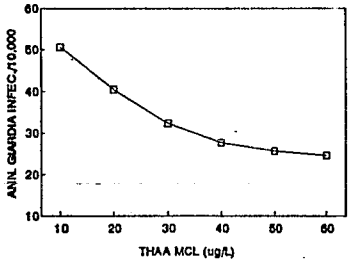
Population = *103,000,000* *(persons)*

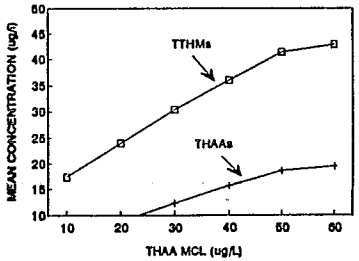
MCL (THAAs)	Trt. Code	% of Sys. Ending[1]	Cumulative % of Sys. < MCL[2]	Mean Concentrations of By-Products (Avg.Cus.)[3]		Cancer Incidence				Giardia Infections	
						THMs		HAAs		Endemic[4]	Epidemic[5]
				TTHMs	THAAs	95%	MLE	95%	MLE	Infections	(90%) #.Yrs. to Outbreak
60	1	70	70	55	24	33.8	1.3	153.3	49.4		
60	2	12	82	46	21	30.2	1.1	139.9	45.0		
60	3	11	93	44	20	29.2	1.1	134.0	43.1		
60	4	7	99	43	19	28.2	1.1	129.7	41.7	246,631	212.089
50	1	64	64	55	24	33.8	1.3	153.3	49.4		
50	2	15	79	45	20	29.9	1.1	137.3	44.1		
50	3	14	93	43	19	28.6	1.1	128.4	41.3		
50	4	7	99	41	19	27.7	1.0	124.5	40.0	257,263	1.091
40	1	56	56	55	24	33.8	1.3	153.3	49.4		
40	2	16	72	42	19	28.0	1.1	131.5	42.3		
40	3	16	88	39	17	26.6	1.0	116.8	37.5		
40	4	12	99	36	16	25.3	0.9	105.0	33.7	277,142	0.658
30	1	48	48	55	24	33.8	1.3	153.3	49.4		
30	2	12	60	40	19	27.0	1.0	128.9	41.4		
30	3	19	79	35	16	24.6	0.9	105.1	33.8		
30	4	21	99	30	12	22.7	0.8	80.3	25.8	324,038	0.174
20	1	37	37	55	24	33.8	1.3	153.3	49.4		
20	2	8	45	39	18	25.9	1.0	126.1	40.5		
20	3	20	65	31	14	22.2	0.8	93.9	30.1		
20	4	35	99	24	9	19.1	0.7	54.6	17.5	403,945	0.034
10	1	19	19	55	24	33.8	1.3	153.3	49.4		
10	2	3	22	38	18	25.2	0.9	124.2	39.9		
10	3	21	43	28	13	20.3	0.7	84.2	27.1		
10	4	57	83	17	6	14.6	0.5	30.6	9.8	506,430	0.006











[1] percent of systems installing each treatment tier (includes 20% over-design factor)
[2] cumulative percent of systems able to meet MCL at each treatment tier (includes 20% over-design factor)
[3] mean concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL
[4] assumes 10% of population exposed at first customer
[5] estimate for 90th percentile

Exhibit A-7

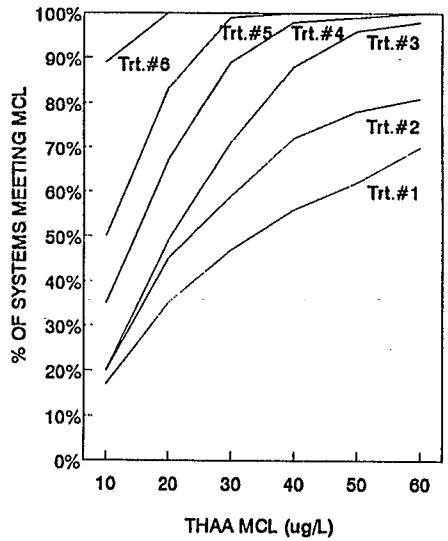
MODEL OUTPUT (surface w/o softening): ENHANCED SWTR W/ ALTERNATIVE DISINFECTION

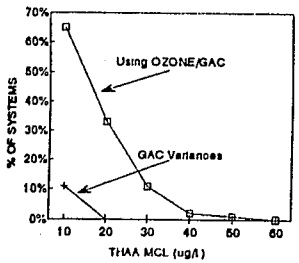
Treatment Code:

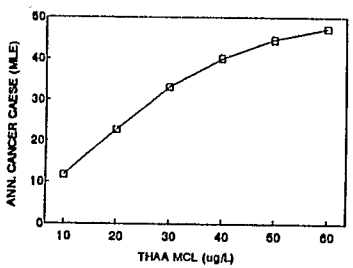
1 – not requiring further treatment modification	4 – pre-chlor + ammonia + alum dose
2 – eliminate pre-chlorination	5 – pre-chlor + ammonia + alum + ozone
3 – eliminate pre-chlor + add ammonia	6 – pre-chlor + ammonia + alum + ozone + GAC

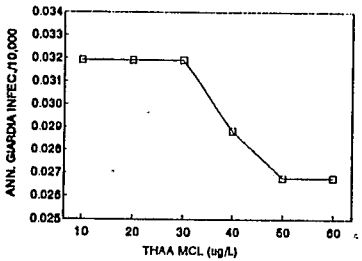
Population = *103,000,000* *(persons)*

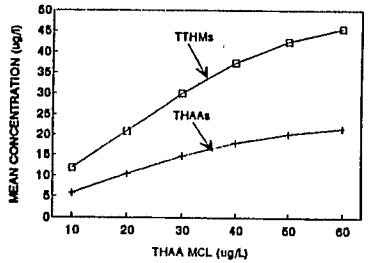
MCL (THAAs)	Trt. Code	% of Sys. Ending[1]	Cumulative % of Sys. < MCL[1]	Mean Concentrations of By-Products (Avg.Cus.)[2] TTHMs	THAAs	Cancer Incidence THMs 95%	THMs MLE	HAAs 95%	HAAs MLE	Giardia Infections Endemic[3] Infections	Epidemic[3] (90%) #.Yrs. to Outbreak
60	1	70	70	57	25	34.8	1.3	156.3	50.3		
60	2	11	81	48	21	31.2	1.2	143.2	46.1		
60	3	17	98	46	22	29.4	1.1	144.9	46.6		
60	4	2	100	45	22	29.1	1.1	143.4	46.1		
60	5	0	100	45	22	29.1	1.1	143.4	46.1		
60	**6**	**0**	**100**	**45**	**22**	**29.1**	**1.1**	**143.4**	**46.1**	**288**	**infinity**
50	1	62	62	57	25	34.8	1.3	156.3	50.3		
50	2	16	78	46	21	30.7	1.2	139.5	44.8		
50	3	18	96	44	21	28.7	1.1	139.3	44.8		
50	4	3	99	43	20	28.2	1.1	136.1	43.8		
50	5	1	100	42	20	28.1	1.1	135.3	43.5		
50	**6**	**0**	**100**	**42**	**20**	**28.1**	**1.1**	**135.3**	**43.5**	**288**	**infinity**
40	1	56	56	57	25	34.8	1.3	156.3	50.3		
40	2	16	72	44	20	29.0	1.1	135.1	43.4		
40	3	16	88	41	20	26.8	1.0	131.8	42.4		
40	4	10	98	38	18	25.9	1.0	123.2	39.6		
40	5	2	100	37	18	25.7	1.0	121.7	39.1		
40	**6**	**0**	**100**	**37**	**18**	**25.7**	**1.0**	**121.7**	**39.1**	**288**	**infinity**
30	1	47	47	57	25	34.8	1.3	156.3	50.3		
30	2	12	59	42	19	28.0	1.0	132.5	42.6		
30	3	12	71	37	19	24.8	0.9	124.9	40.2		
30	4	18	89	32	16	22.9	0.8	107.2	34.4		
30	5	10	99	30	15	22.2	0.8	101.6	32.6		
30	**6**	**1**	**100**	**30**	**15**	**22.2**	**0.8**	**100.6**	**32.3**	**319**	**infinity**
20	1	35	35	57	25	34.8	1.3	156.3	50.3		
20	2	10	45	40	19	26.8	1.0	129.0	41.4		
20	3	4	49	33	18	22.1	0.8	120.0	38.6		
20	4	18	67	26	14	19.2	0.7	95.9	30.8		
20	5	16	83	23	12	17.5	0.6	82.9	26.6		
20	**6**	**17**	**100**	**21**	**10**	**16.9**	**0.6**	**69.3**	**22.2**	**319**	**infinity**
10	1	17	17	57	25	34.8	1.3	156.3	50.3		
10	2	3	20	39	19	28.1	1.0	127.6	41.0		
10	3	0	20	31	18	20.0	0.8	122.9	39.5		
10	4	15	35	21	13	15.5	0.6	88.5	28.4		
10	5	15	50	16	10	12.4	0.4	67.6	21.7		
10	**6**	**50**	**50**	**12**	**6**	**10.8**	**0.4**	**35.4**	**11.3**	**319**	**infinity**











[1] percent of systems installing each treatment tier (includes 20% over-design factor)
[2] cumulative percent of systems able to meet MCL at each treatment tier (includes 20% over-design factor)
[3] mean concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL
[4] assumes 10% of population exposed at first customer
[5] estimate for 90th percentile

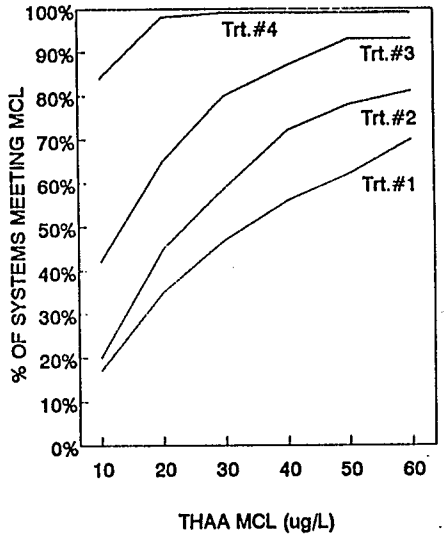
Exhibit A-8

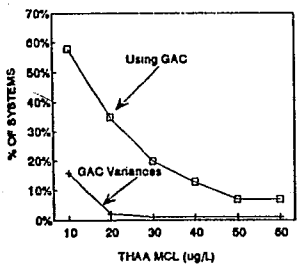
MODEL OUTPUT (surface w/o softening): ENHANCED SWTR W/O ALTERNATIVE DISINFECTION

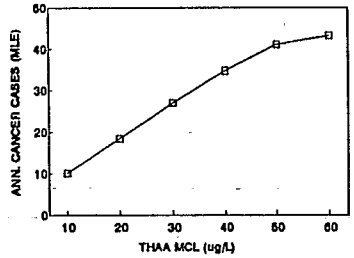
Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + modify alum dose
4 – pre-chlor + alum dose + GAC

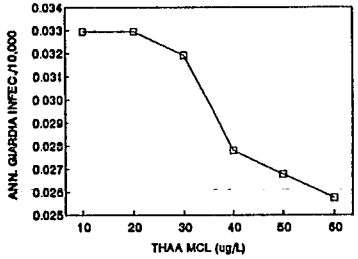
Population = 103,000,000 *(persons)*

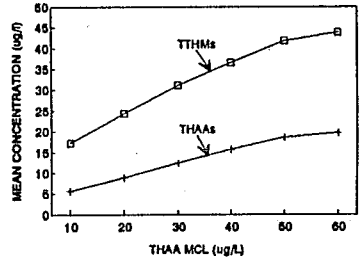
MCL (THAAs)	Trt. Code	% of Sys. Ending[1]	Cumulative % of Sys. < MCL[2]	Mean Concentrations of By-Products (Avg.Cus.)[3] TTHMs	Mean Concentrations of By-Products (Avg.Cus.)[3] THAAs	Cancer Incidence THMs 95%	Cancer Incidence THMs MLE	Cancer Incidence HAAs 95%	Cancer Incidence HAAs MLE	Giardia Infections Endemic[4] Infections	Giardia Infections Epidemic[5] (90%) #.Yrs. to Outbreak
60	1	70	70	57	25	34.8	1.3	156.3	50.3		
60	2	11	81	48	21	31.2	1.2	143.2	46.1		
60	3	12	93	45	20	29.9	1.1	135.3	43.5		
60	4	7	99	44	20	28.8	1.1	131.0	42.1	258	infinity
50	1	62	62	57	25	34.8	1.3	156.3	50.3		
50	2	16	78	46	21	30.7	1.2	139.5	44.8		
50	3	15	93	43	19	29.2	1.1	128.4	41.3		
50	4	7	99	42	19	28.2	1.1	124.5	40.0	268	infinity
40	1	56	56	57	25	34.8	1.3	156.3	50.3		
40	2	16	72	44	20	29.0	1.1	135.1	43.4		
40	3	15	87	40	18	27.3	1.0	119.2	38.3		
40	4	13	99	37	16	25.8	0.9	105.4	33.9	278	infinity
30	1	47	47	57	25	34.8	1.3	156.3	50.3		
30	2	12	59	42	19	28.0	1.0	132.5	42.6		
30	3	21	80	36	16	25.3	0.9	106.2	34.1		
30	4	20	99	31	13	23.3	0.8	82.0	26.4	319	infinity
20	1	35	35	57	25	34.8	1.3	156.3	50.3		
20	2	10	45	40	19	26.8	1.0	129.0	41.4		
20	3	20	65	32	14	22.7	0.8	95.1	30.5		
20	4	35	98	24	9	19.5	0.7	55.4	17.8	330	infinity
10	1	17	17	57	25	34.8	1.3	156.3	50.3		
10	2	3	20	39	19	26.1	1.0	127.6	41.0		
10	3	22	42	28	13	20.6	0.8	84.8	27.2		
10	4	58	84	17	6	14.6	0.5	30.0	9.6	330	infinity











[1] percent of systems installing each treatment tier (includes 20% over-design factor)
[2] cumulative percent of systems able to meet MCL at each treatment tier (includes 20% over-design factor)
[3] mean concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL
[4] assumes 10% of population exposed at first customer
[5] estimate for 90th percentile

Appendix B

Exhibit B-1

Draft: 20-Feb-92

MODEL OUTPUT (surface w/o softening): SWTR W/O ALTERNATIVE DISINFECTION

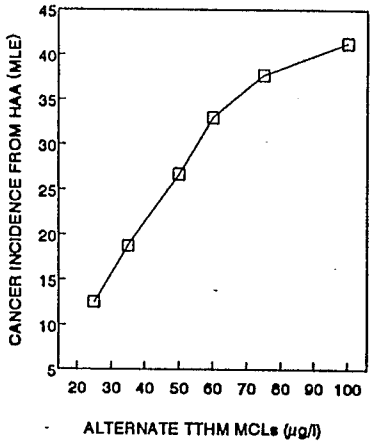
Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + modify alum dose
4 – pre-chlor + alum dose + GAC

Population = 103,000,000 (persons)

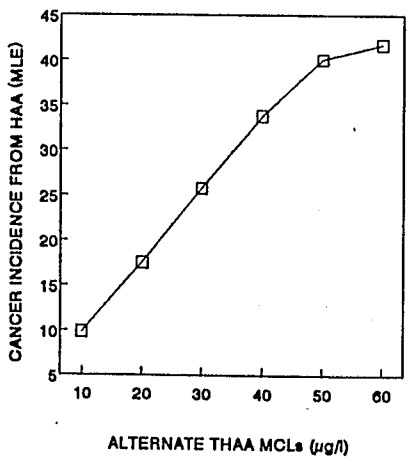
MCL (TTHMs)	Cumulative % of Sys. < MCL[1]	Mean Concentrations of By-Products (Average Customer)[2] TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA	Cancer Incidence (Maximum Likelihood Estimate) TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA
100	99	39	20	9	9	0.61	19	9	7	0.9	0.3	0.3	0.3	0.01	41	35	6
75	99	34	17	8	8	0.58	17	9	6	0.8	0.3	0.3	0.3	0.01	38	32	6
60	99	29	14	7	7	0.55	15	8	5	0.7	0.2	0.3	0.2	0.01	33	28	5
50	99	24	11	6	6	0.57	13	6	4	0.6	0.2	0.2	0.2	0.01	27	23	4
35	98	19	8	5	5	0.63	9	4	3	0.5	0.1	0.2	0.2	0.01	19	16	3
25	95	14	5	4	4	0.63	7	3	2	0.4	0.1	0.2	0.1	0.01	13	11	2

MCL (THAAs)	Cumulative % of Sys. < MCL[1]	Mean Concentrations of By-Products (Average Customer)[2] TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA	Cancer Incidence (Maximum Likelihood Estimate) TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA
60	99	43	21	10	12	0.71	19	9	7	1.1	0.3	0.3	0.4	0.01	42	35	7
50	99	41	19	10	12	0.71	19	9	7	1.0	0.3	0.3	0.4	0.01	40	34	6
40	99	36	15	9	11	0.70	16	8	5	0.9	0.2	0.3	0.4	0.01	34	29	5
30	99	30	11	8	11	0.69	12	6	4	0.8	0.2	0.3	0.4	0.01	26	22	4
20	98	24	7	6	10	0.68	9	4	3	0.7	0.1	0.2	0.3	0.01	18	15	2
10	83	17	4	4	8	0.71	6	2	1	0.5	0.1	0.2	0.3	0.01	10	9	1

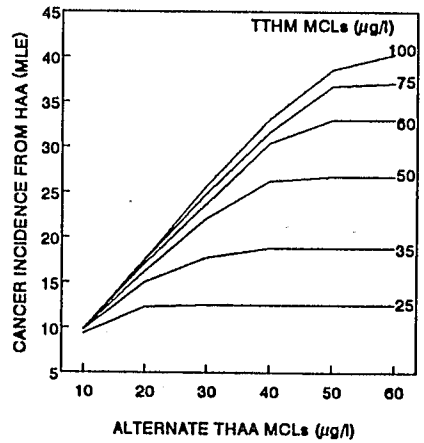
Cancer Incidence at Alternate TTHM MCLs



Cancer Incidence at Alternate THAA MCLs



Cancer Incidence at Alternate THAA / TTHM MCLs



[1] cummulative percent of systems able to meet MCL at the last treatment tier (includes 20% over-design factor)
[2] mean concentration at the last treatment tier of all systems; those meeting MCL and those not meeting MCL

MCL (THAAs)	MCL (TTHMs)	Cancer Incidence THAAs
60	100	40
50	100	39
40	100	33
30	100	26
20	100	17
10	100	10
60	75	37
50	75	37
40	75	32
30	75	25
20	75	17
10	75	10
60	60	33
50	60	33
40	60	30
30	60	24
20	60	17
10	60	10
60	50	27
50	50	27
40	50	26
30	50	22
20	50	16
10	50	10
60	35	19
50	35	19
40	35	19
30	35	18
20	35	15
10	35	10
60	25	13
50	25	13
40	25	13
30	25	13
20	25	12
10	25	9

Exhibit B-2

MODEL OUTPUT (surface w/o softening): SWTR W/ ALTERNATIVE DISINFECTION

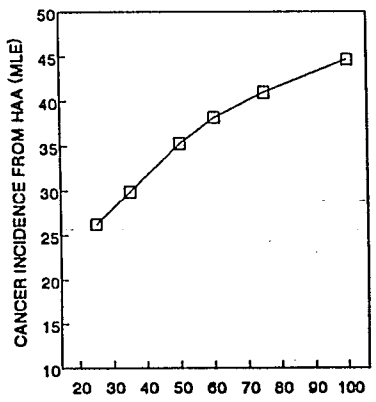
Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + modify alum dose
4 – pre-chlor + alum dose + GAC
5 – pre-chlor + ammonia + alum + ozone
6 – pre-chlor + ammonia + alum + ozone + GAC

Population = 103,000,000 (persons)

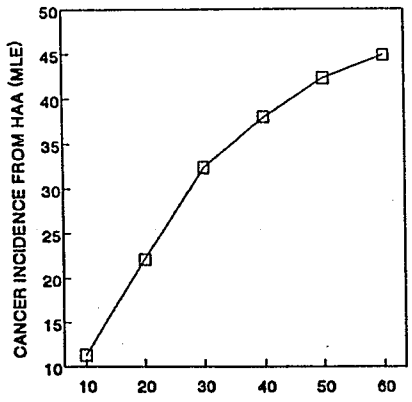
MCL (TTHMs)	Cumulative % of Sys. < MCL[1]	Mean Concentrations of By-Products (Average Customer)[2] TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA	Cancer Incidence (Maximum Likelihood Estimate) TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA
100	100	40	21	9	9	0.60	20	10	8	0.9	0.3	0.3	0.3	0.01	45	38	7
75	100	33	18	8	8	0.55	19	9	7	0.8	0.3	0.3	0.3	0.01	41	35	6
60	100	29	15	7	6	0.50	17	9	6	0.7	0.2	0.2	0.2	0.01	38	33	5
50	100	25	13	6	6	0.46	16	8	5	0.6	0.2	0.2	0.2	0.01	35	30	5
35	100	19	9	5	5	0.42	14	7	4	0.5	0.1	0.2	0.2	0.01	30	26	4
25	100	15	7	4	4	0.34	12	6	4	0.4	0.1	0.1	0.1	0.01	26	23	3

MCL (THAAs)	Cumulative % of Sys. < MCL[1]	Mean Concentrations of By-Products (Average Customer)[2] TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA	Cancer Incidence (Maximum Likelihood Estimate) TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA
60	100	43	22	10	11	0.69	21	10	8	1.1	0.3	0.3	0.4	0.01	45	38	6
50	100	41	19	9	11	0.68	20	10	7	1.0	0.3	0.3	0.4	0.01	42	36	9
40	100	36	16	9	11	0.66	17	9	6	0.9	0.2	0.3	0.4	0.01	38	33	4
30	100	29	11	7	10	0.63	15	8	5	0.8	0.2	0.3	0.4	0.01	32	28	4
20	100	20	6	5	9	0.57	10	5	3	0.6	0.1	0.2	0.3	0.01	22	20	6
10	89	12	2	2	7	0.49	6	3	1	0.4	0.0	0.1	0.2	0.01	11	10	0

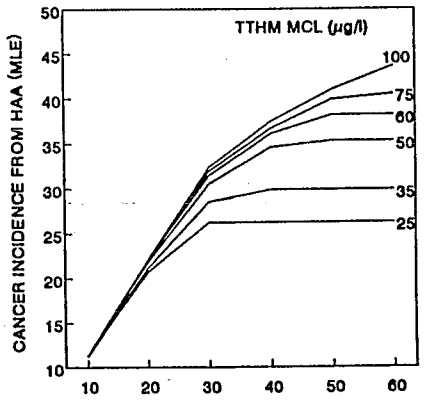
Cancer Incidence at Alternate TTHM MCLs



Cancer Incidence at Alternate THAA MCLs



Cancer Incidence at Alternate THAA / TTHM MCLs



[1] cummulative percent of systems able to meet MCL at the last treatment tier (includes 20% over-design factor)
[2] mean concentration at the last treatment tier of all systems; those meeting MCL and those not meeting MCL

MCL (THAAs)	MCL (TTHMs)	Cancer Incidence THAAs
60	100	44
50	100	41
40	100	37
30	100	32
20	100	22
10	100	11
60	75	40
50	75	40
40	75	37
30	75	32
20	75	22
10	75	11
60	60	38
50	60	38
40	60	36
30	60	31
20	60	22
10	60	11
60	50	35
50	50	35
40	50	35
30	50	31
20	50	22
10	50	11
60	35	30
50	35	30
40	35	30
30	35	29
20	35	21
10	35	11
60	25	26
50	25	26
40	25	26
30	25	26
20	25	21
10	25	11

Exhibit B-3

MODEL OUTPUT (surface w/o softening): ENHANCED SWTR W/O ALTERNATIVE DISINFECTION

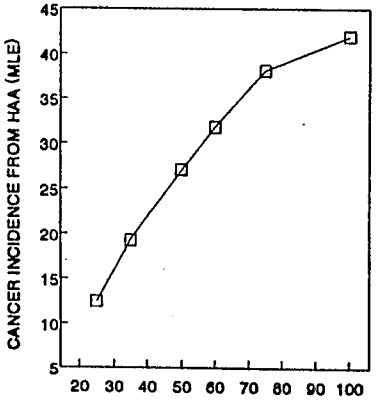
Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + modify alum dose
4 – pre-chlor + alum dose + GAC

Population = 103,000,000 (persons)

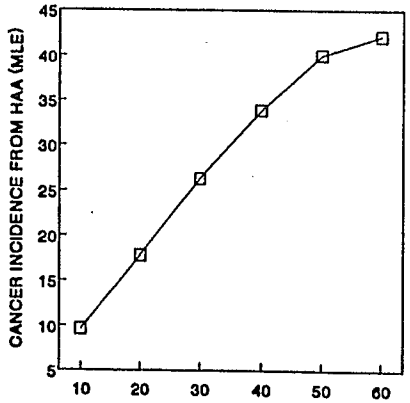
MCL (TTHMs)	Cumulative % of Sys. < MCL[1]	Mean Concentrations of By-Products (Average Customer)[2] TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA	Cancer Incidence (Maximum Likelihood Estimate) TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA
100	99	40	20	9	10	0.58	19	10	7	1.0	0.3	0.3	0.3	0.01	42	35	7
75	99	34	18	8	8	0.54	18	9	6	0.8	0.3	0.3	0.3	0.01	38	32	6
60	99	29	14	7	7	0.51	15	7	5	0.7	0.2	0.3	0.2	0.01	32	27	5
50	99	25	11	7	6	0.53	13	6	4	0.6	0.2	0.2	0.2	0.01	27	23	4
35	98	19	8	5	5	0.58	9	5	3	0.5	0.1	0.2	0.2	0.01	19	17	3
25	95	14	5	4	4	0.59	7	3	2	0.4	0.1	0.2	0.1	0.01	12	11	2

MCL (THAAs)	Cumulative % of Sys. < MCL[1]	Mean Concentrations of By-Products (Average Customer)[2] TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA	Cancer Incidence (Maximum Likelihood Estimate) TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA
60	99	44	21	10	12	0.69	20	10	8	1.1	0.3	0.4	0.4	0.01	42	35	7
50	99	42	19	10	12	0.68	19	9	7	1.1	0.3	0.4	0.4	0.01	40	34	6
40	99	37	15	9	11	0.67	16	8	6	0.9	0.2	0.3	0.4	0.01	34	29	5
30	99	31	11	8	11	0.66	13	6	4	0.8	0.2	0.3	0.4	0.01	26	23	4
20	98	24	7	7	10	0.64	9	4	3	0.7	0.1	0.2	0.3	0.01	18	15	2
10	84	17	4	4	8	0.66	6	2	1	0.5	0.1	0.2	0.3	0.01	10	8	1

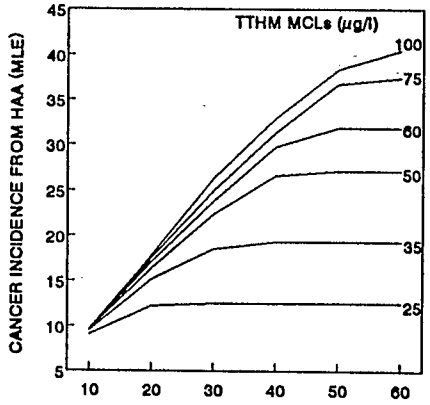
Cancer Incidence at Alternate TTHM MCLs



Cancer Incidence at Alternate THAA MCLs



Cancer Incidence at Alternate THAA / TTHM MCLs



[1] cummulative percent of systems able to meet MCL at the last treatment tier (includes 20% over-design factor)
[2] mean concentration at the last treatment tier of all systems; those meeting MCL and those not meeting MCL

MCL (THAAs)	MCL (TTHMs)	Cancer Incidence THAAs
60	100	40
50	100	38
40	100	33
30	100	26
20	100	18
10	100	10
60	75	37
50	75	37
40	75	31
30	75	25
20	75	18
10	75	10
60	60	32
50	60	32
40	60	30
30	60	24
20	60	17
10	60	10
60	50	27
50	50	27
40	50	27
30	50	22
20	50	16
10	50	10
60	35	19
50	35	19
40	35	19
30	35	18
20	35	15
10	35	9
60	25	12
50	25	12
40	25	12
30	25	12
20	25	12
10	25	9

Exhibit B-4

MODEL OUTPUT (surface w/o softening): ENHANCED SWTR W/ ALTERNATIVE DISINFECTION

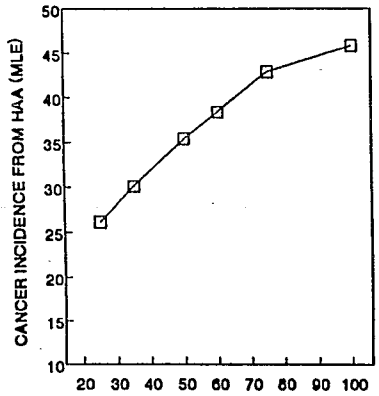
Treatment Code:
1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + modify alum dose
4 – pre-chlor + alum dose + GAC
5 – pre-chlor + ammonia + alum + ozone
6 – pre-chlor + ammonia + alum + ozone + GAC

Population = 103,000,000 (persons)

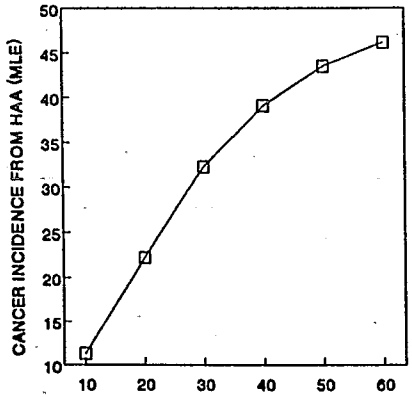
MCL (TTHMs)	Cumulative % of Sys. < MCL[1]	Mean Concentrations of By-Products (Average Customer)[2] TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA	Cancer Incidence (Maximum Likelihood Estimate) TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA
100	100	41	22	9	10	0.59	21	10	8	1.0	0.3	0.3	0.3	0.01	46	39	7
75	100	36	19	8	8	0.52	20	10	7	0.9	0.3	0.3	0.3	0.01	43	36	6
60	100	30	16	7	6	0.46	18	9	6	0.7	0.2	0.3	0.2	0.01	38	33	6
50	100	26	13	6	6	0.44	16	8	6	0.6	0.2	0.2	0.2	0.01	35	30	5
35	100	20	10	5	5	0.40	14	7	4	0.5	0.1	0.2	0.2	0.01	30	26	4
25	100	15	7	4	3	0.33	12	6	4	0.4	0.1	0.1	0.1	0.01	26	23	3

MCL (THAAs)	Cumulative % of Sys. < MCL[1]	Mean Concentrations of By-Products (Average Customer)[2] TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA	Cancer Incidence (Maximum Likelihood Estimate) TTHMs	CF	C2B	B2C	BF	THAAs	DCAA	TCAA
60	100	45	23	10	12	0.67	22	10	8	1.1	0.3	0.4	0.4	0.01	46	39	7
50	100	42	20	10	12	0.67	20	10	8	1.1	0.3	0.3	0.4	0.01	43	37	7
40	100	37	16	9	11	0.65	18	9	6	1.0	0.2	0.3	0.4	0.01	39	33	6
30	100	30	11	8	11	0.61	15	8	5	0.8	0.2	0.3	0.4	0.01	32	28	4
20	100	21	6	5	9	0.55	10	5	3	0.6	0.1	0.2	0.3	0.01	22	20	3
10	89	12	2	2	7	0.46	6	3	1	0.4	0.0	0.1	0.3	0.01	11	10	1

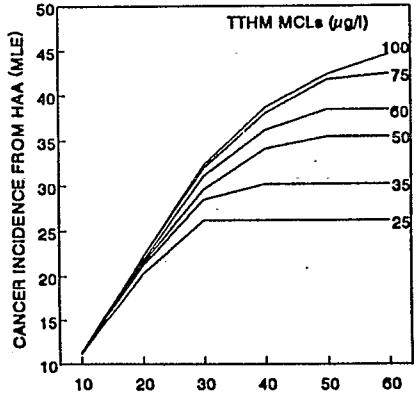
Cancer Incidence at Alternate TTHM MCLs



Cancer Incidence at Alternate THAA MCLs



Cancer Incidence at Alternate THAA / TTHM MCLs



[1] cummulative percent of systems able to meet MCL at the last treatment tier (includes 20% over-design factor)
[2] mean concentration at the last treatment tier of all systems; those meeting MCL and those not meeting MCL

MCL (THAAs)	MCL (TTHMs)	Cancer Incidence THAAs
60	100	45
50	100	42
40	100	39
30	100	32
20	100	22
10	100	11
60	75	42
50	75	42
40	75	38
30	75	32
20	75	22
10	75	11
60	60	38
50	60	38
40	60	36
30	60	31
20	60	22
10	60	11
60	50	35
50	50	35
40	50	34
30	50	30
20	50	21
10	50	11
60	35	30
50	35	30
40	35	30
30	35	28
20	35	21
10	35	11
60	25	26
50	25	26
40	25	26
30	25	26
20	25	20
10	25	11

Appendix C

Exhibit C-1

Concentrations of Individual THMs and HAAs at Alternate TTHM MCLs

Treatment Group Code:
1 – SWTR w/o Alternative Disinfection
2 – SWTR w/ Alternative Disinfection
3 – ENHANCED SWTR w/o Alternative Disinfection
4 – ENHANCED SWTR w/ Alternative Disinfection

Group Code	MCL (TTHMs)	Concentrations of By-Products (µg/L) (Average Customer)*																					
		TTHMs			Chloroform			Bromodichloromethane			Dibromochloromethane			Bromoform			THAAs			DCAA			TCAA		
		mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th
1	100	39	39	78	20	14	55	9	8	22	9	3	44	0.6	0.3	2	19	17	44	9	8	24	7	5	20
1	75	34	36	56	17	13	44	8	7	18	8	3	35	0.6	0.3	2	17	14	39	9	7	20	6	5	17
1	60	29	30	46	14	11	38	7	7	16	7	3	31	0.6	0.3	2	15	12	35	8	6	19	5	4	14
1	50	24	24	39	11	9	28	6	6	13	6	3	26	0.6	0.4	2	13	11	28	6	5	16	4	3	11
1	35	19	18	27	8	7	21	5	5	10	5	3	18	0.6	0.4	2	9	9	20	4	4	11	3	3	7
1	25	14	14	20	5	4	14	4	4	8	4	2	12	0.6	0.4	2	7	6	15	3	3	8	2	1	5
2	100	40	39	78	21	16	57	9	7	22	9	3	48	0.6	0.3	2	20	18	45	10	10	24	8	6	20
2	75	33	34	56	18	15	46	8	7	16	8	3	36	0.6	0.3	2	19	17	39	9	9	20	7	6	17
2	60	29	29	46	15	13	35	7	7	16	6	2	25	0.5	0.3	2	17	17	35	9	9	18	6	5	14
2	50	25	25	39	13	12	31	6	5	13	6	2	21	0.5	0.2	2	16	17	31	8	9	16	5	5	12
2	35	19	20	27	9	9	22	5	4	9	5	2	19	0.4	0.2	2	14	14	26	7	7	14	4	5	10
2	25	15	15	20	7	7	15	4	4	7	4	1	13	0.3	0.2	1	12	12	21	6	6	12	4	3	7
3	100	40	39	76	20	16	59	9	9	22	10	3	47	0.6	0.3	2	19	17	45	10	8	24	7	5	21
3	75	34	36	57	18	13	46	8	8	18	8	3	33	0.5	0.3	2	18	14	40	9	7	20	6	5	17
3	60	29	27	45	14	11	37	7	7	15	7	3	23	0.5	0.3	2	15	12	33	7	6	17	5	4	14
3	50	25	24	39	11	10	29	7	6	14	6	3	23	0.5	0.3	2	13	11	30	6	5	17	4	4	11
3	35	19	18	28	8	7	20	5	5	10	5	2	15	0.6	0.4	2	9	9	21	5	4	11	3	3	7
3	25	14	13	20	5	4	14	4	4	8	4	2	12	0.6	0.4	2	7	6	15	3	3	8	2	1	5
4	100	41	41	75	22	17	59	9	8	21	10	2	51	0.6	0.3	2	21	19	45	10	10	24	8	7	21
4	75	36	37	57	19	17	46	8	8	19	8	2	31	0.5	0.3	2	20	19	39	10	10	20	7	7	16
4	60	30	30	45	16	14	36	7	7	16	6	2	23	0.5	0.3	2	18	18	34	9	10	17	6	6	14
4	50	26	26	39	13	12	32	6	6	13	6	2	22	0.4	0.2	2	16	15	32	8	7	17	6	5	13
4	35	20	20	27	10	9	22	5	5	10	5	2	19	0.4	0.2	2	14	13	26	7	7	14	4	4	10
4	25	15	15	19	7	7	15	4	4	8	3	1	13	0.3	0.2	1	12	12	21	6	6	12	4	3	7

* concentration at the last treatment tier of all systems; those meeting MCL and those not meeting MCL

Exhibit C-2

Concentrations of Individual THMs and HAAs at Alternate TTHM MCLs
– SWTR w/o Alternate Disinfection –

Treatment Code: w/o Alternate Disinfection

1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + modify alum dose
4 – pre-chlor + alum dose + GAC

MCL (TTHMs)	Trt. Code	Concentrations of By-Products (µg/L) (Average Customer)*																					
		TTHMs			Chloroform			Bromodichloromethane			Dibromochloromethane			Bromoform			HAAs			DCAA			TCAA		
		mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th
100	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
100	2	42	41	78	21	15	58	9	9	23	11	3	53	0.7	0.4	2	20	17	46	10	9	24	8	6	21
100	3	40	41	78	20	15	55	9	9	22	10	3	44	0.6	0.3	2	20	17	44	10	9	24	7	6	20
100	4	39	39	78	20	14	55	9	8	22	9	3	44	0.6	0.3	2	19	17	44	9	8	24	7	5	20
75	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
75	2	39	39	78	20	14	51	9	8	22	10	3	39	0.6	0.3	2	19	17	44	10	8	24	7	5	19
75	3	35	37	58	18	14	44	8	8	19	8	3	35	0.6	0.3	2	18	17	39	9	8	20	7	5	17
75	4	34	36	56	17	13	44	8	7	18	8	3	35	0.6	0.3	2	17	14	39	9	7	20	6	5	17
60	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
60	2	38	37	78	19	13	51	9	8	22	9	3	39	0.6	0.3	2	19	17	44	10	8	24	7	5	19
60	3	32	33	48	16	12	44	8	7	16	8	3	32	0.5	0.3	2	17	14	36	8	7	19	6	4	16
60	4	29	30	46	14	11	38	7	7	16	7	3	31	0.6	0.3	2	15	12	35	8	6	19	5	4	14
50	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
50	2	37	34	78	18	13	51	9	8	22	9	3	39	0.6	0.3	2	18	15	44	9	8	24	6	5	19
50	3	29	27	48	14	11	35	7	7	16	7	3	31	0.5	0.3	2	15	12	34	8	6	19	5	4	14
50	4	24	24	39	11	9	28	6	6	13	6	3	26	0.6	0.4	2	13	11	28	6	5	16	4	3	11
35	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
35	2	37	32	78	18	13	51	9	8	22	9	3	39	0.6	0.3	2	18	15	44	9	8	24	6	5	19
35	3	27	25	48	13	11	35	7	6	15	7	3	31	0.5	0.3	2	14	12	33	7	6	17	5	4	14
35	4	19	18	27	8	7	21	5	5	10	5	3	18	0.6	0.4	2	9	9	20	4	4	11	3	3	7
25	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
25	2	36	32	78	18	13	51	9	7	22	9	3	39	0.5	0.3	2	18	14	44	9	8	24	6	5	19
25	3	26	23	48	12	10	35	7	6	15	7	3	31	0.5	0.2	2	13	12	33	7	6	17	4	3	14
25	4	14	14	20	5	4	14	4	4	8	4	2	12	0.6	0.4	2	7	6	15	3	3	6	2	1	5

* concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL

Exhibit C-3

Concentrations of Individual THMs and HAAs at Alternate TTHM MCLs
– SWTR w/ Alternate Disinfection –

Treatment Code: w/ Alternate Disinfection

1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + add ammonia
4 – pre-chlor + ammonia + alum dose
5 – pre-chlor + ammonia + alum dose + ozone
6 – pre-chlor + ammonia + alum dose + ozone + GAC

MCL (TTHMs)	Trt Code	Concentrations of By-Products (µg/L) (Average Customer)*																					
		TTHMs			Chloroform			Bromodichloromethane			Dibromochloromethane			Bromoform			THAAs			DCAA			TCAA		
		mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th
100	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
100	2	42	41	78	21	15	58	9	9	23	11	3	53	0.7	0.4	2	20	17	46	10	9	24	8	6	21
100	3	40	39	78	21	16	57	9	7	22	9	3	48	0.6	0.3	2	20	18	45	10	10	24	8	6	20
100	4	40	39	78	21	16	57	9	7	22	9	3	48	0.6	0.3	2	20	18	45	10	10	24	8	6	20
100	5	40	39	78	21	16	57	9	7	22	9	3	48	0.6	0.3	2	20	18	45	10	10	24	8	6	20
100	6	40	39	78	21	16	57	9	7	22	9	3	48	0.6	0.3	2	20	18	45	10	10	24	8	6	20
75	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
75	2	39	39	78	20	14	51	9	8	22	10	3	39	0.6	0.3	2	19	17	44	10	8	24	7	5	19
75	3	34	35	59	18	15	48	8	7	16	8	3	36	0.6	0.3	2	19	17	41	10	9	20	7	6	18
75	4	33	34	56	18	15	46	8	7	16	8	3	36	0.6	0.3	2	19	17	39	9	9	20	7	6	17
75	5	33	34	56	18	15	46	8	7	16	8	3	36	0.6	0.3	2	19	17	39	9	9	20	7	6	17
75	6	33	34	56	18	15	46	8	7	16	8	3	36	0.6	0.3	2	19	17	39	9	9	20	7	6	17
60	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
60	2	38	37	78	19	13	51	9	8	22	9	3	39	0.6	0.3	2	19	17	44	10	8	24	7	5	19
60	3	31	30	52	17	13	46	7	7	16	7	2	26	0.5	0.3	2	18	17	38	9	9	20	6	5	17
60	4	29	29	46	15	13	37	7	7	16	6	2	25	0.5	0.3	2	18	17	35	9	9	18	6	5	14
60	5	29	29	46	15	13	35	7	7	16	6	2	25	0.5	0.3	2	17	17	35	9	9	18	6	5	14
60	6	29	29	46	15	13	35	7	7	16	6	2	25	0.5	0.3	2	17	17	35	9	9	18	6	5	14
50	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
50	2	37	34	78	18	13	51	9	8	22	9	3	39	0.6	0.3	2	18	15	44	9	8	24	6	5	19
50	3	28	26	50	15	13	34	7	6	14	6	2	25	0.5	0.2	2	17	17	35	9	9	19	6	5	14
50	4	26	25	39	13	12	31	6	5	13	6	2	21	0.5	0.2	2	16	17	31	8	9	16	5	5	12
50	5	25	25	39	13	12	31	6	5	13	6	2	21	0.5	0.2	2	16	17	31	8	9	16	5	5	12
50	6	25	25	39	13	12	31	6	5	13	6	2	21	0.5	0.2	2	16	17	31	8	9	16	5	5	12
35	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
35	2	37	32	78	18	13	51	9	8	22	9	3	39	0.6	0.3	2	18	15	44	9	8	24	6	5	19
35	3	25	23	50	13	11	34	6	5	12	6	2	23	0.5	0.2	2	16	16	35	8	8	17	6	5	14
35	4	20	20	28	10	9	23	5	4	10	5	2	19	0.4	0.2	2	14	14	27	7	7	14	5	5	11
35	5	19	20	27	10	9	23	5	4	9	5	2	19	0.4	0.2	2	14	14	27	7	7	14	4	5	10
35	6	19	20	27	9	9	22	5	4	9	5	2	19	0.4	0.2	2	14	14	26	7	7	14	4	5	10
25	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
25	2	36	32	78	18	13	51	9	7	22	9	3	39	0.5	0.3	2	18	14	44	9	8	24	6	5	19
25	3	23	19	50	12	10	34	5	4	12	5	1	23	0.4	0.2	2	16	15	35	8	8	17	5	5	14
25	4	17	16	24	8	7	19	4	4	8	4	1	13	0.3	0.2	1	13	12	24	7	7	13	4	4	9
25	5	15	15	20	8	7	15	4	4	8	4	1	13	0.3	0.2	1	12	12	22	6	7	12	4	4	8
25	6	15	15	20	7	7	15	4	4	7	4	1	13	0.3	0.2	1	12	12	21	6	6	12	4	3	7

* concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL

Exhibit C-4

Concentrations of Individual THMs and HAAs at Alternate TTHM MCLs
– Enhanced SWTR w/o Alternate Disinfection –

Treatment Code: w/o Alternate Disinfection

1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + modify alum dose
4 – pre-chlor + alum dose + GAC

MCL	Trt.	Concentrations of By-Products (µg/L) (Average Customer)*																							
		TTHMs			Chloroform			Bromodichloromethane			Dibromochloromethane			Bromoform			THAAs			DCAA			TCAA		
(TTHMs)	Code	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th
100	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
100	2	44	42	79	22	17	60	10	9	26	11	3	55	0.6	0.4	2	21	18	47	10	9	25	8	6	21
100	3	41	42	76	21	17	59	10	9	22	10	3	47	0.6	0.3	2	20	18	45	10	9	24	8	6	21
100	4	40	39	76	20	16	59	9	9	22	10	3	47	0.6	0.3	2	19	17	45	10	8	24	7	5	21
75	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
75	2	41	39	79	21	16	51	10	9	23	10	3	41	0.6	0.3	2	20	18	45	10	9	25	7	6	19
75	3	36	37	57	18	15	46	9	8	19	8	3	33	0.5	0.3	2	18	17	40	9	8	20	7	5	17
75	4	34	36	57	18	13	46	8	5	18	8	3	33	0.5	0.3	2	18	14	40	9	7	20	6	5	17
60	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
60	2	39	37	79	20	14	51	9	8	23	10	3	41	0.6	0.3	2	19	17	45	10	9	25	7	5	19
60	3	32	31	49	16	12	41	8	7	16	7	3	30	0.5	0.3	2	16	13	35	8	7	18	6	4	16
60	4	29	27	45	14	11	37	7	7	15	7	3	23	0.5	0.3	2	15	12	33	7	6	17	5	4	14
50	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
50	2	39	36	79	19	14	51	9	8	23	10	3	41	0.6	0.3	2	19	17	45	10	9	25	7	5	19
50	3	30	28	49	15	12	40	8	7	16	7	3	30	0.5	0.3	2	15	13	34	8	6	18	5	4	15
50	4	25	24	39	11	10	29	7	6	14	6	3	23	0.5	0.3	2	13	11	30	6	5	17	4	4	11
35	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
35	2	38	35	79	19	13	51	9	8	23	10	3	41	0.6	0.3	2	19	16	45	10	8	25	7	5	19
35	3	28	25	49	13	11	40	7	7	15	7	3	30	0.5	0.3	2	14	12	34	7	6	17	5	4	15
35	4	19	18	28	8	7	20	5	5	10	5	2	15	0.6	0.4	2	9	9	21	5	4	11	3	3	7
25	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
25	2	37	35	79	19	13	51	9	7	23	9	3	41	0.5	0.3	2	19	15	45	10	8	25	7	5	19
25	3	26	23	49	12	10	40	7	6	15	7	3	30	0.4	0.2	1	13	11	34	7	6	17	4	4	15
25	4	14	13	20	5	4	14	4	4	8	4	2	12	0.6	0.4	2	7	6	15	3	3	8	2	1	5

* concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL

Exhibit C-5

Concentrations of Individual THMs and HAAs at Alternate TTHM MCLs
– Enhanced SWTR w/ Alternate Disinfection –

Treatment Code: w/ Alternate Disinfection

1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + add ammonia
4 – pre-chlor + ammonia + alum dose
5 – pre-chlor + ammonia + alum dose + ozone
6 – pre-chlor + ammonia + alum dose + ozone + GAC

MCL	Trt.	Concentrations of By-Products (µg/L) (Average Customer)*																							
		TTHMs			Chloroform			Bromodichloromethane			Dibromochloromethane			Bromoform			THAAs			DCAA			TCAA		
(TTHMs)	Code	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th
100	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
100	2	44	42	79	22	17	60	10	9	26	11	3	55	0.6	0.4	2	21	18	47	10	9	25	8	6	21
100	3	43	42	78	23	17	62	9	8	21	10	2	51	0.6	0.3	2	22	19	49	11	10	24	8	7	23
100	4	41	41	75	22	17	59	9	8	21	10	2	51	0.6	0.3	2	21	19	45	10	10	24	8	7	21
100	5	41	41	75	22	17	59	9	8	21	10	2	51	0.6	0.3	2	21	19	45	10	10	24	8	7	21
100	6	41	41	75	22	17	59	9	8	21	10	2	51	0.6	0.3	2	21	19	45	10	10	24	8	7	21
75	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
75	2	41	39	79	21	16	51	10	9	23	10	3	41	0.6	0.3	2	20	18	45	10	9	25	7	6	19
75	3	38	39	60	21	17	48	9	8	19	8	2	37	0.5	0.3	2	20	19	43	10	10	22	8	7	19
75	4	36	37	57	19	17	46	9	8	19	8	2	31	0.5	0.3	2	20	19	40	10	10	20	7	7	17
75	5	36	37	57	19	17	46	8	8	19	8	2	31	0.5	0.3	2	20	19	39	10	10	20	7	7	16
75	6	36	37	57	19	17	46	8	8	19	8	2	31	0.5	0.3	2	20	19	39	10	10	20	7	7	16
60	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
60	2	39	37	79	20	14	51	9	8	23	10	3	41	0.6	0.3	2	19	17	45	10	9	25	7	5	19
60	3	34	33	58	19	15	46	8	7	17	7	2	30	0.5	0.3	2	19	18	36	10	10	20	7	6	16
60	4	30	30	45	16	14	37	7	7	16	6	2	23	0.5	0.3	2	18	18	35	9	10	18	6	6	15
60	5	30	30	45	16	14	36	7	7	16	6	2	23	0.5	0.3	2	18	18	34	9	10	17	6	6	14
60	6	30	30	45	16	14	36	7	7	16	6	2	23	0.5	0.3	2	18	18	34	9	10	17	6	6	14
50	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
50	2	39	36	79	19	14	51	9	8	23	10	3	41	0.6	0.3	2	19	17	45	10	9	25	7	5	19
50	3	33	31	58	18	15	45	8	7	17	7	2	30	0.5	0.2	2	19	18	36	9	9	20	7	6	15
50	4	27	26	39	14	13	32	7	6	14	6	2	22	0.4	0.2	2	17	16	33	8	8	17	6	5	14
50	5	26	26	39	13	12	32	6	6	13	6	2	22	0.4	0.2	2	16	15	32	8	7	17	6	5	13
50	6	26	26	39	13	12	32	6	6	13	6	2	22	0.4	0.2	2	16	15	32	8	7	17	6	5	13
35	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
35	2	38	35	79	19	13	51	9	8	23	10	3	41	0.6	0.3	2	19	16	45	10	8	25	7	5	19
35	3	30	25	58	16	13	45	7	6	17	7	2	30	0.5	0.2	2	18	18	36	9	9	18	7	6	15
35	4	22	22	34	11	10	24	6	5	10	5	2	19	0.4	0.2	2	15	14	27	7	7	14	5	4	11
35	5	20	20	28	10	9	23	5	5	10	5	2	19	0.4	0.2	2	14	13	26	7	7	14	5	4	11
35	6	20	20	27	10	9	22	5	5	10	5	2	19	0.4	0.2	2	14	13	26	7	7	14	4	4	10
25	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
25	2	37	35	79	19	13	51	9	7	23	9	3	41	0.5	0.3	2	19	15	45	10	8	25	7	5	19
25	3	29	22	58	16	12	45	7	5	17	6	1	30	0.4	0.2	2	18	17	36	9	9	18	6	6	15
25	4	19	18	34	9	8	23	5	5	10	4	1	15	0.4	0.2	1	14	13	27	7	7	14	5	4	11
25	5	15	15	20	7	7	16	4	4	8	4	1	13	0.3	0.2	1	12	12	21	6	6	12	4	4	7
25	6	15	15	19	7	7	15	4	4	8	3	1	13	0.3	0.2	1	12	12	21	6	6	12	4	3	7

* concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL

Exhibit C-6

Concentrations of Individual THMs and HAAs at Alternate THAA MCLs

Treatment Group Code:
1 – SWTR w/o Alternative Disinfection
2 – SWTR w/ Alternative Disinfection
3 – ENHANCED SWTR w/o Alternative Disinfection
4 – ENHANCED SWTR w/ Alternative Disinfection

Group Code	MCL (THAAs)	Concentrations of By-Products (µg/L) (Average Customer)*																							
		TTHMs			Chloroform			Bromodichloromethane			Dibromochloromethane			Bromoform			THAAs			DCAA			TCAA		
		mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th
1	60	43	39	90	21	16	51	10	8	30	12	3	69	0.7	0.3	3	19	17	43	9	8	22	7	6	20
1	50	41	37	90	19	16	45	10	7	30	12	3	69	0.7	0.3	3	19	17	38	9	8	19	7	6	17
1	40	36	28	89	15	13	35	9	7	27	11	3	63	0.7	0.4	3	16	15	30	8	7	16	5	5	12
1	30	30	23	78	11	10	28	8	6	21	11	3	63	0.7	0.4	3	12	12	23	6	6	12	4	4	9
1	20	24	19	78	7	7	17	6	5	16	10	3	63	0.7	0.4	3	9	9	15	4	4	8	3	3	6
1	10	17	13	65	4	3	11	4	4	9	8	2	63	0.7	0.4	2	6	5	11	2	2	5	1	1	4
2	60	43	38	90	22	16	56	10	7	29	11	3	66	0.7	0.3	3	21	18	43	10	10	22	8	6	20
2	50	41	36	90	19	16	46	9	7	29	11	3	66	0.7	0.3	3	20	18	38	10	10	19	7	6	17
2	40	36	27	86	16	15	35	9	6	25	11	2	60	0.7	0.3	3	17	18	31	9	9	16	6	6	12
2	30	29	21	78	11	12	25	7	5	20	10	2	60	0.6	0.3	3	15	17	24	8	9	13	5	5	9
2	20	20	15	71	6	6	14	5	4	12	9	1	60	0.6	0.3	2	10	11	16	5	6	9	3	3	5
2	10	12	5	55	2	2	4	2	2	7	7	1	54	0.5	0.2	2	6	6	9	3	3	6	1	1	3
3	60	44	40	91	21	17	51	10	8	30	12	3	71	0.7	0.3	3	20	18	42	10	9	22	8	6	19
3	50	42	37	91	19	17	46	10	8	30	12	3	71	0.7	0.3	3	19	18	37	9	9	19	7	6	17
3	40	37	29	89	15	14	36	9	7	27	11	3	69	0.7	0.4	3	16	15	31	8	7	17	6	5	12
3	30	31	24	78	11	11	28	8	6	22	11	2	69	0.7	0.4	3	13	12	23	6	6	12	4	4	9
3	20	24	20	78	7	7	17	7	6	16	10	2	69	0.6	0.4	3	9	9	15	4	4	8	3	3	6
3	10	17	12	73	4	3	11	4	4	9	8	2	69	0.7	0.4	2	6	5	11	2	2	5	1	1	4
4	60	45	41	90	23	18	58	10	8	29	12	2	70	0.7	0.3	3	22	20	44	10	10	22	8	7	21
4	50	42	37	90	20	18	46	10	8	29	12	2	70	0.7	0.3	3	20	20	36	10	10	18	8	7	16
4	40	37	29	89	16	16	36	9	6	27	11	2	63	0.6	0.3	3	18	19	31	9	10	16	6	7	13
4	30	30	23	78	11	12	24	8	5	21	11	2	63	0.6	0.3	3	15	17	22	8	9	12	5	6	8
4	20	21	15	75	6	6	13	5	4	14	9	1	63	0.6	0.3	2	10	11	16	5	6	9	3	3	5
4	10	12	5	61	2	2	4	2	2	7	7	1	58	0.5	0.2	2	6	6	9	3	3	6	1	1	3

* concentration at the last treatment tier of all systems; those meeting MCL and those not meeting MCL

Exhibit C-7

Concentrations of Individual THMs and HAAs at Alternate THAA MCLs
– SWTR w/o Alternate Disinfection –

Treatment Code: w/o Alternate Disinfection
1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + modify alum dose
4 – pre-chlor + alum dose + GAC

MCL (THAAs)	Trt. Code	Concentrations of By-Products (µg/L) (Average Customer)*																					
		TTHMs			Chloroform			Bromodichloromethane			Dibromochloromethane			Bromoform			THAAs			DCAA			TCAA		
		mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th
60	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
60	2	46	41	105	22	17	58	10	9	30	13	3	69	0.7	0.4	3	21	17	46	10	9	24	8	6	21
60	3	44	41	90	21	17	51	10	8	30	12	3	69	0.7	0.3	3	20	17	43	10	10	22	8	6	20
60	4	43	39	90	21	16	51	10	8	30	12	3	69	0.7	0.3	3	19	17	43	9	8	22	7	6	20
50	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
50	2	45	41	105	21	17	51	10	8	30	13	3	69	0.7	0.4	3	20	17	44	10	9	24	8	6	19
50	3	43	39	90	20	17	45	10	8	30	12	3	69	0.7	0.3	3	19	17	38	9	10	19	7	6	17
50	4	41	37	90	19	16	45	10	7	30	12	3	69	0.7	0.3	3	19	17	38	9	8	19	7	6	17
40	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
40	2	42	37	90	20	15	51	10	8	27	12	3	63	0.7	0.4	3	19	17	44	10	8	24	7	6	19
40	3	39	35	89	17	15	40	9	7	27	12	3	63	0.7	0.3	3	17	17	33	9	9	18	6	6	14
40	4	36	28	89	15	13	35	9	7	27	11	3	63	0.7	0.4	3	16	15	30	8	7	16	5	5	12
30	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
30	2	40	36	89	19	14	51	9	8	23	12	3	63	0.7	0.3	3	19	17	44	10	8	24	7	5	19
30	3	35	30	78	15	13	35	8	7	21	11	3	63	0.7	0.3	3	16	15	33	8	8	17	5	5	14
30	4	30	23	78	11	10	28	6	6	21	11	3	63	0.7	0.4	3	12	12	23	6	6	12	4	4	9
20	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
20	2	39	34	84	18	13	51	9	8	22	11	3	63	0.7	0.3	3	18	15	44	9	8	24	6	5	19
20	3	31	26	78	13	11	35	7	7	16	10	3	63	0.6	0.3	3	14	12	33	7	6	17	5	4	14
20	4	24	19	78	7	7	17	6	5	16	10	3	63	0.7	0.4	3	9	9	15	4	4	8	3	3	6
10	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
10	2	38	34	79	18	12	51	9	7	22	11	3	63	0.6	0.3	2	18	14	44	9	8	24	6	4	19
10	3	28	25	70	11	7	35	7	6	15	10	3	63	0.6	0.2	2	13	9	33	6	5	17	4	3	14
10	4	17	13	65	4	3	11	4	4	9	6	2	63	0.7	0.4	2	6	5	11	2	2	5	1	1	4

concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL

Exhibit C-8

Concentrations of Individual THMs and HAAs at Alternate THAA MCLs
– SWTR w/ Alternate Disinfection –

reatment Code: w/ Alternate Disinfection

1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + add ammonia
4 – pre-chlor + ammonia + alum dose
5 – pre-chlor + ammonia + alum dose + ozone
6 – pre-chlor + ammonia + alum dose + ozone + GAC

MCL	Trt.	Concentrations of By-Products (µg/L) (Average Customer)*																							
		TTHMs			Chloroform			Bromodichloromethane			Dibromochloromethane			Bromoform			THAAs			DCAA			TCAA		
(THAAs)	Code	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th
60	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
60	2	46	41	105	22	17	58	10	9	30	13	3	69	0.7	0.4	3	21	17	46	10	9	24	8	6	21
60	3	43	38	90	22	16	56	10	7	29	11	3	66	0.7	0.3	3	21	18	43	10	10	22	8	6	20
60	4	43	38	90	22	16	56	10	7	29	11	3	66	0.7	0.3	3	21	18	43	10	10	22	8	6	20
60	5	43	38	90	22	16	56	10	7	29	11	3	66	0.7	0.3	3	21	18	43	10	10	22	8	6	20
60	6	43	38	90	22	16	56	10	7	29	11	3	66	0.7	0.3	3	21	18	43	10	10	22	8	6	20
50	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
50	2	45	41	105	21	17	51	10	8	30	13	3	69	0.7	0.4	3	20	17	44	10	9	24	8	6	19
50	3	42	37	90	20	16	50	9	7	29	11	3	66	0.7	0.3	3	20	18	40	10	10	20	8	6	18
50	4	41	36	90	19	16	46	9	7	29	11	3	66	0.7	0.3	3	20	18	38	10	10	19	7	6	17
50	5	41	36	90	19	16	46	9	7	29	11	3	66	0.7	0.3	3	20	18	38	10	10	19	7	6	17
50	6	41	36	90	19	16	46	9	7	29	11	3	66	0.7	0.3	3	20	18	38	10	10	19	7	6	17
40	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
40	2	42	37	90	20	15	51	10	8	27	12	3	63	0.7	0.4	3	19	17	44	10	8	24	7	6	19
40	3	38	30	86	17	15	40	9	7	25	11	2	60	0.7	0.3	3	18	18	35	9	10	18	7	6	14
40	4	36	27	86	16	15	35	9	6	25	11	2	60	0.7	0.3	3	18	18	31	9	9	16	6	6	12
40	5	36	27	86	16	15	35	9	6	25	11	2	60	0.7	0.3	3	17	18	31	9	9	16	6	6	12
40	6	36	27	86	16	15	35	9	6	25	11	2	60	0.7	0.3	3	17	18	31	9	9	16	6	6	12
30	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
30	2	40	36	89	19	14	51	9	8	23	12	3	63	0.7	0.3	3	19	17	44	10	8	24	7	5	19
30	3	34	26	78	15	13	35	8	6	20	10	2	60	0.6	0.3	3	17	17	35	9	9	17	6	6	14
30	4	30	22	78	12	12	28	7	5	20	10	2	60	0.6	0.3	3	15	17	24	8	9	13	5	5	10
30	5	30	22	78	12	12	28	7	5	20	10	2	60	0.6	0.3	3	15	17	24	8	9	13	5	5	9
30	6	29	21	78	11	12	25	7	5	20	10	2	60	0.6	0.3	3	15	17	24	8	9	13	5	5	9
20	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
20	2	39	34	84	18	13	51	9	8	22	11	3	63	0.7	0.3	3	18	15	44	9	8	24	6	5	19
20	3	29	23	78	13	11	34	6	5	15	9	1	60	0.6	0.2	3	16	15	35	8	8	17	6	5	14
20	4	23	19	71	8	7	19	5	4	12	9	1	60	0.6	0.2	2	13	13	24	7	7	13	4	4	9
20	5	22	16	71	7	7	15	5	4	12	9	1	60	0.6	0.2	2	12	13	20	6	7	11	4	4	7
20	6	20	15	71	6	6	14	5	4	12	9	1	60	0.6	0.2	2	10	11	16	5	6	9	3	3	5
10	1	55	46	173	30	16	113	11	9	31	13	4	72	0.8	0.4	3	24	17	80	11	8	31	11	6	38
10	2	38	34	79	18	12	51	9	7	22	11	3	63	0.6	0.3	2	18	14	44	9	8	24	6	4	19
10	3	26	20	71	12	8	34	5	4	12	8	1	54	0.5	0.2	2	16	15	35	8	8	17	5	5	14
10	4	18	14	58	6	5	19	4	3	8	7	1	54	0.4	0.1	2	12	10	24	6	5	13	3	3	9
10	5	15	11	55	5	3	13	3	3	7	7	1	54	0.4	0.1	2	10	8	20	5	4	11	3	2	7
10	6	12	5	55	2	2	4	2	2	7	7	1	54	0.5	0.2	2	6	6	9	3	3	6	1	1	3

concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL

Exhibit C-9

Concentrations of Individual THMs and HAAs at Alternate THAA MCLs
– Enhanced SWTR w/o Alternate Disinfection –

eatment Code: w/o Alternate Disinfection
1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + modify alum dose
4 – pre-chlor + alum dose + GAC

MCL (THAAs)	Trt. Code	Concentrations of By-Products (µg/L) (Average Customer)*																							
		TTHMs			Chloroform			Bromodichloromethane			Dibromochloromethane			Bromoform			THAAs			DCAA			TCAA		
		mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th
60	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
60	2	48	42	109	23	17	60	11	9	30	13	3	71	0.7	0.4	3	21	18	47	10	10	25	8	7	21
60	3	45	42	91	22	17	51	11	9	30	12	3	71	0.7	0.3	3	20	18	42	10	10	22	8	7	19
60	4	44	40	91	21	17	51	10	8	30	12	3	71	0.7	0.3	3	20	18	42	10	9	22	8	6	19
50	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
50	2	46	39	109	22	17	51	11	8	30	13	3	71	0.7	0.4	3	21	18	45	10	10	25	8	7	19
50	3	43	38	91	20	17	46	10	8	30	12	3	71	0.7	0.3	3	19	18	37	9	10	19	7	7	17
50	4	42	37	91	19	17	46	10	8	30	12	3	71	0.7	0.3	3	19	18	37	9	9	19	7	6	17
40	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
40	2	44	37	90	21	17	51	10	8	27	12	3	69	0.7	0.4	3	20	18	45	10	9	25	7	6	19
40	3	40	35	89	18	17	41	10	7	27	12	3	69	0.7	0.3	3	18	18	34	9	9	18	6	6	15
40	4	37	29	89	15	14	36	9	7	27	11	3	69	0.7	0.4	3	16	15	31	8	7	17	6	5	12
30	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
30	2	42	37	89	20	16	51	10	8	26	12	3	69	0.7	0.3	3	19	18	45	10	9	25	7	6	19
30	3	36	30	78	15	13	40	9	7	22	11	3	69	0.6	0.3	3	16	16	34	8	8	17	5	5	15
30	4	31	24	76	11	11	28	8	6	22	11	2	69	0.7	0.4	3	13	12	23	6	6	12	4	4	9
20	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
20	2	40	36	89	19	13	51	9	8	23	12	3	69	0.6	0.3	3	19	15	45	10	8	25	7	5	19
20	3	32	25	78	13	11	40	8	7	18	11	3	69	0.6	0.3	3	14	13	34	7	6	17	5	4	15
20	4	24	20	78	7	7	17	7	6	16	10	2	69	0.6	0.4	3	9	9	15	4	4	8	3	3	6
10	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
10	2	39	36	82	18	13	51	9	8	23	11	3	69	0.6	0.3	2	19	15	45	9	8	25	7	5	19
10	3	28	24	73	11	6	40	7	6	15	10	2	69	0.5	0.2	2	13	9	34	6	5	17	4	2	15
10	4	17	12	73	4	3	11	4	4	9	8	2	69	0.7	0.4	2	6	5	11	2	2	5	1	1	4

concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL

Exhibit C-10

Concentrations of Individual THMs and HAAs at Alternate THAA MCLs
– Enhanced SWTR w/ Alternate Disinfection –

Treatment Code: w/ Alternate Disinfection

1 – not requiring further treatment modification
2 – eliminate pre-chlorination
3 – eliminate pre-chlor + add ammonia
4 – pre-chlor + ammonia + alum dose
5 – pre-chlor + ammonia + alum dose + ozone
6 – pre-chlor + ammonia + alum dose + ozone + GAC

MCL (THAAs)	Trt. Code	Concentrations of By-Products (µg/L) (Average Customer)*																							
		TTHMs			Chloroform			Bromodichloromethane			Dibromochloromethane			Bromoform			THAAs			DCAA			TCAA		
		mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th	mean	median	95th
60	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
60	2	48	42	109	23	17	60	11	9	30	13	3	71	0.7	0.4	3	21	16	47	10	10	25	8	7	21
60	3	46	42	93	24	18	60	10	8	29	12	2	70	0.7	0.3	3	22	20	45	11	10	23	9	7	21
60	4	45	41	90	23	18	58	10	8	29	12	2	70	0.7	0.3	3	22	20	44	10	10	22	8	7	21
60	5	45	41	90	23	18	58	10	8	29	12	2	70	0.7	0.3	3	22	20	44	10	10	22	8	7	21
60	6	45	41	90	23	18	58	10	8	29	12	2	70	0.7	0.3	3	22	20	44	10	10	22	8	7	21
50	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
50	2	46	39	109	22	17	51	11	8	30	13	3	71	0.7	0.4	3	21	18	45	10	10	25	8	7	19
50	3	44	39	93	22	18	50	10	8	29	12	2	70	0.7	0.3	3	21	20	39	10	10	20	8	7	19
50	4	43	38	90	21	18	46	10	8	29	12	2	70	0.7	0.3	3	20	20	37	10	10	18	8	7	18
50	5	42	37	90	20	18	46	10	8	29	12	2	70	0.7	0.3	3	20	20	36	10	10	18	8	7	16
50	6	42	37	90	20	18	46	10	8	29	12	2	70	0.7	0.3	3	20	20	36	10	10	18	8	7	16
40	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
40	2	44	37	90	21	17	51	10	8	27	12	3	69	0.7	0.4	3	20	18	45	10	9	25	7	6	19
40	3	41	36	90	20	17	45	9	7	27	11	2	63	0.6	0.3	3	20	19	36	10	10	18	7	7	15
40	4	38	29	89	17	16	37	9	6	27	11	2	63	0.6	0.3	3	18	19	32	9	10	17	7	7	13
40	5	37	29	89	16	16	36	9	6	27	11	2	63	0.6	0.3	3	18	19	31	9	10	16	6	7	13
40	6	37	29	89	16	16	36	9	6	27	11	2	63	0.6	0.3	3	18	19	31	9	10	16	6	7	13
30	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
30	2	42	37	89	20	16	51	10	8	26	12	3	69	0.7	0.3	3	19	18	45	10	9	25	7	6	19
30	3	37	30	86	18	16	45	8	7	21	11	2	63	0.6	0.3	3	19	19	36	9	10	18	7	6	15
30	4	32	25	78	13	12	28	8	6	21	11	2	63	0.6	0.3	3	16	17	27	8	9	14	5	6	11
30	5	30	23	78	11	12	25	8	5	21	11	2	63	0.6	0.3	3	15	17	23	8	9	12	5	6	9
30	6	30	23	78	11	12	24	8	5	21	11	2	63	0.6	0.3	3	15	17	22	8	9	12	5	6	8
20	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
20	2	40	36	89	19	13	51	9	8	23	12	3	69	0.6	0.3	3	19	15	45	10	8	25	7	5	19
20	3	33	25	82	16	13	45	7	6	18	10	2	63	0.6	0.2	3	18	17	36	9	9	18	6	6	15
20	4	26	20	75	10	9	23	6	5	15	9	2	63	0.5	0.2	2	14	14	27	7	7	14	5	4	11
20	5	23	17	75	7	7	15	6	4	14	9	1	63	0.5	0.2	2	12	13	20	6	7	11	4	4	7
20	6	21	15	75	6	6	13	5	4	14	9	1	63	0.6	0.3	2	10	11	16	5	6	9	3	3	5
10	1	57	49	173	31	17	114	12	9	31	14	4	72	0.7	0.4	3	25	18	80	11	8	31	11	7	38
10	2	39	36	82	18	13	51	9	8	23	11	3	69	0.6	0.3	2	19	15	45	9	8	25	7	5	19
10	3	31	24	79	15	10	45	6	5	17	9	1	58	0.5	0.2	2	18	17	36	9	9	18	6	6	15
10	4	21	16	71	8	5	23	5	4	10	8	1	58	0.4	0.2	2	13	11	27	7	6	14	4	3	11
10	5	16	10	61	5	3	13	3	3	8	7	1	58	0.4	0.1	2	10	8	20	5	4	11	3	2	7
10	6	12	5	61	2	2	4	2	2	7	7	1	58	0.5	0.2	2	6	6	9	3	3	6	1	1	3

* concentration at each treatment tier of all systems; those meeting MCL and those not meeting MCL