GOVERNMENT REGULATION OF TAP WATER & BOTTLED WATER

JURISDICTION:	CANADA		ONTARIO			QUEBEC		U.S.	
Type of Water:	**Tap Water**	**Bottled**	**Tap Water**		**Bottled**	**Tap Water**	**Bottled**	**Tap Water**	**Bottled**
Legislation:	Guidelines for Can Drinking Water Qual -ity	F&D Act Regs. Div. 12	Drinking Water Objectives (under Ont Water Res. Act.7(1)d		No Prov Reg	Drinking Water Reg	Reg resp Bottled H_2O. Env Qual Act	Drinking Water Reg under the SOWA	F&D Adm. Reg. pt. 103.3
PARAMETERS	MAC		MAC	MDC		MAC mg/l	MAC	Max Sec Con MCL Lev	MCL
GENERAL									
Chloride mg/L	(250)			250				250	250
Colour	15			5				15	15
Corrosivity								Non Cor	
Fluoride mg/L	1.5[W]		2.4			1.5		1.4-2.4[C]	
Foaming Agents mg/L								0.5	
Nitrate(AsN)mg/L	10.0		10.0			10.0	10.0	10.0	10.0
Nitrite(AsN)mg/L	1.0		1.0			10.0	10.0		
Organic Nitrogen mg/L				0.15[1]					
TDS mg/L	500			500				500	
pH (Standard Units)	(6.5-8.5)			(6.5-8.5)				(6.5-8.5)	
TOC mg/L				5.0					
Turbidity(NTU)	5		1 FTU			5		1[A]	5.0
Temperature C	15			15					
Odour	-			inoffensive				3(Ton)	3
Taste	-			inoffensive					
Sulpate mg/L	500			500		500	500	250	250
Phenols mg/L	(.0.002)			0.002		0.002			.001
MICROBIOLOGICAL									
Fecal Coliform (per 100 ml)	0[X]		nil			0	0		
Fecal Streptococci (per 100 ml)				nil			0		
Standard Plate Count (per 100 ml)				50,000			0		
Total Coliform	10[u]		≤5	<5[u]		10	0	10[B]	
RADIOLOGICAL[Y]									
Gross Alpha Bq/L	0.1							15pci/L	15pci/L
Gross Beta[E] Bq/L	1							50pci/L	
CESIUM-137 Bq/L	50		50	5[K]		50			
IODINE-131 Bq/L	10		10	1[K]		10			
RADIUM-226 Bq/L	1.0		1.0	0.1[K]		1		5[V]pci/L	5*pci/L
STRONTIUM-90 Bq/L	10		10	1.0[K]		10		8pci/L	
TRITIUM Bq/L	40,000		40,000	4,000[K]		40,000		20,000pci/L	
INORGANIC									
ALUMINUM mg/L									
ARSENIC mg/L	0.05		0.05			0.05	.01	0.05	.05
BARIUM mg/L	1.0		1.0			1.0	1.0	1.0	1.0
BORON mg/L	5.0		5.0			5.0	5.0		
CADMIUM mg/L	0.005		0.005			0.005	.01	0.010	.01
CHROMIUM mg/L	0.05		0.05			0.05	.05	0.05	.05
COPPER mg/L	(1.0)			1.0			1.0	1.0	1.0
CYANIDE mg/L	0.2		0.2			0.2	.01		
IRON mg/L	(0.3)			0.3			.3	0.3	.3
LEAD mg/L	0.05		0.05			0.05	.05	0.05	.05

GOVERNMENT REGULATION OF TAP WATER & BOTTLED WATER

JURISDICTION:	CANADA		ONTARIO			QUEBEC		U.S.	
Type of Water:	**Tap Water**	**Bottled**	**Tap Water**		**Bottled**	**Tap Water**	**Bottled**	**Tap Water**	**Bottled**
Legislation:	Guidelines for Can Drinking Water Qual -ity	F&D Act Regs. Div. 12	Drinking Water Objectives (under Ont Water Res. Act.7(1)d		No Prov Reg	Drinking Water Reg	Reg resp Bottled H_2O. Env Qual Act	Drinking Water Reg under the SOWA	F&D Adm. Reg. pt. 103.3
PARAMETERS	**MAC**		**MAC**	**MDC**		**MAC mg/l**	**MAC**	**Max Sec Con MCL Lev**	**MCL**
MANGANESE mg/L	(0.05)			0.05			.05	0.05	.05
MERCURY mg/L	0.001		0.001			0.001		0.002	.002
SELENIUM mg/L	0.01		0.01			0.01	.01	0.01	.01
SILVER mg/L	0.05		0.05			0.05	.05	0.05	.05
URANIUM mg/L	0.02		0.02[L]			0.02			
ZINC mg/L	(5.0)			5.0		5.0	5.0	5.0	
SULPHIDE (AS H_2S) mg/L	(0.05)			inoffensive		.3			
BASE/NEUTRALS									
BENZO(A)PYRENE mg/L									
VOLATILE ORGANICS									
BENZENE mg/L									
CARBON TETRACHLORIDE mg/L									
1.2-DICHLOROETHANE mg/L									
HEXACHLOROBENZENE mg/L									
METHANE L/m^3				$3L/m^3$					
TETRACHLOROETHENE mg/L									
TRICHLOROETHENE mg/L									
TRIHALOMETHANES mg/L	0.35		0.35					0.1	.1
PESTICIDES & P.C.B.'S									
ALDRIN + DIELDRIN mg/L	0.0007		0.0007			0.0007			
GAMMA-BHC(LINDANE)mg/L	0.004		0.004			0.004		0.004	
CARBARYL mg/L	0.07		0.07			0.07			
CHLORDANE (TOTAL ISOMERS) mg/L	0.007		0.007			0.007			
2,4-D mg/L	0.1		0.1			0.01		0.1	.1
ENDRIN mg/L	0.0002		0.0002			0.0002		0.0002	.0002
HEPTACHLOR mg/L	0.0003[P]		0.003[P]			}			
HEPTACHLOR EPOXIDE mg/L	0.003.[P]		0.003[P]			}.003			
METHOXYCHLOR mg/L	0.1		0.1			0.1		0.1	.1
METHYL PARATHION mg/L	0.007		0.007			0.007			
PARATHION mg/L	0.035		0.035			0.035			
PCB'S mg/L			0.003[L]						
TOXAPHENE mg/L	0.005		0.005			0.005		0.005	.005
2.4.5-TP (SILVEX) mg/L	0.01		0.01			0.01		0.01	.01
PESTICIDES - TOTAL[R] mg/L	0.1					0.01			
DIAZINON mg/L	0.014		0.014			0.014			
DDT-TOTAL mg/L	0.03		0.03			0.03			
PHENOLICS & ACIDS									
NITRILOTRIACETIC ACID (NTA) mg/L	0.05		0.05			0.05			
PENTACHLOROPHENOL mg/L									
2.4.6-TRICHLOROPHENOL mg/L									
AMMONIA							.5		
CALCIUM							200.00		
FLUORINE							1.5		
MAGNESIUM							150.00		
URANYLS							5.0		
TOTAL DISSOLVED SOLIDS							500.00		
LINDANE							.004		

REGULATION OF BOTTLED WATER - GOVERNMENT VS. INDUSTRY

JURISDICTION:	CANADA		ONTARIO		QUEBEC		U.S.	
Regulator	Government	Industry	Government	Industry	Government	Industry	Government	Idustry
Legislation:	F&D Act Div. 12	No Federal Regulations	No Provin-cial Regs.	OBWA Model Bottled Water Code	Regulation Re: Bottled H_2O; Env. Quality Act		F&D Adm. Reg. Pt. 103.3	
PARAMETERS				MAC	MAC			
GENERAL								
Chloride mg/L				250			250	
Colour							15	
Corrosivity								
Fluoride mg/L				10				
Foaming Agents mg/L								
Nitrate(AsN)mg/L					10.00		10.00	
Nitrite(AsN)mg/L					10.00		10.00	
Organic Nitrogen mg/L								
TDS mg/L								
pH (Standard Units)								
TOC mg/L								
Turbidity(NTU)							5	
Temperature C								
Odour							3	
Taste								
Sulpate mg/L					500		250	
Phenols mg/L							.001	
MICROBIOLOGICAL								
Fecal Coliform					0			
(per 100 ml)					0			
Fecal Streptococci				<100/ml	0			
(per 100 ml)				<100/ml	0			
Standard Plate Count								
(per 100 ml)								
Total Coliform								
(per 100 ml)								
RADIOLOGICAL[Y]								
Gross Alpha Bq/L							15pci/L	
Gross Beta[E] Bq/L								
CESIUM-137 Bq/L				5.0				
IODINE-131 Bq/L				1.0				
RADIUM-226 Bq/L				.1			5pci/L	
STRONTIUM-90 Bq/L				1.0				
TRITIUM Bq/L				4000.0				
INORGANIC								
ALUMINUM mg/L				.2				
ARSENIC mg/L				.01	.01ppm		.05	
BARIUM mg/L				1.00	1.0		1.0	
BORON mg/L				5.0	5.0			
CADMIUM mg/L				.005	.01		.01	
CHROMIUM mg/L				.05	.05		.05	
COPPER mg/L					1.0		1.0	
CYANIDE mg/L				.1	.01			
IRON mg/L					.3		.3	
LEAD mg/L				.02	.05		.05	

TABLES

Table 2 Concentration of Chemicals Detected in Seven Major Brands of Bottled Spring Water Delivered to Toronto Homes. (continued)

Parameter Units: as indicated below	Brand of Bottled Spring Water							Blank	Detection Limit
	Crystal Springs	Caledon Springs	Spring Valley	Cenizi Springs	Highland Springs	Blue Mountain	Cedar Springs		
METALS AND OTHER PARAMETERS									
Aluminum (ug/L)	5		10	5	5	5	7.5		5.0
Arsenic (ug/L)									1.0
Barium (ug/L)	60	140	20	20	20		110		10.0
Beryllium (mg/L)									0.01
Cadmium (ug/L)							0.1		0.1
Calcium (mg/L)	84	72	91	86	70	54	90		0.01
Chromium (ug/L)			1						1.0
Cobalt (ug/L)	10								10.0
Copper (ug/L)			0.5	1	1				1.0
Iron (ug/L)		20							20.0
Lead (ug/L)									1.0
Magnesium (mg/L)	15.9	17.8	26	11.0	29	25	16.6		0.01
Manganese (ug/L)		2	0.5				2		1.0
Mercury (ug/L)									0.1
Molybdenum (ug/L)			20		20				20.0
Nickel (ug/L)									10.0
Potassium (mg/L)	1.25	1.20	0.95	0.40	0.55	0.60	2.0		0.05
Selenium (ug/L)									1.0
Silver (ug/L)									0.1
Sodium (mg/L)	7.9	4.0	6.9	5.0	4.0	2.0	5.5		0.1
Strontium (mg/L)	0.16	0.18	1.60	0.17	0.10	0.05	0.21		0.01
Total Cyanide (mg/L)					0.006				0.002
Total Organic Carbon (mg/L)	1.5	1.5	1.0	1.75	2.5	1.5	1.5		0.5
Total Phosphorus (mg/L)		0.004		0.006	0.002		0.003		0.001
Vanadium (ug/L)									10.0
Zinc (mg/L)	0.02						0.05		0.01

NOTE: A blank space indicates that the concentration of the contaminant was below the detection limit for this sample.

Bacteria

Testing of 66 different bottled water products available on the Toronto market revealed zero faecal and total coliforms in all brands, thereby meeting Ontario Drinking Water Objectives. In contrast, 29 percent of the bottled water samples exceeded the Ontario guideline of 500 bacteria per millilitre for the aerobic plate count (APC), and 35 percent of samples exceeded the Ontario Bottled Water Association's own guideline of 100 bacteria per millilitre. Twenty-five percent of the brands failed to meet the bottlers' guidelines in all three samples tested. Table 3 give the results of this assessment.

6.0 CHEMICAL AND BACTERIOLOGICAL QUALITY OF DEVICE-TREATED WATER

Trace Organic Contaminants

New activated carbon and reverse osmosis home water treatment units tested under optimum conditions greatly reduced the level of many contaminants present in Toronto tap water (see Table 1). Table 4 shows removal efficiencies for the devices tested in the field study.

Trihalomethanes were reduced by more than 98 percent, and chlorinated compounds, such as chlorobenzenes, were typically reduced by more than 80 percent with both devices. Many polycyclic aromatic hydrocarbons (PAHs) such as acenaphthylene, anthracene and fluoranthene were lowered more than 90 percent by both units. However, other compounds such as methylnaphthalene were reduced by less than 50 percent. Toluene and xylene were poorly removed by either device.

Trace Metals

The reverse osmosis unit showed a higher removal capacity for metals and other inorganic substances than the activated carbon unit. Sodium, strontium, cyanide and aluminum were removed well by the reverse osmosis unit but not the activated carbon unit. Overall, reverse osmosis units that incorporate activated carbon filters remove a wider range of chemicals than activated carbon units alone.

The results of the field study on the chemical removal efficiency of water treatment devices in use in 28 Toronto homes generally confirmed the results of controlled testing. Where poor removal efficiencies were observed (compared to the controlled test), they were usually the result of poorly maintained or aging devices. These same devices in use in other homes demonstrated good chemical removal efficiencies. In general, activated carbon devices showed a poor ability to remove aluminum. However, the

Table 3 Results of Bacteriological Analysis of Bottled Water (a)

Brand of Bottled Water	Aerobic Plate Count (aerobic bacteria per ml)		
	Sample 1	Sample 2	Sample 3
A & P Carbonated Natural Mineral	<10	<10	10
Apollinaris Mineral	<10	20	<10
Boario Natural Mineral	60	620	40
Boario Carbonated Natural Mineral	<10	<10	<10
Blue Mountain Carbonated Spring	>2000	<10	<10
Blue Mountain Spring	290	395	260
Caledon Springs Spring	630	<10	>2000
Caledon Springs Distilled	<10	<10	<10
Caramulo Still Natural	80	40	120
Castello Carbonated Mineral	<10	80	<10
Cedar Springs	<10	<10	<10
Ceniti Springs	>2000	950	1200
Cool Brook Carbonated Spring	>2000	>2000	>2000
Crodo Carbonated Mineral	<10	<10	<10
Cruzeiro Spring	<10	<10	>2000
Crystal Springs Distilled	<10	<10	<10
Crystal Springs Natural Spring	<10	<10	<10
Dominion Spring	<10	<10	<10
Echo Springs	<10	<10	>2000
Evian Natural Spring	60	770	590
Fern Brook Spring	960	>2000	300
Fern Brook Spring (b)	<10	<10	<10
Ferrarelle Mineral	<10	<10	<10
Fiuggi Natural Spring	<10	<10	40
Fonte S. Moderanno Mineral	<10	<10	<10
Gerolsteiner Sprudel	<10	<10	<10
Health Springs Natural Mineral	30	50	<10
Highland Country Springs	940	720	1700
Iceland Natural Spring (Cynar)	>2000	>2000	>2000
Labrador Spring	<10	<10	>2000
Lombadas Natural Sparkling Mineral	<10	<10	10

(a) Total coliform and faecal coliform counts were 0 for all brands of bottled water.

(b) The second set of results for Fern Brook Natural Spring Water are from samples taken after ozonation was introduced to the company's bottling process, and consequently better represents the current bacteriological quality of their product.

Table 3 Results of Bacteriological Analysis of Bottled Water (a) (continued)

Brand of Bottled Water	Aerobic Plate Count (aerobic bacteria per ml)		
	Sample 1	Sample 2	Sample 3
Nora Carbonated Mineral	<10	<10	<10
Naso Mineral	90	460	1400
Mangiatorella Mineral	<10	<10	<10
Maple Brand	>2000	>2000	>2000
Magnu Spring	>2000	>2000	>2000
Maxime Carbonated Natural Mineral	<10	240	<10
Miracle Food Mart Mineral	<10	<10	<10
Miracle Food Mart Natural Spring	>2000	<10	<10
Mirol Radenska Mineral	50	<10	<10
Mont Blanc Carbonated Spring	<10	<10	<10
Montclair Natural Spring	<10	<10	<10
Montpriz Dominion Mineral	<10	<10	<10
Naya Natural Spring	1400	890	260
No-Name Mineral	10	<10	<10
Pedras Salgadas Mineral	<10	<10	<10
Perrier Mineral	<10	<10	<10
Polar Distilled	<10	<10	<10
Polar Spring	<10	<10	<10
President's Choice Mineral	<10	<10	<10
President's Choice Natural Spring	>2000	>2000	>2000
Puretap Distilled	>2000	>2000	>2000
Recoaro Mineral	<10	<10	<10
Pevex Demineralized	900	1500	1200
Rocky Mountain Carbonated Spring	<10	<10	<10
Roman Springs Spring	>2000	>2000	>2000
Saint Justin Carbonated Mineral	<10	<10	330
Salus Vidago Mineral	<10	<10	<10
Sangemini Natural Mineral	80	<10	<10
Spa Reine Mineral	50	400	<10
Spring Valley Artesian Spring	<10	<10	<10

(a) Total coliform and faecal coliform counts were 0 for all brands of bottled water.

Table 3 Results of Bacteriological Analysis of Bottled Water (a) (continued)

Brand of Bottled Water	Aerobic Plate Count (aerobic bacteria per ml)		
	Sample 1	Sample 2	Sample 3
S. Pellegrino Mineral	420	30	540
Uliveto Natural Mineral	>2000	>2000	>2000
Valle de Cavalos	560	1200	>2000
Vimeiro Mineral	870	>2000	>2000
Vittel Mineral	250	1400	1300
White Mountain Spring	<10	<10	<10

(a) Total coliform and faecal coliform counts were 0 for all brands of bottled water.

Table 6 Removal of Trihalomethanes, TDS, TOC, Aluminum, Lead and Silver by Point-of-Use Devices.

Sample No.	Name of Device	Chloroform			Bromodichloromethane		
		T (ug/L)	D (ug/L)	RE (%)	T (ug/L)	D (ug/L)	RE (%)
15	Amway	5.0	<1.0	>80	5.8	<0.2	>97
12	Aqua Sana	4.9	1.9	61	5.7	3.1	46
18	Boiled Water	6.7	<1.0	>85	5.8	<0.2	>97
8	Boiled Water	3.4	<1.0	>71	4.4	<0.2	>95
20	Brita	5.8	<1.0	>83	6.2	1.6	74
1	Brita	4.0	<1.0	>75	5.2	0.2	96
3	Brita	6.9	2.1	70	6.6	2.2	67
19	Brita	5.0	<1.0	>80	5.8	1.3	78
26	HMB Systems	4.8	<1.0	>79	5.7	<0.2	>96
21	Clear'N Fresh & Sternsyl	12.9	1.0	92	9.5	1.3	86
25	Dol Fyn	3.1	<1.0	>68	6.3	<0.2	>95
13	Hurley Town & Country	3.6	<1.0	>72	4.9	1.0	80
6	Hurley Town & Country	5.0	<1.0	>80	5.7	0.7	88
4	L'Eau Pure TFC	4.2	<1.0	>76	5.3	<0.2	>96
17	Multipure	4.4	<1.0	>77	5.3	<0.2	>96
5	[illegible] Spring	5.0	5.3	0	5.8	1.3	78
7	[illegible] Water Dome	4.9	<1.0	>80	5.8	<0.2	>97
9	[illegible] Water Dome	5.5	6.1	0	5.7	6.0	0
27	[illegible] Water Dome	5.0	<1.0	>80	5.6	<0.2	>96
10	[illegible] Water Dome	5.2	5.6	0	5.4	5.8	0
11	[illegible] Mini II	4.3	<1.0	>77	5.5	<0.2	>96
22	[illegible] Mini II	3.5	3.4	6	4.1	3.0	27
23	[illegible] Mini III	3.8	<1.0	>74	4.2	<0.2	>95
24	[illegible] NSA	4.0	<1.0	>75	5.4	<0.2	>96
2	NSA [illegible] static	3.8	<1.0	>74	5.3	<0.2	>95
16	Vitaliser Mark	3.6	<1.0	>72	4.5	<0.2	>96
14	Watermill	3.4	<1.0	>70	4.2	0.3	93

T - Tap water sample
D - Water from treatment device.
RE - Chemical removal efficiency by the home water treatment device expressed as percent removal of chemical from tap water.

Table 4 Removal of Trihalomethanes, TDS, TOC, Aluminium, Lead and Silver by Point-of-Use Devices. (continued)

Sample No.	Name of Device	Dibromochloromethane			Bromoform			Total THMs		
		T (ug/L)	D (ug/L)	RE (%)	T (ug/L)	D (ug/L)	RE (%)	T (ug/L)	D (ug/L)	RE (%)
15	Amway	3.6	<0.2	>95	0.5	<0.3	>40	15.0	<0.2	>98
12	Aqua Sana	4.7	1.2	74	0.5	<0.3	>40	15.6	6.2	61
18	Boiled Water	4.1	<0.2	>95	0.5	<0.3	>40	17.1	<0.2	>98
8	Boiled Water	2.2	<0.2	>91	0.3	<0.3	NA	10.3	<0.2	>98
20	Brita	3.8	1.2	68	0.5	<0.3	>40	16.3	2.8	83
1	Brita	3.1	0.2	94	0.5	<0.3	>40	12.8	0.4	97
3	Brita	4.1	1.2	71	0.6	<0.3	>50	18.2	5.5	70
19	Brita	3.5	0.7	80	0.5	<0.3	>40	14.7	2.0	86
26	CCW Systems	3.5	<0.2	>94	0.5	<0.3	>40	14.4	<0.2	>98
21	Clear'N Fresh & Sterasyl	4.7	0.6	87	0.3	<0.3	NA	27.4	2.9	89
23	Dol Fyn	2.7	<0.2	>93	0.3	<0.3	NA	10.4	<0.2	>98
13	Hurley Town & Country	2.8	0.3	89	0.5	<0.3	>40	11.8	1.3	89
6	Hurley Town & Country	3.8	0.2	95	0.5	<0.3	>40	15.0	0.9	94
4	L'Eau Pure TFC	3.3	<0.2	>94	0.5	<0.3	>40	13.3	<0.2	>98
17	Multipure	3.1	<0.2	>94	0.5	<0.3	>40	13.2	<0.2	>98
5	Nature's Spring	3.3	<0.2	>94	0.5	<0.3	>40	14.5	6.5	55
7	Neolife Water Dome	3.5	<0.2	>94	0.5	<0.3	>40	14.7	<0.2	>99
9	Neolife Water Dome	2.5	3.0	0	0.5	0.5	0	14.2	15.6	0
27	Neolife Water Dome	3.0	<0.2	>93	0.5	<0.3	>40	14.1	<0.2	>98
10	Neolife Water Dome	2.5	2.6	0	0.5	0.5	0	13.5	14.7	0
11	Nimbus Mini II	3.2	<0.2	>94	0.5	<0.3	>40	13.3	<0.2	>98
22	Nimbus Mini II	1.6	2.0	0	<0.3	<0.3	NA	9.2	8.4	9
25	Nimbus Mini III	2.6	<0.2	>92	<0.3	<0.3	NA	10.3	<0.2	>98
24	Nimbus N3A	3.7	<0.2	>95	0.5	<0.3	>40	13.6	<0.2	>98
2	NSA Bacteriostatic	3.8	<0.2	>95	0.5	<0.3	>40	13.4	<0.2	>98
16	Vitalizer Mark	1.3	<0.2	>85	0.3	<0.3	>0	9.7	<0.2	>98
14	Watermill	2.1	<0.2	>90	0.5	<0.3	>40	10.1	0.3	97

T - Tap water sample
D - Water from treatment device.
RE - Chemical removal efficiency by the home water treatment device expressed as percent removal of chemical from tap water.

Table 6 Removal of Trihalomethanes, TDS, TOC, Aluminum, Lead and Silver by Point-of-Use Devices. (continued)

Sample No.	Name of Device	TDS T (mg/L)	TDS D (mg/L)	TDS RE (%)	TOC T (mg/L)	TOC D (mg/L)	TOC RE (%)
15	[illegible]	230	190	17	2.0	0.5	75
12	Aqua Sana	210	[illegible]	0	2.0	4.5	0
8	Boiled Water	210	230	0	2.5	3.0	0
18	Boiled Water	190	[illegible]	5	1.5	2.0	0
1	Brita	20	170	0	1.5	3.0	0
3	Brita	130	120	8	2.0	3.5	0
19	Brita	100	90	10	2.0	1.5	~25
20	Brita	200	140	30	2.0	2.5	0
26	CCW Systems	200	180	10	2.0	<0.5	>75
21	Clear'N Fresh with Sterasyl	190	170	11	3.0	1.0	67
23	Dol Fyn	190	20	89	2.0	<0.5	>75
6	Hurley Town & Country	200	210	0	2.0	<0.5	>75
13	Hurley Town & Country	190	180	5	2.0	1.0	50
4	L'Eau Pure TPC	190	20	89	2.0	<0.5	>75
17	Multipure	200	220	0	1.5	<0.5	>67
5	Nature's Spring	230	100	50	2.0	<0.5	>75
7	[illegible] Water Dome	190	190	0	2.0	<0.5	>75
9	[illegible] Water Dome	180	180	0	2.0	2.0	0
10	[illegible] Water Dome	180	190	0	3.0	2.0	33
27	[illegible] Water Dome	180	190	0	2.0	<0.5	>75
11	Nimbus Mini II	190	20	89	1.5	<0.5	>67
22	Nimbus Mini II	180	180	0	2.0	11.5	0
25	Nimbus Mini III	180	50	72	2.0	<0.5	>75
24	Nimbus USA	60	10	83	2.0	<0.5	>75
2	NSA Bacteriostatic	140	130	0	2.0	<0.5	>75
16	Vitalizer Mark IX	200	20	90	2.0	1.5	25
14	Watermill	200	130	15	2.0	0.5	75

T - Tap water sample.
D - Water from treatment device.
RE - Chemical removal efficiency by the home water treatment device expressed as percent removal of chemical from tap water.
TN - Concentration of the chemical in the water from the treatment device.
NA - Not applicable.

Table 4 Removal of Trihalomethanes, TDS, TOC, Aluminum, Lead and Silver by Point-of-Use Devices. (continued)

Sample No.	Name of Device	Aluminum			Lead			Silver		
		T (ug/L)	D (ug/L)	RE (%)	T ug/L)	D ug/L)	RE (%)	T ug/L)	D ug/L)	RE (%)
15	Amway	200	100	50	24	<1	>96	<10	<10	NA
12	Aqua Sure	200	160	20	1	2	NA	<10	<10	NA
8	Boiled Water	180	260	0	50	39	22	<10	<10	NA
18	Boiled Water	140	140	0	8	3	63	<10	<10	NA
1	Brita	160	120	25	2	2	NA	<10	<10	NA
3	Brita	180	60	67	13	1	92	<10	60	IN
19	Brita	160	120	25	6	1	83	<10	20	IN
20	Brita	180	120	33	10	2	80	<10	40	IN
26	CCW Systems	200	120	40	2	1	NA	<10	<10	NA
21	Clear'N Fresh with Sterasyl	160	180	0	1	<1	NA	<10	<10	NA
23	Del Fyn	220	<20	>91	13	9	31	<10	<10	NA
6	Hurley Town & Country	220	140	36	12	1	92	<10	<10	NA
13	Hurley Town & Country	200	120	40	14	2	86	<10	<10	NA
4	L'Eau Pure TFC	200	<20	>90	3	<1	>67	<10	<10	NA
17	Multipure	160	140	13	47	2	96	<10	<10	NA
5	Nature's Spring	240	20	92	8	<1	>88	<10	<10	NA
7	Neolife Water Dome	180	140	22	7	<1	>86	<10	<10	NA
9	Neolife Water Dome	140	160	0	198	100	49	<10	<10	NA
10	Neolife Water Dome	220	180	18	26	27	0	<10	<10	NA
27	Neolife Water Dome	160	120	25	1	1	NA	<10	<10	NA
11	Nimbus Mini II	180	<20	>89	2	1	NA	<10	<10	NA
22	Nimbus Mini II	260	60	77	11	<1	>91	<10	<10	NA
25	Nimbus Mini III	220	<20	>91	7	1	86	<10	<10	NA
24	Nimbus NSA	240	<20	>92	1	2	NA	<10	<10	NA
2	NSA Bacteriostatic	180	140	22	21	2	90	<10	<10	NA
16	Vitalizer Mark IX	160	<20	>88	13	<1	>92	<10	<10	NA
14	Watermill	240	40	83	9	<1	>89	<10	<10	NA

T - Tap water sample.
D - Water from treatment device.
RE - Chemical removal efficiency by the home water treatment device expressed as percent removal of chemical from tap water.
IN - Concentration of the chemical in the water from the treatment device.
NA - Not applicable.

manufacturers of these devices do not make claims for aluminum reduction. Most devices claiming a capacity to reduce lead did reduce it.

Bacteria

The Ontario Drinking Water Objectives stipulate that no faecal coliform bacteria should be present in treated tap water. The field study indicated that for two of the 25 devices tested, faecal coliform counts were in excess of 80 per 100 ml, in the water generated by the device. One of these two households also had elevated faecal coliform levels in the tap water contrary to the Ontario guideline. Table 5 presents the results of these analyses. The presence of faecal coliforms in drinking water can indicate a potential serious risk to health.

The Ontario Drinking Water Objectives stipulate a maximum level for total coliforms of five bacteria per 100 ml. (In the United States, the maximum acceptable level for total coliforms is one per 100 ml.) The field study of treatment devices in 25 homes demonstrated that 24 percent of the first-draw and 16 percent of the flushed water samples from the treatment devices contained higher levels of total coliforms than specified by the Ontario guidelines.

The Ontario Drinking Water Objectives stipulate a maximum desirable concentration of 500 bacteria per ml (APC). In the field study, 88 percent of the first-draw samples collected from devices in 25 homes exceeded the Ontario APC guideline for aerobic bacteria, and 68 percent of the flushed samples did as well. This compares with 24 percent (first-draw) and zero (flushed) of non-treated tap water samples collected in the homes that exceed the Ontario guideline.

These results suggest that the bacteriological quality of water additionally treated in the home with a water treatment device was inferior to that of Toronto tap water.

The field study questionnaire revealed that although 70 percent of the 25 householders that participated in the field study still had maintenance instructions for their device, most users had poor recollection of the date of the last filter change or maintenance procedure. All users reported that maintenance instructions were not attached to the device itself for easy reference. This is significant because the results of removal-efficiency tests indicate that proper maintenance is essential to prevent "break through" of contaminants through a poorly maintained or over-age device.

Table 5 Bacteriological Results for Home Water Treatment Systems.*

Sample No.	Name of Device	Fecal Coliforms (/100 ml)				Total Coliforms (/100 ml)			
		Tap		Device		Tap		Device	
		First Draw (a)	Flushed (b)	First Draw (a)	Flushed (b)	First Draw (a)	Flushed (b)	First Draw (a)	Flush (b)
15	Amway	0	0	0	0	0	0	2	0
12	Aqua Sure	0	0	0	0	0	0	0	0
3	Brita	0	0	0	0	0	0	0	0
19	Brita	0	0	0	0	0	0	0	0
20	Brita	0	0	0	0	2	0	0	0
1	Brita	0	0	0	0	0	0	49	1
26a	CCW Systems	0	0	>80	0	15	0	>80	3
26b*	CCW Systems	0	0	0	0	2	0	0	0
26c*	CCW Systems	0	0	0	0	0	0	0	0
26d*	CCW Systems	0	0	0	0	0	0	0	0
[illegible]	Clear'N Fresh w/Sterasyl	0	0	0	0	0	0	0	0
[illegible]	Sol Fyn	0	0	1	0	0	0	1	0
[illegible]	Hurley Town & Country	0	0	0	0	0	0	0	0
6	Hurley Town & Country	0	0	0	0	5	2	>80	>80
4	L'Eau Pure TFC	0	0	0	0	0	0	0	0
17	Multipure	0	0	0	0	1	2	0	0
5	Nature's Spring	0	0	0	0	0	0	0	4
27	Neolife Water Dome	0	0	0	0	0	0	0	5
11	Neolife Water Dome	0	0	0	0	0	0	0	0
9	Neolife Water Dome	0	0	0	0	0	0	0	0
7	Neolife Water Dome	0	0	0	0	0	19	1	0
14	[illegible] Mini II	0	0	0	0	0	0	>80	>80
22	[illegible] Mini II	0	0	0	0	0	0	22	26
23	[illegible] Mini III	10	1	>80	>80	45	12	>80	>80
24	[illegible]	0	0	0	0	0	0	0	0
2	NSA Bacteriostatic	0	0	0	0	0	1	0	0
16	Vitalizer Mark IX	0	0	0	0	0	0	5	1
18	Watermill	0	0	0	0	0	0	3	1
8	United Water	0	0	0	0	0	4	0	0
10	[illegible] Water	0	0	0	0	1	1	0	0

(a) First 100 ml sample collected from disinfected faucet.
(b) Sample collected after approximately 1 litre of water had passed through the faucet.

* Sample 26a was a retest of sample 26a. Sample 26c and 26d were additional samples collected at the time of retesting 26a.

* This chart is not intended as a Consumer Guide to home water treatment systems. The results shown in this table reflect not only the capability of the device to enhance water quality, but also reflect the vigilance with which the user maintains the device itself and the water storage and delivery system.

Table 5 Bacteriological Results for Home Water Treatment Systems. (continued)

Sample No.	Name of Device	Aerobic Plate Count (per 1 ml)				Background Bacteria (per 100 ml)			
		Tap		Device		Tap		Device	
		First Draw (a)	Flushed (b)	First Draw (a)	Flushed (b)	First Draw (a)	Flushed (b)	First Draw (a)	Flush (b)
15	Amway	10	50	>2000	>2000	0	0	>200	0
12	Aqua Sana	240	100	>2000	50	0	0	0	0
3	Brita	<10	<10	<10	10	0	1	0	0
19	Brita	<10	<10	740	30	0	0	0	0
20	Brita	<10	<10	60	<10	3	0	0	0
1	Brita	160	10	>2000	>2000	0	0	>200	>200
26a	CCW Systems	20	40	590	140	70	0	150	3
26b	CCW Systems	110	10	>2000	30	25	0	>200	>200
26c	CCW Systems	<10	10	50	<10	0	0	0	0
26d	CCW Systems	<10	<10	<10	<10	18	0	0	0
21	Clear'N Fresh w/Sterasyl	80	60	>2000	1700	49	21	0	0
23	Dol Fyn	<10	<10	>2000	>2000	0	0	2	0
13	Hurley Town & Country	170	40	>2000	>2000	17	1	0	0
6	Hurley Town & Country	560	10	>2000	>2000	0	3	>200	>200
4	L'Eau Pure TFC	720	20	>2000	>2000	>200	0	0	0
17	Multipure	650	10	1600	60	0	0	0	0
5	Nature's Spring	10	10	1400	>2000	0	0	14	>200
27	Neolife Water Dome	10	<10	>2000	150	0	0	1	0
10	Neolife Water Dome	90	10	>2000	660	0	0	>200	12
9	Neolife Water Dome	<10	<10	430	100	0	0	1	0
7	Neolife Water Dome	70	<10	>2000	1100	38	190	160	0
11	Nimbus Mini II	600	30	>2000	1100	0	0	>200	>200
22	Nimbus Mini II	600	0	>2000	>2000	2	0	>200	>200
25	Nimbus Mini III	100	120	>2000	>2000	38	40	>200	>300
24	Nimbus N3A	<10	<10	990	560	0	0	0	0
2	NSA Bacteriostatic	460	<10	>2000	>2000	0	0	15	17
16	Vitalizer Mark IX	30	<10	>2000	>2000	0	0	>200	>200
14	Watermill	530	<10	>2000	>2000	2	0	>200	130
8	Boiled Water	20	30	50	120	0	4	14	>200
18	Boiled Water	60	30	20	10	1	2	0	0

a) First 100 ml sample collected from disinfected faucet.
(b) Sample collected after approximately 1 litre of water had passed through the faucet.

9.0 COMPARISON OF TAP WATER, BOTTLED WATER AND DEVICE-TREATED WATER

Reference to Tables 1 and 2 shows that different detection limits were used for the low detection limit study (tap water and device-treated water) than were used for the analysis of bottled water. To allow a fair comparison, only values measured above the higher detection limits were considered in the following analysis.

The "Priority" Chemicals

A conventional risk assessment procedure applied to Toronto tap water allowed the identification of chemical constituents that may be of public health concern. In particular, six chemicals were present in concentrations that are already at or above "acceptable" levels. For the purpose of this analysis, an "acceptable" concentration for known or presumed carcinogens was defined as one which, ingested over a 70 year lifetime in two litres of water per day, would result in less than a one in a million chance of cancer occurrence. For comparison, the current average Canadian lifetime cancer risk, excluding skin cancer, is between one-in-four and one-in-three. In addition, it has been estimated that smoking 1.4 cigarettes annually increases the annual chance of lung cancer by one in a million. For non-carcinogens such as aluminum and barium "acceptable" concentration was defined as one which if ingested over a 70 year lifetime would result in no observable adverse health effect.

The six chemicals identified in the risk assessment as having little or no "relative margin of safety" were lead, aluminum, bis(2-ethylhexylphthalate), chloroform, alpha-hexachlorocyclohexane and tetrachloroethylene. Of these, only lead and chloroform currently have health-based guidelines in Canada. The chloroform guideline is actually an "umbrella" value which includes all the other trihalomethanes.

A further seven chemicals were identified as having somewhat reduced "relative margins of safety" (within a factor of 10 of the "acceptable" level). While these are not of immediate health concern, it may be advisable over the longer term to consider reducing their concentrations and thus the risk of exposure to them. These were chromium, trichloroethylene, barium, lindane, cyanide (total), bromodichloromethane and dibromochloromethane.

This body of 13 chemicals thus provided a "priority" list against which to evaluate the various sources of drinking water.

The results of this study suggest that, under good operating and maintenance conditions, reverse osmosis/activated carbon treated water has the potential to contain the lowest levels of the priority contaminants. Activated carbon treated water has the next lowest level of contaminants, followed by bottled water. Tap water contained the highest levels, but it must be noted that several of the contaminants are added intentionally as part of the treatment process, such as aluminum and the trihalomethanes.

Tap water contained the highest levels of trihalomethanes, but bottled water showed the highest levels of other chlorinated compounds (for example, 1,2-dichlorobenzene, 1,4-dichlorobenzene and 1,2,3,4-tetrachlorobenzene), of base neutral compounds (for example, naphthalene and benzothiozole), and of volatile organics (for example, toluene). Many of these compounds are known to cause adverse reproductive effects in animal studies.

Phthalates were present in tap water, carbon-treated and reverse-osmosis treated water. In bottled water, phthalate levels varied greatly by brand, but on average were lower than for other alternatives. Phthalates are used in the manufacture of many plastics. These chemicals may leach from plastic into water stored in certain plastic containers or passing through plastic pipes. Phthalates are of concern because of evidence that they cause cancer and reproductive effects in animal studies. This study was not able to conclude whether the phthalates measured in the drinking water originated in the source of water or in the means of distribution.

Tap water had the highest levels of aluminum compared to the other sources. Levels of other trace metals were also somewhat higher in tap water than in device-treated water. Some brands of bottled water showed the highest levels of trace metals over-all. However, it must be noted that there was considerable variation among brands with respect to metal content, with some brands containing lower levels than tap water.

Bacteria

The results of this study suggest that tap water has the best bacteriological quality, followed by bottled water. Water treated with a home treatment device had the poorest bacteriological quality, demonstrating frequent and significant exceedance of Ontario guidelines for faecal coliforms, total coliforms and aerobic plate counts.

Potential Health Effects

Although chemical exposures are lowest with properly maintained home treatment devices compared to bottled water and tap water, the opposite appears to be true with respect to exposures to bacteriological contamination. Device-treated water tended to have the poorest microbiological quality of the alternatives tested and consequently would appear to present a greater exposure with respect to bacteriological parameters.

This study cannot make conclusive statements as to the relative quality of the water made available through the many brands of bottled water and treatment devices on the market because budget constraints prohibited the comprehensive testing of all brands. This study does, however, provide considerable information on the merits and disadvantages of the major sources of Toronto water, whether tap water, bottled water or device-treated water. The concerned consumer must weigh the potential and perceived health risks inherent in each source against the potential benefits. This includes taste and aesthetic values. In doing so, it is important to place the theoretical risks of consuming drinking water from any source in the context of risks posed by breathing air or eating food, both major routes by which chemicals enter the human body. For the purpose of this study, we assumed that drinking water accounted for 20 percent of an individual's daily exposure.

On the basis of the study results, the Department of Public Health confirms its longstanding position that residents of the City of Toronto can continue to drink tap water with reasonable assurance that it is not likely to cause harm or injury. The Department does not promote the use of alternatives to tap water because of their inconsistent bacteriological quality, their variable chemical quality, and the lack of applicable standards to guarantee the quality of product to the consumer. In addition, they are costly relative to tap water and thus may be inaccessible to a large sector of the population.

Nevertheless, it is likely that the quality of Toronto tap water can be further improved. Government officials and the public should work closely together in making decisions about "acceptable" levels of exposure or risk, and hence acceptable expenditures on additional treatment technologies. A few candidate technologies and management practices are presented for discussion in the next section.

10.0 CANDIDATE TECHNOLOGIES FOR IMPROVING THE QUALITY OF TORONTO TAP WATER

More advanced and costly municipal water treatment technologies are in use in some U.S. and European communities. These sophisticated technologies could in principle reduce the levels of most contaminants including the priority chemicals identified in Toronto tap water.

Furthermore, the cost per person for improvements to municipal water treatment is less than if every resident were to pay individually for an alternative such as a home treatment device or bottled water. In Cincinnati, advanced treatment such as Granular Activated Carbon (GAC) or Biological Activated Carbon (BAC) is estimated to cost about $40 per person per year over a ten year period. In contrast, city-wide use of a home water treatment device is estimated to cost about $110 for a reverse osmosis unit and about $30 for an activated carbon unit per person per year over a ten year period. The annual cost of bottled water per person, assuming two litres are consumed each day, ranges from $220 to $380, depending on whether water is delivered in bulk to the home or purchased in smaller containers at a store.

Feasibility studies will be helpful in determining which technologies are best to apply and whether the associated costs are worth the anticipated reduction in chemical exposure. The Metropolitan Toronto Works Department is currently investigating some of these approaches.

Biological Activated Carbon (BAC)

BAC is an important advanced water treatment technology to consider for minimizing trihalomethane levels and for eliminating many of the trace toxic organic compounds found in tap water. It is used in Europe and combines the use of ozone (as an oxidant and disinfectant) with Granular Activated Carbon (GAC).

The introduction of GAC or BAC to water treatment plants in Toronto represents the most expensive centralized water treatment improvement available, and would generate the most comprehensive reduction of a wide range of trace toxic contaminants. The introduction of GAC or BAC technologies could mean that existing water bills are more than doubled.

Aluminum Reduction Through Process Change

Aluminum occurs in Toronto tap water as a result of the addition of aluminum compounds during treatment to improve the clarity of the treated water. The treatment process typically results in a three to five fold increase in aluminum levels in treated water compared with raw water from Lake Ontario.

Prior to 1984, the Metro Works Department applied aluminum compounds during water treatment on an "as needed basis". Between 1979 and 1983, mean aluminum levels in treated water were approximately 80 ppb. In 1984, "continuous coagulation/flocculation" was introduced to the treatment process, resulting in average aluminum residuals in treated water of about 160 ppb between 1984 and 1987.

Given the increasing health concern about aluminum in drinking water, it may be advisable to substitute less toxic, coagulant compounds for aluminum, or to return to the practice of adding aluminum compounds on an "as needed" basis.

Reduction of Lead Through Corrosion Control and Tap Flushing

Lead levels are low in water leaving Toronto's treatment plants, but those levels increase through the distribution system and particularly in the home, where water may stand in lead or lead-soldered plumbing for several hours.

The reduction of lead exposures through tap water requires both immediate and long-term actions. In the short-term, citizens should flush standing water prior to drinking. However, as a long-term strategy, a water flushing program is wasteful and inconvenient.

Corrosion control of water at the treatment plant can be achieved through changes to the acidity of the water before it leaves the plant. Reduced corrosiveness would likely provide more comprehensive protection against the leaching of lead from the distribution system.

Finally, prohibit the sale of lead-based solder and lead pipes is the best long-term solution. The reduction of the Canadian and Ontario guidelines for lead in water from 50 ppb to 10 ppb in keeping with the United States is a useful strategy because this action will stimulate corrosion control and public awareness programs. Similarly, the removal of all lead service connections and lead-based solder is an effective long-term solution and can be done by attrition.

Ozonation to Reduce Trihalomethane Levels

One promising method of reducing trihalomethane levels is to use ozone to disinfect water. Ozone is the most powerful of the major disinfection agents used for water, but its effect does not persist through the distribution system. A second agent such as chlorine or chloramine must therefore be added to protect the quality of water in the distribution system. Although there are some concerns regarding the toxicity of ozonation by-products, most studies suggest that ozonated water may be superior to chlorinated water.

Measures the Consumer Can Take at the Point of Consumption

Several simple measures are available to the consumer who wishes to reduce exposure risks. Flushing of taps demonstrably reduces lead concentrations, particularly when the water has been standing for several hours. Flushing also reduces the slight risk of bacteria accumulating in the tap.

In this study, boiling water for five minutes reduced trihalomethane levels in tap water by more than 90 percent, and it is likely that other compounds such as trichloroethylene, tetrachloroethylene, toluene and xylene would also be reduced.

This obviously presents a ready alternative for parents seeking an alternate way of reducing an already low childhood exposure.

Metro Works Department Initiatives to Improve Municipally Treated Drinking Water Quality

The Metropolitan Toronto Department of Works is currently planning a major expansion of its R. L. Clark Filtration Plant, to be completed from 1992 to 1995 at a projected cost of $197 million. As part of that expansion, the Department is investigating some of the technologies discussed above, among others. A number of these have been tested in pilot studies and have shown promising results. The Department of Public Health supports these initiatives. In carrying out this work, Metro Works has selected the most stringent available guidelines for their treatment criteria.

Current proposed changes include:

(a) preoxidation using ozone to assist in flocculation and improve taste and odour;

(b) taking measures to reduce aluminum concentrations in the finished water;

(c) dechlorination prior to ammoniation to reduce excess chlorine and THM levels;

(d) lessen the corrosivity of the water prior to its leaving the plant to reduce its ability to dissolve lead from plumbing.

An underground reservoir has been designed as part of the expansion. Although GAC and BAC will not be implemented at this stage, the reservoir is designed to accommodate future expansion for GAC equipment. The pilot studies have shown that it is possible to reduce THMs to levels of 3-6 ug/l without the use of GAC. At present, an advanced oxidation process using hydrogen peroxide is the preferred method. Changes to other plants will be considered after the Clark expansion has been completed.

In addition to these initiatives, Metro Works has retained a consultant to develop components of their Water Supply Master Plan for the period 1990 to 2011. This Plan will include a comprehensive study of present and future water quality objectives for Metropolitan Toronto, including detailed forecasting of future demand. Taken together, these proposals are in keeping with the recommendations of this report and promise significantly improved tap water quality by 1992.

11.0 REDUCING EXPOSURE RISKS FOR ALTERNATIVE SOURCES OF DRINKING WATER

Bottled Water

Under existing law, suppliers of bottled water are not required to undertake comprehensive chemical testing of their product, nor to disclose to the public the results of such testing if they have them. Health and Welfare Canada does compliance testing of bottled water for bacteriological parameters under the Food and Drugs Act, but not for trace toxic chemicals. Furthermore, Health and Welfare Canada currently does not release bacteriological test results by brand to the public.

Although the Ontario Bottled Water Association encourages its members to undertake chemical testing of their product in conformance with the Canadian Drinking Water Guidelines, and encourages the distribution of test results to the public upon request, such action is strictly voluntary.

The potential consumer of bottled water, therefore, has no evidence that a particular bottled water product meets drinking water guidelines or is superior to tap water. The introduction of regulatory measures to require adequate chemical and bacteriological testing and public disclosure of test results for bottled water would likely lead to improvements in the quality of bottled water on the market, particularly with respect to bacteriological quality.

Home Treatment Devices

The field study of water treatment devices in Toronto clearly revealed that removal efficiencies depend on the age and maintenance of the device. However, it also showed that most residents were unsure of the life expectancy of their device and its required maintenance schedule.

The potential health risks associated with home water treatment devices can be reduced by careful attention on the part of consumers to the manufacturer's recommendations for maintenance and replacement. Attention to filter changes is essential.

In the longer term, regulations should be developed requiring manufacturers to place maintenance instructions in a visible area on each device, requiring vendors to administer a maintenance program with each consumer, and establishing a certification process for all water treatment devices permitted for sale in Canada.

12.0 SUMMARY AND CONCLUSIONS

This study provides evidence of the presence of organic and inorganic trace contaminants in municipally treated drinking water, water treated with a point-of-use device, and bottled waters. Bacteriological contamination was also noted frequently in device-treated water and bottled waters.

Many of the chemicals measured in this study are the same chemicals that scientists have detected in the water, sediment, fish, birds and other biota of the Great Lakes Ecosystem, particularly in Lake Ontario and the Niagara River. The presence of these chemicals in drinking water emphasizes the need for concerted action on both sides of the Canada-U.S. border to virtually eliminate the discharge of persistent toxic substances into the Great Lakes basin.

Drinking water is only one source through which humans are exposed to contaminants. Food and air are also major exposure routes. The risks inherent in life-long ingestion of tap water, device-treated water, and bottled water are difficult to estimate given current uncertainty in the scientific literature and divergence of opinion as to how best to estimate risk.

Nevertheless, an assessment of the relative quality of the three major sources resulted in the following conclusions:

1. In the view of the Department of Public Health, tap water is currently the best choice for drinking water in terms of health considerations. The Department thus confirms its longstanding position that residents of the City of Toronto can continue to drink tap water with reasonable assurance that it is not likely to cause harm or injury.

2. The Department does not promote the use of alternatives because of their currently inferior bacteriological quality, their variable chemical quality, and the lack of applicable standards to guarantee the quality of product to the consumer. In addition, they are costly relative to tap water and thus may be inaccessible to a large sector of the population.

3. There is considerable variation in the quality of the major sources of water used by Toronto residents, and thus in the risks associated with lifetime ingestion of those sources. This problem could be corrected in large part by the introduction of legally-enforceable standards for drinking water.

This study has identified the presence of 66 substances in Toronto tap water, about 42 of which may occur on a regular basis. The results are reassuring because they quantify chemical exposure levels, and determine through risk assessment procedures that most of these exposures are so low as to be of little, if any, health consequence.

Six contaminants measured in Toronto tap water were observed to occur at levels that are at, or above, "acceptable" concentrations as determined in the risk assessment (lead, chloroform, aluminum, alpha-hexachlorocyclohexane, bis(2-ethylhexyl)phthalate and tetrachloroethylene). A further seven chemicals are present at concentrations that, while not currently of major health significance, have a relatively low "margin of safety" remaining. These were chromium, trichloroethylene, barium, lindane, cyanide (total), bromodichloromethane and dibromochloromethane.

Prudent public health policy would suggest undertaking measures to reduce the levels of all of these contaminants in drinking water. Various technologies are available to improve the quality of Toronto tap water. The introduction of GAC or BAC to water treatment plants in Toronto would represent the most expensive centralized water treatment improvement available, and would probably provide the most comprehensive reduction of a wide range of trace toxic chemicals. The introduction of GAC or BAC technologies would likely mean that existing water bills are more than doubled.

In contrast, treatment plant and distribution system changes directed at minimizing the priority contaminants, particularly lead, aluminum and trihalomethanes (including chloroform) would appear to be less costly while offering an immediate improvement in water quality.

Government officials should work closely with the public in determining levels of "acceptable" risk, and thus "acceptable" levels of public expenditure on treatment improvements.