

# Reduction in Mercury Loading to Four Toronto Area Sewage Treatment Plants Due to Implementation of an Amalgam Separator By-Law

**Martin Shaw**  
(416) 392-9932  
mshaw@toronto.ca

## **Abstract:**

Data from the Toronto Sewer District regarding the mercury concentration in the sludge at four sewer treatment plants illustrates the effect of pollution prevention regulations requiring dental clinics to install amalgam separators. For each plant we have data on the monthly average concentration of mercury in the sewer sludge (bio-solids, raw or digested) and the total monthly mass of sludge produced for the time period from January, 2001 to June, 2002. On January 1, 2002 a sewer by-law came into effect requiring dentists to install amalgam separators that met the ISO 11143 standard (95% removal of particulate matter). According to Environment Canada, no other mercury reduction efforts have taken place over this time period, therefore all mercury reduction is attributable to reduction in discharge from dental clinics.

The total average monthly mass of mercury in the combined sludge at all four plants has been reduced from 17 Kg to 7 Kg per month (a reduction of 58%). Plant by plant reduction rates varied from 44.8% to 74.3%. The Toronto Sewer District reports compliance with the by-law is at an estimated 800 out of 1100 dental clinics (73% compliance). Full compliance with the by-law would result in 79.7% reduction in the monthly mass mercury in sewer sludge. The 10 Kg per month reduction by 800 dental clinics installing amalgam separators projects to an annual reduction of mercury loading to sewer sludge of 151 grams per clinic per year (0.33 pounds per clinic per year).

Applying the Toronto Sewer District mercury removal rate data to the 133,000 dental clinics in the United States implies that universal implementation of amalgam separators would prevent the 22.1 tons of mercury from ending up in the sludge at sewer treatment plants.

## **Data:**

The four plants for which we have data are the Highland Creek Treatment Plant, the Humber Treatment Plant, the Ashbridge Bay Treatment Plant and the North Toronto Treatment Plant. The data is taken from measurements performed by the sewer treatment plant operators as part of their normal quality control procedures. Chart A1 (see appendix) is the average monthly mercury concentration in dry bio-solids for each plant. Chart A2 (see appendix) is the total monthly mass of dry bio-solids for each plant. Multiplying the concentration times the amount of solids gives the mass of mercury present in the sludge for each plant for each month. This mass of mercury per month is given in Chart 1. In addition, we have totaled the four plants to get a system wide mercury removal total. This data is also provided in Chart 1.

**Chart 1: Monthly Mass of Mercury in Sewer Sludge**

Month	Highland Creek (g Hg)	Humber (g Hg)	Ashbridges Bay (g Hg)	North Toronto (g Hg)	Grand Total (g Hg)
Jan-01	2688.7	6410.9	6574.8	653.3	16327.7
Feb-01	721.6	2106.2	5117.2	495.5	8440.5
Mar-01	1335.7	247.6	6367.9	636.8	8588.0
Apr-01	1369.0	2218.0	7799.9	185.1	11572.0
May-01	2501.4	1852.2	8191.2	196.1	12740.9
Jun-01	3513.1	4004.2	8407.0	125.9	16050.2
Jul-01	1679.7	25114.2	9428.5	271.4	36493.9
Aug-01	2049.8	9050.0	15547.4	269.6	26916.8
Sep-01	949.2	3724.8	12659.1	277.2	17610.3
Oct-01	1310.1	9706.4	15072.0	192.2	26280.7
Nov-01	904.5	5738.0	6821.2	615.5	14079.2
Dec-01	1346.4	3551.2	8438.6	156.0	13492.2
<b>Average 2001</b>	<b>1697.4</b>	<b>6143.6</b>	<b>9202.1</b>	<b>339.6</b>	<b>17382.7</b>
Jan-02	1035.5	1819.4	3093.8	86.4	6035.1
Feb-02	1343.0	1569.5	6070.3	45.5	9028.2
Mar-02	753.3	1329.2	5278.4	381.1	7742.0
Apr-02	744.6	651.4	2719.1	224.2	4339.2
May-02	441.0	1190.1	4279.7	132.3	6043.1
Jun-02	468.8	2903.9	7021.8	255.3	10649.9
<b>Average 2002</b>	<b>797.7</b>	<b>1577.2</b>	<b>4743.8</b>	<b>187.5</b>	<b>7306.3</b>

The first six months of 2002 (after the effective date of the by-law) can be compared to the average monthly amount of mercury in 2001. The comparison is provided on both a percentage reduction basis and a mass reduction basis. The comparison is presented in Chart 2.

**Chart 2: Comparison of Mercury in Sewer Sludge Before and After Amalgam Separator By-law**

	Highland Creek	Humber	Ashbridges Bay	North Toronto	Grand Total
Percent Reduction of Monthly Average Mercury Loading	53.0	74.3	48.4	44.8	58.0
Amount Reduction of Monthly Average Mercury Loading (g Hg)	899.7	4566.4	4458.2	152.1	10,076

**Calculations:**

Toronto Sewer Treatment Plant personnel estimate that 800 amalgam separators have been purchased and installed. All purchased separators have been installed in areas served by the Toronto Sewage District. We can therefore attribute the reduction in mercury loading to each installed separator. These calculations are given in Chart 4.

**Chart 3: Calculated Reduction in Sewer Sludge per Amalgam Separator/Clinic**

	<b>grams Hg</b>	<b>Pounds Hg</b>
Mass of mercury per month	12.6	0.028
Mass of mercury per month	151.1	0.33

We can further calculate the total removal if all of the 1100 clinics in the Greater Toronto area comply and achieve the same removal rates. These rates are given in Chart 4.

**Chart 4: Comparison of Calculated Mercury in Sewer Sludge Before and After Amalgam Separator By-law given 100% Compliance**

	<b>Toronto Sewer System Grand Total</b>
Percent Reduction of Monthly Average Mercury Loading	79.7%
Amount Reduction of Monthly Average Mercury Loading (g Hg)	13,855

Finally, we can calculate what the Toronto removal rates would imply about mercury removal in the United States. There are approximately 133,000 dental clinics in the United States. If we apply the Toronto rate to these clinics we get the results presented in Chart 5

**Chart 5: Calculated Annual Reduction in Mercury in Sewer Sludge Before and After Amalgam Separator By-law given 100% Compliance in the United States**

	<b>Hg</b>
Reduction of Annual Mercury Loading in Kg	20,100
Reduction of Annual Mercury Loading in Tons	22.1

**Appendix:**

**Chart A1: Average Monthly Mercury Concentrations at Four Sewage Plants**

<b>Month</b>	<b>Highland Creek</b> mg Hg/Kg dry wt.	<b>Humber</b> mg Hg/Kg dry wt.	<b>Ashbridges Bay</b> mg Hg/Kg dry wt.	<b>North Toronto</b> mg Hg/Kg dry wt.
Jan-01	1.90	4.83	2.40	3.86
Feb-01	0.70	1.48	1.75	3.47
Mar-01	1.10	0.17	1.80	3.93
Apr-01	1.20	1.40	1.90	3.08
May-01	2.00	1.19	2.00	2.45
Jun-01	2.40	2.31	2.00	3.08
Jul-01	1.10	14.36	2.20	3.88
Aug-01	1.80	4.48	3.50	2.97
Sep-01	0.90	1.81	3.00	3.05
Oct-01	1.10	4.40	3.70	2.58
Nov-01	0.90	3.17	1.55	3.17
Dec-01	1.40	2.02	2.00	3.39
<b>Average 2001</b>	<b>1.38</b>	<b>3.47</b>	<b>2.32</b>	<b>3.24</b>
Jan-02	0.75	1.15	0.75	1.68
Feb-02	1.10	1.00	1.55	1.30
Mar-02	0.56	1.18	1.45	2.32
Apr-02	0.50	0.50	0.80	2.70
May-02	0.30	0.70	1.15	1.31
Jun-02	0.40	2.04	1.50	2.28
<b>Average 2002</b>	<b>0.60</b>	<b>1.10</b>	<b>1.20</b>	<b>1.93</b>

**Chart A2: Monthly Mass of Dry Sludge at Four Sewage Plants**

<b>Month</b>	<b>Highland Creek (dry Tonnes)</b>	<b>Humber (dry Tonnes)</b>	<b>Ashbridges Bay (dry Tonnes)</b>	<b>North Toronto (dry Tonnes)</b>
Jan-01	1415.1	1327.3	2739.5	169.3
Feb-01	1030.9	1423.1	2924.1	142.8
Mar-01	1214.3	1456.4	3537.7	162.0
Apr-01	1140.8	1584.3	4105.2	60.1
May-01	1250.7	1556.5	4095.6	80.0
Jun-01	1463.8	1733.4	4203.5	40.9
Jul-01	1527.0	1748.9	4285.7	70.0
Aug-01	1138.8	2020.1	4442.1	90.8
Sep-01	1054.7	2057.9	4219.7	90.9
Oct-01	1191.0	2206.0	4073.5	74.5
Nov-01	1005.0	1810.1	4400.8	194.2
Dec-01	961.7	1758.0	4219.3	46.0
<b>Average 2001</b>	<b>1199.5</b>	<b>1723.5</b>	<b>3937.2</b>	<b>101.8</b>
Jan-02	1380.7	1582.1	4125.0	51.4
Feb-02	1220.9	1569.5	3916.3	35.0
Mar-02	1345.2	1126.4	3640.3	164.3
Apr-02	1489.1	1302.7	3398.9	83.0
May-02	1470.0	1700.1	3721.5	101.0
Jun-02	1172.1	1423.5	4681.2	112.0
<b>Average 2002</b>	<b>1346.3</b>	<b>1450.7</b>	<b>3913.9</b>	<b>91.1</b>