

# Wayne County Rouge Program Office (RPO)

## MEMORANDUM

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Date: February 26, 1997  
To: Kelly Cave, Ed Kluitenberg, Gary Mercer  
From: Jeff Boerma, Barry Johnson

Subject: Estimated Total Pollution Delivered to Rouge River by Illicit Connections

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This memorandum summarizes the methods used to determine an estimate of total pollution delivered to the Rouge River by illegal connections to the storm sewer system ("illicit connections"). Information used to determine total pollution from illicit connections came from the Rouge Program Office Technical Memorandum "Summary of Illicit Connection Detection Programs in Michigan" (RPO-NPS01A-TM01.00, Pomeroy, 1996), the Illicit Connection Program Annual Reports and the quarterly reports of the Wayne County Department of Public Health Environmental Health Division and Wayne County Department of the Environment, Watershed Management Division (1987- Sept. 1996).

### *Background*

The reports from the Wayne County Department of Public Health indicate that they investigated 2754 facilities from 1987 to September 1996. Of the facilities investigated, 249 were found to have improper connections. When one violation was found at a facility it resulted in two to three others usually being found. The total number of violations found were 645 at the 249 facilities. In the quarterly and Annual Reports the pollutant loads are calculated for the various types of violations. Discussions with the staff doing the inspections revealed that several violations were not expected to be typical of the entire watershed, or would not result in a significant load to the river. For this reason the horse washing machine, downspout and drinking fountain data was subtracted, from the summary data in this paragraph, for the purposes of projecting the impact of an illicit connection/removal program in the entire Rouge Watershed.

The facilities investigated by Wayne County are all non-residential. The non-residential facilities have been characterized as Priority I, II, III or IV facilities. They are;

- Priority I: Automobile related businesses\facilities and heavy manufacturing.
- Priority II: Printers, dry cleaners\laundries, photo processors, utilities, paint stores, water conditioners, chemical laboratories, construction companies and medium-light manufacturing.
- Priority III: Institutional facilities, private service agencies, retail establishments and schools.
- Priority IV: Agriculture production, forestry, and fishing, hunting and trapping.

## Method Used for Projecting the Impact of an Illicit Connection Program for the Entire Rouge Watershed

Illicit connections can be grouped into four main categories: drains, toilets, pools and sinks. Drains are floor drains, trench drains, interior catch basins, interior catch basins with oil separators, machine process water, and sump pumps. Toilet wastewater amounts are based on an average of 26,390 gallons a year for a restroom serving a business operation. Illicit pool connections are public pools that discharge to the river. Sinks are those facilities that discharge wastewater similar to a tub, shower, or washing machine. These four types of illicit connections send ammonia, surfactants, potassium, chlorine, solids, BOD5, COD, phosphorus, volatile solids and fecal coliform organisms to the Rouge River. Each illicit connection sends different amounts of these contaminants to the river. Each of the four types of discharges have a different volume that they discharge per year. Using the type of illicit connection and characteristics of the connection, an average pollutant load for an average illicit connection in the Rouge River can be predicted. The predicted value for one connection is then multiplied by the number of illicit connections to give the estimated total pollution delivered to the Rouge River by illicit connections.

*Table 1* uses 486 illicit connections examined by Wayne County Health Department in the years 1987 through September 1996 that fit into the four categories. The second column in *Table 1* shows what percentage of each type were encountered. The third column shows the volume in gallons per year per connection for each different type of connection. Column four multiplies the percent of cases by the volume per case per year (drains % cases \* gallons / year/ connection, or  $57.6\% * 1,000 = 576$ ). Column 5 is a factor which when multiplied by each illicit connection type's pollutant load will give it's share of an average illicit connection. The column 5 factors are given by dividing each value in column four by the total in volume in column 4 (drains / total, or  $576/9702 = 0.0594$ ).

*Table 2 & Table 3* uses the weight factors in *Table 1*, column 5 and the expected pollutant concentrations for each illicit connection to determine an average pollutant concentration for any given connection.

*Table 2* has a column of each illicit connection type. The left side of each column shows the pollutant concentration that the given connection has. The right side shows how much of that load will be added to the average illicit connection in *Table 3*. The number on the right of each column is determined by multiplying pollutant load weight factors of *Table 1*, column 5 by the number on the left (drains, ammonia \* drain weight factor *Table 1*, or  $0.24 * 0.0594 = 0.014$ ).

*Table 3* sums up the information in *Table 2* for each contaminate, to give an average pollutant concentration for an average illicit connection. The weighted mg/L of each illicit connection type of *Table 2* are added to give the pollutant concentrations in *Table 3*. *Table 3* shows the pollutant concentration that the average illicit connection in the Rouge Watershed will have.

**Table 1: Weight Factors for Each Type of Illicit Connection**

<b>Type of Illicit Connection</b>	<b>- 1 - Number of Illicit Connection Cases *</b>	<b>- 2 - Percent of Cases</b>	<b>- 3 - Gallons of discharge per year per illicit connection (1)</b>	<b>- 4 - Weighted discharge per year per illicit connection</b>	<b>- 5 - Pollutant Load Weight Factor</b>
Drains	280	57.6%	1,000	576	0.0594
Toilets	67	13.8%	26,390	3,642	0.3754
Pools **	10	2.1%	24,500	515	0.0530
Sinks	129	26.5%	18,750	4,969	0.5121
<b>Total</b>	<b>486</b>	<b>100%</b>	<b>70,640</b>	<b>9,702</b>	<b>1</b>

\* This represents illicit connections found from 1987 - Sept. 1996 and does not include atypical illicit connections such as horse washing machines and drinking fountains.

\*\* Gallons of discharge per year per illicit connection is the average of four pools.

N/A = Not Applicable

**Table 2: Pollutant Concentrations for Each Type of Illicit Connection**

Contaminant	Units	Drains (1)		Toilets (2)		Pools (3)		Sinks (1,4)	
		Concentration	Weighted Average	Concentration	Weighted Average	Concentration	Weighted Average	Concentration	Weighted Average
Ammonia	mg/L	0.24	0.014	12	4.50			0.8	0.41
Surfactants	mg/L	49	2.91	1.50	0.56			27.0	13.83
Potassium	mg/L	43	2.55	6	2.25			3.5	1.79
Chlorine	mg/L	0.07	0.0042	0.01	0.0038	1.00	0.05	0.4	0.205
Total Solids	mg/L			840	315.31			382.0	195.64
Suspended Solids	mg/L			245	91.97			33.0	16.90
BOD5	mg/L			245	91.97			328.0	167.98
COD	mg/L			705	264.63			452.0	231.49
Total Phosphorus	mg/L			23	8.63			59.0	30.22
Volatile Solids	mg/L			440	165.16				
Fecal Coliform	organisms/liter			10,000,000,000	3,753,679,654			19,500,000	9,986,665

**Table 3: Average Pollutant Concentrations**

<b>Contaminant</b>	<b>Units</b>	<b>Average Concentration *</b>
Ammonia	mg/L	4.928
Surfactants	mg/L	17.300
Potassium	mg/L	6.598
Chlorine	mg/L	0.266
Total Solids	mg/L	510.945
Suspended Solids	mg/L	108.866
BOD5	mg/L	259.946
COD	mg/L	496.120
Total Phosphorus	mg/L	38.850
Volatile Solids	mg/L	165.162
Fecal Coliform	organisms/liter	3,763,666,319

\* Contaminant concentration for any given illicit connection weighted by occurrence and volume of occurrence

**Table 4 : Summary of Pollutant Loads Discharged  
to the Rouge River by Illicit Connections**

<b>Contaminant</b>	<b>Units</b>	<b>Load</b>
Ammonia	lbs/year	2,099
Surfactants	lbs/year	7,367
Potassium	lbs/year	2,809
Chlorine	lbs/year	113
Total Solids	lbs/year	217,568
Suspended Solids	lbs/year	46,357
BOD5	lbs/year	110,689
COD	lbs/year	211,256
Total Phosphorus	lbs/year	16,543
Volatile Solids	lbs/year	70,328
Fecal Coliform	organisms/year	727,059,419,000,000,000
Flow Reduction	gallons/year	51,032,520

Estimated number of facilities with  
illicit connections: 2,031  
Estimated number of Violations: 5,260

Pounds of Pollution for each  
connection is calculated using:  
 $P=(8.344 \text{ E-}6) * X * Q*V$

X = concentrations in (mg/L)  
Q = Volume per year of connection  
(gal/Year)  
P = Pounds of pollutant (lbs)  
V = Number of violations  
8.344E-6 = conversion factor

References:

1. Investigation of Inappropriate Pollutant Entries into Storm Drainage Systems. A Users Guide, EPA 1600/R-92/258 January 1993. P. 27.
2. Design Manual, On Site Wastewater Treatment and Disposal Systems, EPA, October 1980. P. 56.
3. Van der Leedon, F., et. all., The Water Encyclopedia, 2nd Edition, Chelsea & Lewis Publishers, Inc. 1990. P. 336.
4. Manual of Grey Water Treatment Practice, Part II, Monogram Industries, Inc., San Marino CA, 1975. P. 22, 26.
5. Illicit Connection Investigation Program Annual Reports, 1994, 1995, Wayne County Department of Public Health, Environmental Health Division.
6. Subwatershed Baseline Information: characterization and comparison Nonpoint Work Plan No. urbsw12, Task No. 4 Oct. 1996

Table 4 shows how many pounds of pollutants that are deposited into the Rouge Watershed by illicit connections except for fecal coliform and flow reduction. Fecal coliform is reported in organisms per year. Flow is reported in gallons per year. The formula  $P=(8.344E-6)*X*Q*V$  gives pounds of pollutant. X is the concentration determined in Table 3. Q is the weighted volume of discharge per year, Table 1, Column 3 (average volume is 9702 gallons / year). 8.344E-6 is a conversion factor. V is the number of facilities with potential illicit connections which is 2031. This number is the total number of Priority I, II and III (22461 @) facilities on separated sewers times the percent found to have illicit connections (249/2754). To date 645 violations have been found at the 2754 facilities investigated. This gives an average of 2.59 violations for each facility found to have an illicit connection. The estimated number of violations in the entire Rouge Watershed is 5260 (2031 \*2.59). The rest of Table 4 is an application of the load formula showing how many pounds of pollutant from illicit connections that can be expected in the Rouge Watershed.

A separate calculation is necessary for fecal coliform since these are reported in organisms per liter. The projected number of fecal coliform organisms that can be eliminated by an illicit connection is the number in Table 3, fecal organisms per liter \* volume of discharge in gallons per year \*3.785 liters per gallon \* the number of violations.

Flow is based on the weighted discharge per year, 9702 gallons times the number of illicit connections, 5260.  $9702 * 5260 = 51,032,520$  gallons per year.

#### Table 5 - Subwatersheds

For the 3 pilot subwatersheds the impact of an illicit connection\elimination program would be the elimination of 866 violations in the Upper 2, 194 in the Middle 1 and 699 in the Middle 3. As communities separate sewers and extend new sanitary sewers, the number of potential illicit violations is expected to be more than these estimated numbers. Table 5 summarizes the expected violations for all 11 subwatersheds.

#### Table 6

The estimated pollutants discharged by each of the subwatersheds is calculated as in Table 4 and is shown in Table 6.

#### Summary

Analysis of the data (Table 2 and 4) indicates that toilets contribute the majority of the pollutants for ammonia, total solids, suspended solids, COD, volatile solids and fecal coliform. This projection estimates that trillions of fecal coliform bacteria would be eliminated from the river if all toilets were disconnected from discharge to the river. Sinks are major contributors to surfactants, chlorine, total phosphorus and BOD5.

The elimination of fecal coliform bacteria is critical to stretches of the river where human contact is the goal. Activities such as canoeing, wading, paddle boat use, and swimming are affected by fecal coliform.

Phosphorus impacts on impoundments by stimulating weed and algae growth. Eliminating phosphorus on stretches of the river that have impoundments will improve the visual appearance and clarity of the water.

#### Recommendations

The present illicit connection program has been doing a comprehensive survey of Priority I, II and III facilities. The biggest return on water quality improvements and goals would result in the program targeting toilets and sinks (tubs, showers, laundry facilities) for illicit connections. This would significantly reduce fecal coliform bacteria, phosphorus, ammonia, total and suspended solids, potassium, BOD5, COD and volatile solids discharged to the river.

@ The number 22461 is calculated from the River Rouge Subwatershed Baseline Information<sup>6</sup> prepared by Public Sector Consultants (PSC) using the percent of the subwatershed served by separated sewers and the Summary Report, Priority Businesses by Watershed also prepared by PSC which lists the number of each type of priority businesses.

cc: Jim Ridgway, Christine Pomeroy, Tom Quasebarth

Table 5

Subwatershed Priority 1,2,3	Area on Separated Facilities	Number of Sewers	Facilities estimated to be on Separated Sewers	Violations +
Lower 1	332	30%	100	23
Lower 2	3450	57%	1967	461
Main 1	8882	61%	5418	1269
Main 2	6159	44%	2710	635
Main 3	4316	13%	561	131
Main 4	4725	15%	709	166
Middle 1	2367	35%	828	194
Middle 2	3826	78%	2984	699
Middle 3	2444	78%	1906	446
Upper 1	2472	64%	1582	370
Upper 2	<u>4454</u>	83%	<u>3697</u>	<u>866</u>
Totals	43427		22462	5260

+ Estimated illicit violations is calculated by  $\frac{249}{2754} * 2.59 * \text{number of facilities on separate sewers}$ . I.e.  $\frac{249}{2754} * 2.59 * 3697 = 866$

**Table 6: Summary of Pollutants Discharged In Each Subwatershed of the Rouge River**

Pounds of Pollution for each connection is given by formula of

$$P=(8.344E-6)*X*Q*V$$

Where

X= concentrations in (mg/L)

**Table 3**

Q=Volume per year of connection (gal/Year)

**(9,700 gal/year)**

P=Pounds of pollutant (lbs)

**Table 4**

V=Number of Violations per Year

**Table 5**

8.344E-6= conversion factor

Branch	Lower 1	Lower 2	Middle 1	Middle 2	Middle 3	Upper 1	Upper 2	Main 1	Main 2	Main 3	Main 4	Watershed Total
# of potential Illicit Violations (From Table 6)	23	461	194	699	446	370	866	<b>1269</b>	635	131	166	5260
<b>Pounds of Pollutant per Year</b>												
Contaminant, lbs./year												
Ammonia	9.2	183.9	77.4	278.9	177.9	147.6	345.5	<b>506.3</b>	253.3	52.3	66.2	2,098.6
Surfactants	32.2	645.6	271.7	978.9	624.6	518.2	1,212.8	<b>1,777.2</b>	889.3	183.5	232.5	7,366.5
Potassium	12.3	246.2	103.6	373.3	238.2	197.6	462.5	<b>677.8</b>	339.2	70.0	88.7	2,809.3
Chlorine	0.5	9.9	4.2	15.0	9.6	8.0	18.6	<b>27.3</b>	13.7	2.8	3.6	113.2
Total Solids	951.3	19,068.3	8,024.4	28,912.6	18,447.8	15,304.2	35,820.2	<b>52,489.4</b>	26,265.4	5,418.5	6,866.2	217,568.4
Suspended Solids	202.7	4,062.8	1,709.7	6,160.3	3,930.6	3,260.8	7,632.1	<b>11,183.8</b>	5,596.3	1,154.5	1,463.0	46,356.7
BOD5	484.0	9,701.1	4,082.4	14,709.4	9,385.4	7,786.1	18,223.7	<b>26,704.2</b>	13,362.6	2,756.7	3,493.2	110,689.0
COD	923.7	18,515.0	7,791.6	28,073.7	17,912.5	14,860.2	34,780.9	<b>50,966.4</b>	25,503.3	5,261.3	6,667.0	211,255.6
Total Phosphors	72.3	1,449.8	610.1	2,198.4	1,402.7	1,163.7	2,723.6	<b>3,991.0</b>	1,997.1	412.0	522.1	16,542.7
Volatile Solids	307.5	6,163.8	2,593.9	9,345.9	5,963.2	4,947.1	11,578.8	<b>16,967.1</b>	8,490.2	1,751.5	2,219.5	70,328.5
Bacteria, organisms/yr	3.2E+15	6.4E+16	2.7E+16	9.7E+16	6.2E+16	5.1E+16	1.2E+17	1.8E+17	8.8E+16	1.8E+16	2.3E+16	7.3E+17
Flow, gallons/year	223,146.0	4,472,622.0	1,882,188.0	6,781,698.0	4,327,092.0	3,589,740.0	8,401,932.0	12,311,838.0	6,160,770.0	1,270,962.0	1,610,532.0	51,032,520.0

**BOLD** branch with minimum impact from illicit connections  
branch with maximum impact from illicit connections