Contribution of car, truck, bus and subway wash station discharges to stormwater pollution (Toulouse, France)

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Abstract

The European Water Framework Directive requires the monitoring of priority pollutants entering surface waters. This includes notably the stormwater network. In this study, the contribution of discharges from wash stations to pollution of the stormwater network was investigated. Six wash stations discharging wastewater into the stormwater network were selected: (i) one trucks wash station, (ii) two self-service stations for cars and motorcycles, (iii) two bus wash stations, (iv) one subway wash station. Classical parameters (conductivity, pH, turbidity, chemical oxygen demand, total nitrogen, total phosphorus, suspended solid) and organic micropollutants (Polycyclic Aromatic Hydrocarbons (PAHs), Total Hydrocarbons (TH) and Methylterbutylether (MTBE)) were checked and measured. Concentrations were compared with limit values from Greater Toulouse decontamination service regulations for the discharge licenses of carwashes, and under the French decree for discharges into the natural environment and with the proposed directive from the European Parliament and the Council, dealing with environmental quality standards. The result showed a decrease of pollution downstream of the pre-treatments for subway wash stations but not for bus wash stations. According to the directives, the pre-treatment processes are not sufficient to justify a discharge into the stormwater network.

Keywords: *Organic compounds, concentrations, separated sewage system, water quality, run-off waters.*

Introduction

Stormwater is known to be an important source of received water pollution [1]. With regard to the European Water Directive [2], it is necessary to monitor a wide range of organic micropollutants in addition to classical water quality parameters.

Concentrations of classical parameters observed in urban runoff are listed in Table 1. The values observed in the literature for classical parameters show an average pH around 7.5 ([3], [4]). The COD values varied according to the type of surface considered ([5]; [6]). Organic micropollutants in the environment originate from anthropogenic activities. Their concentrations observed in urban runoff are listed in Table 2. The main sources of polycyclic aromatic hydrocarbons originate from pyrolysis of organic matter under high temperature [7]. Actually, urban surfaces can receive deposits of PAHs from different sources via both atmospheric transport and local activity [8]. Methyltertbutylether is a volatile organic compound produced from natural gas. It is introduced into the environment via leaking petroleum storage tanks, urban runoff, and motorized watercraft [9].
The case of Toulouse in France is particularly interesting since the town has a separated sewer system where organic micropollutants in the wastewater system cannot mix with the stormwater [10]. However, water in the latter system comes not only from runoffs but also from wash station discharges. Indeed, industrial waters can be discharged into sewers under a permission of discharge from the community [11]. Wash stations can discharge their waters after pre-treatment through two structures (figure 1). Waters go through the scrubber, where the solids are removed, then through the oil separator to remove hydrocarbons. These systems should be in accordance with French norm XP P 16-441 [13] and require regular maintenance to keep up their efficiency [12].

The aim of this work was to study the efficiency of these pre-treatment processes and the rejects from wash stations upstream of the stormwater network to accurately evaluate the impact of this source of pollution on stormwater quality.

Materials and Methods

Sampling sites

The pre-treatment efficiency was evaluated at three points for the subway and three points for bus wash stations. For the subway station, the three points tested were: machine parts washing (site A), vehicle washing (site B) and rail washing (site C). The selected points for bus stations were the large workshop wash (site D), vehicle wash station (site E) and the machine parts washing (site F).

One subway, one bus, one truck and two car wash stations were selected to evaluate pollution. On Site 1, trucks only, were washed manually. The second site chosen was for cars and motorcycles with a self-service high-pressure water jet (Site 2). Site 3 was in a petrol station and comprised a self-service high-pressure water jet and roller brush washing. Site A was a subway wash station (machine parts washing). Site E was a bus wash station. These five sites discharged wastewater into the stormwater network downstream of a pre-treatment system composed of a scrubber and an oil separator.

Figure 2 shows the sampling site locations.

Sampling method

Concerning sites selected to evaluate pre-treatment efficiency, samples were collected and analysed between September 2002 and September 2003. Five samples per site were taken during the year. Samples were taken manually upstream and downstream of the pre-treatment system. Each time, around 15L of discharge was collected and then homogenized in order to obtain a representative sample.

Concerning sites 1, 2 and 3, samples were collected and analysed between December 2006 and December 2007. For sites A and E samples were collected and analysed between September 2002 and September 2003. Five samples per site were taken during the year. Samples were taken manually from a conveyance at the pre-treatment process exit. Each time, around 15L of discharge was collected and then homogenized in order to obtain a representative sample.

Analysis

Conductivity, pH and turbidity of total water samples were checked and measured. Commercial tests (Spectroquant ®, Merck) were used to analyze chemical oxygen demand (COD), nitrogen (tot-N), phosphorus (tot-P) on raw and filtered samples. Suspended solid (SS) was investigated by filtration using NF-T90-105-1 and NF-T90-029 respectively.

To complete the common characterization, organic micropollutants were analyzed. Polycyclic aromatic hydrocarbons (PAHs) were analysed using liquid-liquid extraction with Hexane followed by liquid chromatography with fluorescence detection according to NF EN ISO 17993. The elution was made with mobile phase consisted of acetonitrile and water. A mixed of two deuterated compounds was used as internal standard. Detection was performed with a fluorescence detector at emission and excitation wavelengths of studied compounds. The 16 PAHs from the United States Environmental Protection Agency were targeted. Limit of quantification (LOQ) for the sum of PAHs was 0.01 µg/L. Methyl *tert*-butyl ether (MTBE) was analysed with gas chromatography-mass spectrometry after head-space extraction with a limit of quantification of 1 µg/L. A deuterated compound (MTBE-d_3) was used as internal standard. Mass chromatography of m/z 73 (MTBE) and m/z 76 (MTBE-d_3) in full scan mode was used for quantification. Total hydrocarbons (TH) were analysed using liquid-liquid extraction with oil ether and a gas chromatograph equipped with a flame ionization detector according to NF EN ISO 9377-2. Two compounds were used as references for the retention time: n-Decane and n-Tetracontane. Limit of quantification was 0.10 mg/L.

Table 3 and 4 resume analytical method.

To complete the study, subway wash station effluents (site A) were tested using a biodegradability test according to the standardised OCDE 301 B test. This test is based on the modified Sturm method. Principle of the method is to quantify the CO_2 release by the effluent during 28 days. This is a respirometric method. In the modified Sturm test, we consider that we have an easily biodegradable effluent if produced CO_2 reaches 60% in ten days after the rate of produced CO_2 reaches 10%.

Results and discussion

Pre-treatment system efficiency

The concentrations of classical parameters were determined upstream and downstream of the pre-treatment for the bus and subway wash stations selected. Table 5 shows concentrations for raw and filtered samples.

From Table 5 it can be seen that concentrations of COD, Tot-P, Tot-N and SS, for the three sites (A, B, C) of subway wash stations and for site D, are less downstream of pre-treatment than upstream. The Pre-treatments for these sites seem to be efficient since a reduction of pollution is observed. On the other hand, concentrations of classical parameters are higher in downstream samples than in upstream ones for sites E and F, and no reduction of pollution is observed. Therefore pre-treatment systems seem to be inefficient to treat the wastewater from the bus wash stations. This can be explained by the fact that either the pre-treatment is not adapted to this type of effluent, or there is insufficient maintenance.
On account of the high COD concentration of subway wash effluent, a biodegradability test was performed on site A effluent. Figure 3 shows the results obtained for the biodegradability test.
As can be seen in Figure 3, the curve reaches 60% of produced CO_2 at the 10^{th} day of the test. According to the modified Storm method, the subway wash effluent was easily biodegradable. Moreover, the curve reaches 100% biodegradability after 25 days. The subway effluent rejected a lot of pollution into the stormwater network but considering its biodegradability this effluent rejected into the stormwater network, was an acceptable effluent. This result showed that the pollution covering classical parameters is not sufficient to characterize the effluent considered and the biodegradability should also be tested to evaluate the quality of the effluent rejected.
Concentrations of Tot-P and Tot-N are almost equal between raw and filtered samples. These types of pollutant are more concentrated in aqueous phase than in particulate phase. The values of COD decrease between the raw and filtered samples for sites A, B, C, D and F. For site E, COD values are higher in filtered samples than in raw samples. The difference between raw and filtered samples corresponds to suspended solids (SS). The pollutants (tot-N, tot-P and COD) are fixed on the suspended solids and consequently they transport most of the pollution. This result agrees with the studies of [14], [15], and [16]. They explain that more than 80% of pollution is conveyed by suspended solids.

Concentrations in wash station samples

Minimum, maximum, mean, median and standard deviation values were calculated for each parameter for the six wash stations selected (Table 6). Values less than the quantification limit were taken as zero for statistical calculations.
According to Table 6, pH of water seems to be constant during the study for each site. It satisfies the legislation which requires a value between 5.5 and 9.5 for discharge in surface water [17] and corresponds to the values found in the literature ([4], [10], [18]). Conductivity is high and variable over the sampling period with mean values from 490 to 4 360 µS/cm according to type of wash station. Globally, the observed values are higher than those found in urban runoff literature ([3], [10]). Mean values of COD (from 227 to 949 mg/L) are always above the required threshold of 125 mg/L [17] and these observed values are higher than those found in the literature ([10], [19], [20], [21]). The mean values for SS from 45 to 869 mg/L do not conform to the legislation which requires a value below 35 mg/L. Concerning tot-P, only Site 3 and Site 5 satisfy the limit value of 10 mg/L. Concentrations of tot-N for the five sites are lower than the limit value of 30 mg/L. For conventional water parameters, Site 1 (manual truck wash) and 4 (subway wash station) appear to be much more polluted overall than Sites 6, 2, 4 and 3. Nevertheless, classical parameters give values with an order of magnitude closer to wastewater than urban runoff and these results show that the pre-treatment processes of at least one of these wash stations are not sufficient to justify discharge into the storm water network.
Mean values for the sum of PAHs was higher than values found in the literature for urban runoffs ([22], [23]). MTBE mean concentrations correspond to German and Italian drinking water values for instance ([24], [25]). Total Hydrocarbons were always under the 10 mg/L fixed by the discharge license. Results overall show that Site 1 is the most polluted in the organic compounds analyzed.

Conclusions

This study aims to evaluate the efficiency of pre-treatment systems of wash stations and the impact of their discharges on the stormwater quality in a city equipped with a separated sewer system. Screening of classical parameters upstream and downstream of pre-treatment was performed. It reveals that this system is not adapted to treat water from bus wash stations unlike the subway wash stations. It was noticeable that suspended solids transport a lot of pollutants. The screening of classical parameters and organic micropollutants in wash station wastewaters reveals that measured concentrations in wash station discharges were closer to values found in wastewater than in runoff water. According to this observation and the directive, pre-treatment processes are not sufficient to justify discharge into the stormwater network.

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Table 1. Reported concentrations of classical parameters in waters.

Water type	n	Origin	Concentrations				References
			Min.	Max.	Mean	Median	
pH							
Runoff water: -Tank structure -Drainage area	28 16	France	6.1 6.2	8.7 8.1	7.5 7.2		[4]
Runoff water	-	France				7.51	[19]
Runoff water	48	France	6.3	7.9	7.3	7.4	[6]
Runoff water	27 29	France	6.9 6.8	8.2 8	7.5 7.5		[3]
Runoff water	9	France	6.7	7.7	7.1		[18]
Dam water	30	Turkey	8.1	8.4	8.3		[26]
Runoff water: - Boulevards outlet - Mirail outlet	20 19	Toulouse (France)	6.8 7.4	9.2 9.4	8.1 8.3	8.1 8.0	[10]
Conductivity (µS/cm)							
Runoff water	-	France			245		[19]
Runoff water	46	France	60	17620	1356	290	[6]
Runoff water	27 29	France	50 107	244 402	99 189		[3]
Runoff water	9	France	54	110	74.4		[18]
Runoff water: - Boulevards outlet - Mirail outlet	20 19	Toulouse (France)	52 80	533 462	293 230	285 227	[10]
Turbidity (NTU)							
Runoff water: - Boulevards outlet - Mirail outlet	20 19	Toulouse (France)	6.4 13	619 223	123 48	65 28	[10]
Dam water	30	Turkey	3.5	30	8.4		[26]
COD (mg/L)							
Runoff water: -Roof -Courtyard -Street	16 15 26	France	5 34 48	318 580 964		31 95 131	[5]
Runoff water: -Tank structure -Drainage area	31 18	France	<20 <20	36 43	<22 <23		[4]
Runoff water	-	France			116		[19]
Wastewater GOS Wastewater UCW	- -	Turkey	129 28.1	178 107	169 67.6		[26]
Runoff water	45	France	21	507	103	80	[6]
Runoff water	-	France	16	75	27		[20]

Runoff water	-	Europe	20	365	85		[21] ; [28]
Runoff water: - Boulevards outlet - Mirail outlet	20 19	Toulouse (France)	20 <10	360 123	116 48	56 37	[10]
Suspended Solid (mg/L)							
Runoff water: -Roof -Courtyard -Street	16 15 26	France	3 22 49	304 490 498		29 74 92,5	[5]
Runoff water: -Tank structure -Drainage area	31 19	France	0.6 5	139 86	13 33		[4]
Runoff water		France				152	[19]
Runoff water	16	France	267		71	47	[6]
Runoff water	-	France	1	150	18		[20]
Runoff water	-	Europe	1	4582	190		[21] ; [28]
Runoff water	27 29	France	11 25	458 964	158 199		[3]
Runoff water	9	France	4	130	45		[18]
Wastewater GOS Wastewater UCW	- -	Turkey	8.0 940	197 958	54 949		[26]
Runoff water: - Boulevards outlet - Mirail outlet	20 19	Toulouse (France)	4 11	1063 314	211 81	96 45	[10]
Total Nitrogen (mg/L)							
Runoff water	43	France	0.6	10.2	2.3	1.7	[6]
Runoff water	-	Europe	0.4	20	3.2		[21] ; [28]
Runoff water	27 29	France	1 1	12 50	2.8 4.7		[3]
Runoff water	9	France	1.2	3.6	2.2		[18]
Wastewater GOS Wastewater UCW	- -	Turkey	24 7.6	200 10.2	55 8.9		[26]
Runoff water: - Boulevards outlet - Mirail outlet	20 19	Toulouse (France)	<10 <10	32 40	12 6.1	11 0	[10]
Total Phosphorus (mg/L)							
Runoff water	-	Europe	0.02	14.3	0.34		[21] ; [28]
Runoff water	26 29	France	0.3 0.3	4.7 19.1	0.56 1.1		[3]
Runoff water: - Boulevards outlet - Mirail outlet	20 19	Toulouse (France)	0.5 0.1	3.6 2.5	1.2 0.5	0.8 0.2	[10]

Table 2. Reported concentrations of organic pollutants in waters.

Organic micropollutants	Water type	n	Origin	Concentrations				References
				Min.	Max.	Mean	Median	
PAHs (µg/L)								
PAHs (Σ11)	Surface water	6	France	4.10^{-3}	0.036	0.020	-	[22]
PAHs (Σ15)	Sea water	-	UK	1.10^{-3}	24.821	1.002	-	[30]
PAHs (–)	Runoff water	35	France	0.011	0.474	0.096	0.074	[6]
PAHs (Σ16)	Raw wastewater	4	France	1.277	3.240	1.998	1.737	[26]
PAHs (Σ15)	Underground water Surface water Rainwater	1 1 1	Germany	- - -	- - -	$9.4.10^{-3}$ 0.280 0.079	- - -	[23]
PAHs (Σ14)	Runoff water	33	France	-	-	0.149	0.063	[31]
PAH (Σ16)	Fresh water Wastewater	5 5	Turkey	<0.05 3.73	1.85 8.33	0.83 5.35	0.79 4.45	[30]
PAHs (Σ12)	Surface water	27	Spain	2.10^{-3}	0.336	0.042	0.013	[32]
PAHs (Σ15)	Rainwater	6	France	0.031	0.105	0.060	0.061	[27]
PAHs (Σ11)	Surface water	10	France	0.123	0.407	0.227	0.211	[8]
Total hydrocarbons (mg/L)								
TH	Runoff water	56	France	0.1	4.9	2.3	-	[3]
TH	Runoff water	44	France	0.14	4.2	1.2	0.86	[6]
TH	Runoff water	-	Europe	0.04	25.9	1.9	-	[18]
MTBE (µg/L)								
MTBE	Rainwater Runoff water	35 12	Germany	<0.01 0.030	0.085 1.174	0.032 0.204	0.024 0.114	[9]
MTBE	Drinking water River water	5 3	Italy	0.05 0.10	0.40 0.15	0.17 0.12	0.08 0.10	[25]
MTBE	Drinking water	83	Germany	0.017	0.712	0.089	0.038	[24]

Table 3. Analytical methods for classical parameters.

Parameters	Standard	Spectroquant® test reference	Measuring range	Method
pH	NFT 90-008	-	-	potentiometric
Conductivity	NF EN 27888	-	-	condutimetric
Turbidity	NF EN ISO 7027	-	-	optical
SS	NF EN ISO 872	-	-	filtration
COD	NFT 90-101	1.14541.0001	100 – 1500 mg/L	Photometry (593 nm)
tot-P	NF EN ISO 11905-1	1.14543.0001	0.05 – 5 mg/L	Photometry (710 nm)
tot-N	NF EN ISO 6878	1.14763.0001	10 – 150 mg/L	Photometry (338nm)

Table 4. Analytical methods for organic micropollutants.

Organic micropollutants	Standard	Extraction	Analyse	LOQ
PAH	NF EN ISO 17993	Liquid – Liquid with Hexane	HPLC – FLD (Acetonitrile/Water)	0.01 µg/L (sum of 16 PAHs from EPA)
MTBE	-	Head-space	GC - MS	1.0 µg/L
TH	NF EN ISO 9377-2	Liquid-Liquid with oil ether	GC - FID	0.1 mg/L

Table 5. Concentration of classical parameters for the bus and subway wash stations studied.

	Units	n	Raw samples		Filtered samples	
			Upstream of pre-treatment	Downstream of pre-treatment	Upstream of pre-treatment	Downstream of pre-treatment
Site A: machine parts washing – Subway						
COD	mg/L	5	3290 ±329	1790 ±179	2200 ±220	1172 ±117
Tot-P	mg/L	5	108 ±10.8	42.9 ±4.3	47.5 ±4.8	42.9 ±4.3
Tot-N	mg/L	5	31 ±3.1	22 ±2.2	31 ±3.1	24 ±2.4
pH	-	5	10.3 ±0.1	10.1 ±0.1	10.2 ±0.1	9.9 ±0.1
Conductivity	µS/cm	5	2820 ±10	1906 ±10	2670 ±10	1789 ±10
Turbidity	NTU	5	950 ±95	870 ±87	-	-
SS	mg/L	5	1136 ±114	790 ±79	-	-
Site B: vehicle washing – Subway						
COD	mg/L	5	106 ±11	38 ±4	43 ±4	21 ±2
Tot-P	mg/L	5	1.9 ±0.2	0.8 ±0.1	0.6 ±0.1	0.6 ±0.1
Tot-N	mg/L	5	7.0 ±0.7	5.0 ±0.5	6 ±0.6	2 ±0.2
pH	-	5	8.7 ±0.1	8.5 ±0.1	8.4 ±0.1	8.4 ±0.1
Conductivity	µS/cm	5	255 ±10	230 ±10	236 ±10	233 ±10
Turbidity	NTU	5	81.5 ±8.2	27.5 ±2.8	-	-
SS	mg/L	5	314 ±31	20 ±2	-	-
Site C: rail washing – Subway						
COD	mg/L	5	1148 ±115	51 ±5	372 ±37	25 ±3
Tot-P	mg/L	5	1.5 ±0.2	0.7 ±0.1	0.4 ±0.1	0.4 ±0.1
Tot-N	mg/L	5	22 ±2.0	11 ±1.0	16 ±2.0	11 ±1.0
pH	-	5	9.7 ±0.1	9.2 ±0.1	8.4 ±0.1	8.1 ±0.1
Conductivity	µS/cm	5	1395 ±10	234 ±10	1129 ±10	227 ±10
Turbidity	NTU	5	958 ±96	59 ±6	-	-
SS	mg/L	5	1252 ±125	81 ±8	-	-
Site D: large workshop wash – Bus						
COD	mg/L	5	413 ±41	285 ±29	298 ±30	144 ±14
Tot-P	mg/L	5	0.6 ±0.1	0.2 ±0.1	0.1 ±0.1	0.1 ±0.1
Tot-N	mg/L	5	<10	<10	<10	<10
pH	-	5	7.6 ±0.1	7.4 ±0.1	6.7 ±0.1	6.9 ±0.1
Conductivity	µS/cm	5	534 ±10	540 ±10	518 ±10	512 ±10
Turbidity	NTU	5	203 ±20	79 ±8	-	-
SS	mg/L	5	318 ±32	77 ±8	-	-
Site E: vehicle wash station – Bus						
COD	mg/L	5	129 ±13	349 ±35	190 ±19	1119 ±112
Tot-P	mg/L	5	0.17 ±0.1	0.3 ±0.1	0.13 ±0.1	0.34 ±0.1
Tot-N	mg/L	5	<10	<10	<10	<10
pH	-	5	7.6 ±0.1	7.0 ±0.1	6.2 ±0.1	6.8 ±0.1
Conductivity	µS/cm	5	255 ±10	222 ±10	237 ±10	199 ±10
Turbidity	NTU	5	76 ±8	59 ±6	-	-
SS	mg/L	5	94 ±9	73 ±7	-	-
Site F: machine parts washing – Bus						
COD	mg/L	5	669 ±67	786 ±79	233 ±23	209 ±21
pH	-	5	7.5 ±0.1	7.5 ±0.1	7.8 ±0.1	7.6 ±0.1
Turbidity	NTU	5	252 ±25	324 ±32	-	-
SS	mg/L	5	420 ±42	869 ±87	-	-

Table 6. Statistical data on water quality of the three carwashes studied.
*Environmental standards under French legislation (Decree February 2nd, 1998)

	Units	n	Min.	Max.	Mean	Median	Standard deviation	Environmental standards
Site 1: truck carwash								
COD	mg /L	5	539	1 506	949	654	462	125*
Tot-P	mg/L	5	16.5	53.2	35.5	29.6	15.6	10*
Tot-N	mg/L	5	8	19	12	11	4	30*
pH	-	5	4.9	6.9	6.0	5.8	0.8	5.5-9.5*
Conductivity	µS/cm	5	687	8450	4357	3849	2884	-
Turbidity	NTU	5	60	152	126	133	38	-
SS	mg/L	5	46	518	302	236	208	35*
Σ PAHs (16)	µg/L	5	1.002	2.740	1.778	1.726	0.638	-
MTBE	µg/L	5	<LOQ	12.0	2.4	<LOQ	5.4	-
TH	mg/L	5	<LOQ	0.92	0.56	0.58	0.34	10*
Site 2: self-service carwash								
COD	mg/L	5	80	421	239	185	145	125*
Tot-P	mg/L	5	4.0	99	28	5.4	41	10*
Tot-N	mg/L	5	6	14	9	8	3	30*
pH	-	5	8.6	9.6	9.1	9.2	0.4	5.5-9.5*
Conductivity	µS/cm	5	562	2880	1457	1273	958	-
Turbidity	NTU	5	42	203	100	80	68	-
SS	mg/L	5	35	223	130	124	67	35*
Σ PAHs (16)	µg/L	5	0.016	0.826	0.372	0.361	0.318	-
MTBE	µg/L	5	<LOQ	1.5	0.3	<LOQ	0.7	-
TH	mg/L	5	<LOQ	0.12	0.02	<LOQ	0.05	10*
Site 3: petrol station carwash								
COD	mg/L	5	144	301	227	235	59	125*
Tot-P	mg/L	5	0.3	0.8	0.5	0.5	0.2	10*
Tot-N	mg/L	5	6	13	10	9	3	30*
pH	-	5	6.7	7.5	7.0	7.1	0.3	5.5-9.5*
Conductivity	µS/cm	5	254	638	490	523	153	-
Turbidity	NTU	5	23	43	32	27	9	-
SS	mg/L	5	13	90	45	51	32	35*
Σ PAHs (16)	µg/L	5	0.101	0.731	0.319	0.170	0.276	-
MTBE	µg/L	5	<LOQ	1.3	0.3	<LOQ	0.6	-
TH	mg/L	5	<LOQ	0.24	0.09	0.11	0.10	10*
Site A: subway wash station								
COD	mg /L	5	38	1790	626	51	1008	125*
Tot-P	mg/L	5	0.7	42	14	0.8	24	10*
Tot-N	mg/L	5	5	22	13	11	9	30*
pH	-	5	8.5	10.1	9.3	9.2	0.8	5.5-9.5*
Conductivity	µS/cm	5	230	1906	790	234	966	-
Turbidity	NTU	5	28	870	319	59	478	-
SS	mg/L	5	20	790	297	81	428	35*
Σ PAHs (16)	µg/L	5			<LOQ			-
MTBE	µg/L	5			<LOQ			-
TH	mg/L	5			<LOQ			10*
Site E: bus wash station								
COD	mg/L	5	285	349	317	317	45	125*
Tot-P	mg/L	5	0.2	0.3	0.2	0.2	0.1	10*
Tot-N	mg/L	5	<10	<10	<10	<10	<10	30*
pH	-	5	7.0	7.4	7.2	7.2	0.3	5.5-9.5*
Conductivity	µS/cm	5	222	540	381	381	225	-
Turbidity	NTU	5	58.6	79	68.8	68.8	14.4	-
SS	mg/L	5	73	77	75	75	3	35*
Σ PAHs (16)	µg/L	5			0.037			-
MTBE	µg/L	5			<LOQ			-
TH	mg/L	5			0.47			10*

Figure 1. Pre-treatment diagram.

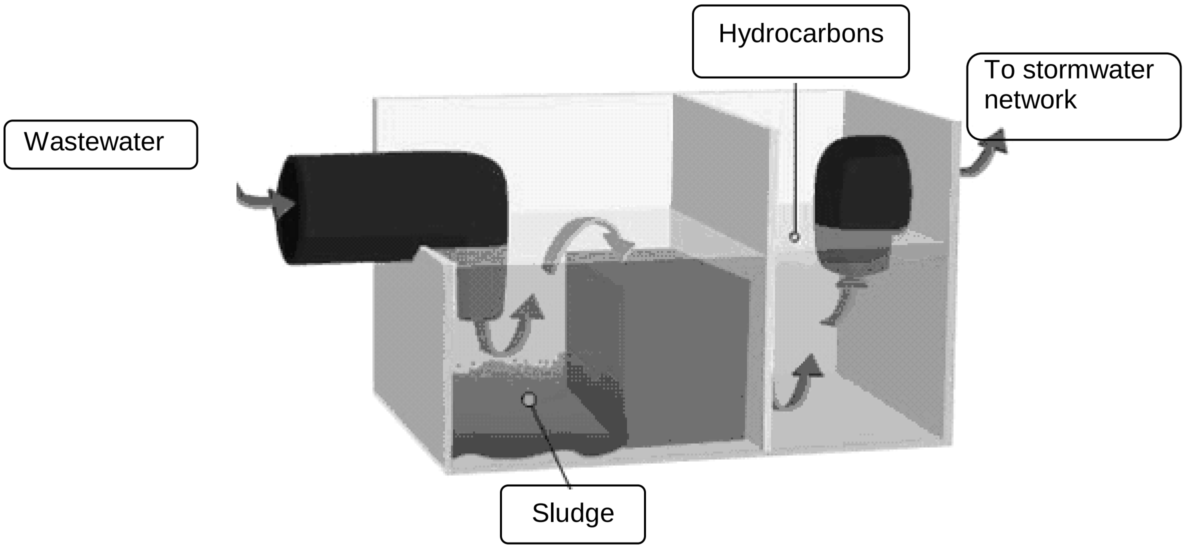

Figure 2. Location of sampling sites.

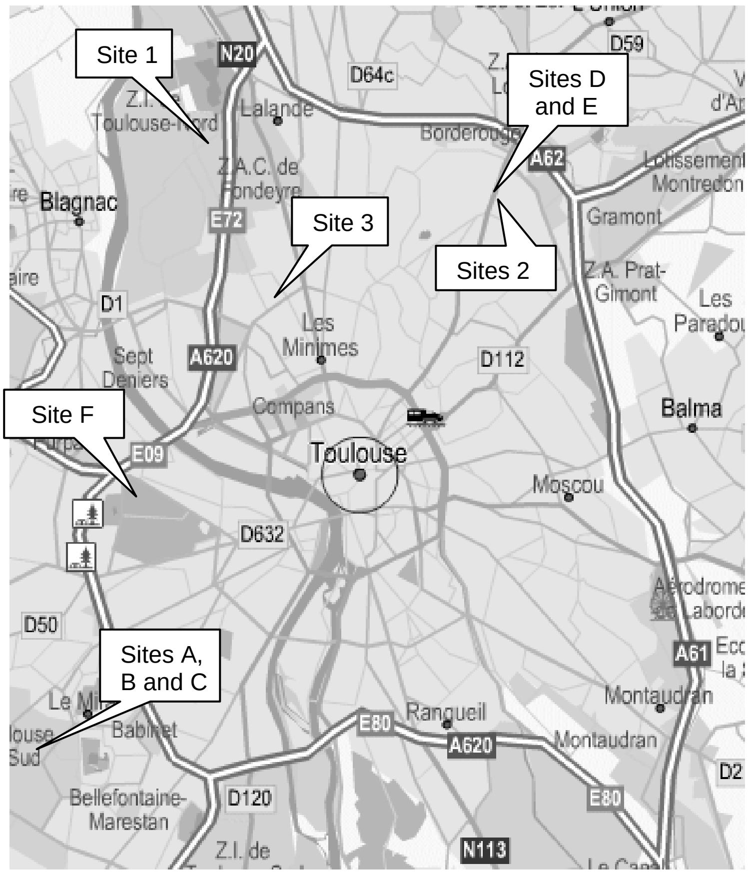

Figure 3. Biodegradability curve of subway wash effluent.