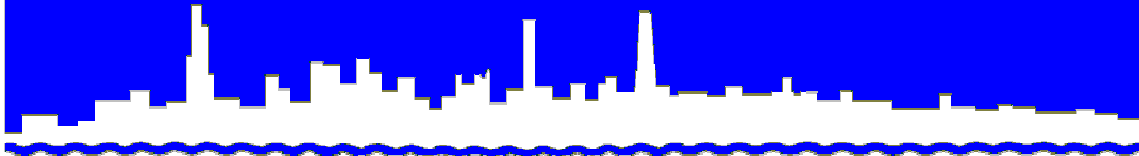


*Protecting Our Water Environment*



*Metropolitan Water Reclamation District of Greater Chicago*

***RESEARCH AND DEVELOPMENT  
DEPARTMENT***

*REPORT NO. 06-70*

*REPORT ON COMMERCIAL LAUNDRIES AS SOURCES OF  
ALKYLPHENOL ETHOXYLATES TO DISTRICT WATER  
RECLAMATION PLANTS*

*NOVEMBER 2006*

**Metropolitan Water Reclamation District of Greater Chicago**

**100 East Erie Street Chicago, Illinois 60611-2803 312-751-5600**

REPORT ON COMMERCIAL LAUNDRIES AS SOURCES OF ALKYLPHENOL  
ETHOXYLATES TO DISTRICT WATER RECLAMATION PLANTS

By

Ali Oskouie  
Research Scientist I

David T. Lordi  
Research Scientist III

Catherine O'Connor  
Research Scientist IV

Thomas Granato  
Assistant Director of Research and Development  
Environmental Monitoring and Research Division

## TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES	ii
ACKNOWLEDGMENT	iii
DISCLAIMER	iii
SUMMARY AND CONCLUSIONS	iv
INTRODUCTION	1
Sampling	1
Results	1

## LIST OF TABLES

<u>Table No.</u>		<u>Page</u>
1	Commercial Laundries Sampled for Alkylphenol Ethoxylates	2
2	Alkylphenol Ethoxylate Concentrations in Effluents From Commercial Laundries	3
3	Alkylphenol Ethoxylate Concentrations in Influent to District WRPs	6
4	Commercial Laundries' Mass Loadings of Alkylphenol Ethoxylates in Lbs/Day	7
5	Comparison of Industrial Laundry and WRP Influent Alkylphenol Ethoxylate Loading	8

## **ACKNOWLEDGMENT**

Acknowledgment is given to the Industrial Waste Division field staff for their efforts in sampling the various commercial laundries. Also acknowledged is the Organic Compounds Analytical Laboratory staff for the analysis of the collected samples.

Thanks are also due to Ms. Laura Franklin, Principal Office Support Specialist, for her diligence in typing this report.

## **DISCLAIMER**

Mention of proprietary equipment and chemicals in this report does not constitute endorsement by the Metropolitan Water Reclamation District of Greater Chicago.

## SUMMARY AND CONCLUSIONS

A joint study with United States Environmental Protection Agency (USEPA) Region V was initiated in February 2003 to determine the occurrence of alkylphenol ethoxylates (APEs) at the Metropolitan Water Reclamation District of Greater Chicago's (District) water reclamation plants (WRPs). As part of this study a sampling of 18 commercial laundries that discharge to the Stickney, Calumet, North Side, John E. Egan, and James C. Kirie WRPs was conducted in 2005-2006. Twenty-four-hour composite samples of the discharges were taken on two consecutive days using automatic samplers. The samples were analyzed for five different APE congeners, bisphenol A, 4-(tert-octyl)phenol, total nonylphenols, total nonylphenol monoethoxylates, and total nonylphenol diethoxylates.

The following are the conclusions from this study:

- There is a wide variation in effluent concentrations of APEs at different laundry facilities.
- Nonylphenol ethoxylates and nonylphenol were the predominant APEs found in the laundry effluents.
- The highest concentrations and loadings of APEs were found in laundries discharging to the Stickney WRP.
- The Stickney WRP had the highest influent APE concentrations and loadings of the District's WRPs.
- Commercial laundries are a source of APEs in the wastewater influent to the WRPs, but they are not the only source.

## INTRODUCTION

As part of a joint study with USEPA Region V which was initiated in February 2003 to determine the concentration of alkylphenol ethoxylates (APEs) in the influent, effluent and bio-solids from the District's water reclamation plants (WRPs), a sampling of the commercial laundries that discharge to the Stickney, Calumet, North Side, and Kirie WRPs was conducted. This study was initiated because ethoxylate surfactants are in detergents used by commercial laundries.

APEs are highly effective cleaning agents or surfactants that have been widely used for more than 50 years in a number of industrial sectors. APEs are also used in a variety of cleaning products and detergents for home and institutional use. Alkylphenols, the materials from which APEs are made, consist primarily of nonylphenol (80 percent) and octylphenol (most of the rest).

APEs are considered to be endocrine disrupting chemicals, and can have a range of effects on living organisms. The main concern is APEs' ability to mimic estrogen, which is believed to cause the feminization of river fish which may affect fish population density. Other possible effects of the presence of these chemicals in the environment are an earlier onset of puberty in humans, decreased sperm count in male humans, and subtle birth defects.

### Sampling

Samples of the discharges from 18 commercial laundries were collected by the Industrial Waste Division and analyzed by the District's Organic Compounds Analytical Laboratory. In this study, 24-hour composite samples were taken by automatic composite samplers at 15-minute intervals for two consecutive days. The samples were analyzed for five different APE congeners, bisphenol A, 4-(tert-octyl)phenol, total nonylphenols, total nonylphenol monoethoxylates, and total nonylphenol diethoxylates. The laundries, their discharge rates on the days sampled, and the WRPs into which they discharge are listed in Table 1. The discharge rates shown in Table 1 for some facilities are influent water usage, and for other facilities are the actual discharges from the facilities. When only the influent rate was provided, an equivalent discharge rate was assumed for the facility.

### Results

The results of the APE analyses of the laundry discharges are shown in Table 2. The concentrations measured on two consecutive days are separated by a slash (/).

There is a wide variation in concentrations of APEs discharged by different laundries. In general, the laundries discharging to the Stickney WRP have the highest concentration of APEs. The highest concentrations generally were found for the nonylphenol diethoxylates, followed by nonylphenols. The majority of the samples had nonylphenol concentrations of less than 300 µg/L, with a maximum observed concentration of 2,620 µg/L. Similarly, for nonylphenol monoethoxylates the majority of the concentrations were less than 300 µg/L, with a maximum concentration of 940 µg/L. The highest observed concentration for the nonylphenol diethoxylates was 9,210 µg/L, with the majority of the samples having less than 500 µg/L.

TABLE 1: COMMERCIAL LAUNDRIES SAMPLED FOR ALKYLPHENOL  
ETHOXYLATES

Industry	WRP Service Area	Date Sampled	Discharge Rate (gal/day)	
			Day 1	Day 2
Five Star Laundry, Inc.	Stickney (WS)	2/7-2/8/06	171,458	171,458
AlSCO American Industrial Division	Stickney (WS)	12/6-12/7/05	186,200	222,200
Angelica Textiles Svcs	Stickney (WS)	12/12-12/13/05	128,216	97,845
Roscoe Co.	Stickney (WS)	12/12-12/13/05	748	121,932
Morgan Services, Inc.	Stickney (SW)	12/12-12/13/05	37,200	34,400
Aramark Uniform & Career Apparel, Inc.	Stickney (SW)	12/12-12/13/05	146,100	153,700
Cintas Corporation	Stickney (SW)	1/17-1/18/06	263,800	477,000
G&K Services	Stickney (SW)	1/17-1/18/06	88,300	89,300
Denormandie Towel & Linen	Stickney (SW)	1/9-1/10/06	82,809	55,505
Western Piece Dyers/Finishers	Stickney (SW)	12/5-12/6/05	171,700	176,300
Van Dyne Crotty Inc.	Calumet	1/9 -1/10/06	36,180	20,070
Domestic Uniform Rental Company	North Side	1/9-1/10/06	54,683	72,860
AlSCO-American Industrial Division	North Side	1/9-1/10/06	32,166	26,182
Mickey's Linen & Towel Supply	North Side	2/6-2/7/06	62,400	62,400
Lechner and Sons, Inc	Kirie	12/5-12/6/05	27,000	28,000
Unifirst Corp	Kirie	1/17-1/18/06	58,200	58,200
Hospital Laundry Services (Sta 1)*	Kirie	1/17-1/18/06	301,000	315,000
Hospital Laundry Services (Sta 2)	Kirie	1/17-1/18/06	59,600	65,200
Cintas Corporation	Egan	12/6-12/7/05	93,000	78,000

\*This laundry has two outfalls.

WS = West Side interceptor.

SW = Southwest interceptor.



TABLE 2: ALKYLPHENOL ETHOXYLATE CONCENTRATIONS IN EFFLUENTS FROM COMMERCIAL LAUNDRIES

Industry	WRP Service Area	Concentration, µg/L (ppb)				
		Bisphenol A	4-(tert-octyl)phenol	Total Nonylphenols	Total Nonylphenol Monoethoxylates	Total Nonylphenol Diethoxylates
Five Star Laundry, Inc.	Stickney (WS)	ND/ND	ND/ND	ND/ND	15.1/ND	29.4/67.9
AlSCO American Industrial Division	Stickney (WS)	ND/ND	ND/ND	21.4/286	82.3/232	248/868
Angelica Textiles Svcs	Stickney (WS)	ND/ND	ND/ND	13.5/15.8	64.8/71.4	227/294
Roscoe Co.	Stickney (WS)	6.6/ND	3.1/ND	566/2520	142/802	162/1470
Morgan Services, Inc.	Stickney (SW)	ND/20.8	ND/ND	139/110	148/252	ND/120
Aramark Uniform & Career Apparel, Inc.	Stickney (SW)	9.5/6.3	ND/ND	93.7/125	676/940	7210/9210
Cintas Corporation	Stickney (SW)	ND/ND	ND/ND	1590/2620	ND/412	1790/1810
G&K Services	Stickney (SW)	21.3/21.7	ND/ND	282/250	106/ND	428/270
Denormandie Towel & Linen	Stickney (SW)	23.4/18.4	ND/ND	79.4/88.5	198/215	275/482
Western Piece Dyers/Finishers	Stickney (SW)	ND/ND	33.4/8.6	71/10.3	32/11.8	ND/11.8
Van Dyne Crotty Inc.	Calumet	16.1/7.7	ND/ND	68.7/152	45.8/72.6	210/338
Domestic Uniform Rental Company	North Side	2.0/1.1	ND/ND	105/32.7	ND/10	ND/36.8
AlSCO-American Industrial Division	North Side	2.0/5.0	ND/ND	151/158	55.5/98.8	203/456
Mickey's Linen & Towel Supply	North Side	ND/ND	ND/ND	27.4/19.7	46.6/27.8	73.9/46.1
Lechner and Sons, Inc	Kirie	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND

TABLE 2 (Continued): ALKYLPHENOL ETHOXYLATE CONCENTRATIONS IN EFFLUENTS FROM COMMERCIAL LAUNDRIES

Industry	WRP Service Area	Concentration, $\mu\text{g/L}$ (ppb)				
		Bisphenol A	4-(tert-octyl)phenol	Total Nonylphenols	Total Nonylphenol Monoethoxylates	Total Nonylphenol Diethoxylates
Unifirst Corp	Kirie	4.9/5.0	ND/ND	ND/ND	ND/ND	400/308
Hospital Laundry Services Sta 1)	Kirie	ND/ND	ND/ND	19.5/18	149/181	358/441
Hospital Laundry Services Sta 2)	Kirie	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND
4 Cintas Corporation	Egan	15/ND	1.7/ND	65.9/322	70/245	355/950

ND = Not detected.

The / (slash) separates the results of analysis for two consecutive days of sampling.

In order to compare the concentrations of APEs found in the laundry discharges with the influent concentrations at the WRPs, analytical results from samples collected in February 2005 and January/February 2006 are summarized in Table 3. There is some variation in the influent concentrations between the two samples, with the 2006 values generally higher than the 2005 values. The highest APE concentrations occurred in the Stickney WRP influents (Table 3) and the laundries discharging to the Stickney WRP (Table 2). No nonylphenol diethoxylates were found in any of the WRP influents except for the Stickney WRP influent samples collected in 2005. The WRP influent concentrations of APEs are generally significantly lower than in the laundry discharges, which is expected due to the dilution from other wastewater.

Table 4 shows the loadings in lbs/day for each of the APE compounds, and the total loading for all APE compounds for the 2-day sampling event for each industrial facility. The total APE loadings observed ranged from 0 to 19.3 lbs/day.

In Table 5, the highest daily total mass loading in each facility's discharge is compared with the average influent loadings at the receiving WRP. The average influent loadings to the WRPs were calculated based upon only two samples collected in 2005 and 2006. The influent APE loadings to the WRPs ranged from 533 lbs/day (Stickney WRP) to 9.5 lbs/day (Egan WRP). The highest and lowest combined laundry loadings were 41.9 lbs/day to the Stickney WRP and 0.1 lbs/day to the Calumet WRP. The results suggest that while commercial laundries are a source of APEs to the WRPs, they are not the only source of these compounds.

TABLE 3: ALKYLPHENOL ETHOXYLATE CONCENTRATIONS IN INFLUENTS TO DISTRICT WRPs

	Concentration ( $\mu\text{g/L}$ )									
	Bisphenol A		4-(tert-octyl)phenol		Total Nonylphenols		Total Nonylphenol Monoethoxylates		Total Nonylphenol Diethoxylates	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Stickney (WS)	ND	1.2	ND	1.8	27	97.7	32	29.5	26	ND
Stickney (SW)	10	ND	ND	ND	32	16.4	46	27.3	25	ND
Calumet	2	3.9	ND	ND	11	19.1	ND	19.3	ND	ND
North Side	ND	ND	ND	ND	14	17.7	ND	20.1	ND	ND
Kirie	ND	ND	ND	1.2	ND	49.8	ND	60	ND	ND
Egan	11	ND	ND	ND	11	26.3	ND	34.3	ND	ND
Reporting Limit	1		1		7		10		19	

\*One sample collected in February 2005 and January or February 2006.

ND = Not detected.

TABLE 4: COMMERCIAL LAUNDRIES' MASS LOADINGS OF ALKYLPHENOL ETHOXYLATES IN LBS/DAY

Industry	WRP Source Area	Mass Loading (lb/day) at the Facility Discharge										Total Loading		
		Bisphenol A		4-(tert-octyl) phenol		Total Nonylphenols		Total Nonylphenol Monoethoxylates		Total Nonylphenol Diethoxylates		Day 1	Day 2	
Five Star Laundry, Inc.	Stickney (WS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.04	0.10	0.06	0.10
Alsco American Industrial Division	Stickney (WS)	0.00	0.00	0.00	0.00	0.03	0.53	0.13	0.43	0.39	1.61	0.55	2.57	
Angelica Textiles Svcs	Stickney (WS)	0.00	0.00	0.00	0.00	0.01	0.01	0.07	0.06	0.24	0.24	0.33	0.31	
Roscoe Co.	Stickney (WS)	0.00	0.00	0.00	0.00	0.00	2.56	0.00	0.82	0.00	1.49	0.01	4.87	
Morgan Services, Inc.	Stickney (SW)	0.00	0.01	0.00	0.00	0.04	0.03	0.05	0.07	0.00	0.03	0.09	0.14	
Aramark Uniform & Career Apparel, Inc.	Stickney (SW)	0.01	0.01	0.00	0.00	0.11	0.16	0.82	1.20	8.79	11.81	9.73	13.18	
Cintas Corporation	Stickney (SW)	0.00	0.00	0.00	0.00	3.50	10.42	0.00	1.64	3.94	7.20	7.44	19.26	
G&K Services	Stickney (SW)	0.02	0.02	0.00	0.00	0.21	0.19	0.08	0.00	0.32	0.20	0.62	0.40	
Denormandie Towel & Linen	Stickney (SW)	0.02	0.01	0.00	0.00	0.05	0.06	0.14	0.15	0.19	0.33	0.4	0.55	
Western Piece Dyers/Finishers	Stickney (SW)	0.00	0.00	0.05	0.01	0.10	0.02	0.05	0.02	0.00	0.02	0.2	0.07	
Van Dyne Crotty Inc.	Calumet	0.00	0.00	0.00	0.00	0.02	0.03	0.01	0.01	0.06	0.06	0.10	0.10	
Domestic Uniform Rental Company	North Side	0.00	0.00	0.00	0.00	0.05	0.02	0.00	0.01	0.00	0.02	0.05	0.05	
Alsco-American Industrial Division	North Side	0.00	0.00	0.00	0.00	0.04	0.03	0.01	0.02	0.05	0.10	0.11	0.15	
Mickey's Linen & Towel Supply	North Side	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.04	0.02	0.08	0.05	
Lechner and Sons, Inc	Kirie	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Unifirst Corp	Kirie	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.15	0.20	0.15	
Hospital Laundry Services Sta 1)	Kirie	0.00	0.00	0.00	0.00	0.05	0.05	0.37	0.48	0.90	1.16	1.32	1.69	
Hospital Laundry Services Sta 2)	Kirie	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Cintas Corporation	Egan	0.01	0.00	0.00	0.00	0.05	0.21	0.05	0.16	0.26	0.62	0.38	0.99	

7

TABLE 5: COMPARISON OF INDUSTRIAL LAUNDRY AND WRP INFLUENT ALKYLPHENOL ETHOXYLATE LOADING

WRP	Number of Laundries	Total Laundry Mass Loading <sup>1</sup> lbs/day	WRP Influent Loading <sup>2</sup> lbs/day
Stickney (WS)	4	7.9	305
Stickney (SW)	6	34.0	228
Calumet	1	0.1	55
North Side	3	0.3	57
Kirie	3	1.9	14
Egan	1	1.0	9.5

<sup>1</sup>Maximum loading from two samples.

<sup>2</sup>Average of two samples collected February 2005 and January or February 2006.

WS = West Side plant.

SW = Southwest plant.