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Evaluation and Wastewater Characterization Northeast Philadelphia Water Pollution Control Plant Philadelphia, Pennsylvania

(SEPTEMBER 16–23, 1976)

NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
DENVER, COLORADO
AND
REGION III, PHILADELPHIA, PENNSYLVANIA

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EVALUATION AND WASTEWATER CHARACTERIZATION
NORTHEAST PHILADELPHIA WATER POLLUTION CONTROL PLANT

Philadelphia, Pennsylvania
(September 16-23, 1976)

January 1977

National Enforcement Investigations Center - Denver, Colorado
and
Region III - Philadelphia, Pennsylvania

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I. INTRODUCTION

The Northeast Philadelphia Water Pollution Control Plant (WPCP), servicing the Northeast section of the Philadelphia metropolitan area, treats an average 720,000 m^3/day (190 mgd) of domestic and industrial wastewaters. The National Pollutant Discharge Elimination System (NPDES) Permit No. PA 0026689, issued December 31, 1974 and effective February 13, 1975, established certain requirements for the plant. Following issuance of the permit, the city of Philadelphia by letter dated January 17, 1975, requested an adjudicatory hearing to contest several permit requirements.

In June 1976, EPA, Region III, requested that the National Enforcement Investigations Center (NEIC) conduct an intensive field survey at the Northeast WPCP to gather data pertinent to the upcoming hearings. NEIC was asked to conduct routine NPDES compliance monitoring, to evaluate possible effects due to tidal action, of the Northeast discharge on the Torresdale Water Treatment Plant (WTP), and to evaluate the kinds and disposition of a broad range of complex organic compounds believed to be discharged from the Northeast WPCP. The Northeast WPCP was of particular concern in that the city does not have a pre-treatment ordinance to regulate its many industrial users.

The Northeast plant is an intermediate plant providing approximately 60% BOD and TSS removal. Schematically [Fig. 1] the treatment process is a modified activated sludge system. Due to limited aeration capacity, however, treatment efficiency is considerably less than that of a secondary plant.

Raw wastewater reaches the plant via four interceptors. Flow from three interceptors passes through grit removal facilities at the

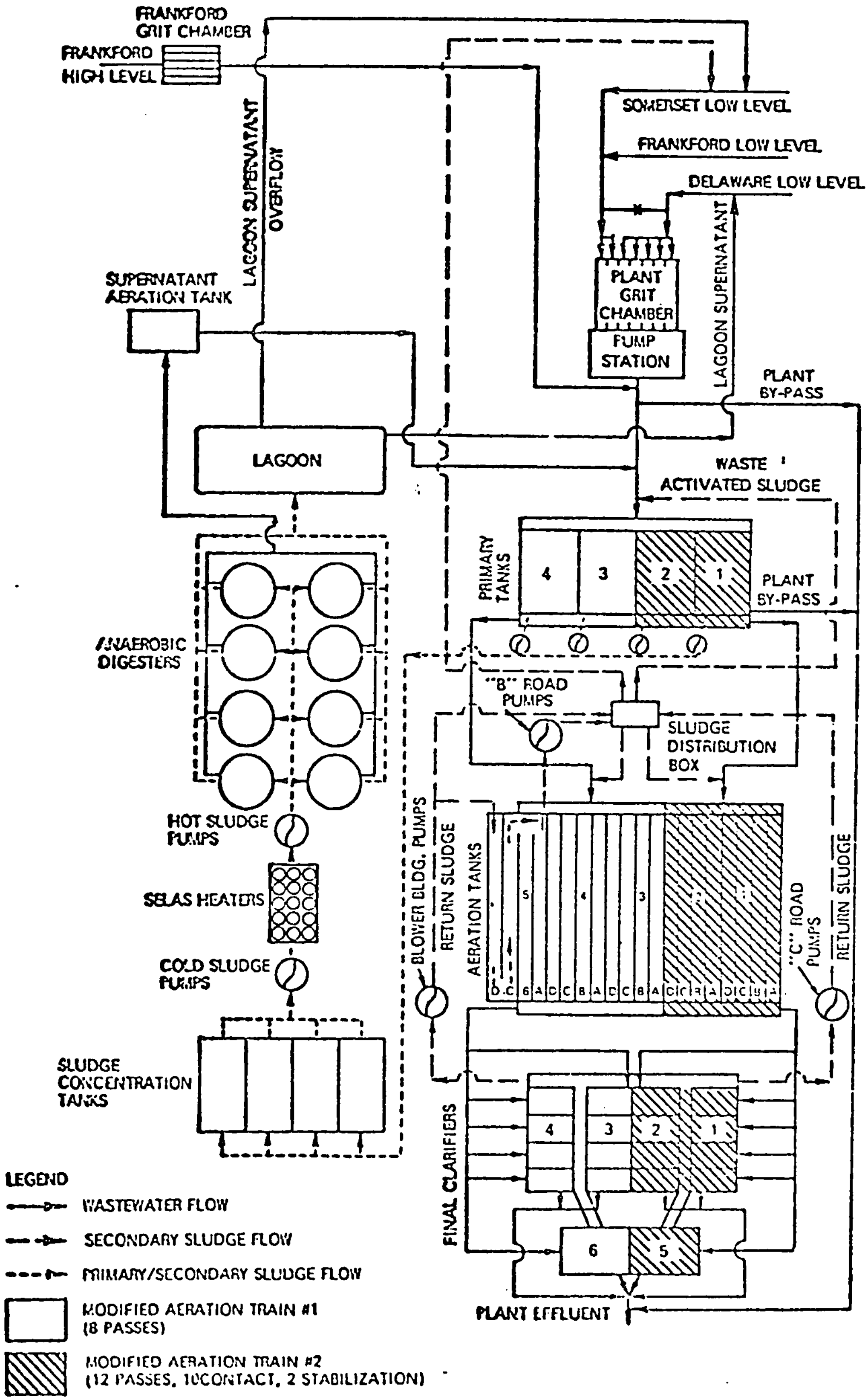

Figure 1. Schematic Flow Diagram
Philadelphia Northeast Water Pollution Control Plant

Northeast plant. Grit is removed from the wastewater of the fourth interceptor at a remote facility. Additional unit processes include primary clarification, aeration, and secondary clarification. Effluent is discharged without disinfection to the Delaware River approximately six miles downstream from the Torresdale WTP. Sludge is anaerobically digested and barged to sea for disposal.

The Torresdale WTP, with a rated capacity of about one million m^3/day (280 mgd), operates at full capacity during the summer and treats an average of 0.76 x 10^6 m^3/day (200 mgd) during the winter. The treatment process includes the following major unit operations; screening, prechlorination, preliminary settling, flocculation, final settling, filtration, post-chlorination, and fluoridation. Raw water from the Delaware River enters the plant through a tide gate which automatically operates on head differential. When the water level in the river exceeds the water level in the preliminary settling basin by 15 cm (6 inches), the gate opens allowing the basin to fill until its level is within 5 cm (2 inches) of the river level. Operation of the intake closely parallels flood tide. Typically, the intake gates open about 30 minutes after the beginning of flood tide and close about 30 minutes after the end of flood tide. Thus, tidal action brings downstream water into the water treatment plant. NEIC was asked to evaluate Torresdale WTP water because of potential contamination from the Northeast WPCP and other downstream sources.

II. CONCLUSIONS

1. Raw wastewater and final effluent from the Philadelphia Northeast WPCP were monitored by NEIC for seven consecutive days from September 16 to 23, 1976. Effluent was monitored to determine compliance with NPDES permit limitations. Raw wastewater was characterized by monitoring for a broad range of pollutants. The Torresdale WTP, which intakes water during flood tide, was monitored to determine the effect of the Northeast WPCP discharge six miles downstream. Tracing dye was released into the Northeast effluent from September 11 to 23, 1976 to evaluate the extent to which the effluent is diluted upon arrival at the Torresdale intake.

2. City of Philadelphia self-monitoring procedures have not complied with EPA requirements. The NPDES permit states that, "Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored parameters." During the NEIC survey, city officials stated that samples are equal-volume composites. EPA also recommends a maximum six-hour holding time for BOD samples. City officials indicated during the survey that for about the past two years it has been the practice to hold BOD samples 18 hours before beginning the analysis. This practice generally results in lower than actual BOD values. It was also determined that the City monitors plant influent downsewer of supernatant and sludge concentration tank return flows. This practice would theoretically cause BOD and TSS percent removal figures for the two years prior to the NEIC survey to be high by approximately 1 and 2%, respectively.

3. NEIC compliance monitoring results indicated that the 7-day average BOD and TSS limitations were met. NPDES initial limitations are compared with survey results as follows:

	NPDES 7-Day Limitations	NEIC 7-Day Results
BOD	150 mg/l	87
TSS	165 mg/l	69

pH limitations were exceeded on numerous occasions during the survey. The permit requires that final effluent pH be within the limits of 6.0 to 9.0 at all times. NEIC measured effluent pH hourly throughout the seven-day monitoring period. Twenty-three measurements were less than 6.0 and one measurement was greater than 9.0.

4. Influent reaches the Northeast WPCP via four interceptors, each of which NEIC monitored separately. Results indicated that the major sources of industrial wastes discharge to the DLL (Delaware Low Level) and the SLL (Somerset Low Level) interceptors. The daily TSS, BOD, COD and oil and grease concentrations varied widely, ranging from 130 to 680, 150 to 600, 410 to 920, and 8 to 320 mg/l, respectively. Similarly, pH fluctuated widely in the DLL and SLL flows ranging from 1.2 to 11.0. The pH of raw wastewater from the DLL and SLL interceptors was severely depressed for extended periods on several occasions. Consecutive hourly readings on September 18, 19, and 20 showed that the pH of the DLL flow was less than 4.0 during three major periods extending 8, 12, and 5 hours, respectively. Data indicated that limited industrial wastes were also present in FLL (Frankford Low Level) and the FHL (Frankford High Level) flows.

5. Final effluent monitoring results indicated that removal efficiencies were sporadic for some pollutants and relatively constant for others. TSS and BOD removal efficiencies changed 41 and 28%, respectively in one day. The high variability in removal efficiency is thought to be one of the effects of incompatible industrial wastes on the biological treatment system. Final effluent pH ranged from 4.0 to 9.2. On three different sampling days, consecutive hourly pH measurements were less than 6.0 for eight, five and four hours. It is most probable that the depressed pH impaired the efficiency of the biological system.

6. Tracing dye was injected under mean tidal conditions into the Northeast WPCP final effluent and found to be carried upstream by flood tides to the Torresdale WTP intake within one tide cycle. Approximately 1 to 2% of the dye concentration at Northeast was found at the Torresdale intake. A persistent pollutant discharged from Northeast at a concentration of 1 mg/l could be expected to be in the Torresdale raw water at a concentration of 0.01 to 0.02 mg/l.

7. The Delaware River and the Torresdale Water Treatment Plant were monitored for COD and heavy metals. No correlation was found between COD concentrations in the Northeast WPCP effluent and the Torresdale WTP intake. Because metal concentrations at the WTP were generally less than detectable levels it is not known whether a correlation exists between metals concentrations from the Northeast WPCP effluent and the Torresdale WTP intake.

8. Heavy metals concentrations, with the exception of mercury, were near or less than the detection limit in the Torresdale WTP finished water. Mercury averaged 1.3 μg/l and reached 1.9 μg/l on one of

the seven days sampled. The EPA maximum contaminant level for mercury in drinking water is 2 μg/l. The mercury concentration in the raw water at Torresdale exceeded 2 μg/l and ranged from 2.7 to 3.2 μg/l on three of the seven days sampled. Two upstream stations in the Delaware River averaged 1.4 and 1.5 μg/l mercury. The Northeast WPCP final effluent averaged 3.3 μg/l and ranged from 0.1 to 18 μg/l mercury.

9. For three days from September 19 to 22, 1976 nine stations were monitored for a broad range of organic compounds. A total of 156 different organic compounds were identified, their toxicity investigated and a toxicity index developed to estimate the relative toxicity of all compounds found. Consideration of absolute toxicity factors, such as the development of cancer or lethal dose, was used to indicate the compounds which are potentially more harmful than others.

10. Seventy-one compounds were identified only in influents to the Philadelphia Northeast WPCP. During three days of monitoring 7,650 kg (16,850 lb) of non-volatile organic compounds were discharged into the Northeast WPCP and based on grab sample results, an estimated 51,100 kg (112,400 lb) of volatile organics also reached Northeast in the raw wastewater. The Delaware Low Level Interceptor was by far the major source of both volatile and non-volatile organics contributing 95 and 92%, respectively of total influent loads to the Northeast Plant. For the same time period, 2,440 kg (5,370 lb) of non-volatiles and an estimated 26,310 (57,800 lb) of volatiles were discharged through the Northeast WPCP outfall to the Delaware River. In addition, an unknown quantity of organic compounds reach the ocean through the barging of anaerobically digested sludge.

11. Raw and finished water from the Torresdale WTP was monitored for three days from September 19 to 22, 1976. Forty-four compounds

were detected in all. Based on extensive literature searches, eighteen of these compounds have not previously been reported in any other finished drinking water. During the three-day monitoring period a total of 560 kg (1,230 lb) of non-volatile organics and an estimated 187 kg (410 lb) of volatile organics were detected in the Torresdale WTP intake. Finished water monitoring showed the presence of 46 kg (101 lb) of non-volatile organics during the three-day period. Volatile organics were monitored only one day by grab samples. The estimated volatile organics load for one day of sampling was 250 kg (550 lb).

12. Nine suspected carcinogens: ethanol (1), chloroform (9), phenol (47), benzyl chloride (56), m-cresol (71), naphthalene (90), indole (97), biphenyl (112), and tetramethyl butyl phenol (132) were detected in the raw wastewater entering the Northeast WPCP. The three-day total load of these compounds was: non-volatile organics -- 794 kg (1,750 lb), of which 97% was from the Delaware Low Level Interceptor, and estimated volatile organics based on grab samples 1,626 kg (3,577 lb), of which 71% was from the Somerset Low Level Interceptor. Seven compounds -- ethanol (1), chloroform (9), bis (2-chloroethyl), ether (43), benzyl chloride (56), indole (97), biphenyl (112) and tetramethyl butyl phenol (132) -- were identified in the Northeast WPCP final effluent. The three-day total load of suspected carcinogens discharged from Northeast was: non-volatile organics -- 94 kg (207 lb), and estimated volatile organics based on grab samples -- 225 kg (494 lb).

13. Two suspected carcinogens were detected in the raw water at the Torresdale WTP intake. During three days of monitoring 0.1 kg (0.3 lb) of bis (2-chloroethyl) ether (43) and based on grab sample results an estimated 51 kg (111 lb) of chloroform (9) passed through the WTP intake. Finished water monitoring results indicated the

presence of two suspected carcinogens. During three days of monitoring 0.5 kg (1.0 lb) of tetramethyl butyl phenol (132) and based on one day's grab sample results, an estimated 176 kg (387 lb) of chloroform (9) were distributed to the city. Monitoring at two upstream stations in the Delaware River revealed the presence of 0.05 μg/l of naphthalene (90), a suspected carcinogen.

III. EVALUATION PROCEDURES

Reconnaissance inspections of the Northeast WPCP and the Torresdale WTP were made on June 30 and July 1, 1976, respectively [Appendix A and B]. Treatment processes were evaluated, sampling locations selected, and flow measurement equipment inspected. NPDES self-monitoring data and other background materials were obtained during the reconnaissance inspections and subsequent visits to local, State, and Federal offices.

NEIC conducted wastewater and water quality monitoring from September 16-23, 1976. The NEIC survey was designed to achieve four major objectives. First, routine monitoring was conducted to determine compliance with NPDES effluent limitations (Section IV). Second, raw wastewater was characterized by monitoring each of the four plant interceptors for parameters indicative of industrial wastes (Section V). Third, dye was injected as a tracer at the Northeast WPCP effluent channel to evaluate the effect of the Northeast discharge on water quality at the Torresdale intake. Two stations in the Delaware River upstream of the Torresdale intake were monitored to ascertain the effect of upstream sources on the water quality at the Torresdale intake (Section VI). The fourth objective was to determine the extent to which complex organic compounds discharged by the Northeast WPCP are present in water treatment at the Torresdale WTP (Section VII).

Influent flows to the Northeast plant were measured using the existing venturi meters and by the dye dilution method [Appendix C]. Effluent flow was taken as the sum of influent flows as determined by existing venturi meters. Flow at each monitoring location was determined hourly throughout the survey. Heavy rainfall occurred on September 16, resulting in increased flow in the combined sewers serving the Northeast plant. During and for several hours after the storm, flow through the SLL and FLL interceptors was severly restricted at the influent gate resulting in direct bypassing to the river.

Sampling was conducted seven consecutive days for a broad range of parameters. Station description, sample type, and parameters are presented in Table 1. Compliance with NPDES 7-day effluent limitations for BOD, suspended solids, and pH was evaluated. All paramenters except pH and oil and grease were monitored on a 24-hour composite basis. Oil and grease were grab sampled three times/day and pH was measured hourly. Hourly sample portions were manually collected and composited on a flow-weighted basis. Samples were collected, preserved, and analyzed in accordance with NEIC Chain of Custody [Appendix D] and Analytical Quality Control Procedures [Appendix E]. Analytical methodology used in organics determinations is available [Appendix F].

Intake and finished water from the Torresdale WTP was sampled on an equal-volume basis for seven consecutive days. Intake samples were collected only during flood tide. Two upstream river stations were monitored for three days [Table 1]. Sample portions were collected hourly during ebb tide over a 24-hour period and composited on an equal-volume basis.

Table 1

SAMPLING SUMMARY
PHILADELPHIA NORTHEAST WATER POLLUTION CONTROL PLANT SURVEY
September 16-23, 1976

Station Description	Date Sampled[a] (Sept.)	Type of Sample	Parameters
Delaware Low Level Interceptor, NEWPCP	16-23	24-hr Flow-Weighted Composite	Organics,[b] COD, TSS, NH_3-N, TKN, $NO_2 + NO_3$, Total P, PO_4, Heavy Metals[c]
		Grab	Volatile Organics,[b,d] O/G[e]
Somerset Low Level Interceptor, NEWPCP	16-23	24-hr Flow-Weighted Composite	Organics,[b] COD, TSS, NH_3-N, TKN, $NO_2 + NO_3$, Total P, PO_4, Heavy Metals[c]
		Grab	Volatile Organics,[b,d] O/G[e]
Frankford Low Level Interceptor, NEWPCP	16-23	24-hr Flow-Weighted Composite	Organics,[b] COD, TSS, NH_3-N, TKN, $NO_2 + NO_3$, Total P, PO_4, Heavy Metals[c]
		Grab	Volatile Organics,[b,d] O/G[e]
Frankford High Level Interceptor, NEWPCP	16-23	24-hr Flow-Weighted Composite	Organics,[b] COD, TSS, NH_3-N, TKN, $NO_2 + NO_3$, Total P, PO_4, Heavy Metals[c]
		Grab	Volatile Organics,[b,d] O/G[e]
Combined Influent, NEWPCP	19-21	Grab	Nitrosamines[b,d]
Final Effluent, NEWPCP	16-23	24-hr Flow-Weighted Composite	Organics,[b] COD, TSS, NH_3-N, TKN, $NO_2 + NO_3$, Total P, PO_4, Heavy Metals[c]
		Grab	Volatile Organics,[b,d] O/G,[e] Nitrosamines[b,d]
Torresdale WTP Intake	16-23	Equal-Volume Composites[f]	Organics,[b] COD, Heavy Metals,[c]
		Grab	Volatile Organics,[b,d] Nitrosamines[b,d]
Torresdale WTP Finished Water	16-23	Equal-Volume Composite[g]	Organics,[b] COD, Heavy Metals[c]
		Grab	Volatile Organics[b,d]
Delaware River @ Buoy 36, 5.9 Miles Upstream of Torresdale WTP Intake	19-22	24-hr Equal-Volume Composite[h]	Organics,[b] COD, Heavy Metals[c]
Delaware River @ Buoy 48, 8.8 Miles Upstream of Torresdale WTP Intake	19-22	24-hr Equal-Volume Composite[h]	Organics,[b] COD, Heavy Metals[c]

a *For 24-hr composite samples, beginning date is day sampling began. Ending date is day final 24-hr composite samples came off. Sampling day was 6 a.m.-6 a.m.*
b *Organics, volatile organics and nitrous amines were collected for three days September 20, 21 and 22.*
c *Heavy metals include Ag, Al, As. Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Zn, Sn, Se and Ti.*
d *Volatile organics and nitrosamines were grab sampled once per day.*
e *Oil and grease were grab sampled three times per day.*
f *Composites for Sept. 17, 18, 19 and 23 covered one flood tide. Composites for Sept. 20, 21 and 22 covered two flood tides.*
g *Composites for Sept. 16, 17, 18 and 23 were approximately 8-hour composites. Composites for Sept. 20, 21 and 22 were 24-hr composites.*
h *Composites collected over 24-hr during ebbtide only.*

IV. COMPLIANCE MONITORING

The Northeast WPCP was monitored to determine compliance with the NPDES permit 7-day effluent limitations. The permit established initial and interim limitations; however, the interim limitations among other permit conditions were contested by the city in a formal request for adjudicatory hearing dated January 17, 1975. The following initial effluent limitations have been in effect since February 12, 1975:

	30-day Average	7-day Average
BOD_5	100 mg/l, 84,100 kg/day (187,000 lb/day) 60% removal	150 mg/l
TSS	110 mg/l, 92,500 kg/day (205,000 lb/day) 65% removal	165 mg/l
pH	within limits of 6.0-9.0 at all times	

City self-monitoring data [Table 2] indicates that BOD and TSS removal requirements and pH limitations were exceeded during the 17-month period from February 1975 to June 1976. BOD and TSS removal efficiencies were exceeded on three and six months respectively, and effluent pH was reported less than 6.0 during March 1975.

City personnel collect influent samples downsewer of sludge concentration tank and digester supernatant return flows. This practice would theoretically cause BOD and TSS percent removal figures for the two years prior to the NEIC survey to be high by approximately 1 and 2%, respectively. Therefore, reported BOD and TSS removal efficiencies [Table 2] are greater than actual.

Table 2

SELF-MONITORING DATA NORTHEAST WPCP EFFLUENT
February 1975 - June 1976

Date	BOD Average mg/l	% Removal	TSS Average mg/l	% Removal	pH Minimum	pH Maximum
February 1975	75	54†	95	53††	6.3	7.4
March	62	61	75	60††	5.4†††	7.3
April	71	56†	79	62††	6.9	7.0
May	57	58†	76	57††	6.9	6.9
June	57	60	85	54††	6.5	6.9
July	33	75	51	71	6.6	6.9
August	51	64	56	69	7.0	7.1
September	46	71	52	74	6.8	7.1
October	58	67	59	70	6.7	7.0
November	59	66	67	70	7.1	7.3
December	65	63	74	60††	7.3	7.5
January 1976	64	64	68	65	7.3	7.4
February	56	66	46	76	6.8	7.1
March	70	62	75	65	6.8	7.1
April	60	65	63	66	6.3	7.3
May	54	66	60	65	6.2	7.2
June	62	61	57	71	6.9	7.5

† *Less than the 60 percent BOD removal required by NPDES permit.*
†† *Less than the 65 percent TSS removal required by NPDES permit.*
††† *Less than the 6.0 minimum pH allowed by NPDES permit.*

Hourly sample portions are composited on an equal-volume basis instead of a flow-weighted basis. The NPDES permit specifies that samples shall be representative of the volume and nature of the monitored parameter. Northeast plant personnel also stated that for approximately the last two years BOD analyses were begun 18 hours after samples were collected. This exceeds the six-hour holding time recommended by EPA[1] and probably results in BOD concentrations lower than the actual due to bacterial decomposition and oxygen uptake.

NEIC compliance monitoring results [Tables 3 and 4] show that the discharge met the initial BOD and TSS permit limitations with 7-day average effluent concentrations of 87 and 69 mg/l, respectively. BOD and TSS removal efficiencies averaged 61 and 64%, respectively. When influent loadings due to digester supernatant return are subtracted, removal efficiencies for BOD and TSS are 60 and 62%, respectively. The pH limitations, however, were exceeded on three out of the seven days. Hourly pH measurements [Table 4] show that the effluent pH was less than 6.0 twenty-three times and greater than 9.0 once. It is probable that the pH was depressed in the biological system and overall treatment efficiency was reduced.

Table 3

FIELD MEASUREMENTS AND ANALYTICAL DATA
NORTHEAST PHILADELPHIA WATER POLLUTION CONTROL PLANT
September 16-23, 1976

Station Description	Date†	Flow††		pH Range	TSS			BOD			COD		
		m^3/day x 10^3	mgd		mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day
Delaware Low Level Interceptor	9/17	310	88	3.5-6.8	280	93,000	210,000	150	50,000	110,000	410	140,000	300,000
	9/18	290	76	3.1-9.0	320	92,000	200,000	220	63,000	140,000	680	190,000	430,000
	9/19	230	61	1.5-8.0	130	30,000	66,000	170	39,000	87,000	850	200,000	430,000
	9/20	260	69	1.2-7.9	150	39,000	86,000	280	73,000	160,000	440	110,000	250,000
	9/21	290	76	2.1-7.4	170	49,000	110,000	320	92,000	200,000	590	170,000	380,000
	9/22	280	73	3.8-8.2	170	47,000	100,000	200	55,000	120,000	470	130,000	290,000
	9/23	250	65	6.3-7.2	160	39,000	87,000	250	62,000	140,000	580	140,000	320,000
	7-Day Average	270	71		200	55,000	120,000	230	61,000	140,000	570	150,000	340,000
Somerset Low Level Interceptor†††	9/17	170	44	3.1-7.4	380	63,000	140,000	160	26,000	58,000	620	100,000	230,000
	9/18	140	38	5.8-9.2	490	71,000	160,000	600	87,000	190,000	840	120,000	270,000
	9/19	130	35	5.1-11.0	680	89,000	200,000	380	50,000	110,000	920	120,000	270,000
	9/20	120	31	6.6-7.1	370	44,000	96,000	370	44,000	96,000	630	74,000	160,000
	9/21	120	33	6.6-8.8	340	42,000	93,000	440	55,000	120,000	860	110,000	240,000
	9/22	120	30	6.7-7.8	240	28,000	61,000	340	39,000	87,000	830	96,000	210,000
	9/23	150	40	6.4-7.4	330	50,000	110,000	430	65,000	140,000	920	140,000	310,000
	7-Day Average	140	36		400	55,000	120,000	390	52,000	110,000	800	110,000	240,000
Frankford Low Level Interceptor	9/17	36	9.4	2.3-6.6	80	2,800	6,300	76	2,700	6,000	330	12,000	26,000
	9/18	36	9.5	5.4-8.8	85	3,100	6,700	140	5,000	11,000	400	14,000	32,000
	9/19	44	12	4.5-9.1	45	2,000	4,400	94	4,100	10,000	210	9,200	20,000
	9/20	23	6.0	6.4-7.0	120	2,700	6,000	170	3,900	8,500	290	6,600	15,000
	9/21	55	15	2.9-8.5	88	4,900	11,000	260	14,000	32,000	330	18,000	40,000
	9/22	51	13	6.2-9.1	60	3,000	6,700	100	5,100	11,000	290	15,000	32,000
	9/23	56	15	6.3-8.6	55	3,100	6,800	140	7,900	17,000	340	19,000	42,000
	7-Day Average	43	12		76	3,100	6,900	140	4,300	14,000	310	13,000	30,000
Frankford High Level Interceptor	9/17	270	70	5.7-6.7	110	29,000	65,000	68	18,000	40,000	240	64,000	140,000
	9/18	220	58	5.1-6.6	82	18,000	39,000	200	44,000	100,000	330	72,000	160,000
	9/19	200	53	6.0-7.0	58	12,000	26,000	80	16,000	35,000	220	44,000	100,000
	9/20	200	54	6.1-7.0	90	18,000	40,000	230	47,000	100,000	280	57,000	130,000
	9/21	210	56	5.5-8.1	110	24,000	52,000	170	36,000	80,000	250	53,000	120,000
	9/22	210	55	6.0-8.2	85	18,000	39,000	100	21,000	46,000	250	52,000	110,000
	9/23	210	55	6.4-7.8	45	9,300	21,000	110	23,000	50,000	240	50,000	110,000
	7-Day Average	220	57		83	18,000	40,000	140	29,000	64,000	260	56,000	120,000
Final Effluent	9/17	760	200	4.0-7.1	55	42,000	90,000	40	30,000	67,000	200	150,000	340,000
	9/18	720	190	5.4-9.2	80	58,000	130,000	76	55,000	120,000	200	140,000	320,000
	9/19	660	180	5.5-7.7	80	53,000	120,000	59	39,000	86,000	230	150,000	340,000
	9/20	640	170	6.4-7.2	88	56,000	120,000	160	100,000	220,000	190	120,000	270,000
	9/21	720	190	6.5-7.2	110	79,000	170,000	140	100,000	220,000	240	170,000	380,000
	9/22	680	180	6.7-7.6	28	19,000	42,000	60	40,000	90,000	240	160,000	360,000
	9/23	670	180	6.5-7.3	42	28,000	62,000	77	50,000	110,000	270	180,000	400,000
	7-Day Average	690	180		69	48,000	105,000	87	59,000	130,000	220	150,000	340,000
Total of Influents	7-Day Average	670	180			130,000	290,000		150,000	330,000		330,000	730,000
Percent Removal	7-Day Average					63%			60%			54%	

† Date is the day the sample was composited. 24-hr sampling day was from 0600 to 0600.
†† Flows are average of hourly flows during each sampling day.
††† The Somerset Low Level Interceptor was sampled upsewer of all plant return flows.

Table 4

pH DATA
NORTHEAST PHILADELPHIA WATER POLLUTION CONTROL PLANT
September 16-23, 1976

Time	9/17[†]	9/18	9/19	9/20	9/21	9/22	9/23
			DELAWARE LOW LEVEL INTERCEPTOR				
0600	6.6	5.6	6.3	3.7	2.5	6.8	6.5
0700	6.7	6.0	6.7	3.5	5.0	6.5	6.9
0800	6.6	3.1	6.0	3.7	5.7	††	7.1
0900	5.5	6.7	5.5	3.5	5.8	8.2	7.2
1000	3.5	7.2	2.9	3.8	6.0	7.2	7.0
1100	6.4	7.0	2.5	2.5	5.6	6.9	7.1
1200	6.3	7.7	3.4	1.8	6.1	6.9	7.0
1300	6.4	7.2	2.7	2.7	3.3	6.3	7.0
1400	6.1	7.3	2.7	3.0	2.5	6.6	7.0
1500	6.2	7.2	2.8	3.0	2.1	6.6	7.0
1600	6.1	6.8	1.5	2.7	2.3	7.0	7.0
1700	6.0	7.0	3.0	1.2	2.5	3.8	6.5
1800	6.7	7.5	6.6	6.9	7.1	6.3	6.7
1900	6.4	7.9	7.4	7.2	7.2	6.5	6.9
2000	5.9	7.5	7.1	7.9	6.8	6.8	7.2
2100	6.4	9.0	7.3	6.8	6.4	6.7	6.9
2200	6.1	8.2	8.0	7.1	6.6	6.9	7.0
2300	6.8	6.4	7.3	6.8	6.8	6.9	7.0
2400	6.0	7.5	7.4	7.4	6.7	7.0	6.6
0100	6.5	7.3	7.2	7.5	7.4	7.0	6.3
0200	6.7	7.3	6.0	7.0	7.0	7.0	6.5
0300	6.6	7.3	7.1	7.2	7.2	6.7	7.0
0400	6.5	7.2	6.1	7.1	6.6	6.7	7.0
0500	6.4	7.3	6.0	6.4	6.7	7.0	7.1
Maximum	6.8	9.0	8.0	7.9	7.4	8.2	7.2
Minimum	3.5	3.1	1.5	1.2	2.1	3.8	6.3
			SOMERSET LOW LEVEL INTERCEPTOR[†††]				
0600	7.0	6.0	6.8	6.6	7.0	6.9	6.9
0700	††	5.8	6.8	6.8	7.4	6.9	6.8
0800	6.2	6.3	6.8	6.8	8.8	6.9	6.7
0900	6.5	6.1	6.6	6.6	7.0	6.9	7.4
1000	7.3	6.6	6.9	6.8	6.9	6.8	6.8
1100	6.3	6.2	6.6	6.8	6.7	6.9	6.9
1200	6.3	6.5	6.9	6.8	7.1	6.9	6.9
1300	6.4	6.2	6.7	6.8	6.9	7.1	6.9
1400	6.2	6.8	11.0	6.9	6.8	6.8	6.9
1500	5.9	6.3	9.0	6.8	6.9	6.8	6.7
1600	6.2	6.7	7.1	6.7	8.6	6.8	6.7
1700	6.1	6.2	6.8	6.8	6.6	6.7	6.8
1800	6.5	6.6	9.4	6.8	7.1	6.8	6.9
1900	5.9	8.5	7.5	6.8	8.5	6.9	7.0
2000	5.0	8.4	9.0	7.1	8.3	7.0	7.2
2100	3.3	7.9	9.4	6.8	7.5	6.9	6.4
2200	3.1	9.2	7.7	6.9	7.1	7.8	7.2
2300	6.9	6.2	7.3	6.8	7.8	7.2	7.2
2400	5.5	6.7	7.2	6.8	7.2	7.2	7.2
0100	4.4	-	6.5	6.6	7.1	6.9	7.0
0200	4.3	7.3	5.1	6.9	7.1	7.0	6.9
0300	5.1	7.2	6.0	6.9	7.2	7.0	7.1
0400	4.7	7.2	6.4	6.9	7.5	6.9	7.0
0500	6.7	7.1	6.8	6.8	6.9	6.8	7.2
Maximum	7.4	9.2	11.0	7.1	8.8	7.8	7.4
Minimum	3.1	5.8	5.1	6.6	6.6	6.7	6.4

Table 4 (Continued)

pH DATA

Time	9/17†	9/18	9/19	9/20	9/21	9/22	9/23
			FRANKFORD LOW LEVEL INTERCEPTOR				
0600	6.1	5.4	6.7	6.6	6.8	6.2	6.8
0700	6.2	5.6	6.7	6.6	6.7	6.6	6.6
0800	6.1	5.8	6.8	6.8	8.5	7.2	6.3
0900	5.9	7.8	6.5	6.8	7.9	6.9	8.6
1000	6.1	7.6	6.6	6.9	8.1	8.7	8.5
1100	6.0	8.5	6.8	6.8	7.0	7.6	6.7
1200	5.8	6.4	6.7	6.8	7.1	8.5	7.6
1300	6.6	6.3	6.5	6.7	7.2	6.9	7.2
1400	5.9	6.2	6.9	6.8	7.1	7.2	6.9
1500	6.2	6.3	5.7	6.8	8.2	7.8	8.3
1600	6.5	6.4	6.9	6.9	7.8	9.1	8.2
1700	6.2	6.1	6.5	6.8	7.3	7.1	6.9
1800	6.5	7.9	6.9	6.7	7.3	6.8	7.5
1900	6.4	8.3	7.1	6.4	7.1	6.8	7.3
2000	5.2	7.5	6.4	7.0	2.9	6.7	7.0
2100	2.3	8.8	9.1	6.8	6.7	6.8	6.5
2200	4.2	7.9	8.4	6.8	7.8	6.9	7.5
2300	7.0	6.0	6.9	6.8	6.9	7.8	7.3
2400	5.7	6.4	7.0	7.0	6.5	7.3	7.1
0100	5.4	††	6.9	6.7	6.8	7.0	7.2
0200	5.0	6.9	5.1	6.8	6.9	6.8	7.0
0300	5.8	6.9	4.5	6.8	7.0	6.9	7.1
0400	5.0	6.7	5.7	6.8	7.1	6.8	7.1
0500	6.4	6.8	5.7	6.8	6.9	7.0	7.1
Maximum	6.6	8.8	9.1	7.0	8.5	9.1	8.6
Minimum	2.3	5.4	4.5	6.4	2.9	6.2	6.3
			FRANKFORD HIGH LEVEL INTERCEPTOR				
0600	5.7	††	6.8	6.2	8.1	7.5	6.8
0700	6.5	††	6.8	6.6	6.9	6.7	6.9
0800	6.6	6.0	6.8	6.8	7.0	6.9	7.0
0900	6.7	5.4	7.0	6.8	6.7	7.4	7.7
1000	6.4	6.6	6.7	6.9	7.3	8.2	7.8
1100	6.5	6.3	6.8	6.9	7.3	7.3	7.4
1200	6.3	6.4	7.0	6.9	7.3	7.2	7.2
1300	6.7	6.0	6.8	6.9	7.1	6.9	6.9
1400	6.2	6.3	6.7	6.9	7.2	7.1	7.0
1500	6.2	6.2	6.5	6.9	7.0	7.2	6.4
1600	6.3	6.4	6.6	6.8	6.9	6.8	6.8
1700	6.3	6.5	6.7	6.9	7.2	6.9	7.0
1800	6.5	5.8	7.0	6.9	6.5	6.8	7.0
1900	6.3	5.4	7.0	6.9	6.0	6.5	6.9
2000	6.5	5.2	6.8	6.9	5.5	6.0	7.0
2100	6.6	5.5	6.8	6.9	6.5	6.8	7.0
2200	6.5	5.2	6.0	6.8	6.5	6.8	6.9
2300	6.4	5.6	6.0	6.9	6.5	6.5	6.8
2400	6.5	5.7	6.1	7.0	6.0	7.0	6.8
0100	6.7	5.1	6.5	7.0	5.5	6.8	7.0
0200	6.7	5.6	6.2	6.8	5.8	6.8	7.0
0300	6.6	6.0	6.1	6.8	5.8	6.9	7.0
0400	6.7	5.5	6.0	6.8	5.7	6.5	6.9
0500	6.5	5.8	6.1	6.1	5.5	6.5	7.2
Maximum	6.7	6.6	7.0	7.0	8.1	8.2	7.8
Minimum	5.7	5.1	6.0	6.1	5.5	6.0	6.4

Table 4 (Continued)

pH DATA

Time	9/17†	9/18	9/19	9/20	9/21	9/22	9/23
			FINAL EFFLUENT				
0600	6.2	5.7	7.5	6.8	6.5	6.9	6.5
0700	6.2	5.4	6.8	6.8	7.2	6.7	6.9
0800	6.2	5.6	6.6	6.9	7.2	††	7.1
0900	5.5	5.8	6.7	6.9	7.1	7.6	7.3
1000	5.9	5.7	6.6	7.1	7.0	7.0	7.1
1100	6.5	7.6	6.7	7.0	7.2	7.0	7.1
1200	6.0	7.5	7.2	7.0	7.2	7.2	7.0
1300	6.5	7.2	7.7	7.0	7.1	6.8	7.1
1400	6.2	7.3	6.9	7.0	7.0	7.2	7.3
1500	6.2	7.1	6.9	7.2	7.0	7.4	7.2
1600	5.9	7.2	6.8	7.2	7.1	7.1	7.0
1700	5.9	6.5	††	7.0	††	7.0	6.9
1800	7.1	6.7	7.1	6.4	7.0	6.8	6.8
1900	6.1	7.5	7.2	6.9	7.0	6.8	6.9
2000	5.4	7.3	7.1	7.1	6.9	6.9	7.0
2100	6.4	8.0	6.9	6.9	7.0	6.9	6.6
2200	4.6	9.2	7.2	7.1	6.9	6.8	7.1
2300	5.2	6.0	6.8	7.0	6.7	6.9	6.9
2400	5.6	6.8	6.8	7.2	6.8	6.9	7.0
0100	5.9	6.8	6.5	6.9	6.9	6.9	7.0
0200	5.9	7.1	5.8	6.9	7.0	6.8	7.1
0300	4.0	7.1	5.8	6.9	6.8	6.9	7.1
0400	4.6	7.1	5.7	7.0	7.1	6.9	7.1
0500	4.6	7.2	5.5	6.9	6.9	6.8	7.1
Maximum	7.1	9.2	7.7	7.2	7.2	7.6	7.3
Minimum	4.0	5.4	5.5	6.4	6.5	6.7	6.5

† *Sampling day was from 0600 to 0600. Date is end of sampling day.*

†† *No measurement was made.*

††† *The Somerset Low Level Interceptor was monitored upsewer of all plant return flows except from 0600 to 0900 9-16-76 when pH was measured at the manhole receiving supernatant return flows.*

V. WASTEWATER CHARACTERIZATION

The Northeast WPCP treats domestic and industrial wastes with a combined total average flow of approximately 720,000 m^3/day (190 mgd). About 16% or 114,000 m^3/day (30 mgd) of the total flow is industrial wastewater and originates from approximately 120 major industrial sources [Table 5]. It is estimated that approximately 850 industries with more than 20 employees each discharge to the Northeast system.

NEIC monitoring was conducted to characterize raw and treated wastewater to ascertain the presence and possible effect of industrial wastes on the treatment system. Each of the four influent flows and final effluent were monitored for TSS, BOD, COD, oil and grease [Table 6], nutrients [Table 7], heavy metals [Table 8], complex organics, and pH. In addition the combined influent and final effluent were monitored for nitrosamines; however, measurable quantities were not detected. Monitoring results except for complex organics are presented and discussed in this section. Results of complex organics analyses are presented in Section VII.

DELAWARE LOW LEVEL INTERCEPTOR (DLL)

The DLL flow averaged 270 x 10^3 m^3/day (71 mgd) and accounted for 40% of the total plant influent during NEIC sampling. Comparison of daily pollutant concentrations [Table 9] show that industrial inputs cause a substantial impact on DLL wastewater quality. BOD and COD concentrations ranged from 150-320 and 410-850 mg/l, respectively - a broader range than would be expected from domestic wastes.

The pH ranged from 1.2-9.0 during the survey. Consecutive hourly readings on September 18, 19 and 20 [Table 4] showed that the pH was less than 4.0 during three major periods extending 8, 12 and 5 hours,

Table 5

SUMMARY OF MAJOR CONTRIBUTING INDUSTRIES[†]

NORTHEAST WASTEWATER TREATMENT PLANT[††]

Industry	Address	Product	SIC[†††]	Flow m^3/day	Flow 1,000 gpd	City[††††] Surcharge	Pre-[††††] Treatment	Major Constituents[†††††]
		Chemicals						
Allied Chemical	Margaret & Bermuda Sts	Organic Chemicals	2815	8,140	2150	X	X	BOD Organics
Armak	7240 Tacony St.	Cosmetic Chemicals	2818	850	225		X	COD
Haven Chemical	5000 Langdon St.	Esters	2869	300	80		X	-
NL Industries	Araming Ave & Thompson St	Paint Chemicals	2899	1,060	280			COD, Pb*
Philadelpha Coke	4501 Richmond St.	Coke	3312	340	90	X	X	BOD, NH_3, Organics
Rhom & Haas	5000 Richmond St.	Organic Chemicals	2818	14,000	3,700	X	X	BOD, TSS, Organics, pH
			Subtotal:	24,690	6,525			
		Electroplating						
Abaco Platers	1814 E. Russell St.	Electroplating	3471	11	3		X	Cu*, CN_T*
Accurate Electroplating	11th & Westmoreland	Electroplating	3471	200	53		X	CN_T*
Aetna Electroplating	7770 Dungan Road	Electroplating	3471	757	200		X	CN_T*, Zn*
Ed's Polishing	1920 E. Cornwall	Electroplating	3471	42	11		X	Cd*,Cu*,Cr, Ni*, Pb*,Zn*,Hg*
Everbond Electroplating	3751 N. Second St.	Electroplating	3471	757	200		X	CN_T,Pb*,Zn*
Frankford Plating	2505 Orthodox St.	Electroplating	3471	23	6		X	Cu,Cr,Ni*,Pb
Martin's Metal Co.	7327 State Road	Electroplating	3471	38	10		X	Cr
Philadelphia Rust Roof	3225 Frankford Ave.	Electroplating	3471	227	60		X	Ni*,Cr
			Subtotal:	2,055	543			
		Electronics						
Eby Company	4701 Germantown Ave.	Electronic Components	3679	416	110		X	Cd*,Cr
ITE Imperial Corp.	601 E. Erie Ave	Circuit Breakers	3613	1,970	520		X	Cd*,Hg*CN_T*
Komak, Inc.	9th & Ontario	Circuit Breakers	3679	299	79		X	-
Viz	335 E. Price St.	Electronic Instruments	3679	333	88			-
			Subtotal:	3,018	797			
		Food Processing						
Boulevard Baking	9088 Blue Grass Rd.	Bakery	2051	265	70	X	X	BOD
Boulevard Beverage	2000 Bennett	Soft Drinks	2086	227	60	X		BOD
Canada Dry	5300 Whitaker	Soft Drink	2086	378	100	X	X	BOD
Coca Cola	Erie Ave & "G" St.	Soft Drink	2086	662	175	X	X	BOD
Corenco	Wheatsheaf & Aramingo Ave.	Rendering	2077	208	55	X	X	BOD
Cross Bros.	Front & Venango	Abbatoir	2011	2,500	660	X	X	BOD,TSS
Dietz & Watson	Tacony & VanKirk Sts.	Prepared Meats	2013	284	75		X	BOD
E. J. Brach & Sons	4337 Stenton Ave.	Confectionery	2071	314	83			-
Franks Beverages	3901 "G" St.	Soft Drinks	2086	606	160	X		BOD
General Baking	300 E. Godfrey Ave.	Bakery	2051			X		BOD,TSS
Harbison Dairies	3981 Kensington Ave.	Dairy Products	2026	680	180			-
Jacob Stern	2401 E. Tioga St.	Tallow & Oil Refining	2076	680	180	X	X	BOD,TSS
Keystone Rendering	300 E. Ontario	Rendering	2077	246	65		X	BOD,TSS
Mrs. Smith's Pie Co.	7th E. Lindley Sts	Pies	2051	303	80	X		BOD,TSS

Table 5 (Continued)

SUMMARY OF MAJOR CONTRIBUTING INDUSTRIES†,††

Industry	Address	Product	SIC†††	Flow m³/day	Flow 1,000 gpd	City†††† Surcharge	Pre-†††† Treatment	Major Constituents†††††
National Biscuit	12000 Roosevelt Blvd.	Cookies & Crackers	2052	379	100	X	X	-
Northern Bakery	9801 Blue Brass Road	Bakery	2051	568	150	X	X	BOD,TSS
Penn Packing	Butler St. & Aramingo Ave.	Abattoir	2011	1,440	380	X	X	BOD,TSS
Pepsi Cola	Roosevelt Blvd. & Comly Rd	Soft Drinks	2086	416	110	X		BOD,Hg
Quaker City Chocolate and Confectionery	2901 Grant Ave.	Candy	2065	227	60	X		BOD,TSS
Ready Food Products	1821 E. Sedgley Ave.	Dairy	2026	379	100			-
Sealtest	5501 Tabor Rd.	Dairy	2026	1,325	350		X	BOD,TSS
Simonins	2500 E. Tioga St.	Vegetable Oils	2096	680	180	X		BOD,TSS
Theresa Friedman & Sons	Jamison & Tomlinson Rds.	Jams & Jellies	2033	908	240	X		BOD
Whitman Chocolates	9701 Roosevelt Blvd.	Confectionery	2071	1,210	320	X		-
			Subtotal:	14,886	3,933			
			Laundry					
Coyne Industries	1825 E. Atlantic	Laundry	7218	265	70		X	Pb*
Kline's Laundry	4090 Frankford Ave.	Laundry	7211	719	190		X	BOD, TSS
Maurice Kaneff	2741 N. Sixth ST.	Laundry	7211	284	75		X	-
Standard Uniform	4334 N. American	Laundry	7218	227	60		X	-
Unity Uniform Rental Service	1696 Foulkrod St.	Laundry	7218	265	70		X	-
			Subtotal:	1,760	465			
			Metal Products					
Aldine Mfg. Co.	"C" & Clearfield St.	Lighting Fixtures	3642	68	18		X	-
Allied Tube Co.	Norcom & Red Lion Rds.	Steel Tubing	3317	409	108			-
Budd Company	Red Lion & Veree Rds.	Auto Frames & RR Pass.	3711	757	200			-
Budd Company	2450 Hunting Park Ave.	Auto Components	3712	1,590	420			-
Bunting Corp.	1771 Tomlinson Rd.	Metal Outdoor Fur.	2514	606	160			-
Cardo Automotive Prod.	11500 Norcom Rd.	Recond. Carburetors	3717	291	77		X	Cr*,Zn*
Crown Cork & Steel	9300 Ashton Rd.	Cans	3411	1,041	275			-
Dodge Foun. & Mach. Co.	6501 State Rd.	Steel Castings	3323	299	79			-
FMC Corp.	2045 W. Hunting Park Ave.	Speed Reducers	3566	303	80			-
Fox Products Co.	4720 N. 18th St.	Wire Products	3714	129	34		X	-
Futuro Industries	3301 N. 10th St.	Dinettes	2514	246	65		X	-
George Garrett	8801 Torresdale Ave.	Metal Washers	3452	908	240			Cu,Cr*,Zn*,CN_T*
ITT Nesbitt	State Rd. & Rhawn	Air Cond. & Htg. Equip.	3433	537	142			-
Janney Cylinder	7401 Tacony St.	Cylinders	3367	553	146			-
Joseph Hall Co.	2121 W. Clearfield	Hardware	3429	220	58		X	Cu*
Kensey Hays	Front & Olney	Auto Parts	3352	1,665	440			-
Krometal Mfg. Co.	5825 Tacony	Steel Tubes	2514	110	29		X	-

Table 5 (Continued)

SUMMARY OF MAJOR CONTRIBUTING INDUSTRIES†,††

Industry	Address	Product	SIC†††	Flow m³/day	Flow 1,000 gpd	City†††† Surcharge	Pre-†††† Treatment	Major Constituents†††††
Lupton	633 Dunksferry Rd.	Aluminum Windows	3400	-	-		X	COD,TSS
Lustrik	4317 Paul St.	Aluminum Anodizing	3471	284	75		X	-
Metalstand	11518 Roosevelt Blvd.	Steel Office Furniture	2522	329	87			-
Midvale Happenstall	4301 Wissohickon Ave.	Steel Forgings	3391	2,650	700			COD, TSS, O & G
Nice Ball Bearing	30th St & Huntington Park	Ball Bearings	3562	197	52		X	COD, TSS, O & G
Nicholson File	Decatur & Red Lion Rds.	Metal Files	3444	197	52	X	X	BOD, TSS
Olin Corp.	700 E. Godfrey Ave.	Alum. Doors & Windows	3354	379	100			Al, Cr
Peerless Steel Equip.	6610 Hasbrook Ave.	Metal Office Furn.	3579	284	75			Cr
Phila. Steel Wire Corp.	Charter & Caroline Rds.	Wire Products	3316	1,703	450		X	Cr*,Zn*,Hg*
Plumb Inc.	4837 James St.	Forged Tools	3423	303	80			-
Progress Lighting	900 E. Erie Ave	Lighting Fixtures	3642	2,763	730		X	Cu*,Cr*,CN_T*
SKF Industries	Tulip & Kennedy Sts.	Ball Bearings	3399	1,798	475			-
SKF industries	Front & Erie	Ball Bearings	3399	757	200			-
Taylor Lock Co.	2024 W. Lippincott St.	Locks	3429	201	53		X	-
Tube Turns	5245 Bleigh St.	Steel Tubing	3317	435	115			
			Subtotal:	22,012	5,815			
		Paper Products						
American Bag & Paper	Grant Ave. & Ashton Rd.	Bags	2643	303	80			TSS
Continental Can Co.	9820 Blue Grass Rd.	Corrugated Paper Boxes	2653	337	89	X		BOD, TSS
David Weber Co.	3500 Richmond St.	Corrugated Paper Boxes	2653	254	67			-
Marcal Paper	3100 N. Second St.	Tissue Paper	2621	946	250	X		TSS
Newman Paper	6101 Tacony St.	Recycled Paperboard	2631	1,817	480	X		BOD,TSS
Paper Mfg. Co.	9800 Bustleton Ave.	Gummed Paper	2621	227	60	X		BOD,TSS
United Container	9230 Ashton Rd.	Corrugated Paper Boxes	2653	265	70			-
			Subtotal:	4,149	1,096			
		Textile Products						
Anchor Dyeing	1300 Adams Ave.	Textile Dyeing	2231	3,217	850			-
Brehm	3101 Trenton Ave.	Textile Dyeing	2231	757	200			-
D.F. Waters & Sons, Inc.	47 E. Wister St.	Textile Dyeing	2269	405	107			-
Globe Dye Works	4520 Worth St.	Textile Dyeing	2231	1,798	475			-
Jeffries Processing	2800 Jasper St.	Textile Dyeing	2231	1,136	300			-
Keystone Dyeing	107 W. Clearfield	Textile Dyeing	2231	1,514	400			-
Luithlen Dye Corp.	"J" & Tioga St.	Textile Dyeing	2261	379	100			-
Orinoka Mills	2717 Jasper St.	Textile Dyeing	2231	303	80			-
Peerless Dyeing	1825 E. Pacific	Textile Dyeing	2231	757	200			-
Sterling Dyeing	3300 N. Third St.	Textile Dyeing	2231	454	120			-
Victor Dye Works	2270 E. Westmoreland	Textile Dyeing	2231	220	58			-
			Subtotal:	10,940	2,890			

Table 5 (Continued)
SUMMARY OF MAJOR CONTRIBUTING INDUSTRIES †,††

Industry	Address	Product	SIC†††	Flow m^3/day	Flow 1,000 gpd	City†††† Surcharge	Pre-†††† Treatment	Major Constituents†††††
		Miscellaneous Products						
Alco Oil & Chemical	2142 E. Williams St.	Latex Components	3069	341	90		X	-
Black Mfg. Co.	300 W. Bristol St.		3699	95	25		X	Cu
Clover Knitting Mills	Erie Ave. & "M" St.	Sweaters	2253	227	60			-
Delaware Valley Wool Scouring	3419 Richmond St.	Wool	2297	303	80	X	X	BOD,TSS
Dittman & Penn	5155 Belfield Ave		3841	38	10		X	Cr*,Ni*
ESB Corp.	5691 Rising Sun Ave.	Storage Batteries	3691	4,542	1,200		X	Pb*,Hg*
Film Corp. of America	Charter & Caroline Rds.	Film Developing	7395	765	202	X	X	-
F. J. Stokes Co.	5520 E. Tabor Rd.	Vacuum & Drying Equip.	3559	341	90			-
Frankford Arsenal	Tacony & Bridge Sts.	Research & Development	-	4,542	1,200			-
GAF	1900 W. Logan St.	Film Developing	7395	719	190		X	-
General Felt	2121 Wheatsheaf Ln.	Indoor-Outdoor Carpet	2279	492	130		X	TSS
Grover & Sons	2201 E. Somerset St.	Wool Scouring & Dyeing	2297	757	200		X	-
Masland Duraleather	2121 E. Allegheny Ave.	Vinyl Uphol. & Wall Cov.	2821	889	235			-
Northeast Incinerator	Lewis St. & Delaware Ave.	Municipal Trash Inciner.	4953	7,835	2,070		X	Pb
Precision Grind. Wheel	8301 Torresdale Ave.	Grinding Wheels	3291	265	70		X	-
Proctor Schwarts/Silex	5400 N. 6th St.	Textile Equip. & R & D	3552	341	90			-
Quaker Lace Co.	401 W. Lehigh Ave.	Lace Products	2221	416	110		X	-
Snyder Mfg. Co.	23rd & Westmoreland Ave.	Health Products	3429	379	100		X	Cr*,Ni*
Soabar Co.	7722 Dungan Rd.	Marking Equipment	2751	250	66		X	-
S. W. Evans	4639 Paul St.	Umbrellas	3995	833	220		X	Cu,Ni*
United Specialties	7501 Edmund St.	Auto Vent Windows	3465	678	179			-
			Subtotal:	25,048	6,617			

Major Industrial Categories	Flow m^3/day	Flow mgd
Chemicals	24,690	6.625
Electroplating	2,055	0.543
Electronics	3,018	0.797
Food Processing	14,886	3.933
Laundry	1,760	0.465
Metal Products	22,012	5.815
Paper Products	4,149	1.096
Textile Products	10,940	2.890
Miscellaneous Products	25,048	6.617
Total:	108,558	28.681

† *A major contributing industry is one that: (a) has a flow of 50,000 gallons or more per average workday; (b) has a flow greater than 5% of the flow carried by the municipal system receiving the waste; (c) has in its waste a toxic pollutant in toxic amounts as defined in standards issued under Section 307 (a) of the Act; or (d) has significant impact either singly or in combining industries on the treatment works or the quality of its effluent.*

†† *Information from NPDES Permit Application Standard Form A-Municipal, Section IV. Industrial Waste Contribution to Municipal System dated May 6,1976*

††† *Standard Industrial Classification.*

†††† *The x indicates the presence of a city surcharge and/or pretreatment of industrial wastes.*

††††† *Major Constituents are those parameters whose concentrations, as reported on Standard Form A-Municipal May 6, 1976, exceeded one-half the composite sample limitation in the city of Philadelphia revised version of the Industrial Waste Regulations dated May 25, 1976. In addition BOD, COD and TSS are considered major constituents if the concentration reported on Form A is greater than 300 mg/l.*

* *Indicates concentrations exceeding city of Philadelphia revised version of the Industrial Waste Regulations dated May 25, 1976.*

Table 6

OIL AND GREASE DATA†,*

NORTHEAST PHILADELPHIA WATER POLLUTION CONTROL PLANT

September 16-23, 1976

Date	Delaware Low Level Interceptor		Somerset Low Level Interceptor**		Frankford Low Level Interceptor		Frankford High Level Interceptor		Final Effluent	
	Time	mg/l	Time	mg/l	Time	mg/l	Time	mg/l	Time	mg/l
9/16	1002	33	1030	64	1045	37	1135	20	1020	2
	1605	30	1645	22	1630	25	1720	13	1620	8
	2310	30	2345	32	2335	64	2320	25	2325	5
Daily Avg.		31		39		42		19		5
9/17	1010	37	1030	44	1045	36	1010	16	1025	<1
	1610	41	1630	67	1640	53	1610	32	1625	<1
	2300	30	2325	19	2315	26	2310	26	2310	5
Daily Avg.		36		43		38		25		2
9/18	1210	18	1020	140	1030	60	1010	61	1235	2
	1605	32	1620	74	1640	26	1640	21	1620	6
	2330	26	2305	38	2320	10	2315	15	2335	7
Daily Avg.		25		84		32		32		5
9/19	1105	17	1030	320	1040	14	1010	12	1115	5
	1608	34	1630	16	1640	12	1610	28	1620	7
	2305	24	2330	8	2320	26	2315	27	2310	15
Daily Avg.		25		115		17		22		9
9/20	1010	18	1030	79	1040	41	1010	19	1028	4
	1610	34	1630	50	1640	31	1610	18	1615	7
	2305	36	2330	36	2325	12	2315	28	2315	7
Daily Avg.		29		55		28		22		6
9/21	1012	23	1030	82	1040	60	1010	19	1025	6
	1600	19	1630	120	1640	27	1610	20	1615	6
	2330	54	2315	31	2320	27	2315	28	2325	8
Daily Avg.		32		78		38		22		7
9/22	1007	16	1030	88	1040	62	1010	13	1014	2
	1600	20	1630	120	1640	17	1610	29	1610	5
	2340	32	2320	20	2325	8	2305	19	2335	5
Daily Avg.		23		76		29		20		4
7-Day Avg.		29		70		32		23		5

† *All data are based on grab samples. Sampling day is from 6:00 a.m. to 6:00 a.m.*

* *Freon-extractable material.*

** *The Somerset Low Level Interceptor was sampled upsewer of all plant return flows.*

Table 7

NUTRIENT DATA
NORTHEAST PHILADELPHIA WATER POLLUTION CONTROL PLANT
September 16-23, 1976

Station Description	Date†	Flow†† m³/day x 10³	Flow†† mgd	Total Phosphorous mg/l	Total Phosphorous kg/day	Total Phosphorous lb/day	Ortho-Phosphate mg/l	Ortho-Phosphate kg/day	Ortho-Phosphate lb/day	Organic Nitrogen mg/l	Organic Nitrogen kg/day	Organic Nitrogen lb/day	Ammonia mg/l	Ammonia kg/day	Ammonia lb/day	Nitrite and Nitrate mg/l	Nitrite and Nitrate kg/day	Nitrite and Nitrate lb/day
Delaware	9/17	330	88	5.0	1,700	3,700	1.0	330	730	2.1	700	1,500	18	6,000	13,000	0.20	66	150
Low Level	9/18	290	76	6.2	1,800	3,900	3.0	840	1,900	2.2	630	1,400	25	7,200	16,000	0.23	66	150
Interceptor	9/19	230	61	6.0	1,400	3,000	3.7	860	1,900	1.2	280	610	26	5,900	13,000	0.04	9.3	20
	9/20	260	69	6.4	1,700	3,600	3.8	1,000	2,200	0.0	0.0	0.0	24	6,300	14,000	0.05	13	29
	9/21	290	76	7.8	2,300	5,000	3.5	1,000	2,200	0.0	0.0	0.0	22	6,500	14,000	0.04	12	25
	9/22	280	73	5.8	1,600	3,500	3.0	830	1,800	0.0	0.0	0.0	24	6,600	15,000	0.08	22	49
	9/23	250	65	6.2	1,500	3,400	2.0	480	1,100	0.1	25	54	24	6,000	13,000	0.05	12	27
7-Day Average		270	71	5.8	1,700	3,700	2.9	760	1,700	0.8	230	510	23	6,400	14,000	0.10	29	64
Somerset*	9/17	170	44	5.8	950	2,100	1.1	180	400	18	2,900	6,500	9.2	1,500	3,400	1.5	250	560
Low Level	9/18	140	38	6.0	870	1,900	2.8	410	900	18	2,600	5,600	9.4	1,400	3,000	1.4	210	460
Interceptor	9/19	130	35	7.8	1,000	2,200	3.2	430	940	26	3,400	7,600	11	1,400	3,200	1.9	250	550
	9/20	120	31	1.6	190	430	0.54	64	140	1.2	140	310	4.0	470	1,000	1.1	130	290
	9/21	120	33	6.1	760	1,700	3.3	410	900	24	3,000	6,700	12	1,500	3,300	1.7	210	450
	9/22	120	30	5.6	650	1,400	2.8	320	700	24	2,700	6,100	10	1,200	2,600	1.4	170	370
	9/23	150	40	5.4	810	1,800	2.5	280	830	22	3,300	7,200	10	1,600	3,500	1.3	200	430
7-Day Average		140	36	5.5	750	1,600	2.3	310	690	19	2,600	5,700	9.4	1,300	2,900	1.5	200	450
Frankford	9/17	36	9.4	2.6	92	200	0.72	26	56	1.5	53	120	6.8	240	530	1.3	46	100
Low Level	9/18	36	9.5	6.4	230	510	3.0	110	240	6.4	230	510	7.2	260	570	1.4	49	110
Interceptor	9/19	44	12	4.0	170	380	1.6	71	160	2.4	110	230	7.0	310	680	1.1	50	110
	9/20	23	6.0	2.6	60	130	1.2	28	62	0.50	11	25	6.8	150	340	0.99	22	50
	9/21	55	15	5.0	280	620	2.6	150	320	1.2	66	150	12	650	1,400	1.3	73	160
	9/22	51	13	4.7	240	530	2.8	140	310	0.70	35	78	10	530	1,200	1.1	56	120
	9/23	56	15	6.5	370	810	4.3	240	540	3.0	170	370	11	610	1,300	1.1	64	140
7-Day Average		43	12	4.5	210	690	2.3	110	240	2.2	96	210	8.7	390	860	1.2	51	110
Frankford	9/17	270	70	2.7	720	1,600	1.1	300	660	2.8	750	1,600	6.2	1,700	3,600	1.1	290	630
High Level	9/18	220	58	4.0	860	1,900	1.8	400	890	4.5	980	2,200	8.2	1,800	3,900	1.1	240	540
Interceptor	9/19	200	53	6.0	1,200	2,600	3.2	630	1,400	5.3	1,100	2,300	11	2,100	4,700	0.69	140	300
	9/20	200	54	5.2	1,000	2,300	2.7	540	1,200	1.4	280	630	13	2,700	5,900	0.41	83	180
	9/21	210	56	7.0	1,500	3,300	4.0	860	1,900	4.3	920	2,000	14	2,900	6,400	0.73	160	340
	9/22	210	55	5.1	1,100	2,300	2.5	510	1,100	0.90	190	410	13	2,700	6,000	0.31	64	140
	9/23	210	55	4.8	1,000	2,200	2.5	510	1,100	0.00	0.0	0.0	13	2,700	5,900	0.33	68	150
7-Day Average		220	57	5.0	1,100	2,300	2.5	540	1,200	2.7	600	1,300	11	2,400	5,200	0.67	150	330
Final	9/17	760	200	3.2	2,400	5,300	2.3	1,700	3,800	0.0	0.0	0.01	12	9,100	20,000	0.07	53	120
Effluent	9/18	720	190	3.6	2,600	5,800	2.7	1,900	4,300	0.0	0.0	0.0	15	11,000	24,000	0.02	14	32
	9/19	660	180	4.8	3,200	7,100	3.4	2,200	4,900	0.20	130	290	17	11,000	25,000	0.02	13	29
	9/20	640	170	4.6	2,900	6,400	3.0	1,900	4,100	0.0	0.0	0.0	19	12,000	26,000	0.04	25	56
	9/21	720	190	5.0	3,600	7,800	3.2	2,300	5,100	0.10	72	160	19	14,000	30,000	0.11	79	170
	9/22	680	180	4.2	2,800	6,300	2.8	1,900	4,200	1.5	1,000	2,200	18	12,000	27,000	0.01	7	15
	9/23	670	180	4.5	3,000	6,600	3.0	2,000	4,400	3.1	2,100	4,600	18	12,000	27,000	0.03	20	44
7-Day Average		690	180	4.3	2,900	6,500	2.9	2,000	4,400	0.7	470	1,000	17	12,000	26,000	0.03	30	67
Total of Influents 7-Day Average		670	180	-	3,800	8,300								12,000	32,000*			
% Removal 7-Day Average					22%									14%**				

† Date is the day the sample was composited. 24-hour sampling day ran from 0600 to 0600.
†† Flows are average of hourly flows during each sampling day.
* The Somerset Low Level Interceptor was sampled upsewer of all plant return flows.
** Influent and percent removal are calculated from total nitrogen, which is the sum of organic, ammonia, nitrite and nitrate nitrogen forms.

Table 8

HEAVY METALS DATA
NORTHEAST PHILADELPHIA WATER POLLUTION CONTROL PLANT
September 16-23, 1976

Station Description	Date†	Flow††		Silver*			Aluminum			Arsenic			Barium			Cadmium		
		m³/day x 10³	mgd	µg/l	kg/day	lb/day	mg/l	kg/day	lb/day	µg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day
Delaware	9/17	310	88	35	12	26	<1	<330	<730	<4	<1.3	<2.9	0.4	130	290	0.04	13	29
Low Level	9/18	290	76	35	10	22	11	3,100	6,900	<4	<1.1	<2.5	0.4	110	250	0.02	6	13
Interceptor	9/19	200	53	15	3.5	8.0	<1	<230	<510	<4	<0.93	<2.0	0.4	93	200	0.01	2	5
	9/20	260	69	13	3.4	7.0	7	1,800	4,000	<4	<1.0	<2.3	0.3	78	170	0.01	3	6
	9/21	290	76	41	12	26	5	1,400	3,200	<4	<1.2	<2.5	0.3	87	190	0.02	6	13
	9/22	280	73	24	6.6	15	<1	<280	<610	<4	<1.1	<2.4	0.4	110	240	0.02	6	12
	9/23	250	65	35	8.6	19	18	4,400	9,800	<4	<0.99	<2.2	0.3	74	160	0.04	10	22
7-Day Average		270	71	28	8.0	18	6	1,500	3,400	<4	<1.1	<2.4	0.4	97	210	0.02	7	14
Somerset	9/17	170	44	59	9.8	22	<1	<170	<360	12	2.0	4.4	0.2	33	73	0.17	28	62
Low Level	9/18	140	38	43	6.2	14	<1	<140	<320	4	0.6	1.3	<0.2	<29	<64	0.24	35	76
Interceptor**	9/19	130	35	10	1.3	2.9	7	920	2,000	17	2.2	4.9	0.2	26	58	0.04	5.2	12
	9/20	120	31	<8	<0.94	<2.1	18	2,100	4,700	<4	<0.5	<1.0	0.3	35	78	0.01	1.2	2.6
	9/21	120	33	55	6.8	15	16	2,000	4,400	890	110	240	0.4	50	110	0.23	29	63
	9/22	120	30	116	13	30	7	810	1,800	41	4.7	10	<0.2	<23	<51	0.31	36	79
	9/23	150	40	54	8.2	18	8	1,200	2,700	42	6.4	14	0.2	30	67	0.29	44	97
7-Day Average		140	36	48	6.5	15	8	1,200	2,200	140	18	39	0.2	25	55	0.18	25	60
Frankford	9/17	36	9.4	12	0.43	0.94	30	1,100	2,400	<4	<0.14	<0.31	0.3	11	24	0.01	0.36	0.78
Low Level	9/18	36	9.5	17	0.61	1.3	6	220	480	<4	<0.14	<0.32	0.5	18	40	0.02	0.72	1.6
Interceptor	9/19	44	12	12	0.53	1.2	27	1,200	2,600	<4	<0.18	<0.39	0.2	8.8	19	0.06	2.6	5.8
	9/20	23	6.0	13	0.30	0.65	7	160	350	<4	<0.09	<0.20	0.3	6.8	15	<0.01	<0.23	<0.50
	9/21	55	15	<8	<0.44	<0.97	18	990	2,200	<4	<0.22	<0.49	0.4	22	49	0.03	1.7	3.7
	9/22	51	14	<8	<0.40	<0.89	12	610	1,300	<4	<0.20	<0.45	0.4	20	45	0.04	2.0	4.5
	9/23	56	15	<8	<0.45	<0.99	<1	<56	<120	<4	<0.23	<0.50	0.4	23	50	0.04	2.3	5.0
7-Day Average		43	12	8	0.27	0.58	14	610	1,300	-	-	-	0.4	16	35	0.03	1.4	3.1
Frankford	9/17	270	70	12	3.2	7.0	13	3,500	7,600	<4	<1.1	<2.3	0.4	110	230	0.01	2.7	5.9
High Level	9/18	220	58	23	5.0	11	35	7,600	17,000	<4	<0.87	<1.9	0.4	90	190	<0.01	<2.2	<4.8
Interceptor	9/19	200	53	11	2.2	4.8	17	3,400	7,500	<4	<0.80	<1.8	0.5	100	220	<0.01	<2.0	<4.4
	9/20	200	54	<8	<1.6	<3.6	25	5,100	11,000	<4	<0.81	<1.8	0.4	80	180	<0.01	<2.0	<4.5
	9/21	210	56	9	1.9	4.2	15	3,200	7,100	<4	<0.86	<1.9	0.4	90	190	<0.01	<2.1	<4.7
	9/22	210	55	13	2.7	5.9	16	3,300	7,300	<4	<0.83	<1.8	0.4	80	180	<0.01	<2.1	<4.6
	9/23	210	55	33	6.8	15	13	2,700	5,900	<4	<0.83	<1.8	0.5	100	230	<0.01	<2.1	<4.6
7-Day Average		220	57	14	3.1	6.8	19	4,100	9,100	-	-	-	0.4	90	200	<0.01	<0.4	<0.8
Final	9/17	760	200	19	15	33	22	18,000	39,000	<4	<3.2	<7.0	0.5	400	880	0.01	8.0	18
Effluent	9/18	720	190	9	6.2	14	17	12,000	26,000	<4	<2.7	<6.0	0.2	140	300	0.02	14	30
	9/19	660	180	12	7.3	16	7	4,200	9,300	<4	<2.4	<5.3	0.5	300	670	0.02	12	27
	9/20	640	170	<8	<4.8	<11	5	3,000	6,700	<4	<2.4	<5.3	0.3	180	400	0.01	6.1	13
	9/21	720	190	13	8.9	20	4	2,700	6,000	<4	<2.7	<6.0	0.5	340	750	0.02	14	30
	9/22	680	180	21	14	30	<1	<650	<1,400	<4	<2.6	<5.7	0.3	200	430	0.01	6.5	14
	9/23	670	180	22	15	32	<1	<660	<1,500	<4	<2.6	<5.8	0.4	260	580	0.02	13	29
7-Day Average		690	180	14	9.5	21	8	5,700	12,000	-	-	-	0.4	260	570	0.02	11	23
Total of Influents 7-Day Average					18	40		7,400	16,000		18	39		230	500		34	78
Percent Removal 7-Day Average				47				24			85			0			70	

Table 8 (Continued)

HEAVY METALS DATA

Station Description	Date†	Flow††		Chromium*			Copper			Iron			Mercury			Manganese		
		m^3/day x 10^3	mgd	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	µg/l	kg/day	lb/day	mg/l	kg/day	lb/day
Delaware Low Level Interceptor	9/17	310	88	0.34	110	250	0.01	3.3	7.3	3.5	1,200	2,600	0.2	0.07	0.15	0.95	320	700
	9/18	290	76	0.40	110	250	0.01	2.9	6.3	2.5	720	1,600	0.1	0.03	0.06	1.90	540	1,200
	9/19	200	53	0.07	16	36	<0.01	<2.3	<5.1	1.7	390	870	0.5	0.12	0.26	1.39	320	710
	9/20	260	69	0.05	13	29	<0.01	<2.6	<5.7	1.6	420	920	0.9	0.23	0.52	1.36	350	780
	9/21	290	76	0.31	89	200	0.01	2.9	6.4	3.2	920	2,000	0.5	0.14	0.32	1.66	480	1,100
	9/22	280	73	0.44	120	270	0.02	5.9	12	3.9	1,100	2,400	0.5	0.14	0.30	1.33	370	810
	9/23	250	65	0.29	72	160	0.01	2.5	5.4	8.4	2,100	4,600	1.1	0.27	0.60	1.84	450	1,000
7-Day Average		270	71	0.27	76	170	0.01	3.2	6.9	3.5	920	2,100	0.5	0.14	0.32	1.49	400	900
Somerset Low Level Interceptor**	9/17	170	44	0.57	94	210	2.1	350	770	6.8	1,100	2,500	0.7	0.12	0.26	0.44	73	160
	9/18	140	38	0.84	120	270	3.7	530	1,200	5.2	750	1,700	0.2	0.03	0.06	0.47	68	150
	9/19	130	35	1.32	170	380	1.1	140	320	6.5	850	1,900	1.0	0.13	0.29	0.65	85	190
	9/20	120	31	0.06	0.71	1.6	0.02	2.4	5.2	5.8	680	1,500	<0.1	<0.01	<0.03	0.82	97	210
	9/21	120	33	1.00	120	270	15	1,900	4,100	5.2	650	1,400	0.1	0.01	0.03	0.44	55	120
	9/22	120	30	1.23	140	3[illegible]0	2.6	300	660	6.2	720	1,600	1.2	0.14	0.30	0.42	48	110
	9/23	150	40	1.00	150	330	2.4	360	800	5.7	860	1,900	0.5	0.08	0.17	0.42	64	140
7-Day Average		140	36	0.86	110	250	3.8	510	1,100	5.9	800	1,800	0.5	0.07	0.16	0.52	70	150
Frankford Low Level Interceptor	9/17	36	9.4	0.04	1.4	3.1	0.02	0.71	1.6	3.0	110	240	0.4	0.01	0.03	0.25	8.9	20
	9/18	36	9.5	0.04	1.4	3.1	<0.01	<0.36	<0.79	2.4	86	190	0.6	0.02	0.05	0.28	10	22
	9/19	44	12	0.04	1.8	3.9	<0.01	<0.44	<0.97	2.4	110	230	0.9	0.04	0.09	0.35	15	34
	9/20	23	6.0	<0.02	<0.45	<1.0	<0.01	<0.23	<0.50	1.8	41	90	0.7	0.02	0.04	0.41	9.3	21
	9/21	55	15	0.16	8.8	19	0.02	1.1	2.4	4.3	240	520	0.3	0.02	0.04	0.34	19	41
	9/22	51	14	0.04	2.0	4.5	0.02	1.0	2.2	2.5	130	280	0.3	0.02	0.03	0.31	16	35
	9/23	56	15	0.07	3.9	8.7	0.01	0.56	1.2	3.5	200	440	1.0	0.06	0.12	0.41	23	51
7-Day Average		43	12	0.06	2.8	6.0	0.01	0.48	1.1	2.8	130	280	0.6	0.03	0.06	0.34	14	32
Frankford High Level Interceptor	9/17	270	70	0.03	8.0	18	<0.01	<2.7	<5.9	1.7	450	1,000	1.0	0.27	0.59	0.08	21	47
	9/18	220	58	0.03	6.6	14	<0.01	<2.2	<4.8	1.3	290	640	0.5	0.11	0.24	0.08	17	39
	9/19	200	53	<0.02	<4.0	<8.8	<0.01	<2.0	<4.4	0.8	150	330	0.5	0.10	0.22	0.10	20	44
	9/20	200	54	<0.02	<4.1	<9.0	<0.01	<2.0	<4.5	0.9	180	400	0.4	0.08	0.18	0.08	16	36
	9/21	210	56	0.03	6.4	14	<0.01	<2.1	<4.7	1.3	270	590	0.3	0.06	0.14	0.08	17	38
	9/22	210	55	0.02	4.1	9.1	<0.01	<2.1	<4.6	1.5	310	690	0.5	0.10	0.23	0.10	21	46
	9/23	210	55	0.03	6.2	14	<0.01	<2.1	<4.6	1.0	210	460	0.5	0.10	0.23	0.08	17	36
7-Day Average		220	57	0.02	4.5	9.9	-	-	-	1.2	270	590	0.5	0.12	0.26	0.09	18	41
Final Effluent	9/17	760	200	0.07	56	120	<0.01	<8.0	<18	1.2	930	2,000	0.9	0.72	1.6	0.48	380	850
	9/18	720	190	0.05	34	76	<0.01	<6.9	<15	1.3	860	1,900	1.4	0.96	2.1	0.72	490	1,100
	9/19	660	180	0.06	36	80	<0.01	<6.1	<13	1.3	800	1,800	1.2	0.71	1.6	0.74	450	990
	9/20	640	170	0.02	12	27	<0.01	<6.1	<13	1.0	610	1,300	1.0	0.60	1.3	0.65	390	870
	9/21	720	190	0.07	48	110	<0.01	<6.8	<15	1.2	820	1,800	0.6	0.41	0.90	0.62	420	930
	9/22	680	180	0.09	59	130	<0.01	<6.5	<14	2.0	1,300	2,900	0.1	0.065	0.14	0.75	490	1,100
	9/23	670	180	0.09	60	130	<0.01	<6.6	<15	1.8	1,200	2,600	18	12	26	0.85	560	1,200
7-Day Average		690	180	0.06	44	96	-	-	-	1.4	930	2,000	3.3	2.2	4.8	0.79	450	1,000
Total of Influents 7-Day Average					200	440		510	1,100		2,100	4,800		0.36	0.80		500	1,100
Percent Removal 7-Day Average					78			>99			57			0			90	

Table 8 (Continued)

HEAVY METALS DATA

Station Description	Date†	Flow††		Nickel*			Lead			Zinc		
		m³/day x 10³	mgd	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day
Delaware	9/17	310	88	0.08	27	59	0.27	90	200	0.82	2.70	600
Low Level	9/18	290	76	0.33	94	210	0.27	77	170	0.79	230	500
Interceptor	9/19	200	53	0.06	14	31	0.24	56	120	0.22	51	110
	9/20	260	69	0.04	10	23	0.22	57	130	0.22	57	130
	9/21	290	76	0.09	26	57	<0.17	<49	<110	0.78	220	500
	9/22	280	73	0.18	50	110	0.18	50	110	0.72	200	440
	9/23	250	65	0.07	17	38	0.17	42	90	0.71	180	390
7-Day	Average	270	71	0.12	34	75	0.19	53	120	0.61	170	380
Somerset	9/17	170	44	0.38	63	140	0.45	74	160	1.35	220	490
Low Level	9/18	140	38	0.43	62	140	<0.17	<25	<54	1.03	150	330
Interceptor **	9/19	130	35	0.37	48	110	<0.17	<22	<49	0.47	62	140
	9/20	120	31	0.38	45	99	<0.17	<20	<44	0.28	33	73
	9/21	120	33	1.65	200	450	0.21	26	57	0.64	79	180
	9/22	120	30	1.37	160	350	0.18	21	46	0.53	61	135
	9/23	150	40	1.11	170	370	0.27	41	90	0.54	82	180
7-Day	Average	140	36	0.81	110	240	0.16	23	50	0.69	98	220
Frankford	9/17	36	9.4	0.16	5.7	13	0.24	8.5	19	0.44	16	35
Low Level	9/18	36	9.5	0.26	9.3	21	<0.17	<6.1	<13	0.59	21	47
Interceptor	9/19	44	12	0.22	9.7	21	<0.17	<7.5	<16	0.62	27	60
	9/20	23	6.0	0.03	0.68	1.5	<0.17	<3.9	<8.5	0.17	3.9	8.5
	9/21	55	15	0.40	22	49	0.21	12	26	0.72	40	88
	9/22	51	14	0.47	24	53	0.18	9.1	20	0.52	26	58
	9/23	56	15	0.36	20	45	0.22	12	27	0.60	34	75
7-Day	Average	43	12	0.27	13	29	0.12	5.9	13	0.52	24	53
Frankford	9/17	270	70	<0.03	<8	<18	0.42	110	250	0.36	96	210
High Level	9/18	220	58	<0.03	<7	<14	0.31	68	150	0.30	66	140
Interceptor	9/19	200	53	<0.03	<6	<13	0.17	34	75	0.19	38	84
	9/20	200	54	<0.03	<6	<13	<0.17	<35	<76	0.19	39	85
	9/21	210	56	<0.03	<6	<14	0.21	45	99	0.31	66	150
	9/22	210	55	<0.03	<6	<14	0.32	66	150	0.33	68	150
	9/23	210	55	<0.03	<6	<14	0.37	76	170	0.24	50	110
7-Day	Average	220	57	-	-	-	0.26	57	130	0.27	60	130
Final	9/17	760	200	0.08	64	140	<0.17	<140	<300	0.27	220	480
Effluent	9/18	720	190	0.14	96	210	<0.17	<120	<260	0.33	230	500
	9/19	660	180	0.09	54	120	0.18	110	240	0.52	310	690
	9/20	640	170	0.09	54	120	<0.17	<100	<230	0.32	190	430
	9/21	720	190	0.12	82	180	0.22	150	330	0.45	310	680
	9/22	680	180	0.11	72	160	<0.17	<110	<240	0.34	220	490
	9/23	670	180	0.12	79	180	<0.17	<110	<250	0.36	240	530
7-Day	Average	690	180	0.11	72	160	0.06	37	81	0.37	250	540
Total of Influents												
7-Day	Average				160	340		140	310		350	780
Percent Removal												
7-Day	AVerage				54			74			30	

† *Date is the day the sample was composited. 24-hr sampling day was from 0600 to 0600.*

†† *Flows are average of hourly flows during each sampling day.*

* *Analyses for selenium, tin and titanium indicated concentrations less than detectability limits of 5 μg/l, 1 mg/l and 1 mg/l, respectively.*

** *The Somerset Low Level Interceptor was sampled upsewer of all plant return flows.*

Table 9

RAW WASTEWATER CHARACTERISTICS-DELAWARE LOW LEVEL INTERCEPTOR
PHILADELPHIA NORTHEAST WATER POLLUTION CONTROL PLANT
SEPTEMBER 16-23, 1976

Parameter†	9-17†† Thur.	9-18 Fri.	9-19 Sat.	9-20 Sun.	9-21 Mon.	9-22 Tue.	9-23 Wed.
Flow m^3/day x 10^3	310	290	200	260	290	280	250
(mgd)	88	76	53	69	76	73	65
pH range (S.U.)	3.5-6.8	3.1-9.0	1.5-8.0	1.2-7.9	2.1-7.4	3.8-8.2	6.3-7.2
Oil/Grease†††	31	36	25	25	29	32	23
Suspended Solids	280	320	130	150	170	170	160
BOD	150	220	170	280	320	200	250
COD	410	680	850	440	590	470	580
Organic-N	2.1	2.2	1.2	0.0	0.0	0.0	0.1
Ammonia-N	18	25	26	24	22	24	24
Nitrite+Nitrate-N	0.20	0.23	0.04	0.05	0.04	0.08	0.05
Total Phosphorus	5.0	6.2	6.0	6.4	7.8	5.8	6.2
Ortho Phosphate	1.0	3.0	3.7	3.8	3.5	3.0	2.0
Silver (µg/l)	35	35	15	13	41	24	35
Aluminum	<1	11	<1	7	5	<1	18
Arsenic (µg/l)	<4	<4	<4	<4	<4	<4	<4
Barium	0.4	0.4	0.4	0.3	0.3	0.4	0.3
Cadmium	0.04	0.02	0.01	0.01	0.02	0.02	0.04
Chromium	0.34	0.40	0.07	0.05	0.31	0.44	0.29
Copper	0.01	0.01	<0.01	<0.01	0.01	0.02	0.01
Iron	3.5	2.5	1.7	1.6	3.2	3.9	8.4
Mercury (µg/l)	0.2	0.1	0.5	0.9	0.5	0.5	1.1
Manganese	0.95	1.90	1.39	1.36	1.66	1.33	1.84
Nickel	0.08	0.33	0.06	0.04	0.09	0.18	0.07
Lead	0.27	0.27	0.24	0.22	<0.17	0.18	0.17
Selenium (µg/l)	<5	<5	<5	<5	<5	<5	<5
Tin	<1	<1	<1	<1	<1	<1	<1
Titanium	<1	<1	<1	<1	<1	<1	<1
Zinc	0.82	0.79	0.22	0.22	0.78	0.72	0.71

† *Units are mg/l except as noted.*
†† *Date is the day sample was composited. 24-hr sampling day was from 0600 to 0600.*
††† *Average of three grab samples during sampling day.*

respectively. Seventeen percent of the hourly pH readings were less than 5.0. On six different occasions the pH changed three or more standard units within one hour, apparently due to the intermittent discharge of industrial wastes. A continuous recording pH meter, installed by NEIC and operated from September 15-19, verified the low hourly readings on September 18 and 19. The data indicated the intermittent presence of acidic wastes. During the survey, the discharge of these strong acidic wastes probably caused adverse effects on operation of the biological system.

Suspended solids [Table 3] and oil and grease [Table 6] concentrations were approximately that expected for domestic sewage. Nutrients [Table 7] were present at concentrations typical of domestic wastewater. The ammonia nitrogen concentration in the DLL interceptor was approximately twice that present in the other influents.

The wastewater was analyzed for 16 heavy metals. NEIC average concentrations of eight metals are compared with 1974 city of Philadelphia monitoring results for the DLL as follows:

	mg/l							μg/l
	Cd	Cr	Cu	Fe	Ni	Pb	Zn	Hg
NEIC (1976)	0.02	0.27	0.01	3.54	0.12	0.19	0.61	0.54
City (1974)	0.17	0.4	0.88	9.88	0.27	0.21	5.73	3.3

City samples were 24-hour equal-volume composites collected for 10 consecutive days from September 17-26, 1974. Each daily composite consisted of portions collected on a four-hour cycle. NEIC samples were 24-hour flow-weighted composites consisting of portions collected on a one-hour cycle. NEIC results in each case are less than 1974 city results. When NEIC results, however, are compared on a weekend vs. weekday basis [Table 9], it is apparent that five metals, Ag, Cd, Cr, Fe and Zn, are present in lower concentrations on weekends than weekdays. The differences in concentrations are apparently due to industries which operate less than seven days per week.

SOMERSET LOW LEVEL INTERCEPTOR (SLL)

During the NEIC survey, an average of 140 x 10^3 m^3/day (36 mgd) or 21% of the total influent flow entered the plant through the SLL interceptor. Daily monitoring results [Table 10] indicate that industrial wastes are also discharged to the SLL interceptor. The pH ranged from 3.1-11.0 and 16 hourly pH readings were either greater than 9.0 or less than 6.0. On three different occasions the pH changed three or more standard units within one hour, indicating an intermittent discharge of industrial wastes or their changing characteristics.

Other parameters including oil and grease, TSS, BOD and COD were present in concentrations considerably in excess of those normally found in domestic sewage. The maximum concentration of these parameters was:

Oil & Grease	320 mg/l
TSS	680
BOD	600
COD	920

Nutrient concentrations were similar to those of domestic wastewater. Organic nitrogen averaged 19 mg/l and showed a marked decline along with other nutrients on Sunday, suggesting that the major input of nutrients was from industrial sources.

Heavy metals concentrations during NEIC monitoring were generally less than those observed in the DLL influent. Distinct decreases in Ag, As, Cd, Cr, Cu and Zn concentrations during the weekend indicated that these heavy metals were primarily from industrial sources. On September

Table 10

RAW WASTEWATER CHARACTERISTICS-SOMERSET LOW LEVEL INTERCEPTOR PHILADELPHIA NORTHEAST WATER POLLUTION CONTROL PLANT SEPTEMBER 16-23, 1976

Parameter†	9-17†† Thur.	9-18 Fri.	9-19 Sat.	9-20 Sun.	9-21 Mon.	9-22 Tue.	9-23 Wed.
Flow $m^3/day \times 10^3$	170	140	130	120	120	120	150
(mgd)	44	38	35	31	33	30	40
pH range (S.U.)	3.1-7.4	5.8-9.2	5.1-11.0	6.6-7.1	6.6-8.8	6.7-7.8	6.4-7.4
Oil/Grease†††	39	43	84	115	55	78	76
Suspended Solids	380	490	680	370	340	240	330
BOD	160	600	380	370	440	340	430
COD	620	840	920	630	860	830	920
Organic-N	18	18	26	1.2	24	24	22
Ammonia-N	9.2	9.4	11	4.0	12	10	10
Nitrite+Nitrate-N	1.5	1.4	1.9	1.1	1.7	1.4	1.3
Total Phosphorus	5.8	6.0	7.8	1.6	6.1	5.6	5.4
Ortho Phosphate	1.1	2.8	3.2	0.5	3.3	2.8	2.5
Silver (μg/l)	59	43	10	<8	55	116	54
Aluminum	<1	<1	7	18	16	7	8
Arsenic (μg/l)	12	4	17	<4	890	41	42
Barium	0.2	<0.2	0.2	0.3	0.4	<0.2	0.2
Cadmium	0.17	0.24	0.04	0.01	0.23	0.31	0.29
Chromium	0.57	0.84	1.32	0.06	1.00	1.23	1.00
Copper	2.1	3.7	1.1	0.02	15	2.6	2.4
Iron	6.8	5.2	6.5	5.8	5.2	6.2	5.7
Mercury (μg/l)	0.7	0.2	1.0	<0.1	0.1	1.2	0.5
Manganese	0.44	0.47	0.65	0.82	0.44	0.42	0.42
Nickel	0.38	0.43	0.37	0.38	1.65	1.37	1.11
Lead	0.45	<0.17	<0.17	<0.17	0.21	0.18	0.27
Selenium (μg/l)	<5	<5	<5	<5	<5	<5	<5
Tin	<1	<1	<1	<1	<1	<1	<1
Titanium	<1	<1	<1	<1	<1	<1	<1
Zinc	1.35	1.03	0.47	0.28	0.64	0.53	0.54

† *Units are mg/l except as noted.*

†† *Date is the day sample was composited. 24-hr sampling day was from 0600 to 0600.*

††† *Average of three grab samples during sampling day.*

21 the As concentration was more than 20 times that of other days.

In 1974 the city of Philadelphia monitored the SLL interceptor downsewer of supernatant return flows for eight metals recycled in the sludge.[2] These results and NEIC monitoring are summarized as follows:

	mg/l							µg/l
	Cd	Cr	Cu	Fe	Ni	Pb	Zn	Hg
NEIC (1976)	0.18	0.86	3.8	5.9	0.81	0.16	0.69	0.5
City (1974)	0.24	1.10	1.14	22.19	1.25	0.41	3.92	5.76

The sampling regimen was the same as that described under DLL. NEIC results are less than City results for every parameter except copper. This may be the case partly as a result of sampling location.

FRANKFORD LOW LEVEL INTERCEPTOR (FLL)

During NEIC monitoring at the Northeast plant the FLL interceptor discharged approximately 6% of the total influent flow. The flow averaged 43 x 10^3 m^3/day (12 mgd) during the seven-day period. Monitoring results [Table 11] suggest that limited amounts of industrial wastes are discharged to the FLL interceptor. The pH ranged from 2.3-9.1, with 21 separate hourly readings in violation of permit criteria (i.e. 6-9). On one occasion the pH changed three or more standard units within one hour. There were, however, four periods of three-hour duration or longer in which hourly pH readings were less than 6.0 [Table 4]. These results indicate that acidic industrial wastes were intermittently discharged to the interceptor. Results of the other parameters monitored were typical for domestic sewage.

Concentrations of selected heavy metals during the NEIC survey are compared below with the 1974 city of Philadelphia results.[2]

Table 11

RAW WASTEWATER CHARACTERISTICS-FRANKFORD LOW LEVEL INTERCEPTOR
PHILADELPHIA NORTHEAST WATER POLLUTION CONTROL PLANT
SEPTEMBER 16-23, 1976

Parameter†	9-17†† Thur.	9-18 Fri.	9-19 Sat.	9-20 Sun.	9-21 Mon.	9-22 Tue.	9-23 Wed.
Flow m^3/day x 10^3	36	36	44	23	55	51	56
(mgd)	9.4	9.5	12	6.0	15	14	15
pH range (S.U.)	2.3-6.6	5.4-8.8	4.5-9.1	6.4-7.0	2.9-8.5	6.2-9.1	6.3-8.6
Oil/Grease†††	42	38	32	17	28	38	29
Suspended Solids	80	85	45	120	88	60	55
BOD	76	140	94	170	260	100	140
COD	330	400	210	290	330	290	340
Organic-N	1.5	6.4	2.4	0.5	1.2	0.7	3.0
Ammonia-N	6.8	7.2	7.0	6.8	12	10	11
Nitrite+Nitrate-N	1.3	1.4	1.1	0.99	1.3	1.1	1.1
Total Phosphorus	2.6	6.4	4.0	2.6	5.0	4.7	6.5
Ortho Phosphate	0.7	3.0	1.6	1.2	2.6	2.8	4.3
Silver (μg/l)	12	17	12	13	<8	<8	<8
Aluminum	30	6	27	7	18	12	<1
Arsenic (μg/l)	<4	<4	<4	<4	<4	<4	<4
Barium	0.3	0.5	0.2	0.3	0.4	0.4	0.4
Cadmium	0.01	0.02	0.06	<0.01	0.03	0.04	0.04
Chromium	0.04	0.04	0.04	<0.02	0.16	0.04	0.07
Copper	0.02	<0.01	<0.01	<0.01	0.02	0.02	0.01
Iron	3.0	2.4	2.4	1.8	4.3	2.5	2.5
Mercury (μg/l)	0.4	0.6	0.9	0.7	0.3	0.3	1.0
Manganese	0.25	0.28	0.35	0.41	0.34	0.31	0.41
Nickel	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Lead	0.42	0.31	0.17	<0.17	0.21	0.32	0.37
Selenium (μg/l)	<5	<5	<5	<5	<5	<5	<5
Tin	<1	<1	<1	<1	<1	<1	<1
Titanium	<1	<1	<1	<1	<1	<1	<1
Zinc	0.44	0.59	0.62	0.17	0.72	0.52	0.60

† *Units are mg/l except as noted.*
†† *Date is the day sample was composited. 24-hr sampling day was from 0600 to 0600.*
††† *Average of three grab samples during sampling day.*

	mg/l							µg/l
	Cd	Cr	Cu	Fe	Ni	Pb	Zn	Hg
NEIC (1976)	0.03	0.06	0.01	2.8	0.27	0.12	0.52	0.6
City (1974)	0.17	0.32	0.34	5.47	0.33	0.03	1.49	0.93

The sampling regimen was the same as that described under DLL. Each metal, with the exception of lead, was present in lower concentrations during the NEIC survey than in 1974.

FRANKFORD HIGH LEVEL INTERCEPTOR (FHL)

Thirty-three percent of the total flow entered the plant through the FHL interceptor. Flow as relatively constant, ranging from 200-270 x 10^3 m^3/day (53-70 mgd) and averaged 220 x 10^3 m^3/day (57 mgd). NEIC monitoring results [Tables 4 and 12] indicate that of the four influents to Northeast, the FHL flow was least affected by industrial wastes. During seven days, the pH was less than 6.0 for 19 measurements and the lowest reading was 5.1. Two intervals, 12 hours on September 17 and 18 and five hours on September 21, resulted in hourly pH readings of 6.0 or less. All other pollutants monitored were present in concentrations typical of domestic wastewater. Eight heavy metals were present in lower concentrations than found by the city in 1974.[2] Results are compared as follows:

	mg/l							µg/l
	Cd	Cr	Cu	Fe	Ni	Pb	Zn	Hg
NEIC (1976)	<0.10	0.02	<0.01	1.21	<0.03	0.26	0.27	0.5
City (1974)	0.16	0.56	0.34	2.4	0.21	0.06	1.1	1.06

The sampling regimen was the same as that described for DLL.

Table 12

RAW WASTEWATER CHARACTERISTICS-FRANKFORD HIGH LEVEL INTERCEPTOR
PHILADELPHIA NORTHEAST WATER POLLUTION CONTROL PLANT
SEPTEMBER 16-23, 1976

Parameter†	9-17†† Thur.	9-18 Fri.	9-19 Sat.	9-20 Sun.	9-21 Mon.	9-22 Tue.	9-23 Wed.
Flow m^3/day x 10^3	270	220	200	200	210	210	210
(mgd)	70	58	53	54	56	55	55
pH range (S.U.)	5.7-6.7	5.1-6.6	6.0-7.0	6.1-7.0	5.5-8.1	6.0-8.2	6.4-7.8
Oil/Grease	19	25	32	22	22	22	20
Suspended Solids	110	82	58	90	110	85	45
BOD	68	200	80	230	170	100	110
COD	240	330	220	280	250	250	240
Organic-N	2.8	4.5	5.3	1.4	4.3	0.9	0.0
Ammonia-N	6.2	8.2	11	13	14	13	13
Nitrite+Nitrate-N	1.1	1.1	0.69	0.41	0.73	0.31	0.33
Total Phosphorus	1.1	1.8	3.2	2.7	4.0	2.5	2.5
Ortho Phosphate	1.1	1.8	3.2	2.7	4.0	2.5	2.5
Silver (μg/l)	12	23	11	<8	9	13	33
Aluminum	13	35	17	25	15	16	13
Arsenic (μg/l)	<4	<4	<4	<4	<4	<4	<4
Barium	0.4	0.4	0.5	0.4	0.4	0.4	0.5
Cadmium	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	0.03	0.03	<0.02	<0.02	0.03	0.02	0.03
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	1.70	1.33	0.75	0.89	1.26	1.51	1.02
Mercury (μg/l)	1.0	0.5	0.5	0.4	0.3	0.5	0.5
Manganese	0.08	0.08	0.10	0.08	0.08	0.10	0.08
Nickel	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Lead	0.42	0.31	0.17	<0.17	0.21	0.32	0.37
Selenium (μg/l)	<5	<5	<5	<5	<5	<5	<5
Tin	<1	<1	<1	<1	<1	<1	<1
Titanium	<1	<1	<1	<1	<1	<1	<1
Zinc	0.36	0.30	0.19	0.19	0.31	0.33	0.24

† *Units are mg/l except as noted.*
†† *Date is the day sample was composited. 24-hr sampling day was from 0600 to 0600.*

FINAL EFFLUENT

Final effluent ranged from 640-760 x 10^3 m^3/day (170-200 mgd) and averaged 690 x 10^3 m^3/day (180 mgd). Monitoring results [Table 13] indicate that removal efficiencies were sporadic for some pollutants and relatively constant for others. In addition, removal efficiencies of several pollutants were different for weekdays than for weekends. The mean percent removal and the standard deviation for pollutant removals varied widely [Table 14]. Removal efficiencies for silver, cadmium, chromium, copper, nickel and zinc declined markedly during the weekend, primarily due to a reduction in pollutant concentrations in the influent. Other parameters including TSS, BOD, total-N, aluminum, arsenic, barium, mercury, manganese and lead showed sporadic variation in removal efficiency. The percent removal standard deviation for these parameters [Table 14] exceeded ten. The high variability in TSS and BOD removal efficiency is undoubtedly due to the effects of industrial wastes on the biological treatment system. TSS and BOD removal efficiencies changed as much as 41 and 28%, respectively, from one day to the next. Oil and grease, COD, total phosphorus and iron removals were relatively constant during NEIC monitoring.

Final effluent pH [Table 4] ranged from 4.0 to 9.2 and exceeded NPDES limitations 24 times (see Section IV). On three different days, consecutive hourly pH measurements were less than 6.0 for eight, five and four hours. The depressed pH very likely caused an overall reduction in the efficiency of the biological system.

Table 13

COMPARISON OF INFLUENT AND EFFLUENT CHARACTERISTICS
NORTHEAST PHILADELPHIA WASTEWATER TREATMENT PLANT
September 16-23, 1976

	9/17			9/18			9/19			9/20			9/21			9/22			9/23		
	Inf.	Eff.	% Rem.	Inf.	Eff.	% Rem.	Inf.	Eff.	% Rem.	Inf.	Eff.	% Rem.	Inf.	Eff.	% Rem.	Inf.	Eff.	% Rem.	Inf.	Eff.	% Rem.
Flow† $m^3/day \times 10^{-3}$	800	760	-	690	720	-	610	660	-	610	640	-	680	720	-	650	680	-	660	670	-
mgd	210	200	-	180	190	-	160	180	-	160	170	-	180	190	-	170	180	-	180	180	-
pH Range	2.3-7.4	4.0-7.1		3.1-9.2	5.4-9.2		1.5-11.0	5.5-7.7		1.2-7.9	6.4-7.2		2.1-8.8	6.5-7.2		3.8-9.1	6.7-7.6		6.3-8.6	6.5-7.3	
Oil and Grease	30	5	83	36	2	94	49	5	90	40	9	78	33	6	82	35	7	80	35	4	89
Suspended Solids	240	55	77	270	80	70	230	80	65	170	88	48	180	110	39	140	28	80	150	42	72
BOD	120	40	67	290	76	74	190	59	69	270	160	41	290	140	52	180	60	67	240	77	68
COD	400	200	50	590	200	66	640	230	64	420	190	55	520	240	54	450	240	47	520	270	48
Organic-N	5.5	0.0		6.4	0.0		8.4	0.20		0.7	0.0		5.9	0.10		4.6	1.5		5.2	3.1	
Ammonia-N	12	12	34††	15	15	32††	17	17	34††	16	19	††,*	17	19	††,*	17	18	12††	16	18	3††
Nitrite+Nitrate-N	0.82	0.07		0.83	0.02		0.78	0.02		0.41	0.04		0.65	0.11		0.47	0.01		0.51	0.03	
Total Phosphorus	4.3	3.2	26	5.4	3.6	33	6.4	4.8	25	4.8	4.6	4	7.1	5.0	30	5.4	4.2	32	5.6	4.5	20
Ortho Phosphorus	1.0	2.3	†††	2.6	2.7	†††	3.4	3.4	†††	2.7	3.0	†††	3.5	3.2	†††	2.7	2.8	†††	2.4	3.0	†††
Silver (μg/l)††††	32	19	41	32	9	72	13	12	8	<8	<8	0	30	13	57	35	21	40	36	22	39
Aluminum	6	22	*	16	17	*	9	7	22	15	5	67	11	4	64	7	<1	86	13	<1	92
Arsenic (μg/l)	<4	<4	**	<4	<4	**	4	<4	0	<4	<4	**	160	<4	98	7	<4	43	10	<4	40
Barium	0.3	0.5	*	0.3	0.2	33	0.4	0.5	*	0.3	0.3	0	0.4	0.5	*	0.3	0.3	0	0.3	0.4	*
Cadmium	0.06	0.01	83	0.06	0.02	67	0.02	0.02	0	<0.01	0.01	*	0.05	0.02	60	0.07	0.01	86	0.08	0.02	75
Chromium	0.27	0.07	74	0.35	0.05	86	0.33	0.06	82	0.02	0.02	0	0.33	0.07	79	0.41	0.09	78	0.35	0.09	74
Copper	0.44	<0.01	98	0.80	<0.01	99	0.25	<0.01	96	<0.01	<0.01	**	2.7	<0.01	100	0.47	<0.01	98	0.55	<0.01	98
Iron	3.6	1.2	67	2.7	1.3	52	2.6	1.3	50	2.2	1.0	55	3.0	1.2	60	3.5	2.0	43	5.1	1.8	65
Mercury	0.6	0.9	*	0.3	1.4	*	0.7	1.2	*	0.6	1.0	*	0.4	0.6	*	0.6	0.1	83	0.8	18	*
Manganese	0.53	0.48	9	0.93	0.72	23	0.77	0.74	4	0.78	0.65	17	0.86	0.62	28	0.70	0.75	*	0.84	0.85	*
Nickel	0.12	0.08	33	0.24	0.14	42	0.13	0.09	31	0.09	0.09	0	0.37	0.12	68	0.36	0.11	69	0.31	0.12	61
Lead	0.36	<0.17	53	0.21	<0.17	19	<0.17	0.18	*	<0.17	<0.17	**	<0.17	0.22	*	0.23	<0.17	26	0.26	<0.17	35
Zinc	0.76	0.27	64	0.67	0.33	51	0.31	0.52	*	0.22	0.32	*	0.66	0.45	32	0.55	0.34	38	0.52	0.36	31

† *Influent flow was determined by adding the flow from four individual interceptors. Individual interceptor flows were determined by existing venturi meters and the dye dilution technique. Effluent flow is a summation of influent flow as determined solely by existing venturi meters. Influent (pollutant concentrations) were derived by calculation using pollutant concentrations of individual interceptor flows.*

†† *Percent removal is based on total nitrogen*

††† *Ortho phosphorus changes form, therefore removal efficiency is not meaningful.*

†††† *Analyses for selenium, tin and titanium indicated concentrations less than detectability limits of 5 μg/l, 1 μg/l and 1 μg/l, respectively.*

* *Effluent concentration exceeded influent concentration*

** *Influent and effluent concentrations were less than detectable.*

Table 14

MEAN PERCENT REMOVAL AND STANDARD DEVIATION
PHILADELPHIA NORTHEAST WATER POLLUTION CONTROL PLANT
SEPTEMBER 16-23, 1976

Pollutant	Mean Percent Removal	Standard Deviation
O/G	85.1	5.9
TSS	64.4	15.3
BOD	62.6	11.7
COD	54.9	7.5
Total-N	16.4	16.3
Total-P	24.3	10.0
Silver	36.7	25.4
Aluminum	47.3	39.3
Arsenic	25.9	37.4
Barium	4.7	12.5
Cadmium	53	37.3
Chromium	67.6	30.1
Copper	84.1	37.1
Iron	56.0	8.6
Mercury	11.9	31.4
Manganese	11.6	11.3
Nickel	43.4	24.9
Lead	19.0	20.6
Zinc	30.9	24.0

VI. DYE TRACING AND WATER QUALITY STUDY

BACKGROUND

Potable water is supplied to the City of Philadelphia through three water treatment plants with a total capacity of 1.8×10^6 m^3/day (480 mgd). Largest of these plants is the Torresdale WTP, serving the northeast part of the Philadelphia metropolitan area and located on the west bank of the Delaware River approximately six miles upstream from the Northeast WPCP. The Torresdale WTP has a rated capacity of 1.07×10^6 m^3/day (282 mgd) and intakes water by gravity from the Delaware River during flood tide.

EPA, Region III, inspected the Philadelphia water supply system from February 7 to 11, 1972, and made the following recommendations in a letter dated April 21, 1972.[3]

> It is recommended that tracer studies be conducted on the Delaware River downstream from the Torresdale intake to conclusively and quantitatively demonstrate the effect of discharges upon the water quality in the vicinity of the water supply intake. These studies could be conducted in cooperation with the Delaware River Basin Commission.

In July 1974, the EPA, Region III, Annapolis Field Office conducted a dye study and verified that effluent from Northeast reaches the Torresdale intake.

METHODOLOGY

NEIC, in conjunction with monitoring for complex organic compounds (Section VII) from the Northeast WPCP, injected tracing dye into the

Northeast final effluent channel and monitored for its presence at the Torresdale intake. Dye injection began at 1130 hrs. September 11 and ended at 1030 hrs. September 21, 1976. In addition, a batch release of dye was made September 22, 1976 at 2030 hrs. During the dye injection period, dye concentration at Torresdale was continuously monitored and recorded with the exception of brief intervals, usually during ebb tide, when the fluorometer and recorder were used to determine dye concentrations at other locations in the Delaware River. Details pertinent to the dye-dilution technique are provided in Appendix C. Freshwater inflow and tide height varied during NEIC monitoring [Table 15].

In addition, monitoring was conducted by NEIC at two stations in the Delaware River upstream of the Torresdale intake. Raw and finished water at Torresdale was also monitored. Upstream stations were sampled during ebb tide only on an equal-volume composite basis while raw water at the Torresdale intake was sampled only during flood tide. Samples from all four stations were analyzed for COD, heavy metals, and complex organics. The Torresdale intake was also monitored for nitrosamines; however, measurable quantities were not detected. COD and heavy metals results are presented in this section and complex organics are discussed in Section VII.

RESULTS

The time necessary for wastewater from Northeast to reach the Torresdale intake is dependent upon several variables including tide height, wind, and upstream freshwater flow. During the NEIC survey, tides ranged from 1.5 m (4.9 ft) to 2.2 m (7.1 ft). NEIC results confirmed that the dye injected into the Northeast WPCP effluent reached the Torresdale intake within one tidal cycle. A flood tide lasts for approximately five and one-half hours. Study findings showed that when a batch of dye was released into the Northeast effluent on September 22, 1976, at 2030 hrs., the peak concentration reached Torresdale seven hours later September 23 at approximately 0345 hrs., about midway

Table 15

DELAWARE RIVER TIDAL CONDITIONS
September 11-23, 1976

Date	Freshwater Inflow at Trenton		Tide Height† at Torresdale		Range††
	cms	cfs	m	ft	
9-11	105	3720	1.9	6.1	M
			1.9	6.1	M
9-12	116	4100	1.8	5.8	M
			1.9	6.1	M
9-13	113	3980	1.7	5.5	M
			1.8	6.0	M
9-14	107	3760	1.6	5.3	M
			1.8	5.9	M
9-15	105	3720	1.5	5.0	M
			1.8	5.8	M
9-16	111	3910	1.5	4.9	M
			1.8	5.9	M
9-17	151	5340	1.5	5.0	M
			1.8	6.0	M
9-18	182	6420	1.6	5.1	M
			1.8	5.9	M
9-19	179	6300	1.6	5.4	M
			2.0	6.4	M
9-20	158	5580	1.7	5.7	M
			2.0	6.6	S
9-21	149	5260	1.9	6.3	M
			2.1	7.0	S
9-22	149	5260	2.1	6.8	S
			-	-	
9-23	130	4580	2.2	7.1	S
			2.2	7.2	S

† *Tide heights are reported as net difference between low and high tide and occur approximately twice every 25 hours.*
†† *Mean tide (M) is 1.9 meters (6.2 ft) or less; spring tide (S) is 2.0 meters (6.5 ft) or more.*

through ebb tide. Theoretically this means that the dye mass moved upstream past Torresdale during flood tide. During the NEIC study a recording fluorometer monitored the Torresdale intake water. Apparently the dye slug moved near center channel during flood tide and did not become mixed with water near the intake until ebb tide. The peak dye concentration passed the intake, moving downstream 2-1/4 hours after the beginning of ebb tide.

During the survey, the dye injection rate varied. However, relatively constant injection rates occurred for three distinct periods between September 11 and 21. The dye concentration measured at Torresdale was partly a function of the injection rate [Table 16].

Delaware River and Torresdale WTP raw and finished water were monitored for COD and heavy metals [Table 17]. COD of the river stations and the intake ranged from 6 to 25 mg/l and averaged 15 mg/l, while finished water COD averaged 12 mg/l. Heavy metals concentrations were very low with many of the metals analyzed either undetected or present in concentrations near the detection limit. The maximum contaminant levels for drinking water as established by EPA[4] for heavy metals are compared with NEIC survey findings for Torresdale WTP finished water as follows:

Contaminant	Max. Level mg/l	NEIC Survey Level Average mg/l	NEIC Survey Level Max.Day mg/l
Arsenic	0.05	<0.004	<0.004
Barium	1	<0.2	0.2
Cadmium	0.010	<0.01	0.01
Chromium	0.05	<0.02	<0.02
Lead	0.05	<0.17	<0.17
Mercury	0.002	0.0013	0.0019
Selenium	0.01	<0.005	<0.005
Silver	0.05	<0.008	<0.008

Table 16

COMPARISON OF DYE INJECTION RATE AT NORTHEAST WPCP AND DYE CONCENTRATION AT TORRESDALE WTP INTAKE
September 11-21, 1976

Time Period	Average Injection Rate (gr/hr active ingredient)	Average Dye Concentration in Northeast Effluent (mg/l)†	Average Net Dye Concentration During Flood Tide	Average Dilution %††	Average Peak Net Dye Concentration During Flood Tide†††	Peak Dilution %
9-11/1130 to 9/13/0330	493	17.4	0.13	0.75	0.23	1.3
9-13/1300 to 9-16/1130	720	25.4	0.20	0.79	0.32	1.3
9-18/1600 to 9-21/0630	300	10.6	0.11	1.0	0.20	1.9

† *Based on flow of 680 x 10^3 m^3/day (180 mgd) final effluent from Northeast WPCP.*
†† *Dilution attained after approximately 24 hours. The dilution is the percent of the original dye concentration.*
††† *Peak concentration occurred at the end of each flood tide.*

Table 17

COMPARISON OF WATER QUALITY
DELAWARE RIVER, TORRESDALE WTP AND NORTHEAST WPCP

Station Description	Date†	COD mg/l	Ag (µg/l)	As (µg/l)	Hg (µg/l)	Se (µg/l)	Al (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	Fe (mg/l)	Mn (mg/l)	Ni (mg/l)	Pb (mg/l)	Sn (mg/l)	Ti (mg/l)	Zn (mg/l)
Delaware River @ Buoy 48, 8.8 miles upstream of Torresdale WTP intake.††	9-20	6	<8	<4	1.8	<5	18	<0.2	0.01	<0.02	<0.01	0.34	0.06	<0.03	<0.17	<1	<1	0.03
	9-21	20	<8	<4	1.1	<5	<1	<0.2	0.01	<0.02	<0.01	0.29	0.07	<0.03	<0.17	<1	<1	0.02
	9-22	17	<8	<4	1.4	<5	11	<0.2	0.01	<0.02	<0.01	0.41	0.10	<0.03	<0.17	<1	<1	0.03
	Average	14	<8	<4	1.4	<5	10	<0.2	0.01	<0.02	0.01	0.35	0.08	<0.03	<0.17	<1	<1	0.03
Delaware River @ Buoy 36, 5.9 miles upstream of Torresdale WTP intake.††	9-20	13	<8	<4	2.4	<5	17	<0.2	<0.01	<0.02	<0.01	0.29	0.10	<0.03	<0.17	<1	<1	0.02
	9-21	25	<8	<4	1.3	<5	<1	<0.2	0.01	<0.02	<0.01	0.22	0.06	<0.03	<0.17	<1	<1	0.02
	9-22	16	9	<4	0.9	<5	10	<0.2	0.01	0.02	<0.01	0.48	0.07	<0.03	<0.17	<1	<1	0.03
	Average	18	<8	<4	1.5	<5	9	<0.2	0.01	<0.02	<0.01	0.33	0.08	<0.03	<0.17	<1	<1	0.02
Torresdale WTP intake†††	9-16	14	<8	<4	0.6	<5	2	0.2	0.01	<0.02	<0.01	0.39	0.06	0.03	<0.17	<1	<1	0.02
	9-17	12	<8	<4	0.7	<5	2	0.3	<0.01	<0.02	<0.01	0.33	0.06	<0.03	<0.17	<1	<1	<0.01
	9-18	15	<8	<4	1.4	<5	<1	<0.2	<0.01	<0.02	<0.01	0.59	0.06	0.03	<0.17	<1	<1	0.01
	9-20	8	<8	<4	2.9	<5	<1	0.3	<0.01	<0.02	<0.01	0.28	0.06	<0.03	<0.17	<1	<1	0.03
	9-21	23	<8	<4	3.2	<5	4	<0.2	0.01	<0.02	<0.01	0.19	0.06	<0.03	<0.17	<1	<1	0.02
	9-22	11	<8	<4	2.7	<5	5	<0.2	0.01	<0.02	<0.01	0.38	0.06	<0.03	<0.17	<1	<1	0.02
	9-23	24	<8	<4	1.3	<5	<1	0.2	<0.01	<0.02	<0.01	0.68	0.10	<0.03	<0.17	<1	<1	0.04
	Average	15	<8	<4	1.8	<5	2	0.2	<0.01	<0.02	<0.01	0.41	0.07	<0.03	<0.17	<1	<1	0.02
Torresdale WTP finished water	9-16	14	<8	<4	1.9	<5	7	0.2	<0.01	<0.02	<0.01	0.08	<0.01	<0.03	<0.17	<1	<1	<0.01
	9-17	6	<8	<4	1.5	<5	13	<0.2	<0.01	<0.02	<0.01	0.04	<0.01	<0.03	<0.17	<1	<1	0.01
	9-18	9	<8	<4	0.8	<5	15	<0.2	<0.01	<0.02	<0.01	0.07	<0.01	<0.03	<0.17	<1	<1	0.02
	9-20	17	<8	<4	1.3	<5	25	0.2	<0.01	<0.02	<0.01	0.06	<0.01	<0.03	<0.17	<1	<1	0.03
	9-21	8	<8	<4	0.8	<5	4	<0.2	0.01	<0.02	<0.01	0.07	<0.01	<0.03	<0.17	<1	<1	0.02
	9-22	15	<8	<4	1.2	<5	4	<0.2	0.01	<0.02	<0.01	0.06	<0.01	<0.03	<0.17	<1	<1	0.01
	9-23	14	<8	<4	1.3	<5	2	<0.2	0.01	<0.02	<0.01	<0.04	<0.01	<0.03	<0.17	<1	<1	<0.01
	Average	12	<8	<4	1.3	<5	10	<0.2	<0.01	<0.02	<0.01	0.05	<0.01	<0.03	<0.17	<1	<1	0.01
Northeast WPCP final effluent	9-17	200	19	<4	0.9	<5	22	0.5	0.01	0.07	<0.01	1.16	0.48	0.08	<0.17	<1	<1	0.27
	9-18	200	9	<4	1.4	<5	17	0.2	0.02	0.05	<0.01	1.26	0.72	0.14	<0.17	<1	<1	0.33
	9-19	230	12	<4	1.2	<5	7	0.5	0.02	0.06	<0.01	1.32	0.74	0.09	0.18	<1	<1	0.52
	9-20	190	<8	<4	1.0	<5	5	0.3	0.01	0.02	<0.01	1.00	0.65	0.09	<0.17	<1	<1	0.32
	9-21	240	13	<4	0.6	<5	4	0.5	0.02	0.07	<0.01	1.21	0.62	0.12	0.22	<1	<1	0.45
	9-22	240	21	<4	0.1	<5	<1	0.3	0.01	0.09	<0.01	2.05	0.75	0.11	<0.17	<1	<1	0.34
	9-23	270	22	<4	18	<5	<1	0.4	0.02	0.09	<0.01	1.75	0.85	0.12	<0.17	<1	<1	0.36
	Average	220	14	<4	3.3	<5	8	0.4	0.02	0.06	<0.01	1.39	0.69	0.11	<0.17	<1	<1	0.37

† *Date is day in which composite ended.*
†† *Samples for 9-20, 9-21, and 9-22 are 24-hour composites collected during ebb tides.*
††† *Samples for 9-16, 9-17, 9-18, and 9-23 are 6-hour composites collected at the intake gate during flood tide. Samples for 9-20, 9-21, and 9-22 are 24-hr composites collected in the Delaware River 100 yd out from the intake gate during flood tides.*

INTERPRETATION

NEIC findings indicate that soluble pollutants discharged from the Northeast WPCP will reach the Torresdale WTP intake under normal tidal conditions within one tide cycle. Average and peak dilution ranged from 0.75 to 1.0% and 1.3 to 1.9%, of effluent concentration respectively. Therefore, under tidal conditions similar to those experienced from September 11 to 23, 1976, a soluble pollutant discharged from the Northeast Plant at a concentration of 10 mg/l will be present in the raw water at Torresdale at an average concentration of 0.075 to 0.10 mg/l and a peak concentration of 0.13 to 0.19 mg/l.

With respect to water quality monitoring for COD no correlation was apparent between the Northeast WPCP and Torresdale WTP raw water. Because metal concentrations at the WTP were generally less than detectable levels it is not known whether a correlation exists between metals concentrations from the Northeast WPCP effluent and the Torresdale WTP intake. In addition, river monitoring did not indicate the presence of significant concentrations of COD or metals upstream from the Torresdale intake.

Heavy metals concentrations, with the exception of mercury, were near or less than the detection limit in the Torresdale WTP finished water. Mercury averaged 1.3 μg/l and reached 1.9 μg/l, on one of the seven days sampled. The EPA maximum contaminant level for mercury in drinking water is 2 μg/l. The mercury concentration in the raw water at Torresdale exceeded 2 μg/l and ranged from 2.7 to 3.2 μg/l on three of the seven days sampled. Two upstream stations in the Delaware River averaged 1.4 and 1.5 μg/l mercury. The Northeast WPCP final effluent averaged 3.3 μg/l and ranged from 0.1 to 18 μg/l mercury.

VII. ORGANICS INTERPRETATION

Samples collected September 19-22 from nine stations, five at the Northeast WPCP, two at the Torresdale WTP and two in the Delaware River upstream of the Torresdale intake [Table 1], were analyzed for volatile and non-volatile organic compounds. A total of 155 compounds were identified. Volatile organics were grab sampled while non-volatiles were sampled on a 24-hr composite basis. Non-volatile samples from Northeast were composited on an hourly flow-weighted basis. Samples at the Torresdale intake were collected only during flood tide. Samples from upstream of Torresdale were collected only during ebb tide.

The purpose of this section is to interpret the significance of the organic compounds found in the survey, with particular emphasis on adverse environmental and health effects. Because of the large number of compounds involved (155), much of the information has been condensed into a tabular format by sampling point and day [Tables 18 and 19]. Each compound has been assigned a unique number which is given with the chemical compound for quick reference to Tables 18 and 19. The compound reference number is listed in the left hand column in ascending order, followed by the compound name and Chemical Abstracts Service (CAS) Registry number if available.

DETERMINING THE TOXICITY INDEX

It has been commonly accepted that organic compounds occur in sewage effluents, rivers and, more recently, drinking water. In the past, most data relating to these occurrences were from gross measurements, such as carbon-chloroform extracts and non-volatile total organic

Table 18

VOLATILE ORGANICS
PHILADELPHIA NORTHEAST WPCP SURVEY†
September 1976

Reference Number††	Compound Name	Chemical Abstracts Service Number	Sampling Day†††	Plant Influent: Delaware Low Level Interceptor (μg/l)	Plant Influent: Somerset Low Level Interceptor (μg/l)	Plant Influent: Frankford Low Level Interceptor (μg/l)	Plant Influent: Frankford High Level Interceptor (μg/l)	Final Effluent (μg/l)	Torresdale WTP Intake (μg/l)	Torresdale WTP Finished Water (μg/l)	Aquatic Toxicity	Toxic Substance List	OSHA Standard††††	Suspected Carcinogen List	Toxline	Toxicity Index
1	Ethanol	000064175	1								6/3	21/TD5	3	3112[a]/7	319	360[b]
			2	600	9,300	510	1,200	250								
			3													
2	*n*-Pentane	000109660	1		MS[1]							1/TC1			3	5
			2													
			3													
3	Acetone	000067641	1	33,000	1,600	140	50	2,200	50		15/5	1/TD4	3		104	132
			2	43,000	2,000	550	1,700	600	50	50						
			3		740	380	230	4,400	120							
4	Dimethoxymethane	000109875	1	14,000				980	59			1/LD3	3		0	7
			2	17,000				3,100								
			3					1,700								
5	Dichloromethane	000075092	1		110	28	59		28			5/LD4	4		39	52
			2		750	170	130	80[2]	80	16						
			3		120	38	25	80[2]	16							
6	Carbon disulfide	000075150	1	MS[1]				MS[1]			1/4	2/LD4	5		128	144
			2													
			3					MS[3]								
7	1,2-Dichloroethene	000107062	1	MS[1]											29	29
			2													
			3													
8	2-Butanone	000078933	1		MS[1]						1/2	3/LD3	4		16	26
			2													
			3													
9	Chloroform	000067663	1		48	43	43	33	20		2/4	15/TC5	4	3111/6	108	144
			2		110	59	11	12	4	160						
			3		180			22	22							
10	1-Butanol	000071363	1								1/3	5/TC 5	4		18	36
			2													
			3													
11	1,2-Dichloroethane[4]	000107063	1	26,000	130			4,000	34		1/4	16/LD4	4		14	43
	1,2-Dichloroethane[3]		2	40,000	38			12,000	28	9						
	1,2-Dichloroethane[4]		3		42			8,700								
12	1,1,1-Trichloroethane	000071556	1		MS[1]						1/4	4/TC4	3		31	47
	1,1,1-Trichloroethane[4]		2		70											
	1,1,1-Trichloroethane[5]		3		46		23									
13	Trichloroethene	000079016	1		15	17						10/LD5			103	123
			2			25	140									
			3			26										
14	Bromodichloromethane	000075274	1			MS[1]						0/0			4	4
	Bromodichloromethane[5]		2						20							
	Bromodichloromethane[6]		3			65	48									
15	Dimethyl disulfide	000624920	1									0/0			17	17
			2			MS[6]										
			3				MS[2]									
16	Tetrachloroethane	001299907	1			130						4/LD4			18	26
			2			500	240									
			3			370	51									

Table 18 (Continued)

VOLATILE ORGANICS

PHILADELPHIA NORTHEAST WPCP SURVEY†

:

† *Column headings are explained in the text.*

†† *The chemical compounds have been assigned unique numbers which appear in ascending order.*

††† *Non-volatile organics were 24-hr composited, based on a sampling day from 6 a.m. to 6 a.m. Ending dates for sampling days 1, 2, 3 were September 20, 21, 22, 1976.*

†††† *The OSHA Standard toxicity rating is explained in Appendix G.*

[a] *Ethanol is listed in the Suspected Carcinogens List but is not listed in An Ordering of the NIOSH Suspected Carcinogens List. The carcinogenicity ranking was calculated in accord with the system described in the explanation of An Ordering of the NIOSH Suspected Carcinogens List.*

[b] *The toxicity index for both compounds No. 2 and 247 (Ethanol and Caffeine) are biased because they are not normal human metabolites. They are consumed in foods, thus there is a great deal of literature on their health effects.*

Day 1
- [1] *Mass spec ID only, unable to quantitate.*
- [2] *No sample at Torresdale WTP Intake available for Day 1.*
- [3] *Detection limits vary with sample size and response.*
- [4] *Concentrations estimated using response of 1,2-Dichloropropane.*

Day 2
- [1] *Detection limits will vary with sample size and response.*
- [2] *Estimated only, interference from Dimethoxymethane.*
- [3] *Concentrations estimated using response of 1,2-Dichloropropane.*
- [4] *Estimated only, interference from Dimethoxymethane.*
- [5] *Concentrations estimated using response of Chloroform.*
- [6] *Mass spec ID only, unable to quantitate.*

Day 3
- [1] *No samples available for Delaware Low Level Interceptor and Somerset Low Level Interceptor this day.*
- [2] *Mass spec ID only, unable to quantitate results.*
- [3] *Concentrations estimated using response of Trichloroethane.*
- [4] *Dichloromethane masked by Dimethoxymethane.*
- [5] *Concentrations estimated using response of 1,2-Dichloropropane.*
- [6] *Concentrations estimated using response of Chloroform.*

Table 19

NON-VOLATILE ORGANICS
PHILADELPHIA NORTHEAST WPCP SURVEY†
September 1976

Reference Number††	Compound Name	Chemical Abstracts Service Number	Sampling Day†††	Plant Influent: Delaware Low Level Interceptor	Plant Influent: Somerset Low Level Interceptor	Plant Influent: Frankford Low Level Interceptor	Plant Influent: Frankford High Level Interceptor	Final Effluent	Torresdale WTP Intake	Torresdale WTP Finished Water	Delaware River 5.9 miles upstream of WTP intake	Delaware River 8.8 miles upstream of WTP intake	Aquatic Toxicity	Toxic Substance List	OSHA Standard††††	Suspected Carcinogen List	Toxline	Toxicity Index
				µg/l														
17	Methyl Isobutylketone	000108101	1 2 3	 10 										1/TC4			4	13
18	2-Pentanol	006032297	1 2 3	120										3/LD3			0	6
19	4-Methyl-2-Pentanol	000108112	1 2 3	 100[1] 120[1]										3/LC3			1	13
20	Nonadecane	000629295	1 2 3			 21 								0/0			1	1
21	Toluene	000108883	1 2 3	590 1,000 1,740	11 3 32	27 7 12	5	650 200 180					5/5	6/TC4	4		101	125
22	*n*-Butylacetate	000123864	1 2 3	100 210 1,400										2/TC4	4		4	14
23	Tetrachloroethylene	000127184	1 2 3	280 290 [2]		71 40 29		30 50 60						4/LD4			47	59
24	Diacetone Alcohol	000123422	1 2 3	 25 	 5 12			 10 					1/4	1/LD3	4		0	13
25	1,2-Epoxy cyclohexane	000286004	1 2 3									0.21[1]		3/LD4			8	15
26	Chlorobenzene	000108907	1 2 3	30 25 20				 10 20					4/5	1/LD3	4		26	43
27	3-Chlorocyclohexene		1 2 3							0.50 0.42				0/0			0	0
28	Ethylbenzene	000100414	1 2 3	250 220 450	 16	 21 12	 4	50 60 40					4/5	3/LD4	4		10	30
29	*m* & *p*-Xylene	*m* = 000108383 *p* = 000106423	1 2 3	490 990 1,670	7 3 31	4 47 46	5 10 11	130 170 90	 0.04 	 0.18 0.08	 0.09 	 0.08 	6/5	0/0			9	20
30	2-Cyclohexenol	000822673	1 2 3								0.08[1]			0/0			12	12
31	Styrene	000100425	1 2 3	550 570 1,050				120 70 50	 0.20 					5/LD4			39	52
32	*o*-Xylene	000095476	1 2 3	 [3]	6 	2 14 19	2 3 4	 20				0.05	6/5	1/LD3			10	25

Table 19 (Continued)

NON-VOLATILE ORGANICS
PHILADELPHIA NORTHEAST WPCP SURVEY†
September 1976

Reference Number††	Compound Name	Chemical Abstracts Service Number	Sampling Day†††	Plant Influent: Delaware Low Level Interceptor	Plant Influent: Somerset Low Level Interceptor	Plant Influent: Frankford Low Level Interceptor	Plant Influent: Frankford High Level Interceptor	Final Effluent	Torresdale WTP Intake	Torresdale WTP Finished Water	Delaware River 5.9 miles upstream of WTP intake	Delaware River 8.8 miles upstream of WTP intake	Aquatic Toxicity	Toxic Substance List	OSHA Standard††††	Suspected Carcinogen List	Toxline	Toxicity Index
				uc/l														
33	1-Chlorocyclohexene	000930665	1							0.42				0/0			0	0
			2															
			3							0.25								
34	3-Octanone	000106683	1			3[1]								0/0			0	0
			2															
			3															
35	2-n-Butoxyethanol	000111762	1		25[1]									11/TD4	4		3	22
			2		61[1]	17[1]												
			3		380[1]													
36	Cumene	000098828	1	110			1	10						2/LD3	4		6	15
			2	160		7		10			0.02							
			3	180				10										
37	2-Hexanone	000591786	1							0.25[1]				4/LD4	4		9	21
			2															
			3															
38	2-Cyclohexenone	000930687	1								0.08		5/5	0/0			1	11
			2															
			3															
39	C-7 Alcohol	000111706	1											0/0			4	4
			2															
			3	50[1,4]														
40	Methyl hexanol	000627985	1	60[1]				10[1]						0/0			0	0
			2	40[1]				T0[1]										
			3															
41	o-Chlorotoluene	000095498	1											0/0			2	2
			2			36												
			3															
42	Benzaldehyde	000095498	1							0.93				3/LD3			15	21
			2							0.89								
			3							0.71								
43	Bis (2-Chloro-ethyl) Ether	000100527	1					10	0.13					5/TD5	5	3111/6	5	26
			2					20										
			3					20										
44	2-Ethyl-4-methyl pentanol	000111444	1											0/0			0	0
			2			25[1]												
			3															
45	m-Ethyltoluene	000620144	1											0/0			2	2
			2				4											
			3			23	5											
46	Ethylmethylbenzene	025550145	1											0/0			2	2
			2															
			3					10										
47	Phenol	000108952	1	750									6/69	21/TD5	5	3121/7	176	226
			2	820														
			3	120														
48	1,1,1,3-Tetrachloro-2-methyl-2-pronanol		1							0.08[1]				0/0			0	0
			2															
			3															

Table 19 (Continued)

NON-VOLATILE ORGANICS
PHILADELPHIA NORTHEAST WPCP SURVEY[†]
September 1976

Reference Number[††]	Compound Name	Chemical Abstracts Service Number	Sampling Day[†††]	Plant Influent: Delaware Low Level Interceptor	Plant Influent: Somerset Low Level Interceptor	Plant Influent: Frankford Low Level Interceptor	Plant Influent: Frankford High Level Interceptor	Final Effluent	Torresdale WTP Intake	Torresdale WTP Finished Water	Delaware River 5.9 miles upstream of WTP intake	Delaware River 8.8 miles upstream of WTP intake	Aquatic Toxicity	Toxic Substance List	OSHA Standard[††††]	Suspected Carcinogen List	Toxline	Toxicity Index
				μg/l														
49	2,2,3,4-Tetra-methylpentane		1				4[1]							0			0	0
			2															
			3											0				
50	1,3,5-Trimethylbenzene	000108678	1											2			10	15
			2									0.05						
			3											LD3				
51	o-Ethyltoluene	000611143	1				4							0			1	1
			2															
			3			29	11							0				
52	6-Methyl-1-heptanol	001653403	1											0			0	0
			2	290[1]				90[1]										
			3	220[1]				40[1]						0				
53	Ethylidene Diacetate	000542109	1								0.08[1]	0.09[1]		0			0	0
			2															
			3											0				
54	2-Bromo-1-methyl-propylacetate		1						0.21[1]	0.017[1]				0			0	0
			2															
			3											0				
55	Cis-2-Chlorocyclohexanol	016536586	1							2.90[1]				0			0	0
			2															
			3											0				
56	Benzyl chloride	000100447	1	10				20						4	6	4101	13	34
			2	250														
			3	60				20						TCS		6		
57	1,2,4-Trimethylbenzene	000095636	1			4	4							2			5	10
			2			16	10				0.11	0.13						
			3		3	36								LD3				
58	m-Dichlorobenzene	000541731	1				6		0.05			0.07		0			6	6
			2															
			3						0.13					0				
59	Isopropyl propanoate		1	1[1]										0			0	0
			2															
			3											0				
60	nC-10 Decane	000124185	1											0			0	0
			2			16	7											
			3		3	17	7							0				
61[a]			1															
			2															
			3															
62	Methyl Benzaldehyde	001334787	1											0			3	3
			2			83[1]	21[1]											
			3				17							0				
63	2-Ethyl-1-Hexanol	000104767	1	420[1,2]				100[1,2]	0.92	4.6	0.02			5			7	15
			2	500[1,2]				250[1,2]	0.20	5.00	0.25							
			3	290				70	0.49	3.25	0.17			LD3				
64	2,3-Dihydrobenzaldehyde	000095012	1				13[1]							0			0	0
			2															
			3											0				

Table 19 (Continued)

NON-VOLATILE ORGANICS
PHILADELPHIA NORTHEAST WPCP SURVEY[†]
September 1976

Reference Number[††]	Compound Name	Chemical Abstracts Service Number	Sampling Day[†††]	Plant Influent: Delaware Low Level Interceptor (µg/l)	Plant Influent: Somerset Low Level Interceptor (µg/l)	Plant Influent: Frankford Low Level Interceptor (µg/l)	Plant Influent: Frankford High Level Interceptor (µg/l)	Final Effluent (µg/l)	Torresdale WTP Intake (µg/l)	Torresdale WTP Finished Water (µg/l)	Delaware River 5.9 miles upstream of WTP intake (µg/l)	Delaware River 8.8 miles upstream of WTP intake (µg/l)	Aquatic Toxicity	Toxic Substance List	OSHA Standard[††††]	Suspected Carcinogen List	Toxline	Toxicity Index
65	2-Butyloctanol		1 2 3		8[1]	4[1]								0/0			0	0
66	o-Dichlorobenzene	000095501	1 2 3			6 69 62							5/5	2/LD4	5		11	32
67	o-Cresol	000095487 000095487	1 2 3	 200									7/5	5/LD4	5		5	31
68	Cis-1,2-Dichlorocyclohexane		1 2 3						 0.04 0.08	1.9 0.13	 0.07	 0.08 0.21		0/0			0	0
69	Acetophenone	000098862	1 2 3	160 230 180	1			70 70 60						2/LD4			10	16
70[c]			1 2 3													d		
71	m-Cresol	000108394	1 2 3	140 230 180									4/5	5/LD4	5	3121/7	4	34
72	Diethylbenzene	000141935	1 2 3			5 50								1/LD3			4	8
73	trans-1,2-dichlorocyclohexane	000141935	1 2 3							 4.20 2.95				0/0			0	0
74	2-Phenyl-2-propanol	000617947	1 2 3	540[3] 640 800				170[3] 200 220	 0.08 0.15	 0.13	 0.15 0.11	 0.17 0.16		0/0			2	2
75	1,2,3,5-Tetramethylbenzene		1 2 3			 15 17								0/0			0	0
76	n-Nonanal	000124196	1 2 3		7[1]									0/0			11	11
77	4,8- Dimethyltridecane		1 2 3	17[1]	4[1]									0/0			0	0
78	3-Methylindene	000767602	1 2 3	20[1] 80										0/0			0	0
79	1-Methylpyrrole	000096549	1 2 3			13[1]								0/0			7	7
80	1,4-Dichlorocyclohexane	024955633	1 2 3					15 10						0/0			0	0

Table 19 (Continued)

NON-VOLATILE ORGANICS
PHILADELPHIA NORTHEAST WPCP SURVEY†
September 1976

Reference Number††	Compound Name	Chemical Abstracts Service Number	Sampling Day†††	Plant Influent: Delaware Low Level Interceptor	Plant Influent: Somerset Low Level Interceptor	Plant Influent: Frankford Low Level Interceptor	Plant Influent: Frankford High Level Interceptor	Final Effluent	Torresdale WTP Intake	Torresdale WTP Finished Water	Delaware River 5.9 miles upstream of WTP intake	Delaware River 8.8 miles upstream of WTP intake	Aquatic Toxicity	Toxic Substance List	OSHA Standard††††	Suspected Carcinogen List	Toxline	Toxicity Index
				µg/l														
81	Benzylcyanide	000140294	1 2 3							0.33				6 / LD5			9	19
82	nC-11 Undecane	001120214	1 2 3	 10	 2 4	1 18 27	12 8 14							0 / 0			8	8
83	Methylacetophenone	000122009	1 2 3		5[1]									4 / LD4			4	12
84	1,2,4,5-Tetra-methylbenzene	000095932	1 2 3			7 21 22								0 / 0			1	1
85	2,4 & 2,5-Dimethylphenol	000105679 000095874	1 2 3	50				20						0 / 0			12	12
86	Dimethyl cyclohexyl-carbinol		1 2 3			21[1]								0 / 0			0	0
87	Dimethylcyclooctyl-carbinol		1 2 3				21[1] 17[1] 17	30[1]						0 / 0			0	0
88	m-Ethylphenol	000620177	1 2 3	30										0 / 0			2	2
89	Isoborneol	000124765	1 2 3		3 14	13 25	25 21 17	21 10 10						0 / 0			4	4
90	Naphthalene	000091203	1 2 3	50 80 20								0.05		4 / LD4	5	4101 / 6	70	89
91	Alpha Terpineol	000098555	1 2 3	36 37 38	75 246 215	130 103 100	80 80 90				0.03			0 / 0			40	40
92	Tert-Butyl acetate	000540885	1 2 3					 4[1]							4		1	1
93	nC-12 Dodecane	000112403	1 2 3		 3	 16 10	10 4 13							0 / 0			8	8
94	3-Methyltridecane		1 2 3	 4[1]										0 / 0			0	0
95	Quinoline	000091225	1 2 3					 4 5						3 / LD4			7	14
96	1,2-bis(2-Chloro-ethoxy)ethane	000112265	1 2 3	20[3] 80 330				1.17[3] 30 75	0.67[3] 0.30 0.33[1]	0.50[3] 0.72 0.40				2 / LD4			0	6

Table 19 (Continued)

NON-VOLATILE ORGANICS
PHILADELPHIA NORTHEAST WPCP SURVEY†
September 1976

Reference Number††	Compound Name	Chemical Abstracts Service Number	Sampling Day†††	Plant Influent: Delaware Low Level Interceptor	Plant Influent: Somerset Low Level Interceptor	Plant Influent: Frankford Low Level Interceptor	Plant Influent: Frankford High Level Interceptor	Final Effluent	Torresdale WTP Intake	Torresdale WTP Finished Water	Delaware River 5.9 miles upstream of WTP intake	Delaware River 8.8 miles upstream of WTP intake	Aquatic Toxicity	Toxic Substance List	OSHA Standard††††	Suspected Carcinogen List	Toxline	Toxicity Index
				ug/l														
97	Indole	000120729	1 2 3	20 				 5 						6/LD4		3101/5	13	28
98	1-Heptyne	000628717	1 2 3		5[1] 									0/0			0	0
99	P- tert-Butylphenol	000098544	1 2 3	50 					0.19 0.17 		0.22 0.33 0.21	0.27 0.47 0.25		2/LD3			8	13
100	2-Methylnaphthalene	000091576	1 2 3	10 20 	3 	10 18 23	6 8 14	5 5 5						0/0			4	4
101	Dimethylindan		1 2 3											0/0			0	0
102	1-Methylnaphthalene		1 2 3			10 								0/0			5	5
103	nC-13 Tridecane	000629505	1 2 3				14 4 15							0/0			9	9
104	Glycerol triacetate	000102761	1 2 3	 80 110		10 		15 20 						3/LC3			4	10
105	Tetraisobutylene	015220856	1 2 3	110 200 370		2 		7 10 						0/0			0	0
106	Tetraisobutylene isomers		4 3 6		4		4 3							0/0			0	0
107	Butyl butanoate	000109217	1 2 3						 0.12[1]	 0.07[1]	 0.05[1]			0/0			1	1
108	5-Bromobenzofuran		1 2 3						0.08[1] 					0/0			0	0
109	Methylbutyl bromide	000107824	1 2 3			3[1] 								0/0			2	2
110[c]			1 2 3															
111	Isobutyl butanoate	000109217	1 2 3						0.04[1] 					0/0			0	0
112	Biphenyl	000092524	1 2 3			9 180 240	1 	 5 10						3/LD3	6	3101/5	17	34

Table 19 (Continued)

NON-VOLATILE ORGANICS
PHILADELPHIA NORTHEAST WPCP SURVEY[†]
September 1976

Reference Number ††	Compound Name	Chemical Abstracts Service Number	Sampling Day †††	Plant Influent: Delaware Low Level Interceptor	Plant Influent: Somerset Low Level Interceptor	Plant Influent: Frankford Low Level Interceptor	Plant Influent: Frankford High Level Interceptor	Final Effluent	Torresdale WTP Intake	Torresdale WTP Finished Water	Delaware River 5.9 miles upstream of WTP intake	Delaware River 8.8 miles upstream of WTP intake	Aquatic Toxicity	Toxic Substance List	OSHA Standard ††††	Suspected Carcinogen List	Toxline	Toxicity Index
				ug/l														
113	t-Butylmethylphenol		1 2 3									0.12		0 0			0	0
114	Diphenyl ether	000101848	1 2 3	 20 20										0 0			7	7
115	p-tert-Amylphenol		1 2 3								 0.03[1]	 0.25[1]		0 0			0	0
116	Tributylphenyl ether		1 2 3	 30[1]										0 0			0	0
117	nC-14 Tetradecane	000629954	1 2 3			 4	13 3 14							0 0			20	20
118	2-Methyl tridecane		1 2 3	 10[1]		 17[1]								0 0			0	0
119	Dimethyl naphthalene	000573988	1 2 3				16 17							0 0			5	5
120	2-Propyl-4-methyl-pentanol		1 2 3			20[1]								0 0			0	0
121	Dimethyl phthalate	000131113	1 2 3			 850		 20	0.22 0.05 0.05	0.03 0.04 0.02	 0.07			5 TD3	5		20	33
122	2-tert-Butyl-p-hydroxy-anisole		1 2 3						 0.33[1] 0.25[1]	 0.33[1] 0.33[1]	 0.33[1] 0.12[1]	 0.33[1] 0.33[1]		1 LD3			2	6
123	Heptanolactone		1 2 3				 80[1]							0 0			0	0
124	2-Tert-Butyl-4-methoxy-phenol	000121006	1 2 3						0.23[1]	0.32[1]	0.35[1]	0.21[1]		1 LD3			7	11
125	Tridecanol	000112709	1 2 3			 33[1] 17[1]								1 LD3			3	7
126	o-Phenylphenol	000090437	1 2 3			1		1 16[1] 10						2 TD4			9	15
127	nC-15 Pentadecane	000629629	1 2 3		4	2 12 4	15 3 14							0 0			9	9
128	2,6-Di-tert-butyl-4-methylphenol[5]	000128370	1 2 3						 0.27		0.16 0.28 0.20	0.18 0.28		0 0			67	67

Table 19 (Continued)

NON-VOLATILE ORGANICS
PHILADELPHIA NORTHEAST WPCP SURVEY†
September 1976

Reference Number††	Compound Name	Chemical Abstracts Service Number	Sampling Day†††	Plant Influent: Delaware Low Level Interceptor	Plant Influent: Somerset Low Level Interceptor	Plant Influent: Frankford Low Level Interceptor	Plant Influent: Frankford High Level Interceptor	Final Effluent	Torresdale WTP Intake	Torresdale WTP Finished Water	Delaware River 5.9 miles upstream of WTP intake	Delaware River 8.8 miles upstream of WTP intake	Aquatic Toxicity	Toxic Substance List	OSHA Standard††††	Suspected Carcinogen List	Toxline	Toxicity Index
				ug/l														
129	A-Di-o-isopropylidene-1-sorbose	032717650	1 2 3						0.12[1] 0.17[1]	0.17[1] 0.13[1]	0.17[1] 0.03[1]	0.17[1]		0/0			0	0
130	Substituted Phenol		1 2 3	80[1]				10[1]	0.24[1]					0/0				
131	Diethyl phthalate	000084662	1 2 3	30 10		5 8 6	9 8 13	9 10	0.09 0.16	0.10	0.12 0.14	0.08 0.22		2/TD3			8	13
132	Tetramethyl butyl phenol		1 2 3	50[1]				30[1]		0.41[1]				2/LD3		3121[d]/7	0	12
133	nC-16 Hexadecane	000544763	1 2 3	10	6	16 7	8 3 13							0/0			8	8
134	Tri-n-butyl phosphate	000126738	1 2 3	50					0.38 0.33 0.38	0.31 0.42 0.33	0.25 0.35 0.32	0.29 0.25 0.33		0/0			2	2
135	Benzyl ether	000103504	1 2 3	10		166 125		10						1/LD3			0	4
136	2-Methylhexadecane		1 2 3	10[1]										0/0			1	1
137	Tetradecanol	000112721	1 2 3	30										0/0			5	5
138	Bis(2-Ethylhexyl)ether		1 2 3			3[1]								0/0			0	0
139	p-Nonylphenol	000104405	1 2 3	80[1] 20[1]				3[1] 10[1]	0.33[1]		0.33[1] 0.17[1]	0.18	4/5	0/0			0	0
140	Isoamyl benzoate	000094462	1 2 3							0.21[1] 0.12[1]				0/0			0	0
141	nC-17 Heptadecane	000629787	1 2 3			14	9 3 15	12						0/0			11	11
142	Diallyl phthalate	000131179	1 2 3							5.0 0.12				4/LD3			1	8
143	Pentadecanol		1 2 3			58								0/0			1	1
144	Methylheptadecane		1 2 3				13[1]							0/0			2	2

Table 19 (Continued)

NON-VOLATILE ORGANICS
PHILADELPHIA NORTHEAST WPCP SURVEY[†]
September 1976

Reference Number [††]	Compound Name	Chemical Abstracts Service Number	Sampling Day [†††]	Plant Influent: Delaware Low Level Interceptor (µg/l)	Plant Influent: Somerset Low Level Interceptor (µg/l)	Plant Influent: Frankford Low Level Interceptor (µg/l)	Plant Influent: Frankford High Level Interceptor (µg/l)	Final Effluent (µg/l)	Torresdale WTP Intake (µg/l)	Torresdale WTP Finished Water (µg/l)	Delaware River 5.9 miles upstream of WTP intake (µg/l)	Delaware River 8.8 miles upstream of WTP intake (µg/l)	Aquatic Toxicity	Toxic Substance List	OSHA Standard [††††]	Suspected Carcinogen List	Toxline	Toxicity Index
145	2-Methyl heptadecane		1											0/0			0	0
			2			12[1]			0.33[1]		0.25[1]	0.33[1]						
			3															
146	nC-18 Octadecane	000593453	1											0/0			20	20
			2			27	4											
			3	20		14	11											
147	Caffeine	000058082	1										1-3	13/LD6			166	170[b]
			2	70				20										
			3															
148	C-15 Alcohol		1	200[1]										0/0			0	0
			2															
			3															
149	Di-isobutyl phthalate	000084695	1						0.16	0.17	0.08	0.12		0/0			4	4
			2						0.20	0.18	1.40	0.18						
			3							0.12	0.38	0.15						
150	2(p-tert-Butylphenoxy)ethanol		1											0/0			0	0
			2															
			3	20[1]														
151	Trimethylhexadecane		1			8[1]								0/0			0	0
			2			8[1]												
			3															
152	Hexadecanol	036653824	1			7								0/0			4	4
			2						0.20									
			3	20						0.08[1]								
153	nC-19 Nonadecane	000629925	1											0/0			3	3
			2															
			3			12	6											
154	Di-n-Butyl Phthalate	000084742	1		4				0.14	0.77	0.10	0.09		2/LD4			20	26
			2						0.17	1.00	0.17	0.08						
			3						0.07	0.89	0.09							
155	Geranyl Formate		1											0/0			0	0
			2															
			3	60[1]														
156	C-17 Alcohol	001454859	1	450[1]										0/0			2	2
			2															
			3															
157	2,4,6-Tri-Tert-Butyl Phenol		1											0/0			3	3
			2															
			3	60[1]														
158	Octadecanol	026762447	1											0/0			7	7
			2															
			3	50					0.08									

Table 19 (Continued)

NON-VOLATILE ORGANICS
PHILADELPHIA NORTHEAST WPCP SURVEY†
September 1976

† Column headings are explained in the text.
The chemical compounds have been assigned unique numbers which appear in ascending order.
Non-volatile organics were 24-hr composited, based on a sampling day from 6 a.m. to 6 a.m. Ending dates for sampling days 1, 2, 3 were September 20, 21, 22, 1976.
†† The OSHA Standard toxicity rating is explained in Appendix G.

a Ethanol is listed in the Suspected Carcinogens List but is not listed in An Ordering of the NIOSH Suspected Carcinogens List. The carcinogenicity ranking was calculated in accord with the system described in the explanation of An Ordering of the NIOSH Suspected Carcinogens List.
b The toxicity index for both compounds No. 1 and 147 (Ethanol and Caffeine) are biased because they are not normal human metabolites. They are consumed in foods, thus there is a great deal of literature on their health effects.
c Compounds 61, 70 and 110 were duplicates and have been removed from the table.
d m-Cresol and Tetramethyl butyl phenol are not listed individually in the Toxic Substances List but are listed as being toxic if they occur with 7, 12-Dimethyl benz(a)anthracene.
e No toxicity data are given for compound No. 92 but there is an OSHA Standard. Also, see Table 21.

1. These compounds have been identified by combined gas chromatography/mass spectrometry, but have not been confirmed because standard compounds were not available to check GC retention times and mass spectra run on our mass spectrometer. Quantitative results were estimated based on comparable standard compounds having corresponding retention times.
2. 2-Ethyl-1-Hexanol can be identified but not confirmed as positively because of an interfering compound in these two samples.
3. 2-Phenyl-2-propanol and bis(2-Chloroethoxy)ethane were reported as not confirmed in the initial reporting of this day's sampling. Standards have become available and these two compounds can now be confirmed.
4. Tetraisobutylene shows two isomers and these can readily be identified. They are also present in the standard Tetraisobutylene in the same ratio as the sample and are obvious impurities.
5. This compound was initially reported as 2,6-Di-t-butyl-p-cresol, but we decided to report it as 2,6-Di-tert-butyl-4-methylphenol. Both names are correct but in keeping with the reporting of other phenols we changed it.

1. These compounds have been identified by combined gas chromatography/mass spectrometry, but have not been confirmed because standard compounds were not available to check GC retention times and mass spectra run on our instrument. Quantitative results were estimated based on comparable standard compounds with corresponding retention times.
2. The identity of 2-Ethyl-1-hexanol in Delaware Low Level Interceptor and Final Effluent was uncertain because of another interfering compound present. The GC retention time is the same as the standard.
3. Two tetraisobutylene isomers can be readily identified in the sample, and they were also present as obvious impurities in the standard in the same ratio as the sample.

1. These compounds have been identified by combined gas chromatography/mass spectrometry, but have not been confirmed because standard compounds were not available to check GC retention times and mass spectra run on our instrument. Quantitative results were estimated based on comparable standard compounds with corresponding retention times.
2. Tetrachloroethylene was masked by the gross amount of n-Butyl acetate in this sample.
3. The presence of o-Xylene in this sample can be confirmed but separation from styrene is not complete enough to determine quantitatively.
4. On previous sampling days this sample was identified as Methyl hexanol. It could not be identified on this day.
5. 2-Ethyl-1-hexanol can be confirmed more readily in this sample. An interfering compound was present in an earlier sample and identification was not as positive.
6. Again the isomers of tetraisobutylene were present in the sample in the same ratio as in the standard of tetraisobutylene.

carbon. Today the use of ultra-sensitive analytical tools, such as the computer-assisted gas chromatography-mass spectrometer scan, has led to definitive understanding of the many organic molecules present in small amounts in such waters. (For NEIC analytical methodology, see Appendix F.) Although Tables 18 and 19 list 155 compounds, recent EPA estimates indicate that these identified compounds constitute about 10% by weight of the total organic compounds present in such waters. A much fuller discussion of these methods is found in the recently published book *Identification and Analysis of Organic Pollutants in Water.*[5]

The compounds listed in Table 18 and 19 are not unique to the waters sampled. Concurrent exposure to the compounds, by various segments of the United States population, exists via some foods, ambient air, occupational environment, and household products including over-the-counter medications, cleaning solutions, and cosmetics. Exposure to such chemicals can cause adverse reactions in people, modified by individual susceptibility in terms of specific adaptation. Adverse reactions, which are manifested in a wide variety of physical and mental symptoms, are often chronic in nature and cyclic in occurrence, producing conditions which are frequently undiagnosed or poorly identified. Interpretation of the clinical ecological effects of data in Tables 18 and 19 is difficult and beyond the scope of this report, but may be found in *Clinical Ecology.*[6] The compounds identified during the survey [Tables 18 and 19] were evaluated and a toxicity index developed [Appendix G]. The toxicity index developed herein is a number estimating the relative toxicity of all the organic compounds found. Consideration of absolute toxicity factors, such as the development of cancer or lethal dose, was used to indicate the compounds which are potentially more harmful than others. The toxicity index is more a safety hazard evaluation than a clinical ecological interpretation.

One of the most critical aspects of this study to emerge is that the effects of long-term exposure to any one or exposure to the whole spectrum of 155 compounds identified and listed in Tables 18 and 19 are unknown. It has been determined that 60 of these compounds have been identified as toxic substances and that 10 are listed as suspected carcinogens [Tables 18, 19, 20, and 21].

TOXICITY DATA

Table 20 summarizes the number of reported toxic doses to various organisms of the chemicals identified. Although 155 chemicals were identified [Tables 18 and 19] toxic dose data are reported for only 60 in the 1974 NIOSH Toxic Substances List[7] or in the 1975 NIOSH Suspected Carcinogens - a Subfile of the NIOSH Toxic Substances List.[8] For several of these chemicals there are multiple reports as to toxicity by each of several modes of exposure. For example for ethanol there are four reports concerning human toxicity through oral exposure, for other chemicals there may be several reported toxicities for "Oral dog," "Oral rat," "Inhalation human," etc. A total of 261 individual bits of toxicity data are reported for the 60 chemicals identified.

To refine the significance of this tabulation a more detailed presentation was made of the data relating to oral and inhalation exposure as these are the more likely modes of human contact [Table 21]. This table also lists the U.S. Occupational Standards of chemicals for which data are reported in references 7 and 8.

Most of the analytical data, from the several sampling locations involved, indicate that concentrations were one or more orders of magnitude less than toxic doses, lethal doses and the U. S. Occupational Standards. However, important considerations remain unknown. Most of the toxic dosage and lethal dosage studies were of short duration using relatively high concentrations of the substances investigated, and, importantly, the toxic and lethal effects of each substance was evaluated

Table 20

SUMMARY OF REPORTED TOXIC DOSES BY ORGANISM AND TYPE OF EXPOSURE
NORTHEAST PHILADELPHIA WPCP SURVEY
September 16 - 23, 1976

Toxicity Scale†		Number of Reported Toxic Doses								
		Oral	Inhalation	Subcutaneous	Intraperitoneal	Skin	Intravenous	Parenteral	Ocular	Total
7	Human	9	21	-	-	-	-	-	1	31
6	Monkeys	-	-	-	-	-	-	-	-	0
5	Cat, Dog, Pig, Cattle, or Domestic Animal	5	2	3	1	-	8	-	-	19
4	Rat	49	12	11	19	1	2	-	-	94
3	Mouse	14	4	14	10	3	4	-	1	50
2	Guinea Pig, Gerbil, Hamster, Rabbit, etc.	21	5	10	5	17	6	-	-	64
1	Wild Bird, Bird, Chicken, Duck, Quail, Turkey	1	-	-	-	-	-	-	-	1
0	Frog	-	-	-	-	-	-	2	-	2
	Total	99	44	38	35	21	20	2	2	261

† *Refer to text Section VII for explanation.*

Table 21

SUMMARY OF ORAL AND INHALATION EXPOSURES TO TOXIC ORGANIC CHEMICALS[†]
NORTHEAST PHILADELPHIA WPCP SURVEY
September 16 - 23, 1976

Ref. No.	Chemical	Lowest Published Toxic Dose mg/kg	Lowest Published Lethal Dose mg/kg	Lethal Dose or Concentration 50% Kill mg/kg	U.S. Occupational Std. Time Weighted Avg. Conc. in Air mg/l
	ETHANOL				1,000[†††]
	Oral Human	50	1,400		
	Oral Man		6,000		
	Oral Child		2,000		
	Oral Mouse	2,770[††]	220		
	Oral Cat		6,000		
	Oral Rabbit		9,500	6,300	
	Oral Guinea Pig			5,560	
2	*n*-PENTANE				1,000[†††]
	Inhalation Human	130,000			
3	ACETONE				1,000
	Inhalation Human	500[†††]			
4	DIMETHOXY METHANE				1,000
5	DICHLORO METHANE				500
	Inhalation Human	500[†††]/1 yr.			
	Inhalation Human	500[†††]/8 hrs.			
	Oral Dog		200		
6	CARBON DISULFIDE				20
8	2-BUTANONE				200
	Oral Rat			3,100	
	Inhalation Rat		2,000		
9	CHLOROFORM				50
	Inhalation Human	10[†††]/1 yr.			
	Oral Rat			300	
	Oral Rat			800	
	Inhalation Rat		8,000[†††]/4 hrs.		
	Oral Mouse	18 (Int.120 d.)	2,400		
	Oral Dog		1,000		
	Inhalation Dog	75			
	Inhalation Dog	100			
	Inhalation Rabbit			59[†††]	
	Inhalation Guinea Pig		20,000[†††]/2 hrs.		
10	1,BUTANOL				100
	Inhalation Human	25[†††]			
	Oral Rat			2,510	
	Oral Rabbit		4,250		
11	1,2-DICHLOROETHANE				50
	Inhalation Human	4,000[†††]			
	Oral Human		845		
	Oral Rat			680	
	Inhalation Rat		1,000[†††]/4 hrs.		
	Oral Mouse		600		
	Oral Dog		2,000		
	Inhalation Rabbit		3,000[†††]		
	Inhalation Pig		3,000[†††]/7 hrs.		
	Inhalation Guinea Pig		9,000[†††]		

Table 21 (Continued)

SUMMARY OF ORAL AND INHALATION EXPOSURES TO TOXIC ORGANIC CHEMICALS[†]

Ref. No.	Chemical	Lowest Published Toxic Dose mg/kg	Lowest Published Lethal Dose mg/kg	Lethal Dose or Concentration 50% Kill mg/kg	U.S. Occupational Std. Time Weighted Avg. Conc. in Air mg/l
12	1,1,1-TRICHLOROETHANE				350
	Inhalation Human	920[†††]/170 min.			
	Inhalation Man	350[†††]			
	Oral Rabbit			5,660	
	Oral Guinea Pig			9,470	
16	TETRACHLOROETHANE				
	Oral Rat			200	
	Inhalation Rat		1,000[†††]/4 hrs.		
17	METHYLISOBUTYL KETONE				100
	2-PENTANONE, 4 METHYL				
	Inhalation Human	200[†††]			
	Oral Rat			2,080	
18	2-PENTANOL				
	Oral Rat			1,470	
	Oral Rabbit		3,500		
19	4-METHYL-2-PENTANOL			2,600	
	Oral Rat				
	Inhalation Rat		2,000[†††]/4 hrs.		
21	TOLUENE				200
	Inhalation Human	200[†††]			
	Inhalation Man	100[†††]			
	Oral Rat			3,000	
	Inhalation Rat		4,000[†††]/4 hrs.		
22	BUTYL ACETATE				150
	Inhalation Human	200[†††]			
23	TETRACHLOROETHYLENE				100
	Inhalation Human	230[†††]			
	Inhalation Rat		4,000[†††]		
24	DIACETONE ALCOHOL				50
	Oral Rat			4,000	
25	1,2-EPOXY CYCLOHEXANE				
	Oral Rat			1,090	
	Inhalation Rat		2,000[†††]/4 hrs.		
26	CHLOROBENZENE				75
	Oral Rat			2,910	
28	ETHYLBENZENE				100
	Oral Rat			3,500	
	Inhalation Rat		4,000[†††]/4 hrs.		

Table 21 (Continued)

SUMMARY OF ORAL AND INHALATION EXPOSURES TO TOXIC ORGANIC CHEMICALS[†]

Ref. No.	Chemical	Lowest Published Toxic Dose mg/kg	Lowest Published Lethal Dose mg/kg	Lethal Dose or Concentration 50% Kill mg/kg	U.S. Occupational Std. Time Weighted Avg. Conc. in Air mg/l
31	STYRENE				100
	Inhalation Human	600[†††]			
	Inhalation Human	376[†††]			
	Inhalation Man	500[†††]			
	Oral Rat			4,920	
	Oral Mouse			316	
35	2-n-BUTOXYETHANOL				50
	Inhalation Human	195[†††]/8 hrs.			
	Oral Rat			1,480	
	Oral Mouse			1,230	
	Inhalation Mouse			700[†††]/7 hrs.	
	Oral Rabbit			320	
	Oral Guinea Pig			1,200	
36	CUMENE				50
	Oral Rat			1,400	
	Inhalation Mouse		2,000[†††]		
37	2-HEXANONE				100
	Oral Rat			2,590	
	Oral Guinea Pig			914	
	Inhalation Guinea Pig		6,000[†††]/7 hrs.		
42	BENZALDEHYDE				
	Oral Rat			1,300	
	Oral Guinea Pig			1,000	
43	BIS (2-CHLOROETHYL) ETHER				15
	Oral Rat			75	
	Inhalation Rat		1,000[†††]/45 weeks		
	Oral Mouse	192			
	Oral Mouse	33/79 wks.			
47	PHENOL				5(skin)
	Oral Human	14			
	Oral Human		140		
	Oral Rat			414	
	Oral Mouse		500		
	Oral Rabbit		420		
	Oral Mouse			300	
56	BENZYL CHLORIDE				1
	Inhalation Human	16[†††]		1,2362	
	Oral Mouse			1,624	
63	2-ETHYL-1-HEXANOL				
	Oral Rat			4,125	
	Oral Rabbit			3,580	
	Oral Guinea Pig			1,300	
66	o-DICHLOROBENZENE				50 (ceiling c.)
	Oral Rat			500	

Table 21 (Continued)

SUMMARY OF ORAL AND INHALATION EXPOSURES TO TOXIC ORGANIC CHEMICALS[†]

Ref. No.	Chemical	Lowest Published Toxic Dose mg/kg	Lowest Published Lethal Dose mg/kg	Lethal Dose or Concentration 50% Kill mg/kg	U.S. Occupational Std. Time Weighted Avg. Conc. in Air mg/l
67	σ-CRESOL				5 (skin)
	Oral Rat			121	
	Oral Rabbit		940		
69	ACETOPHENONE				
	Oral Rat			3,000	
71	M-CRESOL				5 (skin)
	Oral Rat			242	
	Oral Rabbit		1,400		
72	DIETHYLBENZENE				
	Oral Rat			1,200	
81	BENZYL CYANIDE				
	Oral Rat			270	
	Inhalation Rat			430 mg/m^3/2 hrs.	
	Oral Mouse			78	
	Inhalation Mouse		100 mg/m^3		
85	METHYL ACETOPHENONE			500	
	Oral Rat				
90	NAPHTHALENE				10
	Oral Child		100		
	Oral Rat			1,780	
92	TERT-BUTYL ACETATE				200
95	QUINOLINE				
	Oral Rat			400	
96	1,2-BIS(2-CHLOROETHOXY) ETHANE				
	Oral Rat			250	
	Oral Guinea Pig			120	
97	INDOLE				
	Oral Rat			1,000	
99	p-TERT-BUTYLPHENOL				
	Oral Rat			3,250	
104	GLYCEROL TRIACETATE				
	Oral Rat			3,000	
112	BIPHENYL				0.2
	Oral Rat			2,180	
	Oral Rabbit			2,400	
121	DIMETHYL PHTHALATE (PHTHALIC ACID, DIMETHYL ESTER)				5 mg/m^3
	Oral Rabbit			4,400	
	Oral Guinea Pig			2,400	
	Oral Chicken			8,500	

Table 21 (Continued)

SUMMARY OF ORAL AND INHALATION EXPOSURES TO TOXIC ORGANIC CHEMICALS†

Ref. No.	Chemical	Lowest Published Toxic Dose mg/kg	Lowest Published Lethal Dose mg/kg	Lethal Dose or Concentration 50% Kill mg/kg	U.S. Occupational Std. Time Weighted Avg. Conc. in Air mg/l
122	2 TERT-BUTYL-p-HYDROXY-ANISOLE (without "2-TERT" and without "p") ANISOLE, BUTYLHYDROXY				
	Oral Rat		1,000		
124	2-TERT-BUTYL-4-METHOXY-PHENOL				
	Oral Rat			4,000	
125	TRIDECANOL				
	Oral Rat		4,750		
126	o-PHENYLPHENOL				
	Oral Rat			2,700	
132	1,1,3,3(TETRAMETHYLBUTYL)PHENOL				
	Oral Rat			2,160	
135	BENZYL ETHER				
	Oral Rat			2,740	
142	DIALLYL PHTHALATE				
	Oral Rat			770	
	Oral Rabbit			1,500	
147	CAFFEINE				
	Oral Human		192		
	Oral Rat			192	
	Oral Rat	1,650 (2-15 days preg.)			
	Oral Mouse	650 (6-18 days preg.)			
	Oral Rabbit	1,500 (1-15 days preg.)			

† *From references 9 and 10.*
†† *Intermittent exposure for 79 weeks.*
††† *Concentration in parts per million.*
†††† *Milligrams per cubic meter for 120 min.*

on an individual basis. Virtually no reports are available concerning long-term effects of exposure to most of the substances identified and data are not available on the combined effects of exposure to this wide spectrum of toxic substances.

ASSESSMENT

Although other surveys of similar nature have been made there were fewer compounds identified than in this study. The principal reasons are the large number of industries discharging wastewater to the Philadelphia Northeast WPCP and improved analytical techniques which have made it possible to identify a greater number of compounds at lower concentrations than in previous studies. There were 155 separate compounds identified in this survey: 71 compounds were identified only in the influent to the Northeast WPCP, 40 additional compounds were found in the Northeast WPCP effluent and/or two upstream stations in the Delaware River, and 44 more compounds were detected in the Torresdale WTP intake and/or finished water. A number of trends can be discerned by noting their place of occurrence and non-occurrence as discussed in the following paragraphs.

Raw Wastewater Influents

There were 71 compounds identified only in influents to the Philadelphia Northeast WPCP. These are listed below:

Compound Number	Compound Name
2	n-pentane
7	1,2 dichloroethene
8	2-butanone
10	1-butanol
12	1,1,1-trichloroethane
13	trichloroethene
15	dimethyl disulfide
16	tetrachloroethene
17	methylisobutylketone

Compound Number	Compound Name
18	2-pentanol
19	4-methyl-2-pentanol
20	nonadecane
22	n-butyl acetate
34	n-octanone
35	2n-butoxy ethanol
39	C-7 alcohol
41	σ-chlorotoluene
44	2-ethyl-4-methyl-pentanol
45	m-ethyltoluene
47	phenol
49	2,2,3,4-tetramethylpentane
51	σ-ethyltoluene
59	isopropyl propanoate
60	decane
62	methylbenzaldehyde
64	dihydrobenzaldehyde
65	2-butyl-1-octanol
66	σ-dichlorobenzene
67	σ-cresol
71	m-cresol
72	diethylbenzene
75	1,2,3,5-tetramethylbenzene
76	n-nonanol
77	trimethyltridecane
78	3-methyindene
79	1-methyl pyrrole
82	undecane
83	methylacetophenone
84	tetramethylbenzene
86	dimethyl cyclohexylcarbinol
88	m-ethylphenol
93	dodecane
94	3-methyl tridecane
98	1-heptyne
101	dimethyl indan
102	1-methylnaphthalene
103	tridecane
109	methylbutyl bromide
114	diphenyl ether
116	tributylphenyl ether
117	tetradecane
118	2-methyltridecane
119	dimethylnaphthalene
120	2-propyl-4-methyl-pentanol
123	heptanolactone

Compound Number	Compound Name
125	tridecanol
127	pentadecane
133	hexadecane
136	2-methyl hexadecane
137	tetradecanol
138	bis-(2-ethylhexyl) ether
143	pentadecanol
144	methylheptadecane
146	octadecane
148	C-15 alcohol
150	2(p-tert-butylphenoxy) ethanol
151	trimethyl hexadecane
153	nonadecane
155	geranyl formate
156	C-17 alcohol
157	2,4,6-tri-tert-butyl phenol

The concern with these chemicals is related to their potential for harm in the environment, since, at present they have only been reported within the confines of the wastewater treatment system. Although these chemicals were only found in the wastewater it is possible that some may represent slugs which were entering but had not passed through the plant during sampling. Although the low concentration detected may not interfere with treatment efficiency, if concentrations increase with time or if heavy slugs enter the system the probability of interference with treatment efficiency should increase.

The most general observation is that none of these compounds represent normal human metabolites. They are all of industrial origin. It is likely that many of these compounds are foreign and inhibitory to the metabolism of organisms normally found in biological treatment systems. A second observation is the wide range in concentration, 1400 fold, from 1 ppb for isopropyl propanoate (59) to 1.4 ppm for n-butyl acetate (22). This latter compound also demonstrates another noticeable trend, namely that daily waste concentrations varied by a factor of more than 10 during sampling. Such rapid fluxes in concentration of these foreign chemicals makes it that much more difficult for activated sludge organisms to attempt to adjust their metabolic processes to accommodate them.

Table 22 shows the flows for each sampling station. For the upstream stations, flows are daily river means taken at Trenton, New Jersey. The daily load of n-butyl-acetate (22) discharged during the survey was 26 kg (57 lb), 60.9 kg (134 lb), 392 kg (863 lb) for days 1, 2, and 3, respectively. Since this compound is of industrial origin, and it occurs only in one interceptor, it most likely represents a chronic discharge from a single manufacturing operation in which cleaning processes result in intermittent high concentrations. A single industrial operation therefore probably discharged 479 kg (1,054 lb) of n-butyl-acetate in a three-day period. Similar inferences can be found throughout Tables 18 and 19 where a periodic or one-time significant discharge occurred along with chronic low-level discharges.

Nine suspected carcinogens -- ethanol (1), chloroform (9), phenol (47), benzyl chloride (56), m-cresol (71), naphthalene (90), indole (97), biphenyl (112) and tetramethyl butyl phenol (132) -- were detected in the raw wastewater entering the Northeast WPCP. The three-day total load of these compounds was, non-volatile organics, 794 kg (1,750 lb), of which 97% was from the Delaware Low Level Interceptor and estimated volatile organics based on grab samples, 1,626 kg (3,577 lb), of which 71% was from the Somerset Low Level Interceptor. Substantial amounts of such hazardous compounds were introduced to the collection system, even though they were apparently treated and removed on the days sampled.

Overall, approximately 7,650 kg (16,850 lb) of non-volatile organic compounds were discharged to the Philadelphia Northeast WPCP during three days of sampling [Table 23].

The Delaware Low Level Interceptor was by far the major source of both volatile and non-volatile organics contributing 95% and 92%, respectively, of total influent loads to the Northeast Plant.

Table 22

FLOW AT ORGANIC SAMPLE SITES

Philadelphia, Pennsyvania
September 19-22, 1976

Station Description	Flow† mld	Day	Date††
Delaware Low Level Interceptor†††	260	1	9-20
	290	2	9-21
	280	3	9-22
Somerset Low Level Interceptor	120	1	9-20
	120	2	9-21
	120	3	9-22
Frankford Low Level Interceptor	23	1	9-20
	55	2	9-21
	51	3	9-22
Frankford High Level Interceptor	200	1	9-20
	210	2	9-21
	210	3	9-22
Final Effluent	640	1	9-20
	720	2	9-21
	680	3	9-22
Torresdale WTP Intake	1,100	1	9-20
	1,100	2	9-21
	1,100	3	9-22
Torresdale WTP Finished Water	1,100	1	9-20
	1,100	2	9-21
	1,100	3	9-22
Delaware River††††	14,000	1	9-20
	13,000	2	9-21
	12,000	3	9-22

† *Flow is reported in million liters per day average flow during the sampling day from 6 a.m. to 6 a.m.*

†† *The date refers to the date of the end of the sampling day.*

††† *Each interceptor carries raw wastewater into the Philadelphia Northeast WPCP.*

†††† *Two stations were on the Delaware River 5.9 miles and 8.8 miles upstream of the Torresdale WTP intake respectively.*

Table 23

NON-VOLATILE ORGANICS LOADINGS
NORTHEAST PHILADELPHIA WPCP SURVEY
September 16-23, 1976

Parameter	Day 1			Day 2			Day 3			3-Day Average			3-Day Total	
	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	kg	lb
Delaware Low Level Interceptor	6	1,570	3,450	9.4	2,700	5,960	10	2,760	6,090	8.5	2,340	5,170	7,030	15,500
Somerset Low Level Interceptor	0.2	23	52	0.7	87	190	0.7	80	180	0.5	63	140	190	422
Frankford Low Level Interceptor	0.4	9	20	2.1	120	260	0.9	44	98	1.1	58	130	173	378
Frankford High Level Interceptor	0.29	59	130	0.5	110	230	0.42	87	190	0.40	85	180	256	550
Total Influent	-	1,660	3,650	-	3,020	6,640	-	2,970	6,560	-	2,550	5,620	7,650	16,850
Final Effluent	1.5	970	2,130	1.0	720	1,590	1.1	750	1,650	1.2	810	1,790	2,440	5,370
Torresdale WTP Intake†	0.19	200	440	0.18	190	420	0.16	170	370	0.18	190	410	560	1,230
Delaware River, 9.5 km (5.9 mi) upstream of Torresdale WTP Intake	0.0018	-	-	0.0043	-	-	0.0019	-	-	0.0027	-	-	-	-
Delaware River, 14 km (8.8 mi) upstream of Torresdale WTP Intake	0.0017	-	-	0.0027	-	-	0.0021	-	-	0.0022	-	-	-	-

† *Loads computed for flow of 1,060 mld (280 mgd)*

Significant concentrations of volatile organic compounds were detected. Because grab samples were collected for volatile organics actual daily loads discharged could not be calculated. Daily loads were estimated, however, based on instantaneous concentration and average daily flows [Table 24]. The estimated total load of volatile organics discharged to the Northeast WPCP during three days of sampling was 51,100 kg (112,400 lb). Although these loads are only estimates, their magnitude in combination with the non-volatile organics and the relatively unknown environmental effects of many compounds raises serious question as to their long-term impact upon the waste treatment process, the Delaware River and the Torresdale WTP.

Due to the substantial quantities of organics in the four interceptors, the distribution of manufacturing industries potentially discharging to the Philadelphia Northeast WPCP was evaluated. The Northeast WPCP sewerage area was translated into zip code districts which were machine searched in a computerized file of manufacturers in the area. There are 869 industrial plants within the area served by the Northeast collection system employing 20 or more people. Of these companies, 98 are in *Fortune's* top 1,000 manufacturing establishments for the entire U.S.

The 869 industries are categorized into 20 broad SIC or product codes as follows.

SIC Code	Number of Plants	Industry
20	68	Food and kindred products
21	1	Tobacco Products
22	89	Textile Mill Products
23	60	Apparel and Related Products
24	14	Wood and Wood Products
25	25	Furniture
26	59	Paper and Allied Products
27	38	Printing and Publishing
28	44	Chemicals and Allied Products

Table 24

VOLATILE ORGANICS CONCENTRATIONS AND ESTIMATED LOADS[†]
NORTHEAST PHILADELPHIA WPCP SURVEY
September 16-23, 1976

Parameter	Day 1			Day 2			Day 3			3-Day Average			3-Day Total	
	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	kg	lb
Delaware Low Level Interceptor	73	19,000	41,800	101	29,300	64,400	0	0	0	58	16,100	35,400	48,300	106,200
Somerset Low Level Interceptor	1.9	230	500	12.3	1,480	3,250	1.1	130	290	5.1	615	1,350	1,840	4,040
Frankford Low Level Interceptor	0.36	8	18	1.8	99	220	0.88	45	99	1.0	51	112	152	337
Frankford High Level Interceptor	0.15	30	66	3.4	710	1,570	0.38	80	180	1.3	273	605	820	1816
Total Influent	-	19,300	42,400	-	31,600	69,400	-	250	570	-	17,000	37,500	51,100	112,400
Final Effluent	7.2	4,610	10,100	16	11,500	25,300	15	10,200	22,400	13	8,770	19,300	26,310	57,800
Torresdale WTP Intake	0.19	200	440	0.18	190	420	0.16	170	370	0.18	187	410	560	1,230

† *Volatile Organics are daily grab samples, therefore loads are only estimates based on instantaneous concentration and average daily flows.*

SIC Code	Number of Plants	Industry
29	8	Petroleum and Energy Products
30	16	Rubber and Allied Products
31	3	Leather and Products
32	26	Stone, Clay and Glass Products
33	30	Metals
34	143	Fabricated Metal Products
35	131	Machinery, Electric
36	40	Electric and Electronic Equipment
37	9	Transport Equipment
38	30	Instruments and Related Products
39	35	Manufacturing, Miscellaneous

An alphabetized list of all 869 manufacturing industries, including employment, share of market, and sales statistics is on record at NEIC.[9]

Wastewater Effluent and Delaware River

Forty additional compounds (see the following list) were identified either in the effluent from the Philadelphia Northeast WPCP or at sampling locations upstream from the water treatment plant intake. The upstream locations are included because compounds present there could have been discharged from other sources and represent a potential threat to the environment and to the water treatment plant. However, these compounds were not detected in either the intake to or the finished water from the Torresdale WTP. In the following list, the compounds marked with an asterisk also occurred in one or more influents to the Northeast WPCP.

Compound Number	Compound Name
1*	ethanol
6*	carbon disulphide
21*	toluene
23*	tetrachloroethylene
24*	diacetone alcohol
25*	1,2-epoxy cyclohexane
26*	chlorobenzene
28*	ethylbenzene

Compound Number	Compound Name
30	2-cyclohexenol
32*	σ-xylene
36*	cumene
38	2-cyclohexenone
40*	methyl hexanol
46	ethylmethylbenzene
50	1,3,5-trimethylbenzene
52*	6-ethyl-1-heptanol
53	ethylidene diacetate
56*	benzyl chloride
57*	1,2,4-trimethylbenzene
69*	acetophenone
80	cis-1,3-dichlorocyclohexane
85*	dimethylphenol
87*	dimethyl cyclooctyl carbinol
89*	isoborneol
90*	naphthalene
91*	alpha terpineol
92	tert-butyl acetate
95	quinoline
97	indole
100*	2-methylnaphthalene
104*	glycerol triacetate
105*	tetraisobutylene
106*	tetraisobutylene isomers
112*	biphenyl
113	tert-butylmethylphenol
115	p-tert-amylphenol
126*	σ-phenylphenol
135*	benzyl ether
141*	heptadecane
147*	caffeine

The potential for environmental harm from these 40 compounds in the effluent or upstream locations is certainly greater than for those which were not being discharged by the Northeast WPCP at the time of sampling.

Of the approximately 7,650 kg (16,850 lb) of non-volatiles and an estimated 51,100 kg (112,400 lb) of volatiles discharged to the Northeast WPCP collection system during the 3 days of sampling, 2,440 kg (5,370 lb) of non-volatiles and an estimated 26,310 kg (57,800 lb) of volatiles were discharged through the Northeast WPCP outfall to the Delaware River.

These industrial chemicals are then available to cause harm to organisms living in the river, or to organisms feeding on aquatic life or consuming the water. In general then about 49% by weight of the chemicals entering the Northeast WPCP were discharged to the river environment. In addition, an unknown quantity of the organic compounds reach the ocean through the barging of anaerobically digested sludge.

Since 30 of the above 40 compounds were in one or more of the influents to the Northeast WPCP it would seem likely that almost all could be from this source. Some specific samples will be dealt with in the next section.

By contrast, the amounts of non-volatile organic industrial chemicals in the Delaware River upstream of the Torresdale intake were only an average of about 32 kg (70 lb) per day, or, for the three days of sampling, about 95 kg (210 lb). This is only about 2% of the load discharged by the Northeast effluent. It appears that a great deal of the industrial chemical burden in the Delaware River comes from the Northeast WPCP discharge.

In all, seven suspected carcinogens; ethanol (1), chloroform (9), bis-(2-chloroethyl)ether (43), benzyl chloride (56), indole (97), biphenyl (112) and tetramethyl butyl phenol (132) were identified in the Northeast WPCP final effluent. Naphthalene (90), another suspected carcinogen, occurred in the Northeast WPCP influent and in an upstream discharge, but was not detected in the Northeast WPCP effluent discharged during the NEIC survey. The three-day total load of suspected carcinogens discharged to the Delaware River from Northeast was, non-volatile organics -- 94 kg (207 lb) and estimated volatile organics based on grab samples -- 225 kg (494 lb).

Monitoring at two upstream stations in the Delaware River revealed the presence of naphthalene (90), a suspected carcinogen at a concentration of 0.05 μg/l.

Torresdale Water Treatment Plant

Forty-four compounds were detected in the Torresdale WTP intake, the finished water or both. Many of these compounds occurred in one or more influents to the Northeast WPCP and some also occurred in upstream samples from the Delaware River. One important finding was that 18 compounds that have not been previously reported in the literature were discovered in the finished drinking water of the Torresdale WTP. The scope of the literature survey, included extensive computerized searches [Appendix G]. Of the following list of compounds detected at the Torresdale WTP, those compounds with an asterisk have not previously been reported in drinking water.

Compound Number	Compound Name
3	acetone
4	dimethoxymethane
5	dichloromethane
9	chloroform
11	1,2-dichloroethane
14	bromodichloromethane
27*	3-chlorocyclohexene
29	m + p xylene
31	styrene
33*	1-chlorocyclohexene
37	2-hexanone
42	benzaldehyde
43	bis(2-chloroethyl)ether
48*	1,1,1,3-tetrachloro-2-methyl-2-propanol
54*	2-bromo-1-methyl-propylacetate
55*	cis-2-chlorocyclohexanol
58	m-dichlorobenzene
63*	2-ethyl-1-hexanol
68*	cis-1,2-dichlorocyclohexane
73*	trans-1,2-dichlorocyclohexane
74*	2-phenyl-2-propanol
81*	benzyl cyanide
96	1,2-bis(2-chloroethoxy) ethane
99	p-tert-butylphenol
107*	butyl butanoate
108	5-bromobenzofuran
111*	isobutyl butanoate
121	dimethyl phthalate

Compound Number	Compound Name
122*	2-tert-butyl-p-hydroxy anizole
124*	2-tert-butyl-4-methoxy-phenol
128*	2,6-di-tert-butyl-4-methyl-phenol
129	A-di-σ-isopropylidene-l-sorbose
130	substituted phenol
131	diethyl phthalate
132	tetramethyl butyl phenol
134	tri-n-butyl-phosphate
139*	p-nonyl-phenol
140*	isoamyl benzoate
142*	diallyl phthalate
145	2-methyl heptadecane
149	di-isobutyl phthalate
152	hexadecanol
154	di-n-butyl phthalate
158	octadecanol

The chemicals are not human metabolites, but are either of industrial origin or chlorinated derivatives of chemicals of industrial origin. EPA is currently studying the effect of organic chemicals on chlorination in the water treatment processes.

However, 13 of the 19 chemicals not previously reported are not products of chlorination. Since such chemicals were not added during the water treatment process, they were presumed to have been present in the intake water from the Delaware River.

Two suspected carcinogens were detected in the raw water at the Torresdale WTP intake. During three days of monitoring 0.1 kg (0.3 lb) of bis(2-chloroethyl)ether (43) and, based on grab sample results, an estimated 51 kg (111 lb) of chloroform (9) passed through the WTP intake. Finished water monitoring results indicated the presence of two suspected carcinogens. During three days of monitoring 0.5 kg (1.0 lb) of tetramethyl butyl phenol (132) and based on one day's grab sample results, an estimated 176 kg (387 lb) of chloroform (9) were distributed to the City. Bis(2-chloroethyl)ether (43) was present in effluent from the Northeast WPCP at an average concentration of 17 μg/l and in influent to the Torresdale WTP at a concentration of 0.13 μg/l.

Stated another way, effluent was diluted to 0.8% by the time discharged pollutants reached the Torresdale WTP intake. Because industrial chemical inputs to the Northeast WPCP are not uniform, neither are effluent discharges to the Delaware River. A dye study by NEIC (Section VI), combined with other studies, showed that the Northeast discharge was diluted to about 1% by the time it reached the Torresdale WTP intake during flood tide. In the case of chloroform (9), a suspected carcinogen, it has been shown that chlorination will produce chloroform (9) from other chemicals not removed in the water treatment process.[3,4] During the NEIC study 0.16 $\mu g/l$ of chloroform (9) was present in the finished drinking water from the Torresdale WTP on day 2, but none was detected for day 1 or day 3. Were this the average concentration for day two, 170 kg (370 lb) would have been released.

Of the 44 compounds under consideration in this section, 29 occurred at the Torresdale WTP intake. Included in this group were cis-1,2-dichlorocyclohexane (68), 1,2-bis(2-chloroethoxy)ethane (96), and 2-methyl heptadecane (145), which occurred upstream from the WTP intake, but not in the Northeast WPCP effluent. As discussed previously, these compounds are of industrial origin. Accordingly, 2-methyl heptadecane (145) was reported in the influent to the Northeast WPCP. Twenty-one industrial chemicals in this subgroup were reported in one or more influents to the Northeast WPCP. Fourteen of these compounds occurred both in the discharge from Northeast and in the Torresdale WTP intake. These compounds, and their relative dilution from discharge to inlet are given in Table 25. This greater than threefold difference in dilution can be better understood in view of both the complicated tidal regime and the wide variance in waste loading to the Delaware River. For example, 13 kg (28 lb) of diethyl phthalate (13) were discharged during the three days of sampling, while an estimated 3,830 kg (8,430 lb) of acetone (3) were discharged, a difference in concentration of almost 300 times.

Table 25

ORGANIC COMPOUNDS OBSERVED IN BOTH THE NORTHEAST WPCP EFFLUENT AND THE TORRESDALE WTP INTAKE

Compound Number	Compound Name	Relative Dilution† %
3	Acetone	3
4	Dimethoxymethane	1
5	Dichloromethane	50
9	Chloroform	70
11	1,2-dichloroethane	0.3
29	m & p xylene	0.01
31	Styrene	0.09
43	Bis(2-chloroethyl)ether	0.01
63	2-ethyl-1-hexanol	0.04
74	2-phenyl-2-propanol	0.04
96	1,2-bis(2-chloroethoxy)ethane	0.6
121	Dimethyl phthalate	2
130	Substituted phenol	2
131	Diethyl phthalate	1
139	p-nonyl-phenol	3

† *Relative dilution was computed from average concentrations during the three-day sampling period.*

During the three-day monitoring period, a total of 560 kg (1,230 lb) of non-volatile organics and an estimated 187 kg (410 lb) of volatile organics were detected in the Torresdale WTP intake. Finished water monitoring showed the presence of 46 kg (101 lb) of non-volatile organics during the three-day period. Volatile organics were monitored only one day by grab samples. The estimated volatile organics load for one day of sampling was 250 kg (550 lb).

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APPENDICES

A	Reconnaissance Report
B	Visit/Inspection of City of Philadelphia Torresdale Water Treatment Plant
C	Dye Dilution Technique for Flow Measurement
D	Chain of Custody Procedures
E	Analytical Procedures and Quality Control
F	Organics Analytical Methodology
G	Determination of Toxicity Index

APPENDIX A

RECONNAISSANCE REPORT

RECONNAISSANCE REPORT
PHILADELPHIA NORTHEAST WATER POLLUTION CONTROL PLANT

A reconnaissance inspection of the Philadelphia Northeast Water Pollution Control Plant was conducted on June 30, 1976. The following people participated:

Francis Crumety, Plant Operator
Bob Sharp, Assistant Superintendent
Bill Blackman, Ed Struzeski, Jim Vincent, and Jim Pennington of NEIC and Ed Rogan, EPA Region III

Mr. Rick Dimenna, the Plant Superintendent, was on vacation. It was explained that NEIC at the request of EPA Region III will conduct compliance monitoring in the near future.

General Information

The existing Northeast Plant was constructed in 1951. Additional secondary treatment capacity was added in 1962 and 1970 with the addition of aeration basin No. 5 and an additional blower installed in 1961 and 1970 respectively. Major plant operations include grit removal, raw sewage pumping, flow measurement, primary sedimentation, aeration, final sedimentation, and discharge to the Delaware River. Anaerobically digested sludge is barged to sea for final disposal.

Raw sewage reaches the plant via four main interceptors. Three of these interceptors are referred to as low level interceptors and wastewater is pumped after grit removal and prior to treatment. The low level interceptors are the Delaware Low Level (DLL), the Frankford Low Level (FLL), and the Somerset Low Level (SLL). A fourth interceptor, the Frankford High Level (FHL), discharges to the primary clarifiers by gravity. Grit is removed at a grit removal facility located several miles from the plant. Average flow to the plant is 190 mgd. Four Venturi meters measure and record plant influent flow. During the inspection flow through the major interceptors was as follows: DLL 84 mgd; SLL and FLL combined 34 mgd; and FHL 60 mgd for a total of 178 mgd. Major industrial input to the system is reportedly on the DLL interceptor while the FHL interceptor sewers primarily residential area.

Because much of the system is combined sewers, influent flow rapidly increases during a rain storm. When this happens the Somerset gate is the first to be closed causing wastewater to back up into the sewer until it reaches a relief point. A map at the plant indicated that several such relief points were located on the SLL interceptor adjacent to the river. Mr. Crumety estimated that during the first 6 months of 1976 the Somerset gate was closed approximately 20 times. Thus the vast majority of combined sewer overflows logically occur from the SLL interceptor.

Plant Operation

Mr. Sharp indicated that the plant removes approximately 30% of the BOD and suspended solids during primary treatment and an additional 40% through secondary treatment. Grit is removed from the grit chambers by mechanical scrapers which operate approximately two hours per shift. Screenings and grit are trucked to lagoon A. Primary sludge is pumped once per day from each of four primary clarifiers for approximately 6 hours. Plant officials reported that oil and grease from each tank is skimmed for approximately 6 hours per day. Accumulated scum is collected in a manually operated scum trough and pumped to lagoon B by pneumatic ejectors.

Mr. Sharp reported that the following control parameters are used to operate the aeration system. The dissolved oxygen level is maintained at from 2.6 to 3.0 mg/l. The mixed liquor volatile suspended solids (MLVSS) is maintained at 2,000-3,000 mg/l. A sludge age of 6 to 7 is maintained. Sharp reported that the sludge volume index is 50 to 60. The aeration basin is operated on a modified aeration-contact stabilization process. Total air supply is 85,000 cfm. A good description of the operating mode for the five basins could not be obtained from either Mr. Sharp or Mr. Crumety. They referred to Basins 1 and 2 as the modified aeration process and maintain an MLVSS of 1,000 mg/l. Basins 3 and 4 are reportedly contact basins in which an MLVSS of 7,000 to 9,000 mg/l is maintained. Basin 5 is a reaeration basin.

The return sludge rate is approximately 15-22% of the flow. Plant flow meters indicated a return sludge flow of 21 mgd (12% of the total flow) during the inspection. The activated sludge basins were very dark brown to black in color and had little of the normal earthy odor present in the activated sludge process.

Additional scum has accumulated in the influent channels to the rectangular secondary clarifiers. No facilities for removal of secondary scum were included in the original plant design. However, temporary piping has been installed and secondary scum is pumped to lagoon B.

Sludge is anaerobically digested in eight heated digesters. Reportedly only primary sludge is pumped to the digesters. Prior to reaching the digesters, however, primary sludge is gravity thickened. Digester supernatant is returned to the head of the plant via the SLL or the FHL interceptor.

Plant personnel reported that all secondary sludge is recycled with intermittent wasting back to the head of the plant via the Somerset interceptor. Secondary sludge is wasted only on an emergency basis. Five sludge lagoons cover an extensive area south and east of the plant. Lagoon A receives all grit and screenings. Lagoon B receives all primary and secondary scum. Lagoon C, presently out of service, is approximately two-thirds full of dried sludge and is maintained for emergency use. Lagoon D receives digested sludge and supernatant. From Lagoon D digested sludge is pumped into barges for sea disposal. Approximately 120 x 10^6 gal/yr of sludge is barged to sea. Lagoon E presently out of service, is full of dried sludge. All storm drainage in the plant area drains to the SLL interceptor.

Observations

Essentially all phases of the plant operation were run down and poorly maintained. The grit removal and screening facilities were cluttered with debris consisting of screenings and accumulated dried sludge apparently from previous overflow of the facilities. The primary sedimentation basins showed an accumulation of floating scum at several locations. Influent to the basins was not being distributed evenly resulting in several stagnant areas in the basin. Scum removal troughs were badly in need of cleaning and casual observation indicated that consistent cleanup is not practiced.

Observation of the aeration basins revealed that diffusers were apparently clogged resulting in uneven distribution of air along the basin legs. Secondary clarifier influent channels were badly clogged with accumulated scum. Although temporary piping is installed for pumping of secondary scum to lagoon B, observation during the survey indicated that scum had not been removed for some time.

During the inspection influent to the primary sedimentation basins was green in color for several minutes. Mr. Crumety stated that wastewater from the Globe Dye Company often caused color changes in the influent. Although a multitude of industries discharge to the Northeast Plant, Mr. Sharp and Mr. Crumety both stated that they have not experienced problems from industrial wastes. A pH meter located at Grit Chamber 2 provides an instantaneous readout of influent pH. However, pH is not recorded or connected to an alarm system. Industries discharging to Northeast routinely collect and transport samples to the city for analysis by city personnel. Analyses are conducted at three labs, two operated by the city and a private lab.

The plant effluent discharges to the Delaware River through 3 or 4 outfall pipes at the end of a pier 150-200 yds long. Observation was during high tide and all outfall pipes were submerged.

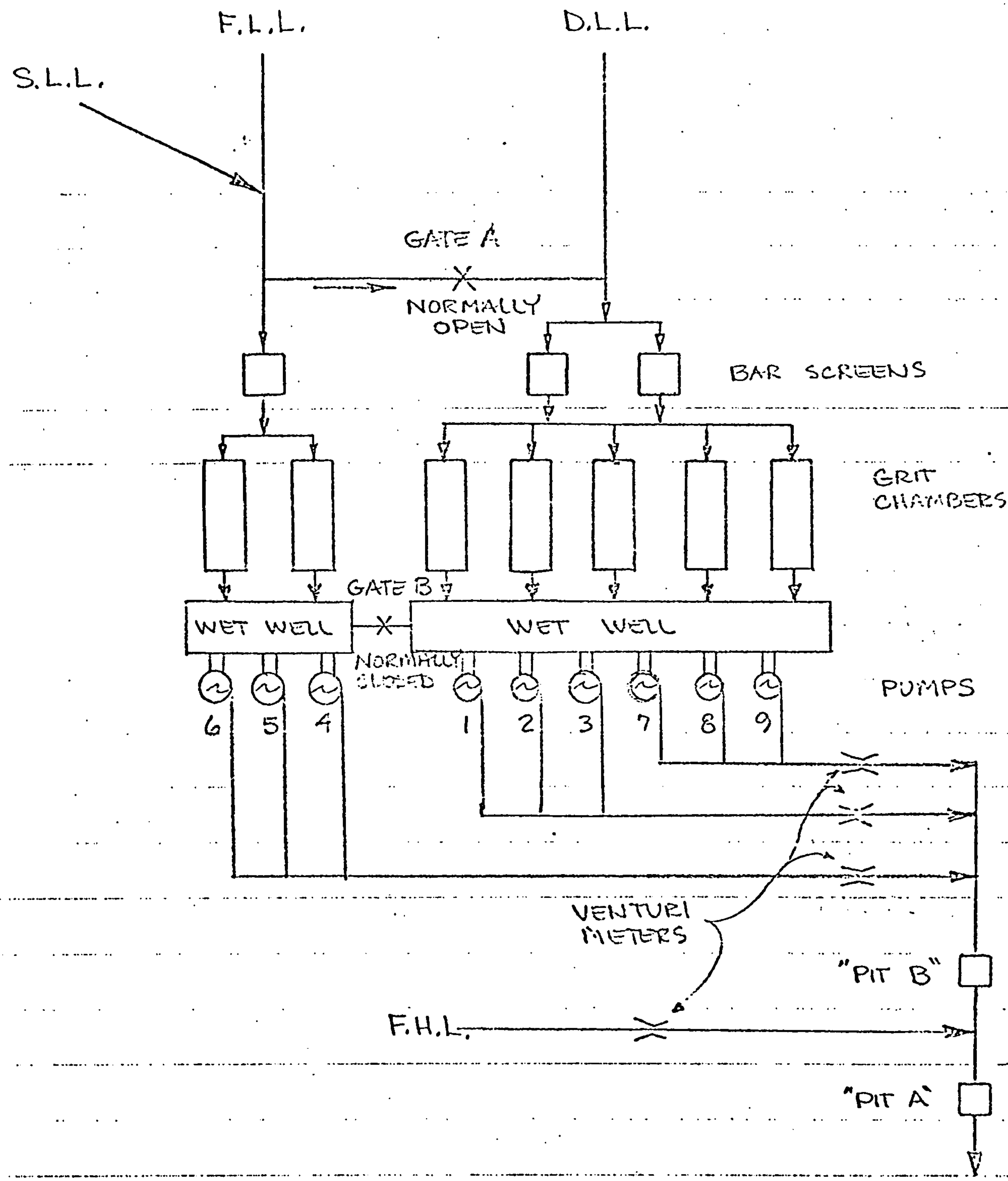
Monitoring Locations

Combined influent from the four interceptors is currently sampled on a routine basis from "Pit A" (entire flow) and "Pit B" (DLL, FLL, SLL). Effluent is sampled at the "Combined Effluent Shack".

The attached schematic of the Northeast WPCP influent works shows that under normal operating conditions the only interceptor for which individual flow is measured is the FHL. Gate A is normally open to prevent flooding of the bar screen serving the FLL and the SLL. As a

SCHEMATIC DIAGRAM - INFLUENT WORKS

PHILADELPHIA NORTHEAST WPCP



result, flows metered at the Venturi's do not represent flows from individual interceptors. Thus it appears that flow weighted monitoring of each individual interceptor will necessitate flow measurement by NEIC.

APPENDIX B

VISIT/INSPECTION OF CITY OF PHILADELPHIA TORRESDALE WATER TREATMENT PLANT

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT
NATIONAL FIELD INVESTIGATIONS CENTER—DENVER
BUILDING 53, BOX 25227, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

TO : Files

DATE: September 24, 1976

FROM : Industrial Waste Consultant

SUBJECT: Visit/Inspection of City of Philadelphia Torresdale Water Treatment Plant

Visit Made By: Messrs. W. C. Blackman, J. Vincent, E. Struzeski, Jr., and J. Pennington, all of EPA, NEIC and E. J. Rogan, Reg. III

Dates: June 30 and July 1, 1976

Plant Personnel: Mr. John Boettger, Assistant Superintendent and Mr. Ed Shervin, Superintendent (absent)

A. Field Observations and Results for the Philadelphia Water Treatment Plants

The Torresdale water treatment plant is a complete, large-scale facility with a rated capacity of around 282 MGD. However, peak rate at the Torresdale Plant can be as high as 423 MGD. Unit operations include withdrawal of Delaware River waters through tide or sluice gates; bar screens; traveling screens; prechlorination by chlorine gas or by chlorine dioxide; a pre-settling basin holding up to 12 hours of plant flow; a low lift pumping station having a 360 MGD capacity; addition of ferric or ferrous chloride, lime, carbon, chlorine or chlorine dioxide; rapid mixing for a few seconds followed by slow mixing and flocculation for 45 minutes or longer in eight chambers; four settling basins having a total of 40 MG capacity and providing 2.5 hours of plant detention; up to 94 rapid sand filter beds capable of passing through 282 MGD water; final addition of lime, fluoride, chlorine or chlorine dioxide as post treatment; and five filtered water storage basins holding up to 193 MG water before release into the Philadelphia water distribution system. The Torresdale plant around the time of the EPA visit was experiencing a peak daily water demand around 280 MGD, and on the day of the visit was exceeding peaks of 360 MGD.

The City of Philadelphia through its three water treatment plants (Torresdale, Belmont and Queen Lane) serves a population of around 2.0 million persons plus heavy industrial usage. Approximately 40% this supply is derived from the Delaware River through Torresdale. The remainder is derived from the Schuylkill River via the Belmont and Queen

Lane water treatment plants. The Torresdale plant within the city generally serves municipal and industrial customers east of Broad Street. Delaware River water compared to Schuylkill River water contains only half as much hardness as the latter. Delaware River water averages about 100 mg/l hardness vs 165 mg/l for the Schuylkill.

A series of butterfly valves actually control the entry of Delaware River water into the large earthen presedimentation basin at Torresdale of approximately 140 MG capacity. River water is received into the Torresdale facility on the rising tide. Thusly, M and I discharges from a number of miles downriver including the Philadelphia NE STP together with upstream sources can enter and affect the Torresdale Works. Delaware River water is drawn through a tide gate which opens when there is a 6 inch differential between the River and the presedimentation basin. The intake is shut when the differential eventually becomes 2 inches or less between the River and the basin. Mr. Boettger indicated water is taken into the Torresdale plant over 2 tide cycles per day. Each cycle is about 8 hours in duration which means water is drawn into the plant about 16 out of every 25 hours. However occasionally an entire cycle may be missed, i.e. no water is drawn into the presedimentation basin. Intake flow rates may range upward to 600 MGD and the zone of influence of the takeoff may extend as far as the center channel of the River.

The City people were asked if the Torresdale intake could be sampled without chlorine being present. Mr. Boettger reported that chlorine backs up through the intake and even into the River. In subsequent conversation with Mr. Alan Hess of the City Water Department (Chief of Water Treatment at 3110 W. Queen Lane), we were however told that a chlorine-free sample could probably be obtained ahead of the traveling screen being careful to stay clear of a chlorinated backwash return on the same screen. Intake water can be sampled if desired between the initial gate and the bar screens. The Water Company has installed a continuous recording turbidometer at this particular intake location.

Prechlorination is practiced immediately before the supply enters the presedimentation basin. The Company in previous years had employed breakpoint chlorination but this had been discontinued in favor of maintaining a reasonable combined chlorine just short of obtaining a chlorine residual. Torresdale employs about 20 lb. chlorine/MG water equivalent to a dosage of $\pm$ 2 mg/l for prechlorination purposes. Effluent from the presedimentation basin to flocculation contains in the range of 0.15 to 0.50 mg/l total or combined chlorine and 0.0 to 0.05 mg/l free chlorine.

Delaware River waters have a slightly higher pH compared to the Schuylkill and this may be part of the reason why iron chlorides are used as the coagulant agent at Torresdale vs alum salts used at the Belmont and Queen Lane water plants. The pH of the Torresdale finished water is around 8.4.

The presedimentation basin is dredged or cleaned about once every seven years. This basin additionally receives the backwashes and sludges from inside the plant. Chemical treatment residues are planned in the future to be directed into a separate settling basin and transferred out of the presedimentation basin.

Chlorine is again added following presettling and just prior to flocculation at the rate of 35 to 50 lb/MG. Breakpoint is exceeded with the free chlorine residual reaching a level of 2.0 to 2.2 mg/l. Free chlorine is eventually reduced to 1.2 to 1.3 mg/l near the end of the water treatment plant. Immediately following chlorine, lime is added at the rate of about 170 lb/MG water. Crude pebble lime received at the Torresdale plant is slaked prior to use. The lime causes the pH of the treatment process to rise to 9.0 to 9.4. Ferric chloride is then added at the rate of 70 lb (MG/dry lbs. of $FeCl_3$). The ferric chloride is actually a waste liquid byproduct derived from titanium dioxide manufactured at DuPont's Edgemore plant in Wilmington, Delaware. The Philadelphia Water Department hopes in the future to use the $FeCl_3$ waste product at its Belmont and Queen Lane water treatment plants because it is considerably cheaper than conventional flocculating chemicals.

Polyelectrolytes, ammonia and activated carbon represent other chemicals added after flocculation but before the sand filters. No polyelectrolytes are used on a routine basis but the Water Department is experimenting with a few different types. Ammonia has been introduced in the past at the end of the settling basins when tastes and odors were high. Ammonia was stopped in January of this year because of cost. Approximately one part of ammonia was added for each 4 parts of chlorine residual, say 0.4 mg/l ammonia for each 1.6 mg/l chlorine residual. When ammonia dosage is kept on the low side, the tendency is to form monochloramines which are preferred to di- and trichloramines. The higher operating Ph's also favor the formation of the mono form over the di- and tri-forms.

Powdered activated carbon was added for approximately 6 weeks around April, 1975 following strange odors in the Delaware River water supply at that time. Critical months for tastes and odors in Philadelphia's water supplies more often than not seem to be March through May, that is in early-spring. PAC, mostly of the Westvaco type, was introduced in the spring of 1975 at the rate of about 50 lb/MG but only for a relatively limited time. The City's consultant did not attach any great advantages in using activated carbon. Carbon addition was made either just ahead of the rapid mixers or at the end of the four settling basins.

Final chemical conditioning at Torresdale is made following the sand filters on the water being directed into the five filtered water storage basins. Chlorine and fluoride are added at this final point. Post-chlorination usually amounts to about 4 to 10 lbs/MG. Fluoro-salicylic acid is added at the approximate rate of one gallon of 24% acid for each 1 MG water. The Department strives for 1.2 to 1.4 mg/l chlorine residual and about 1.0 mg/l fluoride in the final treated waters.

The City is believed to have conducted considerable collection and analysis of trace organics especially in their water supplies but these results will be difficult to obtain. Two of the more important trace organics found in the Torresdale supply include chloroform and BCEE reported in 1975. The City conducts weekly sampling on the Delaware River together with river stations close to the Torresdale intake. River samples are analyzed for pH, alkalinity, conductance, chlorides, Nitrogen series, BOD, DO, COD, phenols, phosphates, temperature, turbidity, Al, Cd, Ca, Hg, Cr, Cu, Fe, Mn, Pb, Zn, Co, Hg, Ag, Ni, Ba, total and fecal coliforms. The Torresdale intake is analyzed routinely for various parameters some of which include SO_4, Si, Na, K, total and filterable solids, Fe, Mn, filtered color and CO_2. The intake is sampled at the tide gate before pre-chlorination.

B. Recommendations and Comments from Reports of Survey of the Philadelphia Water Supply Systems Made By the EPA, Region III in April 1972 and in June 1973

1) The City initiated a cooperative agreement with Drexel University in the amount of $25,000 for a comprehensive monitoring program on organic compounds in the finished water. Purpose of this program was to identify and quantify an organics problem, association of these organics with taste and odor and to observe fluctuations caused by upstream and natural sources. Special laboratory facilities for liquid extraction of organics were placed under development at the Torresdale Plant.

2) "Through the use of a steady-state continuity model, the Water Department has determined that the effluent from the Northeast Water Pollution Control Plant does affect the raw water quality at the Torresdale intake, particularly during low flow conditions." At a meeting in August, 1976, City of Philadelphia personnel would not confirm the above statement.

3) "It is recommended that tracer studies be conducted on effluent from the Northeast Water Pollution Control Plant in order to demonstrate the effects on raw water quality at the Torresdale intake. An attempt should be made to correlate the effects with increased chemical costs."

4) The intake for the Torresdale Plant normally receives water from the Delaware River on the flood tide. Consequently downstream sources of pollution such as the NE STP, the Rohm and Haas Co., and the Allied Chemical Co. are of interest since their discharges could adversely affect water quality at the Torresdale intake. Extent of upstream migration of these discharges during flood tide and their degree of influence on water quality in the vicinity of the intake are unknown. The processes in the water treatment train should be based upon the quality of the raw water. Therefore, all factors which influence the quality of the raw water should be thoroughly evaluated.

5) The Water Department samples raw and finished waters at its water treatment plants by a new technique designed to measure organic concentrations in water. Results showed as follows for the finished water supplies:

	Carbon Chloroform Extract, (mg/l)	Carbon Alcohol Extract,(mg/l)
Schuylkill River	0.7	2.3
Delaware River	0.5	1.2

Results were generally in excess of the then-established limits of 0.3 mg/l and 1.5 mg/l respectively of CCE and CAE. However, these limits were based upon a high flow rate method of sample collection and were consequently considered too stringent for the new sampling and analysis techniques that were utilized by the City of Philadelphia. The results did lead to the consideration that further means should be taken to reducing organic content of finished water. Organic materials were deemed responsible for taste and odor, and additionally it was reported that CCE contains toxic materials such as pesticides and petrochemicals. CAE although partially measuring naturally-occurring substances, was reported as a caustive agent in shortening life in rates.

6) It is recommended that the relative removal efficiencies of the various unit operations at the three water treatment plants be evaluated with respect to organic materials. Such results would provide a meaningful basis for possible alteration or addition of unit processes in the treatment train in order to satisfactorily reduce the level of organics in the finished waters.

C. Trace Organics Investigations and Analysis, City of Philadelphia And Drexel University

Cooperative studies were undertaken with Drexel University in 1972 or before, dealing with the isolation, identification and removal of organic substances in the Philadelphia water supplies. Some $186,000 was budgeted for organic pollutants and optimization of treatment processes in removing trace organic compounds over the period of November 1972 through November 1975.

In 1972-1973, study was directed to developing analytical methods for monitoring organoleptic compounds and a rapid organoleptic testing method. The latter consisted of an odor panel receiving a known concentration of the compound being tested in distilled water and pouring this solution into a spray nozzle bottle which in turn was pressured with nitrogen. When the vapor from the solution comes into equilibrium, the panelist then sprays and smells the sample. The panelists were shown to respond well to identifying odors. Three analytical methods were particularly developed for the extraction and concentration of trace organics. The first method involves use of a Rohm and Haas XAD-2 macroreticular resin with ether extraction, the concentrate then injected into a gas chromatograph together with mass spectrophotometer. The second method utilizes continuous or batch chloroform liquid-liquid extraction to extract trace organics from water. The chloroform extract is concentrated and analyzed by GC. The third method-head gas analysis, is specific for volatile organics. A water sample is heated and the gas vapor withdrawn into a head gas container. The City augments its GC-MS capabilities with Rohm and Haas instrumentation. Interpretation of mass spectral data has been greatly improved by use of the Cornell University STIRS and PBM Systems. Many trace organics have been isolated and identified to date by the City of Philadelphia investigations.

D. Advanced Water Treatment Pilot Plant at Torresdale

Construction of a 30,000 gpd research pilot plant was started at the Torresdale water treatment plant in mid-1975. This special facility at a cost of around $300,000 is expected to be completed in September 1976. The pilot facility is constructed of stainless steel, glass and teflon. The pilot plant is essentially installed inside the NE end of the filter gallery at the Torresdale plant. Water will be pumped from the Delaware River some 3,000 feet to a raw water basin and from the raw water basin to a stainless steel circular clarifier. From the clarifier, the water travels to two stainless steel and glass rectangular rapid sand filters. Glass adsorption columns filled with activated carbon and macroreticular resins follow the rapid sand filters. The various types of chemicals to be used at the pilot plant will include chlorine, chlorine dioxide, ozone, coagulants, polyelectrolytes, ammonia, lime, and powdered activated carbon. Concentration of trace organics and subsequent analysis will be undertaken by analytical resin columns, continuous liquid-liquid extraction, and the head gas method.

Edmund J. Struzeski, Jr.

cc: Gallagher
Blackman
Struzeski
Vincent
Pennington ✓
Harp
Files
Region III (2)

APPENDIX C

DYE DILUTION TECHNIQUE FOR FLOW MEASUREMENT

DYE DILUTION TECHNIQUE FOR FLOW MEASUREMENT

Flow determinations were made using dye dilution with fluorometric detection technique. In this procedure, a dye of known concentration is injected at constant rate upstream of the sample site, an adequate distance to insure mixing. Samples are collected and the dye concentration is determined by a fluorometer. Knowing the dye injection rate, initial dye concentration, and concentration after the dye has mixed with the wastewater flow, the flow can be calculated.

The G. K. Turner Model III fluorometer was used. Calibration of the fluorometer was accomplished daily using dye standards prepared in the NEIC laboratory. Rhodamine WT dye was used due to its low sorptive tendency and stability under varying pH conditions.

Background investigations of all stations were conducted to determine if any substances in the waste stream would fluoresce in the range that could induce errors in flow determinations. Background samples were taken each time samples for flow determination were collected. The fluorescence measured on background samples was subtracted from the fluorescence measured on the flow samples.

Special precautions taken to insure against interference in flow measurements consisted of: 1) cuvettes triple rinsed with distilled water between each sample; 2) cuvettes cleaned daily with solvent; 3) cuvettes filled with distilled water and fluorescence measured twice daily to insure against contamination from operator handling; 4) fluorometer checked for "0" reference between each reading and after use, using "0" reference blank; 5) all readings were taken on upward movement of indicator to eliminate any error due to gear "slop;" and 6) rubber gloves were worn when handling raw dye to avoid contamination during fluorometer operation.

Dye was injected into the Somerset Low Level Interceptor (SLL) and sampled for fluorescence downsewer after completely mixing with the SLL flow. Further downsewer, after the SLL flow has completely mixed with the Frankford Low Level Interceptor (FLL) flow, fluorescence was determined and the combined flow of SLL and FLL calculated. The difference in the combined flow (SLL + FLL) and the SLL flow is equal to the FLL flow.

Some of the combined SLL plus FLL flow is bypassed [Figure 2] to the Delaware Low Level (DLL) influent channel. The quantity of flow bypassed was determined by taking the difference between the combined SLL plus FLL flow and the flow measured by the venturi meter associated with pumps 4, 5, and 6. Similarly the DLL flow was determined by subtracting the bypassed flow from the flow measured by the venturi meters associated with pumps 1, 2, 3, 7, 8, and 9. The Frankford High Level (FHL) Interceptor flow was determined directly by a venturi meter.

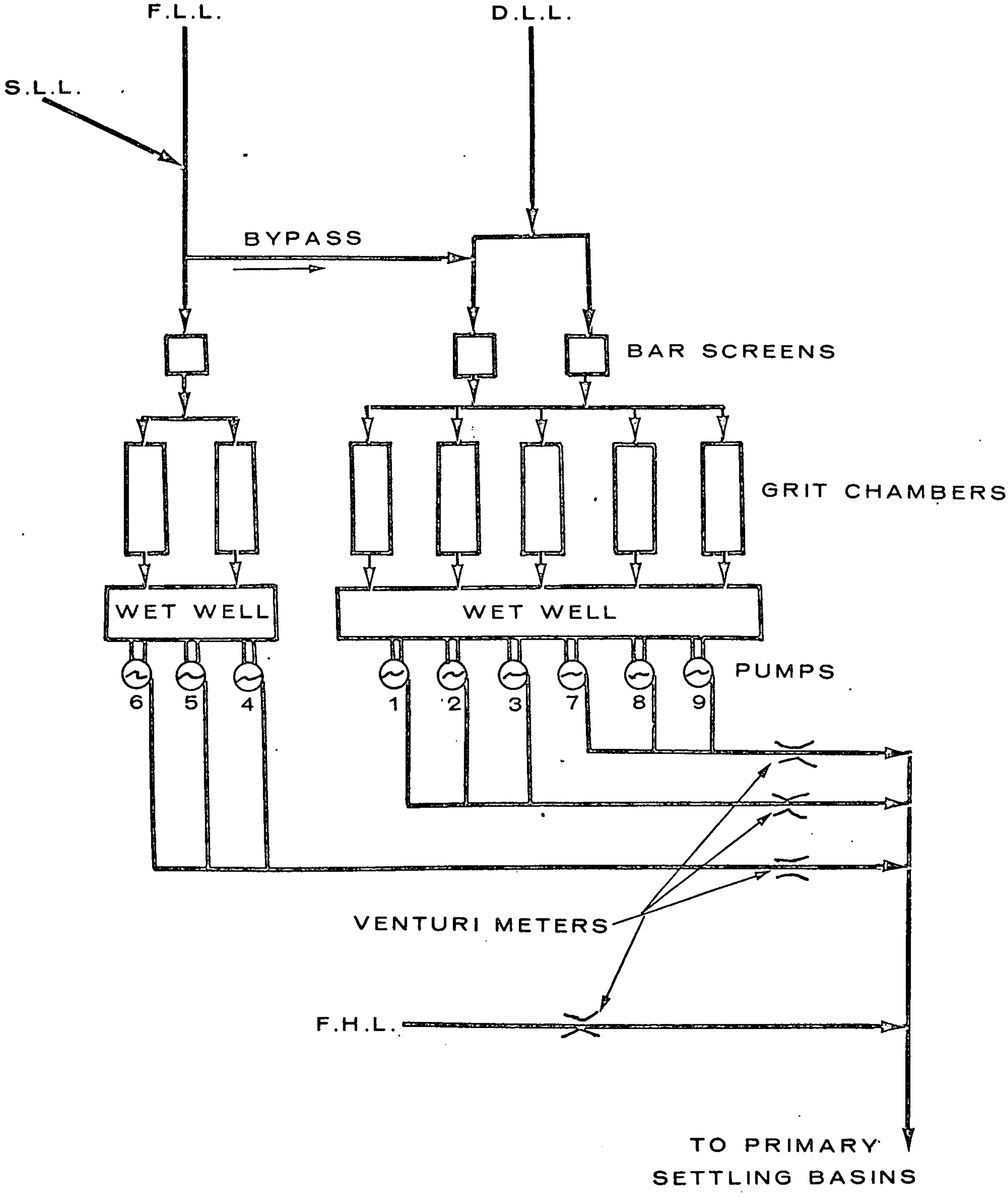


Figure 2. Schematic Diagram – Influent Works

Philadelphia Northeast WPCP

APPENDIX D

CHAIN OF CUSTODY PROCEDURES

ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ENFORCEMENT INVESTIGATIONS CENTER

CHAIN OF CUSTODY PROCEDURES
June 1, 1975

GENERAL

The evidence gathering portion of a survey should be characterized by the minimum number of samples required to give a fair representation of the effluent or water body from which taken. To the extent possible, the quantity of samples and sample locations will be determined prior to the survey.

Chain of Custody procedures must be followed to maintain the documentation necessary to trace sample possession from the time taken until the evidence is introduced into court. A sample is in your "custody" if:

1. It is in your actual physical possession, or

2. It is in your view, after being in your physical possession, or

3. It was in your physical possession and then you locked it up in a manner so that no one could tamper with it.

All survey participants will receive a copy of the survey study plan and will be knowledgeable of its contents prior to the survey. A pre-survey briefing will be held to re-appraise all participants of the survey objectives, sample locations and Chain of Custody procedures. After all Chain of Custody samples are collected, a de-briefing will be held in the field to determine adherence to Chain of Custody procedures and whether additional evidence type samples are required.

SAMPLE COLLECTION

1. To the maximum extent achievable, as few people as possible should handle the sample.

2. Stream and effluent samples shall be obtained, using standard field sampling techniques.

3. Sample tags (Exhibit I) shall be securely attached to the sample container at the time the complete sample is collected and shall contain, at a minimum, the following information: station number, station location, data taken, time taken, type of sample, sequence number (first sample of the day - sequence No. 1, second sample - sequence No. 2, etc.), analyses required and samplers. The tags must be legibly filled out in ballpoint (waterproof ink).

4. Blank samples shall also be taken with preservatives which will be analyzed by the laboratory to exclude the possibility of container or preservative contamination.

5. A pre-printed, bound Field Data Record logbook shall be maintained to record field measurements and other pertinent information necessary to refresh the sampler's memory in the event he later takes the stand to testify regarding his actions during the evidence gathering activity. A separate set of field notebooks shall be maintained for each survey and stored in a safe place where they could be protected and accounted for at all times. Standard formats (Exhibits II and III) have been established to minimize field entries and include the date, time, survey, type of samples taken, volume of each sample, type of analysis, sample numbers, preservatives, sample location and field measurements such as temperature, conductivity,

DO, pH, flow and any other pertinent information or observations. The entries shall be signed by the field sampler. The preparation and conservation of the field logbooks during the survey will be the responsibility of the survey coordinator. Once the survey is complete, field logs will be retained by the survey coordinator, or his designated representative, as a part of the permanent record.

6. The field sampler is responsible for the care and custody of the samples collected until properly dispatched to the receiving laboratory or turned over to an assigned custodian. He must assure that each container is in his physical possession or in his view at all times, or locked in such a place and manner that no one can tamper with it.

7. Colored slides or photographs should be taken which would visually show the outfall sample location and any water pollution to substantiate any conclusions of the investigation. Written documentation on the back of the photo should include the signature of the photographer, time, date and site location. Photographs of this nature, which may be used as evidence, shall be handled recognizing Chain of Custody procedures to prevent alteration.

TRANSFER OF CUSTODY AND SHIPMENT

1. Samples will be accompanied by a Chain of Custody Record which includes the name of the survey, samplers' signatures, station number, station location, date, time, type of sample, sequence number, number of containers and analyses required (Fig. IV). When turning over the possession of samples, the transferor and transferee will sign, date and time the sheet. This record sheet allows transfer of custody of a group of samples in the field, to the mobile laboratory or when samples are dispatched to the NEIC - Denver laboratory. When transferring a portion of the samples identified on the sheet to the field mobile laboratory, the individual samples must be noted in the column with the signature of the person relinquishing the samples. The field laboratory person receiving the samples will acknowledge receipt by signing in the appropriate column.

2. The field custodian or field sampler, if a custodian has not been assigned, will have the responsibility of properly packaging and dispatching samples to the proper laboratory for analysis. The "Dispatch" portion of the "Chain of Custody Record shall be properly filled out, dated, and signed.

3. Samples will be properly packed in shipment containers such as ice chests, to avoid breakage. The shipping containers will be padlocked for shipment to the receiving laboratory.

4. All packages will be accompanied by the Chain of Custody Record showing identification of the contents. The original will accompany the shipment, and a copy will be retained by the survey coordinator.

5. If sent by mail, register the package with return receipt requested. If sent by common carrier, a Government Bill of Lading should be obtained. Receipts from post offices, and bills of lading will be retained as part of the permanent Chain of Custody documentation.

6. If samples are delivered to the laboratory when appropriate personnel are not there to receive them, the samples must be locked in a designated area within the laboratory in a manner so that no one can tamper with them. The same person must then return to the laboratory and unlock the samples and deliver custody to the appropriate custodian.

LABORATORY CUSTODY PROCEDURES

1. The laboratory shall designate a "sample custodian." An alternate will be designated in his absence. In addition, the laboratory shall set aside a "sample storage security area." This should be a clean, dry, isolated room which can be securely locked from the outside.

2. All samples should be handled by the minimum possible number of persons.

3. All incoming samples shall be received only by the custodian, who will indicate receipt by signing the Chain of Custody Sheet accompanying the samples and retaining the sheet as permanent records. Couriers picking up samples at the airport, post office, etc. shall sign jointly with the laboratory custodian.

4. Immediately upon receipt, the custodian will place the sample in the sample room, which will be locked at all times except when samples are removed or replaced by the custodian. To the maximum extent possible, only the custodian should be permitted in the sample room.

5. The custodian shall ensure that heat-sensitive or light-sensitive samples, or other sample materials having unusual physical characteristics, or requiring special handling, are properly stored and maintained.

6. Only the custodian will distribute samples to personnel who are to perform tests.

7. The analyst will record in his laboratory notebook or analytical worksheet, identifying information describing the sample, the procedures performed and the results of the testing. The notes shall be dated and indicate who performed the tests. The notes shall be retained as a permanent record in the laboratory and should note any abnormalties which occurred during the testing procedure. In the event that the person who performed the tests is not available as a witness at time of trial, the government may be able to introduce the notes in evidence under the Federal Business Records Act.

8. Standard methods of laboratory analyses shall be used as described in the "Guidelines Establishing Test Procedures for Analysis of Pollutants," 38 F.R. 28758, October 16, 1973. If laboratory personnel deviate from standard procedures, they should be prepared to justify their decision during cross-examination.

9. Laboratory personnel are responsible for the care and custody of the sample once it is handed over to them and should be prepared to testify that the sample was in their possession and view or secured in the laboratory at all times from the moment it was received from the custodian until the tests were run.

10. Once the sample testing is completed, the unused portion of the sample together with all identifying tags and laboratory records, should be returned to the custodian. The returned tagged sample will be retained in the sample room until it is required for trial. Strip charts and other documentation of work will also be turned over to the custodian.

11. Samples, tags and laboratory records of tests may be destroyed only upon the order of the laboratory director, who will first confer with the Chief, Enforcement Specialist Office, to make certain that the information is no longer required or the samples have deteriorated.

EXHIBIT I

EPA, NATIONAL ENFORCEMENT INVESTIGATIONS CENTER

Station No.	Date	Time	Sequence No.

Station Location

_____ Grab
_____ Comp.

		Remarks/Preservative:
_____ BOD	_____ Metals	
_____ Solids	_____ Oil and Grease	
_____ COD	_____ D.O.	
_____ Nutrients	_____ Bact.	
	_____ Other	

Samplers:

★GPO IMPRINT

Front

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT
NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
BUILDING 53, BOX 25227, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Back

EXHIBIT II

FOR ______________________________ SURVEY, PHASE ______, DATE ______________

TYPE OF SAMPLE ______________________________

					ANALYSES REQUIRED																				
STATION NUMBER	STATION DESCRIPTION	TOTAL VOLUME	TYPE CONTAINER	PRESERVATIVE	NUTRIENTS	BOD	COD	TOC	TOTAL SOLIDS	SUSPENDED SOLIDS	ALKALINITY	DO	pH*	CONDUCTIVITY*	TEMPERATURE*	TOTAL COLIFORM	FECAL COLIFORM	TURBIDITY	OIL AND GREASE	METALS	BACTI	PESTICIDES	HERB	TRACE ORGANICS	PHENOL

REMARKS

E[redacted]IT [redacted]

Samplers: ____________________

____

____

____

FIELD DATA RECORD

STATION	NUMBER	DATE	TIME	TEMPERATURE °C	CONDUCTIVITY μmhos/cm	pH S.U.	D.O. mg/1	Gage Ht. or Flow Ft. or CFS

EXHIBIT IV

ENVIRONMENTAL PROTECTION AGENCY
Office Of Enforcement
NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
Building 53, Box 25227, Denver Federal Center
Denver, Colorado 80225

CHAIN OF CUSTODY RECORD

SURVEY	SAMPLERS: *(Signature)*

STATION NUMBER	STATION LOCATION	DATE	TIME	SAMPLE TYPE			SEQ. NO.	NO. OF CONTAINERS	ANALYSIS REQUIRED
				Water		Air			
				Comp.	Grab.				

Relinquished by: *(Signature)*		Received by: *(Signature)*	Date/Time
Relinquished by: *(Signature)*		Received by: *(Signature)*	Date/Time
Relinquished by: *(Signature)*		Received by: *(Signature)*	Date/Time
Relinquished by: *(Signature)*		Received by Mobile Laboratory for field analysis: *(Signature)*	Date/Time
Dispatched by: *(Signature)*	Date/Time	Received for Laboratory by:	Date/Time
Method of Shipment:			

Distribution: Orig. — Accompany Shipment
1 Copy — Survey Coordinator Field Files

GPO 356-80?

APPENDIX E

ANALYTICAL PROCEDURES AND QUALITY CONTROL

ANALYTICAL PROCEDURES AND QUALITY CONTROL

Samples collected during this survey were analyzed, where appropriate, according to procedures approved by EPA for the monitoring of industrial effluents.* The procedures are listed in the following table.

Parameter	Method	Reference
Cd, Mn, Ni, Al, Cr, Fe, Hg, Ag, As, Pb, Sn, Zn, Cu, Ba, Se	Atomic absorption	EPA Methods for Chemical Analyses of Water and Wastes 1974, p 78.
TSS	Gravimetric	ibid., p 268
Ammonia	Automated Colorimetric phenate	ibid., page 168
Oil and grease (Freon-extractable materials)	Separatory funnel extraction	ibid., p 229
BOD	Serial dilution (Winkler-Azide)	ibid., page 11
COD	Dichromate reduction	ibid., page 20
TKN	Automated phenate	ibid., page 182
$NO_3 + NO_2$	Automate Codminum reduction	ibid., page 207
Total P	Automated ascorbic acid reduction	ibid., page 256
PO_4	Automated ascorbic acid reduction	ibid., page 256

* *Federal Register, Vol. 44, No. 232, December 1, 1976.*

Reliability of the analytical results was documented through an active Analytical Quality Control Program. As part of this program, replicate analyses were normally performed with every tenth sample to ascertain the reproducibility of the results. In addition, where appropriate, every tenth sample was spiked with a known amount of the constituents to be measured and reanalyzed to determine the percent recovery. These results were evaluated in regard to past AQC data on the precision, accuracy and detection limits of each test. On the basis of these findings, all analytical results reported for the survey were found to be acceptable with respect to the precision and accuracy control of this laboratory.

APPENDIX F

ORGANICS ANALYTICAL METHODOLOGY

PHILADELPHIA SURVEY
ORGANICS ANALYTICAL METHODOLOGY

Samples collected for general organics analyses were divided into three categories to facilitate characterization of the constituents. The first category, 3 and 6 liter extracts, were composite samples collected at sewage treatment plant (STP) influent and effluent stations. These samples were expected to contain the highest concentrations of organic constituents. The second category, 60 l extracts, were field extracted and composited on site so that very large sample volumes could be utilized where organics concentrations were expected to be lower, such as in open waters and finished water from the water treatment plant (WTP). The final category, volatile organics, were collected at all sites using the same technique since this method can tolerate a large range of concentrations of constituents.

EXTRACTION TECHNIQUES

3 and 6 Liter Samples

Composited 3 or 6 liter (l) samples were received at the laboratory packed in ice. Each sample was warmed to room temperature and 3 l from each gallon container of composited sample was extracted with 300 milliliters (ml) of methylene chloride ($MeCl_2$). The $MeCl_2$ extract was passed through prewashed (100 ml acetone) anhydrous sodium sulfate (Na_2SO_4) to to remove any residual water. The Na_2SO_4 was then washed with 100 ml of acetone and the $MeCl_2$ extract and acetone wash combined in a 500 ml Kadurna-Danish (KD) equipped with a 3 ball Snyder column. After the volume was reduced to 10 ml, the extracts were transferred to graduated centrifuge tubes and concentrated to 5 ml under a stream of organic free air.

60 l Samples

Samples were received at the mobile laboratory as 4 five gallon glass containers of water for each 24 hour composite. 15 liter of each container were transferred to a 5 gallon pyrex bottle. 1 liter of $MeCl_2$ was added and the mixture stirred for 10 minutes using a hand-held industrial mixer. After allowing time for the $MeCl_2$ to separate, the water layer was siphoned off and the remaining mixture transferred to a 2 liter separatory tunnel. The $MeCl_2$ was drained and transferred to a 500 ml KD and the volume reduced to approximately 25 ml. On average, 600 ml of $MeCl_2$ were recovered. The extracts were transported to the NEIC laboratory where they were dried, composited and reduced in volume in the same manner as the 3 liter extracts.

Volatile Organics

The technique for volatile organics is attached as a separate section.

Gas Chromatography

The extracts from 3, 6 and 60 liter samples were analyzed using a gas chromatograph (GC) equipped with a 10 foot 2 mm ID glass column packed with 6% OV 101 on Gas-Chrom Q support and a flame ionization detector (FID). 1 microliter (μl) of the extracts (or dilutions as necessary to maintain peaks on scale) were injected onto the column. Analytical conditions were: injector temperature 220°C, detector temperature 250°C, He flow rate 20 ml/minute, initial oven temperature 80°C, final oven temperature 220°C, oven temperature program rate 6°C/min.

Mass Spectrometry

The constituents of each extract were identified using a gas chromatograph-mass spectrometer (GC-MS). The GC conditions were identical to those described earlier. Samples were injected onto the column and the oven program started. Mass spectrometer data acquisition was initiated after the solvent eluted from the GC column. A complete mass spectrum was collected in less than 4 seconds from 20-350 amμ. Mass spectra were selected on each peak of the chromatogram and identified by comparison to reference spectra obtained at the NEIC laboratory; Eight Peak Index of Mass Spectra, Second Edition, 1974; EPA mass spectral search system on the Cyphernetics Computer System or the Registry of Mass Spectral Data, Wiley & Sons, 1974. Constituents identified are considered only tentative unless verified by reference spectra obtained from the standard compound at NEIC.

Quantitation

After identification of the constituents by GC-MS, available standards were analyzed on FID GC. Retention times and peak heights of the standards were measured and used to calculate the concentrations of the identified constituents in the samples. Comparisons were also made of retention times to provide an additional verification of the identification.

Numerous other compounds were identified by GC-MS that could not be verified due to the lack of an appropriate standard at NEIC. In cases where the identification was considered very good when compared to external reference spectra, the concentrations were estimated using response factors of similar compounds with similar retention times.

NEIC METHOD FOR DETERMINATION OF VOLATILE ORGANICS
September 1976

1. Scope and Application
   1.1 This method is applicable to open, waste, and drinking waters where volatile components are present at and above 20 ug/l.
   1.2 Since purging of the sample may not remove 100% of some components and the detector responses vary for classes of compounds, the sensitivity of the method may vary significantly for different compounds.

2. Summary of the Method
   2.1 Volatile components of the sample are purged with helium and trapped on a polymer adsorbant. The components are then desorbed and readsorbed at the head of a porous polymer analytical GC column. The GC oven is temperature programmed and the components analyzed by mass spectrometer (MS) or flame ionization detector (FID) detectors. The working range is 20 to 250 ug/l for most compounds using FID. The upper limit may be increased by using smaller sample volumes.

3. Comments
   3.1 This method requires a well conditioned GC column to avoid excessive baseline drift due to column bleed during temperature programming.
   3.2 The purging and desorbing procedure is applicable to either FID or MS detectors and is presented here independent of detector.
   3.3 The initial GC oven temperature (now 170°C) may be lowered to accommodate lower boiling components; however, some loss in information will occur due to peak broadening and decreased sensitivity.

4. Precision and Accuracy
   4.1 Replicate analyses of chloroform were performed at 500 ug/l at NEIC. Standard deviations were 0.50 and 0.006 for peak height and retention time (in cm) respectively.
   4.2 No accuracy data are available.

5. Sample Handling and Preservation
   5.1 Samples are collected in small (2 to 8 oz) glass bottles with Teflon lined screw caps and stored in ice or refrigerated at 4°C.
   5.2 Sample bottles should be filled completely to leave no air spaces. During analysis, the samples should be opened for as short a time as practicable to remove sufficient sample for analysis.

6. Apparatus
   6.1 Gas Chromatograph: Varian 1400 series or other unit capable of accepting FID or MS detectors. Unit should be temperature programmable and operable from ambient to 210°C.

6.2 GC column: 6 ft. by 2 mm ID glass column packed with 60/80 mesh Chromosorb 101. The column should be conditioned 16 hours at 230°C with 20 ml/min He flow before use.

6.3 Liquid Sample Concentrator: Tekmar LSC-1 or equivalent unit capable of purging 5 ml or more sample with He onto a Tenex adsorber column, then desorbing at 140°C from the Tenex into the injector of the GC. Bake the trap for 16 hours at 140°C with 20 ml/min He flow before use.

6.4 Mass spectrometer: Finnigan 1015 or similar.

6.5 Syringe: 5 ml gas tight syringe.

7. Reagents

7.1 Volatile organics free water: Tap or distilled water purged with He to remove volatile organics.

7.2 Helium: Zero grade He for use to purge the water samples.

7.3 Standards: Pure compounds diluted to working concentrations with water, tightly capped and stored at 4°C.

8. Procedure

8.1 Set up liquid sample concentrator (LSC) as described in the owner's manual. Adjust the purge flow rate to 20 ml/min with 65 psig He pressure at the tank. Adjust the desorb flow rate to 20 ml/min.

8.2 Set up the gas chromatograph as follows:

Injector temperature:	190-200°C
FID temperature:	250°C
GC column flow rate:	20 ml/min He @ 60 psig
Program rate:	4°C/min
Initial temperature:	170°C
Limit temperature:	200°C

8.3 Attach the LSC to the GC by pushing the hypodermic needle from the LSC trap effluent through the injector septum. Remove the LSC tubing and push a fine wire from the back of the needle through the point to remove any septum material that may have clogged the needle. Reattach the LSC to the needle.

8.4 Place 5 ml of sample into the LSC purging chamber and purge the sample for 5 minutes at 20 ml/min.

8.5 Desorb the sample components from the Tenex column for 5 minutes at 140°C onto the GC column at ambient temperature.

8.6 Immediately after 8.5, switch back to purge mode on the LSC, close the GC oven door and raise the oven temperature to 170°C by switching to "hold" with the initial temperature set to 170°C. Wait 2 minutes as the temperature rises.

8.7 Start the GC oven program at 4°C/min and the chart recorder or mass spectrometer. Note that the oven may not have stabilized at 170°C but should have just reached 170°C by this time. Collect data as necessary then repeat procedure for subsequent samples. 200°C is a sufficient upper limit for most analyses.

9. Results

9.1 Table I gives approximate retention times for a number of compounds. Figure 1 is a chromatogram showing the response using this method.

TABLE I

Retention Times of Selected Volatile Organic Compounds

Name	Minutes
Acetone	1.4
Methlene Chloride	1.7
Chloroform	2.9
Benzene	3.9
Toluene	6.2
Ethyl Benzene	9.2
Cumene	13.9

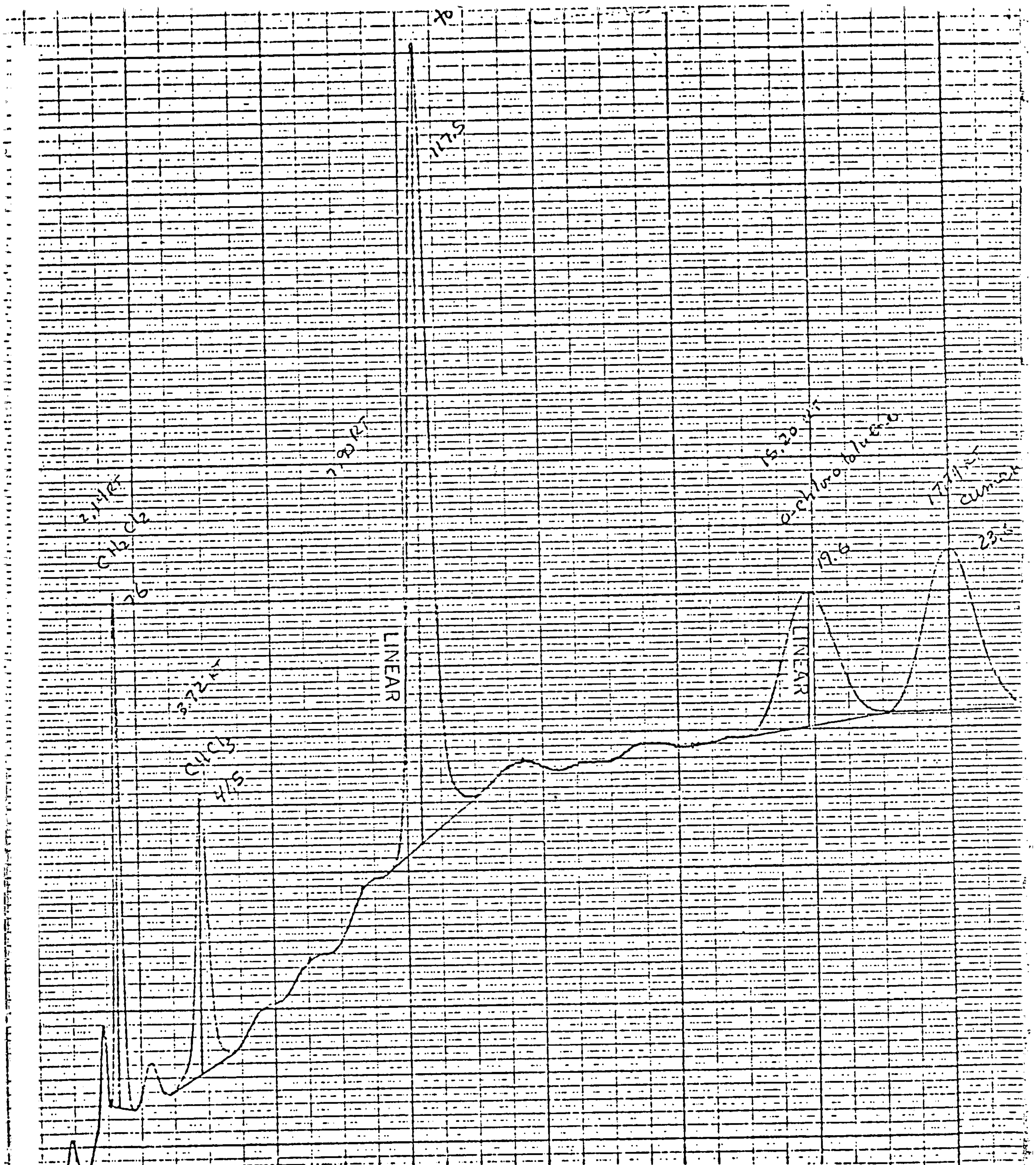


FIGURE 1. TYPICAL CHROMATOGRAM

APPENDIX G

DETERMINATION OF TOXICITY INDEX

APPENDIX G
DETERMINATION OF TOXICITY INDEX

The compounds identified during the survey [Tables 18 and 19] were evaluated and a toxicity index developed. The toxicity index developed herein is a number estimating the relative toxicity of all the organic compounds found. Consideration of absolute toxicity factors, such as the development of cancer or lethal dose, was used to indicate the compounds which are potentially more harmful than others. The toxicity index is more a safety hazard evaluation than a clinical ecological interpretation.

Aquatic Toxicity

Data on acute doses required for intoxication serve first as a yardstick against which to compare one compound with another, and second, as a starting point in the design of repeated exposure and metabolism studies. The compounds listed in Tables 18 and 19 underwent an extensive literature search. The column heading "Aquatic Toxicity" was taken from the five-volume set *Water Quality Criteria Data Book*, published by EPA in the Water Pollution Control Research series over a period of several years. The numerator indicates the number of times a separate reference was found on the effects of that chemical on aquatic life. The denominator indicates the most toxic doses reported, according to the rating system of Gleason, et al[1], as follows:

CLASSIFICATION SYSTEM FOR ACUTE TOXICITY OF CHEMICALS

Toxicity Rating or Class	Lowest published toxic dose (TD) or LD_{50} for animals (LD)
6 - Super toxic	Less than 5 mg/kg (5 ppm)
5 - Extremely toxic	5 to 50 mg/kg (5 to 50 ppm)
4 - Very toxic	50 to 500 mg/kg (50 to 500 ppm)
3 - Moderately toxic	500 to 5,000 mg/kg (0.5 to 5 ppt)
2 - Slightly toxic	5 to 15 gm/kg (5 to 15 ppt)
1 - Practically non-toxic	Greater than 15 gm/kg (>15 ppt)

The specific toxicity doses (oral and inhalation) for which data are provided in reference 2 are given in Table 21. The number of citations addressing toxicity of one or another compound may reflect either the duration of the period of concern over the compound or the extraordinary recent recognition of its toxicity. Either of these motives could cause an abundance of literature citations with respect to the toxicity of a given compound. Conversely, many of the compounds which were identified have not been assigned a CAS (Chemical Abstract Registry Number) and no data concerning their toxicity and/or carcinogenicity are reported in the literature. Hence, although the number of references found is not a strict measure of the toxicity of a given substance, it is indicative of the concern and attention provided in literature. Presumably, the higher the sum of the numerator and denominator, the more toxic the chemical, the more widespread its effects, and the more cause for concern. Such a measurement does not necessarily take into account the difference between species nor does it necessarily bear any relationship to chronic toxicity which is more relevant to the low levels reported in Tables 18 and 19. This "measure" used in conjunction with other data provided in Tables 18, 19, 20 and 21 should be used collectively in evaluating the health effects of exposure to the compounds identified.

In addition, the Occupational Safety and Health Act (OSHA) standards have been developed for some chemicals and are given in the column "OSHA Standard. Standards were also taken from the Toxic Substances List, 1974 Edition.[2] The OSHA standards were rated in the same manner as was aquatic toxicity. For example, the OSHA standard for compound number 1 (Ethanol) in Table 18 is 1,000 ppm which would give it a toxicity rating of 3 (moderately toxic). This rating system, based on a scale of 1 (practically non-toxic) to 6 (super toxic) is used to aid in weighting the overall toxicity index.

Suspected Carcinogen List

The column "Suspected Carcinogen List" contains a numerator from which the four digits are summed to yield the denominator. The information came from the *Suspected Carcinogens: A Subfile of the NIOSH Toxic Substances List.*[3] However, in an ateempt to solve the same problems encountered in interpreting the data presented in this report, the Suspected Carcinogens List was computer permuted by EPA[4] to produce a ranking of hazard, according to the following schedule:

The first digit, A, represents the species in which a carcinogenic (CAR) or neoplastic (NEO) response was reported, and assignments were made thus:

7: human
6: monkey
5: cat, dog, pig, cattle, or domestic animal
4: rat
3: mouse
2: guinea pig, gerbil, hamster, rabbit, squirrel, unspecified mammal
1: wild bird, bird, chicken, duck, pigeon, quail or turkey
0: frog

For compounds where CAR or NEO responses were reported in more than one species, the highest number was assigned.

The second digit, B, designates the number of different species for which a CAR or NEO response was reported, up to a maximum number of 9.

The third digit, C, was assigned on the basis of the route of administration for which a CAR or NEO response was reported:

2: inhalation, ocular or skin application
1: oral administration
0: all other routes of administration

Only the highest number was retained where CAR or NEO responses were reported for more than one route or administration.

The final digit, D, is the total number of CAR and/or NEO responses reported for this substance, up to a maximum of 9. Because the NIOSH Registry included only one entry for any route/species combination (specifically, the study in which the lowest effective dose was reported for that combination), this digit is a count of the number of different species/route combinations reported to result in a carcinogenic or neoplastic response.

Toxline

The column "Toxline" lists the relative frequency of occurrence of toxic substance literature. The computerized data bases of the National Libraries of Medicine TOXLINE were exhaustively searched, both on-line for current files and off-line for historical files. This base contains data on toxicity and adverse effects of environmental pollutants and chemicals on the human food chain, laboratory animals, and biological systems; it also contains analytical techniques.

Accessible through Toxline are citations, and abstracts where available, from the following indexes for a total of 878,000 records, spanning the last 3-1/2 decades of medical literature.

CANCERLINE 1963-76 - Cancer Abstracts
CANCER PROJ 1975-76 - Cancer Projects
CBAC - 1965-76 - Chemical Abstracts, biochemistry sections
CHEMLINE 1973-76 - Chemical Information on Structure and Nomenclature
EMIC - 1971-74 - Environmental Mutagen Information Center
EPILEPSY - 1945-76 - Epilepsy Abstracts
HEEP - 1972-76 - Health Effects of Environmental Pollutants
PESTAB - 1966-76 - Pesticide Abstracts, EPA
HAYES - 1930-76 - EPA Pesticide File
IPA - 1970-76 - International Pharmaceutical Abstracts
TOXBIB - 1968-76 - Index Medicus toxicity subset

the search logic used was broadly constructed to retrieve any references to the adverse effects of any of the 156 chemicals listed.

Science Citation Index[R] determines the apparent scientific merit of an author's work by determining the number of times his work has been cited by other authors. Similarly, it was assumed that the more references there were in the literature to the adverse effects of a chemical, the more toxic it was in fact. Thus, the "Toxline" column lists the number of citations to the literature on the adverse effects of each chemical found in the TOXLINE.

Toxicity Index

All of these columns are mechanically summed, including both the numerators and denominators, if they occur, to create the "Toxicity Index" column. The exception is the "Suspected Carcinogen List" column, in which only the denominator was included. The "Toxicity Index" serves only as a guide to the potential hazard of those compounds found. The larger the index, the greater the potential hazard.

The total number of separate literature references gathered in the development of this report is substantial.* It should be recognized that 156 chemicals were evaluated against 19 data bases, resulting in some 3,000 possible intersections. The actual number of references located was 2,182 and some intersections contained more than one reference.

* *Obviously, to explore this much information in depth on the adverse effects of these 156 chemicals would have required a report of inordinate length. However, the adverse aspects of a particular chemical can be further investigated by consulting the references on file at NEIC, Denver.*[5]

APPENDIX REFERENCES

1. Marion N. Gleason, R. E. Gosselin, H. F. Hodge and R. P. Smith, 1969. Clinical Toxicology of Commercial Products: Acute Poisoning, 3 ed., Williams and Wilkins Co., Baltimore.

2. Herbert E. Christensen and T. T. Luginbyhl, Eds., 1974. Toxic Substances List 1974. U. S. Dept. HEW, Rockville, Md.

3. Herbert E. Christensen and T. T. Luginbyhl, Eds., 1975. Suspected Carcinogens - A Subfile of the NIOSH Toxic Substances List. U. S. Dept. HEW, Rockville, Md.

4. An Ordering of the NIOSH Suspected Carcinogens List (based only on data contained in the List), March 1976. Environmental Protection Agency, Office of Toxic Substances, Washington, D.C., 436 p.

5. Douglas B. Seba, Toxic Substances Coordinator, EPA National Enforcement Investigations Center, Bldg. 53, DFC, Denver, Colorado, 303/234-5306.