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COMPILATION OF ENVIRONMENTAL ASSESSMENT DATA February 1978–March 1979

Volume III, Studies 10–14

by

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16. ABSTRACT The three-volume report compiles all data from EPA/IERL-RTP's phased environmental assessment program for the period 2/78-3/79. It includes data from 14 environmental assessment studies, compiled in standard format. The formatted Level 1 data are organized within each study by the analytical technique used to generate the data. Inorganic data as generated by spark source mass spectroscopy, atomic absorption, gas chromatography, chemiluminescence for oxides of nitrogen, anion analysis, and aqueous analysis precede the organic data generated by gas chromatography for C1-C6/C7 or C7-C17, liquid chromatographic fractionation, infrared spectroscopy, and low resolution mass spectroscopy. Sampling and analytical techniques that were used, that are not specified in Level 1, are documented in the summaries and data pages. Each Level 1 data section is followed by a Level 2 data section and/or an additional data section. Tables and figures in the Level 2 and additional data sections have been reproduced from the documents originally published by the organization conducting the study. The studies are organized by industrial type: (Vol. I) chemically active fluidized-bed combustion, coal-fired boiler and oil-fired boiler, coal-fired power plant, and coal gasifier; (Vol. II) coke production and ferroalloy process; and (Vol. III) the remaining industrial processes.

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ABSTRACT

This document compiles all available data from the IERL Phased Environmental Assessment Program for the period February 1978 through March 1979. This document follows an earlier publication, EPA-600/2-78-211, Compilation of Level 1 Environmental Assessment Data, which compiled all available chemical data from the inception of the Environmental Assessment Program through March 1978.

Available data from 14 environmental assessment studies are compiled in this document in standard formats. The formatted Level 1 data are organized within each study by the analytical technique used to generate the data. Inorganic data as generated by spark source mass spectroscopy, atomic absorption, gas chromatography, chemiluminescence for oxides of nitrogen, anion analysis, and aqueous analysis precede the organic data generated by gas chromatography for C_1-C_6/C_7 or C_7-C_{17}, liquid chromatographic fractionation, infrared spectroscopy, and low resolution mass spectroscopy. Sampling and analytical techniques that were used that are not specified in Level 1 are documented in the summaries and data pages.

Each Level 1 data section is followed by a Level 2 data section and/or an additional data section. The tables and figures in the Level 2 and additional data sections have been reproduced from the documents originally published by the organization conducting the study.

Each study is introduced by a summary, which is followed by the data generated in that study. The studies are organized by industrial type as follows: Chemically Active Fluidized-Bed Combustion, Coal-Fired Boiler and Oil-Fired Boiler, Coal-Fired Power Plant, Coal Gasifier, Coke Production, Ferroalloy Process, Internal Combustion Engine, Iron and Steel Mills, Residential Heating, Shale Oil Retorting, and Textiles.

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†In Volume II.

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INTRODUCTION

This document is an accumulation of all available environmental assessment data published from February 1978 through March 1979.

This document is the second comprehensive compilation of data from the IERL Phased Environmental Assessment Program. The first data compilation was published in October 1978 as EPA-600/2-78-211, Compilation of Level 1 Environmental Assessment Data. As in the first data compilation, the primary purpose of this compilation is to permit those involved in environmental assessment programs to evaluate the quality and quantity of data generated by the phased approach. It is felt that critical reviews of these data may lead to improvements in procedures, data formatting, data storage, and data interpretation. Although conclusions related to specific sources or source types may have been abstracted from the references to provide background information, the focus of this presentation is on data resulting from the Level 1 sampling and analytical methods. The interested reader should consult the referenced documents for more details and conclusions concerning pollutant sources, control techniques, etc.

The phased environmental assessment program, developed by the Industrial Environmental Research Laboratory (IERL) of the Environmental Protection Agency (EPA) at Research Triangle Park (RTP), North Carolina, is divided into three levels. Level 1 is the survey step to determine which samples from an environmental assessment might be hazardous or toxic. Level 1 also serves to establish the priority of samples and rank samples for further testing. When the Level 1 sampling and analysis scheme shows the possible presence of hazards a Level 2 scheme is initiated to specifically identify and quantify suspected hazardous materials. If Level 2 reveals pollutants capable of environmental detriment, then a Level 3 scheme is begun to evaluate control technologies and to assess long-term effects.

Fourteen studies have been identified that contain phased environmental assessment data; these studies are organized alphabetically by source types in

STUDY NUMBER 10

STUDY NUMBER 10

DATA SOURCE:	**EMISSIONS ASSESSMENT OF CONVENTIONAL STATIONARY COMBUSTION SYSTEMS;** **Volume II. Internal Combustion Sources**
DATA STATUS:	EPA—600/7-79-029c, February 1979
AUTHORS:	C. C. Shih, J. W. Hamersma, D. B. Ackerman, R. G. Beimer, M. L. Kraft, and M. M. Yamada
CONTRACTOR:	TRW, Inc. One Space Park Redondo Beach, California 90278 Contract No. 68-02-2197
PROJECT OFFICER:	Ronald A. Venezia Industrial Environmental Research Laboratory Office of Energy, Minerals, and Industry U.S. Environmental Protection Agency Research Triangle Park, NC 27711

The purpose of this study was to assess the contribution of gaseous emissions from stationary internal combustion sources to the total air pollution load. Two source categories, gas turbines and reciprocating engines, were considered in this assessment. Gas turbines may be classified as simple open cycle, regenerative open cycle, and combined cycle; and reciprocating engines may be classified as spark- and compression-ignited (diesel) engines. These large stationary internal combustion engines are used for "electricity generation, oil and gas transmission, natural gas processing, oil and gas production and exploration."

A thorough survey and evaluation of available information was performed and, based on deficiencies in the existing data base, eleven sites were chosen for sampling and analysis. There were five distillate oil-fueled gas turbines of the simple open cycle type (sites #111, #112, #306, #307, and #308), five distillated oil (diesel) reciprocating engines (sites #309, #310, #311, #312, and #313), and one gas-fueled gas turbine of the simple open cycle type (site #110). A thorough study of load factors and operating conditions was performed so that representative samples could be acquired.

No fugitive emissions were sampled since previous data indicated that there was an insignificant contribution to total pollutants from these sources.

The sampling and analysis protocol consisted of a modified Level 1 chemical assessment, Level 2 chemical assessment on three sites (#309, #312, and #313) as indicated by Level 1, and additional analyses for POM's by GC/MS. The modified Level 1 procedure involves sampling with a SASS train without cyclones and gas sampling bags for C_1-C_6 hydrocarbons and CO, CO_2, O_2, and SO_2. The Level 1 inorganic protocol was followed (SSMS for elemental composition; AAS for As, Hg, and Sb; colorimetric analysis for NO_3^-; and specific ion electrode method for Cl^- and F^-), and the following samples were analyzed: SASS filter (and hot water extracts of filter particulates); SASS XAD-2 sorbent; a composite of SASS organic module condensate, HNO_3 rinse, and the first impinger solution; and the fuel oil. The Level 1 organic protocol for sample recovery and fractionation was followed but final analyses were by gravimetry, GC, infrared spectrometry, and GC/MS rather than LRMS. A cutoff of 500 $\mu g/m^3$ for total organics in stack gas was used as the criterion for fractionation and detailed organic analysis.

The Level 2 sampling effort utilized the Goksöyr-Ross sampling system for sulfur oxides and the SASS train without cyclones. As compared to Level 1 tests, which used CH_2Cl_2 or CH_2Cl_2/CH_3OH rinses in this study, the Level 2 SASS tests added acetone to the rinse solutions and omitted isopropyl alcohol from the impinger recovery washes. The turbidimetric method was used for determination of SO_2 in Goksöyr-Ross H_2O_2 impinger and SO_4 in filter particulates and probe rinses. Initially unconcentrated and unfractionated organic samples were analyzed by capillary GC/MS. Some concentrated and LC fractionated samples were also analyzed by GC/MS, with reference to the unconcentrated and unfractionated sample, for trace levels of organics.

Quoting from the abstract of the final report,

> Assessment results indicate that internal combustion (IC) sources contribute significantly to the national emissions burden. NO_x, hydrocarbon, and CO emissions from IC sources account for approximately 20, 9, and 1%, respectively, of the emissions of these pollutants from all stationary sources. The sources severity factor (the ratio of the calculated maximum ground level concentration of the pollutant species to the level at which a potential environmental hazard exists) was used to identify pollutants of environmental concern.

POM's, CO, SO_2, particulates, and individual organic species were not found at levels of environmental concern. Trace element emissions from gas-fueled engines were insignificant but oil-fueled engines emitted nickel, copper, and phosphorus at levels of concern.

Figure 10-1 from the final report gives an explanation of sample codes used in some of the data tables.

XXX-XX-XX-XXX-XX-X

SITE IDENTIFICATION

Consecutively numbered by sampling team:

100-199, TRW West Coast
200-299, TRW East Coast
300-399, GCA

SAMPLE TYPE

Numbers and corresponding sample types are as follows:

1-bulk liquid (separated from a slurry)
2-bulk liquid (separated from a slurry)
3-bulk liquid
4-bulk liquid
FF-liquid fuel feed
CD-condensate from XAD-2 module
PR-solvent probe/cyclone rinse
MR-solvent XAD-2 module rinse
HM-HNO_3 XAD-2 module rinse
HI-H202 impinger
AI-APS impingers
XR-XAD-2 resin
PF-filter(s)
1C-1-3μ cyclone
3C-3-10μ cyclone
10C->10μ cyclone
XM-XR extract plus MR
CH-HM plus CD plus HI
FC-PF plus 1C
CC-3C plus 10C
CF-solid fuel feed (coal)
5-bulk solids
6-bulk solids
7-bulk solids (separated from a slurry)
8-bulk solids (separated from a slurry)

SAMPLE PREPARATION

Numbers and corresponding preparation steps are as follows:

0-no preparation
LE-liquid-liquid extraction
SE-Soxhlet extraction
A-acidified aliquot
B-basified aliquot
PB-Parr bomb combustion
HW-hot water extraction
AR-aqua regia extraction

FIRST LEVEL ANALYSIS

Numbers and corresponding procedures are as follows:

Organic	Inorganic
0-no conc required	SS-SSMS
GC-C_7-C_{17} GC	AAS-Hg,As,Sb
KD-K-D Conc	SO_4-SO_4
	NO_3-NO_3
	CF-Cl,F

SECOND LEVEL ANALYSIS

Organic analyses on conc samples will be coded as follows:

GM-GC/MS for PAHs
GI-Grav.,IR
MS-LRMS
LC-LC separation

THIRD LEVEL ANALYSIS

Resulting LC fractions for grav./IR/LRMS analyses will be numbered in order, 1-8

Figure 10-1. EACCS sample control numbers.

LEVEL 1

TABLE 10-1. SPARK SOURCE MASS SPECTROSCOPY
GAS-FUELED GAS TURBINE (SITE 110)
XAD-2 RESIN (μg/m^3)

U	<2.22	Dy	<1.53	Rh	<0.97	Cr	<10.94
Th	<2.19	Tb	<1.50	Ru	<0.94	V	<0.50
Bi	<1.97	Gd	<1.47	Mo	<2.63	Ti	<5.94
Pb	<14.4	Eu	<1.44	Nb	0.03	Sc	<228
Tl	<1.91	Sm	<1.41	Zr	<0.84	Ca	<156
Hg		Nd	<1.34	Y	<0.84	K	<156
Au	<1.84	Pr	<1.31	Sr	<5.00	Cl	
Pt		Ce	0.23	Rb	0.34	S	<562
Ir	<1.81	La	<1.31	Br	<5.31	P	<53.1
Os	<1.78	Ba	<81.2	Se	<1.06	Si	<116
Re	<1.75	Cs	0.02	As	<1.19	Al	<43.8
W	<1.72	I	<1.19	Ge	<0.69	Mg	<188
Ta		Te	<1.19	Ga	<0.66	Na	<87.50
Hf	<1.69	Sb	<2.09	Zn	<75.0	F	
Lu	<1.63	Sn	<4.06	Cu	68.8	B	<0.34
Yb	<1.63	In		Ni	<78.1	Be	<0.08
Tm	<1.59	Cd	<0.38	Co	<0.84	Li	0.22
Er	<1.56	Ag		Fe	<153		
Ho	<1.53	Pd	<1.00	Mn	<7.50		

TABLE 10-2. SPARK SOURCE MASS SPECTROSCOPY
GAS-FUELED GAS TURBINE (SITE 110)
COMPOSITE SAMPLE*
($\mu g/m^3$)

U	<0.44	Dy	<0.30	Rh	<0.19	Cr	<2.78
Th	<0.44	Tb	<0.29	Ru	<0.19	V	0.06
Bi	<0.38	Gd	<0.29	Mo	0.34	Ti	0.19
Pb	1.59	Eu	<0.28	Nb	<0.17	Sc	
Tl	<0.38	Sm	<0.28	Zr	0.02	Ca	13.4
Hg		Nd	<0.27	Y	<0.16	K	15.6
Au	<0.38	Pr	<0.26	Sr	0.17	Cl	
Pt		Ce	0.03	Rb	0.03	S	300.
Ir	<0.34	La	0.04	Br	1.28	P	2.63
Os	<0.34	Ba	0.94	Se	<0.30	Si	8.75
Re	<0.34	Cs	<0.24	As	<0.14	Al	<3.75
W	<0.34	I	<0.23	Ge	<0.13	Mg	8.75
Ta		Te	<0.23	Ga	<0.13	Na	<81.2
Hf	<0.34	Sb	0.13	Zn	5.63	F	
Lu	<0.31	Sn	0.44	Cu	<10.0	B	3.44
Yb	<0.31	In		Ni	4.69	Be	<0.003
Tm	<0.31	Cd	0.47	Co	0.07	Li	<0.02
Er	<0.31	Ag		Fe	17.8		
Ho	<0.30	Pd	<0.20	Mn	2.56		

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

TABLE 10-3. SPARK SOURCE MASS SPECTROSCOPY
GAS-FUELED GAS TURBINE (SITE 110)
TOTAL SASS CATCH
(μg/m³)

U	<2.66	Dy	<1.81	Rh	<1.16	Cr	2.78 to 10.94
Th	<2.60	Tb	<1.78	Ru	<1.12	V	0.06 to 0.50
Bi	<2.34	Gd	<1.75	Mo	0.34 to 2.63	Ti	0.19 to 5.94
Pb	1.59 to 14.4	Eu	<1.72	Nb	0.03 to 0.17	Sc	
Tl	<2.28	Sm	<1.69	Zr	0.02 to 0.84	Ca	13.44 to 228
Hg		Nd	<1.63	Y	<1.0	K	15.6 to 156
Au	<2.22	Pr	<1.60	Sr	0.17 to 5.0	Cl	
Pt		Ce	0.26	Rb	0.38	S	300.0
Ir	<2.16	La	0.04 to 1.31	Br	1.28 to 5.31	P	2.63 to 53.1
Os	<2.12	Ba	0.94 to 81.2	Se	<1.38	Si	8.75 to 116
Re	<2.09	Cs	0.02 to 0.24	As	<1.34	Al	<46.9
W	<2.06	I	<1.44	Ge	<0.81	Mg	8.75 to 188
Ta		Te	<1.44	Ga	<0.78	Na	<166
Hf	<2.0	Sb	0.13 to 2.09	Zn	5.62 to 75.0	F	
Lu	<1.97	Sn	0.44 to 4.06	Cu	68.75	B	3.44
Yb	<1.94	In		Ni	4.69 to 78.1	Be	<0.003 to 0.05
Tm	<1.91	Cd	0.47	Co	0.07 to 0.84	Li	<0.24
Er	<1.88	Ag		Fe	17.8 to 153.		
Ho	<1.84	Pd	<1.19	Mn	2.56 to 7.50		

TABLE 10-4. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 111)
FUEL
(ppm)

U	<0.48	Dy	<0.33	Rh	<0.21	Cr	0.13
Th	<0.46	Tb	<0.32	Ru	<0.20	V	0.062
Bi	<0.42	Gd	<0.31	Mo	0.093	Ti	<0.2
Pb	1.3	Eu	<0.30	Nb	<0.19	Sc	
Tl	<0.41	Sm	<0.30	Zr	<0.18	Ca	15
Hg		Nd	<0.29	Y	<0.18	K	36
Au	<0.39	Pr	<0.28	Sr	0.33	Cl	
Pt		Ce	0.0098	Rb	0.023	S	490
Ir	<0.38	La	<0.28	Br	<0.55	P	8.8
Os	<0.38	Ba	1.4	Se	0.11	Si	60
Re	<0.37	Cs	<0.27	As	<0.082	Al	2.7
W	<0.37	I	<0.25	Ge	<0.15	Mg	<11
Ta		Te	<0.26	Ga	<0.14	Na	33
Hf	<0.36	Sb	0.053	Zn	12	F	
Lu	<0.35	Sn	0.13	Cu	3.1	B	3.9
Yb	<0.35	In		Ni	3.2	Be	<0.0021
Tm	<0.34	Cd	0.14	Co	0.053	Li	<0.021
Er	<0.33	Ag		Fe	18		
Ho	<0.33	Pd	<0.21	Mn	71		

TABLE 10-5. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINE
PROBE SOLIDS (SITE 111)
($\mu g/m^3$)

U	<0.02	Dy	<0.01	Rh	<0.01	Cr	0.69
Th	<0.02	Tb	<0.01	Ru	<0.01	V	0.06
Bi	<0.01	Gd	<0.01	Mo	0.02	Ti	0.09
Pb	0.56	Eu	<0.01	Nb	<0.003	Sc	
Tl	<0.01	Sm	<0.01	Zr	<0.05	Ca	1.84
Hg		Nd	<0.01	Y	0.01	K	0.86
Au	<0.01	Pr	<0.01	Sr	0.02	Cl	
Pt		Ce	<0.003	Rb	<0.003	S	214
Ir	<0.01	La	<0.003	Br	0.016	P	0.17
Os	<0.01	Ba	0.05	Se	0.08	Si	14.5
Re	<0.01	Cs	<0.003	As	0.03	Al	1.25
W	<0.01	I	<0.01	Ge	0.02	Mg	0.43
Ta		Te	<0.01	Ga	<0.003	Na	0.30
Hf	<0.01	Sb	0.01	Zn	0.09	F	
Lu	<0.01	Sn	<0.02	Cu	0.21	B	1.18
Yb	<0.01	In		Ni	1.84	Be	<0.003
Tm	<0.01	Cd	<0.003	Co	0.08	Li	<0.003
Er	<0.01	Ag		Fe	18.1		
Ho	<0.01	Pd	<0.01	Mn	42.8		

TABLE 10-6. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 111)
FILTER CATCH
(μg/m³)

U	<0.36	Dy	<0.25	Rh	<0.16	Cr	0.82
Th	<0.36	Tb	<0.25	Ru	<0.16	V	<0.04
Bi	<0.32	Gd	<0.24	Mo	1.68	Ti	<1.97
Pb	2.27	Eu	<0.23	Nb	<0.14	Sc	
Tl	<0.23	Sm	<0.23	Zr	<0.29	Ca	<27.3
Hg		Nd	<0.22	Y	<0.14	K	<25.7
Au	1.35	Pr	<0.22	Sr	<0.21	Cl	
Pt		Ce	<0.05	Rb	<0.10	S	493
Ir	<0.30	La	<0.21	Br	1.84	P	4.28
Os	<0.30	Ba	2.66	Se	0.27	Si	<88.8
Re	<0.29	Cs	<0.003	As	<0.20	Al	<24.3
W	<0.28	I	<0.20	Ge	<0.11	Mg	<30.9
Ta		Te	<0.20	Ga	<0.11	Na	329
Hf	<0.28	Sb	<0.12	Zn	<3.62	F	
Lu	<0.27	Sn	<0.06	Cu	<4.61	B	<2.47
Yb	<0.27	In		Ni	49.3	Be	<0.003
Tm	<0.26	Cd	0.10	Co	1.45	Li	<0.72
Er	<0.26	Ag		Fe	1,680		
Ho	<0.26	Pd	<0.16	Mn	253		

TABLE 10-7. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 111)
XAD-2 RESIN
(μg/m³)

U	<2.34	Dy	<1.61	Rh	<1.02	Cr	3.95
Th	<2.30	Tb	<1.58	Ru	<0.99	V	<0.62
Bi	<2.07	Gd	<1.55	Mo	2.11	Ti	1.84
Pb	<25.3	Eu	<1.51	Nb	0.07	Sc	
Tl	<2.01	Sm	<1.48	Zr	<0.89	Ca	<395
Hg		Nd	<1.41	Y	<0.89	K	<164
Au	<1.94	Pr	<1.38	Sr	<4.61	Cl	
Pt		Ce	<1.38	Rb	0.29	S	<1,460
Ir	<1.91	La	<1.38	Br	<9.54	P	<72.4
Os	<1.87	Ba	<27.0	Se	<0.79	Si	1,610
Re	<1.84	Cs	<1.32	As	<2.07	Al	<52.6
W	<1.81	I	<1.25	Ge	<0.72	Mg	<197
Ta		Te	<1.25	Ga	<0.69	Na	276
Hf	<1.78	Sb	<1.25	Zn	<155	F	
Lu	<1.71	Sn	<3.62	Cu	<158	B	52.6
Yb	<1.71	In		Ni	42.8	Be	0.003
Tm	<1.68	Cd	<2.27	Co	0.79	Li	<2.17
Er	<1.64	Ag		Fe	<171		
Ho	<1.61	Pd	<1.05	Mn	8.55		

TABLE 10-8. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 111)
COMPOSITE SAMPLE*
($\mu g/m^3$)

U	<0.29	Dy	<0.19	Rh	<0.12	Cr	4.61
Th	<0.28	Tb	<0.19	Ru	<0.14	V	0.09
Bi	<0.25	Gd	<0.19	Mo	0.39	Ti	0.21
Pb	5.92	Eu	<0.18	Nb	0.03	Sc	
Tl	<0.24	Sm	<0.18	Zr	<0.11	Ca	65.8
Hg		Nd	<0.19	Y	<0.11	K	7.57
Au	<0.24	Pr	<0.17	Sr	0.39	Cl	
Pt		Ce	0.03	Rb	0.02	S	109
Ir	<0.23	La	<0.17	Br	0.33	P	<3.06
Os	<0.24	Ba	1.12	Se	0.99	Si	7.57
Re	<0.22	Cs	<0.16	As	0.11	Al	2.01
W	<0.22	I	<0.15	Ge	<0.09	Mg	3.62
Ta		Te	<0.15	Ga	<0.08	Na	<59.2
Hf	<0.26	Sb	<0.14	Zn	1.58	F	
Lu	<0.21	Sn	4.93	Cu	<2.93	B	<0.59
Yb	<0.21	In		Ni	1.35	Be	<0.01
Tm	<0.20	Cd	<0.14	Co	0.06	Li	0.04
Er	<0.20	Ag		Fe	7.57		
Ho	<0.20	Pd	<0.13	Mn	8.88		

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

TABLE 10-9. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 111)
TOTAL SASS
(μg/m³)

U	<3.03	Dy	<2.07	Rh	<1.32	Cr	10.20
Th	<2.93	Tb	<2.01	Ru	<1.32	V	0.15 to 0.69
Bi	<2.66	Gd	<2.01	Mo	4.28	Ti	2.17
Pb	8.55 to 25.3	Eu	<1.94	Nb	0.11	Sc	
Tl	<2.60	Sm	<1.91	Zr	<1.35	Ca	69.1 to 428
Hg		Nd	<1.84	Y	0.01 to 1.12	K	8.55 to 191
Au	1.35	Pr	<1.78	Sr	0.39 to 4.61	Cl	
Pt		Ce	0.03 to 1.45	Rb	0.31	S	822 to 1,640
Ir	<2.43	La	<0.003 to 1.74	Br	2.20 to 9.54		
Os	<2.43	Ba	3.95 to 27.0	Se	1.35	Si	1,610
Re	<2.37	Cs	<0.003 to 1.48	As	0.14 to 2.27		
W	<2.33	I	<1.61	Ge	0.02 to 0.92	Mg	3.95 to 227
Ta		Te	<1.61	Ga	<0.89	Na	625
Hf	<2.30	Sb	0.01 to 1.51	Zn	1.68 to 158	F	
Lu	<2.20	Sn	4.93	Cu	0.21 to 164	B	52.6
Yb	<2.20	In		Ni	98.7	Be	0.01 to 0.0[illegible]
Tm	<2.14	Cd	0.10 to 2.40	Co	2.40	Li	0.04 to 2.24
Er	<2.11	Ag		Fe	1,710		
Ho	<2.11	Pd	<1.35	Mn	312		

TABLE 10-10. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 112)
FUEL
(ppm)

U	<0.65	Dy	<0.33	Rh	<0.21	Cr	1.8
Th	<0.95	Tb	<0.32	Ru	<0.48	V	0.081
Bi	<0.42	Gd	<0.31	Mo	<0.44	Ti	0.51
Pb	4.3	Eu	<0.30	Nb	<0.19	Sc	
Tl	<0.41	Sm	<0.52	Zr	<0.21	Ca	22
Hg		Nd	<0.65	Y	<0.18	K	11
Au	<0.48	Pr	<0.28	Sr	0.18	Cl	
Pt		Ce	<0.28	Rb	0.069	S	140
Ir	<0.74	La	<0.28	Br	<0.64	P	4.4
Os	<0.81	Ba	14	Se	<0.25	Si	5,300
Re	<0.51	Cs	<0.27	As	<0.14	Al	14
W	<0.69	I	<0.45	Ge	<0.18	Mg	51
Ta		Te	<0.38	Ga	<0.14	Na	300
Hf	<0.86	Sb	<0.26	Zn	29	F	
Lu	<0.35	Sn	2.0	Cu	31	B	180
Yb	<0.35	In		Ni	4.5	Be	0.0050
Tm	<0.34	Cd	<0.46	Co	0.076	Li	
Er	<0.52	Ag		Fe	17		
Ho	<0.33	Pd	<0.37	Mn	0.41		

TABLE 10-11. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 112)
FILTER CATCH
(μg/m³)

U	<0.15	Dy	<0.10	Rh	<0.06	Cr	0.49
Th	<0.14	Tb	<0.10	Ru	<0.61	V	<0.07
Bi	<0.13	Gd	<0.10	Mo	0.09	Ti	<0.77
Pb	2.55	Eu	<0.09	Nb	<3.07	Sc	
Tl	<0.13	Sm	<0.09	Zr	<0.11	Ca	<30.7
Hg		Nd	<0.09	Y	0.01	K	<18.7
Au	0.02	Pr	<0.09	Sr	<0.16	Cl	
Pt		Ce	<0.01	Rb	<0.03	S	337
Ir	<0.12	La	<0.003	Br	0.03	P	<0.64
Os	<0.12	Ba	<0.71	Se	0.06	Si	<3.99
Re	<0.11	Cs	<0.003	As	<0.30	Al	<9.51
W	0.01	I	0.01	Ge	<0.05	Mg	<6.75
Ta		Te	<0.08	Ga	<0.04	Na	<187
Hf	<0.11	Sb	0.49	Zn	1.17	F	
Lu	<0.11	Sn	<0.27	Cu	<0.95	B	<0.26
Yb	<0.11	In		Ni	0.80	Be	<0.003
Tm	<0.10	Cd	0.34	Co	0.34	Li	
Er	<0.10	Ag		Fe	<14.7		
Ho	<0.10	Pd	<0.06	Mn	2.98		

TABLE 10-12. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 112)
XAD-2 RESIN
(μg/m³)

U	<2.18	Dy	<1.50	Rh	<0.95	Cr	<6.75
Th	4.29	Tb	<1.47	Ru	<1.56	V	<0.83
Bi	<1.93	Gd	<1.44	Mo	<1.47	Ti	5.21
Pb	61.3	Eu	<1.41	Nb	<0.86	Sc	
Tl	<1.87	Sm	<1.72	Zr	<0.83	Ca	368
Hg		Nd	<2.15	Y	<0.83	K	<307
Au	<1.81	Pr	<1.29	Sr	8.90	Cl	
Pt		Ce	<1.29	Rb	0.27	S	<1,040
Ir	<2.45	La	<1.29	Br	<4.29	P	<95.1
Os	<2.67	Ba	736	Se	<0.83	Si	<132
Re	<1.72	Cs	<1.23	As	1.44	Al	<288
W	<2.27	I	6.13	Ge	<0.67	Mg	92.0
Ta		Te	<1.23	Ga	<0.64	Na	307
Hf	<2.82	Sb	<1.17	Zn	<144	F	
Lu	<1.60	Sn	3.37	Cu	<92.02	B	<196
Yb	<1.60	In		Ni	<64.4	Be	0.003
Tm	<1.56	Cd	2.21	Co	<0.98	Li	
Er	<1.72	Ag		Fe	<95.1		
Ho	<1.50	Pd	<1.23	Mn	<3.37		

TABLE 10-13. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 112)
COMPOSITE SAMPLE*
($\mu g/m^3$)

U	<0.64	Dy	<0.30	Rh	<0.14	Cr	1.50
Th	<0.95	Tb	<0.22	Ru	<0.49	V	0.04
Bi	<0.29	Gd	<0.30	Mo	<0.46	Ti	<0.07
Pb	1.04	Eu	<0.21	Nb	<0.13	Sc	
Tl	<0.37	Sm	<0.52	Zr	<0.21	Ca	29.4
Hg		Nd	<0.64	Y	<0.13	K	<6.79
Au	<0.49	Pr	<0.20	Sr	0.22	Cl	
Pt		Ce	<0.20	Rb	<0.12	S	117
Ir	<0.74	La	<0.20	Br	<0.64	P	<0.67
Os	<0.83	Ba	0.92	Se	<6.75	Si	4.29
Re	<0.52	Cs	<0.19	As	<0.40	Al	1.41
W	<0.71	I	<0.46	Ge	<0.18	Mg	6.13
Ta		Te	<0.37	Ga	<0.10	Na	<20.6
Hf	<0.86	Sb	<0.26	Zn	<5.83	F	
Lu	<0.25	Sn	0.64	Cu	<1.32	B	0.26
Yb	<0.29	In		Ni	1.07	Be	0.01
Tm	<0.24	Cd	<0.46	Co	0.14	Li	
Er	<0.52	Ag		Fe	107		
Ho	<0.23	Pd	<0.37	Mn	0.40		

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

TABLE 10-14. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 112)
TOTAL SASS
(μg/m³)

U	<2.98	Dy	<1.90	Rh	<1.17	Cr	1.99 to 6.75
Th	4.29	Tb	<1.78	Ru	<2.12	V	0.04 to 0.92
Bi	<2.33	Gd	<1.84	Mo	0.09 to 1.90	Ti	5.21
Pb	64.4	Eu	<1.72	Nb	<3.07 to 0.98	Sc	
Tl	<2.36	Sm	<2.33	Zr	<1.17	Ca	399
Hg		Nd	<2.88	Y	0.01 to 0.95	K	<337
Au	0.02 to 2.30	Pr	<1.60	Sr	9.20	Cl	
Pt		Ce	<1.50	Rb	0.27	S	460 to 1,040
Ir	<3.37	La	<0.003 to 1.47	Br	0.03 to 4.90	P	<98.2
Os	<3.68	Ba	736	Se	0.06 to 7.36	Si	4.29 to 135
Re	<2.33	Cs	<0.003 to 1.41	As	1.44	Al	1.41 to 298
W	0.01 to 2.94	I	6.13	Ge	<0.89	Mg	98.2
Ta		Te	<1.69	Ga	<0.80	Na	307
Hf	<3.68	Sb	0.49 to 1.41	Zn	1.17 to 150	F	
Lu	<1.96	Sn	3.99	Cu	<95.1	B	0.26 to 196
Yb	<1.99	In		Ni	1.87 to 64.4	Be	0.01
Tm	<1.90	Cd	2.55	Co	0.49	Li	
Er	<2.36	Ag		Fe	107		
Ho	<1.84	Pd	<1.66	Mn	3.37		

TABLE 10-15. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 306)
FUEL
(ppm)

U	<0.48	Dy	<0.33	Rh	<0.21	Cr	0.56
Th	<0.46	Tb	<0.32	Ru	<0.20	V	0.47
Bi	<0.42	Gd	<0.31	Mo	0.17	Ti	<0.54
Pb	2.8	Eu	<0.30	Nb	<0.19	Sc	
Tl	<0.41	Sm	<0.30	Zr	<0.18	Ca	27
Hg		Nd	<0.29	Y	<0.18	K	<8.4
Au	<0.39	Pr	<0.28	Sr	0.099	Cl	
Pt		Ce	<0.28	Rb	<0.028	S	480
Ir	<0.38	La	<0.28	Br	<0.35	P	11
Os	<0.38	Ba	<0.49	Se	<0.16	Si	<120
Re	<0.37	Cs	<0.27	As	<0.21	Al	2.8
W	<0.37	I	0.040	Ge	<0.15	Mg	<7.2
Ta		Te	<0.26	Ga	<0.14	Na	<21
Hf	<0.36	Sb	<0.090	Zn	15	F	
Lu	<0.35	Sn	5.5	Cu	31	B	<0.72
Yb	<0.35	In		Ni	53	Be	<0.0056
Tm	<0.34	Cd	<0.22	Co	0.35	Li	0.017
Er	<0.33	Ag		Fe	20		
Ho	<0.33	Pd	<0.21	Mn	9.0		

TABLE 10-16. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 306)
FILTER CATCH
($\mu g/m^3$)

U	<0.11	Dy	<0.07	Rh	<0.05	Cr	6.89
Th	<0.10	Tb	<0.07	Ru	<0.05	V	0.02
Bi	<0.09	Gd	<0.07	Mo	0.77	Ti	<1.85
Pb	<22.1	Eu	<0.07	Nb	<0.003	Sc	
Tl	<0.09	Sm	<0.07	Zr	0.41	Ca	49.6
Hg		Nd	<0.07	Y	0.02	K	55.1
Au	<0.09	Pr	<0.06	Sr	0.16	Cl	
Pt		Ce	0.02	Rb	0.02	S	441
Ir	<0.09	La	<0.03	Br	<0.12	P	26.2
Os	<0.09	Ba	<8.54	Se	1.49	Si	331
Re	<0.09	Cs	<0.003	As	0.55	Al	<22.6
W	<0.18	I	0.02	Ge	0.16	Mg	130
Ta		Te	<0.06	Ga	<0.03	Na	<127
Hf	<0.08	Sb	<0.09	Zn	16.5	F	
Lu	<0.08	Sn	0.77	Cu	2.18	B	212
Yb	<0.08	In		Ni	30.3	Be	<0.07
Tm	<0.08	Cd	<0.12	Co	0.16	Li	<0.23
Er	<0.08	Ag		Fe	99.2		
Ho	<0.07	Pd	<0.05	Mn	27.6		

TABLE 10-17. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 306)
XAD-2 RESIN
(μg/m³)

U	<2.45	Dy	<1.68	Rh	<1.05	Cr	12.1
Th	<2.40	Tb	<1.63	Ru	<1.05	V	0.36
Bi	<2.15	Gd	<1.63	Mo	7.72	Ti	22.6
Pb	10.2	Eu	<1.57	Nb	0.33	Sc	
Tl	<2.09	Sm	<1.54	Zr	2.51	Ca	157
Hg		Nd	<1.49	Y	0.09	K	74.4
Au	<2.04	Pr	<1.46	Sr	4.69	Cl	
Pt		Ce	0.47	Rb	0.30	S	3,030
Ir	<1.98	La	0.24	Br	7.99	P	33.1
Os	<1.96	Ba	13.5	Se	0.83	Si	276
Re	<1.93	Cs	0.04	As	4.41	Al	<634
W	<1.90	I	0.28	Ge	<0.74	Mg	46.9
Ta		Te	<1.32	Ga	<0.72	Na	<248
Hf	<1.85	Sb	0.36	Zn	38.6	F	
Lu	<1.79	Sn	5.51	Cu	119	B	<2.76
Yb	<1.79	In		Ni	113	Be	<0.01
Tm	<1.74	Cd	0.85	Co	1.60	Li	0.07
Er	<1.74	Ag		Fe	99.2		
Ho	<1.71	Pd	<1.10	Mn	3.03		

TABLE 10-18. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 306)
COMPOSITE SAMPLE*
($\mu g/m^3$)

U	<0.61	Dy	<0.41	Rh	<0.26	Cr	13.5
Th	<0.58	Tb	<0.41	Ru	<0.26	V	<0.33
Bi	<0.52	Gd	<0.41	Mo	<7.17	Ti	<0.80
Pb	1.07	Eu	<0.39	Nb	0.003	Sc	
Tl	<0.52	Sm	<0.39	Zr	0.04	Ca	<38.6
Hg		Nd	0.06	Y	<0.23	K	11.3
Au	<0.50	Pr	<0.36	Sr	<0.17	Cl	
Pt		Ce	0.04	Rb	<0.06	S	132
Ir	<0.50	La	<0.36	Br	0.17	P	<21.2
Os	<0.50	Ba	1.07	Se	<1.79	Si	<71.7
Re	<0.47	Cs	<0.02	As	<2.21	Al	<9.37
W	<0.47	I	0.05	Ge	<0.18	Mg	4.69
Ta		Te	<0.33	Ga	<0.18	Na	<386
Hf	<0.44	Sb	<0.18	Zn	6.34	F	
Lu	<0.44	Sn	<55.1	Cu	<6.06	B	<0.13
Yb	<0.44	In		Ni	16.5	Be	<0.003
Tm	<0.44	Cd	0.30	Co	0.50	Li	<0.01
Er	<0.41	Ag		Fe	35.8		
Ho	<0.41	Pd	<0.27	Mn	<11.0		

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

TABLE 10-19. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 306)
TOTAL SASS
($\mu g/m^3$)

U	<3.03	Dy	<2.15	Rh	<1.38	Cr	33.1
Th	<3.03	Tb	<2.12	Ru	<1.35	V	0.39
Bi	<2.76	Gd	<2.09	Mo	8.27	Ti	22.6
Pb	11.3	Eu	<2.01	Nb	0.33	Sc	
Tl	<2.73	Sm	<2.01	Zr	3.03	Ca	207
Hg		Nd	0.06 to 1.54	Y	0.10 to 0.23	K	141
Au	<2.62	Pr	<1.87	Sr	4.96	Cl	
Pt		Ce	0.52	Rb	0.33	S	3,580
Ir	<2.56	La	0.24	Br	7.99	P	57.9
Os	<2.54	Ba	14.6	Se	2.29	Si	634
Re	<2.48	Cs	0.04	As	4.96	Al	<662
W	<2.54	I	0.36	Ge	0.16 to 0.94	Mg	182
Ta		Te	<1.71	Ga	<0.94	Na	<744
Hf	<2.37	Sb	0.36	Zn	60.6	F	
Lu	<2.32	Sn	6.34 to 55.1	Cu	119	B	212
Yb	<2.32	In		Ni	157	Be	<0.08
Tm	<2.26	Cd	1.16	Co	2.26	Li	0.07 to 0.24
Er	<2.23	Ag		Fe	237		
Ho	<2.21	Pd	<1.41	Mn	30.3		

TABLE 10-20. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 307)
FUEL
(ppm)

U	<0.48	Dy	<0.33	Rh	<0.21	Cr	0.72
Th	<0.46	Tb	<0.32	Ru	<0.20	V	0.13
Bi	<0.42	Gd	<0.31	Mo	0.14	Ti	<0.32
Pb	<2.2	Eu	<0.30	Nb	0.020	Sc	
Tl	<0.41	Sm	<0.30	Zr	<0.18	Ca	<5.1
Hg		Nd	<0.29	Y	<0.18	K	<5.1
Au	<0.39	Pr	<0.28	Sr	<0.14	Cl	
Pt		Ce	<0.28	Rb	<0.024	S	210
Ir	<0.38	La	<0.28	Br	<0.29	P	<2.2
Os	<0.38	Ba	<0.21	Se	<0.16	Si	<69
Re	<0.37	Cs	<0.27	As	<0.13	Al	<2.4
W	<0.37	I	0.40	Ge	<0.15	Mg	<3.0
Ta		Te	<0.26	Ga	<0.14	Na	<22
Hf	<0.36	Sb	0.12	Zn	<9.6	F	
Lu	<0.35	Sn	<0.45	Cu	31	B	<0.11
Yb	<0.35	In		Ni	22	Be	<0.0067
Tm	<0.34	Cd	<0.22	Co	0.18	Li	<0.023
Er	<0.33	Ag		Fe	<17		
Ho	<0.33	Pd	<0.21	Mn	16.0		

TABLE 10-21. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 307)
FILTER CATCH
($\mu g/m^3$)

U	<0.11	Dy	<0.07	Rh	<0.05	Cr	2.78
Th	<0.10	Tb	<0.07	Ru	<0.05	V	0.01
Bi	<0.09	Gd	<0.07	Mo	0.74	Ti	<1.29
Pb	19.1	Eu	<0.07	Nb	<0.003	Sc	
Tl	<0.09	Sm	<0.07	Zr	0.14	Ca	<20.7
Hg		Nd	<0.06	Y	<0.003	K	<11.0
Au	<0.09	Pr	<0.06	Sr	0.06	Cl	
Pt		Ce	<0.01	Rb	<0.02	S	<26.2
Ir	<0.09	La	<0.01	Br	<0.11	P	6.15
Os	<0.09	Ba	<0.84	Se	1.04	Si	<2.30
Re	<0.09	Cs	<0.003	As	0.32	Al	<0.06
W	<0.01	I	0.01	Ge	<0.03	Mg	<0.81
Ta		Te	<0.06	Ga	<0.03	Na	<1.23
Hf	<0.08	Sb	<0.02	Zn	9.39	F	
Lu	<0.08	Sn	0.17	Cu	<2.14	B	<7.12
Yb	<0.08	In		Ni	<0.55	Be	<0.003
Tm	<0.07	Cd	0.27	Co	<0.13	Li	<0.01
Er	<0.07	Ag		Fe	<45.3		
Ho	<0.07	Pd	<0.05	Mn	4.53		

TABLE 10-22. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 307)
XAD-2 RESIN
($\mu g/m^3$)

U	<2.04	Dy	<1.39	Rh	<0.87	Cr	<0.32
Th	<2.01	Tb	<1.36	Ru	<0.87	V	<0.02
Bi	<1.81	Gd	<1.36	Mo	<0.01	Ti	0.03
Pb	0.10	Eu	<1.33	Nb	<0.81	Sc	
Tl	<1.75	Sm	<1.29	Zr	<0.78	Ca	<17.5
Hg		Nd	<1.23	Y	<0.78	K	<30.1
Au	<1.72	Pr	<1.23	Sr	<0.05	Cl	
Pt		Ce	<1.20	Rb	<0.003	S	<236
Ir	<1.65	La	<1.20	Br	<0.07	P	<19.7
Os	<1.65	Ba	<0.11	Se	<0.68	Si	<48.6
Re	<1.62	Cs	<1.13	As	<0.03	Al	453
W	<1.59	I	<1.10	Ge	<0.62	Mg	<35.6
Ta		Te	<1.10	Ga	<0.62	Na	518
Hf	<1.55	Sb	<0.01	Zn	<8.42	F	
Lu	<1.52	Sn	<0.06	Cu	<8.42	B	<19.4
Yb	<1.49	In		Ni	<0.07	Be	<1.20
Tm	<1.46	Cd	<0.97	Co	<0.01	Li	0.07
Er	<1.46	Ag		Fe	<3.88		
Ho	<1.42	Pd	<0.91	Mn	<0.32		

TABLE 10-23. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 307)
COMPOSITE SAMPLE*
(μg/m³)

U	<0.94	Dy	<0.65	Rh	<0.39	Cr	4.86
Th	<0.91	Tb	<0.62	Ru	<0.39	V	<0.49
Bi	<0.81	Gd	<0.62	Mo	3.11	Ti	0.55
Pb	3.56	Eu	<0.58	Nb	<0.36	Sc	
Tl	<0.81	Sm	<0.58	Zr	<0.10	Ca	<80.9
Hg		Nd	<0.55	Y	0.02	K	<14.6
Au	<0.78	Pr	<0.55	Sr	0.29	Cl	
Pt		Ce	<0.11	Rb	0.11	S	<149
Ir	<0.74	La	<0.55	Br	<0.30	P	3.14
Os	<0.74	Ba	0.52	Se	0.71	Si	<149
Re	<0.74	Cs	<0.003	As	<1.55	Al	5.50
W	<0.71	I	<0.49	Ge	<0.28	Mg	<5.18
Ta		Te	<0.49	Ga	<0.27	Na	<117
Hf	<0.71	Sb	<0.12	Zn	<11.7	F	
Lu	<0.68	Sn	<23.6	Cu	2.85	B	0.45
Yb	<0.68	In		Ni	35.6	Be	<0.003
Tm	<0.65	Cd	<1.04	Co	0.65	Li	<0.09
Er	<0.65	Ag		Fe	32.4		
Ho	<0.65	Pd	<0.42	Mn	<6.80		

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

TABLE 10-24. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 307)
TOTAL SASS
(μg/m³)

U	<3.11	Dy	<2.10	Rh	<1.33	Cr	7.45
Th	<3.01	Tb	<2.07	Ru	<1.33	V	0.01 to 0.49
Bi	<2.72	Gd	<2.04	Mo	3.88	Ti	0.58 to 1.29
Pb	23.0	Eu	<1.97	Nb	<1.17	Sc	
Tl	<2.65	Sm	<1.94	Zr	0.14 to 0.87	Ca	<120
Hg		Nd	<1.88	Y	0.02 to 0.78	K	<55.0
Au	<2.56	Pr	<1.84	Sr	0.36	Cl	
Pt		Ce	<1.33	Rb	0.11	S	<421
Ir	<2.49	La	<1.75	Br	<0.49	P	9.39 to 19.7
Os	<2.46	Ba	0.52	Se	1.75	Si	<201
Re	<2.43	Cs	0.003 to 1.13	As	0.32 to 1.59	Al	453
W	<2.33	I	0.01 to 1.59	Ge	<0.94	Mg	<42.1
Ta		Te	<1.65	Ga	<0.91	Na	518
Hf	<2.33	Sb	<0.15	Zn	9.39 to 20.1	F	
Lu	<2.27	Sn	0.17 to 23.6	Cu	2.85 to 10.7	B	0.45 to 26.5
Yb	<2.23	In		Ni	35.6	Be	<0.003 to 1.20
Tm	<2.20	Cd	0.27 to 2.01	Co	0.65	Li	0.07
Er	<2.17	Ag		Fe	32.4		
Ho	<2.14	Pd	<1.39	Mn	4.53		

TABLE 10-25. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 308)
FUEL
(ppm)

U	<0.48	Dy	<0.33	Rh	<0.21	Cr	1.5
Th	<0.46	Tb	<0.32	Ru	<0.20	V	<0.053
Bi	<0.42	Gd	<0.31	Mo	0.32	Ti	<0.21
Pb	4.0	Eu	<0.30	Nb	0.028	Sc	
Tl	<0.41	Sm	<0.30	Zr	0.11	Ca	9.8
Hg		Nd	<0.29	Y	<0.18	K	<6.8
Au	<0.39	Pr	<0.28	Sr	0.066	Cl	
Pt		Ce	<0.28	Rb	<0.032	S	130.0
Ir	<0.38	La	<0.28	Br	<0.57	P	<4.3
Os	<0.38	Ba	<0.40	Se	<0.16	Si	<23.0
Re	<0.37	Cs	<0.27	As	<0.35	Al	<4.3
W	<0.37	I	<0.25	Ge	<0.15	Mg	<2.9
Ta		Te	<0.26	Ga	<0.14	Na	<50.0
Hf	<0.36	Sb	6.4	Zn	4.6	F	
Lu	<0.35	Sn	0.46	Cu	42.0	B	<0.58
Yb	<0.35	In		Ni	43.0	Be	<0.018
Tm	<0.34	Cd	<0.22	Co	0.27	Li	<0.022
Er	<0.33	Ag		Fe	<22.0		
Ho	<0.33	Pd	<0.21	Mn	<0.40		

TABLE 10-26. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 308)
FILTER CATCH
($\mu g/m^3$)

U	<0.13	Dy	<0.09	Rh	<0.06	Cr	1.03
Th	<0.13	Tb	<0.09	Ru	<0.06	V	<0.07
Bi	0.06	Gd	<0.09	Mo	0.43	Ti	<2.20
Pb	<26.6	Eu	<0.09	Nb	<0.003	Sc	
Tl	<0.12	Sm	<0.09	Zr	<0.47	Ca	<43.30
Hg		Nd	<0.08	Y	<0.003	K	<16.0
Au	<0.11	Pr	<0.08	Sr	0.47	Cl	
Pt		Ce	<0.08	Rb	0.03	S	253
Ir	<0.11	La	<0.08	Br	<0.26	P	<2.33
Os	<0.11	Ba	<8.99	Se	1.73	Si	<183
Re	<0.11	cs	<0.003	As	0.27	Al	<15.0
W	<0.02	I	0.06	Ge	<0.04	Mg	<11.3
Ta		Te	<0.07	Ga	<0.04	Na	167
Hf	<0.10	Sb	<0.10	Zn	14.0	F	
Lu	<0.10	Sn	70.0	Cu	<4.33	B	<2.07
Yb	<0.10	In		Ni	<9.66	Be	<0.003
Tm	<0.10	Cd	<0.30	Co	<0.08	Li	<0.01
Er	<0.09	Ag		Fe	<15.0		
Ho	<0.09	Pd	<0.06	Mn	0.50		

TABLE 10-27. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 308)
XAD-2 RESIN
(μg/m³)

U	<1.60	Dy	<1.10	Rh	<0.70	Cr	<13.0
Th	<1.57	Tb	<1.07	Ru	<0.80	V	12.3
Bi	<1.40	Gd	<1.07	Mo	<2.13	Ti	<1.20
Pb	17.0	Eu	<1.03	Nb	<0.63	Sc	
Tl	<1.37	Sm	<1.00	Zr	<0.60	Ca	<766
Hg		Nd	<1.10	Y	<0.60	K	117
Au	<1.33	Pr	<0.93	Sr	<4.33	Cl	
Pt		Ce	<0.93	Rb	<0.26	S	1,370
Ir	<1.30	La	<0.93	Br	1.60	P	<70.0
Os	<1.37	Ba	<13.0	Se	<0.53	Si	<190
Re	<1.27	Cs	<0.90	As	0.90	Al	<147
W	<1.23	I	<0.86	Ge	<0.50	Mg	83.3
Ta		Te	<0.86	Ga	<0.47	Na	466
Hf	<1.43	Sb	<0.83	Zn	<66.6	F	
Lu	<1.17	Sn	<1.67	Cu	33.3	B	46.6
Yb	<1.17	In		Ni	<66.6	Be	<0.02
Tm	<1.13	Cd	0.77	Co	<1.00	Li	2.90
Er	<1.13	Ag		Fe	<99.9		
Ho	<1.10	Pd	<0.70	Mn	4.00		

TABLE 10-28. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 308)
COMPOSITE SAMPLE*
(µg/m³)

U	<0.90	Dy	<0.60	Rh	<0.40	Cr	<4.00
Th	<0.87	Tb	<0.60	Ru	<0.37	V	<0.06
Bi	<0.80	Gd	<0.60	Mo	<1.40	Ti	0.17
Pb	<1.90	Eu	<0.57	Nb	0.01	Sc	
Tl	<0.77	Sm	<0.57	Zr	<0.02	Ca	<50.0
Hg		Nd	<0.53	Y	<0.33	K	<13.0
Au	<0.73	Pr	<0.01	Sr	<0.33	Cl	
Pt		Ce	<0.07	Rb	0.03	S	143
Ir	<0.73	La	<0.53	Br	<0.06	P	2.56
Os	<0.73	Ba	<0.43	Se	<0.16	Si	<99.9
Re	<0.70	Cs	<0.01	As	0.80	Al	<8.33
W	<0.70	I	<0.43	Ge	<0.27	Mg	<5.00
Ta		Te	<0.47	Ga	<0.26	Na	53.3
Hf	<0.67	Sb	<0.11	Zn	<16.7	F	
Lu	<0.67	Sn	<15.66	Cu	<3.66	B	<0.04
Yb	<0.67	In		Ni	3.66	Be	<0.003
Tm	<0.63	Cd	4.33	Co	<0.70	Li	0.06
Er	<0.63	Ag		Fe	15.32		
Ho	<0.63	Pd	<0.40	Mn	<4.33		

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

TABLE 10-29. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL-FUELED GAS TURBINES (SITE 308)
TOTAL SASS
(μg/m³)

U	<2.63	Dy	<1.80	Rh	<1.13	Cr	1.03 to 16.[illegible]
Th	<2.56	Tb	<1.77	Ru	<1.23	V	12.3
Bi	0.06 to 2.20	Gd	<1.73	Mo	0.43 to 3.66	Ti	0.17 to 3.3[illegible]
Pb	17.0	Eu	<1.67	Nb	0.01 to 0.63	Sc	
Tl	<2.27	Sm	<1.67	Zr	<1.10	Ca	<866
Hg		Nd	<1.73	Y	0.003 to 0.93	K	117
Au	<2.17	Pr	<1.03	Sr	0.47 to 4.66	Cl	
Pt		Ce	<1.10	Rb	0.06 to 0.26	S	1770
Ir	<2.13	La	<1.53	Br	1.60	P	2.56 to 70.[illegible]
Os	<2.20	Ba	<22.3	Se	1.73	Si	<466
Re	<2.07	Cs	<0.90	As	2.00	Al	<170
W	<1.97	I	0.06 to 1.27	Ge	<0.80	Mg	83.3
Ta		Te	<1.40	Ga	<0.77	Na	700
Hf	<2.20	Sb	<1.03	Zn	14.0 to 83.3	F	
Lu	<1.93	Sn	70.0	Cu	33.3	B	46.6
Yb	<1.90	In		Ni	3.66 to 73.3	Be	<0.03
Tm	<1.87	Cd	5.00	Co	<1.77	Li	2.96
Er	<1.87	Ag		Fe	15.3 to 113		
Ho	<1.83	Pd	<1.17	Mn	4.33		

TABLE 10-30. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 309)
FUEL
(ppm)

U	<0.48	Dy	<0.33	Rh	<0.21	Cr	1.5
Th	<0.46	Tb	<0.32	Ru	<0.20	V	0.035
Bi	<0.42	Gd	<0.31	Mo	1.5	Ti	<0.43
Pb	1.5	Eu	<0.30	Nb	0.063	Sc	
Tl	<0.41	Sm	<0.30	Zr	<0.18	Ca	<8.0
Hg		Nd	<0.29	Y	<0.18	K	<24
Au	<0.39	Pr	<0.28	Sr	<0.092	Cl	
Pt		Ce	0.012	Rb	<0.045	S	280
Ir	<0.38	La	<0.28	Br	<0.39	P	<4.2
Os	<0.38	Ba	0.21	Se	<0.67	Si	<33
Re	<0.37	Cs	0.016	As	<0.17	Al	2.8
W	<0.37	I	0.032	Ge	<0.15	Mg	<4.1
Ta		Te	<0.26	Ga	<0.14	Na	50
Hf	<0.36	Sb	0.27	Zn	6.6	F	
Lu	<0.35	Sn	0.29	Cu	29	B	<1.5
Yb	<0.35	In		Ni	43	Be	<0.048
Tm	<0.34	Cd	<0.15	Co	0.27	Li	
Er	<0.33	Ag		Fe	<22		
Ho	<0.33	Pd	<0.21	Mn	0.94		

TABLE 10-31. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 309)
FILTER CATCH
(μg/m³)

U	<0.46	Dy	<0.21	Rh	<0.07	Cr	16.5
Th	<0.67	Tb	<0.08	Ru	<0.33	V	0.16
Bi	<0.20	Gd	<0.21	Mo	5.26	Ti	3.51
Pb	<9.82	Eu	<0.09	Nb	<0.06	Sc	
Tl	<0.25	Sm	<0.35	Zr	2.28	Ca	260
Hg		Nd	<0.46	Y	0.03	K	59.6
Au	<0.34	Pr	<0.08	Sr	3.37	Cl	
Pt		Ce	<0.11	Rb	1.12	S	1,090
Ir	<0.53	La	<0.12	Br	0.42	P	140
Os	<0.56	Ba	16.5	Se	1.61	Si	3,510
Re	<0.35	Cs	0.63	As	2.28	Al	91.2
W	0.26	I	<0.31	Ge	<0.12	Mg	123
Ta		Te	<0.26	Ga	<0.05	Na	337
Hf	<0.60	Sb	0.46	Zn	<8.07	F	
Lu	<0.14	Sn	2.74	Cu	8.42	B	63.2
Yb	<0.20	In		Ni	137	Be	
Tm	<0.12	Cd	<0.32	Co	1.51	Li	<0.003
Er	<0.35	Ag		Fe	1,400		
Ho	<0.12	Pd	<0.26	Mn	26.7		

TABLE 10-32. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 309)
XAD-2 RESIN
(μg/m³)

U	<3.51	Dy	<2.42	Rh	<1.54	Cr	<18.9
Th	<3.44	Tb	<2.35	Ru	<1.51	V	2.49
Bi	<3.12	Gd	<2.35	Mo	<1.86	Ti	<2.18
Pb	28.4	Eu	<2.25	Nb	<0.23	Sc	
Tl	<3.05	Sm	<2.25	Zr	<0.63	Ca	102
Hg		Nd	<2.14	Y	<1.33	K	133
Au	<2.95	Pr	<2.11	Sr	<3.86	Cl	
Pt		Ce	<0.95	Rb	0.20	S	4,910
Ir	<2.84	La	<0.35	Br	9.82	P	52.6
Os	<2.84	Ba	<8.07	Se	<1.16	Si	491
Re	<2.77	Cs	0.05	As	1.47	Al	<91.2
W	<2.74	I	3.86	Ge	<1.09	Mg	561
Ta		Te	<1.89	Ga	<1.05	Na	772
Hf	<2.67	Sb	<1.05	Zn	59.6	F	
Lu	<2.60	Sn	1.82	Cu	80.7	B	22.1
Yb	<2.56	In		Ni	<168	Be	0.06
Tm	<2.53	Cd	3.86	Co	0.98	Li	
Er	<2.49	Ag		Fe	182		
Ho	<2.46	Pd	<1.58	Mn	9.82		

TABLE 10-33. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 309)
COMPOSITE SAMPLE*
(μg/m³)

U	<1.09	Dy	<0.74	Rh	<0.46	Cr	22.8
Th	<1.05	Tb	<0.74	Ru	<0.46	V	<0.25
Bi	<0.95	Gd	<0.74	Mo	3.05	Ti	0.35
Pb	2.39	Eu	<0.70	Nb	<0.42	Sc	
Tl	<0.95	Sm	<0.70	Zr	<0.42	Ca	807
Hg		Nd	<0.67	Y	<0.42	K	7.72
Au	<0.91	Pr	<0.63	Sr	9.47	Cl	
Pt		Ce	<0.08	Rb	<0.04	S	1,540
Ir	<0.88	La	<0.63	Br	<0.33	P	3.86
Os	<0.88	Ba	0.63	Se	<0.35	Si	<77.2
Re	<0.84	Cs	<0.60	As	<0.29	Al	27.7
W	<0.84	I	<0.60	Ge	<0.33	Mg	5.26
Ta		Te	<0.60	Ga	<0.32	Na	59.6
Hf	<0.81	Sb	<0.17	Zn	70.18	F	
Lu	<0.81	Sn	<30.9	Cu	3.30	B	0.84
Yb	<0.81	In		Ni	24.9	Be	<0.003
Tm	<0.77	Cd	2.39	Co	456	Li	
Er	<0.77	Ag		Fe	73.7		
Ho	<0.77	Pd	<0.49	Mn	2.84		

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

TABLE 10-34. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 309)
TOTAL SASS
(μg/m³)

U	<4.91	Dy	<3.37	Rh	<2.11	Cr	38.6
Th	<5.26	Tb	<3.16	Ru	<2.32	V	2.67
Bi	<4.21	Gd	<3.26	Mo	8.07	Ti	3.86
Pb	30.9	Eu	<3.05	Nb	<0.70	Sc	
Tl	<4.21	Sm	<3.30	Zr	2.28	Ca	1,190
Hg		Nd	<3.26	Y	0.03 to 1.72	K	200
Au	<4.21	Pr	<2.81	Sr	12.6	Cl	
Pt		Ce	<1.12	Rb	1.33	S	7,370
Ir	<4.21	La	<1.09	Br	10.2	P	200
Os	<4.21	Ba	17.2	Se	1.61	Si	4,210
Re	<3.86	Cs	0.67	As	3.86	Al	119
W	0.26 to 3.51	I	3.86	Ge	<1.54	Mg	667
Ta		Te	<2.74	Ga	<1.40	Na	1,160
Hf	<4.21	Sb	0.46 to 1.23	Zn	130	F	
Lu	<3.51	Sn	4.56 to 30.9	Cu	91.2	B	84.2
Yb	<3.51	In		Ni	161	Be	0.07
Tm	<3.40	Cd	6.32	Co	456	Li	
Er	<3.51	Ag		Fe	1,680		
Ho	<3.33	Pd	<2.32	Mn	38.6		

TABLE 10-35. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 310)
FUEL
(ppm)

U	<0.48	Dy	<0.33	Rh	<0.21	Cr	2.1
Th	<0.46	Tb	<0.32	Ru	<0.20	V	0.11
Bi	<0.42	Gd	<0.31	Mo	0.61	Ti	<0.37
Pb	<5.1	Eu	<0.30	Nb	0.054	Sc	
Tl	<0.41	Sm	<0.30	Zr	<0.18	Ca	3.3
Hg		Nd	<0.29	Y	<0.18	K	<17
Au	<0.39	Pr	<0.28	Sr	<0.16	Cl	
Pt		Ce	0.046	Rb	0.097	S	0.15 (%)
Ir	<0.38	La	<0.28	Br	<0.49	P	6.0
Os	<0.38	Ba	<0.70	Se	<0.16	Si	<32
Re	<0.37	Cs	0.0099	As	<0.43	Al	<4.5
W	<0.37	I	<0.25	Ge	<0.15	Mg	<5.0
Ta		Te	<0.26	Ga	<0.14	Na	23
Hf	<0.36	Sb	<0.064	Zn	9.7	F	
Lu	<0.35	Sn	<0.51	Cu	24	B	<0.49
Yb	<0.35	In		Ni	19	Be	0.0014
Tm	<0.34	Cd	<0.22	Co	0.36	Li	0.15
Er	<0.33	Ag		Fe	<21		
Ho	<0.33	Pd	<0.21	Mn	1.2		

TABLE 10-36. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 310)
FILTER CATCH
($\mu g/m^3$)

U	<0.14	Dy	<0.09	Rh	<0.06	Cr	1.12
Th	<0.14	Tb	<0.09	Ru	<0.06	V	<0.05
Bi	<0.12	Gd	<0.09	Mo	0.34	Ti	<1.75
Pb	8.03	Eu	<0.09	Nb	<0.05	Sc	
Tl	<0.12	Sm	<0.09	Zr	0.20	Ca	119
Hg		Nd	<0.08	Y	0.01	K	<22.7
Au	<0.12	Pr	<0.08	Sr	0.45	Cl	
Pt		Ce	<0.02	Rb	0.06	S	1,470
Ir	<0.11	La	<0.02	Br	<0.80	P	13.6
Os	<0.11	Ba	<1.54	Se	<0.05	Si	<122
Re	<0.11	Cs	<0.003	As	0.30	Al	<21.7
W	<0.11	I	0.02	Ge	<0.04	Mg	<27.6
Ta		Te	<0.07	Ga	<0.04	Na	419
Hf	<0.10	Sb	0.06	Zn	15.4	F	
Lu	<0.10	Sn	0.25	Cu	1.50	B	<14.7
Yb	<0.10	In		Ni	30.0	Be	<0.02
Tm	<0.10	Cd	<0.07	Co	<0.13	Li	<0.13
Er	<0.10	Ag		Fe	<11.18		
Ho	<0.09	Pd	<0.06	Mn	<0.28		

TABLE 10-37. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 310)
XAD-2 RESIN
(μg/m³)

U	<2.03	Dy	<1.36	Rh	<0.87	Cr	8.73
Th	<1.96	Tb	<1.33	Ru	<0.84	V	2.83
Bi	<1.75	Gd	<1.33	Mo	1.96	Ti	2.24
Pb	30.4	Eu	<1.29	Nb	<0.77	Sc	
Tl	<1.71	Sm	<1.26	Zr	<0.77	Ca	<349
Hg		Nd	<1.22	Y	<0.73	K	147
Au	<1.68	Pr	<1.19	Sr	1.36	Cl	
Pt		Ce	0.16	Rb	0.25	S	<1,430
Ir	<1.61	La	<1.19	Br	2.31	P	<45.4
Os	<1.61	Ba	3.14	Se	<0.66	Si	<83.8
Re	<1.57	Cs	<1.12	As	<1.78	Al	97.8
W	<1.54	I	0.98	Ge	<0.63	Mg	27.6
Ta		Te	<1.08	Ga	<0.59	Na	454
Hf	<1.50	Sb	<1.01	Zn	<87.3	F	
Lu	<1.47	Sn	3.35	Cu	59.4	B	11.2
Yb	<1.47	In		Ni	29.3	Be	0.01
Tm	<1.43	Cd	2.06	Co	0.30	Li	0.42
Er	<1.40	Ag		Fe	41.9		
Ho	<1.40	Pd	<0.91	Mn	1.36		

TABLE 10-38. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 310)
COMPOSITE SAMPLE*
($\mu g/m^3$)

U	<1.36	Dy	<0.94	Rh	<0.59	Cr	5.24
Th	<1.33	Tb	<0.91	Ru	<0.59	V	<0.09
Bi	<1.22	Gd	<0.91	Mo	<1.29	Ti	<0.25
Pb	<1.75	Eu	<0.87	Nb	<0.52	Sc	
Tl	<1.19	Sm	<0.87	Zr	<0.52	Ca	<136
Hg		Nd	<0.84	Y	<0.52	K	<11.5
Au	<1.15	Pr	<0.80	Sr	<0.22	Cl	
Pt		Ce	<0.04	Rb	<0.01	S	234
Ir	<1.12	La	<0.80	Br	<0.45	P	<24.1
Os	<1.08	Ba	<0.49	Se	<1.15	Si	<38.4
Re	<1.08	Cs	<0.77	As	<0.03	Al	21.0
W	<1.05	I	<0.16	Ge	<0.42	Mg	11.9
Ta		Te	<0.73	Ga	<0.42	Na	<108
Hf	<1.05	Sb	<0.25	Zn	10.83	F	
Lu	<1.01	Sn	41.9	Cu	2.58	B	<0.49
Yb	<1.01	In		Ni	10.5	Be	<0.05
Tm	<0.98	Cd	0.25	Co	<0.80	Li	0.014
Er	<0.98	Ag		Fe	<76.8		
Ho	<0.94	Pd	<0.63	Mn	3.84		

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

TABLE 10-39. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 310)
TOTAL SASS
($\mu g/m^3$)

U	<3.49	Dy	<2.41	Rh	<1.54	Cr	15.0
Th	<3.42	Tb	<2.34	Ru	<1.50	V	2.83
Bi	<3.11	Gd	<2.34	Mo	2.31	Ti	2.24
Pb	38.4	Eu	<2.24	Nb	<1.36	Sc	
Tl	<3.04	Sm	<2.24	Zr	0.20 to 1.29	Ca	119 to 489
Hg		Nd	<2.13	Y	0.01 to 1.26	K	147
Au	<2.90	Pr	<2.10	Sr	1.82	Cl	
Pt		Ce	0.16	Rb	0.30	S	1,680
Ir	<2.83	La	<1.99	Br	2.31	P	13.6 to 66.4
Os	<0.83	Ba	3.14	Se	<1.85	Si	<244
Re	<2.76	Cs	<1.89	As	0.30 to 1.82	Al	119
W	<2.72	I	0.98	Ge	<1.08	Mg	38.4
Ta		Te	<1.89	Ga	<1.05	Na	838
Hf	<2.65	Sb	0.06 to 1.26	Zn	26.2 to 87.3	F	
Lu	<2.58	Sn	45.4	Cu	62.9	B	11.2
Yb	<2.55	In		Ni	69.9	Be	0.01 to 0.08
Tm	<2.51	Cd	2.31	Co	0.30 to 0.91	Li	0.42
Er	<2.48	Ag		Fe	41.9 to 87.3		
Ho	<2.44	Pd	<1.57	Mn	5.24		

TABLE 10-40. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 311)
FUEL
(ppm)

U	<0.48	Dy	<0.33	Rh	<0.21	Cr	0.59
Th	<0.46	Tb	<0.32	Ru	<0.20	V	0.023
Bi	<0.42	Gd	<0.31	Mo	0.14	Ti	<0.24
Pb	<1.6	Eu	<0.30	Nb	<0.018	Sc	
Tl	<0.41	Sm	<0.30	Zr	<0.034	Ca	4.0
Hg		Nd	<0.29	Y	<0.18	K	<35
Au	<0.39	Pr	<0.28	Sr	<0.20	Cl	
Pt		Ce	<0.035	Rb	0.033	S	380
Ir	<0.38	La	0.0095	Br	<0.30	P	4.5
Os	<0.38	Ba	<0.62	Se	<0.19	Si	<18
Re	<0.37	Cs	0.0031	As	<0.27	Al	3.1
W	<0.37	I	0.10	Ge	<0.15	Mg	<18
Ta		Te	<0.26	Ga	<0.14	Na	240
Hf	<0.36	Sb	0.44	Zn	<4.5	F	
Lu	<0.35	Sn	0.32	Cu	19	B	<0.23
Yb	<0.35	In		Ni	28	Be	<0.0008
Tm	<0.34	Cd	<0.085	Co	0.45	Li	0.024
Er	<0.33	Ag		9.5Fe			
Ho	<0.33	Pd	<0.21	Mn	0.24		

TABLE 10-41. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 311)
FILTER CATCH
(μg/m³)

U	<0.11	Dy	<0.08	Rh	<0.05	Cr	0.26
Th	<0.11	Tb	<0.07	Ru	<0.05	V	<0.03
Bi	<0.10	Gd	<0.07	Mo	<0.15	Ti	<2.01
Pb	8.65	Eu	<0.07	Nb	<0.01	Sc	
Tl	<0.10	Sm	<0.07	Zr	0.28	Ca	27.0
Hg		Nd	<0.07	Y	<0.04	K	<2.77
Au	<0.10	Pr	<0.07	Sr	0.18	Cl	
Pt		Ce	<0.07	Rb	<0.01	S	121
Ir	<0.09	La	<0.07	Br	<0.05	P	4.50
Os	<0.09	Ba	<2.42	Se	<0.04	Si	83.0
Re	<0.09	Cs	<0.06	As	0.07	Al	<4.15
W	<0.09	I	<0.06	Ge	<0.03	Mg	<4.50
Ta		Te	<0.06	Ga	<0.03	Na	38.1
Hf	<0.08	Sb	0.14	Zn	7.27	F	
Lu	<0.08	Sn	<0.35	Cu	<2.60	B	18.7
Yb	<0.08	In		Ni	10.7	Be	<0.01
Tm	<0.08	Cd	<0.06	Co	<0.07	Li	<0.07
Er	<0.08	Ag		Fe	<6.92		
Ho	<0.08	Pd	<0.05	Mn	<0.12		

TABLE 10-42. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 311)
XAD-2 RESIN
(μg/m³)

U	<1.76	Dy	<1.21	Rh	<0.76	Cr	<2.73
Th	<1.73	Tb	<1.18	Ru	<0.76	V	<0.24
Bi	<1.56	Gd	<1.18	Mo	<1.18	Ti	<0.35
Pb	3.36	Eu	<1.14	Nb	<0.70	Sc	
Tl	<1.52	Sm	<1.11	Zr	<0.70	Ca	<450
Hg		Nd	<1.17	Y	<0.66	K	96.9
Au	<1.49	Pr	<1.04	Sr	<2.39	Cl	
Pt		Ce	<1.04	Rb	<0.59	S	3,460
Ir	<1.45	La	<1.04	Br	<14.2	P	51.9
Os	<1.42	Ba	<38.1	Se	<0.59	Si	<107
Re	<1.38	Cs	<1.00	As	<1.11	Al	<38.1
W	<1.38	I	<0.93	Ge	<0.55	Mg	<0.18
Ta		Te	<0.97	Ga	<0.52	Na	<450
Hf	<1.35	Sb	<1.87	Zn	79.6	F	
Lu	<1.31	Sn	<1.90	Cu	<58.8	B	0.33
Yb	<1.28	In		Ni	<76.1	Be	<0.07
Tm	<1.25	Cd	<3.46	Co	0.38	Li	0.15
Er	<1.25	Ag		Fe	256		
Ho	<1.25	Pd	<0.80	Mn	3.81		

TABLE 10-43. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 311)
COMPOSITE SAMPLE*
($\mu g/m^3$)

U	<1.52	Dy	<1.04	Rh	<0.66	Cr	<6.57
Th	<1.49	Tb	<1.00	Ru	<0.66	V	<0.14
Bi	<1.31	Gd	<1.00	Mo	<0.52	Ti	<1.14
Pb	<5.54	Eu	<0.97	Nb	<0.59	Sc	
Tl	<1.31	Sm	<0.97	Zr	<0.59	Ca	<86.5
Hg		Nd	<0.90	Y	<0.55	K	<18.0
Au	<1.25	Pr	<0.90	Sr	<0.35	Cl	
Pt		Ce	0.03	Rb	<0.04	S	1,830
Ir	<1.21	La	<0.90	Br	<0.26	P	<11.1
Os	<1.21	Ba	<0.72	Se	<0.52	Si	<86.5
Re	<1.18	Cs	<0.83	As	<0.16	Al	<17.0
W	<1.18	I	<0.24	Ge	<0.45	Mg	<0.16
Ta		Te	<0.80	Ga	<0.45	Na	<235
Hf	<1.14	Sb	<0.27	Zn	<58.8	F	
Lu	<1.11	Sn	<69.2	Cu	<10.7	B	1.90
Yb	<1.11	In		Ni	<14.9	Be	<0.003
Tm	<1.07	Cd	0.59	Co	<0.87	Li	0.03
Er	<1.07	Ag		Fe	<83.0		
Ho	<1.04	Pd	<0.69	Mn	<11.8		

*Composited HNO_3 module wash, condensate, and the H_2O_2 impinger.

TABLE 10-44. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 311)
TOTAL SASS
(μg/m³)

U	<3.39	Dy	<2.32	Rh	<1.49	Cr	0.26 to 9.34
Th	<3.32	Tb	<2.28	Ru	<1.45	V	<0.42
Bi	<2.98	Gd	<2.25	Mo	<1.83	Ti	<3.46
Pb	3.36 to 14.2	Eu	<2.18	Nb	<1.28	Sc	
Tl	<2.91	Sm	<2.15	Zr	0.28 to 1.25	Ca	27.0 to 519
Hg		Nd	<2.08	Y	<1.28	K	95.9
Au	<2.80	Pr	<2.01	Sr	0.18 to 2.73	Cl	
Pt		Ce	0.03 to 1.11	Rb	<0.62	S	5,540
Ir	<2.73	La	<1.97	Br	<14.5	P	55.4
Os	<2.73	Ba	<41.5	Se	<1.14	Si	83.0 to 194
Re	<2.66	Cs	<1.90	As	0.07 to 1.28	Al	<58.8
W	<2.63	I	<1.25	Ge	<1.04	Mg	<4.84
Ta		Te	<1.83	Ga	<1.0	Na	38.1 to 692
Hf	<2.56	Sb	0.14 to 2.15	Zn	86.5	F	
Lu	<2.49	Sn	<72.7	Cu	<72.7	B	21.1
Yb	<2.46	In		Ni	10.7 to 90.0	Be	<0.003 to 0.08
Tm	<2.42	Cd	0.59 to 3.81	Co	0.38 to 0.93	Li	0.18
Er	<2.39	Ag		Fe	256		
Ho	<2.35	Pd	<1.52	Mn	3.81 to 11.8		

TABLE 10-45. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 312)
FUEL
(ppm)

U	<0.48	Dy	<0.33	Rh	<0.21	Cr	1.4
Th	<0.46	Tb	<0.32	Ru	<0.20	V	0.034
Bi	<0.42	Gd	<0.31	Mo	0.46	Ti	<0.83
Pb	<7.4	Eu	<0.30	Nb	0.06	Sc	
Tl	<0.41	Sm	<0.30	Zr	<0.041	Ca	6.0
Hg		Nd	<0.29	Y	<0.18	K	<9.1
Au	<0.39	Pr	<0.28	Sr	<0.12	Cl	
Pt		Ce	<0.28	Rb	0.047	S	600.0
Ir	<0.38	La	<0.28	Br	<0.18	P	<4.0
Os	<0.38	Ba	0.58	Se	<0.16	Si	<16.0
Re	<0.37	Cs	0.0078	As	<0.15	Al	<5.0
W	<0.37	I	0.087	Ge	<0.15	Mg	<3.9
Ta		Te	<0.26	Ga	<0.14	Na	<67.0
Hf	<0.36	Sb	1.5	Zn	17.0	F	
Lu	<0.35	Sn	0.45	Cu	11.0	B	<0.19
Yb	<0.35	In		Ni	20.0	Be	<0.0004
Tm	<0.34	Cd	<0.24	Co	0.16	Li	0.033
Er	<0.33	Ag		Fe	<15.0		
Ho	<0.33	Pd	<0.21	Mn	0.89		

TABLE 10-46. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 312)
FILTER CATCH
(μg/m³)

U	<0.12	Dy	<0.08	Rh	<0.05	Cr	1.44
Th	<0.12	Tb	<0.08	Ru	<0.05	V	0.16
Bi	<0.11	Gd	<0.08	Mo	0.90	Ti	2.27
Pb	46.7	Eu	<0.08	Nb	<0.05	Sc	
Tl	<0.10	Sm	<0.08	Zr	0.50	Ca	534
Hg		Nd	<0.07	Y	0.02	K	18.4
Au	<0.10	Pr	<0.07	Sr	5.01	Cl	
Pt		Ce	0.04	Rb	0.05	S	3,300
Ir	<0.10	La	<0.06	Br	0.47	P	17.4
Os	<0.10	Ba	11.02	Se	0.37	Si	434
Re	<0.09	Cs	<0.003	As	1.60	Al	<26.7
W	<0.09	I	0.04	Ge	<0.04	Mg	23.7
Ta		Te	<0.06	Ga	<0.04	Na	<76.89
Hf	<0.09	Sb	0.50	Zn	50.1	F	
Lu	<0.09	Sn	3.67	Cu	7.01	B	20.7
Yb	<0.09	In		Ni	110	Be	<0.003
Tm	<0.09	Cd	0.53	Co	0.53	Li	<0.37
Er	<0.09	Ag		Fe	1,000		
Ho	<0.08	Pd	<0.05	Mn	13.4		

TABLE 10-47. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 312)
XAD-2 RESIN
(μg/m³)

U	<2.30	Dy	<1.57	Rh	<1.00	Cr	<8.01
Th	<2.24	Tb	<1.54	Ru	<0.97	V	<0.21
Bi	<2.00	Gd	<1.50	Mo	2.24	Ti	1.24
Pb	<17.4	Eu	<1.47	Nb	<0.90	Sc	
Tl	<1.97	Sm	<1.44	Zr	<0.87	Ca	<401
Hg		Nd	<1.40	Y	<0.87	K	<321
Au	<1.90	Pr	<1.37	Sr	<6.01	Cl	
Pt		Ce	<1.34	Rb	<0.37	S	<935
Ir	<1.84	La	<1.34	Br	<3.14	P	<70.1
Os	<1.84	Ba	<18.7	Se	2.00	Si	<70.1
Re	<1.80	Cs	<1.27	As	<1.00	Al	<21.0
W	<1.77	I	<1.24	Ge	<0.70	Mg	<66.8
Ta		Te	<1.24	Ga	<0.67	Na	<367
Hf	<1.70	Sb	<0.83	Zn	15.36	F	
Lu	<1.67	Sn	<2.47	Cu	<36.7	B	<7.01
Yb	<1.67	In		Ni	<96.8	Be	<0.09
Tm	<1.64	Cd	2.34	Co	<1.04	Li	<2.10
Er	<1.60	Ag		Fe	174		
Ho	<1.57	Pd	<1.04	Mn	<26.04		

TABLE 10-48. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 312)
COMPOSITE SAMPLE*
($\mu g/m^3$)

U	<1.27	Dy	<0.87	Rh	<0.57	Cr	3.27
Th	<1.24	Tb	<0.87	Ru	<0.53	V	0.06
Bi	<1.14	Gd	<0.83	Mo	0.73	Ti	<5.68
Pb	1.94	Eu	<0.80	Nb	0.11	Sc	
Tl	<1.10	Sm	<0.80	Zr	<0.50	Ca	<73.5
Hg		Nd	<0.77	Y	<0.47	K	<11.0
Au	<1.07	Pr	<0.77	Sr	0.33	Cl	
Pt		Ce	<0.77	Rb	0.02	S	4,340
Ir	<1.04	La	<0.73	Br	<0.60	P	<5.01
Os	<1.04	Ba	<1.30	Se	4.67	Si	<20.4
Re	<1.00	Cs	0.02	As	0.11	Al	<28.0
W	<1.00	I	0.60	Ge	<0.40	Mg	<13.4
Ta		Te	<0.67	Ga	<0.37	Na	<110
Hf	<0.97	Sb	0.63	Zn	30.1	F	
Lu	<0.93	Sn	<32.1	Cu	<9.35	B	6.01
Yb	<0.93	In		Ni	<7.01	Be	0.003
Tm	<0.90	Cd	1.54	Co	0.33	Li	0.02
Er	<0.90	Ag		Fe	<56.8		
Ho	<0.87	Pd	<0.57	Mn	<7.35		

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

TABLE 10-49. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 312)
TOTAL SASS
(μg/m³)

U	<3.67	Dy	<2.50	Rh	<1.60	Cr	4.67
Th	<3.67	Tb	<2.47	Ru	<1.57	V	0.22
Bi	<3.24	Gd	<2.44	Mo	4.01	Ti	3.67
Pb	50.1	Eu	<2.37	Nb	0.11 to 0.93	Sc	
Tl	<3.17	Sm	<2.34	Zr	0.50 to 1.37	Ca	534
Hg		Nd	<2.24	Y	0.20 to 1.34	K	18.4 to 33[illegible]
Au	<3.04	Pr	<2.17	Sr	5.34	Cl	
Pt		Ce	0.04 to 2.10	Rb	0.07 to 0.37	S	7,680
Ir	<2.97	La	<2.14	Br	0.47 to 3.67	P	17.4 to 76.[illegible]
Os	<2.94	Ba	11.0	Se	7.01	Si	434
Re	<2.87	Cs	0.02 to 1.27	As	1.70	Al	<76.8
W	<2.84	I	0.67	Ge	<1.14	Mg	23.7 to 83.[illegible]
Ta		Te	<1.97	Ga	<1.07	Na	<534
Hf	<2.77	Sb	1.10	Zn	93.5	F	
Lu	<2.70	Sn	3.67 to 33.4	Cu	7.01 to 46.7	B	26.7
Yb	<2.67	In		Ni	110	Be	0.003 to 0.[illegible]
Tm	<2.60	Cd	4.34	Co	0.87	Li	0.02 to 2.4[illegible]
Er	<2.60	Ag		Fe	1,170		
Ho	<2.54	Pd	<1.64	Mn	13.4 to 33.4		

TABLE 10-50. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 313)
FUEL
(ppm)

U	<0.48	Dy	<0.33	Rh	<0.21	Cr	<0.17
Th	<0.46	Tb	<0.32	Ru	<0.20	V	<0.059
Bi	<0.42	Gd	<0.31	Mo	<0.15	Ti	<0.23
Pb	<3.3	Eu	<0.30	Nb	<0.19	Sc	
Tl	<0.41	Sm	<0.30	Zr	<0.18	Ca	32.0
Hg		Nd	<0.29	Y	<0.18	K	<30.0
Au	<0.39	Pr	<0.28	Sr	0.089	Cl	
Pt		Ce	<0.28	Rb	<0.025	S	330.0
Ir	<0.38	La	<0.28	Br	<0.16	P	5.4
Os	<0.38	Ba	1.5	Se	<0.16	Si	<37
Re	<0.37	Cs	<0.27	As	<0.047	Al	2.6
W	<0.37	I	<0.25	Ge	<0.15	Mg	<18
Ta		Te	<0.26	Ga	<0.14	Na	<56
Hf	<0.36	Sb	0.21	Zn	<7.2	F	
Lu	<0.35	Sn	<0.48	Cu	19.0	B	<0.89
Yb	<0.35	In		Ni	8.1	Be	0.0013
Tm	<0.34	Cd	<0.30	Co	<0.097	Li	0.091
Er	<0.33	Ag		Fe	<25.0		
Ho	<0.33	Pd	<0.21	Mn	<0.62		

TABLE 10-51. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 313)
FILTER CATCH
(μg/m³)

U	<0.16	Dy	<0.11	Rh	<0.07	Cr	1.00
Th	<0.16	Tb	<0.11	Ru	<0.07	V	0.03
Bi	0.04	Gd	<0.11	Mo	0.27	Ti	<2.16
Pb	12.3	Eu	<0.10	Nb	<.003	Sc	
Tl	<0.14	Sm	<0.10	Zr	0.26	Ca	399
Hg		Nd	0.01	Y	.003	K	10.30
Au	<0.13	Pr	<.003	Sr	2.13	Cl	
Pt		Ce	<0.03	Rb	0.03	S	432
Ir	<0.13	La	<0.01	Br	<0.37	P	6.31
Os	<0.13	Ba	<9.30	Se	<0.04	Si	<199
Re	<0.13	Cs	<.003	As	0.40	Al	<31.9
W	<0.02	I	0.01	Ge	<0.05	Mg	<0.02
Ta		Te	<0.09	Ga	<0.05	Na	<126
Hf	<0.12	Sb	0.09	Zn	59.8	F	
Lu	<0.12	Sn	1.93	Cu	4.65	B	<4.32
Yb	<0.12	In		Ni	25.91	Be	<.00
Tm	<0.11	Cd	0.08	Co	<0.22	Li	<0.04
Er	<0.11	Ag		Fe	116		
Ho	<0.11	Pd	<0.07	Mn	<1.23		

TABLE 10-52. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 313)
XAD-2 RESIN
(µg/m³)

U	<1.96	Dy	<1.33	Rh	<0.86	Cr	<2.82
Th	<1.93	Tb	<1.30	Ru	<0.83	V	0.13
Bi	<1.73	Gd	<1.30	Mo	1.36	Ti	1.10
Pb	17.9	Eu	<1.26	Nb	<0.76	Sc	
Tl	<1.69	Sm	<1.23	Zr	<0.76	Ca	<332
Hg		Nd	<1.20	Y	<0.73	K	<229
Au	<1.63	Pr	<1.16	Sr	1.50	Cl	
Pt		Ce	<1.16	Rb	0.33	S	1,160
Ir	<1.59	La	<1.13	Br	5.98	P	<59.8
Os	<1.56	Ba	<15.3	Se	<2.43	Si	<59.8
Re	<1.53	Cs	<1.10	As	<1.23	Al	<21.6
W	<1.53	I	0.23	Ge	<0.60	Mg	<59.8
Ta		Te	<1.06	Ga	<0.56	Na	<1,230
Hf	<1.46	Sb	0.37	Zn	<43.2	F	
Lu	<1.43	Sn	0.90	Cu	<79.7	B	2.96
Yb	<1.43	In		Ni	23.6	Be	<0.01
Tm	<1.40	Cd	6.31	Co	0.70	Li	<0.47
Er	<1.36	Ag		Fe	7,970		
Ho	<1.36	Pd	<0.86	Mn	6.31		

TABLE 10-53. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 313)
COMPOSITE SAMPLE*
(μg/m³)

U	<1.26	Dy	<0.86	Rh	<0.53	Cr	7.64
Th	<1.23	Tb	<0.83	Ru	<0.53	V	0.22
Bi	<1.10	Gd	<0.83	Mo	1.73	Ti	0.16
Pb	4.65	Eu	<0.80	Nb	<0.50	Sc	
Tl	<1.06	Sm	<0.80	Zr	<0.47	Ca	49.8
Hg		Nd	<0.76	Y	<0.47	K	11.6
Au	<1.03	Pr	<0.73	Sr	0.40	Cl	
Pt		Ce	<0.73	Rb	0.05	S	10,300
Ir	<1.00	La	<0.73	Br	0.56	P	8.97
Os	<1.00	Ba	<1.57	Se	15.3	Si	15.0
Re	<0.96	Cs	0.06	As	0.11	Al	36.5
W	<0.96	I	0.29	Ge	<0.37	Mg	10.6
Ta		Te	<0.66	Ga	<0.37	Na	<56.5
Hf	<0.93	Sb	1.59	Zn	39.87	F	
Lu	<0.93	Sn	53.7	Cu	8.31	B	1.40
Yb	<0.90	In		Ni	19.9	Be	<0.003
Tm	<0.90	Cd	2.62	Co	1.06	Li	0.06
Er	<0.90	Ag		Fe	326		
Ho	<0.86	Pd	<0.56	Mn	7.64		

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

TABLE 10-54. SPARK SOURCE MASS SPECTROSCOPY
DISTILLATE OIL RECIPROCATING ENGINE (SITE 313)
TOTAL SASS
(μg/m³)

U	<3.32	Dy	<2.29	Rh	<1.46	Cr	8.64
Th	<3.29	Tb	<2.26	Ru	<1.43	V	0.37
Bi	0.04 to 2.82	Gd	<2.23	Mo	3.32	Ti	1.26
Pb	36.54	Eu	<2.16	Nb	<1.26	Sc	
Tl	<2.89	Sm	<2.13	Zr	0.26 to 1.23	Ca	432
Hg		Nd	0.01 to 1.96	Y	3.32(-03) to 1.20	K	21.9 to 229
Au	<2.79	Pr	<1.89	Sr	3.99	Cl	
Pt		Ce	<1.93	Rb	0.40	S	12,000
Ir	<2.72	La	<1.89	Br	6.31	P	15.3 to 59.8
Os	<2.69	Ba	<26.2	Se	15.3	Si	15.0 to 259
Re	<2.62	Cs	0.06 to 1.10	As	0.50 to 1.23	Al	36.5
W	<2.49	I	0.53	Ge	<1.03	Mg	10.6 to 59.8
Ta		Te	<1.79	Ga	<1.00	Na	<1,400
Hf	<2.52	Sb	2.06	Zn	103	F	
Lu	<2.49	Sn	56.5	Cu	13.0 to 79.7	B	4.32
Yb	<2.46	In		Ni	69.8	Be	0.003 to 0.01
Tm	<2.39	Cd	8.97	Co	1.76	Li	0.06 to 0.02
Er	<2.36	Ag		Fe	8,640		
Ho	<2.33	Pd	<1.50	Mn	13.6		

TABLE 10-55. ATOMIC ABSORPTION ANALYSIS
SASS TRAIN
DISTILLATE OIL-FUELED GAS TURBINE SITE 111

Sample	As	Hg	Sb
Particulate (μg)	<19	<0.3	<23
XAD-2 (μg)	<110	3.1	<37
Impingers			
Composite* (μg)	<23	2.5	<76
APS† (μg)	18	1	6.4
Total catch (μg)	18-170	5.7	6.4-140
Fuel feed (μg/G)	<0.015	0.04	<0.025

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-56. ATOMIC ABSORPTION ANALYSIS
SASS TRAIN
DISTILLATE OIL-FUELED GAS TURBINE SITE 112

Sample	As	Hg	Sb
Particulate (μg)	*	0.2	<0.98
XAD-2 (μg)	60	42	400
Impingers			
Composite† (μg)	<31	1.9	10
APS‡ (μg)	<18	0.85	<6
Total catch (μg)	60-110	45	410
Fuel feed (μg/G)	<0.015	0.48	<0.25

*Blank values equal to or slightly higher than sample concentrations.

†Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

‡The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-57. ATOMIC ABSORPTION ANALYSIS
SASS TRAIN
DISTILLATE OIL-FUELED GAS TURBINE SITE 306
(ppm)

Sample	As	Hg	Sb
Particulate (μg)	<0.13	<0.02*	<0.13
XAD-2 (μg)	<1.3	<5.6*	58
Impingers			
Composite† (μg)	<0.92	<0.92	<0.92
APS‡ (μg)	<0.98	<20	<0.98
Total catch (μg)	<3.3	<27	60
Fuel feed (μg/G)	0.097	0.024	0.0097

*Blank values equal to or higher than samples.

†Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

‡The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-58. ATOMIC ABSORPTION ANALYSIS
SASS TRAIN
DISTILLATE OIL-FUELED GAS TURBINE SITE 307
(ppm)

Sample	As	Hg	Sb
Particulate (μg)	<0.01	<0.01*	5.4
XAD-2 (μg)	<1.2	<5.4*	55
Impingers			
Composite† (μg)	<1.2	<24	<1.2
APS‡ (μg)	<1.0	<21	<1.0
Total catch (μg)	<3.4	<50	63
Fuel feed (μg/G)	0.099	0.007	0.099

*Blank values equal to or higher than samples.

†Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

‡The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-59. ATOMIC ABSORPTION ANALYSIS
SASS TRAIN
DISTILLATE OIL-FUELED GAS TURBINE SITE 308
(ppm)

Sample	As	Hg	Sb
Particulate (μg)	1.2	<0.03*	<0.2
XAD-2 (μg)	<2.4	<0.12	<2.4
Impingers			
Composite† (μg)	<1.1	<2.3	<1.1
APS‡ (μg)	<1.1	<22	<1.1
Total catch (μg)	<1.2	<25	<4.8
Fuel feed (μg/G)	0.099	0.003	0.69

*Blank values equal to or higher than samples.

†Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

‡The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-60. ATOMIC ABSORPTION ANALYSIS
SASS TRAIN
DISTILLATE OIL RECIPROCATING ENGINE SITE 309
(ppm)

Sample	As	Hg	Sb
Particulate (μg)	<0.9	<0.04	<0.9
XAD-2 (μg)	<2.5	4.7	<2.5
Impingers			
Composite* (μg)	---	<1.3	<1.3
APS† (μg)	‡	<22	<1.1
Total catch (μg)	<3.4	4.7	<5.8
Fuel feed (μg/G)	<0.098	0.003	0.29

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

‡Not determined due to interference of isopropanol.

TABLE 10-61. ATOMIC ABSORPTION ANALYSIS
SASS TRAIN
DISTILLATE OIL RECIPROCATING ENGINE SITE 310
(ppm)

Sample	As	Hg	Sb
Particulate (μg)	<0.63	<0.01	<0.35
XAD-2 (μg)	<2.4	2.2	<51
Impingers			
Composite* (μg)	<1.7	<6.6	<1.7
APS† (μg)	‡	<22	<1.1
Total catch (μg)	<4.7	2.2	<54
Fuel feed (μg/G)	<0.10	0.009	<0.10

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

‡Not determined due to interference of isopropanol.

TABLE 10-62. ATOMIC ABSORPTION ANALYSIS
SASS TRAIN
DISTILLATE OIL RECIPROCATING ENGINE SITE 311
(ppm)

Sample	As	Hg	Sb
Particulate (μg)	<0.73	<0.05	<0.73
XAD-2 (μg)	<3.2	<0.53	<3.2
Impingers			
Composite* (μg)	<1.8	<1.8	<1.8
APS† (μg)	ǂ	<24	<1.2
Total catch (μg)	<5.7	<27	<6.9
Fuel feed (μg/G)	<0.10	0.007	<0.10

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

ǂNot determined due to interference of isopropanol.

TABLE 10-63. ATOMIC ABSORPTION ANALYSIS
SASS TRAIN
DISTILLATE OIL RECIPROCATING ENGINE SITE 312
(ppm)

Sample	As	Hg	Sb
Particulate (μg)	<0.56	<0.01	3.9
XAD-2 (μg)	<1.1	0.98	<1.1
Impingers			
Composite* (μg)	<1.6	<1.6	<1.6
APS† (μg)	ǂ	<2.1	<1.1
Total catch (μg)	<3.3	0.98	<7.7
Fuel feed (μg/G)	<0.10	0.007	<0.10

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

ǂNot determined due to interference of isopropanol.

TABLE 10-64. ATOMIC ABSORPTION ANALYSIS
SASS TRAIN
DISTILLATE OIL RECIPROCATING SITE 313
(ppm)

Sample	As	Hg	Sb
Particulate (μg)	<0.71	<0.01	1.7
XAD-2 (μg)	<1.1	<0.42	<1.1
Impingers			
Composite* (μg)	<1.6	<4.8	<1.6
APS† (μg)	‡	<27	<1.4
Total catch (μg)	<3.4	<32	1.7
Fuel feed (μg/G)	<0.10	0.004	2.0

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

‡Not determined due to interference of isopropanol.

TABLE 10-65. ATOMIC ABSORPTION ANALYSIS
SASS TRAIN, MASS EMISSIONS
($\mu g/m^3$)

Site	As	Hg	Sb
110	<1.4	9.1	<1.6
111	0.59-5.6	0.18	0.21-4.6
112	1.8-3.3	1.4	13
306	<0.09	<0.74	1.7
307	<0.11	<1.6	1.9
308	0.4	<0.83	<0.16
309	<0.12	0.16	<0.20
310	<0.17	0.77	<1.9
311	<0.20	<0.91	<0.24
312	<0.11	0.03	<0.30
313	<0.11	<1.1	0.06

TABLE 10-66. ATOMIC ABSORPTION ANALYSIS
SASS TRAIN, FOR GAS-FUELED GAS TURBINE, SITE 110

Sample	As	Hg	Sb
Particulate*	-	-	-
XAD-2 (μg)	**	290	<37
Impingers			
Composite† (μg)	<44	<.32	<15
APS‡ (μg)	-	-	-
Total catch (μg)	<44	290	<52

*There was no particulate sample for site 110.

†Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

‡The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

**Blank values equal to or slightly higher than sample concentrations.

TABLE 10-67. ANION ANALYSIS
SASS TRAIN, DISTILLATE OIL FUELED GAS TURBINE SITE 111

Sample	F^-	Cl^-	NO_3^-	$SO_4^=$
Particulate (μg)	*	1,000	870	*
XAD-2 (μg)	*	150,000	---	60,000
Impingers				
Composite† (μg)	310	<760	---	---
APS‡ (μg)	---	---	---	---
Total catch (μg)	310	150,000	870	60,000
Fuel feed (μg/G)	20	100	---	2,049

*Blank values equal to or slightly higher than sample concentrations.

†Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

‡The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-68. ANION ANALYSIS
SASS TRAIN, DISTILLATE OIL-FUELED GAS TURBINE, SITE 112

Sample	F^-	Cl^-	NO_3^-	$SO_4^=$
Particulate (μg)	*	1,100	590	7,600
XAD-2 (μg)	750	45,000	---	90,000
Impingers				
Composite† (μg)	840	36,000	---	---
APS‡ (μg)	---	<620	---	---
Total catch (μg)	1,600	82,000	590	98,000
Fuel feed (μg/G)	20	50	---	2,199

*Blank values equal to or slightly higher than sample concentrations.

†Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

‡The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-69. ANION ANALYSIS
SASS TRAIN DISTRIBUTION DISTILLATE OIL-FUELED GAS TURBINE SITE 306
(ppm)

Sample	F^-	Cl^-	NO_3^-	$SO_4^=$
Particulate (μg)				1,290
XAD-2 (μg)				31,700
Impingers				
Composite* (μg)				---
APS† (μg)				---
Total catch (μg)				33,000
Fuel feed (μg/G)				1,200

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-70. ANION ANALYSIS
SASS TRAIN, DISTILLATE OIL-FUELED GAS TURBINE, SITE 307
(ppm)

Sample	F^-	Cl^-	NO_3^-	$SO_4^=$
Particulate (μg)				2,300
XAD-2 (μg)				128,000
Impingers				
Composite* (μg)				---
APS† (μg)				---
Total catch (μg)				130,000
Fuel feed (μg/G)				700

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-71. ANION ANALYSIS
SASS TRAIN DISTILLATE OIL-FUELED GAS TURBINE, SITE 308
(ppm)

Sample	F^-	Cl^-	NO_3^-	$SO_4^=$
Particulate (μg)				2,050
XAD-2 (μg)				9,600
Impingers				
Composite* (μg)				---
APS† (μg)				---
Total catch (μg)				12,000
Fuel feed (μg/G)				690

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containg APS.

TABLE 10-72. ANION ANALYSIS
SASS TRAIN
DISTILLATE OIL RECIPROCATING ENGINE SITE 309
(ppm)

Sample	F^-	Cl^-	NO_3^-	$SO_4^=$
Particulate (µg)				21,200
XAD-2 (µg)				10,500
Impingers				
Composite* (µg)				---
APS† (µg)				---
Total catch (µg)				31,700
Fuel feed (µg/G)				7,000

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-73. ANION ANALYSIS
SASS TRAIN,
DISTILLATE OIL RECIPROCATING ENGINE, SITE 310
(ppm)

Sample	F^-	Cl^-	NO_3^-	$SO_4^=$
Particulate (μg)				20,800
XAD-2 (μg)				44,000
Impingers				
Composite* (μg)				---
APS† (μg)				---
Total catch (μg)				65,000
Fuel feed (μg/G)				7,400

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-74. ANION ANALYSIS
SASS TRAIN,
DISTILLATE OIL RECIPROCATING ENGINE, SITE 311
(ppm)

Sample	F^-	Cl^-	NO_3^-	$SO_4^=$
Particulate (μg)				28,500
XAD-2 (μg)				82,400
Impingers				
Composite* (μg)				---
APS† (μg)				---
Total catch (μg)				111,000
Fuel feed (μg/G)				7,700

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-75. ANION ANALYSIS
SASS TRAIN
DISTILLATE OIL RECIPROCATING ENGINE, SITE 312
(ppm)

Sample	F^-	Cl^-	NO_3^-	$SO_4^=$
Particulate (μg)				15,000
XAD-2 (μg)				104,000
Impingers				
Composite* (μg)				---
APS† (μg)				---
Total catch (μg)				119,000
Fuel feed (μg/G)				4,500

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-76. ANION ANALYSIS
SASS TRAIN
DISTILLATE OIL RECIPROCATING ENGINE, SITE 313
(ppm)

Sample	F^-	Cl^-	NO_3^-	$SO_4^=$
Particulate (μg)				22,100
XAD-2 (μg)				122,000
Impingers				
Composite* (μg)				---
APS† (μg)				---
Total catch (μg)				144,000
Fuel feed (μg/G)				5,000

*Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

†The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-77. ANION ANALYSIS
SASS TRAIN EMISSIONS
($\mu g/m^3$)

Site	F^-	Cl^-	NO_3^-	$SO_4^=$
110		890		3,800
111	10	4,900	29	2,000*
112	49	2,500	18	3,000*
306				910*
307				4,200*
308				400*
309				1,100*
310				2,300*
311				3,800*
312				4,000*
313				4,800*

*SO_4 values do not represent total sulfur in the SASS train.

TABLE 10-78. ANION ANALYSIS
SASS TRAIN, GAS-FUELED GAS TURBINE, SITE 110

Sample	F^-	Cl^-	NO_3^-	$SO_4^=$
Particulate	-	-		-
XAD-2 (μg)	*	23,000		120
Impingers				
Composite† (μg)	*	5,900		-
APS‡ (μg)	-	-		-
Total catch (μg)	-	29,000		120,000

*There was no particulate sample for site 110.

†Composite of HNO_3 module wash, condensate, and the H_2O_2 impinger.

‡The second impinger containing ammonium persulfate (APS) and silver nitrate and the third impinger containing APS.

TABLE 10-79. GAS CHROMATOGRAPHY ANALYSIS
Sample 110-PR-0-KD-1
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	106	
GC8	110-140	153	
GC9	140-160	67	
GC10	160-180	25	
GC11	180-200	23	
GC12	200-220	<1	
GC13		ND	
GC14		ND	
GC15		ND	
GC16		ND	
GC17		ND	

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-80. GAS CHROMATOGRAPHY ANALYSIS
Sample 110-XR-Wet-S-GC
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	†	
GC8	110-140	†	
GC9	140-160	377	
GC10	160-180	357	
GC11	180-200	ND	
GC12	200-220	ND	
GC13		ND	
GC14		ND	
GC15		ND	
GC16		ND	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
† Peaks, if any, obscured on shoulder of solvent peak.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-81. GAS CHROMATOGRAPHY ANALYSIS
Sample 110-XR-Dry-S-GC
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	ND	
GC8	110-140	1,049	
GC9	140-160	ND	
GC10	160-180	345	
GC11	180-200	ND	
GC12	200-220	ND	
GC13		29	
GC14		ND	
GC15		ND	
GC16		ND	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-82. GAS CHROMATOGRAPHY ANALYSIS
Sample 110-XM-S-KD-1
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	377†	
GC8	110-140	ND	
GC9	140-160	ND	
GC10	160-180	ND	
GC11	180-200	ND	
GC12	200-220	ND	
GC13		ND	
GC14		ND	
GC15		ND	
GC16		ND	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
† Response possibly caused by traces of methanol not removed during K-D concentration.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-83. GAS CHROMATOGRAPHY ANALYSIS
Sample 111-XR-SKD
Reserve
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	32	
GC8	110-140	61	
GC9	140-160	57	
GC10	160-180	912	
GC11	180-200	ND	
GC12	200-220	84	
GC13		ND	
GC14		ND	
GC15		ND	
GC16		ND	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-84. GAS CHROMATOGRAPHY ANALYSIS
Sample 111-XM-S-KD
Reserve
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	ND	
GC8	110-140	37	
GC9	140-160	80	
GC10	160-180	15	
GC11	180-200	ND	
GC12	200-220	ND	
GC13		ND	
GC14		ND	
GC15		ND	
GC16		ND	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-85. GAS CHROMATOGRAPHY ANALYSIS
Sample 112-OR-O-KD-1
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	29	
GC8	110-140	118	
GC9	140-160	83	
GC10	160-180	21	
GC11	180-200	21	
GC12	200-220	9	
GC13		ND	
GC14		ND	
GC15		ND	
GC16		ND	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-86. GAS CHROMATOGRAPHY ANALYSIS
Sample 112-XR-Wet-S-GC
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	ND	
GC8	110-140	†	
GC9	140-160	56	
GC10	160-180	394	
GC11	180-200	ND	
GC12	200-220	113	
GC13		56	
GC14		ND	
GC15		ND	
GC16		244	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
† Peaks, if any, obscured on shoulder of solvent peak.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-87. GAS CHROMATOGRAPHY ANALYSIS
Sample 112-XR-Dry-S-GC
($\mu g/m^3$)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	†	
GC8	110-140	†	
GC9	140-160	61	
GC10	160-180	198	
GC11	180-200	ND	
GC12	200-220	30	
GC13		ND	
GC14		ND	
GC15		46	
GC16		213	
GC17			

ND = Not detectable (below 0.5 $\mu g/m^3$ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
† Peaks, if any, obscured on shoulder of solvent peak.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-88. GAS CHROMATOGRAPHY ANALYSIS
Sample 306-PR
($\mu g/m^3$)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	ND	
GC8	110-140	ND	
GC9	140-160	ND	
GC10	160-180	ND	
GC11	180-200	ND	
GC12	200-220	ND	
GC13		23	
GC14		ND	
GC15		149	
GC16		188	
GC17			

ND = Not detectable (below 0.5 $\mu g/m^3$ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
† Peaks, if any, obscured on shoulder of solvent peak.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-89. GAS CHROMATOGRAPHY ANALYSIS
Sample 306-XR
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	100	
GC8	110-140	52	
GC9	140-160	7	
GC10	160-180	17	
GC11	180-200	89	
GC12	200-220	6	
GC13		5	
GC14		210	
GC15		335	
GC16		595	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-90. GAS CHROMATOGRAPHY ANALYSIS
Sample 307-XR
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	82	
GC8	110-140	27	
GC9	140-160	5	
GC10	160-180	14	
GC11	180-200	12	
GC12	200-220	15	
GC13		ND	
GC14		<1	
GC15		1	
GC16		8	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-91. GAS CHROMATOGRAPHY ANALYSIS
Sample 308-XR
(μg/μ3)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	ND	
GC8	110-140	<1	
GC9	140-160	ND	
GC10	160-180	99	
GC11	180-200	ND	
GC12	200-220	25	
GC13		12	
GC14		11	
GC15		38	
GC16		71	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-92. GAS CHROMATOGRAPHY ANALYSIS
Sample 309-MR.
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	24	
GC8	110-140	<1	
GC9	140-160	<1	
GC10	160-180	<1	
GC11	180-200	<1	
GC12	200-220	2	
GC13		6	
GC14		14	
GC15		38	
GC16		150	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-93. GAS CHROMATOGRAPHY ANALYSIS
Sample 309-XR
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	0	
GC8	110-140	251	
GC9	140-160	685	
GC10	160-180	1,488	
GC11	180-200	1,945	
GC12	200-220	2,914	
GC13		4,913	
GC14		3,618	
GC15		3,065	
GC16		2,456	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-94. GAS CHROMATOGRAPHY ANALYSIS
Sample 310-MR
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	7	
GC8	110-140	<1	
GC9	140-160	<1	
GC10	160-180	<1	
GC11	180-200	<1	
GC12	200-220	21	
GC13		129	
GC14		164	
GC15		462	
GC16		611	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-95. GAS CHROMATOGRAPHY ANALYSIS
Sample 310-XR
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	207	
GC8	110-140	323	
GC9	140-160	611	
GC10	160-180	1,486	
GC11	180-200	2,200	
GC12	200-220	2,426	
GC13		3,639	
GC14		3,554	
GC15		3,508	
GC16		3,006	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-96. GAS CHROMATOGRAPHY ANALYSIS
Sample 310-PF
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	ND	
GC8	110-140	5	
GC9	140-160	22	
GC10	160-180	29	
GC11	180-200	92	
GC12	200-220	65	
GC13		59	
GC14		92	
GC15		222	
GC16		129	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-97. GAS CHROMATOGRAPHY ANALYSIS
Sample 311-MR
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	ND	
GC8	110-140	<1	
GC9	140-160	<1	
GC10	160-180	<1	
GC11	180-200	<1	
GC12	200-220	<1	
GC13		45	
GC14		38	
GC15		396	
GC16		523	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data has been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-98. GAS CHROMATOGRAPHY ANALYSIS
Sample 311-XR
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	98	
GC8	110-140	497	
GC9	140-160	683	
GC10	160-180	1,228	
GC11	180-200	1,265	
GC12	200-220	1,438	
GC13		2,854	
GC14		1,895	
GC15		1,424	
GC16		1,418	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data has been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-99. GAS CHROMATOGRAPHY ANALYSIS
Sample 312-MR
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	386	
GC8	110-140	ND	
GC9	140-160	3	
GC10	160-180	1	
GC11	180-200	3	
GC12	200-220	9	
GC13		44	
GC14		139	
GC15		393	
GC16		417	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-100. GAS CHROMATOGRAPHY ANALYSIS
Sample 312-XR
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	110	
GC8	110-140	239	
GC9	140-160	534	
GC10	160-180	1,652	
GC11	180-200	2,100	
GC12	200-220	2,614	
GC13		3,895	
GC14		2,250	
GC15		1,956	
GC16		1,621	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-101. GAS CHROMATOGRAPHY ANALYSIS
Sample 312-CDS
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	35	
GC8	110-140	12	
GC9	140-160	24	
GC10	160-180	31	
GC11	180-200	19	
GC12	200-220	11	
GC13		5	
GC14		6	
GC15		18	
GC16		2	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-102. GAS CHROMATOGRAPHY ANALYSIS
Sample 312-PF
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	54	
GC8	110-140	1	
GC9	140-160	4	
GC10	160-180	19	
GC11	180-200	37	
GC12	200-220	30	
GC13		25	
GC14		18	
GC15		22	
GC16		9	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-103. GAS CHROMATOGRAPHY ANALYSIS
Sample 313-MR
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	ND	
GC8	110-140	ND	
GC9	140-160	ND	
GC10	160-180	ND	
GC11	180-200	6	
GC12	200-220	5	
GC13		18	
GC14		75	
GC15		248	
GC16		287	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample code identification.

TABLE 10-104. GAS CHROMATOGRAPHY ANALYSIS
Sample 313-XR
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	10	
GC8	110-140	154	
GC9	140-160	300	
GC10	160-180	1,032	
GC11	180-200	672	
GC12	200-220	1,261	
GC13		1,706	
GC14		1,433	
GC15		1,457	
GC16		646	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample identification.

TABLE 10-105. GAS CHROMATOGRAPHY ANALYSIS
Sample 313-CDS
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	59	
GC8	110-140	ND	
GC9	140-160	1	
GC10	160-180	2	
GC11	180-200	3	
GC12	200-220	1	
GC13		1	
GC14		1	
GC15		14	
GC16		2	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample identification.

TABLE 10-106. GAS CHROMATOGRAPHY ANALYSIS
Sample 313-PF
(μg/m³)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	18	
GC8	110-140	<1	
GC9	140-160	<1	
GC10	160-180	<1	
GC11	180-200	<1	
GC12	200-220	<1	
GC13		18	
GC14		<1	
GC15		52	
GC16		3	
GC17			

ND = Not detectable (below 0.5 μg/m³ detection limit).
* Not usually included in TCO range, i.e., C_8-C_{16}.
Note: Data have been corrected for blanks. Refer to Figure 10-1 for sample identification.

TABLE 10-107. GAS CHROMATOGRAPHY ANALYSIS
GASEOUS GRAB SAMPLE
GAS TURBINE, SITE 110

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		ND	
GC2		ND	
GC3		ND	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		483	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 μg/m^3) per C_1-C_6 and 0.001 ppm (~0.5 μg/m^3) per C_7-C_{16}.

TABLE 10-108. GAS CHROMATOGRAPHY ANALYSIS
GASEOUS GRAB SAMPLE
DISTILLATE OIL TURBINE, SITE 111

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		ND	
GC2		ND	
GC3		ND	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		32	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 μg/m^3) per C_1-C_6 and 0.001 ppm (~0.5 μg/m^3) per C_7-C_{16}.

TABLE 10-109. GAS CHROMATOGRAPHY ANALYSIS
GASEOUS GRAB SAMPLE
DISTILLATE OIL TURBINE, SITE 112

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		ND	
GC2		ND	
GC3		ND	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		29	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 μg/m³) per C_1-C_6 and 0.001 ppm (~0.5 μg/m³) per C_7-C_{16}.

TABLE 10-110. GAS CHROMATOGRAPHY ANALYSIS
GASEOUS GRAB SAMPLE
DISTILLATE OIL TURBINE, SITE 306

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		ND	
GC2		67,620	
GC3		ND	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		100	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 μg/m³) per C_1-C_6 and 0.001 ppm (~0.5 μg/m³) per C_7-C_{16}.

TABLE 10-111. GAS CHROMATOGRAPHY ANALYSIS
GASEOUS GRAB SAMPLE
DISTILLATE OIL TURBINE, SITE 307

Gas	Range	Volatile Weight, ppm	No. of peaks
GC1		ND	
GC2		15,130	
GC3		ND	
GC3		ND	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		82	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 µg/m^3) per C_1-C_6 and 0.001 ppm (~0.5 µg/m^3) per C_7-C_{16}.

TABLE 10-112. GAS CHROMATOGRAPHY ANALYSIS
GASEOUS GRAB SAMPLE
DISTILLATE OIL TURBINE, SITE 308

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		ND	
GC2		2,275	
GC3		ND	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		ND	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 µg/m^3) per C_1-C_6 and 0.001 ppm (~0.5 µg/m^3) per C_7-C_{16}.

TABLE 10-113. GAS CHROMATOGRAPHY ANALYSIS
DISTILLATE OIL RECIPROCATING ENGINES,
GASEOUS GRAB SAMPLE
SITE 309

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		1,000	
GC2		7,765	
GC3		3,535	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		24	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 µg/m^3) per C_1-C_6 and 0.001 ppm (~0.5 µg/m^3) per C_7-C_{16}.

TABLE 10-114. GAS CHROMATOGRAPHY ANALYSIS
DISTILLATE OIL RECIPROCATING ENGINES,
GASEOUS GRAB SAMPLE
SITE 309-2

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		500	
GC2		700	
GC3		700	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		10	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 µg/m^3) per C_1-C_6 and 0.001 ppm (~0.5 µg/m^3) per C_7-C_{16}.

TABLE 10-115. GAS CHROMATOGRAPHY ANALYSIS
DISTILLATE OIL RECIPROCATING ENGINES,
GASEOUS GRAB SAMPLE
SITE 310

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		1,570	
GC2		10,380	
GC3		3,065	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		214	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 μg/m^3) per C_1-C_6 and 0.001 ppm (~0.5 μg/m^3) per C_7-C_{16}.

TABLE 10-116. GAS CHROMATOGRAPHY ANALYSIS
DISTILLATE OIL RECIPROCATING ENGINES,
GASEOUS GRAB SAMPLE
SITE 311

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		2,570	
GC2		5,970	
GC3		1,140	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		98	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 μg/m^3) per C_1-C_6 and 0.001 ppm (~0.5 μg/m^3) per C_7-C_{16}.

TABLE 10-117. GAS CHROMATOGRAPHY ANALYSIS
DISTILLATE OIL RECIPROCATING ENGINES,
GASEOUS GRAB SAMPLE
SITE 312

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		3,285	
GC2		17,540	
GC3		705	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		585	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 μg/m³) per C_1-C_6 and 0.001 ppm (~0.5 μg/m³) per C_7-C_{16}.

TABLE 10-118. GAS CHROMATOGRAPHY ANALYSIS
DISTILLATE OIL RECIPROCATING ENGINES,
GASEOUS GRAB SAMPLE
SITE 312-2

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		800	
GC2		1,900	
GC3		ND	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		90	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 μg/m³) per C_1-C_6 and 0.001 ppm (~0.5 μg/m³) per C_7-C_{16}.

TABLE 10-119. GAS CHROMATOGRAPHY ANALYSIS
DISTILLATE OIL RECIPROCATING ENGINES,
GASEOUS GRAB SAMPLE
SITE 313

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		4,000	
GC2		26,015	
GC3		745	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		87	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 μg/m^3) per C_1-C_6 and 0.001 ppm (~0.5 μg/m^3) per C_7-C_{16}.

TABLE 10-120. GAS CHROMATOGRAPHY ANALYSIS
DISTILLATE OIL RECIPROCATING ENGINES,
GASEOUS GRAB SAMPLE
SITE 313-2

Gas	Range	Volatile weight, ppm	No. of peaks
GC1		1,100	
GC2		1,700	
GC3		ND	
GC4		ND	
GC5		ND	
GC6		ND	
GC7		ND	

ND = Concentration of the species is below the limit of detection of the instrument: 1 ppm (~1,000 μg/m^3) per C_1-C_6 and 0.001 ppm (~0.5 μg/m^3) per C_7-C_{16}.

TABLE 10-121. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
GAS TURBINE, SITE 110

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	1,202	
GC9	140-160	444	
GC10	160-180	727	
GC11	180-200	23	
GC12	200-220	ND	
GC13		29	
GC14		ND	
GC15		ND	
GC16		ND	
>GC16		310	

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 μg/m³) per C_7-C_{16}.

TABLE 10-122. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL TURBINE, SITE 111

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	100	
GC9	140-160	137	
GC10	160-180	927	
GC11	180-200	ND	
GC12	200-220	84	
GC13		ND	
GC14		ND	
GC15		ND	
GC16		ND	
>GC16		6,800	

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 μg/m³) per C_7-C_{16}.

TABLE 10-123. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL TURBINE, SITE 112

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	147	
GC9	140-160	200	
GC10	160-180	613	
GC11	180-200	21	
GC12	200-220	152	
GC13		56	
GC14		ND	
GC15		46	
GC16		457	
>GC16		3,710	

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 μg/m³) per C_7-C_{16}.

TABLE 10-124. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL TURBINE, SITE 306

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	52	
GC9	140-160	7	
GC10	160-180	17	
GC11	180-200	89	
GC12	200-220	6	
GC13		28	
GC14		210	
GC15		484	
GC16		783	
>GC16		440	

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 μg/m³) per C_7-C_{16}.

TABLE 10-125. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL TURBINE, SITE 307

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	27	
GC9	140-160	5	
GC10	160-180	14	
GC11	180-200	12	
GC12	200-220	15	
GC13		ND	
GC14		ND	
GC15		1	
GC16		8	
>GC16		1,400	

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 μg/m³) per C_7-C_{16}.

TABLE 10-126. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL TURBINE, SITE 308

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	ND	
GC9	140-160	ND	
GC10	160-180	99	
GC11	180-200	ND	
GC12	200-220	25	
GC13		12	
GC14		11	
GC15		38	
GC16		71	
>GC16		1,270	

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 μg/m³) per C_7-C_{16}.

TABLE 10-127. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL RECIPROCATING ENGINES, SITE 309

GC8	110-140	251
GC9	140-160	685
GC10	160-180	1,488
GC11	180-200	1,945
GC12	200-220	2,916
GC13		4,919
GC14		3,632
GC15		3,103
GC16		2,606
>GC16		56,180

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 $\mu g/m^3$) per C_7-C_{16}.

TABLE 10-128. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL RECIPROCATING ENGINES, SITE 309-2

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	370	
GC9	140-160	850	
GC10	160-180	2,410	
GC11	180-200	2,890	
GC12	200-220	3,230	
GC13		3,000	
GC14		3,580	
GC15		2,760	
GC16		2,290	
>GC16		55,380	

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 $\mu g/m^3$) per C_7-C_{16}.

TABLE 10-129. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL RECIPROCATING ENGINES, SITE 310

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	328	
GC9	140-160	633	
GC10	160-180	1,516	
GC11	180-200	2,292	
GC12	200-220	2,512	
GC13		3,827	
GC14		3,810	
GC15		4,192	
GC16		3,746	
>GC16		53,880	

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 μg/m³) per C_7-C_{16}.

TABLE 10-130. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL RECIPROCATING ENGINES, SITE 311

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	497	
GC9	140-160	683	
GC10	160-180	1,228	
GC11	180-200	1,265	
GC12	200-220	1,438	
GC13		2,899	
GC14		1,933	
GC15		1,810	
GC16		1,941	
>GC16		43,040	

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 μg/m³) per C_7-C_{16}.

TABLE 10-131. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL RECIPROCATING ENGINES, SITE 312

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	251	
GC9	140-160	565	
GC10	160-180	1,704	
GC11	180-200	2,159	
GC12	200-220	2,663	
GC13		3,970	
GC14		2,413	
GC15		2,389	
GC16		2,149	
>GC16		63,590	

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 μg/m^3) per C_7-C_{16}.

TABLE 10-132. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL RECIPROCATING ENGINES, SITE 312-2

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	400	
GC9	140-160	1,100	
GC10	160-180	1,800	
GC11	180-200	2,120	
GC12	200-220	2,450	
GC13		2,330	
GC14		2,200	
GC15		2,250	
GC16		1,680	
>GC16		55,040	

TABLE 10-133. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL RECIPROCATING ENGINES, SITE 313

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	154	
GC9	140-160	301	
GC10	160-180	1,034	
GC11	180-200	682	
GC12	200-220	1,267	
GC13		1,742	
GC14		1,509	
GC15		1,771	
GC16		937	
>GC16		46,680	

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 mg/m^3) per C_7-C_{16}.

TABLE 10-134. GAS CHROMATOGRAPHY ANALYSIS
C_8-C_{16} VOLATILE ORGANICS
DISTILLATE OIL RECIPROCATING ENGINES, 313-2

Gas	Range	Volatile weight, ppm	No. of peaks
GC8	110-140	560	
GC9	140-160	1,290	
GC10	160-180	2,120	
GC11	180-200	2,580	
GC12	200-220	3,120	
GC13		2,810	
GC14		3,100	
GC15		3,010	
GC16		2,350	
>GC16		66,340	

ND = Concentration of the species is below the limit of detection of the instrument: 0.001 ppm (~0.5 μg/m^3) per C_7-C_{16}.

The following samples had totals less than 75 μg/m³, so quantities in each range were not reported.

Sample	Total C_7-C_{16}
111-PR-0-KD	ND
111-PF-S-KD	2
112-XM-S-KD-1	29
306-PF	34
307-PR	ND
307-PF	35
308-PR	ND
308-MR	*
308-CDS	19
308-PF	ND
309-PR	30
309-CDS	8
309-PF	5
309-2	21
310-PR	30
310-CDS	3
311-PR	7
311-CDS	42
311-PF	40
312-PR	5
312-2	16
313-PR	36
313-2	21

ND = not detectable (below 0.5 μg/m³ detection limit).
*No value reported, so ND is assumed.

TABLE 10-135

LC ANALYSIS RESULTS

309-2- XR+PF+MR+PR

	TCO mg	GRAV mg	TCO + GRAV Total mg	Concentration mg/ (m^3, L, or kg)[5]
Total Sample[1]				51
Taken for LC[2]				
Recovered[3]				

Fraction	TCO in mg				GRAV in mg				TCO + GRAV Total mg	Concentration mg/ (m^3, L, or kg)[5]
	Found in Fraction	Blank	Corrected	Total[4]	Found in Fraction	Blank	Corrected	Total[4]		
1				611				954		38.4
2				1.62				34.1		1.19
3				0.10				71.3		2.33
4				10.8				83.8		2.76
5				0.07				48		1.57
6				ND				127		4.17
7				ND				16.7		0.55
Sum								1335		51

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample
5. Supply values for both sample size and concentration

ND = Not detectable.

NOTE: For sample code identification refer to Figure 10-1.

TABLE 10-136
LC ANALYSIS RESULTS
308 XR+MR

	TCO mg	GRAV mg	TCO + GRAV Total mg	Concentration mg/ (m3, L, or kg)[5]
Total Sample[1]				0.374†
Taken for LC[2]				
Recovered[3]				

Fraction	TCO in mg				GRAV in mg				TCO + GRAV Total mg	Concentration mg/ (m3,L, or kg)[5]
	Found in Fraction	Blank	Corrected	Total[4]	Found in Fraction	Blank	Corrected	Total[4]		
1				ND				1.7		0.055
2				ND				0.6		0.0194
3				ND				0.4		0.0129
4				ND				0.5		0.0162
5				ND				0.6		0.0194
6				ND				2.6		0.0841
7				ND				4.1		0.133
Sum				ND				11.5*		0.374†

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample
5. Supply values for both sample size and concentration

ND = Not detectable.
* Includes LC8 (1.0) no longer used in Level 1 data.
† Includes LC8 (0.034) no longer used in Level 1 data.

NOTE: For sample code identification refer to Figure 10-1.

TABLE 10-137

LC ANALYSIS RESULTS

313-2-XR-PF-MR-PR

	TCO mg	GRAV mg	TCO + GRAV Total mg	Concentration mg/ (m³, L, or kg)[5]
Total Sample[1]				64.9
Taken for LC[2]				
Recovered[3]				

Fraction	TCO in mg				GRAV in mg				TCO + GRAV Total mg	Concentration mg/ (m³, L, or kg)[5]
	Found in Fraction	Blank	Corrected	Total[4]	Found in Fraction	Blank	Corrected	Total[4]		
1				190				1395		50.9
2				4.4				153		5.05
3				0.53				48.2		1.57
4				ND				33.6		1.08
5				ND				59.8		1.92
6				1.4				102		3.32
7				ND				31.6		1.02
Sum				196				1823		64.9

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample
5. Supply values for both sample size and concentration

ND = Not detectable.

NOTE: For sample code identification refer to Figure 10-1.

TABLE 10-138

LC ANALYSIS RESULTS

312-2-XR+PF+MR+PR

	TCO mg	GRAV mg	TCO + GRAV Total mg	Concentration mg/ (m³, L, or kg)[5]
otal Sample[1]				51
iken for LC[2]				
ecovered[3]				

Fraction	TCO in mg				GRAV in mg				TCO + GRAV Total mg	Concentration mg/ (m³,L, or kg)[5]
	Found in Fraction	Blank	Corrected	Total[4]	Found in Fraction	Blank	Corrected	Total[4]		
1				220				954		38.4
2				2.42				34.1		1.19
3				ND				71.3		2.33
4				0.57				83.8		2.76
5				ND				48		1.57
6				0.48				127		4.17
7				ND				16.7		0.55
Sum				223				1335		51

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample
5. Supply values for both sample size and concentration

ND = Not detectable.

NOTE: For sample code identification refer to Figure 10-1.

TABLE 10-139

LC ANALYSIS RESULTS

306- XR+MR

	TCO mg	GRAV mg	TCO + GRAV Total mg	Concentration mg/ (m³, L, or
Total Sample[1]				†
Taken for LC[2]				
Recovered[3]				

Fraction	TCO in mg				GRAV in mg				TCO + GRAV Total mg	Concentration mg/ (m³, L, or
	Found in Fraction	Blank	Corrected	Total[4]	Found in Fraction	Blank	Corrected	Total[4]		
1				*				0.7		†
2				*				0.3		†
3				*				0.1		†
4				*				0.5		†
5				*				0.4		†
6				*				2.8		†
7				*				ND		†
Sum				-				4.8		†

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample
5. Supply values for both sample size and concentration

ND = Not detectable.
* Data not required.
† Total not meaningful because of lack of TCO data.

NOTE: For sample code identification refer to Figure 10-1.

TABLE 10-140

LC ANALYSIS RESULTS

307 XR+MR

	TCO mg	GRAV mg	TCO + GRAV Total mg	Concentration mg/ (m^3, L, or kg)[5]
Total Sample[1]				0.11
Taken for LC[2]				
Recovered[3]				

Fraction	TCO in mg				GRAV in mg				TCO + GRAV Total mg	Concentration mg/ (m^3,L, or kg)[5]
	Found in Fraction	Blank	Cor-rected	Total[4]	Found in Fraction	Blank	Cor-rected	Total[4]		
1				ND				0.5		0.016
2				ND				0.3		0.0097
3				ND				0.3		0.0097
4				ND				0.3		0.0097
5				ND				ND		ND
6				ND				1.1		0.036
7				ND				0.9		0.029
Sum				ND				3.4		0.11

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample
5. Supply values for both sample size and concentration

ND = Not detectable.

NOTE: For sample code identification refer to Figure 10-1.

IR REPORT

SAMPLE: Distillate oil reciprocating engines, site 309

Wave Number (cm^{-1})	Intensity	Assignment/Comments
		LC
		fraction
		1 alkyl, aryl and CO-OX groups*:
		carboxylic acid
		2 alkyl, carbonyl, and C-O-X groups
		3 alkyl, alkenyl, aryl, carbonyl, and
		C-O-X groups
		4 alkyl and C-O-X groups - all aliphatic
		5 alkyl, alkenyl, and C-O-X groups -
		all aliphatic
		6 alkyl, aryl, carbonyl, and C-O-X groups
		7 only aliphatic species
		8 species containing alkyl and C-O-X
		groups - all aliphatic

OTHER REMARKS:

Note: Level 1 procedure now uses 7, rather than 8, LC fractions.

*X group in C-O-X linkage was not identified in any sample.

		5	saturated [illegible]
		6	aldehydes, ketones, esters
		7	hydrocarbons, esters, ketones
		8	*

OTHER REMARKS:

Note: Level 1 procedure now uses 7, rather than 8, LC fractions.

*Insufficient material was found in this sample to justify further analysis.

TABLE 10-143

IR REPORT

SAMPLE: Distillate oil reciprocating engines, site 310

Wave Number (cm^{-1})	Intensity	Assignment/Comments
		LC
		fraction
		1 only aliphatic groups
		2 only aliphatic groups
		3 only aliphatic groups
		4 alkyl, aryl, and C-O-X groups*
		5 alkyl, aryl, and C-O-X groups
		6 alkyl, aryl, and C-O-X groups
		7 alkyl, aryl, and C-O-X groups
		8 alkyl, aryl, and C-O-X groups

OTHER REMARKS:

Note: Level 1 procedure now uses 7, rather than 8, LC fractions.

*X group in C-O-X linkage was not identified in any sample.

TABLE 10-144

IR REPORT

Distillate oil reciprocating engines, site 312

Wave Number (cm^{-1})	Intensity	Assignment/Comments
		LC
		fraction
		1 alkyl and aryl groups
		2 alkyl, aryl, and C-O-X groups*
		3 alkyl, aryl, and C-O-X groups
		4 only aliphatic groups
		5 alkyl, alkenyl, aryl, and C-O-X groups
		6 alkyl, alkenyl, aryl, and C-O-X groups
		7 alkyl, aryl, and C-O-X groups
		8 only aliphatic groups

REMARKS:

Note: Level 1 procedure now uses 7, rather than 8, LC fractions.

*X group in C-O-X linkage was not identified in any sample.

TABLE 10-145

IR REPORT

SAMPLE: Distillate oil reciprocating engines, site 311

Wave Number (cm^{-1})	Intensity	Assignment/Comments
		LC
		fraction
		1 alkyl and aryl groups
		2 alkyl, aryl, and C-O-X groups*
		3 alkyl, aryl, and C-O-X groups
		4 alkyl, alkenyl, aryl, and C-O-X groups
		5 alkyl, alkenyl, aryl, and C-O-X groups
		6 alkyl, alkenyl, aryl, carbonyl, and
		C-O-X groups
		7 alkyl, aryl, and C-O-X groups
		8 alkyl, aryl, and C-O-X groups

OTHER REMARKS:

Note: Level 1 procedure now uses 7, rather than 8, LC fractions.

*X group in C-O-X linkage was not identified in any sample.

TABLE 10-146

IR REPORT

Distillate oil reciprocating engines, site 312-2

umber (-1)	Intensity	Assignment/Comments	
		LC	
		fraction	
		1	hydrocarbons
		2	hydrocarbons, unsaturated or aryl
			esters, ketones
		3	hydrocarbons, unsaturated or aryl
			esters
		4	hydrocarbons, saturated ketones
		5	unsaturated or aryl esters, ketones
		6	esters, aldehydes, ketones
		7	unsaturated or aryl esters, ketones
		8	*

RKS:

e: Level 1 procedure now uses 7, rather than 8, LC fractions.

ısufficient material was found in these samples to justify further ıalysis.

TABLE 10-147

IR REPORT

SAMPLE: Distillate oil reciprocating engines, site 313

Wave Number (cm^{-1})	Intensity	Assignment/Comments
		LC
		fraction
		1 alkyl, aryl, and C-O-X groups*
		2 only aliphatic groups
		3 alkyl, alkenyl, aryl, carbonyl and
		C-O-X groups
		4 only saturated and unsaturated
		aliphatic groups
		5 only aliphatic groups
		6 alkyl, alkenyl, aryl, and C-O-X groups
		7 alkyl and aryl groups
		8 no data

OTHER REMARKS:

Note: Level 1 procedure now uses 7, rather than 8, LC fractions.

*X group in C-O-X linkage was not identified in any sample.

TABLE 10-148

IR REPORT

E: Distillate oil reciprocating engines, site 313-2

'ave Number (cm^{-1})	Intensity	Assignment/Comments
		LC
		fraction
		1 hydrocarbons
		2 hydrocarbons, esters, ketones
		3 hydrocarbons, esters, ketones
		4 hydrocarbons
		5 saturated ketones, aryl, or unsaturated
		esters
		6 esters, ketones
		7 esters, ketones, amides, amines,
		unsaturated or aryl ketones
		8 *

REMARKS:

Note: Level 1 procedure now uses 7, rather than 8, LC fractions.

*Insufficient material was found in these samples to justify further analysis.

TABLE 10-149

IR REPORT

SAMPLE: Distillate oil-fueled gas turbine, site 110

Wave Number (cm^{-1})	Intensity	Assignment/Comments
		LC
		Fraction
		1 *
		2 *
		3 *
		4 *
		5 *
		6 Esters: includes vinyl ester; aldehyde/ketone;
		aromatic nitro compound; other organic nitrate
		silica
		7 Esters: includes vinyl ester; aldehyde/ketone;
		aromatic nitro compound; other organic nitrate
		silica
		8 Esters (trace); silica; water
		Residue of original sample
		Esters: includes benzoates, phthalates and
		vinyl ester; amide; glycol; aldehyde;
		chlorinated compound; other benzene
		derivatives

OTHER REMARKS:

*Insufficient material was found in these samples to justify further analysis.

Note: Level 1 procedure now uses 7, rather than 8, LC fractions.

TABLE 10-150

IR REPORT

IMPLE: Distillate oil-fueled gas turbine, site 111

Wave Number (cm^{-1})	Intensity	Assignment/Comments
		LC
		Fraction
		1 Aliphatic hydrocarbons
		2 *
		3 *
		4 *
		5 *
		6 Esters: includes vinyl ester; aldehyde/ketone;
		glycol; aromatic nitro compound; other organic
		nitrate
		7 Esters: includes vinyl ester; aldehyde/ketone;
		glycol; aromatic nitro compound; other organic
		nitrate
		8 Ester (trace): silica; water
		Residue of original sample
		Aliphatic hydrocarbons; esters: includes
		benzoates phthalates and vinyl ester; amide;
		glycol; aldehyde; chlorinated compound; other
		benzene derivatives; inorganic sulfate

THER REMARKS:

Insufficient material was found in these samples to justify further analysis.

ote: Level 1 procedure now uses 7, rather than 8, LC fractions.

TABLE 10-151

IR REPORT

SAMPLE: Distillate oil-fueld gas turbine, site 112

Wave Number (cm^{-1})	Intensity	Assignment/Comments
		LC
		Fraction
		1 *
		2 *
		3 *
		4 *
		5 *
		6 *
		7 *
		8 *
		Residue of original sample
		Esters: includes benzoates and phthalates;
		glycol; aldehyde; chlorinated compound;
		other benzene derivatives

OTHER REMARKS:

*Insufficient material was found in these samples to justify further analysis.

Note: Level 1 procedure now uses 7, rather than 8, LC fractions.

TABLE 10-152

IR REPORT

AMPLE: Distillate oil-fueled gas turbines, site 306

Wave Number (cm^{-1})	Intensity	Assignment/Comments
		LC
		Fraction
		1 *
		2 *
		3 *
		4 *
		5 *
		6 Alkyl, unsaturated aliphatics, aryl, carbonyl
		and C-O-X groups†
		7 *
		8 *

HER REMARKS:

Insufficient material was found in these samples to justify further analysis.
K group in C-O-X linkages was not identified in any sample.

bte: Level 1 procedure now uses 7, rather than 8, LC fractions.

TABLE 10-153

IR REPORT

SAMPLE: Distillate oil-fueled gas turbines, site 307

Wave Number (cm^{-1})	Intensity	Assignment/Comments
		LC
		Fraction
		1 *
		2 *
		3 *
		4 *
		5 *
		6 Alkyl and C-O-X groups†- all aliphatic
		7 *
		8 *

OTHER REMARKS:

*Insufficient material was found in these samples to justify further analysis.

†X group in C-O-X linkages was not identified in any sample.

Note: Level 1 procedure now uses 7, rather than 8, LC fractions.

TABLE 10-154

IR REPORT

MPLE: Distillate oil-fueled gas turbines, site 308

Wave Number (cm^{-1})	Intensity	Assignment/Comments
		LC
		Fraction
		1 Aliphatics
		2 Alkyl, aryl and C-O-X groups†
		3 Alkyl, aryl and C-O-X groups
		4 Alkyl, aryl, carbonyl and C-O-X groups
		5 Alkyl, aryl, carbonyl and C-O-X groups
		6 Alkyl, aryl, carbonyl, aliphatic C-O-X and
		unsaturated aliphatic groups
		7 Alkyl, aryl, unsaturated aliphatics, carbonyl
		and C-O-X groups
		8 Alkyl, and C-O-X groups - all aliphatic

ER REMARKS:

nsufficient material was found in these samples to justify further analysis.

group in C-O-X linkages was not identified in any sample.

te: Level 1 procedure now uses 7, rather than 8, LC fractions.

LRMS REPORT

SAMPLE: Diesel engine sites, sample no. 309-XM-LC1

(See Figure 10-1 for sample code identification.)

Major Categories

Intensity	Category	MW Range
NR	Hydrocarbon oil	NR
NR	Fatty acid esters	NR
NR	Dioctyl phthalate (trace)	NR
NR	Di-tert-butyl phenol (possible)	NR

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

NR = not reported

LRMS REPORT

SAMPLE: Diesel engine site, sample no. 310-XM-LC1

(See Figure 10-1 for sample code identification.)

Major Categories

Intensity	Category	MW Range
NR	Hydrocarbon oil	NR
NR	Aromatics	NR
NR	Dioctyl phthalate	NR
NR	Fatty acid esters	NR
NR	Anisole (possible)	NR

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

NR = not reported

LRMS REPORT

SAMPLE: Diesel engine site, sample no. 310-XM-LC6

(See Figure 10-1 for sample code identification.)

Major Categories

Intensity	Category	MW Range
NR	Hydrocarbon oil	NR
NR	Aromatics	NR
NR	Dioctyl phthalate	NR

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

NR = not reported

LRMS REPORT

SAMPLE: Diesel engine site, sample no. 310-XM-LC7

(See Figure 10-1 for sample code identification.)

Major Categories

Intensity	Category	MW Range
NR	Hydrocarbon oil (trace)	NR
NR	Dioctyl phthalate (trace)	NR

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

NR = not reported

LRMS REPORT

SAMPLE: Diesel engine site, sample no. 311-XM-LC1

(See Figure 10-1 for sample code identification.)

Major Categories

Intensity	Category	MW Range
NR	Hydrocarbon oil	NR
NR	Aromatics	NR
NR	Dioctyl phthalate	NR
NR	Di-tert-butyl phenol (possible)	NR

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

NR = not reported

LRMS REPORT

SAMPLE: Diesel engine site, sample no. 311-XM-LC3

(See Figure 10-1 for sample code identification.)

Major Categories

Intensity	Category	MW Range
NR	Hydrocarbon oil	NR
NR	Aromatics	NR
NR	Dioctyl phthalate	NR
NR	Fatty acid esters	NR

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

NR = not reported

LRMS REPORT

SAMPLE: Diesel engine site, sample no. 311-XM-LC4

(See Figure 10-1 for sample code identification.)

Major Categories

Intensity	Category	MW Range
NR	Hydrocarbon oil	NR
NR	Dioctyl phthalate	NR
NR	Nonyl phenol (possible)	NR

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

NR = not reported

LRMS REPORT

SAMPLE: Diesel engine site, sample no. 312-XM-LC1

(See Figure 10-1 for sample code identification.)

Major Categories

Intensity	Category	MW Range
NR	Hydrocarbon oil	NR
NR	Dioctyl phthalate	NR
NR	Di-tert-butyl phenol (possible)	NR

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

NR = not reported

LRMS REPORT

SAMPLE: Diesel engine site, sample no. 312-XM-LC3

(See Figure 10-1 for sample code identification.)

Major Categories

Intensity	Category	MW Range
NR	Hydrocarbon oil	NR
NR	Aromatics	NR
NR	Dioctyl phthalate	NR

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

NR = not reported

LRMS REPORT

SAMPLE: Diesel engine site, sample no. 312-XM-LC4

(See Figure 10-1 for sample code identification.)

Major Categories

Intensity	Category	MW Range
NR	Hydrocarbon oil	NR
NR	Aromatics	NR
NR	Dioctyl phthalate	NR
NR	Trimethyl naphthalene (possible)	NR

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

NR = not reported

LRMS REPORT

SAMPLE: Diesel engine site, sample no. 312-XM-LC6

(See Figure 10-1 for sample code identification.)

Major Categories

Intensity	Category	MW Range
NR	Hydrocarbon oil	NR
NR	Aromatics	NR
NR	Dioctyl phthalate	NR
NR	Anisole (possible)	NR

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

NR = not reported

LRMS REPORT

SAMPLE: Diesel engine site, sample no. 313-XM-LC1

(See Figure 10-1 for sample code identification.)

Major Categories

Intensity	Category	MW Range
NR	Hydrocarbon oil	NR
NR	Dioctyl phthalate	NR
NR	Di-tert-butyl phenol (possible)	NR

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

NR = not reported

LEVEL 2

TABLE 32. LEVEL II CONTROLLED CONDENSATION TRAIN ANALYTICAL RESULTS

Sample Number	Sample Type	H_2SO_4 mg/m^3	SO_2 mg/m^3	SO_4 mg/m^3
309-2-GC	Coil rinse	ND	*	*
309-2-GI	H_2O_2 impinger	*	38.96	*
309-2-GP/GF	Probe rinse and filter wash	*	*	1.56
312-2-GC	Coil rinse	1.38	*	*
312-2-GI	H_2O_2 impinger	*	88.64	*
312-2-GP/GF	Probe rinse and filter wash	*	*	1.58
313-2-GC	Coil rinse	1.36	*	*
313-2-GI	H_2O_2 impinger	*	81.20	*
313-2-GP/GF	Probe rinse and filter wash	*	*	1.74

ND indicates not detected

*The sulfur species indicated is not expected to be trapped in this part of the sampling train. Samples collected are therefore not analyzed for the specific sulfur species.

TABLE D-16. LEVEL II ORGANIC ANALYSIS RESULTS - COMPOUNDS FOUND IN SAMPLE 309-2-XRPF-MRPR

Compound	Amount (μg/m^3)	Scan No.
Toluene	*	5
Xylene	14 †	45
Xylene	56 †	50
Xylene	30 †	65
C_3 Cyclohexane	54	69
n-C_9 Hydrocarbon (Nonane)	38	78
Benzaldehyde	48	111
C_3 Benzene	24	118
C_3 Benzene	110	127
C_3 Benzene	100	136
C_{10} Branched (Hydrocarbon)	46	154
C_3 Benzene	320	169
C_{10} Unsaturated (Hydrocarbon)	78	179
n-C_{10} Hydrocarbon (Decane)	220	199
C_3 Benzene	86	209
Methyl Styrene	20	226
C_{11} Branched (Hydrocarbon)	16	233
C_{11} Branched (Hydrocarbon)	34	240
C_5 Cyclohexane	12	247
C_3 Benzene	96	267
C_3 Benzene	100	274
C_4 Benzene	140†	282

- Continued -

* Equal to or less than amount found in blank.

† Corrected for blank concentration, amount actually present in sample rather questionable due to blank level variations.

TABLE D-16. (Continued)

Compound	Amount ($\mu g/m^3$)	Scan No.
C_4 Benzene	18†	296
C_4 Benzene	310†	322
C_4 Benzene	100†	341
Methyl Benzoate	*	344
C_{11} Branched (Hydrocarbon)	110	346
C_4 Benzene	260†	394
n-C_{11} Hydrocarbon (Undecane)	780	440
C_4 Unsaturated (Benzene)	86	480
C_5 Benzene	110	492
C_3 Benzene	30	147
C_5 Benzene	410	522
C_5 Benzene	100	542
C_5 Benzene	20	554
C_5 Benzene	52	570
C_5 Benzene	8	584
Naphthalene	170†	596
C_5 Benzene	84	610
C_{12} Branched (Hydrocarbon)	54	623
C_{12} Branched (Hydrocarbon)	280	639
C_{12} Branched (Hydrocarbon)	140	657
C_5 Benzene	84	682
C_{12} Unsaturated Hydrocarbon	240	711

- Continued -

* Equal to or less than amount found in blank.

† Corrected for blank concentration, amount actually present in sample rather questionable due to blank level variations.

TABLE D-16. (Continued)

Compound	Amount ($\mu g/m^3$)	Scan No.
n-C_{12} Hydrocarbon (Dodecane)	780	752
Methyl Tetrahydronaphthalene	42	763
C_{13} Branched (Hydrocarbon)	160	789
C_{13} Unsaturated Hydrocarbon	62	798
C_{13} Branched Hydrocarbon	62	807
C_6 Benzene	8	817
C_6 Benzene	56	825
C_6 Benzene	32	852
C_{13} Branched Hydrocarbon	46	891
Methyl Naphthalene	300	906
C_{13} Branched Hydrocarbon	130	918
C_{13} Branched Hydrocarbon	36	932
Methyl Naphthalene	160	939
Unknown Substituted Cyclohexane	10	957
Unknown	14	964
C_{13} Unsaturated Hydrocarbon	140	973
n-C_{13} Hydrocarbon (Tridecane)	1000	1007
C_{14} Branched Hydrocarbon	12	1024
C_3 Tetrahydronaphthalene	28	1030
C_{14} Branched Hydrocarbon	68	1041

- Continued -

TABLE D-16. (Continued)

Compound	Amount ($\mu g/m^3$)	Scan No.
Unknown	2	1047
Unknown	14	1052
C_3 Tetrahydronaphthalene	20	1064
Unknown Substituted Cyclohexane	82	1075
Chloronaphthalene	Internal Standard	1083
Biphenyl	Trace	1092
C_{14} Branched Hydrocarbon	74	1113
C_{14} Unsaturated Hydrocarbon	18	1120
C_2 Naphthalene	10	1126
C_{14} Branched Hydrocarbon	36	1130
C_{14} Branched Hydrocarbon	130	1142
C_2 Naphthalene	290	1156
C_{14} Branched Hydrocarbon	120	1171
C_2 Naphthalene	24	1181
C_2 Naphthalene	130	1186
n-C_{14} Hydrocarbon (Tetradecane)	980	1221
Unknown aromatic	100	1229
C_2 Naphthalene	20	1249
Unknown Acid Ester	32	1260
C_{15} Branched Hydrocarbon	40	1275
C_2 Naphthalene	32	1291
Unknown Aromatic	32	1300

- Continued -

TABLE D-16. (Continued)

Compound	Amount (μg/m^3)	Scan No.
C_{15} Branched Hydrocarbon	180	1318
C_{15} Branched Hydrocarbon	84	1334
C_{15} Branched Hydrocarbon	310	1347
C_3 Naphtbalene	120	1357
C_3 Naphthalene	40	1363
C_3 Naphthalene	52	1379
C_3 Naphthalene	110	1394
n-C_{15} Hydrocarbon (Pentadecane)	1000	1420
C_3 Naphthalene	38	1432
C_3 Naphthalene	130	1439
C_3 Naphthalene	140	1467
C_{16} Unsaturated Hydrocarbon	68	1483
C_4 Naphthalene	120	1502
C_{16} Unsaturated Hydrocarbon	40	1513
C_{16} Unsaturated Hydrocarbon	70	1525
C_4 Naphthalene	82	1534
C_{16} Branched Hydrocarbon	96	1545
C_4 Naphthalene	40	1571
C_4 Naphthalene	110	1586
n-C_{16} Hydrocarbon (Hexadecane)	990	1604
C_{17} Unsaturated Hydrocarbon	90	1615
C_4 Naphthalene	78	1630
n-C_{17} Branched Hydrocarbon	58	1645
Methoxybiphenyl	48	1663
C_4 Naphthalene	32	1682

- Continued -

TABLE D-16. (Continued)

Compound	Amount ($\mu g/m^3$)	Scan No.
C_{17} Branched Hydrocarbon	190	1695
C_{17} Branched Hydrocarbon	26	1709
C_{17} Branched Hydrocarbon	62	1720
C_{17} Branched Hydrocarbon	100	1735
C_5 Naphthalene	34	1749
C_5 Naphthalene	20	1763
C_5 Naphthalene	52	1778
n-C_{17} Hydrocarbon (Heptadecane)	820	1806
C_{18} Branched Hydrocarbon	400	1822
C_3 Biphenyl	16	1837
Phenanthrene (or Isomer)	94	1852
Unknown	16	1867
C_5 Naphthalene	14	1881
Unknown Substituted Cyclohexane	76	1901
C_{18} Branched Hydrocarbon	46	1911
C_{18} Branched Hydrocarbon	48	1930
C_{18} Branched Hydrocarbon	56	1945
Ethyl Fluorene (or Isomer)	24	1955
n-C_{18} Hydrocarbon (Octadecane)	650	2007
C_{19} Unsaturated Hydrocarbon	170	2028
Methylphenanthrene (or Isomer)	86	2088
C_{19} Branched Hydrocarbon	66	2123
n-C_{19} Hydrocarbon (Nonadecane)	490	2192
C_{20} Branched Hydrocarbon	42	2263

- Continued -

TABLE D-16. (Continued)

Compound	Amount (μg/m^3)	Scan No.
Pyrene (or Isomer)	Trace	2301
n-C_{20} Hydrocarbon (Eicosane)	310	2360
n-C_{21} Hydrocarbon (Heneicosane)	130	2524
n-C_{22} Hydrocarbon (Docosane)	76	2677
Dioctylphthalate	(a)	3080

* Equal to or less than amount found in blank.

TABLE D-17. LEVEL II ORGANIC ANALYSIS RESULTS - COMPOUNDS FOUND IN SAMPLE #309-2-CD-LE

Compound	Amount ($\mu g/m^3$)	Scan No.
Benzene	*	20
n-C_7 Hydrocarbon (Heptane)	1	32
Methyl Cyclohexane	*	44
Toluene	*	68
Unknown Unsat. Hydrocarbon	0.5	395
Silicone	1	517
Naphthalene	0.5	841
Silicone	3	894
n-C_{12} Hydrocarbon (Dodecane)	0.2	944
Methyl Naphthalene	0.2	1078
Methyl Naphthalene	0.2	1115
n-C_{13} Hydrocarbon (Tridecane)	0.6	1178
Chloronaphthalene	Internal Standard	1278
Silicone	15	1307
n-C_{14} Hydrocarbon (Tetradecane)	2	1418
n-C_{15} Hydrocarbon (Pentadecane)	2	1628
Dichloronaphthalene	I.S. Impurity	1649
Trimethylnaphthalene	1	1656
Silicone	38	1683
n-C_{16} Hydrocarbon (Hexadecane)	3	1818
C_{17} Branched Hydrocarbon	1	1911
n-C_{17} Hydrocarbon (Heptadecane)	16	1994
C_{18} Branched Hydrocarbon	2	2012
Silicone	2	2090

- Continued -

* Equal to or less than amount found in blank.

TABLE D-17. (Continued)

Compound	Amount ($\mu g/m^3$)	Scan No.
n-C_{18} Hydrocarbon (Octadecane)	4	2158
C_{19} Branched Hydrocarbon	1	2179
Silicone	10	2261
n-C_{19} Hydrocarbon (Nonadecane)	2	2314
Dibutylphthalate	1	2337
n-C_{20} Hydrocarbon (Eicosane)	1	2465
Silicone	5	2486
Silicone	6	2501
n-C_{21} Hydrocarbon (Heneicosane)	0.5	2610
Silicone	6	2727
Silicone	5	2935
Silicone	6	3132
Dioctylphthalate	3	3154
Silicone	11	3321
Silicone	9	3400
Silicone	19	3445

TABLE D-18. LEVEL II ORGANIC ANALYSIS RESULTS - COMPOUNDS FOUND IN SAMPLE #312-2-XRPF-MRPR

Compound	Amount ($\mu g/m^3$)	Scan No.
Benzene	*	20
Methylcyclohexane	*	40
Toluene	*	64
Xylene	24	163
Xylene	54	175
Xylene	26	207
Cyclohexane	26	216
C_9 Unsat. Hydrocarbon	24	226
n-C_9 Hydrocarbon (Nonane)	66	245
C_3 Benzene	18	261
Cyclohexane	26	285
Benzaldehyde	12	299
C_{10} Branched Hydrocarbon	38	306
C_{10} Branched Hydrocarbon	4	318
C_3 Benzene	80	325
C_3 Benzene	42	341
C_3 Benzene	44	357
C_{10} Branched Hydrocarbon	30	362
C_{10} Branched Hydrocarbon	32	374
C_3 Benzene	120	386
C_{10} Unsat. Hydrocarbon	62	392
C_{10} Unsat. Hydrocarbon	60	409
C_4 Benzene	18	420
n-C_{10} Hydrocarbon (Decane)	250	437
C_4 Benzene	22	445
Dihydroindene	15	459

- Continued -

* Equal to or less than amount found in blank.

TABLE D-18. (Continued)

Compound	Amount ($\mu g/m^3$)	Scan No.
Unknown	12	467
C_{11} Branched Hydrocarbon	72	484
C_{11} Unsat. Hydrocarbon	18	495
C_4 Benzene	48 †	506
C_4 Benzene	62 †	515
C_4 Benzene	28 †	521
C_4 Benzene	25 †	534
C_{11} Branched Hydrocarbon	12	542
Methyl Benzoate	*	547
C_{11} Unsat. Hydrocarbon	80	557
C_{11} Branched Hydrocarbon	110	560
C_{11} Branched Hydrocarbon	160	570
C_{11} Branched Hydrocarbon	80	581
C_{11} Unsat. Hydrocarbon	160	616
n-C_{11} Hydrocarbon (Undecane)	570	647
Decahydronaphthalene, 2-Methyl	44	671
C_5 Benzene	38	681
C_5 Benzene	180	702
C_5 Benzene	14	716
C_5 Benzene	22	734
Naphthalene	58 †	752
C_{12} Branched Hydrocarbon	86	761
C_{12} Branched Hydrocarbon	34	769
C_{12} Branched Hydrocarbon	162	781
C_{12} Branched Hydrocarbon	64	792

- Continued -

* Equal to or less than amount found in blank.

† Corrected for blank concentration. Amount actually present in sample rather questionable due to blank level variations.

TABLE D-18. (Continued)

Compound	Amount ($\mu g/m^3$)	Scan No.
C_5 Benzene	36	810
C_5 Benzene	110	831
n-C_{12} Hydrocarbon (Dodecane)	400	859
C_6 Benzene	10	870
C_6 Benzene	12	881
C_{13} Branched Hydrocarbon	114	888
Methyl Tetrahydronaphthalene	96	939
C_{13} Branched Hydrocarbon	62	970
Methylnaphthalene	330	989
Methylnaphthalene	240	1015
n-C_{13} Hydrocarbon (Tridecane)	470	1071
Chloronaphthalene	Internal Standard	1152
C_2 Unsat. Naphthalene	20	1158
C_2 Naphthalene	22	1190
C_2 Naphthalene	130	1219
C_2 Naphthalene	82	1227
C_2 Naphthalene	350	1247
n-C_{14} Hydrocarbon (Tetradecane)	440	1274
C_2 Naphthalene	140	1279
C_2 Naphthalene	54	1305
C_3 Unsat. Naphthalene	78	1366
C_{15} Unsat. Hydrocarbon	170	1392
n-C_{15} Hydrocarbon (Pentadecane)	490	1459
C_3 Naphthalene	44	1484
C_3 Naphthalene	72	1544
C_{16} Branched Hydrocarbon	60	1560
C_3 Naphthalene	72	1575

- Continued -

TABLE D-18. (Continued)

Compound	Amount ($\mu g/m^3$)	Scan No.
C_{16} Branched Hydrocarbon	120	1619
n-C_{16} Hydrocarbon (Hexadecane)	350	1634
C_{17} Branched Hydrocarbon	48	1663
C_{17} Branched Hydrocarbon	190	1723
n-C_{17} Hydrocarbon (Heptadecane)	260	1809
C_{13} Unsat. Hydrocarbon	200	1825
Phenanthrene (or isomer)	28	1862
Phenanthrene (or isomer)	10	1867
n-C_{18} Hydrocarbon (Octadecane)	220	1973
C_{19} Branched Hydrocarbon	100	1993
Methylphenanthrene (or isomer)	22	2062
n-C_{19} Hydrocarbon (Nonadecane)	200	2135
n-C_{20} Hydrocarbon (Eicosane)	100	2288
n-C_{21} Hydrocarbon (Heneicosane)	66	2435
Dioctylphthalate	42†	2948

TABLE D-20. LEVEL II ORGANIC ANALYSIS RESULTS - COMPOUNDS FOUND IN SAMPLE #313-2-XRPF-MRPR

Compound	Amount ($\mu g/m^3$)	Scan No.
Benzene	*	23
Methylcyclohexane	*	43
Toluene	*	69
C_9 Unsat. Hydrocarbon	16	100
C_2 Benzene	38	172
C_2 Benzene	110	184
C_9 Branched Hydrocarbon	12	198
C_2 Benzene	56	215
C_3 Cyclohexane	62	224
C_9 Unsat. Hydrocarbon	64	234
n-C_9 Hydrocarbon (Nonane)	170	253
C_3 Benzene	38	271
C_4 Cyclohexane	48	294
C_{10} Branched Hydrocarbon	240	315
C_{10} Branched Hydrocarbon	200	339
C_3 Benzene	76	351
C_3 Benzene	66	370
C_{10} Unsat. Hydrocarbon	44	387
C_3 Benzene	320	399
C_{10} Unsat. Hydrocarbon	150	423
C_3 Benzene	34	435
n-C_{10} Hydrocarbon (Decane)	250	450
C_3 Benzene	30	454
C_4 Benzene	40	458
C_{11} Branched Hydrocarbon	140	499
C_{11} Unsat. Hydrocarbon	40	510

- Continued -

* Equal to or less than amount found in blank.

TABLE D-19. LEVEL II ORGANIC ANALYSIS RESULTS - COMPOUNDS FOUND IN SAMPLE 312-2-CD-LE

Compound	Amount ($\mu g/m^3$)	Scan No.
Benzene	*	23
Methyl Cyclohexane	*	42
Toluene	*	58
Chloronaphthalene	Internal Standard	111
n-C_{14} Hydrocarbon (Tetradecane)	1	1247
n-C_{15} Hydrocarbon (Pentadecane)	2	1451
n-C_{16} Hydrocarbon (Hexadecane)	4	1636
C_{17} Branched Hydrocarbon	1	1731
n-C_{17} Hydrocarbon (Heptadecane)	6	1811
C_{18} Branched Hydrocarbon	2	1828
n-C_{18} Hydrocarbon (Octadecane)	6	1977
C_{19} Branched Hydrocarbon	2	1997
n-C_{19} Hydrocarbon (Nonadecane)	4	2133
n-C_{20} Hydrocarbon (Eicosane)	2	2288
n-C_{21} Hydrocarbon (Heneicosane)	2	2438
n-C_{22} Hydrocarbon (Docosane)	Trace	2582
Dioctylphthalate	6	2983

* Equal to or less than amount found in blank.

Trace - Detected but too low to quantitate (0.05 - 1.0 $\mu g/m^3$).

TABLE D-20. (Continued)

Compound	Amount (μg/m^3)	Scan No.
C_4 Benzene	78†	522
C_4 Benzene	128†	531
C_4 Benzene	40†	538
C_4 Benzene	34†	552
Methylbenzoate	*	556
C_4 Benzene	10†	559
C_4 Benzene	190	578
C_{11} Unsat. Hydrocarbon	290	589
C_{11} Branched Hydrocarbon	120	601
C_{11} Unsat. Hydrocarbon	630	638
n-C_{11} Hydrocarbon (Undecane)	950	668
C_{12} Branched Hydrocarbon	140	704
C_5 Benzene	22	725
C_5 Benzene	42	736
C_5 Benzene	68	766
Naphthalene	220†	778
C_{12} Unsat. Hydrocarbon	66	793
C_2 Indene	150	803
C_2 Indene	66	814
C_{12} Unsat. Hydrocarbon	340	853
n-C_{12} Hydrocarbon (Dodecane)	680	881
C_{13} Unsat. Hydrocarbon	200	910
C_{13} Branched Hydrocarbon	66	925
Unknown Substituted Cyclohexane	80	940
Tetrahydromethyl Naphthalene	150	955
C_{13} Branched Hydrocarbon	120	991

- Continued -

* Equal to or less than amount found in blank.

† Corrected for blank concentration. Amount actually present in sample rather questionable due to blank level variations.

TABLE D-20. (Continued)

Compound	Amount ($\mu g/m^3$)	Scan No.
Methylnaphthalene	450	1011
C_{13} Unsat. Hydrocarbon	120	1027
C_{13} Unsat. Hydrocarbon	328	1036
Methylnaphthalene	140	1042
C_{13} Unsat. Hydrocarbon	48	1061
C_2 Tetrahydronaphthalene	82	1072
n-C_{13} Hydrocarbon (Tridecane)	810	1088
Chloronaphthalene	Internal Standard	1170
Biphenyl	36	1174
C_{14} Branched Hydrocarbon	130	1190
C_2 Naphthalene	150	1207
C_{14} Branched Hydrocarbon	160	1216
C_2 Naphthalene	210	1234
C_{14} Branched Hydrocarbon	150	1246
C_2 Naphthalene	560	1263
n-C_{14} Hydrocarbon (Tetradecane)	840	1291
C_2 Naphthalene	20	1298
Unknown	76	1307
C_2 Naphthalene	150	1322
C_{15} Branched Hydrocarbon	54	1353
C_{15} Branched Hydrocarbon	140	1366
Methyl Biphenyl	120	1383
Methyl Biphenyl	30	1399
C_{15} Branched Hydrocarbon	350	1411
C_3 Naphthalene	180	1424
C_3 Naphthalene	150	1468
n-C_{15} Hydrocarbon (Pentadecane)	1000	1483

- Continued -

TABLE D-20. (Continued)

Compound	Amount ($\mu g/m^3$)	Scan No.
C_3 Naphthalene	130	1512
C_3 Naphthalene	120	1533
C_3 Naphthalene	92	1571
C_{16} Branched Hydrocarbon	140	1586
Methyl Biphenyl	130	1600
Unknown	100	1630
Alkyl Subst. Cyclopentanedione	160	1645
n-C_{16} Hydrocarbon (Hexadecane)	690	1665
C_4 Naphthalene	28	1746
C_{17} Hydrocarbon Branched	410	1758
C_{17} Hydrocarbon Branched	98	1775
C_{17} Unsat. Hydrocarbon	100	1821
n-C_{17} Hydrocarbon (Heptadecane)	540	1834
C_{18} Unsat. Hydrocarbon	500	1855
Phenanthrene (or Isomer)	92	1893
n-C_{18} Hydrocarbon (Octadecane)	580	2009
C_{19} Branched Hydrocarbon	260	2028
Methylphenanthrene (or isomer)	Trace	2088
n-C_{19} Hydrocarbon (Nonadecane)	490	2169
n-C_{20} Hydrocarbon (Eicosane)	360	2321
Pyrene (or isomer)	Trace	2410
n-C_{21} Hydrocarbon (Heneicosane)	210	2470
n-C_{22} Hydrocarbon (Doeicosane)	110	2616
Dioctylphthalate	1200†	3013

†Corrected for blank concentration. Amount actually present in sample rather questionable due to blank level variations.

Trace - Detected but too low to quantitate (0.05 - 1.0 $\mu g/m^3$).

TABLE D-21. LEVEL II ORGANIC ANALYSIS RESULTS - COMPOUNDS FOUND IN SAMPLE 313-2-CD-LE

Compound	Amount ($(\mu g/m^3)$)	Scan No.
Benzene	*	27
Methylcyclohexane	*	45
Toluene	*	92
Chloronaphthalene	Internal Standard	1259
C_{14} Branched Hydrocarbon	2	1541
n-C_{14} Hydrocarbon (Tetradecane)	2	1582
n-C_{15} Hydrocarbon (Pentadecane)	2	1765
n-C_{16} Hydrocarbon (Hexadecane)	2	1938
C_{17} Branched Hydrocarbon	2	1957
n-C_{17} Hydrocarbon (Heptadecane)	1	2107
n-C_{18} Hydrocarbon (Octadecane)	2	2270
Dioctylphthalate	22	3188

* Equal to or less than amount found in blank.

ADDITIONAL DATA

TABLE 1. SUMMARY OF RESULTS OF EMISSIONS ASSESSMENT FOR GAS-FUELED INTERNAL COMBUSTION SOURCES

Pollutant	Gas-Fueled Gas Turbines				Gas Reciprocating Engines			
	Elec. Gen.		Industrial		Elec. Gen.		Industrial	
	Emission Factor (ng/J)	Severity Factor	Emission Factor (ng/J)	Severity Factor	Emission Factor (ng/J)	Severity Factor	Emission Factor (ng/J)	Severity Factor
NO_x	168	0.17	130	0.52	1549	7.1	1549	5.7
Total hydrocarbons	23.2	0.020	8.6	0.025	528	1.7	528	1.3
CO	64.8	0.0003	48.8	0.0007	340	0.0051	340	0.0040
Particulate	5.1	0.0019	5.1	0.0062	5.7	0.0068	5.7	0.0055
SO_x	0.26	<0.0001	0.26	<0.0001	0.26	0.0002	0.26	0.0002

TABLE 2. SUMMARY OF RESULTS OF EMISSIONS ASSESSMENT FOR OIL-FUELED INTERNAL COMBUSTION SOURCES

Pollutant	Distillate Oil-Fueled Gas Turbines				Distillate Oil Reciprocating Engines			
	Elec. Gen.		Industrial		Elec. Gen.		Industrial	
	Emission Factor (ng/J)	Severity Factor	Emission Factor (ng/J)	Severity Factor	Emission Factor (ng/J)	Severity Factor	Emission Factor (ng/J)	Severity Factor
NO_x	311	0.32	207	0.83	1392	6.4	1392	5.1
Total hydrocarbons	17.5	0.015	3.6	0.010	52	0.16	52	0.13
CO	43.8	0.0002	101	0.0014	266	0.0040	266	0.0032
Particulate	13.0	0.0049	13.0	0.016	14.1	0.019	14.1	0.015
SO_x	33.1	0.0089	33.1	0.029	101	0.097	101	0.077
SO_3	1.5	0.056	1.5	0.18	1.8	0.23	1.8	0.18
Trace Elements								
Copper	0.58	0.085	0.58	0.28	0.45	0.23	0.45	0.20
Nickel	0.53	0.16	0.53	0.51	0.56	0.60	0.56	0.48
Phosphorus	0.13	0.037	0.13	0.12	0.097	0.10	0.097	0.082

TABLE 23. CHARACTERISTICS OF INTERNAL COMBUSTION SITES TESTED

Combustion Source Type	Site No.	Engine Model*	Rated Capacity Base Load	Peak Load	Age	Pollution Control Device
Gas Turbine	#110	TPM FT 4A-11DF	20.6 MW	22.6 MW	5 Years	None
Distillate Oil Turbine	#111	TPM FT 4A-11DF	20.6 MW	22.6 MW	5 Years	CI-2 Fuel Additive
	#112	TPM GG 4C-1D-DF	28 MW	30 MW	4 Years	None
	#306	TPM FT 4A-8LF	14.5 MW	22 MW	8 Years	CI-2 Fuel Additive
	#307	TPM FT 4A-8LF	14.5 MW	22 MW	8 Years	CI-2 Fuel Additive
	#308	TPM FT 4A-11LF	20.2 MW	26 MW	5 Years	None
Distillate Oil Reciprocating Engine	#309	EMD 64-5E4	2.5 MW	2.75 MW	8 Years	None
	#310	EMD 64-5E4	2.5 MW	2.75 MW	8 Years	None
	#311	EMD 64-5E4	2.5 MW	2.75 MW	8 Years	None
	#312	EMD 654	2.5 MW	2.75 MW	1 Year	None
	#313	EMD 654	2.5 MW	2.75 MW	1 Year	None

* TPM - Turbo Power and Marine Systems
EMD - Electromotive Division of General Motors

TABLE 29. OPERATING LOAD AND FUEL FEED RATES OF INTERNAL COMBUSTION SOURCES TESTED

Combustion Source Type	Site No.	Operating Load	% Base Load	Fuel Used	Fuel Rate	Energy Input
Gas Turbine	#110	19.5 MW	94.7%	Natural Gas	7,100 Nm^3/hr	294 GJ/hr
Distillate Oil Turbine	#111	18.0 MW	87.4%	JP-5	7.50 m^3/hr	278 GJ/hr
	#112	22.5 MW	80.4%	JP-5	8.18 m^3/hr	303 GJ/hr
	#306	14.5 MW	100 %	JP-5	5.49 m^3/hr	204 GJ/hr
	#307	14.5 MW	100 %	JP-5	5.49 m^3/hr	204 GJ/hr
	#308	20.2 MW	100 %	JP-5	7.77 m^3/hr	288 GJ/hr
Distillate Oil Reciprocating Engine	#309	2.5 MW	100 %	No. 2 Diesel	0.70 m^3/hr	26.2 GJ/hr
	#310	2.5 MW	100 %	No. 2 Diesel	0.70 m^3/hr	26.2 GJ/hr
	#311	2.5 MW	100 %	No. 2 Diesel	0.70 m^3/hr	26.2 GJ/hr
	#312	2.5 MW	100 %	No. 2 Diesel	1.02 m^3/hr	39.9 GJ/hr
	#313	2.5 MW	100 %	No. 2 Diesel	1.02 m^3/hr	39.9 GJ/hr
	#309-2	2.5 MW	100 %	No. 2 Diesel	0.70 m^3/hr	26.2 GJ/hr
	#312-2	2.5 MW	100 %	No. 2 Diesel	1.02 m^3/hr	39.9 GH/hr
	#313-2	2.5 MW	100 %	No. 2 Diesel	1.02 m^3/hr	39.9 GJ/hr

TABLE 31. SUMMARY OF RESULTS FROM SPECIFIC INORGANIC ANALYSES

Combustion Source Type	Site No.	Mass Emissions (mg/m^3)						
		Hg	As	Sb	SO_4*	Cl	F	NO_3*
Gas Turbine	110	0.0091	<0.0014	<0.0016	-	0.89	-	-
Distillate Oil Turbine	111	0.00018	<0.0056	<0.0046	-	4.9	0.010	0.029
	112	0.0014	<0.0033	0.013	0.23	2.5	0.049	0.018
	306	<0.00074	<0.00009	0.0017	0.035	-	-	-
	307	0.0016	<0.00011	0.0019	0.018	-	-	-
	308	<0.00033	<0.00019	<0.00016	0.068	-	-	-
Distillate Oil Reciprocating Engine	309	0.00016	<0.00012	<0.00020	0.74	-	-	-
	310	0.00077	<0.00017	<0.0019	0.74	-	-	-
	311	<0.00091	<0.00020	<0.00024	0.98	-	-	-
	312	0.00003	<0.00011	<0.00030	0.50	-	-	-
	313	<0.0011	<0.00011	<0.00019	0.74	-	-	-

*Values are from particulate samples only.

NOTE: This table is a summary of Tables D-1, D-3, D-4, and D-10 from the document.

TABLE 35. GRAVIMETRIC RESULTS FOR INTERNAL COMBUSTION SITES

Sample Identification Number	Residue Weight (mg)	Aliquot Factor	Total Weight (mg)	Blank Corrected Weight (mg)	Net Sample Nonvolatile Content (mg/m³)
110-XR-Wet-S-KD-2	11.7	x 10	117.2	0	0
110-XR-Dry-S-KD-2	9.9	x 10	98.8		
110-PR-0-KD-2	0.4	x 10	3.7	3.4	0.1
110-XM-S-KD-2	0.6	x 10	6.5	6.0	0.2
111-XR-S-KD-2	38.7	x 10	386.7	147.9	4.9
111-PR-0-KD-2	4.3	x 10	43.3	42.8	1.4
111-XM-S-KD-2	0.6	x 10	6.4	6.0	0.2
111-PF-S-KD-2	1.0	x 10	9.8	8.6	0.3
112-XR-Wet-S-KD-2	19.4	x 10	194.0	107.8	3.3
112-XR-Dry-S-KD-2	15.3	x 10	152.6		
112-PR-0-KD-2	0.4	x 10	3.7	3.4	0.1
112-XM-S-KD-2	1.0	x 10	10.0	9.7	0.3
306-PR	0.5	0.2 x 0.75	3.33	1.11	0.03
306-MR	0.6	0.2 x 0.75	4.00	1.78	0.05
306-XR	3.8	0.2 x 0.95	20.00	12.8	0.35
306-PF	0.1	0.2 x 0.49 x 0.75	1.36	0.30	0.01
306-CDS[a]					

[a]Not analyzed because of small condensate volume.

(Continued)

TABLE 35. (CONTINUED)

Sample Identification Number	Residue Weight (mg)	Aliquot Factor	Total Weight (mg)	Blank Corrected Weight (mg)	Net Sample Nonvolatile Content (mg/m^3)
307-PR	0.5	0.2 x 0.75	3.33	0	0
307-MR	0.7	0.2 x 0.75	4.67	0	0
307-XR	8.2	0.2 x 0.95	43.16	43.16	1.40
307-PF	0.1	0.2 x 0.50	1.00	0	0
307-CDS	0.5	0.2 x 0.75 x 0.67	4.98	0	0
308-PR	0.7	0.2 x 0.75	4.66	4.66	0.15
308-MR	1.0	0.2 x 0.75	6.67	6.67	0.22
308-XR	5.5	0.2 x 0.95	28.95	21.99	0.71
308-PF	0.1	0.2 x 0.51	0.01	0.01	0
308-CDS	0.5	0.2 x 0.75 x $\frac{100}{178}$	5.93	5.93	0.19
309-PR	0.7	0.2 x 0.75	4.67	4.67	0.16
309-MR	74.6	0.2 x 0.75	497.33	497.33	17.47
309-XR	208.2	0.2 x 0.95	1,095.79	1,080.19	37.95
309-PF	0.0	0.2 x 0.47 x 0.75	0.00	0.00	0.00
309-CDS	1.5	0.2 x 0.75 x $\frac{150}{248}$	17.20	17.20	0.60
310-PR	0.7	0.2 x 0.75	8.67	1.89	0.07
310-MR	77.3	0.2 x 0.75	515.33	505.61	17.88
310-XR	199.2	0.2 x 0.95	1,048.42	1,004.72	35.52
310-PF	1.1	0.2 x 0.53	10.38	6.78	0.25
310-CDS	1.0	0.2 x 0.75 x $\frac{250}{258}$	12.93	4.53	0.16

(Continued)

TABLE 35. (CONTINUED)

Sample Identification Number	Residue Weight (mg)	Aliquot Factor	Total Weight (mg)	Blank Corrected Weight (mg)	Net Sample Nonvolatile Content (mg/m^3)
311-PR	2.9	0.2 x 1.00	14.50	11.32	0.39
311-MR	72.2	0.2 x 0.75	481.33	477.77	16.56
311-XR	125.8	0.2 x 0.95	662.11	634.84	21.98
311-PF	10.2	0.2 x 0.50	102.00	100.2	3.47
311-CDS	2.1	0.2 x 1.0 x 0.5085	20.65	18.65	0.64
312-PR	1.0	0.2 x 0.75	6.67	3.73	0.12
312-MR	131.6	0.2 x 0.75	877.33	873.12	29.17
312-XR	196.5	0.2 x 0.95	1,034.21	1,007.57	33.66
312-PF	0.6	0.2 x 1.0 x 0.5028	5.97	4.17	0.14
312-CDS	2.3	0.2 x 0.75 x $\frac{400}{542}$	20.78	15.04	0.50
313-PR	2.0	0.2 x 0.75	13.33	1.69	0.06
313-MR	49.7	0.2 x 0.25	994.00	991.00	32.94
313-XR	78.6	0.2 x 0.95	413.68	392.89	13.06
313-PF	0.6	0.2 x 1.0 x 0.4471	6.71	1.25	0.04
313-CDS	4.1	0.2 x 0.75 x 0.6947	39.35	17.33	0.58

TABLE 41. POM EMISSIONS FROM DIESEL ENGINE SITES 309-313* ($\mu g/m^3$)

Compound	309	309-2	310	311	312	312-2	313	313-2
Naphthalene	16	170	18	36	BL	58	3	220
Methylnaphthalenes	BL	461	22	BL	BL	570	BL	590
C_2-substituted naphthalenes	30	506	12	64	BL	798	BL	1090
C_3-substituted naphthalenes	8	631	4	BL	BL	266	BL	672
C_4-substituted naphthalenes	BL	462	BL	BL	BL	BL	BL	28
C_5-substituted naphthalenes	BL	120	BL	BL	BL	BL	BL	BL
Biphenyl	2	T+	6	10	BL	BL	15	37
Methylbiphenyls	BL	BL	BL	BL	BL	BL	BL	150
C_3-substituted biphenyls	BL	BL	BL	BL	BL	BL	BL	BL
Dibenzothiophene	5	BL	2	BL	BL	BL	BL	BL
Methyldibenzothiophenes	BL	BL	0.8	BL	BL	BL	BL	BL
Phenanthrene	8	94	3	BL	BL	38	BL	92
Methylphenanthrenes	20	86	8	60	77	22	150	T
Dimethylphenanthrenes	4	BL	0.8	24	46	BL	58	BL
Trimethylphencenthrenes	BL	BL	2	BL	12	BL	15	BL
Ethylfluorene	BL	24	BL	BL	BL	BL	BL	BL
Pyrene	BL	T	BL	BL	BL	BL	BL	T
Detection limit, $\mu g/m^3$	0.08	0.05	0.08	0.08	0.08	0.05	0.1	0.05

*POMs were found only in XAD-2/XAD-2 module rinse samples

+T indicates trace, 0.5-1.0 $\mu g/m^3$

NOTE: This table is a summary of Tables D-16 through D-21 from the document.

TABLE 42. SUMMARY OF EMISSION FACTOR DATA FOR PARTICULATE, SO_x AND TOTAL ORGANICS FROM INTERNAL COMBUSTION SOURCES TESTED

Combustion Source Type	Site No.	Emission Factor, ng/J Particulate	SO_x	Total Organics
Gas-Fueled Gas Turbine	#110	ND	ND	11.1
Distillate Oil-Fueled Gas Turbine	#111	21.4	28.5	27.9
	#112	4.2	30.6	9.0
	#306	2.1	<4.2	57.8
	#307	2.6	<4.2	2.8
	#308	4.9	<4.2	7.5
	Mean $\bar{x}$	7.0	14.3	21.0
	$s(\bar{x})$	3.6	6.2	10.2
	$ts(\bar{x})/\bar{x}$	1.4298	1.2038	1.3425
Distillate Oil Reciprocating Engine	#309	11.0	83.1	47.7
	#310	20.8	153.1	65.9
	#311	33.0	153.1	74.1
	#312	6.6	61.2	54.6
	#313	10.0	74.3	54.4
	#309-2	10.8	83.3	58.2
	#312-2	8.8	106.3	45.8
	#313-2	11.5	97.0	54.4
	Mean $\bar{x}$	14.1	101.4	56.9
	$s(\bar{x})$	3.1	12.2	3.3
	$ts(\bar{x})/\bar{x}$	0.5176	0.2856	0.1366

ND. - Not determined

$s(\bar{x})$ = Standard deviation of the mean

$ts(\bar{x})/\bar{x}$ = Variability

TABLE 43. COMPARISON OF CRITERIA POLLUTANT EMISSIONS FACTORS FOR GAS AND DISTILLATE OIL-FUELED GAS TURBINES

Combustion Source Type	Data Source	Emission Factor, ng/J				
		NO_x	HC	CO	Part	SO_x
Industrial Gas-Fueled Gas Turbines	Existing Data	130	8.6	48.8	ND	ND
	EPA	123	9.4	49.1	ND	0.26
Industrial Distillate Oil-Fueled Gas Turbines	Existing Data	207	3.6	101	ND	ND
	EPA	208	17.0	47.1	15.3	430S
Electricity Generation Gas-Fueled Gas Turbines	Current Study	ND	11.1	ND	ND	ND
	Existing Data	168	15.0	29.7	5.1	4.4
	Combined Existing Data & Current Study	168	14.7	29.7	5.1	4.4
	EPA	169	17.2	47.0	5.7	0.26
Electricity Generation Distillate Oil-Fueled Gas Turbines	Current Study	ND	21.0	ND	7.0	14.3
	Existing Data	311	4.6	20.1	15.5	41.0
	Combined Existing Data & Current Study	311	11.1	20.1	13.0	33.1
	EPA	208	17.0	47.1	15.3	430S

ND - No data

S - Weight percent of sulfur in fuel

TABLE 44. COMPARISON OF CRITERIA POLLUTANT EMISSION FACTORS FOR GAS AND DISTILLATE OIL ENGINES

Combustion Source Type	Data Source	Emission Factor, ng/J				
		NO_x	HC	CO	Part	SO_x
Industrial Gas Engines	Existing Data	1550	528	340	ND	ND
	EPA	1390	573	176	ND	0.26
Industrial Distillate Oil Engines	Existing Data	1390	51	266	ND	ND
	EPA	1420	115	312	102	430S
Electricity Generation Gas Engines	Existing Data	1550	528	340	ND	ND
	EPA	1230	17	47	5.7	0.26
Electricity Generation Distillate Oil Engines	Current Study	ND	56.9	ND	14.1	101
	Existing Data	1390	51	266	ND	ND
	Combined Existing Data and Current Study	1390	52	266	14.1	101
	EPA	1420	115	312	102	430S

ND - No data

S - Weight percent of sulfur in fuel

TABLE 45. MEAN SOURCE SEVERITY FACTORS FOR CRITERIA POLLUTANTS

	Gas Turbine				Reciprocating Engine			
Pollutant	Industrial Gas	Industrial Distillate Oil	Elec. Gen. Gas	Elec. Gen. Distillate Oil	Industrial Gas	Industrial Distillate Oil	Elec. Gen. Gas	Elec. Gen. Distillate Oil
NO_x	0.52	0.82	0.17	0.32	5.66	5.09	7.09	6.35
HC	0.025	0.010	0.021	0.052	1.33	0.13	1.65	0.16
CO	0.0007	0.0014	0.0003	0.0002	0.0040	0.0032	0.0051	0.0040
Particulate	0.097	0.016	0.0019	0.0049	0.0055	0.015	0.0068	0.019
SO_x	<0.0001	0.029	<0.0001	0.0089	0.0002	0.078	0.0002	0.097

TABLE 46. SUMMARY OF EMISSION FACTOR DATA FOR PARTICULATE SULFATE FROM INTERNAL COMBUSTION SOURCES TESTED*

Combustion Source Type	Site No.	Emission Factor (ng/J)	Sulfur in Particulate $SO_4^=$ / Sulfur in Fuel
Distillate Oil Fueled Gas Turbine	#112	0.335	0.731%
	#306	0.030	>0.476%
	#307	0.011	>0.175%
	#308	0.077	>1.222%
	Mean $\bar{x}$	0.113	0.651%
	$s(\bar{x})$	0.075	0.222%
	$ts(\bar{x})/\bar{x}$	2.1143	1.0835
Distillate Oil Reciprocating Engine	#309	0.383	0.308%
	#310	0.520	0.226%
	#311	0.971	0.423%
	#312	0.268	0.292%
	#313	0.468	0.420%
	Mean $\bar{x}$	0.522	0.334%
	$s(\bar{x})$	0.120	0.038%
	$ts(\bar{x})/\bar{x}$	0.6385	0.3190

The particulate sulfate data reported include metallic sulfates and a small amount of condensed sulfuric acid aerosols.

$s(\bar{x})$ - Standard deviation of the mean.

$ts(\bar{x})/\bar{x}$ - Variability.

TABLE 47 SUMMARY OF EMISSION FACTOR DATA FOR TRACE ELEMENTS FROM ELECTRICITY GENERATION DISTILLATE OIL-FUELED GAS TURBINES TESTED

Trace Element	Emission Factor, pg/J								
	Site 111	Site 112	Site 306	Site 307	Site 308	$\bar{x}$	$s(\bar{x})$	$\frac{ts(\bar{x})}{\bar{x}}$	$\bar{x}_u$
Pb	27	90	59	< 46	84	61	11	0.53	-
Ba	29	293	13	0.07	8	12.6	6.2	1.55	32
Sb*	< 5.2	< 5.2	< 2.0	< 2.1	14.5	5.8	2.3	1.09	12
Sn	2.7	42	115	3.6	9.6	35	21	1.71	94
Cd	2.9	3.8	1.0	0.3	5.8	2.8	0.98	0.99	5.5
Mo	1.9	2.8	3.6	2.9	6.7	3.6	0.82	0.64	-
Br	< 11.5	7.1	6.9	< 0.07	1.8	5.5	2.0	1.04	11
Se	2.3	< 5.2	1.9	0.3	1.9	2.3	0.81	0.96	4.6
As*	< 0.31	< 0.31	< 2.0	< 2.1	< 2.1	< 1.4	0.43	0.87	2.6
Zn	251	607	314	<201	96	294	86	0.81	533
Cu	65	649	649	649	879	578	136	0.65	-
Ni	67	94	1110	461	900	526	210	1.11	1110
Co	1.1	1.6	7.3	3.8	5.7	3.9	1.2	0.84	7.2
Fe	377	356	419	5	124	256	81	0.88	481
Mn	1487	8.6	188	335	4.9	405	277	1.90	1175
Cr	2.7	38	12	15	31	20	6.5	0.91	38
V	1.3	1.7	9.8	2.7	< 1.1	3.3	1.7	1.37	7.9

(Continued)

TABLE 47. (CONTINUED)

Trace Element	Emission Factor, pg/J								
	Site 111	Site 112	Site 306	Site 307	Site 308	$\bar{x}$	$s(\bar{x})$	$\frac{ts(\bar{x})}{\bar{x}}$	$\bar{x}_u$
Ca	314	460	565	<107	205	330	83	0.70	-
K	335	230	118	<107	135	185	43	0.65	-
P	184	92	230	< 46	80	127	35	0.76	223
Si	1256	110,970	533	< 30	482	575	254	1.40	1382
Al	57	293	< 59	< 50	90	64	8.9	0.44	-
Mg	<230	1068	152	< 63	61	127	41	1.02	256
Na	691	6280	<440	<460	768	590	82	0.44	-
B	82	3770	< 15	< 2.3	< 12	28	18	2.08	86
Be	< 0.044	0.11	< 0.12	< 0.14	< 0.38	0.16	0.06	1.02	0.32
Hg*	0.84	10	0.50	0.15	0.06	0.39	0.18	1.46	0.95

* Sb, As, and Hg emissions were determined by AA.

$\bar{x}$ = Mean emission factor

$s(\bar{x})$ = Standard deviation of the mean.

$ts(\bar{x})/\bar{x}$ = Variability.

$\bar{x}_u = \bar{x} + ts(\bar{x})$.

TABLE 48. SUMMARY OF EMISSION FACTOR DATA FOR TRACE ELEMENTS FROM ELECTRICITY GENERATION DISTILLATE OIL-FUELED GAS TURBINES BASED ON COMBINED CURRENT STUDY AND EXISTING DATA

Trace Element	Mean Emission Factor $\bar{x}$ (pg/J)	$s(\bar{x})$ (pg/J)	$\frac{ts(\bar{x})}{\bar{x}}$	$\bar{x}_u$ (pg/J)
Pb	25	7.8	0.67	-
Ba	8.4	2.6	0.68	-
Cd	1.8	0.52	0.62	-
Mn	145	99	1.46	357
V	1.9	0.63	0.70	-
Mg	100	27	0.65	-
Be	0.14	0.03	0.46	-

$s(\bar{x})$ - Standard deviation of the mean.

$ts(\bar{x})/\bar{x}$ - Variability.

$\bar{x}_u = \bar{x} + ts(\bar{x})$. $\bar{x}_u$ values are not computed for trace element emissions with $ts(\bar{x})/\bar{x} \leq 0.7$.

TABLE 49. MEAN SOURCE SEVERITY FACTORS FOR TRACE ELEMENT EMISSIONS FROM DISTILLATE OIL-FUELED GAS TURBINES

Trace Element	Emission Factor (pg/J)	TLV (mg/m^3)	Mean Source Severity Factor: Elec. Gen. Distillate Oil-Fueled Gas Turbine	Mean Source Severity Factor: Industrial Distillate Oil-Fueled Gas Turbine
Cu	578	0.20	0.085	0.28
Ni	526	0.10	0.16	0.51
P	127	0.10	0.037	0.12

Trace Element	Emission Factor, pg/J								
	Site 309	Site 310	Site 311	Site 312	Site 313	$\bar{x}$	$s(\bar{x})$	$\frac{ts(\bar{x})}{\bar{x}}$	$\bar{x}_u$
Pb	33	34	14	27	22	26	3.7	0.40	-
Ba	4.7	3.0	<13.8	12.9	33.3	14	5.4	1.11	28
Sb*	6.4	< 2.2	< 2.2	< 2.2	44.4	12	8.3	2.00	35
Sn	6.4	<11.3	7.1	10.0	<10.7	9.1	1.0	0.30	-
Cd	< 3.3	2.1	< 1.9	2.3	5.8	3.1	0.72	0.64	-
Mo	33	14	3	10	2	12	5.6	1.25	28
Br	5.2	2.2	< 6.7	2.0	4.1	4.0	0.89	0.61	-
Se	0.8	< 1.5	< 1.1	3.7	< 3.6	2.1	0.62	0.81	3.9
As*	< 2.2	< 2.2	< 2.2	< 2.2	< 2.2	2.2	0.01	0.01	-
Zn	147	15	88	377	63	178	56	0.88	334
Cu	644	533	422	244	422	453	66	0.41	-
Ni	955	422	622	444	375	563	106	0.52	-
Co	6.0	8.0	10.0	3.6	1.1	5.7	1.6	0.77	10.1
Fe	<488	38	211	<333	<555	325	94	0.80	585
Mn	20.9	26.6	5.3	19.8	8.0	16	3.9	0.68	-
Cr	33	47	13	31	6	26	7.4	0.79	46
V	0.78	2.44	0.51	0.76	0.25	0.95	0.39	1.13	2.02

(Continued)

TABLE 50. (CONTINUED)

Trace Element	Emission Factor, pg/J								
	Site 309	Site 310	Site 311	Site 312	Site 313	$\bar{x}$	$s(\bar{x})$	$\frac{ts(\bar{x})}{\bar{x}}$	$\bar{x}_u$
Ca	<178	73	89	133	710	237	120	1.41	569
K	<344	134	97	175	146	179	43	0.67	-
P	< 93	133	100	40	120	97	16	0.46	-
Si	<733	<191	189	229	165	301	108	1.00	602
Al	62	100	69	< 40	58	66	9.7	0.41	-
Mg	< 91	35	< 5	44	37	44	15	0.95	85
Na	1110	511	5330	<287	<889	1625	937	1.60	4226
B	< 33	11	< 5.1	< 4.2	2.7	11	5.7	1.41	27
Be	< 0.052	0.031	< 0.018	< 0.009	0.029	0.028	0.007	0.73	0.048
Hg*	0.07	0.20	0.16	0.16	0.09	0.13	0.02	0.51	-

* Sb, As, and Hg emissions were determined by AA.

$\bar{x}$ - Mean emission factor.

$s(\bar{x})$ - Standard deviation of the mean.

$ts(\bar{x})/\bar{x}$ - Variability.

$\bar{x}_u = \bar{x} + ts(\bar{x})$.

TABLE 51. MEAN SOURCE SEVERITY FACTORS FOR TRACE ELEMENT EMISSIONS FROM DISTILLATE OIL ENGINES

Trace Element	Emission Factor (pg/J)	TLV (mg/m^3)	Mean Source Severity Factor: Elec. Gen. Distillate Oil Engine	Mean Source Severity Factor: Industrial Distillate Oil Engine
Cu	453	0.20	0.23	0.20
Ni	563	0.10	0.60	0.48
[illegible]	97	0.10	0.10	0.082

TABLE 52. COMPARISON OF TRACE ELEMENT EMISSION FACTORS FOR DISTILLATE OIL-FUELED GAS TURBINES AND DISTILLATE OIL ENGINES

Trace Element	Mean Emission Factor, pg/J Distillate Oil Fueled Gas Turbine	Mean Emission Factor, pg/J Distillate Oil Reciprocating Engine
Aluminum	64	66
Antimony	9.4	12
Arsenic	2.1	2.2
Barium	8.4	14
Beryllium	0.14	0.03
Boron	28	11
Bromine	1.8	4.0
Cadmium	1.8	3.1
Calcium	330	237
Chromium	20	26
Cobalt	3.9	5.7
Copper	578	453
Iron	256	325
Lead	25	26
Magnesium	100	44
Manganese	145	16
Mercury	0.39	0.13
Molybdenum	3.6	12.5
Nickel	526	564
Phosphorus	127	97
Potassium	185	179
Selenium	2.3	2.1
Silicon	575	301
Sodium	590	1625
Tin	35	9.1
Vanadium	1.9	0.95
Zinc	294	178

TABLE 53. SUMMARY OF POM EMISSION FACTOR DATA FROM ELECTRICITY GENERATION DISTILLATE OIL ENGINES TESTED*

Compound	Emission Factor (pg/J)											
	Site 309	Site 310	Site 311	Site 312	Site 313	Site 309-2	Site 312-2	Site 313-2	$\bar{x}$	$s(\bar{x})$	$\frac{ts(\bar{x})}{\bar{x}}$	$\bar{x}_u$
Naphthalene	8.4	12.7	35.8	-	1.9	124.5	34.5	131.9	43.7	19.0	1.03	88.8
Methyl Naphthalene	-	15.5	-	-	-	336.2	339.2	353.7	130.6	62.3	1.13	277.8
C_2 Substituted Naphthalene	15.6	8.5	63.7	-	-	369.5	474.9	653.4	198.2	92.5	1.10	417.0
C_3 Substituted Naphthalene	4.2	2.8	-	-	-	460.7	158.3	402.8	128.6	69.1	1.27	292.0
C_4 Substituted Naphthalene	-	-	-	-	-	249.7	-	16.8	33.3	31.0	2.20	106.6
C_5 Substituted Naphthalene	-	-	-	-	-	87.6	-	-	11.0	11.0	2.37	36.8
Biphenyl	1.0	4.2	10.0	-	9.5	-	-	21.6	5.8	2.7	1.10	12.2
Methyl Biphenyl	-	-	-	-	-	-	-	167.8	21.0	21.0	2.37	70.6
C_3 Biphenyl	-	-	-	-	-	11.7	-	-	1.5	1.5	2.37	4.9
Dibenzothiophene	2.6	1.4	-	-	-	-	-	-	0.50	0.35	1.64	1.3
Methyl Dibenzothiophene	-	0.57	-	-	-	-	-	-	0.071	0.071	2.37	0.24
Phenanthrene/Anthracene	4.2	2.1	-	-	-	68.6	22.6	55.1	19.1	9.8	1.21	42.2
Methyl Phenanthrene**	10.4	5.6	59.7	40.9	95.2	62.8	13.1	-	36.0	12.1	0.80	64.6
Dimethyl Phenanthrene**	2.1	0.6	23.9	24.4	36.8	-	-	-	10.8	5.3	1.13	23.5
Trimethyl Phenanthrene**	-	-	-	6.4	9.5	-	-	-	2.0	1.3	1.59	5.1
Ethyl Fluorene	-	-	-	-	-	17.5	-	-	2.2	2.2	2.37	7.4

*Emissions below detection limits or cannot be distinguished from blank values are indicated by -. For Site Nos. 309, 310, 311, 312 and 313, detection limits for POM compounds were approximately 0.05 ng/J (0.08 μg/m³). For Site Nos. 309-2, 312-2 and 3-312, detection limits for POM compounds were approximately 0.03 ng/J (0.05 μg/m³).

**All phenanthrene compounds could also be anthracenes.

TABLE 54. MEAN SOURCE SEVERITY FACTORS FOR POM EMISSIONS FROM ELECTRICITY GENERATION DISTILLATE OIL ENGINES

Compound	Mean Emission Factor (pg/J)	MATE* Value (mg/m^3)	Mean Source Severity Factor S
Naphthalene	43.7	50	<0.0001
Methyl Naphthalene	130.6	230	<0.0001
C_2 Substituted Naphthalene†	198.2	230	<0.0001
C_3 Substituted Naphthalene†	128.6	230	<0.0001
C_4 Substituted Naphthalene†	33.3	230	<0.0001
C_5 Substituted Naphthalene†	11.0	230	<0.0001
Biphenyl	5.8	1.0	0.0006
Methyl Biphenyl‡	21.0	1.0	0.0022
C_3 Biphenyl‡	1.5	1.0	0.0002
Dibenzothiophene	0.50	23	<0.0001
Methyl Dibenzothiophene**	0.071	23	<0.0001
Phenanthrene/Anthracene	19.1	1.6	0.0013
Methyl Phenanthrene/Anthracene	36.0	30	0.0001
Dimethyl Phenanthrene/Anthracene††	10.8	30	<0.0001
Trimethyl Phenanthrene/Anthracene††	2.0	30	<0.0001
Ethyl Fluorene‡‡	2.2	90	<0.0001

*MATE values are obtained from Reference 29.

†The MATE values for C_2, C_3, C_4 and C_5 substituted naphthalenes are assumed to be the same as that for dimethyl naphthalene.

‡The MATE values for methyl and C_3 biphenyl are assumed to be the same as that for biphenyl.

**The MATE value for methyl dibenzothiophene is assumed to be the same as that for dibenzothiophene.

††The MATE values for dimethyl and trimethyl phenanthrene are assumed to be the same as that for methyl phenanthrene.

‡‡The MATE for ethyl fluorene is assumed to be the same as that for fluoranthene.

STUDY NUMBER 11

STUDY NUMBER 11

DATA SOURCE:	**ASSESSMENT OF SURFACE RUNOFF FROM IRON AND STEEL MILLS**
DATA STATUS:	EPA—600/2-79-046, February 1979
AUTHORS:	G. T. Brookman, B. C. Middlesworth, and J. A. Ripp
CONTRACTOR:	TRC—Environmental Consultants, Inc. 125 Silas Deane Highway Wethersfield, Connecticut 06109 Contract No. 68-02-2133
PROJECT OFFICER:	Norman Plaks Industrial Environmental Research Laboratory Office of Energy, Minerals, and Industry U.S. Environmental Protection Agency Research Triangle Park, NC 27711

The purposes of this study were to chemically characterize stormwater runoff from iron and steel mills and to determine if this runoff could cause environmental insult.

The first task in the study was to identify runoff sources and determine what data were available. Twelve iron and steel plants were toured. A literature survey showed that previous analysis of runoff samples had been performed at two plants. Based on this information, the following pollutants were chosen to be monitored in a field study:

Total suspended solids	Total dissolved solids
Cyanide	Phenols
Dissolved iron	Total iron
Ammonia	Sulfates

Oil and grease, BOD_5, COD, and TOC were not measured because the available data indicated that results would not be "of sufficient magnitude to be of concern." All chemical analyses were performed by procedures specified in Standard Methods for the Examination of Water and Wastewater, 14th edition, M. A. Franson, ed., APHA, AWWA, WPCF, Washington, D. C., 1976.

Two sites were selected for field studies. Figures 11-1 and 11-2 (from the final report) show the sampling locations at these sites and Table 11-1 (from the document) gives general site characteristics. Automatic sequential samplers, set for flow-based sampling rates (more samples at higher runoff rates), were set up at sites 005, 010, and 011, along with automatic weather stations. Grab samples were collected at other sites. Dustfall samples, for settleable airborne particulates, were also collected. Because of site-related constraints, no data were obtained from this study on slag dump runoff or iron ore pile runoff.

This study indicated that the dissolved solids content of stormwater runoff from iron and steel mills was greater than the suspended solids content. When results were compared to point source mass loadings, which would exist under the proposed BAT control (see Code of Federal Regulations, Title 40, Part 420 as of July 1, 1976), significantly higher measurements were generally noted for total suspended solids (at all sites) and for ammonia,

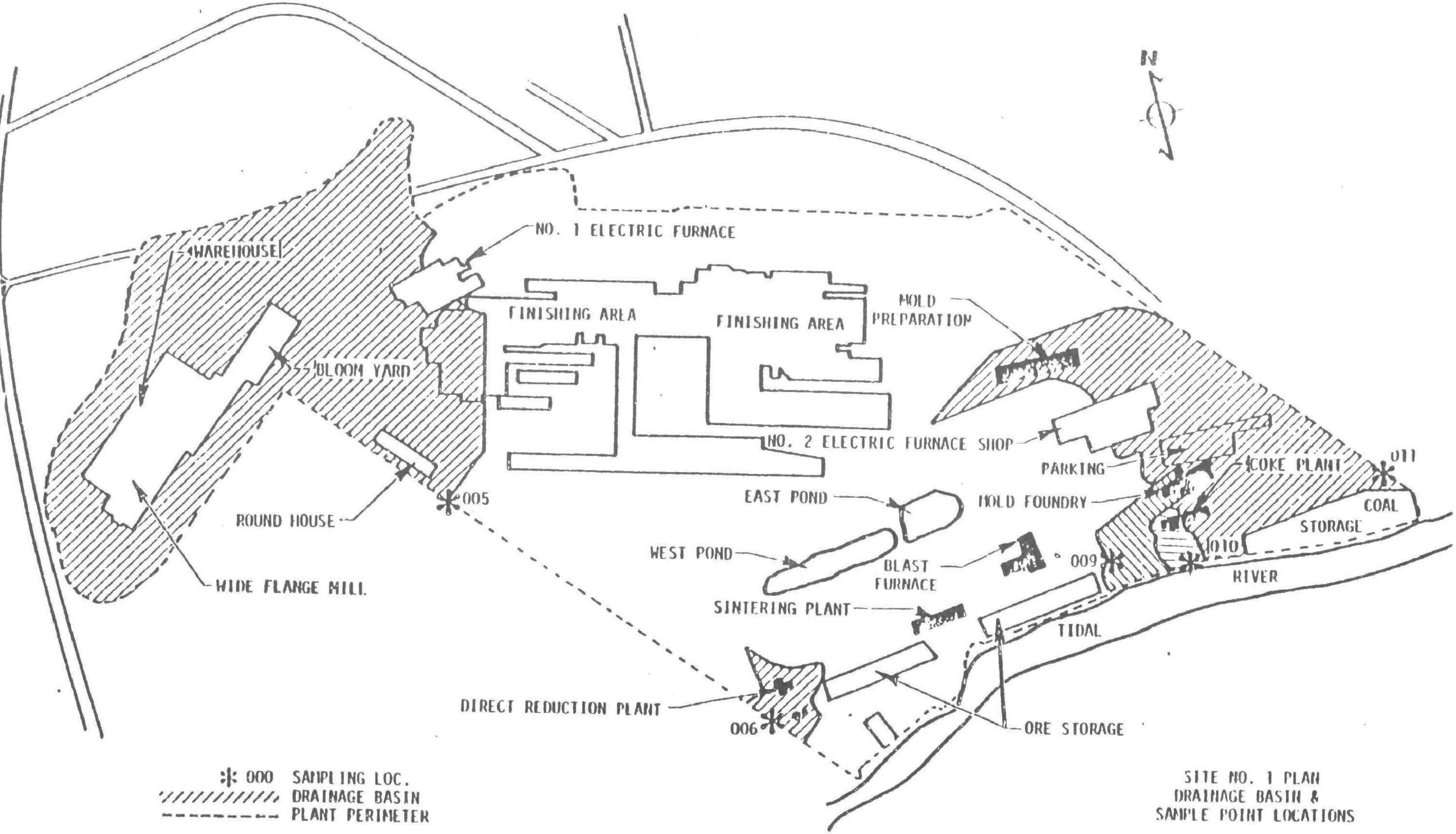

Figure 11-1. Plan—site no. 1.

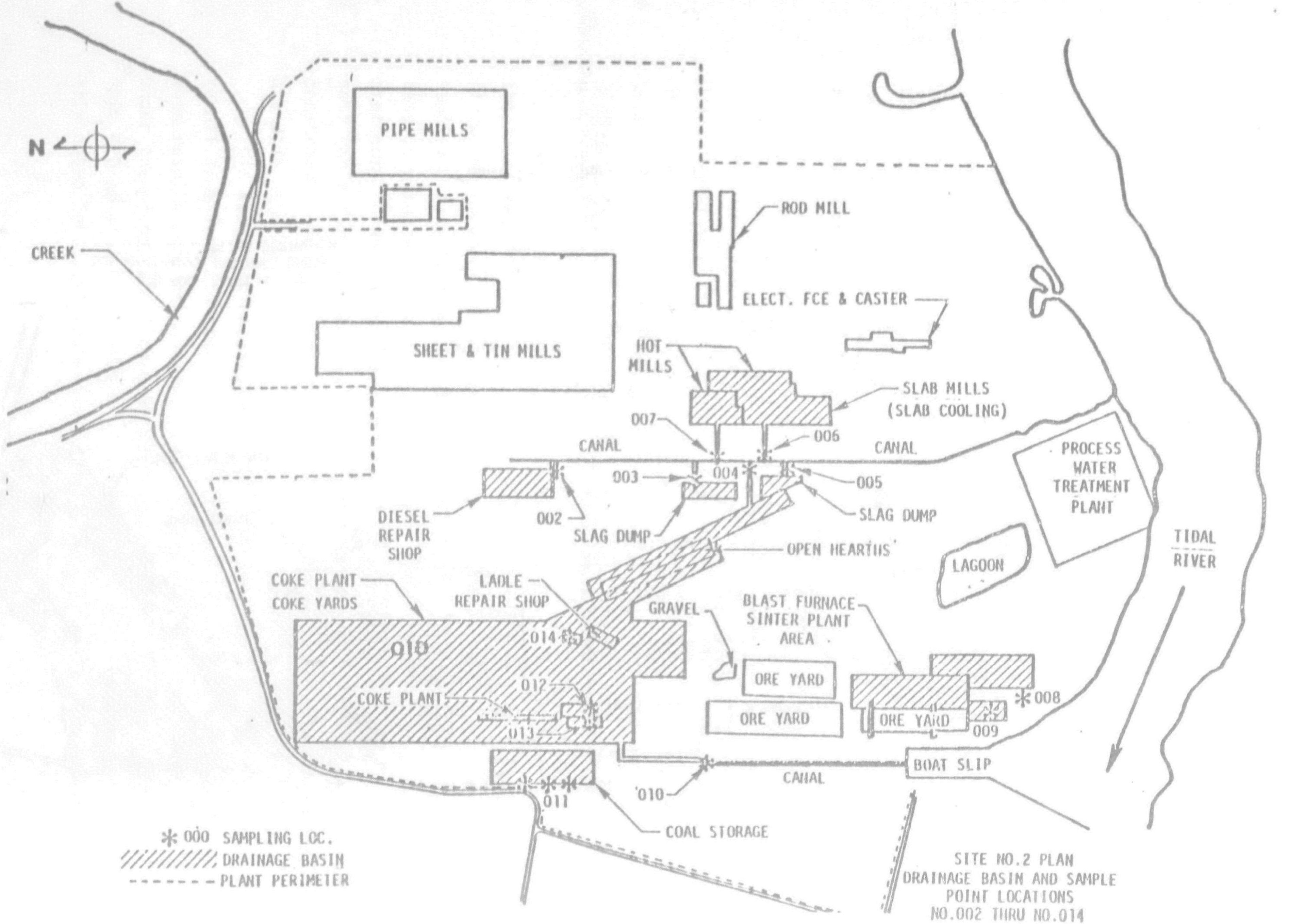

Figure 11-2. Plan—site no. 2.

TABLE 11-1. GENERAL SITE CHARACTERISTICS

	Site 1	Site 2
Age of Plant	37 Years	25 Years
Developed Area (Hectares)	230	1600
Terrain	Flat, Semi-Permeable	Flat, Permeable
Runoff Receiving Body	Tidal River	Tidal River
Plant Operations	Coke Plant, Sinter Plant, Blast Furnaces, Electric Furnaces, Finishing Operations	Coke Plant, Sinter Plant, Blast Furnaces, Open Hearth Furnaces, Electric Furnaces, Finishing Operations
Period of Sampling	3/77 to 4/77	5/77 to 6/77
Number of Sampling Points	5	13
Permanent Flow Devices	Yes	No

phenols, and total iron (at the coal pile runoff sites). The coal and coke storage piles and handling areas showed the highest potential for contaminating stormwater. Parameter concentrations appeared to be positively correlated with rainfall volume; and the runoff data did not indicate a "first flush" effect. Since there were significant differences between plants, a stormwater control strategy should be developed on a plant by plant basis.

LEVEL 1

TABLE 11-2. TSS RESULTS IN mg/L, SITES #1 AND #2
MARCH - JUNE 1977

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
	Site #1					
4	011	3/24	1040	Storm #1	11	1,196
5	011	3/24	1100	Storm #1	10	1,095
13	011	3/24	1200	Storm #1	16	1,095
18	011	3/24	1300	Storm #1	12	1,110
21	011	3/24	1400	Storm #1	17	1,098
32	010	3/24	1000	Storm #1	122	2,090
38	010	3/24	1100	Storm #1	54	2,222
42	010	3/24	1200	Storm #1	44	2,269
47	010	3/24	1300	Storm #1	62	2,088
52	010	3/24	1400	Storm #1	59	1,964
59	010	3/24	1500	Storm #1	100	2,310
63	010	3/24	1600	Storm #1	163	2,262
64	005	3/24	1000	Storm #1	34	939
65	005	3/24	1100	Storm #1	45	922
66	005	3/24	1200	Storm #1	53	964
67	005	3/24	1300	Storm #1	64	897
68	005	3/24	1400	Storm #1	25	947
70	005	3/24	1600	Storm #1	17	949
78	009A	3/28	0115	Storm #2	527	376
85	009A	3/27	2100	Storm #2	761	617
91	Coal pile	3/28	0012	Storm #2	2,384	2,205
99	Coal pile	3/28	0030	Storm #2	1,116	2,557
100	006	3/27	2240	Storm #2	511	200
102	006	3/28	0305	Storm #2	180	373
112	011	3/28	0022	Storm #2	20	878
118	011	3/28	0225	Storm #2	151	506
125	011	3/28	1100	Storm #2	76	427
132	005	3/27	2230	Storm #2	69	319
134	005	3/28	0045	Storm #2	66	300

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
	Site #1					
136	005	3/28	0140	Storm #2	78	238
138	005	3/28	0300	Storm #2	36	253
140	005	3/28	0830	Storm #2	22	357
144	005	3/28	1300	Storm #2	38	294
150	010	3/27	2100	Storm #2	22	4,993
154	010	3/27	2215	Storm #2	32	3,791
159	010	3/27	2225	Storm #2	293	2,376
163	010	3/28	0040	Storm #2	198	1,059
168	010	3/28	0145	Storm #2	238	661
172	010	3/28	0445	Storm #2	94	1,315
175	010	3/28	0645	Storm #2	10	1,684
181	011	3/29	0800	Dry weather #1	15	676
188	011	3/29	1000	Dry weather #1	15	668
195	011	3/29	1200	Dry weather #1	15	689
201	011	3/29	1400	Dry weather #1	13	698
202	010	3/29	0800	Dry weather #1	14	2,007
209	010	3/29	0900	Dry weather #1	17	2,110
210	010	3/29	1000	Dry weather #1	5	2,172
216	010	3/29	1100	Dry weather #1	6	2,044
218	010	3/29	1200	Dry weather #1	7	2,048
224	010	3/29	1300	Dry weather #1	4	2,066
226	010	3/29	1400	Dry weather #1	11	2,108

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
	Site #1					
231	005	3/29	0800	Dry weather #1	21	327
232	005	3/29	0900	Dry weather #1	15	329
233	005	3/29	1000	Dry weather #1	16	347
236	005	3/29	1300	Dry weather #1	19	364
240	005	3/29	1700	Dry weather #1	6	385
244	005	3/29	2100	Dry weather #1	17	365
245	005	3/31	1444	Storm #3	25	559
246	005	3/31	1740	Storm #3	44	556
247	005	3/31	2100	Storm #3	13	703
248	005	4/1	0315	Storm #3	65	482
249	005	4/1	0846	Storm #3	21	623
250	005	4/4	0450	Storm #4	50	525
251	005	4/4	0626	Storm #4	11	642
252	005	4/4	1031	Storm #4	67	753
253	005	4/4	1109	Storm #4	23	641
268	010	4/5	0900	Dry weather #2	184	4,063
277	010	4/5	1100	Dry weather #2	81	4,198
282	010	4/5	1200	Dry weather #2	58	3,639
286	010	4/5	1300	Dry weather #2	29	3,955
291	010	4/5	1400	Dry weather #2	22	4,106
295	010	4/5	1500	Dry weather #2	27	4,503

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
297	005	4/5	0900	Dry weather #2	4	445
300	005	4/5	1200	Dry weather #2	23	463
303	005	4/5	1500	Dry weather #2	31	433
307	005	4/5	1900	Dry weather #2	8	432
310	011	4/5	0900	Dry weather #2	10	1,045
314	011	4/5	1000	Dry weather #2	11	1,049
318	011	4/5	1100	Dry weather #2	28	998
321	011	4/5	1200	Dry weather #2	20	995
325	011	4/5	1300	Dry weather #2	13	1,025
328	011	4/5	1400	Dry weather #2	7	1,034
332	011	4/5	1500	Dry weather #2	7	998
342	Coal pile	4/16	1140	Storm #5	9,559	1,419
347	Coal pile	4/16	1155	Storm #5	3,691	2,974
349	009A	4/16	1040	Storm #5	951	1,023
353	009A	4/16	1125	Storm #5	474	1,316
358	009A	4/16	1205	Storm #5	159	609
363	009A	4/16	1415	Storm #5	156	529
365	006	4/16	1055	Storm #5	41	1,360
366	006	4/16	1120	Storm #5	676	376
367	005	4/16	1121	Storm #5	11	719
368	005	4/16	1133	Storm #5	11	715
369	005	4/16	1146	Storm #5	18	611

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
370	005	4/16	1208	Storm #5	65	603
371	005	4/16	1245	Storm #5	47	341
372	005	4/16	1339	Storm #5	113	305
373	005	4/16	1504	Storm #5	96	284
374	005	4/16	1626	Storm #5	65	259
378	011	4/16	0842	Storm #5	20	1,155
381	011	4/16	1138	Storm #5	84	1,133
387	011	4/16	1239	Storm #5	46	892
390	011	4/16	1423	Storm #5	34	992
400	011	4/16	1614	Storm #5	27	915
401	011	4/16	2223	Storm #5	18	845
409	011	4/17	0742	Storm #5	30	753
414	005	4/18	0945	Dry weather #3	19	395
417	005	4/18	1245	Dry weather #3	12	424
420	005	4/18	1545	Dry weather #3	16	420
423	005	4/18	1845	Dry weather #3	14	400
426	005	4/18	2145	Dry weather #3	11	413
427	005	4/18	2245	Dry weather #3	10	399
431	011	4/18	0930	Dry weather #3	36	790
434	011	4/18	1030	Dry weather #3	23	793
440	011	4/18	1130	Dry weather #3	42	790
444	011	4/18	1230	Dry weather #3	20	767
447	010	4/18	1137	Dry weather #3	649	2,713

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
450	010	4/18	1237	Dry weather #3	171	2,757
457	010	4/18	1337	Dry weather #3	100	5,438
461	010	4/18	1437	Dry weather #3	52	2,741
465	010	4/18	1537	Dry weather #3	78	2,728
	Site #2					
1	006	5/9	0000	Dry weather	416	148
4	006	5/9	0130	Dry weather	23	140
7	006	5/9	0300	Dry weather	20	103
10	006	5/9	0430	Dry weather	25	131
14	006	5/9	0630	Dry weather	24	109
15	007	5/9	0000	Dry weather	10	126
18	007	5/9	0130	Dry weather	8	143
21	007	5/9	0300	Dry weather	1	124
24	007	5/9	0430	Dry weather	8	155
28	007	5/9	0630	Dry weather	5	87
39	015	5/10	1000	Dry weather	15	128
41	010A	5/9	0000	Dry weather	37	100
44	010A	5/9	0100	Dry weather	17	122
50	010A	5/9	0200	Dry weather	9	76
53	010A	5/9	0300	Dry weather	15	106
59	010A	5/9	0400	Dry weather	12	104
62	010A	5/9	0500	Dry weather	19	116
68	010A	5/9	0600	Dry weather	22	109
75	004	5/9	0000	Dry weather	18	144
78	004	5/9	0030	Dry weather	16	145
81	004	5/9	0100	Dry weather	7	153
84	004	5/9	0130	Dry weather	9	142

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
90	004	5/9	0230	Dry weather	6	164
97	004	5/9	0330	Dry weather	7	179
103	004	5/9	0430	Dry weather	11	151
109	004	5/9	0530	Dry weather	12	156
118	006	5/10	0000	Dry weather	38	109
122	006	5/10	0200	Dry weather	23	102
126	006	5/10	0630	Dry weather	63	126
127	007	5/10	0000	Dry weather	12	245
132	007	5/10	0230	Dry weather	30	140
136	007	5/10	0430	Dry weather	4	108
140	007	5/10	0630	Dry weather	13	102
141	004	5/10	0000	Dry weather	8	160
144	004	5/10	0030	Dry weather	8	140
150	004	5/10	0130	Dry weather	9	134
159	004	5/10	0300	Dry weather	7	205
168	004	5/10	0430	Dry weather	7	150
177	004	5/10	0600	Dry weather	17	144
184	010A	5/10	0000	Dry weather	13	93
197	010A	5/10	0300	Dry weather	16	117
205	010A	5/10	0500	Dry weather	5	98
211	010A	5/10	0600	Dry weather	9	102
219	015	5/10	1845	Dry weather	40	130
237	002	5/10	1340	Dry weather	29	137
238	002	5/10	1615	Dry weather	11	91
239	008	5/10	1125	Dry weather	55	163
242	008	5/10	1410	Dry weather	22	172
245	008	5/10	1550	Dry weather	56	112
248	009	5/10	1140	Dry weather	4	138
251	009	5/10	1400	Dry weather	33	116
254	009	5/10	1545	Dry weather	58	119

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
261	015	5/10	1050	Dry weather	2	103
268	006	5/10	1030	Dry weather	197	138
271	006	5/10	1200	Dry weather	46	143
274	006	5/10	1330	Dry weather	188	152
277	006	5/10	1500	Dry weather	91	159
278	007	5/10	1030	Dry weather	10	66
281	007	5/10	1200	Dry weather	60	118
284	007	5/10	1330	Dry weather	1	54
287	007	5/10	1500	Dry weather	1	88
291	007	5/10	1700	Dry weather	50	92
292	004	5/10	1030	Dry weather	4	113
295	004	5/10	1100	Dry weather	2	126
298	004	5/10	1130	Dry weather	47	114
301	004	5/10	1200	Dry weather	13	187
304	004	5/10	1230	Dry weather	17	187
307	004	5/10	1300	Dry weather	10	185
310	004	5/10	1330	Dry weather	20	193
313	004	5/10	1400	Dry weather	8	169
316	004	5/18	1430	Dry weather	12	132
319	004	5/18	1500	Dry weather	12	166
322	004	5/18	1530	Dry weather	16	189
325	004	5/18	1600	Dry weather	17	163
328	004	5/18	1630	Dry weather	18	156
331	004	5/18	1700	Dry weather	18	162
335	010A	5/18	1030	Dry weather	21	108
338	010A	5/18	1130	Dry weather	27	125
344	010A	5/18	1230	Dry weather	28	104
346	010A	5/18	1330	Dry weather	19	99
351	010A	5/18	1430	Dry weather	30	94
354	010A	5/18	1530	Dry weather	11	97
363	010B	5/18	1030	Dry weather	19	89

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
366	010B	5/18	1130	Dry weather	13	108
371	010B	5/18	1230	Dry weather	21	133
374	010B	5/18	1330	Dry weather	26	89
379	010B	5/18	1430	Dry weather	28	108
382	010B	5/18	1530	Dry weather	24	95
387	010B	5/18	1630	Dry weather	23	93
390	006	6/9	0930	Storm #1	2,537	301
393	006	6/9	1015	Storm #1	225	228
396	006	6/9	1100	Storm #1	812	186
400	006	6/9	1200	Storm #1	1,720	324
403	006	6/9	1245	Storm #1	183	218
404	007	6/9	0930	Storm #1	45	107
412	007	6/9	1130	Storm #1	6	193
416	007	6/9	1230	Storm #1	10	129
418	004	6/9	0930	Storm #1	11	171
430	004	6/9	1030	Storm #1	8	184
442	004	6/9	1130	Storm #1	11	202
454	004	6/9	1230	Storm #1	6	201
460	007	6/9	1330	Storm #1	17	344
463	007	6/9	1500	Storm #1	33	108
466	007	6/9	1630	Storm #1	48	288
469	007	6/9	1800	Storm #1	51	418
473	007	6/9	2000	Storm #1	17	325
474	004	6/9	1345	Storm #1	6	305
483	004	6/9	1515	Storm #1	11	326
492	004	6/9	1645	Storm #1	8	359
501	004	6/9	1815	Storm #1	11	254
513	004	6/9	2015	Storm #1	3	276
517	010A	6/9	0930	Storm #1	48	173
525	010A	6/9	1030	Storm #1	20	211

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
533	010A	6/9	1130	Storm #1	17	253
540	010A	6/9	1230	Storm #1	25	212
552	010B	6/9	1030	Storm #1	60	239
568	010B	6/9	1230	Storm #1	21	185
572	012	6/9	0930	Storm #1	513	245
582	012	6/9	1030	Storm #1	259	307
592	012	6/9	1130	Storm #1	109	316
596	012	6/9	1200	Storm #1	67	431
602	012	6/9	1230	Storm #1	29	423
607	012	6/9	1430	Storm #1	563	222
617	012	6/9	1950	Storm #1	230	546
660	010A	6/9	1515	Storm #1	38	
674	010A	6/9	1915	Storm #1	15	
682	010A	6/9	2115	Storm #1	31	
685	010B	6/9	1515	Storm #1	702	
693	010B	6/9	1715	Storm #1	22	
696	010B	6/9	1815	Storm #1	12	
701	010B	6/9	1915	Storm #1	32	
704	010B	6/9	2015	Storm #1	27	
709	010B	6/9	2115	Storm #1	29	
712	006	6/9	1315	Storm #1	268	
714	006	6/9	1415	Storm #1	331	
716	006	6/9	1515	Storm #1	295	
718	006	6/9	1615	Storm #1	487	
720	006	6/9	1715	Storm #1	85	
722	006	6/9	1815	Storm #1	629	
725	006	6/9	1945	Storm #1	306	
726	002	6/9	0950	Storm #1	176	
727	002	6/9	1130	Storm #1	66	

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
728	002	6/9	1630	Storm #1	11	
729	002	6/9	2005	Storm #1	9	
730	003	6/9	0955	Storm #1	21	
731	003	6/9	1125	Storm #1	14	
732	003	6/9	1630	Storm #1	11	
733	005	6/9	1000	Storm #1	17	
734	008	6/9	1030	Storm #1	41	
736	008	6/9	1215	Storm #1	30	
739	008	6/9	1605	Storm #1	19	
742	008	6/9	2315	Storm #1	89	
745	009	6/9	1035	Storm #1	109	
748	009	6/9	1230	Storm #1	69	
751	009	6/9	1615	Storm #1	58	
754	009	6/9	2315	Storm #1	55	172
757	011	6/9	1045	Storm #1	448	389
760	011	6/9	1205	Storm #1	223	516
764	011	6/9	1520	Storm #1	2,684	299
766	011	6/9	2025	Storm #1	56	681
769	006	6/9	2215	Storm #1	354	191
772	006	6/9	2345	Storm #1	218	190
776	006	6/10	0145	Storm #1	151	
783	007	6/9	2200	Storm #1	93	143
787	007	6/10	0000	Storm #1	45	155
791	007	6/10	0200	Storm #1	39	196
796	007	6/10	0430	Storm #1	10	240
842	013	6/9	1100	Storm #1	152	601
846	013	6/9	1150	Storm #1	72	873
850	013	6/9	1530	Storm #1	1,380	884
854	013	6/9	1650	Storm #1	12	1,353
858	013	6/9	1945	Storm #1	12	1,690

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
861	014	6/9	1115	Storm #1	76	430
868	014	6/9	1540	Storm #1	60	232
874	014	6/9	1935	Storm #1	24	496
877	014	6/9	2050	Storm #1	61	524
884	015	6/10	1145	Storm #1	49	150
887	015	6/9	2235	Storm #1	21	215
891	004	6/9	2225	Storm #1	7	233
894	004	6/9	2255	Storm #1	6	233
903	004	6/10	0025	Storm #1	39	213
912	004	6/10	0155	Storm #1	6	223
921	004	6/10	0325	Storm #1	9	222
933	010A	6/10	0000	Storm #1	21	186
941	010A	6/10	0200	Storm #1	17	164
946	010A	6/10	0300	Storm #1	13	158
953	010A	6/10	0500	Storm #1	16	197
956	010A	6/10	1516	Storm #1	7	207
960	010A	6/10	1716	Storm #1	3	184
962	010A	6/10	1816	Storm #1	7	232
966	010A	6/10	2016	Storm #1	3	175
970	006	6/10	1500	Storm #1	232	285
972	006	6/10	1600	Storm #1	21	173
976	006	6/10	1800	Storm #1	54	171
980	006	6/10	2000	Storm #1	16	158
984	010B	6/9	2300	Storm #1	13	158
987	010B	6/10	0000	Storm #1	20	138
994	010B	6/10	0200	Storm #1	21	182
1001	010B	6/10	0400	Storm #1	26	179
1011	010B	6/10	1650	Storm #1	29	154
1018	010B	6/10	1850	Storm #1	21	152
1029	010B	6/10	2150	Storm #1	25	137

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentrati mg/L
1032	010A	6/10	1550	Storm #1	23	165
1035	010A	6/10	1650	Storm #1	20	175
1046	010A	6/10	1950	Storm #1	27	158
1053	010A	6/10	2150	Storm #1	18	133
1056	004	6/10	1440	Storm #1	10	231
1080	004	6/10	1840	Storm #1	3	190
1095	007	6/20	1545	Storm #2	32	253
1098	007	6/20	2110	Storm #2	29	172
1100	007	6/20	1615	Storm #2	119	157
1102	007	6/20	1645	Storm #2	100	196
1104	007	6/20	1715	Storm #2	8	352
1108	007	6/20	1815	Storm #2	62	192
1112	007	6/20	1915	Storm #2	77	186
1116	007	6/20	2015	Storm #2	71	144
1120	007	6/20	2115	Storm #2	21	361
1124	007	6/20	2215	Storm #2	6	332
1127	010B	6/20	1610	Storm #2	137	146
1135	010B	6/20	1710	Storm #2	41	158
1138	010B	6/20	1740	Storm #2	38	161
1143	010B	6/20	1810	Storm #2	36	191
1151	010B	6/20	1910	Storm #2	30	185
1154	006	6/20	1545	Storm #2	398	490
1156	006	6/20	1615	Storm #2	188	199
1158	006	6/20	1645	Storm #2	77	231
1160	006	6/20	1715	Storm #2	76	251
1164	006	6/20	1815	Storm #2	24	226
1168	006	6/20	1915	Storm #2	16	213
1172	006	6/20	2015	Storm #2	13	190
1176	006	6/20	2115	Storm #2	17	190
1180	006	6/20	2215	Storm #2	20	253
1182	004	6/20	1545	Storm #2	34	188

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
1185	004	6/20	1600	Storm #2	12	164
1188	004	6/20	1615	Storm #2	12	174
1191	004	6/20	1630	Storm #2	9	164
1194	004	6/20	1645	Storm #2	12	176
1197	004	6/20	1700	Storm #2	10	170
1200	004	6/20	1715	Storm #2	12	160
1206	004	6/20	1745	Storm #2	11	167
1212	004	6/20	1815	Storm #2	13	188
1219	004	6/20	1845	Storm #2	10	195
1222	004	6/20	1900	Storm #2	12	180
1226	007	6/21	0100	Storm #2	14	270
1230	007	6/21	0300	Storm #2	10	205
1234	007	6/21	0500	Storm #2	4	225
1238	007	6/21	0700	Storm #2	9	201
1242	007	6/21	0900	Storm #2	9	271
1246	007	6/21	1100	Storm #2	3	182
1252	006	6/21	0115	Storm #2	8	147
1256	006	6/21	0315	Storm #2	13	153
1260	006	6/21	0515	Storm #2	11	145
1268	006	6/21	0915	Storm #2	24	149
1272	006	6/21	1115	Storm #2	24	146
1276	012	6/20	1530	Storm #2	533	372
1279	012	6/20	1600	Storm #2	179	370
1284	012	6/20	1630	Storm #2	182	378
1286	012	6/20	1700	Storm #2	158	350
1303	004	6/21	0115	Storm #2	7	203
1315	004	6/21	0315	Storm #2	7	264
1327	004	6/21	0515	Storm #2	5	218
1339	004	6/21	0715	Storm #2	6	217
1343	010B	6/20	2345	Storm #2	24	186
1354	010B	6/21	0245	Storm #2	29	190

(continued)

TABLE 11-2 (continued)

Sample no.	Outfall	Date	Time	Sampling event	TSS concentration, mg/L	TDS concentration, mg/L
1359	010B	6/21	0345	Storm #2	27	216
1362	010B	6/21	0445	Storm #2	31	200
1370	002	6/20	1540	Storm #2	79	112
1371	002	6/20	1555	Storm #2	17	132
1372	002	6/20	1650	Storm #2	15	156
1373	003	6/20	1535	Storm #2	132	106
1374	003	6/20	1550	Storm #2	97	93
1375	003	6/20	1635	Storm #2	34	98
1376	003	6/20	1645	Storm #2	23	104
1377	005	6/20	1535	Storm #2	78	69
1378	005	6/20	1550	Storm #2	36	59
1380	013	6/20	1525	Storm #2	727	355
1384	014	6/20	1530	Storm #2	121	398
1387	014	6/20	1600	Storm #2	44	416

TABLE 11-3. AMMONIA ANALYSIS RESULTS
SITES #1 AND #2
MARCH-JUNE 1977

Sample no.	Outfall	Date	Time	Sampling event	Ammonia concentration, mg/L
	SITE #1				
2	011	3/24	1040	Storm #1	1.7
10	011	3/24	1200	Storm #1	1.5
14	011	3/24	1300	Storm #1	1.6
23	011	3/24	1500	Storm #1	1.1
34	010	3/24	1100	Storm #1	47.0
43	010	3/24	1300	Storm #1	52.0
84	009A	3/27	2225	Storm #2	3.5
88	009A	3/27	2100	Storm #2	0.23
92	Coal pile	3/28	0012	Storm #2	84.0
111	011	3/27	2306	Storm #2	1.4
117	011	3/28	0131	Storm #2	2.0
131	011	3/28	1200	Storm #2	28.0
148	010	3/27	2100	Storm #2	73.0
157	010	3/27	2225	Storm #2	55.0
165	010	3/28	0145	Storm #2	3.6
182	011	3/29	0900	Dry weather #1	20.0
190	011	3/29	1100	Dry weather #1	21.0
197	011	3/29	1300	Dry weather #1	26.0
206	010	3/29	0900	Dry weather #1	54.0
221	010	3/29	1300	Dry weather #1	56.0
266	010	4/5	0900	Dry weather #2	96.0
284	010	4/5	1300	Dry weather #2	87.0
309	011	4/5	0900	Dry weather #2	4.9
323	011	4/5	1300	Dry weather #2	5.0
346	Coal pile	4/16	1155	Storm #5	27.0
351	009A	4/16	1040	Storm #5	2.0
359	009A	4/16	1205	Storm #5	2.6

(continued)

TABLE 11-3 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Ammonia concentration mg/L
	SITE #1				
377	011	4/16	0842	Storm #5	1.3
385	011	4/16	1239	Storm #5	0.66
392	011	4/16	1423	Storm #5	0.77
405	011	4/16	2223	Storm #5	0.87
408	011	4/17	0742	Storm #5	0.65
429	011	4/18	0930	Dry weather #3	0.57
436	011	4/18	1030	Dry weather #3	1.2
438	011	4/18	1130	Dry weather #3	1.1
442	011	4/18	1230	Dry weather #3	1.0
446	010	4/18	1137	Dry weather #3	66.0
453	010	4/18	1237	Dry weather #3	74.0
455	010	4/18	1337	Dry weather #3	56.0
460	010	4/18	1437	Dry weather #3	84.0
463	010	4/18	1537	Dry weather #3	82.0
	SITE #2				
32	015	5/9	1130	Dry weather	6.0
42	010A	5/9	0000	Dry weather	5.2
56	010A	5/9	0300	Dry weather	86.0
195	010A	5/10	0200	Dry weather	4.8
336	010A	5/18	1030	Dry weather	5 2
349	010A	5/18	1330	Dry weather	3.8
360	010A	5/18	1630	Dry weather	5.7
380	010B	5/18	1430	Dry weather	7.1
518	010A	6/9	0930	Storm #1	0.36
526	010A	6/9	1030	Storm #1	0.70
534	010A	6/9	1130	Storm #1	0.49
541	010A	6/9	1230	Storm #1	0.45
545	010B	6/9	0930	Storm #1	0.88

(continued)

TABLE 11-3 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Ammonia concentration, mg/L
	SITE #2				
553	010B	6/9	1030	Storm #1	1.3
569	010B	6/9	1230	Storm #1	0.60
574	012	6/9	0930	Storm #1	0.41
584	012	6/9	1030	Storm #1	1.0
594	012	6/9	1130	Storm #1	0.79
604	012	6/9	1230	Storm #1	0.73
609	012	6/9	1430	Storm #1	0.56
661	010A	6/9	1515	Storm #1	0.17
668	010A	6/9	1715	Storm #1	0.10
675	010A	6/9	1915	Storm #1	0.22
683	010A	6/9	2115	Storm #1	0.21
686	010B	6/9	1515	Storm #1	0.28
694	010B	6/9	1715	Storm #1	0.10
702	010B	6/9	1915	Storm #1	0.12
710	010B	6/9	2115	Storm #1	0.10
762	011	6/9	1205	Storm #1	0.23
767	011	6/9	2025	Storm #1	0.43
845	013	6/9	1100	Storm #1	31.0
853	013	6/9	1530	Storm #1	39.0
882	015	6/9	1010	Storm #1	0.20
886	015	6/9	1145	Storm #1	0.39
889	015	6/9	2235	Storm #1	0.51
931	010A	6/9	2300	Storm #1	0.12
944	010A	6/10	0200	Storm #1	0.23
954	010A	6/10	0500	Storm #1	0.33
985	010B	6/9	2300	Storm #1	0.11
992	010B	6/10	0100	Storm #1	0.50
999	010B	6/10	0300	Storm #1	0.10
1006	010B	6/10	0500	Storm #1	0.10

(continued)

TABLE 11-3 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Ammonia concentration mg/L
	SITE #2				
1009	010B	6/10	1550	Storm #1	0.15
1016	010B	6/10	1750	Storm #1	0.15
1023	010B	6/10	1950	Storm #1	0.10
1030	010B	6/10	2150	Storm #1	0.15
1033	010A	6/10	1550	Storm #1	0.14
1040	010A	6/10	1750	Storm #1	0.10
1051	010A	6/10	2050	Storm #1	0.10
1128	010B	6/20	1610	Storm #2	4.1
1132	010B	6/20	1640	Storm #2	1.2
1136	010B	6/20	1710	Storm #2	0.50
1140	010B	6/20	1740	Storm #2	1.6
1144	010B	6/20	1810	Storm #2	0.39
1152	010B	6/20	1910	Storm #2	0.40
1280	012	6/20	1600	Storm #2	1.3
1288	012	6/20	1700	Storm #2	1.6
1295	012	6/20	1800	Storm #2	1.6
1344	010B	6/20	2345	Storm #2	0.18
1356	010B	6/21	0245	Storm #2	0.18
1364	010B	6/21	0445	Storm #2	0.23
1383	013	6/20	1525	Storm #2	18.0
1395	015	6/20	1640	Storm #2	0.28

TABLE 11-4. CYANIDE ANALYSIS RESULTS
SITES #1 AND #2
MARCH-JUNE 1977

Sample no.	Outfall	Date	Time	Sampling event	Cyanide concentration, mg/L
	SITE #1				
6	011	3/24	1100	Storm #1	ND
25	011	3/24	1500	Storm #1	ND
37	010	3/24	1100	Storm #1	ND
51	010	3/24	1400	Storm #1	ND
54	010	3/24	1500	Storm #1	ND
82	009A	3/27	2225	Storm #2	ND
87	009A	3/27	2100	Storm #2	ND
95	Coal pile	3/28	0125	Storm #2	ND
113	011	3/28	0022	Storm #2	ND
121	011	3/28	0225	Storm #2	ND
126	011	3/28	1100	Storm #2	ND
153	010	3/27	2215	Storm #2	ND
162	010	3/28	0040	Storm #2	ND
171	010	3/28	0445	Storm #2	ND
184	011	3/29	0900	Dry weather #1	ND
198	011	3/29	1300	Dry weather #1	ND
205	010	3/29	0900	Dry weather #1	ND
222	010	3/29	1300	Dry weather #1	ND
273	010	4/5	1000	Dry weather #2	0.99
289	010	4/5	1400	Dry weather #2	0.56
312	011	4/5	1000	Dry weather #2	ND
326	011	4/5	1400	Dry weather #2	ND
343	Coal pile	4/16	1140	Storm #5	0.17
356	009A	4/16	1125	Storm #5	0.03
362	009A	4/16	1415	Storm #5	0.01
383	011	4/16	1138	Storm #5	ND
389	011	4/16	1423	Storm #5	0.01

(continued)

TABLE 11-4 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Cyanide concentration mg/L
	SITE #2				
47	010A	5/9	0100	Dry weather	0.01
55	010A	5/9	0300	Dry weather	0.01
189	010A	5/10	0100	Dry weather	0.01
259	015	5/18	1050	Dry weather	0.01
267	015	5/18	1630	Dry weather	0.01
340	010A	5/18	1130	Dry weather	0.01
348	010A	5/18	1330	Dry weather	0.01
367	010B	5/18	1130	Dry weather	0.01
383	010B	5/18	1530	Dry weather	ND
521	010A	6/9	1000	Storm #1	0.01
529	010A	6/9	1100	Storm #1	0.01
536	010A	6/9	1200	Storm #1	0.01
548	010B	6/9	1000	Storm #1	0.02
556	010B	6/9	1100	Storm #1	0.01
578	012	6/9	1000	Storm #1	0.22
588	012	6/9	1100	Storm #1	0.10
613	012	6/9	1710	Storm #1	0.3
664	010A	6/9	1615	Storm #1	0.01
671	010A	6/9	1815	Storm #1	0.01
678	010A	6/9	2015	Storm #1	0.01
690	010B	6/9	1615	Storm #1	0.02
698	010B	6/9	1815	Storm #1	0.01
705	010B	6/9	2015	Storm #1	0.01
848	013	6/9	1150	Storm #1	0.38
856	013	6/9	1650	Storm #1	0.72
935	010A	6/10	0000	Storm #1	0.01
942	010A	6/10	0200	Storm #1	0.01

(continued)

TABLE 11-4 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Cyanide concentration, mg/L
	SITE #2				
950	010A	6/10	0400	Storm #1	0.01
988	010B	6/10	0000	Storm #1	0.01
995	010B	6/10	0200	Storm #1	0.01
1002	010B	6/10	0400	Storm #1	0.01
1012	010B	6/10	1650	Storm #1	0.01
1019	010B	6/10	1850	Storm #1	ND
1026	010B	6/10	2050	Storm #1	0.01
1036	010A	6/10	1650	Storm #1	0.01
1050	010A	6/10	2050	Storm #1	0.01
1131	010B	6/20	1640	Storm #2	0.01
1139	010B	6/20	1740	Storm #2	0.01
1282	012	6/20	1600	Storm #2	0.29
1287	012	6/20	1700	Storm #2	0.09
1294	012	6/20	1800	Storm #2	0.17
1347	010B	6/21	0045	Storm #2	0.01
1355	010B	6/21	0245	Storm #2	0.01
1363	010B	6/21	0445	Storm #2	0.01
1392	015	6/20	1640	Storm #2	0.01

ND = Not detectable; detectable limit is 0.001 mg/L.

TABLE 11-5. SULFATE ANALYSIS RESULTS
SITES #1 AND #2
MARCH-JUNE 1977

Sample no.	Outfall	Date	Time	Sampling event	Sulfate concentration mg/L
	SITE #1				
36	010	3/24	1100	Storm #1	270
41	010	3/24	1200	Storm #1	303
46	010	3/24	1300	Storm #1	260
55	010	3/24	1500	Storm #1	303
149	010	3/27	2100	Storm #2	490
152	010	3/27	2215	Storm #2	380
166	010	3/28	0145	Storm #2	180
204	010	3/29	0800	Dry weather #1	560
211	010	3/29	1000	Dry weather #1	488
219	010	3/29	1200	Dry weather #1	1380
227	010	3/29	1400	Dry weather #1	419
267	010	4/5	0900	Dry weather #2	400
276	010	4/5	1100	Dry weather #2	450
285	010	4/5	1300	Dry weather #2	1580
294	010	4/5	1500	Dry weather #2	475
	SITE #2				
218	015	5/10	1845	Dry weather	20
257	015	5/18	1050	Dry weather	20
263	015	5/18	1630	Dry weather	20
575	012	6/9	0930	Storm #1	68
580	012	6/9	1000	Storm #1	70
585	012	6/9	1030	Storm #1	79
595	012	6/9	1130	Storm #1	100
605	012	6/9	1230	Storm #1	128
610	012	6/9	1430	Storm #1	52
615	012	6/9	1710	Storm #1	54
620	012	6/9	1950	Storm #1	70

(continued)

TABLE 11-5 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Sulfate concentration, mg/L
	SITE #2				
758	011	6/9	1045	Storm #1	195
761	011	6/9	1205	Storm #1	270
844	013	6/9	1100	Storm #1	160
851	013	6/9	1530	Storm #1	190
855	013	6/9	1650	Storm #1	36
1278	012	6/20	1530	Storm #2	85
1380	013	6/20	1525	Storm #2	128

TABLE 11-6. TOTAL IRON ANALYSIS RESULTS
SITES #1 AND #2
MARCH-JUNE 1977

Sample no.	Outfall	Date	Time	Sampling event	Total iron concentration mg/L
	SITE #1				
7	011	3/24	1100	Storm #1	0.96
20	011	3/24	1400	Storm #1	1.0
31	010	3/24	1000	Storm #1	3.6
40	010	3/24	1200	Storm #1	2.6
61	010	3/24	1600	Storm #1	2.3
79	009A	3/28	0115	Storm #2	51.0
90	Coal pile	3/28	0012	Storm #2	34.0
116	011	3/28	0131	Storm #2	5.8
151	010	3/27	2215	Storm #2	1.2
180	011	3/29	0800	Dry weather #1	1.5
200	011	3/29	1400	Dry weather #1	1.1
203	010	3/29	0800	Dry weather #1	1.5
220	010	3/29	1200	Dry weather #1	1.1
272	010	4/5	1000	Dry weather #2	2.5
288	010	4/5	1400	Dry weather #2	2.3
313	011	4/5	1000	Dry weather #2	2.7
327	011	4/5	1400	Dry weather #2	2.5
341	Coal pile	4/16	1140	Storm #5	44.0
348	009A	4/16	1040	Storm #5	29.0
357	009A	4/16	1205	Storm #5	18.0
380	011	4/16	1138	Storm #5	3.7
386	011	4/16	1239	Storm #5	3.5
391	011	4/16	1423	Storm #5	3.7
402	011	4/16	2223	Storm #5	1.7
430	011	4/18	0930	Dry weather #3	1.9
433	011	4/18	1030	Dry weather #3	1.7

(continued)

TABLE 11-6 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Total iron concentration, mg/L
	SITE #1				
439	011	4/18	1130	Dry weather #3	2.6
443	011	4/18	1230	Dry weather #3	1.5
448	010	4/18	1137	Dry weather #3	8.3
451	010	4/18	1237	Dry weather #3	4.2
	SITE #2				
38	015	5/10	1000	Dry weather	0.57
60	010A	5/9	0400	Dry weather	0.72
79	004	5/9	0030	Dry weather	0.57
110	004	5/9	0530	Dry weather	0.51
145	004	5/10	0030	Dry weather	0.20
200	010A	5/10	0300	Dry weather	0.57
240	008	5/18	1125	Dry weather	1.5
243	008	5/18	1410	Dry weather	2.2
246	008	5/18	1550	Dry weather	1.0
249	009	5/18	1140	Dry weather	0.78
255	009	5/18	1545	Dry weather	1.4
258	015	5/18	1050	Dry weather	0.26
266	015	5/18	1630	Dry weather	0.47
293	004	5/18	1030	Dry weather	1.2
302	004	5/18	1200	Dry weather	0.47
311	004	5/18	1330	Dry weather	0.26
320	004	5/18	1500	Dry weather	0.26
329	004	5/18	1630	Dry weather	1.2
337	010A	5/18	1030	Dry weather	1.3
361	010A	5/18	1630	Dry weather	0.82
381	010B	5/18	1430	Dry weather	1.5
419	004	6/9	0930	Storm #1	2.2
431	004	6/9	1030	Storm #1	0.25

(continued)

TABLE 11-6 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Total iron concentration mg/L
	SITE #2				
443	004	6/9	1130	Storm #1	0.28
455	004	6/9	1230	Storm #1	0.96
475	004	6/9	1345	Storm #1	0.35
484	004	6/9	1515	Storm #1	0.30
493	004	6/9	1645	Storm #1	0.29
502	004	6/9	1815	Storm #1	0.30
514	004	6/9	2015	Storm #1	0.18
519	010A	6/9	0930	Storm #1	3.4
527	010A	6/9	1030	Storm #1	1.5
542	010A	6/9	1230	Storm #1	1.1
546	010B	6/9	0930	Storm #1	5.9
554	010B	6/9	1030	Storm #1	3.7
562	010B	6/9	1130	Storm #1	1.3
570	010B	6/9	1230	Storm #1	1.1
573	012	6/9	0930	Storm #1	26.0
583	012	6/9	1030	Storm #1	25.0
593	012	6/9	1130	Storm #1	6.0
603	012	6/9	1230	Storm #1	1.5
608	012	6/9	1430	Storm #1	3.4
618	012	6/9	1950	Storm #1	6.5
662	010A	6/9	1515	Storm #1	5.9
669	010A	6/9	1715	Storm #1	1.5
676	010A	6/9	1915	Storm #1	1.1
684	010A	6/9	2115	Storm #1	1.6
687	010B	6/9	1515	Storm #1	225.0
695	010B	6/9	1715	Storm #1	1.1
703	010B	6/9	1915	Storm #1	1.2
735	008	6/9	1030	Storm #1	7.5

(continued)

TABLE 11-6 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Total iron concentration, mg/L
	SITE #2				
737	008	6/9	1215	Storm #1	2.8
740	008	6/9	1605	Storm #1	3.0
743	008	6/9	2315	Storm #1	7.2
746	009	6/9	1035	Storm #1	4.2
749	009	6/9	1230	Storm #1	5.2
752	009	6/9	1615	Storm #1	3.0
755	009	6/9	2315	Storm #1	3.6
759	011	6/9	1045	Storm #1	11.0
765	011	6/9	1520	Storm #1	25.0
843	013	6/9	1100	Storm #1	5.7
852	013	6/9	1530	Storm #1	27.0
859	013	6/9	1945	Storm #1	0.82
862	014	6/9	1115	Storm #1	6.7
865	014	6/9	1145	Storm #1	1.5
869	014	6/9	1540	Storm #1	14.0
875	014	6/9	1935	Storm #1	0.95
878	014	6/9	2050	Storm #1	3.2
881	015	6/9	1010	Storm #1	0.89
888	015	6/9	2235	Storm #1	0.95
892	004	6/9	2225	Storm #1	0.68
895	004	6/9	2255	Storm #1	0.45
904	004	6/10	0025	Storm #1	0.68
913	004	6/10	0155	Storm #1	0.40
922	004	6/10	0325	Storm #1	0.38
940	010A	6/10	0100	Storm #1	1.1
948	010A	6/10	0300	Storm #1	1.3
955	010A	6/10	0500	Storm #1	0.93
1000	010B	6/10	0300	Storm #1	0.74
1007	010B	6/10	0500	Storm #1	0.80

(continued)

TABLE 11-6 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Total iron concentration mg/L
	SITE #2				
1010	010B	6/10	1550	Storm #1	0.93
1017	010B	6/10	1750	Storm #1	0.90
1031	010B	6/10	2150	Storm #1	1.2
1034	010A	6/10	1550	Storm #1	0.98
1041	010A	6/10	1750	Storm #1	1.0
1048	010A	6/10	1950	Storm #1	1.1
1057	004	6/10	1440	Storm #1	0.29
1081	004	6/10	1840	Storm #1	0.22
1096	004	6/10	2110	Storm #1	1.2
1129	010B	6/20	1610	Storm #2	5.9
1183	004	6/20	1545	Storm #2	1.3
1186	004	6/20	1600	Storm #2	0.18
1189	004	6/20	1615	Storm #2	0.35
1192	004	6/20	1630	Storm #2	0.41
1207	004	6/20	1745	Storm #2	0.22
1223	004	6/20	1900	Storm #2	0.38
1277	012	6/20	1530	Storm #2	5.7
1285	012	6/20	1630	Storm #2	18.0
1316	004	6/21	0315	Storm #2	0.31
1340	004	6/21	0715	Storm #2	0.56
1345	010B	6/20	2345	Storm #2	1.6
1381	013	6/20	1525	Storm #2	16.0
1385	014	6/20	1530	Storm #2	11.0
1388	014	6/20	1600	Storm #2	3.2
1393	015	6/20	1640	Storm #2	0.65

TABLE 11-7. DISSOLVED IRON ANALYSIS RESULTS
SITES #1 AND #2
MARCH-JUNE 1977

Sample no.	Outfall	Date	Time	Sampling event	Dissolved iron concentration, mg/L
	SITE #1				
8	011	3/24	1100	Storm #1	0.1
89	009A	3/27	2100	Storm #2	0.1
120	011	3/28	0225	Storm #2	0.1
147	010	3/27	2100	Storm #2	0.2
167	010	3/28	0145	Storm #2	0.1
183	011	3/29	0900	Dry weather #1	0.1
207	010	3/29	0900	Dry weather #1	0.1
217	010	3/29	1100	Dry weather #1	0.1
269	010	4/5	0900	Dry weather #2	0.6
287	010	4/5	1300	Dry weather #2	0.6
311	011	4/5	0900	Dry weather #2	0.1
324	011	4/5	1300	Dry weather #2	0.1
344	Coal pile	4/16	1155	Storm #5	0.5
352	009A	4/16	1125	Storm #5	0.1
361	009A	4/16	1415	Storm #5	0.1
379	011	4/16	1138	Storm #5	0.3
388	011	4/16	1423	Storm #5	0.1
403	011	4/16	2223	Storm #5	0.2
432	011	4/18	1030	Dry weather #3	0.1
441	011	4/18	1230	Dry weather #3	0.1
449	010	4/18	1237	Dry weather #3	0.4
	SITE #2				
54	010A	5/9	0300	Dry weather	0.1
80	004	5/9	0030	Dry weather	0.2
111	004	5/9	0530	Dry weather	0.1
146	004	5/10	0030	Dry weather	ND
190	010A	5/10	0100	Dry weather	0.1

(continued)

TABLE 11-7 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Dissolved iron concentration mg/L
	SITE #2				
207	010A	5/10	0500	Dry weather	0.1
241	008	5/18	1125	Dry weather	0.3
247	008	5/18	1550	Dry weather	0.1
250	009	5/18	1140	Dry weather	0.3
256	009	5/18	1545	Dry weather	0.1
260	015	5/18	1050	Dry weather	0.1
265	015	5/18	1630	Dry weather	0.1
294	004	5/18	1030	Dry weather	ND
303	004	5/18	1200	Dry weather	0.1
312	004	5/18	1330	Dry weather	0.1
321	004	5/18	1500	Dry weather	ND
330	004	5/18	1630	Dry weather	0.1
339	010A	5/18	1130	Dry weather	0.1
347	010A	5/18	1330	Dry weather	0.1
385	010B	5/18	1530	Dry weather	0.2
420	004	6/9	0930	Storm #1	0.1
432	004	6/9	1030	Storm #1	0.1
444	004	6/9	1130	Storm #1	0.1
456	004	6/9	1230	Storm #1	0.1
476	004	6/9	1345	Storm #1	0.1
485	004	6/9	1515	Storm #1	0.1
494	004	6/9	1645	Storm #1	0.1
503	004	6/9	1815	Storm #1	0.1
515	004	6/9	2015	Storm #1	0.2
531	010A	6/9	1100	Storm #1	0.1
550	010B	6/9	1000	Storm #1	0.1
558	010B	6/9	1100	Storm #1	ND
566	010B	6/9	1200	Storm #1	0.1
577	012	6/9	1000	Storm #1	0.1

(continued)

TABLE 11-7 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Dissolved iron concentration, mg/L
	SITE #2				
587	012	6/9	1100	Storm #1	0.6
597	012	6/9	1200	Storm #1	0.1
612	012	6/9	1710	Storm #1	0.1
666	010A	6/9	1615	Storm #1	0.2
673	010A	6/9	1815	Storm #1	0.3
681	010A	6/9	2015	Storm #1	0.3
692	010B	6/9	1615	Storm #1	ND
700	010B	6/9	1815	Storm #1	0.2
708	010B	6/9	2015	Storm #1	0.1
736	008	6/9	1030	Storm #1	0.1
738	008	6/9	1215	Storm #1	0.7
741	008	6/9	1605	Storm #1	0.1
744	008	6/9	2315	Storm #1	0.1
747	009	6/9	1035	Storm #1	0.4
750	009	6/9	1230	Storm #1	0.2
753	009	6/9	1615	Storm #1	0.2
756	009	6/9	2315	Storm #1	0.2
763	011	6/9	1205	Storm #1	0.2
768	011	6/9	2025	Storm #1	0.2
849	013	6/9	1150	Storm #1	0.9
863	014	6/9	1115	Storm #1	0.9
867	014	6/9	1145	Storm #1	1.2
876	014	6/9	1935	Storm #1	0.3
879	014	6/9	2050	Storm #1	0.2
883	015	6/9	1010	Storm #1	0.3
890	015	6/9	2235	Storm #1	0.4
893	004	6/9	2225	Storm #1	0.1
905	004	6/10	0025	Storm #1	0.2
914	004	6/10	0155	Storm #1	0.6

(continued)

TABLE 11-7 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Dissolved iron concentration mg/L
	SITE #2				
937	010A	6/10	0000	Storm #1	0.1
952	010A	6/10	0400	Storm #1	0.1
990	010B	6/10	0000	Storm #1	0.1
1004	010B	6/10	0400	Storm #1	0.3
1014	010B	6/10	1650	Storm #1	0.1
1024	010B	6/10	1950	Storm #1	1.1
1038	010A	6/10	1650	Storm #1	0.1
1052	010A	6/10	2050	Storm #1	0.4
1058	004	6/10	1440	Storm #1	0.1
1082	004	6/10	1840	Storm #1	0.1
1097	004	6/10	2110	Storm #1	0.3
1133	010B	6/20	1640	Storm #2	0.1
1184	004	6/20	1545	Storm #2	0.1
1187	004	6/20	1600	Storm #2	0.1
1190	004	6/20	1615	Storm #2	0.1
1208	004	6/20	1745	Storm #2	0.1
1224	004	6/20	1900	Storm #2	0.1
1281	012	6/20	1600	Storm #2	0.1
1289	012	6/20	1700	Storm #2	0.1
1317	004	6/21	0315	Storm #2	0.1
1382	013	6/20	1525	Storm #2	1.1
1386	014	6/20	1530	Storm #2	0.2
1389	014	6/20	1600	Storm #2	0.3
1394	015	6/20	1640	Storm #2	0.1

ND = Not detectable; detectable limit is 0.02 mg/L.

TABLE 11-8. PHENOL ANALYSIS RESULTS
SITES #1 AND #2
MARCH-JUNE 1977

Sample no.	Outfall	Date	Time	Sampling event	Phenol concentration, mg/L
	SITE #1				
1	011	3/24	1000	Storm #1	0.52
9	011	3/24	1200	Storm #1	0.01
19	011	3/24	1400	Storm #1	0.05
27	011	3/24	1600	Storm #1	0.01
30	010	3/24	1000	Storm #1	0.21
39	010	3/24	1200	Storm #1	0.03
48	010	3/24	1400	Storm #1	0.93
60	010	3/24	1600	Storm #1	0.44
77	009A	3/28	0115	Storm #2	0.04
96	Coal pile	3/28	0030	Storm #2	0.85
109	011	3/27	2306	Storm #2	0.04
115	011	3/28	0131	Storm #2	0.06
122	011	3/28	0333	Storm #2	0.05
146	010	3/27	2100	Storm #2	0.05
155	010	3/27	2225	Storm #2	1.1
164	010	3/28	0145	Storm #2	0.02
178	011	3/30	1000	Storm #2	0.02
179	011	3/29	0800	Dry weather #1	0.05
199	011	3/29	1400	Dry weather #1	0.06
265	010	4/5	0900	Dry weather #2	31.0
283	010	4/5	1300	Dry weather #2	34.0
308	011	4/5	0900	Dry weather #2	0.68
315	011	4/5	1100	Dry weather #2	0.05
322	011	4/5	1300	Dry weather #2	0.05
334	Coal pile	4/16	1140	Storm #5	0.13
335	Coal pile	4/16	1155	Storm #5	0.18
340	009A	4/16	1205	Storm #5	0.09
360	009A	4/16	1415	Storm #5	0.06

(continued)

TABLE 11-8 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Phenol concentration mg/L
	SITE #1				
375	011	4/16	0842	Storm #5	0.06
384	011	4/16	1239	Storm #5	0.10
406	011	4/17	0742	Storm #5	0.04
428	011	4/18	0930	Dry weather #3	0.03
437	011	4/18	1130	Dry weather #3	0.02
445	010	4/18	1137	Dry weather #3	25.0
454	010	4/18	1337	Dry weather #3	16.0
462	010	4/18	1537	Dry weather #3	23.0
	SITE #2				
35	015	5/10	1000	Dry weather	0.02
40	010A	5/9	0000	Dry weather	0.01
58	010A	5/9	0400	Dry weather	ND
183	010A	5/10	0000	Dry weather	0.01
215	015	5/10	1845	Dry weather	ND
262	015	5/18	1050	Dry weather	ND
264	015	5/18	1630	Dry weather	ND
334	010A	5/18	1030	Dry weather	0.01
350	010A	5/18	1430	Dry weather	ND
362	010B	5/18	1030	Dry weather	0.01
386	010B	5/18	1630	Dry weather	ND
516	010A	6/9	0930	Storm #1	0.01
524	010A	6/9	1030	Storm #1	0.01
539	010A	6/9	2230	Storm #1	0.01
543	010B	6/9	0930	Storm #1	0.01
551	010B	6/9	1030	Storm #1	0.01
559	010B	6/9	1130	Storm #1	0.06
567	010B	6/9	1230	Storm #1	0.01

(continued)

TABLE 11-8 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Phenol concentration, mg/L
	SITE #2				
571	012	6/9	0930	Storm #1	0.01
581	012	6/9	1030	Storm #1	0.01
591	012	6/9	1130	Storm #1	0.01
601	012	6/9	1230	Storm #1	0.01
606	012	6/9	1430	Storm #1	0.03
616	012	6/9	1950	Storm #1	0.02
622	015	6/9	1010	Storm #1	0.01
624	015	6/9	2235	Storm #1	0.01
626	015	6/10	1145	Storm #1	0.01
627	011	6/9	1045	Storm #1	0.01
628	011	6/9	1205	Storm #1	0.02
629	011	6/9	1520	Storm #1	0.01
630	011	6/9	2025	Storm #1	ND
631	013	6/9	1100	Storm #1	0.04
632	013	6/9	1150	Storm #1	0.04
633	013	6/9	1530	Storm #1	0.04
634	013	6/9	1650	Storm #1	0.02
635	013	6/9	1945	Storm #1	0.01
636	010A	6/9	1515	Storm #1	0.01
637	010A	6/9	1715	Storm #1	0.01
639	010A	6/9	2115	Storm #1	0.02
640	010B	6/9	1515	Storm #1	0.02
642	010B	6/9	1915	Storm #1	0.01
645	010B	6/10	0100	Storm #1	0.01
647	010B	6/10	0500	Storm #1	ND
648	010A	6/9	2300	Storm #1	0.01
649	010A	6/9	0100	Storm #1	0.01
650	010A	6/9	0300	Storm #1	0.01

(continued)

TABLE 11-8 (continued)

Sample no.	Outfall	Date	Time	Sampling event	Phenol concentration mg/L
	SITE #2				
651	010A	6/9	0500	Storm #1	ND
653	010A	6/9	1750	Storm #1	0.01
656	010B	6/9	1550	Storm #1	ND
658	010B	6/9	1950	Storm #1	0.01
1126	010B	6/20	1610	Storm #2	ND
1142	010B	6/20	1810	Storm #2	0.01
1150	010B	6/20	1910	Storm #2	ND
1275	012	6/20	1530	Storm #2	0.12
1283	012	6/20	1630	Storm #2	0.02
1290	012	6/20	1730	Storm #2	0.01
1297	012	6/20	1830	Storm #2	0.19
1342	010B	6/20	2345	Storm #2	0.02
1358	010B	6/21	0345	Storm #2	ND
1366	010B	6/21	0545	Storm #2	ND
1379	013	6/20	1525	Storm #2	0.04
1390	015	6/20	1640	Storm #2	0.03

ND = Not detectable; detectable limit is 0.001 mg/L.

ADDITIONAL DATA

TABLE 5-6

STORM EVENT DATA
SITE 1
MARCH - APRIL, 1977

Date	Storm Beginning	Storm Ending	Total Rainfall		Average Rainfall Intensity		Maximum Rainfall Intensity	
			cm	(inches)	cm/hr	(in/hr)	cm/hr	(in/hr)
3/24/77	0500	2130	0.84	(0.33)	0.05	(0.02)	0.13	(.05)
3/27-3/28/77	2000 (3/27)	0200 (3/28)	1.42	(0.56)	0.23	(0.09)	0.61	(0.24)
3/31/77	1410	1430	0.20	(0.08)	0.61	(0.24)	1.07	(0.42)
4/4/77	0200	0500	0.36	(0.14)	0.13	(0.05)	0.41	(0.16)
4/16/77	0430	2000	0.71	(0.28)	0.05	(0.02)	0.56	(0.22)

TABLE 5-7

DRY VS WET FLOWS[a][d]
SITE 1
MARCH - APRIL, 1977

OUTFALL	005				010		011			
DATE	DRY		WET		WET[b]		DRY		WET	
	Avg. Flow lpm(gpm)	Range lpm(gpm)	Avg. Flow lpm(gpm)	Range lpm(gpm)	Avg. Flow lpm(gpm)	Range lpm(gpm)	Avg. Flow lpm(gpm)	Range lpm(gpm)	Avg. Flow lpm(gpm)	Range lpm(gpm)
3/24			1056 (279)	227-2233 (60-590)	12.5 (3.3)	0 - 29.1 (0 - 7.7)			189 (50)	45 - 534 (12-141)
3/27 - 28			6083 (1607)	454-15026 (120-3970)	16.0 (4.2)	0 - 67.0 (0 - 17.7)			708 (187)	38 - 2203 (10 - 582)
3/29	473 (125)	435-568 (115-150)					38 (10)	27-53 (7-14)		
3/31			401 (106)	227-984 (60-260)	ND[c]	ND[c]			405 (107)	95-939 (25-248)
4/4			2112 (558)	568-4542 (150-1200)	ND[c]	ND[c]			170 (45)	15-367 (4-97)
4/5	227 (60)	227 (60)					3.4 (0.9)	0-13.2 (0-3.5)		
4/16			3456 (913)	228-15900 (60-4200)	13.3 (3.5)	0 - 49.02 (0 - 13.0)			583 (154)	83-1374 (22-363)
4/18	216 (57)	76-254 (20-67)					87 (23)	76-106 (20-28)		

(a) No flow data were taken at Outfalls 006 and 009, nor at the coal pile drainage ditch.
(b) There was no measurable dry flow at 010 during the program.
(c) ND - No flow data were obtained.
(d) Flow values are time weighted averages for the entire event.

TABLE 5-8

RANGE OF POLLUTANT CONCENTRATIONS AT THE SAMPLING LOCATIONS AT SITE 1 MARCH - APRIL, 1977

Pollutant	Range of Pollutant Concentrations, mg/ℓ											
	Outfall 005		Outfall 006[b]		Outfall 009A[a],[b]		Outfall 010		Outfall 011		Coal Pile[b]	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Total Suspended Solids	4-31	11-113		11-676		156-951	4-649	10-1272	7-42	9-151		1116-9559
Total Dissolved Solids	327-463	238-964		200-1501		376-1316	2007-5438	661-4993	668-1049	427-1196		1419-2974
Total Iron						18-51	1.1-8.3	1.2-3.6	1.1-2.7	0.96-5.8		34-44
Dissolved Iron						0.10[c]	0.1-0.6	0.1-0.2	0.10[c]	0.10-0.30		0.50[c]
Phenols						0.04-0.09	16-34	0.02-1.1	0.02-0.68	0.01-0.52		0.13-0.85
Cyanide (Total)						n.d.-0.03[d]	n.d.-0.99[d]	n.d.[d]	n.d.[d]	n.d.-0.01[d]		n.d.-0.17[d]
Ammonia						0.23-3.5	54-96	3.6-73	0.57-26	0.65-28		27-84
Sulfate							400-1580	180-490				

[a] Road runoff at 009.

[b] No dry samples obtained.

[c] Only one value obtained.

[d] n.d. -not detectable - detectable limit = 0.001 mg/ℓ.

TABLE 5-9

MEAN POLLUTANT CONCENTRATIONS, IN mg/ℓ AT SITE 1
MARCH - APRIL, 1977

Outfall	005		006[a]		009[a]		010		011		Coal Pile Drainage Ditch[a]	
Pollutant	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
TSS	15	45		284		505	84	184	18	35		4188
TDS	396	541		762		745	3078	2158	868	919		2289
Total Iron						32.4	3.3	2.4	1.9	2.6		39.3
Dissolved Iron						0.1	0.4	0.1	0.1	0.2		_ (b)
Phenols						0.06	25	0.37	0.13	0.086		0.39
Cyanide (Total)						0.01	0.5	_(b)	_(b)	0.002		_(b)
Ammonia						2.1	73	43	9.1	3.4		56
Sulfate							718	312				

(a) No dry samples collected.

(b) Several non-detectable values were also obtained.

TABLE 5-10

AVERAGE MASS LOADINGS OF POLLUTANTS[(a),(b),(c)]
DRY VS. WET WEATHER
MARCH - APRIL, 1977
OUTFALL 005 - SITE 1

Date	3/24 (Wet)			3/27-28 (Wet)			3/29 (Dry)			3/31 (Wet)		
Parameter	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)
Total Suspended Solids	39	1200 (317)	2.82 (6.2)	48	3845 (1016)	11.1 (24.4)	16	473 (125)	0.45 (0.99)	38	401 (106)	0.91 (2.0)
Total Dissolved Solids	938	1200 (317)	67.5 (149)	332	3847 (1016)	76.6 (168.5)	353	473 (125)	10.0 (22.0)	581	401 (106)	14.0 (30.8)

Date	4/4 (Wet)			4/5 (Dry)			4/16 (Wet)			4/18 (Dry)		
Parameter	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)
Total Suspended Solids	37	2434 (643)	5.46 (12.0)	17	227 (60)	0.23 (0.51)	75	4205 (1111)	19.0 (41.8)	14	227 (60)	0.19 (0.42)
Total Dissolved Solids	669	2434 (643)	97.7 (214.9)	443	227 (60)	6.0 (13.2)	371	4205 (1111)	93.6 (206.0)	409	227 (60)	5.6 (12.3)

(a) Average Mass Loadings for wet weather calculated by multiplying the time weighted average concentration by the time weighted average flow, which were determined from the flow and concentration curves for each event.

(b) Average wet weather flows are time-weighted flows for the sampling period for each parameter. These may vary for the different parameters within each storm.

(c) Average Mass Loadings for dry weather calculated by multiplying the straight average concentration by the time-weighted average flow from Table 5-7.

TABLE 5-11

AVERAGE MASS LOADINGS OF POLLUTANTS[(a),(b),(c)]
DRY VS. WET WEATHER
MARCH - APRIL, 1977
OUTFALL 010 - SITE 1

Date	3/24 (Wet)			3/27-28 (Wet)		
Parameter	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)
Total Suspended Solids	76	12.7 (3.36)	0.06 (0.13)	1717	34.4 (9.1)	3.54 (7.80)
Total Dissolved Solids	2170	12.7 (3.36)	1.65 (3.64)	150	34.4 (9.1)	0.31 (0.68)
Total Iron	2.61	12.7 (3.36)	0.002 (0.004)			
Dissolved Iron				0.119	34.4 (9.1)	0.0002 (0.0005)
Phenol	0.46	12.7 (3.36)	0.0004 (0.0009)	0.559	34.4 (9.1)	0.001 (0.003)
Ammonia	50	4.43 (1.17)	0.013 (0.03)	41.0	34.4 (9.1)	0.08 (0.19)
Sulfate	285	14.7 (3.88)	0.25 (0.55)	224	34.4 (9.1)	0.46 (1.02)

a) Average Mass Loadings for wet weather calculated by multiplying the time weighted average concentration by the time weighted average flow, which were determined from the flow and concentration curves for each event.

b) Average wet weather flows are time-weighted average flows for the sampling period for each parameter. These may vary for the different parameters within each storm.

c) Average Mass Loadings for dry weather calculated by multiplying the straight average concentration from Appendix B by the time-weighted average flow from Table 5-7.

TABLE 5-12

AVERAGE MASS LOADINGS OF POLLUTANTS[(a),(b),(c)]
DRY VS. WET WEATHER
MARCH - APRIL, 1977
OUTFALL 011 - SITE 1

Date	3/24 (Wet)			3/27-28 (Wet)			3/29 (Dry)			4/5 (Dry)			4/16 (Wet)			4/18 (Dry)		
Parameter	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)
Total Suspended Solids	11	217 (57.29)	0.14 0.32	97	1764 (466)	10.3 (22.6)	14	38 (10)	0.03 (0.07)	14	3.4 (0.9)	0.003 (0.007)	51	568 (150)	1.74 (3.83)	30	87 (23)	0.16 (0.34)
Total Dissolved Solids	1363	217 (57.29)	17.5 (38.5)	624	1764 (466)	66.0 (145.3)	683	38 (10)	1.56 (3.43)	1021	3.4 (0.9)	0.21 (0.46)	1062	568 (150)	36.2 (79.6)	785	87 (23)	4.1 (9.0)
Total Iron	0.98*	282 (74.4)	0.02 (0.04)	5.8**	742 (196)	0.26 (0.57)	1.3	38 (10)	0.003 (0.007)	2.6	3.4 (0.9)	0.001 (0.002)	3.63*	935 (247)	0.2 (0.45)	1.9	87 (23)	0.01 (0.02)
Dissolved Iron	0.1**	275 72.8	0.002 (0.004)	0.1**	696 (184)	0.004 (0.009)	0.1**	38 (10)	0.0002 (0.0005)	0.1	3.4 (0.9)	2.0x10⁻⁵ (4.4x10⁻⁵)	0.2*	935 (247)	0.01 (0.02)	0.1	87 (23)	0.001 (0.002)
Phenol	0.117	262 (69.22)	0.002 (0.004)	0.038	1669 (444)	0.004 (0.009)	0.055	38 (10)	0.0001 (0.0003)	0.26	3.4 (0.9)	5.3x10⁻⁵ (1.2x10⁻⁵)	0.08*	477 (126)	0.002 (0.004)	0.025	87 (23)	0.0001 (0.0003)
Ammonia	1.49	252 (66.63)	0.023 (0.05)	13.04	742 (196)	0.58 (1.28)	22	38 (10)	0.05 (0.11)	4.9	3.4 (0.9)	0.001 (0.002)	0.912	568 (150)	0.03 (0.07)	0.97	87 (23)	0.005 (0.011)

*straight average
**one value only

(a) Average Mass Loadings for wet weather calculated by multiplying the time weighted average concentration by the time weighted average flow, which were determined from the flow and concentration curves for each event.

(b) Average wet weather flows are time-weighted average flows for the sampling period for each parameter. These may vary for the different parameters within each storm.

(c) Average Mass Loadings for dry weather calculated by multiplying the straight average concentration from the time-weighted average flow from Table 5-7.

TABLE 5-13

STORM EVENT DATA
SITE 2
MAY - JUNE, 1977

Date	Storm Beginning	Storm Ending	Total Rainfall		Average Rainfall Intensity		Maximum Rainfall Intensity During Storm	
			cm	(inches)	cm/hr	(in/hr)	cm/hr	(in/hr)
6/9-6/10/77	0500 (6/9)	1500 (6/10)	4.45	(1.75)	0.13	(0.05)	1.42	(0.56)
6/20/77	0900	2030	2.59	(1.02)	0.23	(0.09)	-(a)	-(a)

(a) No rainfall intensity data were collected on June 20 due to equipment failure and manpower constraints.

TABLE 5-14

DRY VS. WET FLOWS[a]
SITE 2
MAY - JUNE, 1977

Outfall	Date	Sampling Condition	Average Flow lpm (gpm)	Range, lpm (gpm)
002[b]	5/10	Dry	-	-
	5/18	Dry	53 (14)	23-91 (6-24)
	6/9-10	Wet	-	-
	6/20	Wet	-	-
004[c]	5/10	Dry	163 (43)	132-310 (35-82)
	5/18	Dry	413 (109)	223-727 (59-192)
	6/9-10	Wet	549 (145)	163-988 (43-261)
	6/20	Wet	382 (101)	189-795 (50-210)
006[c]	5/10	Dry	1120 (296)	655-3410 (173-900)
	5/18	Dry	2150 (568)	1540-3293 (407-870)
	6/9-10	Wet	2498 (660)	730-4290 (193-1133)
	6/20	Wet	3066 (810)	1692-9463 (447-2500)
007[c]	5/10	Dry	4.5 (1.2)	4.0-4.9 (1.0-1.3)
	5/18	Dry	2.9 (0.8)	2.5-4.0 (0.7-1.0)
	6/9-10	Wet	45 (12)	1.1-216 (0.3-57)
	6/20	Wet	291 (77)	45-5776 (12-1526)
009[b]	5/10	Dry	-	-
	5/18	Dry	5344 (1412)	5223-5465 (1380-1444)
	6/9-10	Wet	-	-
	6/20	Wet	-	-
010A[b]	5/10	Dry	-	-
	5/18	Dry	1.08×10^5 (28570)	1.03×10^5-1.12×10^5 (27280-29580)
	6/9-10	Wet	-	-
	6/20	Wet	-	-
010B[b]	5/10	Dry	-	-
	5/18	Dry	5.14×10^4 (13590)	3.3×10^4-6.6×10^4 (8640-17480)
	6/9-10	Wet	-	-
	6/20	Wet	-	-

[a] Flow data were not collected at outfalls 003, 005, 008, 011, 012, 013, 014, and 015.

[b] Straight averages.

[c] Time-weighted averages.

TABLE 5-15

RANGE OF POLLUTANT CONCENTRATIONS AT THE SAMPLING LOCATIONS AT SITE 2 IN mg/l MAY - JUNE, 1977

	Outfall													
	002		003		004		006		007		008		009	
POLLUTANT	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Total Suspended Solids	11-29	9-176		11-132	2-47	3-39	20-416	8-2537	1-60	3-119	22-56	19-89	4-58	55-109
Total Dissolved Solids	?1-2019	112-284		93-148	113-205	160-359	102-159	145-490	54-245	107-418	112-172	224-265	116-138	151-251
Total Iron					0.20-1.2	0.18-2.2					1.0-2.2	2.8-7.5	0.78-1.4	3.0-5.2
Dissolved Iron[d]					n.d.-0.2	0.1-0.6					0.1-0.3	0.1-0.7	0.1-0.3	0.2-0.4

	Outfall											
	010A		010B		011[a]		012[a]		013[a]		014[a]	
POLLUTANT	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Total Suspended Solids	5-37	3-48	13-28	12-702		56-2684		29-563		12-1380		24-121
Total Dissolved Solids	76-125	131-253	89-133	137-239		299-681		222-546		355-1690		232-524
Total Iron	0.57-1.3	0.93-5.9	1.5[b]	0.74-225		11-25		1.5-26		0.82-28		0.95-14
Dissolved Iron[d]	0.1	0.1-0.4	0.2[b]	n.d.-1.1		0.2		0.1-0.6		0.9-1.1		0.2-1.2
Phenol[e]	n.d.-0.01	n.d.-0.02	n.d.-0.01	n.d.-0.06		n.d.-0.02		0.01-0.19		0.01-0.04		
Cyanide(Total)[f]	0.01	0.01	n.d.-0.01	n.d.-0.02		-[c]		0.09-0.3		0.38-0.72		
Ammonia	3.8-8.6	0.1-0.7	7.1[b]	0.07-4.1		0.23-0.43		0.41-1.6		18-39		
Sulfate						195-270		52-128		36-190		

[a] No dry weather samples collected.

[b] Only one sample analyzed.

[c] Cyanide was not analyzed at this outfall.

[d] n.d.-not detectable. Detectable limit for dissolved iron is 0.02 mg/l.

[e] n.d.-not detectable. Detectable limit for phenol is 0.001 mg/l.

[f] n.d.-not detectable. Detectable limit for total cyanide is 0.001 mg/l.

TABLE 5-16

MEAN POLLUTANT CONCENTRATIONS IN mg/l AT SITE 2 MAY - JUNE, 1977

Outfall	Sampling Condition	Pollutant: TSS	TDS	Total Iron	Dissolved Iron	Phenol	Total Cyanide	Ammonia	Sulfate
002	Dry	20	749						
	Wet	47	178						
003[(a)]	Dry								
	Wet	21	110						
004	Dry	13	157	0.61	0.08				
	Wet	11	216	0.51	0.14				
006	Dry	96	130						
	Wet	298	223						
007	Dry	15	118						
	Wet	35	227						
008	Dry	44	149	1.6	0.21				
	Wet	45	241	5.2	0.2				
009	Dry	32	124	1.1	0.2				
	Wet	73	201	4.0	0.2				
010A	Dry	18	104	0.85	0.1	0.01	0.01	18.45	
	Wet	23	183	1.75	0.2	0.004	0.01	0.26	
010B	Dry	19	102	-(b)	-(b)	0.005	0.005	-(b)	
	Wet	60	183	18	0.2	0.01	0.011	0.6	
011[(a)]	Dry								
	Wet	853	471	18	0.18	0.01		0.33	232
012[(a)]	Dry								
	Wet	257	360	11.4	0.2	0.04	0.2	1.6	78
013[(a)]	Dry								
	Wet	192	959	17.6	1.0	0.03	0.55	29.3	129
014[(a)]	Dry								
	Wet	64	416	5.8	0.5				

(a) No dry weather samples collected.

AVERAGE MASS LOADINGS OF POLLUTANTS[a],[b],[c],[f]
DRY VS. WET WEATHER
MAY-JUNE, 1977
OUTFALL 002-SITE 2

Date	5/18 (Dry)			6/9-10 (Wet)			6/20 (Wet)[d]		
Parameter	Avg.[e] Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg.[e] Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg.[e] Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)
Total Suspended Solids	20	53 (14)	0.07 (0.14)	65	53 (14)	0.21 (0.45)	37	53 (14)	0.12 (0.26)
Total Dissolved Solids	114	53 (14)	0.36 (0.8)	212	53 (14)	0.67 (1.48)	133	53 (14)	0.42 (0.93)

(a) Average mass loadings for wet weather calculated by multiplying the time weighted average concentration by the time weighted average flow, which were determined from the flow and concentration curves for each event.

(b) Average wet weather flows are time weighted average flows for the sampling period for each parameter. These may vary for the different parameters within each storm.

(c) Average mass loadings for dry weather calculated by multiplying the straight average concentrations from the Appendices by the average flows from Table 5-14.

(d) Wet weather average mass loadings were estimated using dry weather flows because wet weather flow data were not obtained.

(e) Straight average used.

(f) No dry flow data collected on 5/10/77.

TABLE 5-18

AVERAGE MASS LOADINGS OF POLLUTANTS[a],[b],[c]
DRY VS. WET WEATHER
MAY-JUNE, 1977
OUTFALL 004 - SITE 2

Date	5/10 (Dry)			5/18 (Dry)			6/9-10 (Wet)			6/20 (Wet)		
Parameter	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)
Total Suspended Solids	9	163 (43)	0.09 (0.2)	15	413 (109)	0.37 (0.81)	10	662 (175)	0.4 (0.88)	9	401 (106)	0.22 (0.48)
Total Dissolved Solids	155	163 (43)	1.5 (3.3)	160	413 (109)	4.0 (8.8)	250	662 (175)	9.9 (21.8)	203	401 (106)	4.9 (10.8)
Total Iron	0.2[d]	163 (43)	0.002 (0.004)	0.68	413 (109)	0.02 (0.04)	0.49	662 (175)	0.02 (0.04)	0.36	401 (106)	0.01 (0.02)
Dissolved Iron	n.d.[e]	163 (43)	-	0.06	413 (109)	0.001 (0.002)	0.11 (0.002)	693 (183)	0.003 (0.011)	0.04	424 (112)	0.001 (0.002)

[a] Average mass loadings for wet weather calculated by multiplying the time weighted average concentration by the time weighted average flow, which were determined from the flow and concentration curves for each event.

[b] Average wet weather flows are time weighted average flows for the sampling period for each parameter. These may vary for the different parameters within each storm.

[c] Average mass loadings for dry weather calculated by multiplying the straight average concentrations from the Appendices by the average flows from Table 5-14.

[d] One value only.

[e] n.d.-not detectable. Detectable limit is 0.02 mg/l.

TABLE 5-19

AVERAGE MASS LOADINGS OF POLLUTANTS[(a),(b),(c)]
DRY VS. WET WEATHER
MAY-JUNE, 1977
OUTFALL 006 - SITE 2

Date	5/10 (Dry)			5/18 (Dry)			6/9-10 (Wet)			6/20 (Wet)		
Parameter	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)
Total Suspended Solids	41	1120 (296)	2.8 (6.2)	130	2150 (568)	16.8 (37)	495	1851 (489)	55 (121)	32	2824 (746)	5.4 (11.9)
Total Dissolved Solids	112	1120 (296)	7.5 (16.5)	148	2150 (568)	19.1 (42)	244	1851 (489)	27.1 (59.6)	186	2824 (746)	31.6 (69.3)

(a) Average mass loadings for wet weather calculated by multiplying the time weighted average concentration by the time weighted average flow, which were determined from the flow and concentration curves for each event.

(b) Average wet weather flows are time weighted average flows for the sampling period for each parameter. These may vary for the different parameters within each storm.

(c) Average mass loadings for dry weather calculated by multiplying the straight average concentrations from the Appendices by the average flows from Table 5-14.

TABLE 5-20

AVERAGE MASS LOADINGS OF POLLUTANTS[(a),(b),(c)]
DRY VS. WET WEATHER
MAY-JUNE, 1977
OUTFALL 007 - SITE 2

Date	5/10 (Dry)			5/18 (Dry)			6/9-10 (Wet)			6/20 (Wet)		
Parameter	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)
Total Suspended Solids	15	4.5 (1.2)	0.004 (0.009)	24	2.9 (0.8)	0.004 (0.009)	36	33.3 (8.8)	0.07 (0.15)	22	165.4 (43.7)	0.22 (0.48)
Total Dissolved Solids	149	4.5 (1.2)	0.04 (0.09)	84	2.9 (0.8)	0.01 (0.02)	222	33.3 (8.8)	0.44 (0.97)	244	165.4 (43.7)	2.42 (5.32)

(a) Average mass loadings for wet weather calculated by multiplying the time weighted average concentration by the time weighted average flow, which were determined from the flow and concentration curves for each event.

(b) Average wet weather flows are time weighted average flows for the sampling period for each parameter. These may vary for the different parameters within each storm.

(c) Average mass loadings for dry weather calculated by multiplying the straight average concentrations from the Appendices by the average flows from Table 5-14.

AVERAGE MASS LOADINGS OF POLLUTANTS[(a),(b),(c),(d)]
DRY VS. WET WEATHER
MAY-JUNE, 1977
OUTFALL 009 - SITE 2

Date	5/18 (Dry)			6/9-10 (Wet)		
Parameter	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)
Total Suspended Solids	32	5344 (1412)	10.3 (22.7)	73	5344 (1412)	23.4 (51.5)
Total Dissolved Solids	124	5344 (1412)	39.8 (87.6)	201	5344 (1412)	64.4 (141.7)
Total Iron	1.1	5344 (1412)	0.35 (0.77)	4.0	5344 (1412)	1.28 (2.82)
Dissolved Iron	0.2	5344 (1412)	0.06 (0.13)	0.25	5344 (1412)	0.08 (0.18)

(a) Average mass loadings calculated by multiplying the straight average concentrations from the Appendices by the straight average flow.

(b) Wet weather average mass loadings were estimated using dry weather flow data because wet weather flow data were not obtained.

(c) No dry flow data collected on 5/10/77.

(d) No sample collected on 6/20/77.

TABLE 5-22

AVERAGE MASS LOADINGS OF POLLUTANTS[(a),(b),(c),(d)]
DRY VS. WET WEATHER
MAY-JUNE, 1977
OUTFALL 010A - SITE 2

Date	5/18 (Dry)			6/9-10 (Wet)		
Parameter	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)
Total Suspended Solids	23	1.08×10^5 (28570)	149 (328)	19	1.08×10^5 (28570)	123 (271)
Total Dissolved Solids	104	1.08×10^5 (28570)	674 (1483)	183	1.08×10^5 (28570)	1186 (2609)
Total Iron	1.06	1.08×10^5 (28570)	6.87 (15.11)	1.73	1.08×10^5 (28570)	11.21 (24.66)
Dissolved Iron	0.1	1.08×10^5 (28570)	0.65 (1.43)	0.2	1.08×10^5 (28570)	1.3 (2.86)
Phenol	0.005	1.08×10^5 (28570)	0.03 (0.07)	0.01	1.08×10^5 (28570)	0.06 (0.13)
Total Cyanide	0.01	1.08×10^5 (28570)	0.06 (0.13)	0.01	1.08×10^5 (28570)	0.06 (0.13)
Ammonia	4.9	1.08×10^5 (28570)	31.7 (69.7)	0.27	1.08×10^5 (28570)	1.75 (3.85)

(a) Average mass loadings calculated by multiplying the straight average concentrations from the Appendices by the straight average flow.

(b) Wet weather average mass loadings were estimated using dry weather flow data because wet weather flow data were not obtained.

(c) No dry flow data collected on 5/10/77.

MAY-JUNE, 1977
OUTFALL 010B - SITE 2

Date	5/18 (Dry)			6/9-10 (Wet)			6/20 (Wet)		
Parameter	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)	Avg. Conc., mg/l	Avg. Flow, lpm (gpm)	Avg. Mass Loading, kg/hr (lb/hr)
Total Suspended Solids	22	5.14×10^4 (13590)	67.8 (149.2)	71	5.14×10^4 (13590)	219 (482)	44	5.14×10^4 (13590)	136 (299)
Total Dissolved Solids	102	5.14×10^4 (13590)	314.6 (692.1)	185	5.14×10^4 (13590)	570.5 (1255.1)	181	5.14×10^4 (13590)	558.2 (1228)
Total Iron	1.5[d]	5.14×10^4 (13590)	4.63 (10.2)	20.3	5.14×10^4 (13590)	62.6 (137.7)	3.75	5.14×10^4 (13590)	11.57 (25.45)
Dissolved Iron	0.2[d]	5.14×10^4 (13590)	0.62 (1.36)	0.21	5.14×10^4 (13590)	0.65 (1.43)	0.1[d]	5.14×10^4 (13590)	0.31 (0.68)
Phenol	0.005	5.14×10^4 (13590)	0.02 (0.04)	0.014	5.14×10^4 (13590)	0.04 (0.09)	0.005	5.14×10^4 (13590)	0.02 (0.04)
Total Cyanide	0.005	5.14×10^4 (13590)	0.02 (0.04)	0.011	5.14×10^4 (13590)	0.03 (0.07)	0.01	5.14×10^4 (13590)	0.03 (0.07)
Ammonia	7.1[d]	5.14×10^4 (13590)	21.9 (48.2)	0.32	5.14×10^4 (13590)	0.99 (2.18)	0.98	5.14×10^4 (13590)	3.02 (6.64)

[a] Average mass loadings calculated by multiplying the straight average concentrations from the Appendices by the straight average flow.

[b] Wet weather average mass loadings were estimated using dry weather flow data because wet weather flow data were not obtained.

[c] No dry flow data collected on 5/10/77.

[d] One value only.

TABLE 5-24

MEAN POLLUTANT CONCENTRATIONS, mg/l
IN THE TIDAL RIVER AT SITE 2
MAY-JUNE, 1977
(SAMPLING LOCATION 015)

Pollutant	Mean Pollutant Concentrations, mg/l	
	Dry	Wet
TSS	19	35
TDS	120	182
Total Iron	0.43	0.83
Dissolved Iron	0.1	0.3
Phenols	0.005	0.010
Total Cyanide	0.004	-
Ammonia	-	0.34
Sulfates	20	-

TABLE B-1

DUSTFALL DATA, SITE 1*

Outfall 010 | Estimated Acreage 2.6 | Coal Handling

Sample Area	Description
#1	Moderate Activity - Near Water Tower
#2	High Activity - Near Conveyor
#3	Low Activity - Outside Conveyor Area

	Dustfall Values (mg)/4 sq ft					
	#1		#2		#3	
Day No.	Cumulative Weights	Average Per Day	Cumulative Weights	Average Per Day	Cumulative Weights	Average Per Day
1	4.67	4.67	15.22	15.22	0.06	0.06
2	7.48	3.74	28.54	14.27	0.09	0.04
3	49.44	16.48	32.23	10.74	2.38	0.79
4	16.29	4.07	26.27	6.57	2.94	0.74
5	15.04	3.01	96.61	19.32	1.25	0.25

Total Daily Average/ft^2 = 1.67 mg/day/ft^2

Total Daily Average/Acre = 72.75 g/day/acre

Total Daily Average/Basin 010 = 0.19 kg/day (0.42 lb/day)

*Data is calculated in metric/English units from raw field data and is converted to metric units only in text of report.

TABLE B-2

DUSTFALL DATA SITE 2**

Sinter Plant	Estimated Acreage 11.4	High Activity
Coke and Coal Piles	Estimated Acreage 1.5	Moderate Activity

Sinter Plant Dustfall Site

Dustfall Weights (mg)/4 sq ft

Sample Squares	#1	#2	#3	#4	#5	#6	#7	#8	#9
	8.48	8.09	2.91	5.86	9.03	15.24	25.76	22.21	25.46
	11.38	16.90	8.72	13.16	6.98	7.86	14.09	4.05	4.71
	7.05	6.91	9.50	3.50	3.05	17.60	9.53	7.36	
Total Weight	26.91	31.9	21.1	22.52	19.06	40.7	49.38	33.62	29.63
No. Days	20	21	22	23	24	25	26	27	19
Avg. Wgh.	1.35	1.52	0.96	0.98	0.79	1.63	1.90	1.25	1.56

Average Daily Accumulation 1.33 mg/day/4 sq ft
0.33 mg/day/ft^2
14.48 gm/day/acre

Average Daily Accumulation for the Sinter Plant Area 0.17 kg/day
0.36 lb/day

Coke and Coal Storage Site

Dustfall Weights (mg)/4 sq ft

Sample Squares	#1	#2	#3	#4	#5	#6	#7	#8	#9
	2.04	5.16	3.03	5.88	6.50	7.36	6.73	23.27	34.52
	8.92	11.73	*	5.66	5.39	13.55	6.05	0.82	1.59
	2.33	2.27	0.99	1.73	2.56	4.08	3.70	8.52	
Total Weight	13.29	19.16	4.02	13.27	14.45	24.99	16.48	32.61	36.11
No. Days	20	21	22	23	24	25	26	27	19
Avg. Wgh.	0.67	0.91	-	0.58	0.60	1.0	0.63	1.21	1.9

Average Daily Accumulation 0.94 mg/day/4 sq ft
0.24 mg/day/ft^2
10.24 gm/day/acre

Average Daily Accumulation for the Coke and Coal Area 0.015 kg/day
0.034 lb/day

*The sample square was tampered with.

**Data is calculated in metric/English units from raw field data and is converted to metric units only in text of report.

STUDY NUMBER 12

STUDY NUMBER 12

DATA SOURCE:	**SOURCE ASSESSMENT: COAL-FIRED RESIDENTIAL COMBUSTION EQUIPMENT FIELD TESTS, JUNE 1977**
DATA STATUS:	EPA–600/2-78-004o, June 1978
AUTHORS:	D. G. DeAngelis and R. B. Reznick
CONTRACTOR:	Monsanto Research Corporation 1515 Nichols Road Dayton, Ohio 45407 Contract No. 68-02-1874
PROJECT OFFICER:	Ronald A. Venezia Industrial Environmental Research Laboratory Office of Energy, Minerals, and Industry U.S. Environmental Protection Agency Research Triangle Park, NC 27711

The objective of this study, performed in Denver, Colorado, during June 1977, was to compile an emissions data base for coal-fired residential combustion sources. With the recent trend toward again using coal as a home heating fuel, this information is important in planning regional air quality management strategies. Two coal-fired home units were tested: a stoker-fed hot-water boiler and a stoker-fed warm-air furnace. Tests were run using three types of coal of varying ash and sulfur content and with representative "on" and "off" cycles. In the coal burner beds, combustion continues during the "off" cycle, although at a much slower rate. Table 12-1 from the final report shows the sampling plan.

A modified and supplemented Level 1 protocol was followed. Particulates and condensable organics were collected with a Method 5 train and analyzed by AA, ICAP, and GC/MS.

Atomic absorption analysis was performed for arsenic, mercury, and selenium; inductively coupled argon plasma was employed for the analysis of aluminum, antimony, barium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, phosphorus, silicon, silver, sodium, strontium, tin, titanium, vanadium, and zinc. The Level 1 separation scheme (CH_2Cl_2 extraction, solvent exchange, LC fractionation) was followed for organics but analysis of the fractionated sample was by GC/MS. It should also be noted that the second, third, and fourth LC fractions were combined for specific analysis by GC/MS for PCB and POM components.

Sulfur oxides were sampled and analyzed by Federal Register Method 6. Method 7 was used for NO_x determinations. Carbon monoxide was determined by Dräger tube, and a Fyrith test kit (employing the Orsat Method) was used to analyze Tedlar bag samples for O_2 and CO_2. Grab samples of coal and bottom ash (and a 1:10 distilled water leachate of the ash) were analyzed by AA and ICAP for the same selected elements as in the modified Method 5 sample. The coal was also analyzed by standard procedures for proximate and ultimate composition (moisture, ash, S, C, H, N, O, Cl, volatiles, fixed carbon, Btu value),

TABLE 12-1. EMISSION SAMPLING PROGRAM FOR COAL-FIRED RESIDENTIAL COMBUSTION EQUIPMENT

Test run	Combustion equipment		Test coal: Designated[a]			Test coal: Ash level			Heating cycle segment sampled			Sample types collected							
	Boiler	Furnace	A	B	C	Low	Medium	High	ON	OFF	Total	Particulates	SO_x	NO_x	CO	POM	Condensable organics	Elements	SASS
1	X		X					X			X	X	X	X	X	X		X	
2	X		X					X			X	X	X	X	X		X		
3	X		X				X				X	X	X	X	X		X		
4	X		X				X				X	X	X	X	X		X		
5	X		X			X					X	X	X	X	X	X		X	
6	X		X			X					X	X	X	X	X		X		
7	X			X				X			X	X	X	X	X		X		
8	X			X				X			X	X	X	X	X		X		
9	X			X			X				X	X	X	X	X		X		
10	X			X			X				X	X	X	X	X		X		
11	X			X		X					X	X	X	X	X		X		
12	X			X		X					X	X	X	X	X		X		
13		X		X		X			X			X	X	X	X		X		X
14		X		X		X			X			X	X	X	X	X		X	
15		X		X		X				X		X	X	X	X	X		X	
16		X		X		X				X		X	X	X	X	X		X	
17		X		X				X	X			X	X	X	X		X		X
18		X		X				X	X			X	X	X	X		X		
19		X		X				X		X		X	X	X	X		X		
20		X		X				X		X		X	X	X	X		X		
21		X		X				X	X			X	X	X	X	X		X	
22		X		X				X	X			X	X	X	X	X		X	
23		X		X				X		X		X	X	X	X	X		X	
24		X		X				X		X		X	X	X	X	X		X	
25		X		X			X		X			X	X	X	X		X		
26		X		X			X		X			X	X	X	X		X		
27		X		X			X			X		X	X	X	X		X		
28		X		X			X			X		X	X	X	X		X		
29		X			X	X					X	X					X		

[a]Coal A rank: high volatile B bituminous; Coal B rank: high volatile C bituminous; Coal C rank: subbituminous C.

ash fusion temperature, and free swelling index (a test in which 1 g of pulverized coal is heated under specified conditions to form a coke button, the size and shape of which are compared with a series of standard profiles numbered 1 to 9 in increasing order of swelling).

SASS train samples of the flue gas were also taken from the warm-air furnace during the "on" cycle. The SASS cyclone and filter catches were weighed to determine particulate loading and analyzed for the 27 selected elements by AA and ICAP. Organic extracts were analyzed for C_7-C_{12} organics by GC/FID and for PCB's and POM's by GC/MS.

Quoting from the abstract of the final report, the following significant results were found:

> Particulate emissions factors from the warm-air furnace were found to be about an order of magnitude higher than those from the boiler while burning a high volatile western coal. High volatile coals with high free swelling index produced the highest particulate emission factors. No correlation was observed between particulate emission factors and the ash content of the coals fired. The composition of particulate emissions was primarily carbon, rather than elements present in the ash. In most cases, emissions of individual elements amounted to less than 5% of the elemental content of the coal burned.
>
> The low-fire, or "off", portion of a typical heating cycle made a significant contribution to the total emissions from the combustion equipment. In the case of polynuclear organic materials (POM's) the greatest contribution came during the off period. Over 50 organic species, including many POM's, were identified in the organic material collected from the flue gas during combustion of high volatile coals. Maximum POM emission factors occurred when high volatile coals were burned at low excess air levels.

LEVEL 1

TABLE 12-2. ATOMIC ABSORPTION ANALYSIS
TEST COAL B, LOW AND HIGH ASH CONTENT
(lb/ton)

Sample	As	Hg
Low ash content	0.006	<0.00002
High ash content	0.01	<0.00002

Note: For this intermittent feed process, lb/ton of feed coal is an appropriate unit of measure (rather than the standard Level 1 measures).

TABLE 12-3. GAS CHROMATOGRAPHY ANALYSIS
COAL-FIRED RESIDENTIAL FURNACE HEATING CYCLE
SASS RUN 2, COAL B, LOW ASH CONTENT
(lb/ton)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	0.004	
GC8	110-140	0.012	
GC9	140-160	ND	
GC10	160-180	ND	
GC11	180-200	ND	
GC12	200-220	0.016	
GC13		ND	
GC14		ND	
GC15		0.008	
GC16		ND	
GC17			

*Not usually included in TCO range, i.e., C_8-C_{16}.

Notes:
1. For this intermittent feed process, lb/ton of feed coal is an appropriate unit of measure (rather than the standard Level 1 ppm).
2. The authors include a category, C_7 to C_8, that shows a weight of 0.090 lb/ton. This is not standard Level 1 procedure.
3. Test run of 100 minutes' duration.

TABLE 12-4. GAS CHROMATOGRAPHY ANALYSIS
COAL-FIRED RESIDENTIAL FURNACE HEATING CYCLE
SASS RUN 2, COAL B, HIGH ASH CONTENT
(lb/ton)

Gas	Range	Volatile weight, ppm	No. of peaks
GC7*	90-110	ND	
GC8	110-140	ND	
GC9	140-160	0.004	
GC10	160-180	0.008	
GC11	180-200	0.006	
GC12	200-220	0.022	
GC13		ND	
GC14		0.002	
GC15		0.008	
GC16		0.002	
GC17			

*Not usually included in TCO range, i.e., C_8-C_{16}.

Notes: 1. For this intermittent feed process, lb/ton of feed coal is an appropriate unit of measure (rather than the standard Level 1 ppm).

2. The authors include a category, C_7 to C_8, that shows a weight of 0.038 lb/ton. This is not standard Level 1 procedure.

3. Test run of 480 minutes' duration.

TABLE 12-5. SIZE DISTRIBUTION OF PARTICULATE EMISSIONS DURING "ON" SEGMENT OF A COAL-FIRED RESIDENTIAL FURNACE HEATING CYCLE

Particle size range by SASS train component	Emission factors			
	SASS run 2,* Coal B, low ash content		SASS run 3,† Coal B, high ash content	
	lb/ton‡	Percent of total	lb/ton‡	Percent of total
Large cyclone (10 μm)	2.1	10.7	1.6	9.9
Intermediate cyclone (3 μm)	0.78	4.0	0.42	2.5
Small cyclone (1 μm)	1.1	5.4	0.34	2.1
Filter	16	79.9	14	85.5
Total	20	100	16	100

*Test run of 100-min duration.
†Test run of 480-min duration.
‡For this intermittent feed process, lb/ton of feed coal is an appropriate unit of measure (rather than the standard Level 1 units).

Note: From 80% to 85% of the particulate emissions during the ON segment of the warm-air furnace heating cycle pass through the cyclones and are trapped on the filter. The filter catch normally represents particulates of less than 1-μm diameter; however, proper operation of the cyclones requires a volumetric flow rate at the dry gas meter of 3 cfm to 5 cfm. In this program, the volumetric flow rate for the SASS runs could not be maintained above an average of 2.8 cfm. Lower velocities result in more particulates greater than 1 μm passing through the cyclones and being caught by the filter.

ADDITIONAL DATA

TABLE 1. AVERAGE EMISSION FACTORS FOR COAL-FIRED RESIDENTIAL COMBUSTION EQUIPMENT OPERATING ON A 20-MIN ON/ 40-MIN OFF HEATING CYCLE[a]
(lb/ton)

Emission species	Boiler		Furnace	
	Coal A	Coal B	Coal B	Coal C
Particulate	6.6 (0.28)	4.4 (0.20)	32. (1.5)	4.0 (0.21)
SO_x	8.8[b] (0.37)[b]	20[b] (0.90)[b]	26. (1.2)	–[c] –[c]
NO_x	9.2[b] (0.39)[b]	4.6[b] (0.21)[b]	10. (0.46)	–[c] –[c]
CO	1.6 (0.07)	0.08 (0.004)	22. (1.0)	–[c] –[c]
Condensable organics	2.2 (0.09)	3.6 (0.16)	7.4 (0.34)	3.6 (0.19)
POM	0.4 (0.02)	–[c] –[c]	0.06 (0.003)	–[c] –[c]
Elements:				
Aluminum	0.014	–[c]	0.17	–[c]
Antimony	<0.001[d]	–[c]	<0.032[d]	–[c]
Arsenic	0.0008	–[c]	0.002	–[c]
Barium	0.0006	–[c]	0.014	–[c]
Boron	0.004	–[c]	0.034	–[c]
Cadmium	<0.004[d]	–[c]	<0.0008[d]	–[c]
Calcium	0.024	–[c]	0.32	–[c]
Chromium	<0.001[d]	–[c]	0.004	–[c]
Cobalt	<0.001[d]	–[c]	<0.001[d]	–[c]
Copper	<0.001[d]	–[c]	0.006	–[c]
Iron	0.034	–[c]	0.2	–[c]
Lead	<0.006[d]	–[c]	<0.014[d]	–[c]
Magnesium	0.004	–[c]	0.094	–[c]
Manganese	0.00006	–[c]	0.002	–[c]
Mercury	0.0002	–[c]	0.0006	–[c]
Molybdenum	<0.0002[d]	–[c]	<0.04[d]	–[c]
Nickel	0.0001	–[c]	<0.04[d]	–[c]
Phosphorus	<0.018[d]	–[c]	<0.028[d]	–[c]
Selenium	<0.004[d]	–[c]	0.001	–[c]
Silicon	0.004	–[c]	0.18	–[c]
Silver	<0.001[d]	–[c]	<0.066[d]	–[c]
Sodium	0.018	–[c]	<0.012[d]	–[c]
Strontium	<0.0008[d]	–[c]	0.004	–[c]
Tin	0.006	–[c]	<0.074[d]	–[c]
Titanium	0.004	–[c]	0.014	–[c]
Vanadium	<0.004[d]	–[c]	0.006	–[c]
Zinc	0.006	–[c]	0.028	–[c]

[a]Pound of pollutant per ton of coal feed. Emissions of nonelemental pollutants are also shown parenthetically in pounds per million BTU's.

[b]Data for the ON segment of the heating cycle only.

[c]No data obtained due to program limitations.

[d]Value is the detection limit.

TABLE 2. AVERAGE EMISSION RATES FOR THE ON AND OFF HEATING CYCLE SEGMENTS OF THE WARM-AIR FURNACE BURNING COAL B
(10^{-3} lb/hr)

Emission species	Heating cycle segment	
	ON	OFF
Particulates	183	36
SO_x	167	10
NO_x	61	12
CO	127	31
POM	0.057	0.17
Condensable organics	28	13
Elements:		
Aluminum	0.85	0.26
Antimony	<0.048[b]	<0.12[b]
Arsenic	0.019	0.006
Barium	0.055	0.020
Boron	0.15	0.051
Cadmium	<0.0007[b]	<0.005[b]
Calcium	1.8	0.13
Chromium	0.017	0.021
Cobalt	0.007	0.011
Copper	0.031	<0.003[b]
Iron	1.3	0.15
Lead	<0.016[b]	<0.081[b]
Magnesium	0.64	0.036
Manganese	0.016	<0.001[b]
Mercury	<0.00007[b]	0.004
Molybdenum	<0.083[b]	<0.030[b]
Nickel	<0.048[b]	0.13
Phosphorus	<0.069[b]	<0.071[b]
Selenium	0.007	<0.012[b]
Silicon	0.42	0.50
Silver	<0.26[b]	<0.067[b]
Sodium	0.12	<0.052[b]
Strontium	0.024	<0.003[b]
Tin	<0.21[b]	<0.33[b]
Titanium	0.097	<0.010[b]
Vanadium	0.013	0.013
Zinc	0.16	<0.018[b]

[a]Emissions are presented as pounds per hour rather than pounds per ton because quantifying the amount of coal combusted during each cycle segment was not possible.

[b]Value is the detection limit.

TABLE 4. PROXIMATE AND ULTIMATE ANALYSES, FREE SWELLING INDEX, AND ASH FUSION TEMPERATURES FOR TEST COALS COMPARED WITH 86 ROCKY MOUNTAIN PROVINCE COAL SAMPLES (PROXIMATE AND ULTIMATE ONLY) (6)

	Test coals (as received)							Rocky Mountain Province coal		
	A			B			C	Average of 86 samples	Range	
	Low ash	Low/high ash blend	High ash	Low ash	Low/high ash blend	High ash	as mined		Minimum	Maximum
Moisture, %	8.77	8.36	7.82	10.00	11.18	12.35	21.15	12.9	1.6	35.0
Ash, %	4.26	7.50	10.92	5.04	7.09	9.06	3.26	9.1	2.1	32.2
Sulfur, %	0.42	0.38	0.41	0.58	0.97	1.45	0.47	0.6	0.2	5.1
Carbon, %	69.23	66.55	64.26	65.80	62.56	59.79	-[a]	59.7	27.1	75.2
Hydrogen, %	5.22	4.98	4.84	4.72	4.75	4.44	-[a]	5.6	4.4	6.7
Nitrogen, %	1.46	1.36	1.48	1.55	1.31	1.36	-[a]	1.2	0.5	1.6
Oxygen, %	10.64	10.87	10.27	12.31	12.14	11.52	-[a]	23.8	8.2	47.9
Chlorine, %	0.00	0.00	0.00	0.00	0.00	0.00	-[a]	-[b]	-[b]	-[b]
Volatile matter, %	42.27	40.52	39.08	38.68	38.79	37.51	34.72	36.0	22.7	46.7
Fixed carbon, %	44.70	43.62	42.12	46.28	42.94	41.05	40.87	42.0	17.1	52.5
Heat value, Btu/lb	12,368	11,894	11,510	11,593	11,079	10,592	9,638	10,480	4,660	13,390
Free swelling index	1	1	1	1/2	1/2	0	0	-[b]	-[b]	-[b]
Ash fusion temperatures, °F										
Oxidizing atmosphere:										
Initial deformation	2,285	2,295	2,310	2,180	2,220	2,230	-[a]	-[b]	-[b]	-[b]
First softening	2,305	2,315	2,330	2,190	2,240	2,260	-[a]	-[b]	-[b]	-[b]
Second softening	2,325	2,330	2,350	2,200	2,250	2,280	-[a]	-[b]	-[b]	-[b]
Fluid	2,345	2,360	2,370	2,220	2,270	2,310	-[a]	-[b]	-[b]	-[b]
Reducing atmosphere:										
Initial deformation	2,160	2,230	2,255	2,100	2,170	2,175	-[a]	-[b]	-[b]	-[b]
First softening	2,180	2,250	2,275	2,110	2,190	2,210	-[a]	-[b]	-[b]	-[b]
Second softening	2,200	2,270	2,295	2,120	2,215	2,240	-[a]	-[b]	-[b]	-[b]
Fluid	2,220	2,290	2,315	2,140	2,240	2,245	-[a]	-[b]	-[b]	-[b]

[a]Analysis not performed.

[b]No data reported in reference.

TABLE 7. EMISSION FACTORS FOR POM AND CRITERIA POLLUTANTS FROM COAL-FIRED RESIDENTIAL HEATING EQUIPMENT OPERATED ON A 20-MIN "ON"/40-MIN "OFF" HEATING CYCLE[a]

Test run number	Heating equipment[b]	Coal: Designation	Coal: Ash content,[c] %	Coal: Sulfur content,[c] %	Excess air, %	Emission factor, lb/ton (lb/10^6 Btu): Particulates[d]	SO_x[e]	NO_x[f]	CO[g]	Condensable organics[h]	POM[i]
1,2	Boiler	A	10.9	0.41	238	5.0 (0.22)	6.0[j] (0.26)	12.8[j] (0.56)	0.26 (0.011)	2.0 (0.087)	0.26 (0.011)
3,4	Boiler	A	7.5	0.38	123	7.8 (0.33)	11.0[j] (0.46)	7.0[j] (0.29)	4.0 (0.17)	2.4 (0.10)	–[k]
5,6	Boiler	A	4.3	0.42	171	6.8 (0.28)	9.6[j] (0.39)	7.6[j] (0.31)	0.30 (0.012)	2.2 (0.089)	0.58 (0.023)
7,8	Boiler	B	9.1	1.5	128	2.8 (0.13)	17.8[j] (0.84)	2.8[j] (0.13)	0.08 (0.0038)	2.4 (0.11)	–[k]
9,10	Boiler	B	7.1	1.0	151	4.8 (0.22)	30[j] (1.4)	4.6[j] (0.21)	0.08 (0.0036)	3.6 (0.16)	–[k]
11,12	Boiler	B	5.0	0.58	160	5.8 (0.25)	14[j] (0.60)	6.4 (0.28)	0.08 (0.0035)	5.0 (0.22)	–[k]
13,14,15,16	Furnace	B	5.0	0.58	129	44 (1.9)	12.6 (0.54)	13.6 (0.59)	24 (1.0)	–[k]	0.070 (0.0030)
25,26,27,28	Furnace	B	7.1	1.0	–[k]	20 (0.90)	30 (1.4)	13.2 (0.60)	8.8 (0.40)	9.4 (0.42)	–[k]
17,18,19,20	Furnace	B	9.1	1.5	117	26 (1.2)	28 (1.3)	7.8 (0.37)	26 (1.2)	5.2 (0.25)	–[k]
21,22,23,24	Furnace	B	9.1	1.5	182	34 (1.6)	30 (1.4)	6.0 (0.28)	26 (1.2)	–[k]	0.036 (0.0017)
29	Furnace	C	3.3	0.47	207	4.0 (0.21)	–[k]	–[k]	–[k]	3.6 (0.19)	–[k]

[a] Most emission factors represent the average of duplicate sampling runs.

[b] Both units are rated at about 200,000 Btu/hr; boiler fuel feed rate averaged 19.8 lb/hr when stoker was ON, furnace fuel feed rate averaged 15.5 lb/hr when stoker was ON.

[c] As received. [d] Front half Method 5. [e] Method 6. [f] Method 7. [g] Dräger tube. [h] Back half Method 5. [i] Modified Method 5 with XAD-2 resin trap.

[j] Data for ON segment of heating cycle only. [k] No data obtained due to program limitations.

TABLE 8. EXPERIMENTAL DATA FOR THE COAL-FIRED HEATING EQUIPMENT OPERATED ON A 20-MIN ON/40-MIN OFF CYCLE

				Average stack gas conditions[a]							
Test run number	Heating equipment	Coal type	Stoker feed rate, lb/hr	Temperature, °F	Velocity, fpm	Flow rate, acfm	H_2O, %	CO_2, %	O_2, %	Total particulate run time, min (cycles)	Heating cycle segment tested
1	Boiler	A	21.3	226	164	57	5.5	0.2	21.0	300 (5)	Total
2	Boiler	A	21.3	188	265	92	3.0	0.8	20.8	180 (3)	Total
3	Boiler	A	22.0	200	159	56	4.2	1.2	18.8	300 (5)	Total
4	Boiler	A	22.0	179	325	114	1.9	0.1	18.8	240 (4)	Total
5	Boiler	A	21.6	240	177	62	4.3	0.8	20.2	300 (5)	Total
6	Boiler	A	21.6	233	288	100	3.1	0.6	20.3	180 (3)	Total
7	Boiler	B	21.1	214	170	59	4.0	0	20.7	300 (5)	Total
8	Boiler	B	21.1	204	164	57	4.2	0	20.5	300 (5)	Total
9	Boiler	B	17.2	222	192	67	2.7	2.4	17.7	420 (7)	Total
10	Boiler	B	17.2	189	240	84	3.0	0.5	20.5	360 (6)	Total
11	Boiler	B	15.4	239	216	75	3.1	0.3	21.0	240 (4)	Total
12	Boiler	B	15.4	217	204	71	3.2	0.5	20.2	240 (4)	Total
13	Furnace	B	15.6	277	496	173	3.0	3.2	17.3	80 (4)	ON
14	Furnace	B	15.6	252	527	184	2.9	1.8	18.0	80 (4)	ON
15	Furnace	B	—[b]	199	318	111	2.0	0	21.0	120 (4)	OFF
16	Furnace	B	—[b]	186	330	115	1.9	0.2	21.1	120 (4)	OFF
17	Furnace	B	15.8	256	530	185	5.2	2.6	17.3	160 (8)	ON
18	Furnace	B	15.8	318	589	206	2.5	2.6	17.0	160 (8)	ON
19	Furnace	B	—[b]	180	343	120	2.5	0.2	20.0	240 (8)	OFF
20	Furnace	B	—[b]	162	270	94	0.9	0.2	20.8	240 (8)	OFF
21	Furance	B	15.8	278	498	174	2.7	1.8	18.9	80 (4)	ON
22	Furance	B	15.8	338	504	176	3.7	1.6	16.5	80 (4)	ON
23	Furnace	B	—[b]	202	129	45	1.8	0.1	20.8	120 (4)	OFF
24	Furnace	B	—[b]	204	186	65	1.4	0	19.5	120 (4)	OFF
25	Furnace	B	15.0	282	398	139	2.9	0	20.5	80 (4)	ON
26	Furnace	B	15.0	260	488	170	4.8	0	20.5	60 (3)	ON
27	Furnace	B	—[b]	185	192	67	1.6	0.8	20.3	120 (4)	OFF
28	Furnace	B	—[b]	167	288	100	1.8	0.3	21.0	100 (3)	OFF
29	Furnace	C	22.0	187	374	141	2.3	1.0	21.2	180 (3)	Total

[a] Conditions are at sampling location.

[b] Stoker off; no fuel fed.

TABLE 10. CARBON, HYDROGEN, AND NITROGEN CONTENT OF PARTICULATE EMISSIONS FROM COAL-FIRED RESIDENTIAL HEATING SYSTEMS

Run	Sample identification	Composition, percent of particulate		
		Carbon	Hydrogen	Nitrogen
2	Particulate train filter catch[a]	77.84	1.53	0.87
6	Particulate train filter catch[a]	82.33	1.24	0.53
1	POM train front half particulate catch after extraction of organics[a]	79.81	1.97	0.94
SASS 2	SASS train filter catch of one filter[b]	88.66	0.97	0.50
SASS 3	SASS train filter catch of filter 1[b]	50.38	0.93	1.20
SASS 3	SASS train filter catch of filter 2[b]	83.61	0.93	1.20

[a]Sample collected from total heating cycle.

[b]Sample collected during ON segment of heating cycle. Each SASS filter represents approximately 40 min of sampling time.

TABLE 11. ELEMENTAL EMISSION FACTORS FROM COAL-FIRED RESIDENTIAL HEATING EQUIPMENT OPERATED ON A 20-MIN "ON"/40-MIN "OFF" HEATING CYCLE (lb/ton)

Element	Boiler burning Coal A		Furnace burning Coal B	
	High ash content	Low ash content	High ash content[a]	Low ash content[a]
Aluminum	0.014	0.014	0.17	0.18
Antimony	<0.002[b]	0.00008	0.054	<0.010[b]
Arsenic	0.002	0.0002	0.004	0.002
Barium	<0.0008[c]	0.001	0.014	0.014
Boron	0.002	0.004	0.016	0.050
Cadmium	<0.006[b]	0.0004	0.0002	<0.001[b]
Calcium	0.028	0.02	0.28	0.34
Chromium	<0.002[b]	0.0004	0.001	0.006
Cobalt	<0.002[b]	0.0002	0.001	0.001
Copper	<0.001	0.0014	0.008	0.004
Iron	0.030	0.036	0.22	0.19
Lead	<0.008[b]	0.002	0.002	0.024
Magnesium	0.006	0.002	0.072	0.11
Manganese	<0.0008[c]	0.0001	0.001	0.002
Mercury	<0.00002[b]	0.0004	0.0006	<0.00002[b]
Molybdenum	<0.0004[b]	0.00002	<0.066[b]	<0.014[b]
Nickel	<0.0006[b]	0.0002	0.012	0.068
Phosphorus	<0.032[b]	0.002	0.014	0.042
Selenium	<0.003[b]	<0.0004[b]	<0.006[b]	<0.007[b]
Silicon	0.006	<0.012[c]	0.17	0.19
Silver	<0.002[b]	<0.0008[c]	0.12	0.010
Sodium	<0.015[c]	0.034	0.001	0.024
Strontium	<0.0008[b]	0.0006	0.004	0.002
Tin	0.004	0.006	0.014	0.14
Titanium	0.002	0.004	0.010	0.016
Vanadium	<0.008[b]	0.0002	0.004	0.006
Zinc	0.008	0.004	0.04	0.016

[a]Average of duplicate runs.

[b]Value is the detection limit.

[c]Value is that of the reagent blank used as upper limit.

TABLE 12. EMISSION FACTORS FOR C_7 TO C_{16} HYDROCARBONS DURING THE "ON" SEGMENT OF A COAL-FIRED RESIDENTIAL FURNACE HEATING CYCLE

Hydrocarbon	Emission factors: SASS run 2,[a] Coal B, low ash content		SASS run 3,[b] Coal B, high ash content	
	lb/ton	Percent of total	lb/ton	Percent of total
C_7	0.004	3.1	-[c]	0
C_7 to C_8	0.090	69.2	0.038	42.2
C_8	0.012	9.2	-[c]	0
C_9	-[c]	0	0.004	4.4
C_{10}	-[c]	0	0.008	8.9
C_{11}	-[c]	0	0.006	6.7
C_{12}	0.016	12.3	0.022	24.5
C_{13}	-[c]	0	-[c]	0
C_{14}	-[c]	0	0.002	2.2
C_{15}	0.008	6.2	0.008	8.9
C_{16}	-[c]	0	0.002	2.2
Total	0.13	100	0.090	100

[a]Test run of 100-min duration.

[b]Test run of 480-min duration. [c]None found.

TABLE 14. ASH RESIDUE FROM COAL B BURNED IN THE WARM-AIR FURNACE (lb/ton)

Test number	Coal ash content	Average ash residue
13	100	600
14	100	242
17	182	310
18	182	298
22	182	236
25	142	220

TABLE 16. FRACTION OF COAL ELEMENTAL CONTENT EMITTED TO THE ATMOSPHERE AND TOTAL MATERIAL BALANCE[a] (percent)

Element	Coal B, low ash content			Coal B, high ash content		
	Air emission[b]	Solid residue[b]	Total	Air emission[b]	Solid residue[b]	Total
Aluminum	1.8	110	112	1.4	105	106
Antimony	<36	164	<200	19	22	41
Arsenic	33	33	66	40	20	60
Barium	5.4	131	136	4.4	81	85
Boron	1.0	1.2	2	1.0	2	3
Cadmium	8.6[c]	>10	19[c]	>1.4	>29	>30
Calcium	4.1	136	140	2.2	58	60
Chromium	7.0	81	88	1.8	74	76
Cobalt	35	700	735	4.0	100	104
Copper	6.1	142	148	7.6	132	140
Iron	3.2	157	160	1.8	80	82
Lead	<18	>38	[d]	>1.5	>23	>25
Magnesium	3.8	140	144	2.1	59	61
Manganese	4.8	267	272	1.5	100	102
Mercury	100[c]	10[c]	110[c]	3,000	10[c]	3,010[c]
Molybdenum	25[c]	>18	43[c]	118[c]	>29	147[c]
Nickel	20	25	45	6.0	43	49
Phosphorus	6.8	84	91	2.0	94	96
Selenium	9.7[c]	>0.6	10[c]	<250	<83	<333
Silicon	70	12	82	70	14	84
Silver	19	78	97	400	233	633
Sodium	0.6	23	24	0.2	28	28
Strontium	1.5	169	171	1.2	88	89
Tin	>128	>19	>147	>13	>20	>33
Titanium	2.7	140	143	1.1	130	131
Vanadium	5.3	104	109	3.0	91	94
Zinc	>2,000	>14,750	>16,750	>667	>200	>867

[a] Warm-air furnace employing a 20-min ON/40-min OFF heating cycle.

[b] $\frac{\text{emission factor, lb/ton}}{\text{coal content, lb/ton}}$ (100)

[c] Value determined by using the detection limit in numerator and denominator; actual value may be lower or higher.

[d] Cannot be determined from data.

TABLE 17. ELEMENTS LEACHED FROM ASH REMOVED FROM THE COAL-FIRED WARM-AIR FURNACE

Element	Amount leached per quantity of ash, lb/ton	Fraction of element in ash leached to water, %
Aluminum	0.024	0.035
Antimony	<0.0004	<0.13
Barium	0.038	2.3
Boron	0.004	1.9
Cadmium	<0.0001	<0.77
Calcium	11.6	23
Chromium	<0.00004	<0.011
Cobalt	<0.0002	<0.12
Copper	<0.0002	<0.029
Iron	<0.00002	<0.00004
Lead	<0.001	<0.42
Magnesium	0.004	0.024
Manganese	<0.00002	<0.004
Mercury	<0.000004	<92
Molybdenum	0.002	2.0
Nickel	<0.001	<0.20
Phosphorus	<0.002	<0.059
Selenium	0.0006	74
Silicon	0.094	45
Silver	<0.0008	<0.23
Sodium	2.4	91
Strontium	0.30	20
Tin	<0.0008	<0.62
Titanium	<0.00004	<0.0007
Vanadium	<0.0001	<0.015
Zinc	<0.00004	<0.013

TABLE 19. COMPARISON OF EMISSIONS FROM THE ON AND OFF SEGMENTS OF THE WARM-AIR FURNACE HEATING CYCLE WHILE BURNING COAL B (10^{-3} lb/hr)

Emission species	Low ash content		Medium ash content		High ash content		Average	
	ON	OFF	ON	OFF	ON	OFF	ON	OFF
Particulates	240	53	134	29	174	26	183	36
SO_x	97	4.2	176	20	229	6.4	167	10
NO_x	42	31	92	2.6	48	2.6	61	12
CO	191	0	1.3[a]	90[a]	190	2.2	127	31
POM	0.055	0.21	-[b]	-[b]	0.059	0.12	0.057	0.17
Condensable organics	26	-[b]	44	13	15	12	28	13
Elements:								
Aluminum	0.86	0.26	-[b]	-[b]	0.84	0.26	0.85	0.26
Antimony	<0.009	<0.033	-[b]	-[b]	<0.086	<0.21	<0.048	<0.12
Arsenic	0.013	0.004	-[b]	-[b]	0.024	0.007	0.019	0.006
Barium	0.062	0.020	-[b]	-[b]	0.046	0.020	0.055	0.020
Boron	0.26	0.062	-[b]	-[b]	0.033	0.040	0.15	0.051
Cadmium	<0.0004	<0.007	-[b]	-[b]	<0.001	<0.002	<0.0007	<0.005
Calcium	2.4	0.059	-[b]	-[b]	1.2	0.20	1.8	0.13
Chromium	0.02	0.013	-[b]	-[b]	0.013	0.029	0.017	0.021
Cobalt	0.009	0.009	-[b]	-[b]	0.004	0.013	0.007	0.011
Copper	0.02	<0.004	-[b]	-[b]	0.042	0.002	0.031	<0.003
Iron	1.3	0.092	-[b]	-[b]	1.2	0.2	1.3	0.15
Lead	<0.020	<0.086	-[b]	-[b]	<0.011	<0.075	<0.016	<0.081
Magnesium	0.84	0.020	-[b]	-[b]	0.44	0.051	0.64	0.036
Manganese	0.018	<0.001	-[b]	-[b]	0.013	<0.0009	0.016	<0.001
Mercury	<0.00004	0.007	-[b]	-[b]	0.0001	0.0002	<0.00007	0.004
Molybdenum	<0.079	<0.026	-[b]	-[b]	0.086	<0.033	<0.083	<0.030
Nickel	0.055	0.24	-[b]	-[b]	<0.040	0.018	<0.048	0.13
Phosphorus	0.062	<0.14	-[b]	-[b]	<0.075	<0.001	<0.069	<0.071
Selenium	<0.013	<0.012	-[b]	-[b]	0.0002	0.011	0.007	<0.012
Silicon	0.48	0.51	-[b]	-[b]	0.35	0.48	0.42	0.50
Silver	0.013	0.035	-[b]	-[b]	<0.51	<0.099	<0.26	<0.067
Sodium	0.19	<0.058	-[b]	-[b]	0.057	<0.046	0.12	<0.052
Strontium	0.018	<0.0004	-[b]	-[b]	0.029	<0.006	0.024	<0.003
Tin	0.35	<0.37	-[b]	-[b]	<0.077	0.29	<0.21	<0.33
Titanium	0.13	<0.011	-[b]	-[b]	0.064	<0.009	0.097	<0.010
Vanadium	0.015	0.018	-[b]	-[b]	0.011	0.007	0.013	0.013
Zinc	0.12	<0.029	-[b]	-[b]	0.20	0.007	0.16	<0.018

[a] Data are not consistent with the majority of the results but are consistent with Battelle data.

[b] No data collected.

TABLE 20. COMPARISON OF EMISSION DATA FROM THE SASS TRAIN TO CONVENTIONAL SAMPLING METHODS[a] (10^{-3} lb/yr)

Emission species	Emission rate: SASS train, Low ash coal[b]	SASS train, High ash coal[c]	Method 5, Low ash coal	Method 5, High ash coal
Particulate	154[f]	128[f]	187[d]	163[e]
Organic material	8.1[f]	8.1[f]	26[d]	14[e]
POM	0.013[f]	0.013[f]	0.055[g]	0.059[h]
Trace elements:				
Aluminum	0.88	0.84	0.84	0.86
Antimony	<0.004	<0.0004	<0.011	<0.13
Arsenic	0.022	0.022	0.007	0.024
Barium	0.048	0.024	0.070	0.057
Boron	0.46	0.013	0.064	0.042
Cadmium	0.002	<0.002	0.002	0.001
Calcium	2.2	0.16	2.9	1.7
Chromium	0.040	0.031	0.004	0.004
Cobalt	0.013	0.004	0.004	0.004
Copper	0.024	0.011	0.020	0.055
Iron	1.1	1.2	1.5	1.3
Lead	<0.009	<0.004	<0.031	0.013
Magnesium	0.68	0.40	0.99	0.46
Manganese	0.02	0.02	0.015	0.011
Mercury	0.00009	0.00009	<0.0000007	0.0002
Molybdenum	0.018	<0.007	<0.14	<0.13
Nickel	0.077	<0.04	0.033	0.040
Phosphorus	0.099	<0.095	0.026	0.07
Selenium	0.024	0.0009	<0.002	<0.002
Silicon	0.79	0.53	0.17	0.29
Silver	0.015	<0.004	<0.009	<0.75
Sodium	0.35	0.17	<0.08	<0.07
Strontium	0.018	0.026	0.17	0.029
Tin	0.70	0.024	0.024	0.103
Titanium	0.20	0.064	0.053	0.064
Vanadium	0.015	0.009	0.013	0.011
Zinc	0.097	0.24	0.14	0.17

[a]Emissions from the warm-air furnace ON segment of the heating cycle while burning Coal B.

[b]SASS run 2. [c]SASS run 3.

[d]Data are from run 13 sampled simultaneously to SASS run 2.

[e]Data are from runs 17 and 18 sampled simultaneously to SASS run 3.

[f]Average value from SASS runs 2 and 3; samples were accidentally combined.

[g]Data are from run 14 sampled at conditions similar to those for SASS run 2 but not sampled simultaneously.

[h]Data are from runs 21 and 22 sampled at conditions similar to those for SASS run 3 but not sampled simultaneously.

STUDY NUMBER 13

STUDY NUMBER 13

DATA SOURCE:	**SAMPLING AND ANALYSIS RESEARCH PROGRAM AT THE PARAHO SHALE OIL DEMONSTRATION PLANT**
DATA STATUS:	Final Reports, January 1977 and May 1977
AUTHORS:	J. E. Cotter, C. H. Prien, J. J. Schmidt-Collerus, D. J. Powell, R. Sung, C. Habenicht, R. E. Pressey, and K. Gala
CONTRACTORS:	TRW Environmental Engineering Division One Space Park Redondo Beach, California 90278 Denver Research Institute University of Denver Denver, Colorado 80210 In cooperation with Laramie Energy Research Center, ERDA, and Development Engineering, Inc., Rifle, Colorado Contract 68-02-1881
PROJECT OFFICER:	Thomas J. Powers, III Energy Systems Environmental Control Division Industrial Environmental Research Laboratory U.S. Environmental Protection Agency Cincinnati, Ohio 45268

The objectives of this study, as stated in the documentation, were "to obtain preliminary quantitative and qualitative measurements of air, water, and solid compositions (from the effluents of shale oil retorting), and to gain experience that would lead to improved sampling procedures and the determination of priorities for sampling and analysis of shale oil recovery operations. To achieve these goals, Denver Research Institute and TRW conducted a sampling and analysis research program at the Paraho oil shale demonstration site at Anvil Points, Colorado, in the spring of 1976.

Recovery of crude oil from shale at the Paraho site involves mining the shale rock, crushing the rock, and heating the crushed shale to drive off volatile crude oils and gases. The Anvil Points oil shale mine is 5.5 miles from the retorting plant, but no sampling was done at the mine since the mine was not in operation at the time of this study. This effort was, therefore, directed at the crushing and the retorting processes.

The Paraho site has the only operational surface retorting plant within the United States. Figure 13-1 (from the report on this study) is a drawing of a Paraho retort. Two such retorts are located at the site, a 75-ft-high semiworks unit and a 60-ft-high pilot plant retort. These oil shale retorts can be operated in a direct mode in which the shale is combusted in the retort as the principal heat source, with the volatile offgases being recycled to both the combustion zone and the gas preheating zone; or the retorts can be operated in an indirect mode, where heat for retorting is supplied by combustion of the offgases in an external furnace. Figures 13-2 and 13-3 (from the report) are schematic representations of the direct and indirect operating modes. During this study, the semi-works retort was operated only in the indirect mode and the pilot plant was operated only in the direct mode.

Sampling and analysis included some Level 1 and some additional methods. Sampling approaches included the following:

- Proportional and grab sampling of the recycle process gas stream for analysis by instrumental and wet chemical methods
- Grab sampling of the product crude oil, recycle process gas condensate water, and retorted shale for organic and trace element analysis
- Grab sampling of recycle process gas stream condensate water for gross parameter analysis--for example, biochemical oxygen demand chemical oxygen demand, and total organic carbon
- High-volume sampling of particulate emissions from raw shale crushing
- Cascade impactor sampling for particulate sizing of airborne crushing emissions

*from Jones, John B., "The Paraho Oil Shale Retort, 81st Nat. Mtg., AIChE, Kansas City, Mo., April 11-14, 1976.

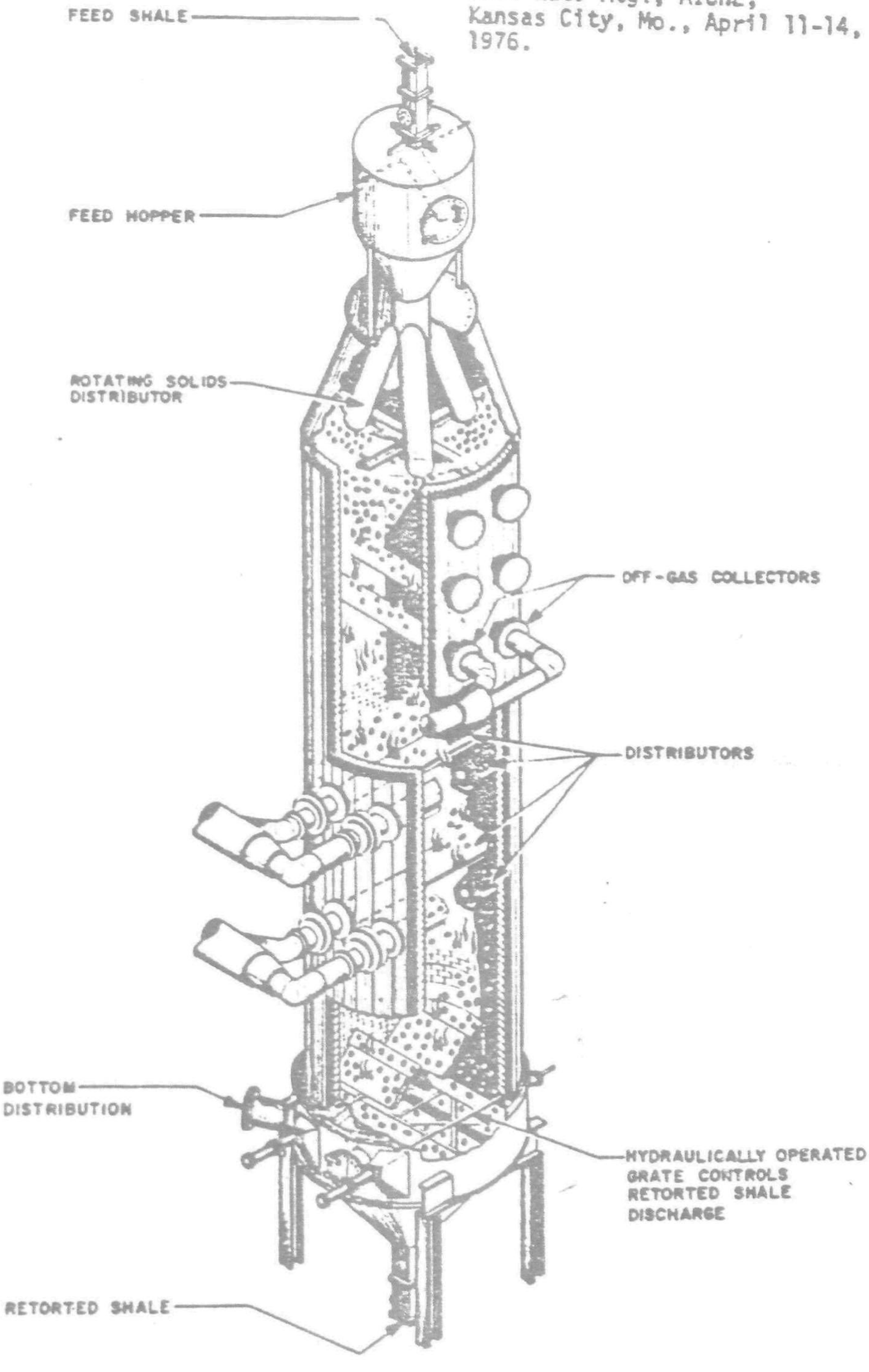

Figure 13-1. The Paraho retort.

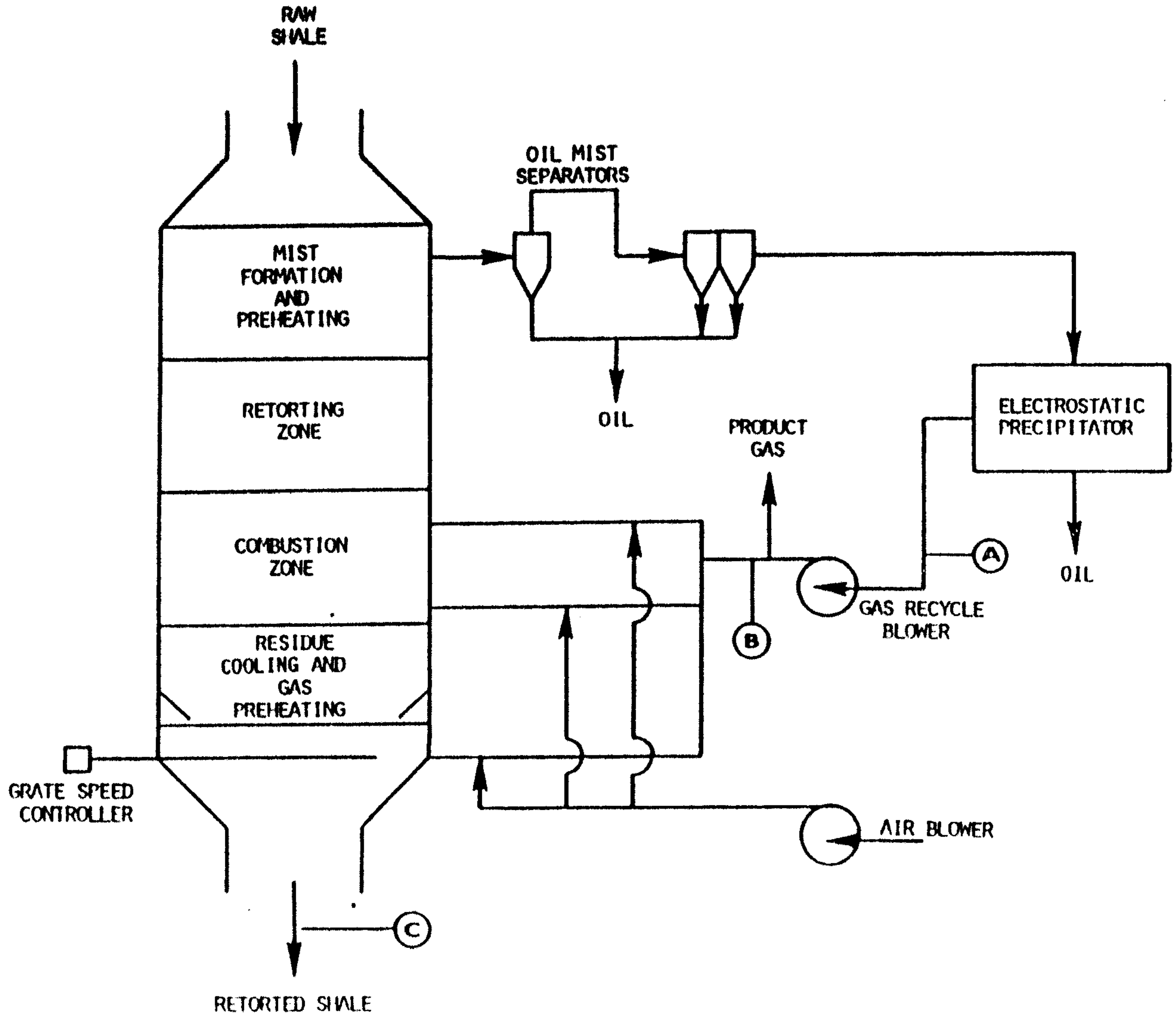

Figure 13-2. Paraho direct mode flow diagram (pilot plant operation).

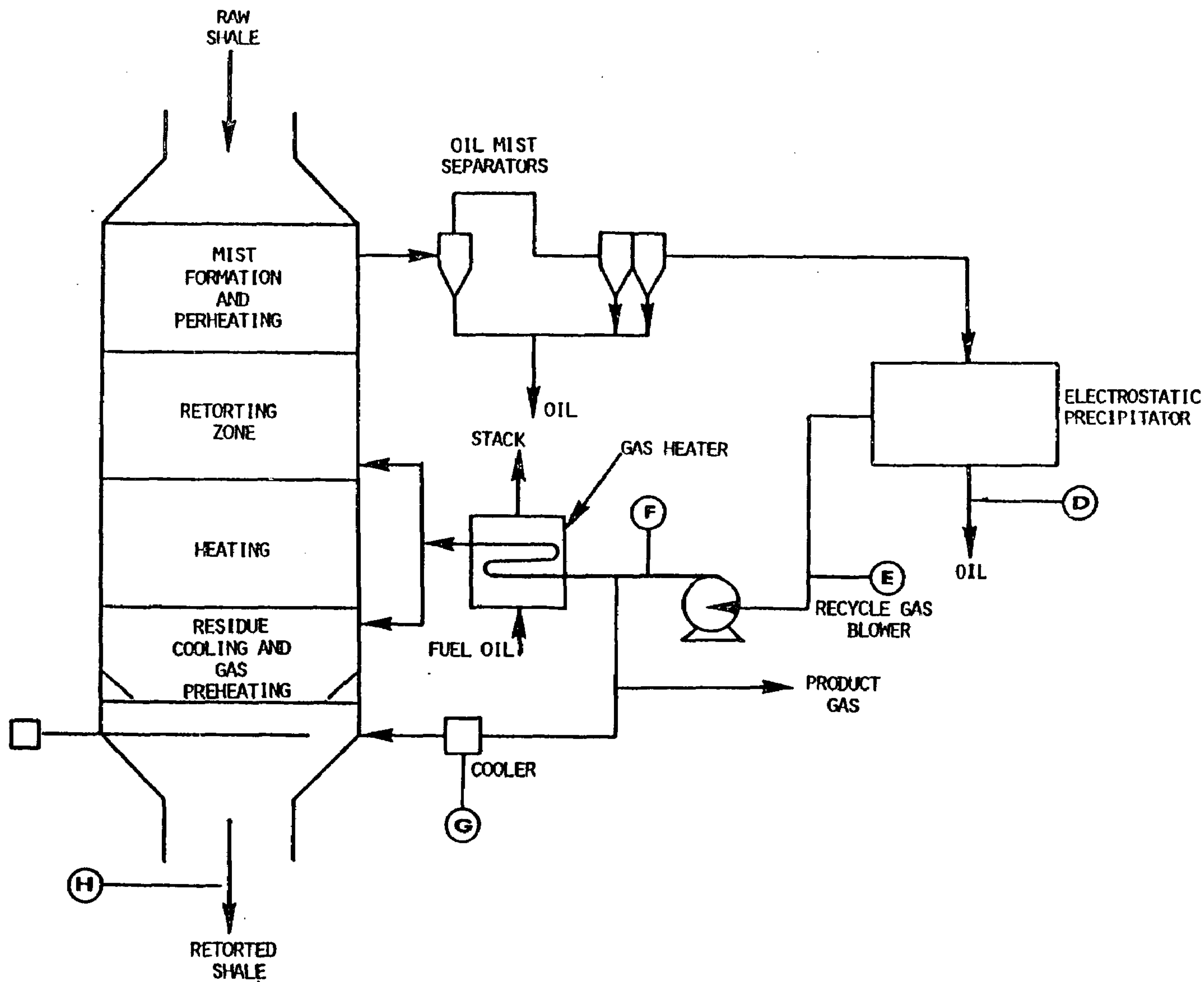

Figure 13-3. Paraho indirect mode flow diagram (semiworks operation).

Standard analytical methods were used wherever possible. Specific techniques were developed to handle some of the various process samples. Analytical methods included

- Inorganic and trace elements analysis
  - wet chemistry
  - atomic absorption spectrophotometry
  - spark source mass spectrometry (SSMS)
- Organic analysis, separation with
  - gas chromatography (GC)/mass spectrometry (MS)
  - thin layer chromatography (TLC)
  - high-pressure liquid chromatography (HPLC)
  - spectrophotofluoremetry (SPF)
- Polynuclear aromatic hydrocarbons analysis--two-dimensional elution with TLC*

Figures 13-4, 13-5, and 13-6 from the publication references above are flow diagrams for the analysis of the various samples.

Analysis of the recycle gases indicated a need to remove NH_3 and H_2S before combustion. Contrary to some predictions, the recycled gas was not found to contain significant levels of COS, CS_2, HCN, or AsH_3. The inorganic constituents in the condensate water were principally ammonium carbonate and bicarbonates with very low levels of trace elements. Traces of similar organic compounds were detected in the retorted shale, the condensate, and the product water. These organics were characterized as neutrals (especially aromatics), acids, and bases.

A great deal of qualitative information was accumulated during this study. Quantitative Level 2 type efforts, long-term studies, and a battery of bioassays were recommended to more thoroughly characterize the various plant discharges.

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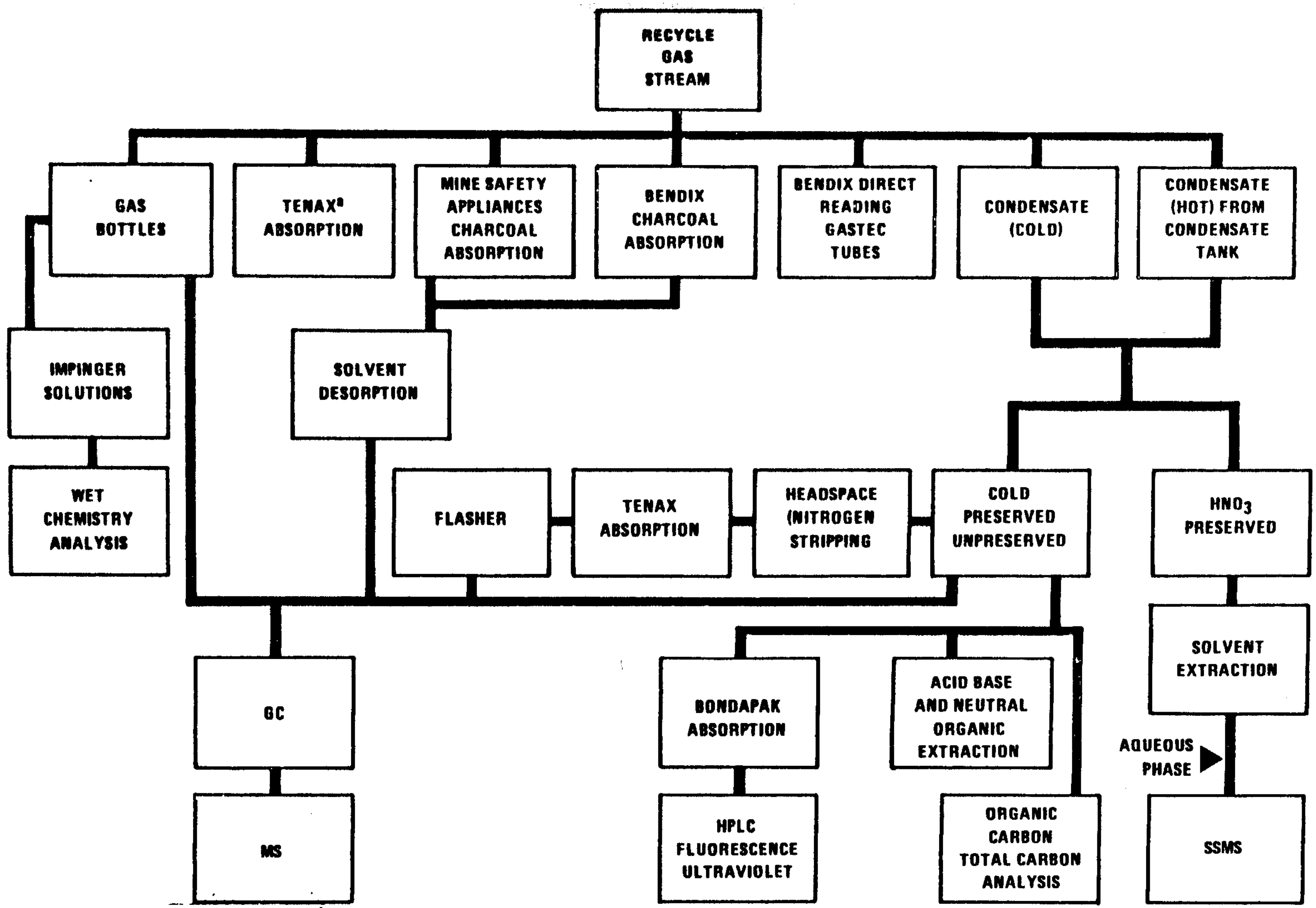
*Executive Briefing, Environmental Sampling of the Paraho Oil Shale Retort Process at Anvil Points, technology transfer series, EPA-625/9-77-002, U.S. Environmental Protection Agency, Environmental Research Information Center, Cincinnati, Ohio, October 1977.



[a]NOT USED BECAUSE OF THE PRESENCE OF AEROSOL.

Figure 13-4. Separation and analysis scheme, gaseous samples.

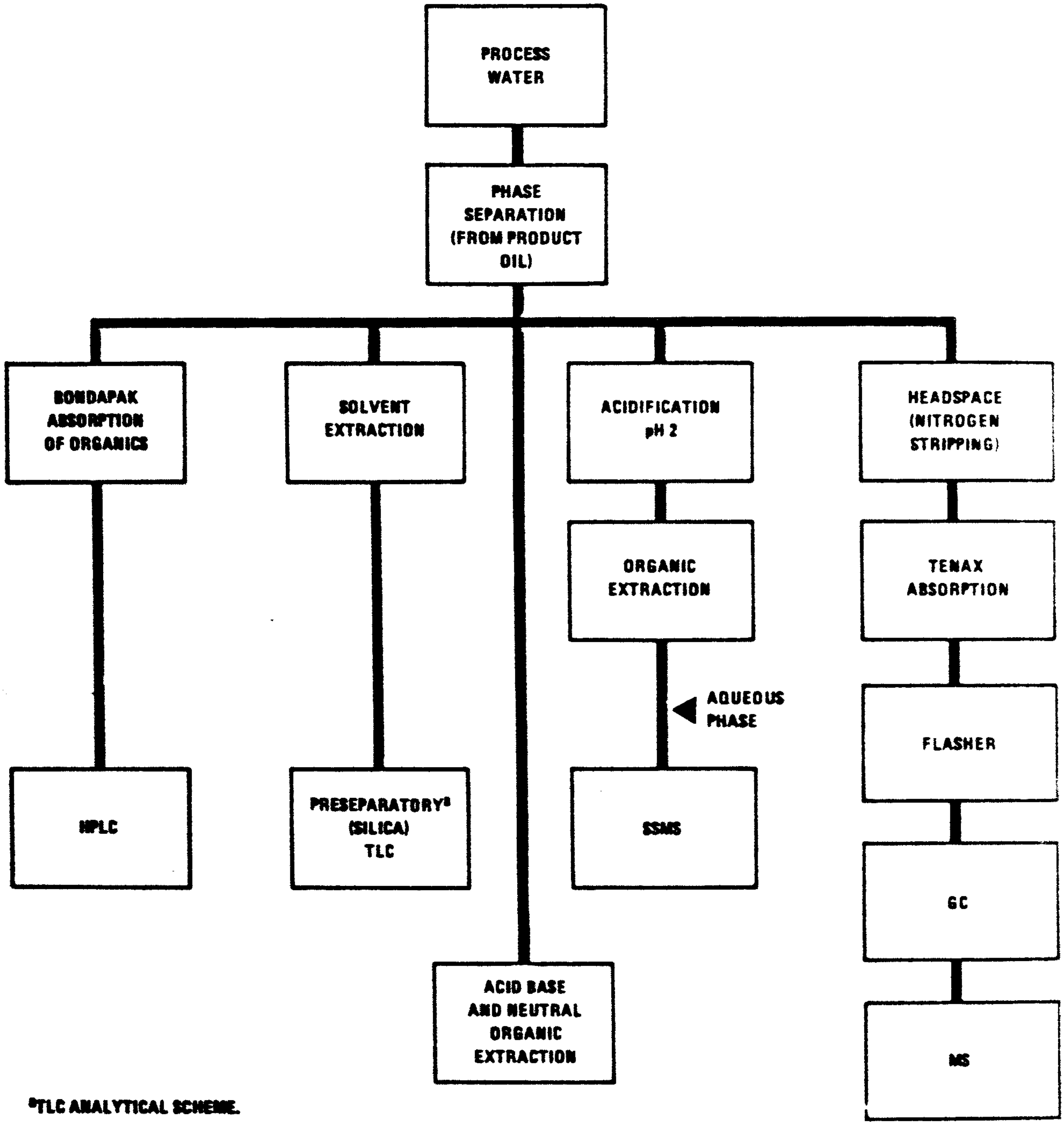
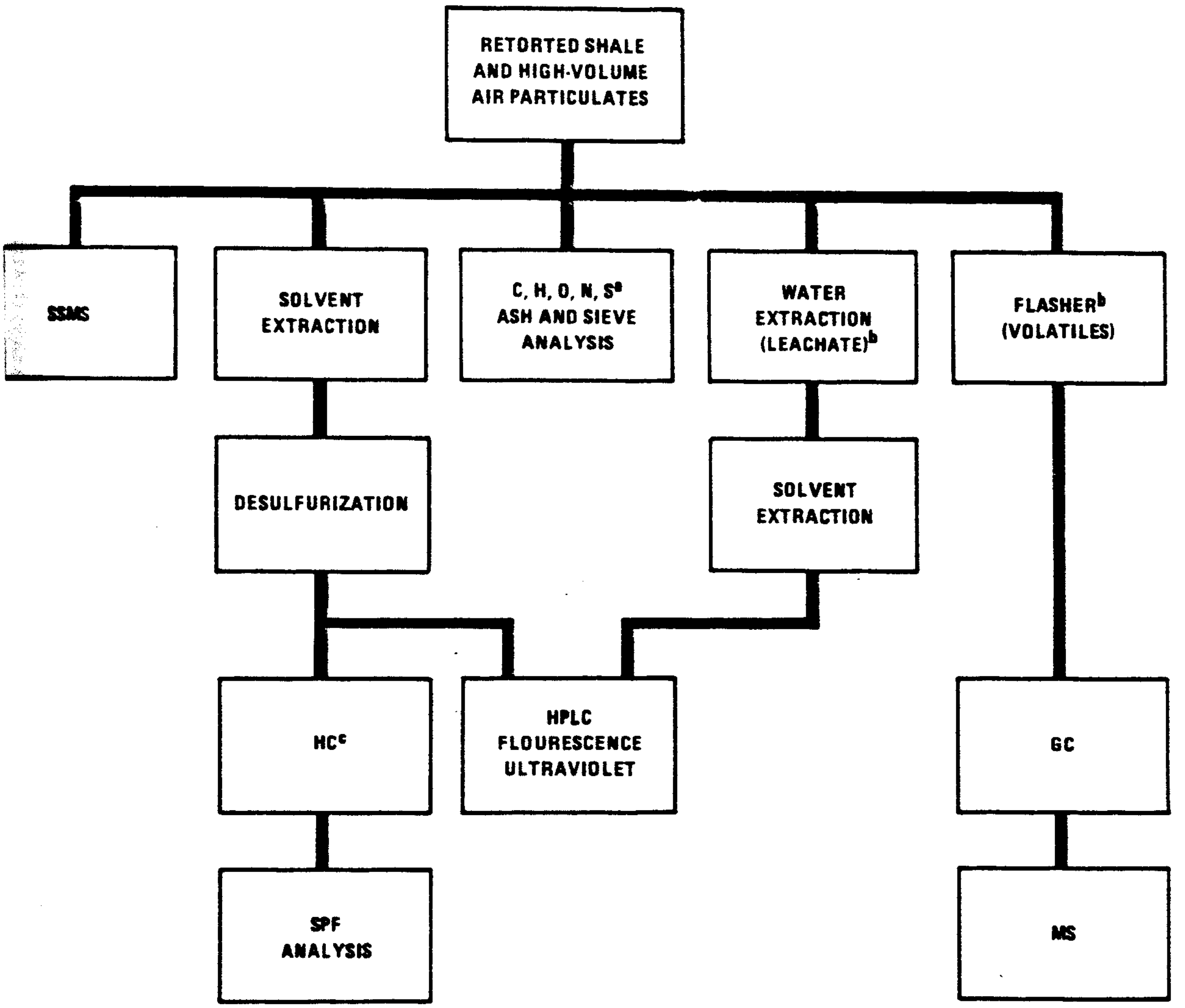


Figure 13-5. Separation and analysis scheme, water samples.



...ON, HYDROGEN, OXYGEN, NITROGEN, SULFUR.
...PERFORMED ON AIR PARTICULATES.
...ANALYTICAL SCHEME.

Figure 13-6. Separation and analysis scheme, retorted shale and high-volume sampler air particulates.

LEVEL 1

TABLE 13-1. SPARK SOURCE MASS SPECTROSCOPY
RETORTED SHALE, INDIRECT MODE, SEMI-WORKS, 3-16-76, 1415 HRS
(ppm)

U	5	Dy		Rh		Cr	82
Th	5	Tb	0.3	Ru		V	110
Bi		Gd	0.6	Mo	12	Ti	
Pb	14	Eu	0.3	Nb	5	Sc	12
Tl		Sm	0.8	Zr	77	Ca	
Hg*	0.04	Nd	6	Y	19	K	
Au		Pr	1	Sr	760	Cl	45
Pt		Ce	37	Rb	130	S	
Ir		La	11	Br	0.3	P	
Os		Ba	210	Se	0.3	Si	
Re		Cs	6	As	22	Al	
W		I	0.1	Ge	0.5	Mg	
Ta		Te		Ga	8	Na	
Hf		Sb	1	Zn	26	F	560
Lu		Sn	1	Cu	32	B	22
Yb		In		Ni	17	Be	0.9
Tm		Cd		Co	20	Li	33
Er		Ag		Fe			
Ho		Pd		Mn	340		

MC = Major component.
ND - Not determined.
*Flameless atomic absorption.

Note: 1. Fe, Ti, Ca, K, S, P, Si, Al, Mg, Na, O, N, C, H are all present in quantities greater than 1,000 ppm.
2. All elements not reported <0.2 ppm by weight.

TABLE 13-2. SPARK SOURCE MASS SPECTROSCOPY
INDIRECT MODE, RETORTED SHALE (COLLECTED AS AIR PARTICULATE),
3-17-76, 1545 HOURS
(ppm)

U	5	Dy		Rh		Cr	210
Th	5	Tb	0.7	Ru		V	140
Bi		Gd	2	Mo	23	Ti	
Pb	20	Eu	0.7	Nb	11	Sc	43
Tl		Sm	2	Zr	130	Ca	
Hg*	ND	Nd	13	Y	45	K	
Au		Pr	10	Sr	MC	Cl	25
Pt		Ce	130	Rb	200	S	
Ir		La	48	Br	0.8	P	
Os		Ba	410	Se	1	Si	
Re		Cs	8	As	32	Al	
W		I	0.2	Ge	0.8	Mg	
Ta		Te		Ga	15	Na	
Hf		Sb	1	Zn	20	F	MC
Lu		Sn	0.9	Cu	62	B	43
Yb		In		Ni	25	Be	2
Tm		Cd		Co	38	Li	130
Er		Ag		Fe			
Ho		Pd		Mn	650		

MC = Major component.
ND = Not determined.
*Flameless atomic absorption.

Note: 1. Fe, Ti, Ca, K, S, P, Si, Al, Mg, Na, O, N, C, H are all present in quantities greater than 1,000 ppm.
2. All elements not reported <0.2 ppm by weight.

TABLE 13-3. SPARK SOURCE MASS SPECTROSCOPY
RETORTED SHALES, DIRECT MODE (PILOT PLANT), 3-15-76, 1100 HOURS
(ppm)

U	5	Dy		Rh		Cr	230
Th	7	Tb	0.7	Ru		V	180
Bi		Gd	1	Mo	14	Ti	
Pb	23	Eu	0.7	Nb	7	Sc	26
Tl		Sm	2	Zr	65	Ca	
Hg*	0.06	Nd	6	Y	40	K	
Au		Pr	2	Sr	970	Cl	43
Pt		Ce	59	Rb	110	S	
Ir		La	21	Br	0.2	P	
Os		Ba	180	Se	0.5	Si	
Re		Cs	6	As	35	Al	
W		I	<0.2	Ge	0.9	Mg	
Ta		Te		Ga	17	Na	
Hf		Sb	0.7	Zn	22	F	>1,000
Lu		Sn	0.2	Cu	57	B	48
Yb		In		Ni	75	Be	2
Tm		Cd		Co	19	Li	85
Er		Ag		Fe			
Ho		Pd		Mn	800		

*Flameless atomic absorption.

Note: 1. Fe, Ti, Ca, K, S, P, Si, Al, Mg, Na, O, N, C, H are all present in quantities greater than 1,000 ppm.
2. All elements not reported <0.2 ppm by weight.

TABLE 13-4. SPARK SOURCE MASS SPECTROSCOPY
RETORTED SHALES, DIRECT MODE (Semi-Works), 3-15-75, 1100 hours
(ppm)

U	7	Dy		Rh		Cr	110
Th	4	Tb	0.6	Ru		V	110
Bi		Gd	0.9	Mo	18	Ti	
Pb	24	Eu	0.6	Nb	8	Sc	20
Tl		Sm	1	Zr	41	Ca	
Hg*	0.06	Nd	9	Y	17	K	
Au		Pr	5	Sr	760	Cl	42
Pt		Ce	100	Rb	85	S	
Ir		La	33	Br	0.2	P	
Os		Ba	310	Se	0.4	Si	
Re		Cs	10	As	18	Al	
W		I	<0.2	Ge	<0.2	Mg	
Ta		Te		Ga	13	Na	
Hf		Sb	1	Zn	17	F	920
Lu		Sn	2	Cu	53	B	82
Yb		In		Ni	20	Be	1
Tm		Cd		Co	15	Li	370
Er		Ag		Fe			
Ho		Pd		Mn	700		

*Flameless atomic absorption.

Note: 1. Fe, Ti, Ca, S, P, Si, Al, Mg, Na, O, N, C, H are all present in quantities > 1,000 ppm.
2. All elements not reported <0.2 ppm by weight.

TABLE 13-5. SPARK SOURCE MASS SPECTROSCOPY
COLD CONDENSATE WATER, PILOT PLANT, 3/10/76, 1700-0800 HOURS
(μg/L)

U	30	Dy		Rh		Cr	70
Th		Tb		Ru		V	<10
Bi		Gd		Mo	300	Ti	900
Pb	700	Eu		Nb		Sc	10
Tl		Sm		Zr	50	Ca	8,000
Hg	<10	Nd		Y	7	K	3,000
Au		Pr	8	Sr	100	Cl	400
Pt		Ce	10	Rb	400	S	3,000
Ir		La	40	Br	20	P	200
Os		Ba	100	Se	40	Si	4,000
Re		Cs		As	90	Al	200
W		I	8	Ge		Mg	3,000
Ta		Te		Ga	40	Na	5,000*
Hf		Sb		Zn	200	F	~100
Lu		Sn	50	Cu	100	B	60
Yb		In		Ni	100	Be	
Tm		Cd		Co	<10	Li	20
Er		Ag		Fe	<10,000		
Ho		Pd		Mn	200		

*Heterogeneous.

Note: After extraction of organics, sample was thermally ashed @ 450° C for ½ hr in a laboratory furnace in a quartz crucible prior to analysis.

TABLE 13-6. SPARK SOURCE MASS SPECTROSCOPY
CONDENSATE WATER, SEMI-WORKS, 3/18/76, 1120-1330 HOURS
(μg/L)

U	70	Dy		Rh		Cr	70
Th		Tb		Ru		V	6
Bi		Gd		Mo	100	Ti	900
Pb	300	Eu		Nb		Sc	≤10
Tl		Sm		Zr	50	Ca	10,000
Hg	<10	Nd		Y		K	1,000
Au		Pr	8	Sr	80	Cl	>10,000*
Pt		Ce	10	Rb	10	S	>10,000
Ir		La	10	Br	20	P	200
Os		Ba	100	Se	80	Si	7,000
Re		Cs		As	90	Al	500
W		I	10	Ge		Mg	7,000
Ta		Te		Ga	100	Na	900
Hf		Sb		Zn	200	F	~2,000
Lu		Sn	40	Cu	200	B	60
Yb		In		Ni	1,000*	Be	
Tm		Cd		Co	≤40	Li	40
Er		Ag		Fe	>10,000		
Ho		Pd		Mn	300		

*Heterogeneous.

Note: After extraction of organics, sample was thermally ashed @ 450° C for ½ hr in a laboratory furnace in a quartz crucible prior to analysis.

TABLE 13-7. SPARK SOURCE MASS SPECTROSCOPY
PROCESS WATER, SEMI-WORKS, 3/15/76, 1500 HOURS
(μg/L)

U		Dy		Rh		Cr	300
Th		Tb		Ru		V	30
Bi		Gd		Mo	100*	Ti	300
Pb	200	Eu		Nb		Sc	<50
Tl		Sm		Zr		Ca	>10,000
Hg	<10	Nd		Y		K	>10,000
Au		Pr		Sr	3,000	Cl	2,000
Pt		Ce	10	Rb		S	>10,000
Ir		La		Br	9	P	5,000
Os		Ba	2,000	Se	100	Si	>10,000
Re		Cs		As	1,000	Al	800
W		I		Ge	<50	Mg	>10,000
Ta		Te		Ga	<20	Na	>10,000
Hf		Sb		Zn	400	F	7,000
Lu		Sn		Cu	200	B	~5,000
Yb		In		Ni	200	Be	
Tm		Cd		Co	<40	Li	1,000
Er		Ag		Fe	5,000		
Ho		Pd		Mn	300		

*Heterogeneous.

Note: After extraction of organics, sample was thermally ashed @ 450° C for ½ hr in a laboratory furnace in a quartz crucible prior to analysis.

TABLE 13-8. RECYCLE GAS--AMMONIA, ARSINE (ppmv)

	Pilot plant (direct mode) March 9-12, 1976		Semi-works (indirect mode) March 14-15, 1976	
	NH_3	AsH_3	NH_3	AsH_3
3/9, 1330-1445				
3/9, 1500-1545				
3/10, 1000-1400		ND		
3/11, 1000-1400		ND		
3/11, 1500	1,614			
3/11, 1600	2,689			
3/12, 1600				
3/14, 1500				
3/14, 1700				
3/15, 1200			25,945	
3/15, 1600			27,642	
3/15, 1715				
3/15, 1730				

ND = Not detected.

TABLE 13-9. RECYCLE GAS--FIXED GASES (vol %)

	Pilot plant (direct mode) March 9-12, 1976			Semi-works (indirect mode) March 14-15, 1976		
	O_2	CO_2	CO	O_2	CO_2	CO
3/9, 1330-1445						
3/9, 1500-1545						
3/10, 1000-1400						
3/11, 1000-1400	ND	24.5	2.1			
3/11, 1500						
3/11, 1600						
3/12, 1600						
3/14, 1500						
3/14, 1700						
3/15, 1200						
3/15, 1600						
3/15, 1700						
3/15, 1715						
3/15, 1730						

ND = Not detected.

TABLE 13-10. RECYCLE GAS--SULFUR SPECIES
(ppmv)

	Pilot plant (direct mode) March 9-12, 1976			Semi-works (indirect mode) March 14-15, 1976		
	COS/CS_2	H_2S	SO_2	COS/SC_2	H_2S	SO_2
3/9, 1330-1445			14			
3/9, 1500-1545			4			
3/10, 1000-1400		2600 (Bendix tube)				
3/11, 1000-1400						
3/11, 1500						
3/11, 1600						
3/12, 1600	ND					
3/14, 1500						773
3/14, 1700						328
3/15, 1200						
3/15, 1600						
3/15, 1700						
3/15, 1715						
3/15, 1730						

ND = Not detected.

TABLE 13-11. RECYCLE GAS--NITROGEN OXIDES
(ppmv)

	Pilot plant (direct mode) March 9-12, 1976	Semi-works (indirect mode) March 14-15, 1976
	NO_x	NO_x
3/9, 1330-1445	9	
3/9, 1500-1545	16	
3/10, 1000-1400		
3/11, 1000-1400		
3/11, 1500		
3/11, 1600		
3/12, 1600		
3/14, 1500		
3/14, 1700		
3/15, 1200		
3/15, 1600		
3/15, 1700		30
3/15, 1715		37
3/15, 1730		49

TABLE 13-12. ANION ANALYSIS
(mg/L)

Anion	Pilot plant recycle gas cold condensate (direct mode) 3/11/76 - 0800-1800 hr	Semi-works recycle gas hot condensate (indirect mode) 3/14/76 - 0800-1800 hrs
F^-	0.35	0.10
Cl^-	TR	TR
Br^-		
NO_2^-	0.02	<.002
NO_3^-	118	1.0
$SO_3^=$		
$SO_4^=$	113.6	1.65
$PO_4^=$		
$S^=$ *	<0.1	390
$CO_3^=$ *	30,500†	3,030†
HCO_3^- *	31,265†	6,280†

*Not included in Level 1 protocol (October 1978).

†Calculated rather than measured.

TABLE 13-13. CATION ANALYSIS
(mg/L)

Cation	Pilot plant recycle gas cold condensate (direct mode) 3/11/76 - 0800-1800 hr	Semi-works recycle gas hot condensate (indirect mode) 3/14/76 - 0800-1800 hr
Calcium	60.74	39.16
Magnesium	<0.1	0.1
Sodium	.20	0.29
Potassium	.08	0.18
Ammonium (NH_4^+)	5,652*	13,540*

*Calculated rather than measured.

TABLE 13-14. NUTRIENT ANALYSIS
(mg/L)

Nutrient	Pilot plant recycle gas cold condensate (direct mode) 3/11/76 - 0800-1800 hr	Semi-works recycle gas hot condensate (indirect mode) 3/14/76 - 0800-1800 hr
NH_3-N	14,060*	16,800*
TKN†	31,400	
Phosphate (total)	0.58	0.75

*Calculated rather than measured.
†Total Kjeldahl nitrogen.

TABLE 13-15. GROSS PARAMETER ANALYSIS
(mg/L)

Gross parameter	Pilot plant recycle gas cold condensate (direct mode) 3/11/76 - 0800-1800 hr	Semi-works recycle gas hot condensate (indirect mode) 3/14/76 - 0800-1800 hrs
BOD*	12,000	4,850
COD*	19,400	17,100
TOC*	29,200	9,800†
TIC*	9,800	1,600
Oil & Grease*	502	33.3
Solids, Total	22,000	429
Solids, Dissolved	21,800	406
Solids, Suspended	200	
Total, Alkalinity	68,550	12,900
Hardness	152‡	98‡
Phenols*	46	42
pH	9.8	9.5

*This is not a Level 1 required analysis.
†Semi-works process water total organic carbon (TOC) was 36,900 mg/L on 3/15 @ 1500 hr.
‡Calculated rather than measured.

TABLE 13-16. CARBON ANALYSIS AND pH VALUES FOR AQUEOUS SAMPLE COLLECTED FROM PARAHO PROCESS (ppm)

	Indirect mode semi-works recycle gas (cold) condensate 3/17/76	Indirect mode semi-works process water 3/15/76	Direct mode pilot plant recycle gas condensate 3/15/76
Total carbon	8,000	37,200	13,500
Total inorganic carbon (TIC)	4,450	275	10,000
Total organic carbon (TOC)	3,550	36,900	3,500
pH	9.5	9.7	9.4

Note: All oily material was removed from the top of the sample followed by equilibrating at ambient for 4 hours, then removing any additional surficial oils before analysis.

TABLE 13-17. SUMMARY OF HIGH-VOLUME AIR PARTICULATES

Filter number	Date	Δt (hr)	Total volume of air filtered (m^3)	Dry weight of air particulates collected (g)	Mass concentration of suspended particulates ($\mu g/m^3$)
			PRIMARY CRUSHER BUILDING		
18	3-15 day-night	24.1	22.48	2.6277	116,900
2	3-16 day	8.1	8.47	1.4530	171,500
22	3-16 night	16.7	20.08	0.4739	23,600
27	3-17 day	6.3	7.16	0.9708	135,600
32	3-17 night	16.9	20.61	0.9764	47,400
			SECONDARY CRUSHER AREA		
17	3-15 day-night	24.4	20.76	6.9700	335,700
12	3-16 day	8.4	7.96	6.9126	868,400
23	3-16 night	16.6	19.96	2.2272	111,600
28	3-17 day	6.3	5.92	7.0380	1,188,900
			BINS AND WEIGH HOUSE		
16	3-15 day-night	24.7	12.91	92.1878	7,140,800
13	3-16 day	6.8	3.62	39.9150	11,026,200
24	3-16 night	16.8	8.55	90.5423	10,589,700
29	3-17 day	6.2	2.80	33.6678	12,024,200
34	3-17 night	24.4	12.09	101.3944	8,386,600

(continued)

TABLE 13-17 (continued)

Filter number	Date	Δt (hr)	Total volume of air filtered (m^3)	Dry weight of air particulates collected (gr)	Mass concentration of suspended particulates ($\mu g/m^3$)
			BELT DIVERTER BOX (During Pilot Plant Only Run)		
11	3-9 day	5.2	4.62	11.4303	2,474,100
15	3-10 day	6.3	3.4	9.4080	2,767,100
			SEMI-WORKS OUTPUT BELT (Next to Last Stationary Belt)		
19	3-15 day-night	24.6	14.61	89.4437	6,122,100
14	3-16 day	7.8	6.09	32.2564	5,296,600
25	3-16 night	16.8	9.97	63.7401	6,393,200
30	3-17 day	6.2	5.58	25.0370	4,486,900
35	3-17 night	17.0	10.85	84.0003	7,742,000
			SEMI-WORKS OUTPUT BELT (At End of Last Stationary Belt)		
20	3-15 day-night	24.4	14.53	43.4901	2,993,100
21	3-16 day	7.9	6.06	23.8886	3,942,000
26	3-16 night	16.7	17.05	11.4969	674,300
31	3-17 day	6.2	5.69	16.3360	2,871,000
36	3-17 night	17.2	16.54	11.2979	683,100

LEVEL 2

TABLE 2. TRACE ORGANICS IDENTIFIED BY GC/MS IN THE RECYCLE GAS STREAM (DIRECT AND INDIRECT MODE) SUMMARY OF ALL SAMPLES

Peak Number	Boiling Point (°C at 760 mm)	Compound	Molecular Weight
1	36	Pentane	72
2	69	Hexane	86
3	80.1	Benzene	78
4	93-98	Heptenes	98
5	98.5	Heptane	100
6	110.6	Toluene	92
7	121-129	Octenes	112
8	125.6	Octane	114
9	136.2	Ethyl benzene	106
10	138.3	p-Xylene	106
11	139.1	m-Xylene	106
12	140.6	Cyclooctatetraene	104
13	144.5	o-Xylene	106
14	145-146	Styrene	104
15	150.8	Nonane	128
16	161-165	Methyl ethyl benzene	120
17	163.4	a-Methyl styrene	118
18	164.7	1,3,5-Trimethyl benzene	120
19	169.4	1,2,4-Trimethyl benzene	120
20	170.6	1-Decene	140
21	174.1	Decane	142
22	178	Indan	118
23	181	1,3-Diethyl benzene	134
24	182.6	Indene	116
25	192.7	Undecene	154
26	195.6	Undecane	156
27	213.4	Dodecene	168
28	216.3	Dodecane	170
29	218	Naphthalene	128

TABLE 9. ELEMENTAL ANALYSIS OF RETORTED SHALE, PARTICULATES, AND ORGANIC EXTRACTS

	C Total	C Org.	C Inorg.	H	O	N (Dumas)	S (Free)	S (SO_4)	S (Sx)	Ash (dry)
Benzene Extract of Direct Mode Retorted Shale (3/12/76, 1000 hrs)	81.41	81.41	*	10.70	2.22	2.05	7.79	NA	NA	<0.15
Direct Mode Retorted Shale (3/12/76, 1000 hrs)	2.95	0.80	2.15	0.10	ND	0.13	ND	0.08	0.74	92.88
Raw Shale Collected as Air Particulate (3/15/76 to 3/17/76)	14.25	9.58	4.67	1.51	ND	0.43	ND	0.01	0.04	70.91
Organic Matter† in Raw Shale (average of 10 cores from Colorado & Utah)		80.5		10.3	5.8	2.4	1.0			

* 0.5% of total C

ND = Not Determined
NA = Not Applicable

†Smith, J. W., Ultimate Composition of Organic Matter in Green River Oil Shale, USBM RI5725 (1961)

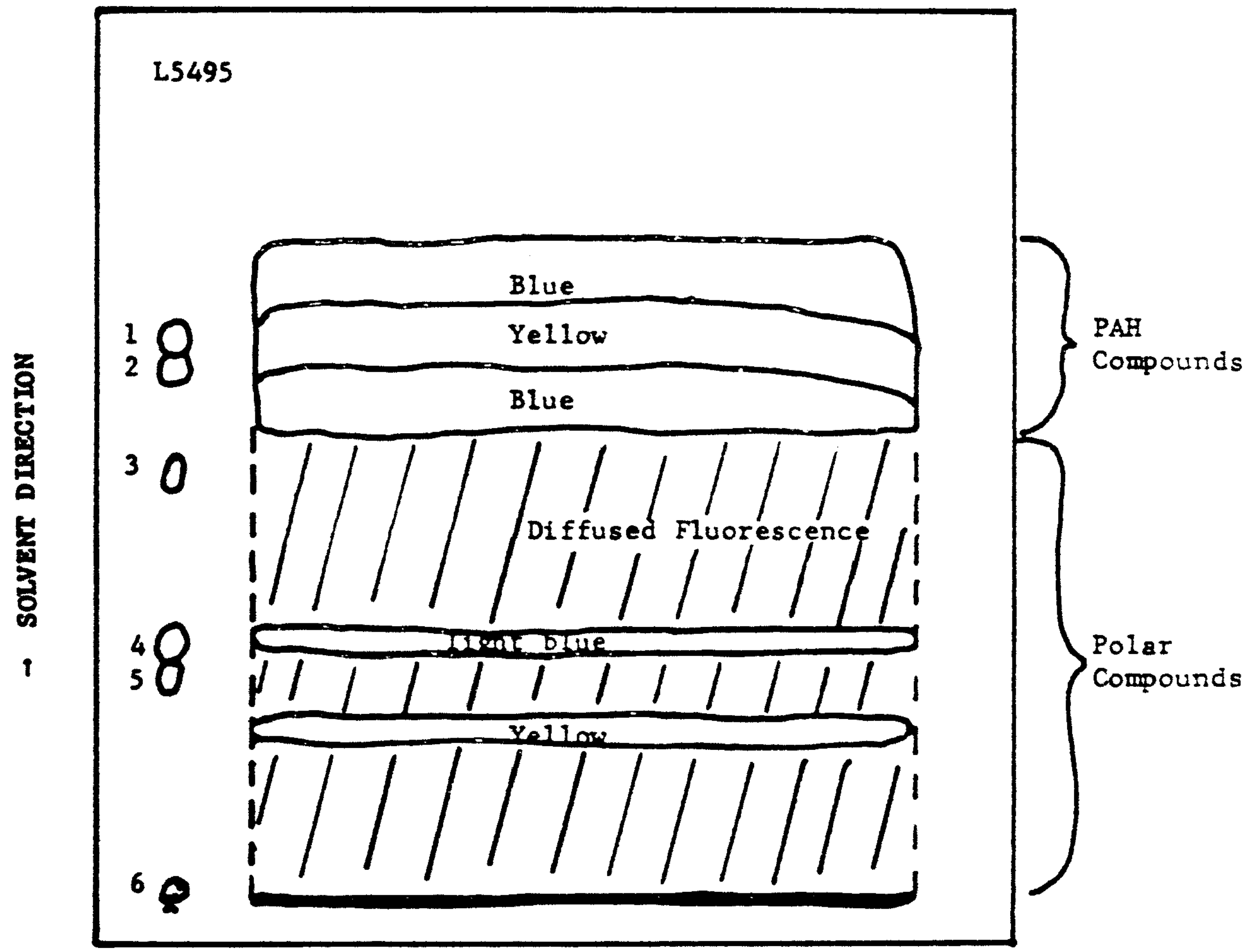


Figure 5.35 One dimensional preseparatory thin layer chromatogram of benzene solubles from carbonaceous spent shale [CSA VII (1)]. Layer: silica gel G. Solvents: benzene, cyclohexane (1.5:1). Compounds: 1 and 2, PAH composite mixture; 3, acridine; 4, carbazole; 5, 1,2,7,8-dibenzacridine; 6, phenanthridine.

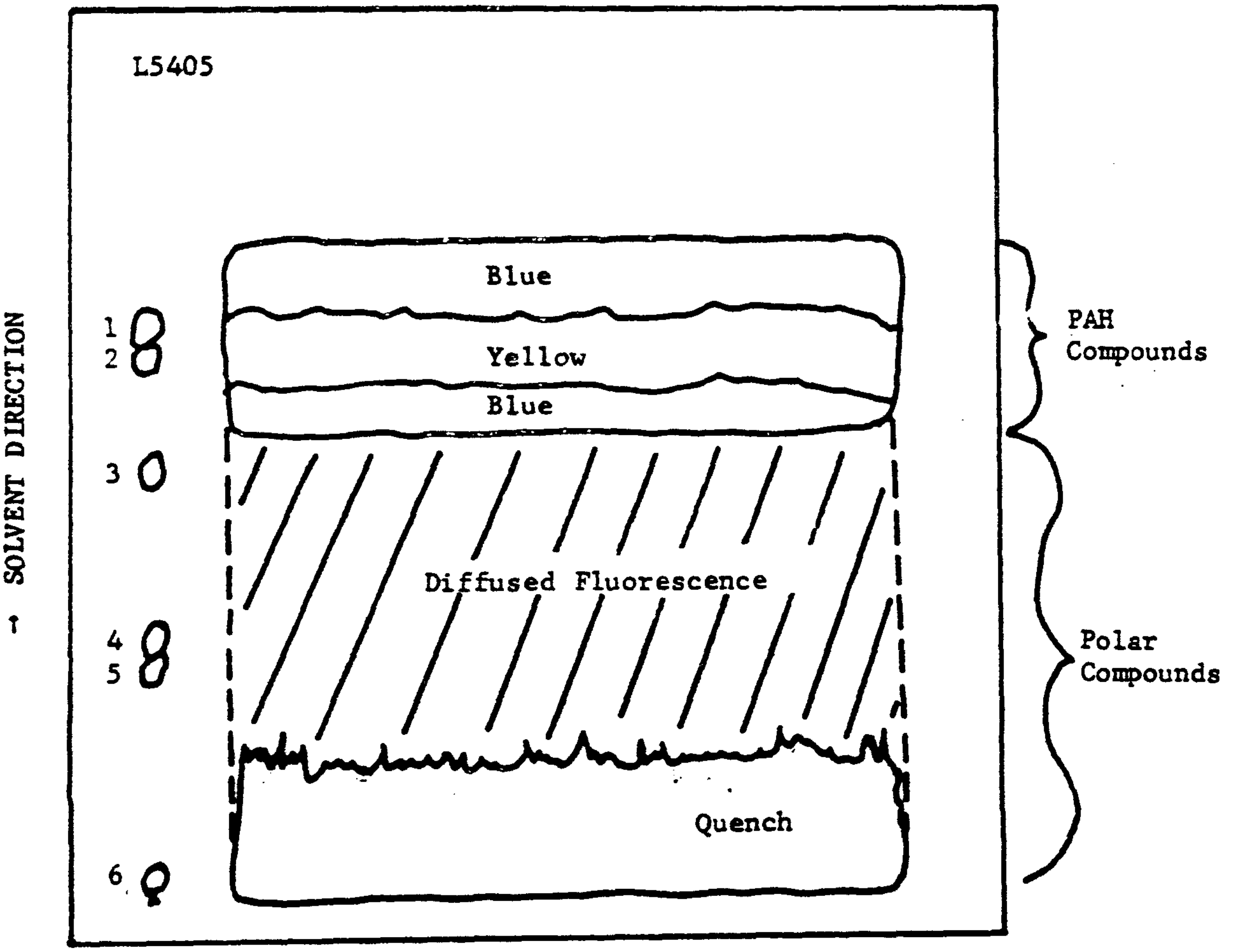


Figure 5.36 One dimensional preseparatory thin layer chromatogram of benzene solubles from carbonaceous spent shale [CSA VIII (1)]. Layer: silica gel G. Solvents: benzene, cyclohexane (1.5:1). Compounds: 1 and 2, PAH composite mixture; 3, acridine; 4, carbazole; 5, 1,2,7,8-dibenzacridine; 6, phenanthridine.

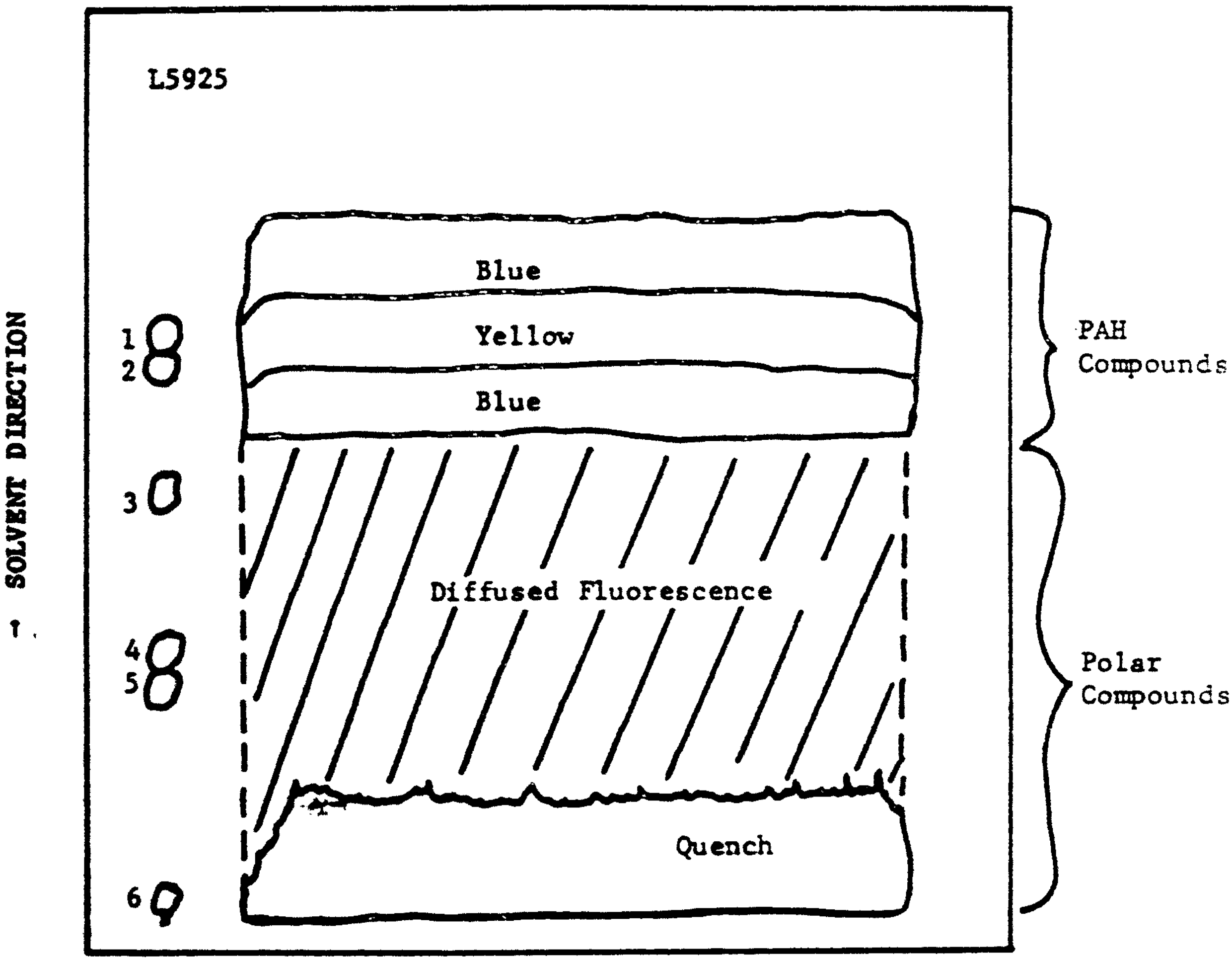


Figure 5.37 One dimensional preseparatory thin layer chromatogram of benzene solubles from unretorted shale collected as air particulate [AP VI (1)]. Layer: silica gel G. Solvents: benzene, cyclohexane (1.5:1). Compounds: 1 and 2, PAH composite mixture; 3, acridine; 4, carbazole; 5, 1,2,7,8-dibenzacridine; 6, phenanthridine.

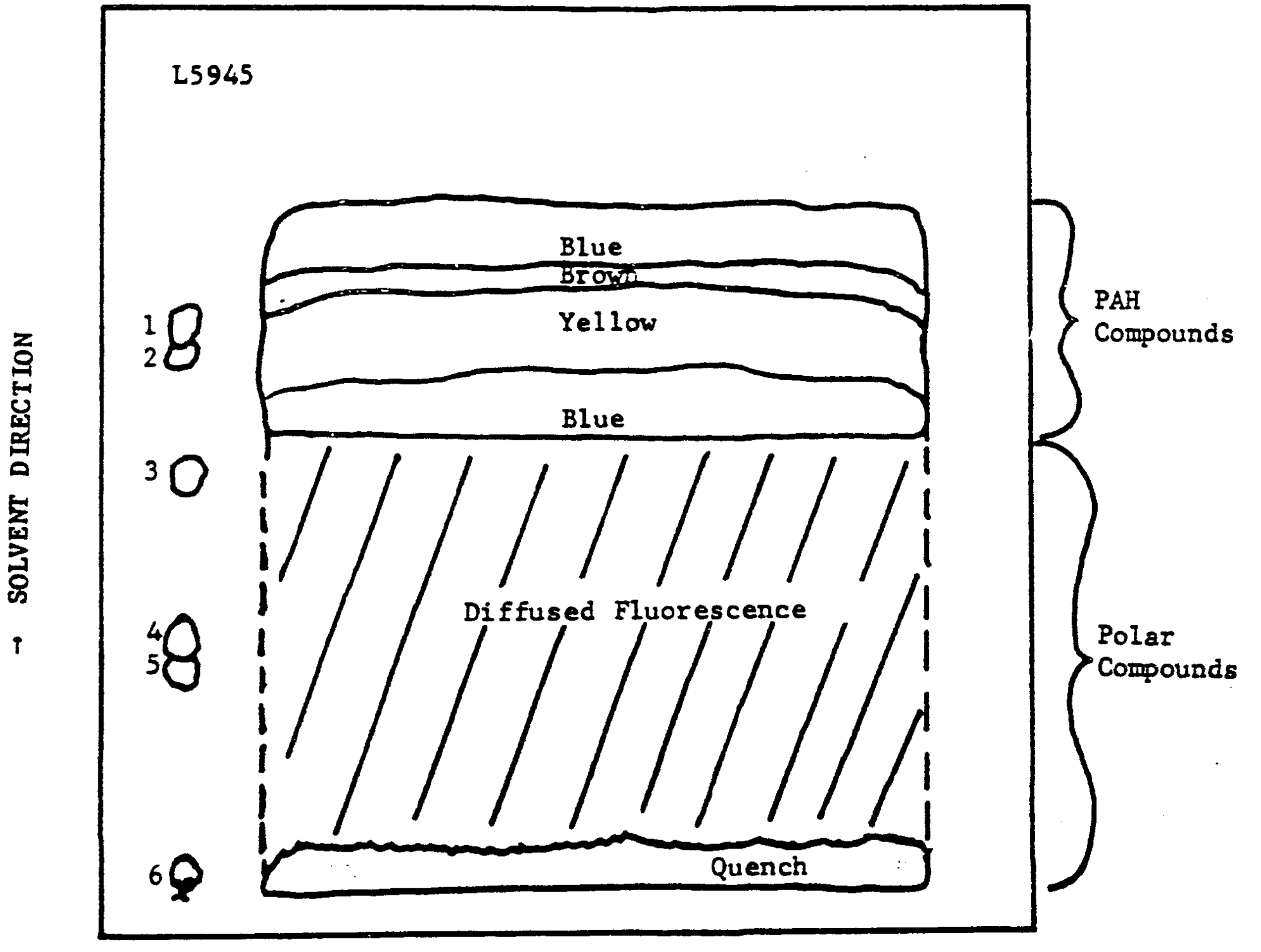


Figure 5.38 One dimensional preseparatory thin layer chromatogram of benzene solubles from retorted shale collected as air particulate [AP V (1)]. Layer: silica gel G. Solvents: benzene, cyclohexane (1.5:1). Compounds: 1 and 2, PAH composite mixture; 3, acridine; 4, carbazole; 5, 1,2,7,8-dibenzacridine; 6, phenanthridine.

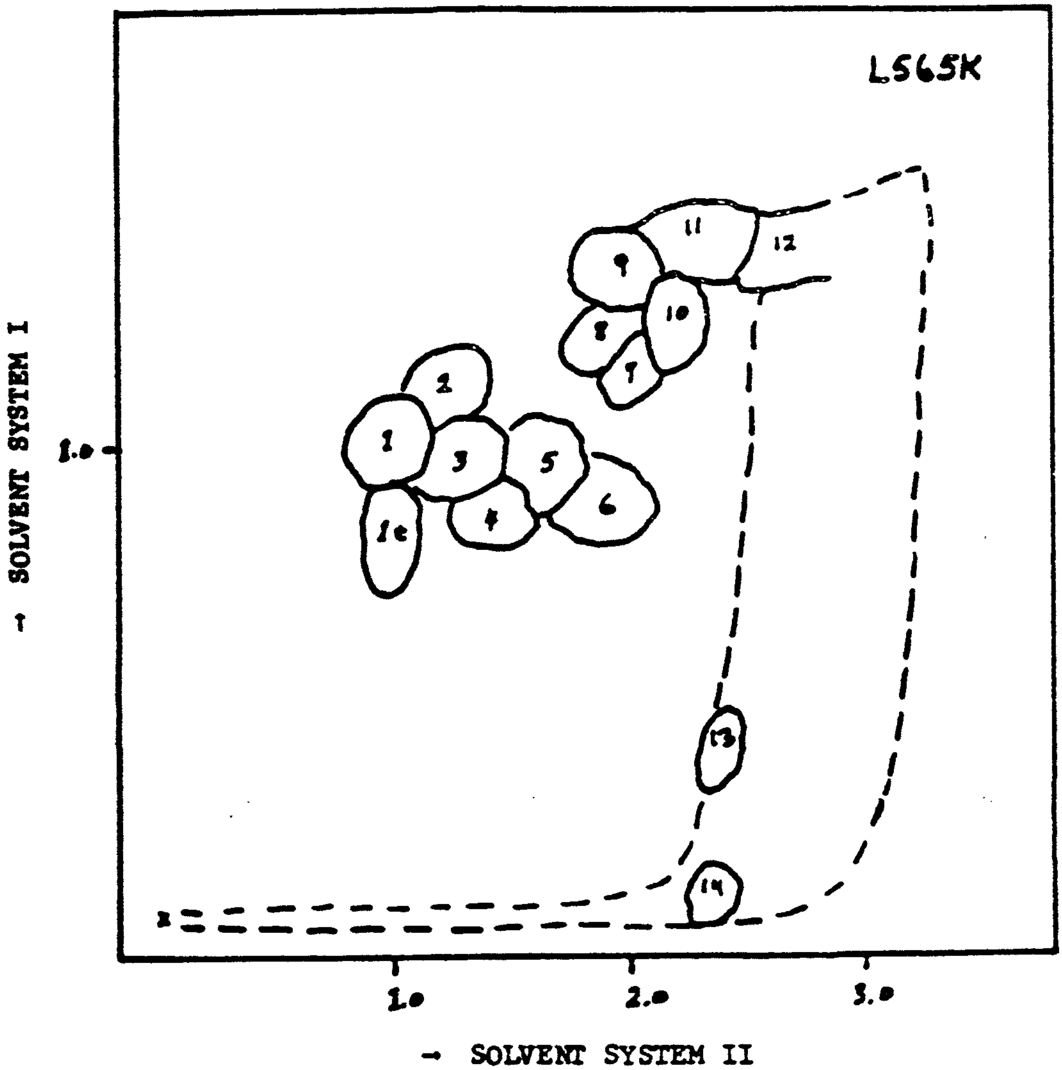
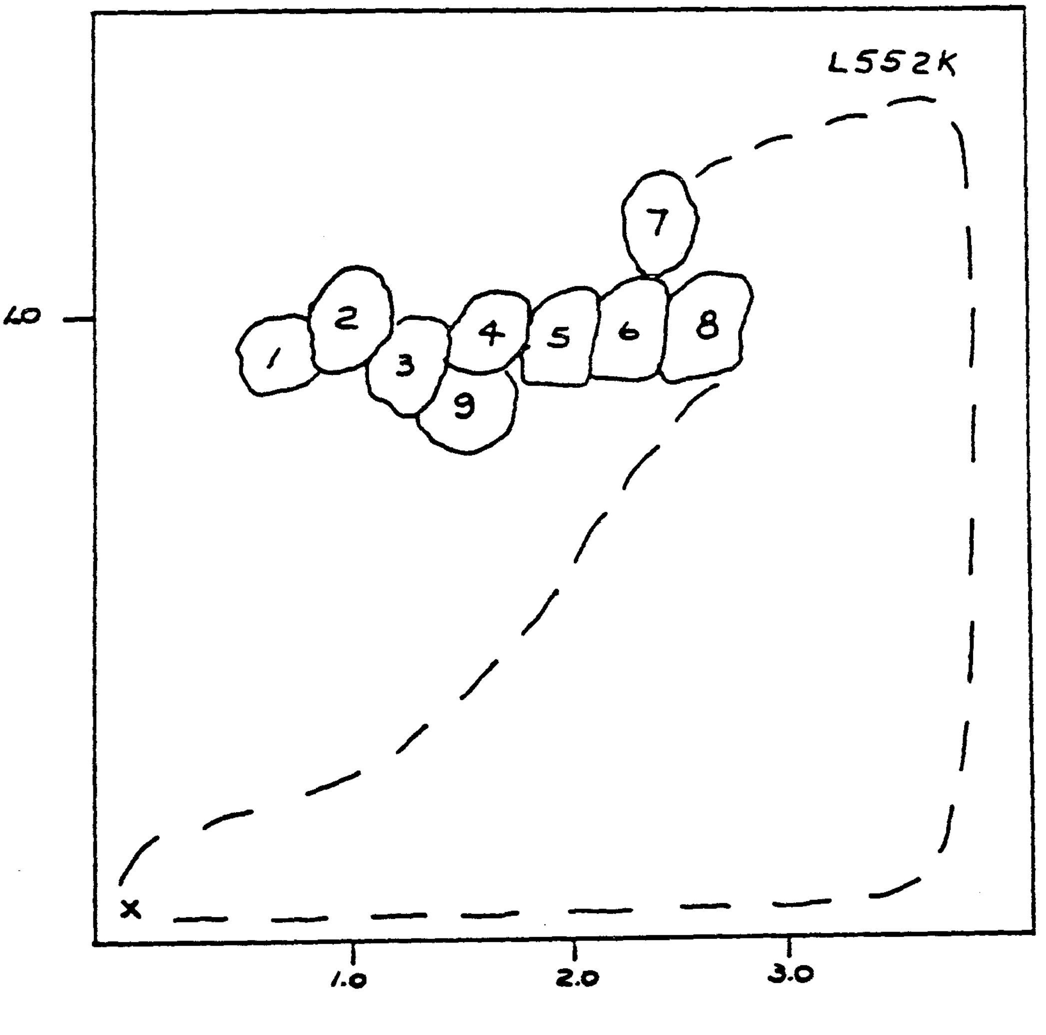


Figure 5.39 Two dimensional mixed thin layer chromatogram of the PAH fraction of benzene solubles from carbonaceous spent shale [CSA VII (1)]. Layer: 40% acetylated cellulose, aluminum oxide G, silica gel G (1:1:1). Solvents: System I, isooctane, drying followed by n-hexane, benzene (95:5). System II, methanol, ether, water (4:4:1). Compounds: 1 and 1 tailing, benzo(a)pyrene.



SOLVENT SYSTEM II →

Figure 5.43 Two dimensional mixed thin layer chromatogram of the PAH fraction of benzene solubles from carbonaceous spent shale [CSA VIII (1)]. Layer: 40% acetylated cellulose, aluminum oxide G, silica gel G (1:1:1). Solvents: System I, isooctane, drying followed by n-hexane, benzene (95:5). System II, methanol, ether, water (4:4:1). Compounds: 2, benzo(a) pyrene.

Table 5.9 Elemental Analysis of Retort Shale, Particulates and Organic Extracts

	C Total	C Org.	C Inorg.	H	O	N (Dumas)	S (Free)	S (SO_4)	S (Sx)	Ash (Dry)
Benzene Extract of Paraho Indirect Mode Spent Shale	84.69	84.69	*	9.60	2.45	2.88	1.01	NA	NA	<0.15
Benzene Extract of Paraho Direct Mode Spent Shale	81.41	81.41	*	10.70	2.22	2.05	7.79	NA	NA	<0.15
Paraho Indirect Mode Spent Shale	9.68	5.85	3.83	0.49	ND	0.29	ND	0.01	0.38	75.99
Paraho Direct Mode Spent Shale	2.95	0.80	2.15	0.10	ND	0.13	ND	0.08	0.73	92.88
Paraho Indirect Mode Spent Shale Collected as Air Particulate	10.43	5.27	5.16	0.48	ND	0.34	ND	0.04	0.42	75.61
Raw Shale Collected as Air Particulate	14.25	9.58	4.67	1.51	ND	0.43	ND	0.01	0.04	70.91
Organic Matter Raw Shale (Smith, LERC, 1961)		80.5		10.3	5.8	2.4	1.0			

*<0.5% of total C

ND Not Determined
NA Not Applicable

Table 5.19 Polar "Oxy" Compounds Present in Carbonaceous Spent Shale

Compound	GC Confirmation	Approx. ppm
Heptanoic Acid	+	0.26
Benzoic Acid	+	0.18
Octanoic Acid	+	0.39
o-Toluic Acid	+	----
m-Toluic Acid	+	0.60
p-Toluic Acid	+	0.60
Nonanoic Acid	+	0.70
2,5 -Dimethylbenzoic Acid	+	----
3,5-Dimethylbenzoic Acid	+	----
Decanoic Acid	+	----
3,5-Dimethylbenzoic Acid	+	----
Isopropylbenzoic Acid	+	----
Trimethylbenzoic Acid	+	----
Tetramethylbenzoic Acid	+	----
β-Hydroxy Aliphatic Acid	+	----
Methylisopropyl Benzoic	+	----
Aliphatic Dibasic Acid (C_{18})	+	----

ADDITIONAL DATA

Operating Parameters for Water Data

	Plant Feed Rate, Tonne/hr (TPH)	Recycle Gas Rate, Std.Cu.Meters/hr (SCFM)
Semi-Works Hot Condensate (3/14/76), 0800-1800 hrs and Process Water (3/15/76, 1500 hrs)**	10.2 (11.2)	6320 (3650)
Pilot Plant Cold Condensate (3/18/76, 1130-1330 hrs) (3/10/76, 0800-1700 hrs)**	0.91 (1.0)	493 (290)

**These operating parameters also apply to Table 4, following.

TABLE 5. SIZE RANGES OF SOLIDS

Material	Size Range	Remarks
Raw Feed Shale	<7.62 cm, >6 mm (-3" +¼")	
Fines	<6 mm (¼")	Includes crushing fines
Raw Shale Air Particulates	>0.01 <5 mm	For particle size distribution see Table 6 and 7
Retorted Shale	see below	

Screen Sieve Analyses of Direct Mode Retorted Shale (3/12/76, 1000 hrs)

Weight Percent	Sieve Designation Standard (New U.S. Nos.)
26.4	>19.0 mm
9.9	19.0
9.0	13.2
11.5	9.5
4.4	4.75
6.6	3.25
3.2	1.70
6.2	1.18
2.7	600 μm
2.4	425
2.4	300
2.1	212
0.6	150
2.4	106
8.7	75
1.6	<45

TABLE 6. MASS FRACTION OF RAW SHALE PARTICULATES

Particulate Size Range	<0.3 μm	<1.0 μm	<3 μm
Cumulative Weight Percent less than stated size	2	26	73

(Sample taken at 1400 hrs, 3/17/76
crushing 28 gal/ton shale)

TABLE 7. NUMERICAL FRACTION OF RAW SHALE PARTICULATES

Particulate Size Range	Breakdown % <1.0 μm					
	<0.01 μm	0.01-0.05 μm	0.05-1 μm	Cumulative % <1.0 μm	1-5 μm	5 μm
Cumulative Count Percent less than stated size	50.4	33.3	1.2	84.9	10.1	5.0

(Sample taken at 1410 hrs, 3/15/76
handling 28 gal/ton shale)

TABLE 8. PARTICLE SIZE VS. MEAN ELEMENTAL COMPOSITION OF RAW SHALE AIR PARTICULATES AS DETERMINED BY X-RAY FLUORESCENCE

Elemental Components Detected \ Size Ranges of Particles Analyzed	<5 μm*	<1.0 μm	>1, <5 μm	>5 μm
Si	40%	30%	44%	43%
Ca	20	16	24	22
Al	10	11	10	8
Mg	10	12	6	8
Fe	+	9	5	6
K	+	2	5	6
Na	+	2	3	2
P	-	3	+	+
S	+	12	+	4
Ti	+	-	+	+

*High background fluorescence.

+Indicates presence of element but not quantifiable

-Indicates element not found in sample at sufficient concentration to be detected by x-ray fluorescence.

TABLE 11. BENZENE AND WATER EXTRACTABLES OF RETORTED SHALE, AND RAW SHALE PARTICULATES

	Total Benzene Solubles Wt %	Benzene Solubles Sulfur Removed Wt %	Water Solubles Wt %	Benzene Solubles of Water Solubles Wt %
Pilot Plant (Direct Mode) Retorted Shale (3/12/76, 1000 hrs)	0.03(4)	0.03(7)	3.39	0.00(3)
Raw Shale Collected as Air Particulate in the Crushing Area (3/15/76 to 3/17/76)	2.05	ND	ND	ND

ND = Not determined

TABLE 12. COMPARISON OF PAH TO POLAR COMPOUNDS IN SOLID SAMPLES

Sample Designation	Wt. % PAH	Wt % Polar Compounds
Pilot Plant Retorted Shale, Direct Mode (3/12/76, 1000 hrs)	43	57
Raw Shale Air Particulate (3/15/76 to 3/17/76)	16	84

TABLE 13. R_B VALUES FOR PAH FRACTION OF BENZENE SOLUBLES FROM DIRECT MODE RETORTED SHALE.

Spot No. on Figure 10	Fluorescence	R_B I	R_B II	Compound
1	purple	1.00	1.00	*Benzo(a)pyrene
1 (tailing)	purple	0.79	1.02	*Benzo(a)pyrene
2	light blue	1.02	1.25	**Coronene
3	blue	0.93	1.27	
4	yellow	0.87	1.45	
5	purple	0.95	1.64	**1,2 Benzanthracene
6	blue	0.83	1.89	
7	purple	1.08	1.95	**1,2 Benzanthracene
8	blue	1.19	1.84	
9	purple	1.36	1.91	**Pyrene
10	blue green	1.24	2.18	**Fluoranthene
11	purple	1.38	2.34	
12	purple	1.27	2.80	
13	blue	0.31	2.41	
14	blue	0.00	2.34	

*Quantitatively identified by fluorescence spectrometry and/or high pressure liquid chromatography.
**These compounds have been qualitatively identified by R_B values only.

TABLE 14. EVALUATION OF BENZO(A)PYRENE CONTENT IN SAMPLES OF BENZENE EXTRACTS FROM DIRECT MODE RETORTED SHALES

Sample Designation	Bz. Sol. Quantity Analyzed (mg)	BaP/TLC Spot (μg)	Wt % BaP in Bz. Solubles	BaP in Bz.Sol. (μg/kg)	BaP in Shale Sample (μg/kg)	BaP in Bz. Sols. ppm	BaP in Sample ppm
Pilot Plant (Direct Mode) Retorted Shale (3/12/76, 1000 hrs)	8.7	0.050	.000(5)	4.7×10^3	2.0	4.7	0.2×10^{-2}
	8.7	0.038	.000(4)	3.6×10^3	1.5	3.6	0.2×10^{-2}
	Ave.	0.044	.001	4.2×10^3	1.8	4.2	0.2×10^{-2}
Retorted Shale (Direct Mode) Semi-Works (3/75)	Ave.	0.189	0.001	14×10^3	1.50	14	0.2×10^{-2}

Table 5.5

Evaluation of Organics Extracted from Aqueous Phase of Recycle Gas (Cold) Condensate (RG-10)

Fraction	Extraction Solvent	Weight (mg)	Weight Percent	ppm	Total Wt. Percent	Total ppm
Neutrals	Methylene Chloride	242.9	0.081	810		
	Benzene	40.0	0.013	130		
	Total	282.9	0.094	940	0.094	940
Acids	Methylene Chloride	247.9	0.083	830		
	Benzene	11.7	0.004	40		
	Total	259.6	0.087	870	0.087	870
Bases	Methylene Chloride	35.2	0.012	120		
	Benzene	26.4	0.009	90		
	Total	61.6	0.021	210	0.021	210
					0.202% wt.	2,020 ppm

Table 5.6

Evaluation of Organics Extracted from Aqueous Phase of Recycle Gas (Hot) Condensate (RG-7)

Fraction	Extraction Solvent	Weight (mg)	Weight Percent	ppm	Total Wt. Percent	Total ppm
Neutrals	Methylene Chloride	99.4	0.041	410		
	Benzene	2.9	0.001	10		
	Total	102.3	0.042	420	0.042	420
Acids	Methylene Chloride	43.1	0.018	180		
	Benzene	10.2	0.004	40		
	Total	53.3	0.022	220	0.022	220
Bases	Methylene Chloride	11.9	0.005	50		
	Benzene	0.5	0.000(2)	2		
	Total	12.4	0.005	52	0.005	52
					0.069%	692 ppm

Table 5.11

Size Distribution of PARAHO Solids

Material	Size Range	Remarks
Raw Feed Shale	-7.62 cm + 6 mm (-3" + ¼)	
Fines	<6 mm (¼")	Includes crushing fines.
Raw Shale Particulates	+0.01 μm - 5 μm	For particle size distribution see Table V.
Retorted Shale	>19 mm	Seive Analysis see Table VI. Larger pieces laminate upon weathering.
Air Particulates from Retorted Shale (above conveyor belt)	+0.01 μm - 5 μm	See Table V for particle size distribution.

Table 5.12

Screen Sieve Analyses of PARAHO Retorted Shale*

Sieve Designation Standard (New U.S. Nos.)	Semi-Works Indirect Mode	Pilot Plant Direct Mode
>19.0 mm	16.9%	26.4%
19.0	9.9	9.9
13.2	11.8	9.0
9.5	15.8	11.5
4.75	5.5	4.4
3.35	10.0	6.6
1.70	8.5	3.2
1.18	3.9	6.2
600 μm	3.0	2.7
425	2.6	2.4
300	2.2	2.4
212	1.8	2.1
150	1.5	0.6
106	0.8	2.4
75	3.9	8.7
<45	2.1	1.6

*Collected from the retorted shale belts.

Table 5.14. Mean Particle Size (Effective Diameter) of LO VOL AIR PARTICULATE SAMPLES Collected at the Paraho Plant as Determined by Scanning and Transmission Electron Microscopy (Values in Count Percent)

	Percent >1.0μm					
	<0.01μm	0.01-0.05μm	0.05-1μm	Summation of Particles <1.0μm	1-5μm	>5μm
Bins & Weigh House (Handling at Unretorted Shale) 3-15-76 1410 hrs.	50.4*	33.3*	1.2*	84.9	10.1	5.0
Pilot Plant Retorted Shale Belt 3-9-76 1030 hrs.	<0.1	<0.1	100	83.2	14.3	2.6
Semi-Works Retorted Shale Belt 3-16-76 1115 hrs.	<0.1	<0.1	100	2.0	71.4	26.5

*Values obtained by Transmission Electron Microscopy as explained in text.

Table 5.15. Particle Size Analysis of Air Particulate Samples Collected at the Paraho Plant as Determined by Cascade Impaction Collector (Cumulative Weight Percent Less than Stated Micron Size)

	%<0.3μm	%<1.0μm	<3μm
Primary Crusher Bldg. 3-17-76 1300 hrs.	2	26	73
Bins & Weigh House 3-18-76	76	87	94
Semi-Works Retorted Shale Belt 3-18-76 1345 hrs.	2	28	76

Table 5.16

PARTICLE SIZE VS.
MEAN ELEMENTAL COMPOSITION OF
AIR PARTICULATES
AS DETERMINED BY X-RAY FLUORESCENCE

	Bins & Weigh House (Unretorted Shale)				Pilot Plant Direct Mode (3- 9-76, 1030 hrs)			Semi-Works Indirect Mode (3-16-76, 1115 hrs.)		
	<0.5 um*	<1.0 um	>1,>5 um	>5 um	<1 um	>1,>5 um	>5 um	<1 um	>1,<5 um	>5
	~40	30	44	43	41	40	40	45	52	41
	~20	16	24	22	28	23	23	21	34	23
	~10	11	10	8	14	9	13	11	14	8
	~10	12	6	8	7	11	9	5	12	10
	+	9	5	6	3	5	4	7	5	4
	+	2	5	6	+	+	3	5	5	6
	+	2	3	2	+	+	3	+	+	+
	-	3	+	+	+	+	+	+	+	+
	+	12	+	4	7	11	2	+	5.4	4
	+	-	+	+	+	-	+	+	+	+
	+	+	+	+	+	+	+	+	+	+

gh background fluorescence, see text.
dicates presence of element but not quantifiable.
dicates element not found in sample at sufficient concentration to be detected.

Table 5.17 Benzene and Water Extractables of Solid Samples

	Total Benzene Solubles Wt. %	Benzene Solubles Sulfur Removed Wt. %	Water Solubles Wt. %	Benzene Solubles of Water Solubles Wt. %
Pilot Plant (Direct Mode) Retorted Shale (3-12-76, 1000 hrs)	0.03(4)	0.03(7)	3.39	0.00(3)
Semi-Works (Indirect Mode) Retorted Shale (3-16-76, 1415 hrs)	2.15	2.15	*0.98	0.03
Semi-Works Retorted Shale Collected as Air Particulate (3-15-76 to 3-18-76)	1.67	N.D.	N.D.	N.D.
Unretorted Shale Collected as Air Particulate (3-15-76 to 3-17-76)	2.05	N.D.	N.D.	N.D.

*Low value is probably due to oily hydrophobic nature of sample.

N.D. = Not Determined

Table 5.21
Evaluation of Benzo(a)pyrene
Content in Samples of Benzene Extracts from
Paraho Spent Shale Coke Samples

ple signa- n		Bz. Sol. Quantity Analyzed (mg)	BaP/TLC Spot (mcg)	Wt. % BaP in Bz. Solubles	BaP in Bz.Sol. (mcg/kg)	BaP in Shale Sample (mcg/kg)	BaP in Bz.Sols. p.p.m.	BaP in Sample p.p.m.
VIII (1)	1	18.4	0.100	.000(5)	5.4×10^3	116	5.4	$12. \times 10^{-2}$
i-works direct Mode)	2	18.4	0.146	.000(8)	7.9×10^3	170	7.9	$17. \times 10^{-2}$
	3	18.4	0.144	.000(8)	7.8×10^3	168	7.8	$17. \times 10^{-2}$
Ave.			0.130	.000(7)	7.0×10^3	151	7.0	$15. \times 10^{-2}$
VII (1)	1	8.7	0.050	.000(5)	4.7×10^3	2.0	4.7	0.2×10^{-2}
ot Plant irect Mode)	2	8.7	0.038	.000(4)	3.6×10^3	1.5	3.6	0.2×10^{-2}
Ave.			0.044	.001	4.2×10^3	1.8	4.2	0.2×10^{-2}
lier PARAHO torted Shale irect Mode)								
Ave.			0.189	0.001	14×10^3	1.50	14	0.2×10^{-2}
O Retorted le								
Ave.			0.295	0.002	17×10^3	42.4	17	4.2×10^{-2}

Table 5.22

R_B Values for PAH Fraction of Benzene Solubles from Carbonaceous Spent Shale [CSA VIII (1)]

Spot No.	Fluorescence	R_B I	R_B II	Compound
1	purple	0.95	0.64	**BaP derivative
2	purple	1.00	1.00	*Benzo(a)pyrene
3	blue	0.93	1.31	
4	purple	0.97	1.72	
5	purple	0.95	2.75	***1,2 Benzanthracene derivative
6	blue	0.98	2.33	
7	light blue	1.15	2.38	***Fluoranthene
8	blue	1.00	2.64	
9	yellow	0.85	1.49	

*These compounds have been quantitatively identified by fluorescence spectrometry and/or high pressure liquid chromatography (Figure 5.36).

**The fluorescent spectra of these compounds indicate possible derivatives of benzo(a)pyrene.

***These compounds have been qualitatively identified by R_B values only.

Table 5.23 Pilot Plant (Direct Mode) Recycle Gas

Gas Sampled	Tube Type	Corrected Values Obtained*	Notes
CO	1H	4.7%	
	1H	4.7%	
	1H	4.7%	
CO_2	2H	>20%	H_2S produces erroneously high values
NH_3	3H	6.3%	H_2S Produces erroneously high values
	3H**	7.5%	
	3M**	1000 ppm	Amines and diamines produ_e a plus error
	3M	1000 ppm	
H_2	4H	2600 ppm	SO_2 >50 ppm produces plus error
	4H**	2600 ppm	
	4HH**	0.25%	
	4HH	0.25%	
SO_2	5La	< 2 ppm	below minimum detectable
NO-NO_2	10	< 5 ppm	below minimum detectable
HCN	12	3.2%	both CO and H_2S produce erronious high values

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Semi Works (Indirect Mode) Recycle Gas

Gas Sampled	Tube Type	Corrected Values Obtained*	Notes
CO	1H	12.5%	Several color bands produced by interferring hydrocarbons. Values in doubt.
	1H	12.5%	
CO_2	2H		Interferences rendered tube unreadable.
NH_3	3M	550 ppm	Amines and diamines produce plus error.
	3M**	675 ppm	
	3H**		Interference rendered tube unreadable probably H_2S.
H_2S	4HH	3.1%	SO_2 < 50 ppm produces plus error.
	4HH	3.1%	
SO_2	5L	150 ppm	Many interferences.
	5L	150 ppm	
NO-NO_2	10	< 2 ppm	Below minimum detectable.
HCN	12H		CO rendered tube unreadable.

*Values obtained corrected for pressure. No other corrections are suggested.

**Indicates that different chemistries are used for the different tube ranges.

Table 6.1. Flame Ionization Response of Sample MSA-34 Extracted with CS_2

PRINT FINAL

N	TIME	COR.TIME	AREA	NOR.AREA	X*NAREA	UG/ML* Y*NAREA	
1	197	197.0000	9265.0100	97.5880	7319.1000	.8197	BENZENE
2	328	328.0000	9494.0000	100.0000	7500.0000	.8400	TOLUENE
3	349	349.0000	878.0000	9.2479	693.5960	.0776	
4	395	395.0000	167.0000	1.7590	131.9250	.0147	
5	405	405.0000	813.0000	8.5633	642.2450	.0719	
6	422	422.0000	746.0000	7.8576	589.3200	.0660	
7	436	436.0000	7739.0000	81.5147	6113.6000	.6847	M-XYLENE
8	457	457.0000	7538.0000	79.3975	5954.8100	.6669	CYCLOOCTA-TETRAENE
9	495	495.0000	646.0000	6.8043	510.3220	.0571	
10	514	514.0000	4059.2000	42.7533	3206.5000	.3591	1- DECENE
11	525	525.0000	5294.0000	55.7615	4182.1200	.4683	N-DECANE
12	547	547.0000	3543.0000	37.3183	2798.8720	.3134	
13	570	570.0000	2903.0000	30.5772	2293.2900	.2568	INDENE
14	588	588.0000	5384.0000	56.7095	4253.2100	.4763	UNDECENE
15	597	597.0000	4859.0000	51.1797	3838.4800	.4299	UNDECANE
16	652	652.0000	1558.0000	16.4103	1230.7700	.1378	
17	658	658.0000	1411.0000	14.8620	1114.6500	.1248	
18	666	666.0000	3745.0000	39.4460	2958.4500	.3313	DODECANE
19	705	705.0000	1880.0000	19.8020	1485.1400	.1663	NAPHTHALENE
20	730	730.0000	1302.0000	13.7139	1028.5400	.1151	
21	804	804.0000	432.0000	4.5291	339.6880	.0380	

$

* ALTHOUGH A QUANTITATIVE DETERMINATION CAN NOT BE MADE UNTIL A STANDARD HAS BEEN PREPARED CONTAINING THESE COMPONENTS IT IS POSSIBLE TO ESTABLISH AN APPROXIMATION. THIS IS ACHIEVED BY MULTIPLING THE PEAK RESPONSE TIMES THE RESPONSE FACTOR PER CARBON FOR THE FLAME IONIZATION DETECTOR TIMES THE SAMPLE DILUTION FACTOR AND DIVIDE BY THE TOTAL VOLUME OF GAS SAMPLED.

STUDY NUMBER 14

STUDY NUMBER 14

DATA SOURCE:	**SOURCE ASSESSMENT: TEXTILE PLANT WASTEWATER TOXICS STUDY PHASE II**
DATA STATUS:	Draft, April 1979
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SOURCE ASSESSMENT: TEXTILE PLANT WASTEWATER TOXICS STUDY PHASE II

This document reports on Phase II of a study cosponsored by the EPA and the American Textile Manufacturers Institute to determine the toxicity of textile plant wastewaters. Phase I of this study was published as Source Assessment: Textile Plant Wastewater Toxics Study, Phase I (EPA-600/2-78-004h)[4] and was reported in a previous compilation of data with summaries of phased environmental assessments. The purpose of the study was "to examine the level of removal of specific toxic pollutants and toxicity (as measured by results of bioassay tests) attained by selected tertiary systems treating secondary effluents from textile plants."

The Phase I study had used IERL's Level 1 chemical tests and bioassays as well as GC/MS analysis for priority pollutants (129 toxic compounds), and wet methods for criteria pollutants (BOD_5, COD, color, sulfide, pH, chromium, phenols, TSS). Phase I results gave preliminary toxicity data and were used to rank 23 textile plant effluents for toxicity.

Phase II employed seven mobile tertiary treatment systems to determine the best available technology economically achievable (BATEA) for the treatment of eight of the most toxic plant effluents as determined in Phase I. Chemical analyses for intake water, secondary effluents, and tertiary effluents are presented; bioassay results are given only for secondary and tertiary effluents. The chemical tests include the effluent guidelines' protocol for analysis of the 129 priority pollutants, analysis for selected metals by ICAP, and other selected aqueous analyses (NH_3, NO_3^-, PO_4^{-3}, salinity, pH, specific conductance, COD, TSS, color, and sulfide). The bioassay procedures performed in the study include the freshwater ecology series (algae, Daphnia, fathead minnow, and/or bluegill), microbial mutagenicity (Ames and pol A), and cytotoxicity (CHO-K1).

The seven tertiary treatment systems were ranked in terms of total pollutant removal efficiency (based on chemical analysis) and in terms of toxicity removal capability (based on bioassay) as shown in Figure 14-1.

Increasing Removal of Toxicity/Toxic Pollutants (↑)

RANKED BY CHEMICAL ANALYSIS

Multimedia filtration followed by granular activated carbon

Flocculation/sedimentation followed by multimedia filtration

Sedimentation; flocculation/sedimentation

Flocculation/sedimentation followed by multimedia filtration and granular activated carbon

Multimedia filtration

Multimedia filtration with precoagulation

Multimedia filtration followed by ozonation

RANKED BY BIOASSAY

Multimedia filtration

Multimedia filtration followed by granular activated carbon; Flocculation/sedimentation followed by multimedia filtration and granular activated carbon

Flocculation/sedimentation followed by multimedia filtration; Multimedia filtration followed by ozonation

Sedimentation

Flocculation/sedimentation; Multimedia filtration with precoagulation

Figure 14-1. Ranking of tertiary treatment systems.

The report, in Section 3, p. 8, mentions several trends:

1. Only seven organic toxic pollutants in excess of 10 μg/L were seen in secondary effluents of the eight textile plants. These were bis(2-ethylhexyl) phthalate, 1,2-dichlorobenzene, 1,2,4-trichlorobenzene, toluene, methylene chloride, di-n-butyl phthalate, and total phenol.

2. Eleven inorganic toxic pollutants were seen in at least one of the eight secondary effluents in levels greater than 10 μg/L (or the detection limit). These were antimony, arsenic, beryllium, cadmium, chromium, copper, cyanide, lead, nickel, silver, and zinc.

3. None of the secondary effluents or tertiary effluents gave a positive response in the mutagenicity or cytotoxicity tests.

4. The freshwater algal assay was the most sensitive bioassay test used in the Phase II program.

5. Multimedia filtration followed by granular activated carbon adsorption demonstrated the best overall toxic pollutant removal capability.

6. Ozonation appeared to add organic and inorganic toxic pollutants to the wastewater being treated.

7. Multimedia filtration alone demonstrated the best overall toxicity removal capability.

8. Tertiary treatment systems that left high levels of residual aluminum or iron from coagulation in their effluents generally increased the toxicity of the wastewater, as compared with treatment systems whose effluents contained lower levels.

9. Systems employing cationic polymer coagulation increased the toxicity of the wastewater being treated.

In this section, the following recommendations were made:

1. Coagulation with high doses of coagulant (alum or ferric salts) should be avoided as a tertiary treatment option, since it appeared that high levels of residual aluminum and iron resulted in an increase in effluent toxicity.

2. Since freshwater algal and Daphnia bioassays were the more sensitive bioassays, these tests should be considered first as a means to characterize the toxicity of textile mill wastewaters.

The results of chemical and biological analysis of each of the eight plants plus conclusions and recommendations for each plant were discussed in detail. The tertiary treatment systems are referred to by number in the following data tables as follows:

1. Sedimentation
2. Coagulation then flocculation/sedimentation
3. Multimedia filtration
4. Coagulation then multimedia filtration
5. Coagulation then flocculation/sedimentation then multimedia filtration
6. Multimedia filtration then granular activated carbon
7. Multimedia filtration then ozonation
8. Coagulation then flocculation/sedimentation then multimedia filtration then granular activated carbon.

Table 14-1 (from the report) shows the tertiary treatment systems that were selected at each plant for detailed chemical analysis and bioassay.

TABLE 14-1. TERTIARY TREATMENT SYSTEMS USED AT SPECIFIC PILOT PLANT SITES

Plant	Type of tertiary treatment system studied							
	1	2	3	4	5	6	7	8
A	-[a]	X			X			X
C		X			X			X
W	X		X			X	X	
S			X	X		X		
P		X	X		X	X		
N		X	X		X	X		
V			X	X		X	X	
T		X	X		X	X		

[a]Blanks indicate treatment technology not tested in "candidate" mode studies at this location.

LEVEL 2

TABLE 6. MINIMUM DETERMINABLE CONCENTRATIONS FOR ORGANIC TOXIC POLLUTANTS

Compound	Concentration, µg/liter
<u>ACIDS</u>	
2-Chlorophenol	0.09
Phenol	0.07
2,4-Dichlorophenol	0.1
2-Nitrophenol	0.4
p-Chloro-*m*-cresol	0.1
2,4,6-Trichlorophenol	0.2
2,4-Dimethylphenol	0.1
2,4-Dinitrophenol	2.0
4,6-Dinitro-*o*-cresol	40.0
4-Nitrophenol	0.9
Pentachlorophenol	0.4
<u>VOLATILES</u>	
Chloromethane	0.2
Dichlorodifluoromethane	0.2
Bromomethane	0.2
Vinyl chloride	0.4
Chloroethane	0.5
Methylene chloride	0.4
Trichlorofluoromethane	2.0
1,1-Dichloroethylene	2.0
1,1-Dichloroethane	3.0
Trans-1,2-dichloroethylene	2.0
Chloroform	5.0
1,2-Dichloroethane	2.0
1,1,1-Trichloroethane	2.0
Carbon tetrachloride	4.0
Bromodichloromethane	0.9
Bis(chloromethyl) ether	1.0
1,2-Dichloropropane	0.7
Trans-1,2-dichloroethylene	2.0
Trichloroethylene	0.5
Dibromochloromethane	0.3
Cis-1,3-dichloropropene	0.5
1,1,2-Trichloroethane	0.7
Benzene	0.2
2-Chloroethyl vinyl ether	1.0
Bromoform	0.6
1,1,2,2-Tetrachloroethene	0.9
1,1,2,2-Tetrachloroethane	0.6
Toluene	0.1
Chlorobenzene	0.2
Ethylbenzene	0.2
<u>DIRECT INJECTABLES</u>	
Acrolein	200
Acrylonitrile	100
<u>BASE NEUTRALS</u>	
1,3-Dichlorobenzene	0.02
1,4-Dichlorobenzene	0.04
Hexachloroethane	0.1
1,2-Dichlorobenzene	0.05
Bis(2-chloroisopropyl) ether	0.06
Hexachlorobutadiene	0.08
1,2,4-Trichlorobenzene	0.09
Naphthalene	0.007
Bis(2-chloroethyl) ether	0.07
Hexachlorocyclopentadiene	0.2
Nitrobenzene	0.08
Bis(2-chloroethoxy)methane	0.06
2-Chloronaphthalene	0.02
Acenaphthylene	0.02
Acenaphthene	0.04
Isophorone	0.06
Fluorene	0.02
2,6-Dinitrotoluene	0.2
1,2-Diphenylhydrazine	0.02
2,4-Dinitrotoluene	0.02
N-nitrosodiphenylamine	0.07
Hexachlorobenzene	0.05
4-Bromophenyl phenyl ether	0.1
Phenanthrene	0.01
Anthracene	0.01
Dimethyl phthalate	0.03
Diethyl phthalate	0.03
Fluoranthene	0.02
Pyrene	0.01
Di-n-butyl phthalate	0.02
Benzidine	0.02
Butyl benzyl phthalate	0.03
Chrysene	0.02
Bis(2-*ethylhexyl*) phthalate	0.04
Benzo(a)anthracene	0.02
Benzo(b)fluoranthene	0.02
Benzo(k)fluoranthene	0.02
Benzo(a)pyrene	0.02
Indeno(1,2,3-cd)pyrene	0.02
Dibenzo(a,h)anthracene	0.02
Benzo(g,h,i)perylene	0.01
N-nitrosodimethylamine	0.8
N-nitrosodi-n-propylamine	0.2
4-Chlorophenyl phenyl ether	0.03
3,3'-Dichlorobenzidine	1.0
<u>PESTICIDES</u>	1.0

TABLE 7. PLANT A ORGANIC TOXIC POLLUTANTS DETECTED
(Concentration, µg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent Phase I	Secondary effluent Phase II	Tertiary effluent Type 2		Tertiary effluent Type 5		Tertiary effluent Type 8	
Bis(2-ethylhexyl) phthalate	5.4	6	32	44	(-38)[a]	14	(56)	4.7	(85)
Pyrene	1.2	–[b]							
Heptachlor		1.6	1.4						
1,2-Dichlorobenzene		1	20		(100)	5.4	(73)		(100)
1,2,4-Trichlorobenzene		46	1,600	150	(91)	94	(94)		(100)
α-BHC			5.8			1.9			
4,4'-DDT			2.1						
Toluene		8.4	31	14	(55)	12	(31)		(100)
Ethylbenzene			5						
Phenol				3		3		1.5	
Benzo(a)pyrene						0.8			
N-nitrosodiphenylamine						0.4			
2,4-Dimethylphenol						0.9			
Pentachlorophenol						10			
1,4-Dichlorobenzene		0.05							
Phenol (total)	12	65	60	47	(22)	55	(8)	17	(72)

[a]Minus percent removals indicate an increase in the concentration of the specific pollutant.

[b]Blanks indicate concentration below detection limit (see Table 6).

TABLE 8. PLANT A INORGANIC TOXIC POLLUTANTS DETECTED
(Concentration, μg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary Effluent Phase I	Secondary Effluent Phase II	Tertiary effluent Type 2		Tertiary effluent Type 5		Tertiary effluent Type 8	
Antimony	<10	30	<10	<10		<10		24[a]	(-140)[b]
Arsenic	72	<5	60	62	(-3)	103	(-72)	<1	(>98)
Beryllium	0.2	<0.1	<0.04	<0.04		1.2	(-2,900)	5.4	(-130,000)
Cadmium	7.5[a]	<0.5	<2	<2		97	(-4,800)	5.2[a]	(-62)
Chromium	<4	180	110	31	(72)	34	(69)	19[a]	(83)
Copper	<4	27	20	13[a]	(35)	110	(-4,500)	47	(-140)
Cyanide	<4	15	10	<4	(>60)	10	(0)	<4	(>60)
Lead	<22	<1	<22	<22		79[a]	(-260)	<22	
Mercury	NA[c]	<0.5	NA	NA		NA		NA	
Nickel	<36	140	<36	<36		<36		<36	
Selenium	NA	<5	NA	NA		NA		NA	
Silver	<5	<5	<5	<5		<5		<5	
Thallium	NA	<5	NA	NA		NA		NA	
Zinc	56	6,400	6,400	5,700	(11)	5,900	(8)	6,000	(6)

[a]Semiquantitative region; value not within 95% confidence limits.

[b]Minus percent removals indicate an increase in the concentration of the specified pollutant.

[c]Not analyzed.

TABLE 9. PLANT A OTHER POLLUTANTS DETECTED
(Concentration, μg/ℓ; percent removal in parentheses

Pollutant	Intake	Secondary effluent	Tertiary effluent Type 2		Tertiary effluent Type 5		Tertiary effluent Type 8	
Aluminum	<12	230	1,600	(-600)[a]	520	(-130)	100	(57)
Barium	<0.2	20	18	(10)	18	(10)	50	(-150)
Boron	50	270	270	(0)	300	(-11)	320	(-19)
Calcium	16,000	37,000	70,000	(-89)	70,000	(-89)	70,000	(-89)
Cobalt	7.7[b]	16[b]	17[b]	(-6)	110	(-590)	18[b]	(-13)
Iron	175	2,000	2,800	(-40)	2,700	(-35)	1,700	(15)
Magnesium	3,000	5,000	4,900	(2)	5,300	(-6)	5,800	(-16)
Manganese	49	92	100	(-9)	200	(-120)	120	(-30)
Molybdenum	<10	<10	<10		<10		<10	
Phosphorus	490[b]	280	<70	(>75)	<70	(>75)	<70	(>75)
Sodium	8,000	270,000	270,000	(0)	280,000	(-4)	265,000	(2)
Silicon	480	1,400	1,300	(7)	1,300	(7)	1,400	(0)
Strontium	90	220	240	(-9)	260	(-18)	370	(-68)
Tin	<15	<15	20[b]	(-33)	17[b]	(-13)	<15	
Titanium	<1.0	3.2[b]	2.0[b]	(38)	<1.0	(>69)	<1.0	(>69)
Vanadium	17	40	53	(33)	42	(-5)	33	(18)

[a] Minus percent removals indicate an increase in the concentration of the specified pollutant.

[b] Semiquantitative region; value not within 95% confidence limits.

TABLE 11. PLANT A EFFLUENT DESCRIPTIONS

Parameter	Secondary effluent		Tertiary effluent		
	Phase I	Phase II	Type 2	Type 5	Type 8
ysical description	Gray with considerable amount of fine particulate; chlorinated	Dark purple with particulate matter	Light purple	Light purple with particulate matter	Clear
	6.2	6.6	6.1	6.6	6.2
linity, g/l	NM[a]	0.05	0.02	0.05	0.05
ecific conductivity, mhos/cm^2	NM	850	900	850	900

t measured.

TABLE 12. PLANT C ORGANIC TOXIC POLLUTANTS DETECTED (Concentration, μg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent Phase I	Secondary effluent Phase II	Tertiary effluent Type 2		Tertiary effluent Type 5		Tertiary effluent Type 6	
Di-n-butyl phthalate	1.9	-[a]	0.6	0.6		0.6		0.4	
Bis(2-ethylhexyl) phthalate	6.6	3.0	7.6	33	(-330)[b]	5.3	(30)	11	(-45)
2-Chlorophenol	0.2								
Anthracene		4.4	0.05	0.1		0.03		0.01	
1,4-Dichlorobenzene		8.7							
Pentachlorophenol		6.7				12	(-79)		
Phenol		0.5	0.4						
Toluene		240	15	1.0	(93)		(>99)		(>99)
Dibromochloromethane			0.6						
1,2-Dichlorobenzene		0.3		13	(-260,000)	5.8			
Ethylbenzene		110		1.3					
Acenaphthene		0.5							
1,2,4-Trichlorobenzene		10							
Trichloroethylene		18							
Tetrachloroethylene		26							
Methylene chloride[c]	35		160	70	(56)	210	(-31)	110	(31)
Phenol (total)		88	23	16	(30)	19	(17)		(>91)

[a] Blanks indicate concentration below detection limit (see Table 6).
[b] Minus percent removals indicate an increase in the concentration of the specified pollutant.
[c] Methylene chloride may originate from analysis contamination.

TABLE 13. PLANT C INORGANIC TOXIC POLLUTANTS DETECTED (Concentration, μg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent Phase I	Secondary effluent Phase II	Tertiary effluent Type 2		Tertiary effluent Type 5		Tertiary effluent Type 6	
Antimony	<10	4	90	120	(-33)[a]	140	(-56)	120	(-33)
Arsenic	<1	<5	1.6	<1		<1		<1	
Beryllium	30	<0.1	1.5	2.2		1.2		2.7	
Cadmium	29	6	<2	2.9[b]		2.7[b]		9.8[b]	
Chromium	<4	31	5.5[b]	17[b]	(-210)	14[b]	(-150)	15[b]	(-170)
Copper	65	30	57	11[b]	(81)	25	(56)	35	(39)
Cyanide	<4	13	<4	<4		<4		<4	
Lead	<22	120	27[b]	66[b]	(-140)	64[b]	(-140)	64[b]	(-140)
Mercury	NA[c]	0.7	NA	NA		NA		NA	
Nickel	<36	140	<36	<36		<36		<36	
Selenium	NA	<5	NA	NA		NA		NA	
Silver	54	<5	80	72	(10)	77	(4)	91	(14)
Thallium	NA	<5	NA	NA		NA		NA	
Zinc	53	120	160	190	(-19)	230	(-44)	83	(48)

[a] Minus percent removals indicate an increase in the concentration of the specified pollutant.
[b] Semiquantitative region; value not within 95% confidence limits.
[c] Not analyzed.

TABLE 14. PLANT C OTHER POLLUTANTS DETECTED
(Concentration, µg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent	Tertiary effluent					
			Type 2		Type 5		Type 8	
Aluminum	<12	98	13,000	(-13,000)[a]	11,000	(-10,000)	9,200	(-9,300)
Barium	81	72	70	(3)	71	(1)	81	(-13)
Boron	<1	54	58	(-7)	57	(-6)	29	(46)
Calcium	3,300	5,200	5,700	(-10)	5,600	(-8)	5,600	(-8)
Cobalt	29[b]	<6	<6		<6		<6	
Iron	110	230	930	(-300)	750	(-230)	310	(-35)
Magnesium	720	3,700	3,700	(0)	3,700	(0)	3,700	(0)
Manganese	33	17	24	(-41)	24	(-41)	28	(-65)
Molybdenum	<10	<10	20[b]	(-100)	22[b]	(-120)	19[b]	(-90)
Nickel	<36	<36	<36		<36		<36	
Phosphorus	120[b]	2,700	2,300	(15)	2,000	(26)	1,900	(30)
Silicon	7,500	15,000	15,000	(0)	15,000	(0)	14,000	(7)
Strontium	49	67	68	(-1)	71	(-6)	74	(-10)
Tin	<15	69[b]	62[b]	(10)	66[b]	(4)	56[b]	(19)
Titanium	<1	2[b]	14	(-600)	11	(-450)	11	(-450)
Vanadium	<2	410	560	(-37)	520	(-27)	180	(-56)

[a]Minus percent removals indicate an increase in the concentration of the specified pollutant.

[b]Semiquantitative region; value not within 95% confidence limits.

TABLE 15. PLANT C BIOASSAY RESULTS

Test species	Parameters	Secondary effluent		Tertiary effluent		
		Phase I	Phase II	Type 2	Type 5	Type 8
Freshwater algae - *S. capricornutum*	EC_{50} - 7 day, % effluent	NM[a]	63 (47-85)[b]	7.7 (2.3-25)	12 (1.2-100)	17 (0.3-100)
	EC_{50} - 12 day, % effluent	NM	56 (40-78)	5.6 (2.3-13)	6.5 (2.5-17)	7.4 (1.9-30)
	EC_{50} - 14 day, % effluent	-[c]	49 (27-89)	5.2 (1.3-20)	5.3 (2.2-13)	4.5 (2.2-9.4)
Water flea - *D. magna*	LC_{50} - 24 hr, % effluent	NM	>100	>100	>100	>100
	LC_{50} - 48 hr, % effluent	41[d]	>100	79	85	89
Bluegill - *L. machrochirus*	LC_{50} - 24 hr, % effluent	NM	>100	>100	>100	>100
	LC_{50} - 48 hr, % effluent	NM	>100	>100	>100	>100
	LC_{50} - 72 hr, % effluent	NM	>100	>100	>100	>100
	LC_{50} - 96 hr, % effluent	NM	>100	>100	>100	>100
Fathead minnow - *P. promelas*	LC_{50} - 24 hr, % effluent	NM	>100	>100	>100	>100
	LC_{50} - 48 hr, % effluent	NM	>100	>100	>100	>100
	LC_{50} - 72 hr, % effluent	NM	>100	>100	>100	>100
	LC_{50} - 96 hr, % effluent	NM	>100	>100	>100	>100
S. typhimurium - strains TA98, TA100, TA1535, TA1537, and TA1538	Response to Ames test for mutagenicity - (-) or (+)	(-)	(-)[e]	(-)	NM	(-)
E. coli - strains W3110 and p3478	Response to pol A test for mutagenicity-zone of inhibition, mm	0	0	0	NM	0
Chinese hamster ovary cells	Response to CHO-K1 test for acute cytotoxicity-EC_{50}	-[f]	>100	>100	NM	>100

[a]Not measured.

[b]95% confidence interval.

[c]20% secondary effluent was highly stimulatory to the growth of *S. capricornutum*.

[d]EC_{50} - 48 hr determined using *Daphnia pulex*.

[e]Increase in number of revertants over background was observed; however, the results were not twofold, nor was there a dose response.

[f]EC_{50} not determinable; cytotoxicity procedure employing rabbit alveolar macrophage (RAM) used in Phase I.

TABLE 16. PLANT C EFFLUENT DESCRIPTIONS

Parameter	Secondary effluent		Tertiary effluent		
	Phase I	Phase II	Type 2	Type 5	Type 6
al description	Clear, blue-black with moderate amount of particulate; unchlorinated	Orange-brown with particulate matter	Light orange-with partic-ulate matter	Light orange-brown with particulate matter	Cloudy white liquid
	10.2	8.3	6.9	7.0	7.1
ty, g/l	NM[a]	3	3	3	2.5
ic conductivity, s/cm²	NM	3,800	4,000	3,900	3,900

asured.

TABLE 17. PLANT W ORGANIC TOXIC POLLUTANTS DETECTED (Concentration, µg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent Phase I	Secondary effluent Phase II	Tertiary effluent Type 2		Tertiary effluent Type 3		Tertiary effluent Type 6		Tertiary effluent Type 7	
Bis(2-ethylhexyl) phthalate	15	19	42	23	(45)	14	(67)	26	(67)	106	(-150)[a]
Anthracene	0.9	-[b]	1.5	0.4		0.2		0.1		0.4	
Benzo(a)anthracene	0.1	1.5									
Fluoranthene	0.7		1.1	0.4		0.2				0.1	
Benzo(a)pyrene	0.7		1.2			0.2					
Pyrene	0.5		0.8	0.2		0.3				0.1	
Benzo(k)fluoranthene	0.4		0.8			0.1					
Di-n-butyl phthalate								1.1			
Toluene		1.7	1.4	9.5				3.1		1.2	
Ethylbenzene				3.0				1.3			
Methylene chloride[c]				2.2		4.8		1.8		61	(-15,000)
Phenol (total)	6	232	16	49	(-67)	17	(-6)	17	(-6)	13	(19)

[a]Minus percent removals indicate an increase in the concentration of the specified pollutant.
[b]Blanks indicate concentration below detection limit (see Table 6).
[c]Methylene chloride may originate from analysis contamination.

TABLE 18. PLANT W INORGANIC TOXIC POLLUTANTS DETECTED (Concentration, µg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent Phase I	Secondary effluent Phase II	Tertiary effluent Type 1		Tertiary effluent Type 3		Tertiary effluent Type 6		Tertiary effluent Type 7	
Antimony	<10	<0.5	540	<200	(>63)	<200	(>63)	<200	(>63)	1,200	(-120)[a]
Arsenic	<1.0	<5	38	39	(-3)	83	(-120)	42	(-10)	43	(-13)
Beryllium	<5	<0.1	<2	<2		<2		<2		<4	
Cadmium	<2	13	130	<40	(>69)	<40	(>69)	<40	(>69)	250	(-92)
Chromium	<4	3	<80	<80		<80		<80		<200	
Copper	<4	2	320	110	(66)	120	(63)	<80	(>75)	590	(-84)
Cyanide	<4	20	200	240	(-20)	260	(-30)	40	(80)	<4	(>98)
Lead	<20	57	3,500	<400	(>86)	<400	(>86)	<400	(>86)	<900	(>74)
Mercury	NA[b]	0.5	NA	NA		NA		NA		NA	
Nickel	<40	60	2,000	<700	(>65)	<700	(>65)	<700	(>65)	5,000	(-150)
Selenium	NA	<5	NA	NA		NA		NA		NA	
Silver	6	95	500	<100	(>80)	<100	(>80)	<100	(>80)	1,300	(-160)
Thallium	NA	<5	NA	NA		NA		NA		NA	
Zinc	17	90	1,500	190	(87)	400	(73)	120	(92)	460	(69)

[a]Minus percent removals indicate an increase in the concentration of the specified pollutant.
[b]Not analyzed.

(Concentration, µg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent	Tertiary effluent Type 1		Type 3		Type 6		Type 7	
Aluminum	22	8,400	4,700	(44)	3,100	(63)	3,100	(63)	7,000	(17)
Barium	110	290	120	(59)	110	(62)	50	(83)	120	(59)
Boron	<1	490	640	(-33)[a]	600	(-22)	630	(-29)	1,000	(-104)
Calcium	16,000	31,000	31,000	(0)	33,000	(6)	22,000	(29)	30,000	(3)
Cobalt	5	170	<40	(>76)	60	(65)	<40	(>76)	380	(-124)
Iron	1,100	5,000	3,400	(32)	2,400	(52)	1,900	(62)	2,300	(54)
Magnesium	1,700	7,000	6,600	(6)	6,600	(6)	4,900	(30)	6,100	(13)
Manganese	30	20	70	(-250)	40	(-100)	20	(0)	90	(-350)
Molybdenum	<10	<200	<200		<200		<200		<400	
Sodium	2,400	54,000	56,000	(-4)	61,000	(-17)	57,000	(-6)	56,000	(-4)
Silicon	5,600	4,800	3,200	(33)	2,700	(44)	2,200	(54)	2,600	(46)
Tin	<20	<300	<300		<300		<300		<600	
Strontium	95	170	160	(6)	160	(6)	120	(29)	2	(99)
Titanium	<1	200	110	(45)	60	(70)	80	(60)	180	(10)
Vanadium	12	2,700	120	(96)	110	(96)	<40	(>99)	540	(80)
Ammonia nitrogen	NA[b]	3,300	3,000	(9)	2,600	(21)	2,200	(33)	5,500	(-67)
Nitrate nitrogen	NA	5,300	7,100	(-34)	6,500	(-23)	6,500	(-23)	8,800	(-66)
Phosphate phosphorus	NA	200	210	(-5)	100	(50)	100	(50)	160	(20)

[a] Minus percent removals indicate an increase in the concentration of the specified pollutant.

[b] Not analyzed.

TABLE 20. PLANT W BIOASSAY RESULTS

Test species	Parameter	Secondary effluent		Tertiary effluent			
		Phase I	Phase II	Type 1	Type 3	Type 6	Type 7
Freshwater algae - *S. capricornutum*	EC_{50} - 7 day, % effluent	NM[a]	1.8 (0.6-5.4)[b]	6.0 (0.9-4.0)	12 (3.6-41)	47 (23-95)	37 (26-53)
	EC_{50} - 12 day, % effluent	NM	2.4 (0.5-12)	10 (4.2-24)	17 (1.5-100)	33 (16-68)	44 (5.5-100)
	EC_{50} - 14 day, % effluent	-[c]	4.0 (2.1-7.6)	8.9 (2.6-30)	11 (3.4-37)	28 (13-61)	29 (16-54)
Water flea - *D. magna*	LC_{50} - 24 hr, % effluent	NM	>36<60	57 (33-99)	58 (34-100)	51 (36-72)	55 (32-95)
	LC_{50} - 48 hr, % effluent	6.3[d]	56 (33-97)	48 (34-66)	59 (34-100)	49 (35-70)	54 (31-93)
Blue gill - *L. macrochirus*	LC_{50} - 24 hr, % effluent	NM	~77	>100	>100	>100	NM
	LC_{50} - 48 hr, % effluent	NM	71 (63-81)	77 (67-85)	68 (61-75)	75 (69-80)	NM
	LC_{50} - 72 hr, % effluent	NM	65 (58-71)	72 (65-81)	61 (54-67)	68 (61-75)	NM
	LC_{50} - 96 hr, % effluent	NM	60 (53-66)	64 (57-71)	60 (53-66)	66 (59-73)	NM
Fathead minnow - *P. promelas*	LC_{50} - 24 hr, % effluent	NM	75 (70-80)	76 (68-89)	>77<100	76 (68-86)	>60<100
	LC_{50} - 48 hr, % effluent	NM	63 (52-76)	59 (50-77)	73 (65-84)	68 (61-75)	68 (54-84)
	LC_{50} - 72 hr, % effluent	NM	61 (51-75)	53 (45-62)	69 (61-79)	65 (58-72)	68 (54-84)
	LC_{50} - 96 hr, % effluent	55	61 (51-75)	48 (39-55)	68 (59-79)	61 (54-67)	65 (51-80)
S. typhimurium - strains TA98, TA100, TA1535, TA1537, and TA1538	Response to Ames test for mutagenicity - (-) or (+)	(-)	(-)	(-)	(-)[e]	(-)	(-)
E. coli - strains W3110 and p3478	Response to pol A test for mutagenicity-increase in zone of inhibition, mm	0	0	0	0	0	0
Chinese hamster ovary cells	Response to CHO-K1 test for acute cytotoxicity-EC_{50}	-[f]	>100	>100	>100	>100	>100

[a] Not measured.

[b] 95% confidence limits.

[c] Growth of *S. capricornutum* supported with 2% and 5% secondary effluent, but inhibited at 10% and 20% levels.

[d] EC_{50} - 48 hr determined using *Daphnia pulex*.

[e] Increase in number of revertants was observed with TA1538, with and without metabolic activation; however, a dose response was not observed.

[f] EC_{50} not determinable; cytotoxicity procedure employing rabbit alveolar macrophage (RAM) used in Phase I.

TABLE 21. PLANT W EFFLUENT DESCRIPTIONS

Parameter	Secondary effluent		Tertiary effluent			
	Phase I	Phase II	Type 1	Type 3	Type 6	Type 7
Physical description	Cloudy orange with a moderate amount of particulate; nonchlorinated	Cloudy brown liquid	Cloudy brown liquid	Cloudy brown liquid	Pale yellow liquid	Cloudy pale yellow liquid
pH	8.0	7.7	7.8	7.8	7.9	7.6
Salinity, g/l	NM[a]	2	2	2	2	2
Specific conductivity, µmhos/cm²	NM	2,400	2,900	2,800	2,400	2,900

[a]Not measured.

TABLE 22. PLANT S ORGANIC TOXIC POLLUTANTS DETECTED
(Concentration, μg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent Phase I	Phase II	Tertiary effluent Type 3		Type 4		Type 6	
Bis(2-ethylhexyl) phthalate	1.2	41	25	42	(-68)[a]	16	(36)	410	(-1,500)
Acenaphthene	-[b]		2.2	0.6		0.6			
Di-n-butyl phthalate			2.8	6					
Phenol	0.5		0.6	0.4		0.2			
2,4-Dimethylphenol						0.4			
2,4-Dichlorophenol						0.2			
p-Chloro-m-cresol						0.3			
Chloroform	120			7					
Toluene	3	21	1.8	0.4		1.4		1.6	
Trichlorofluoromethane								69	(-3,500)
1,2,4-Trichlorobenzene		920							
Naphthalene		260							
Ethylbenzene		110							
Tetrachloroethylene		6.4							
Methylene chloride[c]	55		12	4.6	(62)	7.9	(34)	940	(-7,700)
Phenol (total)	5	29	15	-[d]		21	(-40)	-[d]	
Phenol (total)[e]	-[f]	29	11	9.0	(18)	16	(-45)		(>32)

[a]Minus percent removals indicate an increase in the concentration of the specified pollutant.
[b]Blanks indicate concentration below detection limit (see Table 6).
[c]Methylene chloride may originate from analysis contamination.
[d]Sample bottle broken in shipment.
[e]Sample taken day after all other samples were taken.
[f]Sample not taken.

TABLE 23. PLANT S INORGANIC TOXIC POLLUTANTS DETECTED
(Concentration, μg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent Phase I	Phase II	Tertiary effluent Type 3		Type 4		Type 6	
Antimony	20	70	610	620	(-2)[a]	600	(2)	590	(3)
Arsenic	<10	<10	<10	<10	(0)	11[b]	(-10)	11[b]	(>10)
Beryllium	<5	<5	<5	<5		<5		<5	
Cadmium	3[b]	2	5[b]	5[b]		6[b]		6[b]	
Chromium	<4	<4	<4	<4		<4		<4	
Copper	10[b]	60	26	27	(-4)	24	(8)	<4	(>85)
Cyanide	<10	<10	<10	<10		<10		<10	
Lead	34[b]	<22	75[b]	81[b]	(-8)	85[b]	(-13)	79[b]	(-5)
Mercury	0.5	<0.3	1.7	0.4		0.7		0.4	
Nickel	61[b]	<36	83[b]	81[b]	(2)	98[b]	(-18)	96[b]	(-16)
Selenium	<10	<10	<10	<10		<10		<10	
Silver	<5	<5	<5	<5		<5		<5	
Thallium	<50	<50	<50	<50		<50		<50	
Zinc	42	84	41	75	(-83)	55	(-34)	31	(24)

[a]Minus percent removals indicate an increase in the concentration of the specified pollutant.
[b]Semiquantitative region; value not within 95% confidence limits.

TABLE 24. PLANT S OTHER POLLUTANTS DETECTED
(Concentration, μg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent	Tertiary effluent Type 3		Type 4		Type 6	
Aluminum	110	690	450	(35)	330	(52)	310	(55)
Barium	12	8.3	6.2		5.9		5.7	
Boron	<1	1,100	1,100	(0)	1,000	(9)	1,100	(0)
Calcium	5,500	5,900	6,200	(-5)[a]	5,800	(2)	5,200	(12)
Cobalt	8[b]	10[b]	7[b]		11[b]	(-10)	6[b]	
Iron	240	100	150	(-50)	190	(-90)	58	(42)
Magnesium	860	1,600	1,500	(6)	1,500	(6)	1,400	(13)
Manganese	7.7	11	12	(-9)	11	(0)	8	(27)
Molybdenum	<10	13	14	(-8)	13	(0)	17	(-31)
Sodium	10,000	180,000	190,000	(-6)	180,000	(0)	190,000	(-6)
Silicon	3,600	11,000	11,000	(0)	11,000	(0)	11,000	(0)
Tin	<15	<15	<15		<15		<15	
Strontium	21	22	22	(0)	22	(0)	22	(0)
Titanium	2[b]	4[b]	4[b]		4[b]		4[b]	
Vanadium	11	57	23	(60)	23	(60)	22	(61)
Ammonia nitrogen	NA[c]	6,600	60	(99)	5,600	(15)	1,200	(82)
Nitrate nitrogen	NA	250	120	(52)	210	(16)	670	(-170)
Phosphate phosphorus	NA	1,700	2,100	(-24)	4,500	(-170)	2,000	(-18)

[a]Minus percent removals indicate an increase in the concentration of the specified pollutant.

[b]Semiquantitative region; value not within 95% confidence limits.

[c]Not analyzed.

TABLE 25. PLANT S BIOASSAY RESULTS

Test species	Parameter	Secondary effluent		Tertiary effluent		
		Phase I	Phase II	Type 3	Type 4	Type 6
Freshwater algae - *S. capricornutum*	EC_{50} - 7 day, % effluent	NM[a]	79 (5-100)[b]	>100	73 (26-100)	>100
	EC_{50} - 12 day, % effluent	NM	79 (6-100)	40 (6-100)	62 (16-100)	56 (3-100)
	EC_{50} - 14 day, % effluent	-[c]	72 (7-100)	>56<100	49 (25-95)	>100
Water flea - *D. magna*	LC_{50} - 24 hr, % effluent	NM	>100	>100	>100	>100
	LC_{50} - 48 hr, % effluent	-[d]	>100	>100	>100	>100
Fathead minnow - *P. promelas*	LC_{50} - 24 hr, % effluent	NM	>100	>100	>100	>100
	LC_{50} - 48 hr, % effluent	NM	>100	>100	>100	>100
	LC_{50} - 72 hr, % effluent	NM	>100	>100	>100	>100
	LC_{50} - 96 hr, % effluent	>100	>100	>100	>100	>100
S. typhimurium - strains TA98, TA100, TA1535, TA1537, and TA1538	Response to Ames test for mutagenicity - (-) or (+)	(-)	(-)	(-)	(-)	(-)
E. coli - strains W3110 and p3478	Response to pol A test for mutagenicity-increase in zone of inhibition, mm	0	0	0	0	0
Chinese hamster ovary cells	Response to CHO-K1 test for acute cytotoxicity-EC_{50}	NM	>100	>100	>100	>100

[a]Not measured.

[b]95% confidence interval.

[c]20% secondary effluent was highly stimulatory to the growth of *S. capricornutum*.

[d]LC_{50} not calculated since a heavy solids concentration obscured the analysis; sample did not appear to be acutely toxic; *Daphnia pulex* used in determination.

TABLE 26. PLANT S EFFLUENT DESCRIPTIONS

Parameter	Secondary effluent		Tertiary effluent		
	Phase I	Phase II	Type 3	Type 4	Type 6
sical description	Clear, light champagne with small amount of particulate; unchlorinated	Orange liquid containing a precipitate	Orange liquid containing a precipitate	Light orange liquid containing a precipitate	Clear liquid
	7.7	7.2	7.3	7.0	7.4
idity, g/ℓ	NM[a]	1	0	1	1
cific conductivity, µmhos/cm²	NM	1,100	870	1,100	1,100

a Not measured.

TABLE 27. PLANT P ORGANIC TOXIC POLLUTANTS DETECTED
(Concentration, µg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent		Tertiary effluent			
		Phase I	Phase II	Type 2	Type 3	Type 5	Type 6
Bis(2-ethylhexyl) phthalate	2.0	72	10	10	3.9	3.3	3.9
Di-n-butyl phthalate	0.9	-[a]	2.1	2.8	1.6	2.5	
Diethyl phthalate			1.3		0.8	1.0	1.4
Anthracene			0.8	0.9	0.5	0.5	0.1
Phenol			0.7	0.5	1.8	2.6	
Chloroform	4.1	6.9					
Trichloroethylene	1.4			0.8			
Toluene	1.5	22	0.4	0.4	2.7	2.6	3.6
Benzene				0.4	1.0	0.5	
N-nitroso-di-n-propylamine		19					
Ethylbenzene		280		0.1			
Methylene chloride[b]	20		0.4	2.5	4.1	4.7	7.3
Phenol (total)	11	32	72	82 (-14)[c]	68 (6)	130 (-81)	18 (75)

[a] Blanks indicate concentration below detection limit (see Table 6).

[b] Methylene chloride may originate from analysis contamination.

[c] Minus percent removals indicate an increase in the concentration of the specified pollutant.

TABLE 28. PLANT P INORGANIC TOXIC POLLUTANTS DETECTED
(Concentration, µg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent Phase I	Secondary effluent Phase II	Tertiary effluent Type 2		Tertiary effluent Type 3		Tertiary effluent Type 5		Tertiary effluent Type 6	
Antimony	28[a]	<10	77[a]	43[a]	(44)	48[a]	(38)	34[a]	(56)	36[a]	(53)
Arsenic	<2	<2	<2	<2		<2		<2		12	(-500)[b]
Beryllium	<0.2	<0.1	<0.2	<0.2		<0.2		<0.2		<0.2	
Cadmium	<2	<2	<2	<2		<2		<2		<2	
Chromium	5.7[a]	<4	98	<4	(>96)	<4	(>96)	<4	(>96)	<4	(>96)
Copper	98	<4	36	<4	(>89)	<4	(>89)	<4	(>89)	<4	(>89)
Cyanide	<4	140	<4	<4		<4		<4		<4	
Lead	58[a]	<22	25[a]	<22	(>12)	<22	(>12)	<22	(>12)	<22	(>12)
Mercury	<0.3	<0.5	0.4	<0.3		0.3		0.4		0.4	
Nickel	56[a]	40	66[a]	43[a]	(35)	58[a]	(12)	36[a]	(83)	50[a]	(24)
Selenium	<8	<5	<8	<8		<8		<8		<8	
Silver	<5	8	<5	<5		5		<5		<5	
Thallium	<50	<50	<50	<50		<50		<50		<50	
Zinc	150	140	5,200	160	(97)	150	(97)	160	(97)	<1	(100)

[a] Semiquantitative region; value not within 95% confidence limits.

[b] Minus percent removals indicate an increase in the concentration of the specified pollutant.

TABLE 29. PLANT P OTHER POLLUTANTS DETECTED
(Concentration, µg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent Phase I	Secondary effluent Phase II	Tertiary effluent Type 2		Tertiary effluent Type 3		Tertiary effluent Type 5		Tertiary effluent Type 6	
Aluminum	670	140	300	20[a]	(93)	30[a]	(90)	50[a]	(83)	40[a]	(87)
Barium	11	<0.2	<0.2	<0.2		<0.2		<0.2		<0.2	
Boron	150	520	950	880	(7)	860	(9)	880	(7)	660	(31)
Calcium	3,600	9,500	8,300	7,500	(10)	7,500	(10)	7,300	(10)	5,000	(40)
Cobalt	<6	0.5	<6	<6		<6		<6		<6	
Iron	1,400	100	1,000	300	(70)	300	(70)	600	(40)	20	(98)
Magnesium	1,600	1,800	1,800	1,800	(0)	1,800	(0)	1,800	(0)	1,500	(17)
Manganese	73	20	80	49	(39)	50	(38)	43	(46)	<0.5	(>99)
Molybdenum	10[a]	<0.6	20[a]	<10	(>50)	<10	(>50)	<10	(>50)	<10	(>50)
Sodium	6,200	>100,000	130,000	120,000	(8)	120,000	(8)	120,000	(8)	110,000	(15)
Silicon	6,400	4,800	2,400	2,300	(4)	2,300	(4)	2,100	(13)	2,600	(-8)
Tin	16[a]	<10	<15	22[a]	(-40)[b]	<15		18[a]	(-20)	<15	
Strontium	25	NA[c]	35	33	(6)	33	(6)	35	(0)	35	(0)
Titanium	36	<1	36	<1	(>97)	<1	(>97)	<1	(>97)	<1	(>97)
Vanadium	21	20	18	14	(22)	15	(17)	15	(17)	14	(22)
Ammonia nitrogen	NA	200	790	700	(11)	360	(54)	580	(27)	830	(-5)
Nitrate nitrogen	NA	80	300	280	(7)	130	(57)	250	(17)	300	(0)
Phosphate phosphorus	NA	20[d]	2,800	2,900	(-4)	2,700	(4)	2,500	(11)	2,400	(14)

[a] Semiquantitative region; value not within 95% confidence limits.

[b] Minus percent removals indicate an increase in the concentration of the specified pollutant.

[c] Not analyzed.

[d] *o*-Phosphate only.

TABLE 30. PLANT P BIOASSAY RESULTS

Test species	Parameter	Secondary effluent		Tertiary effluent			
		Phase I	Phase II	Type 2	Type 3	Type 5	Type 6
Freshwater algae - *S. capricornutum*	EC_{50} - 7 day, % effluent	NM[a]	54 (30-100)[b]	41 (14-100)	42 (29-62)	64 (25-100)	83 (18-100)
	EC_{50} - 12 day, % effluent	NM	54 (18-100)	24 (13-42)	42 (14-100)	>32<100	>56<100
	EC_{50} - 14 day, % effluent	-[c]	53 (20-100)	26 (15-43)	33 (10-100)	41 (28-59)	>56<100
Water flea - *D. magna*	LC_{50} - 24 hr, % effluent	NM	>100	>100	>100	>100	>100
	LC_{50} - 48 hr, % effluent	>100[d]	>100	>100	>100	>100	>100
Fathead minnow - *P. promelas*	LC_{50} - 24 hr, % effluent	NM	-[e]	-[e]	-[e]	-[e]	-[e]
	LC_{50} - 48 hr, % effluent	NM	-[e]	-[e]	-[e]	-[e]	-[e]
	LC_{50} - 72 hr, % effluent	NM	-[e]	-[e]	-[e]	-[e]	-[e]
	LC_{50} - 96 hr, % effluent	>100	-[e]	-[e]	-[e]	-[e]	-[e]
S. typhimurium - strains TA98, TA100, TA1535, TA1537 and TA1538	Response to Ames test for mutagenicity (-) or (+)	(-)	(-)	(-)	(-)	(-)	(-)
Chinese hamster ovary cells	Response to CHO-K1 test	>100	>100	>100	>100	>100	>100

[a]Not measured.

[b]95% confidence interval.

[c]20% secondary effluent stimulated the growth of *S. capricornutum*.

[d]EC_{50} - 48 hr determined with *Daphnia pulex*.

[e]LC_{50}'s not calculated because of data scatter; however, none of the samples appear to be toxic since there was no more than a 20% kill in any of the tests with 100% effluent.

TABLE 31. PLANT P EFFLUENT DESCRIPTIONS

Parameter	Secondary effluent: Phase I	Secondary effluent: Phase II	Tertiary effluent: Type 2	Tertiary effluent: Type 3	Tertiary effluent: Type 5	Tertiary effluent: Type 6
Physical description	NM[a]	Brown turbid liquid containing suspended particulate matter	Brown turbid liquid, suspended particulate matter present	Brown turbid liquid, suspended particulate matter present	Brown turbid liquid suspended particulate matter present	Slightly cloudy pale yellow liquid
pH	NM	6.6	6.9	6.8	6.8	6.9
Salinity, g/l	NM	0	0	0	0	0
Specific conductivity, µmhos/cm²	NM	600	520	500	490	480

[a]Not measured.

TABLE 32. PLANT N ORGANIC TOXIC POLLUTANTS DETECTED (Concentration, µg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent: Phase I	Secondary effluent: Phase II	Tertiary effluent: Type 3		Tertiary effluent: Type 5		Tertiary effluent: Type 6	
Bis(2-ethylhexyl) phthalate	53	16.7	230	29	(87)	31	(67)	78	(66)
Anthracene	0.2	–[a]	0.4			0.4		0.4	
Diethyl phthalate	1.0	9.4	0.8	0.4		0.3		1.2	
Di-n-butyl phthalate	1.2		0.6	1.1		0.6		1.8	
Methylene chloride[b]	47		46	47	(-2)[c]	28	(39)	27	(41)
Toluene	0.5	17	0.4	0.6		0.4			
1,2-Dichlorobenzene		6.0	0.9			0.5			
Dimethyl phthalate			1.4						
Fluoranthene			0.07	0.08		0.05			
Pyrene			0.1	0.1		0.09			
Fluorene						0.05			
2,4-Dichlorophenol						0.5			
Phenanthrene				0.5					
1,2-Dichloropropane				1.0					
1,4-Dichlorobenzene		1.5							
Tetrachloroethylene			0.7						
Ethylbenzene		75	0.9						
Phenol		11							
Phenol (total)	14	68	31	17	(45)	25	(19)	11	(65)

[a]Blanks indicate concentration below detection limit (see Table 6).

[b]Methylene chloride may originate from analysis contamination.

[c]Minus percent removals indicate an increase in the concentration of a specified pollutant.

TABLE 33. PLANT N INORGANIC TOXIC POLLUTANTS DETECTED
(Concentration, μg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent		Tertiary effluent					
		Phase I	Phase II	Type 3		Type 5		Type 6	
Antimony	14[a]	<10	18[a]	<10	(>44)	<10	(>44)	<10	(>44)
Arsenic	5	<5	3	3		<1		3	
Beryllium	0.6	NA[b]	<0.04	<0.04		0.1[a]		<0.04	
Cadmium	<2	<0.5	<2	<2		<2		<2	
Chromium	<4	1,800	170	95	(44)	34	(80)	5.2[a]	(97)
Copper	160	8	14[a]	130	(-830)[c]	86	(-510)	24	(-71)
Cyanide	<5	<4	<5	<5		<5		<5	
Lead	<22	1	<22	<22		<22		<22	
Mercury	<0.1	<0.5	<0.1	<0.1		<0.1		<0.1	
Nickel	<36	30	<36	<36		<36		<36	
Selenium	<1	<5	<1	<1		<1		<1	
Silver	10[a]	<5	5.5[a]	<5		<5		<5	
Thallium	<50	<5	<50	<50		<50		<50	
Zinc	22	38,000	1,300	590	(55)	440	(66)	430	(67)

[a]Semiquantitative region; value not within 95% confidence limits.

[b]Not analyzed.

[c]Minus percent removals indicate an increase in the concentration of the specified pollutant.

TABLE 34. PLANT N OTHER POLLUTANTS DETECTED
(Concentration, μg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent	Tertiary effluent Type 3		Tertiary effluent Type 5		Tertiary effluent Type 6	
Aluminum	120	120	36[a]	(67)	390	(-260)[b]	21[a]	(81)
Barium	6.7	6.0	3.3		2.7		4.8	
Boron	0.6	9.1	6.7		6.4		9.0	
Calcium	5,400	7,100	6,200	(13)	6,200	(13)	5,000	(30)
Cobalt	6.2[a]	12[a]	8.7[a]	(28)	8.6[a]	(28)	<6	(>50)
Iron	620	720	290	(60)	55	(92)	110	(85)
Magnesium	1,000	1,100	990	(10)	1,000	(9)	860	(22)
Manganese	530	210	190	(10)	200	(5)	160	(24)
Molybdenum	<10	<10	<10		<10		<10	
Sodium	12,000	180,000	180,000	(0)	200,000	(-11)[b]	180,000	(0)
Phosphorus	<70	2,500	2,300	(8)	1,200	(52)	1,000	(60)
Silicon	4,000	3,800	3,700	(3)	3,400	(11)	3,800	(0)
Tin	<15	<15	<15		<15		<15	
Strontium	51	41	40	(2)	39	(5)	40	(2)
Titanium	2.1[a]	1.9[a]	1.2[a]		<1		<1	
Vanadium	6.9[a]	8.5[a]	7.7[a]		8.5[a]		6.5[a]	
Sulfide	14	12	<5	(>58)	<5	(>58)	<5	(>58)
Ammonia nitrogen	NA[c]	1,700	1,200	(29)	1,600	(6)	1,300	(24)
Nitrate nitrogen	NA	5,200	4,600	(12)	5,200	(0)	3,100	(40)
COD	11,000	128,000	210,000	(-64)	172,000	(-34)	44,000	(66)
TSS	6,000	75,000	<1,000	(>99)	8,000	(89)	12,000	(84)
Color[d] at pH 7.6	47	39	38	(3)	52	(33)	51	(-31)
Color[d] at sample pH	48	36	43	(-19)	48	(-33)	51	(-42)
pH[e]	6.46	7.97	6.95		7.45		746	(6.4)

[a]Semiquantitative region; value not within 95% confidence limits.

[b]Minus percent removals indicate an increase in the concentration of the specified pollutant.

[c]Not analyzed.

[d]ADMI units.

[e]pH units (- log $[H^+]$).

TABLE 35. PLANT N BIOASSAY RESULTS

Test species	Parameter	Secondary effluent Phase I	Secondary effluent Phase II	Tertiary effluent Type 3	Tertiary effluent Type 5	Tertiary effluent Type 6
Freshwater algae - *S. capricornutum*	EC_{50} - 7 day, % effluent	NM[a]	20 (11-36)[b]	23 (13-41)	44 (26-75)	23 (10-51)
	EC_{50} - 12 day, % effluent	NM	28 (20-41)	38 (27-53)	35 (19-66)	16 (10-27)
	EC_{50} - 14 day, % effluent	-[c]	23 (18-31)	30 (16-56)	29 (15-57)	23 (14-38)
Water flea - *D. magna*	LC_{50} - 24 hr, % effluent	NM	>100 (86->100)	>100	>100	>100
	LC_{50} - 48 hr, % effluent	-[d]	77 (60-100)	78 (67-92)	>100	77 (60-100)
Fathead minnow - *P. promelas*	LC_{50} - 24 hr, % effluent	NM	>100	>100	>100	>100
	LC_{50} - 48 hr, % effluent	NM	91 (73->100)	>100	>100	>100
	LC_{50} - 72 hr, % effluent	NM	81 (68-99)	>100	>100	>100
	LC_{50} - 96 hr, % effluent	49	81 (68-99)	>100	>100	>100
S. typhimurium - strains TA98, TA100, TA1535, TA1537, and TA1538	Response to Ames test for mutagenicity - (-) or (+)	(-)	(-)	(-)	(-)	(-)
E. coli - strains W3110 and p3478	Response to pol A test for mutagenicity-increase in zone of inhibition, mm	0	0	0	0	0
Chinese hamster ovary cells	Response to CHO-K1 test for acute cytotoxicity-EC_{50}	-[e]	>100	>100	>100	>100

[a] Not measured.

[b] 95% confidence interval.

[c] All concentrations of secondary effluent (2%, 5%, 10%, and 10%) failed to support the growth of *S. capricornutum*.

[d] 100% kill in all dilutions (4.7% - 100%), EC_{50} determined with *Daphnia pulex*.

[e] EC_{50} not determinable; cytotoxicity procedure employing rabbit alveolar macrophage (RAM) used in Phase I.

TABLE 36. PLANT N EFFLUENT DESCRIPTION

Parameter	Secondary effluent		Tertiary effluent		
	Phase I	Phase II	Type 3	Type 5	Type 6
Physical description	Clear, light grey liquid with moderate amount of particulate matter; non-chlorinated	Turbid, brown liquid with suspended particles	Turbid, brown liquid with suspended particles	Cloudy, light brown liquid with suspended particles	Slightly turbid liquid
pH	3.7	6.6	6.7	6.9	6.5
Salinity, g/l	NM	0	0	0	0
Specific conductivity, µmhos/cm²	NM	600	650	650	850

TABLE 37. PLANT V ORGANIC TOXIC POLLUTANTS DETECTED (Concentration, μg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent		Tertiary effluent							
		Phase I	Phase II	Type 3		Type 4		Type 6		Type 7	
Bis(2-ethylhexyl) phthalate	17	9.5	9.5	16	(-68)[a]	46	(-380)	17	(-79)	90	(-850)
Di-n-butyl phthalate	2.0	–[b]	5.7	12	(-110)	5.4				2.7	
Anthracene			0.2	0.3		0.1					
Butyl benzyl phthalate				0.9							
Methylene chloride[c]	18		24	13	(46)	14	(42)	17	(29)	15	(38)
Toluene	1.3	1,400	1.1	1.3		1.1		1.0		0.9	
Trichloroethylene	1.5		0.7	0.4		2.1		0.6		0.9	
1,1-Dichloroethane	0.4										
Benzene	0.05			0.05							
Ethylbenzene	0.07							0.1		0.1	
Chloroform						0.2					
Trans-1,2-dichloroethylene								1.1		2.1	
Phenol (total)	1,000	230	29	13	(55)	22	(24)	8	(72)	21	(28)

[a]Minus percent removals indicate any increase in the concentration of the specified pollutant.

[b]Blanks indicate concentration below detection limit (see Table 6).

[c]Methylene chloride may originate from analysis contamination.

TABLE 38. PLANT V INORGANIC TOXIC POLLUTANTS DETECTED
(Concentration, μg/ℓ; percent removal in parentheses)

Pollutant	Intake	Secondary effluent		Tertiary effluent							
		Phase I	Phase II	Type 3		Type 4		Type 6		Type 7	
Antimony	<10	4	<10	<10		24[a]	(-140)[b]	24[a]	(-140)	25[a]	(-150)
Arsenic	<1	<5	4	4		<1		5		4	
Beryllium	<0.04	<0.1	<0.04	<0.04		<0.04		<0.04		<0.04	
Cadmium	<2	<0.5	<2	<2		<2		<2		<2	
Chromium	<4	3	4.3[a]	<4		6.7[a]		<4		6.3[a]	
Copper	<4	170	85	75	(12)	100	(-18)	16[a]	(81)	89	(-5)
Cyanide	<2	18	23	3	(87)	27	(-17)	<2	(>91)	<2	(>91)
Lead	<22	<1	<22	31[a]	(-41)	37[a]	(-68)	26[a]	(-18)	<22	
Mercury	<1.1	<0.5	<1.1	<1.1		<1.1		<1.1		<1.1	
Nickel	<36	<10	<36	<36		73[a]	(-103)	67[a]	(-86)	66[a]	(-83)
Selenium	<1	<5	<1	<1		<1		2		<1	
Silver	<5	<5	<5	<5		12[a]	(-140)	15[a]	(-200)	16[a]	(-220)
Thallium	<50	<5	<50	<50		<50		<50		<50	
Zinc	98	340	240	190	(21)	330	(-38)	69	(71)	240	(0)

[a]Semiquantitative region; value not within 95% confidence limits.

[b]Minus percent removals indicate an increase in the concentration of the specified pollutant.

TABLE 40. PLANT V BIOASSAY RESULTS

Test species	Parameter	Secondary effluent		Tertiary effluent			
		Phase I	Phase II	Type 3	Type 4	Type 6	Type 7
Freshwater algea - *S. capricornutum*	EC_{50} - 7 day, % effluent	NM[a]	78 (59-100)[b]	76 (60-96)	19 (14-27)	>100	>100
	EC_{50} - 12 day, % effluent	NM	94 (57-100)	95 (52-100)	25 (13-47)	>100	>100
	EC_{50} - 14 day, % effluent	-[c]	>100	>100	24 (12-48)	>100	>100
Water flea - *D. magna*	LC_{50} - 24 hr, % effluent	NM	>100	>100	77 (60-100)	>100	>100
	LC_{50} - 48 hr, % effluent	9.4[d]	>60<100	>100	54 (44-66)	>100	>100
Fathead minnow - *P. promelas*	LC_{50} - 24 hr, % effluent	NM	-[e]	-[e]	-[e]	-[e]	-[e]
	LC_{50} - 48 hr, % effluent	NM	-[e]	-[e]	-[e]	-[e]	-[e]
	LC_{50} - 72 hr, % effluent	NM	-[e]	-[e]	-[e]	-[e]	-[e]
	LC_{50} - 96 hr, % effluent	36	-[e]	-[e]	-[e]	-[e]	-[e]
S. typhimurium - strains TA98, TA100, TA1535, TA1537, and TA1538	Response to Ames test for mutagenicity- (-) or (+)	(-)	(-)	(-)	(-)	(-)	(-)
E. coli - strains W3110 and p3478	Response to pol A test for mutagenicity-increase in zone of inhibition, mm	0	0	0	0	0	0
Chinese hamster ovary cells	Response to CHO-K1 test for acute cytotoxicity- EC_{50}, % effluent	-[f]	>100	>100	>100	>100	>100

[a]Not measured.

[b]95% confidence limits.

[c]20% secondary effluent was highly stimulatory for the growth of *S. capricornutum*.

[d]EC_{50} determined with *Daphnia pulex*.

[e]LC_{50} not calculated since mortality data did not follow a normal dose - response relationships; secondary effluent (Phase II), Type 3 tertiary effluent, Type 7 tertiary effluent, and Type 8 tertiary effluent do not appear to be acutely toxic to the fathead minnow.

[f]EC_{50} not determinable; cytotoxicity procedure employing rabbit alveolar macrophage (RAM) used in Phase I.

TABLE 41. PLANT V EFFLUENT DESCRIPTIONS

Parameter	Secondary effluent		Tertiary effluent			
	Phase I	Phase II	Type 3	Type 4	Type 6	Type 7
Physical description	NM[a]	Turbid dark brown liquid	Turbid dark brown liquid	Turbid, tan liquid with suspended particles	Slightly turbid liquid	Turbid brown liquid, particles present
pH	NM	6.5	6.3	3.5	6.6	6.5
Salinity, g/l	NM	0	0	0	0	0
Specific conductivity, μmhos/cm²	NM	210	220	300	210	220

[a]Not measured.

TABLE 42. PLANT T ORGANIC TOXIC POLLUTANTS DETECTED (Concentration, μg/ℓ; percent removal in parentheses)

Pollutant	Well Intake	River Intake	Secondary effluent Phase I	Secondary effluent Phase II	Tertiary effluent Type 3	Tertiary effluent Type 5	Tertiary effluent Type 6
Benzene	7.1	6.2		5.7	6.9	6.8	9.8
Chlorobenzene	–[a]			4.1	4.8	0.1	
1,1-Dichloroethylene				4.2		1.8	1.4
p-Chloro-*m*-cresol					0.6	1.1	
1,1-Dichloroethane							0.5
Ethylbenzene	0.3			0.5	0.2	0.3	
Methylene chloride[b]	24	18		20	19 (5)	18 (10)	19 (5)
Trichlorofluoromethane					0.8		
Phenol		0.7		0.4	1.1	0.3	0.9
Bis(2-ethylhexyl) phthalate	4.8	6.1	23	24	19 (21)	5.2 (78)	14 (42)
Butyl benzyl phthalate	1.2	1.1		5.2	2.5	1.3	
Di-n-butyl phthalate	0.4	0.04		4.4	7.0	1.7	1.7
Tetrachloroethylene			2.9		0.8	1.4	
Toluene	1.2	0.6	33	1.0	0.8	1.0	0.6
Trichloroethylene				0.3	0.4		0.1
Phenol (total)	10	36	41	26	160 (-520)[c]	14 (46)	120 (-360)

[a]Blanks indicate concentration below detection limit (see Table 6).

[b]Methylene chloride may originate from analysis contamination.

[c]Minus percent removals indicate an increase in the concentration of the specified pollutant.

TABLE 43. PLANT T INORGANIC TOXIC POLLUTANTS DETECTED
(Concentration, µg/ℓ; percent removal in parentheses)

Pollutant	Well intake	River intake	Secondary effluent Phase I	Secondary effluent Phase II	Tertiary effluent Type 3		Tertiary effluent Type 5		Tertiary effluent Type 6	
Antimony	<10	18[a]	<0.5	54	58	(-7)[b]	49[a]	(9)	39[a]	(28)
Arsenic	<1	<1	<5	3	3		1		3	
Beryllium	<0.04	<0.04	<0.1	<0.04	<0.04		<0.04		<0.04	
Cadmium	<2	<2	<0.5	2[a]	<2		<2		<2	
Chromium	<4	<4	<0.2	97	95	(2)	20	(79)	84	(13)
Copper	780	8[a]	60	110	100	(9)	18	(84)	87	(21)
Cyanide	<2	<2	<4	11	20	(82)	5	(55)	<2	(>82)
Lead	<22	<22	<1	22[a]	26[a]	(-18)	<22	(>0)	29[a]	(-32)
Mercury	<1	<1	<0.5	<1	<1		<1		<1	
Nickel	55[a]	60[a]	4	93[a]	100[a]	(-8)	59[a]	(37)	90[a]	(3)
Selenium	<1	<1	<5	2	2		2		<1	
Silver	19[a]	27	<5	23[a]	32	(-39)	19[a]	(17)	28[a]	(-22)
Thallium	<50	<50	<5	<50	<50		<50		<50	
Zinc	99	370	80	150	97	(35)	52	(65)	110	(27)

[a] Semiquantitative region; value not within 95% confidence limits.

[b] Minus percent removals indicate an increase in the concentration of the specified pollutant.

TABLE 44. PLANT T OTHER POLLUTANTS DETECTED (Concentration, μg/ℓ; percent removal in parentheses)

Pollutant	Well intake	River intake	Secondary effluent	Tertiary effluent Type 3		Tertiary effluent Type 5		Tertiary effluent Type 6	
Aluminum	50[a]	100	160	180	(-13)[b]	3,600	(-2,200)	130	(19)
Barium	5.5	6.0	7.7	7.1		0.6[a]		5.3	
Boron	<1	<1	270	260	(4)	270	(0)	250	(7)
Calcium	13,000	4,700	12,000	11,000	(8)	7,600	(37)	11,000	(8)
Cobalt	<6	<6	<6	<6		<6		<6	
Iron	61	210	520	520	(0)	340	(35)	590	(-13)
Magnesium	4,300	1,500	3,000	3,000	(0)	2,700	(10)	3,300	(-10)
Manganese	300	16	690	710	(-3)	430	(38)	610	(12)
Molybdenum	<10	<10	<10	10[a]		<10		<10	
Sodium	20,000	7,700	180,000	170,000	(6)	370,000	(-106)	170,000	(6)
Phosphorus	140	<70	14,000	13,000	(7)	1,900	(86)	14,000	(0)
Silicon	6,700	2,100	6,400	6,300	(2)	3,300	(48)	6,400	(0)
Tin	<15	<15	<15	<15		<15		<15	
Strontium	85	33	72	70	(3)	50	(31)	70	(3)
Titanium	1.9[a]	3.2[a]	4.0[a]	4.8[a]		4.0[a]		5.0[a]	
Vanadium	33	18	32	35	(-9)	56	(-75)	32	(0)
Ammonia nitrogen	NA[c]	NA	16,000	18,000	(-13)	16,000	(0)	19,000	(-19)
Nitrate nitrogen	NA	NA	1,200	1,200	(0)	1,200	(0)	1,100	(8)
COD	22,000	95,000	630,000	160,000	(75)	140,000	(78)	340,000	(46)
TSS	<1,000	<1,000	20,000	14,000	(30)	28,000	(-40)	12,000	(67)
Sulfide	<3	<3	21	20	(5)	9	(57)	13	(38)
Color[d] at pH 7.6	9	32	177	164	(7)	99	(44)	106	(40)
Color[d] at sample pH	9	26	174	164	(6)	120	(31)	115	(34)
pH[e]	7.6	6.9	8.0	7.6		7.9		7.5	

[a]Semiquantitative region; value not within 95% confidence limits.

[b]Minus percent removals indicate an increase in the concentration of the specified pollutant.

[c]Not analyzed.

[d]ADMI units.

[e]pH units (- log [H^+]).

TABLE 45. PLANT T BIOASSAY RESULTS

Test species	Parameter	Secondary effluent Phase I	Secondary effluent Phase II	Tertiary effluent Type 3	Tertiary effluent Type 5	Tertiary effluent Type 6
Freshwater algae - *S. capricornutum*	EC_{50} - 7 day, % effluent	NM[a]	>100	>100	>100	>100
	EC_{50} - 12 day, % effluent	NM	>100	>100	>100	>100
	EC_{50} - 14 day, % effluent	-[b]	>100	>100	>100	>100
Water flea - *D. magna*	LC_{50} - 24 hr, % effluent	NM	54 (47-63)[c]	77 (66-100)	100	>100
	LC_{50} - 48 hr, % effluent	>100[d]	16 (14-19)	23 (23-36)	80 (69-93)	>100
Fathead minnow - *P. promelas*	LC_{50} - 24 hr, % effluent	NM	22 (15-32)	18 (15-22)	68 (46-100)	-[e]
	LC_{50} - 48 hr, % effluent	NM	18 (15-22)	17 (15-19)	56 (46-68)	-[e]
	LC_{50} - 72 hr, % effluent	NM	18 (15-22)	17 (15-19)	56 (46-68)	-[e]
	LC_{50} - 96 hr, % effluent	47	17 (15-19)	17 (15-19)	56 (46-68)	-[e]
S. typhimurium - strains TA98, TA100, TA1535, TA1537, and TA1538	Response to Ames test for mutagenicity - (-) or (+)	(-)	(-)	(-)	(-)	(-)
E. coli - strains W3110 and p3478	Response to pol A test for mutagenicity-increase in zone of inhibition, mm	0	0	0	0	0
Chinese hamster ovary cells	Respone to CHO-K1 test for acute cytotoxicity EC_{50}	-[f]	>100	>100	>100	>100

[a]Not measured.

[b]20% secondary effluent was extremely stimulatory to the growth of *S. capricornutum*.

[c]95% confidence limits.

[d]EC_{50} determined with *Daphnia pulex*.

[e]LC_{50} not calculated since mortality data did not follow a normal dose-response relationship; effluent did not appear to be acutely toxic.

[f]EC_{50} not determinable; cytotoxicity procedure employing rabbit alveolar macrophage (RAM) used in Phase I.

TABLE 46. PLANT T EFFLUENT DESCRIPTIONS

Parameter	Secondary effluent		Tertiary effluent		
	Phase I	Phase II	Type 3	Type 5	Type 6
Physical description	Clear, blue green with a moderate amount of particulate, nonchlorinated	Turbid, green-brown liquid	Turbid, dark green liquid	Turbid, light green liquid	Turbid yellow-brown liquid
pH	7.4	7.1	3.5	7.2	7.2
Salinity, g/ℓ	NM[a]	0	0	0	0
Specific conductivity, μmhos/cm^2	NM	750	700	1,500	700

[a]Not measured.