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AMBIENT AIR POLYNUCLEAR AROMATIC HYDROCARBONS STUDY SYDNEY, NOVA SCOTIA

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AMBIENT AIR
POLYNUCLEAR AROMATIC HYDROCARBONS STUDY
SYDNEY, NOVA SCOTIA

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ABSTRACT

An ambient air study was conducted in Sydney, Nova Scotia, from October 16, 1981 to September 21, 1982, to determine the magnitude of polynuclear aromatic hydrocarbon (PAH) levels in the area and to determine the major source or sources of PAH. The study was a cooperative effort between the Environmental Protection Service, Atlantic Region of Environment Canada and the Nova Scotia Department of the Environment.

Samples were collected using high volume samplers at three locations in Sydney. Two sites were in the vicinity of the coke ovens, located at the County Jail and Frederick Street, and a third station was located at St. Rita's Hospital to act as a background site. Analysis of the particulate PAH was performed using high pressure liquid chromatography.

Levels of PAH and BaP (benzo(a)pyrene) measured in the study were highest near the coke ovens. The County Jail showed particulate PAH concentration ranging from 0.36-622.44 nanograms per cubic metre (ng/m^3) (average 31.16 ng/m^3), Frederick Street 0.69-201.56 ng/m^3 (average 36.56 ng/m^3), while at St. Rita's Hospital 0.09-23.70 ng/m^3 (average 3.48 ng/m^3). The BaP concentration for the County Jail ranged from 0.02-36.42 ng/m^3 (average 1.74 ng/m^3), Frederick Street 0.06-21.14 ng/m^3 (average 3.74 ng/m^3), St. Rita's Hospital, non-detectable-1.98 ng/m^3 (average 0.23 ng/m^3).

The average BaP for the three locations in Sydney was 1.9 ng/m^3. Comparisons are made to other studies in Canada and the U.S.A. which indicate that the average BaP level measured in Sydney was higher than the average obtained for cities in the U.S.A. with coke ovens.

The wind direction, frequency and relative locations of the sampling sites indicate that the coke ovens were the source of the elevated levels of PAH

in the area. The study results are considered to be on the conservative side since the coke ovens were operating at less than 50% design capacity at the time the study was conducted.

RÉSUMÉ

Une étude de l'air ambiant a été effectuée à Sydney (Nouvelle- Écosse) du 16 octobre 1981 au 21 septembre 1982, afin de déterminer les concentrations d'hydrocarbures aromatiques polycycliques (HAP) dans la région ainsi que leurs principales sources. Cette étude a été réalisée conjointement par le Service de la protection de l'environnement, région de l'Atlantique, d'Environnement Canada et le ministère de l'Environnement de la Nouvelle-Écosse.

Des volumes importants ont été prélevés à trois endroits dans la ville, dont deux près des fours à coke, soit à la prison de comté et sur la rue Frederick, et le troisième, servant de témoin, à l'hôpital St. Rita. Le dosage des HAP particulaires s'est fait par chromatographie liquide à haute pression.

Les concentrations de HAP et de BaP (benzo(a)pyrène) mesurées au cours de cette étude étaient les plus élevées près des fours à coke. Les concentrations de HAP particulaires variaient de 0,36 à 622,44 nanogrammes par mètre cube (ng/m^3) (moyenne de 31,16 ng/m^3) à la prison, et de 0,69 à 201,56 ng/m^3 (moyenne de 36,56 ng/m^3) sur la rue Frederick, alors qu'elles allaient de 0,09 à 23,70 ng/m^3 (moyenne de 3,48 ng/m^3) à l'hôpital St. Rita. Les concentrations de BaP variaient de 0,02 à 36,42 ng/m^3 (moyenne de 1,74 ng/m^3) à la prison, de 0,06 à 21,14 ng/m^3 (moyenne de 3,74 ng/m^3) sur la rue Frederick, de non décelable à 1,98 ng/m^3 (moyenne de 0,23 ng/m^3) à l'hôpital St. Rita.

A Sydney, la concentration moyenne de BaP était de 1,9 ng/m^3 pour les trois postes d'échantillonnage. Des comparaisons avec d'autres études effectuées au Canada et aux États-Unis indiquent que la concentration moyenne de BaP mesurée à Sydney était légèrement supérieure à la moyenne trouvée dans les villes américaines où il y a des fours à coke.

La direction du vent, la répartition des concentrations et l'emplacement des points d'échantillonnage indiquent que les fours à coke sont la principale source de HAP dans la région. On considère que ces résultats sont inférieurs à la concentration habituelle, vu que les fours à coke fonctionnaient à moins de 50 p. 100 de la capacité prévue.

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1. INTRODUCTION

Polynuclear aromatic hydrocarbons (PAHs) have long been recognized as some of the most hazardous materials in the environment. Concern regarding environmental contamination arose because many of the species have been demonstrated to be carcinogenic[1]. The occupational health risk associated with high PAH exposure industries such as coking and asphalt has been well established[2,3]. Consequently due to the potential health hazard from the high PAH emissions from coke oven operations, the United States Environmental Protection Agency (USEPA) in 1978, proposed a standard for new coking facilities which would regulate coke oven emissions from various operations[5]. To date these standards have not been promulgated. Environment Canada, in 1975, promulgated emission guidelines for coke ovens with respect to particulates and sulphur dioxide[5].

Investigations done in the USA in coke oven areas generated an interest in local emissions in Nova Scotia and it was therefore decided by the Environmental Protection Service (EPS), Atlantic Region, and the Nova Scotia Department of Environment (NSDOE) to join in a cooperative study to determine the ambient air levels of particulate PAH* in the vicinity of the coke ovens located in Sydney, Nova Scotia. This study was conducted in the Sydney area from October 16, 1981 to September 21, 1982 to measure ambient PAH particulate levels. This report presents a description of the methods used for sampling and analyses for particulate PAH, as well as results and data interpretation for the survey conducted during the above period.

*** Whenever PAH is mentioned in this report it will refer to particulate PAH unless otherwise specififed.**

2. BACKGROUND INFORMATION

2.1 Polynuclear Aromatic Hydrocarbons

PAHs are a group of organic compounds formed during combustion or pyrolysis of fossil fuels and other carbonaceous materials. Thermal formation of PAHs yields a multitude of individual PAH compounds, the predominant ones are non-alkylated, about 10 or 12 of which account for the bulk of PAHs present in a combustion product such as creosote and coal tar[6]. PAHs have been found at various levels in water, air, soil and sediments. PAH formation can occur over long periods of time at relatively low temperatures, such as in the conversion of organic matter into crude oil. High concentrations in the environment are primarily due to incomplete combustion products from vehicle exhaust, incineration, industrial emissions, and heat and power generation.

2.2 Health Effects

PAHs are among the earliest classes of compounds that have been demonstrated as carcinogens in man, from studies describing tumours in chimney sweeps and coke oven workers[3,7]. Subsequently, many PAH species such as benzo(a)pyrene (BaP) have been shown to be carcinogenic, mutagenic, and/or cocarcinogenic in animals, apparently as a result of the oxidation of the PAH aromatic ring[3,7-11]. Epidemiological findings among coke oven workers show that coke oven emissions can also lead to the development of non-malignant respiratory disease such as chronic bronchitis and emphysema[7,12].

Coke oven emissions, a combination of gases and particulates, carry several of these known carcinogens, such as benzo(a)pyrene and benz(a)anthracene, which present a potential hazard to the health of exposed workers[4]. Extensive epidemiological evidence shows that workers exposed to relatively high levels of coke oven emissions develop cancer, especially

of the respiratory tract, at rates significantly higher than those reported for other workers and for the general population[10]. There are virtually no studies which have investigated possible health effects of PAH to the general public at levels which would normally be experienced from exposure to PAH in the ambient air.

In 1978 the USEPA drafted standards of operation for emissions from wet coal charging and topside leaks at coke ovens. This agency had determined that coke oven emissions were carcinogenic and should be regulated as a hazardous air pollutant under the U.S. Clean Air Act[11]. The intended effect of the proposed regulation was for all by-product coke oven batteries to install and operate the best control technology to reduce emissions to the ambient air and minimize the risks to public health outside a plant boundary. These drafted standards have not yet been proposed to Congress[13].

2.3 Sources of Polynuclear Aromatic Hydrocarbons

Many species of PAH are produced as a result of incomplete combustion of coal and oil in various types of gasoline and diesel engines, incinerators, power plants, coal and wood burning devices and many other emissions resulting from personal and commercial energy consumption. In the USA, it has been estimated that 98% of BaP emissions are from stationary sources. The USEPA has estimated that coke ovens are responsible for 19% of nationwide emissions of BaP (155 tonnes per year using a crude emission factor of 2.7 g per tonne of coal processed)[14]. An estimate of BaP emissions in the USA for 1972 for various sectors is as follows[14]:

Source	Emissions (tonne/year)
Coal, hand stoked residential furnaces	273
Coal, steam power plants	less than 1
Oil, residential	2

Wood, home fireplace	23
Petroleum, catalytic cracking	6
Open burning, coal refuse	282
Coke production	155

Table 1 (a) gives national averages of concentrations of BaP and PAH for the USA. Data for the National Atmospheric Surveillance Network (NASN) in the USA suggest a considerable decline in the BaP concentration in the urban atmosphere during the period 1966 to 1975. The average BaP concentration declined from an annual median value of 3.2 ng/m^3 in 1966 to 2.1 ng/m^3 in 1970 and to 0.5 ng/m^3 in 1975[15]. This decline is believed to be primarily due to the decrease in coal consumption for home heating, as well as improved disposal of solid waste and restrictions on open burning. The decline may also have resulted from reduced emissions from industrial sources[16]; and also from automobiles manufactured later than 1974[10].

Table 1 (b) gives BaP and PAH levels obtained for five sites in Ontario. Katz et al.[17] measured PAH in suspended particulate matter collected by high volume samplers at sites in: Toronto, Bathurst Street at Highway 401, which is influenced mainly by exhaust emissions from heavy motor vehicle traffic; Toronto, Kennedy Street at Lawrence, which is a location subjected to occasional motor vehicle traffic; downtown Hamilton, a major source of particulates derived from steel manufacturing and coke oven operations; Sarnia, near Mill Street Refinery, where the major source is oil refinery and petrochemical operations; and downtown Sudbury, where the major source is large nickel-copper smelting activities. For this study, filters were collected into four bundles, each bundle representing samples pooled together for one season and were analyzed using gas chromatography/mass spectroscopy. PAH mean annual levels ranged from 3.16-18.67 ng/m^3 (the mean referring to an arithmetic average taken of the four seasons for each site).

TABLE 1 - Ambient BaP and PAH concentrations for USA and Canada.

TABLE 1 (a) - Ambient BaP and PAH concentrations (annual means).

Location	BaP (ng/m^3)	PAH (ng/m^3)
Coke oven areas:		
NASN, USA average, 1975[14]	1.2	-
Urban areas:		
NASN, USA average, 1975[14]	0.38	-
Rural Areas:		
NASN, USA average, 1975[14]	less than 0.10	-

TABLE 1 (b) - Annual means of individual sites in Canada.

Location	BaP (ng/m^3)	PAH (ng/m^3)
Coke oven areas:		
Hamilton[17]	2.30	18.67
Urban Areas:		
Toronto site 3400[17]	1.06	11.05
Toronto site 3300[17]	0.65	9.96
Sarnia[17]	0.31	3.42
Sudbury[17]	0.27	3.16

2.4 Particulate PAHs

Most PAHs are emitted in the gaseous phase during combustion. PAHs then cool down, deposit and become adsorbed on particulates, or condense and form particulates of nearly pure condensate. These particulates are then subject to dispersion by turbulence and transport by wind and removal by settling, impaction and washout[18]. Large airborne particulates rapidly settle out near the source while smaller particulates may be transported for considerable distances[19].

Health hazards associated with the inhalation of toxic airborne particulates depend in part on particle size[20]. Authors report different size ranges associated with ambient PAHs, these generally fall between submicron to 7 um diameter[21,22]. It should be noted that particle size distribution associated with coke oven emissions is optimum for penetration and absorption into the human respiratory tract[4]. Over 90% of PAHs from coke oven samples of emitted particulate matter were in the respirable size range[20]. One author reports that for coke ovens, the bulk of PAHs have been found on 0.9-7 um particulates. Only 1% of PAHs were found on particulates greater than 7 um[22].

3. SYDNEY STEEL COKE OVENS

3.1 The Coking Process

Coke is generally manufactured by the destructive distillation of bituminous coal, though some lignite coal is used at the Sydney coke ovens. Coke is manufactured at the Sydney plant by the by-product coke oven process. The ovens are situated in series alternately with heating flues. Heat is supplied by external combustion and air is excluded from the coking process taking place in the ovens.

To produce metallurgical grade coke the coking process takes place at over 1093°C and lasts for approximately 17 hours. As the coal is heated, most of the volatile components are driven off. These compounds are collected and processed to reclaim chemicals and tars as well as to utilize the heating value of the coke oven gas.

As well as the emissions which occur during coking, certain processes create greater emissions for short periods of time. Charging the coal, discharging the coke (pushing) and cooling the coke (quenching) all result in short term higher rates of emissions. The coal is loaded or charged into the coke ovens from the top by means of a larry car. The topside oven doors are opened and as the coal falls into the hot ovens, higher than normal emissions of dust, smoke and gases occur. At the end of the coking cycle, the coke is discharged or pushed into railway cars. The oven doors at one end are opened and a large ram pushes the hot coke into the open railway cars. Again higher than normal emissions occur. Finally, the coke is cooled or quenched using water sprays. As the water hits the hot coke, it vaporizes rapidly and is released to the atmosphere, carrying with it quantities of coke breeze (fine coke dust).

The continuous sources of emission at the coke plant include combustion gases from the underfiring system for the coke ovens which burns

coke oven gas, the boiler plant burning coke breeze or coal, as well as leakage from the ovens.

3.2 The Sydney Coke Ovens

The Sydney coke ovens consist of two batteries or arrays of ovens. Battery #5, a Koppers B Underjet type, contains 53 ovens and was installed in 1949. The second unit, battery #6, also a Koppers B Underjet, contains 61 ovens and was constructed in 1953. The design average charge rate of each oven is 15.5 tonnes.

At the time of this study, one of the coke oven batteries was shut down and the other was not operating at maximum capacity. The level of coke production during the study period is shown in Appendix I. Production ranged from a low of 819 to a high of 1428 tonnes per day of coke with an average production of 1283 tonnes per day of coke.

Table 2 shows the "United States Environmental Protection Agency Emission Factors" for uncontrolled metallurgical coke manufacturing operations. Table 3 shows the estimated emissions for the Sydney coke ovens.

TABLE 2 - United States Environmental Protection Agency emission factors for uncontrolled metallurgical coke manufacturing operations.[23]

Operation	kg/tonne[1] of Coal Charged					
	Particulate	Sulphur Dioxide	Carbon Monoxide	Hydrocarbons[2]	Nitrogen Oxides[3]	Ammonia
Unloading	0.2	-	-	-	-	-
Charging	0.75	0.01	0.3	1.25	0.02	0.01
Coking Cycle	0.05	-	0.3	0.75	0.01	0.03
Discharging	0.3	-	0.03	0.1	-	0.05
Quenching	0.45	-	-	-	-	-
Underfiring	-	2	-	-	-	-
Total	1.75	2.01	0.63	2.1	0.03	0.09

If it is assumed that 1.4 tonnes of coal are required to produce 1 tonne of coke, then the average coal consumption during the sampling period would be 1796 tonnes per day.[23]

On the basis of the EPA emission factors, the expected average emission from the Sydney coke ovens during the sampling period would be as follows:

TABLE 3 - Estimated emissions for Sydney coke ovens.[24]

Operation	kg/day					
	Particulate	Sulphur Dioxide	Carbon Monoxide	Hydrocarbons[2]	Nitrogen Oxides[3]	Ammonia
Unloading	359.2	-	-	-	-	-
Charging	1347	17.96	538.8	2245	35.92	17.96
Coking Cycle	89.8	-	538.8	1347	17.96	53.88
Discharging	538.8	-	53.88	179.6	-	89.90
Quenching	808.2	-	-	-	-	-
Underfiring	-	3592	-	-	-	-
Total	3143	3609.96	1131.48	3771.6	53.88	161.64

(1) Converted to SI units.
(2) Expressed as methane.
(3) NO_2.

4. AMBIENT AIR SAMPLING FOR PARTICULATE POLYNUCLEAR AROMATIC HYDROCARBONS

Based on conventional sampling techniques for PAH in ambient air, it was decided to use high volume samplers for the ambient air sampling. These samplers collect particulates down to 0.3 um in size with the upper limit ranging between 60-100 um. Three different sampling sites were chosen and Figure 1 shows the locations of these sampling sites relative to the coke ovens. The first two sites, Frederick St. and County Jail, were in the vicinity of the coke ovens; the third site, St. Rita's Hospital, was chosen at a farther distance to serve as a control site to provide background ambient air PAH concentrations for the area.

The County Jail site and the St. Rita's Hospital site were chosen because they are existing monitoring stations at these locations, the first being a National Air Pollution Surveillance station and the second a provincial monitoring station used in other ambient air studies to provide background concentrations. The Frederick St. site was chosen because it was thought to be potentially the worst site, being close to and downwind of the coke ovens. The County Jail site lies at a distance of 750 m south of the coke ovens; the Frederick St. site is 450 m northeast of the ovens; and the St. Rita's Hospital site is 3700 m away from the coke ovens and was expected to receive fallout from the coke ovens area only if the wind blows from the northeast. All sampler intakes were 1.2 m above ground level.

The wind data were measured by the Atmospheric Environment Service (AES) at the Sydney Airport, situated 6 km east of the coke ovens, and are considered to be fairly representative of wind speeds and directions at the various sampling locations. Figure 2 shows the wind rose pattern for Sydney Airport obtained over the period from 1955-1980. The prevailing wind was from the south to west quadrant (52% of the time). Secondary wind was from the west to north quadrant (28% of the time). In all cases, the mean monthly wind speeds varied from 18.4 to 24.4 km/hr with an average of 21.7 km/hr.

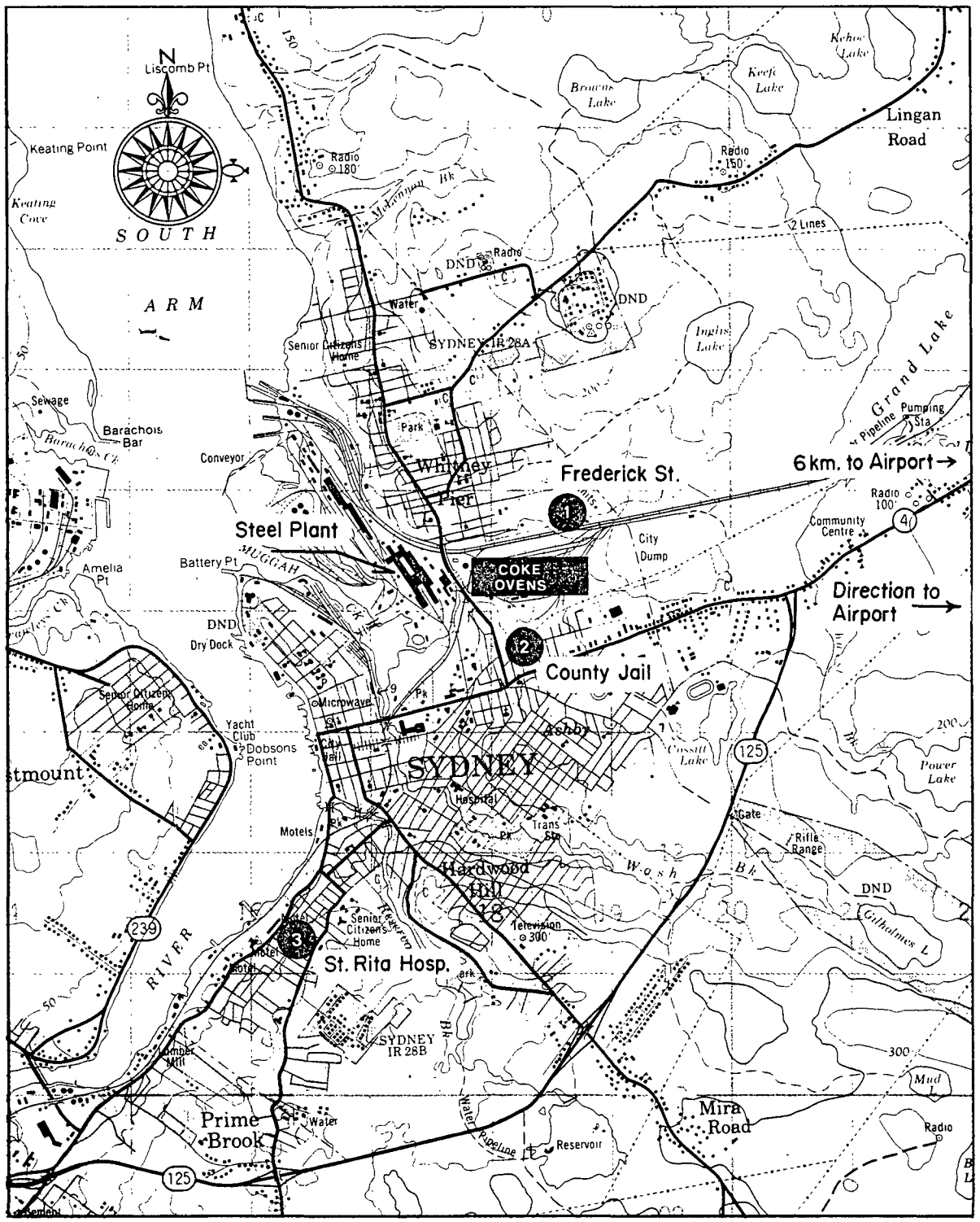

Figure 1 - Sampling Site Locations

SCALE: 1:50,000

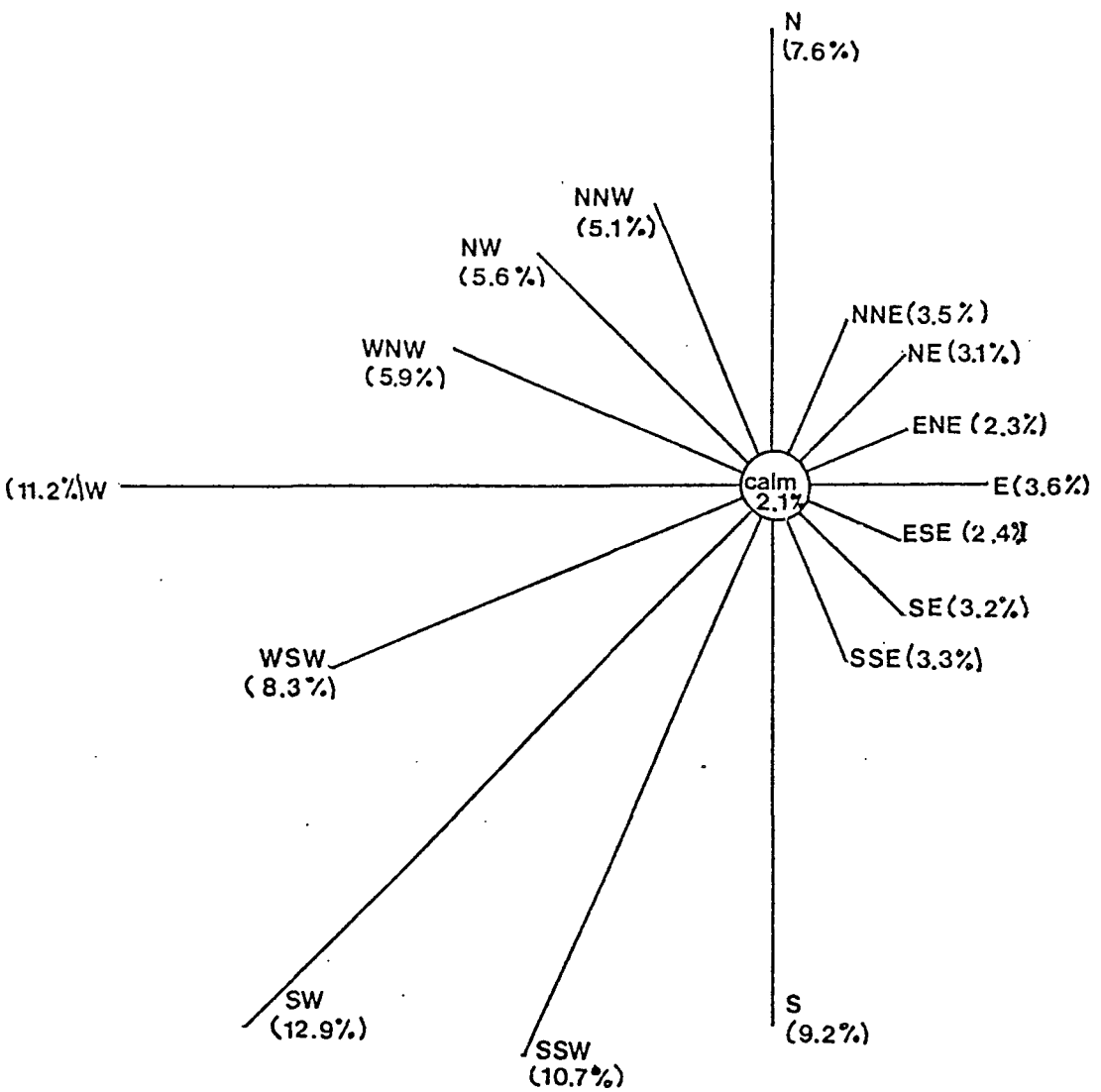

FIGURE 2 - Wind rose for Sydney Airport for the period ranging from 1955 to 1980.

The sampling period extended from October 16, 1981, to September 21, 1982. For the period October 16, 1981, to March 8, 1982, sampling was carried out three times monthly, each time for a continuous period of 96 hours. Beginning on March 18 and extending to September 21, 1982, sampling followed the National Air Pollution Surveillance (NAPS) schedule of one sample every sixth day, with a sample duration of 24 hours. This change in the sampling time was made in order to permit comparison between this survey data and PAH values reported in the literature. Sampling equipment was operated by NSDOE personnel in Sydney. Less data was generated from the Frederick St. site than for the other two sites because of operational problems and vandalism at the beginning of the study. Ninety-seven samples were collected in total. A sample was eliminated when it was the only one collected from the three sites on a particular sampling period due to the breakdown of equipment.

The PAH samples were collected using calibrated high volume samplers which operate at a flow rate through the filter of approximately 1.13 m^3 per minute. The filter medium was Gelman type AE glass fibre 20 x 25 cm sheets. These were prewashed with isopropanol, dessicated, weighed, and packed in isopropanol-washed metal foil envelopes. Three blanks were selected for analysis from these filters. For sample collection, filters were loaded into individual covered cassettes and mounted on the high volume samplers the day before sampling was to begin. Following the sampling period, the cassettes were collected and covered, taken to the Sydney lab, the filter removed from the cassette, folded and placed in an isopropanol prewashed mason jar. The jar was then flushed with nitrogen, capped and shipped immediately to EPS, Dartmouth. The samples were next dessicated in a deep freeze for 48 hours, weighed and returned to the deep freeze until the next step of extraction and analysis. Filters were kept away from light sources as much as possible. Several blanks were treated in this manner as well.

In addition to this sampling survey, the Pollution Measurement Division, River Road Labs, Ottawa, operated a modified high volume sampler which traps PAH in the vapour state, as well as particulates. This sampler was installed at the County Jail site in Sydney for the period August 18 to December 7, 1982. The sampler differs from an ordinary high volume sampler in that air passing through the filter continues its passage through a foam filled cartridge to trap the gaseous PAHs. The work has been completed and published in a preliminary report[25]. Results from this study suggest that a large portion of the total PAH was in the vapour phase while the remaining PAH was associated with the particulates trapped on the filter. However, the implications of these findings have not been fully assessed or investigated.

5. THE DETERMINATION OF POLYNUCLEAR AROMATIC HYDROCARBONS ON AIR FILTERS

Most methods used for the analysis of PAHs involve three steps: extraction of PAH collected on the filter with solvent, chromatographic cleanup, identification and quantification by comparison with reference standards using gas or liquid chromatography and/or mass spectroscopy. The following PAHs were determined in the filter samples: phenanthrene, pyrene, triphenylene, fluoranthene, benzo(a)anthracene, benzo(ghi)perylene, benzo(a)pyrene, benzo(e)pyrene, chrysene, benzo(k)fluoranthene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene. These PAHs include six listed by the World Health Organization for their potential health hazard and for which standards have been set for drinking water[26]. The PAHs analyzed for this study also make up part of the 16 PAHs listed by USEPA as priority pollutants[27]. The twelve compounds selected for identification represent the bulk of the PAHs, and are the same compounds identified and quantified in water and sediment samples collected in Sydney, Nova Scotia[28].

5.1 Apparatus

- All glassware was washed thoroughly with soap and water, rinsed with distilled water and acetone and oven heated to 325°C for three hours. Just prior to use, the glassware was rinsed with HPLC grade solvents.

- High pressure liquid chromatograph (HPLC) obtained from Waters Scientific Limited consisted of two model 6000 A solvent delivery pumps, a model 450 variable UV absorption detector, a model 420 fixed wavelength filter fluorometer, a WISP 710 B autosampler, data module and a model 720 system controller.

- Vydac 210 TP54.6 (5 um, 4.6 mm x 25 cm) reverse phase HPLC column.

- HPLC operating conditions:

Linear gradient: 58% acetonitrile-water to 100% acetonitrile over 20 minutes; held until UV absorbing material was removed from column.
Solvent flow rate: 2 ml/min.
UV absorption wavelength: 280 nm.
Fluorometer excitation wavelength: 280 nm.
Fluorometer emission wavelength: 360 nm.

5.2 Reagents

- Solvents were HPLC grade purchased from commercial sources. Technical grade ethanol was glass distilled in the laboratory and dimethylsulphoxide (DMSO) was spectral grade (Fisher) used without further purification.

- Florisil (60-100 mesh) activated at 760°C for three hours, cooled and deactivated with 7% water.

- Sodium sulphate, anhydrous ACS grade, soxhlet extracted with acetone, dried and heated at 760°C for three hours.

- Potassium hydroxide KOH, ACS grade used as purchased.

5.3 Sample Extraction

Whole filter samples were soxhlet extracted with 170 ml of iso-octane for seven hours. After cooling to room temperature, the extracts were washed three times with 100 ml of water (60°C). The washings were discarded and the iso-octane was transferred to a 500 ml evaporation flask and reduced to 10 ml by rotary evaporation. Toluene (100 ml) was added to the flask and the volume reduced again to 10 ml to remove the iso-octane.

5.4 Florisil Column Cleanup

The cleanup method used in this procedure is principally one developed by Dunn and Armour[29] with minor modifications to suit some specific requirements and instrumentation.

A florisil column was prepared by inserting a small plug of glass wool near the bottom of a 1.9 mm x 400 mm glass column. To this column, 15 g of 7% deactivated florisil was added and 30 g of anhydrous sodium sulphate was placed on the florisil.

The column was washed with 40 ml of toluene and the level of the toluene brought just to the top of the column bed. Ten (10) ml of filter extract (Section 5.3) was added and allowed to drain just to top of column bed. The flask containing the extract was rinsed twice with 10 ml of toluene and added to the column in the same manner as the sample extract. The column was eluted with 200 ml of toluene and the eluate collected in a 500 ml evaporation flask.

5.5 Dimethylsulphoxide (DMSO) Partition

DMSO (5 ml) was added to the flask (from the florisil cleanup) and the volume reduced to 5 ml by rotary evaporation to remove the toluene. The DMSO, together with two 5 ml DMSO washings, were transferred to a 250 ml separatory funnel containing 10 ml of iso-octane. The separatory funnel was shaken and the DMSO phase was transferred to a second separatory funnel containing 40 ml of water and 20 ml of iso-octane. The iso-octane remaining in the first separatory funnel was re-extracted with an additional 10 ml of DMSO, which was then transferred to the second separatory funnel. The second funnel was shaken and the iso-octane phase retained, while the DMSO water phase was transferred to a third separatory funnel containing 20 ml of iso-octane. The contents of the third funnel was shaken and the DMSO water phase discarded while the iso-octane layer was combined with the iso-octane

extracts in the second funnel. The combined extracts were washed twice with 40 ml of water.

The water washings were discarded and the iso-octane was transferred to an evaporation flask with washings and the volume reduced to about 5 ml by rotary evaporation. Ten ml of 10% ethanol in toluene was added and the mixture reduced to about 1 ml, thus removing residual water and changing the solvent to toluene. The toluene was transferred with washings to a 15 ml centrifuge tube containing 0.5 ml of DMSO, and the toluene evaporated under a stream of nitrogen gas leaving the sample in 0.5 ml of DMSO. At this stage, the sample was diluted with acetonitrile to a volume suitable for HPLC analysis.

5.6 Identification

Measured amounts of extract ranging from 20-150 ul were injected into the liquid chromatograph. Polyaromatic hydrocarbons in sample extracts were identified by comparison of retention times of sample peaks and known retention times of reference standards peaks in both fluorescence and UV chromatograms. UV and fluorescence peak height ratios also were used for confirmation.

5.7 Quantitation

Amounts of individual PAHs in filter samples were determined by standard quantitative calculations. The amounts of most PAHs can be determined by integrated peak areas obtained from the fluorescence chromatograms. However, because of their poor fluorescing quality, phenanthrene, triphenylene, chrysene, pyrene and benzo(e)pyrene were quantitated using peak heights obtained from UV chromatograms.

5.8 Quality Control

A method blank was carried through the procedure with every four filters analyzed.

Detection limits ranged from 85 ng chrysene/filter to 140 ng phenanthrene/filter for those PAHs detected by ultraviolet spectrophotometry and 3.5 ng benzo(k)fluoranthene to 21 ng benzo(ghi)perylene for those PAHs detected by fluorescence spectrophotometry.

The average recovery for duplicate spiked filters, analyzed by the method was 83.7%, ranging from 90.8% $\pm$ 0.4% for benzo(e)pyrene to 66.4% $\pm$ 1.5% for benzo(a)pyrene.

6. RESULTS

The results obtained for the twelve PAH compounds identified and quantified from the three sampling locations are reported in Appendix 2. For simplification and to permit comparison of the results for the three locations to other studies, the analytical results were summarized for benzo(a)pyrene and total PAH (Table 4). BaP was chosen from the twelve PAH compounds because of its higher carcinogenicity[12] and its frequent use in the literature as an indicator of PAH.

It should be noted that the values given are considered to be on the conservative side because of losses incurred during sampling and analysis. This is a common problem with all particulate PAH sampling studies since methods for handling the filter and for preserving the sample have not been perfected. Losses during sampling were reported in the literature to be from 20-85%, depending on the volatility of the PAH compound[30]. Losses occur due to thermal and photochemical decomposition and are a function of the temperature, relative humidity, ozone concentration and chemical decomposition[29]. Substantial degradation has also been reported to occur on certain filters[31]. As noted in Section 4, care was taken to control these variables as much as possible.

In addition, a modified high volume sampler developed by the Pollution Measurement Division, EPS, Ottawa, was operated in Sydney, Nova Scotia, from August to December, 1982, at the County Jail site. The one-day samples collected showed that a large portion of the total PAH was in the vapour phase[25]. Therefore PAHs obtained by the traditional high volume sampling technique may not be representative of the total amount of PAHs present in the air, since only particulate PAH are collected on the filter. However this does not affect the comparisons in this study since previous studies also measured the particulate PAHs only.

For each of the sampling periods, Table 4 shows BaP and total PAH concentrations, as well as the wind speed and frequency of wind

TABLE 4 - Concentration of BaP and total PAH in ambient air, Sydney, Nova Scotia.

Station	County Jail				St. Rita Hospital				Frederick St.			
Sampling Period	Concentration (ng/m^3)		Wind Direction (WNW-NE Sector)		Concentration (ng/m^3)		Wind Direction (NE-NNE Sector)		Concentration (ng/m^3)		Wind Direction (WSW-SSW Sector)	
	BaP	PAH	Average Speed (km/hr)	Sum of Frequency of Occurrence	BaP	PAH	Average Speed (km/hr)	Sum of Frequency of Occurrence	BaP	PAH	Average Speed (km/hr)	Sum of Frequency of Occurrence
16/10-19/10/1981	36.4	622.44	15	51%	0.65	11.52	3	7%	sampler not yet in place			
26/10-29/10/1981	5.94	143.12	14	60%	0.61	11.56	9	17%				
05/11-08/11/1981	0.08	1.74	8	13	0.01	0.42	0	0				
25/11-28/11/1981	2.47	58.54	36	61	0.24	5.63	43	20%				
15/12-18/12/1981	0.25	8.19	3	2	0.13	4.45	4	1%				
24/01-27/01/1982	3.11	86.96	12	23	< detectable		0	0				
03/02-06/02/1982	0.29	9.88	8	33	instrument failure				6.21	115.74	24	31%
05/03-08/03/1982	1.99	38.63	18	14	0.034	1.44	13	2%	instrument vandalized			
18/03/1982	2.09	38.14	16	58	0.1	2.16	0	0				
30/03/1982	1.58	22.65	16	59	lab accident							
05/04/1982	0.31	7.66	10	16	0.07	2.71	0	0				
11/04/1982	0.33	8.37	0	0	0.07	2.00	0	0				
17/04/1982	0.1	2.33	0	0	0.04	0.68	0	0				
23/04/1982	0.11	3.06	11	38	0.02	1.10	0	0				
29/04/1982	0.75	8.04	4	18	0.03	0.63	8	14				
05/05/1982	0.50	6.57	8	100	0.51	7.14	9	4%				
11/05/1982	0.12	1.72	15	88	0.24	5.09	21	38%	0.28	2.80	0	0
17/05/1982	2.22	28.28	20	62	0.05	1.59	12	16%	1.58	14.39	11	34%
23/05/1982	0.10	3.94	10	24	< detectable		0	0	1.37	13.78	13	16%
29/05/1982	0.69	9.12	13	33	0.64	6.61	13	21%	2.28	18.40	24	38%
04/06/1982	0.15	2.52	7	29	0.02	0.57	18	12%	9.11	70.90	10	38%
10/06/1982	0.12	2.35	0	0	1.98	23.70	17	67%	0.06	1.08	0	0
16/06/1982	0.17	2.31	9	50	0.01	0.27	5	4%	7.99	52.83	11	8%
22/06/1982	0.14	2.00	0	0	0.03	0.19	0	0	0.37	5.51	6	48%

TABLE 4 - (Continued)

Station	County Jail				St. Rita Hospital				Frederick St.			
Sampling Period	Concentration (ng/m^3)		Wind Direction (NW-N Sector)		Concentration (ng/m^3)		Wind Direction (NE-NNE Sector)		Concentration (ng/m^3)		Wind Direction (WSW-SSW Secto	
	BaP	PAH	Average Speed (km/hr)	Sum of Frequency of Occurrence	BaP	PAH .	Average Speed (km/hr)	Sum of Frequency of Occurrence	BaP	PAH	Average Speed (km/hr)	Sum of Freque of Occurrence
28/06/1982	0.24	3.58	1	4	0.02	0.34	0	0	instrument failure			
04/07/1982	0.11	2.01	4	28	0.02	0.44	8	20%	0.99	14.97	10	32%
10/07/1982	0.06	1.05	6	16	0.02	0.42	10	12%	3.08	29.14	10	30%
16/07/1982	2.72	29.79	7	41	0.01	0.26	0	0	4.03	32.58	18	39%
22/07/1982	0.04	0.75	1	4	0.01	0.12	0	0	0.56	10.75	3	4%
28/07/1982	0.13	2.01	5	24	0.5	7.49	11	12%	0.05	0.69	2	4%
03/08/1982	0.11	2.40	2	4	0.07	0.77	0	0	0.22	1.65	0	0
09/08/1982	0.36	5.23	2	8	0.05	0.96	4	4%	instrument failure			
15/08/1982	0.02	0.36	0	0	0.01	0.09	0	0	4.30	36.90	12	84%
21/08/1982	1.73	18.83	5	45	0.01	0.46	0	0	2.15	18.86	7	32%
26/08/1982	1.74	23.44	10	26	0.83	10.33	0	0	14.18	138.13	25	29%
02/09/1982	0.05	0.88	0	0	0.03	0.74	0	0	1.60	14.13	7	34%
08/09/1982	0.33	3.34	12	30	0.43	5.12	21	25%	0.22	2.89	2	8%
14/09/1982	0.17	1.46	0	0	detect.	0.12	0	0	21.14	201.56	19	100%
21/09/1982	0.04	1.43	7	41	0.32	4.61	16	38%	0.53	6.66	0	0

occurrence blowing from the direction of the coke ovens toward each of the three sampling locations. Particulate emissions from the coke ovens emanate from various operations at different locations in the plant, unlike emissions from a point source such as a stack. The plant can be considered as a ground level source with no effective plume rise, and emissions can be considered to be from a line source approximately 300 metres in length. Because of this and the close proximity of the County Jail site and the Frederick St. site (750 m and 450 m away) to the coke ovens, it can be said that no one wind direction is responsible for transporting emissions from the coke ovens to the sampling sites. Instead, wind blowing from the direction of the coke ovens towards the County Jail site would be from the west northwest to the northeast; while wind blowing towards Frederick St. would be from the west southwest to the south southwest. Wind blowing towards St. Rita's Hospital would be between the northeast and the north northeast.

7. DISCUSSION

7.1 PAH and BaP Levels in Sydney, Nova Scotia

The analytical results indicate that high levels of PAH and BaP were frequently measured at the County Jail and Frederick Street sampling sites and much lower levels at the St. Rita Hospital site.

PAH levels at the County Jail ranged from 0.36-622.44 ng/m^3 with an average of 31.16 ng/m^3. PAH levels at Frederick Street ranged from 0.69-201.56 ng/m^3 with an average of 36.56 ng/m^3. PAH levels at the St. Rita Hospital site ranged from 0.09-23.70 ng/m^3 with an average of 3.48 ng/m^3.

The BaP average concentration for the three sites sampled in this study ranged from 0.23, 1.74 and 3.74 ng/m^3 for St. Rita Hospital, County Jail and Frederick Street respectively, with an overall average for the three sites of 1.9 ng/m^3.

Table 5 gives a comparison of the BaP data obtained in Sydney with that obtained by monitors which form part of the National Atmospheric Surveillance Network (NASN) in the USA. As the data available in the literature is for annual averages of all the monitoring instruments in each area, this data has been compared to the average of all the monitoring instruments which were operated in Sydney.

It should also be noted that the study in Sydney was designed specifically to measure PAH levels in the vicinity of the coke ovens, and as such monitors were placed very near to this source. The objective of the U.S. National Atmospheric Surveillance Network, on the other hand, is to measure overall air pollution in each area; therefore, the locations of monitors in relation to coke ovens, in cities which have coke ovens, may be quite arbitrary.

TABLE 5 - Comparison of BaP and total PAH values.

Location	BaP (ng/m^3)	
	Average	Range
Sydney	1.90	0.23-3.74
NASN, USA National Average with Coke Ovens (1975)[14]	1.21	0.30-4.70
NASN, USA National Average without Coke Ovens (1975)[14]	0.38	0.30-0.9
NASN, USA National Average Rural Areas (1975)[14]	0.10	-

For cities with coke ovens in the USA in 1975 the annual average BaP levels measured ranged from a low of 0.3 ng/m^3 to a high of 4.7 ng/m^3. The annual average BaP level of all the cities in the USA which have coke ovens was 1.21 ng/m^3. The annual average BaP level measured in Sydney was 1.9 ng/m^3 which places it above the average level for coke oven cities in the USA.

Comparisons can also be made with cities in the USA which do not have coke ovens and in rural areas. As would be expected, the levels of BaP measured in these areas is much lower. For example, the annual average for urban areas without coke ovens in the USA in 1975 was only 0.38 ng/m^3 while the annual average for rural areas was less than 0.1 ng/m^3.

Table 6 compares both PAH and BaP levels measured in Sydney with PAH and BaP levels measured in various cities in Canada. In this case, the results for individual monitoring sites and not overall city averages have been reported. For this reason, it is possible to compare the levels measured at each of the monitoring sites in Sydney with those measured at various locations across Canada.

Other than Sydney, Hamilton is the only area in this table that has coke ovens. The average BaP level measured at Frederick St. in Sydney (3.74 ng/m^3) is about 1.5 times the average level measured in Hamilton (2.3 ng/m^3). The monitor in Hamilton was located in an area where the major source of PAH would be a steel and coke oven complex. Unfortunately it is not known how close to the coke ovens the station was located. BaP levels at the other two locations (County Jail and St. Rita Hospital) are lower than the level of BaP measured in Hamilton (1.74 and 0.23 versus 2.3 ng/m^3 respectively).

BaP levels in the other cities in Canada which were monitored (cities which do not have coke ovens) vary from a low of 0.27 ng/m^3 in Sudbury to a high of 1.06 ng/m^3 at Bathurst and the 401 streets in Toronto. This particular site is affected by emissions from heavy motor vehicle traffic.

Average PAH levels measured at both the County Jail site and the Frederick St. site were about twice the PAH level measured in Hamilton (31.16 and 36.56 versus 18.67 ng/m^3 respectively). The PAH level measured at St. Rita Hospital is considerably lower (3.48 ng/m^3) than the PAH levels measured in Hamilton. PAH levels at St. Rita Hospital are comparable with the low levels measured at Sudbury and Sarnia and well below levels measured in Toronto.

Also, it should be noted that during the sampling period, production at the coke ovens ranged between 31% to 52% with an average of

TABLE 6 - Comparison of Canadian sampling sites.

Location	BaP (ng/m^3)		PAH (ng/m^3)	
	Average	Range	Average	Range
County Jail	1.74	0.02-36.42	31.16	.36-622.4
Frederick St.	3.74	0.06-21.14	36.56	.69-201.56
St. Rita Hospital	0.23	ND - 1.98	3.48	0.09- 23.70
Hamilton, Ontario (29025)[17]	2.30	1.40- 3.50	18.67	9.85- 32.15
Sudbury, Ontario (77016)[17]	0.27	0.11- 0.44	3.16	1.66- 5.17
Sarnia (14061)[17]	0.31	0.11- 0.60	3.42	1.71- 6.12
Toronto (33003)[17] Kennedy at Lawrence	0.65	0.41- .81	9.96	5.50- 17.49
Toronto (34007)[17] Bathurst at 401	1.06	0.72- 1.67	11.05	7.86- 17.36

47% of total capacity. Coke production averaged 1283 tonnes/day and the design capacity is 2735 tonnes/day. It is expected that PAH emissions would be higher during full production.

7.2 Effects of Wind Speed and Frequency of Occurrence

Table 7 lists the data obtained at each of the monitoring sites in ascending order of PAH concentration. An inspection shows that the higher PAH levels are associated with the higher percentage of time that the wind was blowing from the direction of the coke ovens.

Determination of the correlation coefficient between the wind frequency of occurrence and the PAH levels for the three sampling sites was inconclusive. This is not surprising given the small number of samples and the variation in wind speeds and directions which occur during any given 24 hour period.

The highest PAH level recorded for the County Jail was 622.44 ng/m^3. During this sampling period the wind blew 52% of the time from the direction of the ovens at a speed of 15 km/hr. Similarly, for Frederick St. 201.56 ng/m^3 was recorded when the wind was blowing 100% of the time at a speed of 19 km/hr from the direction of the coke ovens. The almost consistent low results obtained at St. Rita Hospital indicate that it was a good choice for background determinations.

Other sources of PAH at the three locations would be traffic and residential coal, and wood burning stoves. However, these activities probably do not cause elevated levels of PAH as evidenced by the consistently low levels found at the St. Rita Hospital site.

TABLE 7 - PAH results for the three sampling sites, Sydney, Nova Scotia.

Frederick St.		St. Rita Hospital		County Jail	
PAH (ng/m^3)	Wind WSW-SSW Sector*	PAH (ng/m^3)	Wind NE-NNE Sector*	PAH (ng/m^3)	Wind WNW-NE Sector*
0.7	2, 4%	0.1	-	0.36	-
1.08	-	0.12	-	0.75	1, 4%
1.65	-	0.12	-	0.88	-
2.80	-	0.19	-	1.05	6, 16%
2.89	-	0.26	-	1.43	7, 41%
5.51	6, 48%	0.27	5, 4%	1.46	-
6.66	-	0.34	-	1.72	15, 88%
10.75	3, 4%	0.42	-	1.74	8, 13%
13.78	13, 16%	0.42	10, 12%	2.00	-
14.13	7, 34%	0.44	8, 20%	2.01	4, 28%
14.39	11, 34%	0.46	-	2.01	2, 12%
14.97	10, 32%	0.57	18, 2%	2.40	2, 4%
18.40	24, 38%	0.63	8, 14%	2.31	9, 50%
18.86	7, 32%	0.68	-	2.33	-
29.14	10, 30%	0.74	-	2.35	-
32.58	18, 39%	0.77	-	2.52	7, 29%
36.90	12, 84%	1.10	-	3.06	11, 38%
52.83	11, 8%	1.44	13, 2%	3.34	12, 30%
70.99	10, 38%	1.59	12, 16%	3.58	1, 4%
115.74	24, 31%	2.00	-	3.94	10, 24%
138.13	25, 29%	2.16	-	5.23	2, 8%
201.56	19, 100%	2.71	-	6.57	8, 100%
-	-	4.45	4, 1%	7.66	10, 16%
-	-	4.61	16, 38%	8.04	4, 18%
-	-	5.09	21, 38%	8.19	3, 2%
-	-	5.12	21, 25%	8.37	-
-	-	5.63	4, 20%	9.12	13, 33%
-	-	6.61	13, 21%	9.88	8, 33%
-	-	7.14	9, 4%	18.83	5, 45%
-	-	7.49	11, 12%	22.65	16, 59%
-	-	10.33	-	23.44	10, 26%
-	-	11.52	3, 7%	28.28	20, 66%
-	-	11.56	9, 17%	29.79	8, 41%
-	-	23.70	17, 67%	38.14	16, 58%
-	-	-	-	38.63	16, 14%
-	-	-	-	58.54	16, 14%
-	-	-	-	86.96	12, 23%
-	-	-	-	143.12	14, 60%
-	-	-	-	622.44	15, 52%

* Average speed, frequency of occurrence.

7.3 Seasonal Trends of PAH Levels

The data is insufficient to establish seasonal trends. However, it is doubtful that seasonal trends arising from the residential combustion of coal or wood would show at either of the County Jail or the Frederick St. location due to the masking effect of the coke oven's PAH emissions. Further ambient air particulate PAH measurements would be required at the St. Rita Hospital site before trends could be established.

7.4 Health Effects

As previously mentioned, health effects of industrial workers exposed to coke oven emissions have been studied. Unfortunately, there are virtually no studies which have investigated possible health effects of PAH at levels which would normally be experienced from exposure to ambient air PAH. To our knowledge ambient air quality guidelines or regulations for PAH or BaP have not been developed. For this reason no attempt is made to comment on the possible health consequences of the levels of PAH which were measured in the Sydney study. The health effects of long term exposure to PAH levels normally found in the vicinity of certain industries such as coke ovens is one area for further investigation by environmental health specialists.

7.5 Sampling Method

The established method of sampling is by the use of high volume samplers. However PAH obtained by this traditional method is only representative of particulate PAH. A study undertaken in Sydney concurrent to this study determined, based on a limited number of samples, that a large portion of the total PAH may be in the gaseous form[25]. The results of this work are still preliminary, but initial findings do indicate that more work should be undertaken to establish the relationship between gaseous and particulate PAH in the ambient air. This would also suggest that future studies should take into account total ambient air PAH levels based on measurements for both gaseous and particulate forms.

8. CONCLUSIONS

The purpose of this study was to measure ambient air levels of PAH in the Sydney area and to determine the major source or sources of these levels.

In summary, the following conclusions are drawn from this study:

(a) The average PAH levels measured at the three sites were as follows: County Jail - 31.16 ng/m^3, Frederick Street - 36.56 ng/m^3, and St. Rita's Hospital - 3.48 ng/m^3.

(b) The average BaP levels recorded during the study period at the County Jail, Frederick Street and St. Rita's Hospital were 1.74 ng/m^3, 3.74 ng/m^3, and 0.23 ng/m^3, respectively.

(c) Although ambient air quality objectives or standards do not exist for PAH or BaP, it should be noted that the averages of BaP levels measured at the Frederick Street site exceed recorded levels measured in Hamilton, Ontario, which is a heavily industrialized city with coke ovens. The average BaP concentration for the city of Sydney is 1.9 ng/m^3. This average also is higher than the average obtained for cities in the USA with coke ovens. However, it must be noted that direct comparisons are complicated due to the different sampling conditions used in the various studies.

(d) The St. Rita's Hospital site is representative of background levels in Sydney for PAH and BaP since the concentrations compared favourably with other studies in rural and urban areas of North America.

(e) Based on a knowledge of various sources of PAH in the area and on analysis of the PAH data in relation to location and wind direction, it is concluded that the coke oven is the source of elevated levels of PAH at the County Jail and Frederick Street sites.

(f) Seasonal trends for PAH and BaP could not be established due to the limited amount of monitoring data.

(g) The total PAH and BaP concentrations measured represented the particulate form only. Recent work in Sydney indicate that a large portion of PAH type compounds are in the gaseous form. The full implications of this finding require further assessment and evaluation.

(h) During the study period, the coke oven was operating at about 50% of design capacity. It is concluded, therefore, that levels of PAH and BaP measured during the study are probably lower than the actual levels which have existed in the past when the oven was operating at or near capacity.

(i) Finally, the potential health effects of the elevated levels of PAH are beyond the scope of this study. The report will be referred to the appropriate health departments for their consideration.

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APPENDIX 1

Production levels of coke on sampling days.

Date	Coke Produced* (tonne)	Coal Processed** (tonne)	Date	Coke Produced	Coal Processed
16/10/81	1355	-	5/3/82	1397	-
17	1355	-	6	1397	-
18	1355	-	7	1397	-
19	1355	-	8	1386	-
26	1418	-	18	1365	-
27	1344	-	5/5/82	1218	-
28	1355	-	11	1397	-
29	1344	-	17	1397	-
5/11/81	1292	-	23	1428	-
6	1355	-	29	1397	-
7	1355	-	4/6/82	1397	-
8	1355	-	10	1355	-
25	1323	-	16	1355	-
26	1355	-	22	1355	-
27	1302	-	28	1355	-
28	1355	-	4/7/82	1229	-
15/12/81	1176	-	10	1313	-
16	1292	-	16	1397	-
17	1365	-	22	1397	-
18	1355	-	28	1397	-
24/1/82	1229	-	3/8/82	1271	-
25	1313	-	9	977	-
26	1386	-	15	977	-
27	1376	-	21	956	-
3/2/82	1386	-	26	893	-
4	1344	-	2/9/82	819	-
5	1397	-	8	882	-
6	1218	-	14	882	-
			21	851	-

* Data courtesy of Mr. L. Chaisson, Sydney Steel.

** Coal processed = 1.4 coke produced (calculated based on figures given in reference 24).

APPENDIX 2

SYDNEY AMBIENT AIR PAH DATA

Sampling Period: 16/10/81 - 19/10/81

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	6524	6524	
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	24,663	616	-
Pyrene	71,775	1,087	-
Triphenylene	39,169	-	-
Fluoranthene	61,997	1,009	-
Benzo(a)anthracene	79,332	1,160	-
Benzo(ghi)perylene	56,166	1,419	-
Benz(a)pyrene	36,418	653	-
Benzo(e)pyrene	43,158	1,311	-
Chrysene	89,701	1,317	-
Benzo(k)fluoranthene	32,003	782	-
Benzo(b)fluoranthene	45,285	1,249	-
Indeno(1,2,3-cd)pyrene	42,771	912	-
Total PAH	622,437	11,515	-
Total Suspended Particulate on Filter	67 ug/m^3	25 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

S/25 - 26%	N/31 - 23%	NNW/32 - 20%	SSE/15 - 8%
NNE/6 - 7%	SSW/16 - 4%	E/8 - 2%	ENE/11 - 2%
SE/6 - 1%	NW/23 - 1%	WSW/13 - 1%	C/4%

Sampling Period: 26/10/81 - 29/10/81

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	6524	6524	
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	11,810	576	-
Pyrene	16,568	1,094	-
Triphenylene	-	-	-
Fluoranthene	21,827	1,291	-
Benzo(a)anthracene	29,204	2,305	-
Benzo(ghi)perylene	8,795	1,304	-
Benz(a)pyrene	5,943	612	-
Benzo(e)pyrene	13,565	927	-
Chrysene	14,050	1,265	-
Benzo(k)fluoranthene	5,471	656	-
Benzo(b)fluoranthene	8,176	1,029	-
Indeno(1,2,3-cd)pyrene	7,713	501	-
Total PAH	143,122	11,560	-
Total Suspended Particulate on Filter	47 ug/m^3	22 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

N/29 - 30%	NNE/10 - 6%	NE/8 - 11%	ENE/7 - 6%
E/6 - 1%	SE/11 - 1%	SSE/10 - 2%	S/14 - 7%
SSW/15 - 7%	SW/10 - 5%	WSW/9 - 1%	W/8 - 2%
WNW/11 - 6%	NW/5 - 2%	NNW/23 - 5%	C/5%

Sampling Period: 5/11/81 - 8/11/81

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	6524	6524	
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	57	34	-
Pyrene	115	40	-
Triphenylene	-	-	-
Fluoranthene	104	37	-
Benzo(a)anthracene	192	28	-
Benzo(ghi)perylene	336	66	-
Benz(a)pyrene	80	13	-
Benzo(e)pyrene	190	41	-
Chrysene	115	32	-
Benzo(k)fluoranthene	83	21	-
Benzo(b)fluoranthene	193	57	-
Indeno(1,2,3-cd)pyrene	244	48	-
Total PAH	1,738	417	-
Total Suspended Particulate on Filter	11.34 ug/m^3	2.72 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

SE/52 - 3%	SSE/41 - 7%	S/29 - 29%	SSW/24 - 23%
SW/22 - 13%	WSW/9 - 3%	W/22 - 5%	WNW/25 - 10%
NW/25 - 3%	C/1%		

Sampling Period: 25/11/81 - 28/11/81

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	6524	6524	
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	2,960	403	-
Pyrene	5,245	618	-
Triphenylene	4,315	414	-
Fluoranthene	5,469	469	-
Benzo(a)anthracene	13,394	812	-
Benzo(ghi)perylene	3,582	495	-
Benz(a)pyrene	2,469	239	-
Benzo(e)pyrene	3,349	388	-
Chrysene	6,484	570	-
Benzo(k)fluoranthene	2,661	274	-
Benzo(b)fluoranthene	3,685	501	-
Indeno(1,2,3-cd)pyrene	4,925	441	-
Total PAH	58,536	5,625	-
Total Suspended Particulate on Filter	28.3 ug/m^3	18.1 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

N/52 - 18%	NNE/52 - 2%	NE/33 - 18%	ENE/25 - 3%
S/7 - 2%	SSW/7 - 3%	SW/11 - 5%	WSW/12 - 15%
W/18 - 6%	WNW/14 - 6%	NW/28 - 2%	NNW/39-15%
C/5%			

Sampling Period: 15/12/81 - 18/12/81

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	6524	6524	
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	446	230	-
Pyrene	1,091	605	-
Triphenylene	794	420	-
Fluoranthene	1,137	679	-
Benzo(a)anthracene	982	521	-
Benzo(ghi)perylene	725	340	-
Benz(a)pyrene	250	129	-
Benzo(e)pyrene	984	310	-
Chrysene	811	457	-
Benzo(k)fluoranthene	268	159	-
Benzo(b)fluoranthene	572	308	-
Indeno(1,2,3-cd)pyrene	530	291	-
Total PAH	8,190	4,450	-
Total Suspended Particulate on Filter	24 ug/m^3	18 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

N/9 - 1%	NNE/7 - 1%	ENE/7 - 1%	E/4 - 1%
ESE/19 - 4%	SE/26 - 5%	SSE/14 - 6%	S/30 - 13%
SSW/27 - 21%	SW/29 - 9%	WSW/35 - 10%	W/29 - 28%

Sampling Period: 24/1/82 - 27/1/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	6524	6524	
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	8,905	-	-
Pyrene	13,579	-	-
Triphenylene	6,904	-	-
Fluoranthene	16,556	-	-
Benzo(a)anthracene	13,492	-	-
Benzo(ghi)perylene	4,072	-	-
Benz(a)pyrene	3,109	-	-
Benzo(e)pyrene	3,711	-	-
Chrysene	6,842	-	-
Benzo(k)fluoranthene	2,379	-	-
Benzo(b)fluoranthene	3,712	-	-
Indeno(1,2,3-cd)pyrene	3,746	-	-
Total PAH	86,962	-	-
Total Suspended Particulate on Filter	29 ug/m^3	-	-

Wind direction, average speed (km/hr) and frequency of occurrence:

N/17 - 19%	ESE/26 - 2%	SE/32 - 7%	SSE/41 - 4%
S/41 - 3%	SSW/23 - 5%	SW/21 - 23%	WSW/19 - 18%
W/14 - 14%	WNW/11 - 1%	NW/9 - 2%	NNW/37 - 1%
C/1%			

Sampling Period: 3/2/82 - 6/2/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	6524		7829
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	9,250	-	3,626
Pyrene	1,183	-	7,166
Triphenylene	805	-	5,273
Fluoranthene	1,050	-	7,704
Benzo(a)anthracene	1,395	-	28,336
Benzo(ghi)perylene	849	-	9,786
Benz(a)pyrene	294	-	6,205
Benzo(e)pyrene	819	-	9,738
Chrysene	1,160	-	14,815
Benzo(k)fluoranthene	392	-	5,622
Benzo(b)fluoranthene	728	-	8,307
Indeno(1,2,3-cd)pyrene	673	-	6,664
Total PAH	9,883	-	115,737
Total Suspended Particulate on Filter	14 ug/m^3	-	35 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

NE/6 - 1%	ENE/6 - 1%	ESE/14 - 2%	SE/24 - 2%
SSE/22 - 5%	S/17 - 18%	SSW/21 - 8%	SW/26 - 15%
WSW/26 - 4%	W/20 - 12%	WNW/16 - 19%	NW/14 - 5%
NNW/12 - 8%			

Sampling Period: 5/3/82 - 8/3/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	6524	6524	
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	2,379	130	-
Pyrene	3,820	189	-
Triphenylene	1,973	104	-
Fluoranthene	4,214	207	-
Benzo(a)anthracene	7,220	94	-
Benzo(ghi)perylene	3,450	121	-
Benz(a)pyrene	1,990	34	-
Benzo(e)pyrene	3,557	61	-
Chrysene	3,545	126	-
Benzo(k)fluoranthene	1,613	61	-
Benzo(b)fluoranthene	2,790	201	-
Indeno(1,2,3-cd)pyrene	2,278	113	-
Total PAH	38,625	1,440	-
Total Suspended Particulate on Filter	34.4 ug/m^3	7.0 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

N/14 - 2%	NNE/19 - 1%	NE/7 - 1%	ENE/14 - 4%
E/14 - 3%	ESE/18 - 5%	SE/17 - 4%	SSE/22 - 15%
S/25 - 10%	SSW/36 - 15%	SW/21 - 4%	WSW/20 - 4%
W/15 - 17%	WNW/23 - 4%	NW/11 - 5%	NNW/19 - 1%
C/5%			

Sampling Period: 18/3/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	6,515	405	-
Pyrene	7,117	417	-
Triphenylene	3,031	-	-
Fluoranthene	4,663	251	-
Benzo(a)anthracene	3,153	117	-
Benzo(ghi)perylene	1,086	110	-
Benz(a)pyrene	2,086	98	-
Benzo(e)pyrene	2,362	147	-
Chrysene	4,325	184	-
Benzo(k)fluoranthene	896	68	-
Benzo(b)fluoranthene	1,607	227	-
Indeno(1,2,3-cd)pyrene	1,295	135	-
Total PAH	38,135	2,159	-
Total Suspended Particulate on Filter	49.5 ug/m^3	27.1 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

N/17 - 22%	SSW/35 - 4%	SW/22 - 4%	WSW/22 - 12%
W/26 - 22%	WNW/29 - 12%	NW/26 - 12%	NNW/26 - 12%

Sampling Period: 30/3/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	2509	-	-
Pyrene	3939	-	-
Triphenylene	1767	-	-
Fluoranthene	2583	-	-
Benzo(a)anthracene	2350	-	-
Benzo(ghi)perylene	853	-	-
Benz(a)pyrene	1577	-	-
Benzo(e)pyrene	1632	-	-
Chrysene	2638	-	-
Benzo(k)fluoranthene	675	-	-
Benzo(b)fluoranthene	1166	-	-
Indeno(1,2,3-cd)pyrene	963	-	-
Total PAH	22,652	-	-
Total Suspended Particulate on Filter	51.7 ug/m^3	-	-

Wind direction, average speed (km/hr) and frequency of occurrence:

SSW/35 - 4%	SW/22 - 4%	WSW/22 - 12.5%	W/26 - 21%
WNW/29 - 12.5%	NNW/25 - 12.5%	NW/22 - 12.5%	N/17.2 - 21%

Sampling Period: 5/4/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	889	736	-
Pyrene	1288	393	-
Triphenylene	-	-	-
Fluoranthene	558	153	-
Benzo(a)anthracene	901	313	-
Benzo(ghi)perylene	307	68	-
Benz(a)pyrene	895	233	-
Benzo(e)pyrene	1104	215	-
Chrysene	258	74	-
Benzo(k)fluoranthene	614	252	-
Benzo(b)fluoranthene	540	233	-
Indeno(1,2,3-cd)pyrene	307	42	-
Total PAH	7663	2711	-
Total Suspended Particulate on Filter	43.8 ug/m^3	27.0 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

S/13 - 25%	SSW/20 - 13%	SSW/20 - 13%	WSW/24 - 4%
W/14 - 29%	WNW/19 - 8%	NW/19 - 4%	NNW/19 - 4%

Sampling Period: 11/4/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	1012	172	-
Pyrene	1626	337	-
Triphenylene	-	-	-
Fluoranthene	810	147	-
Benzo(a)anthracene	785	209	-
Benzo(ghi)perylene	331	68	-
Benz(a)pyrene	791	227	-
Benzo(e)pyrene	1160	270	-
Chrysene	282	798	-
Benzo(k)fluoranthene	663	258	-
Benzo(b)fluoranthene	540	203	-
Indeno(1,2,3-cd)pyrene	368	33	-
Total PAH	8368	2003	-
Total Suspended Particulate on Filter	57.8 ug/m^3	18.7 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

SSW/13 - 14% SW/18 - 20% WSW/26 - 33% W/31 - 33%

Sampling Period: 17/4/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	209	117	-
Pyrene	405	104	-
Triphenylene	-	-	-
Fluoranthene	203	86	-
Benzo(a)anthracene	301	61	-
Benzo(ghi)perylene	98	36	-
Benz(a)pyrene	257	68	-
Benzo(e)pyrene	227	68	-
Chrysene	92	25	-
Benzo(k)fluoranthene	282	61	-
Benzo(b)fluoranthene	196	52	-
Indeno(1,2,3-cd)pyrene	60	-	-
Total PAH	2330	677	-
Total Suspended Particulate on Filter	44.5 ug/m^3	13.6 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

SSW/24 - 25% SW/26 - 62% WSW/25 - 13%

Sampling Period: 23/4/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	196	-	-
Pyrene	466	252	-
Triphenylene	-	-	-
Fluoranthene	295	62	-
Benzo(a)anthracene	325	172	-
Benzo(ghi)perylene	110	23	-
Benz(a)pyrene	406	117	-
Benzo(e)pyrene	442	203	-
Chrysene	135	31	-
Benzo(k)fluoranthene	350	141	-
Benzo(b)fluoranthene	282	104	-
Indeno(1,2,3-cd)pyrene	80	-	-
Total PAH	3055	1104	-
Total Suspended Particulate on Filter	27.2 ug/m^3	12.6 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

E/14 - 8%	ESE/23 - 8%	SE/22 - 4%	SSW/19 - 25%
WSW/17 - 4%	W/17 - 13%	WNW/16 - 30%	NNW/22 - 4%

Sampling Period: 29/4/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	724	-	-
Pyrene	1245	123	-
Triphenylene	-	-	-
Fluoranthene	969	55	-
Benzo(a)anthracene	730	80	-
Benzo(ghi)perylene	754	34	-
Benz(a)pyrene	773	74	-
Benzo(e)pyrene	823	86	-
Chrysene	325	27	-
Benzo(k)fluoranthene	656	92	-
Benzo(b)fluoranthene	442	56	-
Indeno(1,2,3-cd)pyrene	595	-	-
Total PAH	8043	626	-
Total Suspended Particulate on Filter	14.1 ug/m^3	10.9 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

N/9 - 4% NNE/16 - 14% SE/19 - 4% SSE/34 - 37%
S/28 - 37% C/4%

Sampling Period: 5/5/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	417	387	-
Pyrene	853	859	-
Triphenylene	283	297	-
Fluoranthene	607	626	-
Benzo(a)anthracene	1,006	1,068	-
Benzo(ghi)perylene	442	503	-
Benz(a)pyrene	503	509	-
Benzo(e)pyrene	436	485	-
Chrysene	693	902	-
Benzo(k)fluoranthene	301	331	-
Benzo(b)fluoranthene	650	791	-
Indeno(1,2,3-cd)pyrene	380	386	-
Total PAH	6,571	7,141	-
Total Suspended Particulate on Filter	11.4 ug/m^3	13.6 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

N/14 - 63% NNE/17 - 4% NNW/14 - 33%

Sampling Period: 11/5/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	2363
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	245	270	148
Pyrene	227	742	305
Triphenylene	190	761	309
Fluoranthene	196	307	199
Benzo(a)anthracene	117	239	288
Benzo(ghi)perylene	68	454	72
Benz(a)pyrene	117	239	279
Benzo(e)pyrene	98	515	182
Chrysene	147	681	292
Benzo(k)fluoranthene	68	135	114
Benzo(b)fluoranthene	153	337	381
Indeno(1,2,3-cd)pyrene	92	405	229
Total PAH	1,718	5,085	2,797
Total Suspended Particulate on Filter	14.3 ug/m^3	20.8 ug/m^3	12 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

N/24 - 42% NNE/18 - 8% NE/23 - 30% ENE/23 - 12%
NNW/24 - 8%

Sampling Period: 17/5/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	2,153	209	1,010
Pyrene	3,767	362	1,823
Triphenylene	1,693	-	647
Fluoranthene	3,552	117	180
Benzo(a)anthracene	4,644	117	2,349
Benzo(ghi)perylene	1,417	166	778
Benz(a)pyrene	2,215	45	1,581
Benzo(e)pyrene	1,638	104	818
Chrysene	2,883	104	1,227
Benzo(k)fluoranthene	1,025	61	556
Benzo(b)fluoranthene	1,914	172	1,071
Indeno(1,2,3-cd)pyrene	1,380	129	732
Total PAH	28,282	1,585	14,394
Total Suspended Particulate on Filter	26.4 ug/m^3	10 ug/m^3	10.8 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

N/26 - 12%	NNE/13 - 12%	NE/11 - 4%	SSW/10 - 12%
SW/11 - 18%	WSW/13 - 4%	WNW/13 - 4%	NW/23 - 22%
NNW/35 - 12%			

Sampling Period: 23/5/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630		1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	337	-	1,318
Pyrene	828	-	2,015
Triphenylene	-	-	823
Fluoranthene	301	-	1,530
Benzo(a)anthracene	257	-	1,485
Benzo(ghi)perylene	313	-	934
Benz(a)pyrene	98	-	1,369
Benzo(e)pyrene	337	-	929
Chrysene	362	-	1,258
Benzo(k)fluoranthene	196	-	485
Benzo(b)fluoranthene	601	-	980
Indeno(1,2,3-cd)pyrene	307	-	652
Total PAH	3,939	-	13,778
Total Suspended Particulate on Filter	25.1 ug/m^3	-	47.8 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

N/22 - 4%	ENE/24 - 4%	E/18 - 12%	ESE/14 - 18%
SSE/11 - 4%	S/7 - 4%	SSW/7 - 4%	SW/12 - 8%
WSW/19 - 4%	W/13 - 18%	WNW/18 - 12%	NW/21 - 8%

Sampling Period: 29/5/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	2025
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	423	411	1,121
Pyrene	1,528	1,110	2,627
Triphenylene	-	-	943
Fluoranthene	853	669	2,114
Benzo(a)anthracene	1,135	693	2,296
Benzo(ghi)perylene	552	362	938
Benz(a)pyrene	687	638	2,282
Benzo(e)pyrene	785	522	1,304
Chrysene	1,190	761	1,630
Benzo(k)fluoranthene	466	350	775
Benzo(b)fluoranthene	994	706	1,363
Indeno(1,2,3-cd)pyrene	509	393	1,007
Total PAH	9,123	6,614	18,400
Total Suspended Particulate on Filter	38.3 ug/m^3	51.7 ug/m^3	86.5 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

NNE/14 - 17%	NE/11 - 4%	ENE/19 - 13%	E/11 - 4%
S/14 - 8%	SSW/21 - 17%	SW/23 - 8%	WSW/29 - 13%
W/37 - 4%	WNW/30 - 8%	NW/20 - 4%	

Sampling Period: 4/6/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	362	172	3,748
Pyrene	307	141	9,318
Triphenylene	-	-	3,712
Fluoranthene	258	49	8.929
Benzo(a)anthracene	258	17	10,702
Benzo(ghi)perylene	233	28	3,460
Benz(a)pyrene	153	18	9,106
Benzo(e)pyrene	196	29	4,450
Chrysene	209	29	7,323
Benzo(k)fluoranthene	104	14	2,687
Benzo(b)fluoranthene	264	48	4,864
Indeno(1,2,3-cd)pyrene	178	23	3,192
Total PAH	2,522	567	70,990
Total Suspended Particulate on Filter	21.3 ug/m^3	14.3 ug/m^3	50.8 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

N/11 - 17%	NNE/19 - 4%	NE/17 - 18%	E/17 - 4%
ESE/22 - 4%	S/15 - 8%	SSW/15 - 17%	SW/7 - 4%
WSW/7 - 17%	NW/15 - 4%	NNW/18 - 8%	C/4%

Sampling Period: 10/6/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1941
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	276	1,460	175
Pyrene	448	3,368	257
Triphenylene	-	1,380	-
Fluoranthene	264	2,233	77
Benzo(a)anthracene	221	2,650	56
Benzo(ghi)perylene	203	1,399	61
Benz(a)pyrene	117	1,976	62
Benzo(e)pyrene	160	1,804	77
Chrysene	172	2,497	77
Benzo(k)fluoranthene	92	1,110	36
Benzo(b)fluoranthene	233	2,442	118
Indeno(1,2,3-cd)pyrene	166	1,380	77
Total PAH	2,350	23,699	1,082
Total Suspended Particulate on Filter	38.3 ug/m^3	72.4 ug/m^3	64.7 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

NNE/16 - 20% NE/17 - 47% ENE/19 - 25% E/23 - 8%

Sampling Period: 16/6/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	209	73	2,025
Pyrene	331	86	4,955
Triphenylene	-	-	2,546
Fluoranthene	74	12	3,894
Benzo(a)anthracene	147	-	7,647
Benzo(ghi)perylene	319	23	5,718
Benz(a)pyrene	172	9	7,988
Benzo(e)pyrene	239	17	3,667
Chrysene	135	-	5,768
Benzo(k)fluoranthene	141	8	2,318
Benzo(b)fluoranthene	307	22	4,349
Indeno(1,2,3-cd)pyrene	239	15	3,369
Total PAH	2,313	266	52,828
Total Suspended Particulate on Filter	12.0 ug/m^3	28.4 ug/m^3	15.4 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

N/9 - 14%	NNE/9 - 4%	ESE/15 - 4%	SE/22 - 4%
SSE/13 - 8%	S/19 - 23%	SSW/17 - 4%	SW/15 - 4%
WNW/11 - 17%	NW/12 - 14%	NNW/15 - 4%	

Sampling Period: 22/6/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	172	34	299
Pyrene	196	40	624
Triphenylene	172	-	439
Fluoranthene	166	19	424
Benzo(a)anthracene	209	-	529
Benzo(ghi)perylene	147	33	369
Benz(a)pyrene	135	10	499
Benzo(e)pyrene	153	9	524
Chrysene	172	-	519
Benzo(k)fluoranthene	92	7	275
Benzo(b)fluoranthene	245	18	639
Indeno(1,2,3-cd)pyrene	141	17	369
Total PAH	2,000	188	5,509
Total Suspended Particulate on Filter	22.6 ug/m^3	14.2 ug/m^3	32.1 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

SE/26 - 4% SSE/15 - 8% S/15 - 38% SSW/9 - 30%
SW/9 - 18% C/4%

Sampling Period: 28/6/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	288	80	-
Pyrene	466	68	-
Triphenylene	325	-	-
Fluoranthene	368	37	-
Benzo(a)anthracene	233	-	-
Benzo(ghi)perylene	344	38	-
Benz(a)pyrene	239	19	-
Benzo(e)pyrene	313	28	-
Chrysene	258	-	-
Benzo(k)fluoranthene	141	14	-
Benzo(b)fluoranthene	368	37	-
Indeno(1,2,3-cd)pyrene	239	18	-
Total PAH	3,582	338	-
Total Suspended Particulate on Filter	27.4 ug/m^3	6.9 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

E/17 - 8%	SE/23 - 8%	S/17 - 26%	SSW/16 - 8%
SW/24 - 4%	WSW/7 - 8%	NW/7 - 4%	C/34%

Sampling Period: 4/7/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	196	61	721
Pyrene	319	68	1,777
Triphenylene	258	27	1,092
Fluoranthene	166	55	1,376
Benzo(a)anthracene	92	35	1,716
Benzo(ghi)perylene	92	31	989
Benz(a)pyrene	110	21	1,973
Benzo(e)pyrene	141	26	1,216
Chrysene	203	29	1,118
Benzo(k)fluoranthene	68	17	680
Benzo(b)fluoranthene	270	45	1,499
Indeno(1,2,3-cd)pyrene	92	25	814
Total PAH	2,006	441	14,972
Total Suspended Particulate on Filter	8.6 ug/m^3	13.3 ug/m^3	45.2 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

NE/16 - 20%	E/9 - 8%	ESE/17 - 4%	SW/15 - 18%
WSW/15 - 14%	W/16 - 20%	NW/6 - 8%	C/8%

Sampling Period: 10/7/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1561
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	104	128	2,056
Pyrene	123	92	3,318
Triphenylene	135	-	2,079
Fluoranthene	68	20	3,011
Benzo(a)anthracene	42	15	5,067
Benzo(ghi)perylene	86	22	1,552
Benz(a)pyrene	58	20	3,075
Benzo(e)pyrene	92	23	2,172
Chrysene	98	23	2,569
Benzo(k)fluoranthene	39	128	1,044
Benzo(b)fluoranthene	153	45	1,794
Indeno(1,2,3-cd)pyrene	50	18	1,249
Total PAH	1,049	420	29,142
Total Suspended Particulate on Filter	24.7 ug/m^3	22.8 ug/m^3	52.8 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

NNE/6 - 4%	NE/13 - 8%	ENE/19 - 14%	E/14 - 16%
SE/5 - 8%	SW/16 - 16%	WSW/15 - 14%	W/13 - 16%
NW/15 - 4%			

Sampling Period: 16/7/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1941
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	1,834	104	2,004
Pyrene	3,491	68	3,612
Triphenylene	2,362	-	2,329
Fluoranthene	2,742	11	3,406
Benzo(a)anthracene	3,933	11	4,786
Benzo(ghi)perylene	1,761	18	1,968
Benz(a)pyrene	2,718	11	4,034
Benzo(e)pyrene	2,399	10	2,488
Chrysene	3,215	-	2,859
Benzo(k)fluoranthene	1,350	6	1,345
Benzo(b)fluoranthene	2,736	14	2,092
Indeno(1,2,3-cd)pyrene	1,245	9	1,645
Total PAH	29,785	263	32,576
Total Suspended Particulate on Filter	25.6 ug/m^3	10.1 ug/m^3	39.3 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

N/14 - 13%	S/12 - 20%	SSW/15 - 18%	SW/18 - 13%
WSW/21 - 8%	WNW/12 - 8%	NW/20 - 20%	

Sampling Period: 22/7/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1941
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	117	34	283
Pyrene	80	29	953
Triphenylene	-	-	556
Fluoranthene	35	15	273
Benzo(a)anthracene	129	9	464
Benzo(ghi)perylene	129	10	1,108
Benz(a)pyrene	39	7	562
Benzo(e)pyrene	61	-	1,638
Chrysene	55	-	1,777
Benzo(k)fluoranthene	25	5	696
Benzo(b)fluoranthene	61	10	1,772
Indeno(1,2,3-cd)pyrene	68	-	665
Total PAH	749	121	10,749
Total Suspended Particulate on Filter	24.7 ug/m^3	8.1 ug/m^3	32.1 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

N/6 - 4% SE/6 - 8% SSE/19 - 33% S/17 - 33%
SSW/9 - 4% C/18%

Sampling Period: 28/7/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1941
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	117	282	72
Pyrene	233	693	93
Triphenylene	-	-	-
Fluoranthene	127	503	67
Benzo(a)anthracene	98	417	42
Benzo(ghi)perylene	276	564	77
Benz(a)pyrene	129	503	49
Benzo(e)pyrene	222	767	72
Chrysene	245	2,227	52
Benzo(k)fluoranthene	98	282	31
Benzo(b)fluoranthene	245	718	72
Indeno(1,2,3-cd)pyrene	209	528	67
Total PAH	2,006	7,485	694
Total Suspended Particulate on Filter	26 ug/m^3	20 ug/m^3	89.7 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

N/6 - 8%	NNE/6 - 4%	NE/16 - 8%	ENE/15 - 4%
ESE/17 - 8%	SE/11 - 4%	SSE/27 - 26%	S/17 - 4%
SW/7 - 4%	NNW/4 - 4%		

Sampling Period: 3/8/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	80	-	71
Pyrene	221	68	162
Triphenylene	-	-	162
Fluoranthene	110	35	75
Benzo(a)anthracene	104	45	81
Benzo(ghi)perylene	466	128	121
Benz(a)pyrene	110	68	217
Benzo(e)pyrene	350	98	248
Chrysene	288	42	49
Benzo(k)fluoranthene	110	48	86
Benzo(b)fluoranthene	319	129	253
Indeno(1,2,3-cd)pyrene	239	104	126
Total PAH	2,399	766	1,650
Total Suspended Particulate on Filter	17.4 ug/m^3	9.8 ug/m^3	36.3 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

ESE/7 - 4%	SE/10 - 20%	SSE/11 - 20%	S/7 - 4%
NW/9 - 4%	C/48%		

Sampling Period: 9/8/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	245	129	-
Pyrene	491	117	-
Triphenylene	387	74	-
Fluoranthene	215	50	-
Benzo(a)anthracene	288	43	-
Benzo(ghi)perylene	509	80	-
Benz(a)pyrene	356	54	-
Benzo(e)pyrene	663	98	-
Chrysene	503	86	-
Benzo(k)fluoranthene	356	42	-
Benzo(b)fluoranthene	767	117	-
Indeno(1,2,3-cd)pyrene	454	68	-
Total PAH	5,233	955	-
Total Suspended Particulate on Filter	22.9 ug/m^3	13.6 ug/m^3	-

Wind direction, average speed (km/hr) and frequency of occurrence:

N/6 - 4%	NE/7 - 4%	E/9 - 8%	ESE/13 - 4%
SSE/15 - 4%	S/14 - 14%	SSW/17 - 33%	SW/6 - 4%
W/7 - 4%	C/20%		

Sampling Period: 15/8/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	56	33	2,833
Pyrene	42	23	5,439
Triphenylene	-	-	-
Fluoranthene	27	12	4,258
Benzo(a)anthracene	9	9	5,465
Benzo(ghi)perylene	80	-	2,763
Benz(a)pyrene	17	6	4,303
Benzo(e)pyrene	35	-	2,889
Chrysene	16	-	2,929
Benzo(k)fluoranthene	9	2	1,556
Benzo(b)fluoranthene	29	9	2,606
Indeno(1,2,3-cd)pyrene	34	-	1,859
Total PAH	355	93	36,899
Total Suspended Particulate on Filter	21.2 ug/m^3	20.9 ug/m^3	37.2 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

S/18 - 16% SSW/21 - 38% SW/16 - 46%

Sampling Period: 21/8/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	497	80	904
Pyrene	2,141	53	2,192
Triphenylene	-	-	-
Fluoranthene	1,926	42	2,066
Benzo(a)anthracene	2,652	17	2,530
Benzo(ghi)perylene	1,626	68	1,434
Benz(a)pyrene	1,730	14	2,152
Benzo(e)pyrene	1,933	41	1,737
Chrysene	2,374	31	2,293
Benzo(k)fluoranthene	976	16	879
Benzo(b)fluoranthene	1,693	56	1,540
Indeno(1,2,3-cd)pyrene	1,282	47	1,131
Total PAH	18,834	464	18,859
Total Suspended Particulate on Filter	28.3 ug/m^3	18.0 ug/m^3	47.2 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

SSW/12 - 20%	SW/10 - 12%	WSW/7 - 4%	W/22 - 15%
WNW/16 - 20%	NW/12 - 25%	C/4%	

Sampling Period: 26/8/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	1,969	1,380	5,056
Pyrene	2,963	1,497	9,030
Triphenylene	-	209	6,131
Fluoranthene	2,522	1,460	6,891
Benzo(a)anthracene	1,595	1,080	17,581
Benzo(ghi)perylene	1,779	656	9,126
Benz(a)pyrene	1,736	828	14,177
Benzo(e)pyrene	2,423	798	16,288
Chrysene	3,301	865	21,227
Benzo(k)fluoranthene	1,074	344	7,429
Benzo(b)fluoranthene	2,546	908	17,389
Indeno(1,2,3-cd)pyrene	1,534	601	7,798
Total PAH	23,442	10,626	138,126
Total Suspended Particulate on Filter	29.6 ug/m^3	22.4 ug/m^3	42.5 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

ENE/15 - 4%	E/14 - 21%	ESE/13 - 8%	SSE/7 - 4%
SSW/23 - 8%	SW/33 - 13%	WSW/20 - 8%	W/17 - 8%
WNW/29 - 13%	NW/32 - 13%		

Sampling Period: 2/9/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1980
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	80	80	748
Pyrene	80	86	1,601
Triphenylene	-	-	712
Fluoranthene	61	135	1,424
Benzo(a)anthracene	36	61	1,944
Benzo(ghi)perylene	117	53	1,389
Benz(a)pyrene	45	34	1,596
Benzo(e)pyrene	123	74	1,561
Chrysene	-	68	1,783
Benzo(k)fluoranthene	36	28	732
Benzo(b)fluoranthene	166	80	1,520
Indeno(1,2,3-cd)pyrene	92	42	1,046
Total PAH	834	738	14,113
Total Suspended Particulate on Filter	17.0 ug/m^3	9.3 ug/m^3	20.9 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

E/8 - 12% ESE/19 - 25% SE/11 - 4% S/17 - 4%
SSW/21 - 34% C/25%

Sampling Period: 8/9/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1978
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	135	233	147
Pyrene	190	515	207
Triphenylene	110	184	248
Fluoranthene	123	484	157
Benzo(a)anthracene	325	479	167
Benzo(ghi)perylene	509	534	298
Benz(a)pyrene	331	429	217
Benzo(e)pyrene	399	515	420
Chrysene	448	472	379
Benzo(k)fluoranthene	135	251	106
Benzo(b)fluoranthene	313	546	324
Indeno(1,2,3-cd)pyrene	319	409	217
Total PAH	3,337	5,123	2,887
Total Suspended Particulate on Filter	22.5 ug/m^3	19 ug/m^3	33.7 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

N/28 - 5%	NNE/26 - 5%	NE/16 - 20%	ENE/14 - 8%
E/14 - 8%	ESE/12 - 20%	SE/14 - 16%	SSE/11 - 5%
S/9 - 5%	SSW/5 - 8%		

Sampling Period: 14/9/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1938
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	58	43	11,388
Pyrene	80	32	22,967
Triphenylene	-	-	13,317
Fluoranthene	60	16	22,981
Benzo(a)anthracene	227	9	32,451
Benzo(ghi)perylene	214	-	15,578
Benz(a)pyrene	166	-	21,135
Benzo(e)pyrene	166	7	16,899
Chrysene	147	-	16,434
Benzo(k)fluoranthene	74	4	7,745
Benzo(b)fluoranthene	141	7	12,054
Indeno(1,2,3-cd)pyrene	123	-	8,658
Total PAH	1,455	119	201,558
Total Suspended Particulate on Filter	27.4 ug/m^3	48.5 ug/m^3	97.0 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

SSW/14 - 13% SW/19 - 67% WSW/25 - 20%

Sampling Period: 21/9/82

Site:	County Jail	St. Rita Hospital	Frederick Street
Sample Volume (m^3):	1630	1630	1976
PAH Compounds	Concentration (ng/1000 m^3)		
Phenanthrene	74	368	278
Pyrene	58	313	668
Triphenylene	-	-	-
Fluoranthene	36	288	638
Benzo(a)anthracene	80	472	617
Benzo(ghi)perylene	184	558	597
Benz(a)pyrene	42	319	531
Benzo(e)pyrene	80	552	678
Chrysene	374	497	1,316
Benzo(k)fluoranthene	74	245	283
Benzo(b)fluoranthene	196	515	597
Indeno(1,2,3-cd)pyrene	129	478	476
Total PAH	1,430	4,607	6,660
Total Suspended Particulate on Filter	777 ug/m^3	14.9 ug/m^3	17.2 ug/m^3

Wind direction, average speed (km/hr) and frequency of occurrence:

N/11 - 3%	NNE/15 - 26%	NE/16 - 12%	ENE/11 - 8%
E/13 - 12%	ESE/17 - 8%	C/23%	