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An Investigative Study of Potential Public Health Hazards at Ohio River Park

Prepared for
Allegheny County Health Department
3333 Forbes Avenue
Pittsburgh, Pennsylvania 15213

Prepared by
Fred C. Hart Associates
527 Madison Avenue
New York, New York 10022
212-371-1140

July 23, 1979

Allegheny County Health Department

[illegible]

N. Mark Richards, M.D.
director

3333 FORBES AVENUE
PITTSBURGH, PENNSYLVANIA 15213
PHONE: (412)
578-8030

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Ohio River Park
PA-170

July 24, 1979

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JUL 30 1979

Miss Barbara Faust
Program Integration Division
Office of Toxic Substances
Environmental Protection Agency - TS-793
401 M Street, Waterside Mall
Washington, D. C. 20460

RE: OHIO RIVER PARK
ALLEGHENY COUNTY, PA.

Dear Miss Faust:

We now have in our possession Fred C. Hart's report entitled, "An Investigative Study of Potential Public Health Hazards at Ohio River Park". This Department is presently in the process of an in-house review of this document.

It is our understanding from your communication of July 9, 1979, to me from Walter W. Kovalick, Jr., Director of Program Integration Division, that the Office of Toxic Substances would be available to review the methodology used and to assist in the interpretation of the data found in the consultant's report. I am, therefore, enclosing with this letter, per your request, four copies of Fred C. Hart Associates report for your dissemination to the appropriate individuals within the Office of Toxic Substances. Also, per your request, a list of the specific chemicals identified at the park can be found in Appendix B of this report.

We would appreciate as rapid a turn around time of your review as possible because of the importance of this matter. If you require any additional information or further clarification of any of the subject matter found in the report, please feel free to contact me or Paul Spence at 412-578-8030.

We look forward to hearing from you concerning this matter.

Sincerely,

Albert H Brunwasser

Albert H. Brunwasser, Deputy Director
for Environmental Health Services

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Enclosures

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AN INVESTIGATIVE STUDY OF POTENTIAL PUBLIC HEALTH HAZARDS AT OHIO RIVER PARK

Prepared for:
ALLEGHENY COUNTY HEALTH DEPARTMENT
3333 Forbes Avenue
Pittsburgh, Pennsylvania 15213

Prepared by:
FRED C. HART ASSOCIATES, INC.
527 Madison Avenue
New York, New York 10022

July 23, 1979

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NOTE: Figures 2 - 6 have been inserted in the pocket attached to the report.

LIST OF PLATES

I. EXECUTIVE SUMMARY

During the development of the Neville Island site, various industrial and municipal wastes were encountered at and near the ground surface. The suggestion that pesticides and other toxic chemicals may have been buried at the site, as well as reports of fumes emanating from certain areas of the park were among the factors that prompted this study to assess whether or not a public health threat exists at the site. The files of the County Health Department, an earlier report by Richardson, Gordon and Associates, and records of the Navarro Corporation (park construction manager) and others provided substantial information with regard to the general types of wastes present and their location.

The investigation by Fred C. Hart Associates (FCHA), involved (1) gathering and interpreting background information; (2) mapping of surface wastes by visual inspection and delineating the likely locations of buried (near-surface) wastes by application of resistivity and metal detection survey techniques; (3) sampling and analysis of solid, liquid and gaseous wastes from the surface and near-surface; and (4) assessing the toxicological aspects of the wastes sampled and identifying possible exposure mechanisms. The NUS Corporation, Cyrus Wm. Rice Division provided laboratory services and conducted the analyses of samples collected by the FCHA field team.

The major waste types found on-site included pigments, coal tar residues, crystalline solids, liquid organics, sludges and leachate. Numerous toxic chemicals were detected in the samples submitted for analysis. A number of these chemicals exceeded various existing standards of concentration for the media in which they were detected. Six substances were selected for detailed toxicological assessment: benzene, phenols, parathion, cyanide, mercury, and coal tar residues. These and other substances present at the park can create a variety of adverse human health effects depending upon exposure factors, concentration, and sensitivity of the exposed individual. Health effects range from skin and eye irritation to systemic problems. Also, carcinogenic, mutagenic, and teratogenic chemicals were found at the site. Children and women of childbearing age are generally the most susceptible to the effects of toxic chemicals.

Several scenarios were developed to describe possible ways in which park visitors may be exposed to the more dangerous chemicals on-site. Although these hypothetical situations cannot be considered the most likely series of events, there is every possibility that they could occur and they were developed for this analysis in order to fully address the health hazard issue.

It was concluded that there are a number of undesirable aspects to the Neville Island Park site in its present condition. These range from relatively minor problems such as disrepair of structures and prevalent poison ivy to the more major problem of fire and explosion hazard. The most significant concern, however, is the presence of toxic chemicals in solid, liquid and gaseous form at or near the surface of the site.

Considering the chemicals present at the park site, their observed prevalence, measured concentrations, toxicological and synergistic properties and the possible exposure mechanisms of park visitors to those chemicals, users of the park could experience adverse health effects. The type and severity of adverse effects and the time at which such effects may occur are, of course, unpredictable. However, the site present state of the site facilitates the exposure of park visitors to a wide variety of harmful chemicals via inhalation, skin contact, or even ingestion, therefore a public health threat does exist at the site.

II. INTRODUCTION AND BACKGROUND

A. Introduction

The objective of this study is to provide an assessment of the Ohio River Park on Neville Island in order to determine the nature and toxicological implications of the wastes which are present at or near the surface of the park. The investigation concentrated on the potential health hazards which could result from human exposure to toxic materials within the park environment.

In 1976, the Hillman Company donated the twenty-five acre site at the western tip of Neville Island to Allegheny County. During the development of the Neville Island Park site various industrial and domestic wastes were encountered at and near the ground surface. The County Health Department was asked to analyze fumes emanating from certain areas of the park during the summer of 1978. The Air Pollution Bureau found that little reliable information on the types and quantities of chemical wastes deposited at the site was available. A consultant's report commissioned by the county to address these issues and to assess potential health implications proved inconclusive; therefore, the current study was undertaken.

B. Setting

Neville Island is located in the Ohio River five miles from the Golden Triangle of Pittsburgh* (see Figure 1). The island is approximately six and one half miles long and three-quarters of a mile wide at its widest part. The total land area is 868 acres. To the north of the island is the deep, heavily utilized main channel of the Ohio River, and to the south a mud-banked untraveled back channel. Neville Island is connected to the mainland along the back channel by bridges leading to McKees Rock and Coraopolis.

Prior to World War I, there were nine industrial companies located on Neville Island. By the Second World War, there were twenty-two industries, employing one-half of the island's population. In the early 1950's, the dominant industries were chemical and steel fabricating plants. The two chemical plants were operated by Pittsburgh Coke and Chemical which, with several affiliates, produced coke, pig iron, cement and agricultural chemicals; and, The Neville Company which manufactured synthetic resins and solvents as well as chemicals. The products manufactured by other companies were extremely varied, ranging from gasoline and kerosene produced at Gulf Oil's refinery to tin and scrap reclaimed by Vulcan Detinning.

The area west of the Coraopolis bridge was owned by Pittsburgh Coke and Chemical. It was an undeveloped area in close proximity to numerous industrial plants. Four acres of the site were reportedly used as a municipal

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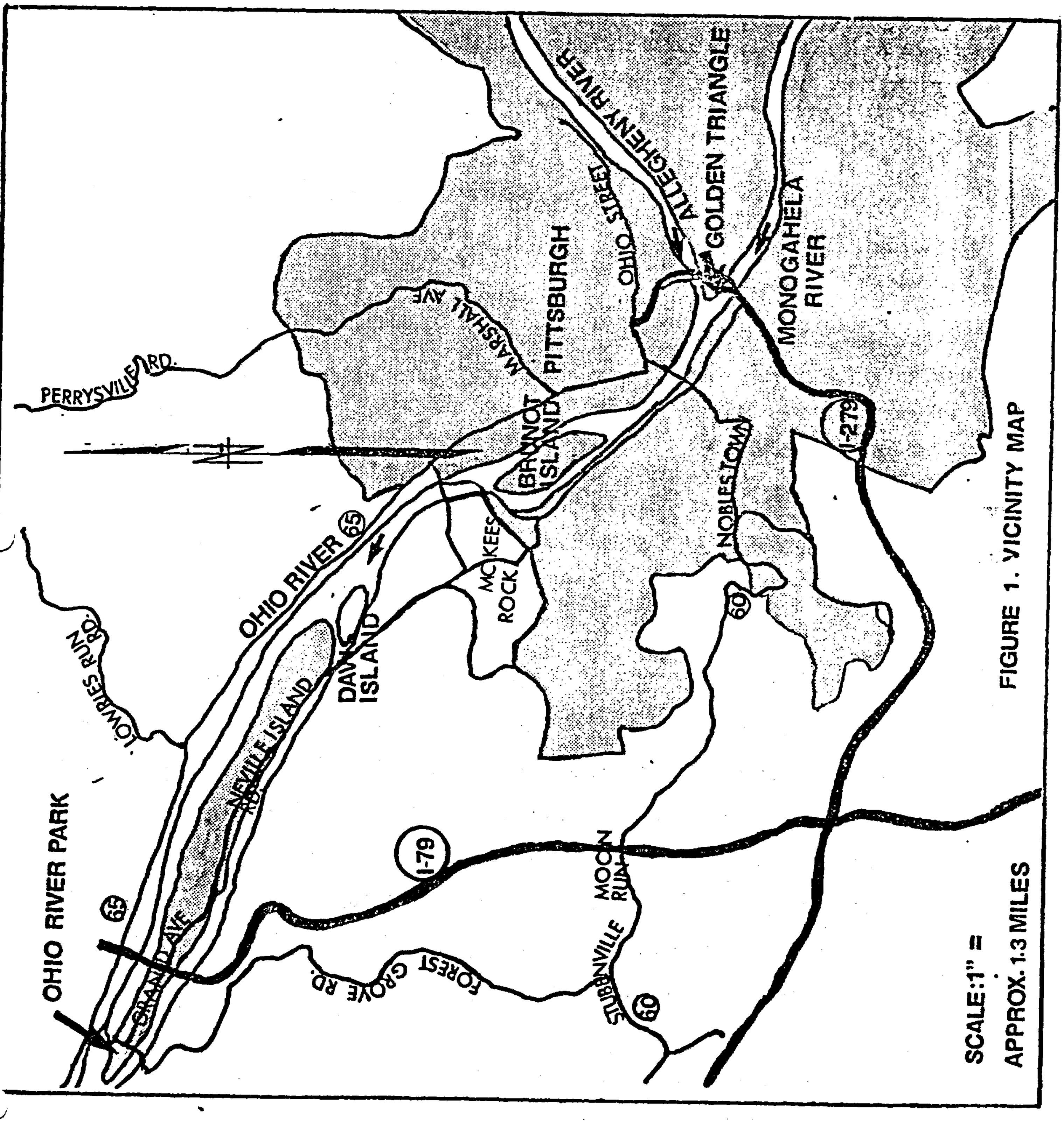
* The major portion of the historical material was derived from The Geographic Factors in the Economic Transition of a River Island in the Pittsburgh Industrial Area, by Edith Irene Jones, University of Pittsburgh, Masters Thesis, 1950.



SCALE:1" =
APPROX. 1.3 MILES

FIGURE 1. VICINITY MAP

garbage dump from 1935 to 1945. In the early 1950's, large quantities of miscellaneous industrial wastes were also deposited extensively in the area now known as Neville Island Park. A retaining wall appears to have been constructed along the western end of the island suggesting that this area may have been filled with a variety of industrial waste. It has also been reported that foundry sand, slag, brick, sawdust and fill are located throughout the site.

It is not clear exactly which companies, both on and off the island, used the Pittsburgh Coke and Chemical property as a waste disposal site. Many of the island industries were able to release effluent directly into the Ohio River or into the sanitary sewer system. Due to the nature of their product, the two chemical companies on the island had the most difficult problems with waste disposal.

Immediately after World War II, in addition to coke and pig iron production, Pittsburgh Coke and Chemical manufactured pesticides, herbicides, and pigments for paint and dye-stuff. From these operations, it is reasonable to assume that the manufacture of coal tar distillate byproducts resulted in the generation of waste still bottoms. It has also been reported that off-specification (off-spec) parathion was probably disposed of at the site during the early 1950's. Finally, Pittsburgh Coke and Chemical had several large settling basins from which silted sludges were recovered. Although some material was recyclable, many wastes were ultimately disposed.

The Neville Company was faced with waste disposal problems similar to those of Pittsburgh Coke and Chemical. Apparently they had a lagoon on their property to temporarily store wastes. In June, 1950, it was reported that the Neville Company disposed twenty-five pounds of phenols per day into the Ohio River. It is possible that some of this material was also disposed of at the site.

C. Geology

Neville Island was formed on an alluvial deposit consisting of layered sands, silts and clays. The deeper buried valley deposits under the Island consist mostly of sands. The high permeability and ready rechargeability from the Ohio River has made those buried valley deposits a valuable source of groundwater to residents of Neville Island, Coraopolis and vicinity. More recently, this plentiful supply of groundwater has been contaminated by organic chemicals infiltrating down from the surface. The background water quality is discussed in Section D.

D. Water Quality

The shallow sand and gravel aquifer beneath Neville Island is one of the most heavily used aquifers (in excess of 13 MGD) of the Pittsburgh area. Water from the more than thirty wells on the island is used for municipal supply and by industry for processing and cooling. The heavy use of the aquifer is the result of its high yield properties (up to 3000 gpm to wells) and its free connection to the Ohio River. In fact, the high sustained yields that have occurred over the years at Neville Island would not have been possible without considerable induced infiltration from the Ohio River. Induced infiltration is so great that water pumped from wells is chemically indistinguishable from water in the Ohio River.

The overall contamination of the aquifer by poor quality river water has been locally obscured by contaminants from industrial waste lagoons, possible leakage from severely corroded or removed oil and gas well casings, and chemical waste residues in landfills. These pollutants have been slowly leaching downward from the land surface over the years, and therefore, after the contaminating source is removed, it may take many years for the aquifer to cleanse itself through the natural flushing action of groundwater.

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III. SUMMARY OF PREVIOUS INVESTIGATIONS

A. Soils Report

In June 1977, a Soil Reconnaissance Report was prepared for Allegheny County by Richardson, Gordon and Associates (RGA), soil engineering consultants. This report included preliminary comments based on field observations and interviews with local individuals to obtain information relevant to the park development. A subsurface soil investigation was conducted during September 1977 by RGA. This study was performed primarily to provide information regarding areas in which the contractor might encounter construction difficulties (under buildings, roads, parking areas, utility lines, and waste areas) and to locate and protect an existing 18" oil pipeline owned by Laurel Pipeline Company. The topographic map (see Figure 2) shows the location of fifty (50) test pits used for general soil analyses and nineteen (19) test pits used to locate the Laurel pipeline. Thirty-seven soil samples were tested for conventional engineering properties such as Atterberg Limits, grain size distribution, specific gravity, and natural moisture content. Nine (9) samples of waste material or waste contaminated soils were sent to NUS Corporation Laboratories to evaluate other properties. NUS conducted pH measurements, elemental x-ray spectrography (silica, iron, calcium, magnesium, phosphorus, sulfur, copper, and aluminum), and tested to determine the percentage of organic matter.

The subsurface investigation contains many findings important to the determination of the nature and extent of past waste disposal at the park site. Only five of the 50 test pits indicated the presence of natural surface top soil; all of the other 45 test pits contained various amounts of waste material. Noticeable odors were detected and reported at six of the test pits.

While the backhoe used to dig the test pits was capable of extending to a depth of at least 15 feet, significant resistance due to hard layers was encountered at a number of sites. At five locations, operations had to be curtailed at depths less than 6.5 feet. In a few pits, trapped water was found above impervious layers. In some areas it was found that the waste material disposed at the site extended to depths in excess of 10 feet. Half of the test pits appeared to contain less than 5.0 feet of waste material, while the rest contained 5.0 feet or more of waste.

The excavated materials were described as industrial waste, slag, tar, cinders, cement, tiles, soaked wood chips, foundry sand, sawdust, bricks, coal, white chalk-like and white paste-like material, and sanitary waste. Drummed wastes were not mentioned in these reports. The natural soil is composed of approximately equal portions of sand, silt, and clay.

Four test pits (TP-3, TP-14, TP-43 and TP-46) which contained different types of industrial waste material were discussed by Richardson, Gordon and Associates in their report. Copies of selected test pit logs and the chemical analyses, available for some of the samples, are presented in Appendix A. Descriptions noted by RGA of the material in four of these test pits follow:

TP-3

> "The remainder of the meadow area and portions of the wooded area are underlain by pockets of industrial waste. While this material varied widely, it generally contains a tar-like substance. The tar substance generally occurred in thin (several inch) layers in a bed of soil that has been contaminated or mixed with the tar. Test pit TP-3 (Sta. 80 + 40, 130' Rt.) has a four foot thick layer of tar at the ground surface."

TP-14

> "There is a four foot layer of industrial waste at the surface in TP-14 (Sta. 46 + 50, 40' Rt.). This waste stretches for 100 feet along the shore and extends from the top of slope two-thirds of the way to the river. The waste is a bluish-green substance that has been soaked into sawdust and wood chips."

TP-43

> "Test Pit TP-43 (Sta. 82 + 50, 140' Lt.) encountered a ten foot deposit which was a mixture of tar and white paste-like substance that is probably calcium carbonate. The material was soft and squeezed into the pit causing considerable difficulty in reaching the required depth."

TP-46

> "Some of the industrial material has apparently been transported by ground water to other portions of the site not otherwise contaminated. The best example of this is TP-46 (Sta. 79 + 00, 115' Lt.). A six-inch layer of odorous black sand was found at a depth of eleven feet, seven feet below what appears to be the top of natural ground. All of the industrial waste has an odor and this odor also shows up in pits that do not contain industrial waste, again indicating apparent migration of contaminents through the ground water system."

At the time that this testing was performed, the chemical nature and possible toxicological character of the wastes were not explored. General knowledge of, and information available on toxic substances was much less substantial than it is today. Later sections of this report provide a more in-depth characterization of the waste types discussed above.

B. Site Construction

The development of the Ohio River Park was supervised by Navarro Corporation which served as the construction manager. The major work activities included: clearing and grubbing; the installation of utilities (sanitary and storm sewer systems, water lines, and electrical conduits); grading, excavating and backfilling waste materials incapable of supporting loads; constructing parking lots, access and loop roads; fencing; laying wood chip paths; erecting shelters, picnic decks, toilets, and the administration building; and landscaping. The superintendent's daily job reports, furnished by Navarro during a meeting with Fred C. Hart Associates on June 20, 1979, indicate that initial clearing and grubbing occurred from August to October 1977. Work was resumed in March 1978 with all phases of construction completed in early 1979.

As a result of the poor structural properties of the waste material, many of the areas proved unable to support the road bed, lightweight structures, or parking lots. To overcome this difficulty, many of the facilities were relocated. Several parking bays and the proposed nature center were subsequently deleted from the original plan. The loop road and the parking lot could not be relocated to avoid the waste material. Large quantities of the underlying undesirable waste material (tar pits and chemical areas) were excavated and buried at other locations. Drums of waste materials were encountered during these operations. The undercut (excavated) areas and the waste burial pits, used in preparing for the loop road and the parking lot, are shown on Figure 3 with the estimated quantities of material handled. Over 12,500 cubic yards of material were undercut and backfilled. Plates 1 and 2 show conditions at the park site during construction. Slag material was hauled to the site in order to fill the excavated areas and serve as a subbase.

Two entries in the superintendent's daily job report dated April 12, 1978, indicated liquids present near the ground surface:

> "In all areas excavated today for waste pit odoriferous liquids, tar, and excessive amounts of trapped water were encountered after only 1' - 2' of excavation"; and,
>
> "petroleum residues coming out of the ground".

Recent discussions with representatives of Navarro Corporation, and the County Health Department provided additional information concerning the wastes encountered during construction:

1. Barrels were encountered throughout the major undercut areas. Several of the barrels were still filled with liquid wastes. These barrels were drained, crushed, and disposed in a burial pit.
2. Some of the waste material encountered in undercut areas were in a semi-liquid state. This material was spread over the surface, and subsequently dried and solidified as the volatiles quickly evaporated.
3. Several construction workers left the job site. Apparently odors emanating from the site caused concern for their personal health.

Plates 1 and 2 show conditions at the Ohio River Park site during construction. Photographs were supplied by Navarro Corporation.

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IV. FRED C. HART ASSOCIATES STUDY

A. Scope of Investigations

Information from the various sources discussed above provided a description of the park background and problem. A visual inspection of the site confirmed the existence of a wide variety of wastes exposed at the surface. There was evidence of soil staining and subsidence as well as vegetative stress which strongly suggested the presence of buried waste.

In order to assess the extent of the problem, the following approach was taken. First, an investigation of the types and quantities of wastes that were possibly disposed on-site was conducted. Information was obtained from the preliminary review conducted by Richardson, Gordon and Associates, from a report on the history of Neville Island, and from speaking with former Pittsburgh Coke and Chemical employees.

Second, an investigation of the location of subsurface wastes was undertaken. Careful visual inspection of the site enabled the mapping of surface wastes. It was also necessary to delineate the location of subsurface and especially near surface wastes. This was accomplished by reviewing maps and files provided by the soils analyses of Richardson, Gordon and Associates and Navarro Corporation. These provided information on known or reported waste locations. This information was supplemented by the use of resistivity and metal detection instrumentation. The results of this field testing were used to decide upon exact sampling locations.

Third, sample collection and analysis was implemented at fifteen site locations. Each sample was analyzed for a variety of chemical constituents in order to determine the range of possible toxic substances present. The concentrations obtained provided a baseline indication of the magnitude of the problem. Finally, a toxicological assessment was undertaken to examine possible human exposure mechanisms and effects. The potential effects of key pollutants are evaluated using standard toxicological parameters. In addition, several scenarios are presented which discuss hypothetical exposure situations.

B. Field Surveys

1. Electrical Resistivity. Electrical resistivity is one indirect geophysical technique for shallow subsurface exploration using electrical measurements taken at the ground surface. The Wenner profiling method utilizes four electrodes (copper coated steel rods), pushed or hammered 4 to 6 inches into the ground. The electrodes are located along a line, and are spaced at equal intervals (A), determined by the depth of interest. In this case, the depth of interest was 10 to 15 feet, the A-spacing was therefore set at 20 feet. An electrical current (I, typically 20 milliamperes) from a 90-volt battery is forced into the ground through the outer two electrodes. The current distributes itself throughout a large volume of earth and the resulting voltage drop (V) is measured across the inner two electrodes. The earth resistivity (R) is then determined by the following equation:

$$R = 2\pi A(V/I)$$

Since some earth materials are much better conductors of electricity than others, the voltage drop will be affected by different subsurface conditions.

Electrical resistivity is a fundamental property of all materials. It is a measure of the resistance of a material to the flow of an electrical current through it, and is inversely proportional to conductivity. Typical resistivity values are as listed below:

Resistivity Value	Resistivity Range (ohm - ft.)	Material
Low	1 to 500	Loose, Wet Clayey Soils, Fills - Ashes, Cinders, Metals, Brine Wastes and Leachates
Medium	200 to 2,000	Moist to Dry Clayey Sand and Fill Materials
High	1,000 to >10,000	Dry, Clean Sand and Gravel Massive Rock, Grouted or Consolidated Slag Layers and Concrete to Air

Apparent resistivity values of subsurface materials obtained by earth resistivity measurements made at the surface are average values of all the materials through which the electric current travels. For this reason, earth resistivity is generally considered an indirect and qualitative method of subsurface exploration.

Interpretation of electrical resistivity readings consists of deducing the subsurface conditions from the measurements. The more uniform the subsurface materials, the more likely that the interpretation approximates actual conditions.

In order to facilitate the location of the resistivity survey points in the field and on the site map, the old baseline, which was used during the construction of the park facilities, was reestablished using the old benchmark for control. The resistivity surveys were conducted at approximately 100 foot intervals, across the site (approximately north-south) and perpendicular to the center baseline. A total of approximately 100 resistivity measurements was obtained. These measurements were recorded, along with the survey point coordinates and remarks on observed surface conditions, in the field log book.

With the above information as a guide and by referring to the contour map of apparent resistivity values (Figure 4), qualitative observations as to the subsurface conditions existing at the site are as follows:

a. A ridge-like extension of the high resistivity values (>3000 ohm-ft.) exists down the center and at the western tip of the park site. This area of high resistivity values may represent the consolidated or grouted slag-like layer that was encountered in some of the test pits and observed in the banks at the northwestern tip of the park. On the other hand, the higher than background resistivity values may indicate dry fill material or differences in subsurface drainage along the original "backbone" of the island.

b. The areas of lower resistivity values (< 1500 ohm-ft.) may indicate moist soils or fill materials which may have been dumped into low areas or previous natural drainage pathways. Another explanation may be that resistivity areas represent perched groundwater and/or leachate. At two sample locations (7 and 13), which were within the lower resistivity contoured areas, leachate was encountered within a few feet of the ground surface.

c. Overall, the contours of higher than expected apparent resistivity values suggest a pattern of relatively deep (>10 ft.) ground-water flow around the site.

d. Detailed classification of waste types by electrical resistivity would be difficult due to the extreme variability of subsurface materials at the park site.

2. Metal Detector. Metal detector instrumentation was also used to assist in locating buried metal drums. It was conjectured that the metered ranged difference between the background and drummed areas would indicate possible disposal locations. Although readings were taken during the preliminary field investigation, the results proved unreliable. Large amounts of slag had been deposited at the park site interfering with the equipment. In addition, the site is underlain by various sewer and water pipelines which interrupted background determinations.

C. Sampling Rationale

The sampling protocol was specifically designed to address the question of whether or not a public health threat exists as a result of wastes present at the park site. Although toxic chemicals on the surface would pose the most obvious exposure hazard and potential immediate risk, the field investigation was not limited to surface sampling. Hazardous wastes buried close to the surface can be exposed by erosion, ferreting animals or curious children. Further, a perched groundwater condition, leading to a "bathtub effect" whereby leachate may surface, was considered to be a strong possibility at Neville Island Park. Thus the examination and testing of near-surface conditions was an essential part of the health threat assessment. The sampling protocol included obtaining grab samples of buried wastes and liquids within a few feet of the surface. These were exposed by digging test pits to a total depth of approximately four feet. This testing was performed with the use of a backhoe in locations suggested by the information obtained from the construction contractor, the Richardson, Gordon and Associates report, intensive visual inspection of the site, and the resistivity and metal detection surveys conducted by Fred C. Hart Associates. Examination of groundwater (or leachate) to detect the migration of wastes was also conducted.

Finally, in order to assess the exposure of park visitors and employees to potentially harmful vapors emanating from surface and buried wastes, testing was performed on gaseous samples. Use of standard monitoring methods for ambient air concentrations of pollutants was deemed to be of questionable value in this instance for two reasons. First, air monitoring in the park would be affected by air quality on other parts of heavily industrialized Neville Island. It would be difficult, if not impossible, to establish that the monitored air contaminants were due to the presence of chemicals in the park itself. Secondly, adequate data for the ambient air concentrations of contaminants in areas adjacent to the park were not available for comparison purposes. Therefore, the head space of surface and buried waste samples was tested for the presence of volatile organics. Head space analysis provides a chemical determination of the volatile components in the air above the sample. Following discussions with the Allegheny County Health Department, it was decided that this testing method would provide more definitive results than ambient air measurements.

The initial investigation of potential surface and subsurface wastes, thorough examination of historical records, visual inspection of the site, and metal detection and resistivity survey data identified sixteen (16) potential sampling locations. This information provided the basis for the sampling protocol submitted to and approved by the Health Department on June 19, 1979. As a result of discussions with a representative of Navarro Corporation on June 20, minor changes were made in the original sampling program, with three additional locations investigated. Samples from 15 of the 19 locations were sent for laboratory analysis. Table 1 lists the sampling locations and describes the types of samples obtained. Figure 5 shows the sampling locations.

D. Sample Collection Procedure

Surface samples were primarily materials which were present in substantial quantities throughout the park. These substances appeared to have been dumped on the surface in various locations or to have become exposed due to erosion of the banks. In several cases, the materials were originally contained in steel drums which are now either partially or totally corroded, thus leaving the material exposed. Plates 3 and 4 illustrate this situation. Subsurface samples were obtained with the aid of a backhoe. Test pits were dug to a maximum depth of four feet. Plate 5 shows a typical test pit. Samples for head space analysis were obtained from each representative waste type - both surface and subsurface. Water (or leachate) samples were obtained from test pits at two locations.

TABLE 1

LOCATION AND DESCRIPTION OF SAMPLING SITES

LOCATION NO. (a)	LOCATION DESCRIPTION (b)	SAMPLE NO.	DEPTH (c)	SAMPLE DESCRIPTION (d)
1	Near Picnic Deck D	1,1a	Surface	Blue wood chips and black tarry matter
		2	Surface	Orange granular clay - like substance
2	Bank by Ohio River	3	Surface	Black tar
3	Bank by Ohio River	4	Surface	Hard grey material
4	Bank by Back Channel	5	Surface	Tan solid, needle-like crystals
5	Bank of Back Channel	6	Surface	Mixture of white, rust and grey granular particles
6	Clump of trees	12	Surface	Hard, granular material (crystalline)
7	Disposal pit for excavated sludges	24	3.5 feet	Brown soil
		25	3.5 feet	Leachate
8	Bank by Back Channel	7	Surface	Blue wood chips
		8	3 feet	Rock coated with blue crystals
		9	3 feet	Soil
9	Spongy fill under proposed Nature Center	10	2 feet	Black tar
10	Next to parking lot near proposed Nature Center	Not Sampled		

TABLE 1 ([illegible]ntinued)

LOCATION NO. (a)	LOCATION DESCRIPTION (b)	SAMPLE NO.	DEPTH (c)	SAMPLE DESCRIPTION (d)
11	Spongy fill under Picknic Deck P	11,11a	2 feet	Black, viscous sludge
12	"Indian Mound"	15	1.5 feet	Hard, blue crystalline material
		16	2 feet	Black, tarry soil
		15	3-4 feet	Black, tarry soil
13	Spongy fill under road	18	3 feet	Tarry soil
		20	4 feet	Leachate
14	Near Group Shelter E	21,21a	½-1 foot	White and yellow crystals
		22	½-1 foot	Blue-black, chalky crystals
15	Next to hydrant between Shelter I & Picnic Deck H	Not Sampled		
16	Western tip of island	Not Sampled		
17	South of oil well	13	2-4 feet	Soil and tarry material
		14	Surface	Yellow resin
18	Between river stairs and parking lot	Not Sampled		
19	West of loop road	23,23a	1 foot	Black tar

NOTES:

a. Sampling site location number - see Map (Figure 5).
b. Location description - physical features observed at sampling site.
c. Sampling point depth - at or below ground surface.
d. Sample description - visible appearance at time of sample collection.

Plate 3. Tar exposed on the surface at location 2. The material retains the shape of its original container.

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Plate 4. White crystalline residue in partially corroded drums exposed on the surface at location 4.

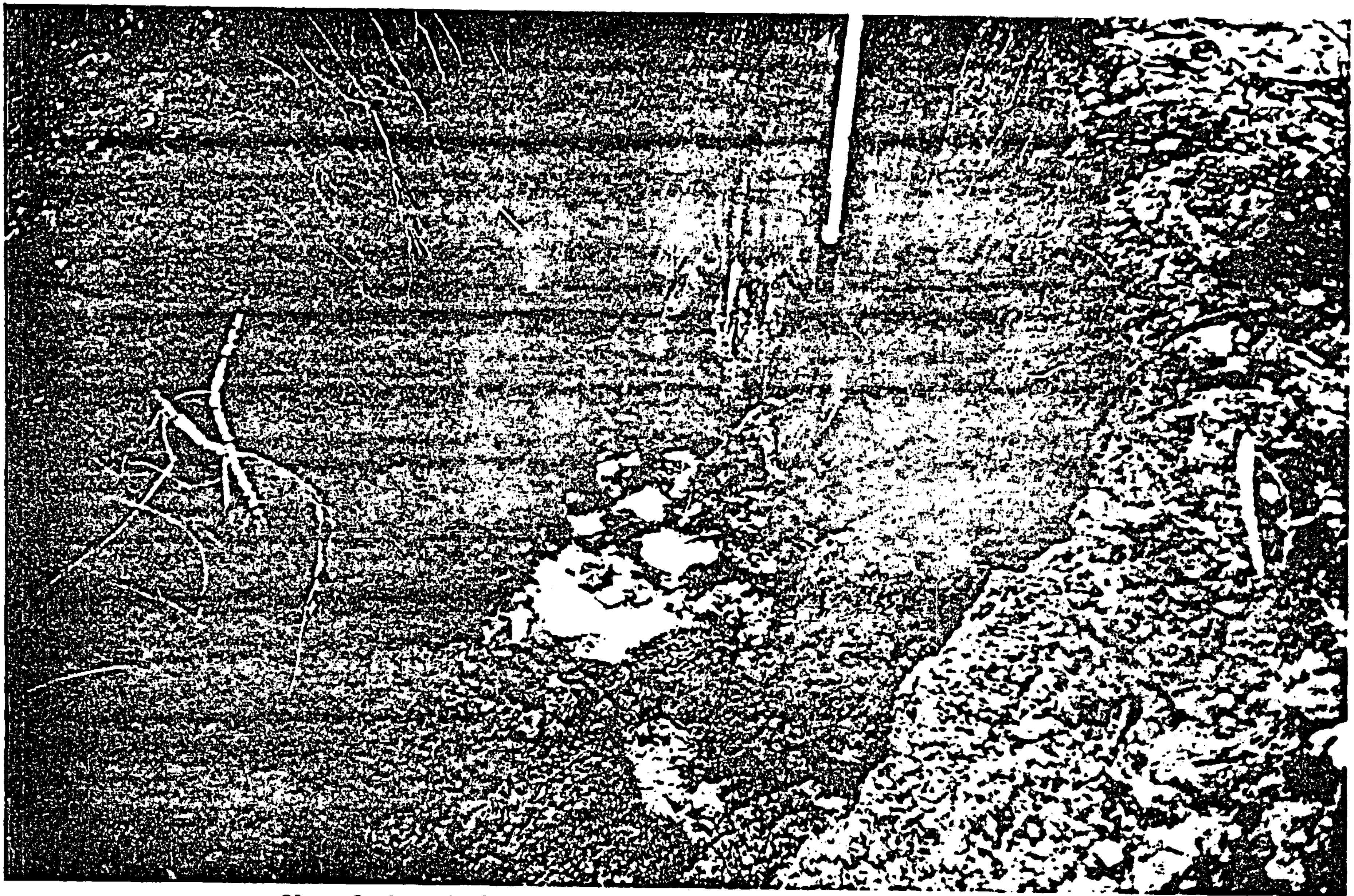

Plate 5. A typical test pit dug four feet deep during F[illegible] sample collection. Leachate is visible at the bottom of the test pit (location 15).

V. TEST RESULTS

A. Introduction

All samples were delivered to NUS Corporation, Cyrus William Rice Division, on the day of sample collection, June 20, 1979. This section presents a description of the four categories of samples collected and their contents. In Table 2, chemicals found in each type of sample are listed. Appendix B presents a complete list of compounds detected in all analyzed samples with the highest measured concentrations.

B. Chemical Waste Types Found in Ohio River Park

1. Pigments. In several areas of the parks, wood chips and other materials highly colored with a blue dye or pigment were encountered at the surface. At location 1, blue-colored wood chips covered the hillside adjacent to the picnic deck (see plate 6). The earth under the blue wood chips was composed of a black tarry material and contained clumps of orange clay-like material. At location 8, a large section of the bank sloping down to the river was strewn with blue wood chips intermixed with clumps of dark blue material. Since it had been indicated that phthalocyanin and chlorinated phthalocyanin dyes were produced on Neville Island, the samples were analyzed for inorganic and organic dye components. The samples of pigments were found to contain volatile organics (sample 1a), the presence of which may be attributed to the tars with which the samples were mixed. The blue material (samples 1 and 7) are a mixture of ferricyanide and ferrocyanide salts. The orange clay-like material (sample 2) is mostly iron oxide.

TABLE 2

CHEMICALS FOUND IN VARIOUS SAMPLES

I. COAL TAR RESIDUES	
A. Volatile Organics:	Benzene Toluene Xylenes Trimethylbenzene Indane Naphthalene Methylindanes Dichlorobenzenes Trichlorobenzenes
B. Polycyclic Aromatic Hydrocarbons:	Acenaphthalene Fluorene Phenanthrene Fluoranthene Pyrene Chrysene Anthracene
C. Other Organics:	Dibenzofuran Phenols
II. PIGMENTS	
A. Volatile Organics:	Benzene Toluene Xylenes Trimethylbenzene Naphthalene Dichlorobenzenes
B. Inorganics:	Cyanide Copper Manganese Silicon Iron Magnesium Sulfur Aluminum Mercury

TABLE 2 (continued)

III. CRYSTALLINE SOLIDS

A. Volatile Organics:	Benzene Toluene Xylenes Trimethylbenzene Naphthalene Dichlorobenzenes Trichlorobenzenes
B. Other Organics:	Phthalic Anhydride
C. Inorganics:	Silicon Iron Magnesium Aluminum Sulfur Cyanide
D. Pesticides:	Parathion alpha-benzene hexachloride gamma-benzene hexachloride (Lindane) Heptachlor

IV. LEACHATES

A. Volatile Organics:	Benzene Carbon Tetrachloride Chlorobenzenes 1,1,2,2-Tetrachloroethane Chloroform 1,2-Dichloropropylene (cis) Ethylbenzene Tetrachloroethylene Toluene Trichloroethylene Xylenes Naphthalene Methylene Chloride Trimethylbenzene
B. Phenols:	Phenol 2-Chlorophenol 2,4-Dichlorophenol 2,4,6-Trichlorophenol (p-Chlorometacresol) 4-Nitrophenol 2,4-Dinitrophenol

TABLE 2 (continued)

C. Polycyclic Aromatic Hydrocarbons (PAH):	Benzo(a)anthracene
	Benzo(a)pyrene
	3,4-Benzofluoranthene
	Benzo(k)fluoranthene
	Chrysene
	Acenaphalene
	Anthracene
	Fluoranthene
	Phenanthrene
	Pyrene
D. Other Organics:	Ethylbenzene
	N-Nitrosodimethylamine
	Pthalate esters
	N-Nitrosodiphenylamine
E. Pesticides:	Parathion
	α-Benzene Hexachloride
	γ-Benzene Hexachloride (Lindane)
	2,4-D
	2,4,5-T
	Silvex
F. Metals and Other Inorganics:	Antimony
	Arsenic
	Copper
	Thallium
	Mercury
	Lead
	Nickel
	Manganese
	Cyanide

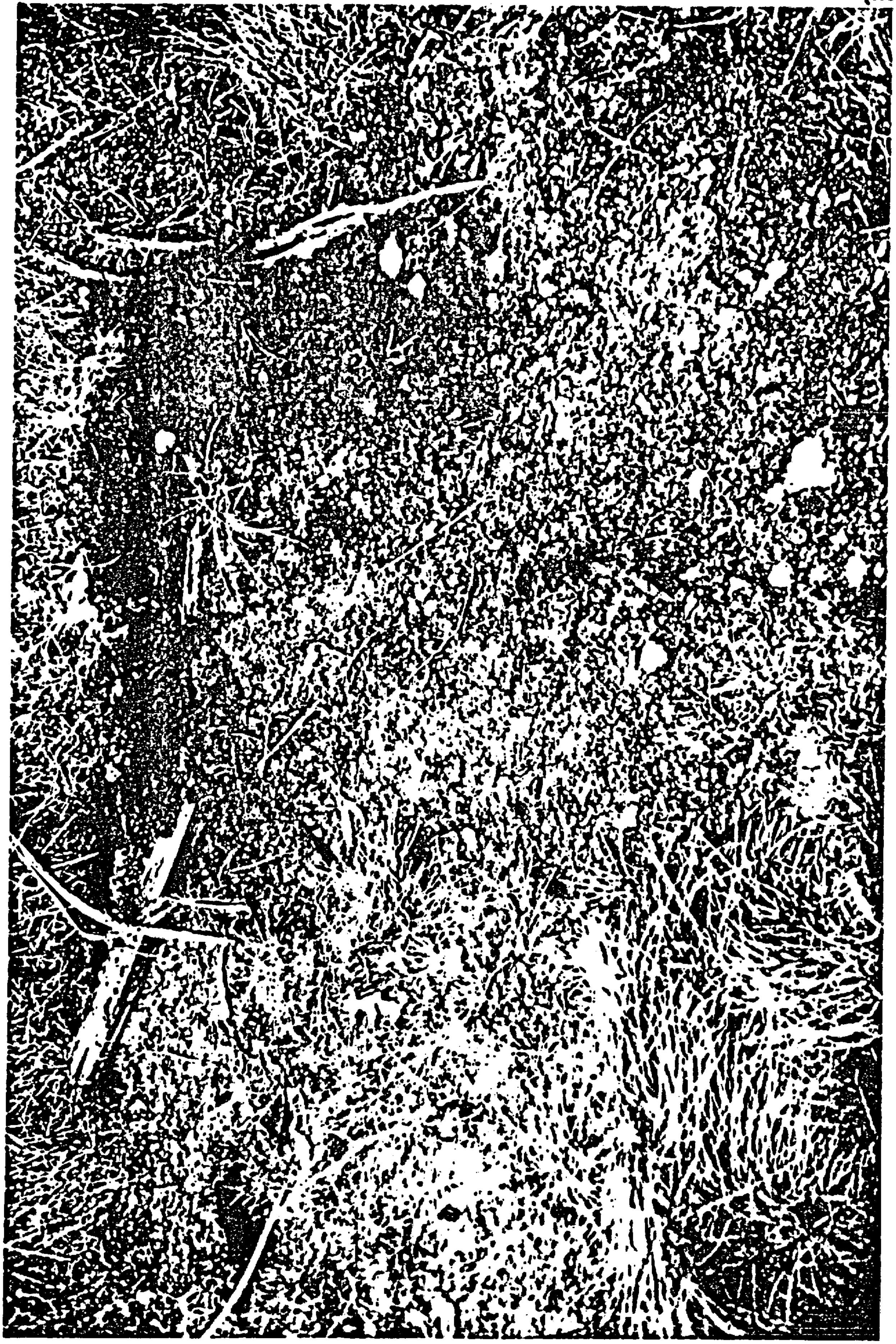

Plate 6. Surface deposit of blue colored wood chips at location 1 adjacent to a picnic deck.

2. Coal Tar Residues. In many areas of the park, tarry materials were encountered, and it was suspected that these substances were coal tar residues from the extensive coke oven processes on Neville Island. These residues ranged from a hard mass of porous black tar in the shape of a drum (location 3) to soft masses of tar in the soil. All tar substances analyzed were found to contain toxic polycyclic aromatic hydrocarbons (PAH's) as well as volatile organic components, such as benzene and toluene. Three tar residues were analyzed and shown to contain toxic phenols. One tar residue (location 9) was positively identified as pitch.

3. Crystalline Solids. The park is strewn with and underlain by deposits of wasted crystalline solid substances. In several locations drum-shaped masses of tan solids are present. Elsewhere the drums are completely disintegrated or partially corroded. The materials vary from hard solids to friable soft substances. It was suspected that some of the drum-shaped wastes were still bottoms generated during the synthesis of various chemicals from coal tar distillate byproducts (e.g., organonitrites or chlorinated solvents used in the manufacture of pesticides). Other wastes were probably off-spec chemicals. Some of these materials may have been buried during construction of the park, since they were found in areas where the contractor filled and covered the surface with topsoil. Analytical results showed that some of the materials (locations 4 and 14) contained volatile organic components such as chlorobenzenes while others were primarily inorganic, as indicated by combustion testing (loss on ignition). One of the samples (location 4) was primarily phthalic anhydride. Two others (locations 12 and 14) contained significant amounts of cyanide.

4. Liquid Organics, Sludges and Leachate. In three areas (locations 7, 11, and 13), liquids or sludge-like wastes were uncovered. Sampling at location 11 was conducted due to reports that the building contractor found "spongy" soil conditions here, and was therefore unable to construct a picnic shelter at this site. Large deposits of black viscous sludge with a strong odor of organic solvents was found under two feet of tarry soil (Plate 7). Analysis of this material showed that it contained a solid component, primarily carbon, and a liquid component, primarily toluene. Other volatile organics, including a large amount of benzene, were detected in the head space analysis. In locations 7 and 13, drums were exposed by digging only a few feet under the surface, and the pits rapidly filled with leachate. At location 7, the leachate had a strong odor and appeared to steam. At location 13, the leachate was yellow-green and also odoriferous. These samples were analyzed for all priority pollutants as well as other toxic chemicals suspected to be present, such as pesticides. As can be seen by examining Table 2, these leachates contain numerous toxic chemicals, including heavy metals, hydrocarbons and chlorinated hydrocarbons, polycyclic aromatic hydrocarbons (including benzo (a) pyrene- a potent carcinogen), phenols, pesticides, and cyanide.

ORIGINAL
(Red)

Plate 7. Viscous, tarry sludge deposit found at location 11 at a depth of two feet. This material was liquid-like when uncovered, but rapidly hardened upon evaporation of the solvent.

VI. TOXICOLOGICAL ASSESSMENT

A. Approach

The approach to this assessment was to identify the most hazardous chemicals which were detected in the samples in amounts judged to be significant from a health effect standpoint. This approach is similar to that used by the U.S. Environmental Protection Agency (EPA) in establishing hazard potential values for environmental contaminants. By focusing on the most hazardous chemicals present, the task of evaluating the potential health hazard is simplified. For those substances which are considered "priority pollutants" by EPA, water quality criteria and standards were used if available. These criteria documents state the recommended maximum permissible concentrations consistent with protection of aquatic organisms, human health, and recreational activities.* Toxic compounds for which EPA water quality criteria are not available have been assessed on the basis of other standards, such as the Occupation Safety and Health Administration (OSHA) standards for toxic chemicals (ambient air concentrations) as well as the recommendations of the National Research Council in setting safe levels of pollutants in drinking water for revision of the Interim Primary Drinking Water Regulations. Table 3 lists the toxic chemicals which are present at the park site in notable quantities.

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* Under Section 304 (a) of the Clean Water Act, EPA is required to publish and periodically update national water quality "criteria" for various water pollutants. These criteria are based on the latest scientific knowledge detailing the identifiable effects of each pollutant on public health and welfare, aquatic life, and recreation.

TABLE 3

COMPARISON OF TOXIC CHEMICAL LEVELS FOUND AT SITE WITH CURRENT FEDERAL CRITERIA AND STANDARDS

ORIGINAL
(Red)

Substance		Level			
Class	Compound	Air		Water	
		Highest Level Found at Site	OSHA Standard	Highest Level Found at Site (µg/l)	EPA Water Quality Criteria
VOLATILE ORGANICS	benzene	2066 ppm*	10 ppm	5100	15
	toluene	85 ppm*	200 ppm	12000	NA
	xylenes	91 ppm*	100 ppm	-	
	naphthalene	+	10 ppm	-	
POLYCYCLIC AROMATIC HYDROCARBONS	fluoranthene	-		150	200
	benzo(a)pryene	-		83	NA
PHENOLS	phenol	-	5 ppm	3700	1
	2-chlorophenol	-	NA	800	0.3
	2,4-dichlorophenol	-	NA	15000	0.5
	2.4-dinitrophenol	-	NA	136	
CHLORINATED SOLVENTS	carbon tetrachloride	-	10 ppm	4	2.6
	tetrachloroethylene	-	NA	5	2.0
	chlorobenzene	-	75 ppm	8	NA
PESTICIDES	parathion	-	NA	4500	NA
OTHER ORGANICS	ethylbenzene	-	100 ppm	43	-
	N-nitrosodi-methylamine	-	0#	3	.026
METALS AND OTHER INORGANICS	antimony	-	0.5 mg/m^3	400±	NA*
	arsenic	-	0.5 mg/m^3	100±	.02
	copper	-	NA	3.2	1.0
	thallium	-	0.1 mg/m^3	190	4
	mercury	-	.05 mg/m^3	1200	2 (proposed)
	lead	-	0.2 mg/m^3	230	50
	nickel	-	1 mg/m^3	0.16	NA
	cyanide	-	40	1.32	NA

-	not detected in this medium
*	head space analysis results
+	present in head space, but only qualitative data available
NA	criteria or standard not available
#	carcinogen (only recommended limit)
±	reliable concentration not available

Using the available information on the toxicological properties of the compounds listed in Table 3, six substances or classes of substances were selected for further health risk assessment: benzene, phenols, parathion, cyanide, mercury, and coal residues. Coal tar residues are discussed as a single substance rather than by individual component in order to consider possible synergistic effects.

Due to the nature of the buried wastes at the site, the health hazard assessment has primarily focused on the identification of chemicals present. Determination of the presence of a toxic substance in a quantity significantly exceeding the criteria is sufficient to consider its effects in the park. The concentrations determined in the samples were considered baseline information to be used in making predictions of health effects and not as an absolute indication of the level present.

Situations found from the sampling and analysis are indicative of more far-reaching problems. One leachate sample was found to contain 4.5 mg/l of parathion. It is known that this pesticide readily decomposes to breakdown products such as p-nitrophenol (which was also detected) in the presence of water. The concentration found suggests the presence of a leaking drum nearby. This situation presents the possibility that unknown amounts of parathion may continue to migrate into the environment.

In addition, the program uncovered unusually high concentrations of volatile components in the coal tar residues. Considering the lengthy burial period, one would expect that these volatile organics would be dissipated. However, the head space samples have proven that benzene and its analogs are still present in the buried wastes. Also, since some head space analyses indicated saturated or supersaturated levels of these solvents, the assumption that they are quite pervasive seems warranted.

Mercury was found in abnormally high concentrations in several samples. One sample (location 13, sample 20), showed a concentration of 1200 ug/l while others were much lower (2.6 ug/l). This wide variance in concentration demonstrates that an average value determination of the level present in the park is not possible. Consequently, health effects from a relatively high exposure to mercury are used in a conservative risk assessment.

B. Health Effects

1. Benzene. Benzene was detected by head space analysis at high concentration in almost all tar samples and in at least trace amounts in all other analyzed samples, both buried and surface. Benzene was also detected in the two leachate samples, at 5,100 and 420 ug/l. Because of benzene's prevasiveness, it is likely that large quantitites of benzene-containing wastes are present in the park. The possibility exists that buried drums are now leaking as a result of corrosion or damage during park construction.

Benzene is a volatile, colorless, liquid hydrocarbon produced principally from coal tar distillation and petroleum, as well as from coal processing and coal coking operations. Both an acute and chronic poison, benzene is absorbed mainly through vapor inhalation but also by skin contact. Its acute toxicity is manifested as a narcotic effect, while chronic benzene poisoning is characterized by damage to the blood-forming tissues.

Blood disorder in workers exposed to 210 ppm have been reported. In addition, benzene can induce aberrations in human chromosomes. Benzene is listed in the NIOSH Suspected Carcinogens List, as a result of a study indicating a leukemia incidence in exposed workers which was five times the expected rate.

Based on benzene's carcinogenic potential, the Labor Department has recommended lowering the worker exposure limit to 1 ppm as an 8-hour time weighted average concentration, as well as prohibiting repeated or prolonged skin exposure to the substance in liquid form. Benzene has also been recognized as a potential carcinogen by the American Council of Government Industrial Hygienists which has listed it as an Occupational Substance Suspected of Oncogenic Potential (i.e., capable of causing tumors). Since benzene is toxic to aquatic life, EPA has issued an ambient water quality criterion of 3.1 mg/l for the protection of freshwater organisms.

2. Phenols. Phenols were detected in both leachate samples as well as in three tar samples specifically tested for these compounds. It is suspected from the acid odor of other pitch-like samples that they also contain phenols, and the presence of these compounds may account for the strong odors encountered in many areas of the park where these substances are present.*

Specific phenols are degradation products of common pesticides, which were found in samples obtained at the park. For example, p-nitrophenol is a

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* Under the gas chromatography, conditions used for the head space analyses, the phenols would not be detected as volatile components of tars.

degradation product of parathion, an organophosphate insecticide. Since parathion degrades fairly rapidly to p-nitrophenol in the presence of water, detection of p-nitrophenol in the leachate (at 80 ppm in sample 20) suggests that a large quantity of parathion may have been present at one time. In fact, a lower concentration of parathion (4.5 ppm) was found in the same sample. Together, these facts indicate the likelihood that a quantity of parathion, possibly in a damaged drum, was leaking into the groundwater near the sample site and decomposing to p-nitrophenol.

In a similar manner, the detection of 15 ppm of 2,4-Dichlorophenol and 48 ppm of 2,4-D in the leachate sample (location 7) suggests there is a deposit of wasted herbicide, since 2,4-Dicholorophenol is a degradation product of the organochlorine herbicide 2,4-D. The hazard created by these compounds is due not only to the toxicity of the herbicides themselves, but also to the hazardous properties of the phenolic degradation products.

As a class, the phenols generally enter the body via inhalation and skin absorption. Their toxicity varies, but some are highly irritating to the skin, mucous membranes and eyes. Systemic effects usually involve the central nervous and/or cardiovascular systems, possibly accompanied by renal and hepatic damage.

Phenols found at the park include:

a. <u>Phenol</u>. Phenol is absorbed through the gastrointestinal and respiratory tracts and can cause both acute and chronic poisoning. Chronic poisoning results in liver and kidney damage.

Although there is no specific evidence of human cancer attributable to phenol, the substance is included in the NIOSH list of suspected carcinogens. The current OSHA standards are 19 mg/m^3 (5 ppm).

b. <u>2-Chlorophenol, 2,4-Dichlorophenol and 2,4,6-Trichlorophenol</u>. Chlorophenols may be absorbed through the skin or inhaled as a vapor. Corrosive to skin and eyes, the vapors are irritating and toxic. 2-Chlorophenol is included in the NIOSH suspected carcinogen list. Concentrations of 0.001 to 0.015 mg/l in water may cause tainting of fish.

c. <u>4-Nitrophenol and 2,4-Dinitrophenol</u>. 4-Nitrophenol and 2,4-Dinitrophenol are stronger acids than phenol and skin contact with either may cause irritation or burns.

Dinitrophenols are readily absorbed through skin contact and by inhalation. They can cause increases in metabolism and temperature, dermatitis, and eye and nerve damage. EPA water quality criteria indicate a 1 ug/l standard for all phenolic compounds.

3. <u>Parathion</u>. The likelihood that parathion is present in large enough quantities to present a health hazard has already been discussed in the previous section on phenols. Parathion was detected in subsurface samples at three widely separated sites (locations 7, 13, and 14), which would suggest that it could be found throughout the park.

Parathion is a highly toxic organophosphorous insecticide currently registered for use on field, forage, and vegetable crops. It can be ingested, inhaled, or absorbed through skin contact. Its toxic properties result mainly from its effect on the nervous system, in particular the inhibition of the enzyme cholinesterase. The symptoms of acute parathion poisoning include: nausea, vomiting, diarrhea, bronchoconstriction, muscle twitching, convulsions, coma, and respiratory failure.

ORIGINAL
(Red)

Reports of parathion intoxication usually appear in the literature as individual case studies and, as such, do not lend themselves to calculations of minimum adverse dosages. However, the NIOSH reported lowest lethal dose (240 ug/kg body weight), indicated that a child weighing approximately 30 pounds could die from ingesting 3.6 mg of parathion.

4. Cyanide. Cyanide was detected in samples at six locations in the park. Although most of the cyanide present in these samples was bound in the less toxic inorganic complexes such as ferro- or ferricyanide, free cyanide was found to be present in the leachate sample at location 7.

Ferricyanides in themselves are of low toxicity. It has been stated, but not conclusively proven, that hydrogen cyanide can be liberated in the stomach, after ingestion of ferricyanide, as a result of contact with gastric acidity.

Ferrocyanides as such are also of a low order of toxicity. However, highly toxic decomposition products can form when ferrocyanides are mixed with hot concentrated acids. In addition, acidic, basic or neutral solutions of these substances will, upon strong irradiation such as bright sunlight, liberate hydrogen cyanides.

Hydrogen cyanide (HCN) is an extremely poisonous, highly flammable and highly explosive colorless gas or liquid. Low concentrations of the substance will result in mild upper respiratory irritation and may cause skin and eye irritation in liquid form. As a systemic poison, HCN is an asphyxiant. Lower levels of exposure may cause weakness, headache, confusion, nausea, and vomiting. Larger doses by ingestion, inhalation, and skin absorption will result in loss of consciousness, cessation of respiration, and death.

The Federal standard for HCN is 11 mg/m^3 (10 ppm).* Due to its toxic effect of HCN on aquatic organisms, the EPA ambient water quality criteria has been set at 5 ug/1. It is conceivable that under certain conditions, cyanide gas might be liberated: from the cyanide-containing wastes on the surface (pigments at locations 1 and 8), from buried wastes, from crystalline solids (location 13 and 14) and from leachates (locations 7 and 13). Again, the detection of cyanide at six locations suggests that it is prevalent throughout the park site.

In addition to creating the potential hazard of serious injury or death from the liberation of free cyanide, low concentrations of all cyanides present the potential for less severe health effects such as skin irritation.

5. Mercury. Detection of high levels of mercury in one of the leachate samples is indicative of mercury-containing wastes at the park site. It is suspected that this mercury comes from the wasting of mercury-containing herbicides and fungicides which may have been manufactured on Neville Island.** Due to the solubility of mercury compounds in water, it

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* NIOSH has recommended a 5 mg/m^3 standard expressed as cyanide and determined as a ceiling concentration based on a 10 minute sampling period.

** An example of a commonly used herbicide and fungicide is phenyl mercuric acetate, made by heating benzene with mercuric acetate.

seems unlikely that the mercury would still be present in soil near the surface unless these chemicals were disposed of in drums which are now leaking and contaminating the soil. The finding of an unusually high concentration of mercury in leachate indicates the probable presence of mercury in amounts sufficient to cause adverse health effects to park visitors under certain conditions.

Human exposure to mercury may cause acute and chronic neurotoxic effects resulting from inhalation or ingestion. The major symptoms of mercury poisoning are stomatitis, tumors and neurological disturbances culminating in convulsions at the advanced stage. In addition, skin exposure may produce a dermatitis characterized by small ulcers on the affected areas. Such dermatitis is often accompanied by conjunctivitis and inflammation of the mucous membranes of the nose and throat.

Some mercury compounds have demonstrated carcinogenic and teratogenic (i.e., causing malformed fetuses) potential. The lower tumor-producing dosage is 400 mg/kg and the lowest dosage resulting in a teratogenic response is 500 ug/kg. Mercury also shows some tendency for accumulation in fatty tissues, rather than prompt excretion. This can be especially dangerous in cases of rapid weight loss and subsequent release of mercury into the system. At present, the threshold limiting value (TLV) for all forms except alkyl mercury is 0.05 mg/m^3. This level does not take possible carcinogenic or teratogenic effects into account. The EPA water quality criteria for protection of freshwater organisms is set at 0.002 mg/1.

6. Coal Tar Residues. Coal tar residues were also found throughout the park, both on and below the surface. Thus the potential exposure of park visitors is considered very high, through inhalation, dermal contact and possible ingestion.

Several of the tar samples were identified by the laboratory as coal tar pitch which is primarily a residual product of coal tar produced by coke oven plants. In the tar substances analyzed, eight PAH's have been positively identified (see Table 2) but others are likely to be present.

The NIOSH recommended standard identifies the polynuclear hydrocarbons identified in coal tar as follows:

> "Some of the polynuclear hydrocarbons that have been identified in coal tar, coal tar pitch, or creosote include anthracene, benz(a)anthracene, benzo(b)chyrsene, benzo(j)fluoranthene, benzo(k)fluoranthene, benzo-(g,h,i)perylene, benzo(a)pyrene (BaP), benzo(e)pyrene (BeP), carbazole, chrysene, dibenz(a,h)anthracene, fluoranthene, perylene, phenanthrene, and pyrene. The BaP and dibenz(a)anthracene analogs have been the subject of much carcinogenicity research. Because of the widespread use of coal, petroleum, and their derivatives, the carcinogenic potential of these PAH's has been extensively investigated.
>
> "In general, the composition of various coal tars and coal tar pitches and, thus, probably their carcinogenic potential depends on the source of the tar and the methods of processing, which determine the relative amounts of tarry matter as well as the chemical characteristics of the products. Over 300 compounds have been positively identified in coal tar, and it is estimated that as many as 10,000 compounds may exist, although many are present only in trace amounts."

In this assessment we have considered the health effects and published criteria for coal tar pitch as an entity rather than evaluating each possible chemical component separately. This is done in order to include the synergistic effects expected from these carcinogens in one exposure. In addition some of the chemicals in coal tar pitch are considered to be promoters of cancer, that is they do not produce cancer themselves but they increase the carcinogenicity of other chemicals present.

Exposure to coal tar pitch has been implicated in a variety of health effects which can be divided into the following broad categories:

a. Skin Effects. A NIOSH health hazard evaluation of 34 roofers exposed to coal tar pitch fumes reported that 23 of the workers suffered skin effects including: burning and tingling sensations, localized erythema, hyperpigmentation, papular dermatitis and thermal burns. Another study (Hodgson and Whitely, 1970) concluded that pitch workers have an increased susceptability to malignant and premalignant skin lesions, while additional investigations point to a possible increased incidence of skin cancers.

b. Eye Effects. In the NIOSH study, 17 of the 34 workers had complaints pertaining to the eyes; ranging from slight burning to burning and inability to close the eyes and interference with vision.

c. Cancer Mortality. In addition to the previously mentioned increase in skin cancers, pitch has also been implicated in increased rates of respiratory cancer among coal tar production workers. This is attributed mainly to the presence of benzo(a)pyrene among the air-borne coal tar components. Instances of scrotal cancer have also been reported.

Coal tar pitch often contains identifiable components (e.g., benzo(a)pyrene) which by themselves are carcinogenic. Thus, the NIOSH criteria sets the recommended standards for all coal tar products at 0.1 mg/m^3, determined as a time-weighted average concentration for up to a 10-hour work shift in a 40-hour workweek.

Although many of the health effects which result from exposure to coal tar products are observed primarily in individuals occupationally exposed to these substances; park visitors, especially children, might be expected to suffer the same effects, although the lower exposures should reduce the incidence of the effects.

C. Possible Human Exposure Mechanisms

1. Introduction. The scenarios presented here include some "worst case" examples of hypothetical incidents should the Ohio River Park be opened in its present condition. It was considered prudent to utilize a worst-case analysis approach in order to fully bring to light the health hazard issue. Although the scenarios cannot be considered the most likely series of events, there is every possibility that, under certain conditions, they could occur.

The scenarios present four specific examples of serious potential public health hazards. In each case, the reader should be reminded that although the substances discussed are toxic to all age groups, certain chemicals pose a special hazard to women of childbearing age and children, the two groups which would be likely to comprise a large portion of park visitors. Although few chemicals are definitely implicated as human teratogens, some of the substances found at Ohio River Park have been shown to cause spontaneous abortions and birth defects in animals.

With regard to children, it has long been recognized that there are age-dependent and weight-dependent variations in chemical toxicity, with younger and smaller individuals generally having higher susceptibility. This factor is especially important in the evaluation of bioaccumulating toxics such as mercury, lead and some chlorinated organics.

2. Benzene Vapors. Benzene vapors have been found in almost all the analyzed samples, with head space samples at sites 11 and 19 showing super-saturated concentrations (see Table 4). Under ordinary meteorological conditions, natural ventilation due to air currents would dissipate the small amounts of benzene and other volatile organics emanating from the wastes. On hot, still days, however, these volatile compounds may reach high concentrations, especially close to the ground. Although these vapors may have little or no effect on adults breathing air 5 to 6 feet above the ground, they might exert an effect on children playing or napping near the surface. It should be stressed that the toxicity levels given in this report are NIOSH standards relating to adults in a work environment. Little data is available on the effects of such solvents on children.

The "worst case" concentrations of benzene can be estimated from the head space data which gives the approximate concentration to be expected without ventilation. The maximum benzene concentration measured by head space analysis was 6,600 ug/l (2,066 ppm at 25°C). Using a dilution factor of 1/5,000 to account for diffusion and ventilation on a still day, we can expect an approximate "worst case" benzene air concentration of 0.41 ppm, which approaches the recommended NIOSH standard of 1 ppm for an 8-hour workday.

VOLATILE ORGANICS DETECTED BY HEAD SPACE ANALYSIS

SUBSTANCE	LOCATION (ORIGIN OF VAPOR)											
	1 (Pigment)	2 (Tar)	4 (Cryst.)	7 (Soil)	8 (Pigment)	9 (Tar)	11 (Org. Sludge)	12 (Soil, Cryst.)	13 (Soil)	14 (Cryst.)	17 (Soil)	19 (Tar)
Benzene	M	T	S	L	M	SA	SS	SA	S	L	SA	SS
Toluene	S	T	T	M	S	SA	SA	M	T	M	L	SS
Xylenes	S	T	T	M	S	L	L	L	T	S	L	S
Trimethyl Benzene	T	T	T	S	T	L	L	S	T	T	S	L
Indane		S		S		M	S					M
Naphthalene	T	S	M	M	S	L	M	S	T	T		SA
Methyl Indane						S			T			
Methylnaphthalene						S						S
Dichlorobenzene	T			S	T					S		S
Trichlorobenzene				S						S		
(Other)									*			

Table Explanation

Letters in body of table give semiquantitative indication of concentration of substances in the head space, based on gas chromatographic analysis. T (trace), S (small), M (medium), L (large); SA (saturated), and SS (supersaturated) indications give relative peak heights and thus indicate relative amounts of the substances present in the headspace.
*: large amount of unknown substance, suspected to be a parathion degradation product.

Although a healthy adult may experience no acute or chronic health effects, as a result of a few hours exposure to this concentration of benzene, certain sensitive individuals exposed to this level are likely to experience symptoms such as headache, lassitude, or weariness, with more severe effects such as fainting occurring in hypersensitive individuals. The simultaneous presence of other toxic volatile organics in the air (Table 4) could be expected to increase the frequency and/or severity of adverse effects. In addition, the consumption of alcohol enhances the effects of these volatile solvents.

In view of conditions observed and tested in the park during this study the benzene exposure potential is high. For example the volatile substances are present in wastes located a few feet from the picnic grounds, a section in which both children and adults might easily spend several hours. High exposure levels might also result through actual leakage from the corrosion of buried drums.

3. Explosion and Fire Hazard. The presence of benzene and other highly flammable volatile organics and the possibility of subsequent accumulation of flammable vapors poses a significant explosion and fire hazard. Outdoor picnicking and use of charcoal grills contribute to this possibility, since coals are generally disposed of on the ground at the closest location. Other improperly extinguished flammables, such as matches or cigarettes, could also ignite these volatile organics. Any explosion or small fire present could spread quickly, since flammable wastes appear to be prevalent throughout the site.

4. Leachate Exposure. There are two possible mechanisms by which park users, particularly children, may come in contact with the contaminated leachate. First, a child with a pail and shovel could easily dig a hole one or two feet deep. Since the perched leachate was found near the surface during the field investigation, a shallow hole could fill with leachate and a facinated child could get it on his hands or feet. Some of these chemicals found in this water can be absorbed through the skin; however, ingestion of residues could occur from nail bitting, snacking, or eating with dirty hands.

There is a further possibility that, under heavy rain conditions, the perched leachate would rise and eventually reach the surface. Visitors or workers in the park could consequently come into direct contact with a wide variety of highly toxic materials.

It is possible to estimate the adverse effects expected from contact with the leachate from the concentrations of toxic contaminants found in the park. For example, one leachate sample contained 4.5 mg/l of parathion and the lowest known lethal dose has been determined as 3.6 mg. Therefore even small amounts of this leachate could easily cause noticeable health effects. However, the situation becomes more serious because among other things this same sample also contained 1.2 mg/l of mercury, 2.6 mg/l phenol, 4.2 mg/l benzene, 12 mg/l toluene and 80 mg/l of nitrophenol. The effect of a small amount of this leachate is difficult to predict but some manifestation of problems can be easily forecasted.

With toxic chemicals such as parathion and organic mercury compounds, indirect routes of ingestion must also be taken into account. Although we only encountered significant quantities of parathion in the leachate samples, it was also detected in two soil samples and the crystalline solid (location 14). There is a likelihood that deposits of relatively pure parathion, or a highly concentrated deposit of parathion-containing pesticide formulation, exists near the surface. A child would simply have to brush his hand or clothing against the chemical, or insert a finger in it and then place the finger in his mouth to obtain a lethal dose. The same scenario could be repeated with other toxic pesticides or other chemicals, and the result would be similar serious poisoning or death.

5. Skin Irritants. The park in its present state provides many possibilities for visitors to experience skin irritations or eye damage. The most significant skin irritants are phenols and coal tar residues. The tar residues, some of which have been positively identified as coal tar pitch, also create skin irritation problems due to their reaction with sunlight i.e., photosensitization. Since this tar is located all over the site, frequent skin contact can be expected. In addition, many other chemicals found at the site such as trichlorethylene, carbon tetrachloride and benzene are also primary irritants. Areas containing these irritants are easily accessible to all park users. Wearing summer clothing, such as shorts and sleeveless shirts increases the possibility of skin contact and of sunlight enhancing the effect.

D. Other Issues

While the toxicological dangers due to the industrial materials present at the park have already been discussed, there are several other factors related to the existing site conditions which could pose some degree of risk to park visitors or employees. These factors involve the site's potential to entrap runoff, leachate and liquid wastes, the prevalence of skin irritants, structural deficiencies, and the presence of hospital wastes such as syringes found over recently landscaped areas.

The potential to collect and entrap liquids exists throughout the site. Standing liquids were observed by Fred C. Hart Associates in surface depressions after a day of rainfall. Hard semi-impermeable layers of solidified waste residues which are present retard drainage and can serve as pockets to entrap surface runoff, leachate, and liquid wastes. While provisions were made to drain the parking areas and roads, no drainage system was constructed throughout the extensive site. Trapped liquids were noticed by the soil engineers, the construction contractors, and during the field work for this study.

Cutaneous sensitizers, such as poison ivy and poison oak, are also present at the site. Through an immunologic mechanism, these alter an individual's capacity to react to chemical substances. The extent of the reaction, however, varies with the individual. Poison ivy exists as an extensive ground cover throughout the site next to picnic areas, shelters, along trails and in open areas. Subcontractors used Amizine weed killer and "sterilized" the wood chip paths, but apparently no recent program was undertaken to control poison ivy or poison oak.

Deficiencies can be seen on various structures on the site. The broken steps and handrailings which were observed on the newly constructed stairs and on the existing wooden tie stairs could be injurious to visitors and employees unless repaired. Wooden cross braces were added as additional support to the framing of the picnic decks.

Portions of plastic syringes can be found on the recently landscaped areas. The source can be attributed most probably to the mushroom manure contractor who mixed hospital wastes with the manure before delivering it to the site. Since the syringes may have been discarded from a hospital, laboratory, or livestock area, their presence could indicate a source of laboratory chemicals and pathogenic viruses or bacteria to visitors or employees.

E. Conclusions

There are a number of undesirable aspects to the Neville Island Park site in its present condition. These range from relatively minor problems such as disrepair of structures and prevalent poison ivy to the more major problem of fire and explosion hazard. The most significant concern, however, is the presence of toxic chemicals in solid, liquid and gaseous form at or near the surface of the site.

Considering the chemicals present at the park site, their observed prevalence, measured concentrations, toxicological and synergistic properties and the possible exposure mechanisms of park visitors to those chemicals, users of the park could experience adverse health effects. The type and severity of adverse effects and the time at which such effects may occur are, of course, unpredictable. However, the present state of the site facilitates the exposure park visitors to a wide variety of harmful chemicals via inhalation, skin contact, or even ingestion; therefore, a public health threat does exist at the site.

APPENDIX A

RICHARDSON, GORDON AND ASSOCIATES

TEST PIT LOG

ORIGINAL
(Red)

PROJECT Neville Island Marine Park

JOB NO. 762 DATE 9-7-77 TEST PIT NO. TP - 3

LOCATION BL Sta. 80+42; 132' RT. G.S. ELEVATION 719.5

DEPTH	DESCRIPTION	REMARKS
4.0	Black industrial waste 0.2 feet of black silt on top of a tar like substance	Lab No. 77124 0.0 to 4.0
6.0	Gray sand and gravel	El. 713.5
8.0	Gray clayey silt. Moist	Est. top of Natural Ground
10.0	Brown clayey silt Water Content = 24.8% Classification = ML (based on Lab No. 77084)	Lab No. 77087

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ORIGINAL

DEPOSIT ANALYSIS (Red)

YRUS WM. RICE DIVISION
ICHARDSON, GORDON, AND ASSOC.
3 Gateway Center
Pittsburgh, PA 15222
ATTN:
Gerald Pitzer

Lab #77124

Client No. 0
Date Sampled NA
Date Received 10- 5-77
Date Reported 10-21-77

Sample Source
TP-3 Depth 0.0 - 4.0

Rice Sample No. 17100162
Client Sample No.

ELEMENTAL	A				
Silica (as SiO_2)	14		Potassium (as K_2O)		
Iron (as Fe_2O_3)	3.0		Lead (as PbO)		
Calcium (as CaO)	< 1		Tin (as SnO_2)		
Magnesium (as MgO)	< 1		Molybdenum (as MoO_2)		
Phosphorus (as P_2O_5)	< 1		Vanadium (as V_2O_5)		
Sulfur (as SO_3)	48		Titanium (as TiO_2)		
Copper (as CuO)	< 1		Cobalt (as CoO)		
Aluminum (as Al_2O_3)	3.5		Cadmium (as CdO)		
Sodium (as Na_2O)			Antimony (as Sb_2O_3)		
Manganese (as MnO_2)			Barium (as BaO)		
Nickel (as NiO)					
Zinc (as ZnO)					
Chromium (as Cr_2O_3)					
Chlorine (Cl)					
Fluorine (F)					

PHASE BY X-RAY DIFFRACTION	
Calcium Phosphate ($15CaO \cdot 2P_2O_5 \cdot H_2O$)	
Hydroxyapatite ($10CaO \cdot 3P_2O_5 \cdot H_2O$)	
Hydroxylapatite ($10CaO \cdot 3P_2O_5 \cdot H_2O$)	
Ferric Oxide (Fe_2O_3)	
Ferro-Ferric Oxide (Fe_3O_4)	
Copper (Cu)	
Calcium Carbonate ($CaCO_3$)	
Sodium Sulfate (Na_2SO_4)	
Silicon Dioxide (SiO_2)	
Alpha Quartz (α-SiO_2)	
Calcium Sulfate ($CaSO_4$)	
Serpentine ($3MgO \cdot 2SiO_2 \cdot 2H_2O$)	
Analcite ($Na_2O \cdot Al_2O_3 \cdot 4SiO \cdot 2H_2O$)	

Note: Remaining Solids Non-Crystalline

MISCELLANEOUS			
Water Soluble Matter		Loss on Ignition	82
Chloroform Extractable Matter	27	Carbon Dioxide (CO_2)	
pH ①	3.3		

All results reported in percentages unless otherwise indicated.
All results reported on an oil free sample except Chloroform Extractable Matter.

(A) X-ray Spectrographic Results (B) Emission Spectrographic Results (C) Wet Chemical Results

① 1 gm. sample / 100 ml DI water.

NUS CORPORATION

CYRUS WM. RICE DIVISION

ANALYTICAL SERVICES LABORATORY
15 NOBLE AVENUE • PITTSBURGH, PA 15205
412-343-9200

ORIGINAL
(Red)

RICHARDSON, GORDON AND ASSOCIATES
3 Gateway Center
Pittsburgh, PA 15222

ATTN: Gerald Pitzer

Client No. Q
Date Sampled NA
Date Received 10- 5-77
Date Reported 10-21-77

Test results reported in mg/liter unless otherwise noted.

Rice Sample No.	TP-3 Depth 0.0 - 4.0
17100822	#64
	The sample visually appears to be "tar-like," black and gummy with a thin layer of "solvent-like" material on the top. It has a sweet organic odor. No positive identification can be made by general inspection.

Project Mgr. ____________________

RICHARDSON, GORDON AND ASSOCIATES

TEST PIT LOG

PROJECT Neville Island Marine Park

JOB NO. 762 DATE 9-7-77 TEST PIT NO. TP-4

LOCATION BL Sta. 79+37; 25' RT. G.S. ELEVATION 718.2

DEPTH	DESCRIPTION	REMARKS
2.0	Brown Silty Sand and Gravel Water Content = 9.2% Classification = GP (based on Lab No. 77083)	Lab No. 77088
3.5	Gray Silty Sand and Gravel Black Seam with an Odor from 3.0 to 3.5 (tar like substance)	
4.5	Hard Gray Slag	El. 713.7
6.5	Stiff Brown Clayey Silt. Moist. Water content = 19.8% Classification = ML (based on Lab No. 77084)	Est. Top of Natural Ground Lab No. 77089

RICHARDSON, GORDON AND ASSOCIATES

TEST PIT LOG

ORIGINAL
(Red)

PROJECT Neville Island Marine Park

JOB NO. 762 DATE 9-12-77 TEST PIT NO. TP - 14

LOCATION BL Sta. 46+50; 40' RT. G.S. ELEVATION 721.2

DEPTH	DESCRIPTION	REMARKS
	Industrial waste Sawdust and wood chips soaked with a bluish green substance.	Lab No. 77123 ~~0.0 to 4.0~~
4.0		
	Reddish brown silty sand and gravel	Lab No. 77122 ~~4.0 to 7.0~~
7.0		El. 714.2
	Brown fine sandy, clayey silt. Moist	Est. top of natural ground
	Water Content = 19.0% Classification = ML-CL	Lab No. 77109
17.0	(Not to Scale)	

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DEPOSIT ANALYSIS

ORIGINAL

CYRUS WM. RICE DIVISION
RICHARDSON, GORDON, AND ASSOC.
3 Gateway Center
Pittsburgh, PA 15222
ATTN: Gerald Pitzer

Client No. 0
Date Sampled NA
Date Received 10- 5-77
Date Reported 10-21-77

Sample Source Lab #77122
TP-14 Depth 4.0 - 7.0

Rice Sample No. 17100160
Client Sample No.

ELEMENTAL

	A				
Silica (as SiO_2)	16		Potassium (as K_2O)		
Iron (as Fe_2O_3)	20		Lead (as PbO)		
Calcium (as CaO)	11		Tin (as SnO_2)		
Magnesium (as MgO)	1.5		Molybdenum (as MoO_2)		
Phosphorus (as P_2O_5)	<1		Vanadium (as V_2O_5)		
Sulfur (as SO_3)	31		Titanium (as TiO_2)		
Copper (as CuO)	<1		Cobalt (as CoO)		
Aluminum (as Al_2O_3)	3.5		Cadmium (as CdO)		
Sodium (as Na_2O)			Antimony (as Sb_2O_3)		
Manganese (as MnO_2)			Barium (as BaO)		
Nickel (as NiO)					
Zinc (as ZnO)					
Chromium (as Cr_2O_3)					
Chlorine (Cl)					
Fluorine (F)					

PHASE BY X-RAY DIFFRACTION

Calcium Phosphate ($15CaO \cdot 2P_2O_5 \cdot H_2O$)	
Hydroxyapatite ($10CaO \cdot 3P_2O_5 \cdot H_2O$)	
Hydroxylapatite ($10CaO \cdot 3P_2O_5 \cdot H_2O$)	
Ferric Oxide (Fe_2O_3)	
Ferro-Ferric Oxide (Fe_3O_4)	
Copper (Cu)	
Calcium Carbonate ($CaCO_3$)	
Sodium Sulfate (Na_2SO_4)	
Silicon Dioxide (SiO_2)	
Alpha Quartz (α-SiO_2)	
Calcium Sulfate ($CaSO_4$)	
Serpentine ($3MgO \cdot 2SiO_2 \cdot 2H_2O$)	
Analcite ($Na_2O \cdot Al_2O_3 \cdot 4SiO \cdot 2H_2O$)	

Note: Remaining Solids Non-Crystalline

MISCELLANEOUS

Water Soluble Matter		Loss on Ignition	19
Chloroform Extractable Matter	1.2	Carbon Dioxide (CO_2)	
pH ①	3.2		

All results reported in percentages unless otherwise indicated.
All results reported on an oil free sample except Chloroform Extractable Matter.

(A) X-ray Spectrographic Results (B) Emission Spectrographic Results (C) Wet Chemical Results

① 1 gm. sample / 100 ml DI water

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CYRUS WM. RICE DIVISION

ANALYTICAL SERVICES LABORATORY
15 NOBLE AVENUE • PITTSBURGH, PA. 15205
412-343-9200

DEPOSIT ANALYSIS

ORIGINAL
(Red)

RICHARDSON, GORDON, AND ASSOC.
3 Gateway Center
Pittsburgh, PA 15222
ATTN: Gerald Pitzer

Client No. 0
Date Sampled NA
Date Received 10- 5-77
Date Reported 10-21-77

Sample Source Lab #77123
TP-14 Depth 0.0 - 4.0

Rice Sample No. 17100161
Client Sample No.

ELEMENTAL

	A				
Silica (as SiO_2)	32		Potassium (as K_2O)		
Iron (as Fe_2O_3)	5.0		Lead (as PbO)		
Calcium (as CaO)	7.3		Tin (as SnO_2)		
Magnesium (as MgO)	< 1		Molybdenum (as MoO_2)		
Phosphorus (as P_2O_5)	< 1		Vanadium (as V_2O_5)		
Sulfur (as SO_3)	23		Titanium (as TiO_2)		
Copper (as CuO)	< 1		Cobalt (as CoO)		
Aluminum (as Al_2O_3)	5.0		Cadmium (as CdO)		
Sodium (as Na_2O)			Antimony (as Sb_2O_3)		
Manganese (as MnO_2)			Barium (as BaO)		
Nickel (as NiO)					
Zinc (as ZnO)					
Chromium (as Cr_2O_3)					
Chlorine (Cl)					
Fluorine (F)					

PHASE BY X-RAY DIFFRACTION

Calcium Phosphate ($15CaO \cdot 2P_2O_5 \cdot H_2O$)	
Hydroxyapatite ($10CaO \cdot 3P_2O_5 \cdot H_2O$)	
Hydroxylapatite ($10CaO \cdot 3P_2O_5 \cdot H_2O$)	
Ferric Oxide (Fe_2O_3)	
Ferro-Ferric Oxide (Fe_3O_4)	
Copper (Cu)	
Calcium Carbonate ($CaCO_3$)	
Sodium Sulfate (Na_2SO_4)	
Silicon Dioxide (SiO_2)	
Alpha Quartz (α-SiO_2)	
Calcium Sulfate ($CaSO_4$)	
Serpentine ($3MgO \cdot 2SiO_2 \cdot 2H_2O$)	
Analcite ($Na_2O \cdot Al_2O_3 \cdot 4SiO \cdot 2H_2O$)	

Note: Remaining Solids Non-Crystalline

MISCELLANEOUS

Water Soluble Matter		Loss on Ignition	19
Chloroform Extractable Matter	21	Carbon Dioxide (CO_2)	
pH 1	2.8		

All results reported in percentages unless otherwise indicated.
All results reported on an oil free sample except Chloroform Extractable Matter.

(A) X-ray Spectrographic Results (B) Emission Spectrographic Results (C) Wet Chemical Results

1 1 gm. sample / 100 ml DI water

Wood chips present

ORIGINAL
(Red)

RICHARDSON, GORDON AND ASSOCIATES

TEST PIT LOG

PROJECT Neville Island Marine Park

JOB NO. 762 DATE

TEST PIT NO. TP - 34

LOCATION BL Sta. 28+60; 15' Lt.

G.S. ELEVATION 720.1

DEPTH	DESCRIPTION	REMARKS
3.0	Industrial waste includes granulated slag, sand and burnt wood.	Lab No. 77121 0.0 to 3.0
	Gray slag that could not be penetrated with the Backhoe.	

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DEPOSIT ANALYSIS

ORIGINAL
~~(Red)~~

CYRUS WM. RICE DIVISION
RICHARDSON, GORDON, AND ASSOC.
3 Gateway Center ATTN:
Pittsburgh, PA 15222 Gerald Pitzer

Client No. 0
Date Sampled NA
Date Received 10- 5-77
Date Reported 10-21-77

Sample Source Lab #77121
TP-34 Depth 0.0 - 3.0

Rice Sample No. 17100159
Client Sample No.

ELEMENTAL

	A				
Silica (as SiO_2)	18		Potassium (as K_2O)		
Iron (as Fe_2O_3)	2.0		Lead (as PbO)		
Calcium (as CaO)	16		Tin (as SnO_2)		
Magnesium (as MgO)	3.5		Molybdenum (as MoO_2)		
Phosphorus (as P_2O_5)	<1		Vanadium (as V_2O_5)		
Sulfur (as SO_3)	46		Titanium (as TiO_2)		
Copper (as CuO)	<1		Cobalt (as CoO)		
Aluminum (as Al_2O_3)	1.5		Cadmium (as CdO)		
Sodium (as Na_2O)			Antimony (as Sb_2O_3)		
Manganese (as MnO_2)			Barium (as BaO)		
Nickel (as NiO)					
Zinc (as ZnO)					
Chromium (as Cr_2O_3)					
Chlorine (Cl)					
Fluorine (F)					

PHASE BY X-RAY DIFFRACTION

Calcium Phosphate ($15CaO \cdot 2P_2O_5 \cdot H_2O$)	
Hydroxyapatite ($10CaO \cdot 3P_2O_5 \cdot H_2O$)	
Hydroxylapatite ($10CaO \cdot 3P_2O_5 \cdot H_2O$)	
Ferric Oxide (Fe_2O_3)	
Ferro-Ferric Oxide (Fe_3O_4)	
Copper (Cu)	
Calcium Carbonate ($CaCO_3$)	
Sodium Sulfate (Na_2SO_4)	
Silicon Dioxide (SiO_2)	
Alpha Quartz (α-SiO_2)	
Calcium Sulfate ($CaSO_4$)	
Serpentine ($3MgO \cdot 2SiO_2 \cdot 2H_2O$)	
Analcite ($Na_2O \cdot Al_2O_3 \cdot 4SiO \cdot 2H_2O$)	

Note: Remaining Solids Non-Crystalline

MISCELLANEOUS

Water Soluble Matter		Loss on Ignition	18
Chloroform Extractable Matter	3.4	Carbon Dioxide (CO_2)	
pH ①	3.0		

All results reported in percentages unless otherwise indicated.
All results reported on an oil free sample except Chloroform Extractable Matter.

(A) X-ray Spectrographic Results (B) Emission Spectrographic Results (C) Wet Chemical Results

① 1 gm. sample / 100 ml DI water

Wood Chips Present

RICHARDSON, GORDON AND ASSOCIATES

TEST PIT LOG

0[illegible]

PROJECT Neville Island Marine Park

JOB NO: 762 DATE

TEST PIT NO. TP - 35

LOCATION BL Sta. 31+44; 20' RT.

G.S. ELEVATION 724.5

DEPTH	DESCRIPTION	REMARKS
4.0	Loose foundry sand	
6.0	Brown slag and gravel	
11.0	Black industrial waste with some areas of tar-like material.	El. 713.5
13.5	Brown fine sandy, clayey silt	Est. top of natural ground Rusted 4" pipe at 12.0'

RICHARDSON, GORDON AND ASSOCIATES

TEST PIT LOG

PROJECT Neville Island Marine Park

JOB NO. 762 DATE TEST PIT NO. TP - 43

LOCATION BL Sta. 82+53; 140' LT. G.S. ELEVATION 714.7

DEPTH	DESCRIPTION	REMARKS
	Industrial waste. Inter-mixed pockets of tar-like material and soft, white waste. The white waste had a paste type consistency.	Lab No. 77127 ~~3.0 to 4.0~~
10.0		
	Brown and gray silty sand	
12.0		

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15 NOBLE AVENUE • PITTSBURGH, PA. [illegible]
412-[illegible]

DEPOSIT ANALYSIS

YRUS WM. RICE DIVISION

CHARDSON, GORDON, AND ASSOC.
Gateway Center
ttsburgh, PA 15222

ATTN:
Gerald Pitzer

Client No. 0
Date Sampled NA
Date Received 10- 5-77
Date Reported 10-21-77

mple Source Lab #77127
P-43 Depth 3.0 - 4.0

Rice Sample No. 17100165
Client Sample No.

ELEMENTAL

	A				
Silica (as SiO_2)	9.0		Potassium (as K_2O)		
ron (as Fe_2O_3)	<1		Lead (as PbO)		
alcium (as CaO)	45		Tin (as SnO_2)		
Magnesium (as MgO)	16		Molybdenum (as MoO_2)		
hosphorus (as P_2O_5)	1.6		Vanadium (as V_2O_5)		
ulfur (as SO_3)	<1		Titanium (as TiO_2)		
Copper (as CuO)	<1		Cobalt (as CoO)		
luminum (as Al_2O_3)	2.5		Cadmium (as CdO)		
odium (as Na_2O)			Antimony (as Sb_2O_3)		
Manganese (as MnO_2)			Barium (as BaO)		
ickel (as NiO)					
inc (as ZnO)					
Chromium (as Cr_2O_3)					
Chlorine (Cl)					
orine (F)					

PHASE BY X-RAY DIFFRACTION

Calcium Phosphate ($15CaO \cdot 2P_2O_5 \cdot H_2O$)	
Hydroxyapatite ($10CaO \cdot 3P_2O_5 \cdot H_2O$)	
Hydroxylapatite ($10CaO \cdot 3P_2O_5 \cdot H_2O$)	
Ferric Oxide (Fe_2O_3)	
Ferro-Ferric Oxide (Fe_3O_4)	
Copper (Cu)	
Calcium Carbonate ($CaCO_3$)	
Sodium Sulfate (Na_2SO_4)	
Silicon Dioxide (SiO_2)	
Alpha Quartz (α-SiO_2)	
Calcium Sulfate ($CaSO_4$)	
Serpentine ($3MgO \cdot 2SiO_2 \cdot 2H_2O$)	
Analcite ($Na_2O \cdot Al_2O_3 \cdot 4SiO \cdot 2H_2O$)	

Note: Remaining Solids Non-Crystalline

MISCELLANEOUS

Water Soluble Matter		Loss on Ignition	41
Chloroform Extractable Matter	<0.5 (.34)	Carbon Dioxide (CO_2)	
pH ①	9.9		

esults reported in percentages unless otherwise indicated.
sults reported on an oil free sample except Chloroform Extractable Matter.

(A) X-ray Spectrographic Results (B) Emission Spectrographic Results (C) Wet Chemical Results

① 1 gm. sample / 100 ml DI water

RICHARDSON, GORDON AND ASSOCIATES

TEST PIT LOG

ORIGI

PROJECT Neville Island Marine Park

JOB NO. 762 DATE

TEST PIT NO. TP - 46

LOCATION BL Sta. 79+06; 115' LT.

G.S. ELEVATION 718.1

DEPTH	DESCRIPTION	REMARKS
1.0	Brown silty sand and gravel	
6.0	Gray granulated and run-of-bank slag	
8.0	Black industrial waste. A tar-like substance.	El. 710.1
9.0	Brown sandy silt	Est. top of natural ground

APPENDIX B

APPENDIX B

MAXIMUM CONCENTRATIONS OF TOXIC CHEMICALS FOUND IN WASTE SAMPLES AT OHIO RIVER PARK

COMPOUNDS	MATERIALS IN WHICH SAMPLES WERE DETECTED	MAXIMUM CONCENTRATION (MICROGRAMS PER LITER UNLESS OTHERWISE NOTED)
Volatile Organics:		
Benzene	P,T,C,S,L	6600(HS),5100(L)
Toluene	P,T,C,S,L	320(HS),1400(L)
Xylenes	P,T,C,S,L	400(HS)
Trimethylbenzene	P,T,C,S,L	Large* (HS)
Indane	T,S	Medium* (HS)
Methylindanes	T	Small* (HS)
Naphthalene	P,T,C,S,L	Saturated* (HS)
Methylnaphthalene	T	Small* (HS)
Chlorobenzenes	L	8
Dichlorobenzenes	P,T,C	Small* (HS)
Trichlorobenzenes	T,C	Small* (HS)
Polycyclic Aromatic Hydrocarbons (PAH)		
Acenaphthalene	T,L	Present[±] (T),32(L)
Fluorene	T,L	Present[±] (T),56(L)

A NDIX B (continued)

COMPOUNDS	MATERIALS IN WHICH SAMPLES WERE DETECTED	MAXIMUM CONCENTRATION (MICROGRAMS PER LITER UNLESS OTHERWISE NOTED)
Phenanthrene	T,L	Present$^{\pm}$ (T), 285(L)
Pyrene	T,L	Present$^{\pm}$ (T), 106(L)
Chrysene	T,L	Present$^{\pm}$ (T), 53(L)
Fluoranthene	T	Present$^{\pm}$ (T)
Anthracene	T,L	Present$^{\pm}$ (T), 285(L)
Benzo(a)pyrene	L	83(L)
Benzo(a)anthracene	L	53(L)
3,4 - Benzofluoranthene	L	113(L)
Benzo(k)fluroanthene	L	113(L)
Phenols:		
Phenolic compounds (as phenol)	T,L	36,500(L),104(T)
Phenol	T,L	3700(L)
2 - Chlorophenol	L	800(L)
2,4 - Dichlorophenol	L	15,000(L)
2,4,6 - Trichlorophenol	L	2400(L)
(p - Chlorometacresol)	L	<2(L)
4 - Nitrophenol	L	80,000(L)
2,4 - Dimitrophenol	L	136(L)

APPENDIX B (continued)

COMPOUNDS	MATERIALS IN WHICH SAMPLES WERE DETECTED	MAXIMUM CONCENTRATION (MICROGRAMS PER LITER UNLESS OTHERWISE NOTED)
<u>Chlorinated Solvents</u>		
Methylene Chloride	L	210
Carbon Tetrachloride	L	4
Chloroform	L	200
1,1,2,2 - Tetrachloroethane	L	6
1,2 - Dichloropropylene (cis)	L	240
Tetrachloroethylene	L	5
Trichloroethylene	L	<1
<u>Pesticides:</u>		
Parathion	L,Sl,C	4500(L),30 ug/g(Sl)
2,4 - D	L,Sl	4800(L),.14 ug/g(Sl)
2,4,5 - T	L,Sl	1200(L),.065 ug/g(Sl)
Silvex	L	50(L)
α- Benzene Hexachloride	L,Sl,C	1.7(L),.28 ug/g(Sl)
β- Benzene Hexachloride	Sl	.09 ug/g(Sl)
γ- Benzene Hexachloride	L,Sl,C	<1(L),.23 ug/g(Sl)
Heptachlor	L,C	<1(L),.02 ug/g(Sl)

NDIX B (continued)

COMPOUNDS	MATERIALS IN WHICH SAMPLES WERE DETECTED	MAXIMUM CONCENTRATION (MICROGRAMS PER LITER UNLESS OTHERWISE NOTED)
Other Organics:		
Dibenzofuran	T	Present
Phthalic Anhydride	C	50%
Ethylbenzene	L	43
N-Nitrosodimethylamine	L	3
Bis (2-Ethylhexyl) pthtlalate	L	50
Di-n-butylphthalate	L	33
D-n-octylphthalate	L	4
Diethylphthalate	L	4
N-nitrosodiphenylamine	L	10
Butylbenzylphthalate	L	2
Metals and Other Inorganics		
Antimony	L	400
Arsenic	L	<100
Copper	L	3200
Thallium	L	190
Mercury	L	1200
Lead	L	230

COMPOUNDS	MATERIALS IN WHICH SAMPLES WERE DETECTED	MAXIMUM CONCENTRATION (MICROGRAMS PER LITER UNLESS OTHERWISE NOTED)
Nickel	L	160
Manganese	L	16,000
Cyanide (total)	P,C,L	835 ug/g(C),360 ug/g(P), 1320(L)
Cyanide (free	L	Present$^{\theta}$

Explanation of Symbols

P, pigment; T, tar; C, crystalline solid; S, soil sample; L, leachate; Sl, organic sludge; HS, head space analysis of sample.

* quantitative data not available. Small, medium, large, and saturated indications give relative gas chromatographic analysis peak heights (no standard used)

‡ present, no quantitative data available

≤ indicates sum of two compounds not separated by method used

< indicates present, but quantitation not reliable at low concentration

θ "Phenolic compounds" includes all phenols except p-substituted phenols