AMOCO BALTIMORE ASPHALT (FORMER REFINERY) TERMINAL

PROPERTY HISTORY
&
ENVIRONMENTAL OVERVIEW

November 1994

SITE HISTORY AND EXISTING DEVELOPMENT CONDITIONS

Each year more than 4,000 ships and nearly 37 million tons of cargo pass through the marine terminals of the Baltimore Harbor making the Baltimore Harbor one of the great world ports. The Amoco Baltimore Asphalt (Former Refinery) Terminal (BAT) is located on Fishing Point in the Fairfield section of Baltimore Harbor. The location of BAT, in reference to the Fairfield area, is given in Figure 1.

The Mexican Petroleum Corporation purchased 19.7 acres of the Fishing Point water front property in July of 1919. The Corporation constructed a petroleum terminal on this site in 1922 and enlarged the site in 1925 with dredged fill to its current 48 acres. The terminal facilities were also expanded in 1925 by constructing a pipe still, oxidizing stills and cutback blending facilities on the added acreage (see Figure 2). The terminal property comprises of approximately 60 acres, with tanker deepwater frontage on the Patapsco River, and approximately 12 acres of the property (southern section) is submerged by the Patapsco River.

During the active refinery years the Terminal produced 7 basic penetration grades of paving asphalt and 3 basic penetration grades of industrial asphalt. The Terminal also operated a tank car repair shop and maintained a fleet of 1,000 company owned tank cars that served the east coast. An aerial photograph of the active refinery is given in Figure 3.

The Terminal's refinery operations were terminated in February of 1982 and on May 1, 1982 the Terminal operated officially as an asphalt storage (marketing) facility. Limited demolition was conducted in 1986; demolition activities included dismantling approximately 16 tanks, pipe stills, oxidizing stills, and boiler facilities. In August of 1990, the Terminal ceased all operations.

Current industrial activity in the Fairfield area includes the operation of 57 industries. Twelve sites are involved with petroleum storage and refining, 10 in chemical manufacturing, and 24 are involved in commodity storage and distribution. The remaining industries are primarily engaged in metal manufacture and fabrication, shipbuilding and repair, and general manufacturing. The industries and companies operating in Fairfield are listed and shown in Figure 1. Figure 4 is presented to display the major shipping channels, highways and railways of the Baltimore Harbor area.

FACILITY CLOSURE ACTIVITIES

Closure Plan

The Amoco Baltimore Asphalt (Former Refinery) Terminal currently holds an Oil Operations Permit issued by the Oil Control Section, Industrial Discharge Division, State of Maryland Department of the Environment (MDE), as required by Maryland Regulation COMAR 26.10.01.07. On June 7, 1990 the MDE issued a letter in conjunction with a modified Oil Operations permit

requiring Amoco to submit a closure plan for the BAT in anticipation of terminating the facility's operations. Dames & Moore, Inc. prepared a Draft Closure Plan for Amoco and the plan was accepted by the Oil Control Section (OCS) as adequately defining the objectives necessary to remove the aboveground oil storage systems.

As requested by the OCS, Amoco continued correspondence and discussions with the OCS as phased closure programs were implemented. Strategies, details and progress of handling the asphalt/oil residues from tank and transfer piping demolition were continually discussed.

Phased Demolition Activities

Prior to implementing closure activities, detailed inventories of the site were conducted to define and quantify the scope of work for terminal closure activities. A physical inventory of all site improvements and a detailed site wide asbestos inventory were conducted in the spring of 1991. The information collected was used to develop cost estimates, bid packages, permit plans, and technical specifications. Site conditions prior to facility closure activities are shown in the aerial photograph in Figure 5.

In preparation of closure activities pre-closure site work was undertaken. Due to the vast electrical power supply system both above and below ground, none essential electric lines were abandoned and active lines were labeled for worker safety. The oil/water separator was rehabilitated to serve as a storm water runoff management control for ground disturbing activities. A deep groundwater well that serviced the BAT's original boiler house was abandoned in accordance with MDE standards.

The largest pre-closure project was the site wide removal of all asbestos containing materials. The asbestos abatement project was competitively bid and awarded in October of 1991. The project was completed in December of the same year. All abated materials were properly wrapped, and were disposed of at an Amoco audited and approved disposal facility. Approximate quantities of the asbestos containing materials abated during the project are listed below:

- 6,000 linear feet of pipe insulation
- 83,000 square feet of transite building siding
- 10,500 square feet of tank insulation

The first phase of facility closure (Phase I Demolition) was conducted from October, 1992 through March, 1993. Major demolition activities included the demolition of three steel/concrete buildings totaling 63,000 square feet; 24 aboveground tanks, major facility pipelines including dock pipelines; and dock appurtenances. Phase II Demolition activities were immediately initiated in March, 1993 and were completed in September of 1993. Major demolition activities included dismantling 25 aboveground tanks, which included 3 - 53,000 barrel capacity tanks.

Surface asphalt ("pooled product") was excavated from the delineated work areas of Phase

I and II. Approximately 1,500 tons of asphalt and asphalt contaminated soils were disposed of at an Amoco audited and approved disposal facility. The work areas of Phase I and II were graded and stabilized with a gravel cover.

Phase III Demolition activities, removing abandoned underground pipes and sewer lines in the work areas of Phase I & II, was planned by Amoco as part of the BAT demolition program and was strongly supported by the OCS because the agency was encouraging facilities to implement underground line surveys to identify potential sources of subsurface contamination. Phase III activities were completed in March of 1994.

Current demolition activities at BAT, Phase IV activities, include the cleaning and demolition of the remaining aboveground tank. Tank No. 11 is a 36,000 barrel capacity tank that contained approximately 9,500 barrels of product and water. Tank cleaning and demolition activities are scheduled to be completed by the end of the year 1994.

Existing site conditions are depicted in the plot plan presented in Figure 6. The Terminal is free of aboveground tankage (tank no. 11 demolition in progress). Underground lines considered to have the potential of containing petroleum product(s) have been removed. The southern part of the site is free of pooled product and the surface of the southern part of the site is stabilized with gravel. A new discharge line from the oil/water separator to the City sanitary sewer has been installed. The existing structures on site include a two story brick office building near the Terminal's entrance; a steel frame and sheet metal warehouse located in the center of the Terminal; two deep water access docks; and an operational oil/water separator.

SITE SUBSURFACE INVESTIGATIONS

Subsurface Monitoring

Brown & Root Environmental (NUS) conducted monthly groundwater well sampling/monitoring events during 1991 and 1992, and annual sampling/monitoring events in 1993 and 1994. The information collected was used to determine groundwater flow direction and contours, and effects on the groundwater levels from tidal and surface water influences. As expected, groundwater flow is predominately towards the Patapsco River and Curtis Bay.

Subsurface/groundwater conditions at BAT are very encouraging, particularly in light of BAT's long refinery/terminal history. There are 22 monitoring wells at BAT (See Figure 7 for well locations and identification).

The latest groundwater well monitoring and sampling event was conducted from October 31 through November 2, 1994 (See Appendix A, with laboratory results and groundwater maps). Water level and liquid phase hydrocarbon (LPH) measurements were collected from all accessible wells. Groundwater samples were collected from accessible wells and analyzed for TPH, and BTEX, two

samples were analyzed for metals. Groundwater levels and flow direction were typical. Free product, LPH, was present in only 3 of the 22 wells: S-1 (0.21 feet), S-2 (0.41 feet) and S-14 (0.04 feet). The product found in well S-14 was suspect because of questionable well integrity. Well S-2 has consistently shown LPH during past monitoring events. NUS recovered product from the well from January to March 1992, but product recovery yields were low and it was concluded that one reason for the low product yield was that there is little LPH in the subsurface formation. The quantity of LPH measured in wells S-1 and S-2 during the 1994 monitoring event was less than expected and affirms the conclusion of minimal amounts of LPH in the subsurface formation.

The site's groundwater is not considered as a source of potable water; however, the USEPA and MDE maximum contaminant limits (MCL) for drinking water could be considered relevant as a comparative basis for weighing analytic results with relative levels of concern of the constituents detected. BTEX concentrations detected in the collected samples were below published MCL's with the exception of well S-2 where the benzene level was 0.016 ppm; the MCL for benzene is 0.005 ppm. Laboratory tests for the selected metals yielded non-detect (ND) levels for each of the five metals. A copy of the letter report prepared by NUS is presented in Appendix A.

At the present time, the subsurface remediation plan at BAT calls for continued annual groundwater well sampling/monitoring event and periodic monitoring and manual bailing of wells that consistently contain LPH.

Preliminary Subsurface Site Assessment

NUS also performed a preliminary subsurface site assessment during September and October, 1991. Activities included collection of subsurface soil and groundwater samples utilizing Geoprobe and Hydropunch II techniques respectively. Collected samples were field screened for relative volatile organic compounds (VOCs) using gas chromatography and headspace techniques. The activities of this initial phase were designed to obtain screening level chemical analytic information required to direct future subsurface site assessment activities. The second phase of the subsurface site assessment has not been undertaken.

EPA Screening Site Inspection

Ecology and Environment, Inc. (E&E) performed a screening site inspection (SSI) in March 1992 of the BAT at the direction of the United States Environmental Protection Agency (EPA) Alternative Remedial Contracting Strategy (ARCS). The BAT was assigned Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Identification Number MDD003093598, Dump Site Number MD-105. SSIs provide a preliminary site analysis to aid EPA in prioritizing sites according to the Hazard Ranking System (HRS).

Amoco has not received a formal report from the EPA prioritizing the BAT according to the HRS, nor has any request been made by the EPA to conduct additional field work. The SSI reported only the findings of the field work conducted by E&E and potential human health and ecological

risks, but did not present recommendations or conclusions pertaining to the further study or necessity of remedial actions at BAT. A copy of the February 1993 Screening Site Inspection report is provided as Appendix B.

Based on the analysis of soil, sediment, and groundwater samples collected by E&E as part of the site inspection at BAT, the SSI report selected 19 chemicals of potential concern at the BAT because of the chemicals toxicity and detected concentration. Analysis of the samples collected at the BAT indicated detectable levels of carcinogenic polycyclic aromatic hydrocarbons (PAHs), beryllium, bis(2-ethylhexyl) phthalate, two carcinogenic pesticides, arsenic, vanadium, and lead. A risk analysis of both human health and ecology was prepared as part of the SSI and was based on its analytic findings.

The estimated human health risks in the SSI assumes simultaneous and continuous exposure to the maximum observed concentrations of all the contaminants of potential concern detected in the soil, sediment, or groundwater at BAT. The estimated excess cancer risks from ingestion of contaminants in the site soil or sediment are approximately 3.5×10^{-5} for adults and 7.5×10^{-5} for children. The cancer risks associated with a hypothetical use of site groundwater as drinking water are 4.8×10^{-4} for adults and 2.3×10^{-4} for children. The hazard indices for soil and sediment ingestion were below 1 for both adults and children, indicating that no noncarcinogenic adverse effects would be expected to result from this potential exposure. The hazard indices for groundwater ingestion as drinking water were 12 for adults and 28 for children, indicating that noncarcinogenic adverse effects might result from the use of groundwater as drinking water.

These risk estimates are considered hyper-conservative because of the following three conservatives assumptions used in determining the risk estimates.

1. simultaneous and continuous exposure to concentrations of all contaminates;
2. exposure to highest concentration of contamination detected; and
3. selected sample collection locations, that were biased towards areas where contaminants were anticipated to be found, were considered representative of the site.

The EPA establishes the acceptable excess cancer risk for residential areas at $1X10^{-6}$ and therefore the excess cancer risk estimates presented in the SSI report for BAT should be viewed optimistically because of the conservative assumptions on which they are based and that the BAT will certainly be developed as an industrial property.

The risk estimates assuming the hypothetical use of site groundwater as drinking water warrant concern only because of the reported risk estimates but should not be considered applicable to the evaluation of this site because the use of site groundwater for this purpose is highly improbable.

Surface water and sediment samples were collected from the estuarine environment adjacent to the site. The benchmarks selected for the sediment were the effects range-low (ER-L) and effect

range-median (ER-M) values for sediments published by the Coastal and Estuarine Assessment Branch of the NOAA. One sediment sample exceeded the ER-L for polycyclic aromatic hydrocarbons (PAHs). Three sediment samples exceeded the ER-M for dieldrin. One sample exceeded the ER-L for chlordane and DDT and its metabolites (DDD and DDE). One sample exceeded the ER-M for lead. Conclusions cannot be drawn from the limited study presented in the SSI because background levels of contaminates were not established nor was there established a route of contamination of the offshore sediments from on-site pollutants. Surface water samples indicated only trace levels of Lindane and methoxychlor in one sample.

Amoco's position, based on the data presented in the SSI and the 1994 groundwater sampling event, is that, for industrial usage of the BAT property, the subsurface conditions at BAT pose negligible risk to human health and environmental receptors. Therefore, BAT should be considered suitable for industrial development.

REGULATORY/ENVIRONMENTAL ISSUES OF REDEVELOPMENT

The City of Baltimore has expressed interest in maintaining the use of the BAT property as an industrial waterfront with deep water access, and in redevelopment of the property and improvements of site appurtenances such as the docks and bulkheads, water, sewer, and electric utilities.

Normal plan submittals will be required by Baltimore City to obtain building and site disturbance (sediment and erosion control and storm water management) permits. The City of Baltimore recommends that a preliminary meeting be requested by the developer to discuss, informally with City agencies, the proposed redevelopment of the property. No submittals are required for the meeting and pencil sketches of the development strategies are typical. The meeting is not required by the City but may assist in reducing the time needed by the City to review, comment and approve the required development plans (i.e., resubmissions of the plans due to City comments, concerns, and requests may be minimal). The plan requirements presented by the City at the meeting may also reduce engineering costs, surveying costs, etc. incurred by the developer to prepare the plans.

Improvements to the docks and bulkhead may require permitting by the Army Corps of Engineers dependent on the extent of the improvements.

In addition to the normal submittal and approval process, the following issues will be specific to BAT:

- Critical Areas Management Program Regulations
- Flood Plain Issues
- Subsurface Conditions

Critical Areas Management Program ("CAMP")

The City of Baltimore's Critical Area Management Program became effective on June 4, 1988 and is based on the Maryland Regulation COMAR 14.15.01. The program identifies property within 1,000-feet landward of waters of the Chesapeake Bay as a critical area. The objective of CAMP is to protect the waters of the Chesapeake Bay by controlling the impact of human activities by reducing or offsetting the storm water runoff pollution associated with a developed property. The program also establishes a 100-foot non-development buffer zone landward from the waters edge, with special conditions for industries with water dependent facilities. CAMP regulations are triggered by ground disturbance activities in excess of 5,000 square feet by either the owner or developer.

The entire BAT property is located within the critical area as defined by CAMP and has approximately 3,400 linear feet of shoreline meeting the buffer zone definition. Property development plans will be required to include:

- Reducing or offsetting the storm water runoff pollution to a level ten percent below agreed baseline conditions.
- Specific criteria for water access development within the buffer zone.

100-Year Flood Plain Issues

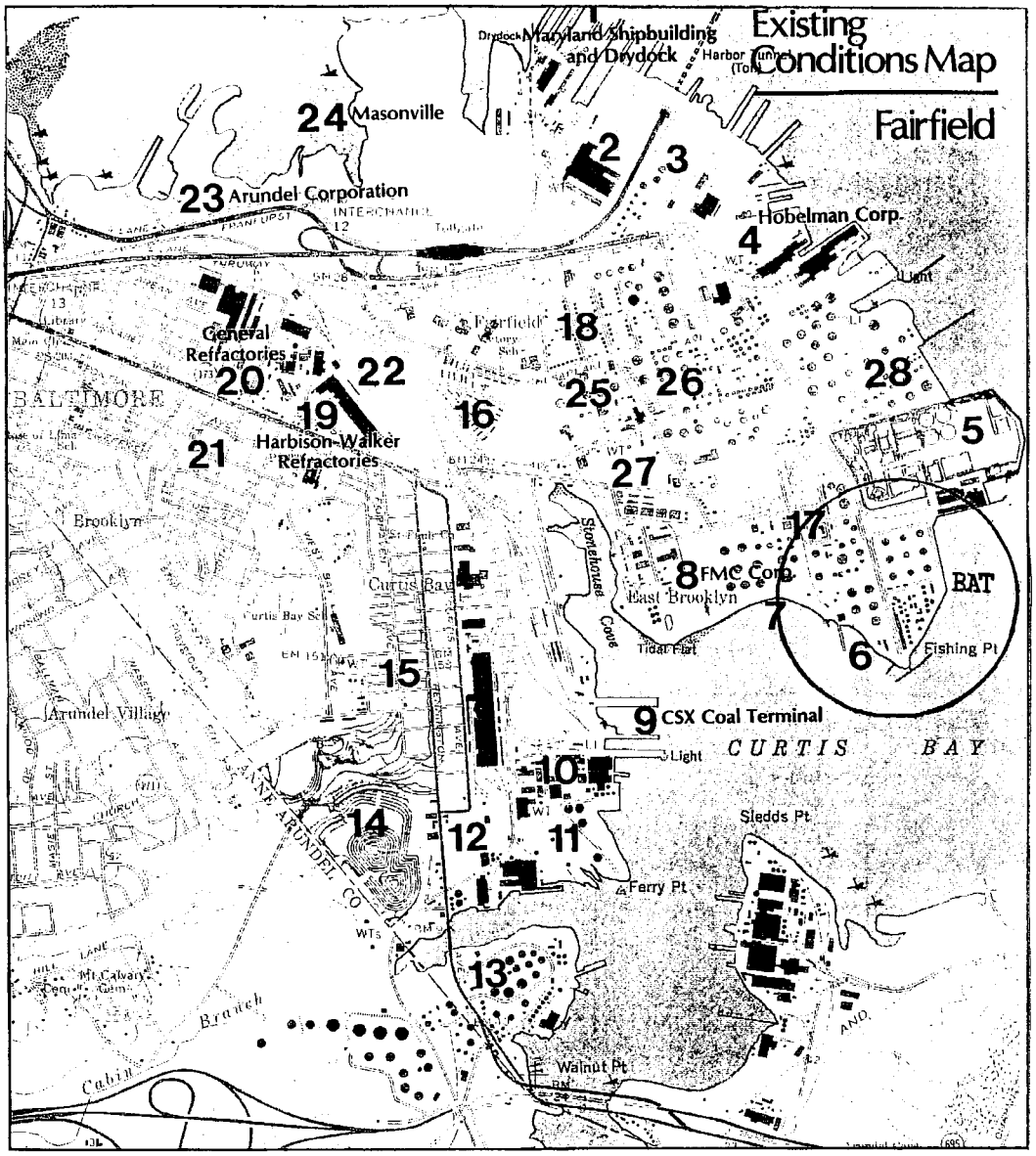
The property at BAT, and most neighboring properties, are within the 100-year flood plain. The elevation of the flood plain at BAT is 9.0 feet Mean Sea Level (MSL). The average land elevation at BAT is approximately 8.0 feet MSL, thus the majority of the site is anticipated to be inundated with 1-foot of water when the Patapsco River reaches maximum elevation during a 100-year flood event. Development within the flood plain is regulated by the City of Baltimore and is in accordance with the FEMA regulations.

The more stringent regulations for development are geared toward structures designed to house mechanical and electrical equipment or designed for human habitation (residential, office, etc.). These type of structures are required to be constructed such that the operation portions of the structure is 1.0-foot, minimum, above the flood plain elevation. Less stringent regulations are applied to proposed developments such as parking lots, warehouses, tankage, etc.

Subsurface Conditions

There are no obvious barriers to redevelopment of BAT based on the status of subsurface site evaluations. The EPA's Screening Site Inspection report did not present recommendations or conclusions pertaining to further study or the necessity of remedial actions at BAT. The information presented in the SSI report may be viewed positively in light of probable development strategies. The results of the 1994 groundwater monitoring/sampling event indicated no apparent restraints to industrial redevelopment of the property.

FIGURE 1

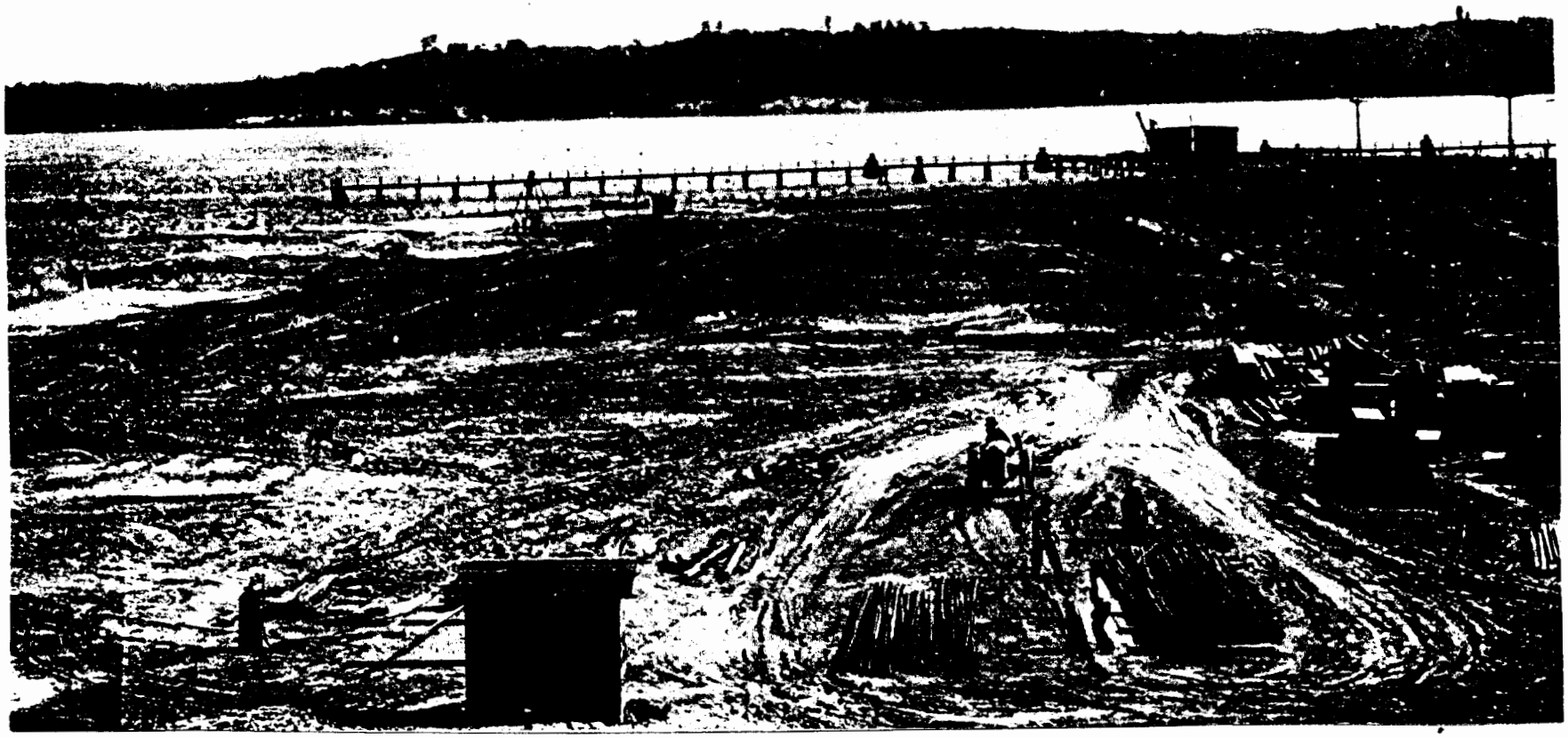


Map Key

Existing Uses

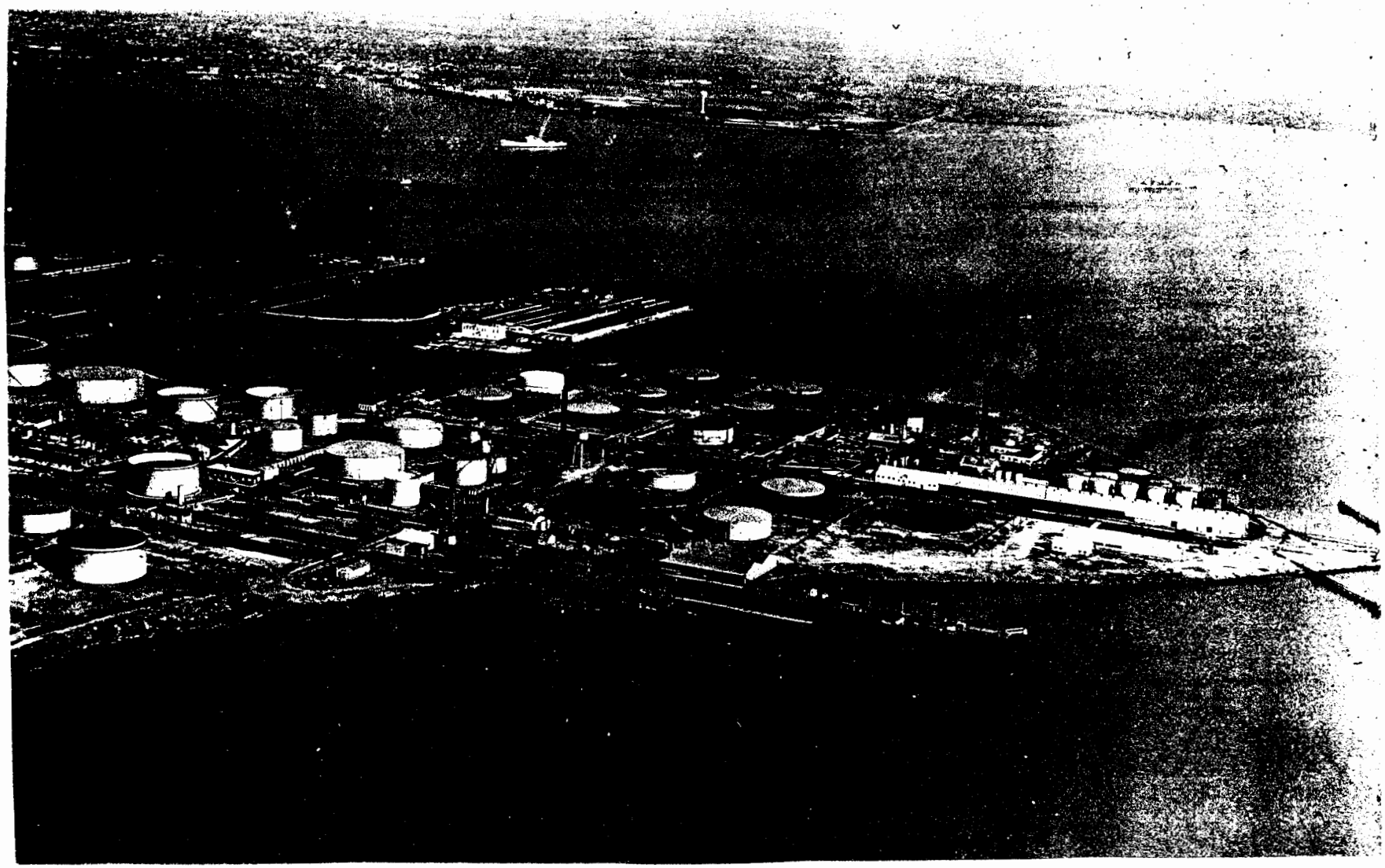
* 1. Maryland Shipbuilding and Drydock
2. Weyerhaeuser Co. - lumber storage
3. W.R. Grace - liquid products storage
* 4. Hobelman Corp. - import terminal
5. Patapsco Wastewater Treatment Plant
6. Texaco, Inc. - petroleum terminal
7. BP Oil Co. - petroleum terminal
* 8. FMC Corp. - organic chemicals
* 9. CSX Coal Terminal - storage and export
10. American Seamless Tubing - offshore drilling parts manufacture
11. Benhill Avenue Industrial Area
12. Essex Industrial Chemicals
13. Amerada Hess - petroleum terminal
14. Pennington Avenue Landfill - completed
15. Curtis Bay - residential community
16. Fairfield Homes Public Housing - residential community
17. Wagner's Point - residential community
18. Old Fairfield - residential community
*19. Harbison-Walker Refractories - firebrick manufacture
*20. General Refractories - firebrick manufacture
21. Brooklyn - residential community
22. CSX Rail Yards - coal car storage
*23. Arundel Corporation - Concrete materials
*24. Masonville - MPA dredge spoil disposal
25. Sun Oil Co. - petroleum terminal
26. Chevron Asphalt Co. - asphalt
27. Alcolac, Inc. - chemical manufacture
28. Shell Oil - petroleum terminal

Baltimore Asphalt (Former Refinery) Terminal - Location Map, Existing Industrial Development in Fairfield Section, Baltimore Harbor



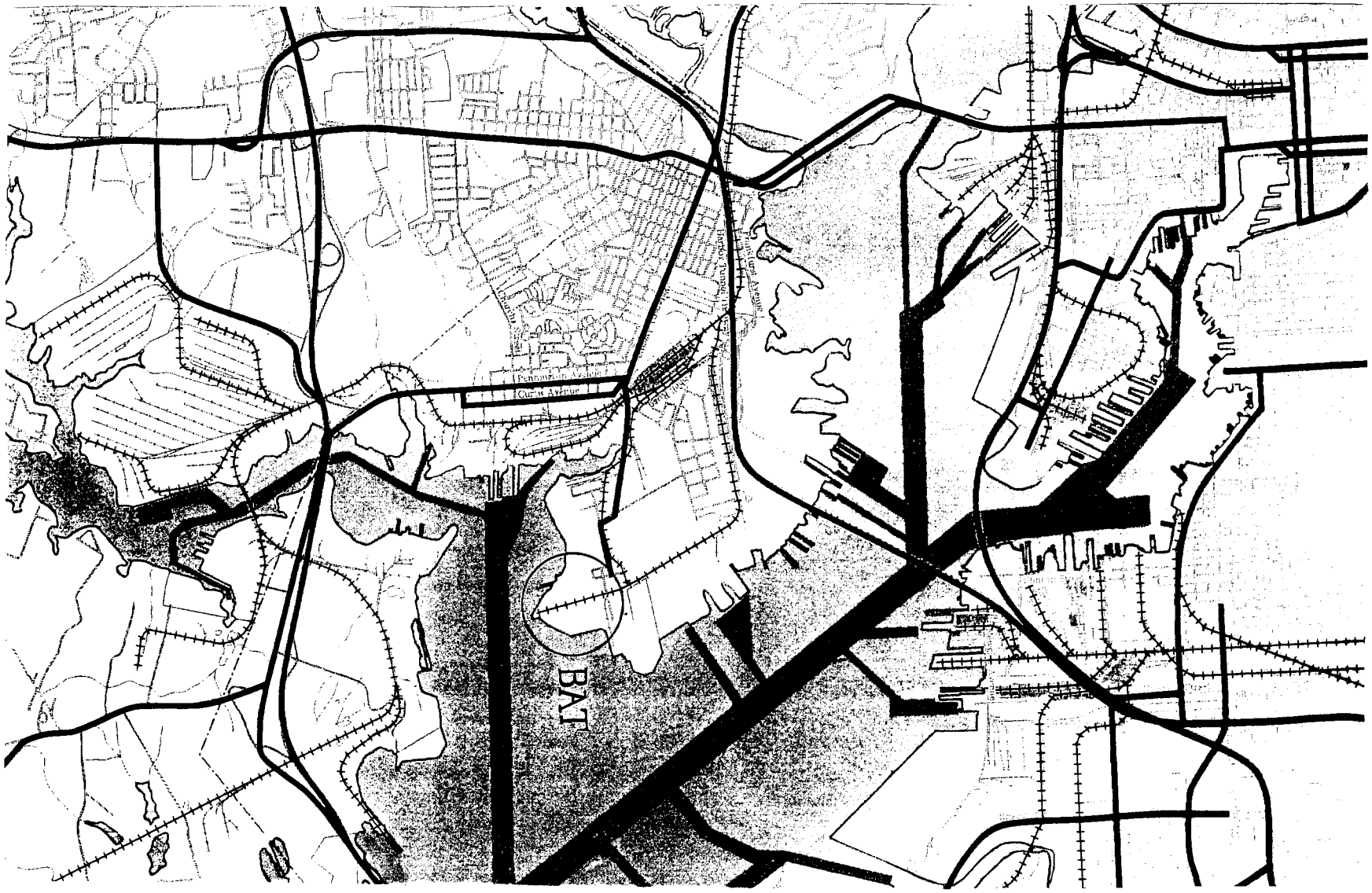
Baltimore Asphalt (Former Refinery) Terminal - Terminal Expansion to Begin on the South Part of the Facility, Photograph Dated to Approximately 1925

FIGURE 2



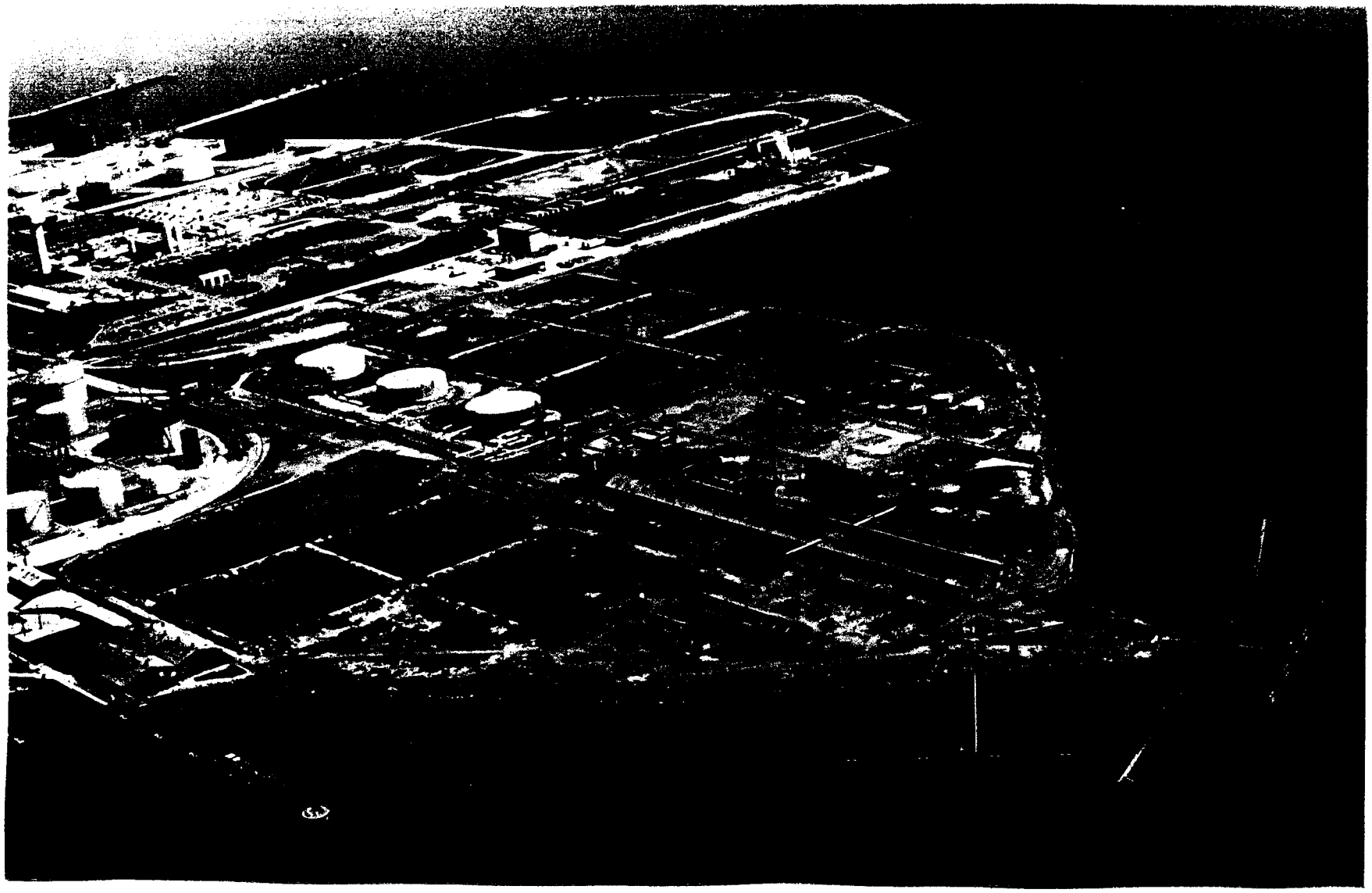
Baltimore Asphalt (Former Refinery) Terminal - Aerial Photograph, Active Refinery

FIGURE 3



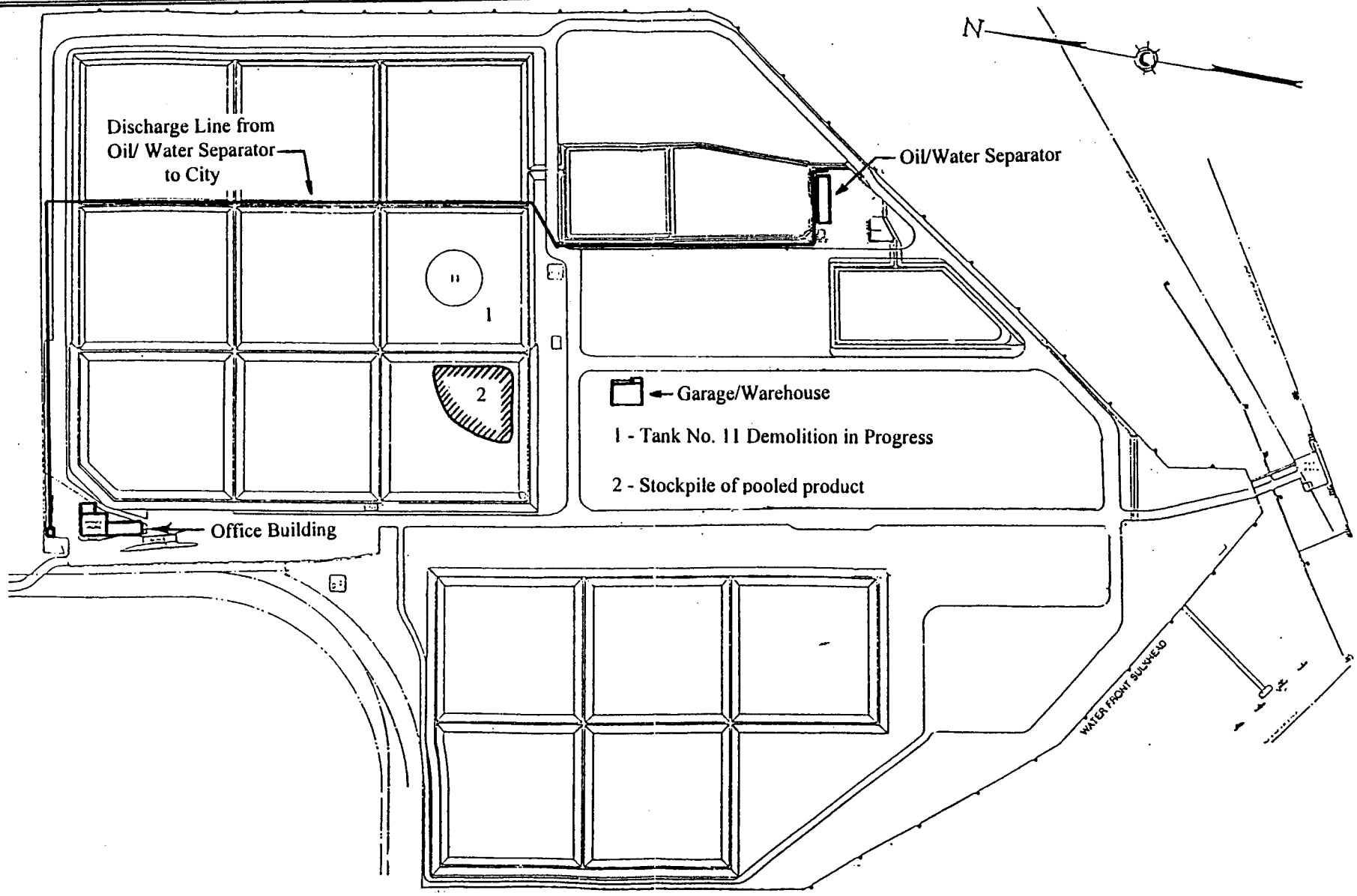
Baltimore Asphalt (Former Refinery) Terminal - Major Transportation Routes, Baltimore Harbor

FIGURE 4



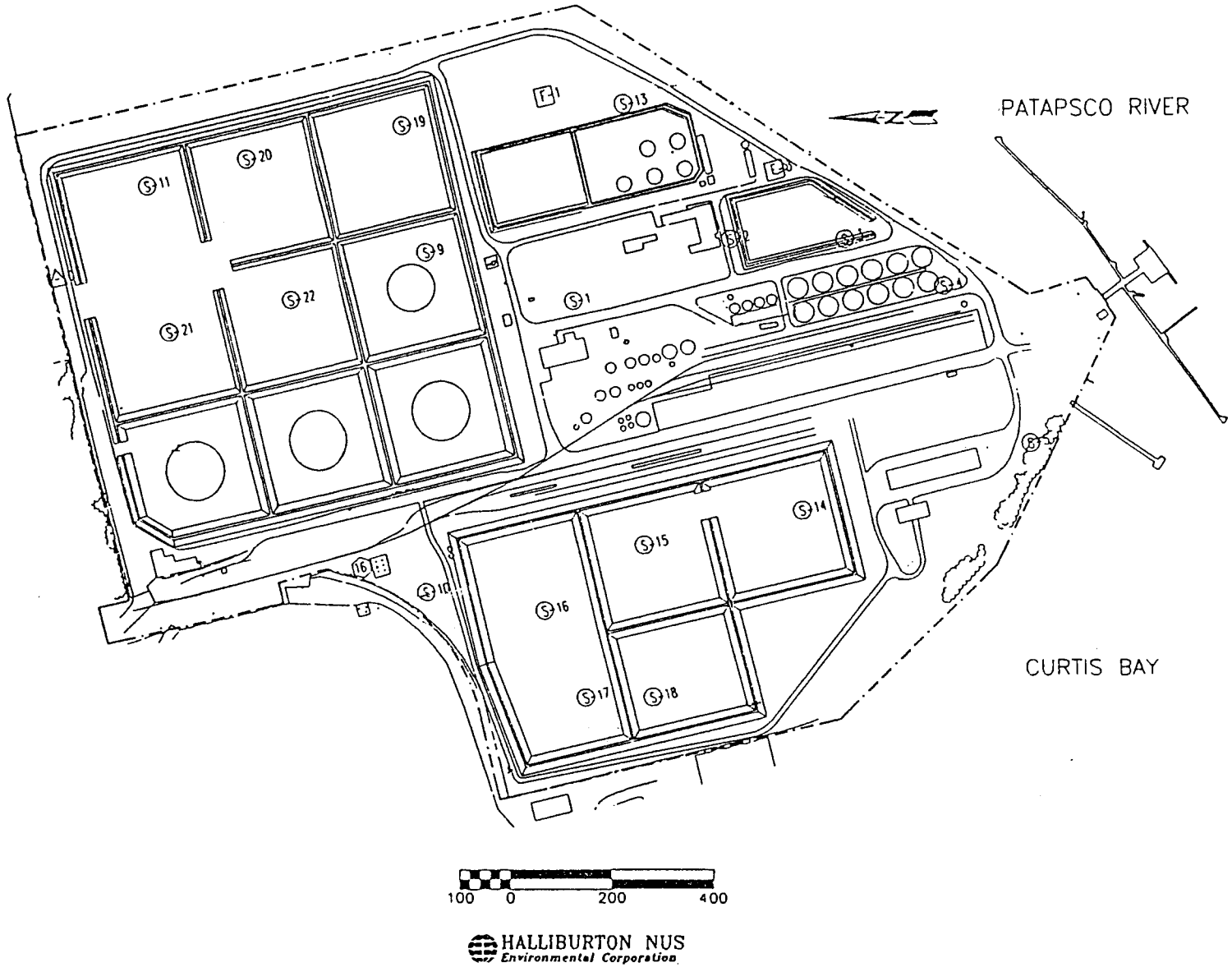
Baltimore Asphalt (Former Refinery) Terminal - Site Conditions Prior to Phased Demoltion (Facility Closure) Projects

FIGURE 5



Baltimore Asphalt (Former Refinery) Terminal - Plot Plan - Existing Site Conditions

FIGURE 6



Baltimore Asphalt (Former Refinery) Terminal - Location and Identification of Existing Groundwater Monitoring/Sampling Wells

FIGURE 7

Brown & Root Environmental

910 Clopper Road
Gaithersburg, MD 20878-1399

(301) 258-6000

2T58-OC-013

November 8, 1994

Mr. Michael Erickson
AMOCO Oil Company
1 West Pennsylvania Avenue
Suite 915
Towson, Maryland 21204

Subject: Baltimore Asphalt Terminal
October/November, 1994 Groundwater Monitoring Results

Dear Mr. Erickson:

This letter transmits the results of the sampling and analysis performed by Brown & Root Environmental (B&RE) in accordance with the authorized proposal dated October 27, 1994. The following discussion outlines the field activities and includes a brief description of the results of sampling and analysis and of the water level measurements.

Field Activities

Field activities were conducted at the Baltimore Asphalt Terminal (BAT) October 31 through November 2, 1994. Activities included collection of water level and free product measurements, and groundwater purging and sampling. Dedicated bailers were used in all cases. All purged fluids were transported to the on-site oil-water separator for processing. The team attempted to recover three well volumes during purging. When recharge was prohibitively slow, all the water in the well was evacuated and the well allowed to recover fully before purging again or sampling, depending on the recovery rate.

Several wells have been destroyed or lost, presumably during the demolition activities at the site. These are wells S-8 and S-12. Well S-11 was not sampled due to the high loading of large size red clay particles in the water removed from the well which indicates that the well screen may have collapsed or the casing severely compromised. In addition, as noted following the 1993 sampling, the well casing for S-5 is broken about 1-2 feet below the ground surface, though this well was sampled. Due to deep water or the presence of extremely soft bottoms in the impoundments, neither groundwater levels nor samples were obtained from wells S-16, S-17, S-18, and S-19.

Measurable free-phase product was present in wells S-1 (0.21 foot), S-2 (0.41 foot), and S-14 (0.04 foot). A sheen was noted in well S-3, although no measurable product layer was present, and a strong

odor was detected. Also, a dark "oily" substance was dispersed through the water column in that well.

Water level and free product thickness measurements were collected from all accessible wells on October 31, 1994. These measurements are presented on Table 1.

Two potentiometric maps, generated using the Surfer® PC-based contouring package, are also attached. Figure 1 illustrates the potentiometric interpretation including the perched water levels measured in the wells located in the impoundments. The other map (Figure 2.) shows the interpreted potentiometric surface without including the impoundment wells. The maps were developed based upon ground elevations from a previous land survey. The distance from top of casing to the ground surface was measured manually in the field.

Quality assurance/quality control samples included a trip blank (TB-110294), a field blank (FB-1-110294), and field duplicates (S100-110194 duplicate for metals analysis for S10-110194; S100-110194 duplicate for dissolved hydrocarbons analysis for S22-110194; and S99-110194 duplicate for dissolved hydrocarbons analysis for F3-110194). The QA/QC samples indicate acceptable precision. The field blank contained xylenes at 0.001 mg/l (the method detection limit). The trip blank contained no detectable levels of BTEX or TPH indicating that the xylenes in the field blank are from either the ambient air, the distilled water or the sample bottles.

Groundwater Analytical Results

Groundwater samples collected for dissolved hydrocarbons analyses were processed in the field according to the procedures provided by the AMOCO Groundwater Management Services (GMS) Lab. The contents of the supplied 2 ml Freon vials were added to the specified I-Chem (blue cap) 40 ml sample bottles and shaken to extract and preserve the sampled groundwater. The samples were analyzed by GMS for benzene, toluene, ethylbenzene and xylenes (BTEX) and total petroleum hydrocarbon (TPH) using the AMOCO Modified 8015 Method.

In addition, two samples were collected (wells S-5 and S-10), filtered and analyzed for dissolved beryllium, cadmium, chromium, lead and nickel. A duplicate sample was also obtained from S-10. The samples were chilled and picked up by lab courier on-site within one hour and taken to the laboratory for immediate filtration and processing. The inorganic analyses were performed by Chemalysis (Savage, Maryland) within twenty four hours of sample receipt.

Accurate chain-of-custody was maintained and recorded on appropriate forms for all samples. The groundwater analytical results are presented on the attached laboratory reports.

No dissolved metals were detected in groundwater collected from wells S-5 and S-10, and none of the tested dissolved metals were detected in the duplicate sample.

BTEX compounds were detected in five wells at total concentrations ranging from 0.006 to 0.252 mg/l. Three of these five wells contained measurable free product. Volatiles (C6 to C11 hydrocarbons) were detected at 10 and 5 mg/l in wells S-2 and S-14, respectively. Semivolatiles (C12 to C22 hydrocarbons) were detected in four wells at concentrations ranging from 6 to 175 mg/l. The well samples with detected concentrations of dissolved hydrocarbons are listed on Table 2, attached.

Should you have any questions or require clarification please call me at (301) 258-8557.

Sincerely,

Jeffrey L. Thielker
Project Manager

Enclosure

cc: E. Novak
Project File 2T58

TABLE 1
WATER LEVEL MEASUREMENTS - 11/94
AMOCO BALTIMORE ASPHALT TERMINAL

Well Number	Time (10/31/94)	Depth to Water from Top of Casing (feet)	Comments
S-1	1140	5.78 (product) 5.99 (water)	
S-2	1155	4.31 (product) 4.72 (water)	
S-3	0940	6.17	turbid-black & sheen noted
S-4	0915	5.89	sheen noted
S-5	0910	6.08	sheen noted
S-8	Lost	NA	
S-9	1130	4.36	sheen noted
S-10	0830	2.24	sheen noted
S-11	1100	5.22	high particulate load - not sampled
S-12	Lost	NA	
S-13	1035	5.11	sheen noted
S-14	0900	2.81 (product) 2.85 (water)	viscous clay/bentonite
S-15	1115 (11/2/94)	4.07	
S-16	Inaccessible	NA	
S-17	Inaccessible	NA	
S-18	Inaccessible	NA	
S-19	Inaccessible	NA	
S-20	1110	3.22	
S-21	1125	2.77	
S-22	1115	2.20	
F-1	1040	3.61	black particulates
F-3	1030	8.41	sheen noted
F-10	1055	4.63	sheen noted
16	0835	3.95	

TABLE 2
GROUNDWATER CHEMICAL RESULTS - ORGANIC ANALYSES
AMOCO BALTIMORE ASPHALT TERMINAL - 11/94

Well	Benzene (mg/l)	Toluene (mg/l)	Ethyl benzene (mg/l)	Xylenes (mg/l)	Volatile (mg/l)	Semi-Volatile (mg/l)
S-1	ND	ND	ND	0.006	ND	6
S-2	0.016	0.020	0.030	0.186	10	94
S-3	ND	0.003	0.002	0.008	ND	ND
S-9	ND	ND	ND	ND	ND	8
S-13	ND	0.002	0.003	0.008	ND	ND
S-14	ND	0.004	0.008	0.081	5	175
F-3D	ND	ND	ND	ND	ND	ND
S-22D	ND	ND	ND	ND	ND	ND
S-10D	ND	ND	ND	ND	ND	ND
FB	ND	ND	ND	0.001	ND	ND
TB	ND	ND	ND	ND	ND	ND

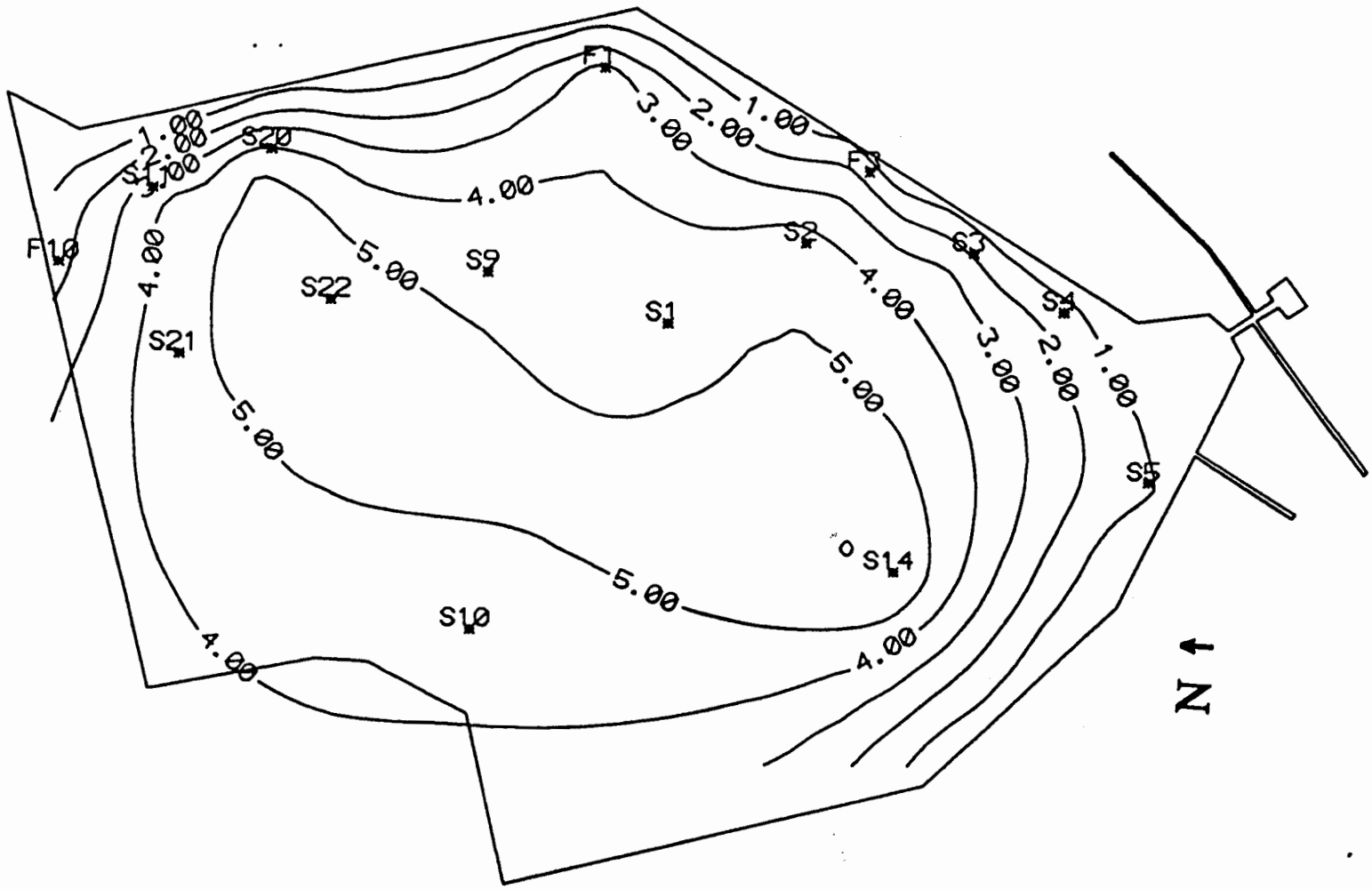
Notes:

Detection Limit for BTEX = 0.001 mg/l
Detection Limit for Volatiles & Semi-Volatiles = 1 mg/l
ND = Not detected at or above detection limits
D = Duplicate sample
FB = Field Blank
TB = Trip Blank

Figure 1.

IMPOUNDMENT WELLS INCLUDED

POTENTIOMETRIC MAP-AMOCO, BALT., NOVEMBER, 1994



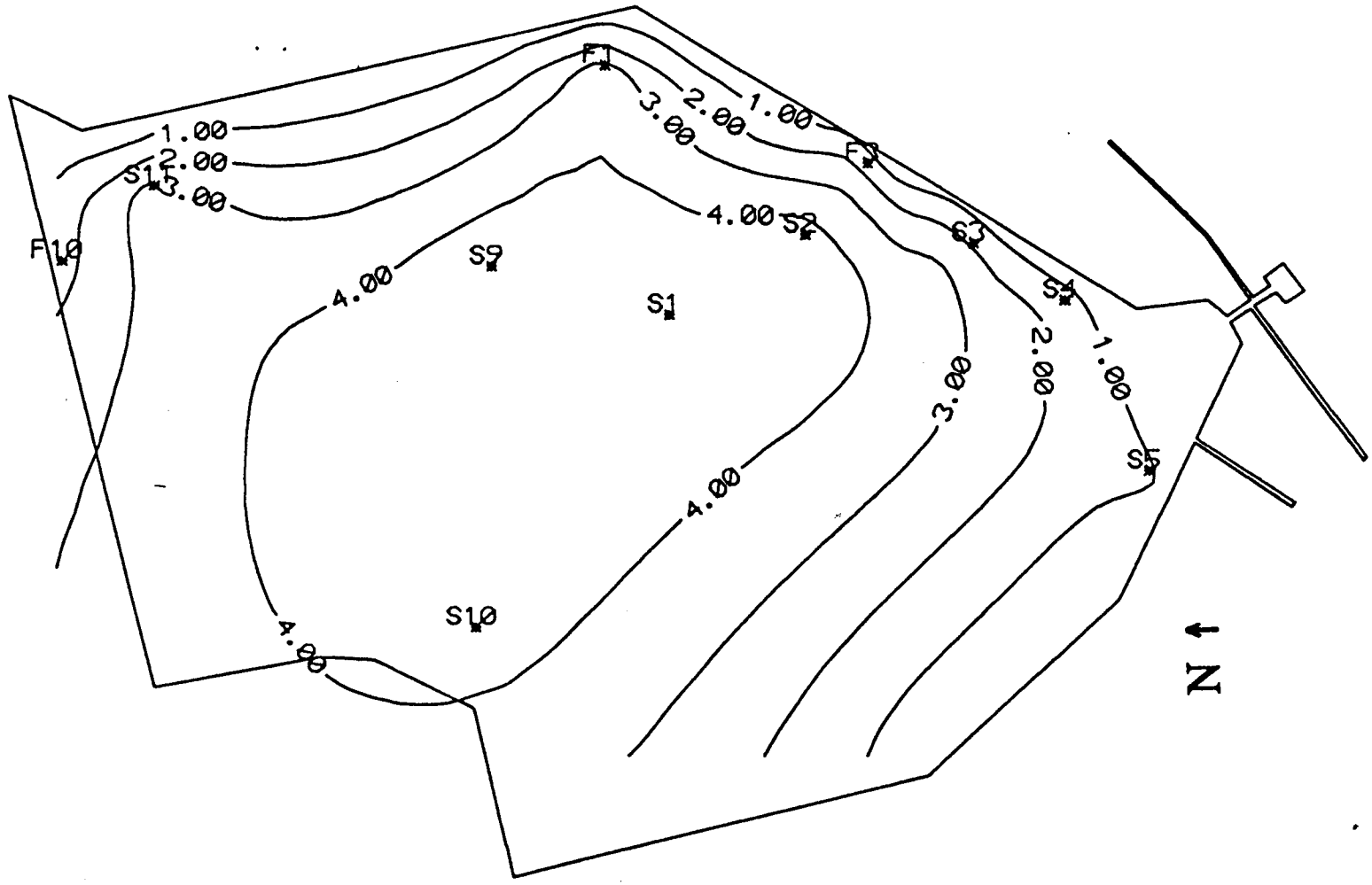
NOTES:

1. Contour elevations are Mean Sea-Level.
2. Reference elevations (top of casing) are surveyed ground surface elevations plus hand-measured stick-up length.

Figure 2.

IMPOUNDMENT WELLS NOT INCLUDED

POTENTIOMETRIC MAP-AMOCO, BALT., NOVEMBER, 1994



NOTES:

1. Contour elevations are Mean Sea-Level.
2. Reference elevations (top of casing) are surveyed ground surface elevations plus hand-measured stick-up length.

AMOCO CORPORATION: GROUNDWATER MANAGEMENT SERVICES
ANALYTICAL RESULTS FOR
DISSOLVED HYDROCARBONS IN WATER

Location: Baltimore Asphalt Terminal/ 3901 Asiatic Avenue/ Baltimore/ MD

Lab Number: 94W2457 Method: AMOCO Modified 8015

Date Sampled: 11/01-02/94 Date Extracted: 11/03/94

Date Received: 11/03/94 Date Analyzed: 11/03-04/94

Sample ID	Benz	Tolu	EtBz	Xyls	Total BTEX
TB-110294	ND	ND	ND	ND	ND
FB-1-110294	ND	ND	ND	0.001	0.001
F1-110194	ND	ND	ND	ND	ND
F3-110194	ND	ND	ND	ND	ND
F10-110194	ND	ND	ND	ND	ND
S1-110294	ND	ND	ND	0.006	0.006
S2-110194	0.016	0.020	0.030	0.186	0.252
S3-110194	ND	0.003	0.002	0.008	0.013
S4-110194	ND	ND	ND	ND	ND
S5-110194	ND	ND	ND	ND	ND
S9-110294	ND	ND	ND	ND	ND
S10-110194	ND	ND	ND	ND	ND
S13-110194	ND	0.002	0.003	0.008	0.013
S14-110194	ND	0.004	0.008	0.081	0.093
S15-110294	ND	ND	ND	ND	ND
S20-110294	ND	ND	ND	ND	ND
S21-110194	ND	ND	ND	ND	ND

AMOCO CORPORATION: GROUNDWATER MANAGEMENT SERVICES
ANALYTICAL RESULTS FOR DISSOLVED HYDROCARBONS IN WATER

Sample ID	Benz	Tolu	EtBz	Xyls	Total BTEX
S22-110194	ND	ND	ND	ND	ND
S99-110194	ND	ND	ND	ND	ND
S100-110194	ND	ND	ND	ND	ND
16-110194	ND	ND	ND	ND	ND

NOTES
1. Unit of data is mg/L.
2. ND = not detected at or above reporting limit.
3. Benz = benzene Tolu = toluene EtBz = ethylbenzene Xyls = xylenes.
4. Reporting limit for benzene - toluene - ethylbenzene - and each xylene is 0.001 mg/L.

Flags: D - Dilution factor = 20
E - Estimate only; Value is above working linear range.
I - Not quantifiable due to matrix interference.

Comments:

Sampled by: Brown & Root Environmental -- J. Dustin Ferris

Checked by: Judy A. Parli

AMOCO CORPORATION: GROUNDWATER MANAGEMENT SERVICES

ANALYTICAL RESULTS FOR PETROLEUM HYDROCARBONS IN WATER

Location: Baltimore Asphalt Terminal/ 3901 Asiatic Avenue/ Baltimore/ MD

Lab Number: 94W2457 Method: AMOCO Modified 8015

Date Sampled: 11/01-02/94 Date Extracted: 11/03/94

Date Received 11/03/94 Date Analyzed: 11/03-04/94

Sample ID	Volatiles	Semi-Vol.	TOTAL
TB-110294	ND	ND	ND
FB-1-110294	ND	ND	ND
F1-110194	ND	ND	ND
F3-110194	ND	ND	ND
F10-110194	ND	ND	ND
S1-110294	ND	6	6
S2-110194	10	94	104
S3-110194	ND	ND	ND
S4-110194	ND	ND	ND
S5-110194	ND	ND	ND
S9-110294	ND	8	8
S10-110194	ND	ND	ND
S13-110194	ND	ND	ND
S14-110194	5	175	180
S15-110294	ND	ND	ND
S20-110294	ND	ND	ND
S21-110194	ND	ND	ND

AMOCO CORPORATION: GROUNDWATER MANAGEMENT SERVICES

ANALYTICAL RESULTS FOR PETROLEUM HYDROCARBONS IN WATER

Sample ID	Volatiles	Semi-Vol.	TOTAL
S22-110194	ND	ND	ND
S99-110194	ND	ND	ND
S100-110194	ND	ND	ND
16-110194	ND	ND	ND

NOTES
1. ND = Not Detected at or above reporting limit.
2. Unit of data is mg/L.
3. Volatiles = C6 to C11 range hydrocarbons.
   Semi-volatiles = C12 to C22 range hydrocarbons.
4. The reporting limit for PHCs by GC is 1 mg/L for volatiles and 1 mg/L for semi-volatiles.

Flags:
E = Estimate; value is above working linear range.
I = Not quantifiable due to matrix interference and/or dilution.

Comments:

Sampled by: Brown & Root Environmental -- J. Dustin Ferris

Checked by: Judy A. Parli

ChemAlysis Incorporated

Inorganic Analysis Results

Client:	Halliburton NUS	Date Sampled:	11/01/94
Client ID:	S-4	Matrix:	Water
Lab ID:	94NU1-19		

CAS Number	Element	EPA Method	Analysis Date	Quantitative Detection Limit (mg/L)	Concentration Detected (mg/L)
7440-41-7	Beryllium	200.7	11/02/94	0.005	ND
7440-43-9	Cadmium	200.7	11/02/94	0.020	ND
7440-47-3	Chromium	200.7	11/02/94	0.040	ND
7439-92-1	Lead	200.7	11/02/94	0.100	ND
7440-02-0	Nickel	200.7	11/02/94	0.050	ND

ND: Denotes less than stated quantitative detection limit

QC Information

Archive:	A:\94NU1-19	Metals Dup/MS:	94NU1-19

ChemAlysis Incorporated

Inorganic Analysis Results

Client:	Halliburton NUS	Date Sampled:	11/01/94
Client ID:	S-10	Matrix:	Water
Lab ID:	94NU1-20		

CAS Number	Element	EPA Method	Analysis Date	Quantitative Detection Limit (mg/L)	Concentration Detected (mg/L)
7440-41-7	Beryllium	200.7	11/02/94	0.005	ND
7440-43-9	Cadmium	200.7	11/25/94	0.020	ND
7440-47-3	Chromium	200.7	11/02/94	0.040	ND
7439-92-1	Lead	200.7	11/02/94	0.100	ND
7440-02-0	Nickel	200.7	11/02/94	0.050	ND

ND: Denotes less than stated quantitative detection limit

QC Information

Archive:	A:\94NU1-19	Metals Dup/MS:	94NU1-19

ChemAlysis Incorporated

Inorganic Analysis Results

Client:	Halliburton NUS	Date Sampled:	11/01/94
Client ID:	8-100	Matrix:	Water
Lab ID:	94NU1-21		

CAS Number	Parameter	EPA Method	Analysis Date	Quantitative Detection Limit (mg/L)	Concentration Detected (mg/L)
7440-41-7	Beryllium	200.7	11/02/94	0.005	ND
7440-43-9	Cadmium	200.7	11/02/94	0.020	ND
7439-47-3	Chromium	200.7	11/02/94	0.040	ND
7439-92-1	Lead	200.7	11/02/94	0.100	ND
7440-02-0	Nickel	200.7	11/02/94	0.050	ND

ND: Denotes less than stated quantitative detection limit

QC Information

Archive:	A:\94NU1-19	Metals Dup/MS:	94NU1-19

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Prog. file SF91

US EPA, Region III
Reviewed and Approved

MAR 26 1993

By Michael Lawrence
Site Assessment Section

ZE070 D3882
FINAL

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SCREENING SITE INSPECTION OF THE AMOCO OIL COMPANY SITE

EPA IDENTIFICATION NO. MDD003093598
DUMP SITE NO. MD-105

February 1993

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ZE070_D3879-02/16/93-D1

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1. INTRODUCTION

1.1 AUTHORIZATION

Ecology and Environment, Inc. (E & E) performed a screening site inspection (SSI) of the Amoco Oil Company (Amoco) site located in Baltimore, Baltimore County, Maryland under United States Environmental Protection Agency (EPA) Alternative Remedial Contracting Strategy (ARCS) Contract No. 68-W8-0085. This report was prepared under Work Assignment No. 85-10-3JZZ. The site has been assigned Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Identification Number MDD003093598, Dump Site Number MD-105.

1.2 SCOPE OF WORK

SSIs provide a preliminary site analysis to help EPA prioritize site according to the Hazard Ranking System (HRS). SSIs are the second phase of the pre-remedial screening process that EPA uses to determine whether a site should be added to the National Priorities List (NPL). The major components of an SSI include background research, field work, and the generation of an SSI report.

1.3 SUMMARY

The Amoco site is located at 3901 Asiatic Avenue, Baltimore, Baltimore County, Maryland. The site is bordered by the Patapsco River and Curtis Bay, which are part of the Chesapeake Bay Estuary system. The site was initially operated by Amoco (then known as the Mexican Petroleum Corporation) as a storage and transfer terminal for gasoline and kerosene in 1922. The site was later converted to an oil refinery

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that produced asphalt, light gas oil, medium gas oil, and heavy gas oil. A research laboratory, asphalt packaging facilities, various maintenance facilities, utility stations, and shipping/receiving operations were associated with the petroleum refinery. Asphalt production and other refining operations ceased in February 1982. Between February 1982 and August 1990, the site operated as an asphalt packaging terminal (NUS 1990). All packaging, refining, and storage operations ended in August 1990. Current operations at the site consist of remedial efforts, including dismantling storage tanks and collecting samples of soil and groundwater (E & E 1992).

The 48-acre Amoco site consists of an approximately 5,000-square-foot area where tank cars were cleaned; an approximately 31,250-square-foot area where laboratory wastes were buried; an approximately 10,000-square-foot area where drums of unknown material were buried; an approximately 5,000-square-foot area where a cooling tower was formerly located; and an area on the southeast side of the site where a filter backwash lagoon and a sludge pond were formerly located (NUS 1990; E & E 1992). Also located at the site is an inactive oil/water separator located on the southeast side of the site that was taken off line in 1971.

Areas of concern at the site include the tank car area and the former cooling tower area. Also of concern is on-site groundwater and the possible off-site migration of compounds via surface water runoff or groundwater to the Patapsco River and Curtis Bay areas adjacent to the site.

E & E performed a site investigation of the Amoco site on March 17, 18, and 19, 1992. Analysis of samples collected at the site indicated elevated levels of carcinogenic polycyclic aromatic hydrocarbons (PAHs), beryllium, bis(2-ethylhexyl)phthlate, two carcinogenic pesticides, arsenic, vanadium, and lead. Sampling results, which include analyses under EPA's Routine Analytical Services portion of the Contract Laboratory Program (CLP), are presented in section 7 of this report. A toxicological evaluation of the samples collected by E & E is presented in Section 8.

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8. TOXICOLOGICAL EVALUATION

8.1 SUMMARY

8.1.1 Chemicals of Potential Concern

The nature and extent of contamination at the Amoco Oil Company site was discussed in Section 4.2. Contaminants were determined to be chemicals of potential concern based on their toxicity and the concentrations detected. The chemicals of potential concern selected for the Amoco site are summarized in Table 8-1.

8.1.2 Potential Exposure Pathways and Receptors

The portion of the site bordering adjacent land areas is fenced, and the site entrance is locked and continuously guarded. There is a small residential area approximately 0.25 mile from of the entrance gate; however, the nearest substantial residential area appears to be Fairfield, located approximately 1 mile northwest of the site. The portions of the site bordering Curtis Bay and the Patapsco River are faced with a low rock-and-wood seawall to prevent erosion. The seawall is easily scaled and is bordered by a narrow beach (see photos 1, 2, and 4 in Section 5). Patches of asphalt were seen on the seawall during the site visit. The site surface consists of sand, gravel, and fill material with some paved or vegetated areas. The surficial materials appear to have a low potential for wind erosion.

The available site characterization information indicates that two discrete areas of the site surface (the cooling tower and tank cleaning areas) are contaminated with CPOCs (arsenic, PAHs, and pesticides); however, the surficial materials have not been thoroughly investigated.

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Lead, PAHs, and pesticides were also detected in sediment samples collected from locations adjoining the site; however, only trace levels of several pesticides were detected in the surface water samples collected at these locations. Volatile and semivolatile organic chemicals, a pesticide, and metals were detected in subsurface soil and groundwater samples.

Under existing site conditions, potential human receptors would include the site security guards, site investigation or remediation workers, and possibly site visitors (i.e., trespassers). The security guards are presumably stationed at the site entrance and would be unlikely to come in contact with site contamination. Hazardous waste workers would be expected to be properly trained and to employ the necessary protective clothing and equipment to avoid exposure to site contaminants. Trespassers might potentially gain access to the site by going around the end of the fence at the shoreline or by landing from a small boat. However, due to the nature of the site, if trespassing occurs it is probably very infrequent and unlikely to result in any significant exposure to site contaminants. Consequently, significant human exposure to site contaminants under existing site conditions appears unlikely.

Chesapeake Bay is rich in marine life, including numerous benthic organism that could be exposed to the contaminants found in the sediments adjacent to the site.

Most of the land within 1 mile of the site is occupied by industrial facilities such as petroleum storage, handling, or processing facilities and a sewage treatment plant (see Figure 2-1). There is a small residential area approximately 0.25 mile from the site.

The most likely future use of the property is as an industrial site; however, since the site is a waterfront property, redevelopment for residential use cannot be ruled out. In that event, subsurface soils could be brought to the surface by excavation and regrading activities accompanying redevelopment. Contaminants in the disturbed subsurface soils would then become available, along with the contaminants in surface soils and sediments, for direct contact by future site residents. Potential exposure pathways would include dermal

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contact with and accidental ingestion of the soils and sediments, and inhalation of contaminant vapors emanating from the soils and groundwater. The site is presently served by a public water supply system, so it is unlikely that the groundwater would be used as a potable water source by future residents. However, the risks such groundwater usage could pose will be estimated for the record.

8.1.3 Risk Evaluation

8.1.3.1 Human Health

While potential future site residents could be exposed to contaminants in site soil and sediment through dermal contact and to volatiles emanating from the soil and groundwater through inhalation, accidental ingestion of soil resulting from hand-to-mouth contact usually accounts for the bulk of the potential exposure and risks. For this reason, and because this is a screening-level assessment, only the risks associated with soil or sediment ingestion will be quantitatively assessed. In the unlikely event that future residents use the site groundwater as a source of potable water, they could be exposed to the groundwater contaminants by drinking the water and through dermal contact with the water and inhalation of volatiles resulting from other domestic water uses such as showering or bathing, washing dishes, or doing laundry. Because only two of the seven groundwater contaminants are volatiles, direct ingestion will probably account for the bulk of the groundwater risks. Therefore, quantitative evaluation of potential groundwater risks will be limited to the ingestion route.

The maximum contaminant concentrations detected in soil, sediment, and groundwater samples were used to evaluate potential exposures to these media. EPA's standard default exposure factors (EPA 1991), which were used to estimate potential exposures, are summarized in Tables 8-2 and 8-3. Reference doses (RfDs) and slope factors (SFs) were obtained from IRIS, HEAST, or EPA Region III's Risk-Based Concentration Table (EPA 1992). Risk estimates, which were prepared for two groups of

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receptors--children 1 to 6 years old and adults--are presented in Tables 8-4 through 8-7.

The estimated excess cancer risks from ingestion of contaminants in site soil or sediment are approximately 3.5×10^{-5} for adults and 7.5×10^{-5} for children. The cancer risks associated with the hypothetical use of site groundwater as drinking water are 4.8×10^{-4} for adults and 2.3×10^{-4} for children. The hazard indices for soil and sediment ingestion, which are ratios of the estimated exposures to the RfDs, were below 1 for both adults and children, indicating that no noncarcinogenic adverse effects would be expected to result from this potential exposure. In contrast, the hazard indices for groundwater ingestion were 12 for adults and 28 for children, indicating that noncarcinogenic adverse effects might result from use of the groundwater as drinking water. These risk estimates assume simultaneous and continuous exposure to the maximum observed concentrations of all of the contaminants of potential concern detected in the soil, sediment, or groundwater samples; therefore, these estimates are at the upper end of the range of risks future residents of the site would actually experience.

Fifty-nine percent of the estimated cancer risk for the soil and sediment was due to the carcinogenic PAHs detected in the sediment samples. PAHs cause tumors at the point of contact; therefore, some additional cancer risk would result from the expected dermal contact with these compounds. The highest concentrations of carcinogenic PAHs, which totaled approximately 15.5 mg/kg, were detected in sediment sample SED4-1, collected from Curtis Bay near the drum burial and tank car cleaning areas. This is higher than the median concentration of 1.1 mg/kg found in urban soils, but well below the median concentration of 137 mg/kg found in road dust (Menzie _et al_. 1992).

Arsenic in the soil accounted for 39% of the estimated cancer risks for soil and sediment. The maximum arsenic concentration detected in the surface soil, 13.3 mg/kg, is below the 90th percentile for soils in the eastern U.S. (Shacklette and Boerngen 1984). This indicates that, while the concentration of the arsenic in surface soil may pose a significant risk, it is not substantially elevated above typical arsenic levels in soil.

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Fifty-three percent of the estimated cancer risk for groundwater was also due to a carcinogenic PAH, chrysene, and 44% was due to bis(2-ethylhexyl)phthalate. Chrysene and bis(2-ethylhexyl)phthalate are very insoluble in water, and water samples analyzed of organic compounds were not filtered; therefore, the presence of these compounds in the samples is probably associated with entrained sediment. Drinking water wells are generally developed sufficiently to eliminate suspended sediment before they are put into service. Consequently, site groundwater used as drinking water would probably be free of chrysene and bis(2-ethylhexyl)phthalate.

Most of the remainder of the estimated cancer risk for groundwater, approximately 1×10^{-5} for adults and 5×10^{-6} for children, was due to 1,1,2,2-tetrachloroethane, a volatile organic chemical associated with liver tumors in mice.

The potentially significant noncarcinogenic risks estimated for site groundwater were due to vanadium, sodium, and bis(2-ethylhexyl)-phthalate. Excessive sodium intake is associated with fluid retention and high blood pressure. No specific adverse effects have been identified for vanadium. Bis(2-ethylhexyl)phthalate has caused liver disease and reproductive effects in laboratory animals. Since the site is located on an arm of Chesapeake Bay, elevated sodium concentrations in groundwater samples collected from within 100 to 200 feet of the shore are to be expected.

8.1.3.2 Ecological Effects

The site borders Curtis Bay and the Patapsco River, which are parts of the Chesapeake Estuary. This estuary includes a number of critical environmental areas (see Section 3.7). The area immediately adjacent to the site is not classified as a critical area; however, it is known to support a number of species, including white perch, Atlantic menhaden, blue crabs, soft-shelled clams, and black-crowned night herons. The surface water and sediment samples collected adjacent to the site were taken from this estuarine environment, so it is appropriate to compare their results to suitable ecological benchmarks. The benchmarks selected for the sediment were the effects range-low (ER-L) and effects

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range-median (ER-M) values for sediments published by the Coastal and estuarine Assessment Branch of NOAA (Long and Morgan 1990). The ER-L and ER-M values are equivalent to the lower 10 percentile and 50 percentile concentrations, respectively, of the available data in which adverse effects were detected. The ER-L is an estimate of the concentration at which adverse effects first begin to appear, and the ER-M is an estimate of the concentration above which effects were often detected. The ER-L and ER-M concentrations for a number of the chemicals of potential concern at the site are presented in Table 8-2. Only sample SED4-1, with 24,000 µg/kg total PAHs, exceeded the ER-L value for total PAHs. Several individual PAHs (dibenz[a,h]anthracene, phenanthrene, and pyrene) exceeded their ER-M values in this sample. Samples SED1-1, SED2-1, and SED3-1 exceeded the ER-L for dieldrin. Sample SED3-1 also exceeded the ER-Ls for chlordane and DDT and its metabolites (DDD and DDE). The concentration of lead detected in SED2-1 (265 mg/kg) exceeded the ER-M for lead.

The results for the surface water samples were compared to the Ambient Water Quality Criteria for marine organisms (EPA 1986). The only organic chemicals detected in these samples were the pesticides gamma-BHC (Lindane) and methoxychlor, which were detected at trace levels in one sample each. Methoxychlor did not exceed its Ambient Water Quality Criteria. No Ambient Water Quality Criteria have been established for gamma-BHC, but the level detected was well below the lowest observed effect level reported for the compound.

8.2 SUPPORTING DATA

The estimated excess risk and hazard indices were calculated for each of the chemicals of potential concern using their respective SFs and RfDs (see Tables 8-8 and 8-9).

8.3 REFERENCES

Health Effects Assessment Summary Tables (HEAST), 1991, EPA Office of Solid Waste and Emergency Response, Washington, D.C.

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Table 8-1

CHEMICALS OF POTENTIAL CONCERN AT THE AMOCO SITE

Chemical	Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment
Volatiles					
Benzene		X	X		
Chlorobenzene		X			
Chloroform	X	X			
1,1,2,2-Tetrachloroethane			X		
Semivolatiles					
Bis(2-ethylhexyl)phthalate			X		
PAHs	X				X
Pentachlorophenol	X				
Pesticides					
Aldrin					X
alpha-BHC	X				
Chlordane	X				X
DDT and metab.	X				X
Dieldrin					X
Heptachlor				X	
Heptachlor epoxide			X	X	X
Metals					
Arsenic	X				
Lead					X
Nickel			X		
Sodium			X		
Vanadium			X		

Brief History

Incorporated in Indiana in 1889, when its first refinery was being built at Whiting, Ind., Standard Oil Company (Indiana) was exclusively a Midwest refiner and marketer of petroleum products in its early years.

The company began an unbroken record of yearly dividend payments in 1894 and regular quarterly dividends in 1913. In 1911, the company's affiliation with all other companies in the old Standard Oil organization was dissolved.

Early on, the company's growth was spurred in part by the company's pioneering invention in 1912-13 of a thermal cracking process which allowed refiners to double the yield of gasoline from crude oil.

Following World War I, Standard established substantial crude oil production and transportation operations, added refineries and marketing properties, and extended its marketing area using the Standard Oil name in the Midwest, the Amoco brand in the East, and through other subsidiaries elsewhere. (The company still retains the exclusive legal right to use the Standard Oil name for trademark purposes in 15 midwestern states.) This expansion was accomplished through both acquisitions and internal growth.

During the 1940's and 1950's, the now integrated company continued its growth. A network of product pipelines was constructed, new refineries were built, marketing facilities were expanded, and a basis for the future development of petrochemical operations was established. Standard began exploration and production in Canada and took steps to expand into overseas areas.

In a 1961 functional reorganization, Standard Oil Company (Indiana) became a parent company, concerned primarily with policy, financing, coordinating and evaluating operations, and providing staff services and planning for its subsidiaries. The subsidiaries carrying Amoco as part of their names, perform the operations described on the inside back cover of this booklet.

In 1969, Amoco Minerals Company was formed to find and develop minerals worldwide. These operations were given impetus in 1979 with the acquisition of Cyprus Mines Corporation.

Standard is one of the most active companies in the search for crude oil and natural gas in the U.S. During 1980, the company conducted 22,000 miles of seismic exploration, drilled 812 gross (499 net) wildcat and extension wells, and 1,199 gross (598 net) development wells. At year-end 1980, the company held 41.9 million acres of exploration and production rights, the most in the industry, in addition to 2.9 million net producing acres. Currently, exploration is especially active in the Overthrust Belt of Wyoming and Utah, the Deep Tuscaloosa trend of Louisiana and the Williston Basin of North Dakota. Standard is also developing plans to produce synthetic fuels from shale and tar sands.

The company produces some 4.5 per cent of the nation's crude oil, about 4 per cent of the natural gas produced and sells about 6 per cent of the petroleum products marketed in the U.S. Its pipelines transport about one-tenth of all domestically produced oil.

Chemical operations, based on strong patent positions for many processes, have grown rapidly since the early 1950's. In the last decade revenues have increased more than six-fold and the company now ranks among the top 10 U.S. chemical companies in terms of total chemical revenues.

Amoco Minerals Company now accounts for about 5 per cent of U.S. primary copper production. It also produces zinc, lead, molybdenum, and silver. In 1980, Standard acquired more than 267 million tons of coal reserves in western Pennsylvania and Colorado.

Although domestic operations account for about two-thirds of its identifiable assets, the company was active in more than 40 other countries in 1980.

The company has some 183,919 shareholders, 56,401 employees, and nearly 23,200 dealers and distributors. At year-end 1980, Standard Oil Company (Indiana) had assets of $20.2 billion, ranking it ninth among the nation's industrial concerns and fifth among U.S. based petroleum companies.