FILE - PORTLAND - BEAZER

KOPPERS INDUSTRIES

Koppers Industries, Inc.
436 Seventh Avenue
Pittsburgh, PA 15219-1800

Telephone: (412) 227-2001
Fax: (412) 227-2423

April 13, 2000

NW Natural
220 NW Second Avenue
Portland, Oregon 97209
Attn: Sandra Hart
Manager: Risk, Environmental and Land

RE: Investigation and Cleanup Studies Documents
Gasco Facility
7900 NW St. Helens Road

Dear Sandra:

As part of recent environmental reviews we have been conducting for all of our operating facilities, we reviewed a draft of a document entitled: *Final Remedial Investigation / Feasibility Study Work Plan* (Hahn and Associates, Inc., August 4, 1995), that was accessed through Beazer East, Inc. As a consequence of this review, we have two related concerns associated with NW Natural's reporting of environmental work in the area of our lease:

1. The common use of "Koppers" as an acronym both for Koppers Company, Inc., now known as Beazer East, Inc., and Koppers Industries, Inc.

2. Any inference or reference to Koppers Industries' lease property use and activities with regard to the need for cleanup work.

With regard to item 1, for example, the report discusses in Section 3.0, "*Site Description*", a lease to "*Koppers Company, Inc. (Koppers) for creosote oil distribution.*" Then further states that "*...leases with Koppers have recently been renegotiated.*" The date of this report and renegotiation of the lease, relative to the environmental issues being addressed through NW Natural's activities have nothing to do with Koppers Industries' activities upon the leased property.

Further, reference and discussions of potential contamination throughout the report discuss "Koppers" property or processes without benefit of the understanding of the ownership transition. For example, Section 4.2, "*Potential Contaminant Sources*", indicates that "*[T]he process areas of concern at the site are identified as: ...Light Oil Plant/Koppers Plant...*"

With regard to item 2, for example, the report discusses in Section 4.6, "*Estimated Nature and Extent of Contamination*", "*[O]ther areas where solid contaminants may be expected are in the ...and in the current area of pencil pitch storage at Koppers*".

Clearly this could be misinterpreted to include Koppers Industries within the scope of the investigation and cleanup work in the area.

I believe these examples demonstrate our concern raised by the language within your consultant's report and request that NW Natural consider Koppers Industries' concerns with regard to all future reports. Providing a clear differentiation between Koppers Industries and Koppers Company with regard to the historic (pre-Koppers Industries) contamination should be reflected in all of NW Natural's documents.

It is Koppers Industries' belief that all of the environmental issues being addressed at and around our lease property represent Existing Environmental Liabilities, as that term is defined in our current lease with NW Natural:

> "Existing Environmental Liabilities" means the liability of Landlord, and Koppers Company, Inc. (now known as Beazer East, Inc. and the previous tenant under the Prior Lease) for certain environmental contamination of Landlord's Plant Property, as established and allocated pursuant to an agreement between Landlord and Beazer East, Inc.

Koppers Industries has dutifully maintained our obligations for repairs and maintenance, and undertaken environmental measures to ensure that environmental concerns have not and will not arise from our activities at the property. Based on Koppers Industries' environmental compliance and stewardship activities, NW Natural, nor any party involved with your assessment work, should have reason to believe that Koppers Industries has any obligation with regard to the historic environmental impairment of the property.

Your attention to this matter is appreciated. Please do not hesitate to contact me should you take issue with any part of this correspondence, or otherwise wish to discuss this matter further.

Sincerely,

Traci I. Self
Environmental Manager

CC:
Amos Kamerer-Portland
Mark Cilley-Stickney
Leslie Hyde
Jim Dietz K-1650

FILE: PORTLAND
SN+E -
TANK GROUND WATER

KOPPERS INDUSTRIES

FAX TRANSMITTAL

7540 N.W. Saint Helens Rd.
Portland, Oregon 97210-3663
Phone: (503) 286-3681
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Web Page: www.koppers.com

TO: J. Dietz, T. Self, M. Cilley, B. Messinger DATE: 8/7/00

FROM: Amos TOTAL # OF PAGES: 7

The attached is self explanatory —
I talked with Bob Wyatt, NWN last week. He still had not meet with Eric/ODEQ, but he had addressed with Eric our time table. Bob thought he would get with Eric in the next few weeks. I will trace with him again next week, if I do not here from Him —

IF THIS TRANSMITTAL IS IN ERROR, PLEASE CALL 503-286-3681 FAX # 503-285-2831

HAHN AND ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS

July 31, 2000

Mr. Amos Kamerer
Koppers Industries, Inc.
7540 NW St. Helens Road
Portland, Oregon 97210-3663

HAI Project #2708

SUBJECT: Groundwater Quality Data, Above-Ground Storage Tank Support Piling Monitoring, Koppers Industries, Inc. Lease Area, NW Natural-Gasco Facility, 7900 NW St. Helens Road, Portland, Oregon

Dear Mr. Kamerer:

On behalf of NW Natural, enclosed please find a summary of available groundwater quality data (Tables 1, 2, and 3) as obtained from wells at the Gasco site that monitor groundwater conditions down-gradient from the new coal tar pitch above-ground tank that was constructed at Koppers Industries, Inc. (Figure 1).

As you are aware, monitoring wells MW-15-50, MW-15-66, and MW-14-110 (all down-gradient of the tank foundation pilings) are being monitored on a quarterly sampling frequency as per a December 14, 1999 assessment plan[1] that has been implemented such that an evaluation of environmental impacts associated with piling construction for the new coal tar pitch tank may be completed (pilings were driven in May 1999).

As per the assessment plan, with completion of the June 2000 sampling event, water quality trends at the referenced wells will be evaluated by HAI, with findings summarized and provided to the Oregon Department of Environmental Quality (ODEQ) within the Second Quarter 2000 Remedial Investigation Progress Report for the Gasco site.

If there are any comments or questions, please contact either the undersigned.

Sincerely,

Robert Ede

Robert Ede
Sr. Project Manager

c: Mr. Bob Wyatt, NW Natural
Mr. Richard Bach, Stoel Rives, LLP
Mr. Steve Cappellino, Anchor Environmental LLC

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[1] Hahn and Associates, Inc. (1999), *Proposed Assessment Plan, Above-Ground Storage Tank Support Pilings, Koppers Lease Area, Northwest Natural Lease Area, Northwest Natural-Gasco Facility, 7900 NW St. Helens Road, Portland, Oregon* (Ede to Blischke, December 14, 1999).

FROM :KOPPERS INDUSTRIES, INC. 286 3681 1900,08-07 15:51 #308 P.03/07

Koppers022125

Table 1a - Summary of Analytical Results for Groundwater Samples
June 2000 Sampling Event
Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Well Number	HAI Sample Number [1]	Chain of Custody Number	Sample Date	Analytical Results														
				EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 335 Series mg/l (ppm)	EPA Method 901 mg/l (ppm)	Total (Unfiltered) Metals by EPA Method 6010 mg/l (ppm)					
				Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Arsenic	Chromium	Copper	Lead	Nickel	Zinc
MW-14-110	000615-MW14-110-102	2708-W084	15-Jun-00	4.85	ND>0.5	ND>0.6	ND>1.5	4.9	ND	0.2	-	ND>0.02	[redacted]	ND>0.005	ND>0.005	ND>0.005	ND>0.005	ND>0.005
MW-15-50	000615-MW15-50-105	2708-W064	15-Jun-00	1,490.	14.3	6.62	42.	1,552.9	268.	475.	-	ND>0.02	ND>0.005	0.008	ND>0.005	ND>0.005	0.0064	0.0359
Duplicate	000615-MW15-50-106	2708-W064	15-Jun-00	1,270.	10.	5.15	28.4	1,313.6	254.	451.	-	ND>0.02	ND>0.005	ND>0.005	ND>0.005	ND>0.005	ND>0.005	0.0388
MW-15-86	000615-MW15-50-104	2708-W064	15-Jun-00	ND>0.6	ND>0.5	ND>0.5	ND>1.6	ND	12.17	22.	-	ND>0.02	[redacted]	ND>0.005	ND>0.005	ND>0.005	ND>0.005	0.0214
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				5.	1,000.	700.	10,000.	#	#	#	0.2	#	0.05	0.1	1.	0.015	0.1	5.
EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water (1999)				0.41	720.	1,300.	1,400.	#	#	#	#	0.73	0.00005	0.11	1.4	#	0.73	11.
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water [2]				40. [3]	424. [3]	1,400. [3]	#	#	0.031 [4]	#	0.0052 [4]	#	0.000017 [4]	0.011 [3]	0.012 [3]	0.0032 [3]	0.1 [4]	0.11 [3]

Note: BTEX = benzene, toluene, ethylbenzene, and xylenes
EPA = U.S. Environmental Protection Agency
mg/l = milligrams/liter
ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ppm = parts per million
ug/l = micrograms per liter
= Reference Level not established
Bold and shaded = Detected above Reference Level

1 = Sample number prefix: 2708-
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (OAR 340-41) based on Fresh Acute, Fresh Chronic (Aquatic Life Protection) and Fish Consumption Only (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
4 = Reference Level based on Human Fish Consumption Criteria of AWQC

FROM :KOPPERS INDUSTRIES, INC. 286 3681 1900.08-07 15:52 #308 P.04/07

Koppers022126

Table 1b - Summary of Analytical Results for Groundwater Samples: June 2000
PAHs by EPA Method 8270

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)				Analytical Results ug/l (ppb)																	
				Carcinogenic PAHs							Non-carcinogenic PAHs										
Well Number	Sample Number 1	Chain of Custody Number	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
MW-14-110	000615-MW14-110-102	2708-W064	15-Jun-00	ND a	ND a	ND a	ND a	ND a	ND a	ND a	0.18	ND a	ND a	ND a	ND a	ND a	ND a	ND a	ND a	ND	0.2
MW-15-50	000615-MW15-50-105	2708-W064	15-Jun-00	43.6	45.6	38.5	57.1	40.5	8.95	33.5	2.91	0.59	4.11	41.8	89.7	1.88	1.23	25.	80.1	267.69	474.76
Duplicate	000615-MW15-50-106	2708-W064	15-Jun-00	40.	44.1	36.3	53.5	38.3	8.87	32.6	2.96	0.77	4.1	40.2	85.2	1.71	1.23	23.8	57.3	253.97	450.94
MW-15-66	000615-MW15-50-104	2708-W064	15-Jun-00	1.93	1.96	1.61	2.64	1.91	0.37	1.55	0.14	ND a	0.39	2.04	3.32	ND a	ND a	1.07	2.92	12.17	22.05
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				#	#	#	2.	#	#	#	#	#	#	#	#	#	#	#	#	#	#
EPA Region 9 Preliminary Remedial Goals (PRGs) for Tap Water (10/99)				0.092	0.092	0.92	0.0092	9.2	0.0092	0.092	370.	#	1,800.	#	1,500.	240.	6.2	#	180.	#	#
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water 2				#	#	#	#	#	#	#	520. 3	#	#	#	54. 4	#	520. 3	#	#	0.031 4	#

NOTE: ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ug/l = micrograms per liter
Bold and shaded = Detected above Reference Level
# = Reference Level not established
a = detection limit is 0.1 ug/l (ppb)

1 = Sample number prefix: 2708-
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (OAR 340-41)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
4 = Reference Level based on Human Fish Consumption Criteria of AWQC

FROM :KOPPERS INDUSTRIES, INC. 286 3681 1900,08-07 15:52 #308 P.05/07

Koppers022127

Table 3e - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide (November 1998 to Present)

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Well Number	HAI Sample Number[1]	Chain of Custody Number	Sample Date	Analytical Results										
				EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)	EPA 901 mg/l (ppm)	EPA 8270 ug/l (ppb)	
				Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols	
MW-14-110	981116-MW14-110-06	2708-W037	16-Nov-98	3.2	ND>0.5	ND>0.5	ND>1.5	3.2	ND	ND	0.05			
	990216-MW14-110-005	2708-W042	16-Feb-99	12.7	ND>0.5	0.6	ND>1.5	13.3	ND	0.11	0.04	ND>0.02		
	990512-MW14-110-09	2708-W045	12-May-99	23.1	ND>0.5	1.88	2.4	28.4	ND	0.28	0.03	0.03		
	990823-MW14-110-06	2708-W049	23-Aug-99	45.6	0.75	1.85	2.09	50.3	ND	0.41	0.05	ND>0.02		
	991027-MW14-110-09	2708-W055	27-Oct-99	28.8	0.81	1.45	ND>1.5	30.9	ND	0.26	0.04	ND>0.02		
	991027-MW14-110-10	2708-W055	27-Oct-99	29.7	0.57	1.52	ND>1.5	31.8	ND	0.27	0.03	ND>0.02		
	000329-MW14-110-109	2708-W060	29-Mar-00	7.84	ND>0.5	0.73	ND>1.5	8.6	ND	0.42	0.03	ND>0.02		
	000329-MW14-110-110	2708-W060	29-Mar-00	8.9	0.5	0.83	ND>1.5	10.2	ND	0.42	0.03	ND>0.02		
	000615-MW14-110-102	2708-W064	15-Jun-00	4.66	ND>0.5	ND>0.5	ND>1.5	4.9	ND	0.2		ND>0.02		
MW-15-50	990726-MW15-50-04	2708-W048	26-Jul-99	95,100.	863.	223.	2,420.	98,606.	ND	18,460.	ND>0.020	ND>0.02		
	991029-MW15-50-25	2708-W057	29-Oct-99	8,910.	134.	59.2	500.	9,603.2	ND	782.	0.16	ND>0.02		
	000403-MW15-50-125	2708-W062	3-Apr-00	44,800.	620.	222.	2,300.	47,842.	3.31	5,611.	0.07	ND>0.02		
	000615-MW15-50-105	2708-W064	15-Jun-00	1,490.	14.3	6.82	42.	1,552.9	268.	475.		ND>0.02		
	000615-MW15-50-106	2708-W064	15-Jun-00	1,270.	10.	5.16	28.4	1,313.6	254.	451.		ND>0.02		
MW-15-66	990728-MW15-66-03	2708-W048	28-Jul-99	3.81	ND>0.5	ND>0.5	ND>1.5	3.8	0.63	3.	ND>0.020	ND>0.02		
	990823-MW15-66-04	2708-W050	23-Aug-99	0.72	ND>0.5	ND>0.5	ND>1.5	0.7						
	991028-MW15-66-07	2708-W054	28-Oct-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.020	ND>0.02		
	000329-MW15-66-106	2708-W060	29-Mar-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	3.91	7.	ND>0.02	ND>0.02		
	000615-MW15-50-104	2708-W064	15-Jun-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	12.17	22.		ND>0.02		
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				5.	1,000.	700.	10,000.	#	#	#	0.2	#	#	
EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water (10/99)				0.41	720.	1,300.	1,400.	#	#	#	#	0.73	#	
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water[2]				40.[3]	424.[3]	1,400.[3]	#	#	0.031.[4]	#	0.0052.[4]	#	#	

Notes:
BTEX = benzene, toluene, ethylbenzene, and xylenes
DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
mg/l = milligrams per liter
ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ppm = parts per million
ug/l = micrograms per liter
= Reference Level not established
Bold and shaded = Detected above Lowest Identified Reference Level

1 = Sample number prefix; 2708-
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (OAR 340-41) based on Fresh Acute, Fresh Chronic (Aquatic Life Protection) and Fish Consumption (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
4 = Reference Level based on Human Fish Consumption Criteria of AWQC

FROM :KOPPERS INDUSTRIES, INC. 286 3681 1900,08-07 15:53 #308 P.05/07

Koppers022128

Table 3b - Summary of Historical Analytical Results for Groundwater Samples: PAHs by EPA Method 8270 (November 1998 to Present)
Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)				Analytical Results ug/l (ppb)																			
				Carcinogenic PAHs							Non-carcinogenic PAHs												
Well Number	Sample Number	Chain of Custody Number	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
MW-14-110	981116-MW14-110-08	2708-WD37	16-Nov-98	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND	ND
	990216-MW14-110-005	2708-WD42	16-Feb-99	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	0.11	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND	0.1
	990512-MW14-110-09	2708-WD45	12-May-99	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	0.14	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	0.14	ND [1]	ND [1]	ND	0.3
	990823-MW14-110-08	2708-WD49	23-Aug-99	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	0.29	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	0.12	ND [1]	ND [1]	ND	0.4
	991027-MW14-110-09	2708-WD55	27-Oct-99	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	0.28	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND	0.3
	991027-MW14-110-09	2708-WD55	27-Oct-99	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	0.28	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND	0.3
	000329-MW14-110-109	2708-WD60	29-Mar-00	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	0.42	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND	0.4
	000329-MW14-110-110	2708-WD60	29-Mar-00	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	0.42	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND	0.4
	000615-MW14-110-102	2708-WD64	15-Jun-00	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	0.18	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND	0.2
MW-15-50	990728-MW15-50-04	2708-WD48	28-Jul-99	ND [4]	ND [4]	ND [4]	ND [4]	ND [4]	ND [4]	ND [4]	56.	9,510.	ND [4]	ND [4]	ND [4]	83.	6,700.	117.	ND [4]	ND	16,460.
	991028-MW15-50-25	2708-WD57	28-Oct-99	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	20.	ND [1]	ND [1]	ND [1]	ND [1]	716.	28.	ND [1]	ND	782.
	000403-MW15-50-125	2708-WD62	3-Apr-00	0.79	0.51	0.49	0.53	0.73	ND [1]	0.24	22.	41.6	2.91	0.25	6.01	23.6	5,460.	25.9	5.18	5.31	5,011.
	000515-MW15-50-105	2708-WD64	15-Jun-00	43.6	45.5	38.5	57.1	40.5	6.85	33.5	2.91	0.59	4.11	41.6	69.7	1.66	1.23	25.	60.1	297.65	475.
	000515-MW15-50-106	2708-WD64	15-Jun-00	40.	44.1	36.3	53.5	39.3	6.87	32.6	2.66	0.77	4.1	40.2	65.2	1.71	1.23	23.8	57.3	251.67	451.
MW-15-66	990728-MW15-66-03	2708-WD48	28-Jul-99	0.15	0.25	ND [1]	0.16	0.15	ND [1]	0.11	0.11	ND [1]	ND [1]	0.14	0.3	ND [1]	0.57	0.17	0.34	0.83	2.5
	991026-MW15-66-07	2708-WD54	26-Oct-99	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	ND	ND
	000329-MW15-66-108	2708-WD60	29-Mar-00	0.57	0.59	0.6	0.77	0.67	0.16	0.53	ND [1]	ND [1]	0.11	0.66	0.98	ND [1]	ND [1]	0.33	0.98	3.91	8.9
	000515-MW15-50-104	2708-WD64	15-Jun-00	1.93	1.98	1.81	2.64	1.91	0.57	1.55	0.14	ND [1]	0.39	2.04	3.92	ND [1]	ND [1]	1.07	2.92	12.67	22.1
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				#	#	#	2.	#	#	#	#	e	e	e	e	e	e	e	e	e	#
EPA Region 9 Preliminary Remedial Goals (PRGs) for Tap Water (1999)				0.092	0.092	0.92	0.0092	9.2	0.0092	0.092	370	e	e	1,800	e	1,500	240	5.2	e	180	e	#
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water [2]				#	#	#	e	#	#	#	520 [3]	e	e	e	e	54 [3]	e	620 [3]	e	e	0.031 [4]	#

Note:
# = Reference Level not established
EPA = U.S. Environmental Protection Agency
ND = not detected above detection limit indicated
DEQ = Oregon Department of Environmental Quality

PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ug/l = micrograms per liter
Bold and shaded = Detected above lowest identified Reference Level

a = detection limit is 0.1 ug/l (ppb)
b = detection limit is 1. ug/l (ppb)
c = detection limit is 2. ug/l (ppb)
d = detection limit is 10. ug/l (ppb)
e = detection limit is 20. ug/l (ppb)

1 = Sample number prefix: 2708-
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (OAR 340-41) based on Fresh Acute, Fresh Chronic (Aquatic Life Protection) and Fish Consumption Only (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
4 = Reference Level based on Human Fish Consumption Criteria of AWQC

FROM :KOPPERS INDUSTRIES, INC. 286 3681 1900,08-07 15:54 #308 P.07/07

Koppers022129

Table 2 - Summary of Analytical Results for Quality Assurance / Quality Control (QA/QC) Samples
June 2000 Sampling Event

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

QA/QC Sample Type	HAI Sample Number	Chain of Custody Number	Sample Date	Comment	Analytical Results ug/l (ppb)					
					EPA Method 8020					EPA Method 8270
					Benzene	Toluene	Ethyl benzene	Xylenes	Naphthalene	Total PAHs
Trip Blank	2708-000615-MW7-101	2708W064	15-Jun-00	Deionized water in sample containers and transported with samples in cooler.	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND>2	-
Equipment Blank	2708-000615-MW7-103	2708-W064	15-Jun-00	Deionized water through decontaminated pump after sampling MW-14-110 and prior to sampling MW-15-66	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND>2	ND>0.1

Note: bgs = below ground surface
BTEX = benzene, toluene, ethylbenzene, and xylenes
EPA = U.S. Environmental Protection Agency
ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ug/l = micrograms/liter

HAHN AND ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT

RECEIVED
DEC 14 1999
KOPPERS INDS, INC.
PORTLAND OR

December 14, 1999

Mr. Eric Blischke
Department of Environmental Quality
Voluntary Cleanup and Site Assessment Section
811 SW 6th Avenue
Portland Oregon 97204

HAI Project #2708

SUBJECT: Proposed Assessment Plan, Above-Ground Storage Tank Support Pilings, Koppers Lease Area, Northwest Natural-Gasco Facility, 7900 NW St. Helens Road, Portland, Oregon

Dear Mr. Blischke:

In correspondence dated October 1, 1999 (Blischke to Hart), you requested that Northwest Natural prepare a plan to assess the source of high benzene and polynuclear aromatic hydrocarbon (PAH) concentrations identified in monitoring well MW-15-50, installed within the upper portion of the Alluvial Sand water bearing zone (WBZ) immediately down-gradient of pilings recently installed to the bedrock surface to support Koppers new coal tar pitch above-ground storage tank.

As indicated in your letter of October 1, 1999, you stated that the identification of contamination at the MW-15-50 well location is indicative that contaminants were either dragged down with the recently installed pilings or that a conduit was opened up through which contaminants from the Surficial Fill WBZ may now migrate to the underlying Alluvial Sand WBZ.

Although piling-induced contamination within the Alluvial Sand WBZ, as described above, is a possibility, sufficient data do not exist at this time to support this conclusion with sufficient certainty. For example, since we do not have the benefit of baseline data, it is similarly possible that the contamination identified within the MW-15-50 well was pre-existing.

Based on the uncertainty related to the contaminant release mechanism, the objective of the assessment plan described herein is to allow the determination of the source for the elevated contaminant concentrations identified at the MW-15-50 monitoring well location. Specifically, a determination must be made as to whether these impacts: (1) pre-date the installation of tank foundation pilings; (2) are the result of limited piling drag-down of shallow contamination into the Alluvial Sand WBZ; or (3) are the result of the pilings acting as an on-going conduit for the continued migration of shallow contamination into the Alluvial Sand WBZ. The preceding determination will be necessary in order to evaluate whether tank installation procedures have exacerbated existing contamination at the site.

In order to make the preceding determination, it is proposed that monitoring wells MW-15-50, MW-15-66, and MW-14-110 (all down-gradient of the foundation pilings) be monitored on a quarterly sampling frequency as proposed in prior correspondence dated October 28, 1999 (Ede to Blischke). The proposed monitoring will allow for identification of concentration trends at these three wells, thereby providing the necessary data to determine the type/mechanism of the contaminant source currently identified at the MW-15-50 location and/or to evaluate whether other investigative techniques will be necessary to make this determination.

If contaminant concentrations continue to decline at both the MW-15-50 and MW-15-66 locations, then it can be concluded that contaminant drag-down was the likely source and that only further monitoring is necessary. However, if concentrations increase or stay the same at well MW-15-50, then further evaluation, likely involving the collection of depth-discrete groundwater samples at various locations, will likely be recommended.

Based on the preceding, it is proposed that water quality trends at the referenced wells be evaluated to make a determination as to contaminant source mechanism after completing data collection activities for the period of one year (i.e., until August 2000). Once this determination is made, it is expected that DEQ will then issue a decision regarding the removal of the current moratorium on further tank construction activities at the site.

If there are any comments or questions, please contact either the undersigned.

Sincerely,

R A B. Ede

Robert Ede
Sr. Project Manager

c: Ms. Sandra Hart, Northwest Natural
Mr. Amos Kamerer, Koppers Industries
Mr. Richard Bach, Stoel Rives, LLP
Mr. Tom Schadt, Anchor Environmental LLC

Post-it® Fax Note 7671	Date 12/16/99	# of pages ▶ 2
To T. Dieta	From Amos	
~~Co./Dept.~~ T. Self	~~Co.~~	
~~Phone #~~ M. Cilley	~~Phone #~~ F.Y.I.	
~~Fax #~~ B. Meisinger	~~Fax #~~	

RECEIVED
DEC 16 1999

Copies to:
Jim Dietz - 1650
Steve K[illegible]r - 1800
Traci Self - 1800
Bill Meisinger - U-PARC
Jack Stephenson - 1950

HAHN AND ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT

RECEIVED
MAY 17 1999

May 13, 1999

Mr. Eric Blischke
Oregon Department of Environmental Quality
Voluntary Cleanup and Site Assessment Section
811 SW 6th Avenue
Portland, Oregon 97204

HAI Project No. 2708

SUBJECT: Proposed Monitoring Well Installation Activities, Northwest Natural-Gasco Facility, 7900 NW St. Helens Road, Portland, Oregon

Dear Mr. Blischke:

1.0 INTRODUCTION

At the request of Northwest Natural and Kopper's, Inc., Hahn and Associates, Inc. (HAI) has prepared this proposal for the installation of two groundwater monitoring wells at the above-referenced site. This proposal results from discussions that were held during a May 5, 1999 meeting with the Oregon Department of Environmental Quality (DEQ) and representatives of Koppers, Inc. and Northwest Natural. Specifically, the DEQ requested that two wells, one to monitor the upper Alluvial Sand Water Bearing Zone (WBZ), and the other to monitor the Bedrock WBZ, be installed at a location down-gradient from a soon to be constructed 2-million gallon coal tar tank at the Kopper's, Inc. portion of the site. A third well, MW-14-110, already exists at a favorable location for monitoring groundwater quality within the lower Alluvial Sand WBZ, immediately above the bedrock surface and down-gradient of the tank location.

2.0 BACKGROUND

As the foundation for the aforementioned tank is to be installed through a location of residual oil tar contamination (with possible DNAPL) at the site, the primary objective of the proposed wells will be to provide adequate coverage for monitoring groundwater quality down-gradient of the tank such that any significant exacerbation / spread of existing contamination that may result from the installation of tank footings (driven pilings to the top of bedrock), may be identified. Such an occurrence would require additional evaluation to determine if predicted exposure points and/or exposure concentrations (components of the site risk assessment) would require updating.

Once installed, both wells will be incorporated into the routine groundwater monitoring program for the Gasco site, and as such they will undergo one-year of quarterly monitoring prior to evaluating them with regard to the possible incorporation into a less frequent sampling schedule. Constituents of analysis would be the same as those for samples collected from existing well MW-14-110, which include Polynuclear aromatic hydrocarbons, aromatic hydrocarbons, cyanide, and select metals. Details of the proposed well installations are provided below.

Recycled Recyclable

3.0 PROPOSED MONITORING WELLS MW-15i AND MW-15br

The final designation for the proposed intermediate depth well (MW-15i) and the bedrock zone well (MW-15br) will be designated by a prefix "MW", followed by the monitoring well number, followed by a number representing the depth of the well in feet below ground surface, such as MW-15-65. The proposed location for wells MW-15i and MW-15br is approximately 75 feet to the southwest of the existing well MW-11-32 (Figure 1). This location will put the wells approximately 100 to 150 feet down-gradient from the location of the new coal tar tank, a location that is as close to the tank location as possible due to the presence of a pencil pitch storage facility immediately adjacent to the tank location.

Monitoring well MW-15i will be installed such that it will monitor the upper Alluvial Sand WBZ, to target a similar zone as is monitored by other intermediate-depth wells at the site. Based on the preceding, it is anticipated that well MW-15i will have a total depth of approximately 65 feet below ground surface (bgs). However, the actual depth interval monitored may be modified in the field based on the hydrogeological conditions encountered at the targeted depth interval (i.e., if a silt or clay occupies the target interval).

The bedrock surface is anticipated to be encountered at a depth of between 90 and 110 feet bgs at the proposed MW-15 well location. Monitoring well MW-15br will be installed to a depth corresponding to the shallowest measurable water bearing zone within bedrock. Due to the uncertainties associated with the depth at which groundwater will be encountered within bedrock, only an estimate of the final depth of this well can be provided herein. As such, it is estimated that well MW-15-br will be installed to a total depth of between 125 and 175 feet bgs.

Installation Procedures

All monitoring well installation work will be performed by an Oregon-bonded and licensed monitoring well constructor. The monitoring well installations will be completed in accordance with the Oregon Groundwater Law (Oregon Revised Statute (ORS) Chapter 537) and the Rules for Construction and Maintenance of Monitoring Wells and Other Holes in Oregon (Oregon Administrative Rules (OAR) Chapter 690, Division 240).

Borehole drilling and well installation activities will be conducted via air rotary drilling methodology. Soil quality screening and sampling methodologies will be as specified within the HAI document entitled *Final Remedial Investigation / Feasibility Study Work Plan, Northwest Natural Gas Company*, dated August 4, 1995.

Above bedrock, soil samples will be collected within MW-15br at approximate 5-foot intervals below a depth of 25 feet. No sampling will be conducted above a depth of 25 feet since sufficient data at this location exists from the B-27 boring. No soil sampling will be conducted at the MW-15i location (to be installed second), other than to confirm surface casing and screen placement. Soil samples will be collected for lithologic descriptive purposes only unless field screening results indicate the presence of contamination at locations that do not correlate with the site conceptual model. Below bedrock, soil cuttings will be collected from the drill rig cyclone for lithological description and contaminant screening purposes.

Monitoring Well Design

Wells will be constructed with 10 feet of 0.020-inch slotted stainless-steel screen, a stainless steel sump installed below the screen, and a PVC riser pipe above the screen. Because drilling for both wells MW-15i and MW-15br will be conducted through a zone of residual soil contamination and possible DNAPL occurrence, as well as through the underlying Silt Unit, an 8-inch (MW-15i) and a 12-inch (MW-15br) steel permanent protective surface casing will be installed through the potential DNAPL zone, and will be set approximately 10 feet into the Silt Unit at a depth of approximately 34 feet bgs prior to the continuation of drilling through the Silt Unit. A split spoon soil sample will be collected prior to setting the casing for the first well to be installed in order to ensure appropriate placement. The proposed depth of completion for the protective casing is based on the lithologic and contaminant conditions identified at boring B-27, located adjacent to the proposed MW-15 well location. The casing will be grouted in-place by tremie pipe methods. The grout will be allowed to set for 12 hours prior to the continuation of drilling.

With regard to MW-15br, a 6-inch diameter steel permanent casing will be installed through the upper 12-inch surface casing and will be set and grouted into a 5-foot socket to be drilled into the top of competent bedrock. This casing will act to seal off the bedrock zone from possible current or future contamination that may be present within the Alluvial Sand WBZ. The remainder of the borehole for well MW-15br will be drilled as a 6-inch diameter open hole. Upon encountering the first isolated zone of groundwater within the bedrock zone, well MW-15br will be completed with a 3.25-inch diameter pre-packed stainless steel well screen and 2-inch diameter Schedule 80 PVC riser. Additional filter pack material will be placed in the annulus adjacent to the well screen, a bentonite plug will be placed, and the remainder of the annulus will be grouted.

Monitoring Well Development

Following installation of well MW-15i and MW-15br, each well will be surged with a surge block and further developed by purging with a submersible pump in an attempt to remove the fine sediment from around the well bore. To prevent grout intrusion into the sand pack, development activities will occur no sooner than within 48 hours of the completion of monitoring well installation activities. Development will continue until a minimum of 10 well volumes of water have been removed from the well, relatively sediment-free water is produced, and the indicator parameters of temperature, pH and specific conductance have stabilized to within 10 percent. Sampling will take place no sooner than 72 hours following development.

Investigative-Derived Waste Management

Soil cuttings, as well as decontamination and development water will be generated during the proposed monitoring well installation activities. All investigative-derived waste (IDW) will be containerized within a water-tight roll-off container, and left on-site. As provided in correspondence dated May 20, 1996 (Blischke to Hart), all liquid IDW will be treated within Northwest Natural's existing water treatment system and will be discharged via a National Pollution Prevention Discharge Elimination System (NPDES) permitted discharge point. Soil cuttings will remain on-site pending a determination of an appropriate disposition.

Anticipated Schedule

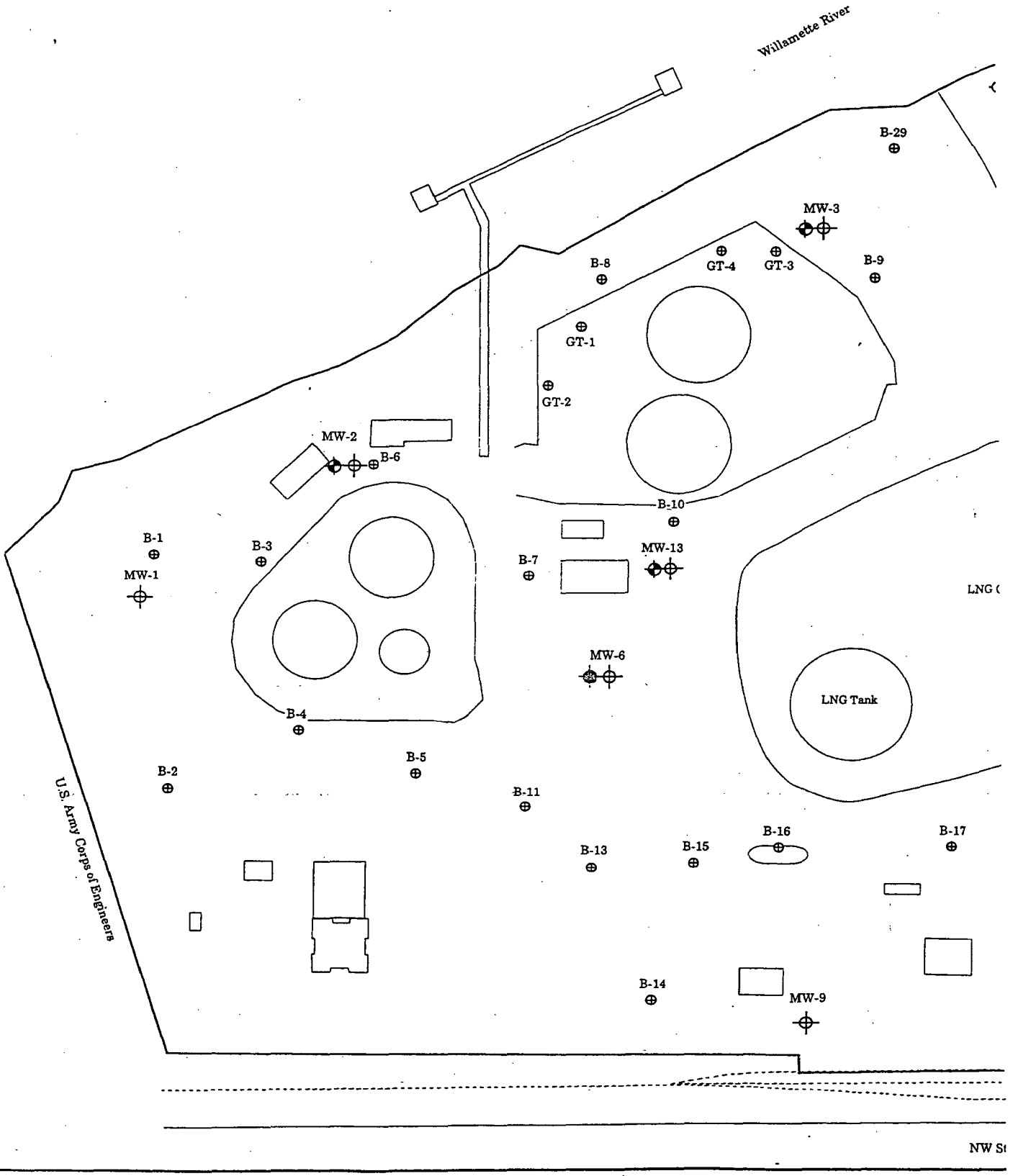
Drilling has been tentatively scheduled to commence on Wednesday, May 19, 1999, with installation activities anticipated to be completed on Wednesday May 26, 1999. Well development and the first round of groundwater monitoring activities will likely occur the following week.

If there are any comments or questions, please contact either the undersigned.

Sincerely,

Robert Ede
Project Manager

c: Ms. Sandra Hart, Northwest Natural
✓Mr. Amos Kamerer, Koppers Industries
Mr. Richard Bach, Stoel Rives, LLP
Mr. Frank Selker, Decision Focus, LLC
Mr. Tom Schadt, Anchor Environmental, LLC
Ms. Karla Urbanowicz, Oregon Department of Environmental Quality


Willamette River
B-29
MW-3
B-8
GT-4
GT-3
B-9
GT-1
GT-2
MW-2
B-6
B-10
B-1
MW-1
B-3
B-7
MW-13
LNG
MW-6
LNG Tank
B-4
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B-11
B-16
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B-15
U.S. Army Corps of Engineers
B-14
MW-9
NW St

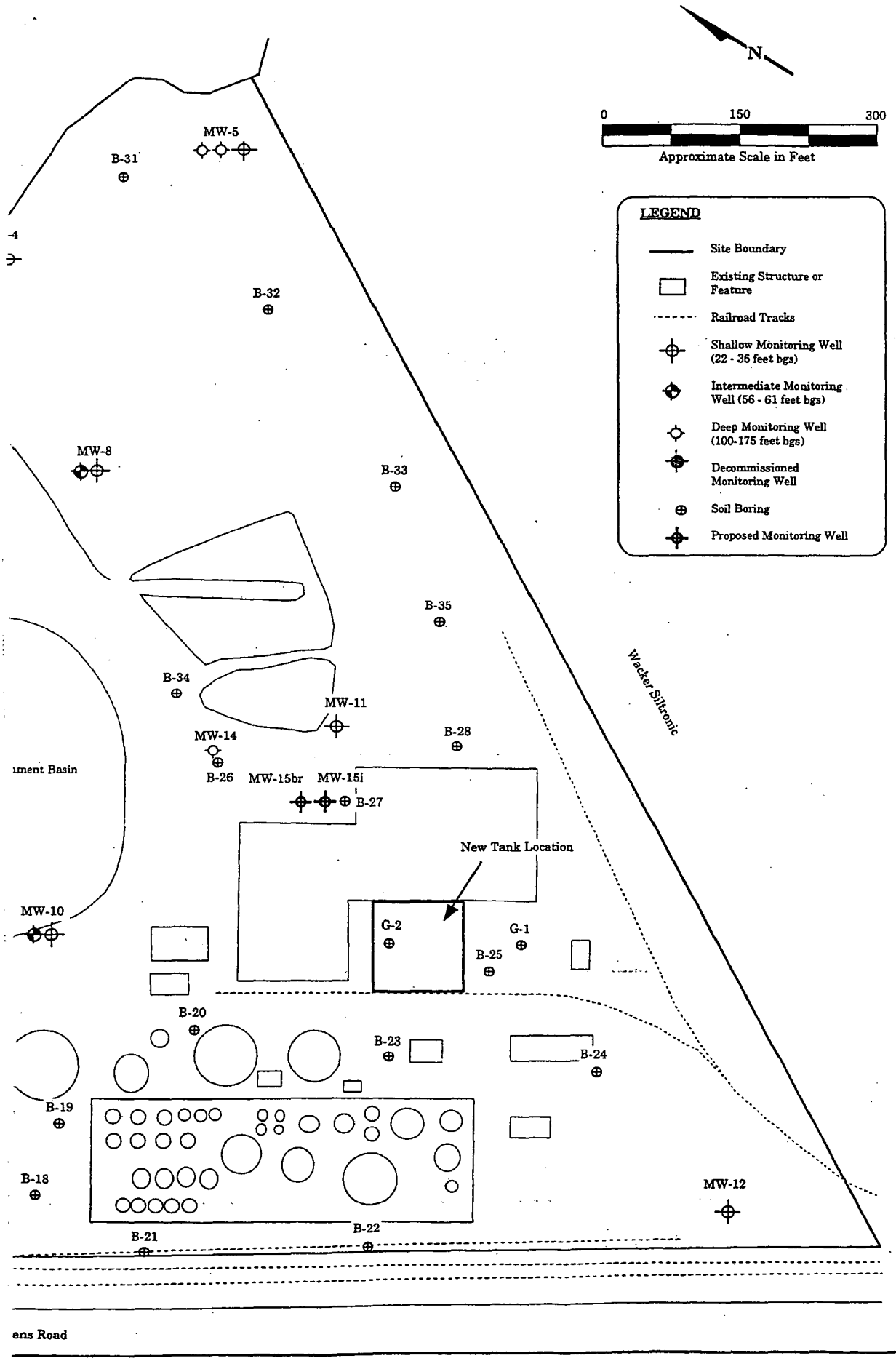


Figure 1

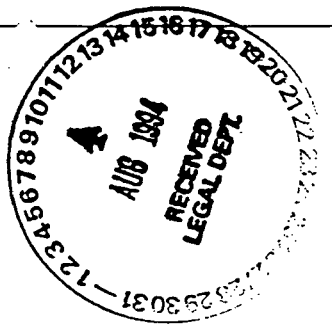
Proposed Kopper's Area Well Location Map

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

May 1999

Project No. 2708



Oregon

August 9, 1994

DEPARTMENT OF ENVIRONMENTAL QUALITY

NORTHWEST REGION

Ms. Carla Kelley
Associate Counsel
Northwest Natural Gas Company
220 N.W. Second Avenue
Portland, OR 97209

Re: RI/FS Agreement and Scope of Work for Northwest Natural Gas Company - GASCO Site

Dear Ms. Kelley:

Enclosed is a signed original of the Remedial Investigation and Feasibility Study Agreement and Scope of Work (SOW) prepared by the Oregon Department of Environmental Quality (DEQ) for the former GASCO facility located at 7540 N.W. St. Helens Road in Portland, Oregon. This document is being returned to you for your records.

DEQ appreciates your participation in the Voluntary Cleanup Program and looks forward to a productive relationship. If you have any questions, please do not hesitate to contact me at 229-6802.

Sincerely,

Eric L. Blischke
Project Manager, Voluntary Cleanup Section
Northwest Region

EB:eb

Enclosure

cc: Mike Rosen, NWR/DEQ (w/o enclosure)
Sandra Hart, NWNG (w/o enclosure)
Norm King, WMCD/DEQ (w/ enclosure)
Kurt Burkholder, DOJ (w/o enclosure)
Dick Bach, Stole, Rives, Boley Jones & Grey (w/o enclosure)

2020 SW Fourth Avenue
Suite 400
Portland, OR 97201-4987
(503) 229-5263 Voice/TDD

DEQ-1

√ CORPORATE SECRETARY REGISTER:

COMPUTER REGISTER:

CUSTOMER SERVICE REGISTER:

GAS PURCHASE/AGENCY REGISTER:

INTERSTATE SALES AGREEMENTS:

NORTHWEST PIPELINE REGISTER:

SYSTEM SUPPLY REGISTER;

ONGDC REGISTER:

NNGES REGISTER:

PACIFIC SQUARE REGISTER:

OTHER AGREEMENTS REGISTER:

NNGFC REGISTER:

KELSO BEAVER PIPELINE REGISTER:

NNG CAPACITY CORPORATION:

CONTRACT NO.:	348
DATE:	August 9, 1994
BETWEEN:	Oregon Department of Environmental Quality
SUBJECT MATTTER:	RI/FS Agreement and Scope of Work for NWNG Co. - GASCO Site

VOLUNTARY AGREEMENT FOR
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

DEQ NO. WMCVC-NWR-94-13

BETWEEN: Northwest Natural Gas Company

AND: Oregon Department of Environmental Quality (DEQ)

EFFECTIVE DATE: 8/8/94

Pursuant to ORS 465.260(2) and (4), the Director, Oregon Department of Environmental Quality (DEQ), enters this Agreement with the Northwest Natural Gas Company (NWNG). This Agreement contains the following provisions:

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	A. Work	3
	B. Public Participation	3
	C. DEQ Access and Oversight	3
	D. Project Managers	4
	E. Notice and Samples	4
	F. Quality Assurance	5
	G. Records	5
	H. Progress Reports	6
	I. Other Applicable Laws	6
	J. Reimbursement of DEQ Costs	6
	K. Force Majeure	7
	L. Prior Approval	7
	M. Dispute Resolution	7
	N. Enforcement of Agreement and Reservation of Rights	8
	O. Hold Harmless	8
	P. Parties Bound	9
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I. RECITALS

A. NWNG is a "person" under ORS 465.200(13).

B. The NWNG site is a "facility" under ORS 465.200(6). The NWNG site occupies approximately 47 acres at 7540 N.W. St. Helens Road, Portland, Oregon and is the location of a former oil gasification plant. A vicinity map and a site map are included in Attachment A to this Agreement.

Koppers022140

C. From 1913 until 1956, NWNG, then known as the Portland Gas and Coke Company (GASCO) operated an oil gasification plant on the present property owned by NWNG. An adjoining approximately 73 acre portion of the property was sold by NWNG in 1962 and is currently the site of the Wacker Siltronics Corporation manufacturing facility. The former GASCO facility produced oil gas and lampblack briquettes. Other materials produced by the plant for sale included light oils, tar and electrode grade coke. Wastes generated at the facility included tar, wastewater containing dissolved and suspended hydrocarbons, and spent oxide. Many of these wastes were disposed of in on-site tar ponds. In 1971 the largest remaining tar pond was estimated to contain 6 million gallons of tar and tar/water emulsion. This tar pond was subsequently filled in with spent oxide material and rubble and spread out over the southeastern portion of the site. NWNG currently operates a liquified natural gas (LNG) plant at the site and leases portions of the former GASCO facility to Pacific Northern Oil Company (Pacific Northern) and Koppers Industries, Incorporated (Koppers).

D. Investigations conducted to date indicate that petroleum hydrocarbons, volatile aromatic hydrocarbons and polycyclic aromatic hydrocarbons (PAHs) are present in subsurface soils and groundwater on the NWNG property. A total PAH concentration of 926 mg/l was detected in a 1984 sample collected from a monitoring well installed on the property leased from NWNG by Koppers. Ethylbenzene and xylene were detected in the same monitoring well at 380 mg/l and 2600 mg/l respectively. Analysis of a 1984 sediment sample collected from the NWNG LNG containment basin detected 300 mg/kg of total PAHs. Analysis of a 1993 water sample collected from the NWNG LNG containment basin detected 8.3 mg/l of benzene and 1.4 mg/l of total PAHs.

   The substances described in this section are "hazardous substances" under ORS 465.200(9). The presence of hazardous substances in soil and groundwater at the facility constitutes a "release" or "threat of release" into the environment under ORS 465.200(14).

E. NWNG requested DEQ oversight of its investigation and cleanup activities and executed a voluntary Letter Agreement with DEQ on January 3, 1994. NWNG provided a $5,000 advance deposit to cover initial DEQ oversight costs.

F. DEQ considers the activities required by this Agreement to be necessary to protect public health, safety, and welfare and the environment.

II. AGREEMENT

The parties agree as follows:

A. Work

1. Remedial Investigation and Feasibility Study.

NWNG shall perform a remedial investigation and feasibility study (RI/FS) satisfying OAR 340-122-070 and OAR 340-122-080, the terms and schedule of a DEQ-approved work plan developed by NWNG, and applicable elements of the general Scope of Work contained in Attachment B to this Agreement. NWNG may specify, in the proposed work plan, elements of the Scope of Work that NWNG considers inapplicable or unnecessary to the RI/FS for the facility. NWNG may propose to perform the work in phases or operable units.

2. Review

DEQ shall provide review, approvals/disapprovals, and oversight in accordance with the schedule set forth in the Scope of Work, or as soon as thereafter practicable in the event staff resources or workload prevent compliance with the schedule. Any DEQ delay shall correspondingly extend NWNG's schedule for a related deliverable or activity.

3. Additional Measures

NWNG may elect at any time during the term of this Agreement to undertake measures other than those required under this Agreement necessary to address a release or threatened release of hazardous substances at the facility which is the subject of this Agreement. Such other measures shall be subject to prior approval by DEQ, which approval shall be granted if DEQ determines that the additional measures will not compromise the validity of the RI/FS and will not threaten human health or the environment.

B. Public Participation

Upon execution of this Agreement, DEQ will provide public notice of this Agreement through issuance of a press release, at a minimum to a local newspaper of general circulation, describing the measures required under this Agreement. Copies of the Agreement will be made available to the public. DEQ shall provide NWNG a draft of such press release and consider any comments by NWNG on the draft press release, before publication.

C. DEQ Access and Oversight

1. DEQ shall use its best efforts, but not be obligated, to provide reasonable advance notice before entering the

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facility. NWNG shall allow DEQ to enter and move freely about all portions of the facility at all reasonable times for the purposes, among other things, of inspecting records relating to work under this Agreement; observing NWNG's progress in implementing this Agreement; conducting such tests and taking such samples as DEQ deems necessary; verifying data submitted to DEQ by NWNG; and, using camera, sound recording, or other recording equipment for purposes relating to work under this Agreement.

2. NWNG shall permit DEQ to inspect and copy all records, files, photographs, documents, and data relating to work under this Agreement, except that NWNG shall not be required to permit DEQ inspection or copying of items subject to attorney-client or attorney work product privilege. DEQ shall use its best efforts, but not be obligated, to provide reasonable advance notice before records inspection and copying requests.

3. Attorney-client and work product privileges may not be asserted with respect to any records required under Section II.G.1 and II.G.2 of this Agreement. NWNG shall identify to DEQ, by addressor-addressee, date, general subject matter, and distribution, any document, record, or item withheld from DEQ on the basis of attorney-client or attorney work product privilege. DEQ reserves its rights under law to obtain documents DEQ asserts are improperly withheld by NWNG.

D. Project Managers

1. To the extent possible, all reports, notices, and other communications required under or relating to this Agreement shall be directed to:

DEQ Project Manager:	NWNG Project Manager:
Eric Blischke Department of Environmental Quality Northwest Region 2020 S.W. Fourth Avenue, Suite 400 Portland, OR 97201 (503) 229-6802	Sandra Hart Northwest Natural Gas Company 220 S.W. Second Avenue Portland, OR 97209 (503) 226-4211

2. NWNG's and DEQ's Project Managers shall be available and have the authority to make day-to-day decisions necessary to complete the scope of work under this Agreement.

E. Notice and Samples

NWNG shall make every reasonable attempt to notify DEQ of any excavation, drilling, or sampling to be conducted under this Agreement at least five (5) working days before such activity but in no event less than twenty-four (24) hours before such activity. Upon DEQ's verbal request, NWNG shall make available to DEQ a

Koppers022143

split or duplicate of any sample taken pursuant to this Agreement. DEQ shall make every effort to complete analysis of any split or duplicate sample on a schedule consistent with NWNG's schedule for related activities.

F. Quality Assurance

NWNG shall conduct all sampling, sample transport, and sample analysis in accordance with the Quality Assurance/ Quality Control (QA/QC) provisions approved by DEQ as part of the work plan. All plans prepared and work conducted as part of this Agreement shall be consistent with DEQ's "Quality Assurance Policy No. 760.00". NWNG shall ensure that each laboratory used by NWNG for analysis performs such analyses in accordance with such provisions.

G. Records

1. In addition to those technical reports and documents specifically required under this Agreement, NWNG shall provide to DEQ within ten (10) days of DEQ's written request copies of existing documents relating to work required under this Agreement, including QA/QC memoranda and audits, final plans, final reports, task memoranda, field notes, and laboratory analytical data that have undergone data quality validation.

2. If DEQ determines that review of raw data or preliminary laboratory reports is necessary in order to ensure protection of public health, safety, and welfare and the environment, that information will be provided by NWNG immediately upon DEQ's written request. When such information is requested, DEQ will fully inform NWNG of the reasons making the request necessary.

3. Except for preliminary drafts which have been superseded, NWNG and DEQ shall preserve all records and documents in possession or control of NWNG and DEQ, respectively, or their employees, agents, or contractors that relate in any way to activities under this Agreement for at least five (5) years after termination under Section II.R. of this Agreement; provided that after such 5-year period, NWNG and DEQ shall provide the other sixty (60) days notice before destruction or other disposal of such records and make them available for inspection and copying.

4. NWNG may assert a claim of confidentiality regarding any documents or records submitted to or copied by DEQ pursuant to this Agreement. DEQ shall treat documents and records for which a claim of confidentiality has been made in accordance with ORS 192.410 through 192.505. If NWNG does not make a claim of confidentiality at the time the documents or records are submitted to or copied by DEQ, the documents or records may be made available to the public without notice to NWNG.

Koppers022144

H. Progress Reports

During each month of this Agreement, NWNG shall deliver to DEQ on or before the tenth (10th) day of each month two (2) copies of a progress report containing the following items. DEQ anticipates that the progress report will not exceed 2 pages in length.

1. Actions taken under this Agreement during the previous month;

2. Actions scheduled to be taken in the next month;

3. Sampling, test results, and any other data generated by NWNG during the previous month; and

4. A description of any problems experienced during the previous month and the actions taken to resolve them.

I. Other Applicable Laws

All actions under this Agreement shall be performed in accordance with all applicable federal, state, and local laws and regulations; except that, in accordance with ORS 465.315(2), DEQ in its discretion may exempt the on-site portion of any removal or remedial action from applicable requirements of ORS 466.005 to 466.385, ORS Chapter 459, or ORS Chapter 468 (1989).

J. Reimbursement of DEQ Oversight Costs

1. DEQ shall submit to NWNG a monthly statement of costs actually and reasonably incurred after issuance of this Agreement by DEQ or the State of Oregon in connection with any activities related to the facility or oversight of NWNG's implementation of this Agreement. Each invoice will include a summary of costs billed to date. DEQ will also include a direct labor summary showing the person charging the time, the number of hours and the nature of the work performed.

2. DEQ or State of Oregon oversight costs payable by NWNG shall include both direct and indirect costs. Direct costs include site-specific expenses, DEQ contractor costs, and DEQ legal costs. Indirect costs are those general management and support costs of the DEQ and of the Waste Management and Cleanup Division allocable to DEQ oversight of this Agreement and not charged as direct, site-specific costs. Indirect costs are based on a percentage of direct personal services costs. DEQ shall maintain work logs, payroll records, receipts and other documents to document work performed and expenses incurred under this Agreement and, upon request, shall make such records available to Respondent for inspection during the time of this Agreement and for at least one year thereafter.

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3. Within thirty (30) days of receipt of the monthly statement, NWNG shall pay the amount of costs billed by check made payable to the "State of Oregon, Hazardous Substance Remedial Action Fund".

K. Force Majeure

1. If any event occurs that is beyond NWNG's reasonable control and that causes or might cause a delay or deviation in performance of the requirements of this Agreement, NWNG shall promptly notify DEQ's Project Manager verbally of the cause of the delay or deviation and its anticipated duration, the measures that have been or will be taken to prevent or minimize the delay or deviation, and the timetable by which NWNG proposes to carry out such measures. NWNG shall confirm in writing this information within five (5) working days of the verbal notification.

2. If NWNG demonstrates to DEQ's satisfaction that the delay or deviation has been or will be caused by circumstances beyond the control and despite the due diligence of NWNG, DEQ shall extend times for performance of related activities under this Agreement as appropriate. Circumstances or events beyond NWNG's control might include but are not limited to acts of God, unforeseen strikes or work stoppages, fire, explosion, riot, sabotage, or war. Increased cost of performance or changed business or economic circumstances shall be presumed not to be circumstances beyond NWNG's control.

L. Prior Approval

Where DEQ review and approval is required for any plan or activity under this Agreement, NWNG shall not proceed to implement the plan or activity until DEQ approval is received. Any DEQ delay in granting or denying approval shall correspondingly extend the time for completion by NWNG. Prior approval shall not be required in emergencies or in instances where NWNG believes a delay in undertaking a particular action will threaten human health, safety or the environment; provided NWNG shall notify DEQ immediately after the emergency or activity and evaluate its impact on the RI/FS.

M. Dispute Resolution

In the event of disagreement between NWNG and DEQ regarding implementation of this Agreement, NWNG and DEQ shall, in the following order: 1) make a good faith effort to resolve the dispute between Project Managers; 2) if necessary, refer the dispute for resolution by the immediate supervisors of the Project Managers; and 3) if necessary, provide each other their respective positions in writing and refer the dispute for resolution by DEQ's Administrator of the Waste Management and Cleanup Division or the appropriate Region Administrator and NWNG's Chief Executive

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Officer. DEQ's final decision after such dialogue shall be enforceable under this Agreement. If NWNG refuses or fails to follow DEQ's final decision, the parties shall be entitled to such rights and remedies, including but not limited to, judicial review and subject to such limitation as provided by applicable law.

N. Enforcement of Agreement and Reservation of Rights

1. In the event of NWNG's failure to comply with this Agreement (including any failure to reimburse oversight costs), DEQ may enforce this Agreement under ORS 465.260(5) or may terminate this Agreement after thirty (30) days written notice to NWNG.

2. In the event of DEQ's failure to provide oversight in accordance with this Agreement, NWNG may terminate this Agreement after thirty (30) days written notice to DEQ. Costs incurred or obligated by DEQ before the effective date of any termination of this Agreement shall be owed under the Agreement notwithstanding such termination.

3. NWNG does not admit any liability or violation of law by virtue of entering this Agreement.

4. Nothing in this Agreement shall prevent NWNG from exercising any rights of contribution or indemnification NWNG might have against any person regarding activities under this Agreement; provided, NWNG waives any right it might have under ORS 465.260(7) to seek reimbursement from the Hazardous Substance Remedial Action Fund for costs incurred under this Agreement.

5. NWNG agrees not to litigate, in any proceeding brought by DEQ to enforce this Agreement, any issue other than NWNG's compliance with this Agreement.

O. Hold Harmless

1. NWNG shall save and hold harmless the State of Oregon and its commissions, agencies, officers, employees, contractors, and agents, and indemnify the foregoing, from and against any and all claims arising from acts or omissions related to this Agreement of NWNG or its officers, employees, contractors, agents, receivers, trustees, or assigns. The State of Oregon shall notify NWNG of any such claims or actions as soon as practicable after receiving notice that such a claim or action is threatened or has been filed. NWNG shall have the right to participate fully at its own expense in the defense or settlement of such claims, including the right to promptly receive related correspondence with the claimant and the opportunity to participate in related meetings and telephone conferences with the claimant. The state will confer with NWNG regarding litigation and settlement strategy and, to the extent practicable, will allow NWNG to review ad comment on

pleadings and settlement documents before they are filed with the court or sent to the claimant. NWNG shall have no obligations under this subsection with respect to any claim settled or otherwise compromised without NWNG's having been provided the opportunity to participate in accordance with this subsection. Subject to Article XI, Section 7 of the Oregon constitution and the Oregon Tort Claims Act, DEQ and the State of Oregon shall be responsible for the acts and omissions of their own employees and agents, except for DEQ acts approving or omissions constituting approval of NWNG's activities under this Agreement. DEQ shall not be considered a party to any contract made by NWNG or its agents in carrying out activities under this Agreement.

2. To the extent permitted by Article XI, Section 7, or the Oregon Constitution and by the Oregon Tort Claims Act, the State of Oregon shall save and hold harmless NWNG and its officers, employees, contractors, and agents, and indemnify the foregoing, from and against any and all claims arising from acts or omissions related to this Agreement of the State of Oregon or its commissions, agencies, officers, employees, contractors, or agents (except for acts approving or omissions constituting approval of any activity of NWNG under this Agreement). NWNG shall not be considered a party to any contract made by DEQ or its agents in carrying out activities under this Agreement.

P. Parties Bound

This Agreement shall be binding on the parties and their respective successors, agents, and assigns. The undersigned representative of each party certifies that he or she is fully authorized to execute and bind such party to this Agreement. No change in ownership or corporate or partnership status relating to the facility shall in any way alter NWNG's obligations under this Agreement, unless otherwise approved in writing by DEQ.

Q. Modification

DEQ and NWNG may modify this Agreement by mutual written agreement.

R. Duration and Termination

Upon completion of work under this Agreement, NWNG shall submit to DEQ a written notice of completion. This Agreement shall be deemed satisfied and terminated upon payment of all oversight cost owed and upon DEQ's issuance of a letter acknowledging satisfactory completion of activities in accordance with this Agreement. Such letter shall be issued within sixty (60) days of receipt of notice of completion and payment of outstanding DEQ oversight costs, or as soon thereafter as is reasonably practicable.

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NORTHWEST NATURAL GAS COMPANY

By: _____ Date: _____
(Name)

Sr V P
(Title)

STATE OF OREGON
DEPARTMENT OF ENVIRONMENTAL QUALITY

By: _____ Date: AUG 8 1994
(Name)

_____
(Title)

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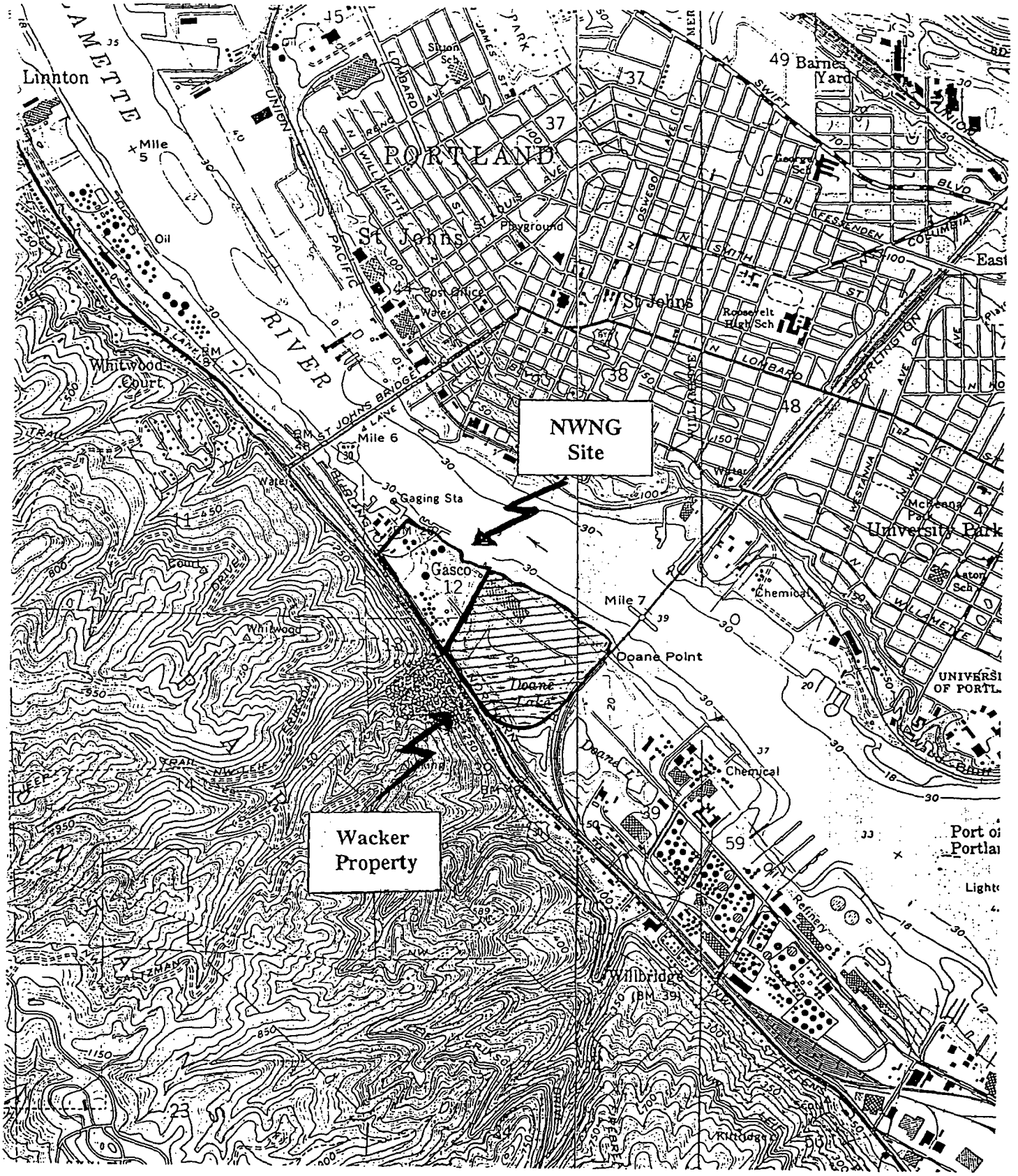
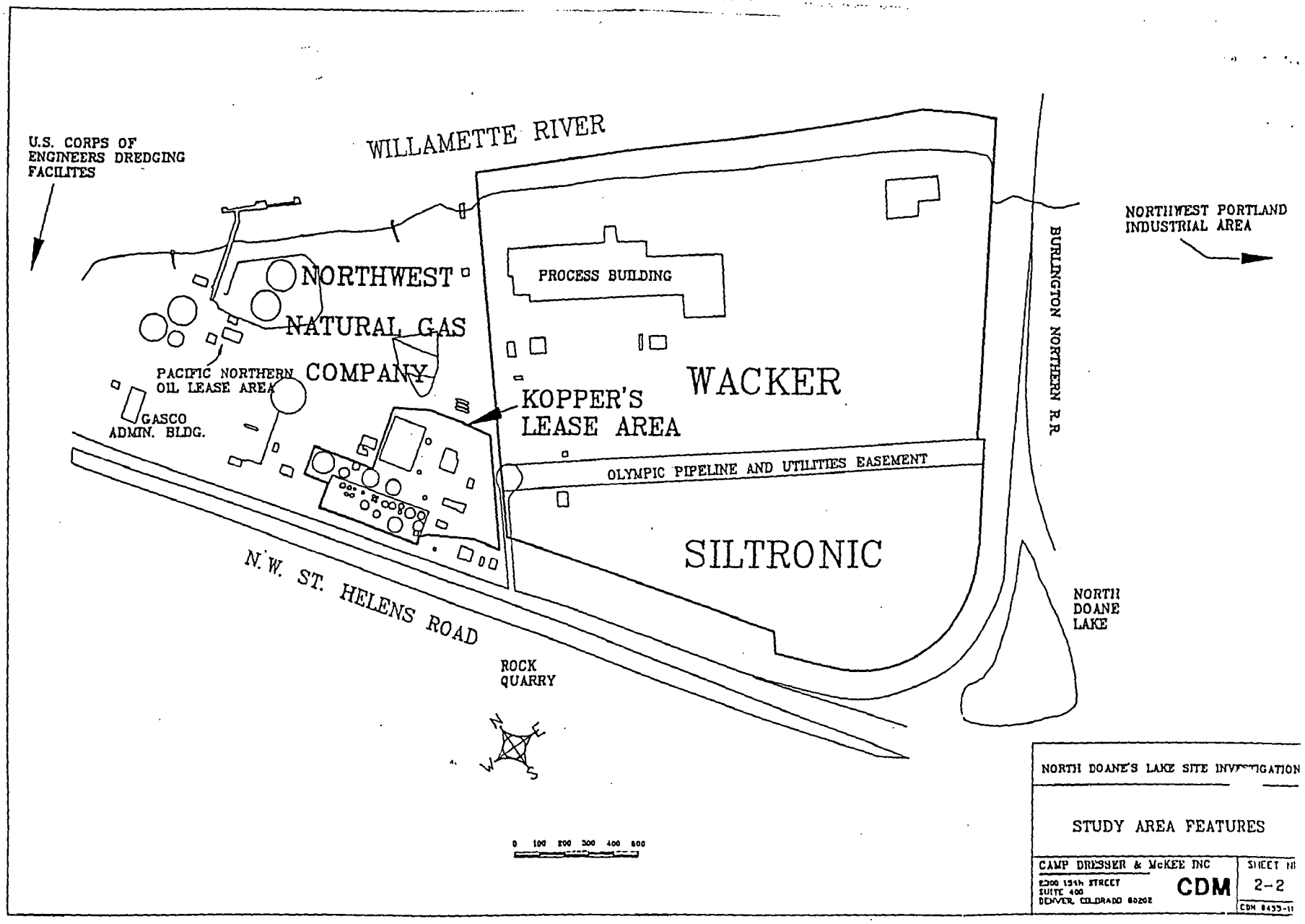
ATTACHMENT A

VICINITY AND SITE MAPS


NWNG
Site
Wacker
Property
PORTLAND
St Johns
Linnton
Whitwood Court
Gasco
Doane Point
Doane Lake
Willbridge
University Park
Barnes Yard
Chemical
Oil
Mile 5
Mile 6
Mile 7
Gaging Sta
Playground
Post Office
Water
Roosevelt High Sch
Port of Portland
Refinery
ST JOHNS BRIDGE
UNION PACIFIC
LOMBARD
SWIFT
BURLINGTON
WILLAMETTE
RIVER



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ATTACHMENT B

SCOPE OF WORK

ATTACHMENT B

VOLUNTARY CLEANUP PROGRAM
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
SCOPE OF WORK

I. OBJECTIVES AND SCHEDULE

A. OBJECTIVES

1. Work performed under this Agreement shall complement and incorporate existing site information with the following specific objectives:

   i. Determine the magnitude, nature and extent of contamination at the Northwest Natural Gas Company (NWNG) site located at 7540 N.W. St. Helens Road. The investigation and cleanup, if required, shall include properties leased to Pacific Northern Oil Company and Koppers Industries, Incorporated. The investigation shall focus on, but not be limited to, petroleum related contaminants such as volatile aromatic compounds and polycyclic aromatic hydrocarbons (PAHs) and inorganic contaminants such as metals, cyanide and hydrogen sulfide.

2. Work performed under this Agreement shall complement and incorporate existing site information with the following overall objectives:

   i. Identify the hazardous substances which have been released to the environment,

   ii. Determine the full nature and extent of hazardous substances in affected media on and off-site,

   iii. Determine the distribution of hazardous substance concentrations,

   iv. Determine the direction and rate of migration of hazardous substances,

   v. Identify migration pathways,

   vi. Identify the environmental impact and risk to human health and/or the environment,

   vii. Develop the information necessary to select a remedial action.

B. SCHEDULE

The Remedial Investigation/Feasibility Study (RI/FS) described in this Scope of Work may be completed in phases if that approach will better enable NWNG to meet the objectives listed above. All work under this Agreement will proceed in accordance with the schedule below, which assumes a phased approach and is measured in calendar days:

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RI/FS Proposal	Provide to DEQ within 30 days of issuance of this agreement.
Meeting to discuss RI/FS Proposal	Between DEQ and NWNG within 15 days of DEQ's receipt of the RI/FS proposal; DEQ and NWNG will meet, if necessary, to review the proposal, concur on the RI/FS approach, and discuss the content and format of deliverables.
DEQ approval of RI/FS Proposal	To NWNG within 10 days of meeting or within 15 days of receipt of RI/FS Proposal if meeting not held.
Draft RI/FS Work Plan	To DEQ within 45 days of receipt of DEQ's approval of the RI/FS Proposal; the Draft RI/FS Work Plan shall include the draft Sampling and Analysis Plan (SAP), Health and Safety Plan (HASP), Quality Assurance Project Plan (QAPP), Endangerment Assessment Work Plan (EAWP) and Feasibility Study Work Plan (FSWP).
DEQ review and comments	To NWNG within 30 days of receipt of the Draft RI/FS Work Plan.
Revised Draft RI/FS Work Plan	To DEQ within 15 days of receipt of DEQ comments; the revised RI/FS Work Plan shall include a revised SAP, HASP, QAPP, EAWP and FSWP as necessary, addressing DEQ comments.
DEQ review and approval	To NWNG within 15 days of receipt of an approvable RI/FS Work Plan.
Implementation of RI	Within 15 days of receipt of DEQ approval; NWNG shall complete work according to the schedule specified in the approved Work Plan.
RI Letter Report	To DEQ within 30 days of completion of RI and receipt of laboratory data. Data shall be validated and any unusable data identified. Shall include a recommendation whether additional phases are required; format to be mutually agreed upon by DEQ and NWNG.
DEQ review and comments	To NWNG within 15 days of receipt.
Subsequent Phase Work Plan Addenda	If it is mutually determined by DEQ and NWNG that additional phases are required, NWNG shall submit a **Work Plan Addendum** according to a format and schedule agreed upon between the parties prior to starting each phase of the Remedial Investigation, the Endangerment Assessment and the Feasibility Study.
DEQ review and comment	To NWNG within 21 days of receipt of each Work Plan Addendum.

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Subsequent Phase RI Letter Reports	Within 30 days of completion of subsequent phases of the RI work, NWNG shall issue additional Phase __ RI Letter Reports which summarize the RI work to date and include a recommendation whether additional phases are required.
DEQ review and comment	To NWNG within 15 days of receipt of the Letter report for each phase of the RI.
Draft RI Report Outline	To DEQ within 30 days of receipt of DEQ's comments on the final phase of the RI work and receipt of all laboratory data; the outline will provide a table of contents and a list of figures and tables.
DEQ Review and Comment	To NWNG within 15 days of receipt.
Draft RI Report	To DEQ within 60 days of receipt of DEQ's comments; the draft RI report will include a draft Endangerment Assessment, summarize all RI work to date and respond to all DEQ comments to-date.
DEQ review and comments	To NWNG within 45 days of receipt of the Draft RI Report.
Final RI Report	To DEQ within 30 days of receipt of DEQ comments.
Review and approval	To NWNG within 30 days of receipt of an approvable RI Report.
Draft FS Report	To DEQ within 60 days of DEQ approval of the Final RI Report
DEQ review and comments	To NWNG within 45 days of receipt of the Draft FS report
Final FS Report	To DEQ within 30 days of receipt of DEQ's comments
DEQ review and approval	To NWNG within 30 days of receipt of an approvable FS Report

II. RI/FS PROPOSAL

The RI/FS Proposal will be a brief discussion of NWNG's proposed approach to the RI/FS, addressing soil, groundwater, surface water, sediments, and air. The proposal will provide the framework for the RI/FS Work Plan and will include the following, assuming a phased approach:

A. A summary of site-specific issues and a review of the results of previously completed work;

B. A general description of each proposed phase, including the goals and objectives of each;

C. Phase I sample locations, depths, proposed analytical methods, and the rationale for each (include map); and

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D. The estimated schedule for implementation of Phase I and subsequent phases if necessary.

III. REMEDIAL INVESTIGATION WORK PLAN

The RI Work Plan shall be based on the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, OSWER Directive 9355.3-01, 1988, and developed in accordance with OAR 340-122-080.

The Work Plan shall include, but not be limited to the following items:

A. PROJECT MANAGEMENT PLAN

1. A proposed schedule for submittals and implementation of all proposed activities.

2. A description of the personnel involved in the project, including their qualifications to do the proposed work.

B. SITE DESCRIPTION

A description of facility operations shall include, but not be limited to, the following:

1. A list of chemical products used on-site currently and historically.

2. The estimated volume of waste disposed of on-site and/or discharged off-site.

3. Time and volume of known spills.

4. A description of past and present waste treatment/disposal practices and areas.

5. The location of past and present raw material and finished product storage areas.

6. The approximate time periods for past operational, treatment, storage, disposal, and/or discharge practices where hazardous substances were involved relative to this investigation.

C. SITE CHARACTERIZATION PLAN

1. Soils

Objective: To identify releases of hazardous substances to soils and to assess the nature and extent of soil contamination.

Scope: The plan shall address all areas which could potentially have received spills, leaks from tanks or piping, been used for waste treatment, storage, or disposal, or have been affected by contaminated surface water or storm water runoff, and all other areas where soil contamination is known or suspected, to the extent necessary for DEQ to select a remedy for the site.

Procedures: The sampling program shall supplement previous soil

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sampling at the facility. At a minimum, the plan shall include, but not be limited to, the following:

a. The proposed location of soil borings including;

i. Depth of borings

ii. Sampling interval

iii. Sample collection methods

iv. Analytical parameters

v. Method to determine background concentrations for each parameter

vi. Rationale for each of the above

b. Provisions for describing soil boring samples, to include:

i. The soil type according to the ASTM D 2487-85, Classification of Soils for Engineering Purposes, and

ii. Soil color, structure, texture, mineral composition, moisture, and percent recovery according to ASTM D 2488-84, Description and Identification of Soils (Visual-Manual Procedures)

iii. Other relevant characteristics such as visual identification of contamination, odor, and detection of vapors by use of field screening instruments such as HNU, OVA or other equivalent type equipment, and as described by a qualified geologist or geotechnical engineer.

2. Groundwater

Objective: To identify releases of hazardous substances and characterize the lateral and vertical extent of these releases to groundwater

Scope: The plan shall supplement previous investigations at the facility and shall identify releases of hazardous substances to groundwater, and shall also characterize the vertical and lateral extent of groundwater contamination, both on-site and migrating off-site to the extent necessary for DEQ to select a remedy for the site.

Procedures: The sampling program shall supplement previous groundwater sampling at the facility. At a minimum, the plan shall include, but not be limited to, the following:

a. Well installation plan to include:

i. Proposed well locations.

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ii. Proposed well depths.

iii. Length of proposed screened intervals.

iv. Proposed drilling methods.

v. Proposed construction materials and installation methods.

vi. Proposed well development and completion methods.

vii. Proposed sample collection methods

viii. Proposed analytical parameters

ix. Proposed method to determine background concentrations of each parameter

x. Proposed schedule for sampling all monitoring wells

b. Hydrologic characterization proposal to include:

i. Provisions to collect and describe formation materials during drilling. NWNG may consider obtaining continuous cores and using borehole geophysics to supplement coring.

ii. A plan to characterize the hydrogeology including a description of:

(a) stratigraphy
(b) structural geology
(c) depositional history
(d) regional ground-water flow patterns

iii. A plan to describe the hydrogeologic properties of affected hydrogeologic units found at the site, and additional units as necessary to complete the RI/FS, including:

(a) hydraulic conductivity
(b) porosity
(c) lithology
(d) hydraulic interconnections between saturated zones

iv. Plans to identify the following for each affected aquifer, and additional aquifers as necessary to complete the RI/FS:

(a) A description of ground-water flow direction.
(b) Identification of vertical and horizontal gradient(s).
(c) Interpretation of the flow system including the rate (horizontal and vertical) of groundwater flow, and including seasonal variations.

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v. A plan to describe surface and subsurface features, characteristics, and interrelationships with a potential to influence groundwater flow patterns at the site, including:

(a) Identification of pumping groundwater wells, past and present.
(b) Influences of rivers, streams, and ditches.
(c) Influences of ponds and lakes.
(d) Identification of areas of recharge/discharge.

c. A plan to conduct a well inventory to identify all active and inactive water wells within a one-mile radius of the facility, to include, as necessary:

i. Identification of all wells listed with the Oregon Water Resources Department and field confirmation of their location

ii. A door-to-door field survey to identify wells for which no logs are on file

iii. For all located wells, to the extent practicable, identify:

(a) Owner
(b) Address
(c) Map location
(d) Driller
(e) Date drilled
(f) Depth
(g) Casing and screen material, depths and intervals
(h) Seal types, depths and intervals
(i) Static water levels
(j) Approximate land surface elevation
(k) Reported water quality and use of well

iv. A plan to sample those private wells identified above which, based on the available hydrogeological information, may be at greatest risk of contamination.

3. **Surface Water and Sediments**

Objective: The Work Plan shall include a plan to identify and evaluate releases of hazardous substances to surface water, including their sediments.

Scope: The plan shall supplement previous investigations at the facility and shall identify all past, existing, and potential impacts to surface waters from the identified release to the extent necessary for DEQ to select a remedy for the site.

Procedures: The sampling program shall supplement previous surface water and sediment sampling at the facility. At a minimum, the plan shall include but not be limited to,

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the following:

a. A delineation of past and present surface drainage patterns at the site.

b. Proposed sampling points in past and current surface drainages.

c. Proposed sample collection methodology.

d. Proposed analytical parameters

e. Proposed method for determining background values for all parameters.

f. A rationale for each of the above.

4. **Air**

Objective: To identify and characterize the release of hazardous substances to the air from unregulated sources at the facility.

Scope: The air assessment plan shall supplement previous investigations at the facility and shall be designed to determine if unregulated air emissions from the site threaten human health or the environment.

Procedures: The sampling plan shall supplement previous air sampling at the facility. At a minimum, the plan shall include, but not be limited to, the following:

a. Proposed sample locations

b. Proposed analytical parameters

c. Proposed sample collection methods

d. Methodology for determining background values for each parameter

e. Rationale for each of the above

D. SAMPLING AND ANALYSIS PLAN (SAP)

Objective: To adequately document all sampling and analysis procedures.

Scope: The SAP shall be sufficiently detailed to function as a manual for field staff. In preparation of the SAP, the following guidance documents shall be utilized: Data Quality Objectives for Remedial Response Activities, EPA/540/G-87/004 (OSWER Directive 9355.0-7B), March, 1987; Test Methods for Evaluating Solid Waste, SW-846; and A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001 (OSWER Directive 9355.0-14), December, 1987. The SAP shall address all topics listed in Policy #760.000, Quality Assurance Policy.

Procedures: The Work Plan shall include a SAP for all sampling activities. The SAP shall include, at a minimum:

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1. Proposed analytical parameters and rationale.

2. Description of sample collection methods, sampling equipment, and sample handling procedures.

3. Quality assurance and quality control procedures for both field and lab procedures, including a data quality objectives plan.

4. Chain of custody procedures.

5. Analytical methods for each parameter.

6. A methodology for determining background concentrations for all detected contaminants.

7. A methodology for determining statistically significant increases in concentrations for the sampling parameters.

E. HEALTH AND SAFETY PLAN (HASP)

The Health and Safety Plan shall:

1. Describe the known hazards and risks.

2. Identifying levels of protective clothing and equipment to be worn.

3. Describe decontamination procedures.

4. Identify any special requirements or training needs.

5. Provide a contingency plan for emergencies.

An existing Health and Safety Plan can be included by reference, if it adequately includes the above items.

F. ENDANGERMENT ASSESSMENT WORK PLAN

The Endangerment Assessment portion of the Work Plan shall be developed based on the *Risk Assessment Guidance for Superfund - Human Health Evaluation Manual Part A*, United States Environmental Protection Agency, Interim Final, July 1989, (RAGS-HHEM); *Risk Assessment Guidance for Superfund Volume II - Environmental Evaluation Manual* (EEM), United States Environmental Protection Agency, Interim Final, March 1989; *EPA Region 10, Supplemental Risk Assessment Guidance for Superfund*, United States Environmental Protection Agency, August 1991, (SRAGS); and, *Human Health Evaluation Manual, Supplemental Guidance:"Standard Default Exposure Factors"*, United States Environmental Protection Agency, March 1991,(HHE-SG).

1. Human Health Evaluation

Objective: The human health evaluation (HHE) is an analysis of the potential adverse health effects caused by hazardous substance release(s) from a site in the absence of any actions to control or mitigate these releases (i.e., under an assumption of no action). It is used to document the magnitude of the potential risk at a site and to evaluate the cause(s) of that risk. It is also

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used to support risk management decisions, and to set remediation goals, if necessary.

Scope: This section shall describe the different tasks involved in preparing the HHE portion of the endangerment assessment. A suggested outline for the human health evaluation is given in Exhibit 9-1 of the RAGS-HHEM. The Work Plan should use this outline as a framework for discussing the methodologies and assumptions to be used in assessing the potential human health risks at the site.

The HHE shall include an estimate of the reasonable maximum exposure (RME) expected to occur under both current and future land use conditions. Guidance on quantifying the RME is given in Chapter 6 of the RAGS-HHEM, SRAGS, and HHE-SG. Quantifying the potential risks associated with the RME shall be the overall goal of the Endangerment Assessment.

The Work Plan should include, but not be limited to the following:

a. A conceptual site model for the site. This model should be an iterative flow chart based on available site information showing contaminant sources, release mechanisms, transport routes and media, potential receptors, and other important information as appropriate. Iterations of this model shall be carried through the work plan and the endangerment assessment as additional information is generated. Exhibit 4-1 of the RAGS-HHEM presents an example of a conceptual site model.

b. The exposure parameters for the RME based on both current and future land use scenarios.

c. A list of all chemicals identified at the site (by media).

d. The analytical methods used during the site investigation, and the method detection limits that were used for all analytes. In addition, an explanation of how non-detect values and qualified data will be used to estimate exposure point concentrations should be provided.

e. The rationale for selecting chemicals that will be carried through the HHE.

f. A discussion of how the fate and transport of site-related chemicals will be evaluated. In addition, a description of the fate and transport model that will be used to estimate the potential infiltration (or contribution) of chemicals in soil to ground water should be included.

g. A summary table of the chemicals found, and their respective critical toxicity values (reference doses - RfDs), slope factors, and other relevant critical toxicity factors) and citations for these values; data on absorption factors that will be used (e.g., dermal absorption factors) should also be included.

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h. The exposure points and exposure point concentrations to be used in the HHE (and/or how they will be estimated). A description of the model(s) that will be to estimate exposure point concentrations should be provided, if necessary.

i. An explanation of how the uncertainty analysis will be conducted.

2. Environmental Evaluation

Objective: The environmental evaluation (EE) provides an assessment of the potential threat to ecological populations, communities or ecosystems in the absence of any remedial action. It can provide a basis for determining whether or not remedial action is necessary, and can also be used to support risk management decisions.

Scope: The EE and the HHE are parallel activities used in the evaluation of hazardous substance sites. Much of the data and analyses relating to the nature, fate, and transport of a site's contaminants can be used for both evaluations. Available data (from the HHE or previous investigations) can be utilized, whenever appropriate, and additional data should be generated whenever necessary in order to conduct the ecological assessment.

The EE shall follow the organization presented in Chapter 6 of the EEM, as applicable. The Work Plan shall discuss the different tasks involved in evaluating whether or not the potential ecological impacts of the contaminants at a site warrant remedial action.

The Work Plan should include, but not be limited to the following:

a. A list of all chemicals identified at the site (by media). The HHE can be referenced, if appropriate.

b. The rationale for selecting chemicals that will be carried through the EE.

c. A description of the site and study area. A description of how the EE will account for the ecosystems and populations potentially exposed to chemicals at the site (e.g., a description of the habitat and lists of species either collected or observed), and how they will be evaluated should be included.

d. A discussion of how the fate and transport of site-related chemicals will be evaluated (through both physical and biological means). The HHE can be referenced, if and/or where appropriate.

e. The exposure points and exposure point concentrations that will be used in the EE (and/or how they will be estimated). A discussion of actual or potential exposure pathways (and the media involved) should also be included.

f. A description of how the potential environmental impacts or threats will be characterized. This should include

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a description of the ecological endpoints that will be considered measurements of potential impact or probability of potential impact (e.g., Water Quality Criteria).

g. An explanation of how the uncertainty analysis will be conducted.

G. FEASIBILITY STUDY WORK PLAN

The Feasibility Study portion of the Work Plan shall be developed in accordance with OAR 340-122-080 and Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, OSWER Directive 9355.3-01, 1988. The Feasibility Study shall develop an appropriate range of alternatives which meet the standards listed in OAR 340-122-040, and 340-122-090. The Feasibility Study shall be developed in parallel with Remedial Investigation activities.

Objective: To present an outline of the Feasibility Study process and identify potential remedial alternatives in order to obtain sufficient analytical data during the RI.

Scope: The purpose of the Feasibility Study is to develop and evaluate remedial alternatives for each contaminated medium, and recommend remedial actions to be taken at the facility

Procedures: A Work Plan shall be submitted which will include, but not be limited to the following:

1. A description of any interim remediation activities which have been implemented to date and the relationship of the interim measures to the ultimate corrective action.

2. The remedial action objectives.

3. A discussion of how volumes or areas of media to which response actions may be applied will be identified.

4. A discussion of how screening criteria will be developed to identify and select treatment technologies and process options.

5. A description of how process options will be evaluated.

6. The criteria for and selection of remedial action alternatives.

7. A preliminary screening of remedial technologies and alternatives based on available data.

H. MAPS

The Work Plan shall include maps of the facility which clearly show:

1. Site topography and surface drainage.

2. On-site structures, including tanks, sumps, catch basins, utilities, and pipelines.

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3. The location of past spills, disposal areas, and all other waste and product management areas.

4. All pertinent structures adjacent to or nearby the site such as drainage ditches, pipelines, roadways, wells and utility corridors.

5. The location of all existing and proposed surface soil sample points, soil borings, monitoring wells, surface drainage, sediment, surface water, and air sample points.

6. The locations of hydrogeologic cross-sections.

7. The drawing date, orientation, and scale.

IV. REPORTS

A. **MONTHLY REPORTS:** Monthly reports shall be submitted to DEQ by the 10th day of the month following the reporting period. These reports shall include, but shall not be limited to, the following:

1. Activities that occurred during the past month.

2. Description of data results collected during the past month.

3. Description of any problems or difficulties experienced during the past month.

4. Description of activities planned for the coming month.

B. **LETTER REPORTS:** Letter Reports are to be submitted to DEQ within 30 days following the completion of each phase of the remedial investigation. These reports shall include, but shall not be limited to, the following:

1. Introduction.

2. Summary of work completed to date.

3. A presentation of all data collected during the investigation.

4. Conclusions and recommendations.

C. **REMEDIAL INVESTIGATION REPORT:** The results of the Remedial Investigation shall be submitted to the DEQ as draft and final report in accordance with the following format:

1. Executive Summary

2. Introduction

   a. Purpose

   b. Report Organization

3. Site Background

   a. Site Description

      i. Location

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ii. Physical features such as building, roads, utilities, wells, etc., include map

iii. Site History

b. Facility Operations

i. Past production processes, waste identification, location of hazardous materials handling and storage areas

ii. Location, time, volume of releases of hazardous substances, include map

iii. Past and present waste treatment/disposal practices and areas

c. Site Setting

i. Regional land use and history

ii. Geology

iii. Hydrogeology

iv. Surface water

v. Climatology

d. Previous Investigations

i. Summary of previous investigations

ii. List of reports referenced

4. Study Area Investigation

a. Soil

i. A map and description of the location of soil borings or surface samples including depth of borings, sampling interval, sampling methods, analytical parameters, analytical methods, as well as quality assurance and quality control procedures

ii. Description of soil samples; all boring and lithologic logs

iii. A map showing the locations of hydrogeologic cross-sections

iv. An evaluation and analysis of all data submitted; use tabular and graphic presentation; include discussion of data limitations

b. Groundwater

i. The well installation plan including well locations (provide map), well depth, length of

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screened intervals, drilling methods, construction materials, and installation methods, well development and completion methods

ii. All boring and lithologic logs; including well construction diagrams with surveyed location, elevation of top of casing, size and depth of well, screened interval

iii. A characterization of the hydrogeology including a description of formation materials, the hydrogeology, and hydrogeologic properties of each pertinent aquifer

iv. A description of the hydraulic influence from groundwater wells, and surface water bodies

v. All areas of recharge/discharge

vi. Results of the well inventory to identify all active and inactive water wells within a one-mile radius of the facility

vii. Results and data analysis including data limitations; tabular and graphic presentations

c. Surface Water and Sediments

i. A map with all relevant surface water bodies within 2 miles of the site

ii. A map with past and present surface drainage patterns and the stormwater collection system

iii. A map with all sample locations

iv. Results and data analysis including data limitations; tabular and graphic presentations

d. Air

i. A wind rose and discussion of predominant wind direction

ii. A map indicating all sample locations and elevations of sample points

iii. Results and data analysis including data limitations; tabular and graphic presentations

5. Summary and Conclusions

a. A discussion of the nature and extent of contamination; discuss the data limitations

b. A discussion of the fate and transport of the contaminants of concern

c. Recommendations for further action

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As part of the Remedial Investigation Report to DEQ, NWNG may incorporate existing data, reports or information, including data from any investigation activity conducted prior to the effective date of this Agreement, to the extent that such data is consistent with the procedures and quality assurance/quality control criteria approved by DEQ.

C. **ENDANGERMENT ASSESSMENT REPORT:** The results of the Endangerment Assessment shall include the Human Health Evaluation and the Environmental Evaluation and shall follow the report formats described in the references cited in IV.F. of this Scope of Work. Any data limitations shall be noted in the report. If information is presented in sections of the RI Report, these may be referenced.

D. **FEASIBILITY STUDY REPORT:** The results of the Feasibility Study shall be submitted to DEQ in a report which, at a minimum, includes a full evaluation of remedial action alternatives, giving a workable number of options which each appear to adequately address site problems and remedial action objectives. These alternatives shall include a no action option, at least one option which will achieve background, and at least one option which will achieve protection of public health, safety, and welfare and the environment. The report shall present the following for each alternative:

1. Description of the remedial action alternative, estimated cost, and rationale for selection.

2. Performance expectation (i.e., reductions in contaminant concentration levels), reliability, and ability to implement.

3. Design criteria and rationale.

4. General operation and maintenance requirements.

5. Monitoring program to assure both short-term and long-term performance of the alternative.

6. Financial assurance mechanism to assure performance.

7. Estimated time for implementation.

8. Evaluation of the short-term and long-term effectiveness and risks of the alternative.

9. Recommendation and justification of the remedial action selected from the developed alternatives.

10. A schedule for implementation of the proposed remedial action.

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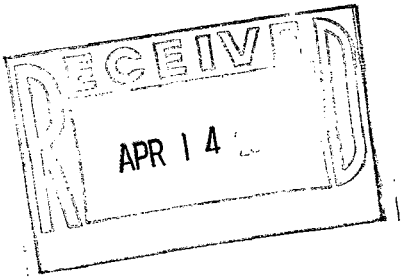
KOPPERS INDUSTRIES

Koppers Industries, Inc.
436 Seventh Avenue
Pittsburgh, PA 15219-1800

Telephone: (412) 227-2001
Fax: (412) 227-2423

April 13, 2000



NW Natural
220 NW Second Avenue
Portland, Oregon 97209
Attn: Sandra Hart
Manager: Risk, Environmental and Land

RE: Investigation and Cleanup Studies Documents
Gasco Facility
7900 NW St. Helens Road

Dear Sandra:

As part of recent environmental reviews we have been conducting for all of our operating facilities, we reviewed a draft of a document entitled: *Final Remedial Investigation / Feasibility Study Work Plan* (Hahn and Associates, Inc., August 4, 1995), that was accessed through Beazer East, Inc. As a consequence of this review, we have two related concerns associated with NW Natural's reporting of environmental work in the area of our lease:

1. The common use of "Koppers" as an acronym both for Koppers Company, Inc., now known as Beazer East, Inc., and Koppers Industries, Inc.

2. Any inference or reference to Koppers Industries' lease property use and activities with regard to the need for cleanup work.

With regard to item 1, for example, the report discusses in Section 3.0, "*Site Description*", a lease to "*Koppers Company, Inc. (Koppers) for creosote oil distribution.*" Then further states that "*...leases with Koppers have recently been renegotiated.*" The date of this report and renegotiation of the lease, relative to the environmental issues being addressed through NW Natural's activities have nothing to do with Koppers Industries' activities upon the leased property.

Further, reference and discussions of potential contamination throughout the report discuss "Koppers" property or processes without benefit of the understanding of the ownership transition. For example, Section 4.2, "*Potential Contaminant Sources*", indicates that "*[T]he process areas of concern at the site are identified as: ...Light Oil Plant/Koppers Plant...*"

With regard to item 2, for example, the report discusses in Section 4.6, "*Estimated Nature and Extent of Contamination*", "*[O]ther areas where solid contaminants may be expected are in the ...and in the current area of pencil pitch storage at Koppers*".

Clearly this could be misinterpreted to include Koppers Industries within the scope of the investigation and cleanup work in the area.

I believe these examples demonstrate our concern raised by the language within your consultant's report and request that NW Natural consider Koppers Industries' concerns with regard to all future reports. Providing a clear differentiation between Koppers Industries and Koppers Company with regard to the historic (pre-Koppers Industries) contamination should be reflected in all of NW Natural's documents.

It is Koppers Industries' belief that all of the environmental issues being addressed at and around our lease property represent Existing Environmental Liabilities, as that term is defined in our current lease with NW Natural:

> "Existing Environmental Liabilities" means the liability of Landlord, and Koppers Company, Inc. (now known as Beazer East, Inc. and the previous tenant under the Prior Lease) for certain environmental contamination of Landlord's Plant Property, as established and allocated pursuant to an agreement between Landlord and Beazer East, Inc.

Koppers Industries has dutifully maintained our obligations for repairs and maintenance, and undertaken environmental measures to ensure that environmental concerns have not and will not arise from our activities at the property. Based on Koppers Industries' environmental compliance and stewardship activities, NW Natural, nor any party involved with your assessment work, should have reason to believe that Koppers Industries has any obligation with regard to the historic environmental impairment of the property.

Your attention to this matter is appreciated. Please do not hesitate to contact me should you take issue with any part of this correspondence, or otherwise wish to discuss this matter further.

Sincerely,

Traci I. Self

Traci I. Self
Environmental Manager

CC:
Amos Kamerer-Portland
Mark Cilley-Stickney
Leslie Hyde
Jim Dietz

Bill - Your turn first - OK?

call Wed. 703 816-8632 Kim Nash

S. Back to me next week

FINAL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WORK PLAN

Northwest Natural Gas Company
Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

August 4, 1995

HAHN AND ASSOCIATES, INC.
Environmental Management

434 NW 6th Avenue, Suite 203
Portland, Oregon 97209-3600
503/796-0717 • 503/227-2209 FAX

Recycled Recyclable

FINAL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WORK PLAN

Northwest Natural Gas Company
Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

August 4, 1995

Prepared for:

Northwest Natural Gas Company
Portland, Oregon

Prepared by:

Hahn and Associates, Inc.
Portland, Oregon

HAI Project #2708

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FINAL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WORK PLAN

Northwest Natural Gas Company
Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

August 4, 1995

1.0 INTRODUCTION

The Northwest Natural Gas Company (NWNG) has retained the environmental management firm of Hahn and Associates, Inc. (HAI) to perform a Remedial Investigation/Feasibility Study (RI/FS) at the NWNG Gasco facility, 7900 NW St. Helens Road, Portland, Oregon (Figure 1). NWNG has also retained Decision Focus Incorporated ("Decision Focus") to perform an Endangerment Assessment for the Gasco site. NWNG and the Oregon Department of Environmental Quality (DEQ) have entered into an Agreement for Remedial Investigation/Feasibility Study (DEQ No. ECVC-WMCVC-NWR-94-13) for the Gasco site. This Work Plan is intended to meet the *Draft RI/FS Work Plan* requirement as outlined in the RI/FS Agreement.

The RI/FS Work Plan presents a phased approach for the investigation of the Gasco site and is partially based on the Expedited Site Characterization (ESC) process[1]. The ESC is a flexible and iterative process that involves the development of a dynamic work plan that serves as a guide for investigation and can be modified as necessary. The ESC process recognizes that uncertainties are involved in the investigation and remediation of a site, and that there is a point in the investigation and design process where additional study only leads to marginal returns of value. The ESC process is performed by an interdisciplinary team that is involved in all phases of the site characterization.

---

[1] J. C. Burton et al, Argonne National Laboratory, *Expedited Site Characterization: A Rapid, Cost-Effective Process for Preremedial Site Characterization*, Proceedings of Superfund XIV: Conference and Exhibition (December 1993).

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The RI/FS for the subject site will be performed in phases as three general projects as follows:

- Phased Remedial Investigation
- Endangerment Assessment
- Feasibility Study

A Remedial Investigation of soils, groundwater, surface water, sediments, and air at the subject site will be performed by HAI in at least two phases. An Endangerment Assessment that will assess the risks to human health and the environment at the site will be performed by Decision Focus. The Endangerment Assessment will be finalized based on the results of the Remedial Investigation. Based on the results of the Remedial Investigation and the Endangerment Assessment, a Feasibility Study will be prepared for the site that will evaluate the potential remedial action alternatives.

This RI/FS Work Plan document is composed of a number of plans including:

- Remedial Investigation (Site Characterization) Plan
- Project Management Plan
- Sampling and Analysis Plan (SAP)
- Health and Safety Plan
- Endangerment Assessment Work Plan
- Feasibility Study Work Plan

Elements of a Quality Assurance Project Plan (QAPP) are included in the SAP. Therefore a separate QAPP is not included in the RI/FS Work Plan.

Laboratory QAPP Should be included

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2.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES

The primary objectives of the proposed RI/FS activities at the Gasco site are to:

- Perform an evaluation of the hydrogeologic conditions at the subject site, including determining site lithology, evaluating vertical and horizontal gradients, flow direction, rate of flow, and potential stratigraphic controls for contaminant migration beneath the site
- Confirm the contaminants of concern at the site
- Determine the media that have been affected by the contaminants of concern at the site, e.g. soil, surface water, groundwater, sediments, and/or air
- Characterize the nature and extent of the contaminants of concern in the affected media at the site
- Identify migration pathways for the contaminants of concern and determine the direction and rate of migration of the contaminants in the affected media
- Perform an assessment of the risks to human health and/or the environment posed by the subject site
- Obtain information that can be utilized in a feasibility study to select appropriate remedial action(s).

An evaluation of the aforementioned objectives indicates that the proposed investigations at the site will be gathering data for four general purposes:

- Hydrogeologic characterization
- Contaminant characterization
- Risk assessment
- Remedial action selection.

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3.0 SITE DESCRIPTION

For purposes of this RI/FS Work Plan, the NWNG Gasco site comprises approximately 47 acres on the west bank of the Willamette River in the North Doane Lake area. The site is located in the Northwest Industrial Area of Portland which has been an industrial area for over 80 years. The Gasco site includes NWNG's established liquefied natural gas (LNG) facility and parcels leased to Pacific Northern Oil Company (PNO) for bulk fuel storage and distribution, and to Koppers Company, Inc. (Koppers) for creosote oil distribution (Figure 2). The LNG facility is a crucial component of NWNG operations. Due to permit limitations, this facility cannot be relocated. Leases with PNO and Koppers have recently been re-negotiated.

The Gasco site was the former location of the Portland Gas and Coke Company oil gasification facility from 1913 to 1956. The locations of former structures and features associated with the former gas manufacturing facility are shown on Figure 3.

The most detailed history of the operations at the Gasco site that is available is included in a report prepared by Camp Dresser & McKee Inc. ("Camp Dresser"), 1987[2]. Excerpts from the 1987 Camp Dresser report relating to the history of operations at the site are included in Appendix A. Discussions in this RI/FS Work Plan regarding potential source areas (Section 4.2) and contaminants of concern (Section 4.3) rely, in part, on the 1987 Camp Dresser report. The potential source areas and contaminants of concern at the site are summarized on Table 1.

[2] Camp Dresser & McKee Inc., *North Doane's Lake Site Characterization Work Plan*, (June 1987).

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A detailed report on the hydrogeology of the Doane Lake area was prepared by Geraghty & Miller, Inc., 1991[3]. A summary report prepared by Mr. Eric Blischke[4] of the DEQ in April 1994 contains a good synthesis of the investigative and regulatory history of the Gasco site and a summary of the hydrogeology of the area. A copy of the April 1994 DEQ report is include in Appendix B.

4.0 PRELIMINARY CONCEPTUAL MODEL OF SITE

A preliminary conceptual model is presented here based on the investigations performed to date at the site and in the surrounding area. This model presents an interpretation of the most probable site conditions as suggested by the available data. Phase I of the Remedial Investigation has been designed based on this preliminary conceptual model. The information gathered during the Phase I investigation will be utilized to modify or reconstruct the conceptual model if necessary. Subsequent investigations will be performed and the conceptual model modified in an iterative manner until the conceptual model is verified with a high degree of confidence and further uncertainties can be handled as reasonable deviations from the model.

---

[3]Geraghty & Miller, Inc., *Hydrogeological Investigation of the Doane Lake Area, Portland, Oregon*, prepared for The Industrial Group Doane Lake Area (February 1991).

[4]Blischke, Eric, Oregon Department of Environmental Quality, *Northwest Natural Gas – North Doane Lake*, Interoffice Memorandum (April 20, 1994).

4.1 Preliminary Hydrogeologic Model

The preliminary conceptual model of the hydrogeology of the site is shown schematically on Figure 4. The geologic units of interest in the vicinity of the subject site can be subdivided as follows, from youngest to oldest:

- Fill Unit
- Alluvial Deposits
  - Willamette River Deposits
  - Catastrophic Flood Deposits
- Columbia River Basalt

It is assumed that the bedrock beneath the subject site is composed of the Columbia River Basalt and that the Troutdale Formation is absent beneath the Gasco site. The basalt surface dips steeply to the northeast, with the top of the basalt lying at depths of less than 50 feet below ground surface (bgs) along the southwest border of the site at NW St. Helens Road and at depths of greater than 150 feet bgs along the northeast border of the site at the Willamette River.

Overlying the basalt at the site are alluvial deposits composed of unconsolidated sands, silts, and clays ranging in thickness from approximately 50 to 150 feet. The alluvial deposits have been differentiated by Geraghty & Miller, 1991, into the Catastrophic Flood Deposits and Willamette River Deposits. Since these two units may be difficult to differentiate in places, the conceptual model groups the two units together and refers to them as undifferentiated Alluvial Deposits. The uppermost unit of the Alluvial Deposits at the site has been identified as a clayey silt by Camp Dresser, 1987. Determining the presence, continuity, and permeability (both to water and tar) of this Clayey Silt Unit will be of critical importance for the investigations at the site, since this unit may act as a barrier to downward migration of contaminants at the site.

The Alluvial Deposits are overlain by a surface Fill Unit that may be up to 25 feet thick in places. Although most of the Fill Unit is likely composed of hydraulically-placed sands

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and silty sands, areas of the site have been filled with various materials, including lampblack, spent oxide, tars, and quarry reject rock.

Groundwater occurs in two principal hydraulic systems at the site including the unconfined Alluvial Aquifer in the Alluvial Deposits and semi-confined Basalt Aquifers in the Columbia River Basalts. The water table at the site likely occurs at depths of 15 to 20 feet bgs. Groundwater may also be locally found in the Fill Unit in areas where the depth of fill is below the water table. Groundwater flow direction is estimated to be towards the north to northeast. Groundwater in the Alluvial Aquifer likely discharges directly to the Willamette River. Groundwater in the Basalt Aquifers likely discharges to the Alluvial Aquifer in places. It is anticipated that downward vertical hydraulic gradients will be present in the Alluvial Aquifer throughout most of the site, with possible reversals of vertical gradient near the Willamette River.

4.2 Potential Contaminant Sources

The potential sources of contamination at the Gasco site are subdivided into two general areas: 1) process or operational areas and 2) by-product and residue placement areas. These potential source areas were identified from a review of the operational history of the site prepared by Camp Dresser, 1987 (Appendix A). The locations of the potential source areas at the site are shown on Figure 5. A summary of the identified source areas and the potential contaminants of concern in each area is presented on Table 1.

The process areas of concern at the site are identified as:

- Retort Area – Mfg Gas
- Tar Processing Area ? – Mfg Gas
- Light Oil Plant/Koppers Plant
- Naphthalene Plant
- Coke Oven Area Mfg Gas
- Pitch Plant/Tar Loading Area – Mfg Gas?
- Oxide Reactor Area
- PNO Tank Farm

any others ons? See p. 14

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The by-product and residue placement areas of concern at the site are identified as:

- Lampblack Storage/Central Fill Area
- Spent Oxide Storage Area
- Settling Ponds/South Fill Area
- Koppers Land Treatment Area

4.3 Predicted Contaminants of Concern

Based on the history of the operations at the Gasco site, and based on the experience of investigations at other manufactured gas facilities, the potential contaminants of concern at the subject site are:

- Polynuclear aromatic hydrocarbons (PAHs)
- Volatile aromatic hydrocarbons, including benzene, toluene, ethylbenzene, and xylenes (BTEX)
- Total petroleum hydrocarbons (TPH)
- Phenols
- Lead
- Cyanide

PAHs are present in the raw materials, by-products, and residues of the oil gasification process and also in Koppers' past and current processes at the site, including heavy oils, oil tars, lampblack, creosote, pitch, and coke. PAHs are also present in the fuels stored at the PNO facility including bunker and diesel fuels. PAHs are generally considered to be the primary contaminants of concern at manufactured gas sites, particularly the carcinogenic PAHs. PAHs have been detected at the Gasco site.

Volatile aromatic hydrocarbons are present in the motor fuels and light oils that were produced at the Gasco facility and have been detected at the site.

Although total petroleum hydrocarbons (TPH) is listed as a contaminant of concern at the subject site, TPH is not expected to constitute a significant portion of the total risk at the site. TPH contains other compounds that are contaminants of concern, notably PAHs and BTEX. Therefore, TPH will be used as a screening parameter at the site to determine the presence of these other contaminants.

Phenols are present in the tar by-products of the oil gasification process. Phenols have been detected at the Gasco site ~~in low concentrations~~.

Again, What did NWNG do w/ those by prod before Koppers?

Lead, a common additive to motor fuels, has also been detected at the Gasco site. Other metals, which may be expected at coal gasification sites, would not be expected at elevated concentrations at the subject site since the process used at Gasco was an oil gasification process.

discernible difference in pet. derived PAHs vs coal tar PAH. discuss manufacturing

interesting need to

Cyanide may be present at the site due to the use of oxide reactors (for purifying the manufactured gas) and the storage of spent oxide materials at the site. However, the experience of investigations at other manufactured gas plants has shown that free cyanide is generally not present at levels of concern. Camp Dresser, 1987, suggests that the potential for high cyanide levels at the site appears small because the oil gas generally had a low nitrogen content and the feed rate of ammonia was low in a low temperature and low pressure process.

Preliminary sampling of soil and groundwater at the Gasco site, appears to confirm that the contaminants of concern are limited to the aforementioned parameters.

4.4 Additional Potential Contaminants

For various reasons, additional chemicals may be potential contaminants at the Gasco site. These potential contaminants will be investigated in phases at the areas where they are most likely to be present. If the potential contaminants are not detected in the areas most likely to be impacted, then additional investigation for the potential contaminants

they are jumping the gun a little to say if a constituent is detected then they will look everywhere for it. Should be if detected at levels of pot. concern then they can should do additional investigation they will almost certainly detect metals.

will not occur. However, if any of the potential contaminants are detected, then they will be elevated to known "contaminants of concern", and additional investigations will occur for these chemicals. The additional potential contaminants at the site include:

- Hydrogen sulfide (H_2S)
- Ammonia (NH_3)
- Chlorinated pesticides and solvents
- Metals

The potential exists for hydrogen sulfide (H_2S) to be present in spent oxide that did not fully oxidize. However, the presence of significant H_2S levels in the soils at the site appears remote because the spent oxide piles were either removed from the site or were moved and mixed with other fill at the site. The loading, transporting, mixing, and filling process likely allowed for adequate liberation of any residual H_2S. However, an evaluation for dissolved H_2S in the groundwater will take place in areas where spent oxide was stored and/or used as fill.

Ammonia (NH_3) was utilized during the gas purifying process. An evaluation of the groundwater for NH_3 down-gradient of the oxide reactor area will take place to determine the presence of this potential contaminant.

Although not used at the Gasco facility, chlorinated solvents and pesticides have been detected on the adjacent Wacker Siltronic Corporation ("Wacker") site and the nearby Rhone Poulenc Ag Company site. Since these chlorinated compounds can affect the mobility of other contaminants and would impact the selection of a remedial action, an evaluation will be performed for the presence of chlorinated pesticides and solvents at locations that would most likely detect these compounds if they are migrating onto the site in the groundwater. Given current knowledge of where these chlorinated compounds were detected on the nearby sites and the groundwater flow direction, testing for chlorinated pesticides and solvents in the groundwater will take place on the southeast portion of the Gasco site. If during the Phase I investigation, it is found that groundwater flow direction is different than expected, then additional areas of the Gasco site may be evaluated for the chlorinated compounds.

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Naturally-occurring metals in the soils can be mobilized in groundwater due to changes in groundwater chemistry resulting from subsurface contamination by organic compounds. An evaluation of groundwater will take place at the Gasco site to determine the presence of elevated levels of Priority Pollutant metals. The selection of the monitoring wells where sampling for Priority Pollutant metals will take place will occur after the results of the sampling for organic contaminants has been received. Only those wells where significant groundwater contamination was detected will be sampled for Priority Pollutant metals, as this should represent a worst-case situation for the presence of mobilized metals.

4.5 Potentially Affected Media

The various media that may be affected by the contaminants of concern at the subject site include:

- Surface and Subsurface Soil
- Groundwater
- Surface Water
- Sediments
- Air

Both surface or subsurface soil in the vicinity of any of the identified source areas could potentially be impacted by the contaminants of concern. PAHs were previously detected in surface soil samples collected in the vicinity of the former Naphthalene Plant, Coke Oven Area, and Koppers Land Treatment Area.

Mentions of Koppers areas makes me suspicious I agree

Groundwater may contain constituents of the source areas where free product or soil contamination has reached the depth of the water table. Due to the hydrogeology of the area, it is postulated that the groundwater only in the Fill Unit and upper Alluvial Deposits may be impacted at the site. PAHs, phenols, and lead have been detected in the shallow

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groundwater at monitoring wells located at the Koppers facility. BTEX compounds are also suspected to be present in the groundwater in this area.

The surface water bodies that may potentially contain contaminants at the site include, the settling ponds and drainage ditch located on the southeastern portion of the site, and the Willamette River.

Process water may have flowed to the Willamette River in the early years of operation possibly depositing tar and lampblack in the river sediments. Some sediments deposited prior to 1936 were likely covered by subsequent filling along the shoreline. The potential for contamination of these pre-1936 sediments will be evaluated as part of the soil investigation at the site. Sediments along the current-day shoreline may also contain contaminants from groundwater or free-phase contaminants that may have or may be migrating into the river from the site. Due to the industrial nature of up-stream properties on the Willamette River, it is likely that contaminants from up-stream sources will also be present in the sediments adjacent to the Gasco site.

Air may be periodically impacted if dust is stirred up from surface soils that contain contaminants. The dust could be naturally wind blown or stirred up by vehicular traffic or other activities. Non-volatile contaminant can become airborne as particles or adhered to soil dust particles. It is also possible that air may be impacted by the volatilization of volatile contaminants from contaminated soils or surface water.

4.6 Estimated Nature and Extent of Contamination

A preliminary conceptual model of the nature and extent of the contaminants of concern at the subject site will be discussed in this section. The nature of the various types of potential contamination that may be present at the site can be predicted with some certainty given a knowledge of the operations at the site. The extent of the potential contaminants can be estimated given a general knowledge of the hydrogeology of the site. However, it has not been confirmed that the expected contaminants are actually present at all or many of the

areas of the site. The conceptual model of the nature and extent of contamination at the site was used to help design the Phase I Remedial Investigation. The model will be revised and refined based on the results of the Phase I investigation.

The contaminants at the site will likely occur in a number of states including:

- Solid – spent oxide, lampblack, naphthalene, coke, and pitch, and as airborne particulates
- Semi-solid – tar, creosote, and pitch
- Liquid – tar, creosote, light oil, and petroleum fuels
- Dissolved – BTEX, PAHs, phenols, cyanide, and Pb
- Vapor – BTEX

The solid and semi-solid contaminants will be found primarily as fill material in the by-product and residue placement areas such as the former Settling Ponds, Lampblack Storage/Fill Area, and the Spent Oxide Storage Area. Other areas where solid contaminants may be expected are in the former Coke Oven, Pitch Plant, and Naphthalene Plant areas, and in the current area of pencil pitch storage at Koppers. Once in place, the solid and semi-solid contaminants are considered to be relatively immobile. However, percolating surface waters may pass through the solid and semi-solid material and leach dissolved contaminants to the water table. This would primarily be a concern with tars and pitch where PAHs could possibly be leached to groundwater. If stirred up, some of the solid contaminants could pose a risk as airborne particulate material, such as lampblack, coke dust, or pencil pitch dust.

Liquid contaminants in the subsurface will occur either as free-phase liquids or as residual liquids adsorbed onto the soils. Free-phase liquids are mobile in subsurface soils whereas residual liquids are immobile in soils. Contaminants in free-phase liquid form will occur in the subsurface either as light non-aqueous phase liquids (LNAPLs) or dense non-aqueous phase liquids (DNAPLs). Given the general sandy nature of the Fill Unit at the site, it is suspected that non-aqueous phase liquids (NAPLs), if present, would have migrated to the water table unimpeded.

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LNAPLs, being lighter than water, will collect and pond on top of the water table and then migrate in the direction of groundwater flow. Possible LNAPLs at the site include light oils, motor fuels, and other petroleum products. LNAPLs may be present in the vicinity of and down-gradient of the Light Oil Plant and the PNO Tank Farm.

DNAPLs, being heavier than water, will tend to sink in the subsurface until some strata of low permeability is encountered that will slow or halt their downward migration. Possible DNAPLs at the site would include tar and creosote. Due to the viscous nature of tars and creosote, they are expected to be relatively immobile and would be found relatively close to their source areas. DNAPLs may be present in the vicinity of the former Retort Area, Tar Processing Area, Pitch Plant, Coke Oven Area, and the former Settling Ponds, all of which were associated with the manufactured gas plant. In addition, DNAPLs may be present in the vicinity of the Koppers Plant. The greatest potential for the presence of DNAPL tars is in the vicinity of the former Settling Ponds where large volumes of tar were known to be discharged. The conceptual model assumes that due to the viscous nature of tars and creosote, the Silty Clay Unit will act as a barrier for further downward migration of any DNAPLs at the site.

Mfg Gas
Koppers

Residual liquid contamination, generally referred to as soil contamination, may be present in any of the source areas where liquids could have leaked, spilled, or have been discharged to the soils at the site. Soil contaminated with residual liquids may be present in the following areas at the subject site: Retort Area, Tar Processing Area, Light Oil Plant, Naphthalene Plant, Coke Oven Area, Settling Pond Area, Koppers Land Treatment Area, and the PNO Tank Farm. The vertical extent of soil contamination at the site is generally expected to occur in the unsaturated zone, in the zone of water table fluctuation where LNAPLs have been present, and possibly below the water table if DNAPLs have been present. The lateral extent of soil contamination will be dependent on the size of the releases from the source area and the lateral extent of LNAPL or DNAPL migration. The areas with the greatest extent of soil contamination at the site are expected to be the Light Oil Plant and Settling Pond areas.

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Have seldom seen a presentation quite like this - i.e. distinguishing between solid waste vs constituents

Contaminants in dissolved form may be present in either surface water or groundwater. Waters percolating through contaminated soils or fill can leach contaminants to the water table to create a dissolved plume in the groundwater. If present, LNAPLs or DNAPLs are generally a source of dissolved contaminants in the groundwater. A dissolved plume will migrate with the groundwater in the direction of the hydraulic gradient. It appears the ultimate fate of any dissolved plumes at the subject site is discharge to the Willamette River. PAHs have been detected in water samples collected from pits excavated near the river's edge. Dissolved plumes could be present in various source areas at the site, but particularly down-gradient of the Light Oil Plant, Naphthalene Plant, Settling Pond Area, Koppers Land Treatment Area, Retort Area, and the PNO Tank Farm. The contaminants of concern that can be expected to be present in dissolved form at the site are PAHs including naphthalene, BTEX, phenols, cyanide, and lead.

Have never seen dissolved phase COPC to be a problem in discharge to a surface water body

Vapor phase contaminants may be present in subsurface soils, structures, or utilities in areas where soils are contaminated with volatile compounds, such as the volatile aromatics (BTEX). Vapor plumes may be present at the subject site in the vicinity of and down-gradient of the Light Oil Plant. Although vapors may escape from contaminated soils and surface water to the air, this route of migration is likely not significant at the subject site. ?

4.7 Potential Migration Pathways

Three migration pathways for the contaminants at the site are estimated to be of possible significance: the groundwater pathway, the surface water pathway, and the air pathway.

not for coal tar constituents

4.7.1 Groundwater Pathway

The groundwater pathway may allow dissolved and free phase contaminants to migrate in the aquifer in a down-gradient direction. The groundwater pathway is not of direct concern since drinking water wells are not present in the aquifers of interest. In addition,

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it is exceedingly unlikely that water wells will be installed in the future at the site (see NWNG memorandum in Appendix C). However, the groundwater pathway is indirectly of concern since the ultimate destination of the contaminants migrating in the groundwater is the Willamette River where sediments and river water can be affected.

4.7.2 Surface Water Pathway

Two surface water features are present at the site that may contain the contaminants of concern, including the drainage ditch and the two on-site settling ponds. In addition, the site is bounded to the northeast by a major surface water feature, the Willamette River.

The on-site drainage ditch carries NPDES-permitted non-contact cooling water from the NWNG LNG Plant operations and storm water from the property. These waters are discharged to the Willamette River. Treated water from the LNG containment basin is discharged separately to the Willamette River under a temporary 1500J permit with the DEQ. The drainage ditch is unlined and may pass through zones of contaminated soil, possibly picking up contaminants along its path.

figuratively I hope ~ha!

The two ponds at the site formerly acted as holding ponds for water pumped from the LNG containment basin. In addition, the on-site ponds formerly discharged to the drainage ditch, although they are currently damned with no outlet. The ponds are seasonal features and generally dry up in the summer months. The ponds are situated in the former tar Settling Pond Area and thus may be impacted by the presence of tars in their vicinity.

The Willamette River presents the most significant potential surface water pathway for off-site migration of contaminants. The Willamette River may possibly receive contaminants from groundwater discharge, drainage ditch discharge, and from disturbed sediments that may be contaminated.

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4.7.3 Air Pathway

Non-volatile contaminants, such as metals and PAHs, may be present in the air at the site in the form of particulates or adsorbed onto soil dust particles. This air pathway may be the result of natural wind-borne dust or dust stirred up by vehicular traffic or other activities. Volatile contaminants may be present in the air at the site by volatilization from contaminated soils and surface water.

4.8 Potential Human Health and Environmental Risks

Human health and environmental risks depend on 1) the presence of contaminated groundwater, soil, air, or other media, and 2) the pathways available for human or environmental exposure. Based on preliminary information, there appears to be some contamination of soil and groundwater at the subject site. However, there is limited access to or contact with contaminated soil or groundwater. In addition, groundwater is not used as a drinking water source down-gradient of this area. The level of contamination of Willamette River sediments along the site is unknown. The conceptual model of human health risks assumes few human contacts with river sediments, so the exposure pathway again appears to limit potential health risks. Environmental risk related to sediment contamination may need to be investigated based on the results of the proposed sediment sampling activities.

Since surface water runoff and groundwater both discharge to the Willamette River, the river water is a potential source of exposure. An important issue in river water contact is the degree of dilution that occurs at the point of possible human or environmental contact. ✓ Discharges from the site are likely to be several orders of magnitude lower than river flows, so dilution will be significant. Therefore, the conceptual model of human health and environmental risks at the site suggests that human health and environmental impacts would be very low. agreed

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5.0 REMEDIAL INVESTIGATION PLAN

5.1 Phased Remedial Investigation

The primary goals of the Remedial Investigation are to define the hydrogeology of the site, identify the nature and extent of the contaminants at the site, and gather other information that will be useful for completing the Endangerment Assessment and Feasibility Study. Therefore, the Remedial Investigation will involve collecting data for four primary purposes: characterization of hydrogeology, characterization of contaminants, performance of a risk assessment, and evaluation of remedial action alternatives. The data will be used to refine and modify the hydrogeological and contaminant distribution conceptual models of the site (Section 4.0).

we need this

The Remedial Investigation will likely be performed in at least two phases. The Phase I investigation will gather the basic information necessary to generally define the hydrogeology of the site and to confirm the presence of contamination in the identified potential source areas of the site. Although definition of the extent of contamination will be attempted during Phase I, full definition of the identified contamination will likely be performed during Phase II. The Phase II investigation will primarily involve filling data gaps that were identified in Phase I. If necessary, a third phase of remedial investigation will be performed at the site. This Work Plan primarily presents the proposed Phase I activities. If a Phase II investigation becomes necessary for the site, then an addendum to this Work Plan will be presented to DEQ detailing the Phase II activities.

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The objectives of the Phase I Remedial Investigation include:

- Determine the hydrogeologic framework of the site
- Confirm the contaminants of concern
- Determine if soil and groundwater have been impacted in potential source areas
- Attempt to define extent of soil and groundwater impacts
- Determine impacts to surface water
- Determine if sediments have been impacted
- Perform preliminary air monitoring or modeling

The objectives of the Phase II Remedial Investigation include:

- Define extent of soil and groundwater impacts not defined in Phase I
- Perform additional sediment sampling, if necessary
- Perform additional air monitoring, if necessary
- Fill other data gaps identified in Phase I

petroleum derived vs coal tar

The following subsections summarize the selected analytical parameters and the various investigations to be performed at the Gasco site subdivided by the potentially affected media, including soils, groundwater, surface water, sediment, and air.

5.2 Analytical Parameters

The analytical parameters selected for the Remedial Investigation are divided into three main categories, including primary parameters, secondary parameters, and Feasibility Study parameters. A summary of the selected analytical parameters is included in Table 2.

The primary analytical parameters were selected based on the predicted contaminants of concern (see Section 4.3), and are expected to be somewhat widespread at the site. The primary analytical parameters include PAHs, BTEX, TPH, phenols, lead, and cyanide. Analyses for PAHs and TPH will generally be performed on most soil and water samples

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from the site. Analyses for BTEX, phenols, lead, and cyanide will be performed on samples from selected potential source areas at the site.

The secondary analytical parameters were selected based on other potential contaminants that may be present at the site (see Section 4.4). The secondary analytical parameters include H_2S, ammonia, chlorinated pesticides and solvents, and Priority Pollutant metals. Although not anticipated to be present or present at levels of concern at the Gasco site, analyses for the secondary parameters will be performed on groundwater samples from selected areas at the site to confirm this supposition.

The Feasibility Study analytical parameters were selected for an evaluation of their potential impact on various remedial options and treatment technologies. The Feasibility Study parameters include alkalinity, hardness, iron, manganese, nitrate, nitrite, orthophosphate, and total organic carbon (TOC). Analyses for these parameters will be performed on groundwater samples from selected monitoring wells at the site. Temperature, conductivity, and pH will be measured in the field for all the groundwater samples. In addition, analyses for British Thermal Unit (BTU) content will be performed on selected tar samples.

technical impracticability data needs -

Selected soil samples will also be analyzed for various geotechnical parameters, including grain size distribution, plasticity, and moisture content. These parameters will be used to confirm field estimates of soil type and to evaluate the optimum slot size and sand pack for any future monitoring or recovery wells at the site.

5.3 Soil Investigation

The overall objectives of the soil investigation are to identify releases of hazardous substances to the soils, to characterize the extent of the identified releases, and to characterize the hydrogeology of the site. Another key objective of the soil investigation is to determine the continuity and extent of the Silty Clay Unit and to determine the unit's capability to act as a barrier to vertical migration of contaminants. The soil investigation

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will be performed in phases. The Phase I investigation is designed to confirm the presence of releases in the identified potential source areas of the site and to generally define the geology of the site. The Phase II investigation will primarily involve defining the extent of releases that were identified in Phase I and filling in other data gaps.

During Phase I, the soils at the subject site will be investigated both by direct sampling and indirect geophysical methods. The surface and subsurface soils will be directly sampled for lithologic description and analytical testing by means of soil borings and/or test pits. Soil samples will be collected from all the identified potential source areas at the site to confirm the presence of the contaminants of concern in each of these areas. The subsurface soils will also be investigated indirectly by geophysical means in attempt to identify fill zones, tar zones, contaminant plumes, and lithologic changes. Aerial photographs and other maps will be used to confirm and delineate past fill areas at the site.

5.3.1 Soil Sampling Activities

Soil samples will be gathered from 35 soil borings and 12 monitoring well borings to be installed at the site. The proposed locations of the soil borings are shown on Figure 6. A summary of the soil sampling and analytical plan is presented on Table 3.

All of the soil borings will be installed into the Fill Unit and Silty Clay Unit to depths of approximately 20 to 25 feet bgs. The soil borings are proposed to be installed to this depth since it is not anticipated that soil contamination will extend below these soil units. However, if soil contamination is encountered, the borings will be advanced until contamination is no longer evident by field screening techniques. If free product tars or DNAPLs are suspected, then drilling will not extend through any significant confining unit to prevent further downward migration of free product. Six of the monitoring well borings will be advanced into the Alluvial Deposits to depths of approximately 50 feet bgs to evaluate the deeper soils below the water table.

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The soil borings will be installed with a hollow-stem auger drilling rig. Upon completion, the soil borings will be abandoned by filling with 3/8-inch bentonite chips as the augers are withdrawn. Above the water table, the bentonite chips will be hydrated in two-foot lifts. The soil borings will be abandoned in accordance with the *Rules for Construction and Maintenance of Monitoring Wells and Other Holes in Oregon* (OAR 690-240-130 to 135) and the ODEQ guidance document *Groundwater Monitoring Well Drilling, Construction, and Decommissioning Guidelines* dated August 24, 1992.

If auger refusal occurs at any of the boring locations, then test pits may be excavated to evaluate the shallow soils in those areas. If the installation of test pits becomes necessary at the site, then an addendum to this Work Plan will be presented to DEQ that will outline the installation procedures and sampling methodologies.

In approximately one-half of the soil borings, soil samples will be collected with a split-spoon sampling device at 2.5 foot intervals. The split-spoon sampling will allow for the collection of undisturbed soil samples and Standard Penetration Test (SPT) data. In the other soil borings, the subsurface soils will be sampled on a continuous basis with a 5-foot long split-barrel continuous coring device. This type of sampling will allow for the observation of soil lithology on a continuous basis and the collection of soil samples at desired locations for analytical purposes.

A minimum number of soil borings (four) have been located in the Former Settling Pond area, because this is an area of know tar accumulation. An attempt will be made to define the extent of the tars by geophysical means, utilizing the soil borings to confirm the geophysical results. Drilling and sampling in known thick tar zones is not desired because the decontamination of equipment is extremely difficult and subsurface cross-contamination is possible. In order to minimize the potential for cross-contamination, all borings within the known tar zones will be drilled by a "step down" method where casing is utilized to seal off the tar zone and drilling is continued through the casing.

In areas where tar zones are suspected, such as in the vicinity of the Former Settling Ponds, a "step down" drilling method will be used to drill through the tar zones. Once sampling

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has indicated that the base of the tar zone has been reached, then 10-inch diameter steel surface casing will be installed through the augers in the borehole. A cement-bentonite grout will be installed as a seal in the annular space as the augers are withdrawn. The grout-slurry mixture will be allowed to set-up, at which point 4 1/4-inch ID augers will be used to drill out through the surface casing into the undisturbed soils. The small-diameter augers will be used to drill to the proposed depth of the borings (20 feet bgs). Upon reaching total depth, the borehole will be immediately sealed with a cement-bentonite grout as the augers and surface casing are pulled from the hole.

A surface soil sample will be collected at each of the boring locations primarily for purposes of assessing exposure risks at the site. A minimum of 25 surface soil samples will be selected for laboratory analyses. Additional surface soil samples may be collected for the Endangerment Assessment after evaluating the results of the Phase I soil investigation.

5.3.2 Selection of Soil Samples for Laboratory Analysis

Subsurface soil samples will be selected for laboratory analyses based on field screening indicators (visual, odor, sheen, and headspace vapor methods). A minimum of two subsurface soil samples will be selected for analysis from soil borings where field screening indicates possible soil contamination. Samples will be selected for analysis to characterize the contaminated zones, both above and below the water table, and to bracket those contaminated zones to define their vertical extent.

A minimum of one subsurface soil sample will be selected for analysis from soil borings where field screening does not indicate the presence of soil contamination. If soil contamination is not indicated by field screening, then a soil sample will be selected in that boring from the zone of water table fluctuation. In addition, soil samples will be selected from the base of any soil unit that lies on top of a significant confining layer below the water table to evaluate for DNAPLs.

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The analytical parameters that are selected for any given soil sample will depend on the location of the soil sample with respect to a potential source area as summarized on Table 3 and described in Section 7.6.1. In summary, analyses for cyanide will be performed on all selected samples from potential cyanide source areas. TPH analyses will be performed on all selected samples from all areas at the site, and will be used as a screen for determining analyses for other parameters. If TPH is detected in any given soil sample, then additional analyses for PAHs, BTEX, phenols, and lead will also be performed on that sample, depending on the location at the site.

5.3.3 Determination of Background Soil Concentrations

If necessary, background soil concentrations will be determined during the Remedial Investigation in accordance with the DEQ *Soil Cleanup Manual, Appendix C, Guidelines for Determining Background Concentrations*, dated April 1994. As stated in the guidance document, background samples only need to be collected for naturally-occurring materials.

But can they be collected for others?

Lead, being naturally-occurring, will be evaluated at the Light Oil Plant area during the Phase I investigation since lead was only known to be used as an additive to the motor fuels at the site. A full evaluation of background lead concentrations will only be performed during the Phase II investigation if the lead levels detected during the Phase I investigation are found to exceed the appropriate reference concentrations in the Soil Cleanup Table [Oregon Administrative Rules (OAR) 340-122-045]. If this evaluation becomes necessary, then the methodology for determining background lead concentrations will be presented in the Phase II Work Plan Addendum.

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5.3.4 Geophysical Investigation

Following the installation of the soil borings at the site, the subsurface soils will also be investigated by surface and subsurface geophysical techniques in attempt to identify and map fill zones, tar zones, contaminant plumes, and lithologic changes. These methods allow for fast non-destructive measurements of parameters in the field with continuous data-acquisition. Two surface geophysical techniques will be applied that appear most useful for determining geological conditions and locating contaminant plumes, including ground penetrating radar (GPR) and the electromagnetic (EM) method. The subsurface geophysical method to be utilized at the site is natural-gamma logging to detail changes in lithology in the deep monitoring wells at the site.

necessary?

• Surface Geophysical Survey

A preliminary survey with the GPR and EM methods will be performed in the vicinity of the former Settling Ponds to confirm that the geophysical methods will yield useful profiles. If it appears that the GPR and EM methods will yield useful data, then either one or both of the methods will be applied in a full survey at the site. The full survey will be performed in the southeast part of the site where the major fill areas are located (see Figure 6). The survey will be performed on a 20-foot grid in the southeast area where possible. The geophysical survey will be tied into soil boring locations to confirm the lithologic and contaminant interpretations.

• Geophysical Borehole Logging

Natural-gamma logging of the soils in the six 50-foot monitoring wells will be performed during the Phase I investigation. Natural-gamma logs are continuous records of the amount of gamma radiation which is emitted from the subsurface soils. This method is very useful in determining lithologic and geologic changes in the subsurface and may be useful for determining stratigraphic correlations across the site.

5.4 Groundwater Investigation

The objective of the groundwater investigation is to identify releases of hazardous substances to groundwater, to characterize the extent of the identified releases, and to characterize the hydrogeology of the site. The groundwater investigation will be performed in phases. The Phase I investigation is designed to generally define the hydrogeology of the site, to confirm the presence of releases in the identified potential source areas of the site, and to setup a basic monitoring network at the site. The Phase II investigation will primarily involve defining the extent of releases that were identified in Phase I and filling in other data gaps.

The Phase I groundwater investigation will include: 1) sampling of the groundwater from temporary well points, 2) the installation of groundwater monitoring wells, 3) water level monitoring, 4) quarterly groundwater monitoring, and 5) aquifer testing. The Phase II groundwater investigation, if necessary, will be presented to DEQ as an addendum to this Work Plan.

5.4.1 Temporary Well Points

In order to optimize the number of monitoring wells necessary at the site, other groundwater investigation techniques will be employed, including sampling the groundwater from temporary well points in soil borings or through the use of a probe unit. These methods can gather a large amount of groundwater contaminant data in a cost effective manner that can be used to better place additional permanent monitoring wells, if necessary. Vertical profiling of contaminant concentrations in the aquifer can also be performed by these methods.

During the Phase I investigation, the uppermost groundwater will be sampled from temporary well points set in 14 of the soil borings that are proposed for the soil investigation

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at the site. The proposed locations of the 14 temporary well points are shown on Figure 7. A summary of the proposed temporary well point locations, depths, and analytical parameters is included on Table 4.

All temporary well point installation work will be performed by an Oregon-bonded and licensed monitoring well constructor. The temporary well points will be installed in accordance with the Oregon Groundwater Law (Oregon Revised Statute (ORS) Chapter 537) and the *Rules for Construction and Maintenance of Monitoring Wells and Other Holes in Oregon* (OAR Chapter 690, Division 240). The temporary well points will also be installed and abandoned according to the ODEQ guidance document *Groundwater Monitoring Well Drilling, Construction, and Decommissioning Guidelines* dated August 24, 1992.

If additional groundwater investigation becomes necessary during Phase II to define the lateral and vertical extent of contamination at the site, then a soil probe unit will likely be used to gather the additional data.

The temporary well points will be installed to a depth of 20 feet bgs in the 14 selected soil borings. If necessary, the soil borings will be advanced deeper so that they are approximately 10 feet below the water table. The well points will be composed of 2-inch diameter steel tubing and a 5-foot long stainless-steel screen that are decontaminated by steam cleaning prior to use. Once the desired water sampling depth is reached, the well point will be placed inside the augers and the augers will be pulled up approximately 5 feet as a temporary sand pack is placed in the annulus. The well point will then be purged of at least one borehole volume of water (approximately 28 gallons for an 8 1/4-inch hole), or until the casing is entirely evacuated, whichever occurs first. Following the purging, the water sample will be collected according to the methodology described in Section 7.2.3. Once the groundwater sample is collected, the well point will be pulled out of the hole and the sand pack will be drilled out. The borehole will then be abandoned by filling with 3/8-inch bentonite chips as the augers are withdrawn. It is anticipated that the temporary well points will be in-place for no more than 4 hours per boring.

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As indicated on Table 4, the groundwater samples from all 16 temporary well points at the site will be analyzed for TPH and BTEX. If TPH is detected in any given sample, then that sample will also be analyzed for PAHs. The other analytical parameters were chosen based on the location of the well point relative to potential source areas. Phenols will be analyzed at well points that are in the vicinity of the former Retort Area, Light Oil and Naphthalene Plants, and Koppers Land Treatment Area. Cyanide and H_2S will be analyzed at well points that are down-gradient of the former Spent Oxide Storage Area and Oxide Reactor Area, and down-gradient of the former Settling Ponds since spent oxide may have been used as fill in this area. Ammonia will be analyzed at well points in the vicinity of the former Oxide Reactor Area, since it is known that ammonia was used in this area.

5.4.2 Monitoring Wells

The groundwater at the subject site will be investigated by a series of monitoring wells to be installed at various key locations and depths at the site. The monitoring wells will be used to: 1) determine hydraulic gradients and other aquifer parameters, 2) characterize dissolved contaminants in the groundwater, including their lateral and vertical extent, and 3) evaluate for the presence of LNAPLs and DNAPLs. In a number of locations, monitoring wells will be nested together at different depths to determine vertical hydraulic gradients. An extensive network of monitoring wells will be placed along the Willamette River on the site to determine the levels of contaminants that may be entering the river. Monitoring wells will be placed in the Fill Unit, Silty Clay Unit, or Alluvial Deposits throughout the site. If information from the proposed monitoring wells suggests that the Basalt Aquifer may be impacted at the site, then additional monitoring wells will be installed during a subsequent phase of investigation to evaluate the Basalt Aquifer.

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5.4.2.1 Monitoring Well Designation

The monitoring well names will be designated by a prefix "MW", followed by the monitoring well number, followed by a number representing the depth of the well in feet below ground surface (bgs), such as "MW-6-50". Where monitoring wells are placed adjacent to one another at different depth intervals, they will bear the same well number, but a different depth designation, such as "MW-6-25" and "MW-6-50". For ease of reading, the depth designation may be dropped for the shallow monitoring wells, so that "MW-6-25" may be abbreviated as "MW-6".

5.4.2.2 Monitoring Well Locations and Depths

A network of 12 shallow monitoring wells (approximately 25 feet bgs) and 6 deep monitoring wells (approximately 50 feet bgs) is proposed for the Gasco site. The proposed locations of the monitoring wells are shown on Figure 7. A summary of and the rationale for the proposed monitoring well locations, depths, and analytical parameters is included on Table 5. A discussion of the selected analytical parameters is included in Section 5.4.4.

The locations of the Phase I monitoring wells will not be modified based on the results of the well point data for the following reasons: 1) the well point data will be gathered concurrently with the installation of the monitoring wells, 2) the proposed monitoring well locations will be drilled as part of the soil investigation, and 3) once a soil boring is drilled, the incremental cost of installing a monitoring well is minor compared to obtaining a groundwater sample from a temporary well point.

The depths of the proposed monitoring wells will be selected based on lithology data collected during the soil investigation. The deep monitoring wells will be installed prior to the shallow monitoring wells. Observations and interpretations of the lithology in the deep monitoring wells, in conjunction with the lithology data from the soil borings will be used to determine the depth of the shallow wells. DEQ will be consulted with the chosen

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depths of the shallow monitoring wells prior to installing the wells. Field notes, boring logs, and cross-sections will be supplied to DEQ to justify the chosen shallow monitoring well depths.

Three preliminary up-gradient monitoring wells have been selected for the Phase I investigation (MW-9, MW-12-25, and MW-12-50). If groundwater flow direction information from the Phase I investigation indicates that there are no appropriate up-gradient monitoring wells, then the Phase I data will be used to place an appropriate up-gradient monitoring well during Phase II.

The locations and depths of any Phase II monitoring wells will be selected based on the results of the Phase I investigation and any groundwater data from a Phase II soil probe investigation.

- Shallow Monitoring Wells

The uppermost groundwater in the Fill Unit or Silty Clay Unit will be investigated through the installation of 12 shallow monitoring wells that will be installed to depths of approximately 20 to 25 feet. The actual depths of the shallow monitoring wells will be selected based on the estimated water table depth during drilling and the lithology data collected during the soil investigation. The shallow monitoring wells will be installed such that the screened interval will extend across the estimated seasonal fluctuation of the water table and allow for the detection of LNAPLs, if present. A 15-foot screen interval is proposed so that the screen will span the potential seasonal water table fluctuation at the site, and yet will also allow enough water in the well for sampling during low water table periods.

If groundwater is encountered in any particular well location in the Fill Unit, then the screen interval will not extend significantly into the underlying Silty Clay Unit, and under no circumstances will extend below the Silty Clay Unit. If groundwater is not encountered until the Silty Clay Unit or other underlying units, then the screen interval will be placed such that it will not extend up into the Fill Unit. The main objective for

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screen placement in the shallow wells at the site is to isolate the Fill Unit from the underlying units to avoid commingling potentially different hydrogeologic units and to eliminate potential vertical conduits for contaminant migration.

• Deep Monitoring Wells

Six deep monitoring wells will be installed adjacent to six of the shallow monitoring wells to evaluate the deeper groundwater and to determine vertical hydraulic gradients. The deep wells will also be utilized to evaluate for the presence of DNAPLs at the site. The deep monitoring wells will be installed in the Alluvial Deposits to depths of approximately 50 feet bgs, although the actual depth of the wells will depend on soil lithology data obtained during drilling. A 10-foot screen interval is proposed for the deep monitoring wells.

All six deep monitoring well borings will be continuously cored during drilling to obtain detailed lithology data and to observe for DNAPLs. Previous geotechnical borings at the site have indicated the presence of a Sand Unit underlying the Silty Clay Unit at the site, and underlying the Sand Unit appears to be a Silt Unit. The objective of the screen placement for the deep monitoring wells is to screen across the base of the Sand Unit, if present. In addition, if any other significant confining units or possible DNAPLs are observed during drilling, then the screen interval will be adjusted to span the potential DNAPL zone. Under no circumstances, however, will the screen extend below the underlying confining unit. If no DNAPLs or significant changes in lithology are observed in the deep monitoring well borings during drilling, then the wells will be set at a depth of 50 feet bgs.

5.4.2.3 Monitoring Well Installation and Development

All monitoring well installation work will be performed by an Oregon-bonded and licensed monitoring well constructor. The monitoring wells will be installed in accordance with the Oregon Groundwater Law (Oregon Revised Statute (ORS) Chapter 537) and the *Rules for Construction and Maintenance of Monitoring Wells and Other Holes in*

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Oregon (OAR Chapter 690, Division 240). The wells will also be installed according to the ODEQ guidance document *Groundwater Monitoring Well Drilling, Construction, and Decommissioning Guidelines* dated August 24, 1992.

All the proposed monitoring wells will be installed with the drilling rig through the hollow stem augers. The monitoring wells will be constructed with 2-inch inside diameter (ID), threaded, Schedule 40, polyvinyl chloride (PVC), blank casing and slotted screen. If DNAPLs are suspected based on observations during drilling, then stainless steel casing and screen will be utilized.

Fifteen (15) feet of screen will be set at the bottom of each shallow monitoring well with blank casing extending to the ground surface. Ten (10) feet of screen will be used in the deep monitoring wells. If the soils that the screen is to span are composed of sand, then a 0.020-inch slotted screen with a Colorado 10/20 silica sand pack will be used in the well. If the soils that the screen is to span are composed of silts or very fine silty sands, then a 0.010-inch slotted screen with a Colorado 20/40 silica sand pack will be used.

The sand pack will be placed in the annular space from the bottom of the boring to two feet above the top of the screen. The wells will then be developed with a surge block to set the sand pack. In the shallow monitoring wells, a well seal composed of 3/8-inch bentonite chips will be placed on top of the sand pack to a depth of two feet bgs and hydrated.

For monitoring wells with over 25 feet of standing water in the completed installation, the use of a grout-slurry mixture is required by the Oregon Water Resources Division (OWRD) in OAR 690-240 005-180. Therefore, in the six deep wells, a two-foot bentonite plug will be placed on top of the sand pack, and the well seal, composed of a cement-bentonite slurry, will then be placed by a tremie pipe from the top of the bentonite plug to within two feet of ground surface.

All of the monitoring wells will be completed with above-grade well monuments cemented in at the surface. The well monuments will be protected by three metal guard posts cemented in at the surface. The well casings will be fitted with locking caps. Schematic

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well construction diagrams are shown in Figures 8 and 9 for the proposed shallow and deep monitoring wells respectively.

Following the installation of the monitoring wells, they will be further developed by purging with a submersible pump in an attempt to remove the fine sediment from around the well bore. During development, at least 10 well volumes of water, and the volume of the well construction water, will be removed from each well. If at this point, the wells are not sediment-free, then well development will continue until the wells are sediment-free.

5.4.2.4 Elevation Survey and Water Level Measurements

Following installation of the monitoring wells, the locations and elevations of the new monitoring wells will be surveyed to the City of Portland datum by an Oregon Registered Professional Land Surveyor. The ground surface elevation will also be surveyed at each location. The top of casing elevations will measured to an accuracy of 0.01 feet, and the locations of the monitoring wells will be measured to an accuracy of 1.0 feet. The locations and ground surface elevations of all other soil borings, well points, and sampling points will also be surveyed.

The static water levels in all the monitoring wells at the site will be measured following the monitoring well installation activities using a Solinst water level indicator (conductive probe). The water levels will be measured from the north side of the top of the casing where a notch will be cut.

Each well will also be checked for the presence of LNAPLs and DNAPLs using an MMC Interface Detector probe.

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5.4.3 Water Level Monitoring

Two types of water level monitoring will be performed at the monitoring wells at the site to better characterize the hydrogeology of the site, including monthly water level monitoring and a short-term continuous water level monitoring test.

5.4.3.1 Monthly Water Level Monitoring

The water levels in all the monitoring wells at the site will be measured on a monthly basis for a period of six months to monitor seasonal fluctuations in groundwater elevations. River stage data will also be collected during each monitoring event to determine hydraulic continuity with the Willamette River. Following the initial six months of monitoring, an evaluation of the data will be conducted and presented to DEQ to determine if a change to quarterly water level monitoring is warranted. As part of the monthly monitoring activities, water levels will be collected quarterly in conjunction with the quarterly groundwater monitoring activities (Section 5.4.4).

The static water levels in the monitoring wells will be measured using a Solinst water level indicator (conductive probe). The water levels will be measured from the north side of the top of the casing. If NAPLs are detected in any given monitoring well during the initial monitoring event, then those wells will continue to be monitored for NAPLs.

5.4.3.2 Short-Term Continuous Water Level Monitoring Test

A 48-hour continuous water level monitoring test will take place at selected monitoring wells to determine if tidal fluctuations in the Willamette River influence groundwater flow direction and hydraulic gradients at the site. Water levels in three monitoring wells located along the river (MW-3, MW-4-25, and MW-4-50) will be collected electronically on a continuous basis using pressure transducers and a central data logger. Water levels will also be simultaneously recorded in the river to compare to the groundwater levels.

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5.4.4 Quarterly Groundwater Monitoring

Quarterly monitoring of selected water quality parameters will be performed at selected monitoring wells at the subject site to establish if there are any seasonal fluctuations or long-term trends of the contaminant concentrations in the groundwater.

Following the installation of the proposed monitoring wells, the quarterly groundwater monitoring program will be initiated. During the first monitoring event, the groundwater will be sampled at all of the monitoring wells at the site. The groundwater samples will be analyzed for the parameters that are listed on Table 5. For the initial sampling event, all 18 wells at the site will be analyzed for TPH, PAHs, BTEX, and total lead. If total lead is detected in any given well, then the groundwater sample will also be analyzed for dissolved lead. The other analytical parameters were chosen based on the location of the monitoring well relative to potential source areas.

Phenols will be analyzed at wells that are down-gradient of the former Retort Area, Light Oil and Naphthalene Plants, and Koppers Land Treatment Area. Cyanide and H_2S will be analyzed at wells that are down-gradient of the former Spent Oxide Storage Area and Oxide Reactor Area, and down-gradient of the former Settling Ponds since spent oxide may have been used as fill in this area. Ammonia will be analyzed at wells in the vicinity of the Oxide Reactor Area, since it is known that ammonia was used in this area. Chlorinated volatiles and pesticides will be analyzed in one shallow and two deep wells located on the southeast portion of the Gasco site, since this is the area most likely to detect these compounds based on known groundwater gradients and the source area. Priority Pollutant metals will be analyzed on a total basis at 8 monitoring wells where the most significant groundwater contamination is detected since these wells should represent worst-case locations for the mobilization of naturally-occurring metals. If metals are detected in any given well on a total basis, then the groundwater samples will also be analyzed for those metals on a dissolved basis.

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Feasibility Study analytical parameters will be analyzed during the second quarterly groundwater monitoring event. The selection of the monitoring wells for analysis of Feasibility Study parameters will be based on the results of the initial sampling event.

Based on the initial monitoring event results, the quarterly monitoring program may be modified to sample selected wells for selected parameters. Following the completion of the initial monitoring event, a groundwater monitoring sampling and analysis plan will be submitted to the DEQ as an addendum to this Work Plan.

5.4.5 Aquifer Tests

Aquifer slug tests and pump tests will be performed on monitoring wells at the site to gather data on aquifer characteristics, including hydraulic conductivity, transmissivity, and storativity. These aquifer characteristics will allow for a calculation of groundwater flow velocity and the rate of contaminant migration in the groundwater. This information, in conjunction with groundwater contaminant levels, will also allow for an estimate of the flux of contaminants from the site into the Willamette River. Knowledge of the aquifer characteristics is also necessary to properly design a groundwater remediation system, if necessary. The aquifer tests will also help in evaluating potential stratigraphic controls for groundwater beneath the site.

5.4.5.1 Slug Tests

During the Phase I investigation, rising-head slug tests will be performed in all monitoring wells at the subject site. The slug tests will be performed by lowering a PVC slug into the well to displace the groundwater in the well. The displaced water in the well is then allowed to return to the original static water level and the slug is quickly removed from the well. This procedure simulates the instantaneous removal of a slug of water from the well. The water level recovery data is measured by a pressure transducer and recorded

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with an electronic data logger. The recovery data will be analyzed by the Bouwer and Rice, 1976[5] solution method to calculate preliminary estimates of transmissivity.

5.4.5.2 Pump Tests

An aquifer pump test will be performed at one or two selected monitoring well pairs at the site. Since there is no information at this time regarding the presence or extent of contaminants in the groundwater at the site, it would be premature to select the most appropriate locations for pump tests at this time. Pumping at an inappropriate location could adversely affect the distribution of contaminants in the groundwater at the site. Therefore, it is likely that the pump tests will occur during the Phase II investigation, after synthesis of the Phase I contaminant, slug test, and some monitoring data is complete. An addendum to this Work Plan will be submitted to DEQ to outline the details of the pump test investigation.

Separate 24-hour pumping tests will likely be performed on the shallow and deep wells at each selected monitoring well pair. The pumping test will be preceded by a step-drawdown test to determine an appropriate pumping rate. The pumping test will be followed by a recovery test, as a check against the pumping data. Water levels will be monitored throughout the testing period with pressure transducers installed in the pumping well and three to seven observation wells. Water level data will be collected electronically from a central data logger.

The aquifer characteristics of transmissivity, hydraulic conductivity, and storativity will be calculated, as well as an estimate of the average linear velocity of water through the aquifer. In addition, information regarding vertical hydraulic conductivity will be gathered.

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[5] Bouwer, H. and R. C. Rice, *A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells*, Water Resources Research, 12 (1976), pg 423-428.

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5.5 Surface Water Investigation

Three surface water bodies, including the Willamette River, the current drainage ditch, and the existing settling ponds, will be sampled to evaluate the current impacts to surface water from the contaminants at the subject site. In addition, aerial photographs and other maps will be used to delineate any other past drainages at the site. The surface water in the settling ponds and the drainage ditch will be sampled during the Phase I investigation. The locations of the Phase I surface water sampling points are shown on Figure 10. The surface water in the Willamette River will be sampled during the latter part of the Phase I investigation. Groundwater quality data from the Phase I investigation will be used to select appropriate surface water sample locations in the river. An addendum to this Work Plan will be submitted to DEQ to outline the details of the Willamette River surface water investigation.

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The drainage ditch will be sampled at an up-stream and down-stream location to determine if the ditch water picks up any contaminants as it flows through the site. Three water samples will be collected from the two existing settling ponds to determine potential impacts to the pond water. The surface water samples will be analyzed for the presence of TPH, PAHs, BTEX, and dissolved lead.

Pretty focussed what about dilution?

In concept, it is envisioned that the Willamette River water will be sampled at three locations adjacent to the site where groundwater impacts are detected during the Phase I investigation. In addition, a background water sample will be collected from an up-stream location adjacent to the Wacker site. The water samples will be collected from near the water/sediment interface and near the water/air interface at locations where it is predicted that contaminated groundwater may be discharging to the river. Water samples will likely be taken at both a high river stage and a low river stage period. In addition, multiple samples will be collected at each location in order to determine if differences in contaminant concentrations at differing locations are statistically significant. The water sample locations will be determined by a Global Positioning System (GPS) unit. If

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contaminants are detected in the samples near the sediment/water interface, then the water samples from near the air/water interface will also be analyzed.

5.6 Sediment Investigation

The sediment investigation will involve sampling of sediments from two surface water bodies at the Gasco site, the settling ponds and the Willamette River. The sediments along the Willamette River throughout the Northwest Industrial Area are likely contaminated due to the industrial history of the area. Therefore, it is likely that the sediments adjacent to the Gasco site contain contaminants from up-stream sources. In addition, the river in this area has been dredged on numerous occasions over the years likely disturbing any natural deposition of the sediments. The feasibility of cleaning up sediments without causing greater environmental harm is limited. Therefore, the focus of the sediment sampling program will be to gather information for performing the Endangerment Assessment.

The sediments in the two on-site settling ponds will be sampled at three locations as shown on Figure 10. The sediment samples in the ponds will be collected at the sediment/water interface.

The sediments in the Willamette River adjacent to the Gasco site will be sampled to determine potential impacts to the river sediments. Six sediment sampling points will be located at approximate 300-foot intervals along a line that will run parallel to the shoreline of the Gasco site. In addition, 5 sediment sampling points will be located up-stream at 300-foot intervals along the Wacker and Atochem North America sites to determine background sediment concentrations. The locations of the proposed sediment sampling points are shown on Figures 10 and 11. Data from recent sediment sampling offshore of the Rhone Poulenc site will be utilized to supplement the background sediment sampling activities at the Gasco site.

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At each sampling point, sediment samples will be obtained approximately 10 feet offshore at an average river stage. At each sample location, sediment samples will be obtained at one-foot intervals to a depth of approximately ten feet below the sediment/water interface. Two discrete sediment samples from each location will be selected for laboratory analysis, including one from the oxygenated zone and one from a greater depth based on field observations. The sediment samples will be obtained from a barge using an impact coring device or a Vibracore device. Alternatively, the sediment samples may be obtained with a Geoprobe unit on a barge depending on the results of another project that is attempting this method. The sediment sample locations will be determined by a GPS unit.

The sediment samples will be analyzed for the presence of TPH, PAHs, BTEX, dissolved lead, and TOC.

5.7 Air Investigation

Potential emissions to the air at the Gasco site would likely take place by two mechanisms: 1) as contaminants sorbed onto soil particles entrained by wind and 2) as volatile contaminants by volatilization from soil or surface water. The former mechanism may be of concern where PAHs or metals occur at the surface and activities occur that generate dust, such as vehicular traffic or strong winds blowing across low vegetation areas. The latter mechanism may be of concern where VOCs occur in near-surface soils or surface waters, such as at the Light Oil Plant or in the LNG containment basin. By either mechanism contaminants rapidly disperse in a down-wind direction.

Two approaches were considered to evaluate the potential for air emissions at the site: 1) soil and water quality data from the Phase I investigation would be utilized to construct an air dispersion model to estimate potential emissions, and 2) air emissions would be evaluated by direct measurement through air monitoring. The results of the Phase I soil and water investigations would be necessary to properly design an investigation by either approach. In addition, some air sampling will occur at the site during the Phase I investigation for worker health and safety purposes (Section 8.0). Based on the Phase I

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results, a decision will be made as to which approach, or combination of approaches, is most appropriate for the site. An addendum to this Work Plan will be submitted to DEQ to outline the details of the air investigation.

If the air modeling approach is chosen for the air investigation, surface soil data including contaminant concentrations, grain size, and density of the fine fractions will be used to estimate the concentrations of contaminants that could be entrained on particulates. Subsurface soil temperatures and contaminant concentrations will be used to estimate soil vapor concentrations for volatile compounds. An estimate of the flux of contaminants from soil vapor to air will be made based on the nature of the ground cover. The estimated flux of contaminants to the air and meteorologic data from nearby stations will be used in an air dispersion model to estimate potential emissions at the site.

If the air monitoring approach is chosen for the air investigation, then fixed air monitoring stations will be setup at various locations at the site. The locations of the air monitoring stations will be determined based on the results of the Phase I investigation and the physical site layout. Likely locations would include an up-wind station, one or more down-wind locations, and locations where site workers tend to spend most of their time. Sampling for VOCs and particulates will take place during various seasons and wind conditions. Likely analytical parameters would include BTEX, PAHs, and lead.

The air quality information gathered by the modeling and/or monitoring approach will be used in the Endangerment Assessment to determine the potential for air emissions to impact potential receptors.

5.8 Investigative Derived Waste Plan

All soil cuttings generated during the drilling of the soil borings and monitoring wells will be placed in 55-gallon drums. The drums will be labeled and temporarily stored on-site. Based on the analytical results from the soil investigation, the disposition of the soil cuttings will be determined. If the soil cuttings are determined to be un-contaminated,

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then they will be spread on-site. If the soil cuttings are determined to be contaminated, then they will be segregated by waste designation and appropriate disposal will be arranged.

All purge, development, and decontamination water from the Phase I activities will be placed in a temporary storage tank at the subject site. Based on the analytical results from the groundwater investigation, the disposition of the waste water will be determined. It is anticipated that the waste water will be discharged to the current water treatment system on site.

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6.0 PROJECT MANAGEMENT PLAN

6.1 Project Management

The overall project management for implementation of the RI/FS work activities, will be handled by Ms. Sandra Hart of NWNG. HAI will manage the field activities, including the sampling and reporting tasks. All project field work will be supervised by an Oregon Registered Geologist. All drilling and monitoring well installation activities will be performed by an Oregon-bonded and licensed monitoring well constructor. Surveying services will be performed by an Oregon Registered Professional Land Surveyor. Preparation of the Endangerment Assessment will be performed by Decision Focus.

Overall Project Management

Northwest Natural Gas Company
220 NW Second Avenue
Portland, Oregon 97209
(503) 226-4211 ext. 4322
Contact: Ms. Sandra Hart

Project Management – RI/FS

Hahn and Associates, Inc.
434 NW Sixth Avenue, Suite 203
Portland, Oregon 97209
(503) 796-0717
Contact: Mr. Roger Brown, R.G.

Project Management – Endangerment Assessment

Decision Focus, Inc.
6121 SW Tower Way
Portland, Oregon 97221
(503) 244-9765
Contact: Mr. Frank Selker

Laboratory Services (Tentative)

National Environmental Testing, Inc. (NET)
17400 SW Upper Boones Ferry Road
Portland, Oregon 97224
(503) 624-5449
Contact: Mr. Derek Chinn

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Drilling Services (Tentative)

Geo-Tech Explorations, Inc.
19700 SW Teton
Tualatin, Oregon 97062
(503) 692-6400
Contact: Mr. Bill Klosterman

Sediment Sampling Services (Tentative)

Fishman Environmental Services, Inc.
434 NW Sixth Avenue, Suite 203
Portland, Oregon 97209
(503) 224-0333
Contact: Mr. Paul Fishman

Surveying Services (Tentative)

Chase Jones & Associates, Inc.
1500 SW 12th Street
Portland, Oregon 97201
(503) 228-9844
Contact: Mr. Eric Jones

Geophysical Services (Tentative)

Geopotential
437 NE Liberty Avenue
Gresham, Oregon 97030
(503) 228-9844
Contact: Mr. Ralph Soule

Borehole Geophysical Services (Tentative)

Well Scope
33132 Coleman Road
Eugene, Oregon 97401
(503) 344-4205
Contact: Mr. Mark Christensen

Utility Locating Services (Tentative)

Maintenance Northwest
18040 SW Lower Boones Ferry Rd. #23
Tigard, Oregon 97223
(503) 684-8824
Contact: Mr. Bruce Jangala

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6.2 Project Deliverables

As per the Agreement, Monthly Reports will be prepared by HAI by the 10th day of the month following the reporting period throughout the RI/FS project. The Monthly reports will begin once the RI/FS Work Plan has been approved by DEQ. The Monthly Reports will summarize the activities that occurred during the previous month, describe in brief the data results collected during that time, describe any problems or difficulties encountered, and summarize the activities planned for the upcoming month.

Letter Reports will be prepared by HAI within 30 days of completion of each phase of the Remedial Investigation at the site. The Letter Reports will summarize the work completed to date, data collected during that phase, and preliminary conclusions and recommendations.

Addendums to this Work Plan will be submitted to DEQ for various activities that were not elaborated on in this document. The addendums may be combined to create a Phase II RI/FS Work Plan

Following the completion of all phases of the Remedial Investigation, a comprehensive Remedial Investigation Report will be prepared that will outline the methodologies and results of the investigations. The Remedial Investigation Report will include all the elements that are outlined in the Agreement. All sampling locations will be surveyed by an Oregon registered professional surveyor, and maps will be prepared to show all the sampling locations. The results of the Endangerment Assessment will be submitted as a separate document prepared by Decision Focus.

Following review and approval of the Remedial Investigation and Endangerment Assessment Reports by the DEQ, a Feasibility Study Report will be prepared which will include the elements outlined in the Agreement.

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6.3 Project Schedule

An estimate of the overall RI/FS project schedule is presented on Table 8. The schedule starts with the signing of the RI/FS Agreement on August 8, 1994. The preparation, review, revision, and approval of the Final RI/FS Work Plan will proceed until approximately late July 1995, when the Phase I Remedial Investigation will start. It is estimated that the Phase I Remedial Investigation, an evaluation of remedial options, and the Endangerment Assessment will proceed until approximately December 1995. As per the schedule outlined in the Agreement, the preparation, review, and approval of the Phase I Remedial Investigation Letter Report and the Phase II Work Plan Addendum will proceed until approximately March 1996 when the Phase II Remedial Investigation will start.

It is estimated that the Phase II Remedial Investigation will proceed from approximately March through July 1996. This schedule assumes that additional phases of investigation will not be necessary. The Phase II Remedial Investigation Letter Report will be prepared for review and approval of DEQ by approximately August 1996.

As per the schedule outlined in the Agreement, the preparation, review, and approval of the Remedial Investigation Report Outline and the final Remedial Investigation Report will proceed until approximately March 1997. As per the schedule outlined in the Agreement, the preparation, review, and approval of the Feasibility Study Report will proceed until approximately August 1997. Preparation for the implementation of the remedial actions recommended in the Feasibility Study will begin in approximately August 1997.

The Phase I Remedial Investigation itself will be completed in phases, with the scope of some later tasks dependent on the results of earlier tasks. A Gantt chart and PERT chart detailing the schedule and dependencies of the Phase I investigation are displayed on Table 9. The initial Phase I field activities will occur from approximately July to October 1995, including the soil boring, temporary well point, and monitoring well installations, sediment sampling, geophysical surveys, slug tests, water level tests, and the first quarterly groundwater monitoring. Based on synthesis of the results of these activities, the scope of work for the aquifer pump tests, Willamette River surface water investigation,

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and the air investigation will be determined, and an addendum to this Work Plan prepared for submittal to DEQ outlining these activities. In addition, an addendum will be prepared which will outline the sampling and analysis plan for subsequent quarterly groundwater monitoring at the site. It is possible that the aquifer pump tests may be delayed to be performed during the Phase II investigation.

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7.0 SAMPLING AND ANALYSIS PLAN

7.1 Data Quality Objectives

Data will be gathered during the Remedial Investigation for a number of purposes including: 1) to determine the nature and extent of contaminants at the site, 2) to define the hydrogeology of the site, 3) to perform an Endangerment Assessment, 4) to identify cleanup criteria, and 5) to identify, screen, and evaluate remedial alternatives. The overall data quality objective for the project is to collect sufficient data of an adequate quality to meet the described data needs. The RI/FS Work Plan has been designed to collect sufficient data for the identified data needs as per EPA, 1987[6]. The data quality assurance objectives for this project are to develop and implement procedures to collect representative samples and to provide chemical and physical data of known quality. In order to meet these objectives, all field activities will be conducted according to the methods describe in this Sampling and Analysis Plan (SAP). Data quality is assessed by precision, accuracy, representativeness, completeness, and comparability, as described below.

Precision is a measure of the spread of the data when more than one measurement is taken of the same sample. Duplicate samples will be analyzed by the laboratory at a ratio of at least one sample per twenty samples analyzed. Split sample analysis (that is, two sub-samples of the same sample are sent to different laboratories for analyses) will not be performed.

Accuracy is a measure of the closeness of the measured value to the true value. Accuracy of chemical test results is assessed by spiking samples with known standards and establishing the average recovery. Surrogate spiking analyses will be performed at a rate of at least one sample per twenty samples analyzed. Matrix spike and matrix spike

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[6]U.S. EPA, *Data Quality Objectives for Remedial Response Activities, Volume 1 - Development Process*, EPA/540/G-87/003A (1987)

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duplicate samples will also be collected and analyzed for the groundwater sampling activities.

Representativeness is a measure of how closely the measured results reflect the actual concentration or distribution of the chemical compounds in the soil or water sampled. The sampling techniques and sample handling protocols outlined in this SAP were designed to collect representative samples.

Completeness is a measure of the amount of valid data obtained from the analytical measurement system described as a percentage of the planned measurements. The completeness of the data will be assessed during quality control reviews.

Comparability of the data will be maintained by using EPA-defined field and analytical procedures and protocols where available. Where EPA standards are not available, the procedures will be fully documented.

7.2 Field Sampling Procedures

7.2.1 Soil Sampling Procedures

During the drilling of the soil borings and monitoring well borings, soil sampling will be conducted with a split-barrel sampling device. The soil sampling will either be on a continuous basis or at 2.5-foot intervals as outlined on Table 3. In borings selected for continuous sampling, a 5-foot long, 3-inch outside diameter (OD), spilt-barrel coring device will be utilized. The coring device is advanced during drilling inside of the lead auger. In borings selected for 2.5-foot sampling, a 1.5-foot long, 3-inch OD, spilt-spoon sampling device will be driven into the undisturbed soils ahead of the augering bit using the Standard Penetration Test (SPT). Since the split-spoon sampler is 1.5 feet long, only one foot of soil is not observed between sampling points. If sample recovery is not adequate with the split-barrel coring device, then the sampling method will be changed to a split-spoon device.

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Soil samples will be collected for both hydrogeological and contaminant characterization purposes. Upon removal from the soil boring, the split-barrel devices are opened at the surface to observe the soil profile. If based on field screening (see Section 7.2.2), a zone of potential soil contamination is observed, then a soil sample will be collected for laboratory analyses from that interval. If no contamination is suspected, then a soil sample will be collected from the middle of the device. Each soil sample will be immediately placed in a laboratory supplied 9-ounce sample jar and capped with a teflon-lined lid. The sample jars will be labeled and transferred to a chilled container for shipment to the analytical laboratory.

Following the collection of samples for analytical purposes, the soil profile will then be noted in the field by an HAI geologist. The properties of the soil, including color, moisture, plasticity, grading, structure, and texture will be noted in the field and incorporated into a boring log for each of the subsurface borings. An estimate of the Unified Soil Classification System (USCS) soil type designation (ASTM D 2487-85) will also be shown on the boring logs. The USCS soil type designation will be a field estimate only and will not be confirmed by laboratory analyses, although an occasion sample may be collected for this purpose. Visual or olfactory evidence of contaminant occurrence in the samples, if present, will also be noted on the boring logs. An example boring log and monitoring well log are included in Appendix D.

7.2.2 Soil Field Screening Procedures

Each soil sample will be screened in the field for the presence of organic contaminants by the visual, sheen, and headspace vapor methods. The sheen method involves mixing a portion of the soil sample into a pan containing water and observing for a sheen. Organic vapor levels in the soil samples will be determined by the headspace vapor method utilizing a MicroTIP Model MP-1,000 equipped with a photoionization detector and a 11.7 electron volt (eV) lamp.

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The headspace vapor method involves placing approximately 8 ounces of soil in a one-quart plastic bag. The bag is sealed and the sample is then set aside for a 20-minute stabilization period, whereupon the detector probe is inserted through the seal into the bag. The results of the headspace screening are recorded on the boring log in parts per million (ppm). The results of the headspace method will be used for qualitative screening purposes only.

7.2.3 Groundwater Sampling Procedures

Groundwater samples will be collected from the temporary well points at the site immediately following installation. The temporary well points will be purged with a submersible pump of at least one borehole volume of water (approximately 28 gallons for an 8 1/4-inch hole), or until the casing is entirely evacuated, whichever occurs first. The pH, temperature, and conductivity of the water will be measured during the purging process to monitor for stabilization of these parameters. The water sample will then be collected using the pump at a low flow rate.

Groundwater samples will be collected from the monitoring wells at the site at least 72 hours following development. The monitoring wells will be sampled in the order of suspected least-contaminated to suspected most-contaminated. Following the initial sampling event, the order of well sampling will be based on the initial analytical results.

Prior to sampling, at least three well volumes of water will be purged from each well using a peristaltic or submersible pump. The pH, temperature, and conductivity of the water will be measured during the purging process to monitor for stabilization of these parameters.

The shallow wells will be purged with a peristaltic pump and dedicated polyethylene tubing for each well. In addition, the silastic tubing in the peristaltic pump will be replaced for every well sampled, thus eliminating the need for decontamination and the risk of cross-contamination. The deeper wells will be purged with an electric submersible pump equipped with teflon tubing that will be decontaminated between wells. A comparison

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study will be performed on three shallow monitoring wells to show that sampling with the peristaltic and submersible pumps will produce consistent data for volatile compounds. The three selected wells will be sampled by both types of pump during the first sampling event and the samples analyzed for BTEX compounds to check for consistency between methods.

Following completion of the purging of the well points or monitoring wells, a representative sample of the groundwater will be obtained using the pump at a low flow rate. The water will be carefully transferred to the appropriate sampling containers (see Table 10). The sampling containers will be completely filled such that no headspace is present that would allow the loss of volatiles. The sample bottles will then be transferred to a chilled container for shipment to the analytical laboratory. Unfiltered samples will be collected for all parameters except metals and orthophosphate, where the groundwater samples will be filtered with an in-line 0.445 micron filter.

7.2.4 Surface Water Sampling Procedures

During the Phase I investigation, surface water samples will be collected from the on-site drainage ditch and settling ponds. Since neither of these water bodies are very deep, the water sample will be obtained from a depth of approximately one foot. However, care will be taken so that the sample is not collected too near the sediment/water interface, thus potentially stirring up sediments into the water sample. If sediment and water sampling are to take place at the same time, all the surface water samples will be collected prior to collecting any sediment samples. In the drainage ditch, the down-stream sample will be collected prior to the up-stream sample. In addition, the ditch samples will be collected prior to the pond samples. The surface water samples will be collected with a 1-liter polypropylene Pond Sampler with a telescoping handle. The details of the Willamette River surface water sampling activities will be presented in an addendum to this Work Plan that will be submitted to DEQ.

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7.2.5 Sediment Sampling Procedures

During the Phase I investigation, sediment samples will be collected from the Willamette River at 11 different locations and from the on-site ponds at three locations. The locations of the proposed sediment sampling points are shown on Figures 10 and 11.

The sediment samples in the ponds will be collected at the sediment/water interface using either a stainless steel Ekman dredge (soft sediments) or 2-inch Lexan core tubes with stainless steel coring head if sandy sediments are present. The core tubes can be inserted into sediment by hand either from a small boat or from a wading position.

At each sampling point in the Willamette River, sediment samples will be obtained approximately 10 feet offshore at an average river stage. At each sample location, sediment samples will be obtained at one-foot intervals to a depth of approximately ten feet below the sediment/water interface. Two discrete sediment samples from each location will be selected for laboratory analysis, including one from the oxygenated zone and one from a greater depth which shall be based on field screening (see Section 7.2.2).

Collection of the sediment core samples will require use of an impact coring device to retrieve cores of approximately 10 feet in length. The coring device is mounted aboard a shallow draft, aluminum catamaran with a moveable A-frame on the forward deck allowing the core tubes to be retrieved and sealed effectively without losing core tube contents. The 4-inch OD core tubes are constructed of aluminum. Core tubes will be cut to the length of the extracted sample with a stainless steel cutting tool following retrieval. The tubes will then be sealed and labeled indicating sample orientation and location prior to transfer.

The core tubes will then be put on ice and transferred to an on-site location for extraction. Individual cores will be extracted using a piston-like extraction device onto polyethylene sheeting. Each sample shall be placed in a laboratory supplied 9-ounce sample jar and capped with a teflon-lined lid. The sample jars will be labeled and transferred to a chilled

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container for shipment to the analytical laboratory. After samples are collected, each core will be logged and characteristics noted.

7.3 Sample Container, Label, and Custody Requirements

All samples will be transferred to the appropriate sampling containers and placed into a chilled (4°C) transport container (cooler) for shipment to the on-site laboratory. Chain-of-Custody tape will be affixed to each sample jar to assure that the sample has not been tampered with. The coolers will be utilized for temporary storage of the samples. Appropriate sample Chain-of-Custody forms will be placed in the sample coolers in a plastic bag. An example of the Chain-of-Custody form and seal are included in Appendix E. The coolers will then be sealed with chain-of-custody tape for delivery to the analytical laboratory. The sample container, preservation, and holding time requirements for each sample matrix and analytical method is summarized on Table 10. The types and numbers of sample bottles required per type of sample are summarized on Table 11.

A sample label will be attached to each sampling container prior to the sampling event. Information to be included on the label will include the following:

- Sample number
- Date and time of sample collection
- Initials of person collecting the sample
- Type of preservative, if any
- Analyses to be performed

Individual samples will be identified using a unique sample number which includes a sample prefix consisting of the HAI project number and a six digit date code. The prefix will be followed by a code indicating the type of sample and an individual sample

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collection number which will be assigned sequentially as the samples are collected (e.g. 2708-9503429-B5-01). The sample type codes are as follows:

- "B" is a soil sample from a soil boring
- "M" is a soil sample from a monitoring well boring
- "BW" is a groundwater sample from a temporary well point
- "MW" is a groundwater sample from a monitoring well
- "SW" is a surface water sample
- "SD" is a sediment sample
- "A" is an air sample

A record of all field activities will be maintained by the Field Team Leader on an HAI Project Field Notes form (Appendix F).

7.4 Decontamination Procedures

The drilling equipment will be steam-cleaned between drilling locations to prevent cross-contamination between borings. All soil and sediment sampling equipment will be decontaminated after each sample by using a detergent solution wash, a potable water rinse, a dilute nitric acid rinse, a second potable water rinse, and a final distilled water rinse. In areas where tar is encountered, a specialized detergent may need to be utilized to remove the tar.

All water purging equipment will be decontaminated by using a detergent solution wash, two potable water rinses, and a final distilled water rinse. All water sampling equipment will be decontaminated by using a detergent solution wash, a potable water rinse, a dilute nitric acid rinse, a second potable water rinse, an isopropanol rinse, and a final de-ionized water rinse.

All water generated during the decontamination of the drilling and sampling equipment will be retained and stored in a temporary storage tank on-site (see Section 5.8).

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7.5 Calibration Procedures

All field equipment will be calibrated prior to use according to the manufacturer's instructions. Users manuals and calibration records will accompany all monitoring equipment into the field and will be stored in the carrying case. Calibrated equipment will be identified by means of an HAI identification number or a manufacturer's serial number. The results of calibrations and records of repair will be maintained in a logbook. Equipment that fails calibration or fails to operate properly will be removed from service, tagged to indicate its condition, and segregated from the operational equipment. Such equipment will be repaired and re-calibrated if possible, or replaced. Preventive maintenance of field equipment is performed according to the procedures indicated in the manufacturer's manuals.

Laboratory analytical equipment and instruments will be calibrated in accordance with the laboratory's internal quality assurance/quality control (QA/QC) program.

7.6 Analytical Methods and Procedures

The analytical parameters selected for the Remedial Investigation are divided into three main categories, including primary parameters, secondary parameters, and Feasibility Study parameters. A summary of the selected analytical parameters and method numbers is included on Table 2.

Analyses for the primary parameters will be performed on soil, sediment, surface water, and groundwater samples and includes PAHs, BTEX, TPH, phenols, lead, and cyanide. Analyses for the secondary parameters will be performed on groundwater samples and includes sulfides, sulfate, ammonia, chlorinated pesticides and solvents, and priority pollutant metals. Analyses for the Feasibility Study parameters will be performed on groundwater samples and includes alkalinity, hardness, iron, manganese, nitrate,

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nitrite, orthophosphate, and total organic carbon (TOC). In addition, analyses for BTU content will be performed on selected tar samples.

With some exceptions, all the analytical methods will follow standard U.S. Environmental Protection Agency (EPA) procedures as outlined in *Test Methods for Evaluating Solid Wastes - Physical/Chemical Methods* (SW-846). The analytical methods for TPH analyses will follow DEQ-approved methods for underground storage tank (UST) cleanups (OAR 340-122-350). Analyses for PAHs will be performed by EPA Method 8270 modified to use the SIM mode. Analyses for phenols will be performed by EPA Method 8270 to achieve lower detection limits, since petroleum hydrocarbons cause interferences using EPA Method 8040. BTU content of the tar samples will be measured by ASTM Method D-2015.

7.6.1 Selection of Analyses for Soil and Sediment Samples

The analyses to be performed on any given soil sample will depend on the location of the soil boring with respect to a potential source area as indicated on Table 3. In addition, analyses will be performed on other soil samples at the site for purposes of performing the Endangerment Assessment as indicated on Table 3. TPH will generally be used as a screen to determine analyses for additional parameters as follows:

A) Cyanide analyses will be performed on all selected samples from the Former Spent Oxide Storage Area, Former Oxide Reactor Area, and Former Settling Ponds.
B) Total lead analyses will be performed on all selected samples in the Light Oil Plant area, former Koppers Land Treatment Area, and former Naphthalene Plant.
    1) Leachable lead analyses by the Toxicity Characteristic Leaching Procedure (TCLP) will be performed on samples where the detected total lead concentration, divided by a factor of 20, is greater than 2 ppm so that a comparison can be made to the Soil Cleanup Table (OAR 340-122-045).
C) Priority Pollutant metals analyses will be performed on all selected samples from the Former Spent Oxide Storage Area.

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D) TPH-HCID analyses will be performed on all selected samples from all areas at the site, and will be used as a screen for determining analyses for other parameters.

1) If TPH is not detected, then additional analyses will not be performed on that sample.

2) If TPH is detected in any given soil sample, then additional analyses, depending on location at the site, will also be performed on that sample.

a) TPH will be quantified by the appropriate DEQ method for gasoline, diesel, or oil range petroleum hydrocarbons.

b) PAH analyses will be performed on all samples where TPH is detected.

c) BTEX analyses will be performed on all samples where TPH is detected in the former Retort Area, Light Oil Plant, former Koppers Land Treatment Area, and former Naphthalene Plant.

d) Phenol analyses will be performed on all samples where TPH is detected in the former Tar Processing Area, Light Oil Plant, former Koppers Land Treatment Area, and former Naphthalene Plant.

All fourteen sediment samples will be analyzed for TPH, PAHs, BTEX, total lead, and TOC as indicated on Table 7. Analyses for leachable lead will be performed based on the same criteria established for soil samples.

7.6.2 Selection of Analyses for Water Samples

The analyses to be performed on water samples from the temporary well points, monitoring wells, and surface water locations are summarized on Tables 4, 5, and 6 respectively.

As indicated on Table 4, the groundwater samples from all 16 temporary well points at the site will be analyzed for TPH and BTEX. If TPH is detected in any given sample, then that sample will also be analyzed for PAHs. The other analytical parameters were chosen based on the location of the well point relative to potential source areas. Phenols will be analyzed at well points that are in the vicinity of the former Retort Area, Light Oil and Naphthalene Plants and Koppers Land Treatment Area. Cyanide and H_2S (sulfides and

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sulfate) will be analyzed at well points that are down-gradient of the former Spent Oxide Storage Area and Oxide Reactor Area, and down-gradient of the former Settling Ponds since spent oxide may have been used as fill in this area. Ammonia will be analyzed at well points in the vicinity of the former Oxide Reactor Area, since it is known that ammonia was used in this area.

During the first quarterly monitoring event (Table 5), the groundwater samples from all 18 monitoring wells will be analyzed for TPH, PAHs, BTEX, and total lead. If total lead is detected in any given well, then the groundwater sample will also be analyzed for dissolved lead. Phenols will be analyzed at wells that are down-gradient of the former Retort Area, Light Oil and Naphthalene Plants, and Koppers Land Treatment Area. Cyanide and H_2S (sulfides and sulfate) will be analyzed at wells that are down-gradient of the former Spent Oxide Storage Area and Oxide Reactor Area, and down-gradient of the former Settling Ponds. Ammonia will be analyzed at wells in the vicinity of the Oxide Reactor Area. Chlorinated volatiles and pesticides will be analyzed in one shallow and two deep wells located on the southeast portion of the Gasco site. Priority Pollutant metals will be analyzed on a total basis at 8 monitoring wells where the most significant groundwater contamination is detected by other parameters. If metals are detected in any given well on a total basis, then the groundwater samples will also be analyzed for those metals on a dissolved basis. Feasibility Study analytical parameters will be analyzed during the second quarterly groundwater monitoring event.

As indicated on Table 6, the surface water samples will be analyzed for the presence of TPH, PAHs, BTEX, and dissolved lead.

7.7 Quality Assurance /Quality Control Procedures

7.7.1 Field Quality Control Samples

As a check of field quality control (QC) procedures, a number of QC samples will be collected and analyzed, including soil and water duplicate samples, water trip blanks,

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field/equipment blanks, matrix spikes, and matrix spike duplicates. The identity of the QC samples will not be made known to the analytical laboratory, with the exception of the matrix spike and matrix spike duplicate samples. The QC samples will be analyzed for the primary analytical parameters only. A summary of the project quality control sample plan is included on Table 12.

One duplicate soil and sediment sample will be collected and analyzed for every 20 investigative samples. A duplicate groundwater sample will be collected from one temporary well point (B-26) and one monitoring well (MW-7-25). One duplicate surface water sample will be collected from a drainage ditch location (SW-5).

One trip blank will be prepared by the analytical laboratory for every two days of sampling or for each sampling event if it is less than 2 days. The trip blank will be kept in the cooler with the investigative samples. A field/equipment blank of water will be obtained prior to sampling a deep and a shallow monitoring well by passing de-ionized water through the decontaminated sampling pump into the appropriate sampling containers. In addition, two soil equipment blanks will be obtained after sampling a tar zone at two different borings at the site. The soil equipment blanks will be obtained by passing de-ionized water through the decontaminated soil sampling device into the appropriate sampling containers.

A matrix spike and matrix spike duplicate sample of groundwater will be obtained from monitoring well MW-7-25. These samples will be spiked in the laboratory for the primary analytical parameters.

Laboratory QC for this project will involve the standard EPA guidelines as described in *Test Methods for Evaluating Solid Wastes - Physical/Chemical Methods* (SW-846) and therefore will not be repeated here. Laboratory QC will include calibration standards, control samples, reagent blanks, matrix spikes, surrogate spikes, and laboratory duplicates.

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7.7.2 Quality Assurance Audits

The HAI Project Manager will monitor and audit the performance of the QA/QC procedures. When necessary, the Project Manager will audit the field work in progress. These audits would evaluate the execution of sample identification, sample control, chain-of-custody procedures, field documentation, instrument calibration, field measurement, and sampling operations. The evaluation would be based on the extent to which the applicable procedures as set forth in the project plans are being followed.

Field documents pertaining to sample identification and control would be examined for completeness and accuracy. Field notebooks and data forms would be reviewed to determine that all entries are dated and signed and that the contents are legible, written in ink, and contain accurate and inclusive documentation of project activities. The auditor also would determine if chain-of-custody procedures were being followed and that samples were being kept in the custody of the Field Team Leader at all times.

If quality control audits result in detection of unacceptable conditions or data, the Project Manager will be responsible for developing corrective action. Corrective action may include:

- Re-analyzing samples if holding time criteria permit
- Re-sampling and analyzing samples
- Evaluating and amending sampling and analytical procedures
- Accepting data while acknowledging the level of uncertainty associated with the data

A Quality Assurance Report will be included as part of the Remedial Investigation Report. The Quality Assurance Report will address the following: assessment of data accuracy, precision, and completeness; results of quality assurance audits; significant QA/QC problems encountered during the project and the recommended solutions.

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7.8 Data Reduction, Validation, Analysis, and Interpretation

All field data will be reviewed to determine accuracy, precision, and completeness. Descriptive data, such as field soil boring logs, will be transferred to a final appropriate format (Appendix F). Numerical data, such as water levels, will be reduced and entered into computer data bases.

All analytical data will be reviewed to determine accuracy, precision, and completeness and provide an assessment of the usability of the data. The review will include an evaluation of the field and laboratory blanks and duplicates results, surrogate and matrix spike recoveries, detection and quantitation limits achieved, holding times, and equipment calibrations. If the data is not considered to be of adequate quality, an appropriate data qualifier will be assigned. After the data have been reviewed and qualified, the data will be entered into computer data bases and presented in tabular and graphical formats for interpretation.

The field and analytical data will be interpreted as appropriate within the context of the Remedial Investigation. The hydrogeologic characteristics and the contaminant distributions of the site will be defined, as appropriate. The data interpretation will be performed so that information is generated that will be useful for the Endangerment Assessment and Feasibility Study.

8.0 SITE HEALTH AND SAFETY PLAN

A site-specific Site Health and Safety Plan will be developed as required by the Occupational Safety and Health Administration (OSHA) according to the Code of Federal Regulations (CFR) 29 CFR 1910.120. The Site Health and Safety Plan will include discussion under the following section headings: Site Description; Organization and Coordination; Site Control; Hazard Evaluation; Personal Protective Equipment;

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Communication Procedures; Decontamination Procedures; and Site Safety and Health. The Site Health and Safety Plan will be submitted to DEQ prior to performing the field activities at the site.

Based on a review of the previous investigatory activities at the subject site, modified Level D protection is recommended during most site activities. The level of protection may be upgraded to Level C if monitoring of the work zone indicates levels of VOCs are above appropriate limits.

Level C protection is recommended during the drilling of the soil borings in the Light Oil Plant area, due to suspected VOCs in the subsurface in this area. Personnel and ambient air monitoring for VOCs and PAHs will be performed during the drilling activities at the site.

9.0 ENDANGERMENT ASSESSMENT WORK PLAN

An Endangerment Assessment will be prepared by Decision Focus for the Gasco site. The Endangerment Assessment will include a Human Health Evaluation to evaluate potential risks to human health, and an Environmental Evaluation to evaluate potential ecological impacts. Both the Human Health Evaluation and Environmental Evaluation will evaluate risks associated with the site in the absence of any actions to control or mitigate releases, that is, for the site with no further action. Where possible, the Endangerment Assessment will provide quantitative estimates of such impacts. The Endangerment Assessment will be based on data collected during the RI/FS, and will:

- Summarize the nature and extent of contaminants as found in the Remedial Investigation
- Identify potentially exposed individuals and ecosystems
- Describe and quantify potential exposure pathways
- Estimate potential impacts of Gasco site contaminants

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9.1 Human Health Evaluation

The Human Health Evaluation will be divided into five elements:

1) Chemicals of concern
2) Dose-response data for chemicals of concern
3) Locations and concentrations of such chemicals
4) Exposure assessment for potentially exposed individuals
5) Quantitative estimates of potential health risks

The Human Health Evaluation will also include an executive summary and conclusions. Each of the elements is described in the following subsections.

9.1.1 Chemicals of Concern

The potential contaminants of concern to be assessed in the Human Health Evaluation are:

- Polynuclear aromatic hydrocarbons (PAHs)
- Volatile aromatic hydrocarbons, including benzene, toluene, ethylbenzene, and xylenes (BTEX)
- Phenols
- Lead
- Cyanide

As outlined in Section 4.4, additional chemicals have also been listed as potential contaminants at the site:

- Hydrogen sulfide (H_2S)
- Ammonia (NH_3)
- Chlorinated pesticides and solvents
- Metals

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The final list of chemicals of concern will be determined by the results of the Remedial Investigation.

9.1.2 Dose-Response Data

Toxicity and dose-response information will be summarized for each of the chemicals of concern. The primary source for this information will be the EPA Integrated Risk Information System (IRIS). For each chemical, adverse health impacts will be described and quantified for:

- Acute health effects
- Chronic, non-cancer health effects, and
- Cancer

For acute effects, the Human Health Evaluation will compare estimated short-term exposures with acute effect thresholds. For chronic non-cancer health effects, long-term exposures will be compared with the Reference Dose (RfD) or Reference Concentration (RfC). When long-term exposures are below the RfD or RfC, no adverse human health effects are expected to occur.

For carcinogens, an EPA cancer potency factor (CPF) will be used. Because the EPA assumes that at low doses the cancer risk increases linearly with dose, increased cancer risk may be estimated by multiplying the potency factor by a dose of the carcinogen. Where available, route-specific potency factors will be used.

There are large uncertainties associated with EPA dose-response estimates. For example, many RfD values have "Uncertainty Factors" (UF) of 10 to 1,000 incorporated into the values. Reasons for these factors include uncertainty in study results, uncertainty in extrapolating animal results to humans, and uncertainty in how effects will scale with organism size. The purpose of multiplying study results by the Uncertainty Factors is to produce standards likely to be protective for the most sensitive people of an exposed

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population in spite of the large uncertainties. The logical implication is that such estimates are likely to overestimate risks. Similar protective assumptions are used for developing cancer potency factors. For example a linearized multi-stage model is used which implies risk at any dose. Further, a 95% upper confidence limit fit to that model is used. Additionally, multipliers similar to the "Uncertainty Factors" are used to be protective where assumptions regarding body size and inter-species extrapolation are required. Again, this is to provide a protective estimate of cancer potencies.

The implication is that results derived using standard EPA dose-response values are likely to overestimate risk, and thus provide a worst-case, rather than best-estimate, value of risk. We will calculate and report results using these standard, highly protective dose-response values. We may also calculate and report results using best-estimate values. Where such values are used, the basis for those values will be clearly explained and documented.

9.1.3 Locations and Concentrations Of Chemicals

The results of the Phase I Investigation will be used to estimate the concentrations of the chemicals of concern. Chemical concentrations will be estimated in:

- Subsurface soil
- Surface soil
- Groundwater
- On-site surface water
- River water
- River sediment
- Air

The focus will be estimating concentrations in the media and location combinations most important for estimating human exposures and environmental releases.

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Groundwater is believed to flow directly into the Willamette river; and accordingly, a significant concern with respect to chemical concentrations in groundwater will be as a source of contaminants for the Willamette River.

Where extrapolation or estimates are required, all available information will be used. Fate and transport modeling may also be used where needed.

There will be uncertainties in concentrations of chemicals. The primary reason is that contaminants are spread unevenly at the site, so it is impossible to know precise concentrations at exposure points. Therefore concentration of a particular chemical in a particular media will be described with low/medium/high values or a probability distribution that reflects Remedial Investigation findings.

9.1.4 Exposure Assessment

In this step the routes of human and environmental exposure will be enumerated and described. Exposure routes will include:

- Surface soil contact
- Surface soil ingestion
- Subsurface soil contact
- Subsurface soil ingestion
- Groundwater dermal contact
- Groundwater incidental ingestion
- Surface water contact
- Surface water incidental ingestion
- River water contact
- River water incidental ingestion
- River sediment contact
- Inhalation

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In addition, prior to commencing the Endangerment Assessment, NWNG and DEQ will consider the necessity of assessing groundwater as a potential source of drinking water. Such consideration will take into account current DEQ policies on this issue, HB 3352 as enacted by the 68th Legislative Assembly (1995), and present and reasonably likely future beneficial uses of and human exposure by ingestion to groundwater.

Information needed to characterize human contact with the site, such as personnel on site, usage of the site, and usage of the river, will be collected to characterize the potentially exposed populations. Examples of parameters to be estimated in this regard include frequency of visits and the time spent in various activities. Exposure parameters will be quantified according to standard EPA practices (EPA, 1989a[7]; EPA Region 10, 1991[8]; EPA, 1990[9] , EPA, 1992a[10]. Examples of such parameters include incidental soil and water consumption and inhalation rates. All assumptions will be clearly described and documented.

There will be uncertainty in many of the exposure parameters. For example, the number of years a person may work at the site, the number of times per week they participate in an activity, and the amount of incidental soil ingestion will all vary by individual. This uncertainty will be described using low/medium/high values or probability distributions.

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[7]U.S. EPA, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)*, Interim Final, EPA/540/1-89/002 (1989a)

[8]U.S. EPA Region 10, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors*, Interim Final, OSWER Directive 9285.6-03, March 25, (1991)

[9]U.S. EPA, *Exposure Factors Handbook*, Exposure Assessment Group, Office of Health and Environmental Assessment, EPA/600/8-89/043, (1990).

[10]U.S. EPA, *Guidelines for Exposure Assessments*, 57 CFR 22888 et seq., May 29,(1992a)

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9.1.5 Quantitative Estimates Of Potential Health Risks and Uncertainty

Potential acute, chronic non-cancer, and cancer health risks will be separately estimated using the above information. For acute and chronic non-cancer results, the possibility of exposures exceeding thresholds (e.g., the RfD) is the primary concern. For carcinogens, estimated increases in cancer risk will be calculated. The chemicals, locations, and exposure routes accounting for the most important risks will be highlighted and discussed.

The information collected on uncertainties in the input parameters will allow reporting of best estimate results as well as the worst case results corresponding to Reasonable Maximum Exposure (RME) assumptions. We anticipate that calculations will be carried out using either discretized uncertainty values (e.g., low/medium/high) or standard probability distributions with selected parameters.

9.2 Environmental Evaluation

For the Environmental Evaluation, on-site wildlife and the Willamette river will be the areas of interest. The Willamette is a substantial river carrying a variety of contaminants from many sources. Since the Gasco site impact is likely to be small relative to other contaminants, biological assessments downstream of the Gasco site may not be useful. The most productive approach will probably be to estimate quantities of contaminants that may enter the river from the site, and project the impacts those contaminants may have on river life. The Environmental Evaluation will be conducted according to available guidance from the national and regional EPA offices (EPA, 1992b[11]; EPA, 1989b[12]). An EPA Region 10 environmental evaluation guidance document

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[11]U.S. EPA, *A Framework for Ecological Risk Assessment*, EPA 630/R-92/001, (1992b)

[12]U.S. EPA, *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference*, EPA/600/3-89/013, (1989b)

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is scheduled for publication in the spring of 1995. The Environmental Evaluation will be defined in greater detail when that document is available.

10.0 FEASIBILITY STUDY WORK PLAN

The Feasibility Study will evaluate the potentially feasible remedial action alternatives that will meet the remedial goals, as appropriate, for the various contaminated media at the site.

Development and evaluation of remedial action alternatives and the remedy selection process will be conducted in accordance with OAR 340-122-080 and 090, as interpreted and applied consistent with the purpose and intent of ORS 465.315(1) as amended by Section 1 of HB 3352 as enacted by the 68th Legislative Assembly (1995), to the maximum extent practicable within the bounds of the existing rules of the Environmental Quality Commission, as may be amended or supplemented.

The Feasibility Study will include the following tasks: 1) development and screening of alternatives, 2) treatability investigations, if necessary, and 3) detailed analysis of alternatives. Guidance for performing the Feasibility Study will be taken from the EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.*[13]

10.1 Development and Screening of Alternatives

The development and screening of alternatives will be an important first step in the Feasibility Study process. The purpose of this task is to 1) define the remedial action objectives, 2) identify an appropriate range of remedial action alternatives that will meet those objectives, and 3) screen the range of appropriate alternatives. Prior to completing

[13]U.S. EPA, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, Interim Final, OSWER Directive 9355.3-01 (October 1988).

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the Remedial Investigation, a preliminary screening of remedial technologies will be performed to assess which technologies may be the most appropriate for the site. The results of the preliminary screening of remedial technologies will be presented in the Phase I RI Letter Report.

Information gathered during the Phase I investigation and Endangerment Assessment will be used to modify the development of alternative remedial options. The preliminary screening of remedial alternatives will also be used to focus the Phase II investigation.

The remedial action alternatives will be developed by assembling combinations of technologies, and the media to which they are to be applied, into alternatives that will address contamination at the Gasco site. This development and screening process will consist of six general steps, as outlined by EPA, 1988:

1) Develop Remedial Action Objectives – Remedial action objectives will be developed by specifying the affected media, exposure pathways, and preliminary remediation goals. The preliminary remediation goals will be developed based on the risk factors from the Endangerment Assessment, and any legally applicable or relevant and appropriate requirements (ARARs).

2) Develop General Response Actions – General response actions will be developed for each media defining the actions that may be taken to satisfy the remedial action objectives for the site. The general response actions at the site may include: 1) containment of hazardous substances to prevent or reduce migration, 2) prevention of exposure to hazardous substances by institutional or engineering controls, 3) removal, treatment, and/or disposal of high concentration deposits of hazardous substances, or 4) any combination of these options.

3) Identify Volumes or Areas of Affected Media – The volumes and areas of affected media that will require general response actions will be identified. Risk-based reference standards developed from the Endangerment Assessment will be used in conjunction with the chemical and physical characterization of the site to delineate the areas and volumes that will require response actions.

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4) Identify and Screen Remedial Technologies and Process Options – The remedial technologies that are applicable to each general response action will be identified. The process options that are applicable to each technology type are also identified. The applicable technologies and process options will be screened to eliminate those that cannot be implemented technically at the site. Potential remedial technologies that will be considered in the Feasibility Study, grouped by general response action, will include, but not be limited to, the following:

- Containment Response Action
  - Capping
  - Gradient control
  - Stabilization/solidification
  - Vertical or horizontal barriers
- Prevention of Exposure Response Action
  - Capping
  - Institutional controls
  - Other engineering controls
- Removal or Collection Response Action
  - Excavation and removal
  - Groundwater extraction
  - Soil washing
  - Product recovery
  - Vapor extraction
- Treatment and/or Disposal Response Action
  - Biological treatment
  - Chemical treatment
  - Physical treatment
  - Thermal treatment
  - Landfill disposal
  - On-site disposal

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5) Evaluate Process Options – The identified technology process options will be evaluated to select a representative process option for each technology type. At this point, the process options are evaluated based generally on cost, effectiveness, and implementability.

6) Assemble and Screen Alternatives – The general response actions and representative process options will be assembled into alternatives representing a range of possible remedial actions for the various media at the site. If a number of remedial action alternatives are identified as appropriate at the Gasco site, then the alternatives will be screened to reduce the number of alternatives that will be analyzed in detail. The screening process will include an evaluation of the interactions of the media to the various technologies and the protection afforded by each. The alternatives will also be evaluated based on site-specific criteria for cost, effectiveness, and implementability.

10.2 Treatability Investigations

If necessary, treatability studies will be conducted to provide sufficient data to allow for a detailed evaluation of the remedial action alternatives, and to support the remedial design of the selected alternative. Treatability studies can reduce performance and cost uncertainties to levels that will allow for a selection of a remedial action. Treatability studies may include bench tests and/or pilot scale tests.

10.3 Detailed Analysis of Alternatives

Following the development and screening of the remedial alternatives, a detailed analysis will take place in order to select or approve the final remedy. The objective of the detailed analysis ~~is~~ will be to compare and contrast screened alternatives, and their advantages and disadvantages, with respect to the remedial goals. The detailed analysis

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will take into consideration, as appropriate and in accordance with the second paragraph of Section 10.0, the following evaluation criteria.

- Protection of human health and the environment
- Use of permanent solutions, alternative technologies or resource recovery technologies, or hot spot treatment
- Cost-effectiveness and cost-reasonableness
- Short-term and long-term effectiveness in achieving protectiveness
- Technical and practical implementability
- Current and reasonably anticipated future land uses

Information from any treatability studies and the Remedial Investigation will ~~also~~ be incorporated into the detailed analysis of the alternatives. The key advantages and disadvantages of each alternative will be integrated with a risk assessment for the site to select the preferred remedial alternative. The results of the detailed analysis will provide the basis for identifying the preferred alternative.

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GLOSSARY OF ABBREVIATIONS

ARARs	applicable or relevant and appropriate requirements
bgs	below existing ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
BTU	British Thermal Unit
Camp Dresser	Camp Dresser & McKee Inc.
CFR	Code of Federal Regulations
CPF	cancer potency factor
Decision Focus	Decision Focus Incorporated
DEQ	Oregon Department of Environmental Quality
DNAPLs	dense non-aqueous phase liquids
EM	electromagnetic method
EPA	U.S. Environmental Protection Agency
ESC	Expedited Site Characterization
GPR	ground penetrating radar
GPS	Global Positioning System
H_2S	hydrogen sulfide
HAI	Hahn and Associates, Inc.
ID	inside diameter
Koppers	Koppers Company, Inc.
LNAPLs	light non-aqueous phase liquids
LNG	liquefied natural gas
NH_3	Ammonia
NWNG	Northwest Natural Gas Company
OAR	Oregon Administrative Rules
OD	outside diameter
ORS	Oregon Revised Statute
OSHA	Occupational Safety and Health Administration
OWRD	Oregon Water Resources Division
PAHs	polynuclear aromatic hydrocarbons
PNO	Pacific Northern Oil Company
ppm	parts per million
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QC	quality control
RfC	Reference Concentration
RfD	Reference Dose
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SPT	Standard Penetration Test
TOC	total organic carbon
TCLP	Toxicity Characteristic Leaching Procedure
TPH	total petroleum hydrocarbons
USCS	Unified Soil Classification System
Wacker	Wacker Siltronic Corporation

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TABLE 1 - Summary of Potential Source Areas and Contaminants of Concern

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project #2708

Potential Source Area	Hazardous Materials	Predicted Contaminants of Concern	Other Potential Contaminants
• Retort Area	Tar	PAHs, TPH	Metals
• Tar Processing Area	Tar	PAHs, TPH	Metals
• Light Oil Plant	Light Oil Motor Fuels	BTEX, PAHs, Phenols, TPH BTEX, PAHs, TPH, Lead	Metals Metals
• Koppers Plant	Creosote Coal Tar Pitch Pencil Pitch	PAHs, Phenols, TPH PAHs, TPH PAHs, TPH	Metals Metals Metals
• Naphthalene Plant	Naphthalene	PAHs, TPH	Metals
• Coke Oven Area	Coke Tar	PAHs, TPH PAHs, TPH	Metals Metals
• Pitch Plant	Tar Pitch Creosote	PAHs, TPH PAHs, TPH PAHs, Phenols, TPH	Metals Metals Metals
• Oxide Reactor Area	Spent Oxide	Cyanide	H2S, Ammonia
• PNO Tank Farm	Diesel Fuel Bunker Fuel	PAHs, TPH PAHs, TPH	Metals Metals
• Lampblack Storage Area	Lampblack Other	PAHs, TPH	Metals Pesticides & Solvents
• Spent Oxide Storage Area	Spent Oxide	Cyanide	H2S
• Settling Ponds/Fill Area	Tar Spent Oxide Lampblack Wastewaters Other	PAHs, TPH Cyanide PAHs, TPH BTEX, PAHs, Phenols, TPH, Lead	Metals H2S Metals Metals Pesticides & Solvents
• Koppers Land Treatment Area	Wastewaters	PAHs, Phenols, TPH	Metals

BTEX = benzene, toluene, ethylbenzene, and xylenes
H2S = hydrogen sulfide
PAHs = polynuclear aromatic hydrocarbons
PNO = Pacific Northern Oil
TPH =total petroleum hydrocarbons

TABLE 2 - Summary of Analytical Parameters

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project #2708

Analytical Parameters	Matrix	Analytical Methods
Primary Parameters		
• Polynuclear Aromatic Hydrocarbons (PAHs)	Soil & Water	EPA Method 8270 SIM Mode
• Volatile Aromatic Hydrocarbons Benzene, Toluene, Ethylbenzene, & Xylenes (BTEX)	Soil & Water	EPA Method 8020
• Total Petroleum Hydrocarbons (TPH)	Soil Water	DEQ Method TPH-HCID EPA Method 418.1
Gasoline	Soil	DEQ Method TPH-G
Diesel	Soil	DEQ Method TPH-D
Oil, Bunker, Tar	Soil	DEQ Method TPH-418.1M
• Phenols	Soil & Water	EPA Method 8040
• Lead (Pb)		
Total & Dissolved	Soil & Water	EPA Method 6010 or 200.7
Leachable	Soil	EPA Methods 1311 (TCLP) and 6010
• Cyanide, Total & Amenable	Soil & Water	EPA Method 9010
Secondary Parameters		
• Hydrogen Sulfide (H2S)		
Sulfides	Water	EPA Method 9030
Sulfate	Water	EPA Method 9038
• Ammonia (NH3)	Water	EPA Method 350.3
• Chlorinated Solvents or VOCs	Water	EPA Method 8260
• Chlorinated Pesticides	Water	EPA Method 8080
• Priority Pollutant Metals Ag, As, Be, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Se, Tl, Zn	Water	EPA Methods 6010 and 7000 Series
Feasibility Study Parameters		
• Alkalinity	Water	EPA Method 310.1
• Hardness	Water	EPA Method 200.7
• Iron & Manganese	Water	EPA Method 200.7
• Nitrate & Nitrite	Water	EPA Method 300.7
• Phosphate, ortho	Water	EPA Method 365.2
• Total Organic Carbon (TOC)	Water	EPA Method 415.1
• Temperature, Conductivity, & pH	Water	Field Measurement
• BTU Content	Tar	ASTM Method D-2015

Note:

DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
HCID = hydrocarbon identification
SIM = single ion monitoring
TCLP = Toxicity Characteristic Leaching Procedure
VOCs = volatile organic compounds

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Table 3 - Sampling and Analytical Summary for Soil Borings
Phase I Investigation

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project # 2708

Soil Boring Number	Potential Source Area	Estimated Depth of (feet bgs)	Soil Sample Interval (feet)	Estimated Samples Selected for Analyses	Analytical Parameters					
					TPH	PAHs	BTEX	Phenols	Lead	Cyanide
B-1	Spent Oxide Storage Area	20	2.5	2	X				PP	X
B-2	Spent Oxide Storage Area	20	2.5	2	X				PP	X
B-3	Spent Oxide Storage Area PNO Tank Farm	20	2.5	2	X	X	*	*	PP	X
B-4	Former Oxide Reactor Area PNO Tank Farm	20	Continuous	2	X	X				X
B-5	Former Oxide Reactor Area	20	2.5	2	X					X
B-6	PNO Tank Farm	20	2.5	2	X	X				
B-7	PNO Tank Farm	20	2.5	2	X	X				
B-8	PNO Tank Farm	20	Continuous	2	X	X				
B-9	PNO Tank Farm	20	2.5	2	X	X				
B-10	PNO Tank Farm	20	Continuous	2	X	X	*	*	*	*
B-11	Former Retort Area	20	2.5	2	X	X	X			
B-12	Former Retort Area	20	2.5	2	X	X	X			
B-13	Former Retort Area	20	Continuous	2	X	X	X	*	*	*
B-14	Former Retort Area	20	2.5	2	X	X	X			
B-15	Former Retort Area	20	2.5	2	X	X	X			
B-16	Former Retort Area Former Tar Processing Area	20	Continuous	2	X	X	X	X		
B-17	Former Tar Processing Area	20	2.5	2	X	X		X		
B-18	Former Tar Processing Area Light Oil Plant	20	2.5	2	X	X	X	X	X	*
B-19	Former Tar Processing Area Light Oil Plant	20	Continuous	2	X	X	X	X	X	
B-20	Light Oil Plant	20	2.5	2	X	X	X	X	X	
B-21	Light Oil Plant	20	2.5	2	X	X	X	X	X	
B-22	Light Oil Plant	20	2.5	2	X	X	X	X	X	
B-23	Light Oil Plant Former Pitch Plant	20	Continuous	2	X	X	X	X	X	*
B-24	Former Pitch Plant	20	2.5	2	X	X				
B-25	Former Pitch Plant	20	Continuous	2	X	X				
B-26	Former Coke Ovens	20	2.5	2	X	X	X	X	X	
B-27	Former Koppers Land Treatment Area	20	2.5	2	X	X	X	X	X	

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Table 3 - Sampling and Analytical Summary for Soil Borings
Phase I Investigation

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project # 2708

Soil Boring Number	Potential Source Area	Estimated Depth of (feet bgs)	Soil Sample Interval (feet)	Estimated Samples Selected for Analyses	Analytical Parameters					
					TPH	PAHs	BTEX	Phenols	Lead	Cyanide
B-28	Former Koppers Land Treatment Area	20	Continuous	2	X	X	X	X	X	
B-29	Lampblack Storage/Fill Area	20	2.5	2	X	X				
B-30	Lampblack Storage/Fill Area	20	Continuous	2	X	X	*	*	*	*
B-31	Lampblack Storage/Fill Area	20	Continuous	2	X	X	*	*	*	*
B-32	Former Settling Ponds	20	2.5	2	X	X				X
B-33	Former Settling Ponds	20	2.5	2	X	X	*	*	*	X
B-34	Former Settling Ponds	20	2.5	2	X	X				X
B-35	Former Settling Ponds	20	2.5	2	X	X				X
MW-1	Spent Oxide Storage Area	25	Continuous	2	X					X
MW-2	PNO Tank Farm	25	Continuous	2	X	X	*	*	*	*
MW-3	PNO Tank Farm	25	Continuous	2	X	X				
MW-4	Lampblack Storage/Fill Area	50	Continuous	2	X	X	*	*	*	*
MW-5	Lampblack Storage/Fill Area	25	Continuous	2	X	X				
MW-6	Former Retort Area	50	Continuous	2	X	X	X			
MW-7	Lampblack Storage/Fill Area	50	Continuous	2	X	X				
MW-8	Former Settling Ponds	50	Continuous	2	X	X				X
MW-9	Former Retort Area	25	Continuous	2	X	X	X			
MW-10	Former Naphthalene Plant	25	Continuous	2	X	X	X	X	X	
MW-11	Former Koppers Land Treatment Area	50	Continuous	2	X	X	X	X	X	
MW-12	Light Oil Plant Former Tar Loading Area	50	Continuous	2	X	X	X	X	X	
Total 47		1,150		94	47	43	27	22	22	19

NOTE:
* = parameters selected for Endangerment Assessment
bgs = below ground surface
BTEX = benzene, toluene, ethylbenzene, and xylenes
PAHs = polynuclear aromatic hydrocarbons
PP = analysis for Priority Pollutant metals
TPH = total petroleum hydrocarbons
X = parameters selected based on source area

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TABLE 4 - Sampling and Analytical Summary for Temporary Well Points
Phase I Investigation

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAI Project # 2708

Soil Boring Number	Soil Boring Location	Estimated Screened Interval (feet bgs)	Analytical Parameters						
			TPH	PAHs	BTEX	Phenols	Cyanide	H2S	NH3
B-1	Former Spent Oxide Storage Area, PNO Tank Farm	15 - 20	X	*	X		X	X	X
B-5	Former Oxide Reactor Area, PNO Tank Farm	15 - 20	X	*	X		X	X	X
B-8	PNO Tank Farm	15 - 20	X	*	X				
B-16	Former Retort and Tar Processing Areas	15 - 20	X	*	X	X			
B-17	Former Tar Processing Area	15 - 20	X	*	X	X			
B-19	Light Oil Plant	15 - 20	X	*	X	X			
B-20	Light Oil Plant	15 - 20	X	*	X	X			
B-21	Light Oil Plant	15 - 20	X	*	X	X			
B-22	Light Oil Plant	15 - 20	X	*	X	X			
B-23	Light Oil Plant	15 - 20	X	*	X	X			
B-24	Former Pitch Plant	15 - 20	X	*	X				
B-25	Former Pitch Plant	15 - 20	X	*	X				
B-26	Former Coke Ovens	15 - 20	X	*	X	X			
B-28	Former Koppers Land Treatment Area	15 - 20	X	*	X	X			
B-29	Lampblack Storage/Fill Area	15 - 20	X	*	X				
B-31	Lampblack Storage/Fill Area	15 - 20	X	*	X		X	X	
TOTAL			**16**	**16**	**16**	**9**	**3**	**3**	**2**

NOTE: * = Analysis for PAHs will be performed if TPH is detected
bgs = below ground surface
BTEX = benzene, toluene, ethylbenzene, and xylenes
H2S = hydrogen sulfide (by sulfides and sulfates)
NH3 = ammonia
PAHs = polynuclear aromatic hydrocarbons
TPH = total petroleum hydrocarbons

Updated: 8/2/95 REB
File: 2708-04 Well Pt SAP

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TABLE 5 - Sampling and Analytical Summary for Proposed Monitoring Wells
Initial Sampling Event

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAI Project # 2708

Proposed Monitoring Well Number	Rational for Monitoring Well Location	Estimated Well Depth (feet bgs)	Estimated Screened Interval (feet bgs)	Analytical Parameters for Groundwater Sampling										
				TPH	PAHs	BTEX	Phenols	Cyanide	Total Lead*	PP Metals	H2S	NH3	CVOCs	Pesticides
MW-1	Down-gradient of Former Spent Oxide Storage Area; immediately up-gradient of Willamette River	25	10-25	X	X	X		X	X	**	X	X		
MW-2	Down-gradient of Former Oxide Reactor Area and PNO Tank Farm; immediately up-gradient of Willamette River	25	10-25	X	X	X		X	X	**	X	X		
MW-3	Down-gradient of PNO Tank Farm; immediately up-gradient of Willamette River	25	10-25	X	X	X			X	**				
MW-4-25	Down-gradient of Lampblack Storage/Fill Area and Former Settling Ponds; immediately up-gradient of Willamette River	25	10-25	X	X	X		X	X	**	X			
MW-4-50	Investigate for DNAPLs down-gradient of Former Settling Ponds; determine vertical hydraulic gradient	50	40-50	X	X	X		X	X	**	X			
MW-5	Down-gradient of Former Settling Ponds; immediately up-gradient of Willamette River	25	10-25	X	X	X		X	X	**	X		X	X
MW-6-25	Down-gradient of Former Retort Area	25	10-25	X	X	X	X	X	X	**	X	X		
MW-6-50	Investigate for DNAPLs down-gradient of Former Retort Area; determine vertical hydraulic gradient	50	40-50	X	X	X	X	X	X	**	X	X		
MW-7-25	Down-gradient of LNG Containment Basin, Former Naphthalene and Light Oil Plants, and Former Tar Processing Area	25	10-25	X	X	X			X	**				
MW-7-50	Investigate for DNAPLs down-gradient of Former Naphthalene and Light Oil Plants and Former Tar Processing Area; determine vertical hydraulic gradient	50	40-50	X	X	X			X	**				
MW-8-25	Down-gradient of Former Settling Ponds and Koppers Land Treatment Area	25	10-25	X	X	X		X	X	**	X			

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TABLE 5 - Sampling and Analytical Summary for Proposed Monitoring Wells
Initial Sampling Event

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAI Project # 2708

Proposed Monitoring Well Number	Rational for Monitoring Well Location	Estimated Well Depth (feet bgs)	Estimated Screened Interval (feet bgs)	Analytical Parameters for Groundwater Sampling										
				TPH	PAHs	BTEX	Phenols	Cyanide	Total Lead*	PP Metals	H2S	NH3	CVOCs	Pesticides
MW-8-50	Investigate for DNAPLs down-gradient of Former Settling Ponds and Koppers Land Treatment Area; determine vertical hydraulic gradient	50	40-50	X	X	X		X	X	**	X		X	X
MW-9	Possible up-gradient shallow well for the property	25	10-25	X	X	X			X	**				
MW-10	At Former Naphthalene Plant; down-gradient of Light Oil Plant	25	10-25	X	X	X	X		X	**				
MW-11-25	Down-gradient of Former Koppers Land Treatment Area and Former Pitch Plant	25	10-25	X	X	X	X		X	**				
MW-11-50	Investigate for DNAPLs down-gradient of Former Koppers Land Treatment Area and Former Pitch Plant; determine vertical hydraulic gradient	50	40-50	X	X	X	X		X	**			X	X
MW-12-25	At Tar Loading Area; possible up-gradient shallow well for the property	25	10-25	X	X	X			X	**				
MW-12-50	Possible up-gradient deep well for the property; determine vertical hydraulic gradient	50	40-50	X	X	X			X	**				
TOTAL		600	-	18	18	18	5	9	18	18	9	4	3	3

NOTE: bgs = below ground surface
BTEX = benzene, toluene, ethylbenzene, and xylenes
CVOCs = chlorinated volatile organic compounds
DNAPLs = dense non-aqueous phase liquids
EPA = U.S. Environmental Protection Agency
H2S = hydrogen sulfide (by sulfides and sulfates)
NH3 = ammonia
PAHs = polynuclear aromatic hydrocarbons
PP = priority pollutant
TPH = total petroleum hydrocarbons

* = if total lead is detected, then analysis for dissolved lead will also be performed.

** = analysis for PP metals will depend on results of other parameter tests; only the 8 most contaminated monitoring wells will be analyzed

Updated: 6/21/95 REB
File: 2708-05 MW SAP

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Table 6 - Sampling and Analytical Summary for Surface Water Phase I Investigation

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project # 2708

Sample Number	Location	Analytical Parameters			
		TPH	PAHs	BTEX	Lead
SW-1	Northern Settling Pond	X	X	X	X
SW-2	Northern Settling Pond	X	X	X	X
SW-3	Southern Settling Pond	X	X	X	X
SW-4	Drainage Ditch; Down-Stream	X	X	X	X
SW-5	Drainage Ditch; Up-Stream	X	X	X	X
Total		5	5	5	5

NOTE: * = Analysis for PAHs will be performed if TPH is detected

BTEX = benzene, toluene, ethylbenzene, and xylenes

PAHs = polynuclear aromatic hydrocarbons

TPH = total petroleum hydrocarbons

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Table 7 - Sampling and Analytical Summary for Sediments
Phase I Investigation

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project # 2708

Sample Number	Location	Estimated Sample Depths (feet bss)	Samples Selected for Analyses	Analytical Parameters				
				TPH	PAHs	BTEX	Lead	TOC
SD-1	Northern Settling Pond	0.25 and 2.5*	2	X	X	X	X	X
SD-2	Northern Settling Pond	0.25 and 2.5*	2	X	X	X	X	X
SD-3	Southern Settling Pond	0.25 and 2.5*	2	X	X	X	X	X
SD-4	Willamette River @ Gasco Down-Stream	0.25 and 2.5*	2	X	X	X	X	X
SD-5	Willamette River @ Gasco Down-Stream	0.25 and 2.5*	2	X	X	X	X	X
SD-6	Willamette River @ Gasco Mid-Stream	0.25 and 2.5*	2	X	X	X	X	X
SD-7	Willamette River @ Gasco Mid-Stream	0.25 and 2.5*	2	X	X	X	X	X
SD-8	Willamette River @ Gasco Up-Stream	0.25 and 2.5*	2	X	X	X	X	X
SD-9	Willamette River @ Gasco Up-Stream	0.25 and 2.5*	2	X	X	X	X	X
SD-10	Willamette River @ Wacker Up-Stream Background	0.25 and 2.5*	2	X	X	X	X	X
SD-11	Willamette River @ Wacker Up-Stream Background	0.25 and 2.5*	2	X	X	X	X	X
SD-12	Willamette River @ Atochem Up-Stream Background	0.25 and 2.5*	2	X	X	X	X	X
SD-13	Willamette River @ Atochem Up-Stream Background	0.25 and 2.5*	2	X	X	X	X	X
SD-14	Willamette River @ Atochem Up-Stream Background	0.25 and 2.5*	2	X	X	X	X	X
Total			**28**	**14**	**14**	**14**	**14**	**14**

NOTE: bgs = below sediment surface
BTEX = benzene, toluene, ethylbenzene, and xylenes
PAHs = polynuclear aromatic hydrocarbons
TOC = total organic carbon
TPH = total petroleum hydrocarbons
* = one sample to be selected from oxygenated zone and one sample to be selected based on field observations

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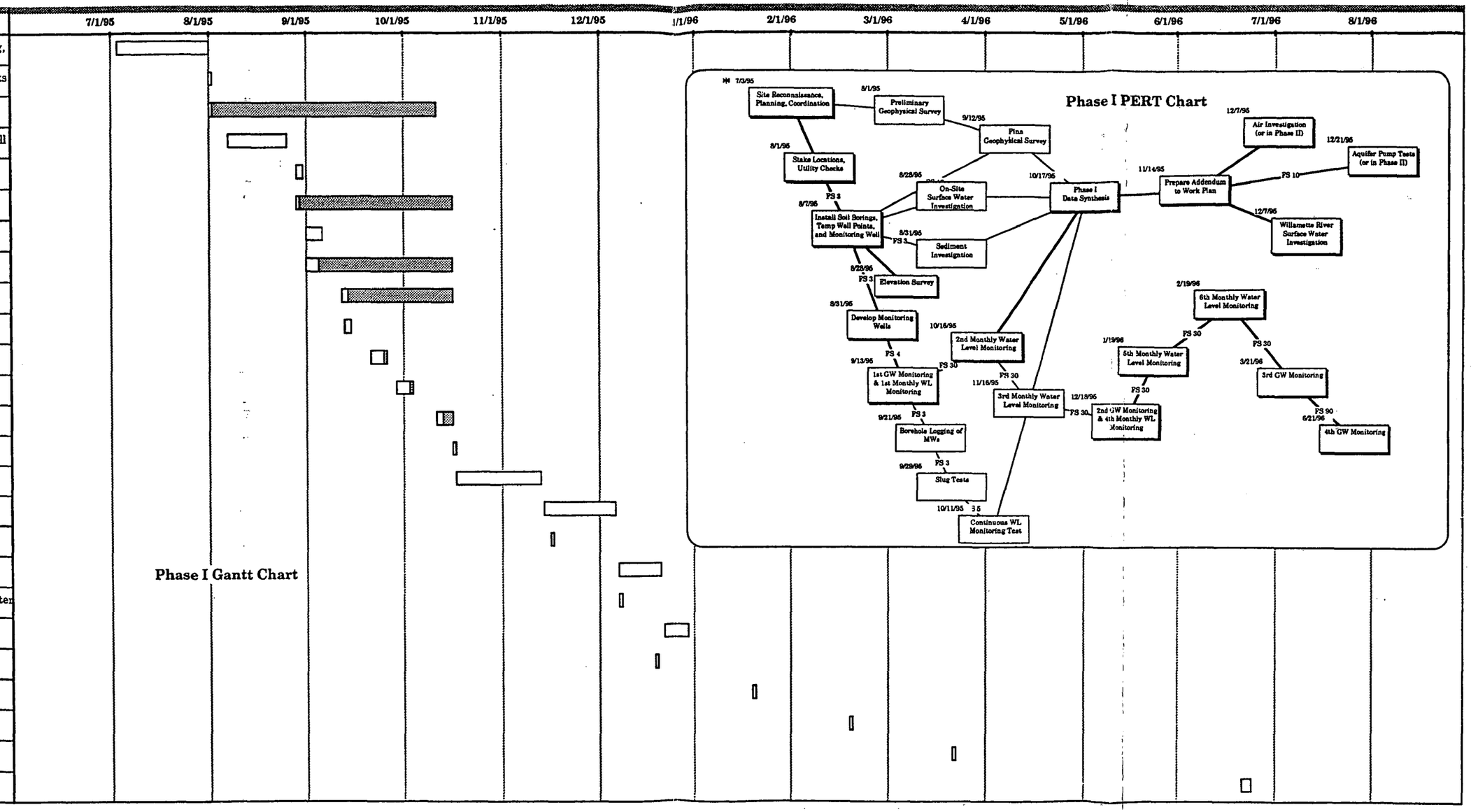
Name
Site Reconnaissance, Planning, Coordination
Stake Locations, Utility Checks
Preliminary Geophysical Survey
Install Soil Borings, Temp Well Points, and Monitoring Wells
Elevation Survey
On-Site Surface Water Investigation
Develop Monitoring Wells
Sediment Investigation
Final Geophysical Survey
1st GW Monitoring & 1st Monthly WL Monitoring
Borehole Logging of MWs
Slug Tests
Continuous WL Monitoring Test
2nd Monthly Water Level Monitoring
Phase Data Synthesis
Prepare Addendum to Work Plan
3rd Monthly Water Level Monitoring
Air Investigation (or in Phase II)
Willamette River Surface Water Investigation
Aquifer Pump Tests (or in Phase II)
2nd GW Monitoring & 4th Monthly WL Monitoring
5th Monthly Water Level Monitoring
6th Monthly Water Level Monitoring
3rd GW Monitoring
4th GW Monitoring



Phase I Gantt Chart

Project #2708	**HAHN AND ASSOCIATES INCORPORATED**	**Phase I Investigation Schedule**	**TABLE**
June 1995	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 795-0717	RI/FS Work Plan NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	9

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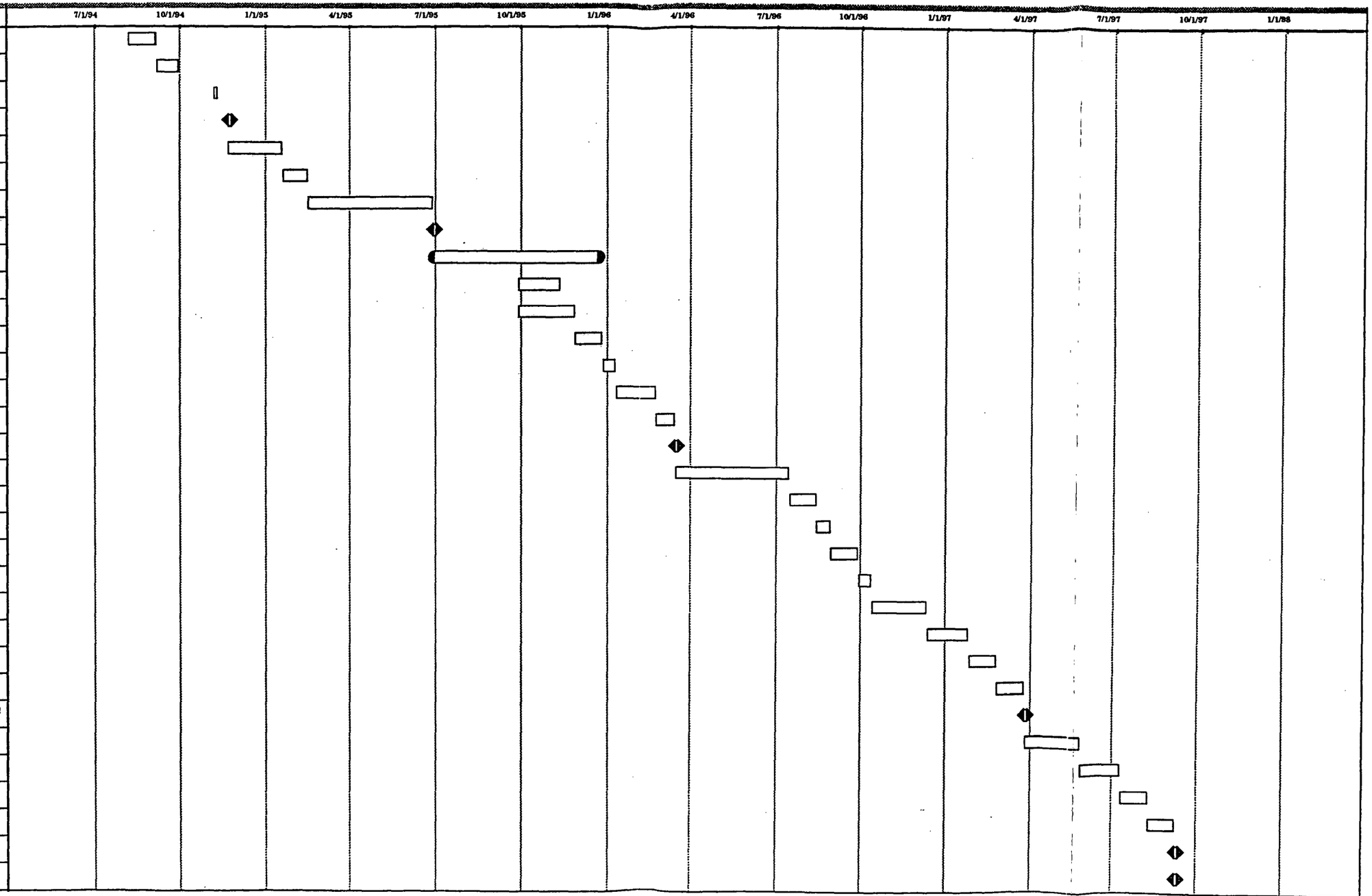
Name
Conceptual Work Plan (CWP) Prep
CWP Review by DEQ
CWP Meeting with DEQ
CWP Approval by DEQ
Draft RI/FS Work Plan (WP) Prep
Draft RI/FS WP Review by DEQ
RI/FS WP Revisions & Negotiations
RI/FS WP Approval by DEQ
Phase I Remedial Investigation
Preliminary Evaluation of Remedial Options
Endangerment Assessment
RI Letter Report Prep
RI Letter Repor: Review by DEQ
Phase II WP Addendum Prep
Phase II WP Addendum Review by DEQ
Phase II WP Approval by DEQ
Phase II Remedial Investigation
RI Letter Report Prep
RI Letter Report Review by DEQ
Draft RI Report Outline
Draft RI Report Outline Review by DEQ
Draft RI Report Prep
Draft RI Report Review by DEQ
Final RI Report Prep
Final RI Report Review by DEQ
RI Report Approval by DEQ
Draft Feasibility Study (FS) Report Prep
Draft FS Report Review by DEQ
Final FS Report Prep
Final FS Report Review by DEQ
FS Report Approval by DEQ
Begin Remedial Actions



Project #2708	**HAHN AND ASSOCIATES** INCORPORATED	**RI/FS Project Schedule**	**TABLE**
June 1995	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 226-0717	RI/FS Work Plan NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	8

Koppers022265

TABLE 10

Sample Container, Preservation, and Holding Time Requirements

RI/FS Work Plan

Northwest Natural Gas Company Gasco Facility

7900 NW St. Helens Road

Portland, Oregon

Project # 2708

Method Number	Technique	Sample Matrix	Sample Container	Preservation	Holding Time
SOIL & SEDIMENT SAMPLES					
DEQ Methods TPH-HCID, TPH-G, TPH-D, TPH-418.1M Total Petroleum Hydrocarbons (TPH)	GC	Soil	(1) 9-ounce glass jar	Cool to 4 C	7days
EPA Method 8020 Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX)	GC/PID	Soil	(1) 4-ounce glass jar	Cool to 4 C	14 days
EPA Method 8270 Modified Polynuclear Aromatic Hydrocarbons (PAHs)	GC/MS SIM	Soil	(1) 9-ounce glass jar	Cool to 4 C	7 days to extraction 40 days to analysis
EPA Method 8270 Phenols, Cresols	GC/MS	Soil	(1) 9-ounce glass jar	Cool to 4 C	7 days to extraction 40 days to analysis
EPA Method 6010 Total Lead	ICPES	Soil	(1) 9-ounce glass jar	Cool to 4 C	6 months
EPA Method 1311 (TCLP) & 6010 Leachable Lead	ICPES	Soil	(1) 9-ounce glass jar	Cool to 4 C	6 months
EPA Method 9010 Cyanide, Total & Amenable	SPM	Soil	(1) 9-ounce glass jar	Cool to 4 C	As soon as possible
EPA Method 415.1 Total Organic Carbon (TOC)	Oxidation IR	Soil	(1) 9-ounce glass jar	Cool to 4 C	28 days

NOTE:

C = degrees centigrade

DEQ = Oregon Department of Environmental Quality

EPA = U.S. Environmental Protection Agency

GC = gas chromatography

ICPES = Inductively Coupled Plasma Emission Spectroscopy

MS = mass spectroscopy

PID = photoionization detector

SIM = selective ion monitoring

SPM = spectrophotometric

TCLP = toxicity characteristic leaching procedure

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TABLE 10
Sample Container, Preservation, and Holding Time Requirements

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project # 2708

Method Number	Technique	Sample Matrix	Sample Container	Preservation	Holding Time
WATER SAMPLES					
EPA Method 418.1 Total Petroleum Hydrocarbons (TPH)	IR	Water	(1) 1,000-ml amber glass bottle	Cool to 4 C H2SO4 pH<2	28 days
EPA Method 8020 Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX)	GC/PID	Water	(3) 40-ml VOA vials	Cool to 4 C HCl pH<2	14 days
EPA Method 8080 Chlorinated Pesticides	GC/ECD	Water	(1) 1,000-ml amber glass bottle	Cool to 4 C	7 days to extraction 40 days to analysis
EPA Method 8260 Volatile Organic Compounds (VOCs)	GC/MS	Water	(3) 40-ml VOA vials	Cool to 4 C HCl pH<2	14 days
EPA Method 8270 Modified Polynuclear Aromatic Hydrocarbons (PAHs)	GC/MS SIM	Water	(1) 1,000-ml amber glass bottle	Cool to 4 C H2SO4 pH<2	7 days to extraction 40 days to analysis
EPA Method 8270 Phenols, Cresols	GC/MS	Water	(1) 1,000-ml amber glass bottle	Cool to 4 C H2SO4 pH<2	7 days to extraction 40 days to analysis
EPA Method 200.7 Priority Pollutant Metals, Total	ICPES/AA	Water	(1) 500 ml plastic bottle	Cool to 4 C HNO3 pH<2	6 months
EPA Method 200.7 Priority Pollutant Metals, Dissolved	ICPES/AA	Water field-filtered 0.45 micron	(1) 500 ml plastic bottle	Cool to 4 C HNO3 pH<2	6 months
EPA Method 9010 Cyanide, Total & Amenable	SPM	Water	(1) 500 ml plastic bottle	Cool to 4 C NaOH pH>12	14 days
EPA Method 376.1 Sulfides	Titrimetric	Water	(1) 500 ml plastic bottle	Cool to 4 C NaOH pH>9 2 ml Zn Acetate	7 days

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TABLE 10

Sample Container, Preservation, and Holding Time Requirements

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project # 2708

Method Number	Technique	Sample Matrix	Sample Container	Preservation	Holding Time
EPA Method 375.4 Sulfate	Turbidimetric	Water	(1) 500 ml plastic bottle	Cool to 4 C	28 days
EPA Method 200.7 Iron and Manganese	ICPES/AA	Water	(1) 500 ml plastic bottle	Cool to 4 C HNO3 pH<2	6 months
EPA Method 200.7 Hardness, Calculated	ICPES/AA	Water	(1) 500 ml plastic bottle	Cool to 4 C HNO3 pH<2	6 months
EPA Method 353.1 Nitrate and Nitrite	SPM	Water	(1) 500 ml plastic bottle	Cool to 4 C H2SO4 pH<2	2 days
EPA Method 310.1 Alkalinity	Titrimetric	Water	(1) 500 ml plastic bottle	Cool to 4 C	14 days
EPA Method 350.3 Ammonia as Nitrogen	Electrode	Water	(1) 500 ml plastic bottle	Cool to 4 C H2SO4 pH<2	28 days
EPA Method 365.2 Phosphate, ortho	SPM	Water field-filtered 0.45 micron	(1) 500 ml plastic bottle	Cool to 4 C	2 days
EPA Method 415.1 Total Organic Carbon (TOC)	Oxidation IR	Water	(1) 1,000-ml amber glass bottle	Cool to 4 C H2SO4 pH<2	28 days

NOTE:

AA = atomic absorption
C = degrees centigrade
ECD = electron capture device
EPA = U.S. Environmental Protection Agency
GC = gas chromatography
H2SO4 = sulfuric acid
HCl = hydrochloric acid
HNO3 = nitric acid
ICPES = Inductively Coupled Plasma Emission Spectroscopy
IR = infrared
ml = milliliter
MS = mass spectroscopy
NaOH = sodium hydroxide
PID = photoionization detector
SIM = selective ion monitoring
SPM = spectrophotometric
TCLP = toxicity characteristic leaching procedure
VOA = volatile organic analyses

Updated: 8/2/95 REB
File: 2708-10 Smpl Container copy

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TABLE 11 - Sample Containers Required Per Sample
Phase I Investigation

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project # 2708

Sample Matrix	Number of Containers Required	Sample Container	Preservative	Filtering Requirements	Analytical Parameters	Analytical Methods
Soil Sample	1	9-ounce glass sample jar with Teflon-lined lid	None	Not applicable	TPH PAHs Phenols	DEQ TPH Methods EPA 8270 SIM EPA 8270
	1	9-ounce glass sample jar with Teflon-lined lid	None	Not applicable	Total Lead Leachable Lead Cyanide	EPA 6010 EPA 1311 (TCLP), 6010 EPA 9010
	1	4-ounce glass sample jar with Teflon-lined lid	None	Not applicable	BTEX	EPA 8020
Sediment Sample	1	9-ounce glass sample jar with Teflon-lined lid	None	Not applicable	PAHs BTEX	EPA 8270 SIM EPA 8020
	1	9-ounce glass sample jar with Teflon-lined lid	None	Not applicable	Total Lead TOC	EPA 6010 EPA 415.1
Groundwater Sample from Temporary Well Point	3	1-liter amber glass bottle	H_2SO_4 pH<2	Unfiltered	TPH PAHs Phenols	EPA 418.1 EPA 8270 SIM EPA 8270
	3	40-ml VOA vials	HCl pH<2	Unfiltered	BTEX	EPA 8020
	1	500-ml plastic bottle	NaOH pH>12	Unfiltered	Cyanide	EPA 9010
	1	500-ml plastic bottle	NaOH pH>12 2 ml Zn Acetate	Unfiltered	Sulfides	EPA 376.1
	1	500-ml plastic bottle	None	Unfiltered	Sulfate	EPA 375.4
	1	500-ml plastic bottle	H_2SO_4 pH<2	Unfiltered	Ammonia	EPA 350.3

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TABLE 11 - Sample Containers Required Per Sample
Phase I Investigation

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project # 2708

Sample Matrix	Number of Containers Required	Sample Container	Preservative	Filtering Requirements	Analytical Parameters	Analytical Methods
Groundwater Sample from Monitoring Well	4	1-liter amber glass bottle	H_2SO_4 pH<2	Unfiltered	TPH	EPA 418.1
					PAHs	EPA 8270 SIM
					Phenols	EPA 8270
					TOC	EPA 415.1
	1	1-liter amber glass bottle	None	Unfiltered	Chlorinated Pesticides	EPA 8080
	3	40-ml VOA vials	HCl pH<2	Unfiltered	BTEX	EPA 8020
					VOCs	EPA 8260
	1	500-ml plastic bottle	HNO_3 pH<2	Unfiltered	Total Priority Pollutant Metals	EPA 200.7
					Total Iron & Manganese	EPA 200.7
					Hardness	EPA 200.7
	1	500-ml plastic bottle	HNO_3 pH<2	Field-Filtered 0.45 micron	Dissolved Priority Pollutant Metals	EPA 200.7
	1	500-ml plastic bottle	NaOH pH>12	Unfiltered	Cyanide	EPA 9010
	1	500-ml plastic bottle	NaOH pH>12 2 ml Zn Acetate	Unfiltered	Sulfides	EPA 376.1
	1	500-ml plastic bottle	H_2SO_4 pH<2	Unfiltered	Ammonia	EPA 350.3
					Nitrate & Nitrite	EPA 353.1
	1	500-ml plastic bottle	None	Unfiltered	Sulfate	EPA 375.4
					Alkalinity	EPA 310.1
	1	500-ml plastic bottle	None	Field-Filtered 0.45 micron	Phosphate, ortho	EPA 365.2

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TABLE 11 - Sample Containers Required Per Sample
Phase I Investigation

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project # 2708

Sample Matrix	Number of Containers Required	Sample Container	Preservative	Filtering Requirements	Analytical Parameters	Analytical Methods
Surface Water Sample	2	1-liter amber glass bottle	H2SO4 pH<2	Unfiltered	TPH PAHs	EPA 418.1 EPA 8270 SIM
	3	40-ml VOA vials	HCl pH<2	Unfiltered	BTEX	EPA 8020
	1	500-ml plastic bottle	HNO3 pH<2	Field-Filtered 0.45 micron	Dissolved Lead	EPA 200.7

NOTE:
BTEX = benzene, toluene, ethylbenzene, and xylenes
DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
H2SO4 = sulfuric acid
HCl = hydrochloric acid
HNO3 = nitric acid
ml = milliliter
NaOH = sodium hydroxide
PAHs = polynuclear aromatic hydrocarbons
SIM = selective ion monitoring
TCLP = Toxicity Characteristic Leaching Procedure
TOC = total organic carbon
TPH = total petroleum hydrocarbons
VOA = volatile organic analyses
VOCs = volatile organic compounds

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TABLE 12 - Quality Control Sampling Plan
Phase I Investigation

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project # 2708

Media	Quality Control Samples				
	Field Duplicate	Sampling Equipment Blank	Trip Blank	Matrix Spike	Matrix Spike Duplicate
Soil	One per 20 samples	Two after sampling tar zones	One per 2 days sampling or One per sampling event	None	None
Sediment	One per 20 samples	None	One per 2 days sampling or One per sampling event	None	None
Groundwater	One per sampling event	One per sampling event	One per day of sampling or One per sampling event	One per sampling event	One per sampling event
Surface Water	One per sampling event	One per sampling event	One per day of sampling or One per sampling event	None	None

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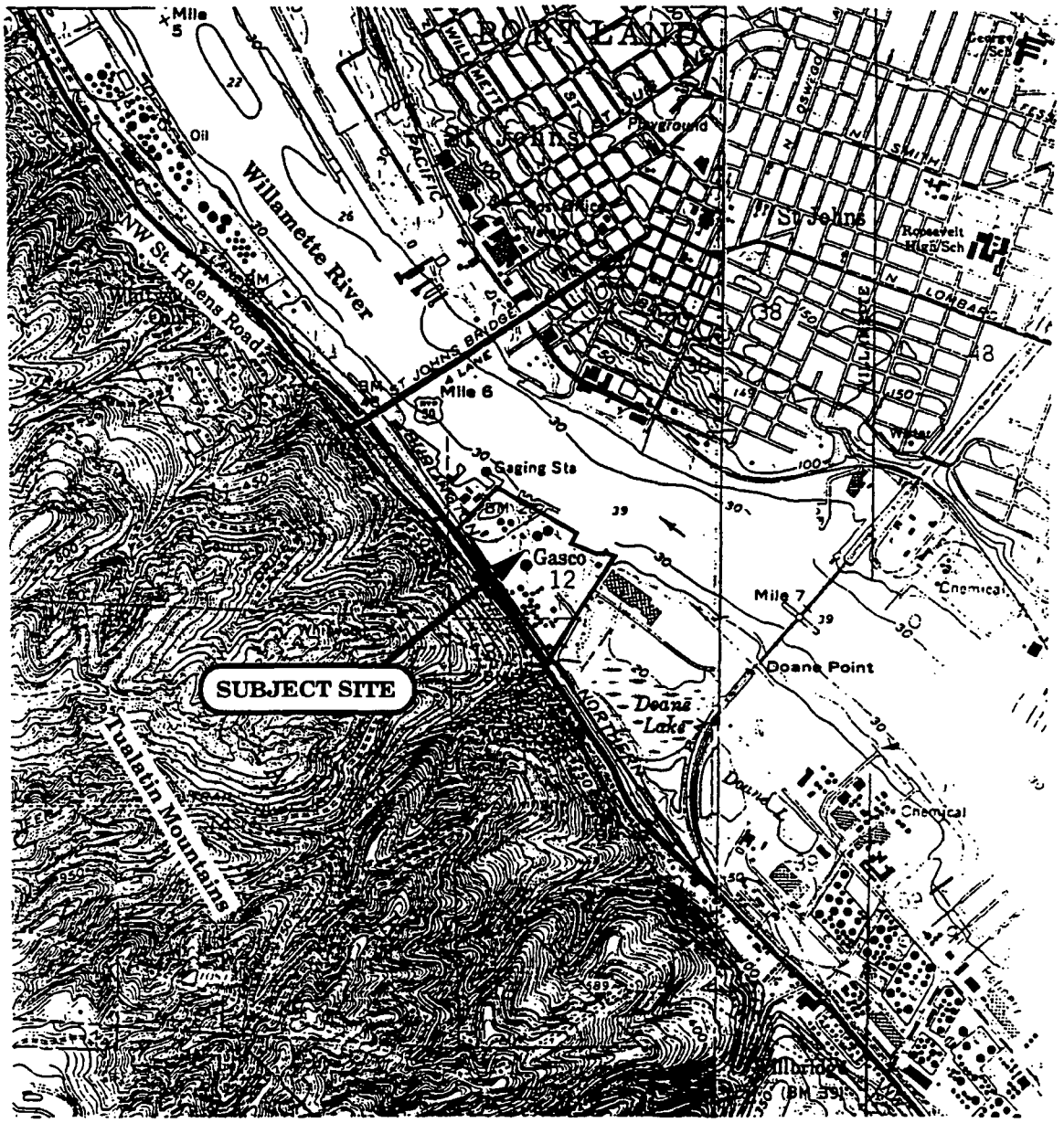

Note: Base Map from Linnton (1984) and Portland (1977), Oregon, USGS 7.5 Minute Quadrangles

HAI Project #2708 January 1995	**HAHN & ASSOCIATES, INC.** **ENVIRONMENTAL MANAGEMENT** 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209-3600 503/796-0717	**LOCATION MAP** RI/FS Work Plan Northwest Natural Gas Company Gasco Facility 7540 NW St. Helens Road Portland, Oregon	FIGURE **1**

LEGEND

- Site Boundary
- Lease Boundary
- Existing Structure or Feature
- Railroad Tracks

N

0 150 300

Approximate Scale in Feet

Willamette River

Dock

Ditch

Wacker Siltronic

Pacific Northern Oil Company Lease Area

Oil Tank

Oil Tank

Oil Tank

Oil Tank

Oil Tank

PNO Office

LNG Containment Basin

LNG Tank

Pond

Pond

Pond

Pencil Pitch Storage

Storeroom

Koppers Company, Inc. Lease Area

Office

NW Natural Gas Co. LNG Plant

Gasco Office

U.S. Army Corps of Engineers

NW St. Helens Road

Figure 2

Site Map

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES
INCORPORATED
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

January 1995

Project #2708

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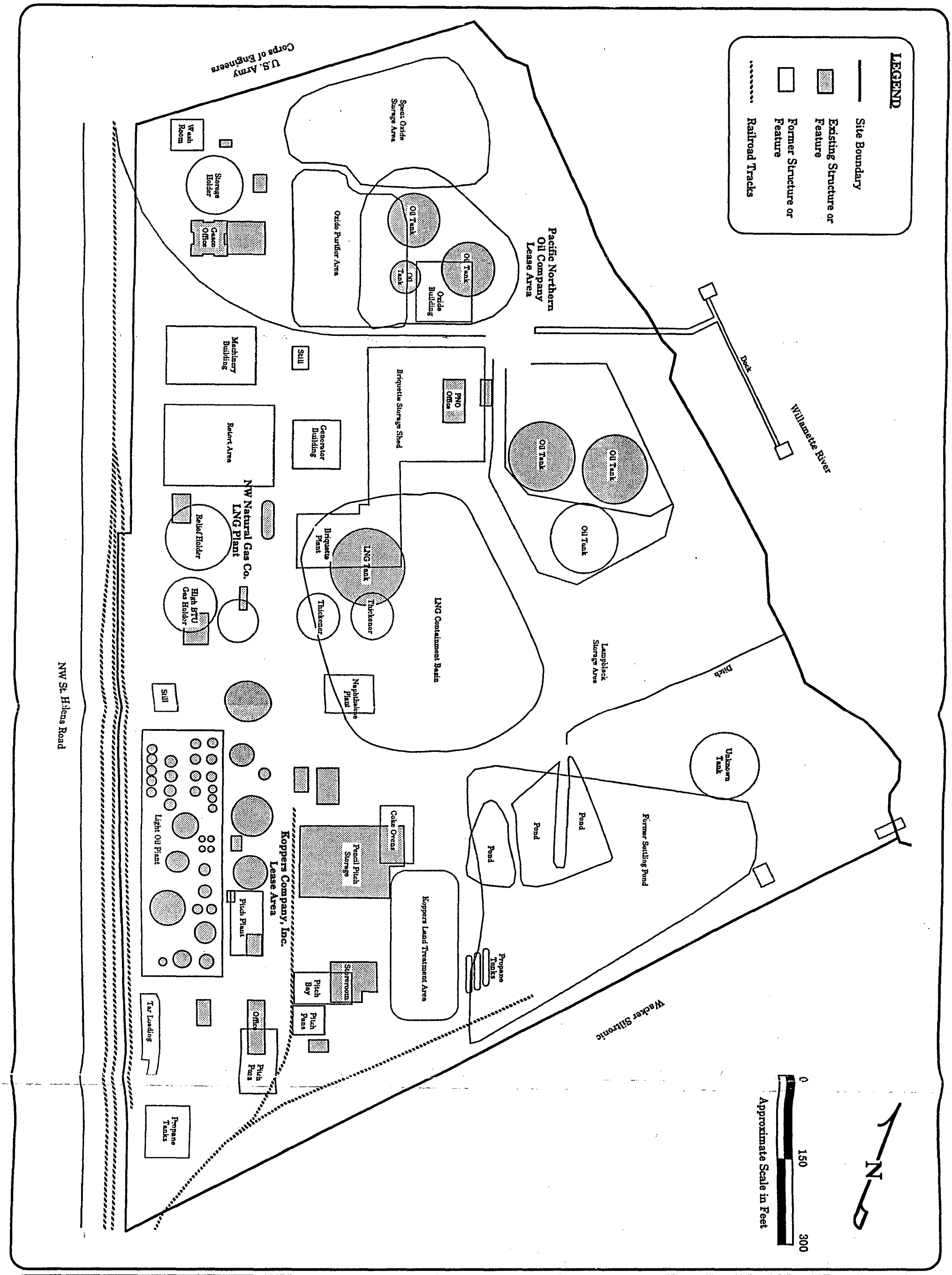

Project #2708	January 1995	**HAHN & ASSOCIATES** INCORPORATED ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 503/796-0717	**Historical Features Map** RI/FS Work Plan Northwest Natural Gas Company Gasco Facility 7540 NW St. Helens Road Portland, Oregon	Figure 3

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Northeast

Southwest

Light Oil Plant

St. Helens Rd.

RR Tracks

Fill Unit

Pond

Filled Settling Pond

Water Table

Water Table

Silty Clay Unit

Willamette River

Alluvial Deposits

Columbia River Basalts

LEGEND

- Surface Water
- Geologic Unit Boundary
- Fill Material
- Water Table
- Groundwater Flow Path

11500

Figure 4

Hydrogeologic Conceptual Model

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES
INCORPORATED
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

January 1995

Project #2708

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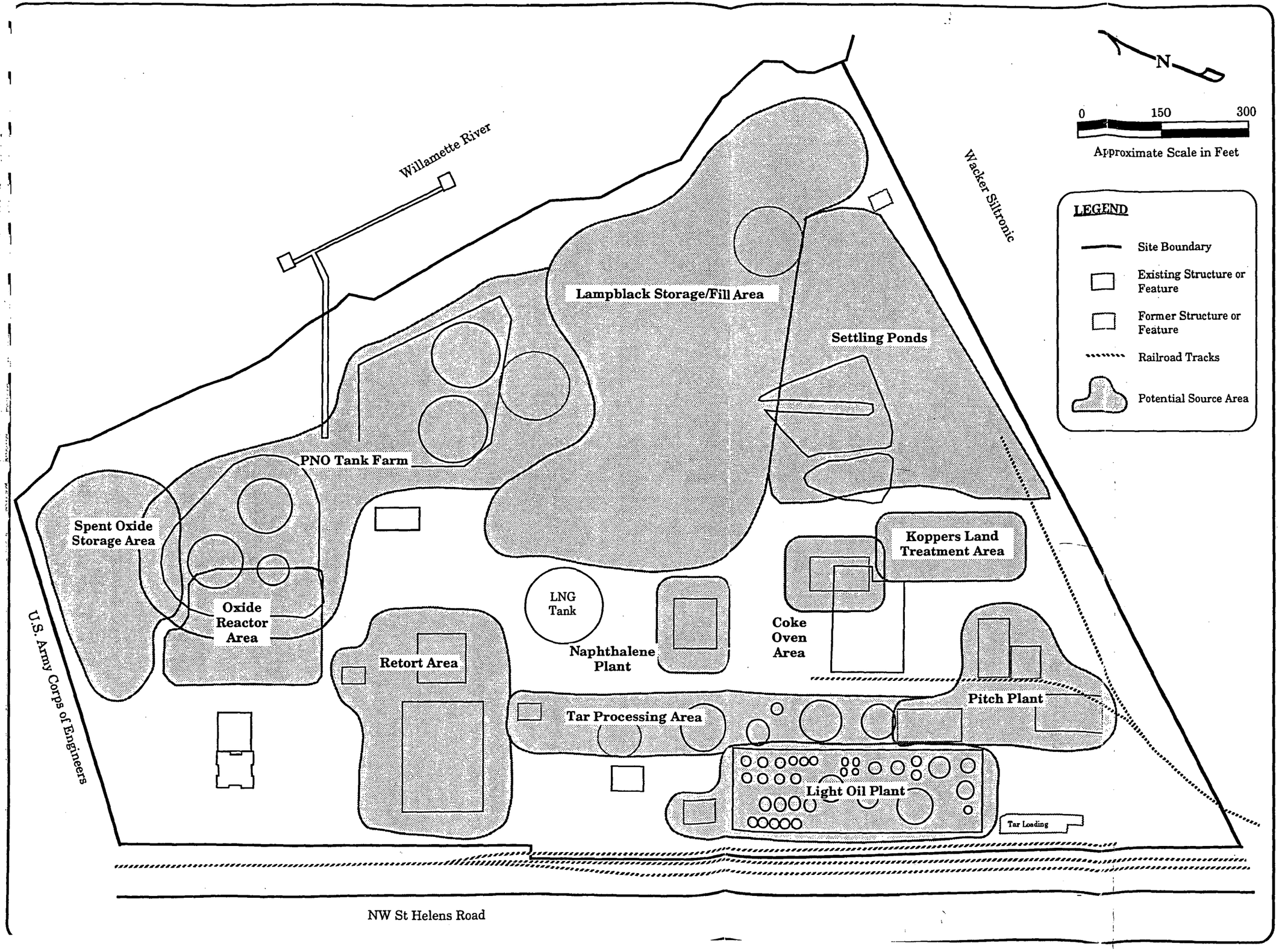

Figure 5

Potential Source Areas

RI/FS Work Plan
Northwest Natural Gas Company Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES
INCORPORATED
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

January 1995

Project #2708

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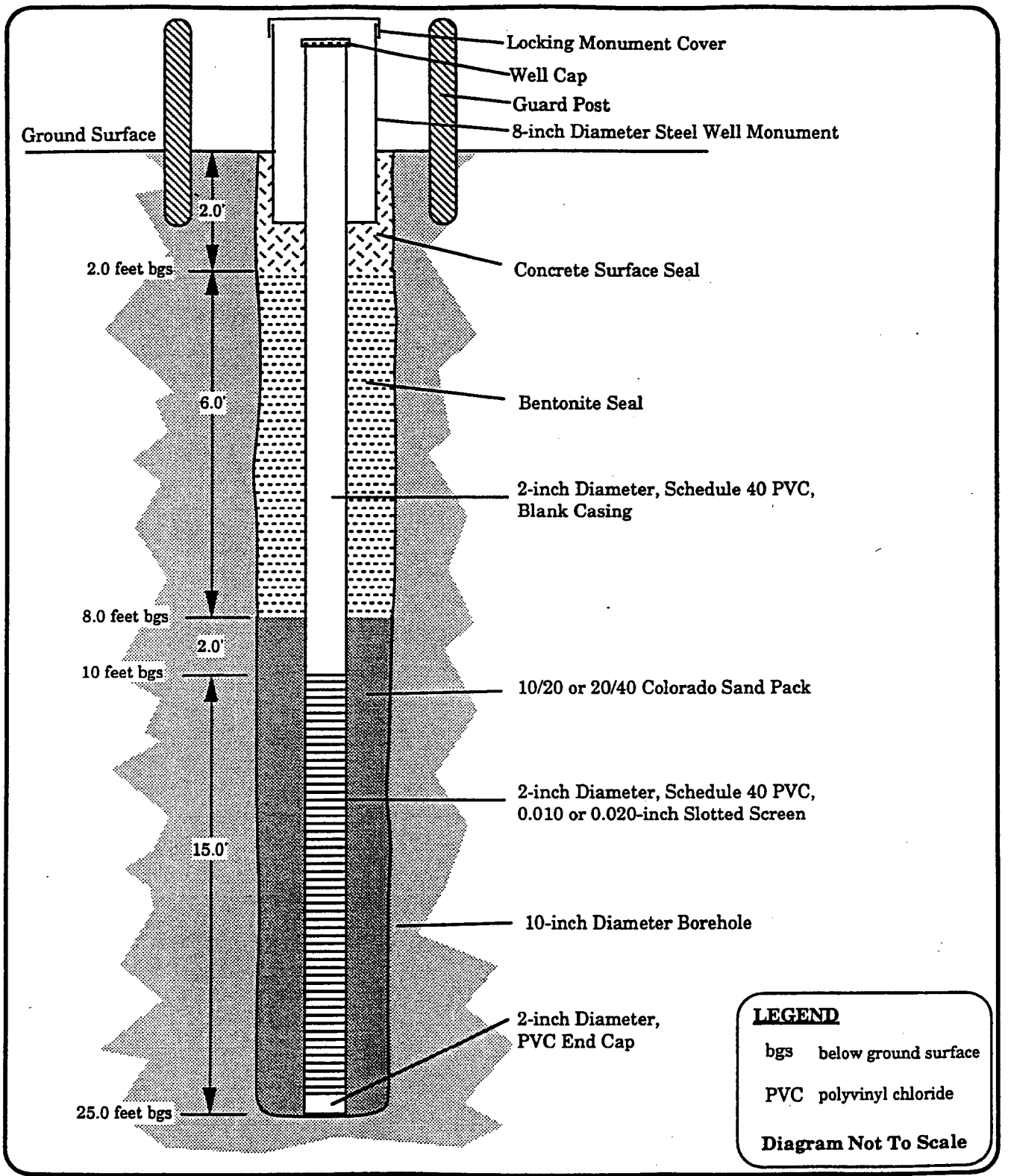
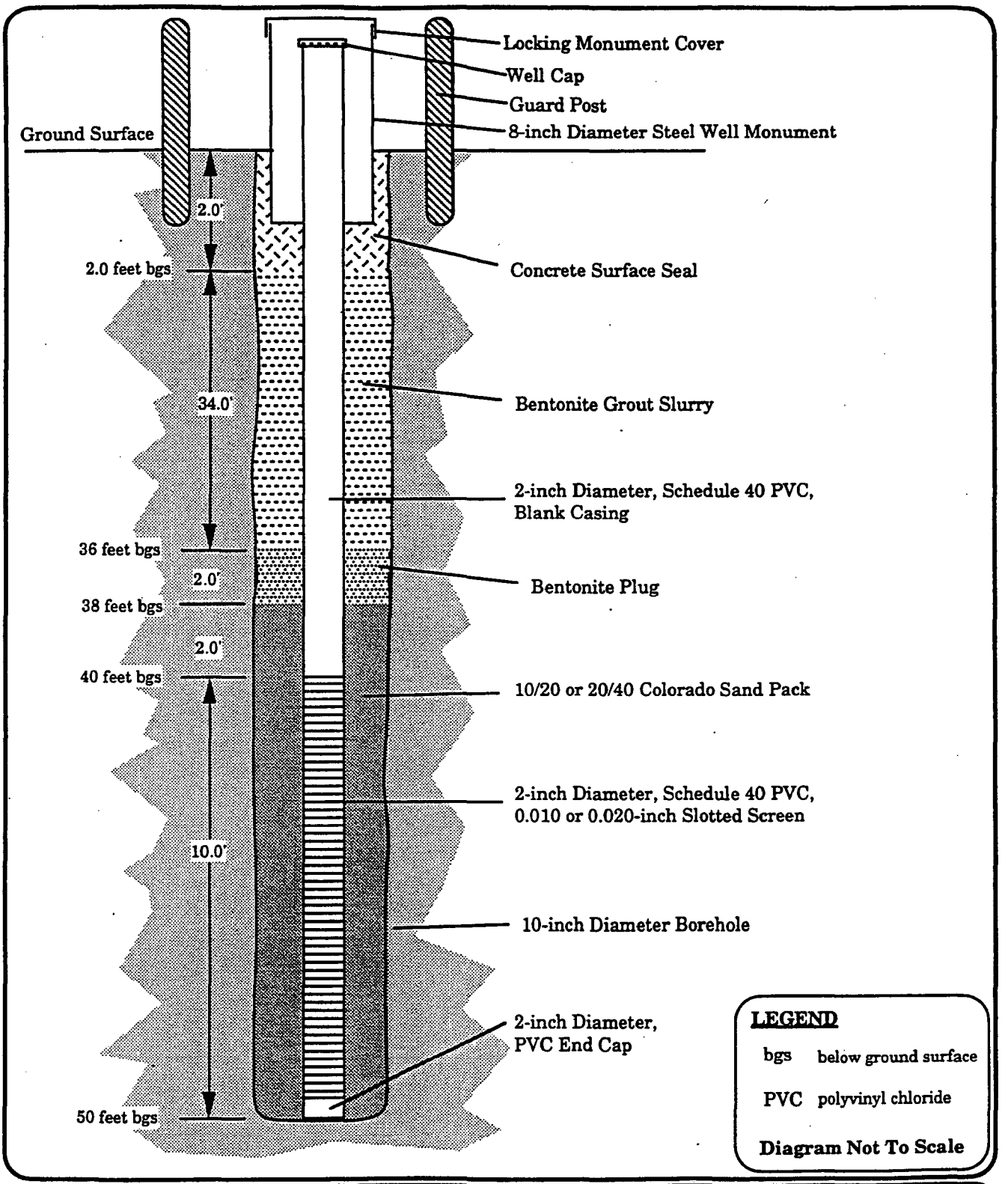


HAI Project #2708 January 1995	**HAHN & ASSOCIATES** **INCORPORATED** ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 503/796-0717	**Shallow Monitoring Well Construction Diagram** RI/FS Work Plan Northwest Natural Gas Company Gasco Facility 7540 NW St. Helens Road Portland, Oregon	**FIGURE** 8



HAI Project #2708 January 1995	**HAHN & ASSOCIATES INCORPORATED** ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 503/796-0717	**Deep Monitoring Well Construction Diagram** RI/FS Work Plan Northwest Natural Gas Company Gasco Facility 7540 NW St. Helens Road Portland, Oregon	**FIGURE 9**

APPENDIX A

Excerpts From Camp Dresser & McKee Inc. Report
Dated June 1987

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NORTH DOANE'S LAKE
SITE CHARACTERIZATION
WORK PLAN

JUNE 1987

Prepared by:
Camp Dresser & McKee Inc.
2300 15th Street, Suite 400
Denver, CO 80202

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REFERENCES

APPENDICIES

A - Logs of borings used in simplified geologic cross-sections
B - Tentatively Identified Organic Compounds at Sample Sites

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2.0 EXISTING SITE CONDITION SUMMARY

2.1 SITE DESCRIPTION

2.1.1 SITE LOCATION

The location of the North Doane's Lake site is in the northwest part of Portland on the west bank of the Willamette River, northwest and downstream of the Northwest Portland industrial area. For the purposes of this study, the site includes land occupied by the former Portland Gas and Coke Company manufactured gas facility, the Northwest Natural Gas (NWNG) LNG facility; Pacific Northern Oil's petroleum terminal; the Koppers Company creosote terminal; and the Wacker Siltronic Corporation semiconductor manufacturing facility. Both Pacific Northern Oil and Koppers lease the property from NWNG. NWNG owns the northwestern part of the site and Wacker owns the southeastern part of the site. Figure 2-1 is a recent aerial photograph of the study area. Figure 2-2 identifies current day features within the study area for reference.

This study area is roughly triangular in shape, consisting of about 120 acres. The northeast boundary of the site is the Willamette River; the southeast boundary is the Burlington Northern (BN) Railroad berm along the approach to the BN Railroad Bridge; the southwest boundary is the main BN Railroad track adjacent to N.W. St. Helens Road; and the northwest boundary is the property line between NWNG property and the U.S. Army Corps of Engineers Moorings facility, which is southeast of the St. John's Bridge. The site is about 6 miles upstream of confluence of the the Willamette River with the Columbia River.

2.1.2 SITE HISTORY

This section discusses history of the site to the present. Much of the information was obtained from a site history prepared for Walker Siltronic

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Corporation by the Portland Development Commission (1984). Section 2.2 presents a detailed discussion of past waste product disposal practices.

In 1883, a rail line was begun between Portland and Astoria and completed in 1898. This is the line that is now owned by BN and forms the southwest boundary of the site. The railroad bridge across the Willamette River was completed in 1908. The railroad leading to the bridge bisected Doane Lake, a small shallow lake originally located partly on the southwest edge of the site.

The federal government purchased the property immediately northwest of the study area in 1903 and 1905 for moorings. Additional property was purchased in 1940. The area of 11 acres is currently used by the U.S. Army Corps of Engineers for storage and operating facilities for dredges and other floating equipment.

In 1913, the Portland Gas and Coke Company built a residual oil gasification facility, known as the GASCO facility, on the present-day NWNG property. The plant produced 570 Btu town gas and pressed lampblack briquettes, which were sold in the area as solid fuel. Beginning in 1923, the process was modified to optimize aromatic generation and light oil recovery for use as motor fuel. In 1925, tar recovery and refining were initiated to provide tar for use as road binder. During the 1930's, the plant expanded and in 1941 a coking plant began production of electrode grade coke and high Btu gas. With the availability of natural gas in the 1950's, much of the facility was shut down and dismantled. The last full year of operation was 1955. Natural gas arrived in 1956 and Portland Gas and Coke became Northwest Natural Gas Company (NWNG) in 1958. NWNG began construction of a liquefied natural gas (LNG) plant in the late 1960's and most of the old gasification plant facilities were demolished.

A small area of the southeastern part of the former plant site, including a small tank farm, was leased to Koppers Company Inc., Organic Material Division. Koppers built a plant in 1966 to make coal tar pitch for the

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aluminum industry. Koppers land farmed wastewater from the tar stills on the property. The coal tar pitch plant ceased operation in 1973. Koppers still leases the facility which currently serves as a terminal for distribution of creosote oils for wood treating.

During the 1960's, several large tanks at the northwest edge of the property near the river were leased to Pacific Northern Oil. Pacific Northern continues to lease and operate in this location today. Oil is received by ship, stored in the tanks, and distributed to customers.

In the 1970's, all of the remaining gas plant structures outside of the lease areas, except for the GASCO Administration Building, were demolished. Most of the spent oxide pile was taken to the Scappose, Oregon landfill. The remaining tar pond was filled with spent oxide, material from the adjacent rock quarry and overburden after action by the Coast Guard regarding leakage of oil from the tar pond to the river. Underground piping was also removed and sold as scrap. The Administration Building remains [redacted]. In the early 1980's, NWNG added a new dock, three tanks, and a new drainage system.

NWNG continues to operate the LNG plant on the property today. During 1985, NWNG contracted to have the river dredged near the docks to accommodate tankers making deliveries to Pacific Northern Oil. About 500 cubic yards of dredge material was taken to an off-site landfill. The U.S. Army Corps of Engineers (COE) dredges the Willamette periodically to maintain the channel. The river reach near the site between the St. John's Bridge and Burlington Northern bridge was last dredged in 1973.

The southeastern part of the site, which is currently owned by Wacker Siltronic Corporation, was formerly a low-lying swampy area occupying an abandoned river oxbow, that was subject to winter flooding. Several small buildings existed on the site in the 1930's on the river bank near the railroad bridge. Western Transportation had a river dock with two piers,

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five buildings and two fuel tanks. The facility was used for refueling tugs, and to tie up log rafts and barges. The dock and piers were removed in the 1950's, and the buildings by 1973.

In the 1930's, Shell Oil Company built a dock and building on the river bank at the boundary of the present-day Wacker and NWNG properties, with a road following that present boundary. Shell purchased a by-product from Portland Gas and Coke and shipped it by barge from the dock. By 1957 the facility was apparently abandoned and the building destroyed by 1973.

The present-day Wacker property was purchased in 1962 from the railroad and Portland Gas and Coke. The purchasers agreed to fill the site to a minimum elevation of 30 feet by the end of 1973 and construct industrial buildings by the end of 1978. The site was filled with material from the adjacent rock quarry (Figure 2-2) and dredge material from the Port of Portland. Port of Portland records indicate that 695,522 cubic yards of dredge material was placed on the site in 1974. Total fill, including rock, was estimated to be 1,529,400 cubic yards. Settling ponds containing tar along the property line with the gasification facility were filled and the contents spread over the low lying area at this time.

In 1978, the City of Portland Development Commission purchased the site as part of an urban renewal project and sold it to the Wacker Siltronic Corporation in the same year. Construction of the Wacker plant began in October 1978. Construction was completed in December 1979, and operation began in March 1980.

Two pipelines that run parallel to the river, cross the site. The pipelines carry a variety of petroleum products and are operated by Olympic Pipeline.

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Ground water in the underlying Columbia River basalt exists primarily as isolated confined aquifers in the permeable fracture zones between individual basalt flows. In places, these confined aquifer units may be interconnected by vertical fractures in the basalt. Recharge to the basalt aquifers is largely from direct infiltration of precipitation on the northeastern slopes of the Tualatin Mountains, located west of the site. Flow is expected to be to the northeast, in the downdip direction toward the Willamette River, where discharge to the alluvial aquifer likely takes place.

Water use in the area is supplied principally by municipal water systems. There are several industrial supply wells which tap basalt aquifers in the area, including one 370 foot well owned by NWNG. The other deep wells, located near the Rhone-Poulenc facility to the southeast, are reportedly no longer in operation. There is no documentation of water use in the area from the unconsolidated aquifer.

2.2 CONTAMINATION PROBLEM DEFINITION

Several industrial facilities have conducted operations in the study area since initial development of the site. These include[1] gas and by-product production from residual oils by the Portland Gas and Coke Company,[2] tar distillation and creosote terminal operations by Koppers,[3] LNG operations by Northwest Natural Gas,[4] petroleum product handling by Northern Petroleum, and semiconductor manufacturing by Wacker-Siltronics. The primary facility of concern for purposes of this work plan document is the oil gasification plant due to its size and waste handling practices. Other operations associated with the Port of Portland, including dredging and historic tanker bilge pumping operations, may have also contributed hydrocarbon contamination to the adjacent river sediments, dredge spoils disposed along the river banks, and dredge spoils used for fill on the Wacker Property. Each of the facilities is described below.

2.2.1 GASCO FACILITY, PORTLAND GAS AND COKE COMPANY

The original development of the site was associated with a residual oil gasification facility, the GASCO plant, that was placed in operation in about 1913. This facility was constructed on hydraulically placed sandy fill material built up on lowland areas adjacent to the Willamette River. No information regarding site layout prior to the first available aerial photographs in 1936 is available. Published process summaries (Hall, 1941; Hall and Kohlhoff, 1952) provide information on changes in plant operations during its history. More general information on the process was obtained from Morgan (1931). Significant milestones in plant operations are summarized on Table 2-1. This facility grew to be one of the largest and most efficient oil-gas generation facilities in the west, with a generation capacity of 77,000,000 standard cubic feet of oil-gas and butane-air gas with a heating value of 570 Btu/cubic ft. The facility did extensive recovery and processing of by-products and near the end of its operation over 1/3 of the plant revenue was derived from the sale of these by-products.

The GASCO facility used two primary processes in the generation of gas for distribution, in addition to a number of refinery type processes for production of tar, pitch, and various other refined petroleum products. A technique known as the "Pacific Coast Oil Gas Process" (Morgan, 1931) was used throughout the life of the facility. This is a cyclical process whereby oil is subjected to thermal cracking at near atmospheric pressure in a cylindrical shell containing heated refractory checkerbrick. The checkerbrick is heated by combustion of oil and burning of carbon deposits on the checkerbrick to attain a temperature of about 2000°F. Heavy oils were introduced after pre-heating the reaction vessel and were thermally cracked as they moved downward through the gassifier. This cycle of alternating heating and gasification was continually repeated. This process generated the following products and by-products for each 10 gallons of 8.4 degree API oil (Hall and Kohlhoff, 1952):

Koppers022290

- o 1,000 cubic ft of 570 Btu/cubic ft oil gas
- o 28.3 lbs lampblack
- o 0.38 gallons tar
- o 0.46 gallons light oil

The gas was cooled and subjected to various cleaning processes to remove tars, light oils, and sulfur prior to distribution. Tars and light oils were removed by cooling and de-misting the gas. Sulfur was removed by passing the cooled gas with small amounts of added ammonia and air through beds of iron oxide adsorbed on wood shavings. In 1941 a coke oven was installed at the plant to generate electrode grade coke and high Btu gas for re-forming in the existing retorts. The coke ovens produced the following products for each 10 gallons of 8.4 degree API feedstock oil and 9 pounds of lampblack (Hall and Kohlhoff, 1952):

- o 540 cubic ft of 1030 Btu/cubic ft gas
- o 19.5 lbs coke
- o 3.6 gallons tar
- o 0.66 gallons light oil
- o 0.06 gallons creosote oil

Figures 2-6, 2-7, and 2-8 show respectively process flow sheets for the gas generator, coke oven and by-product refining operations. Several of these processes likely resulted in generation of waste streams that were deposited on site or were discharged to the adjacent Willamette River. It should be noted that due to the large size of this plant, economic recovery of many of the by-products typically wasted at other plants of this type was conducted and waste quantities are correspondingly smaller. During the life of the plant a total of approximately 70,000,000 barrels of petroleum feedstock were processed. Near the end of the plants operation, processing of 2,100,000 barrels of petroleum resulted in product and by-product sales on an annual basis as follows (Hall and Kohlhoff, 1952):

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- o 9,000,000,000 cubic ft of 570 Btu gas
- o 4,900,000 gallons light oil
- o 8,263,000 gallons tar
- o 114,000 tons lampblack and coke
- o 600,000 gallons gas oil

Due to significant changes in plant processes and site layout, waste generation is separately addressed for the pre-1941 period and post plant expansion in 1941.

Pre 1941 Period

During the initial period of operation from 1913 through 1923 only 570 Btu gas and lampblack briquettes were produced by the plant. Commencing in 1923, light oils were recovered and refined on site for use as motor fuel. In 1925 recovery and processing of tars for use primarily as road binder was initiated. The wastes generated prior to 1925 would include primarily waste water with a lov level of dissolved and suspended hydrocarbons, tar and spent oxide from sulfur removal. Figure 2-9 identifies areas from the 1936 aerial photography that exhibit evidence of either tar, lampblack, or spent oxide deposition. The main area that received waste discharge was along the south side of the fuel storage tank area. This area was subsequently filled in and likely contains tar and other solids discharged from the plant. After 1925, when tar refining operations were started, the quantity of tar going to the waste discharge would only be a small percentage of the total tar generated. Most of the waste tar after 1925 would occur as suspended material and emulsions in waste water discharging from the secondary tar box. Once the discharged tar entered the active stream channel, the velocity of the water would tend to keep the material entrained and likely dispersed it in a narrow plume downstream. This tar was likely transported to an unknown distance downstream before settling.

Spent oxide from the purifiers was stockpiled on site, adjacent to the oxide purifier process units. Some of the spent oxide may have been disposed of either on or off-site.

Post 1941 Period

A major plant expansion was initiated in the late 1930s and came on-line in 1941. This expansion involved implementation of a coking plant for producing electrode grade coke, pitch, and high Btu gas for reforming in the oil gas generators. These additional process units were constructed on artificial fill potentially containing waste materials placed east of the light oil and tar tankage area. Additional pollution abatement facilities were also installed during this expansion. These abatement facilities included a series of four effluent settling basins that received water from the sewers and discharge from tar boxes and lampblack thickeners. All of the oily waste water passed through the tar separation tanks where sulfonates from the refinery were blended to aid in breaking the tar/water emulsion prior to discharge to the settling ponds. The majority of the tars that were not in aqueous solution settled out and remained in these ponds. Periodic flooding may have scoured some of the tars deposited in the ponds, but this mechanism is expected to be minor due to tar properties. Company records indicate occasional cleanout of the settling ponds was done and it is assumed that the dredged materials were disposed of in low lying areas on site. Spent oxide material continued to be stockpiled on site. Plant operations continued in this manner until the plant was shut down in 1955 with the arrival of natural gas. Removal and sale of stockpiled lampblack and possibly tar continued for several years thereafter. At the time of plant closure, a number of waste storage facilities remained on site. Figure 2-10 is a site plan near the time of plant closure. During filling of the adjacent Walker property in the late 1960s, the three smaller tar ponds along the property boundary were eliminated and the tar incorporated into the soil fill material in a low lying area paralleling the Walker property line. The Coast Guard detected an oil slick originating at the remaining tar pond in July 1970 and

initiated enforcement action. The remaining tar pond was filled with material from the spent oxide pile and with waste rock from the adjacent quarry in response to this action to stop oily discharge to the river. Spent oxide material that was not used for fill was disposed of at the Scappose landfill.

2.2.2 KOPPERS FACILITY

Koppers leased a portion of the GASCO facility that included the main light oil and tar tank farm area and the tar processing facility. Distillation of coal tars received via rail was conducted for several years, with the approximately 1,500 gallons per day of wastewater being land treated on site. This facility currently serves as a terminal for distribution of creosote oils for wood treating. Koppers records indicate that only creosotic and tar materials have been handled at this facility.

2.2.3 WACKER-SILTRONICS FACILITY

The Walker facility is constructed on fill material consisting of Port of Portland dredge spoils and waste rock from the adjacent quarry. Construction of the Wacker plant began in 1978, and the plant began operating in 1980. This facility manufactures silicon wafers that are used in semiconductor manufacturing. One small-volume TCE spill has been reported on the site but was remediated by soil removal. Site investigations were conducted for a proposed plant expansion that indicated the presence of tar-related hydrocarbons and other contaminants that may be related to upgradient facilities in both ground water and subsurface soils. It is unknown if this contamination is related to river dredge materials or to fill with tar contaminated soils. Excavations at the site during construction also indicated the presence of refractory brick that suggests some rubble or waste material originating on the adjacent gasification facility may have been used for fill.

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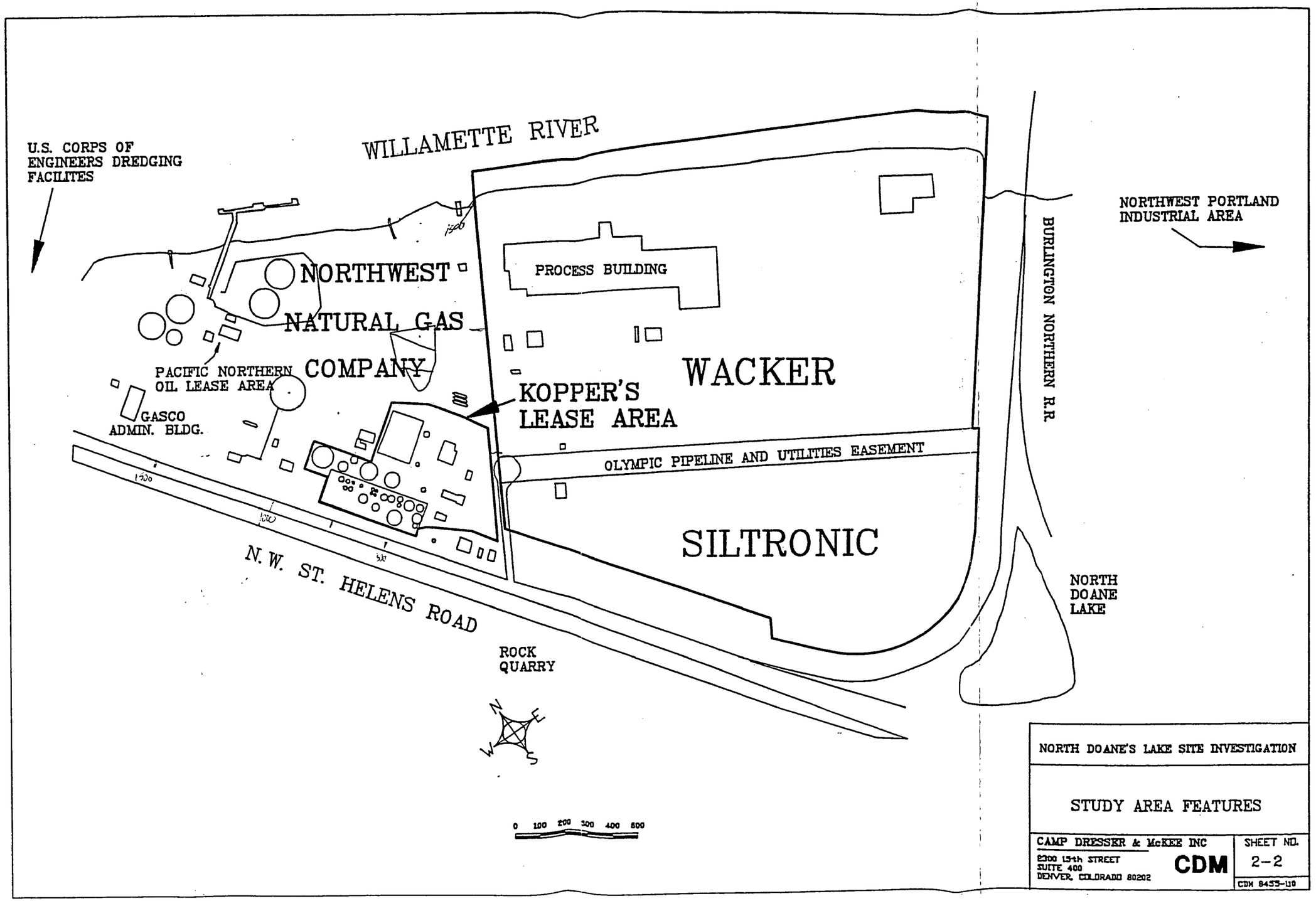
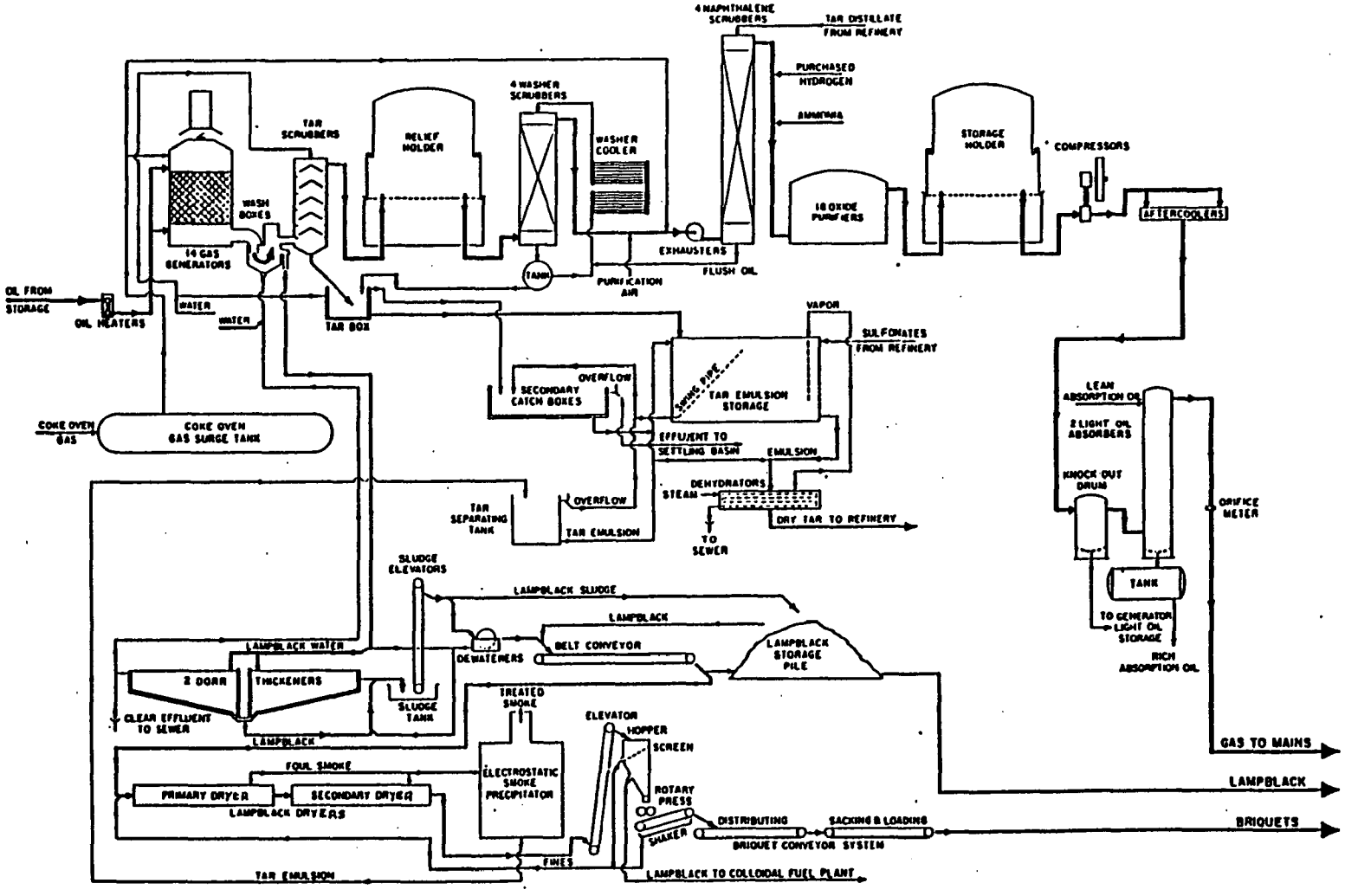
TABLE 2-1

PORTLAND GAS AND COKE PLANT HISTORY SUMMARY

1913	Plant construction completed and production of 570 Btu town gas and pressed lampblack briquettes initiated. Aromatics and tars not recovered. Waste discharge directly to river included all waste water and tars not usable as fuel.
1923	Gassification process modified to optimize aromatic generation. Light oil recovery and refining units placed in operation.
1925	Tar recovery and refining units built and placed in operation for production of road binder. Significant discharge of tars in waste water probable since no emulsion breaking agents used.
1935	Plant modified to use high carbon feedstock.
1941	Coke over installed to produce high Btu gas and electrode grade coke. Settling ponds constructed to treat waste water discharge.
1947	Plant capacity increased. Electrode pitch process line added.
1956	Plant production ceased.



Koppers022296



Source: Hull and Kohlhoff (1952)

Figure 2-6 Flow Sheet - Generator Gas Production

CDM

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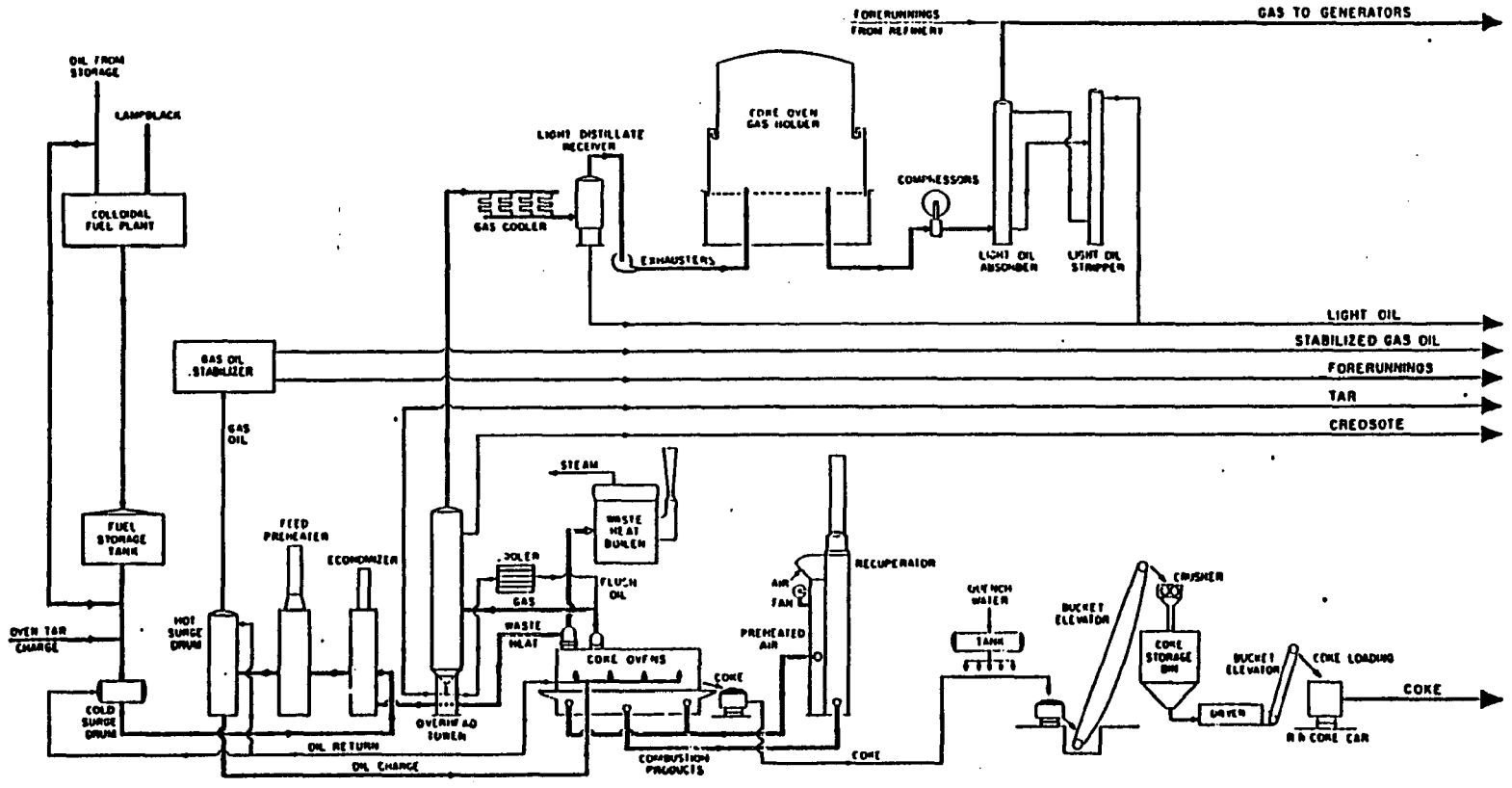
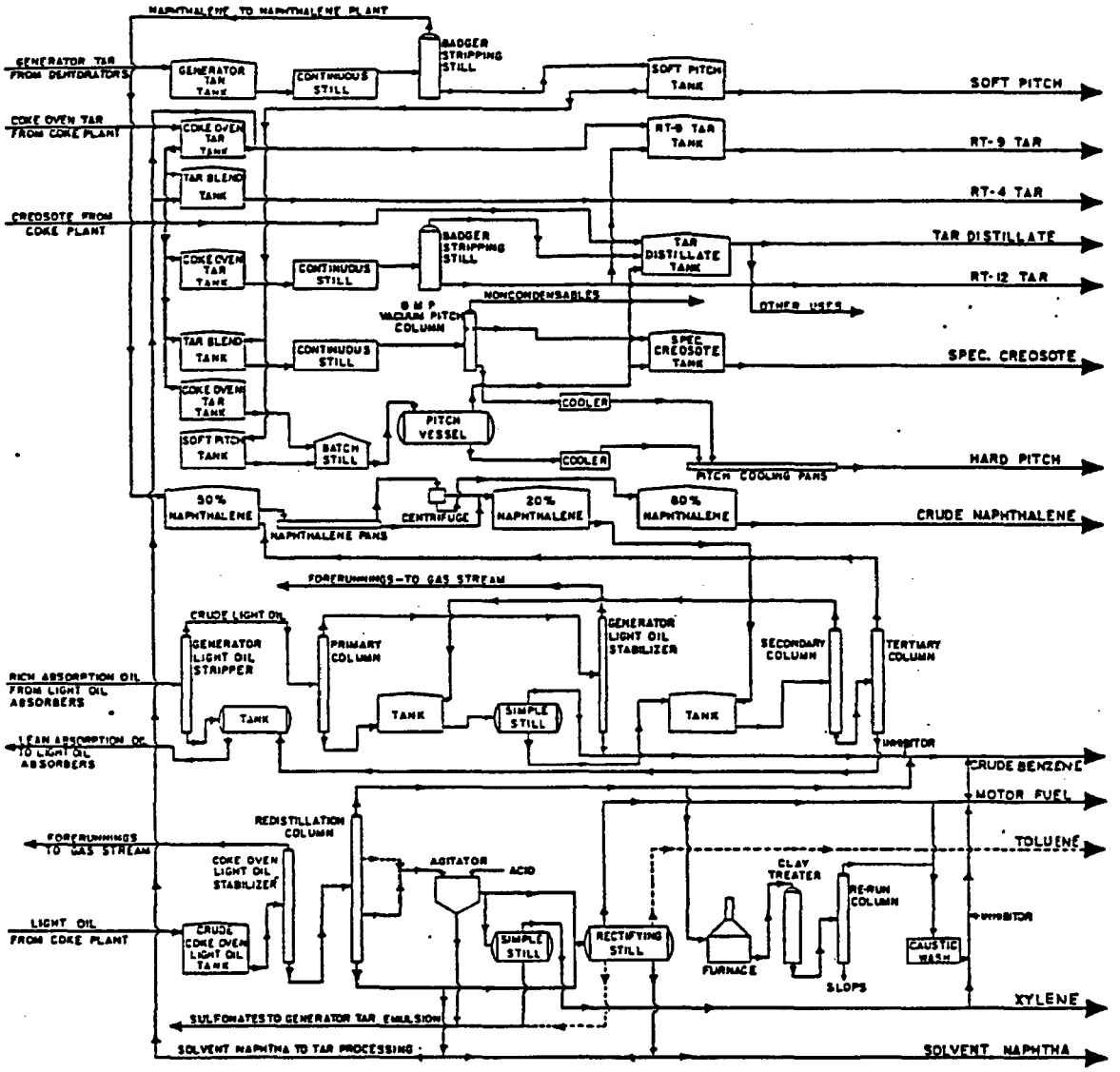


Source: Hull and Kohlhoff (1952)

Figure 2-7 Flow Sheet – Coke Oven Gas Production

CDM

Koppers022298



Source: Hull and Kohlhoff (1952)

Figure 2-8 Flow Sheet - By-Products Refining

CDM

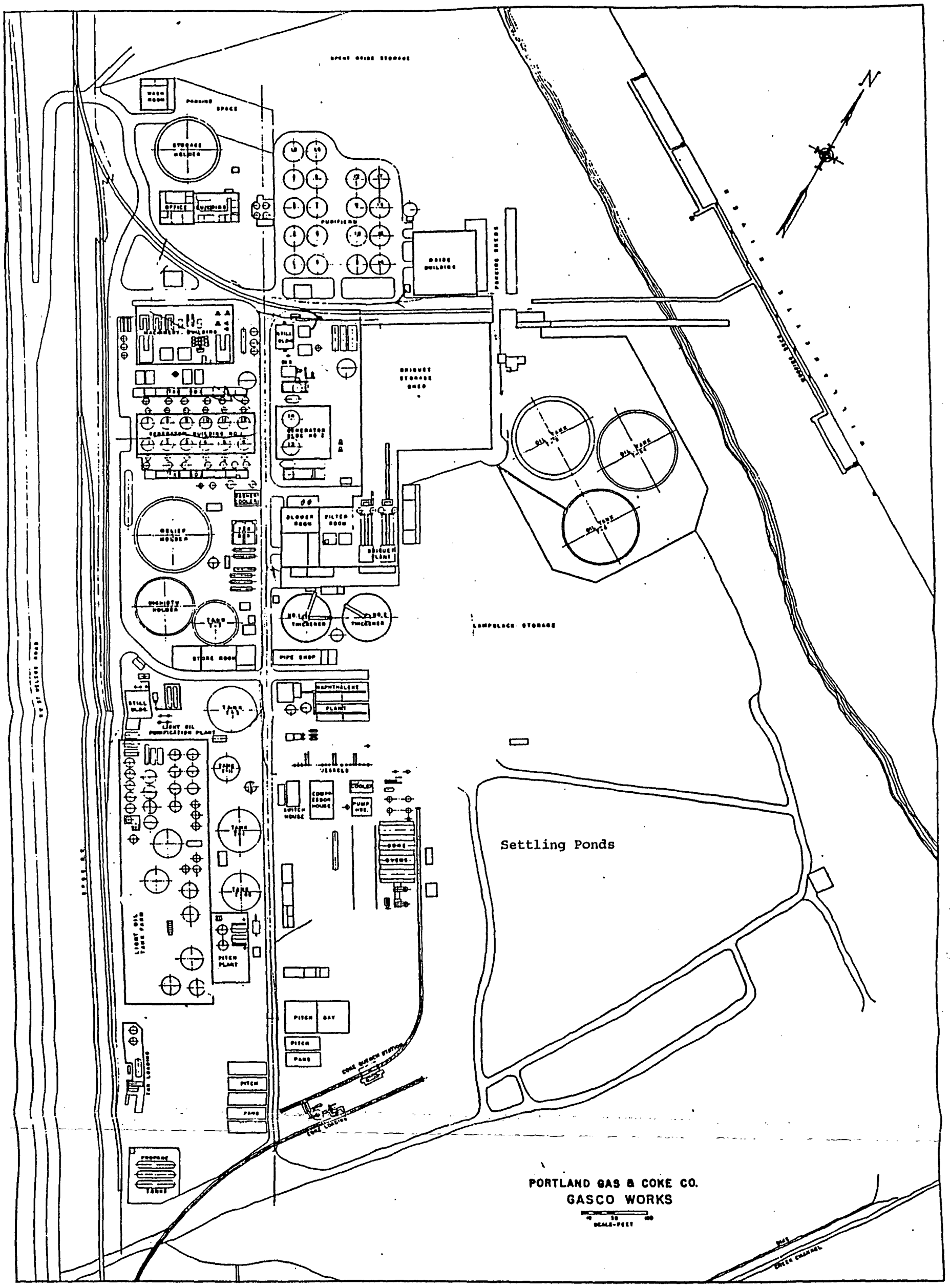
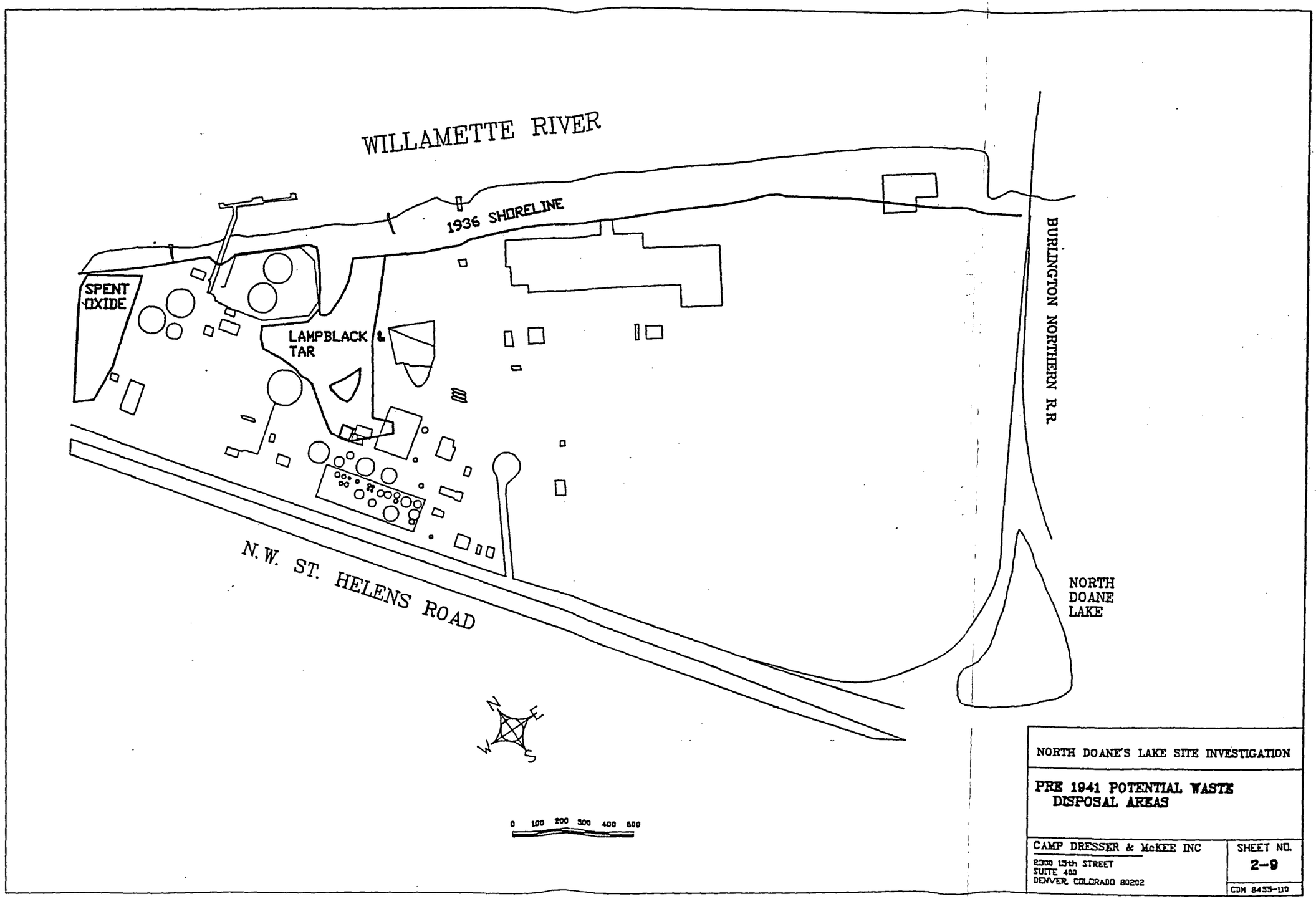


FIGURE 2-10: Plant Layout at Closure



NORTH DOANE'S LAKE SITE INVESTIGATION

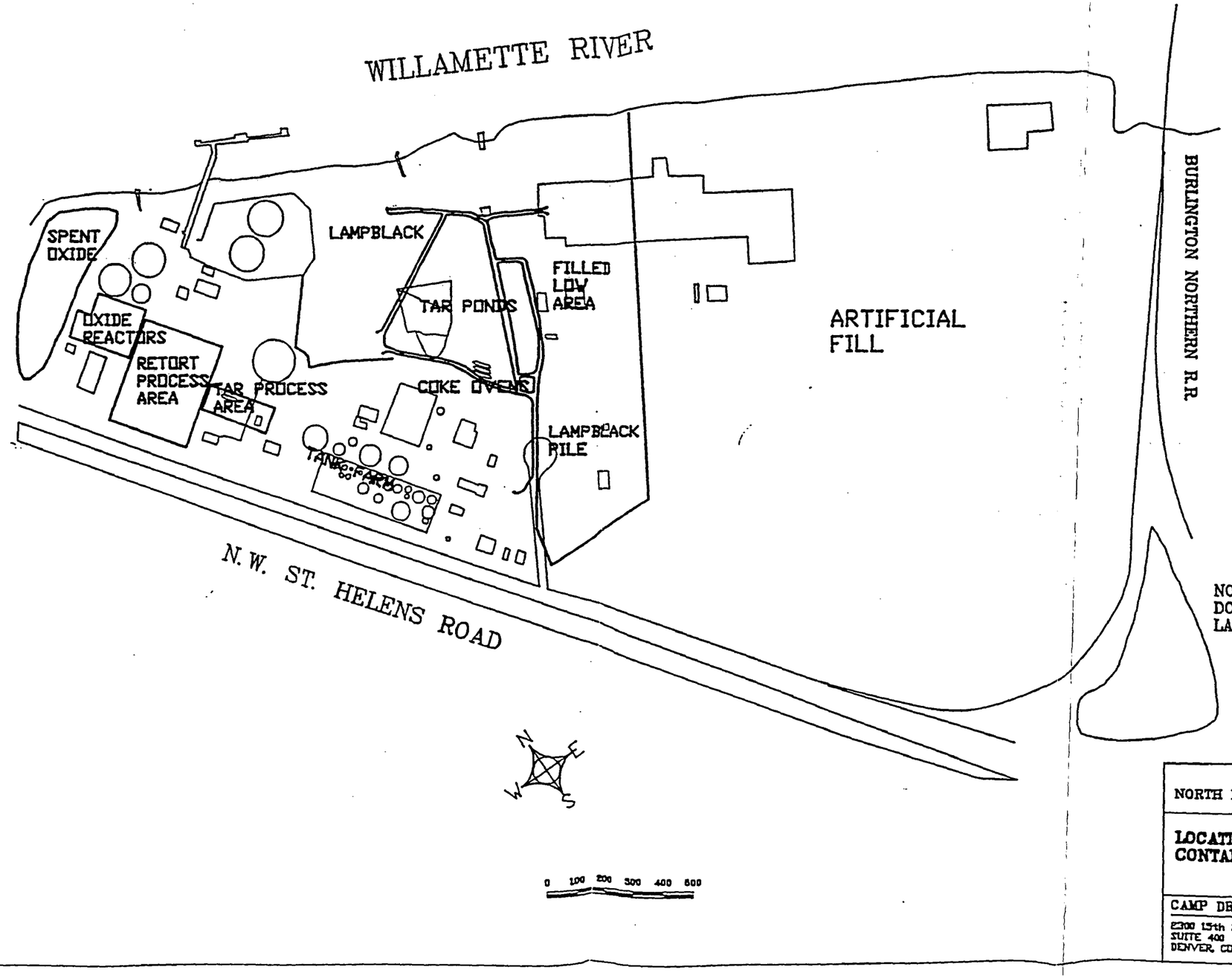
PRE 1941 POTENTIAL WASTE DISPOSAL AREAS

CAMP DRESSER & McKEE INC
2300 15th STREET
SUITE 400
DENVER, COLORADO 80202

SHEET NO. 2-9

CDM 8435-110

Koppers022301



NORTH DOANE'S LAKE SITE INVESTIGATION

LOCATION OF POTENTIALLY CONTAMINATED AREAS

CAMP DRESSER & McKEE INC
2300 15th STREET
SUITE 400
DENVER, COLORADO 80202

SHEET NO. 2-11

CDM 8433-110

Koppers022302

APPENDIX B

Oregon Department of Environmental Quality File Summary Review Memo
Dated April 20, 1994

Koppers022303

Oregon

DEPARTMENT OF ENVIRONMENTAL QUALITY

NORTHWEST REGION

April 21, 1994

Ms. Sandra Hart
Senior Engineer
Northwest Natural Gas Company
220 N.W. Second Avenue
Portland, OR 97209

Re: Voluntary Cleanup Letter Agreement for Northwest Natural Gas Company - GASCO Site

Dear Ms. Hart:

Enclosed is a copy of the file review summary memo prepared for the former GASCO facility located at 7900 N.W. St. Helens Road in Portland, Oregon. I apologize for the delay in getting this summary prepared. It is expected that the recommendations presented in this memo will be utilized in the planning of the investigation of the former GASCO facility.

Please contact me at 229-6802 if you have any questions.

Sincerely,

Eric L. Blischke
Project Manager, Voluntary Cleanup Section
Northwest Region

EB:eb

Enclosure

cc: Mike Rosen, NWR/DEQ (w/enclosure)
Karla Urbanowicz, NWR/DEQ (w/enclosure)
Tom Roick, NWR/DEQ (w/enclosure)
Rich Sedman, NWR/DEQ (w/enclosure)
Jill Kiernan, WMCD/DEQ (w/enclosure)

2020 SW Fourth Avenue
Suite 400
Portland, OR 97201-4987
(503) 229-5263 Voice/TDD

DEQ-1

STATE OF OREGON

DEPARTMENT OF ENVIRONMENTAL QUALITY INTEROFFICE MEMORANDUM

TO: File April 20, 1994

FROM: Eric Blischke

SUBJECT: **Northwest Natural Gas - North Doane Lake**

Several documents were reviewed including DEQ Regional Office and Hazardous and Solid Waste files for the Koppers, Wacker Siltronic, Doane Lake Study Area and Northwest Natural Gas sites. A list is provided as Attachment 1.

SUMMARY OF AVAILABLE INFORMATION

Site Background

From 1913 until 1956, the Northwest Natural Gas Company (NWNG), then known as the Portland Gas and Coke Company (GASCO) operated an oil gasification plant on an approximately 120 acre parcel of land located along the west bank of the Willamette River in northwest Portland (a site location map is included as Attachment 2). NWNG currently operates a liquified natural gas (LNG) plant on 47 acres of the original parcel. The property currently owned by NWNG comprises the northern third of the original GASCO site, and includes the location of the former GASCO plant operations. The southern portion of the former GASCO facility consisting of approximately 73 acres is currently owned by Wacker Siltronics Corporation (Wacker). This portion of the property was primarily vacant during operating life of the GASCO facility. The Wacker parcel was sold by NWNG in 1962 to V. Rosenfeld and H. Anderson. In 1978, this parcel was purchased by the Portland Development Commission who in turn sold it to Wacker in August of the same year. Wacker began construction of their silicon wafer manufacturing plant in October, 1978. The plant was completed in December 1979 and operation began in March 1980. NWNG currently leases a portion of their current property to Koppers Company, Incorporated, Organic Material Division (Koppers) and Pacific Northern Oil Company (Pacific Northern). A site layout map showing the location of the Wacker property, the Pacific Northern lease area and the Koppers Lease area is included as Attachment 3.

The Portland Gas and Coke Company purchased the 120 acre parcel from Security Savings and Trust, Inc. in 1910. In 1913, the Portland Gas and Coke Company built a residual oil gasification facility on the present property owned by NWNG. A plant layout map at the time of closure (1956) is included as Attachment 4. The facility was constructed on hydraulically placed sandy fill material built up on lowland area adjacent to the Willamette River. The facility grew to be one of the largest oil-gas generation facilities in the west with a generation capacity

of 77,000,000 standard cubic feet of oil-gas and butane-air gas. The plant originally produced 570 BTU town gas and pressed lampblack briquettes. In 1923, the process was modified to optimize aromatic generation and light oil recovery for use as a motor fuel. In 1925, tar recovery and refining were initiated to provide tar for use a road binder. During the 1930's, the plant expanded and in 1941, a coking plant began production of electrode grade coke and high BTU gas. Due to the availability of natural gas, the facility was shut down in 1956. In 1958, Portland Gas and Coke became Northwest Natural Gas Company. In the late 1960's, NWNG began construction of the LNG facility which continues to operate on-site. The LNG facility consists primarily of above ground piping and a large LNG storage tank. Natural gas is received via pipeline, cooled and piped to the storage tank.

In 1966, Koppers leased a small tank farm from NWNG and built a coal tar pitch distillation plant in the southeastern portion of the leased property. In 1973, the coal tar pitch distillation plant was closed. In 1977, Koppers notified DEQ that no unprocessed coal tar remained at the site. Koppers currently operates a creosote oil distribution center at the facility. Pencil pitch, a by-product of coke production, is received in solid form. The pitch is fed into a large tank, heated to 450 F and piped into railroad cars or, less frequently, trucks for shipment. Additives, such as naphthalene, are stored on site and used to keep the liquid pitch within specifications. The loading area contains a berm and catch basin to contain potential spills. Spills are routed to a storage tank.

During the 1960's NWNG also began leasing several large storage tanks located along the Willamette River in the northwest corner of the property to Pacific Northern. Pacific Northern currently operates an oil storage, receiving and distribution facility at the site. According to representatives of NWNG, Pacific Northern primarily handles Bunker C fuel oil.

The only structures remaining from the former GASCO facility are the old office building located on the northern portion of the NWNG property, two oil storage tanks utilized by Pacific Northern, the storage tanks utilized by Koppers, concrete pads and an unknown underground structure located in the southeast portion of the site. The majority of the site has been extensively filled and regraded. With the exception of the Pacific Northern storage tanks and the Koppers facility, there is little evidence of the former GASCO plant operations. The majority of the site is vacant and is covered with either concrete pads or grasses. The site is well maintained; grasses are regularly mowed as a fire precaution. An underground fire main and the Olympic pipeline cross the site. Other, unknown, underground pipelines associated with the former GASCO facility may also be present at the site. During a 1994 site visit, a chain-link fence was being installed to prevent access to the site by boaters on the Willamette River.

The NWNG site is part of the Doane Lake Industrial area in Northwest Portland. This area includes numerous other industrial properties which have also resulted in contaminated soil and groundwater including Rhone Poulenc and the Gould Superfund site. These other properties are located south (upstream) from the NWNG property. The location of these facilities is presented in Attachment 5.

Waste Disposal Practices

Much of the information regarding waste disposal practices was obtained from the North Doane's Lake Site characterization Work Plan prepared by Camp Dresser and McKee (CDM). A brief summary is presented below.

Pre-1941 Waste Disposal Practices: From 1913 to 1923, only 570 BTU gas and lampblack briquettes were produced by the plant. Aromatic hydrocarbons and tars were not recovered during the production process and all wastewater and tars not usable as fuel were discharged directly to the Willamette River. The discharge of wastewater to the river continued until the construction of 4 sedimentation ponds in 1941. Tar present as emulsions likely settled out of the waste stream as it migrated downstream. In 1923, the process was modified to optimize aromatic generation and recover light oils for use as motor fuel. In 1925, tar recovery and refining units were installed. Wastes generated prior to 1925 included tar, wastewater containing dissolved and suspended hydrocarbons, and spent oxide generated during sulfur removal. CDM indicated that the spent oxide was disposed of along the northern border of the site while lampblack and tar were disposed of in a low area along the Willamette River. A 1936 aerial photograph depicts a large waste disposal area located adjacent to the Willamette River south of the storage tanks currently leased by Pacific Northern. After 1925 when tar recovery began, the majority of waste tar was likely contained in the wastewater stream and discharged to the river, however some land disposal of tar likely continued to occur. A pre-1941 waste disposal map is included as Attachment 6.

Sedimentation Ponds: As part of a major expansion completed in 1941, four sedimentation ponds were constructed east of the current Koppers lease area. According to the CDM work plan, extensive quantities of tar were present in the four on-site sedimentation ponds. Wastewater from the process sewers, lampblack filtration effluent and tar box were discharged to these ponds to allow tar containing emulsions to settle. Wastewater entered a series of tar separation tanks where sulfonates were added as a de-emulsifier prior to discharge to the settling ponds. The settling ponds were excavated periodically and the dredged material disposed of in low lying areas on site. The exact location of these disposal areas is unknown. The three smaller ponds located south of the larger pond were estimated to contain 700,000 gallons of dry tar. The contents of the three ponds are thought to have been blended with soil material and spread over a low lying area separating the present Wacker and NWNG properties. The largest pond was inventoried in 1971. The pond was estimated to be 2.5 acres in size and found to contain approximately 6 million gallons of tar and tar/water emulsions. The total dry tar content was estimated at 3.9 million gallons. Depth and tar thickness soundings made at that time indicated that an average of 10 feet of tar was present in the 2.5 acre pond. In 1970, the Coast Guard observed an oil slick originating from the remaining 2.5 acre pond and took enforcement action. As a result, the 2.5 acre tar pond was subsequently filled in with rubble and iron oxide waste between 1971 and 1973. The resulting tar/soil mixture was spread out over the southeastern portion of the site and covered with random fill material. It is unknown if any of this material was deposited on the Wacker property. During a 1994 site visit, two small

remnants of the ponds were observed. These ponds reportedly go dry during the dry summer months and refill during the winter. A post-1941 waste disposal map is included as Attachment 7.

Lampblack Storage Area: Lampblack was one of the products produced by the oil gasification plant for sale. Lampblack is defined in the Merck Index (1989) as amorphous carbon obtained by burning various fats, oils resins, etc. under suitable conditions. Significant quantities of lampblack were stored on site during operations and following plant closure. Primary stockpiles were located in an area bounded by the former location of the settling ponds, the bulk oil tanks currently leased by Pacific Northern Oil Company, the LNG containment basin and the Willamette River. A smaller stockpile was located along the railroad spur adjacent to the current Wacker/NWNG property boundary. Lampblack was likely entrained in the waste stream resulting in the discharge of significant quantities of lampblack to the Willamette River and sedimentation ponds. Following shutdown of the plant, accumulated lampblack was hauled to an unknown off-site disposal location. A 1994 site visit found no evidence of the former lampblack storage area. The entire area was vacant and had been extensively regraded.

Spent Oxide Storage Area: Sulfur was removed from the coal gas by adding small amounts of ammonia and air and passing the cooled gas through beds of iron oxide adsorbed on wood shavings. Iron oxide no longer capable of regeneration (spent oxide) was placed on a waste pile adjacent to the oxide reactors at the north end of the NWNG property. At the time of plant closure, it is estimated that 41,000 cubic yards spent oxide was stockpiled on site. Due to the presence of nitrogen in the coal gas and the addition of ammonia during the removal process, oxide wastes may be contaminated with cyanide. However, due to the low nitrogen content in the coal gas and the low ammonia feed rate, the potential for the presence of elevated cyanide concentrations was estimated by CDM as low. In addition, hydrogen sulfide may also be present in the spent oxide. As previously mentioned, the spent oxide material was utilized as fill material for the large tar pond. Spent oxide material not utilized as fill was reportedly disposed of at the Scappose landfill. A 1994 site visit found no evidence of the spent oxide storage area. As with the former lampblack storage area, the spent oxide storage area was vacant and had been extensively regraded.

Koppers Land Treatment Area: During operation, the Koppers coal tar distillation facility generated approximately 1500 gallons of wastewater per day. The wastewater was reportedly land treated on site. This material is thought to have been treated and disposed of in a small area located in the southeast corner of the property leased by Koppers. The location of Koppers' waste disposal area is presented in Attachment 8.

Other wastes such as plant demolition rubble, tank bottom sludges and other miscellaneous wastes may have been disposed of in low lying areas on site.

Koppers022308

Investigative History

A chronological summary of environmental investigations conducted in the North Doane Lake area is provided below. Although limited analytical data has been obtained from the current NWNG site, wastes generated by the GASCO facility have likely been deposited on the Wacker property. Consequently this file review includes a summary of the Wacker site in addition to the NWNG site. It is expected that the nature of contamination detected on the Wacker property is similar to what is present at the NWNG site.

In August, 1977, three soil test borings and penetrometer probes were installed on the Wacker parcel. The sampling was conducted by CH2M Hill and submitted in a September 1977 Geotechnical and Vibration Monitoring Investigation report to Wacker prior to their purchase of the property. Each boring log had multiple references to bitumen, a generic term applied to natural inflammable substances of variable color, hardness, and volatility composed principally of a mixture of hydrocarbons.

In February 1979, DEQ personnel were called to the Wacker Siltronic facility during its construction to determine the origin of a petroleum release found on the property. An initial sample collected on March 1, 1979 from an undefined clarifier was found to contain 40 hydrocarbon components in the C_{10} to C_{22} range with a peak maximum at C_{15}. A sample of diesel fuel obtained from the Olympic Pipeline Company was also analyzed and found to match the sample collected from the clarifier. Another sample collected from an exploratory pit above the pipeline on March 12, 1979 was found to contain hydrocarbons in the C_8 to C_{19} range with a peak maximum at C_{12}. The DEQ laboratory concluded that this sample did not match the sample obtained from the Olympic Pipeline Company (Olympic). Although the above results were inconclusive, Olympic apparently determined that the pipeline had leaked and made the appropriate repairs.

In 1982, four monitoring wells of unknown origin surrounding the former Koppers land treatment area were sampled by Department of Environmental Quality (DEQ) personnel and analyzed for total phenols. Results of this sampling event detected low levels (0.13 - 34 mg/l) of total phenolic compounds. The monitoring wells were resampled by DEQ personnel in December 1984 and analyzed for semivolatile organic compounds (SVOCs). The 1984 groundwater analysis detected presence of various PAHs. Although only a semivolatile analysis was conducted, elevated levels of xylene and ethylbenzene were detected as tentatively identified compounds. No phenolic compounds were detected although three of the four samples required dilution prior to analysis. A sample location map and summary of analytical data obtained from water samples collected at the NWNG site including data obtained from the Koppers monitoring wells is provided in Attachment 9.

In September, 1984 and again in December, 1984, sediment samples were collected by DEQ personnel from the NWNG LNG containment basin. Semivolatile analysis detected 1100 and 3120 mg/kg of PAHs respectively. A sediment sample collected from the Koppers storm drain

was found to contain 3080 mg/kg of PAHs. DEQ sediment sample results are provided in Attachment 10. Aqueous samples collected from the NWNG sump pump and oil-water separator were also found to contain low levels (0.134 - 2.29 mg/l) of PAHs. These results are presented in Attachment 9.

In April 1985, CH2M Hill conducted a soil investigation at the Wacker facility. Wacker was concerned that contamination on their property would prevent or hinder the planned expansion of their facility. Seven soil borings were installed in the vicinity of a proposed polysilicon plant in western portion of the Wacker property. The borings were installed to depths ranging from 31.5 to 41.5 feet and were completed as monitoring wells. Soil samples were analyzed for oil and grease, phenols, volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs) and pesticides, herbicides and metals according to the extraction procedure - toxicity (EP-Tox) methodology.

Analysis of the soil boring samples detected the presence of chlorinated and aromatic volatiles, various phenolic compounds including pentachlorophenol and elevated concentrations of PAHs. EP-Tox analysis detected low concentrations of barium (below the regulatory threshold) and levels of 2,4-dichlorophenoxy acetic acid (2,4-D) above the regulatory threshold. Oil and grease levels ranged from 0.03% to 0.34%. A summary of these results is provided in Attachment 11.

Groundwater samples were collected from the newly installed monitoring wells in July and August 1985 as part of the investigation. Analysis detected the presence of aromatic VOCs (benzene, ethylbenzene and xylene); acetone and methylene chloride (which may represent laboratory contaminants); PAHs; cyanide and low levels of metals. United States Environmental Protection Agency (EPA) Drinking Water Maximum Contaminant Level (MCLs) were exceeded for many of the carcinogenic PAHs, benzene, lead and cyanide. A summary of these results is presented in Attachment 12.

In September 1985, two water samples were collected by DEQ personnel from seepage pits excavated on NWNG property adjacent to the Willamette River. One pit was excavated 20 yards south of the south end of the NWNG LNG dock while the other pit was excavated 10 yards north of the north end of the LNG dock. Elevated levels of PAHs were detected in each of the seep samples. The southern seep sample was found to contain 56.5 mg/l of PAHs while the northern seep sample was found to contain 6.6 mg/l of PAHs. Carcinogenic PAHs were detected in each sample. These results are presented in Attachment 9.

In 1990, Geraghty and Miller conducted a Hydrogeological Investigation of the Doane Lake Area in northwest Portland. The primary purpose of the study was to evaluate the hydrogeologic conditions in the vicinity of the Gould Superfund site, calculate the zone of influence of potential Gould remedies and asses the impact that groundwater quality in the Doane Lake area could have on potential Gould site remedies.

Koppers022310

As part of the investigation, two monitoring wells on the Wacker property were sampled. These included the existing MW-7 installed by CH2M Hill in 1985 and a newly installed intermediate depth well (MW-3I) installed adjacent to the existing MW-3. MW-3I was screened from 55 to 60 feet while the existing MW-3 was screened from 12 to 27 feet. Low levels of phenol (0.003 mg/l) and PAHs (0.215 mg/l total PAHs) were detected in MW-3I while even lower levels of contamination (.016 mg/l total PAHs) were detected in MW-7. These results are included in Attachment 12. Three of the Koppers wells were located during the investigation. However, the wells were found to be dry and were not sampled. Geraghty and Miller noted that the wells appeared to have been sealed off.

In July, 1990, two soil samples were collected from geotechnical borings installed as part of a proposed expansion by Wacker. Wacker was considering constructing an additional manufacturing building - FAB 2 - on their property. The soil samples were found to be saturated with a black oily viscous substance. Elevated levels of BTEX, styrene, chlorobenzene and PAHs were detected. Total PAH concentrations detected in the two samples were 10,000 mg/kg and 6,100 mg/kg respectively. These results are presented in Attachment 10.

In October 1990, CH2M Hill conducted a soil gas and groundwater investigation for Wacker to determine whether the Olympic pipeline was the source of subsurface hydrocarbon contamination previously detected on-site. This investigation was conducted in conjunction with Wacker's proposed expansion plans. Groundwater and soil gas samples were collected along a 600 foot length of the utility corridor adjacent to the proposed FAB 2 building site. CH2M Hill concluded that groundwater samples were more reliable than soil gas samples. Consequently, the investigation concentrated on the collection of groundwater samples with the soil gas probes. Groundwater samples were collected just below the water table at a depth of approximately 25 feet. All samples were field analyzed for BTEX and TPH. A limited number of samples were sent to a laboratory for confirmatory analysis.

The results of the investigation detected elevated levels of BTEX and TPH in groundwater. Benzene concentrations ranged from non-detect to 23.3 mg/l. TPH concentrations ranged from 0.012 to 89.1 mg/l (see Attachment 13 for a summary of the analytical results). The highest concentrations of TPH and benzene were detected at a point south of and immediately adjacent to the pipeline utility corridor. Benzene and TPH concentrations correlated with one another. CH2M Hill concluded that the concentrations of benzene detected in groundwater samples are typical of those associated with a gasoline spill or leak. They further concluded that the location of the highest detected concentrations may be an indication of source of the BTEX contamination. In addition to the BTEX contamination, the soil borings installed by CH2M Hill detected the presence of a black viscous substance thought to be associated with coal tar wastes. The visual observations of oil also correlated with the maximum BTEX and TPH concentrations. As a result, CH2M Hill was not able to ascertain the source of the BTEX contamination.

Based on the results of this investigation, Olympic pipeline excavated and pressure tested the pipeline to 250 psi. No obvious signs of contamination were observed and the pressure test was

inconclusive. An additional pressure test was conducted by Marmac in February 1991. The test resulted in a failure of the pipeline. It is unclear whether the test caused the failure of the pipeline or whether a leak was present in the pipeline prior to the test. As a result of the leak, Olympic replaced approximately 2000 feet of the pipeline in March, 1991.

In November, 1993, NWNG observed a sheen on water within the LNG containment basin. NWNG subsequently collected a sample of the water and had it analyzed for BTEX and PAHs. Benzene was detected at a concentration of 8.3 mg/l. Total carcinogenic and non-carcinogenic PAHs were detected at concentrations of 0.116 and 1.44 mg/l respectively (see Attachment 9). NWNG described this sample as representative of surface run-off from the site and groundwater recharge. During a 1994 site visit, a visible sheen was observed on groundwater entering the containment basin. Based on field observations and analytical results, it appears that significant groundwater contamination exists at the site.

Waste Characteristics

Numerous waste products were generated and disposed of on-site during the operation of the oil gasification plant. According to the CDM work plan, the wastes include tars, pitch, sludges, tank bottoms, spent oxide and lampblack. Releases of these wastes may have occurred in the vicinity of the process areas. These include the oxide reactors, tar process area and the retort process area. Geotechnical borings indicate the presence of liquid hydrocarbons at levels near saturation in the former plant process area. More significant releases of waste to the environment have occurred in the waste disposal areas. These include the tar ponds, the spent oxide pile, the filled area along the current Wacker-NWNG property boundary and the coke oven process area that were filled in the late 1930's. Additional waste products may have been disposed of on the Wacker property when it was filled in during the early 1970's.

Four samples of residual tar were collected in 1971 and analyzed for bulk tar content and physical properties. The samples were found to contain an average tar content of 69.2 % on a wet weight basis and 93.5 % on a dry weight basis. The average naphthalene content was found to be 2.2 % on a wet weight basis and 2.9% on a dry weight basis. A summary of these results is provided in attachment 14.

Analysis of soil and groundwater collected from the Wacker and NWNG properties indicated the presence of contaminants typically associated with petroleum products. These include carcinogenic and non-carcinogenic PAHs, and volatile aromatic hydrocarbons such as benzene, toluene, ethylbenzene and xylene (BTEX). Alkyl substituted benzenes, naphthalenes and phenanthrenes, not included as standard analytes, have been detected in semivolatile analyses as tentatively identified compounds (TICs). Other compounds detected include chlorinated and non-chlorinated phenols, cyanide and miscellaneous pesticides. Concentrations of metals in soil are generally low, however lead has been detected in groundwater at levels above the federal drinking water maximum contaminant level (MCL).

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PAHs, which are typically associated with residues from oil gasification plants, are the predominant contaminant at the site. Soil samples collected by CH2M Hill from soil borings installed on the Wacker Siltronics property detected PAHs at concentrations up to 10,000 mg/kg (1.0 %). PAH concentrations of greater than 1000 mg/kg were detected on NWNG property in sediments in the LNG containment basin and from the Koppers facility storm drain.

The primary PAHs detected were naphthalene, anthracene and phenanthrene. These PAHs are comprised of two and three ring aromatic structures. They are considered non-carcinogenic, relatively mobile and are expected to biologically degrade in the environment. Carcinogenic PAH concentrations were significantly below non-carcinogenic PAH concentrations. Carcinogenic PAHs include: Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and indeno(1,2,3-cd)pyrene. The maximum carcinogenic PAH concentration detected in soil samples was 600 mg/kg. Carcinogenic PAHs are typically comprised of 4,5 and 6 ring aromatic structures. In addition to being more toxic, these PAHs are also less mobile and more resistant to environmental degradation than non-carcinogenic PAHs. A summary of the physical properties of PAHs is presented in Attachment 15.

Groundwater samples collected from the Wacker property also revealed the presence of PAHs. Non-carcinogenic PAH concentrations ranged from 0.016 mg/l to 7.89 mg/l. Although each of the eight monitoring wells installed on the Wacker property contained non-carcinogenic PAHs, only three wells were found to contain detectable levels of carcinogenic PAHs. Carcinogenic PAH concentrations in these samples ranged form 0.037 to 3.08 mg/l. The highest concentrations of PAHs were detected in MW-2 on the Wacker property which is located in the central portion of the property southwest of the location of the Olympic Pipeline. A total carcinogenic PAH concentration of 0.116 mg/l was detected in the LNG containment basin. This sample is considered indicative of current groundwater conditions on the NWNG property.

Hydrogeology

Extensive characterization of the Doane Lake area was conducted by Geraghty and Miller as part of the Doane Lake Hydrogeological Study. Although this characterization included a portion of the Wacker property, it did not extend to NWNG property due to the absence of construction details for the monitoring wells installed at the Koppers site.

The geology of the Doane Lake area is comprised of five primary units. Although details regarding the thickness and/or extent of these units on the NWNG property is currently unknown, it is likely that each of the five units is present to some degree beneath the NWNG property. A summary of each unit is provided below:

Columbia River Basalt: The underlying unit in the Doane Lake area is comprised of Columbia River Basalts. The Columbia River Basalt Group is composed of multiple flows of solidified lava which erupted from volcanic fissures in eastern Washington. These fissures were active

approximately 12 to 16 million years ago. Columbia River basalts extend over much of eastern Washington and northern Oregon into what is now the Portland Basin. Columbia River basalts were encountered at depths of 47 to 101 feet below ground surface (bgs) in the Doane Lake area.

Troutdale Formation: The upper member of the Troutdale formation consisting of sandstone and cemented gravels was encountered variously above the basalt formation within the Doane lake study area. Although the Troutdale formation serves as an important aquifer in parts of the Portland area, due to its discontinuous nature, Geraghty and Miller concluded that it was not of major importance to the Doane Lake Hydrogeological Investigation. The work plan prepared by CDM does not mention the Troutdale Formation.

Catastrophic Flood Deposits: Two types of alluvial deposits are present in the Doane Lake area. These include catastrophic flood deposits from glacial Lake Missoula and Lake Bonneville and fluvial deposits resulting from the meandering Willamette River. The ancient flood deposits from Lake Missoula and Lake Bonneville resulted in erosional scouring of the Troutdale formation and the deposition of large quantities of fine grained soils comprised primarily of silts and clayey silt facies. Geraghty and Miller noted that the silt unit occurred at intermediate depths of 20 to 50 feet bgs and is thickest beneath the Wacker property. The silt unit was described as containing varying amounts of very fine-grained sand, moderately plastic clay and carbonized organic fragments. A Hydraulic conductivity for the silt unit was determined from slug testing conducted on MW-3I on the Wacker site and calculated as 3.22×10^{-5} cm/sec. This result indicates that the silt unit on the NWNG site is not highly conductive.

Willamette River Deposits: The Willamette river deposits were described by Geraghty and Miller as a sand unit composed of sand and silty sand facies. The sand unit was encountered at shallow to intermediate depths of 8 to 25 feet bgs. The sand and silty sand facies were found to contain very fine to medium sized sand grains, some mica flakes and organic fragments. Hydraulic conductivity values calculated from slug test data obtained from the sand unit range from 8.36×10^{-5} to 8.59×10^{-4} cm/sec. Since the sand unit is likely the result of deposition by the Willamette River, it is important to note that an aerial photograph from 1936 shows a distinct meander which stretches from the southeast corner of the NWNG property, across much of the Wacker property and back east towards the railroad bridge.

Fill Material: The uppermost unit present in the Doane Lake area is comprised of fill material. The exact depth of the fill material at the site cannot always be determined because the dredge material is similar to the natural sediments. The thickness of the fill material in the Doane Lake area was estimated by Geraghty and Miller as 10 to 20 feet in most places. Although no lithological data is available for NWNG property, it is likely that fill material of a similar thickness is present at the site. Low lying areas present at the site have typically been filled in. This includes the low lying area in the southeast corner of the site which is the former location of the sedimentation basins and the former location of the lampblack disposal area in the central portion of the site adjacent to the Willamette River. The Wacker site has been extensively filled

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in. The purchasers of the property from NWNG agreed to fill the site to a minimum elevation of 30 feet by the end of 1973 and construct industrial buildings by the end of 1978. The site was filled with dredge material from the Port of Portland and material from the adjacent rock quarry. Port of Portland records indicate that 695,000 cubic yards of dredge material was placed on the site in 1974. Total fill was estimated at 1.5 million cubic yards. A 1974 aerial photo shows the Wacker property almost completely filled in. As described in other sections of this memo, fill material included rubble from the rock quarry located across St. Helens Road, dredged material from the Port of portland and spent oxide. Rubble for the demolition of the former GASCO facility as well as waste from the tar ponds may also have been used as fill material.

Relevant cross-sections, fence diagrams and contour maps of various units found in the Doane Lake area is provided in Attachment 16.

Groundwater: Two principal underground water-bearing zones are present in the study area, an upper alluvial aquifer in the flood and river deposits and a lower confined aquifer zone in the underlying Columbia River basalt. The alluvial aquifer is recharged primarily by direct infiltration of precipitation and discharge from the basalt aquifer. Monitoring wells indicate a general groundwater flow north-northeast towards the Willamette River under varying horizontal gradients. Deviations from the general flow direction and gradient consistently occur near the West Doane Lake remnant located adjacent to the Wacker property in the triangle formed by the Burlington Northern Railroad tracks.

Monitoring wells on the Wacker Property indicate a water table between two and fifteen feet bgs with a flow direction towards the western remnant of Doane Lake. Water level fluctuations in these wells of five to ten feet have been observed and appear to be related to the water stage of the Willamette River. Surface water levels respond more quickly to recharge events than groundwater levels. In addition, Doane lake elevations do not respond as quickly as the Willamette River. Groundwater at the site is likely directly connected to the Willamette River, consequently shallow contamination migrating through groundwater is expected to enter the river. This is confirmed by the detection of contaminants in the two seepage pits excavated adjacent to the Willamette River and the LNG containment basin. Although the alluvial aquifer is unconfined, the presence of river deposited clays may result in confined conditions in some locations. In addition, these clay lenses may inhibit the downward migration of contaminants.

Groundwater in the underlying Columbia River basalt exists primarily as isolated confined aquifers in the permeable fracture zones between individual basalt flows. Recharge to the basalt aquifer is largely from direct infiltration of precipitation. Flow is expected to be to the northeast. Discharge to the alluvial aquifer likely takes place.

As part of the Doane Lake Hydrogeological Investigation, numerous aquifer tests were conducted including slug tests, pump tests and a capture zone analysis. This information is well summarized in the Geraghty and Miller report and will not be addressed in this document.

Exposure Pathways

The majority of contamination resulting from operations at the former GASCO facility lies beneath approximately 10 feet of fill material and is in direct contact with groundwater. Based on borings installed on the adjacent Wacker property, an black, viscous, oily substance is present on top of the water table. In addition, analysis of groundwater samples have detected the presence of elevated levels of PAHs and aromatic VOCs as described above. However, groundwater in the vicinity of the NWNG site is not used for domestic drinking water purposes. The Geraghty and Miller hydrogeologic investigation describes the overall quality of groundwater in the West Portland business district as of naturally low quality (Brown, 1963). The majority of wells in the area have naturally elevated levels of calcium, magnesium and sodium. In addition, contamination originating from neighboring sites further impacts the overall quality of the shallow aquifer.

Due to the lack of groundwater receptors and the depth of the contaminated material, human heath exposures due to groundwater ingestion or direct contact with contaminated soils is expected to be low. The primary human health exposure pathway is via the Willamette River. Contaminants entering the Willamette River from the site may impact recreational users of the river such as water skiers or fishermen.

The primary impact from the site is through environmental exposure pathways. In the early years of its operation, the GASCO facility discharged waste water directly to the Willamette River. As described previously, this waste water likely contained elevated levels of tars and lampblack. Following the construction of the sedimentation basins, more soluble components of the waste stream such as aromatic VOCs and two and three ring PAHs have likely seeped into the river. This seepage likely continues to occur. Periodic flooding along the river also likely resulted in releases to the Willamette River. Contamination entering the river likely impacts fish and wildlife which use the river as habitat. It should be noted that Sauvie Island, prime waterfowl and bird habitat is located only a short distance downstream.

Under future site conditions, excavation activities may result in worker exposure to contaminants. Workers may become exposed to contaminants during the excavation activities themselves or following excavation activities if contaminated soil is brought to the surface. Exposures to on-site groundwater may also occur under future use scenarios. Process water obtained from the upper aquifer could result in inhalation exposures for workers at a future manufacturing facility at the site. In addition, groundwater at the site could also be used to provide drinking water to on-site workers resulting in additional exposure.

Regulatory History

In 1987, a Preliminary Assessment (PA) was prepared by Ecology and Environment (E&E) for the EPA on the Koppers Company site. Although the PA recommended no further action under the EPA pre-remedial action program, it did recommend that the site continue to be addressed

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as part of the Doane Lake investigation. The PA concluded that the Koppers site has a low potential to cause human health problems since residual contaminants present at the Koppers site are unlikely to influence the local drinking water source or air quality. However, the PA noted the potential for environmental damage through surface and subsurface migration of contaminants to the Willamette River. EPA has not conducted a PA for the Northwest Natural Gas site.

A PA was also completed on the Wacker site for EPA by E&E in 1987. Although the PA agreed with DEQ's recommendation that a comprehensive study is needed to characterize the extent of contamination at the Wacker Siltronic site and North Doane Lake area, it did not recommend further action under the EPA's pre-remedial program due to the lack of human receptors.

In November, 1988, DEQ notified Wacker that they had been identified as an owner/operator with regard to the Gould Superfund site. In a March 24, 1989 response to this notification, Wacker claimed they had no legal responsibility to pay for any remedial action costs pertaining to their property. This claim was based on the premise that Wacker had no knowledge or reason to suspect the existence of contamination on their property. However, based on a review conducted by DEQ and the Department of Justice, DEQ determined that Wacker did "not appear to have undertaken all appropriate inquiry into the previous ownership and uses of the property it purchased, as necessary to satisfy the so-called "innocent landowner provision" of ORS 466.567 (1) (b) and (2) (b) as described in ORS 466.567." This finding was based in part on the observance of "bitumen" in three soil borings installed on the Wacker property in August, 1977, and was presented in a letter from Fred Hansen dated January 22, 1990.

In September, 1993, a DEQ strategy recommendation prepared for the NWNG site was sent to NWNG, Wacker, Koppers and Pacific Northern. A DEQ strategy recommendation was also prepared for the Wacker site. Based on a review of available information, DEQ determined that further action was required at both the Wacker and NWNG sites. The letter and strategy recommendation prepared for the NWNG site recommended characterization of the extent of soil and groundwater contamination caused by disposal of coal tars by Portland Gas and Coke Company. DEQ anticipated that the investigation would involve sampling on the Wacker property as well as property leased to Koppers and Pacific Northern. The strategy recommendation noted that although there was extensive contamination on the NWNG property, it did not present an immediate threat to human health. The NWNG site was also recommended for listing on the DEQ Confirmed Release List (CRL) and Inventory of sites requiring further action. The site was given a high priority.

The letter and strategy recommendation prepared for the Wacker site also recommended further action and indicated that although sampling would focus on the NWNG site, the Wacker property would require sampling. DEQ noted that the majority of the contamination on the Wacker property resulted from the disposal of coal tars by Portland Gas and Coke Company and recommended that NWNG should lead the investigation and cleanup. DEQ also recommended

that further actions at Wacker be coordinated with NWNG and that the investigation and cleanup of coal tar contamination on the NWNG site should include contamination on the Wacker property.

A separate letter was also sent to Koppers along with the strategy recommendation prepared for the NWNG site. DEQ noted that in addition to coal tars deposited by Portland Gas and Coke Company, a disposal pit containing creosote and pitch from Koppers' operations was present and required further investigation.

RCRA Considerations

Portland Gas and Coke Company ceased operations in 1956. All waste disposal operations occurred prior to that date. NWNG is not currently listed as a generator of hazardous waste. It does not appear that any unregulated solid waste management units have been created by NWNG since 1980.

Koppers Company ceased their disposal operations in 1973 and no longer generates hazardous waste. A letter sent to Koppers in 1984 by the EPA stated that they have no reason to believe that Koppers ever stored, generated or disposed of hazardous waste on the Koppers property. As a result neither a Part A nor Part B permit was required by EPA. Koppers is currently classified as a small quantity generator of hazardous waste. No unregulated solid waste management units are known to have been created since 1980.

Although Wacker is classified as a large quantity generator of hazardous waste and generates hazardous waste from a wastewater treatment plant, these operations are not expected to impact the investigation of contamination resulting from operations at the former GASCO facility.

Investigative and/or cleanup activities may generate significant quantities of contaminated material. This material will be subject to analytical testing to determine if it meets the definition of a Resource Conservation and Recovery Act (RCRA) hazardous waste. If RCRA hazardous wastes are generated during site activities, they must be managed appropriately.

DATA GAPS AND RECOMMENDATIONS

Data Gaps

Despite the presence of four monitoring wells located on the Koppers portion of the site, groundwater at the site has not been adequately characterized. These monitoring wells represent only a small portion of the 47 acre NWNG site. In addition, the construction details for these wells are unknown and, due to their age, likely do not conform to current standards. Although representatives of Koppers indicate that the monitoring wells are still viable, Geraghty and Miller was unable to collect groundwater samples and suggested the wells had been sealed off.

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Groundwater seepage samples are also inadequate to characterize groundwater conditions at the site.

Based on a review of operations and waste disposal practices at the former GASCO facility, it is likely that significant subsurface soil contamination exists at the NWNG site. This is confirmed in part by the elevated levels of PAHs and BTEX detected in soil borings installed on the adjacent Wacker property. However, no subsurface soil data has been collected to date from the NWNG site.

During the early years of operation, wastes from the GASCO facility were routinely discharged to the Willamette River. In addition, contamination from the site may still be entering the river due to groundwater discharge. However, no surface water or sediment samples have been collected from the Willamette River.

During the operation of the Portland Coke and Gas Company, large quantities of waste were generated and disposed of on-site. Although the location of most of the disposal areas are known, filling operations that took place at the NWNG site and adjacent Wacker site likely resulted in the transfer of waste material to unknown locations.

Summary and Recommendations

Based on the limited data presented in this memo, significant groundwater and subsurface soil contamination is likely present at the NWNG site. Four groundwater samples collected from monitoring wells located on the Koppers site detected elevated concentrations of PAHs and ethylbenzene above risk-based drinking water standards. In addition, water samples collected from two seepage pits excavated on NWNG property along the Willamette River detected the presence of PAHs and petroleum hydrocarbons. This indicates that contaminants from the NWNG site are likely entering the Willamette River. A recent water sample collected from the LNG containment basin detected concentrations of carcinogenic PAHs, naphthalene, toluene and benzene above health based standards.

Soil borings installed on the adjacent Wacker site detected the presence of a black oily viscous substance floating on the water table. Since it is likely that waste from the former GASCO facility are present on the Wacker property, similar conditions are expected to exist on the NWNG site. Consequently, the investigation should include an evaluation of the extent of non-aqueous phase liquid (NAPL) contamination.

Due to the large size of the NWNG site (47 acres) and the large volume of waste generated and disposed of on-site by the former GASCO facility, a comprehensive remedial investigation and feasibility study is required for the NWNG site. A thorough background review and comprehensive effort to locate all waste disposal areas should occur as an initial step in the overall investigation in order to focus the sampling effort. The investigation should focus primarily on contaminants typically associated with oil gasification facilities such as volatile

aromatic hydrocarbons, petroleum hydrocarbons and PAHs. In addition, due to the presence of lead in groundwater above the MCL and the potential for cyanide and hydrogen sulfide formation during sulfur removal, the investigation should also focus on inorganic contaminants such as metals, cyanide and hydrogen sulfide.

With the exception of the Koppers facility and abandoned GASCO office building, little evidence of the former GASCO facility exists on-site. The majority of the site has been extensively filled and regraded. During a 1994 site visit, no visible evidence of surface contamination was apparent. As a result, the investigation should focus primarily on subsurface soil and groundwater contamination. In addition, since wastes were routinely discharged to the Willamette River and since subsurface contamination may continue to impact the river, the investigation should include an assessment of its overall impact (past and current) on the river.

DEQ believes that the investigation should also include property owned by NWNG and leased to Pacific Northern and Koppers. However, since Koppers disposed of creosote and coal tar pitch in on-site ponds, it may be difficult to determine which contamination can be attributed to the former GASCO facility and which is a result of operations at the Koppers facility. Consequently, it is recommended that Koppers participate in the investigation and cleanup of their facility. Although Koppers Industries was founded in December, 1988, as stated in their response to DEQ's September 1993 letter, they are still considered liable for contamination caused by their predecessor Koppers Company.

DEQ believes contamination from the former GASCO site is likely present on the Wacker facility, Consequently, remedial actions selected for the NWNG site may be ineffective if contamination present on the Wacker site is not included in the overall remediation scheme. As a result, DEQ also encourages NWNG to work with Wacker to resolve issues regarding contamination on the Wacker property. Although Wacker does not consider itself liable for pre-existing contamination under the innocent landowner provision (ORS 465.255 (2)(a)), DEQ has determined that Wacker should have reasonably known of the release at the time of purchase and is consequently liable for previous contamination at the Wacker site.

Due to size of the investigation required and the length of time it may take, it is recommended that NWNG enter an RI/FS Agreement with DEQ as soon as practicable.

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Attachment 1
(In Chronological Order)

1) Date Unknown - Summary of Koppers Company, Inc. data prepared by DEQ

2) Date Unknown - North Doane Lake Site History Summary prepared by DEQ

3) 9/77 - Preliminary and Supplemental Site Investigation Report prepared by CH2M Hill

4) 2/12/79 - Memo from DEQ regarding Wacker oil release

5) 3/7/79 - Memo from Wayne Hanson, CH2M Hill regarding Wacker oil release.

6) 2/8/80 - Memo from Fred Bromfeld, DEQ, regarding Doane Lake Study

7) 8/2/84 - Letter from NWNG to Charles Gray, DEQ.

8) 6/85 - Preliminary Report - Soil Investigation for Proposed Polysilicon plant. Prepared for Wacker Siltronics by CH2M Hill

9) 6/19/85 - Memo from Fred Hansen to Governor Vic Atiyeh regarding the history of the Doane Lake Industrial district.

10) 6/24/85 - Oregonian Article regarding proposed Wacker Siltronics expansion.

11) 8/6/86 - Memo from Neil Mullane, DEQ regarding Northern Doane Lake investigation strategy.

12) 6/87 - North Doane Lake Site Characterization Work Plan prepared by Camp Dresser and McKee.

13) 10/87 - Preliminary Assessment report for the Wacker Siltronics site. Prepared for EPA by Ecology and Environment.

14) 10/87 - Preliminary Assessment report for the Koppers site. Prepared for EPA by Ecology and Environment.

15) 7/20/88 - PRP 104(e) Response Records Compilation - Final Report, Doane Lake Area. Prepared for EPA by Ecology and Environment.

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16) 3/24/89 - Letter to Fred Hansen from James H. DiSorbo, President, Wacker Siltronics Corporation.

17) 6/9/89 - Memo to Fred Hansen regarding Wacker Siltronics past practices.

18) 6/18/89 - Memo to Fred Hansen regarding Wacker Siltronics past practices.

19) 8/15/89 - Memo to Larry Edelman, Oregon Department of Justice, from Rick Malin, DEQ regarding Doane Lake.

20) 11/6/89 - Telephone memo documenting conversation between Sarah Anderson of DEQ and Larry Edelman, DOJ regarding Wacker innocent landowner defence.

21) 12/14/89 - Memo to Governor Neil Goldschmidt from Fred Hansen regarding Wacker legal liabilities.

22) 1/22/90 - Letter from Fred Hansen to James DiSorbo, President, Wacker Siltronics Corporation.

23) 12/90 - Findings Report - Groundwater and Soil Gas Investigation. Prepared by CH2M Hill for Wacker Siltronics Corporation.

23) 2/91 - Hydrogeological Investigation of Doane Lake Area - prepared by Geraghty and Miller

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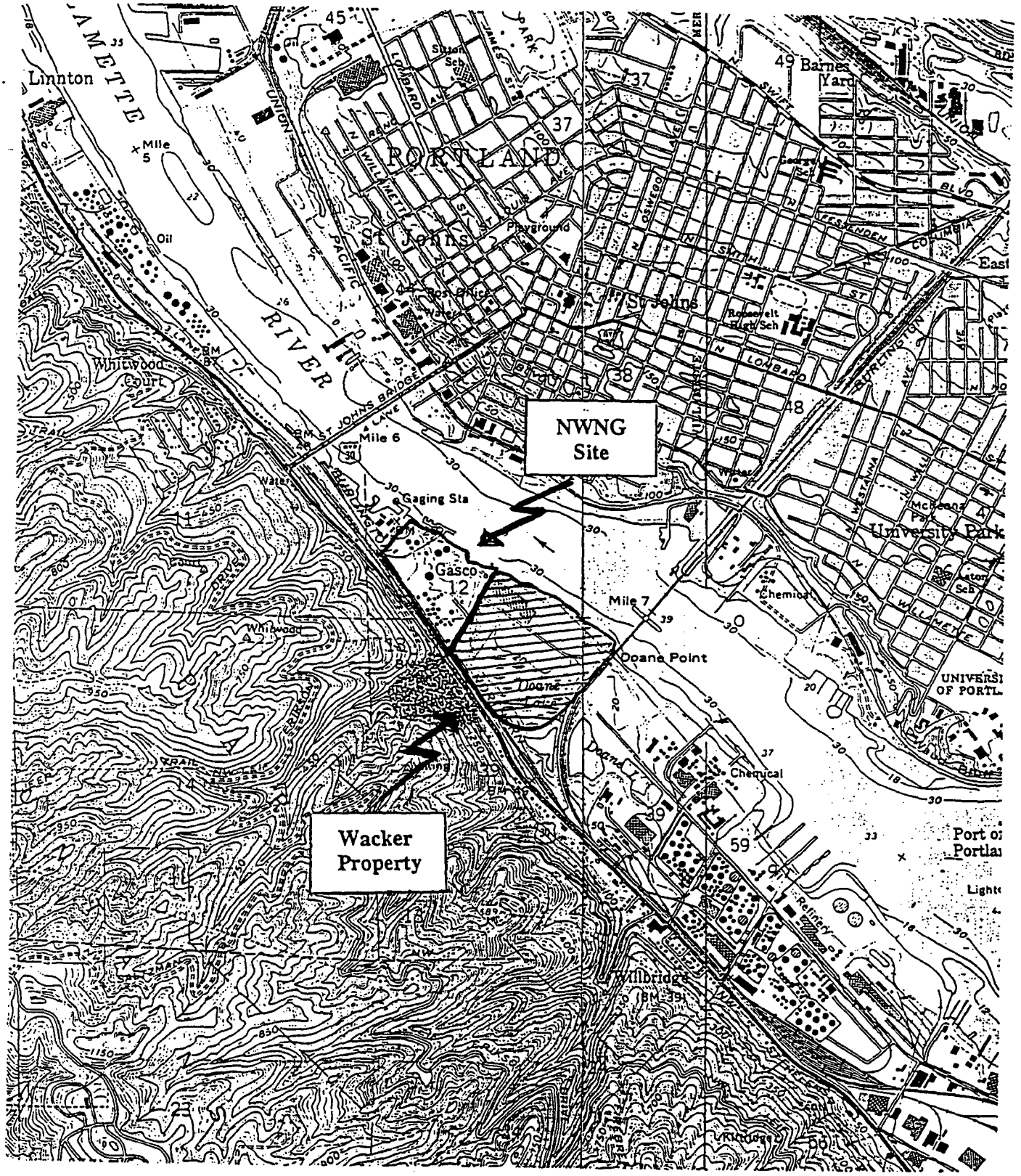
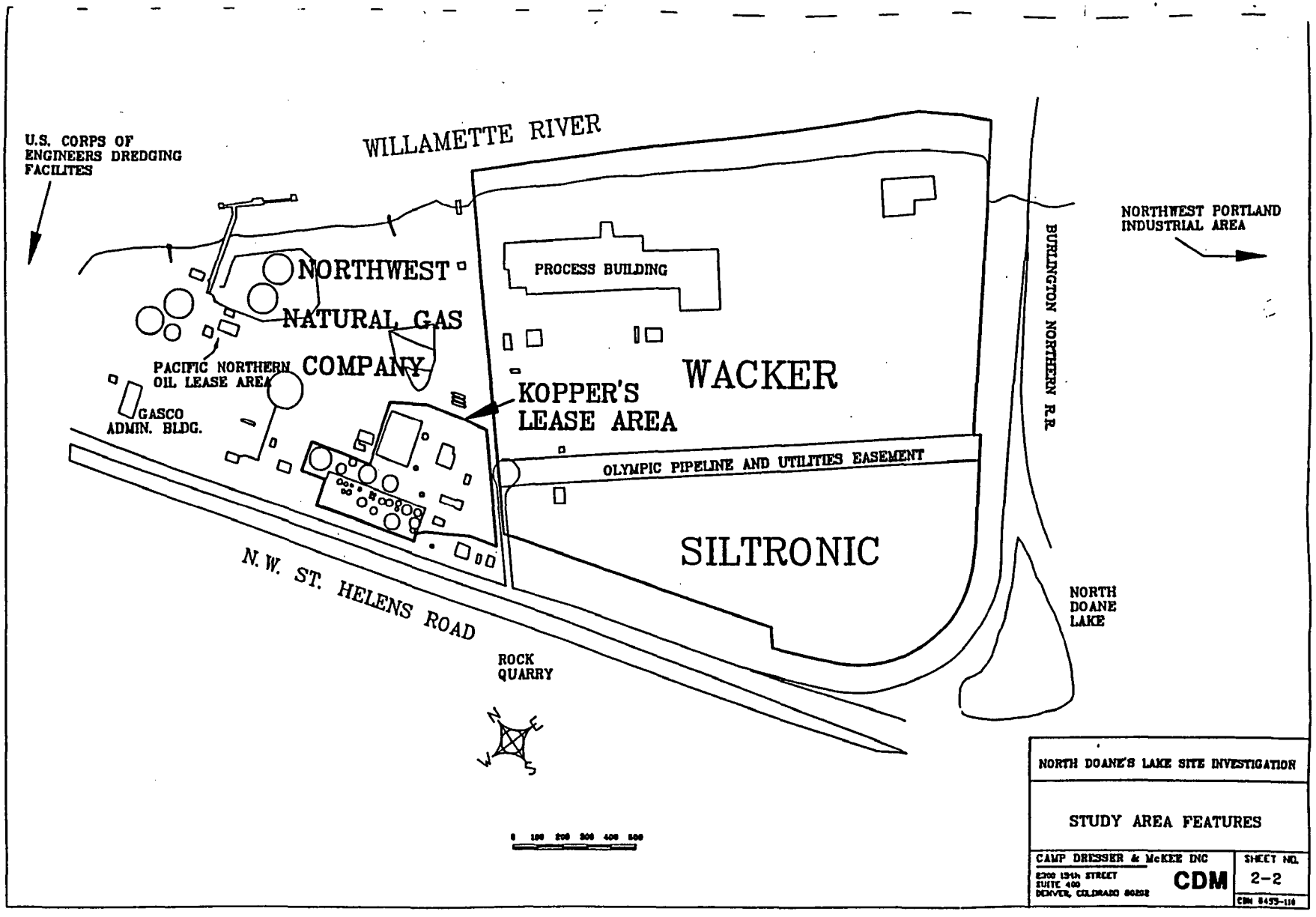
ATTACHMENT 2

SITE LOCATION MAP


NWNG
Site
Wacker
Property
Linnton
Mile 5
Oil
Whitwood Court
Mile 6
Gaging Sta
Gasco
Mile 7
Doane Point
Chemical
Willbridge
PORTLAND
St Johns
Barnes Yard
University Park
Port of Portland
Refinery

ATTACHMENT 3

SITE LAYOUT MAP



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ATTACHMENT 4

GASCO PLANT LAYOUT MAP

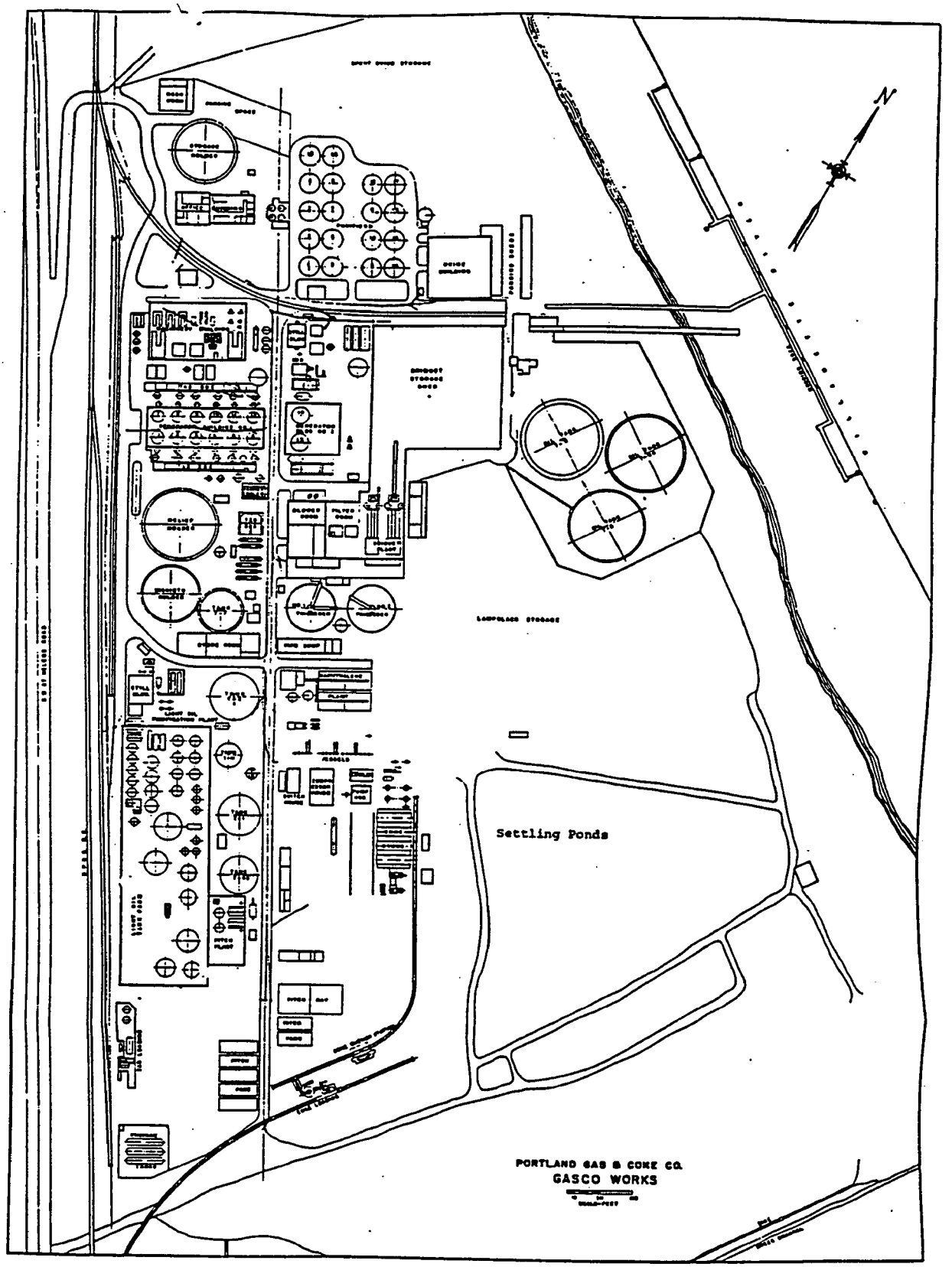
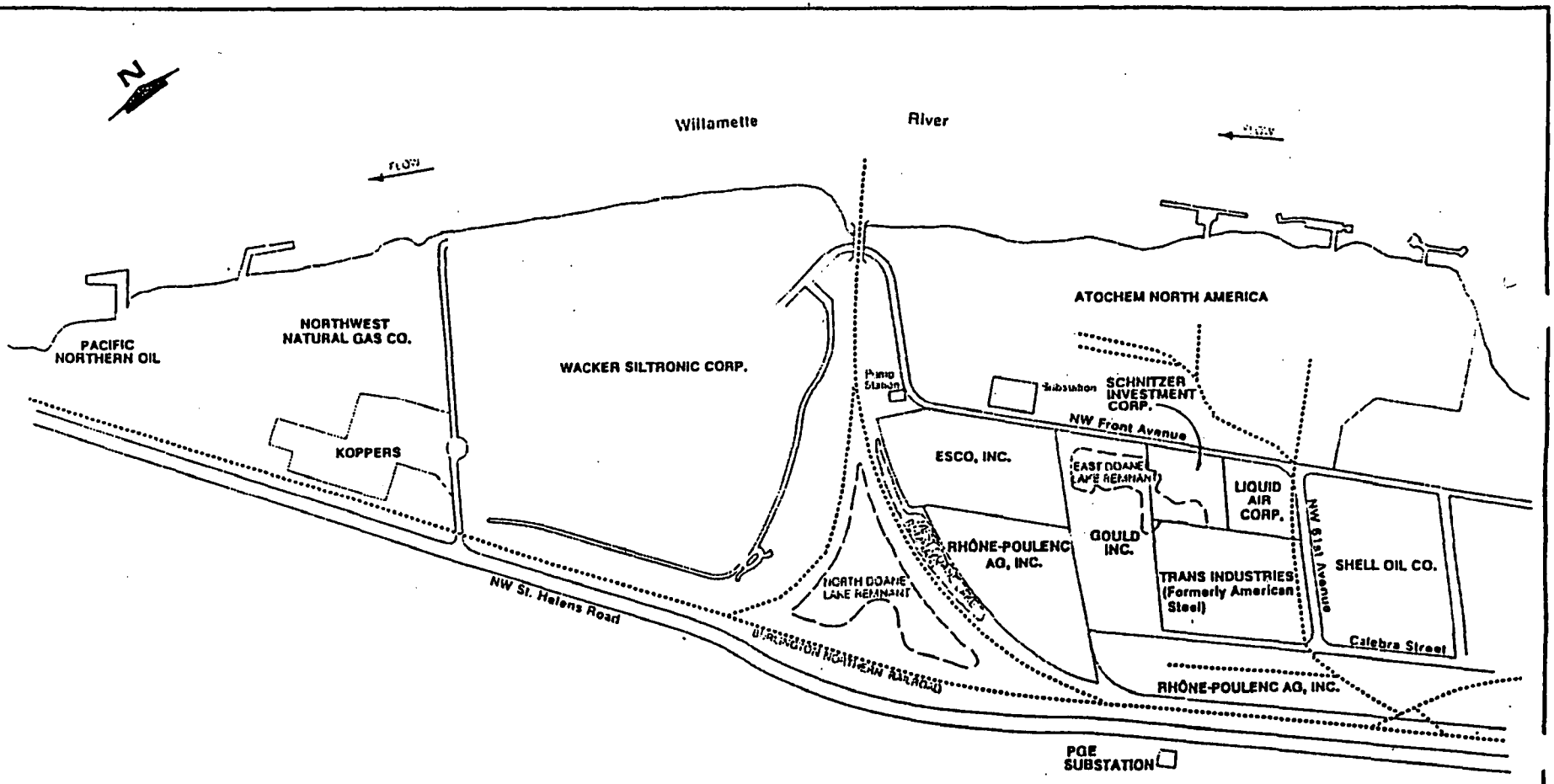


FIGURE 2-10: Plant Layout at Closure

ATTACHMENT 5

DOANE LAKE AREA MAP



GERAGHTY & MILLER, INC.
Environmental Services

SITE PLAN

Doane Lake Area
Portland, Oregon

DRAWN BY	COMPILED BY	DATE	PROJECT NUMBER
SAC	AAR	FEB. 1991	WA103.01

FIGURE 1-2

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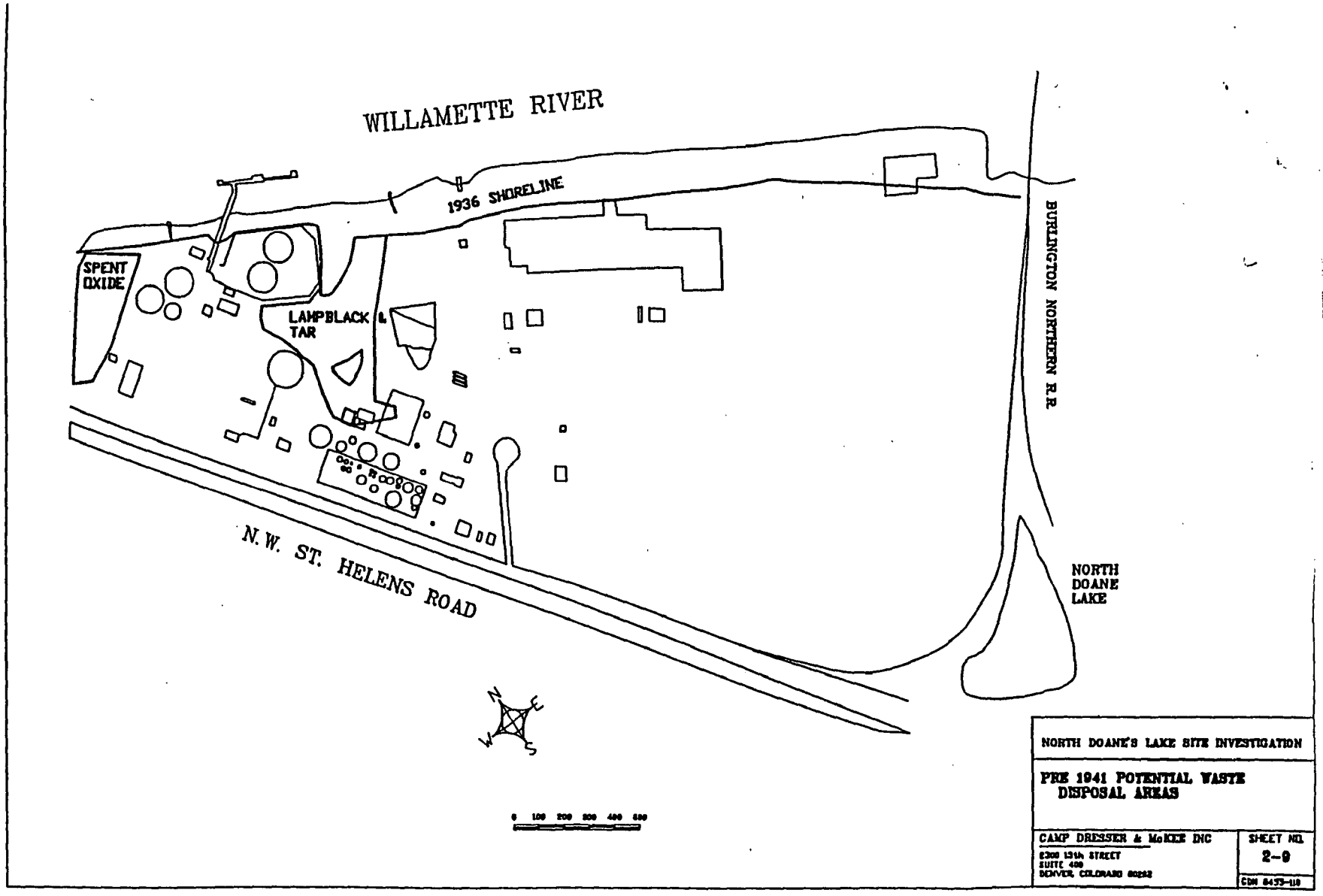
ATTACHMENT 6

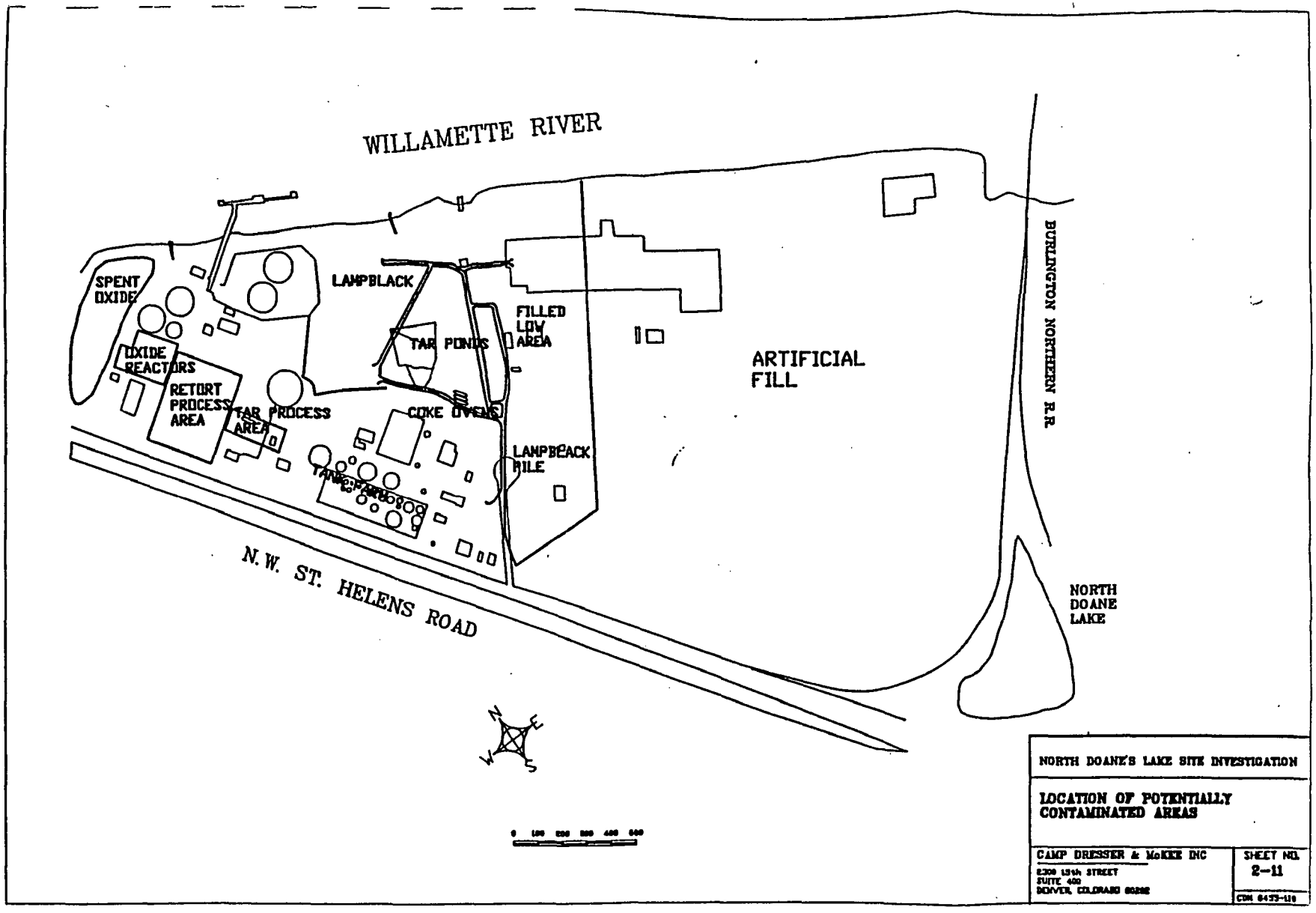
PRE-1941 DISPOSAL AREAS



Koppers022332

ATTACHMENT 7

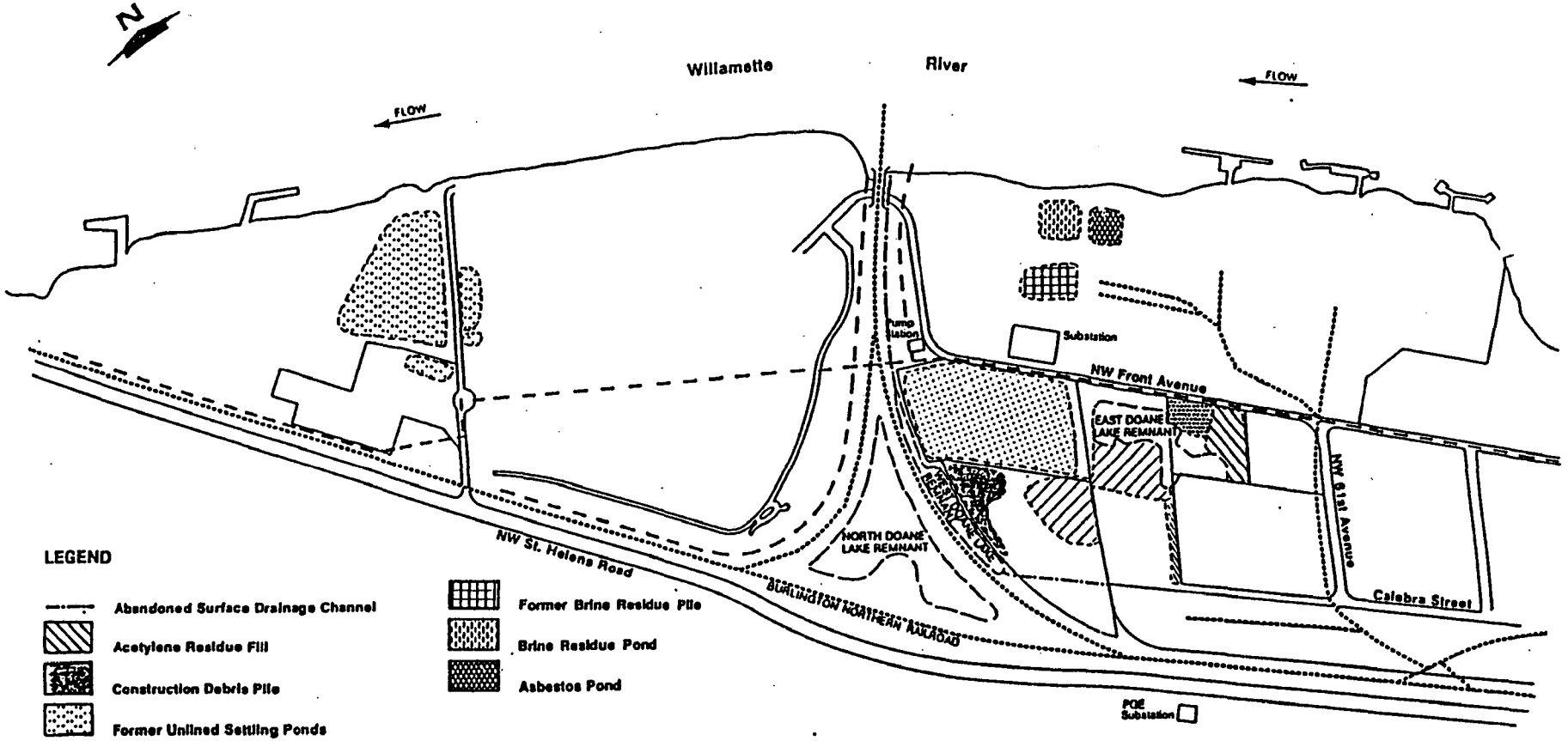
POST-1941 DISPOSAL AREAS



Koppers022334

ATTACHMENT 8

GENERAL WASTE DISPOAL AREAS



GERAGHTY & MILLER, INC.
Environmental Services

APPROXIMATE WASTE DISPOSAL LOCATIONS IN FILL

Doane Lake Area
Portland, Oregon

DRAWN BY	COMPILED BY	DATE	PROJECT NUMBER
SAC	AAR	FEB. 1991	WA103.01

FIGURE 3-12

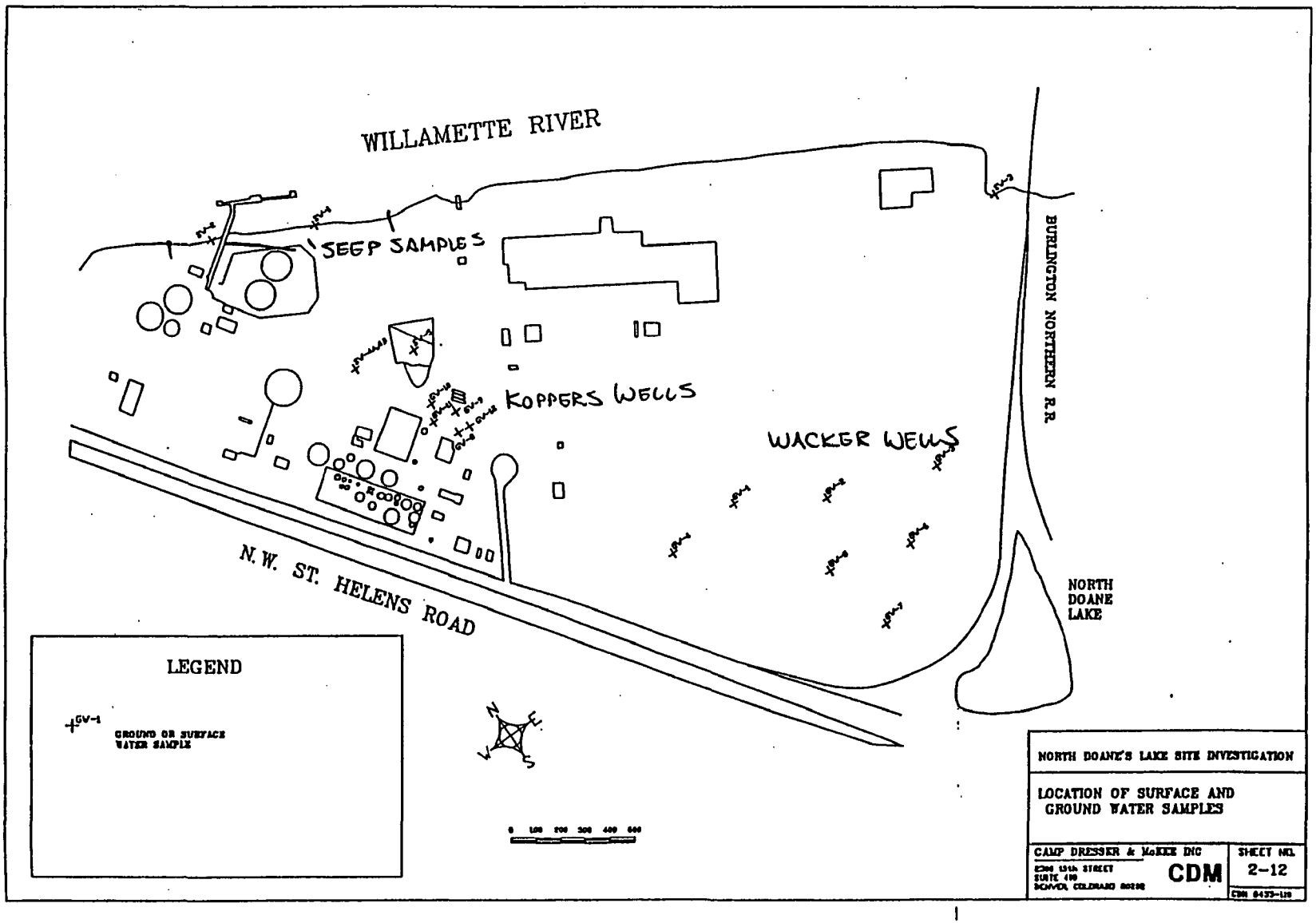
Koppers022336

Attachment 9 - Groundwater and Other Aqueous Data - Northwest Natural Gas Site (mg/l)
(Koppers and NWNG Data)

	Koppers GW-8 (12/84)	Koppers GW-9 (12/84)	Koppers GW-10 (12/84)	Koppers GW-11 (12/84)	NWNG Sump (9/84)	Koppers Separator (12/84)	NWNG Seep 1 (9/85)	NWNG Seep 2 (9/85)	NWNG LNG Basin (11/93)
Volatile Organic Compounds									
Benzene							NA	NA	6.3
Toluene						0.02	NA	NA	2.5
Ethylbenzene	380		24	51		0.06	NA	NA	0.26
Xylene (Total)	2600	3.4	160	22		0.11	NA	NA	0.62
Semivolatile Organic Compounds									
Phenol									
2,4-Dimethylphenol									
2-Methylnaphthalene		0.3	8	14		0.14			
Acenapthene	45	3		1.2	0.03	0.02	1	0.3	0.016
Acenaphthylene					0.03	0.023			0.014
Anthracene	330	9	47			0.006	1.6	0.3	0.0047
Benzo(a)anthracene				0.3		0.001	1.6	0.4	0.014
Benzo(a)pyrene							2.4		0.019
Benzo(b)fluoranthene							2.6		0.024
Benzo(ghi)perylene									0.013
Benzo(k)fluoranthene									0.0054
Chrysene		3	2	0.5		0.001	2.4	0.7	0.023
Dibenzo(ah)anthracene									0.0034
Dibenzofuran		0.1	6	8					
Fluoranthene	110	4	3	1.8		0.007	6.4	1.4	0.031
Fluorene	65	3	3	1.9	0.02	0.018	1.4	0.3	0.0098
Indeno(123-cd)pyrene									0.014
Naphthalene	48	3	2	4.2	2.24		22	0.1	1.3
Phenanthrene	240	11	9	5.5	0.06	0.051	10	1.1	0.038
Pyrene	88	3	2		0.01	0.007	5.1	2	0.028
Carcinogenic PAHs	0	3	2	0.8	0	0.002	9	1.1	0.1158
Non-Carcinogenic PAHs	926	36.4	80	36.6	2.39	0.272	47.5	5.5	1.4415
Total Metals									
Lead	235	22	23	47		NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	0.005	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	0.06	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	0.1	NA	NA	NA	NA

Note: Some VOC and 2-methylnapthalene results were detected as tenatively identified compounds (TICs)

Koppers022337



Koppers022338

Attachment 10 - Miscellaneous Soil Data - Northwest Natural Gas Site (mg/kg)

	Koppers Storm Basin Sed SS-8 (9/84)	NWNG Contain Basin Sed SS-9 (9/84)	NWNG Contain Basin Sed SS-10 (12/84)	Wacker Soil Boring B201 (7/90)	Wacker Soil Boring B202 (7/90)
Volatile Organic Compounds					
Benzene	NA	NA	NA	29	1
Chlorobenzene	NA	NA	NA	1.4	0.37
Ethybenzene	NA	NA	NA	55	3.6
Styrene	NA	NA	NA	1.3	0.49
Toluene	NA	NA	NA	26	2.8
Xylene	NA	NA	NA	57	6.8
Semivolatile Organic Compounds					
Acenapthene	150	15	90	450	120
Acenaphthylene		15	80	170	240
Anthracene	1350		70	430	250
Benzo(a)anthracene	30		20	210	190
Benzo(a)pyrene			90	210	240
Benzo(b)fluoranthene				140	180
Benzo(ghi)perylene				140	120
Benzo(k)fluoranthene				120	190
Chrysene	30	10	40	280	260
Dibenzo(ah)anthracene					
Dibenzofuran				52	28
Fluoranthene	140	30	140	780	760
Fluorene	280	15	120	350	210
Indeno(123-cd)pyrene					160
2-Methylnaphthalene				900	330
Naphthalene	140	920	1750	3000	840
Phenanthrene	840	60	560	1900	1200
Pyrene	120	35	160	890	800
Total Carcingenic PAHs	60	10	150	960	1220
Total Non-carcinogenic PAHs	3020	1090	2970	9062	4898

Koppers022339

ATTACHMENT 11

Table 1
WACKER SILTRONIC, POLYSILICON PLANT SOILS INVESTIGATION
SOURCE: COFFEY LABORATORIES, INC./APRIL 30, 1985
RESULTS OF SOILS ANALYSIS

Chemical Compounds	MW-1, S-3 (15-16.5 ft)	MW-2, S-4 (20-21.5 ft)	MW-3, S-5 (25-26.5 ft)	MW-4, S-1 (5-6.5 ft)	MW-4, S-7 (35-36.5 ft)	MW-5, S-2 (10-11.5 ft)	MW-6, S-3 (15-16.5 ft)	MW-7, S-5 (25-26.5 ft)	MW-7, S-8 (40-41.5 ft)	Detection Limits	Reference Criteria
Organic Analyses											
o Volatile Compounds											
1,1,1-Trichloroethane	0.01	BD	BD	BD	BD	BD	BD	BD	BD	0.01	pp, MW (*)
1,2-Dichloroethane	BD	BD	BD	BD	BD	BD	BD	BD	BD	0.01	pp, MW (*)
1,1,2,2-Tetrachloroethylene	2.2	11	BD	BD	BD	0.14	BD	BD	BD	0.05	
Toluene	1.2	20	0.11	BD	BD	0.20	BD	BD	BD	0.1	pp
Chlorobenzene	0.04	BD	BD	BD	BD	BD	BD	BD	BD	0.04	pp
Ethyl Benzene	17	5.4	BD	BD	BD	BD	BD	BD	0.05	0.04	pp
Xylene	146	116	BD	BD	BD	1.5	BD	2.8	1.2	1.0	
o Acid Extractables											
Phenol	0.35	3.1	0.20	0.30	0.17	0.07	0.05	0.06	0.08	NR	pp, SW
2-Chlorophenol	ND	7.8	0.08	0.26	ND	ND	0.13	ND	0.14	NR	pp, SW
2-Nitrophenol	ND	0.20	ND	ND	ND	ND	ND	ND	ND	NR	pp, SW
2,4-Diethylphenol	ND	3.1	ND	ND	ND	0.22	0.17	ND	ND	NR	pp, SW
2,4-Dichlorophenol	ND	2.7	ND	ND	ND	0.24	ND	ND	ND	NR	pp, SW
2,4,6-Trichlurophenol	ND	ND	ND	ND	ND	0.22	ND	ND	ND	NR	pp, SW
2,4-Dinitrophenol	ND	ND	ND	ND	ND	0.81	ND	ND	ND	NR	pp, SW
Pentachlorophenol	ND	ND	ND	ND	0.31	6.9	5.1	ND	ND	NR	pp, SW, SW
o Base Neutral Extractables											
Naphthalene	6.7	360	BD	BD	BD	230	BD	BD	BD	1	pp
Acenaphthalene	5.6	230	BD	BD	BD	24	BD	BD	BD	1	pp
Acenaphthene	8.0	560	BD	BD	BD	28	BD	BD	BD	1	pp
Fluorene	5.0	290	BD	BD	BD	20	BD	BD	BD	1	pp
Phenanthrine-Anthracene (***)	32	1,400	3	BD	BD	150	BD	1.6	BD	1	pp
Fluoranthene	16	530	BD	BD	BD	50	ND	1.1	BD	1	pp
Pyrene	18	550	BD	BD	BD	57	BD	1.2	BD	1	pp
Chrysene	12	92	BD	BD	BD	36	BD	1.7	BD	1	pp
Benzo (b) + Benzo (k) Fluoranthene (***)	8	120	BD	BD	BD	200	BD	BD	BD	1	pp
Benzo (a) pyrene	19	120	BD	BD	BD	100	BD	BD	BD	1	pp
Indeno (1,2,3-CD) Pyrene + Dibenzo (a,b) Anthracene (***)	BD	270	BD	BD	BD	7	BD	BD	BD	1	
Benzo (ghi) Perylene	BD	360	BD	BD	BD	25	BD	BD	BD	1	pp
o Pesticides (EP Toxicity)											
Gamma BHC (Lindane)	BD	BD	BD	BD	BD	BD	BD	BD	BD	0.04	pp, SW, MW
Endrin	BD	BD	BD	BD	BD	BD	BD	BD	BD	0.002	pp
Toxaphene	BD	BD	BD	BD	BD	BD	BD	BD	BD	0.05	pp

MM956.031.1

Koppers022340

ATTACHMENT 11.

Table 1 (Continued)

Chemical Compounds	MW-1, S-3 (15-16.5 ft)	MW-2, S-4 (20-21.5 ft)	MW-3, S-5 (25-26.5 ft)	MW-4, S-1 (5-6.5 ft)	MW-4, S-7 (35-36.5 ft)	MW-5, S-2 (10-11.5 ft)	MW-6, S-3 (15-16.5 ft)	MW-7, S-5 (25-26.5 ft)	MW-7, S-8 (40-41.5 ft)	Detection Limits	Reference Criteria
Inorganic Analyses (EP Toxicity)											
Arsenic	BD	BD	BD	BD	BD	BD	BD	BD	BD	0.05	pp, SIW, SWQ, PMW
Barium	0.05	0.11	0.05	0.09	BD	0.05	0.11	0.08	0.15	0.05	SIW, SWQ
Cadmium	BD	BD	BD	BD	BD	BD	BD	BD	BD	0.05	pp, SIW, SWQ, PMW
Chromium	BD	BD	BD	BD	BD	BD	BD	BD	BD	0.05	pp, SIW, SWQ, PMW
Lead	BD	BD	BD	BD	BD	BD	BD	BD	BD	0.05	pp, SIW, SWQ, PMW
Mercury	BD	BD	BD	BD	BD	BD	BD	BD	BD	0.05	pp, SIW, PMW
Selenium	BD	BD	BD	BD	BD	BD	BD	BD	BD	0.05	pp, SIW, PMW
Silver	BD	BD	BD	BD	BD	BD	BD	BD	BD	0.05	pp, SIW, PMW
Miscellaneous Analysis											
o non-PP Phenols/Cresols											
3 & 4-Chlorophenol	0.44	17.5	0.06	ND	ND	1.7	0.32	ND	ND	NR	SIW, SWQ
2,4,5-Trichlorophenol	ND	1.9	ND	ND	ND	ND	ND	ND	ND	NR	SIW, SWQ
2,3,4,5-Tetrachlorophenol	4.9	256	ND	0.40	ND	0.23	4.7	0.06	0.25	NR	SIW, SWQ
2,3,4,6-Tetrachlorophenol	0.24	ND	ND	ND	ND	ND	ND	1.0	ND	NR	SIW, SWQ
2,3,5,6-Tetrachlorophenol	ND	4.0	ND	0.58	0.11	0.33	0.55	ND	0.46	NR	SIW, SWQ
o-Cresol	0.04	3.4	ND	0.02	ND	0.19	0.05	ND	ND	NR	
m- and p-Cresol (***)	0.006	ND	ND	0.06	ND	ND	ND	ND	ND	NR	
o Non-PP Pesticides (EP Toxicity)											
Methoxychlor	BD	BD	BD	BD	BD	BD	BD	BD	BD	0.1	SIW, PMW
2,4-D	BD	BD	BD	BD	BD	10.0	160.0	BD	BD	10	SIW, PMW
2,4,5-TP (Silvex)	BD	BD	BD	BD	BD	BD	BD	BD	BD	1	SIW, PMW
o Misc. Constituents/Parameters											
Oil and Grease	0.340%	0.1498%	0.0587%	0.914%	0.0304%	0.190%	0.0539%	0.0650%	0.0586%		

Unless otherwise specified, all units are mg/kg (mg/L).

PP	Priority Pollutant
PMW	National Interim Primary Drinking Water Regulations
PMW(*)	Proposed N.I.P.D.W.R.
SIW	State of Oregon Hazardous Waste Administrative Rules
SWQ	State of Oregon Water Quality Administrative Rules
BD	Parameter detected, but below analytical quantification limits.
ND	Analyzed, but not detected.
NR	Not reported.
(***)	Reported as sum of two compounds.

Koppers022341

Attachment 12 - Groundwater Data - Northwest Natural Gas Site (mg/l)
(Wacker Siltronic Data)

	GW-1 (8/85)	GW-2 (8/85)	GW-3 (8/85)	GW-3I (10/90)	GW-4 (8/85)	GW-5 (8/85)	GW-6 (8/85)	GW-7 (8/85)	GW-7 (10/90)
Volatile Organic Compounds									
Benzene	1.1	0.1	0.39				1.2		
Toluene									
Ethylbenzene	0.41						0.35		
Xylene (Total)	1.2	0.032			0.015		0.43		
Semivolatile Organic Compounds									
Phenol				0.003					
2,4-Dimethylphenol	0.027								
2-Methylnaphthalene		0.26	0.067		0.019	0.012	0.041		
Acenapthene	0.27	0.94	0.086	0.093	0.35	0.054	0.2	0.019	0.002
Acenaphthylene	0.088	0.2		0.002		0.031	0.032		
Anthracene	0.039	0.63		0.002					
Benzo(a)anthracene	0.031	0.48						0.012	
Benzo(a)pyrene	0.04	0.76						0.01	
Benzo(b)fluoranthene	0.024	0.4							
Benzo(ghi)perylene	0.025	0.37							
Benzo(k)fluoranthene		0.12							
Chrysene	0.036	0.65						0.015	
Dibenzo(ah)anthracene									
Dibenzofuran	0.077	0.075		0.004			0.024		0.003
Fluoranthene	0.073	1.38		0.005				0.023	0.003
Fluorene	0.095	0.44	0.013	0.022	0.053	0.012	0.035		0.003
Indeno(123-cd)pyrene	0.02	0.3							
Naphthalene		1.9	0.6	0.77	0.35	0.058	2.1		0.005
Phenanthrene	0.19	0.63	0.013	0.006	0.028	0.021	0.056		
Pyrene	0.081	1.43		0.004	0.014	0.01	0.01	0.011	
Carcinogenic PAHs	0.176	3.08	0	0	0	0	0	0.037	0
Non-Carcinogenic PAHs	0.913	7.885	0.779	0.908	0.814	0.198	2.498	0.053	0.016

Koppers022342

Attachment 12 - Groundwater Data - Northwest Natural Gas Site (mg/l)
(Wacker Siltronic Data)

	GW-1 (8/85)	GW-2 (8/85)	GW-3 (8/85)	GW-3I (10/90)	GW-4 (8/85)	GW-5 (8/85)	GW-6 (8/85)	GW-7 (8/85)	GW-7 (10/90)
Chlorinated Pesticides									
Alpha-BHC					0.24		0.06		
4,4'-DDT							0.26		
Endrin						0.02			
Dissolved Metals									
Lead	0.052	0.04	0.025		0.049	0.028	0.03	0.02	
Arsenic	0.005		0.005				0.01		
Cadmium	0.003	0.002	0.001		0.003	0.002	0.002		
Chromium	0.01	0.008	0.005		0.009	0.006	0.006	0.004	
Copper	0.002	0.007	0.001		0.002	0.02	0.001	0.004	
Nickel	0.01	0.007	0.005		0.011	0.006	0.006	0.003	
Zinc	0.026	0.016	0.017		0.05	0.011	0.011	0.047	0.0256
Cyanide	0.18	0.058	0.13	0.107	0.93	0.13	0.04	0.033	0.0314

Koppers022343

ATTACHMENT 13

MOBILE LABORATORY ANALYTICAL TEST RESULTS
GROUNDWATER AND SOIL GAS SAMPLES

Sample Location Number	Sample Collection Date	Benzene (µg/L)	Toluene (µg/L)	Ethyl-Benzene (µg/L)	M,P - Xylene (µg/L)	O - Xylene (µg/L)	TPH (µg/L)
GW-01	10/10/90	221.00	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
GW-02	10/10/90	181.00	< 0.10	< 0.10	< 0.10	< 0.10	131.00
GW-03	10/11/90	13.50	1.80	1.50	3.30	2.30	43.60
GW-04-A(a)	10/11/90	391.00	< 0.10	68.00	23.00	22.00	406.00
GW-04-B	10/11/90	384.00	7.10	75.00	30.00	25.00	397.00
SG-05 (b,c)	—	—	—	—	—	—	—
GW-06	10/11/90	59.80	4.60	196.00	4.10	13.80	657.00
GW-07	10/11/90	17,560.00	13.10	126.00	124.00	52.60	17,000.00
GW-08	10/11/90	285.00	< 0.10	129.00	33.10	32.30	369.00
GW-09	10/11/90	371.00	13.10	74.40	34.20	32.40	791.00
GW-10	10/12/90	1,820.00	23.90	471.00	240.00	187.00	5,090.00
GW-11-A	10/12/90	18,100.00	3,910.00	2,520.00	2,380.00	1,130.00	56,500.00
GW-11-B	10/12/90	23,300.00	5,960.00	4,680.00	4,450.00	2,000.00	89,140.00
GW-11-C	10/12/90	18,470.00	5,590.00	4,510.00	4,372.00	2,050.00	88,240.00

Koppers022344

ATTACHMENT 13
(Continued)

Sample Location Number	Sample Collection Date	Benzene (µg/L)	Toluene (µg/L)	Ethyl-Benzene (µg/L)	M,P - Xylene (µg/L)	O - Xylene (µg/L)	TPH (µg/L)
SG-12(c)	10/12/90	500.00	58.20	279.00	237.00	70.80	1,760.00
SG-13(c)	10/13/90	1.28	< 0.01	< 0.01	< 0.01	< 0.01	687.00
GW-14	10/12/90	8.60	< 0.10	< 0.10	< 0.10	< 0.10	74.70
GW-15	10/12/90	23.20	< 0.10	75.90	< 0.10	21.30	1,330.00
GW-16	10/13/90	12,600.00	214.00	1,680.00	1,180.00	738.00	21,400.00
GW-17-A	10/13/90	11,300.00	662.00	1,680.00	1,690.00	768.00	24,900.00
GW-17-B	10/13/90	10,930.00	574.00	1,370.00	1,410.00	632.00	19,400.00
GW-18	10/13/90	250.00	20.40	64.20	58.50	28.80	623.00
GW-19	10/13/90	52.40	< 0.10	13.00	12.60	8.00	148.00
GW-20-A	10/13/90	2,920.00	80.60	1,690.00	1,230.00	673.00	16,600.00
GW-20-B	10/13/90	3,120.00	85.60	1,720.00	1,230.00	667.00	14,500.00
GW-21	10/13/90	2,510.00	349.00	37.60	66.60	33.00	3,140.00
GW-22-A	10/14/90	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	12.10
GW-22-B	10/14/90	1.00	0.70	< 0.10	< 0.10	< 0.10	18.10
GW-23	10/14/90	335.00	< 0.10	419.00	67.30	24.60	635.00
GW-24	10/14/90	4,780.00	594.00	926.00	1,050.00	500.00	6,330.00
GW-25-A	10/15/90	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	26.80
GW-25-B	10/15/90	3.70	< 0.10	< 0.10	1.70	1.90	25.30

Koppers022345

ATTACHMENT 13
(Continued)

Sample Location Number	Sample Collection Date	Benzene (µg/L)	Toluene (µg/L)	Ethyl-Benzene (µg/L)	M,P - Xylene (µg/L)	O - Xylene (µg/L)	TPH (µg/L)
GW-26	10/15/90	5,920.00	910.00	584.00	580.00	301.00	12,040.00
GW-27-A	10/15/90	10,300.00	627.00	1,220.00	1,250.00	597.00	16,300.00
GW-27-B	10/15/90	11,400.00	320.00	1,340.00	1,430.00	656.00	20,800.00
GW-28	10/15/90	349.00	9.70	< 0.10	6.20	16.20	328.00
GW-29	10/16/90	541.00	< 0.10	263.00	< 0.10	19.40	735.00

(a) The letters "A," "B," and "C" following the sample location number indicate duplicate analysis.
(b) Sample was too concentrated for instrument calibration setting.
(c) Groundwater sample not collected at this location.

Notes:
GW = groundwater sample; SG = soil gas sample.
Detection Limits for groundwater = 0.10 µg/L; Soil gas detection limits = 0.01 µg/L.
< = Analyte not detected at concentration posted.

All groundwater samples collected at 25 feet below ground surface.
All samples analyzed by Hydro Geo Chem Mobile Lab, using modified EPA Method 8015.

Koppers022346

ATTACHMENT 13

QUALITY CONTROL ANALYTICAL TEST RESULTS

Sample Location Number	Analytical Laboratory	Sample Collection Date	Benzene (µg/L)	Toluene (µg/L)	Ethyl-Benzene (µg/L)	M,P - Xylene (µg/L)	O - Xylene (µg/L)	Total Xylenes (µg/L)	TPH (µg/L)	TFH(b) GAS (µg/L)
GW-04-A(a)	HYDRO GEO CHEM	10/11/90	391.00	< 0.10	68.00	23.00	22.00	45.00	406.00 (a)	
GW-04-B		10/11/90	384.00	7.10	75.00	30.00	25.00	55.00	397.00	
GW-04	CH2M HILL	10/11/90	280.00	9.80	80.00	N/A	N/A	70.00		1,300.00
GW-07	HYDRO GEO CHEM	10/11/90	17,560.00	13.10	126.00	124.00	52.60	176.60	17,000.00	
GW-07	CH2M HILL	10/11/90	8,400.00	100.00	770.00	N/A	N/A	540.00		19,000.00
GW-27-A	HYDRO GEO CHEM	10/15/90	10,300.00	627.00	1,220.00	1,250.00	597.00	1,847.00	16,300.00	
GW-27-B		10/15/90	11,400.00	320.00	1,340.00	1,430.00	656.00	2,086.00	20,800.00	
GW-27 **	CH2M HILL	10/15/90	18,000.00	280.00	1,070.00	N/A	N/A	490.00		40,000.00

(a)The letter "A" following the sample location number indicates field sample; "B" indicates a duplicate sample.

(b)CH2M HILL analyzed for TFH Gas and was recorded in mg/L units. This unit was converted to ug/L for comparison purposes (where 1.0 mg/L = .001 µg/L).

Notes:

** Due to the concentration of target compounds, GW-27 was diluted at 1:50 and then again at 1:100. Reporting limits have been adjusted accordingly.

< = analyte not detected at concentration posted.

All groundwater samples collected at 25 feet below ground surface.

CH2M HILL Lab samples analyzed using EPA Method 8015/8020. Hydro Geo Chem Mobile Lab samples analyzed using MODIFIED EPA Method 8015.

Detection Limits for Hydro Geo Chem groundwater samples = 0.10 µg/L.

N/A = Lab did NOT ANALYZE for this compound.

Koppers022347

ATTACHMENT 14

RESIDUAL TAR PROPERTIES SUMMARY

Collection Date: 1970 and 1971 (4 samples)

Bulk Tar Analysis (weight percent)

	Wet	Dry
Tar	69.2	93.5
Water	26.0	.1
Ash	1.8	2.4
Naphthalene	2.2	2.9
Sulfur	0.8	1.1

Specific Gravity wet 1.225
dry 1.28

Viscosity range (cp) 28,000-67,200

Fraction soluble in CCI_4 46%
Fraction soluble in Acetone 50%

Bulk Tar Distilation Data

Temperature °C	Cumulative % Vaporized	
141	0	initial boiling point
141-170	.93	
170-270	10.86	
270-300	21.34	
over 300	78.66	solids and high boiling liquids

Acetone Soluble Fraction Distilation Data

Temperature °C	Cumulative % Vaporized	
145		initial boiling point
225-236	16.3	
236-280	22.1	
280-295	40.2	
295-310	58.3	
310-365	66.6	
over 365	33.4	solids and high boiling liquids

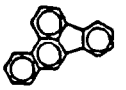
Koppers022348

ATTACHMENT 15

PAH DATA

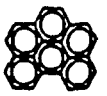
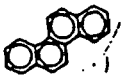
	Acenaphthene	Acenaphthylene	Anthracene
Synonyms	1,2-dihydroacenaphthylene; 1,8-dihydroacenaphthaline; 1,8-ethylenenaphthalene; 1,2-dihydroacenaphthylene	Cyclopenta[de]naphthalene	Anthracin; green oil; paranaphthalene (b) Tetra olive NZG (c) Anthracene oil
Trade names	No data	No data	No data
emical formula	$C_{12}H_{10}$	$C_{12}H_8$	$C_{14}H_{10}$ (b)
emical structure			
weetener	No data	No data	L C666J
entification numbers:			
CAS Registry	83-32-9	208-96-8	120-12-7 (b)
NIOSH RTECS	AB1000000	AB1254000	CA 9350000
EPA Hazardous Waste	No data	No data	No data
OHM/TADS	8200126	No data	8200122
DOT/UN/NA/IMCO shipping	No data	No data	No data
HSDB	2659	2661	702
NCI	No data	No data	No data
STCC	No data	No data	No data
lecular weight	154.21	154.20	178.2 (f)
olor	Orthorhombic bipyramidal needles from alcohol, white Needles	Prisms from ether; plates from alcohol	Tablet or monoclinic prism when pure (f) Colorless with violet fluorescence when pure; yellow with green fluorescence when impure
ysical state	Solid (needles)	Solid (prism/plate)	Solid (tablet or prism) (f)
lting point	95°C	92-93°C	218°C (f)
oiling point	96.2°C	265-275°C	342°C (f) 340°C (b)
nsity	1.225 at 0°C 1.0242 at 0°/4°C (b)	0.8988 at 16°C/2°C	1.25 at 27°/4°C 1.283 at 25°/4°C (b)
Odor	No data	No data	Weak aromatic odor
or threshold:	Threshold odor concentration [TOC] in water at room temperature	No data	No data
Water	0.08 ppm, range 0.02-0.22 ppm	No data	No data
Air	$8.0x10^{-2}$ ppm	No data	No data
lubility:			
Water	Insoluble	3.93 mg/L water	Virtually insoluble in water (f
Organic solvents	Soluble in alcohol, methanol, propanol, chloroform, benzene, toluene, glacial acetic acid	Alcohol, ether, benzene	Benzene, carbon disulphide, carbon tetrachloride, chloroform, ether, ethanol, methano toluene (f) Acetone (b)
rtition coefficients	$K_{ow} = 9.6x10^3$, $K_{oc} = 4.6x10^3$ (c)	log K_{ow} = 4.07 $K_{ow} = 5.3x10^3$; K_{oc} = 2.5x10 (c)	log K_{ow} = 4.45 $K_{oc} = 1.4x10^4$; $K_{ow} = 2.8x10^4$ (c
apor pressure:	$4.47x10^{-3}$ mmHg (d)	0.029 torr (20°C) (c)	1 mm at 145°C (f) $1.7x10^{-5}$ torr at 25°C (c)
enry's law constant	No data	$1.45x10^{-3}$	$8.6x10^{-5}$ (c)
utoignition temperature	No data	No data	540°C 1004°F (g)
Flashpoint	No data	No data	250°F
lammability limits	Dust is moderately flammable (e)	No data	No data
onversion factors	No data	No data	No data

Koppers022350

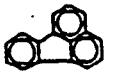
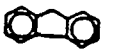
	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene
ynonyms	Benz(a)anthracene 1,2-benzanthracene; benzo(b)-phenanthrene; 2,3-benzophenanthrene; tetraphene (d) BA (e)	Benzo[def]chrysene; 3,4-benzopyrene, 3,4-benzpyrene; benz[a]pyrene; BP; B[a]P (b)	3,4-Benz(e)acephenanthrylen 2,3-benzfluoranthene; 3,4-benzfluoranthene; 2,3-benzofluoranthene; 3,4-benzofluoranthene; benzo(e)fluoranthene B(b)f (b)
rade names	No data	No data	No data
emical formula	$C_{18}H_{12}$	$C_{20}H_{12}$ (b)	$C_{20}H_{12}$ (b)
emical structure			
swesser	L D6 B66 J	L D6 B6666 2AB TJ	L C 65 K666 1A TJ
entification numbers:			
AS Registry	56-55-3	50-32-8	205-99-2 (b)
IOSH RTECS	CV 9275000 (e)	DJ3675000	CU 1400000 (c)
PA Hazardous Waste	U018	U022	No data
OHM/TADS	8000123	8200129	No data
OT/UN/NA/IMCO shipping	No data	No data	No data
ECDB	4003	2554	4035
CI	No data	No data	No data
STCC	No data	No data	No data

Molecular weight	228.29 (h)	252.3 (f)	252.3 (f)
Color	Plates with yellow-blue fluorescence (recrystallized from glacial acetic acid or ethane) (b)	Pale yellow; fluoresces (f) yellow-green in ultraviolet light (i)	Colorless needles (f) Needles recrystallized fr benzene (b)
Physical state	Solid (plates)	Plates or needles (i) (recrystallized from benzene/ligroin)	Solid (needles) (b)
Melting point	158-159°C (h) 162°C (b)	179-179.3°C (i)	168.3°C (f)
Boiling point	400°C (g) 435°C sublimes (i)	310-312°C (at mm Hg) (i) 495°C (at mm Hg) (j)	No data
Density	1.274 (20°C)	1.351	No data
Odor	No data	Unknown	No data
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:			14 µg/L (c)
Water	Virtually insoluble (9-14 µg/L) (f)	$3.8x10^{-6}$ g/L (c)	Virtually insoluble in water
Organic solvents	Slightly soluble in acetic acid and hot ethanol; soluble in acetone and diethyl ether; very soluble in benzene (f)	Sparingly soluble in ethanol and methanol; soluble in benzene, toluene, xylene, and ether (f)	Slightly soluble in benzene, acetone (f)
Partition coefficients	$K_{ow} = 4.1x10^5$, $K_{oc} = 2x10^5$ (e)	$k_{ow} = 1.55x10^6$ (c) $\log k_{ow} = 6.06$ $k_{oc} = 3.5x10^6$ (e)	$K_{ow} = 1.1x10^6$; $K_{oc} = 5.5x10^5$
Vapor pressure:	$2.2x10^{-8}$ torr (20°C)	$5.6x10^{-9}$ mm Hg (c)	10^{-11}-10^{-6} torr at 20°C
Henry's law constant	$1x10^{-6}$	$4.9x10^{-7}$ atm-m^3/mol (c)	$1.22x10^{-5}$ (c)
Autoignition temperature	No data	Unknown	No data
Flashpoint	No data	Unknown	No data
Flammability limits	No data	Unknown	No data
Conversion factors	No data	1 ppm = 10.32 mg/m^3 (l)	No data

Koppers022351

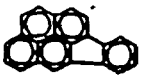
	Benzo(b)fluoranthene	Benzo(ghi)perylene	Chrysene
Synonyms	8,9-benzfluoranthene; 8,9-benzofluoranthene; 11,12-benzofluoranthene; 2,3,1,8-binaphthylene; dibenzo(bjk)fluorene (b)	1,12-benzoperylene (d)	1,2-Benzophenanthrene; benzo(a)phenanthrene; 1,2-benzphenanthrene; benz(a)phenanthrene; 1,2,5,6-dibenzonaphthalene
Trade names	No data	No data	Not applicable (b)
Chemical formula	$C_{20}H_{12}$ (b)	$C_{22}H_{12}$ (d)	$C_{18}H_{12}$ (b)
Chemical structure			
Answer	No data	No data	No data
Identification numbers:			
CAS Registry	207-08-9 (b)	191-24-2 (d)	218-01-9 (b)
NIOSH RTECS	DF 6350000 (e)	DI 6200500 (e)	GC 0700000 (e)
EPA Hazardous Waste	No data	No data	U050 (e)
OHM/TADS	No data	8200129	No data
DOT/UN/NA/IMCO shipping	No data	No data	No data
HSDB	No data	No data	2810
NCI	No data	No data	No data
STCC	No data	No data	No data
Molecular weight	252.3 (f)	276.34 (h)	228.3 (f)
Color	Pale yellow needles (f)	No data	Colorless with blue fluorescence; othorhombic bipyramidal plates (recrystallized from benzene) (f) Red with blue fluorescence (recrystallized from benzene or acetic acid) (b)
Physical state	Solid (needles)	No data	Solid (plates) (b)
Melting point	215.7°C (f)	273°C (h)	255-256°C (f)
Boiling point	480°C (f)	222°C (e)	448°C (f)
Density	No data	No data	1.274 (g)
Odor	No data	No data	No data
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:		2.6x10^{-4} g/L 25°C (e)	
Water	Virtually insoluble (f)		Virtually insoluble in water (1.5-2.2 µg/L) (f)
Organic solvents	Soluble in benzene, acetic acid, ethanol (f)	No data	Slightly soluble in acetone, carbon disulphide, diethyl ether, ethanol (1 g/1300 ml ethanol), glacial acetic acid toluene 10.24 parts/100 parts at 18°C 1 g/480 ml at 20°C; 5% at 100°C), hot xylene. Soluble in benzene. (f) Moderately soluble in boiling benzene (g)
Partition coefficients	K_{ow} = 1.15x10^{-6}; K_{ow} = 5.5x10^{5} (c)	K_{ow} = 3.2x10^{6}; K_{oc} = 1.6x10^{6} (c)	K_{ow} = 4.1x10^{5}; K_{oc} = 2x10^{5} (c)
Vapor pressure:	5x10^{-7} (20°C) torr (c)	1.03x10^{-10} (25°C) torr (c)	6.3x10^{-9} mmHg (25°C) (c)
Henry's law constant	3.87x10^{-5} (c)	1.44x10^{-7} (c)	1.05x10^{-6} (c)
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability limits	No data	No data	No data
Conversion factors	No data	No data	No data

Koppers022352

	Dibenz(a,h)anthracene	Fluoranthene	Fluorene
,nonyms	1,2,5,6-Dibenz(a,h)anthracene (d) Dibenzo(a,h)anthracene, DB(a,h)A; DBA; 1,2:4,6-dibenz(a,h)anthracene; 1,2:5,6-dibenz(a)anthracene (b)	1,2-(1,8-Naphthylene)benzene; 1,2-benzacenaphthene; 1,2-(1,8-naphthalenediyl)benzene; benzo(jk)fluorene	ortho-Biphenylene methane; diphenylenemethane; 2,2-methylene biphenyl (b) 2,3-benzidene (f)
ade names	No data	No data	No data
emical formula	$C_{22}H_{14}$ (b)	$C_{16}H_{10}$	$C_{13}H_{10}$ (b)
hemical structure			
iswesser	L G6 B666J	L C6566 1A PJ	No data
dentification numbers:			
CAS Registry	53-70-3 (b)	206-44-0	86-73-7 (b)
NIOSH RTECS	HN 2625000 (e)	LL4025000	LL5670000
EPA Hazardous Waste	U063	U120	No data
OHM/TADS	No data	8200136	No data
DOT/UN/NA/IMCO shipping	No data	No data	No data
HSDB	5097	5486	2165
NCI	No data	No data	No data
STCC	No data	No data	No data

	Dibenz(a,h)anthracene	Fluoranthene	Fluorene
olecular weight	278.35 (h)	202.26	166.2 (f)
olor	Colorless (f) Plates (recrystallized from acetone) leaflets (recrystallized from acetic acid) (b)	Colored needles; pale yellow needles or plates from alcohol	White when recrystallized from ethanol (f)
ysical state	Solid (plates or leaflets) (b)	Solid (needles or plates)	Solid (leaflets or flakes; crystalline plates) (f)
lting point	262°C (h)	111°C	116-117°C (f)
oiling point	269-270°C	375°C	295°C (f)
ensity	1.282	1.252 at 0°C/4°C	1.203 at 0°C/4°C
dor	No data	No data	No data
dor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
olubility:			
Water	0.5 µg/L (f)	In sea water at 22°C	Almost insoluble in water (1.68-1.98 mg/L) (f)
Organic solvents	Slightly soluble in ethyl alcohol; soluble in acetone, acetic acid, benzene, toluene and xylene (b)	Alcohol, ether, benzene, acetic acid	Acetic acid, acetone, benzene, carbon disulphide, carbc tetrachloride, diethyl e er ethanol, pyrimidine, sol ic toluene (f)
Partition coefficients	K_{ow} 6.9 x10^6; K_{oc} = 3.3x10^6 (c)	log K_{ow} 4.90; K_{oc} = 3.8x10^4 K_{ow} = 7.9x10^4; K_{oc} = 3.8x10^4 (c)	K_{ow} = 1.5x10^4; K_{oc} = 7.3x10^3 (
Vapor pressure:	1x10^{-10} mmHg at 20°C (c)	0.01 mmHg (20°C) 5.0x10^{-6} torr (25°C) (c)	10 mm at 146°C (f) 7.1x10^{-4} torr (c)
Henry's law constant	7.3x10^{-8} (c)	6.5x10^{-6} (c)	6.4x10^{-5} (c)
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability limits	No data	No data	No data
Conversion factors	No data	No data	No data

Koppers022353

	Indeno(1,2,3-cd)pyrene	Phenanthrene	Pyrene
ynonyms	1P; ortho-phenylenepyrene; 1,10-(ortho-phenylene)pyrene; 1,10-(1,2-phenylene)pyrene; 2,3-ortho-phenylene pyrene (b) Indenopyrene	Phenanthrene; Phenantrin (b)	Benzo(def)phenanthrene; β-pyrene (1
:ade names	No data	No data	No data
hemical formula	$C_{22}H_{12}$ (b)	$C_{14}H_{10}$ (b)	$C_{16}H_{10}$ (b)
hemical structure			
weeser	No data	No data	No data
Identification numbers:			
CAS Registry	193-39-5 (b)	85-01-8 (b)	129-00-00 (b)
NIOSH RTECS	NK 9300000	SF7: :000	No data
EPA Hazardous Waste	U137	No data	No data
OHM/TADS	No data	8200140	No data
DOT/UN/NA/IMCO shipping	No data	No data	No data
HSDB	5101	2166	4023
NCI	No data	No data	No data
STCC	No data	No data	No data

S = Chemical Abstracts Services; NIOSH = National Institute for Occupational Safety and Health; RTECS = Registry of Toxic Effects of Chemical bstances; EPA = Environmental Protection Agency; OHM/TADS = Oil and Hazardous Materials/Technical Assistance Data System; DOT/UN/NA/IMCO = epartment of Transportation/United Nations/North America/International Maritime Dangerous Goods Code; HSDB = Hazardous Substance Data Bank; NCI = tional Cancer Institute; and STCC = Standard Transport Commodity Code.

) All information obtained from HSDB 1988 except where noted.
) IARC 1983
) Callahan et al. 1979
1) Eller 1984
) Sax and Lewis 1989
) Weast et al. 1988

Koppers022354

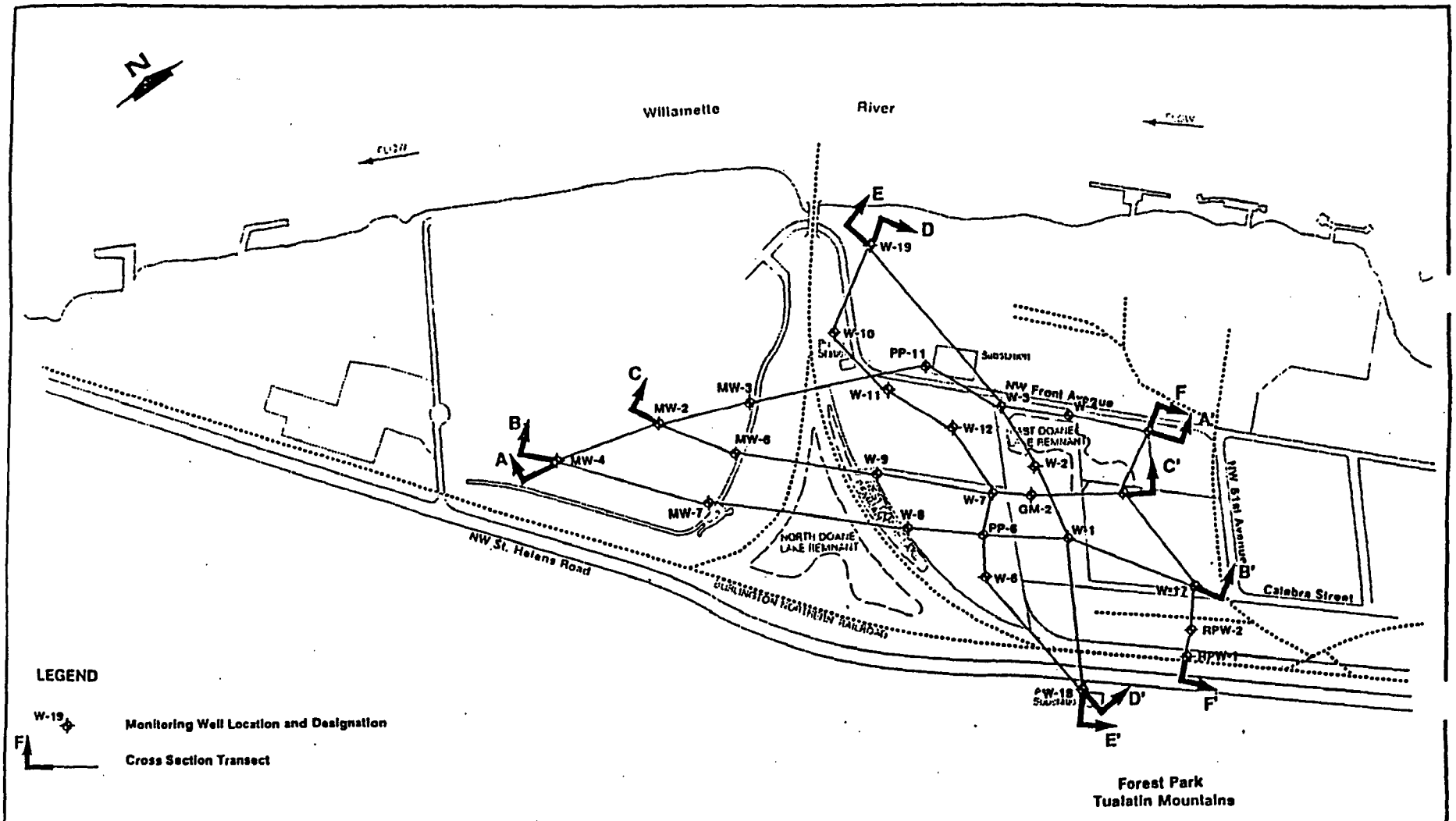
	Indeno(1,2,3-cd)pyrene	Phenanthrene	Pyrene
Molecular weight	276.3 (f)	178.2 (f)	202.3 (f)
Color	Yellow plates or needles showing a greenish-yellow fluorescence (f)	Monoclinic plates (recrystallized from ethanol) colorless, shining crystals; leaflets (f)	Pale yellow plates (recrystallized from toluene) monoclinic prismatic tablets a slight blue fluorescens crystallized from ethanol sublimation) (f)
Physical state	Solid (plates or needles) (f)		Colorless solid
Melting point	163.6°C (f)	100°C (f)	156°C 153-155°C 156°C (k)
Boiling point	530°C	340°C (f)	393°C (b) 404°C (k)
Density	No data	0.900 at 4°C	1.271 at 23°C Boiling point 393°C
Odor	No data	Faint aromatic odor	No data
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:			
Water	Insoluble in water (f)	Virtually insoluble in water (1-1.6 mg/L) (f)	Virtually insolbule in water (129-165 µg/L) (f)
Organic solvents	Soluble in organic solvents (f)	Soluble glacial acetic acid; 1 g dissolves in the following volumes: 2 ml benzene, 1 ml carbon disulphide, 2.4 ml carbon tetrachloride, 3.3 ml anhydrous diethyl ether, 60 ml cold ethanol, 25 ml absolute ethanl, 10 ml boiling 95% ethanol, and 2.4 ml toluene (f)	Soluble in benzene, carbon sulphide, diethyl ether, ethanol, petroleum ether, toluene, race tone (f) Alcohol
Partition coefficients	log K_{ow} 6.58; K_{ow} =3.2x10^6; K_{oc} = 1.6x10^6 (c)	4.57 K_{ow} = 2.8x10^4; K_{oc} = 1.4 x10^4 (c)	Octanol/water: log K_{ow} = 4 K_{ow} = 8.0x10^4; K_{oc} = 3.8x1(
Vapor pressure:	-10^{-10} torr (20°C) (c)	9.6x10^{-4} torr (25°C) (c)	2.5x10^{-6} torr at 25°C (c)
Henry's law constant	6.95x10^{-8} (c)	2.26x10^{-4} (c)	5.1x10^{-6} (c)
Autoignition temperature	No data	No data	No data
Flashpoint	No data	171°C	No data
Flammability limits	No data	No data	No data
Conversion factors	No data	No data	No data

(a) All information obtained from HSDB 1988 except where noted.
(b) Weast et al. 1988
(c) Mabey et al. 1982
(d) EPA 1987a
(e) ITII 1982
(f) IARC 1983
(g) Sax and Lewis 1989
(h) Eller 1984
(i) Weast 1987
(j) Aldrich 1986
(k) Windholz 1983
(l) Verschueren 1983

Koppers022355

ATTACHMENT 16

FENCE DIAGRAMS AND LITHOLOGICAL MAPS



GERAGHTY & MILLER, INC.

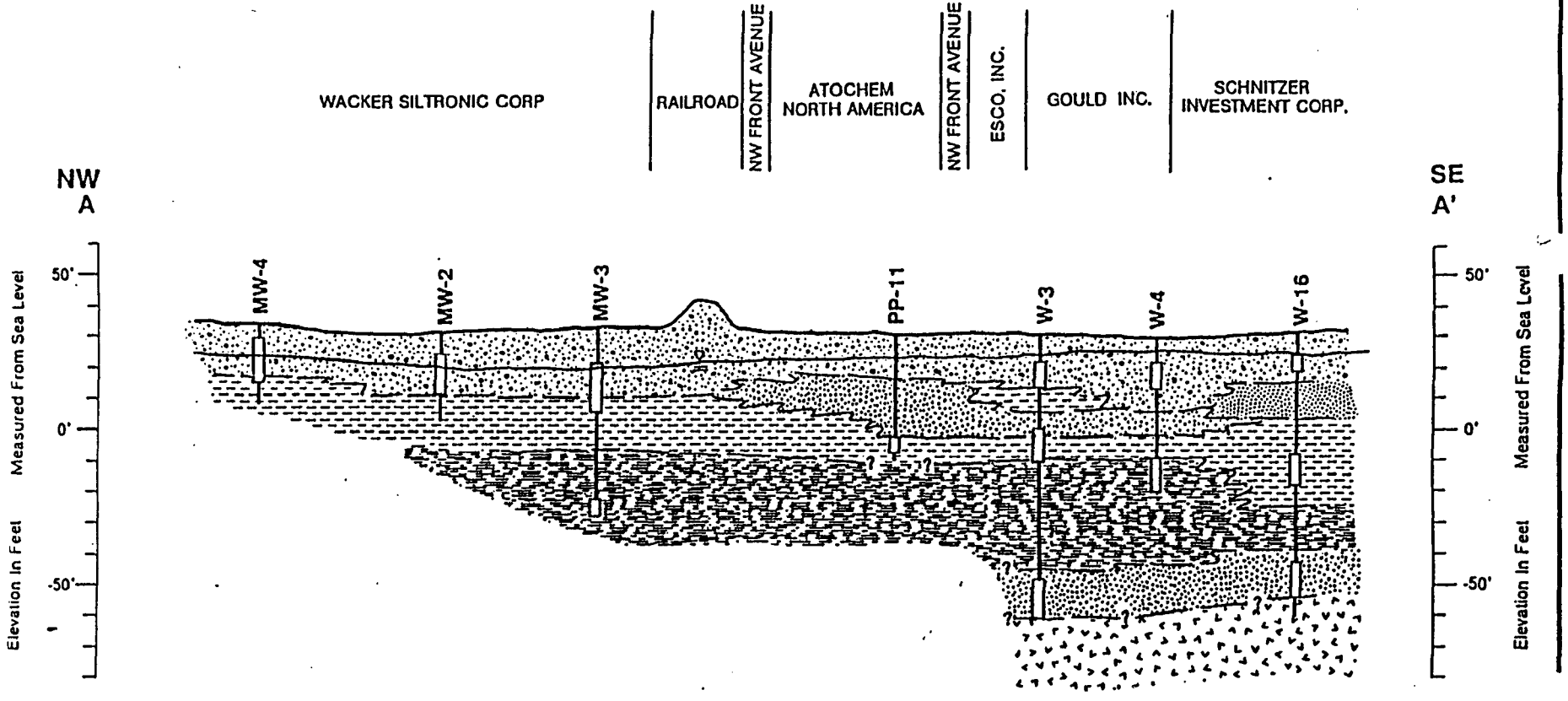
CROSS-SECTION TRANSECT MAP

Doane Lake Area
Portland, Oregon

DRAW SAC
COMPILE AAH
DATE
WA10

FIGURE 3-1

Koppers022357



LEGEND

- Fill
- Sand
- Silty Sand
- Silt
- Clayey Silt
- Troutdale Formation
- Basalt
- Water Level July 1990

Vertical Scale: 1" = 50'
Horizontal Scale: 1" = 500'

GERAGHTY & MILLER, INC.
Environmental Services

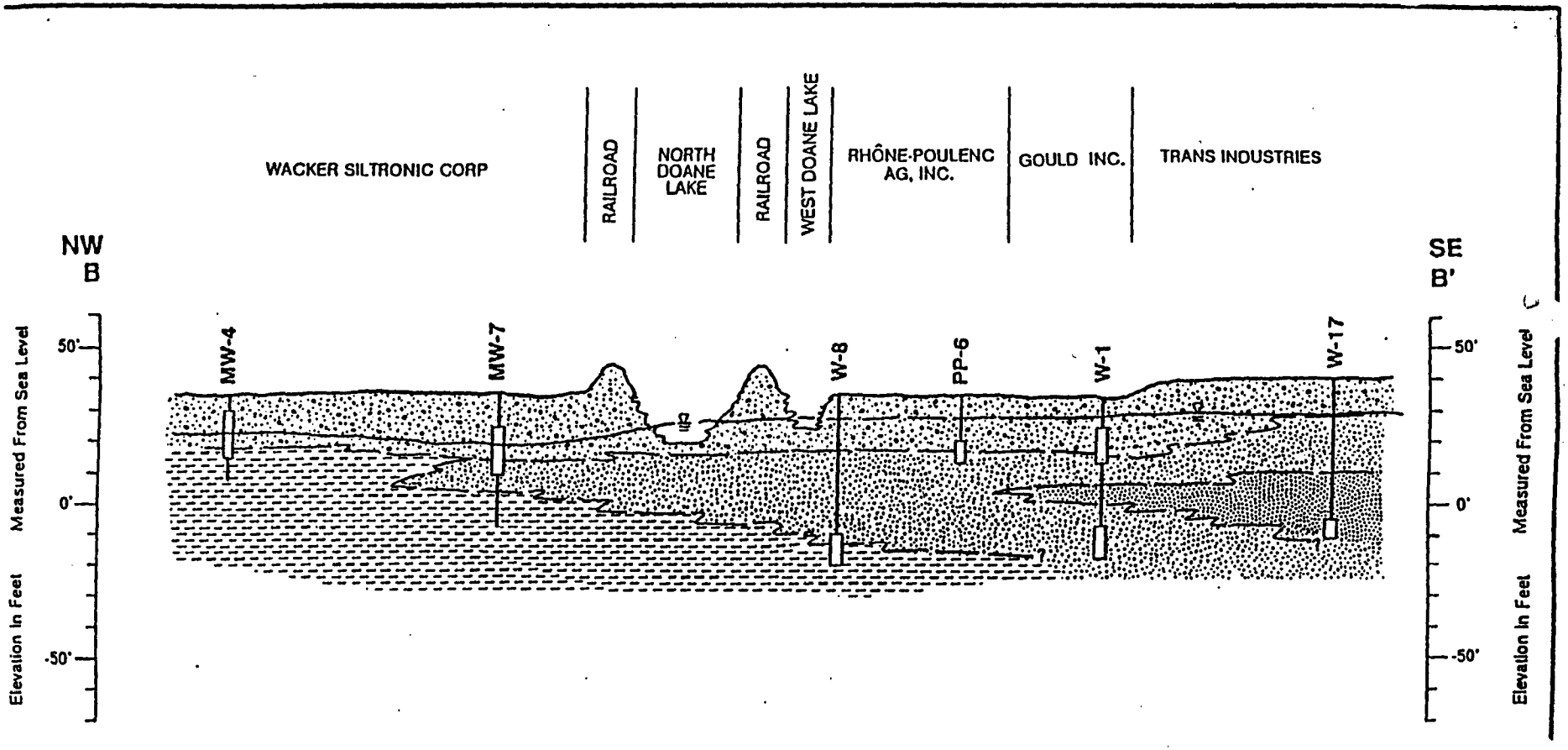
STRATIGRAPHIC CROSS SECTION A-A'

Doane Lake Area
Portland, Oregon

DRAWN BY	COMPILED BY	DATE	PROJECT NUMBER
SAC	AAR	FEB. 1991	WA103.01

FIGURE 3-2

Koppers022358



GERAGHTY & MILLER, INC.
environmental services

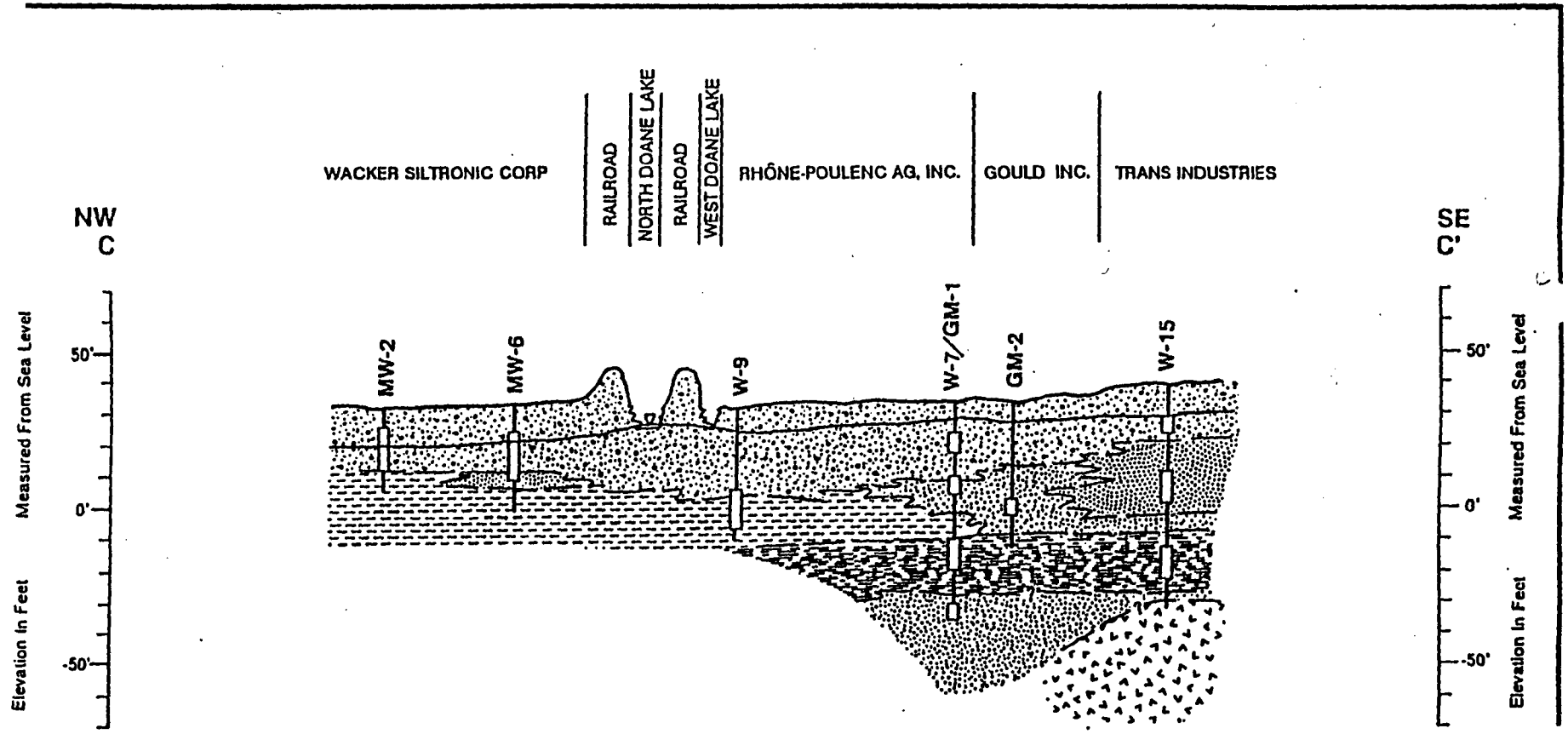
STRATIGRAPHIC CROSS SECTION B-B'

Doane Lake Area
Portland, Oregon

FIGURE 3-3

DRAWN	COMPILED BY	DATE	PROJECT NUMBER
SAC	AAH	Feb. 1991	W 01

Koppers022359



LEGEND

- Fill
- Sand
- Silty Sand
- Silt
- Clayey Silt
- Troutdale Formation
- Basalt
- Water Level July 1990

Vertical Scale: 1" = 50'
Horizontal Scale: 1" = 500'

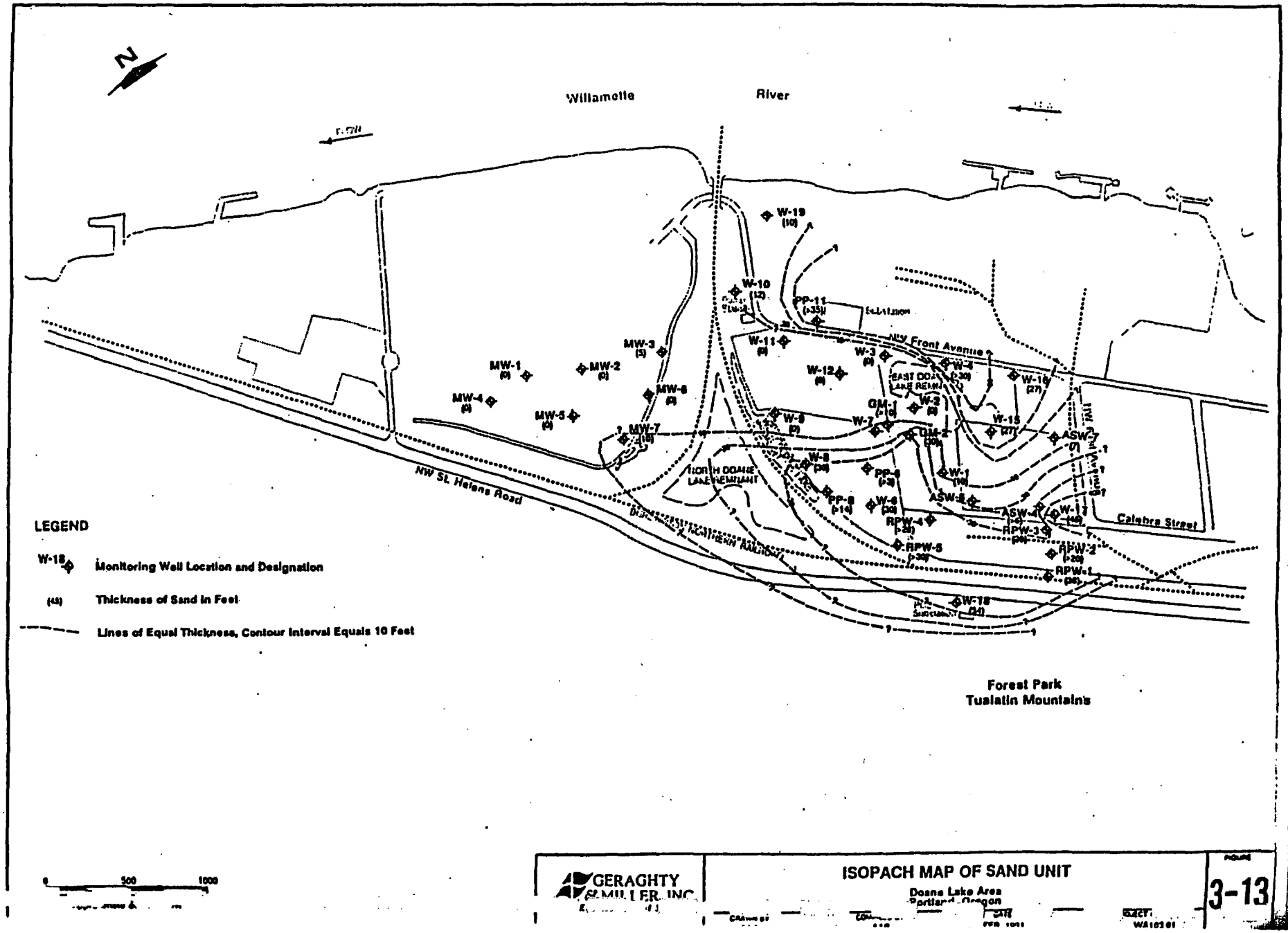
GERAGHTY & MILLER, INC.
Environmental Services

STRATIGRAPHIC CROSS SECTION C-C'

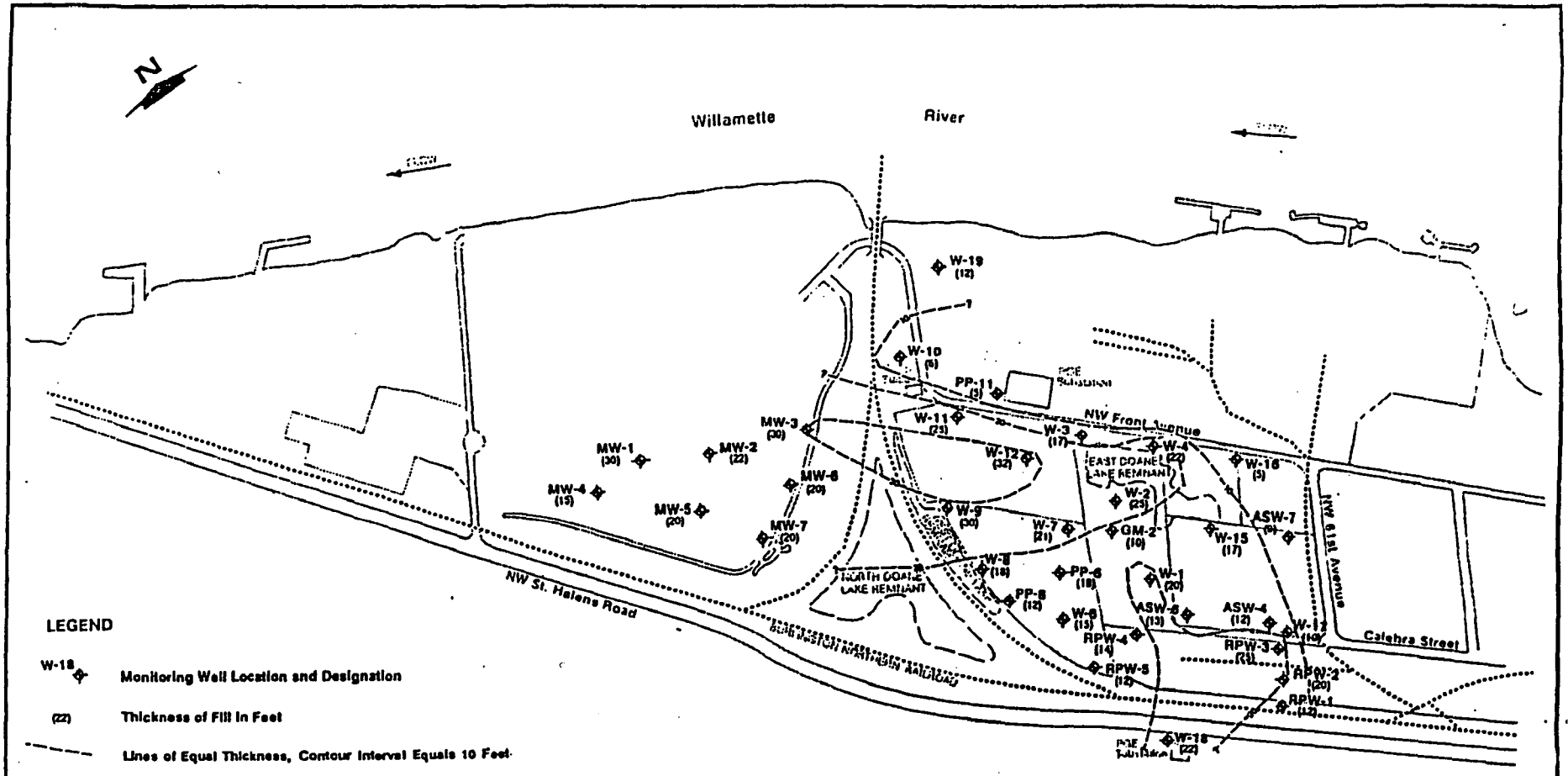
Doane Lake Area
Portland, Oregon.

DRAWN BY	COMPILED BY	DATE	PROJECT NUMBER
SAC	AAR	FEB. 1991	WA103.01

FIGURE 3-4



Koppers022361



GERAGHTY & MILLER, INC.
Environmental Services

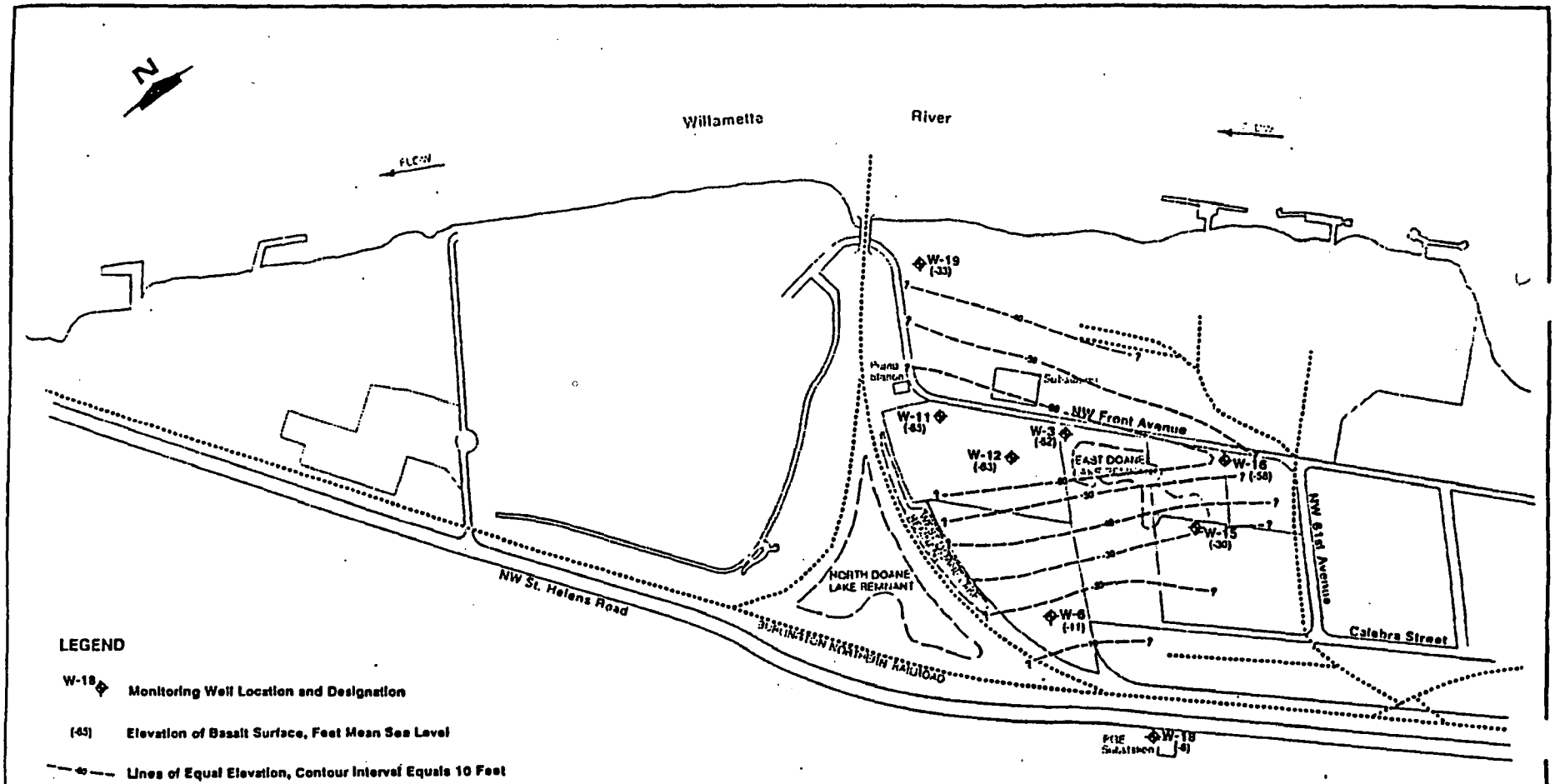
ISOPACH MAP OF FILL

Doane Lake Area
Portland, Oregon

DRAWN BY	COMPILED BY	DATE	PROJECT NUMBER
SAC	AAR	FEB. 1991	WA1030 01

FIGURE 3-11

Koppers022362



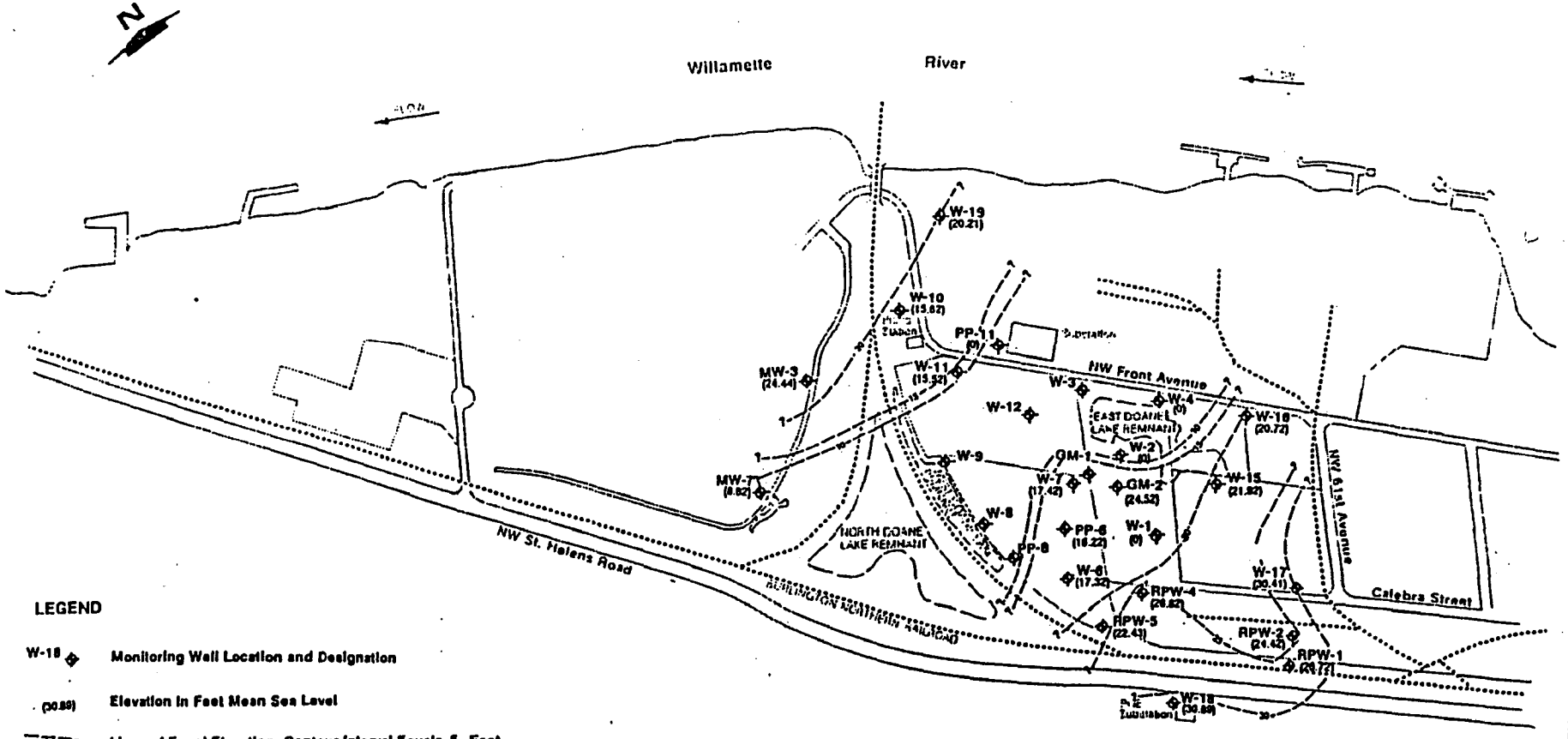
GERAGHTY & MILLER, INC

BASALT SURFACE CONTOUR MAP

Doane Lake Area

FIGURE 3-17

Koppers022363



LEGEND

W-18 ◈ Monitoring Well Location and Designation

(30.89) Elevation in Feet Mean Sea Level

Lines of Equal Elevation, Contour Interval Equals 5 Feet

0 500 1000

Approximate Scale in Feet

GERAGHTY & MILLER, INC.
Environmental Services

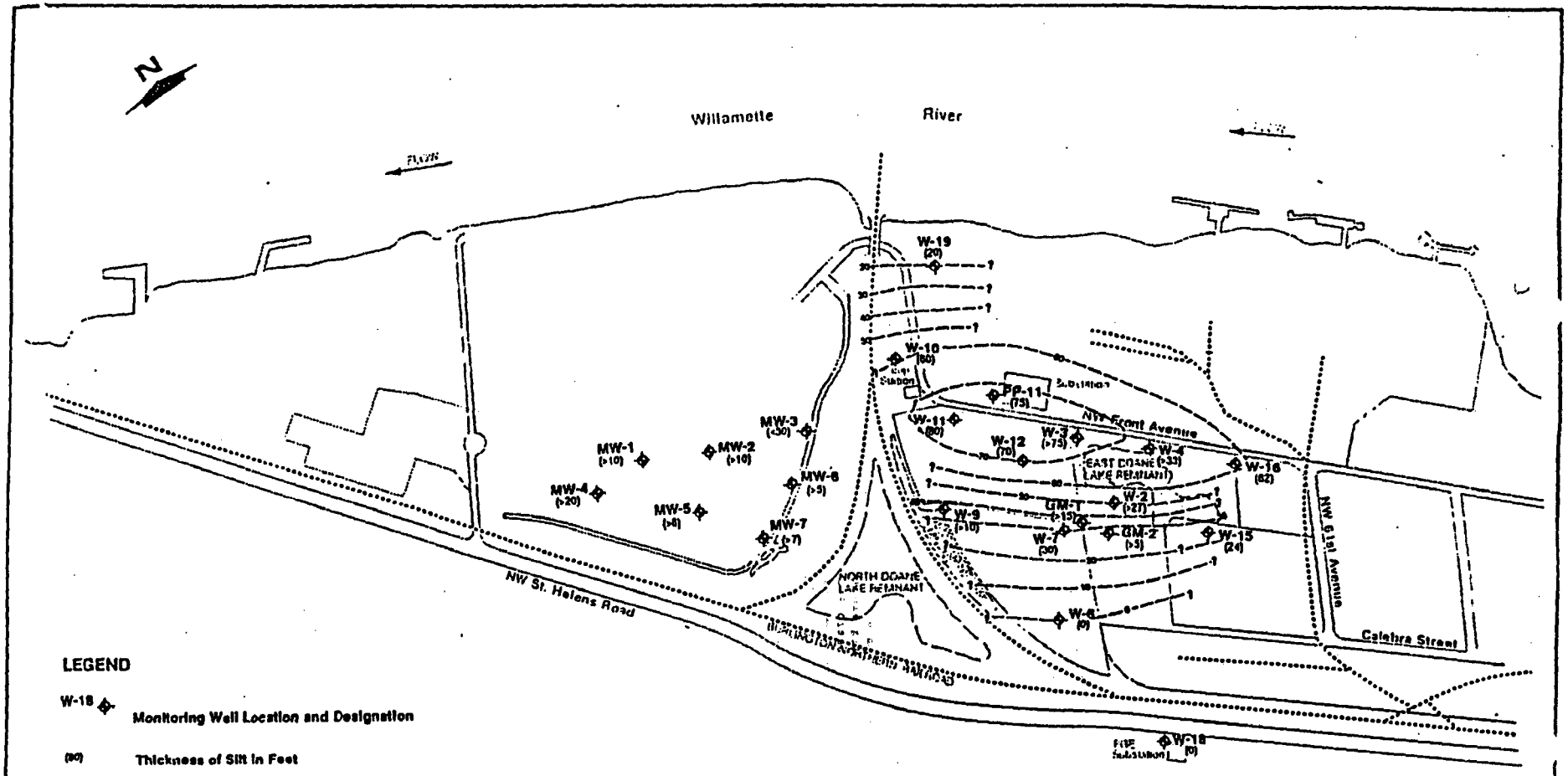
ELEVATION OF TOP OF SAND UNIT

Doane Lake Area
Portland, Oregon

DRAWN BY	COMPILED BY	DATE	PROJECT NUMBER
SAG	AAR	FEB. 1991	WA103.01

FIGURE 3-14

Koppers022364



GERAGHTY & MILLER, INC.

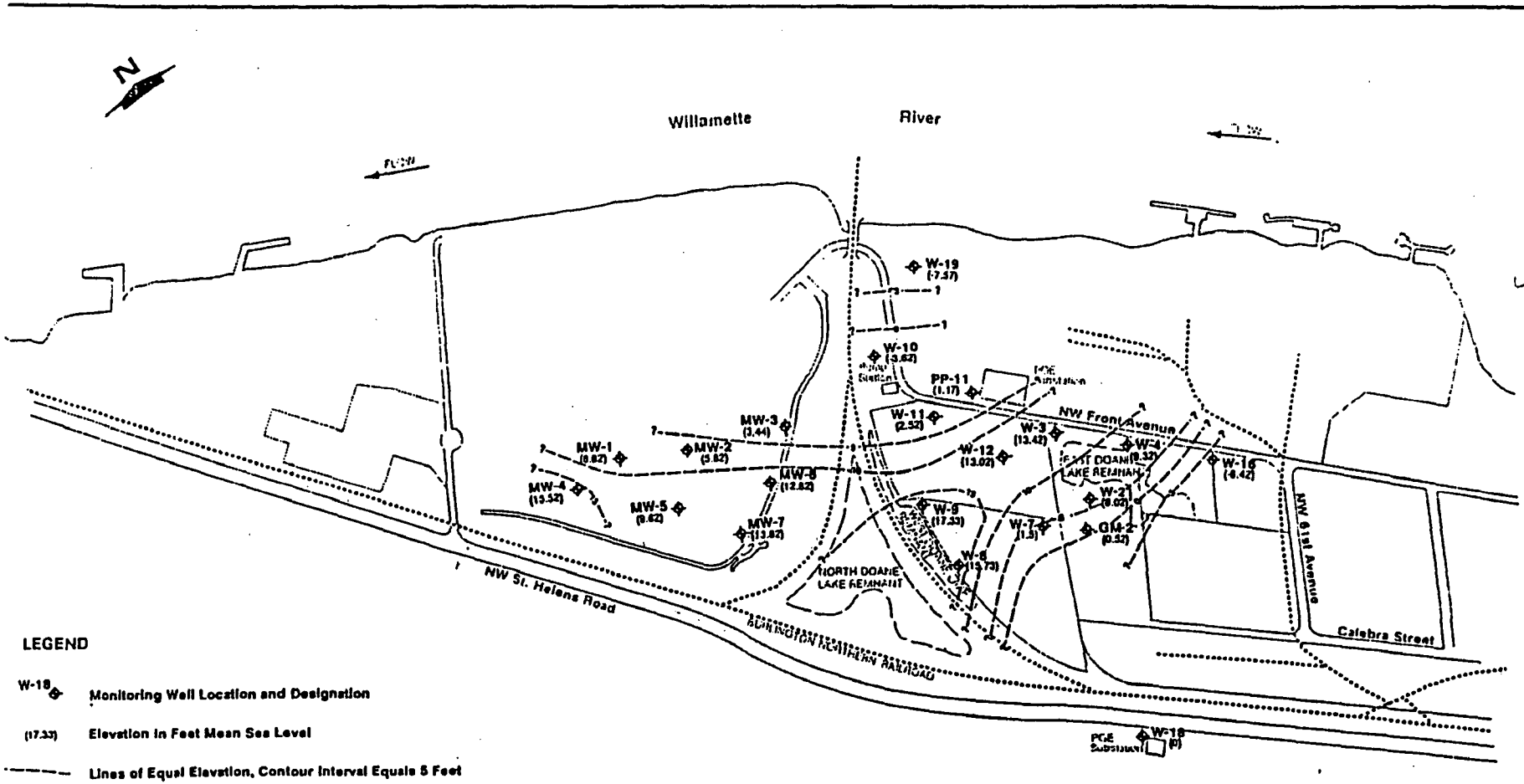
ISOPACH MAP OF SILT UNIT

Doane Lake Area
Portland, Oregon

DRAWN BY
COMPILED BY
DATE
PROJECT WA101.01

FIGURE 3-15

Kappers02365



LEGEND

W-18 ◆ Monitoring Well Location and Designation

(17.33) Elevation in Feet Mean Sea Level

——— Lines of Equal Elevation, Contour Interval Equals 5 Feet

Forest Park
Tualatin Mountains

0 500 1000
Approximate Scale in Feet

GERAGHTY & MILLER, INC.
Environmental Services

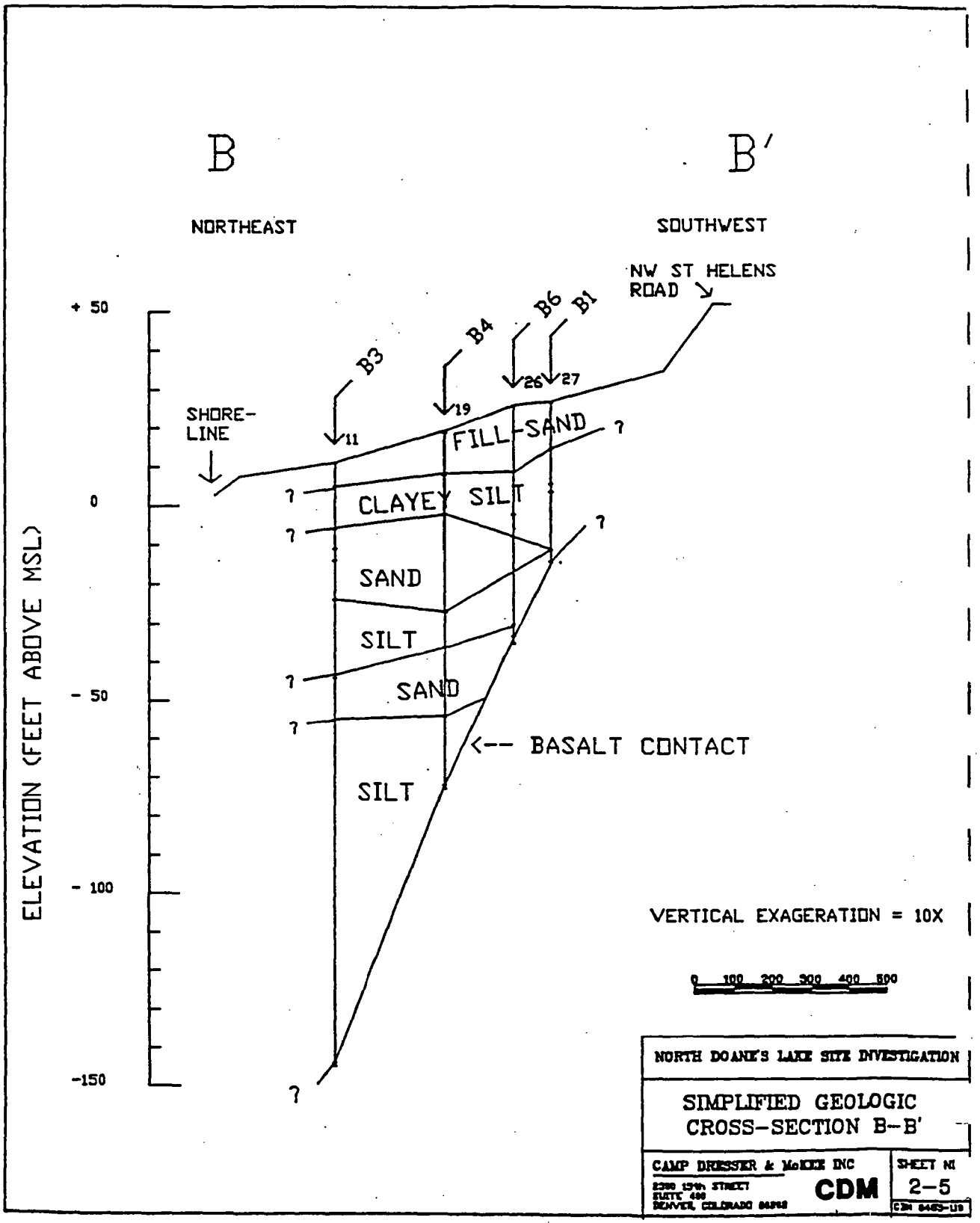
ELEVATION OF TOP OF SILT UNIT

Doane Lake Area
Portland, Oregon

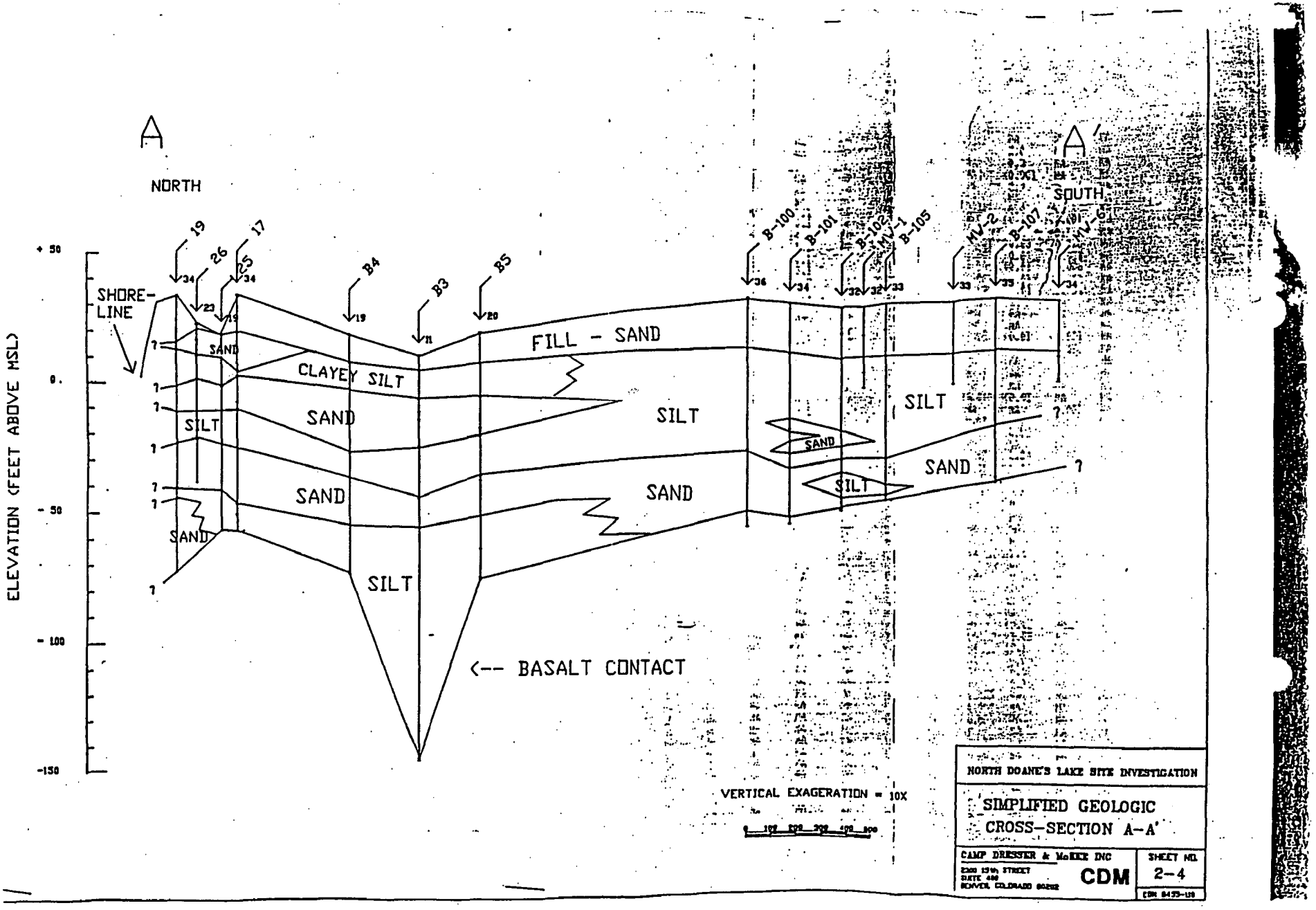
DRAWN BY	COMPILED BY	DATE	PROJECT NUMBER
SAC	AAR	FEB. 1991	WA103.01

FIGURE 3-16

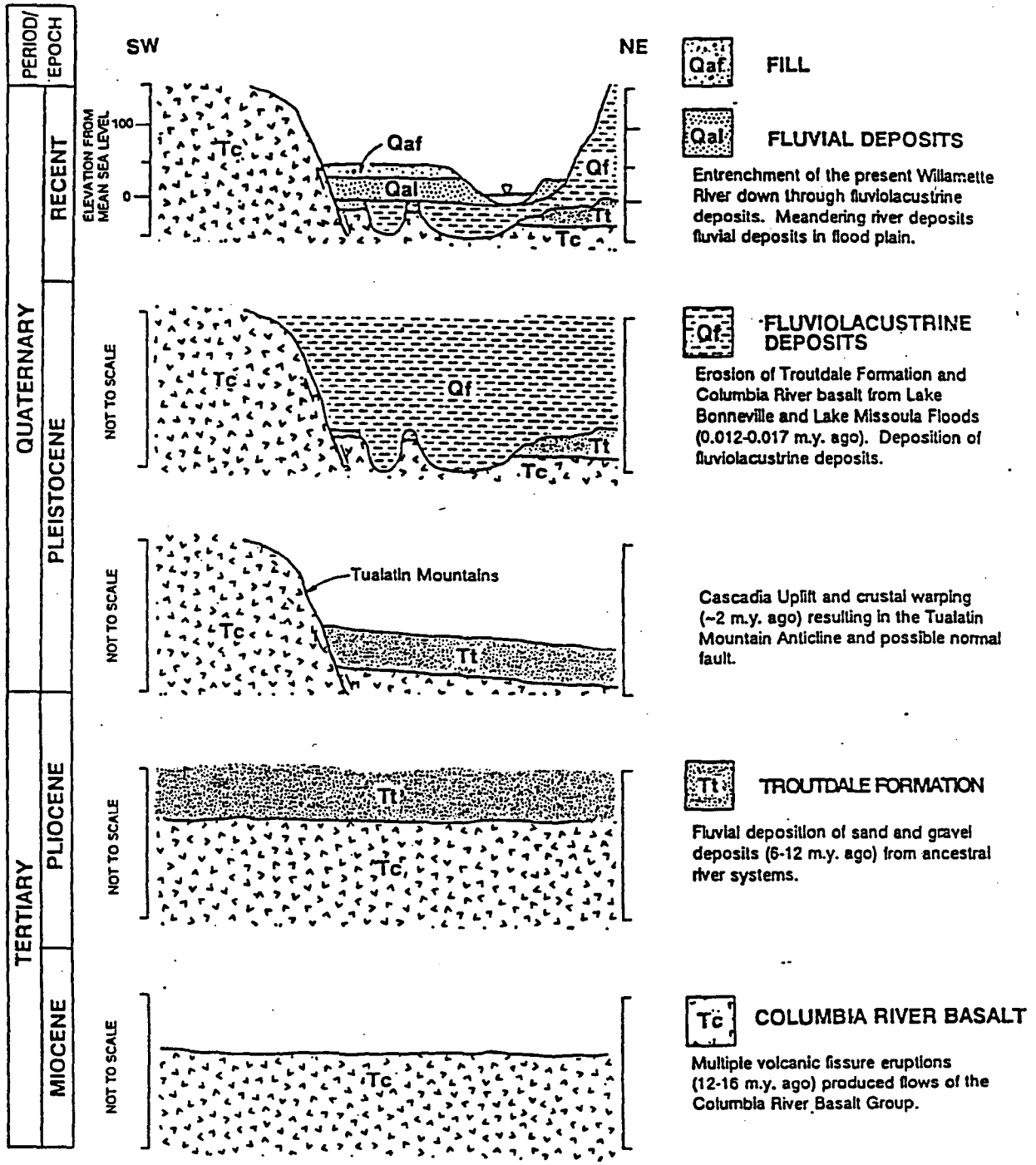
Koppers022366



Koppers022367



Koppers022368



Horizontal Scale: No Scale

GERAGHTY & MILLER, INC.
Environmental Services

GENERALIZED GEOLOGIC HISTORY

Doane Lake Area
Portland, Oregon

FIGURE 3-10

DRAWN BY	COMPILED BY	DATE	PROJECT NUMBER
SAC	AAR	FEB. 1991	WA08301

Koppers022369

APPENDIX C

Northwest Natural Gas Company Office Correspondence
Dated December 8, 1994

Koppers022370

NORTHWEST NATURAL GAS COMPANY
OFFICE CORRESPONDENCE

Date: December 8, 1994

To: Memo to Gasco File

From: S.K. Hart

Subject: **City of Portland - Water Policy - Water Sources**

Re: Telephone Conversation with Jeff Golden, Assistant to Commissioner Mike Lindberg, concerning the city of Portland plans for future water supply sources

I asked Mr. Golden what the city of Portland is planning for future water supplies.

Mr. Golden stated that the city is in phase two of their studies. Phase one listed potential water supply sources. Phase two has limited their preferred options to:

- Third Bull Run Reservoir
- River Water
- Aquifer Storage and Recovery

New groundwater wells are not being considered.

S.K. Hart

SKH036/smj

APPENDIX D
Example Boring Log and Monitoring Well Log

Koppers022372

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER**		
PROJECT:	HAI LOGGER:	DRILL START	DRILL FINISH
	SAMPLING METHOD:		
	DRILLING METHOD:	Time:	Time:
	EQUIPMENT TYPE		
	DRILLER:	Date:	Date:
PROJECT #:	DRILLING CONTRACTOR:		

ABANDONMENT DETAILS	SAMPLE NUMBER	TIME	HEADSPACE (ppm)	LAB RESULTS TPH (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: CASING DIAMETER: SURFACE ELEVATION: TOP OF CASING ELEVATION: SOIL DESCRIPTION
							1			
							2			
							3			
							4			
							5			
							6			
							7			
							8			
							9			
							10			
							11			
							12			
							13			
							14			
							15			
							16			
							17			
							18			
							19			
							20			

Koppers022373

HAHN & ASSOCIATES, INC 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	SOIL BORING NUMBER		
	HAI LOGGER:	DRILL START	DRILL FINISH
PROJECT:	SAMPLING METHOD:		
	DRILLING METHOD:	Time:	Time:
	EQUIPMENT TYPE		
	DRILLER:	Date:	Date:
PROJECT #:	DRILLING CONTRACTOR:		

ABANDONMENT DETAILS	SAMPLE NUMBER	TIME	HEADSPACE (ppm)	LAB RESULTS TPH (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: CASING DIAMETER: SURFACE ELEVATION: TOP OF CASING ELEVATION: SOIL DESCRIPTION
							21			
							22			
							23			
							24			
							25			
							26			
							27			
							28			
							29			
							30			
							31			
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022374

KEY TO BORING LOGS

Soil classification in this report is based upon visual and manual field observations which include moisture, consistency, plasticity and grading estimates and should not be construed to imply field or laboratory testing unless presented herein. Soils are classified in accordance with the Unified Soil Classification System. Stratigraphic boundaries are approximate representations only. No warranty is provided as to the continuity of soil strata between borings.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)				
MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COURSE GRAINED SOILS	GRAVELS More Than Half the Course Fraction is Larger Than No. 4 Sieve Size	Clean Gravels With Little or No Fines	GW	Well Graded Gravels, Gravel-Sand Mixtures
			GP	Poorly Graded Gravels, Gravel-Sand Mixtures
		Gravels With Over 12% Fines	GM	Silty Gravels, Poorly Graded Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Poorly Graded Gravel-Sand-Clay Mixtures
More Than Half is Larger Than #200 Sieve	SANDS More Than Half the Course Fraction is Smaller Than No. 4 Sieve Size	Clean Sands With Little or No Fines	SW	Well Graded Sands, Gravelly Sands
			SP	Poorly Graded Sands, Gravelly Sands
		Sands With Over 12% Fines	SM	Silty Sands, Poorly Graded Sand-Silt Mixtures
			SC	Clayey Sands, Poorly Graded Sand-Clay Mixtures
FINE GRAINED SOILS	SILTS AND CLAYS Liquid Limit Less Than 50%		ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands, or Clayey Silts with Slight Plasticity
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL	Organic Clays and Organic Silty Clays of Low Plasticity
More Than Half is Smaller Than #200 Sieve	SILTS AND CLAYS Liquid Limit Greater Than 50%		MH	Inorganic Silts, Micaceous or Diatomacious Fine Sandy or Silty Soils, Elastic Silts
			CH	Inorganic Clays of High Plasticity, Fat Clays
			OH	Organic Clays of Medium to High Plasticity, Organic Silts
HIGHLY ORGANIC SOILS			Pt	Peat and Other Highly Organic Soils

LEGEND FOR BORING LOGS

- Blank Casing
- Slotted Screen
- Cement Grout
- Concrete
- Bentonite
- Sand Pack
- Fill Material

ABBREVIATIONS

NA	Not Applicable
ND	Not Detected Above Detection Limit
NS	Not Sampled
PCBs	Polychlorinated Biphenyls
ppm	Parts Per Million
SPT	Standard Penetration Test
▽	Measured Static Water Level in Well
▼	Estimated Water Level During Drilling

Updated: 1/15/95
File: Boring Log Key

HAHN AND ASSOCIATES, INC.
Project #2708

Koppers022375

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW - 1** **OWRD# 70144**			
PROJECT:	HAI LOGGER:	Roger Brown	DRILL START	DRILL FINISH
	SAMPLING METHOD:	3-inch OD Split Spoon		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	Time: 555	Time: 918
	EQUIPMENT TYPE	Mobile Model B-59		
	DRILLER:	Bob Roberts	Date: 3-Aug-94	Date: 3-Aug-94
PROJECT:	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	1256.8 Feet MSL
TOP OF CASING ELEVATION:	1259.41 Feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	Lab Results PCBs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Steel Monument							-3			
							-2			
							-1			Ground surface
Concrete	M1-01	610	6.1	0.17	37	100			SP	Dry paint residue and container debris at surface. 3-inches of loose sand fill below paint.
					50/6"	70	1			
	M1-02	616	6.9	3.8	32	80				
					50/6"	0	2			
Bentonite	M1-03	624	10.1	ND	50/2"	100				Silty Sandy GRAVEL with Clay - reddish-brown, dry, very dense, well graded, non-cemented, rounded pebbles and cobbles, matrix is stiff and slightly plastic.
							3			
	NS	630	-	-	30	0				
					50/2"	0	4		GM	No recovery, rock in sampler.
	M1-04	635	-	0.056	50/5"	50				
							5			
					21	100				Silty Sandy GRAVEL with Clay - as above, brown, moist
	M1-05	645	12.8	0.069	40	100	6			
					31	0				
							7			Silty Sandy GRAVEL with Clay - as above.
	M1-06	700	-	ND	50/6"	50	8			
							9	8/9/94		
2-inch ID 0.010-inch PVC Slotted Screen							10			
Colorado 20-40 Sand Pack	M1-07	710	18	ND	18	100			GM	Silty Sandy GRAVEL - as above, wet, matrix is loose and non-plastic
					50/6"	50	11			
							12			
	NS	720	-	-	50/2"	0	13			No recovery
							14	8/3/94		
							15			

2-inch ID Blank PVC Casing

Koppers022376

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** OWRD# 70144		**MW - 1**
PROJECT:	HAI LOGGER:	Roger Brown	DRILL START Time: 555 / DRILL FINISH Time: 918
	SAMPLING METHOD:	3-inch OD Split Spoon	
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	
	EQUIPMENT TYPE	Mobile Model B-59	
	DRILLER:	Bob Roberts	Date: 3-Aug-94 / Date: 3-Aug-94
PROJECT:	DRILLING CONTRACTOR:	Geo-Tech Explorations	

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	Lab Results PCBs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
	M1-08	730	10	ND	50/2"	75	16		GM	Silty Sandy GRAVEL - as above
							17			
10-Slot Screen / Colorado 20-40 Sand Pack	M1-09	740	24	ND	20	100	18			
					50/5"	50	19			
Cap							20			Silty Sandy GRAVEL - as above
	M1-10	748	18.9	ND	50/6"	100	21			
							22			
							23			
							24			
							25			Boring terminated at 20.0 feet bgs Sampled to 20.5 feet Monitoring Well installed to 20.0 feet bgs
							26			Materials: 15 feet 2-inch diameter, 0.010-inch PVC slotted screen 10 feet 2-inch diameter PVC blank casing 10 50# bags 20/40 sand 2 50# bags bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts
							27			
							28			
							29			Well depth is 22.4 feet below top of casing
							30			
							31			
							32			
							33			* Sample Prefix Number is 2626-940803-
							34			
							35			

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	1256.8 Feet MSL
TOP OF CASING ELEVATION:	1259.41 Feet MSL

Koppers022377

APPENDIX E

Example Chain-of-Custody Form

Koppers022378

HAHN AND ASSOCIATES, INC.
Environmental Management
434 NW Sixth Avenue, Suite 203 • Portland OR 97209
(503) 796-0717 • Fax (503) 227-2209

Laboratory National Environmental Testing, Inc.
17400 SW U. Boones Ferry Rd., Portland OR
Lab Project No. _____

CHAIN OF CUSTODY

Chain of Custody No. 2708-001

Project Manager: Roger Brown
Project No.: 2708
Project Name: NWNG Gasco Site
Collected by: _____

Liquid with Sediment Sample
_____ Test Filtrate _____ Test Sediment _____ Test Both
Multi-Phase Sample
_____ Test One (which) _____ Test Separately _____ Shake

Samples Received at 4C (Y or N) _____
Appropriate Containers Used (Y or N) _____
Provide Verbal Results (Y or N) No
Provide Preliminary Fax Results Yes

Comments

NOTE:
Sample Number Prefix: 2708-950322-

Lab ID	Sample #	Date	Time	Sample Description	Matrix: Soil	Matrix: Water	Matrix: Other	Number of Containers	TPH (ODEQ TPH-HCID)	TPH (Quantify as necessary)	PAHs - (EPA 8270 SIM)	BTEX (EPA 8020)	Phenols, Cresols (EPA 8270)	Total Lead (EPA 6010)	TCLP Lead (EPA 1311, 6010)	Cyanide (EPA 9010)		RUSH	Remarks

Relinquished by	Company	Date	Time	Received by	Company
Relinquished by	Company	Date	Time	Received by	Company

Koppers022379

APPENDIX F

Example Project Field Notes Form

Koppers022380

HAHN AND ASSOCIATES, INC.
PROJECT FIELD NOTES

Date : _____
Project: _____
Project Manager: _____

WORK FORCE	EQUIPMENT	SITE
HAI	Rental/Vendor	Conditions
Subcontractor	Rental/Vendor	Temperature
Subcontractor		

HAI EQUIPMENT

Air Pump (Sensidyne)	Gas Meter (GasTech)	Measuring Wheel	Pump, Peristaltic	Water Level Meter
Bailer (SS or Teflon)	Hand Auger	OVA (MicroTip/PID)	Pump, Submersible	Zone Sampler
Cond/pH/Temp Meter	Interface Probe	Power Tool	Purge Pump	
Data Logger (Hermit)	Magnetometer	Pressure Transducer	Wtr Filtration Unit	

HAI SUPPLIES

Bailer (disposable)	Drum Liners	Profile Shipping Kit	Sorbent Boom	
Bentonite (bags)	Gloves, disposable (pr.)	Resp. Cartridges (pr.)	Sorbent Pads	
Booties (pr.)	Gloves, Edmont (pr.)	Sample Tubes	Stakes	
Chlor D Tect Kit	Gloves, Solvex (pr.)	Sensidyne Tubes	Tyvek, coated	
Concrete (bags)	Labels	Siphon Pump	Tyvek, uncoated	
Distilled Water (gal)	Locks	Sorbent (bags)	Water Filters	

ACTIVITIES

Leave Office:	Arrive Site:	Leave Site:	Arrive Office:	
Respirator Use/ Hours:___ Minutes:___		Odometer Out:	Odometer In:	Total Mileage:

Time	Task Description

(3/94)

Signed _____

HAHN AND ASSOCIATES, INC.
PROJECT FIELD NOTES

Page ___ of ___
Date : _____
Project: _____
Project Manager: _____

CONTINUATION SHEET

Time	Task Description

(5/92)

Signed _____

Koppers022382

7304 – TECHNICAL REPORT PORTLAND
Remedial Investigation & Feasibility Study,
1996

Koppers022383

7304 – TECHNICAL REPORT **PORTLAND**
ODEQ request for KII's input land and water use associated with KII's property re: neighbor Rhone-Pollen CO w/ ODEQ to conduct RI/FS

Koppers022384

KOPPERS INDUSTRIES

FAX TRANSMITTAL

Koppers Industries, Inc.
7540 N.W. St. Helens Road
Portland, OR 97210-3683
Telephone: 503-286-3681
Fax: 503-285-2831

TO: Bill Swearingen DATE: 11/22/96

FROM: (Famous) Amos TOTAL # OF PAGES: 7

Please review the attached and call to discuss.

Thanks.

IF THIS TRANSMITTAL IS IN ERROR, PLEASE CALL 503-286-3681 FAX # 503-285-2831

RECEIVED
NOV 22 1996
KOPPERS INDS., INC.
PORTLAND, OR

Oregon

DEPARTMENT OF ENVIRONMENTAL QUALITY

NORTHWEST REGION

November 20, 1996

Property Manager
Koppers Industries, Inc.
7540 NW St. Helens Road
Portland, Oregon 97210

RE: Remedial Investigation and Feasibility Study
6200 NW St. Helens Road, Portland, OR
Request for Information on:

(1) Current and Reasonably Likely Future Land Use
(2) Current and Reasonably Likely Future Beneficial Use of Surface Water and Groundwater

Dear Sir:

The Department of Environmental Quality (DEQ) is overseeing investigation and cleanup of Rhone-Poulenc Ag Company's former pesticide manufacturing plant site located at 6200 NW St. Helens Road, in northwest Portland. Rhone-Poulenc is conducting a Remedial Investigation and Feasibility Study (RI/FS) of the site and affected surrounding areas under a Consent Order with DEQ.

As part of the RI/FS, Rhone-Poulenc must evaluate chemicals that have come from their site, wherever they may be present in soil and water. Rhone-Poulenc must assess any risk of exposure these chemcials may pose to humans and the environment. As part of their risk evaluation, Rhone-Poulenc must compile information on the current and reasonably likely future land uses and current and reasonably likely future uses of surface water and groundwater in the locality of the site. This information will be used to determine what level of remediation will be required.

When Rhone-Poulenc has completed their RI/FS, now expected for September of 1998, DEQ will select a cleanup remedy and will initiate a public comment process. A map of the general area is attached, along with a copy of the most recent Environmental Cleanup Project Bulletin describing the Rhone-Poulenc site, hazardous substances that have been released to the environment, and the current status of the RI/FS work.

As a property owner in the neighborhood of the Rhone-Poulenc site, DEQ would like your input on land and water use associated with your property. Your property may be located upgradient of the site with respect to surface water and groundwater flow. DEQ is seeking the following information:

1. historic land, surface water and groundwater uses,

John A. Kitzhaber
Governor

2020 SW Fourth Avenue
Suite 400
Portland, OR 97201-4987
(503) 229-5263 Voice
TTY (503) 229-5471
DEQ-1

2. current land uses and beneficial uses of surface water and groundwater, and
3. reasonably likely future land uses and beneficial uses of surface water and groundwater.

To make your reply easier, DEQ has prepared the enclosed response postcard and would appreciate if you would complete the postcard and return it by December 11, 1996. DEQ will consider your comments, along with those of agencies and other neighborhood property owners, to ensure that the cleanup remedy to be proposed by Rhone-Poulenc will be protective.

Please call me at (503)229-5071 if you have any questions or need additional information.

Sincerely,

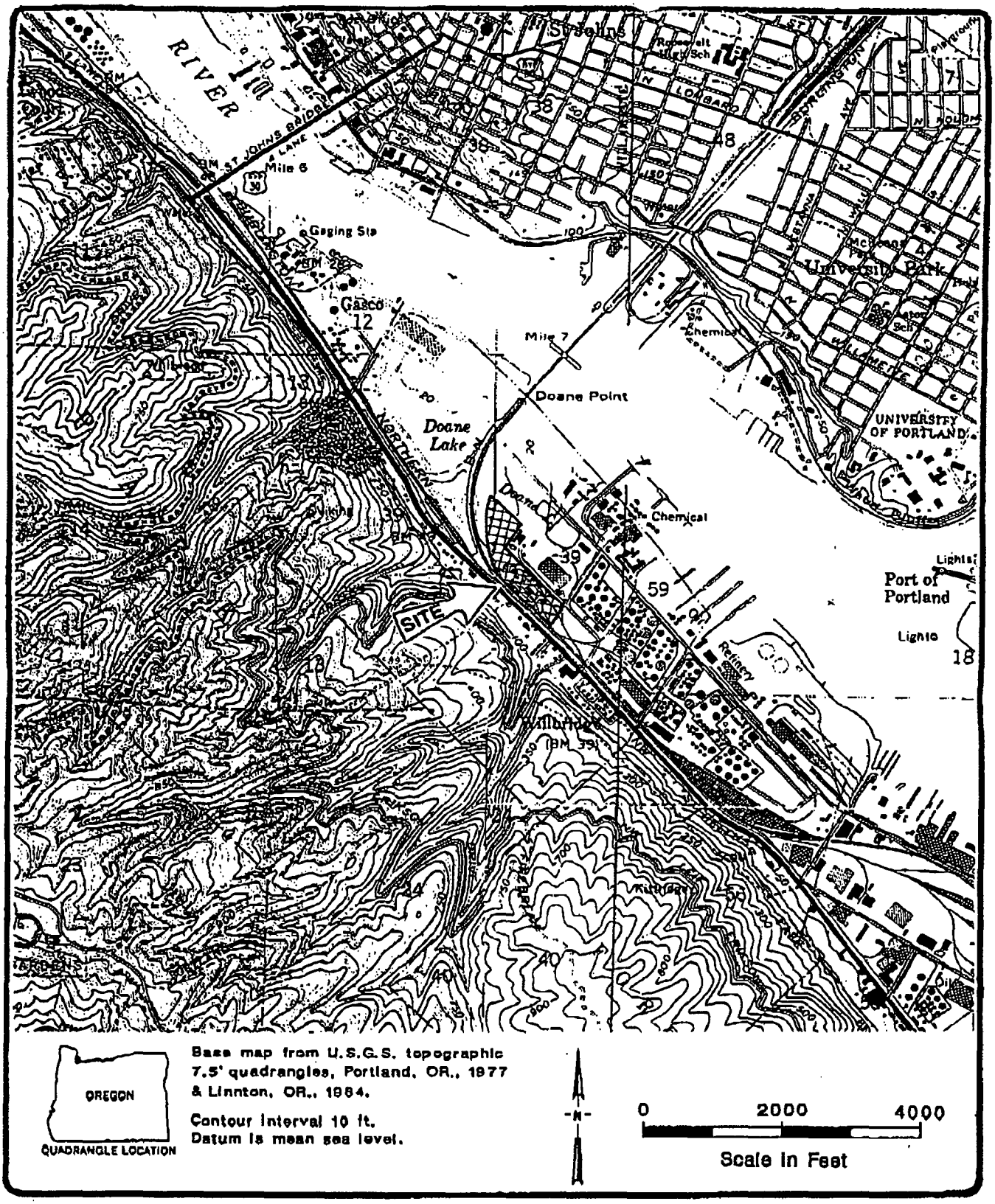
Mavis D. Kent

Mavis D. Kent
DEQ Project Manager

Attachments: Area Map, Cleanup Bulletin, land/water use response form

Property: T1N, R1W, Sec 12, Tax Lot 111 (AREA 5)			
Your Telephone Number for Contact by DEQ:			
Check all of the boxes below that apply to your property and return by mail to DEQ			
Historic	**Current**	**Planned**	**Land Activity/Use**
			Residential
			Commercial
X	X	X	Industrial
			Agricultural
			Recreational
			Other (describe)
			Water Uses
X	X	X	Drinking Water
			Irrigation/Landscape
X	X	X	Industrial PRocess
			Recreational
			Aesthetic (decorative)
			Wildlife
			Other (describe)
			Water Sources(s)
X	X	X	Municipal Supply
			Small Supplier (<5)
			On-site well
			Surface water
Additional Comments?			
For more information contact Mavis D. Kent (503)229-5071 DEQ, NWR, 2020 SW 4th Ave., Ste. 400, Portland OR 97201			

- Boilers
Wet down trucks



EMCON Northwest, Inc.

DATE 11/91
DWN. MMM
APPR. WLC
REVIS.
PROJECT NO. 0240005.16

Figure 1-1
RHÔNE POULENC AG COMPANY
QUARTERLY PROGRESS REPORT - NO. 2

SITE LOCATION MAP

Cleanup Project Bulletin

Quarterly Report November, 1996

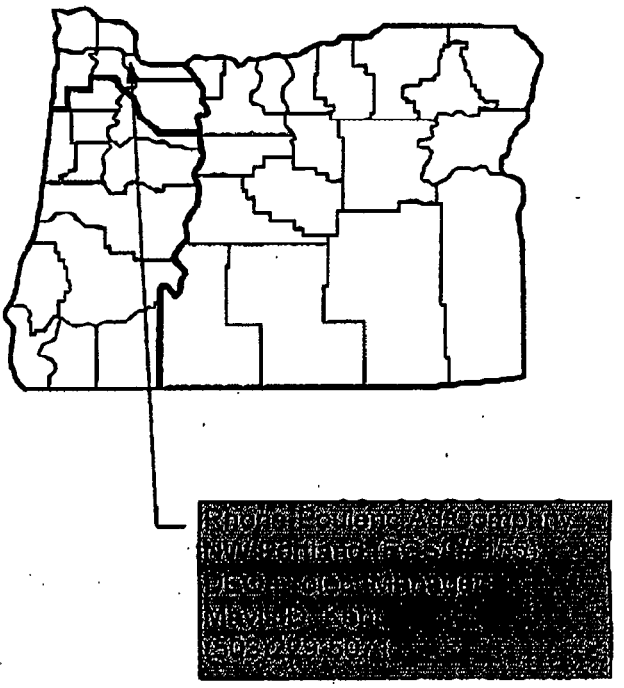
Rhone-Poulenc Ag Company

Project Overview

Rhone-Poulenc Ag Company (RPAC) owns the property at 6200 St. Helens Road where they operated an agrochemical facility from the mid-1940s until manufacturing ceased in the fall of 1990. During operation, the plant manufactured and packaged a variety of herbicides and insecticides, most recently producing only bromoxynil octanoate. Past product and waste spills and disposal of wastes have resulted in contamination of surface water, groundwater and soil. Releases at the site have been primarily through leaks and spills of liquid waste and product into storm drainages discharging into West and East Doane Lake, and historic releases of treated waste water into West Doane Lake and the Willamette River.

An EPA Field Investigation Team sampled the site in 1982 and identified 37 priority pollutants and over 100 non-priority pollutants. The main contaminants are 2,4-D and other pesticides, dichlorobenzene and isomers, chlorinated phenols, chlorinated cresols, other phenolic compounds, benzene, toluene, ethyl benzene, TCE, methylene chloride, dioxin/furans and metals. RPAC began investigation of the site in 1980, and installed a shallow groundwater recovery and treatment system in 1984.

In summer 1992, most of the plant structures and storage facilities were demolished. What remains are the administrative building, two small storage buildings, one of which houses drummed soil cuttings waste, and tanks, piping and machinery related to their stormwater and groundwater treatment facility. Drummed soil waste is regulated under RCRA rules described in Consent Order Addendum 1. Waste water treatment and discharge is regulated under an existing NPDES Permit.



The site is adjacent to the NL/Gould Superfund site, and battery cases related to the Gould site are buried in portions of the northern third of RPACs property. NL/Gould site cleanup has occurred in RPACs Lake Area from late 1993 through late 1994 with excavation of some of the battery casing waste. An NL/Gould ROD amendment, recently out for public comment, would require no further excavation of battery casings, and placement of clean fill in the existing excavation and a cap across the Lake Area. A draft ROD for the NL/Gould site is expected to be out for public comment during the third quarter.

DEQ approved a workplan to complete the RI/FS in October, 1994. RI work, ongoing since the late 1980's, resumed in November, 1994. Additional groundwater monitoring wells were installed by late 1995. Groundwater sampling was conducted in fall of 1995 and again in Spring of 1996. A second Addendum to the existing Consent Order, effective on February 1, 1995, revised the overall RI/FS

schedule. A third Addendum to the Consent Order, effective on September 6, 1996, expanded the scope of RI, Risk Assessment (RA) and FS work to include investigation of East Doane Lake organic contamination, and revised the due dates for the draft and final RI/EA and FS reports, and added necessary RI, EA and FS tasks.

RPAC submitted sampling plans (SAPS) for East Doane Lake sediment and groundwater. These SAPS were approved by DEQ in September, 1996. RPAC submitted a draft East Doane Lake Interim Remedial Measure work plan in October, 1996, including the approved sediment and groundwater SAPS. DEQ review comments on the work plan are pending. Field work for East Doane Lake sediment and groundwater sampling is expected to begin before the end of 1996, as soon as property access is secured.

Environmental Concerns

The risk of exposure to site chemicals for both human and ecological receptors is being addressed by RPAC. A determination of current and reasonably likely future land use and current and reasonably likely future beneficial use of surface and groundwater onsite and offsite will be made to identify and confirm appropriate human health and ecological risk exposure scenarios. This determination will be based on land and water use information that has been submitted by RPAC and will be collected by DEQ.

Site contaminants have been detected in surface water, including North, West, and East Doane Lakes (remnants of an older and larger Doane Lake), and in groundwater seepage into the Willamette River some 2000 feet to the east of the site. Site contaminants have also been detected in groundwater beneath the site and on downgradient properties.

Other potential pathways for exposure include contaminated surface and shallow soil in the Herbicide and Insecticide Areas and some areas of shallow soil in the Lake Area. Air discharges from the existing onsite waste water treatment system, currently treating both storm discharge and extracted contaminated groundwater, will be assessed during remedial alternative development and evaluation.

Non-aqueous phase liquids are present in soil at and below the water table beneath the plant area of the site, the existing waste water treatment plant, in western portions of the Lake Area and the northwesternmost corner of the NL/Gould property. Groundwater beneath the main plant area and portions of the Lake Area may provide a pathway for contamination to reach nearby surface water bodies.

7305 – TECHNICAL REPORT PORTLAND
Phase I Remedial Investigation Summary Report &
Preliminary Analysis of Soil Data, Volume 1&2– 10/9/98

Koppers022392

Koppers022393

KOPPERS INDUSTRIES

Koppers Industries, Inc.
1005 William Pitt Way
Pittsburgh, PA 15238

Telephone: (412) 826-3970
FAX: (412) 826-3999

April 24, 1997

Northwest Natural Gas Company
220 N.W. Second Avenue
Portland, Oregon 97209

Fax transmission to: 503/273-4815, 7 pages.

Attention: Ms. Sandra Hart, Manager Environmental and Engineering

Reference: Koppers, Portland Terminal - Soils Investigation.

Dear Ms. Hart:

Please find attached the Geo Engineers' summary and boring logs of the test borings that we discussed yesterday. I spoke with Jack Tuttle today and he indicated that he thought most of the contamination that they found had a petroleum odor. The depths and qualitative degree of contamination are indicated on the log sheets. Geo Engineers is holding refrigerated samples of the contamination for subsequent analysis, if desired.

Amos Kamerer and I would like to discuss these findings and the impact on our tank construction project with you while I am in Portland next Wednesday and Thursday. I will call you tomorrow to set up a meeting time.

Sincerely,

James T. Dietz, P.E.
Manager of Engineering

cc: Amos Kamerer - Koppers Industries, Portland Terminal, by fax.
Bill Swearingen - Koppers Industries, Pittsburgh, by fax.

→ BILL SWEARINGEN - LET'S DISCUSS.

GeoEngineers

MEMORANDUM

Portland

TO: Jim Dietz, Koppers Industries

FROM: Jack Tuttle

DATE: April 22, 1997

FILE: 5823-001-43

SUBJECT: Summary of Contamination in Test Borings

Jim,

The boring logs have not yet been drafted to final form for the report so I am summarizing the information with respect to contamination by memo. We will fax copies of the logs no later than tomorrow.

Two borings were drilled in the area of the two tanks to be constructed initially. The surface is paved at both boring locations. Beneath the pavement and base course layer, we encountered sand to a depth of 20 to 21 feet. Contamination in this stratum was observed to increase with depth. In the lower portion of the sand layer, free product was noted on the sampler and the concentration of vapors from the borehole increased to the level where it was necessary for the drill crew and our field representative to upgrade personal protection to Level C which included the use of full face respirators with organic vapor cartridges in order to complete the drilling safely. The contamination was noted to extend several feet into the silt layer which was encountered from a depth of 20 to 21 feet down to nearly 40 feet. The contaminant noted in the soil and on the sampling and drilling equipment was described as a coal-tar like substance. We have not submitted any samples to chemical analyses to define the nature or concentration of contamination in accordance with your instructions. We have maintained samples for such testing, if desired.

The cone probes were located in the future tank area near the location of one of the borings (Boring 23) drilled for environmental studies for NW Natural Gas by Hahn and Associates. The probe equipment was noted to be contaminated and had to be cleaned after each probe was completed. No observations of the level of vapors or other evidence of contamination are possible with the probe explorations.

Overall, the level of contamination observed in the borings appears to be comparable to that reported in Boring 23. Borings 24 and 25, also drilled by Hahn, were reported to have lower levels of contamination based on vapor concentrations measured in the borings.

It should be expected that any excavations for tank foundations will encounter contaminated soils which will require special handling and disposal. Also, the contractor will be responsible for preparing a health and safety plan and implementing proper personnel protection measures and work

procedures based on characterization of the soils within the depths of excavation planned. It will be advantageous to minimize the extent of any excavation as much as practical.

The data available from the Hahn report and the observations from our borings is considered sufficient for development of the construction health and safety plan and should be provided to your contractor for his use. During excavation, sampling and chemical testing of the excavated soils will be necessary to characterize the materials for selection of an appropriate disposal site.

If you have any questions about our observations and these conclusions, please call me at 503/6687.

TEST DATA

BORING G-1

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION	Surface Elevation (ft.):
					AC	3 to 4 inches asphalt concrete	0
					GP	1 1/2-inch-minus gravel (dense, moist) (fill)	
					SM	Black silty fine sand with occasional gravel (loose, moist)	
			8			(petroleum-like odor, field screening: moderate sheen, TLV = 400 ppm)	
					SP	Gray-black fine sand with trace silt (loose, moist)	5
			9			(petroleum-like odor)	
			5			Grades to wet (field screening: heavy sheen, TLV = 250 ppm)	
			6			Soil saturated with heavy petroleum-like material	10
			6			(field screening: heavy sheen, TLV = 1,800 ppm)	15
			2		ML	Dark gray silt with trace to no fine sand (soft, moist) (petroleum-like odor)	20
			6			Grades to medium stiff and gray with brown mottling (no petroleum-like odor, field screening: slight sheen, TLV = 160 ppm)	25
			P				
			5		ML	Brown with gray mottling silt with trace fine sand (medium stiff, moist)	30
			4			(field screening: no sheen, TLV = 180 ppm)	35
					SM	Brown silty fine sand (loose, wet)	40

DEPTH IN FEET

Note: See Figure A-2 for explanation of symbols

DLT:MMB:MLN 4/24/97

5823-001-43-2130

LOG OF BORING

FIGURE A-3

TEST DATA

BORING G-1 (Continued)

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
			3			(field screening: no sheen, TLV = 100 ppm)
			2		ML	Brown silt with trace fine sand (soft to medium stiff, moist)
			7			Grades to medium stiff
						Increasing sand content at depth
						Boring completed at 51.5 feet on 04/11/97

DEPTH IN FEET

40 45 50 55 60 65 70 75 80

Note: See Figure A-2 for explanation of symbols

DLT:MMB:MLN 4/24/97

5823-001-43-2130

LOG OF BORING

FIGURE A-3

TEST DATA

BORING G-2

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
						Surface Elevation (ft.):
					AC	1 inch asphalt concrete
					GP	1 1/2-inch-minus gravel (dense, moist) (fill)
					SP	Gray-black fine sand with trace to no silt (medium dense, moist)
			14			(no petroleum-like odor)
			10			(field screening: slight sheen, TLV = 60 ppm)
			7			Grades to loose, wet Soil saturated with petroleum-like product
			3			(field screening: moderate sheen, TLV = 110 ppm)
			2			
			3		ML	Dark gray silt with fine sand (soft, moist) (field screening: slight sheen, TLV = 1,600 ppm)
			3			Grades to gray
			6		ML	Brown with gray mottling silt with trace fine sand (medium stiff, moist) (field screening: slight sheen, TLV = 100 ppm)
			1		SM	Brown silty fine sand (loose, moist to wet)
			5			

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

Note: See Figure A-2 for explanation of symbols

DLT:MMB:MLN 4/24/97

5823-001-43-2130

LOG OF BORING

FIGURE A-4

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TEST DATA

BORING G-2
(Continued)

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
						(field screening: no sheen, TLV = 100 ppm)
			9			
			15			(field screening: slight sheen, TLV = 100 ppm)
			28		SP	Gray-brown fine sand with silt (medium dense, wet) (field screening: no sheen, TLV = 40 ppm)
			50/1"		GM	Dark gray silty fine gravel (weathered bedrock) (very dense, wet)
						Boring completed at 58.6 feet on 04/12/97

DEPTH IN FEET: 40, 45, 50, 55, 60, 65, 70, 75, 80

Note: See Figure A-2 for explanation of symbols

DLT:MME:MLN 4/24/97

5823-001-43-2130

LOG OF BORING

FIGURE A-4

Meeting - Northwest Natural Gas
Subject: Soils investigation at Terminal

J.D. Have a basis for foundation design
Could excavate down to 20 feet deep and refill
then build tanks and allow

Prefer using a piled foundation
Excavate no more than 15 feet down
What about soil disposal - KII will do

S.H Worried about disturbing DNAPL's with piling
Brownfield law - cleanup based on risk + cost benefit
Piling for dockwork is OK

J.D. Need written into scope of work on piling + soil disposal ← important "how piling will be done"
Will do more soil profiling
KII to pay for soil disposal

A.K. Go to Board at August meeting
Start permitting process now
Want foundation poured by end of year
Land use - greenway permit to go forth now

Set up meeting with DEQ + NW Nat Gas soon

S.H. Will check ↑ non HW only
incinerate soil Rivergate close-by (kilns)
landfills won't take locally

Koppers022401

KEY ENVIRONMENTAL INCORPORATED

March 9, 2001

Ms. Traci Self
Manager, Environmental Programs
Koppers Industries, Inc.
436 Seventh Avenue
Pittsburgh, PA 15219-1800

Re: Northwest Natural Gas Gasco Site and Koppers Northwest Terminal Site Portland, Oregon

Dear Ms. Self:

On behalf of Beazer East, Inc. (Beazer), please find enclosed one copy of the following documents:

Phase I Remedial Investigation Summary Report and Preliminary Analysis of Soil Data dated October 9, 1998 (Volumes 1 and 2).

Phase II Remedial Investigation Data Package and Progress Report for Fourth Quarter 1998 RI/FS Activities dated February 17, 1999.

These reports were recently provided to Beazer by Northwest Natural Gas.

If you have any questions regarding this correspondence, please contact Ms. Shannon Craig, Beazer Environmental Manager, at (412) 208-8857.

Sincerely,

James S. Zubrow
Principal Hydrogeologist

cc: S. Craig - w/o enclosures

P:\Beazer\northwest terminal\99-804\kii report transmittal.wpd

Rosslyn Farms Industrial Park • 1200 Arch Street • Suite 200 • Carnegie, PA 15106 • (412) 279-3363 Fax: (412) 279-4332

PHASE I REMEDIAL INVESTIGATION SUMMARY REPORT AND PRELIMINARY ANALYSIS OF SOIL DATA (As Appendix 1)

Volume 1

Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

October 9, 1998

DMA

6121 SW Tower Way
Portland, Oregon 97221
503/244-9765

HAHN AND ASSOCIATES, INC.
Environmental Management

434 NW 6th Avenue, Suite 203
Portland, Oregon 97209-3600
503/796-0717 • 503/227-2209 FAX

Recycled Recyclable

PHASE I REMEDIAL INVESTIGATION SUMMARY REPORT AND PRELIMINARY ANALYSIS OF SOIL DATA (As Appendix 1)

Volume 1

Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

October 9, 1998

Prepared for:

Northwest Natural
Portland, Oregon

Prepared by:

Hahn and Associates, Inc.
Portland, Oregon

and

Decision Management Associates LLC
Portland, Oregon
(Appendix 1)

HAI Project No. 2708

Koppers022404

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2 Site Map

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1 Soil Contamination Evaluation Report, Decision Management Associates LLC

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- Groundwater Elevation Maps
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F Residual Product Maps

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H Groundwater Quality Data
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I On-Site Surface Water and Sediment Quality Data
- Sample Location Maps
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J Willamette River Sediment Quality Data
- Sample Location Maps
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K Air Data
- Chemical Exposure Air Monitoring Report
- Ambient Air Quality Monitoring Report
- Dust Sample Evaluation Chart and Data

L Geophysical Evaluation of Former Tar Pond Area, GeoPotential, Inc.

M Geological Cross-Sections

Koppers022407

PHASE I REMEDIAL INVESTIGATION
SUMMARY REPORT
AND
PRELIMINARY ANALYSIS OF SOIL DATA

Northwest Natural
Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

October 9, 1998

1. PURPOSE

The purpose of this report is to provide a summary and analysis of existing data collected as part of Phase I Remedial Investigation (RI) activities at the Gasco site to assist in the understanding of the site, and to guide decisions regarding additional data acquisition.

As the overall goals of RI activities are to characterize site conditions, provide for an evaluation of the risks to human health and the environment posed by the site, and to provide the basis for the identification and implementation of appropriate remedial actions based on those risks, the following investigatory objectives exist:

- To confirm the contaminants of concern at the site
- To determine the affected media at the site
- To characterize the nature and extent of the contaminants of concern in the affected media at the site
- To identify and characterize migration pathways for contaminants of concern
- To assess the risks to human health and the environment posed by the presence of contaminants of concern in the affected media
- To obtain information that can be utilized in a feasibility study to select appropriate remedial actions(s).

2. SITE DESCRIPTION

The Gasco site comprises approximately 47 acres in the North Doane Lake area of Portland and is bounded by St. Helens Road to the southwest, the Willamette River to the northeast, and industrial properties to the northwest and southeast (Figures 1 and 2). The ground surface at the site slopes gradually northeastward towards the Willamette River with

surface elevations ranging from approximately 38 feet above mean sea level (msl-City of Portland datum) at the southwestern portion of the property to approximately 23 to 30 feet msl at the top of the river bank. The river bank, composed primarily of rip rap, slopes steeply to an elevation of approximately 5 to 8 feet msl, below which exists the shoreline with a more gradual slope. Average monthly river stages, as measured at the Portland Harbor from 1973 to 1990 and converted to the City of Portland datum, range from a low of approximately 6.3 feet msl during August and September, to a high of 10.9 feet msl during May and June (COE, 1991).

The Gasco site was the former location of the Portland Gas and Coke Company manufactured gas plant oil gasification facility from 1913 to 1956. Manufacturing processes at the site have involved the generation of town gas and pressed lampblack briquettes, aromatic generation and light oil recovery, tar recovery and refining, and the production of electrode grade coke and high Btu gas (Camp Dresser & McKee, Inc., 1987). Northwest Natural began construction of the liquefied natural gas (LNG) plant at the site in the late 1960's, at which time a majority of the old gasification plant facilities were demolished.

With regard to other uses of the property, Koppers operated a coal tar pitch manufacturing facility at the southern portion of the former gasification facility from 1966 to 1973. Koppers currently uses the facility as a terminal for the distribution of creosote oils.

Pacific Northern Oil (PNO) has operated a fuel storage and distribution facility at the northern portion of the site from the 1960's to the present.

The locations of former structures and features associated with the former manufactured gas plant, as well as current structures associated with the Northwest Natural, Koppers and PNO facilities, are shown on Figure 3.

3. EXISTING DATA AND DOCUMENTS

Northwest Natural and the Oregon Department of Environmental Quality (DEQ) entered into an Agreement for the completion of a Remedial Investigation/Feasibility Study (DEQ Agreement No. ECVC-WMCVC-NWR-94-13) for the Gasco site in 1994. RI activities were subsequently implemented by Northwest Natural at the Gasco site in September 1995, with investigatory activities being implemented by Hahn and Associates, Inc. (HAI) as provided within the approved RI Work Plan (HAI, 1995). RI activities conducted at the site to date are briefly summarized below.

3.1 Scope

The scope of work for the Phase I RI activities performed by Northwest Natural from September 1995 to the present include the following tasks (see Figure 4, Sample Location Map):

Koppers022409

- Installation of 54 soil borings and well borings (B, G, GT, and MW-series), with the collection and analysis of soil samples
- Collection and analysis of groundwater samples from 7 temporary well point installations
- Installation of 18 groundwater monitoring wells with 8 rounds of sampling from the wells
- Twelve monthly groundwater level monitoring events and 7 subsequent quarterly events
- Installation of 11 vibra cores in the Willamette River with the collection and analysis of sediment samples
- Collection of 5 surface water and sediment samples from on-site ponds and a drainage ditch
- Collection of air and dust samples
- One 48-hour water level monitoring test
- Monitoring well slug test data collection and analysis
- Surface geophysical survey in area of former Tar Ponds with ground penetrating radar, magnetic, and electromagnetic methods

3.2 Previous Document Submittals

Results of Phase I RI activities at the Gasco site have been documented in numerous reports. The documents that provide the most comprehensive synthesis of available site data and data interpretation concerning RI investigatory results are as follows:

- Hahn and Associates, Inc., *Data Package for Remedial Investigation / Feasibility Study, Northwest Natural Gas Company, Gasco Facility,* July 22, 1996
- Hahn and Associates, Inc., *Geological and Hydrogeological Framework, Northwest Natural Gas Company, Gasco Facility,* May 13, 1997
- Hahn and Associates, Inc., *Monitoring Well Abandonment and Installation Activities, Northwest Natural Gas Company, Gasco Facility,* February 19, 1998

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- Hahn and Associates, Inc., *Fourth Quarter 1997 Progress Report for Remedial Investigation / Feasibility Study Activities, Northwest Natural Gas Company, Gasco Facility,* February 23, 1998

- Hahn and Associates, Inc., *Second Quarter 1998 Progress Report for Remedial Investigation / Feasibility Study Activities, Northwest Natural Gas Company, Gasco Facility,* April 24, 1998

In addition to the above reports documenting Phase I RI results, the following are the primary documents that have been prepared to date in support of Risk Assessment activities for the Gasco site:

- Stoel Rives LLP, *Current and Reasonably Anticipated Future Land and Beneficial Water Uses in the Locality of the Facility, Northwest Natural Gas Gasco Facility*, April 1997

- Decision Management Associates and Montgomery Watson, *Data Summary and Exposure Pathway Analysis Technical Memorandum, Gasco Risk Assessment*, May 15, 1997

- Decision Management Associates and Montgomery Watson, *Comparison Between McCormick and Baxter Site and Gasco Site Technical Memorandum, Gasco Risk Assessment*, June 11, 1997

- Decision Management Associates and Montgomery Watson, *Exposure Assessment, Gasco Risk Assessment*, July 2, 1997

- Hahn and Associates, Inc., *Locality of Facility, Northwest Natural Gas Company, Gasco Facility,* August 1, 1997 (A Beneficial Use determination support document)

- Decision Management Associates and Montgomery Watson, *Toxicity Assessment, Gasco Risk Assessment*, December 16, 1997

3.3 Summary of Available Data

A general description of available RI data for the Gasco site, including identification of where this data may be found, is provided in the following Sections.

3.3.1 Soil Data

The majority of soil quality and lithologic data for the Site were collected from September 1995 to January 1996 during which time soil borings B-1 through B-35, MW-1 through MW-12, and M-11 were installed. More recently, soil quality data, geotechnical soil borings G-

Koppers022411

1 and G-2 were installed by GeoEngineers, Inc. within the Koppers lease area in April 1997, geotechnical soil borings GT-1 through GT-4 were installed by GeoEngineers, Inc. within the PNO tank farm area in November 1997, and well boring MW-13 was installed down-gradient of MW-6 (PNO lease area) in December 1997.

For reference herein, a figure depicting all soil boring locations, as well as a summary of available soil quality data collected at the site to date, are included within Appendix G, and soil boring logs depicting lithologic and contaminant conditions at each boring location are provided within Appendices A (soil borings) and B (monitoring well borings).

3.3.2 Willamette River Sediment Data

Fourteen sediment core samples (SD-1 through SD-14) were collected by Northwest Natural from the Willamette River adjacent to, and up-stream of, the Gasco site in January 1996. With regard to additional sediment quality investigatory activities conducted in the vicinity of the site, The U.S. Environmental Protection Agency (EPA) conducted a Site Inspection (SI) of a six-mile reach of the Willamette River in September and October 1997, including the collection of sediment samples adjacent to the Gasco site (Weston, 1998). Also, several sediment studies involving the vicinity of the Gasco site have been undertaken by the U.S. Army Corps of Engineers (COE). Specifically, in 1989 and 1994 the COE conducted sediment studies within the dock area at the U.S. Moorings Station, located adjacent to, and down-river of, the Gasco site (Britton, 1990; Siipola and Britton 1994). Finally, in July 1997, the COE completed sediment sampling activities as part of their overall dredging material evaluation program, that included the collection of sediment samples within the Willamette River, including one adjacent to the Gasco site.

Sediment core logs from investigatory activities conducted by Northwest Natural depicting lithologic and contaminant conditions at each core location are provided within Appendix C. Figures depicting sediment sample locations, as well as a summary of available sediment data collected adjacent to the site to date (Northwest Natural, EPA, and U.S. Army Corps data), are included within Appendix J.

3.3.3 Groundwater Quality and Flow Direction Data

Groundwater quality data at the Gasco site has been collected from 7 temporary well points installed in 1995, as well as from 18 permanent monitoring wells that were installed in 1995 and 1998. Well MW-6-61 was decommissioned by removal in 1997. Eight groundwater quality monitoring events have been conducted at the Gasco site to data from the existing monitoring well network. Static groundwater level measurements from the monitoring well network were collected monthly during 1996, and have been collected on a quarterly frequency since that time.

For reference herein, a figure depicting all temporary well point and monitoring well locations, as well as a summary of available groundwater quality data collected at the site to date, including posting maps and time-concentration plots, are included within

Koppers022412

Appendix H. Groundwater elevation data, hydrographs, and groundwater flow direction maps and hydrographs may be found within Appendix E. Monitoring well construction logs are provided in Appendix B.

3.3.4 On-Site Surface Water and Sediment Data

On-site surface water and sediment sampling activities were conducted at the Gasco site on January 30, 1996. These activities involved the collection of surface water samples at two locations within the on-site drainage ditch, as well as within each of the three on-site ponds. Additionally, a shallow sediment sample was collected from each of the three on-site ponds. A figure depicting sample locations, and tables summarizing the results of these activities, are included within Appendix I.

3.3.5 Air Quality Data

Sampling for airborne contaminants at the Gasco site has been conducted for chemical exposure monitoring during implementation of the early stages of RI investigatory activities (1995), as well as for ambient air quality monitoring (1996). All monitoring activities were conducted by Paul Carlson Associates, Inc. (PCA), a firm specializing in industrial hygiene issues and air monitoring.

In addition to the above described air monitoring activities, two samples of accumulated dust were collected from the site. A figure depicting air and dust sampling locations, and results of all air monitoring activities, are provided within Appendix K.

3.3.6 Geophysical Data

On November 22, 1995, a preliminary survey with ground penetrating radar (GPR), electromagnetic (EM), and magnetic geophysical methods was conducted in the vicinity of the former Settling Ponds / South Fill Area by GeoPotential of Gresham, Oregon. Three profiles were completed in an attempt to identify and map fill zones, tar zones, and lithologic changes. The results of this survey are included within Appendix L.

3.3.7 Aquifer Testing Data

In order to estimate hydraulic properties of the shallow and intermediate-depth water bearing zones at the Gasco site, rising head slug tests were conducted at a majority of the site wells in March 1996. The raw data summary of results of these testing activities was provided within RI Data Package Report (HAI, 1996). A summary of aquifer slug testing results is included within Appendix E (Table E-2).

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4. SITE GEOLOGY

The geologic units of interest at the subject site can be subdivided as follows, from youngest to oldest:

- Surficial Fill Deposits
- Alluvial Deposits

  Willamette River Deposits
  Catastrophic Flood Deposits

- Columbia River Basalt Group

4.1 Columbia River Basalt Group

The oldest and lowermost geologic unit of interest at the site consists of the Columbia River Basalt Group. The Miocene-age Columbia River Basalt Group, composed of a series of individual lava flows, generally forms the base (bedrock) of the Portland Basin and outcrops immediately to the southwest of the Site in the Tualatin Mountains.

A bedrock surface elevation map, utilizing RI data as well as data obtained from historical boring logs from 19 geotechnical soil borings that were installed at the site in 1915 during the early stages of development activities, is included as Figure 5. As depicted on Figure 5, from the Tualatin Mountain outcropping, the basalt surface dips steeply to the northeast, with the top of the basalt lying at an elevation near mean sea level [a depth of approximately 36 feet below ground surface (bgs)] in the southern corner of the site (as observed at the MW-12-36 well location), to elevations deeper than -133 feet msl adjacent to the Willamette River (as observed at boring H-4). Based on the predicted slope of the bedrock surface as interpreted with available data, bedrock is likely the deepest beneath the eastern portion of the site, where based on the observed slope in bedrock surface, it is estimated that the bedrock surface could occur at an elevation deeper than -230 feet msl.

4.2 Alluvial Deposits

Overlying the eroded basalt surface at the site are Quaternary-Age alluvial deposits, composed of unconsolidated sands and silts, that range in thickness from approximately 30 feet near St. Helens Road, to an estimated thickness of greater than 200 feet adjacent to the Willamette River. These alluvial deposits have been differentiated by Geraghty & Miller (1991), into the Catastrophic Flood Deposits and Willamette River Deposits. Since these two units may be difficult to differentiate in places, the conceptual site model groups the two units together and refers to them as undifferentiated Alluvial Deposits. The uppermost unit of the undifferentiated Alluvial Deposits in the vicinity of the site has been

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identified as a clayey silt by Camp Dresser (1987), while Geraghty & Miller (1991) identified both silt and clay facies associated with the upper zone of the Alluvial Deposits.

Borings installed by HAI at the Gasco site encountered a laterally extensive silt unit, with typically little to no clay content, at the upper portion of the undifferentiated Alluvial Deposits. This silt unit exhibits coloration ranging from olive gray to green, with some areas of orangish-brown mottling. Small sand lenses and rootlet zones are present within portions of the silt unit. Fine to medium-grained sands, silty sands, and relatively thin interbedded silts were encountered below the silt unit at intermediate depths within the undifferentiated Alluvial Deposits.

As depicted in Figure 6, the top of the silt unit was encountered at elevations ranging from 20 to 35 feet msl at the southwestern portion of the site, sloping to the northeast towards the Willamette River where it was encountered at elevations of approximately 5 to 10 feet msl. In general, the top of the silt unit appears to slope more steeply beneath the southwestern portion of the Site at the area of the former Light Oil Plant, Pitch Plant, and Tar Processing Area, with the slope becoming more gradual and even reversing slightly, beneath the central and northeastern portions of the site.

As depicted on Figure 6, the existence of a northwest-southeast trending depression in the top of the silt unit is apparent across the central portion of the site. Two low spots within this depression were identified at locations corresponding to wells MW-6 and MW-11, both locations where dense non-aqueous phase liquids (DNAPLs) have been detected. The depression appears to be oriented roughly parallel to the location of a former creek bed, thought to be a former drainage feature associated with Doane Lake, remnants of which are located to the southeast of the Gasco site (Cameron, 1995). The location of the former creek was identified on a detailed elevation survey map for the Gasco site that was prepared in 1906. The location of the former creek, as surveyed in 1906, is depicted on Figure 6. Of additional note concerning the 1906 survey, it is found that, in general, the pre-fill ground surface elevations at the Gasco site roughly correspond with the elevation of the top of the silt unit at the site, thereby supporting the hypothesis that the silt unit does adequately define the top of the Alluvial Deposits / base of the Surficial Fill Deposits across the site.

With regard to the thickness of the silt unit, based on boring log data and depicted on Figure 7, the thickness of the silt unit is greatest in the central-southeast portion of the site, where thicknesses of up to 35 feet have been identified (boring MW-11). The silt unit appears to thin in all directions from this area of the site, with observed thicknesses of 4.5 (B-14), 6.0 (MW-5), and 2.5 (B-3 and B-8) feet. Although the silt unit appears to be laterally continuous across a majority of the site, because sands and silty sands were encountered across the anticipated depth of the silt unit at borings B-9 (drilled to a depth of -3.4 feet msl), GT-1 (drilled to a depth of –16.9 feet msl) and GT-4 (drilled to a depth of –31.8 feet msl), it appears that a thin silt unit was either missed at these locations as an artifact of the selected soil sampling interval, or that the silt unit may be locally absent at these locations.

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4.3 Surficial Fill Deposits

A review of the site history and historical aerial photographs indicates that much of the property, especially to the northeast adjacent to the river, has been extensively filled-in through time. In addition to the overall build-up of ground surface elevations, these filling activities have resulted in the removal of two site drainage features, the creek discussed in Section 4.2, and a drainage ditch formerly located southeast of the southern PNO tank farm, where surface water run-off and manufactured gas plant waste-products were apparently formerly discharged to the Willamette River. Based on review of historical aerial photographs of the site, it appears that this ditch was filled in some time between 1941 and 1961. The axis of this former drainage feature is shown on Figure 3.

Based on results of site investigatory activities, the surficial fill zone was found to overlay the alluvial silt unit with variations in thickness ranging from approximately 2 feet along the southwestern portion of the site near the former Light Oil Plant, to a maximum of 30 feet in the central portion of the site. Much of the fill encountered at the site consisted of poorly graded sands and silty sands that apparently consist of hydraulically placed river-dredge material. However, lampblack, spent oxide materials, quarry reject rock, building debris, and solidified tars were also encountered within the surficial fill unit at the site, especially within the area of the former Tar Ponds and the former Spent Oxide Storage area.

5. SITE HYDROGEOLOGY

Groundwater occurs in three principal hydrologic zones at the site including the unconfined Surficial Fill water-bearing zone (WBZ), the semi-confined Alluvial Sand WBZ, and the confined bedrock aquifers in the Columbia River Basalts. A laterally extensive low permeability silt unit separates the Surficial Fill WBZ from the Alluvial Sand WBZ across a majority of the site.

With respect to the overall regional groundwater flow regime in the vicinity of the Gasco site, it is anticipated that the Tualatin Mountains form a regional groundwater recharge boundary to the southwest of the site, while the Willamette River likely forms a regional groundwater discharge boundary to the northeast, acting as a hydraulic barrier to groundwater flow to the opposite side of the river.

A generalized hydrologic cross-section, depicting the conceptualized groundwater flow regime beneath the site, is provided as Figure 8. General descriptions of each of the three principal hydrologic zones beneath the site are provided below.

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5.1 Surficial Fill Water-Bearing Zone

The water table, generally found to be perched within the Surficial Fill WBZ, above the upper alluvial silt unit, has been identified at depths that fluctuate seasonally from 3 to 12 feet bgs (34 to 25 feet msl) at the southwestern portion of the site (well MW-9), and from 9 to 27 feet bgs (25 to 7 feet msl) at the eastern portion of the site (well MW-4-35). Based on the observed seasonal fluctuations of the water table elevation, the overall saturated thickness of this WBZ may be expected to fluctuate from approximately 3 to 25 feet at the northeastern boundary of the site, located adjacent to the Willamette River. Groundwater elevation data for monitoring wells at the site are provided in Appendix E (Table E-1).

As depicted on groundwater elevation maps generated for the site (Appendix E, Figures E1-E18), the groundwater flow direction within the Surficial Fill WBZ is northeasterly towards the Willamette River, with an overall average hydraulic gradient of approximately 0.017. As measured since December 1995, the observed groundwater flow direction within this WBZ has remained relatively constant through time. The calculated hydraulic gradient within this WBZ has been found to fluctuate from a low of 0.010 in February 1996, to a high of 0.020 in September 1996, and February 1997.

As depicted on water level hydrographs for well pairs installed at the site (Appendix E), a downward vertical hydraulic gradient typically exists between the Surficial Fill WBZ and the Alluvial Sand WBZ. An exception to this overall downward hydraulic gradient was noted at the central portion of the site (MW-8 and MW-10 clusters) during the February 1996 Willamette River flooding event, when an upward gradient existed between these units at these locations. A vertical gradient reversal was also noted at the MW-10 location in February and June 1997, as well as in June 1998. These gradient reversals appear to result from rapid increases in river stage, with the Alluvial Sand WBZ directly responding to increases in river stage, while responses in the Surficial Fill WBZ occur more slowly and are less pronounced with increased distance from the river.

Based on slug testing that was conducted by HAI in March 1996, an overall average hydraulic conductivity of 3.9 feet per day (ft/day) was calculated for the fill WBZ, with the lowest calculated hydraulic conductivity identified at well MW-8-29 (0.0067 ft/day), and the highest calculated hydraulic conductivity identified at well MW-4-35 (26 ft/day) (Table E-2).

Based on the referenced hydraulic conductivities, a calculated average hydraulic gradient of 0.020, and an assumed effective porosity of 0.20, the average groundwater flow velocity within the Surficial Fill WBZ is estimated to be 0.4 ft/day, ranging from an estimated 0.0007 ft/day at the MW-8-26 location, to an estimated 2.6 ft/day at the MW-4-35 well location. Such high variability of calculated flow rates is anticipated within the Surficial Fill WBZ, due to the significant heterogeneaties identified within this zone, and the localized area of influence of each slug test.

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5.2 Alluvial Sand Water-Bearing Zone

The Alluvial Sand WBZ, encountered below the silt unit at the site, extends to a total depth ranging from approximately 36 feet bgs (0 feet msl) at the southern portion of the site (MW-12-36), to greater than an estimated 265 feet bgs (-230 feet msl) adjacent to the Willamette River. Due to its great apparent thickness, the Alluvial Sand WBZ has been arbitrarily subdivided into intermediate and deep zones. Existing site monitoring wells installed in the Alluvial Sand WBZ are screened within the intermediate zone to depths of 36 to 61 feet bgs (-26 to –20 feet msl), while shallow zone monitoring wells are screened within the Surficial Fill WBZ.

As depicted in groundwater elevation maps generated for the site (Appendix E, Figures E19-E37), the groundwater flow direction within the Alluvial Sand WBZ is northeast towards the Willamette River, with an average hydraulic gradient of 0.016 (as measured between wells MW-10-61 and MW-3-56). As measured since December 1995, the observed groundwater flow direction within this WBZ has remained relatively constant through time. The calculated hydraulic gradient within this WBZ has been found to fluctuate from a low of 0.008 in February 1996, to a high of 0.022 in September 1996.

Based on slug testing that was conducted by HAI in March 1996, an overall average hydraulic conductivity of 0.79 ft/day was calculated for the Alluvial Sand WBZ, with the lowest calculated conductivity identified at well MW-8-56 (0.08 ft/day), and the highest calculated conductivity identified at well MW-6-61 (1.5 ft/day).

Based on the referenced hydraulic conductivities, a calculated average hydraulic gradient of 0.017, and an assumed effective porosity of 0.20, the average groundwater flow velocity within the alluvial WBZ is estimated to be 0.07 ft/day, ranging from an estimated 0.007 ft/day at the MW-8-56 location, to an estimated 0.13 ft/day at the MW-6-61 well location.

5.3 Basalt Unit / Bedrock Aquifer

A boring log for an abandoned bedrock zone industrial water supply well drilled on the southern portion of the Gasco site (exact location unknown) in 1948 indicated competent basalt bedrock to occur from a depth of approximately 61 feet bgs to a depth of 241 feet bgs, below which was an approximate 17 foot thick sand zone (corresponding to the zone of water production) that was underlain by fractured basalt to the total depth of the hole at 370 feet bgs. Notes provided on the boring log for this well indicate that pumping of the well at a rate greater than 140 gallons per minute (gpm) would result in the water level being dropped below the pump.

Boring logs for two 400-foot deep cathodic pipeline protection wells drilled on the southwestern portion of the Gasco site in 1976 and 1985 indicate alternating layers of broken rock with clay layers and competent basalt through the entire drilling interval, with a sandstone, perhaps equivalent to the water producing sand horizon identified within the well log for the supply well, being identified in one of the wells at a depth of 290 to 310 feet bgs. No information on the occurrence of water was provided for either of the cathodic

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protection wells. As both wells contain sacrificial anodes and bedding material for the corrosion protection of pipelines at the site, information on water within the bedrock is unavailable at these locations. Boring logs for the former water supply well, and the cathodic protection wells, are included within Appendix D.

Based on the site conceptual model, it is anticipated that groundwater within the basalt unit flows to the northeast towards the Willamette River (a regional discharge zone). An upward hydraulic gradient within the basalt aquifer is likely to occur in the vicinity of the Gasco site and Willamette River, potentially resulting in localized discharge from the basalt aquifer unit upwards into the Alluvial Sand WBZ (Figure 8).

With regard to water use within the bedrock aquifer within the vicinity of the Gasco site, a water well survey conducted for Northwest Natural (Stoel Rives, 1997), identified the presence of twelve documented water wells located on the western side of the Willamette River within a one-mile radius of the Gasco site. Of these twelve wells, eleven were identified as providing an industrial water source, and one was identified as providing a domestic/irrigation water source. None of the eleven industrial wells are currently in service, as the owners have all switched to the use of City of Portland water. The domestic well, located significantly upgradient of the Gasco site within the Tualatin Mountains, is currently used. The well survey did not identify the presence of water wells withdrawing groundwater from either the Surficial Fill WBZ or the Alluvial Sand WBZ.

6. NATURE, EXTENT, AND TRANSPORT OF CONTAMINANANTS

Field observations as identified in soil boring logs (Appendices A and B) indicate that residual tar, oil tar, and lampblack are present within soils at the Gasco site. Oil tar and tar are primarily differentiated herein by their physical characteristics, especially color and viscosity. Specifically, when described herein, tar will refer to a black, viscous to semi-solid petroleum hydrocarbon, while oil tar will refer to a brown to black hydrocarbon that is significantly less viscous than the aforementioned tar and is potentially mobile in the subsurface soils. Additionally, the presence of oil tars in soils as referenced herein, refers to product being visible in a soil sample, and may not include soils that show some other evidence of contamination, such as sheen, odor, or elevated headspace. Lampblack is a term referring to a hydrophobic black powder or sandy material, consisting primarily of carbon, that may contain minor concentrations of petroleum hydrocarbons (Gas Research Institute, 1996).

Free product oil tars, herein referred to as free product DNAPL, or just DNAPL, have been identified in three areas of the site. Free product DNAPL is potentially mobile and recoverable product.

The constituents of primary concern in tars and oil tars are the aromatic hydrocarbons benzene, toluene, ethylbenzene and xylene (BTEX) and polynuclear aromatic hydrocarbon (PAH) compounds. Other contaminants of concern at manufactured gas plant sites include cyanide, phenols, and metals. A discussion on the nature and extent of residual

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product, free product DNAPL, as well as identified soil and groundwater impacts is presented in the following sections.

6.1 Residual Product In Soil

Iso-contour maps depicting the distribution of residual oil tar and tar in soils at the Gasco site have been provided in Appendix F. Specifically, Figures F-1 and F-2 depict the depth to the top and the thickness of residual oil tar as observed at the Gasco site, while Figures F-3 and F-4 depict similar information with regard to the tar. These figures also depict the overall lateral extent of observed residual oil tar and tar within soils, as identified during the soil boring program at the site. Cross-sections provided in Appendix M depict the identified extent of observed oil tar and tar within soil borings installed at the site.

6.1.1 Residual Oil Tar

As depicted on Figures F-1 and F-2, residual oil tar has been identified in soil borings installed throughout the southeasterly and central portion of the site, primarily corresponding to the locations of the former Light Oil Plant, northeastward through the former Tar Ponds, and northwestward through the area of the former Retort Area. Additionally, two apparently small and isolated areas of residual oil contamination have also been identified in borings installed in the vicinity of the former Spent Oxide Storage area (MW-1 and B-1) and the PNO tank farm (GT-1).

With regard to the distribution of residual oil tar within soils across the site, it is apparent that several primary source areas for this product may be identified, including: 1) the former Light Oil Plant; 2) the former Retort Area; and 3) the former Tar Settling Ponds. Residual product found in the former Spent Oxide Storage area (MW-1 and B-1) was likely placed there as contaminated fill, while the minor diesel product found in the PNO tank farm area (GT-1) appears related to PNO tank operations.

6.1.1.1 Former Light Oil Plant / Retort Area

The depth to the surface of residual oil tar product (Figure F-1) at the Gasco site was found to be the shallowest (i.e., less than 5 feet bgs) in the immediate vicinity of the former Light Oil Plant (borings B-19 and B-22). In the vicinity of the former Retort Area, residual oil tar was found at a depth of 7.5 feet bgs at boring B-13. The depth to the top of the residual oil tar was typically found to increase with increasing distance from the former Light Oil Plant and Retort Area, with the residual oil tar surface generally corresponding with the top of the underlying silt unit. Based on the preceding, it appears likely that the former Light Oil Plant and the former Retort Area (including the adjacent railroad siding) are the two primary source areas for the oil tar observed throughout the current Northwest Natural LNG Plant and the Koppers Lease areas, with the oil tar subsequently having migrated from these source areas via gravity along the surface of the northeast sloping silt unit, with

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a preferential pathway being created due to the permeability contrast between the surficial fill and the underlying silt unit.

With regard to the lateral extent of the oil tar originating from the former Retort Area/Light Oil Plant source areas, it is noted that the northwest-southeast trending depression in the surface of the silt unit (Figure 6), appears to have acted as a barrier to the lateral migration of the mobile oil tar product, generically referred to as DNAPL, to the northeast towards the Willamette River. Lows within this silt unit depression also appear to have acted as preferential areas of DNAPL accumulation. Further discussion of DNAPL is presented in Section 6.2. In addition, the silt unit within the western portion of the Gasco site appears to have acted as a vertical barrier to oil tar product migration, with no oil tar observed below the silt unit in this area.

Evidence to support the above-identified barrier / DNAPL accumulation hypothesis for the depression in the surface of the silt unit is provided by the observed presence of DNAPL within wells MW-6-36 and MW-11-32, located at the overall low points within the depression, and in well MW-10-25, located on the up-dip, source area, side of the depression, while no residual oil tar product or DNAPL has been identified at the B-7, B-10, or MW-13 boring locations, all of which were installed on the opposite side of the depression from the former Retort Area. Although residual oil tar is found on the opposite side of the depression in the southern portion of the site, this is thought to be due to a different source area (see Section 6.1.2).

With regard to the vertical extent of the oil tar product that has apparently been sourced within the Light Oil Plant / former Retort Area, it is noted that a lack of BTEX and PAH detections in groundwater at monitoring well MW-13-61, screened beneath the silt unit downgradient from the apparent product-bearing depression, and a lack of BTEX or significant PAH detections at the MW-10-61 location, installed through the shallow DNAPL and screened below the silt unit at a location down-dip of the suspected source areas, indicates that the silt unit at this portion of the site appears to have acted as an effective barrier to the vertical migration of the DNAPL into the underlying Alluvial Sand WBZ.

In order to verify the lack of DNAPL migration into the Alluvial Sand WBZ at the former Light Oil Plant/Retort source area, a deep Alluvial Sand WBZ well, to be constructed on top of bedrock, has been proposed (HAI, 1998a) for installation in the vicinity of the depression in the silt unit surface, down-dip of the former Light Oil Plant (i.e., near boring B-26).

6.1.1.2 Former Tar Pond Area / B-29 Area

The greatest depth at which residual oil tar in soils has been identified at the Gasco site is in the area of the former Tar Ponds. Specifically, the depth to residual oil tar product at this portion of the site has been found to range from 20 feet bgs (14 feet msl at B-35) to 60 feet bgs (-25 feet msl at B-33). Based on observations made during the installation of borings within the former Tar Pond area, it appears that the observed oil tars have likely been sourced as emulsions or degradation of the thick accumulations of tar that had been disposed of at this

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portion of the site. Evidence for such a source is provided by boring logs that indicate the presence of viscous or hardened tar being underlain by vertical fingers of less viscous oil tar that were found to have migrated downward through rootlet casts within the underlying silt unit, and in some cases (B-29, B-32, B-33, B-34, and possibly MW-8), having extended into the upper portion of the underlying Alluvial Sand WBZ.

With regard to the vertical extent of the oil tar identified in the vicinity of the former Tar Ponds, it is noted that the depth to the bottom of the oil tar has been defined at virtually all borings installed at the Gasco site. In the Tar Pond area, the deepest that oil tar was found to extend was to a depth of 67 feet bgs (-32 feet msl) at the B-33 boring location.

Although it appears that the vertical extent of oil tar has been identified beneath the Tar Ponds, in order to more completely evaluate the potential that product may have migrated to greater depths in other areas of the former Tar Ponds, and to define the vertical extent of groundwater contamination at the site, the installation of two deep Alluvial Sand WBZ wells at locations down-gradient of the former Tar Ponds has been proposed (HAI, 1998a). Observations of soil and water quality at these locations will assist in determining the magnitude of deep oil tar impacts at, and down-gradient of, the former Tar Pond area.

Laterally, it is noted that oil tar was not found in soil borings located between the former Tar Ponds and the Willamette River (borings B-31, MW-4, and MW-5), however, oil tar was found to occur (below a thick zone of tar) from a depth of 27 to 39 feet bgs (4 to -8 feet msl) at the B-29 boring location, situated adjacent to the river in the area of the former discharge drainage feature. Although tar was identified in other borings (B-9 and MW-3) installed within drainage feature, no oil tar was found to be associated with the tars at these locations. It appears that the tars and oil tars present at B-9, B-29, and MW-3 are the result of placement during the filling of the drainage feature.

With regard to the lateral extent of oil tar to the south of the former Tar Ponds, based on the location of the former Tar Ponds adjacent to the southern property line, and based on knowledge that soils from the Gasco site were used as fill on the property to the south (i.e., Wacker Siltronic, Inc.), the potential exists that tar and associated oil tar impacts could extend to the Wacker Siltronic, Inc. property.

6.1.1.3 Spent Oxide Storage Area and Vicinity

Soil saturated with oil tar was identified in the vicinity of the former Spent Oxide Storage area at the MW-1 and B-1 boring locations in the northwest portion of the site. The zone of product saturation was found to consist of an interval approximately 5 feet thick located immediately above the silt unit at depths ranging from 16 to 22 feet bgs. Boring logs indicate that much debris had been deposited at this portion of the site as fill, including concrete, bricks, lampblack, and spent oxide. As borings B-2, B-3, B-4, B-5, and B-7, all of which did not show indications of soil impacts, are located between the area of observed oil tar and the primary oil tar source area (former Light Oil Plant / Retort Area at the site), it appears that the identified oil tar was likely directly deposited at this portion of the site as a component of the fill, and its presence is not a result of migration from other portions of the

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site. With regard to the character of the observed product, it is noted that well MW-1 is screened directly across the zone of observed oil tar saturation, and that free product DNAPL has not been found within this well. Based on the preceding, it appears that the observed oil tar at the MW-1 / B-1 portion of the site is likely in the form of residual product as opposed to a potentially mobile DNAPL.

As indicated on the lithological log for boring GT-1, a boring installed within the north end of the southern PNO tank farm, petroleum contamination was found to occur from a depth of 8.5 to 11 feet bgs. This product had a diesel odor uncharacteristic of the oil tar encountered at the site, and was found at a depth that indicated it to be likely floating on the water table. Analysis of a soil sample from the zone of product saturation indicated total petroleum hydrocarbons within the diesel range of 13,400 ppm, with no carcinogenic PAHs identified. The preceding, as well as the location of the product being within the PNO tank farm, an area where petroleum products are actively managed, indicates the source of the diesel is likely related to tank farm operations, and is not due to historic manufactured gas plant activities. Finally, the extent of the apparent diesel product in the subsurface appears to be limited, as no such product was identified at adjacent boring locations B-8 or GT-2.

6.1.2 Tar

In addition to tar distillates (oil tar), an extremely viscous / semi-solid, black tar was identified during the investigation in a number of soil borings at the site. Specifically, as depicted on Figures F-3 and F-4, the tar has been identified in soil borings installed throughout the eastern portion of the site corresponding to the location of the Former Tar Ponds and the former drainage feature. Additionally, isolated areas of tar were identified at the location of the former Naphthalene Plant (MW-10), and in the PNO Lease Area at B-6.

Based on tar thicknesses and depths at the site, it appears that the main source area for the observed tars is the former Tar Settling Ponds, where, according to Camp Dresser & McKee (1987), approximately 4,600,000 gallons, or 23,000 cubic yards (dry content) of tar were discharged. At the former Tar Pond area, tar and tar mixed with lampblack were placed (filled) to depths of approximately 25 feet bgs. Directly beneath the tar ponds, tar has migrated vertically into the underlying silt unit, likely due to the mass and weight of the overlying tar. At one location (B-33), tar was found to extend into the Alluvial Sand WBZ, where the maximum depth of tar observed at the site (60 feet bgs) was encountered. Tarry soils typically were encountered within 5 feet of the ground surface in the eastern portion of the site (Figure F-3).

As evidenced by the tars identified at the MW-3, and B-9 and B-29 locations, it appears that tar may have been discharged to the former drainage ditch, and/or used to fill the ditch feature. As observed on historical aerial photographs, this ditch was located to the southeast of PNO's southern-most tank farm, where it discharged into the Willamette River. Elevated PAH concentrations in river sediments collected in the vicinity of the likely confluence of the former drainage ditch with the river, as discussed in Section 6.6 of this report, tends to support the potential that tarry wastes may have historically been

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discharged to the river through this former ditch. As no tar was identified within borings GT-3 and GT-4, installed immediately to the northwest of the former ditch and within 50 feet of well MW-3, it appears that the tars are not migrating significantly from their apparent location of deposition within the former ditch feature.

Camp Dresser & McKee (1987) indicated that the drainage feature discussed above likely received the main waste discharges at the site up until 1941, at which time the tar ponds were brought on-line to act as a pollution abatement measure. With regard to the type of wastes discharged, Camp Dresser & McKee indicate that wastes discharged prior to 1925 would be characterized primarily as being wastewaters containing dissolved and suspended hydrocarbons, tar, and spent oxide. After 1925, the amount of tar within the waste stream would have been reduced such that it accounted for only a small amount of tar produced at the site, as tar refining operations were begun that year. Finally, with the start-up of the tar ponds beginning in 1941, the volumes of wastes discharged to the river would have been dramatically reduced at that time.

In summary, boring log data suggests that tars are present within the Fill Unit extending from the location of the former Tar Ponds at the eastern portion of the site, northwestward to the location of the former drainage ditch. Based on the thickness of residual tar in soils identified at the Former Tar Pond and drainage ditch areas, it is estimated that in excess of 250,000 cubic yards of tar and tar mixed with soils may be present in the subsurface at this portion of the site.

Approximately 9.5 feet of tarry soils were identified at the MW-10 location, situated at the area of the former Naphthalene Plant. With greater depth the tar at this location is found to become less viscous and more oil-like (oil tar). Although the oil tar extends throughout much of the former Light Oil Plant northward to the former Retort area (as discussed in Section 6.1.1), the tarry soils appear to be restricted to the general area of the former Naphthalene Plant at this portion of the site.

With regard to the tar identified in boring B-6 located near the former Oxide Building and Oxide Storage Area, because the tar was found mixed with sand and brick fragments and was of very limited vertical extent (up to 2.5 feet), it appears likely that the tar was present in fill placed at this portion of the site, and does not represent a source area of significance.

6.2 Free Product DNAPL

Free product DNAPL has been identified at three locations at the Gasco site, all located within the Surficial Fill WBZ and perched on top of the silt unit. Specifically, up to approximately 8 feet of DNAPL has been identified within the bottom of well MW-6-32, while up to 3.5 feet of DNAPL has been identified at the MW-10-26 location, and up to 2 feet of DNAPL has been identified at the MW-11-32 location. It is noted that the observed DNAPL thickness within the wells is apparent, and due to well hydraulics (i.e., a lower hydrostatic head within the well than in the surrounding formation) and screen placement (i.e., penetration below the surface of the impermeable barrier), DNAPL thickness within the wells may actually overestimate the DNAPL thickness that is present within the

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formation (Huling and Weaver, 1991). With specific respect to the Gasco site for instance, although up to eight feet of DNAPL has been identified within well MW-6, only 2.5 feet of product saturated soils were identified during well installation, suggesting the preceding conditions may be applicable.

The source for the DNAPL at the MW-6 location is likely the former Retort area, while the source for the DNAPL at the MW-10 and MW-11 locations is likely the former Tar Processing area and/or the former Light Oil Plant area. The location of these wells relative to the predicted source areas, as well as variations in the color and odor of the DNAPL between the MW-6 and MW-10/MW-11 locations supports this hypothesis.

With regard to DNAPL transport, it is likely that the DNAPL migrated downward within the Surficial Fill WBZ at the source areas until encountering the silt unit, at which point the permeability contrast between the fill and the silt unit would have caused the DNAPL to migrate laterally via gravity along the top of the silt unit in a down-dip direction. Lows within the silt unit located along the area of the former creek bed (i.e., the silt unit depression) appear to have acted as preferential areas of DNAPL accumulation, and also appear to have prevented the continued migration of DNAPL towards the eastern portion of the site (as detailed in Section 6.1.1.1).

As no DNAPL has been identified in wells installed to the northeast of the silt unit depression, the presence of free product DNAPL (versus residual product contamination) at this portion of the site has not been verified. As discussed in Section 6.1.1.1, in order to more completely ascertain the potential for the occurrence of free product DNAPL at depth below the former Tar Ponds, the installation of two deep Alluvial Sand WBZ wells at locations down-gradient of the former Tar Ponds has been proposed (HAI, 1998a).

Additionally, with regard to the areas of known DNAPL occurrence (within and to the west of the silt unit depression), a pilot test has been proposed by Northwest Natural (HAI, 1998b) involving the extraction of the DNAPL from the wells in which it has been identified. The objective of the testing is to evaluate the pumpability and recoverability of the free product in order to ascertain the viability of such an action as a potential remedy at the site.

6.3 Soil Quality Impacts

Laboratory analyses of soils at the site (Appendix G), including those that contain the residual petroleum products identified above, indicate that soils at the site have primarily been impacted by PAHs, BTEX constituents, and cyanide. Additionally, as discussed below, an area of slightly elevated arsenic concentrations appears to exist at one portion of the site.

6.3.1 Polynuclear Aromatic Hydrocarbons and BTEX Compounds

In total, 136 soil samples from 48 locations have been analyzed for PAHs, while 58 soil samples at 31 locations have been analyzed for BTEX constituents at the site. Detectable

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concentrations of total PAHs in soil at Gasco were found to range from less than 0.5 ppm to a maximum concentration 58,822 ppm (B-29 location), while detectable total carcinogenic PAHs in soil were found to range from 0.03 ppm to a maximum concentration of 5,214 ppm (B-29 location). Total BTEX concentrations were found to range from 1.0 ppm to a maximum concentration of 891 ppm (B-18 location), with detectable benzene concentrations ranging from 0.72 ppm to a maximum of 360 ppm (B-18 location). Maximum PAH concentrations tend to be associated with product saturated soils (oil tar and tar) identified in the former Tar Pond portion of the site, while the most significant BTEX contamination tends to be present in both product saturated soils (oil tar and tar) and in soils that bear a petroleum hydrocarbon sheen.

As depicted on the data tables and posting maps provided within Appendix G, the vertical extent of BTEX and PAH contamination within soil at the site has been well defined at most soil boring locations. The most significant impacts are generally restricted to the Surficial Fill Unit, with the exception of the former Tar Pond and drainage ditch areas, where residual tar and oil tar have been found to extend into the silt unit, and in some cases, into the upper Alluvial Sand Unit. At virtually all locations, including the Alluvial Sand Unit, it was found that PAH concentrations declined dramatically just a short distance below zones of observable residual product.

6.3.2 Phenols

In total, 25 soil samples from 20 locations have been analyzed for phenols at the site. Only one soil sample analyzed for phenols resulted in the identification of a phenolic compound. Specifically, pentachlorophenol was identified at the boring B-18 location at a concentration of 0.36 parts per million (ppm), a concentration only slightly above detection limits. The overall lack of phenolic impacts to soil is not unexpected as significant concentrations of phenolic compounds are typically restricted to manufactured gas plant sites that used a coal gasification process, not an oil gasification facility such as Gasco (Gas Research Institute, 1996).

6.3.3 Cyanide

Research conducted at manufactured gas plant sites indicates that cyanides typically exist in complexed forms, with iron complexes dominating (Gas Research Institute, 1996). These cyanide complexes would have been generated during the process of removing sulfur from the product gas, as cyanide within the gas, if any, would also be removed during this process. As oxides were used to remove the sulfur from the gas, the cyanide complexes would be associated with the spent oxide wastes. The iron complexed cyanide (ferrocyanide) within the spent oxide at manufactured gas plant sites may be recognizable by blue staining.

It is of note that the Gas Research Institute (1996) indicates that the most significant quantities of cyanide would be present at coal gasification plant sites, with the least (trace) amounts of cyanide being present at oil gasification sites (e.g., Gasco).

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The toxicity of cyanide complexes pertains to the dissociation of free cyanide from the complexed cyanide. The availability of free cyanide is measured by a determination of cyanide that is amenable to chlorination (i.e. amenable cyanide). At the Gasco site, total cyanide data are available for soils, while both total and amenable cyanide data are available for groundwater.

In total, 46 soil samples from 25 locations have been analyzed for cyanide at the site. Detectable concentrations of total cyanide in soil at the Gasco site have been found to range from 0.17 ppm at the B-23 boring location to a maximum of 518 ppm at the MW-9 boring location (a sample of fill material with blue staining). A map depicting available cyanide data for soil at the site is provided in Appendix G (Figure G-4).

The presence of cyanide within soils at numerous locations throughout the site is not unexpected since spent oxide materials were included as fill materials for the site. As the EPA Region 9 Preliminary Remediation Goal (PRG) for free cyanide in industrial soils is 13,628 ppm, and because the free cyanide concentration cannot exceed the total cyanide concentration, it does not appear that the identified cyanide concentrations in soil at the Gasco site pose a significant risk with regard to an Industrial Land Use scenario. The soil to groundwater pathway for cyanide may require additional evaluation should concentrations in groundwater be deemed to pose an unacceptable risk.

6.3.4 Metals

Metals analyses at the Gasco site have primarily been conducted in the area of the former Spent Oxide Storage Area (borings B-1, B-2, and B-3) as the presence of trace metals within the spent oxide materials is deemed likely (Gas Research Institute, 1996). As such, the metals antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc were all analyzed in soil samples collected from the former Spent Oxide Storage area, with five samples being analyzed at this portion of the site. As a follow-up to the preceding, arsenic was analyzed for in soils collected from borings GT-1, GT-2, GT-3, GT-4, and MW-13, with a total of 19 samples being analyzed at these five locations.

With regard to above-identified metals analyses, with the exception of arsenic, sampling at the Gasco site has not identified the presence of metals at concentrations in excess of EPA Region 9 PRGs for industrial soils or DEQ Industrial Maximum Allowable Soil Concentrations. With regard to arsenic, soil samples collected in the area of the former Spent Oxide Storage area (borings B-1, B-2, and B-3) indicated elevated concentrations relative to samples collected from other portions of the PNO Lease Area, with concentrations ranging from 4.9 ppm to 21 ppm being identified. Arsenic concentrations from soil borings installed elsewhere at the site (GT-1 through GT-4, and MW-13) were all found to be less than 3 ppm, which is consistent with typical naturally-occurring background concentrations in the area. Some of the samples collected within these borings did exceed the 2.38 ppm EPA Region 9 PRG for arsenic.

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6.3.5 Soil Quality Data Analysis

A detailed presentation and analysis of soil contamination data, prepared by Decision Management Associates LLC, entitled "Preliminary Analysis of Soil Contamination Data, Northwest Natural - Gasco Facility", provided in Appendix 1, includes:

- Evaluation of sampling strategy, duplicate results, and mixes of PAH compounds.
- 3-d scatter plots, histograms, and other plots to help visualize the spatial distribution of contaminants.
- Statistical evidence for and against breaking the site into areas based on surface location and on depth. Several area breakdowns are considered, and depths considered are "surface" (0-0.2 feet), "shallow" (0.2-15 feet), and "deep" (>15 feet).
- Analysis of how concentrations are related to soil odor, sheen, and the presence of residual product (oil tar and tar).
- Analysis of bias in sub surface sampling.
- Evaluation of data gaps and examples of how concentration probability distributions can be constructed from site data for risk analyses.

Conclusions of the above described data analysis are as follows:

- There is substantial small-scale variability superimposed on site-scale trends. The variability is consistent with placement of fill, mixing of soils, and preferential transport of contaminants.
- There appear to be significant differences in concentrations and variability by area and depth. For PAHs, site scale trends include increasing contamination towards the eastern corner of the site, and lower and less variable concentrations at the surface. For benzene, concentrations differ by area and appear consistent with a shallow source spreading down-gradient and deeper.
- The mix of PAHs differs between surface soil and subsurface soil. For surface soils the PAH mix is fairly uniform across the site, while subsurface PAHs show a diversity in mix.
- PAH concentrations are related to soil description (odor, sheen, presence of product). Benzene concentrations tend to be elevated when there is oil or sheen, but the relationship is weaker.
- Surface samples were placed randomly and may be used directly. Sub-surface samples were collected in part based on soil appearance, and are therefore biased. An analysis of the bias indicates that it: 1) increases representation of high-concentration PAH samples by approximately 25%, and 2) has no measurable impact on benzene values.
- Seventeen (17) new soil data samples are identified that would be helpful to improve the completeness and uniformity of samples at the surface and in shallow soil. In particular: 1) 10 approximate locations for the collection of additional surface samples

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for PAH analyses have been identified, primarily within the PNO and office areas; and 2) 7 approximate locations for the collection of shallow soil samples for PAH and benzene analyses have been identified.

- Constructing concentration/probability distributions requires agreement in selection of approach and in implementation. Examples are provided for three methods (smoothing of empirical data, fitting and use of family of parametric distributions, and manual piece-wise construction of a distribution.). Other data needs may become apparent with construction of the 8 concentration/probability distributions that are needed for assessing risk.

6.4 Groundwater Impacts

Eight rounds of groundwater monitoring events have been conducted since the initiation of RI activities at the Gasco site. The groundwater monitoring network currently consists of 17 monitoring wells, of which, 12 are screened within the Surficial Fill WBZ (shallow zone), and 5 are screened within the intermediate-depth zone of the Alluvial Sand WBZ. Groundwater quality data collected at the Gasco site to date (Appendix H) indicates that groundwater within the Surficial Fill WBZ and the Alluvial Sand WBZ has primarily been impacted by PAHs, BTEX compounds, and cyanide. Additionally, areas of slightly elevated concentrations of metals have been identified at several monitoring well locations. No halogenated volatile organic compounds (HVOCs) have been identified in groundwater at the site, other than 2.2 ppb of tetrachloroethene detected at well MW-11-32 in March 1996. Only low concentrations of phenols have been detected in the groundwater at the site, generally being restricted to those well locations where groundwater is found to have the highest PAH concentrations. Finally, styrene was identified at a low concentration in groundwater within the Surficial Fill WBZ at the MW-12 location.

Reference levels utilized as a screening tool to evaluate the presence of contaminant concentrations in groundwater that would merit additional evaluation in a risk assessment, include the following:

- EPA Maximum Contaminant Levels (MCLs) established for drinking water
- EPA Region 9 Preliminary Remediation Goals (PRGs) established for tap water
- Ambient Water Quality Criteria (AWQC) established under the Federal Clean Water Act, and adopted by DEQ for the protection of aquatic life in surface water.

Although significant dilution will occur upon discharge to the Willamette River, the AWQC were included herein as a screen for identifying contaminants of concern within groundwater since contaminated groundwater at the site ultimately discharges to the river, where AWQC may be applicable. Once groundwater flux to the river is evaluated,

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an appropriate dilution factor will be applied to the identified groundwater concentrations to ascertain which contaminants may actually represent constituents of concern at the site.

Understanding that the current and likely future beneficial uses of the Willamette River are recreational, aquatic habitat, and aesthetic, the specific AWQC utilized as a screen herein were as follows: 1) For protection of aquatic life - freshwater acute criteria and freshwater chronic criteria, and 2) for protection of human health - fish consumption criteria were used. In utilizing the AWQC as a screen for groundwater quality, the specific AWQC guidance value with the lowest concentration was utilized. To reemphasize, due to the dilution that occurs when groundwater discharges to the Willamette River, the use of AWQC for screening groundwater contaminant concentrations is very conservative.

6.4.1 Polynuclear Aromatic Hydrocarbons

Maps depicting contoured total PAH concentrations within the Surficial Fill WBZ, as well as in the Alluvial Sand WBZ, during June 1998 are provided in Appendix H (Figures H-2 and H-3).

As sampled in June 1998, the maximum concentration of total PAHs in groundwater at the site was 32,376 parts per billion (ppb), as identified in Surficial Fill WBZ well MW-11-32. Well MW-11-32 contains several feet of free product DNAPL, is located down-gradient of the former Light Oil Plant, and is immediately up-gradient of the former Tar Ponds. Surficial Fill WBZ wells MW-6-32 (down-gradient of the former Retort Area) and MW-10-25 (down-gradient of the former Light Oil Plant and Tar Processing area at the location of the former Naphthalene Plant), also contain DNAPL, with total PAH concentrations in groundwater of 2,245 ppb and 12,162 ppb, respectively, as identified during the June 1998 sampling event.

In addition to the preceding, total PAH concentrations of 12,407 ppb and 17,720 ppb were identified in Surficial Fill WBZ well MW-8-29 and Alluvial Sand WBZ well MW-8-56, respectively, a well pair that has been constructed within the area of the former Tar Ponds. Down-gradient of the former Tar Ponds, at locations adjacent to the Willamette River, total PAH concentrations were found to range from 44 ppb and 95 ppb in Surficial Fill WBZ wells MW-4-35 and MW-5-32, respectively, to 2,299 ppb in Alluvial Sand WBZ well MW-4-57.

Elsewhere at the Gasco site, total PAH concentrations in groundwater typically range from non-detect (wells MW-9-29 and MW-13-61) to less than 1,200 ppb (MW-13-29).

As indicated on the total PAH concentration map for the Surficial Fill WBZ (Figure H-2), it is apparent that the most significant PAH impacts (i.e., greater than 1,000 ppb) within this unit correlate extremely well with that portion of the site where the presence of residual oil tar or free-product DNAPL are found to occur (see Figures F1 and F2), with total PAH concentrations attenuating rapidly down-gradient of the zone of residual product, likely due to the low solubility and mobility of PAH compounds in water.

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To better identify a transport mechanism for PAHs in groundwater at the Gasco site, as indicated in the data tables within Appendix H, analyses were conducted in March 1996 for the dissolved fraction (i.e., less than 0.45 micron) of PAHs at well locations MW-6-32 (a DNAPL-bearing well), and MW5-32 (down-gradient of the former Tar Ponds). The results of these dissolved analyses showed that concentrations of total PAHs in groundwater dropped to non-detect at the MW-6 location (from 2,346 ppb), while total PAH concentrations dropped significantly (from 269 ppb to 45 ppb), and total carcinogenic PAH concentrations dropped to non-detect (from 30 ppb) at the MW-5-32 location. The preceding provides evidence that the primary mechanism for PAH transport in groundwater at the site is likely via advection of contaminants that are adsorbed to colloidal material. It is possible that some PAHs in the groundwater samples are the result of mobilizing colloidal material during purging of the wells for sampling.

As indicated on the total PAH concentration map for the intermediate depth zone of the Alluvial Sand WBZ (Figure H-3), the greatest total PAH concentration (17,720 ppb at MW-8) was found to correspond to the area of the former Tar Ponds, the area of the site where residual oil and/or oil tar were identified at the greatest depths and extending into the upper portions of the Alluvial Sand WBZ. Down-gradient of the former Tar Ponds at the MW-4-57 well location, relatively elevated concentrations of PAHs (2,299 ppb) are found to persist, indicating either a greater mobility of the PAH plume within the Alluvial Sand WBZ than there is within the Surficial Fill WBZ, or that their may be oil and/or tar product present within the Alluvial Sand WBZ in the vicinity of the MW-4-57 well location (as was observed at the adjacent B-29 boring location).

Of additional note with regard to the PAH contamination within the Alluvial Sand WBZ, is that although oil tar was found to exist within the Surficial Fill WBZ at the MW-10 (former Naphthalene Plant/ Tar Processing area) and MW-6 (former Retort Area) well locations, with free product DNAPL being identified immediately above the silt unit at these locations, total PAHs in the Alluvial Sand WBZ beneath the silt unit were found to be either non-detect (MW-13-61) or to occur at very low concentrations (6.2 ppb at MW-10-61), with BTEX constituents at both locations found to be non-detect, indicating that the vertical extent of groundwater contamination within the Alluvial Sand WBZ appears to have been adequately defined in the central portion of the site.

To summarize the preceding discussion, existing data indicates that the PAH contaminant plume within the Surficial Fill WBZ is primarily restricted to the portion of the site where residual tar or oil tar contamination has been identified, and that PAH concentrations attenuate rapidly down-gradient of these areas.

With regard to the Alluvial Sand WBZ, it appears that the PAH groundwater contaminant plume is primarily restricted to the eastern portion of the site, within and down-gradient of the former Tar Ponds. Across the central and southern portion of the site the confining nature of the silt unit is such that it appears to prevent the downward migration of contamination into the underlying Alluvial Sand WBZ.

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As the screening criteria for numerous of the PAH constituents in groundwater have been exceeded, it appears that further evaluation of these constituents with regard to flux and potential impact to the Willamette River will be necessary.

6.4.2 BTEX Compounds

Maps depicting contoured total BTEX concentrations within the Surficial Fill WBZ, as well as within the Alluvial Sand WBZ, during June 1998 are provided in Appendix H (Figures H-4 and H-5).

As depicted on Figure H-4, the maximum total BTEX concentration identified at the site during the June 1998 groundwater sampling event was 129,270 ppb in Surficial Fill WBZ well MW-10-25, a well containing several feet of free product DNAPL. A temporary well point (BW-19) installed in 1995 adjacent to the former Light Oil Plant at an up-gradient location relative to well MW-10-25 identified the presence of 151,600 ppb total BTEX in the Surficial Fill WBZ, while a temporary well point (BW-21), installed immediately up-gradient of the former Light Oil Plant identified only 6.4 ppb total BTEX constituents. Based on decreasing concentrations of BTEX down- and cross-gradient of the former Light Oil Plant, dramatically decreasing concentrations immediately up-gradient of the plant, it appears likely that the former Light Oil Plant is the source for the bulk of the BTEX groundwater contaminant plume at Gasco. Additionally, based on soil sampling results of product-saturated soils, it appears that the residual oil tar may be a secondary, and ongoing, source for the BTEX contamination present in groundwater.

Down-gradient of the former Light Oil Plant, concentrations of total BTEX within the Surficial Fill WBZ are found to attenuate, with maximum concentrations of less than 100 ppb total BTEX common at the down-gradient limit of the site, adjacent to the Willamette River. In fact, during the June 1998 sampling event, groundwater samples collected from all Surficial Fill WBZ monitoring wells located adjacent to the river resulted in non-detect for BTEX constituents. As observed with the PAH groundwater contamination, and as discussed below, it appears that the primary migration pathway for BTEX-contaminated groundwater to the Willamette River is via the Alluvial Sand WBZ.

As depicted on Figure H-5, the maximum total BTEX concentration identified within the Alluvial Sand WBZ during June 1998 was 26,610 ppb, as detected at well MW-8-56. As previously stated, well MW-8-56 is installed within the area of the former Tar Ponds, the portion of the site where residual tar and oil tar have been found to extend to the greatest depths, having been identified in soils within and below the silt unit in the upper portion of the Alluvial Sand WBZ.

As indicated by the non-detection of BTEX constituents within the Alluvial Sand WBZ at well locations MW-13-61 and MW-10-61, and the relatively lesser concentrations of total BTEX constituents at the MW-3-56 well location (630 ppb) relative to the MW-4-57 location (10,868 ppb), it appears that the BTEX plume is likely migrating downward into the Alluvial Sand WBZ in the vicinity of the former Tar Ponds. Such a pathway would be similar to that described with regard to the PAH impacts identified in groundwater at this

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portion of the site, with the exception that the BTEX constituents would be expected to dissolve into groundwater from the residual product much more readily than the PAHs would, due to higher solubility limits.

The preceding indicates that the BTEX groundwater contaminant plume within the Surficial Fill WBZ is primarily restricted to the portion of the site where residual tar or oil tar contamination has been identified, and that BTEX concentrations attenuate rapidly down-gradient of these areas.

With regard to the Alluvial Sand WBZ, it appears that the BTEX contaminant plume is primarily restricted to the area of, and down-gradient of, the former Tar Ponds at the Gasco site.

As the screening criteria for each of the BTEX constituents in groundwater have been exceeded, it appears that further evaluation of these constituents with regard to flux into, and potential impact to, the Willamette River will be necessary.

6.4.3 Cyanide

In general, concentrations of total cyanide have been identified at all well locations (Surficial Fill WBZ and Alluvial Sand WBZ) at the site with the exception wells MW-10-61 and MW-12-36. Maximum detectable concentrations of total cyanide in groundwater at the Gasco site have been identified within the Surficial Fill WBZ at the former Spent Oxide Storage area (wells MW-1-22 and well point B-1) and in the area of the former Tar Ponds (MW-8-29). Specifically, a site-wide maximum cyanide concentration of 11 ppm has been identified at the former Spent Oxide area (MW-1), while a maximum of 4.9 ppm total cyanide has been identified at the former Tar Pond location (MW-8-29). Cyanide concentrations at most other well locations at the site are all relatively uniform, and are typically found to be less than 1 ppm.

The relatively uniform total cyanide concentrations across the site are not suggestive of any one particular source area, but rather appear to be the likely result of the presence of spent oxide within the fill unit across the site, with the cyanide potentially having been leached and transported vertically into the Alluvial Sand WBZ with the tar and oil tar.

Amenable cyanide data has been collected over the previous two groundwater sampling events (February and June 1998), with a maximum concentration of 0.045 ppm being identified at well MW-1-22, located at the former Spent Oxide Storage area.

As summarized in Section 6.2.3, the toxicity of cyanide is primarily associated with the available, or amenable, cyanide fraction. It is of note that amenable cyanide has not been identified in groundwater at any monitoring well location at concentrations in excess of the 0.730 ppm Region 9 EPA PRG for amenable cyanide in tap water. However, as the Fresh Chronic AWQC for cyanide in surface water is 0.0052 ppm, it appears that further evaluation of this constituent with regard to its flux and potential impact to the Willamette River will be necessary.

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6.4.4 Metals

Arsenic, chromium, copper, lead, nickel, and zinc concentrations above the screening criteria have been identified in groundwater at the Gasco site. Arsenic, chromium, copper, lead, nickel and zinc have been found to occur at the site. No other of the Priority Pollutant metals have been identified in groundwater at the site at concentrations in excess of the screening criteria. It should be noted that some of the screening criteria are well below analytical method detection limits.

Arsenic has been identified at the Gasco site at concentrations in excess of the AWQC screening level of 0.000017 ppm and EPA PRG of 0.00004 ppm at numerous well locations, both within the Surficial Fill WBZ and within the Alluvial Sand WBZ. Dissolved arsenic data are not available for groundwater at the Gasco site other than one sample with the maximum total arsenic concentration identified in groundwater at the site (0.058 ppm within Surficial Fill WBZ well MW-10-25, as sampled in February 1997), where 0.052 ppm of dissolved arsenic was detected. This information suggests that most of the arsenic is in the dissolved state, at least at the MW-10 location.

With respect to chromium, concentrations of total chromium slightly elevated above the AWQC screening levels (0.011 ppm for hexavalent chromium and 0.210 ppm for trivalent chromium) have been identified at numerous well locations, with the greatest dissolved concentrations (0.23 ppm) being identified within the Surficial Fill WBZ at the well MW-10-25 location, the only location where dissolved concentrations have exceeded the MCL or PRG for this constituent.

Copper has been identified at the Gasco site at concentrations in excess of the AWQC screening level of 0.012 ppm at 6 well locations, both within the Surficial Fill WBZ and within the Alluvial Sand WBZ. Copper has not been identified in groundwater at any location in excess of MCLs or PRGs. Dissolved copper data are not available for groundwater at the Gasco site; however, the maximum total copper concentration identified in groundwater at the site was 0.41 ppm within Surficial Fill WBZ well MW-3-26, as sampled in October 1996.

Total lead has been identified within groundwater at 6 well locations at concentrations in excess of the screening criteria. It is noted that dissolved lead was not identified at concentrations above method detection limits at locations where filtered samples were collected, suggesting that the lead is sorbed onto soils and that transport, if any, would be limited to advection via colloidal particles. The maximum detected concentration of lead at the site was 0.099 ppm at well MW-3-26, as sampled in August 1997.

With respect to nickel, elevated concentrations of this constituent, relative to MCLs and AWQC have been identified at Surficial Fill WBZ wells MW-3-26 and MW-10-25, with maximum detected dissolved concentrations of 0.40 ppm and 0.53 ppm, respectively. Dissolved nickel concentrations in excess of screening values have not been identified at other well locations at the site.

Zinc has been identified at the Gasco site at concentrations in excess of the AWQC screening level of 0.110 ppm at numerous well locations, primarily within the Surficial Fill WBZ. Zinc has not been identified in groundwater at any location in excess of MCLs or PRGs. Dissolved zinc data are not available for groundwater at the Gasco site. The maximum total zinc concentration identified in groundwater at the site was 3.0 ppm within Surficial Fill WBZ well MW-10-25, as sampled in August 1997.

In summary, arsenic, chromium, copper, lead, nickel, and zinc concentrations elevated above the screening criteria have been identified in groundwater at the site. An evaluation of the identified metals with regard to flux into, and potential impact to, the Willamette River, will be conducted. Because metals are naturally occurring in the environment, an evaluation with respect to natural background water quality will be conducted, if metals issues remain at the site subsequent to the completion of the flux evaluation.

6.5 On-Site Surface Water and Sediment Impacts

On-site surface water and sediment sampling activities were conducted at the Gasco site on January 30, 1996. These activities involved the collection of surface water samples at two locations within the on-site drainage ditch, as well as within each of the three on-site ponds. Additionally, a shallow sediment sample was collected from each of the three on-site ponds. A figure depicting sample locations and tables summarizing the results of these activities have been included within Appendix I.

Results of the surface water sampling indicate PAH and BTEX compounds were present in the pond water and the water that was flowing within the drainage ditch. As the outfall from the on-site ponds to the drainage ditch has been sealed, the source of the water located within the ditch would have been one or more of the following: 1) stormwater runoff from the site; 2) LNG plant process cooling water; and 3) stormwater/groundwater removed by PNO from their tank farm containment basins. As there are no influents into the on-site ponds, and these ponds have been observed to only contain water during the rainy season, the water within these ponds would have been stormwater runoff.

With regard to the PAHs identified within the surface water samples, it is noted that PAH concentrations within all water samples were relatively uniform, with total concentrations ranging from 4.7 ppb to 23.7 ppb, while total PAH concentrations in sediments at the surface water sampling locations (ponds only) were found to range from 1,935 ppm to 21,665 ppm. Based on the large differential between PAH concentrations found in sediment and those found in surface water, and the relatively low concentrations identified in surface water, it appears that due to their relatively low aqueous solubilities and high partitioning coefficients, the PAHs will tend to remain within the sorbed phase in sediments and will not readily transfer to the dissolved phase in surface water. The identified sediment concentrations for PAHs exceed sediment screening levels provided within COE Draft Dredged Material Evaluation Framework, Lower Columbia River Management Area, April 1998.

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Although benzene was not identified in any of the on-site sediment samples collected during the referenced investigatory activities, benzene was identified in surface water samples collected from the on-site ponds at concentrations ranging from 0.92 ppb to 3.1 ppb, while benzene was identified within the drainage ditch at concentrations of 110 ppb near the head of the ditch, and at 6.2 ppb near the outfall of the ditch. The benzene concentration identified near the outfall of the ditch does not exceed AWQC for protection of aquatic life or fish consumption.

6.6 Willamette River and Sediment Impacts

With regard to sediment-related investigatory activities conducted in the vicinity of the Gasco site, the following data are available: 1) data collected by Northwest Natural as part of 1996 RI activities; 2) data collected as part of the 1997 EPA Site Inspection of a six-mile reach of the Willamette River (Weston, 1998), 3) data collected as part of the 1997 COE dredging material evaluation program (COE, 1998), and 4) data collected as part of COE sediment evaluations conducted at the U.S. Moorings Station, located immediately down-river of the Gasco site (Britton, 1990; Siipola and Britton 1994). All data point locations within the vicinity of the Gasco site (River Mile 6.0 to 7.0) are provided on Figures J-1 and J-2. It is noted that due to the close spacing of samples collected at the U.S. Moorings Station, it was not possible to depict these locations on the referenced figure. Instead, Figure J-3 provides a COE map that depicts the U.S. Moorings sediment sampling locations.

Figure J-4 provides a bar chart depicting total PAH concentrations for sediment data (Northwest Natural, EPA, and 1998 COE data), posted in relative sampling order from up-stream to down-stream across the Gasco site. Again, due to the large number of sampling points over a relatively small area, the COE U.S. Moorings data was not included on the referenced chart. A summary of sediment data collected by Northwest Natural is provided in Table J-1. A summary of all available sediment PAH data for river miles 6.0 to 7.0 (Northwest Natural, EPA, and all COE data) is provided in Table J-2. Sediment core logs depicting lithologic and contaminant conditions at borings installed as part of Northwest Natural's RI program are provided within Appendix C.

Sediment boring logs indicate that solid to semi-solid tar is present within the river sediments at locations adjacent to the former Tar Pond and former drainage ditch discharge areas, with field evidence (i.e., sheen and/or odor) of petroleum hydrocarbon impacts at other sampling locations adjacent to the site. Tar was found to be present within sediments both at the riverbed surface (SD-7) and extending to depths of at least 8 feet below the riverbed surface (SD-8). It is suspected that this tar is depositional in nature, that is, it was deposited as discharges from the Gasco site during manufactured gas plant operations, as opposed to migrating to the sediments via the subsurface soils.

In general, total PAH concentrations in surface sediments between river mile 6.0 and 7.0 were found to be the greatest at locations adjacent to the central portion of the Gasco site near the discharge point of the former drainage ditch, with impacts found to extend towards the center of the river at least as far as the main shipping channel (approximately 750 feet

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from the shoreline), as observed at the WR-BC-22 sampling location. Specifically, total PAH concentrations in surface sediments adjacent to the Gasco site were found to range from 85 ppm at the SD-063 location, to 26,408 ppm at the SD-7 location (corresponding to a zone of tarry gravel), with a concentration of 1,418 ppm being identified at the WR-BC-22 location in the main shipping channel. Total PAH concentrations in sediments collected from depths of less than 6.5 feet at the U.S. Moorings Station, located immediately down-river of the Gasco site, were found to range from 89 to 142 ppm in 1989 (Britton, 1990), while total PAH concentrations in surface sediments were found to range from 8 to 59 ppm in 1994 (Siipola and Britton, 1994).

As depicted on Figure J-4, total PAH concentrations in sediment samples collected at upstream and downstream locations show a marked decline relative to those collected adjacent to the Gasco site. Also, sediment samples collected on the opposite side of the river from the Gasco site did not result in the identification of significant PAH impacts.

Vertically, as identified at the SD-8 boring location, elevated PAH concentrations were found to extend at least to 9 feet below the river bed surface, with tar being found at that location to a depth of 8 feet bgs.

With regard to the presence of tar within the river sediments adjacent to the Gasco site, it is known that discharges of waste waters to the river from manufactured gas plant operations and the Tar Ponds occurred via the former drainage feature during the operation of the manufactured gas plant at the site, and that such discharges may account for the presence of these tars. The tar identified in soil borings installed adjacent to the river (B-29, B-31) would not be expected to migrate to the river sediments due to the overall high viscosity/low mobility of this material.

As identified during monthly shoreline inspections conducted at the Gasco facility, an area of hardened tar balls, some with a viscous center, exists along the Gasco shoreline at a location downstream from the former drainage ditch. The zone of tar ball accumulation has been found to dissipate before the downstream property line is reached. The presence of these tar balls is indicative that tar is present within the river sediments, but that the tar, in hardened form, has not been significantly transported down-stream by river current.

With regard to oil tar, it is noted that a description matching that of oil tar was provided for shallow river sediments (upper 17 inches) at a location adjacent to the former Tar Ponds in sediment sample SD-067, collected as part of the EPA Portland Harbor Sediment Study Investigation (EPA, 1998). It is unclear whether the oil tar at this location is present as a result of former surface discharges to the river, is a result of separation from the tar known to be present within the river, or is actively being sourced from the upland portion of the Gasco site.

With regard to the ongoing upland source potential, sufficient data to resolve this issue with respect to the former Tar Pond area should exist once the proposed deep Alluvial Sand WBZ wells to be installed between the former Tar Ponds and the river are constructed (HAI, 1998a). Also, additional evaluation with regard to the oil tars identified at the B-29 boring location, within the former low-lying area adjacent to the former drainage ditch, appears necessary in order to completely evaluate the potential for an ongoing upland

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source of oil tar into the river. Finally, it is noted that additional evaluation with regard to the extent, transport, and toxicity of impacted sediments adjacent to the Gasco site is necessary.

With regard to site impacts to surface water in the Willamette River, although surface water samples have not been collected from the river, it will be possible to ascertain potential impacts to the river from the site by evaluating the predicted flux of contaminated groundwater to the adjacent river, as well as by direct analysis of the river water and sediment porewater. An evaluation of flux to the river will be conducted subsequent to the installation of the proposed deep Alluvial Sand WBZ wells at this portion of the site (HAI, 1998a), which will provide necessary information regarding the vertical extent of groundwater impacts.

6.7 Air Impacts

Sampling for airborne contaminants at the Gasco site has been conducted for chemical exposure monitoring during implementation of the early stages of RI investigatory activities, as well as for ambient air quality monitoring. The objective of the chemical exposure monitoring was to ensure an adequate level of respiratory protection during the investigatory activities. The objective of the ambient air monitoring was to provide a general assessment of ambient air quality at a location downwind from the LNG containment basin, the Koppers lease area, and the former Tar Pond area. All monitoring activities were conducted by Paul Carlson Associates, Inc. (PCA), a firm specializing in industrial hygiene issues and air monitoring.

With regard to the chemical exposure monitoring, representative breathing zone concentrations of PAHs, BTEX, metals, cyanide, and total particulate were measured during soil boring installation activities carried out at the Former Light Oil Plant (borings B-18 and B-19), the Former Koppers Land Treatment Area (B-27), and the Former Spent Oxide Storage Area (B-1, B-2, and B-3). Results of the monitoring indicated the presence of PAHs, BTEX, and the metal titanium in certain of the air samples, with no other metals or cyanide being identified in the air samples. Concentrations of the identified constituents all fell below the Oregon Occupational Safety & Health Administration (OR-OSHA) Permissible Exposure Limits (PELs), designed to ensure the health of employees. The air monitoring data, and the summary report prepared by PCA, is included within Appendix K. Figure K-1 depicts the location of the air monitoring station.

With regard to the ambient air monitoring, this monitoring was conducted with a pump sampler over a period of approximately 6 hours on February 27, 1996 at the downwind (north) side of the LNG containment basin. The air sample was analyzed for the presence of particulates, PAHs, and BTEX constituents. Results of the monitoring event indicated that particulates (i.e., dust), PAHs, and BTEX constituents were all non-detect during the period of the referenced event. The air monitoring data and the summary report prepared by PCA are included within Appendix K.

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In addition to the above described air monitoring activities, two samples of accumulated dust were collected from the site (Figure K-1). Specifically, one dust sample was collected from within the fire hose containment box located within the Northwest Natural LNG process area (near well MW-9), and one dust sample was collected from within the fire hose box located directly adjacent to the vehicle exit doorway to the Koppers pencil pitch warehouse. The doors on both fire hose boxes had been ajar, allowing dust to accumulate on the shelving within. The timing of the dust accumulation (i.e., deposition caused by certain climatic conditions and / or site operations) is unknown.

Based on the proximity to the pencil pitch warehouse, the presence of pencil pitch on the ground in the vicinity of the fire hose box, and the black nature of the dust sample, it appeared that the dust sample collected adjacent to the Koppers pencil pitch warehouse was very likely pencil pitch dust derived from the Koppers warehouse operations. The dust sample collected in the Northwest Natural LNG process area did not have the appearance of pencil pitch. Both dust samples were analyzed for PAHs.

Results of the dust sample analyses indicate the presence of 381 ppm total PAHs within the dust sample collected from the LNG process area fire hose box, while 26,919 ppm total PAHs were identified within the sample of pencil pitch dust collected adjacent to the Koppers pencil pitch storage warehouse. A comparison of individual PAH fractions to the total PAH concentration was conducted for both of the dust samples. The comparison indicates a very close match exists between the ratio of individual PAHs to the total PAHs between the two samples, suggesting a common source. In this case, the source appears to be the Koppers pencil pitch storage warehouse. Laboratory sheets for the two dust samples, as well as a chart comparing the PAH ratios between the two samples, are provided within Appendix K, with additional discussion of PAH mixes provided within Appendix 1 (Decision Management Associates Report).

6.8 Contaminants of Concern

6.8.1 Soil

As summarized on the data tables provided in Appendix G, based on investigatory activities conducted at the site to date, PAHs, benzene, toluene, ethylbenzene, and arsenic have been detected in soils at the site at concentrations exceeding screening criteria. Specifically, PAHs and BTEX concentrations have been found to exceed DEQ Cleanup Levels as identified in the ODEQ Soil Cleanup Table (OAR 340-122-045) and/or Region IX PRGs, while arsenic concentrations exceed DEQ Industrial Maximum Allowable Soil Concentrations (OAR 340-122-045).

Pentachlorophenol, cyanide, and the metals antimony, cadmium, chromium, copper, lead, nickel, thallium, and zinc have all been identified in soil samples collected at the site, but none of these constituents were identified at concentrations exceeding EPA Region 9 PRGs, DEQ Soil Cleanup Levels, and/or DEQ Industrial Maximum Allowable Soil Concentrations, where established.

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With regard to amenable cyanide, because the amenable cyanide concentration cannot exceed the total cyanide concentration, and because the maximum identified total cyanide concentration in soil (518 ppm) is well below the 13,628 ppm EPA Region 9 PRG for amenable cyanide, it does not appear that amenable cyanide is a concern with respect to soil quality at the site. However, the soil leaching to groundwater pathway may need further evaluation for cyanide.

Based on the results of the RI activities conducted at the Gasco site to date, the contaminants of concern with respect to soil impacts at the site appear to be limited to the following:

- PAHs
- Volatile aromatic hydrocarbons (benzene, toluene, ethylbenzene)
- Arsenic
- Cyanide

6.8.2 Groundwater

As summarized on the data tables provided in Appendix H, with respect to groundwater quality, PAHs, BTEX compounds, 2,4-dimethylphenol, total cresols (2-, 3-, and 4-methylphenol), styrene, tetrachloroethene, arsenic, chromium, copper, lead, nickel, zinc, and cyanide, have all been detected at concentrations exceeding one or more of the following screening criteria: EPA MCLs established for drinking water, EPA Region 9 PRGs for tap water, and/or the federal AWQC established under the Clean Water Act for the protection of aquatic life and human health. The AWQC were included herein as a screen for identifying contaminants of concern within groundwater since contaminated groundwater at the site does discharge to the Willamette River, where the AWQC may be applicable.

With regard to 2,4-dimethylphenol and total cresols, it is noted that these constituents have been identified at concentrations in excess of the screening criteria at two well locations (i.e., wells MW-10-25 and MW-11-32), both of which are DNAPL-containing wells. Concentrations of these constituents have not been identified above the screening criteria at down-gradient well MW-4-57, the most highly contaminated well located adjacent to the river. As such, it does not appear that these constituents are mobile within the subsurface. Based on the preceding, and assuming that the use of groundwater at the site for a drinking water source would not be a potential beneficial use, then it does not appear that a receptor would exist for the phenol impacted groundwater, and as such, 2-4-dimethylphenol and total cresols do not appear to pose a concern with regard to groundwater quality at the site. All other phenols were identified at concentrations below the referenced screening criteria.

With regard to styrene, this constituent has been identified at the MW-12-36 well location at a maximum concentration of 170 ppb, with styrene having never been identified at

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locations down-gradient from well MW-12 (i.e., wells MW-4-56, MW-5-32, MW-8-56, or MW-11-32). The drinking water MCL for styrene is 100 ppb, while the tap water PRG for this constituent is 1,641 ppb. No AWQC for this constituent has been developed. The lack of styrene detections down-gradient of well MW-12 indicates that this constituent does not appear to be migrating towards the river. Based on the preceding, and assuming that the use of groundwater at the site for a drinking water source would not be a potential beneficial use, then it does not appear that a receptor would exist for the styrene impacted groundwater, and as such, styrene does not appear to pose a concern with regard to groundwater quality at the site.

With regard to tetrachloroethene (PCE), this constituent was identified at the MW-11-32 well location in March 1996 at an estimated concentration of 2.2 ppb, below the 5 ppb MCL and 9 ppb AWQC screening values, but slightly above the 1.08 PRG for this constituent. Due to the low concentration identified, the lack of subsequent detections at the MW-11 location, as well as a lack of detection at the up-gradient and down-gradient well locations, it does not appear that PCE poses a concern with regard to groundwater quality at the Gasco site.

Based on the results of the RI activities conducted at the Gasco site to date, the contaminants of concern with respect to groundwater impacts at the site appear to be limited to the following:

- PAHs
- Volatile aromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylenes)
- Cyanide
- Arsenic
- Chromium
- Copper
- Lead
- Nickel
- Zinc

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7. CONCLUSIONS

The purpose of the data presentation and evaluation presented herein has been to provide a summary and analysis of existing data collected as part of Phase I RI activities at the Gasco site to assist in the understanding of the site, and to guide decisions regarding additional data acquisition. The conclusions presented below are based on the analysis of data presented herein.

7.1 Hydrogeological Conditions

- Groundwater occurs in three principal hydrologic zones at the site including the unconfined Surficial Fill WBZ, the semi-confined Alluvial Sand WBZ, and confined bedrock aquifers in the Columbia River Basalts.

- A silt unit, correlating to the depth of pre-fill ground surface elevations, separates the Surficial Fill WBZ from the Alluvial Sand WBZ across a majority of the site. A northwest-southeast trending depression in the surface of the silt unit exists across the center of the site, correlating with the location of a pre-fill creek bed.

- Groundwater within the Surficial Fill WBZ and the Alluvial Sand WBZ appears to be hydraulically connected to the Willamette River, with groundwater flow beneath the site being to the northeast towards, and discharging to, the river.

- A downward vertical hydraulic gradient between the Surficial Fill and the Alluvial Sand WBZ predominates, with reversals being identified at certain locations during times of high river stage.

9 Depth to bedrock across the site is estimated to range from 36 feet bgs at the southwestern portion of the site near NW. St. Helens Road, to more than 250 feet bgs at the southeastern portion of the site adjacent to the Willamette River.

7.2 Nature, Extent, and Transport of Contamination

Soil, sediment, and groundwater contamination has been found to be associated with the presence of residual manufactured gas plant wastes at the property, primarily tar and oil tar (PAHs and BTEX), and spent oxide materials (metals and cyanide).

7.2.1 Residual Tar, Oil Tar, and DNAPL

- Tar has been found to be primarily restricted to the southeastern portion of the site at the former Tar Pond area and the location of a former drainage feature, areas where tar-bearing wastes were discharged and/or mixed with fill.

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- Residual oil tar has been identified throughout the southern, southeastern and west-central portions of the site, likely sourced from the former Light Oil Plant, former Retort area, former Tar Ponds, and a former drainage feature.

- The silt unit has likely prevented oil tar impacts derived from the Light Oil Plant/Retort Area from migrating vertically into the underlying Alluvial Sand WBZ, with oil tar having migrated from these areas via gravity along the surface of the northeast sloping silt unit. The northwest - southeast trending depression in the surface of the silt unit has acted as a barrier to the lateral migration of the mobile oil tar product to the northeast and towards the Willamette River.

- Oil tar has been found to extend through the silt unit and into the upper portions of the Alluvial Sand WBZ at several locations within the southeastern portion of the site (former Tar Ponds), correlating to areas with the greatest accumulations of tar.

- Oil tar was found within the Alluvial Sand WBZ within the former drainage feature, the only location where oil tar is found adjacent to the Willamette River.

- Soil boring data indicates that the lateral and vertical extent of tar and oil tar have been generally defined across the site. Laterally, tar and oil tar may likely extend across the southeastern property boundary, where placement of these materials as fill may have occurred.

- Three areas of free product DNAPL (oil tar) have been identified within the Surficial Fill WBZ at the site. Two areas of DNAPL occurrence are located on top of the silt at areas where the silt surface is depressed. The third is located up-slope of the depression, but down-slope of the identified oil tar source area.

7.2.2 Soil Quality Impacts

10 Based on the evaluation conducted to date, constituents of concern with regard to soils at the site are PAHs, benzene, toluene, ethylbenzene, and arsenic.

- BTEX and PAH concentrations above EPA Region 9 PRGs are found in the zones of tar and oil tar contamination.

- The vertical extent of BTEX and PAH contamination within soil has been well defined at most soil boring locations, with the most significant impacts being restricted to the surficial fill unit, except in the former Tar Pond area, where contaminants have extended into the alluvial sand unit.

- Cyanide was identified in soils throughout the site, likely as the result of spent oxide materials within fill materials. The maximum total cyanide detection in soil was 518 ppm, well below the 13,628 ppm EPA Region 9 PRG for free cyanide in industrial soils. However, cyanide in soil may be an issue at the site with regard to leaching to

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groundwater, should it be determined that an unsatisfactory risk with regard to groundwater concentrations exists.

- Elevated concentrations of arsenic, relative to screening levels and to soils from other portions of the site, were identified within the former Spent Oxide Storage Area.

Statistical evaluation of the data, as conducted by Decision Management Associates LLC developed the following conclusions with respect to soil quality at the site:

- Data visualization and analysis show substantial small-scale variability superimposed on site-scale trends, with the variability consistent with fill placement, mixing, and preferential transport of contaminants.

- The primary site-scale trend for PAHs is for greater contamination towards the southeastern corner of the site.

- Significant differences in concentrations and variability exist by area and depth.

- PAH concentrations are related to field evidence of contamination (odor, sheen, presence of product), with a lesser relationship being identified with benzene.

- For Risk Assessment purposes, since surface samples were collected randomly this data may be used directly, while sub-surface samples were collected in part based on soil appearance, and are therefore biased. However, the bias in the sampling was found to: 1) increase representation of high-concentration PAH samples by about 25%, and 2) has no measurable impact on benzene values.

7.2.3 Groundwater Impacts

- Groundwater contamination, primarily PAH, BTEX, and cyanide related, has been identified within both the Surficial Fill WBZ and the Alluvial Sand WBZ.

- The former Light Oil Plant is the likely source for the bulk of the BTEX groundwater contaminant plume at Gasco, with the residual oil tar at the site being a secondary, and ongoing, source for the BTEX contamination present in groundwater.

- Oil tar and tar-saturated soils appear to be the source of the PAH impacts to groundwater at the site.

- With regard to the Surficial Fill WBZ, both the BTEX and PAH groundwater contaminant plumes tend to be primarily restricted to the portion of the site where residual tar or oil tar contamination has been identified, with concentrations attenuating rapidly down-gradient of these areas. However, the vertical extent of BTEX and PAH groundwater contamination down-gradient of the former Tar Ponds has not been defined.

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- With regard to the Alluvial Sand WBZ, it has been found that the BTEX and PAH contaminant plume is primarily restricted to the eastern portion of the site, within and down-gradient of the former Tar Ponds.

- Areas of metals concentrations elevated above screening criteria have been identified in groundwater at the site. Specifically, arsenic, chromium, copper, lead, nickel and zinc have been found at concentrations above AWQC, a potential concern because of discharge to the Willamette River.

7.2.4 On-Site Surface Water Impacts

- Results of surface water sampling of the on-site pond water and within the water that was flowing within the on-site drainage ditch indicates that only benzene, at the head of the ditch, was found to exceed screening criteria (AWQC). The benzene concentration identified near the outfall of the ditch does not exceed AWQC for protection of aquatic life or fish consumption.

7.2.5 Sediment Impacts

- Sampling activities identified the presence of solid to semi-solid tar within Willamette River sediments at locations adjacent to the former Tar Pond and former drainage ditch discharge areas, with field evidence of petroleum hydrocarbon impacts at other sampling locations adjacent to the site. Tar was found to be present within sediments at the riverbed surface, extending to depths of at least 8 feet below the riverbed surface at one location.

- It is suspected that the tar identified in the sediments adjacent to the Gasco site is depositional in nature, having been deposited as discharges from the Gasco site during manufactured gas plant operations.

- An area of hardened tar balls exists along the Gasco shoreline at a location downstream from the former drainage ditch. The zone of tar ball accumulation has been found to dissipate before the downstream property line is reached. The presence of these tar balls is indicative that tar is present within the river sediments, but that the tar, in hardened form, has not been significantly transported down-stream by river current.

- Total PAH concentrations in surface sediments in the vicinity of Gasco were found to be the greatest at locations adjacent to the central portion of the site near the discharge point of the former drainage ditch, with impacts found to extend towards the center of the river at least as far as the main shipping channel (approximately 750 feet from the shoreline).

- Total PAH concentrations in surface sediments adjacent to the Gasco site were found to range from 85 ppm to 26,408 ppm (corresponding to a zone of tarry gravel), with a

concentration of 1,418 ppm being identified within the main shipping channel. Total PAH concentrations in sediment samples collected at upstream and downstream locations show a marked decline relative to those collected adjacent to the Gasco site.

- PAHs were identified within sediment samples collected from the three on-site ponds located at the southeastern portion of the site, with concentrations ranging from 1,935 ppm too 21,665 ppm being identified.

7.2.6 Air Quality

- Breathing zone monitoring conducted during drilling activities at the site indicated the presence of PAHs, BTEX, and the metal titanium in certain of the air samples. Concentrations of the identified constituents all fell below limits designed to ensure the health of employees.

- Ambient air monitoring conducted downwind of the LNG containment basin indicated that PAHs and BTEX constituents were all non-detect during the period of the referenced event.

- Analysis and evaluation two dust samples at the site indicate that Koppers pencil pitch may be a contributing factor with regard to PAHs identified in surface soils at the site.

7.3 Existing Data Needs

Based on the findings of RI activities conducted at the site to date, as evaluated herein, the following data needs have been identified such that the objectives of the RI may be satisfied:

7.3.1 Risk Assessment Data Needs

- Statistical data evaluation indicates a need for the collection of ten additional surface soil samples at the site, primarily within the northwest (former office area), and northeast (PNO lease area) portions of the site.

- Statistical data evaluation indicates a need for the collection of seven shallow (<15 feet) soil samples at the site.

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7.3.2 Contaminant Nature, Extent and Transport Data Needs

- The vertical extent of groundwater contamination at the site is not defined. The installation of three deep (up to 160 feet bgs) Alluvial Sand WBZ wells, two down-gradient of the former Tar Ponds, and one down-gradient of the former Light Oil Plant area, have been proposed to satisfy this data need (HAI, 1998a).

- Verification should be obtained that the vertical extent of DNAPL (oil tar) migration has been adequately defined at the site. The installation of the referenced deep Alluvial Sand WBZ wells to be installed down-gradient of the former Tar Ponds, and the deep well to be installed down-gradient of the former Light Oil Plant have been proposed to satisfy this data need (HAI, 1998a).

- Conclusions with regard to the active migration of DNAPL to the Willamette River within the area of the former Tar Ponds and the former drainage feature (B-29 boring) are necessary. The two deep Alluvial Sand WBZ wells to be installed down-gradient of the former Tar Ponds will satisfy this data need with respect to former Tar Pond portion of the site. Additional evaluation appears necessary to satisfy the data need with respect to the B-29/former drainage feature area.

- The lateral extent of on-site groundwater contamination should be defined. The installation of an intermediate-depth (65 feet bgs) monitoring well to be installed within the PNO area at the northeastern portion of the site, and depth-discrete groundwater data to be collected from temporary well points installed at the eastern corner of the site (MW-5 location) will satisfy this data need (HAI, 1998a).

- The on-site lateral extent of residual tar and oil tar in soil should be defined to the northeast of the LNG containment basin.

- An evaluation of the physical and chemical make-up of the free product DNAPL (oil tar) should be conducted to assist in the feasibility study and to assess contaminant transport issues. Additionally, the recoverability of DNAPL from wells at the site should be evaluated. Activities necessary to satisfy these data needs have been proposed (HAI, 1998b).

- Additional evaluation with regard to the extent of contamination in Willamette River sediments is necessary. Such an evaluation may include toxicological studies, porewater and sediment sampling activities, as well as an evaluation of river dynamics with regard to contaminant transport.

- An evaluation of contaminated groundwater flux to the Willamette River should be conducted following the completion of groundwater quality-related data gaps described herein.

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8. LIMITATIONS

The samples discussed in this report were collected, analyzed, and interpreted following the standards of care, skill, and diligence ordinarily provided by a professional in the performance of similar services as of the time the services were performed. This report and the conclusions and/or recommendations contained in it are based solely upon physical sampling and analytical activities that were conducted at the Client's request. The data presented in this report document only the concentrations of the target analytes in the particular sample and not the property as a whole.

(HAI 10/95)

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10. GLOSSARY OF ABBREVIATIONS

AWQC	Ambient Water Quality Criteria
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
DEQ	Oregon Department of Environmental Quality
DNAPL	dense non-aqueous phase liquid
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
gpm	gallon per minute
GPR	ground penetrating radar
HAI	Hahn and Associates, Inc.
HVOCs	halogenated volatile organic compounds
LNG	liquefied natural gas
MCL	Maximum Contaminant Level
msl	mean sea level
OAR	Oregon Administrative Rule
OR-OSHA	Oregon Occupational Safety and Health Agency
PAHs	polynuclear aromatic hydrocarbons
PCA	Paul Carlson Associates, Inc.
PEL	permissible exposure level
PNO	Pacific Northern Oil
ppb	parts per billion
ppm	parts per million
PRGs	Preliminary Remediation Goals
ppb	parts per billion
RI	remedial investigation
SI	Site Inspection
WBZ	water-bearing zone

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Any questions regarding the information presented in this report are welcome and should be referred to the undersigned. Thank you for the opportunity to be of service to Northwest Natural in this manner.

Hahn and Associates, Inc.

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Date 10/9/98

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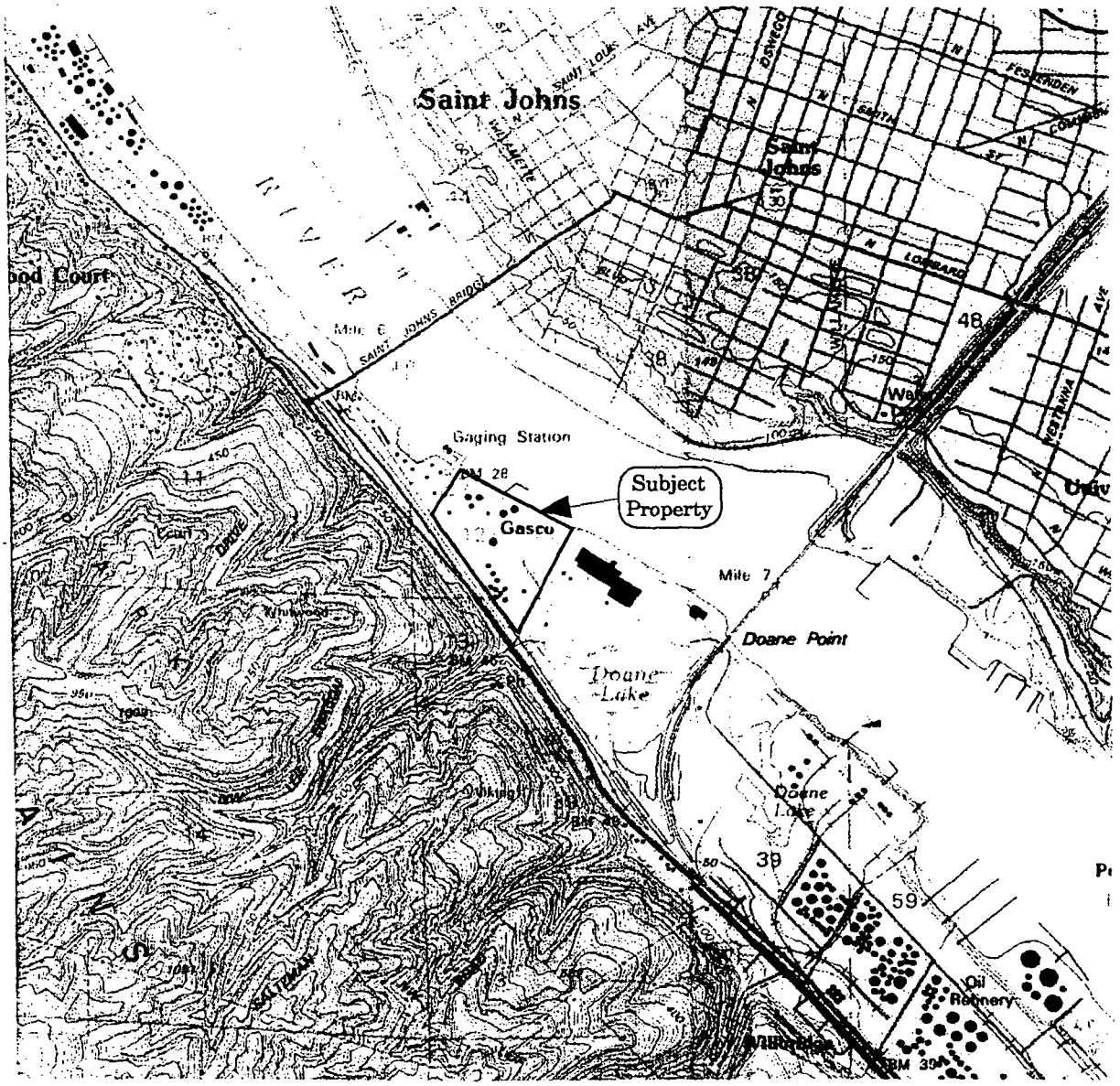

Note: Base Map from Linnton (1990) and Portland (1990), Oregon, USGS 7.5 Minute Quadrangles

Project No. 2708 September 1998	**HAHN AND ASSOCIATES** **INCORPORATED** ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	**LOCATION MAP** Northwest Natural Gasco Facility 7900 NW St. Helens Road Portland, Oregon	**FIGURE** **1**

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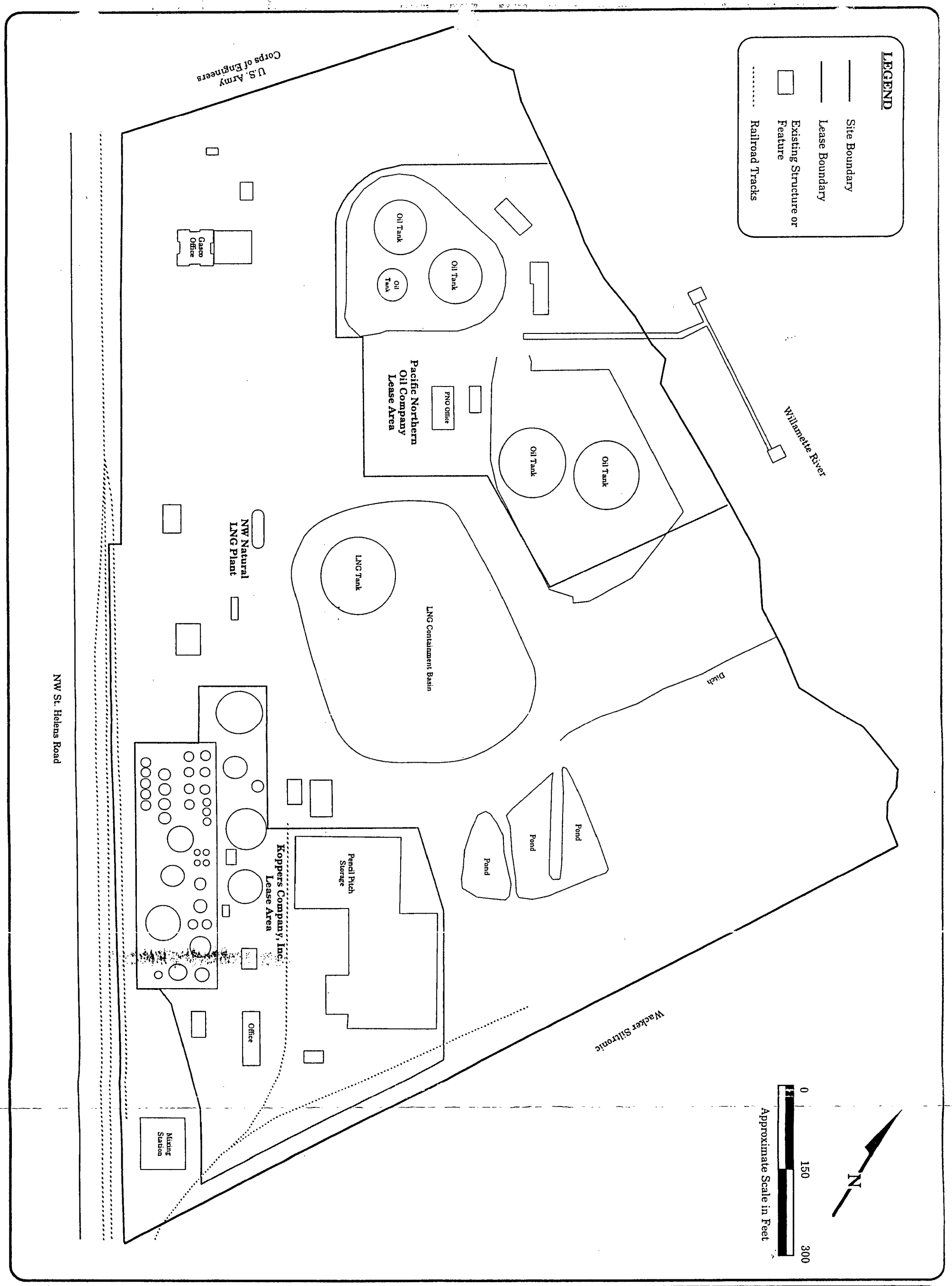

Project No. 2708	September 1998	**HAHN & ASSOCIATES** INCORPORATED ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 503/796-0717	**Site Map** Remedial Investigation Northwest Natural – Gasco Facility 7900 NW St. Helens Road Portland, Oregon	Figure 2

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LEGEND

- Site Boundary
- Lease Boundary
- Existing Structure or Feature
- Former Structure or Feature
- Railroad Tracks

N

0 150 300

Approximate Scale in Feet

Willamette River

Former Drainage Ditch (1940)

Ditch

Unknown Tank

Former Settling Pond

Wacker Siltronic

Pond

Pond

Pond

Oil Tank

Oil Tank

Oil Tank

Oil Tank

Oil Tank

Oil Tank

Oxide Building

PNO Office

Pacific Northern Oil Company Lease Area

Briquette Storage Shed

Spent Oxide Storage Area

Oxide Purifier Area

Lampblack Storage Area

LNG Containment Basin

LNG Tank

Thickener

Thickener

Briquette Plant

Naphthalene Plant

Generator Building

Still

Koppers Land Treatment Area

Coke Ovens

Pencil Pitch Storage

Pitch Bay

Pitch Pans

Koppers Company, Inc. Lease Area

Pitch Plant

Office

Pitch Pans

U.S. Army Corps of Engineers

Storage Holder

Gasco Office

Wash Room

Machinery Building

Retort Area

NW Natural LNG Plant

Relief Holder

High BTU Gas Holder

Still

Light Oil Plant

Tar Loading

Mixing Station

NW St. Helens Road

Figure 3

Historical Features Map

Remedial Investigation
Northwest Natural – Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES
INCORPORATED
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project No. 2708

Koppers022454

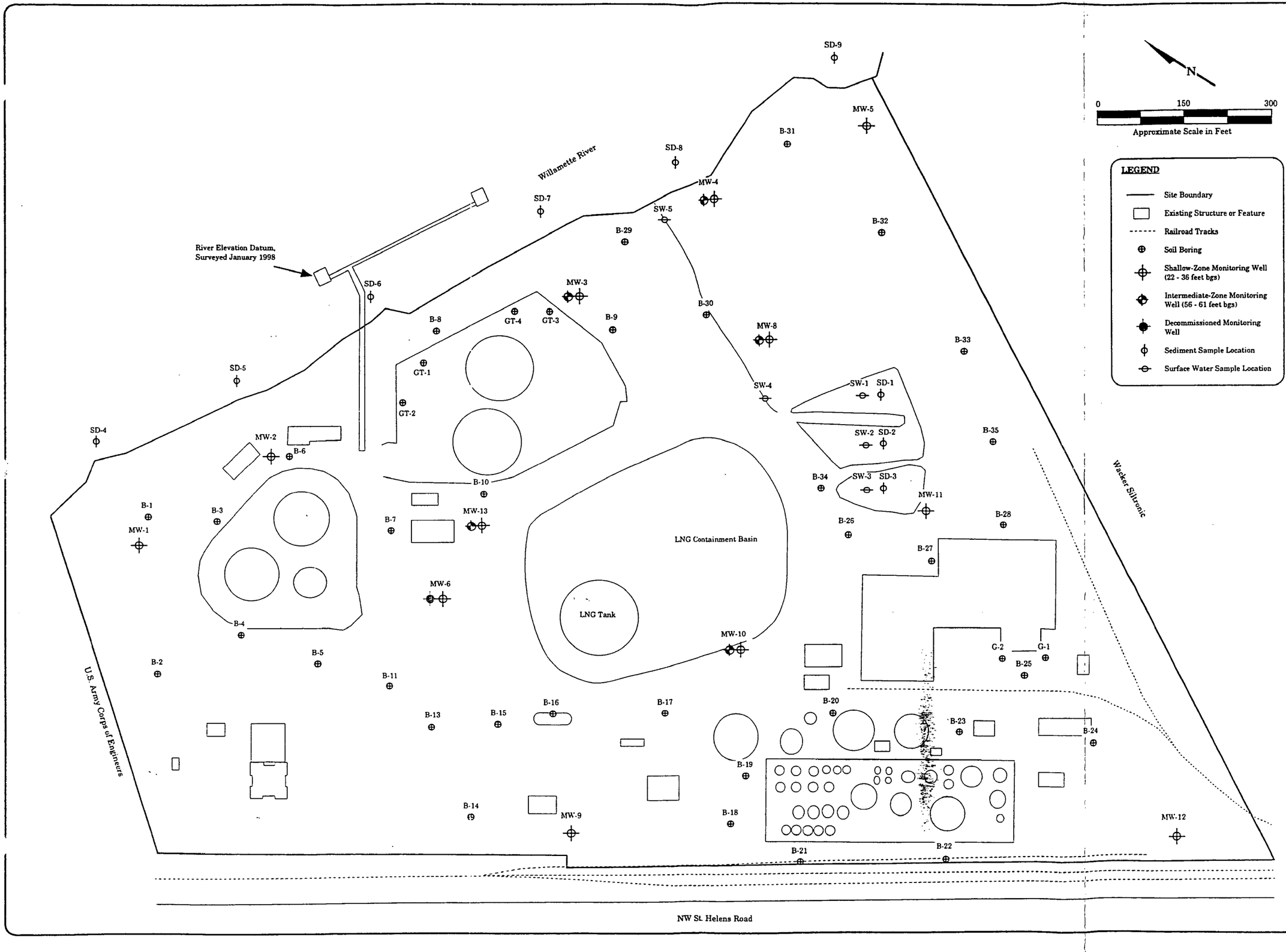

Figure 4

Sample Location Map

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

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503/796-0717

September 1998

Project #2708

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Figure 5

Bedrock Surface Elevation Map

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

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ENVIRONMENTAL MANAGEMENT
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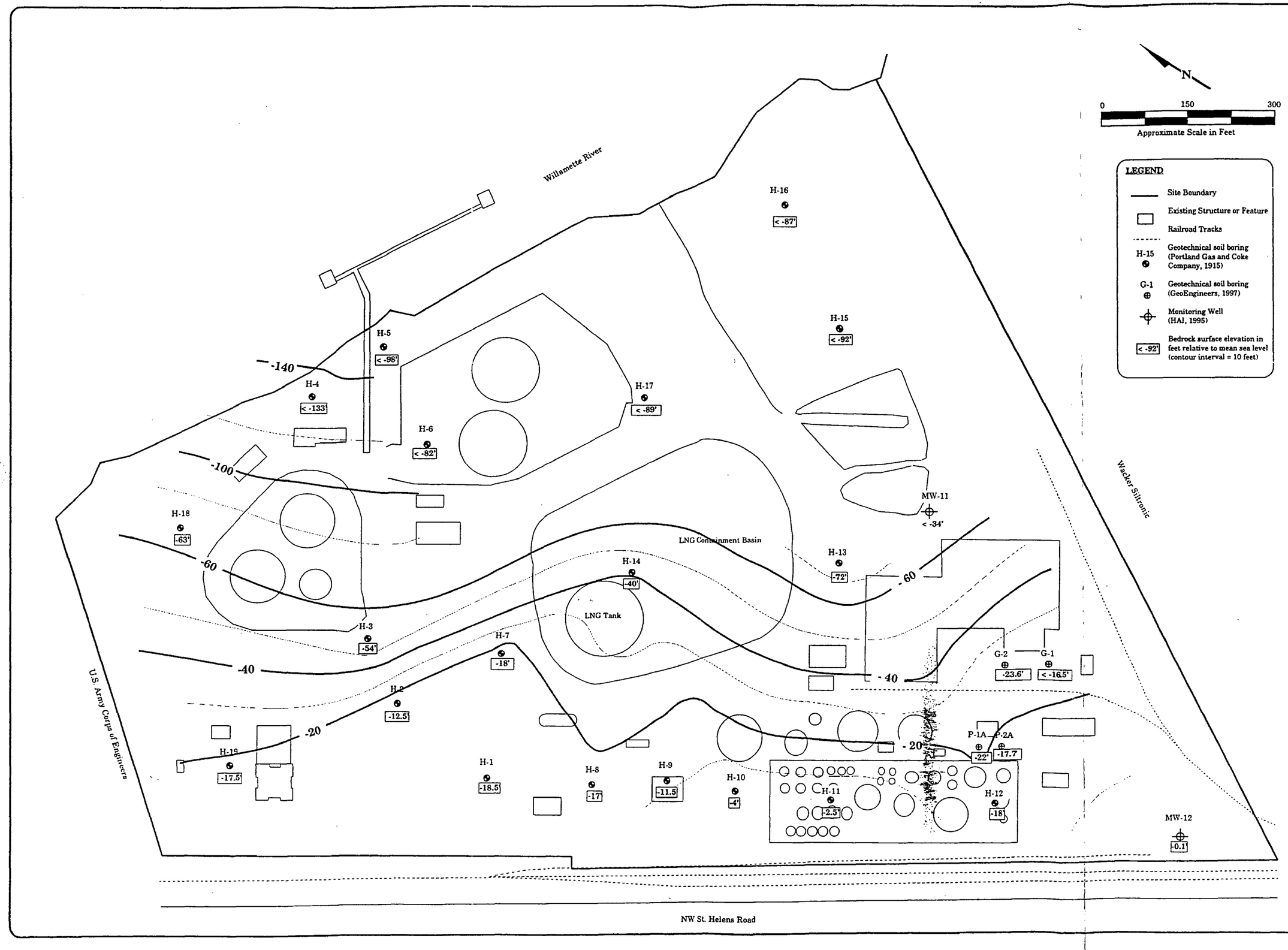
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project #2708



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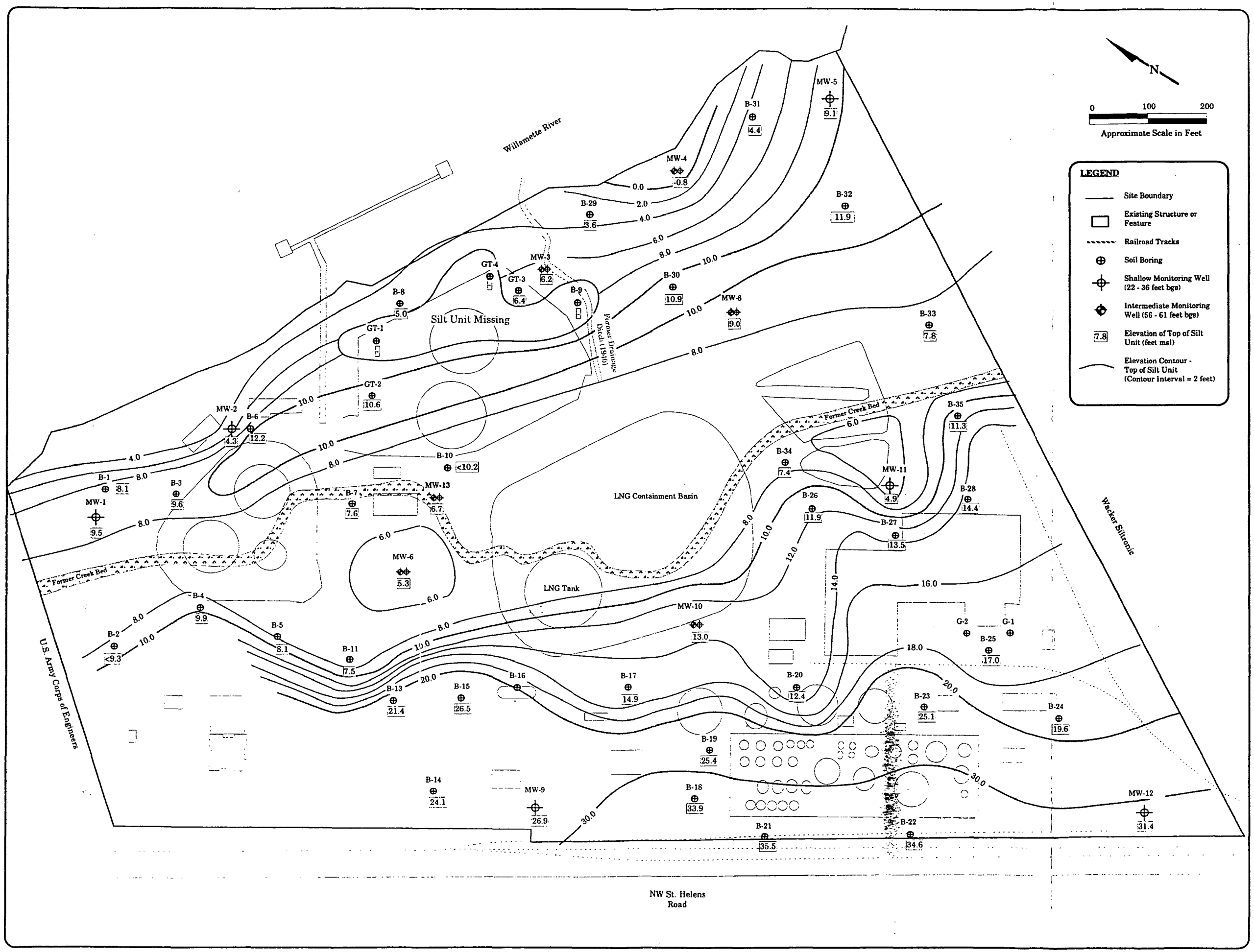

Figure
6

Elevation Map: Top of Silt Unit

Remedial Investigation
Northwest Natural Gas Company Gasco Facility
7990 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES
INCORPORATED
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

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Koppers022457

Willamette River

Silt Missing

Former Drainage Ditch (1940)

LNG Containment Basin

LNG Tank

U.S. Army Corps of Engineers

Wacker Siltronic

NW St. Helens Road

N

LEGEND

- Site Boundary
- Existing Structure or Feature
- Railroad Tracks
- Soil Boring
- Shallow Monitoring Well (22 - 36 feet bgs)
- Intermediate Monitoring Well (56 - 61 feet bgs)
- 15.0 Thickness of Silt Unit (feet)
- 5.0 Isopach Contour (Contour Interval = 5 feet)

Figure
7

Isopach Map: Silt Unit

Remedial Investigation
Northwest Natural Gas Company Gasco Facility
7990 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
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Koppers022458

Northeast

Southwest

Light Oil Plant

St. Helens Rd.

RR Tracks

Pond

Filled Settling Pond

Surficial
Fill Unit

Water Table

Willamette River

Silt Unit

Alluvial Deposits

Columbia River Basalts

LEGEND

- Surface Water
- Geologic Unit Boundary
- Fill Material
- Water Table
- Groundwater Flow Path

Figure
8

Hydrogeologic Conceptual Model

Northwest Natural Gas Company
Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES
INCORPORATED
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
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503/796-0717

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1998

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2708

Koppers022459

Preliminary Analysis
Of Soil Contamination Data

Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

October 9, 1998

Prepared for:

Northwest Natural, Inc.
Portland, Oregon

Prepared by:

Frank Selker
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Portland, Oregon

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Decision Management Associates LLC

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1. Introduction

The purpose of this section is to further our understanding of site contamination by plotting and analyzing soil data and descriptions. The goals are to get a better idea of contaminant location, how reliably we can predict exposures that may lead to risk, and what additional data will be most helpful.

The Data Package (1996) includes both qualitative and quantitative information. Qualitative information includes soil boring logs and cross sections (Data Package Appendices A, B and L) that are helpful in understanding the distribution of contaminants. The RI Summary Report uses such qualitative information and rough ranges of concentrations to provide insights and estimated boundaries and contours of product locations.

In this appendix we focus on the quantitative contamination data, that is the roughly 5,000 data values collected at about 165 locations and depths. The plots and analyses in this appendix are intended to provide a variety of windows into the data to help detect and understand patterns and trends. Specifically, we:

1. Evaluate sampling, duplicate results, and mixes of PAH compounds.
2. Plot concentrations in 3-d scatter plots, histograms, and other plots to help see the spatial distribution of samples with elevated concentrations.
3. Consider statistical evidence for and against breaking the site into areas based on surface location and on depth. Depths considered are "surface" (0-0.2 feet), "shallow" (0.2-15 feet), and "deep" (>15 feet).
4. Consider how concentrations are related to soil odor, sheen, and the presence of product.
5. Provide examples of how concentration probability distributions can be constructed from site data for risk analyses.
6. Summarize findings.

We consider the contaminants:

Carcinogenic PAHs (CPAHs)
Total PAHs (TPAHs)
Benzene
Arsenic

Generally broken down into the following 3 depths:

- Surface (up to 0.2 feet deep; potential source of dust, exposure during surface activities)
- Shallow (between 0.2 and 15 feet; likely to include soil encountered during future trenching and sub-surface work at site)
- Deep (greater than 15 feet; important to understanding site and to groundwater, but not as direct exposure pathway)

CPAHs and benzene are expected to be leading sources of risk among chemicals identified at the site. Total PAHs were considered due to correlation with CPAHs. PAHs are of interest since they are present site wide. Benzene is evaluated since it is the most toxic and prevalent of the BTEX (benzene, toluene, ethylbenzene and xylene) compounds at the site.

Helpful comments to drafts of this memorandum were provided by David Ruppert, Professor of Statistical Science, Cornell University; Rob Ede, Hahn and Associates; and Steve Sonnen, Montgomery and Watson.

Koppers022462

2. Sampling And Data

2.1. Data

The data for this analysis were taken from the Data Package (Hahn, 1996), from samples taken at monitoring well 13 (MW-13), and from the four geotechnical borings taken near the river in the area of B-8 (GT-1, GT-2, GT-3, GT-4). The preceding represents all available soil quality data for the site (see Data Summary document to which this is attached).

2.2. Sampling Strategy

Surface sampling was done essentially at random to roughly cover the site. Thus evaluation of surface samples as random samples is valid for the purposes of statistical analysis.

Sub-surface sampling locations, however, were selected to (1) investigate areas in which historic operations were thought to create contamination potential, and (2) to roughly cover the site. The first of these goals creates a non-random sampling strategy, due to targeting of expected sources. The second introduces a random-grid element into the locations across the site. The laboratory analyses run on samples were generally not selected based on sample appearance, so this did not introduce bias.

Another source of bias in sub-surface samples is that samples were taken in part based on soil appearance and apparent contamination. Typically, samples were taken above, in, and below what appeared to be contaminated soils. At monitoring wells, samples were primarily guided by identifying the lower limits of contamination. See the Final Work Plan, August 4, 1995, for a further description of sampling activities. Such potentially biased data is useful for characterizing contamination, but must be used with caution for statistical analysis (e.g., see Section 1.3, EPA, 1996).

To investigate this bias we consider the relationship between soil appearance and contaminant concentrations later in this document. We find that sub-surface PAH concentrations are modestly biased upward by use of visual inspection, but benzene concentrations are probably not significantly biased.

2.3. Duplicates

Figure 1 shows the ratios of concentrations found in duplicates. If samples were uniform and tests were perfect, all values would be 1.0. In fact, for those duplicates in which significant concentrations of contaminants were found the two duplicates have rather different results, with most varying by about 50%, and sample B-01 varying by a factor of 4. Since the PAHs in these samples were fairly low (about 10 ppm) the differences are large percentages but low quantities. Ranges in precision for PAH analyses in a range from 30-150% of true values, depending on the constituent, are considered acceptable by lab QA/QC standards. Lab QA/QC tests indicated that they were operating within these standards. Therefore it is likely that the differences represent normal test imprecision for all samples except for B-01. For B-01 heterogeneous contamination on the scale of a few inches (the space between samples taken in two 4-9 oz. sample jars) is the likely explanation. However, in analyzing results the significant potential imprecision of testing should be kept in mind.

3. Visual Examination Of Data And Evaluation Of Differences By Area

In the following paragraphs we present several ways to plot and view data.

Koppers022463

3.1. PAH Compound Mix

3.1.1. Relation between CPAHs and TPAHs.

Figure 2 shows TPAHs versus CPAHs by depth on a log-log scale. A linear relation with zero intercept indicates that the relationship between TPAHs and CPAHs is proportional. The two chemical groups are strikingly well correlated for surface soils. Explanations include that surface PAHs are from a single source or that weathering has left them uniform in nature (more discussion below). The two groups of chemicals are roughly correlated for deeper soils, suggesting variety in the nature of sub-surface PAH contamination. This may be associated with diverse sources, differential weathering and/or differing rates of migration. In a number of samples TPAHs were detected at low concentrations while CPAHs were not detected (values of -3 in the figures represent no detects).

3.1.2. PAH Fingerprints.

Beyond the above breakdown into total and carcinogenic, the relative concentrations of the sixteen different PAH compounds analyzed can be considered a "fingerprint" for a PAH mix.

Figure 3 displays the PAH fingerprint of all surface soil samples by constituent. Each sample is shown as one of the thin bars above each constituent. In this figure the right-most thin bar above each constituent is a sample we believe is Koppers pencil pitch dust (see discussion in Data Summary). The fact that for surface soils the thin bars tend to be similar (e.g. most are high for Pyrene and low for Napthalene) indicates similar PAH fingerprints among surface samples. Further, it appears that PAHs in surface samples are generally quite similar to dust collected at Koppers.

Figures 4 and 5 show similar comparisons for shallow and deep soils, respectively. PAHs in shallow and deep soils are more diverse. They are generally dissimilar to surface PAHs and somewhat similar to each other. Part of this the distinction between surface and deeper samples is due to weathering, for example with naphthalene volatilizing near the surface. Similarity of surface samples may also reflect a common source. The differences between surface and deeper PAHs should be addressed in assessing the potency of CPAHs.

3.2. 3-D Concentration Scatter Plots of Concentrations

Figures 6-13 show 3-dimensional scatter plots of the contaminants:

- TPAHs
- CPAHs
- Benzene

In each plot the site is shown from a south-southwest vantage point, with approximate site borders and river locations shown. The north and east coordinates are in feet, and are those used in records of borings and wells at the site. These plots are primarily intended to clarify the extent to which elevated concentrations occur in various areas and at various depths. Sample locations are provided for points with highest concentrations[1].

TPAHs and CPAHs are distributed very similarly, with elevated concentrations of each occurring at the same points. Elevated surface concentrations of CPAHs are about 10% of the concentrations elevated shallow and deep soil concentrations. Elevated concentrations of PAHs occur within each of these

[1] Note that while concentrations of contaminants in deep soil have been carried throughout this analysis, they are not directly important in the evaluation of human health risks due to the lack of a viable route of exposure (DEQ letter to S. Hart, August 23, 1996).

Koppers022464

depth intervals towards the eastern corner of the site (former tar pond area, near Wacker and the river), an area with residual tar product in the soil. A few other samples showing elevated concentrations are scattered across the site, with high variability by both depth and location.

Benzene concentrations in shallow soil are elevated primarily in the central part of the site near the southwest boundary, near the former light oil plant. In deep soil the elevated concentrations are about 50% as high and are farther down-gradient of the light oil plant, with another spike at MW-6. Elevated benzene concentrations do not perfectly coincide with observed product, with the highest concentration occurring in a sample at B18 that had no obvious product.

3.3. Site Breakdown and Histograms

The site could be divided in a number of ways for the purpose of statistical analysis. One reason for breaking the site down is variability of human activity, and thus exposure parameters, by area (e.g. the 3-area breakdown below). Another reason is variability in the nature and extent of contamination (e.g. 2 and 4-area breakdowns below). We consider the site as a whole and using 3 breakdowns as shown in Figures 14 and 14a and described below.

The 2-Area breakdown was used to investigate the apparently higher concentrations occurring in the eastern corner of the site (see scatter plots, above), with the eastern corner being nearly identical to the Former Tar Pond area of the 4-area breakdown.

The 3-Area breakdown follows approximate boundaries of current usage, with the NWN area including all but the northeastern area (PNO) and the southwestern corner (Koppers). This breakdown is likely to be useful to the extent that exposure parameters vary by current lease areas.

The 4-Area breakdown was suggested by DEQ in the memo of June 27, 1997 "Data Summary and Exposure Pathway Analysis-Technical Memorandum, Former GASCO Site." The proposed breakdown included a small fifth area in the northeast corner of the site near the abandoned office building called "Office Area." No data have been taken in that area, as broken out, so it is not included in the analysis. The memo showed the LNG containment basin as an excluded area. The assignment of sampling locations to areas for each breakdown is shown in Table 1 below.

Table 1. Assignment of Sampling Locations to Areas

Area Breakdowns	Borings and Wells by Area			
2-Area	*East Corner* Borings: 9, 29-35 Wells: 3-5, 8	*Main Area* All other samples		
3-Area	*NWN* Borings: 2, 5, 9, 11-17, 26, 29-35 Wells: 3-5, 8-11	*Koppers* Borings: 18-25, 27, 28 Wells: 12	*PNO* Borings: 1, 3, 4, 6-8,10 Wells: 1, 2, 6, 13 Geotech: 1-4	
4-Area	*Tar Pond Area* Borings: 9, 26, 28-35 Wells: 3-5, 8,11	*Retorts/Koppers* Borings: 11, 13-25, 27 Wells: 6, 9,10,12	*PNO* Borings: 7, 8, 10 Wells: 13 Geotech: 1-4	*Oxide Area* Borings: 1-6 Wells: 1-2

Koppers022465

Figures 15-22 are histograms of the frequency with which concentrations of TPAHs, CPAHs, and benzene were found by area and depth, on a log scale. The left-hand columns, at 10^{-3}, indicate non-detects. With the high variability found, mean values primarily reflect the several highest concentrations found. Because of the log scale even fairly subtle differences in the appearance of histograms, particularly in the right-hand most columns, reflect significant differences in the highest and mean concentrations. In cases where a single sample of elevated concentration has a dramatic impact on the mean, the mean is also shown without that sample included in the data set.

In studying these histograms some patterns appear:

- The 4-Area breakdown provides the best resolution of concentrations, most clearly showing lower PAH concentrations in the PNO area and higher concentrations in the eastern corner (near the river and Wacker).
- The 3- and 4-Area sets of histograms both show lower surface concentrations in the northern part of the site (PNO and Oxide areas) relative to other areas.
- Shallow soil has fewer non-detects and higher concentrations than deep soil.
- All 3 sets of histograms show great variability in PAH concentrations in shallow and deep soils (7 orders of magnitude), and somewhat less variability in surface soils (3 orders of magnitude). This reinforces other observations suggesting that surface PAHs differ in distribution and nature from sub-surface PAHs.

Figure 23 shows arsenic concentrations found in the PNO and Oxide areas of the 4-Area break down. Samples have not been taken in other areas. Concentrations are consistently higher in the Oxide area, with no arsenic concentrations in the PNO area exceeding 3 ppm and no arsenic concentrations in the Oxide area below 3 ppm.

4. Statistical Analysis of Concentration Differences by Area and Depth

We can use statistical tools to further evaluate the significance of differences by depth and by the areas defined above. As noted below, however, these statistical results are best used with caution and as supplemental to visual examination of the data, due to method and data limitations.

The Mann-Whitney U test (also known as Wilcoxon Rank Sum test, e.g. EPA, 1996 section 3.3.3) was used to test for significant differences between groups when concentration data were grouped by depth and area. The Mann-Whitney test considers the hypothesis that two populations (e.g., concentrations in two areas or depths) are shifted relative to each other. When assumptions and limitations are not violated, this is the most powerful non-parametric test for this purpose[2]. For information on this test

[2] This test does not assume any distribution shape (i.e., is "nonparametric"), but does assume that the distributions to be compared have the same shape and dispersion. The histograms suggest that this assumption is met to varying degrees across comparisons. Extreme values have limited impact with a ranking statistic. The benefit is that the statistic will not be greatly affected by one or two extreme values, but the caution is that where very high values are considered representative, their importance may be underestimated. Substantial numbers of identical data values in the two sample sets being compared (e.g. non-detects with same assumed values) can lead to underestimates of the confidence that the sets are different - i.e. differences in populations will tend to be greater than indicated by p-values. Our data (like most real data) violates these assumptions to some degree, so results should be viewed as suggestive, not as "proofs."

Koppers022466

Devore 1995, or other statistics texts. The calculations were done in the software Statistica (1998 release 5.1 M, StatSoft Inc.).

The reported p-value is the probability of error in rejecting the null hypothesis that the two samples are from the same population. That is, the test is looking for evidence that the samples are from different populations. The p-value is the probability of error in the statement "the two populations from which samples are drawn are different." Exact two-tailed p-values are used here, since we do not know a-priori which area or depth would have higher concentrations, should they be different. A value of 0.05 indicates a one-in-twenty (5%) chance of such an error, and this is often considered a marginally significant result. P-values closer to .01 are fairly strong statements regarding likely differences.

Applied to arsenic in the PNO versus Oxide areas, the concentrations are significantly different with a p-value of <0.001 when subjected to the Mann-Whitney U Test. The remainder of statistical analyses will be devoted primarily to PAHs.

Mean values for PAHs and benzene (and mean values calculated without extreme values[3]) and number of samples for each area and depth are provided in Table 2.

Detailed results of the Mann-Whitney test for the significance of differences by area and depth are attached in Appendix 1. The following is a summary of the results.

- 2-Area breakdown: PAHs are significantly higher in the eastern corner of the site than the remainder of the site ("Main Area") for shallow and deep soils.
- 3-Area breakdown
  - PNO appears to have lower concentrations than the other two areas. The elevated PNO samples at B6 (shallow) and MW6 (deep) are exceptions to this trend.
  - Mean concentrations at NWN are substantially higher than at Koppers, but the difference is not statistically significant. This lack of significance most likely reflects the limited impact of extreme values on the test..

[3] Extreme values were arbitrarily selected by inspecting data for single samples that accounted for over about ½ of the mean. These extreme values were associated with samples from B6, B13, and B18 in shallow soil; and B6, B27, and MW6 in deep soils.

Koppers022467

Table 2. Mean Concentrations† and Number of Data Points for Each Area Breakdown and Depth.

Area Division	Depth	Area	CPAHs		TPAHs		Benzene	
			Mean (ppm)	N	Mean (ppm)	N	Mean (ppm)	N
1-Area	All Depths	All Areas	285	136	2290	136	21.1	58
	Surface	All Areas	104	23	197	23	0.15	5
	Shallow	All Areas	531	36	3469	36	29.5	21
	Deep	All Areas	223	77	2364	77	18.8	32
2-Area	Surface	Main Area	57	13	129	13	0.15	3
		East Corner	166	10	286	10	0.15	2
	Shallow	Main Area	325	30	1604 (624 w/o B13)	30 (29)	30.9	18
		East Corner	1560	6	12793	6	21.7	3
	Deep	Main Area	52 (24 w/o MW6)	50 (49)	815	50	16.7	26
		East Corner	541	27	5232	27	28.2	6
3-Area	Surface	PNO	10	4	21	4	0.15	1
		NWN	123	15	212	15	0.15	2
		KOP	125	4	318	4	0.15	2
	Shallow	PNO	311 (35 w/o B6)	16 (15)	889 (108 w/o B6)	16 (15)	0.03	10
		NWN	1115	12	8945	12	15.6	6
		KOP	91	8	415	8	105.3	5
	Deep	PNO	65 (1.9 w/o MW6)	22 (21)	941 (4.3 w/o MW6)	22 (21)	4.6	15
		NWN	391	40	3982	40	42.2	9
		KOP	9	15	137 (54 w/o B27)	15 (14)	19.2	8
4-Area	Surface	Oxide	10	4	21	4	0.15	1
		PNO		0		0		0
		Former Tar Pond	132	14	228	14	0.15	3
		Koppers	102	5	251	5	0.15	1
	Shallow	Oxide	956 (73 w/o B6)	5 (4)	2765 (268 w/o B6)	5 (4)	0.15	1
		PNO	21	10	39	10	0.01	9
		Former Tar Pond	1361	7	11053	7	17.7	4
		Koppers	327 (47 w/o B13)	14 (13)	2378 (279 w/o B13)	14 (13)	78.5 (27 w/o B18)	7 (6)
	Deep	Oxide	8.4 (0.4 w/o B6)	5 (4)	19 (2.0 w/o B6)	5 (4)		0
		PNO	0	15	0	15	0.12	13
		Former Tar Pond	484	32	4901	32	41.3	8
		Koppers	67 (11 w/o MW6)	25 (24)	1005 (180 w/o MW6)	25 (24)	24.6	11

†For values in which a single data point has a dramatic impact on the calculated mean, the mean value calculated without that data point has also been calculated and is shown in parenthesis. This is intended to show the impact of extreme values on the mean.

Koppers022468

- 4-Area breakdown
  - All depths: PNO has significantly lower concentrations than other areas in nearly all comparisons.
    - Surface PAHs: The Former Tar Pond and Koppers areas have similar concentrations and both have higher surface PAH concentrations than the Oxide area.
    - Shallow PAHs: The Former Tar Pond area has significantly higher concentrations than all other areas except the Oxide area. If sample B6 is removed from the Oxide area (B6 accounts for about 90% of PAHs found in Oxide area samples) then the Oxide area too has concentrations significantly less than the Pond area ($p < 0.05$ for both TPAHs and CPAHs).
    - Deep PAHs: While the Former Tar Pond shows elevated levels in histograms and means, the difference is not statistically significant in deep soil. As mentioned above, the test may under-estimate significance when extreme values and duplicates are present.

The overall picture from statistical tests is that the PNO area has lower concentrations of PAHs than other areas of the site, and the Former Tar Pond area has higher concentrations of PAHs. The 4-area breakdown shows greatest resolution.

Variations in distribution shapes, substantial numbers of identical values in different groups (non-detects), and extreme values limit test power and reliability. Generally we suggest that test results be considered only supplemental to visual analysis of the data presented in plots and tables.

5. Another Way to View Relation Between Proximity and Concentration – Variograms

Figures 24-27 show scatter plots relating the straight-line distances (x,y,z) between samples and the differences in contaminant concentrations found in those two samples. Thus every possible pair of points is shown as a point with the corresponding difference in concentrations and distance between those points. Such plots, called "variograms" in geo-statistics, are used to examine spatial relations between concentrations. Variograms are shown for the full site (up to 1,600 feet between samples, on x-axis) and for samples within 300 feet. If concentrations change in a continuous fashion across the site then concentration differences will increase with distance between the samples.

For PAHs below the surface the variograms show differences in concentration even for points that are very close together (points spread along or close to the y-axis). This is evidence for what is referred to as "pure nugget" or small clumps with different concentrations than surroundings. For deep PAHs and benzene there no visible "ranges" (a distance over which there seems to be a relation between concentration and distance). This indicates a lack of smooth concentration gradients in deep soil. PAHs in surface and shallow soils show less variation in concentrations for points within about 100 feet, which is consistent with a tendency for concentrations to vary more smoothly.

The nuggets and limited distance/concentrations ranges are consistent with the observed presence of distinct zones and "fingers" of oil tar and tar product (especially the tar) having been incorporated within fill at the site. PAH concentrations beyond the limit of tar or oil product tend to display a sharp decline in contamination. Given the placement of product at numerous portions of the site as fill the presence of gradually declining concentrations from a "source" is not anticipated, but rather the highly heterogeneous patterns displayed by the variograms would be expected.

Koppers022469

6. Relationships Between Shallow Soil Description And Concentrations

Soil odor, sheen, and the presence of product were recorded in boring logs while collecting samples. These descriptions were used in the body of the Summary Report to develop an idea of product location and contour plots showing product location. In this section we look at how soil descriptions are related to concentrations for shallow soils. As described later, we can use these relationships to estimate the degree of bias in the sub-surface sampling.

6.1. Are Contaminant Concentrations Related to Soil Descriptions?

Table 3 below shows, for shallow soils, the number of data points and mean contaminant concentrations when samples are grouped by clean/sheen/odor and by the presence of observed product. There appear to be substantial differences in mean concentrations depending on whether there is sheen, odor, or product. We examine these apparent relationships in more detail below for PAHs and benzene.

Table 3. Shallow Soil Mean Concentrations and Number of Samples by Soil Description and Observed Product

	Carcinogenic PAHs		Total PAHs		Benzene	
Soil Description Observed Product	Means (ppm)	N	Means (ppm)	N	Means (ppm)	N
Clean	13	16	10	16	0.01	8
None	13	16	10	16	0.01	8
Lampblack		0		0		0
Tar		0		0		0
Oil		0		0		0
Odor	861	4	7331	4	0.15	2
None	79	1	163	1	0.15	1
Lampblack	1121	3	9720	3	0.15	1
Tar		0		0		0
Oil		0		0		0
Sheen & Odor	966	16	5962	16	56	11
None	2.2	4	271	4	120	3
Lampblack	638	2	4028	2	18	1
Tar	1961	5	10951	5	24	2
Oil	873	5	6301	5	39	5
All Groups	531	36	3469	36	30	21

6.1.1. PAHs

Soil with no odor, sheen, or product (i.e., looks clean) tends to have low PAH concentrations; soil with odor or sheen but no product tends to have intermediate concentrations, and soil with visible product tends to have the highest concentrations. However, there is significant variation within each category. Details follow.

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Figures 28 and 29 show histograms of the occurrence of PAHs in soil for each combination of soil description, with number of points (N) and mean values shown (Note that the figures show data compiled for all depths, not just shallow depths as in the table above). Samples with no visible product and no odor or sheen have low concentrations and 42% (73 of 174) are non-detects. Soil with visible product usually has a sheen (48 of 54 samples, or 89%) and otherwise has an odor, and these points have elevated concentrations. There is no clear difference between samples with odor versus sheen. The samples with sheen or odor but no product have low to intermediate concentrations.

Based on the above analysis, three soil categories present themselves for evaluation:

- Soil with no odor sheen nor product;
- Soil with odor or sheen but without product
- Soil with product

The data sets associated with each of these categories can be compared to each of the other categories to determine if a statistically significant difference exists between the data categories. Tables 4 and 5 display the statistical difference between data sets associated with the soil categories listed above. The low p-values produced via the Mann-Whitney u-test for the comparison of these data sets indicates that each of the soil categories presented above displays a statistically significant difference from the others for CPAHs and TPAHs. To further illustrate this point, box plots of concentrations in each of the 3 categories used in the above tables, for shallow soil, are shown in Figures 30 and 31 (note the log scale).

Table 4. TPAH Concentrations by Soil Description

Soil Category 1	Soil Category 2	P-value of difference (Mann-Whitney u-test)
No Odor, Sheen, nor Product (N=87, mean =57 ppm TPAH)	Product	<0.001
Odor or Sheen without Product (N=22, mean=369 ppm TPAH)	No Odor, Sheen, or Product	0.001
Product (N=27, mean=11,050 ppm TPAH)	Odor or Sheen without product	<0.001

Table 5. CPAH Concentrations by Soil Description

Soil Category 1	Soil Category 2	P-value of difference (Mann-Whitney u-test)
No Odor, Sheen, or Product (N=87, mean =31 ppm CPAH)	Product	<0.001
Odor or Sheen without visible product (N=22, mean=88 ppm CPAH)	No Odor, Sheen, or Product	0.05
Product (N=27, mean=1263 ppm CPAH)	Odor or Sheen without product	<0.001

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We cannot generally relate the nature of the product (oil versus tar versus lampblack) to concentrations, given the amount and variability of the data. We did find, however, that PAH concentrations in oily soil are higher in the tar pond area than in the Koppers area, suggesting variation in types and sources of oil[4].

6.1.2. Benzene

The relation between soil description categories and concentration is less clear for benzene, with the presence of sheen or oil being the best indicators of benzene. Figure 35 shows the occurrence of benzene concentrations in soil for each combination of soil category. Soil with no visible product and no odor or sheen has lower concentrations. Soil with visible product nearly always has a sheen (16 of 18 samples, or 89%). The two points with product and no sheen have low benzene, and the 7 points with no product but sheen include the point with the highest concentration (B18, 12 ft deep) and 2 other points with significant concentrations. This suggests sheen is a better indicator of benzene concentration than the presence of product.

Figure 36 shows box plots of the log of benzene concentrations with samples either sorted by presence of product or odor and sheen. If we do not exclude the high sample at B18 then there is no difference in mean concentrations based on the presence of lampblack or tar, but samples with oil have elevated concentrations. Using the appearance of odor and sheen seems to give a bit more consistent, although still rough, predictor of benzene concentration.

Based on these graphs of the data, the following two alternative sets of soil categories suggest themselves:

- Clean soil
- Soil with an odor
- Soil with a sheen

and

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[4] While oil was found in soil samples in both the Koppers and tar pond areas, PAH concentrations are higher in the pond area. Thus we investigated whether oily samples in the various areas are comparable. Table 6 below summarizes the concentrations of PAHs in oily soil samples in the Pond and Koppers areas, with the significance of the difference shown in the bottom row. This data is also shown in a box-whisker plot in Figure 32-34.

Table 6. Shallow soil (0.2-15 feet) with Visible Oil, Concentrations of PAHs and Benzene.

	CPAHs		TPAHs		Benzene	
	Mean (ppm)	N	Mean (ppm)	N	Mean (ppm)	N
Former Tar Pond	1997	6	23087	6	79	4
Koppers	727	8	6881	8	52	7
P-value significance of difference (Mann-Whitney)	0.23		0.34		0.53	

The difference is not statistically significant, but concentrations of PAHs in oily soils appear to be higher in the pond area than in the Koppers area. This difference could be due to a differing source for the oil in the former tar pond area than that identified in the Koppers area, with the oils in the former tar pond area perhaps more closely related to, or derived from, the tars, while no tars were present in the Koppers area.

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- No product
- Lampblack
- Tar
- Oil

Table 7 shows the statistical significance of differences in soil categories the first set of categories (i.e., clean, odor and sheen).

Table 7. Benzene Concentrations by Soil Description

Soil Category 1	Soil Category 2	P-value of difference (Mann-Whitney u-test)
Clean (N=20, mean=0.85 ppm benzene)	Sheen	<0.001
Odor (N=4, mean=12.5 ppm benzene)	Clean	0.13
Sheen (N=25, mean=47.8 ppm benzene)	Odor	0.50

Table 7 indicates that soil categorized as clean differs in a statistically significant manner from soil categorized as having a sheen. The other category combinations do not show a strong statistical difference, but there are only 4 samples with just odor.

Table 8 shows the statistical significance of differences in soil categories the second set of categories (i.e., no product, lampblack, oil and tar).

Table 8. Benzene Concentrations by Soil Description

Soil Category 1	Soil Category 2	P-value of difference (Mann-Whitney u-test)
No Product (N=40, mean=11.6 ppm benzene)	Lampblack	0.07
No Product	Oil	<0.001
No Product	Tar	.11
Lampblack (N=3, mean =10 ppm benzene)	Tar	.8
Oil (N=11, mean=62 ppm benzene)	Lampblack	.37
Tar (N=4, mean=12 ppm benzene)	Oil	.28

Table 8 indicates that soil categorized as having no product differs in a statistically significant manner from soil categorized as having oil present. The other category combinations do not show a strong statistical difference, although there are only 3 samples with lampblack and 4 with tar.

In summary, the relationship between soil description categories and concentration for benzene is weaker than the relationship for PAHs. The presence of sheen or oil being the best indicators for the presence of benzene.

Koppers022473

6.2. Estimating Average Concentrations Using Soil Descriptions

We found above that, particularly for PAHs, contaminant concentrations vary significantly with soil description. This confirms the common-sense expectation that the visible presence of contamination is related to the concentrations of contaminants.

It also confirms that sampling preferentially according to soil appearance is likely to result in a biased data set, i.e., the average concentration of such samples is unlikely to be the same as the average of randomly collected samples. This is important in that it could suggest that analyzed samples may be an imperfect indication of what a worker in a trench at a random location would encounter.

However, we can develop an estimated distribution of shallow soil concentrations based on soil categories. We can do this by first associating a distribution of concentrations with each soil category[5]. We can then examine each boring log to determine what fraction of shallow depth soil falls in each category (i.e., soil with no odor sheen nor product; soil with odor or sheen without product; soil with product for PAHs). This information can be determined from the cross-section figures of the Data Package Hahn, 1996, appendix L. Based on this information, we can estimate the distribution of concentrations that would be found if random samples had been collected.

We ran a simulation of 10,000 draws that estimated sample concentrations based on (a) likelihood of encountering each soil category, (b) concentration distribution for the soil category encountered, and (c) uncertainty in the measurement of concentration[6]. This produced distributions for concentrations intended to be representative for the site.

These distributions are shown together with the distributions for sample data in Figure 37. The simulated distributions based on the amount of soil of various descriptions are very similar in shape to those of the samples. However, the distributions based on soil description show about 30% fewer of the highest values of PAHs[7]. The reason for this difference is a bias towards sampling soil with visible product. As shown in Figure 38, about 30% of all soil encountered in boring was product contaminated, but about 40% of samples were taken from such soil. This is consistent with the sampling strategy, which was in part to characterize the worst contamination.

A comparison of average concentrations in shallow soil is shown in Table 9. A site-wide average is of limited use, given site area differences highlighted in other sections. However, averages do provide an idea of the difference in total contamination based sampling that was done versus results which might have been generated by random sampling in shallow soil. It appears that PAH contamination is overestimated by about 25% relative to random samples, while benzene is not overestimated. This is consistent with the results of the previous section - recall that the presence of benzene could not be well predicted on the basis of visual examination. Hence, if sampling preferentially based on soil appearance, benzene data would tend to be relatively unbiased. PAH concentrations, however, would

[5] There a number of alternatives for developing distributions, as discussed later in the report. One approach would be to find the best-fitting parametric distribution. The fit for any distribution will be coarse, given histograms of concentrations. A second approach is to use the existing data as the distribution ("empirical distribution"). The testing error offers some smoothing of this distribution (see footnote below and later in text). As a comparison, a set of parametric distributions were fit (maximum likelihood) and the simulation was run with both these and empirical distributions. The results were nearly identical, with results using the empirical distributions shown.

[6] We multiplied each concentration by a value selected from a normal distribution with mean 1 and standard deviation 0.25 to simulate the random error of sample analysis.

[7] The average values for values shown as "More" on histograms are virtually identical for simulation and samples.

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have a greater tendency to be biased toward high-end concentrations due to the stronger correlation between appearance and concentration.

Table 9. Shallow Soil Average Contaminant Concentrations, Site-wide in Shallow Soil

Contaminant	Average of Sample Concentrations (ppm)	Estimated Average Concentrations for Random Samples, Based on Amount of Soil with Sheen, Odor, Product (ppm)	Percent by Which Sample Average Exceeds Est. Random Samples
CPAHs	531	425	25%
TPAHs	3469	2804	24%
Benzene	29.5	29.7	-1%

To summarize, a comparison of sample concentrations with expected concentrations that would occur with random sampling suggests that sample concentrations are very similar to those that would be collected randomly, but likely overestimates the occurrence of the highest PAH concentrations.

7. Developing Distributions for Contaminant Concentrations

One purpose for concentration data is in assessing possible health risks. A probabilistic risk assessment requires probability distributions for chemical concentrations, so an important criterion for data is whether it is sufficient to construct or select distributions that adequately describe concentrations. The process of constructing distributions will generally help reveal whether data is adequate or inadequate for this purpose.

Unfortunately, there is no single right way to build a probability distribution based on empirical data. Depending on the amount of data, nature of the data, judgement, and available tools, methods include:

- Using data itself as the distribution (simple empirical distribution)
- Selecting the best-fitting parametric distribution
- Creating smoothed distribution from the data (smoothed empirical distribution)
- Selecting a distribution to maximize uncertainty consistent with data (maximum entropy)
- Using Bayesian updating to develop posterior distributions from priors (e.g. Roeder and Wasserman, 1997)
- Bootstrapping a smoothed distribution
- Manually creating a piece-wise combination of simple distributions

NWN and DEQ will need to work together to select and apply approaches that are mutually satisfactory. In this section we first examine existing data for obvious gaps and then provide examples of how distributions may be constructed using GASCO data[8].

[8] For useful general background information see ODEQ 1998 and it's appendix, EPA 1997.

Koppers022475

7.1. Locations and Depths for Risk Assessment

Exposure scenarios and parameters dictate the appropriate area and depth breakdowns for purposes of risk assessment. In terms of area, there are three populations that are active on the lease areas: NWN, Koppers, and PNO. In terms of depth, we are concerned about exposure to surface soils, directly and via dust inhalation, and trenching and other activities that may bring people into contact with sub-surface soil up to 15 feet in depth. CPAHs and benzene appear to pose potential risks. Therefore we ultimately will need 9 soil concentration distributions: CPAH distributions for each of the below six location/depth combinations and benzene for each location at the shallow depth:

1. NWN Surface
2. NWN Shallow
3. PNO Surface
4. PNO Shallow
5. Koppers Surface
6. Koppers Shallow

7.2. Screen for Data Adequacy: Sample Number and Locations

During construction of the distributions we expect to learn about the adequacy of data. However, we can conduct a screening of it's adequacy by first simply considering how many samples are available in each location/depth combination, and how well they are distributed.

Regarding the number of data points, there is no hard and fast number that is either too few or plenty (although we will develop a better idea when constructing distributions). However, our judgement is that a minimum of 4 or 5 samples should be available in each area at each depth.

Regarding location, we do not currently have information indicating that surface or shallow soil exposures will occur more frequently in one area versus another within each of the 3 areas. Thus, as an approximation, we assume that the likelihood of exposures is essentially uniform within each of the 3 areas. This suggests that we would like roughly evenly spaced samples in each area. To the degree that samples are not uniform, we would like to see more samples in areas more likely to be visited.

Reviewing Table 2 we see that we indeed have at least 4 data points for each combination, although only 4 for surface CPAHs at PNO and Koppers. However, the points are not spread evenly. Surface sample locations are shown in Figure 39. This is a "Voronoi Tessellation", which draws lines that are equidistant between points, so the area surrounding each point is closest to that point. This provides an idea of the coarseness and uniformity of sampling locations. The southeastern portion of the site is well sampled, but there are few samples in the PNO and Koppers areas, and few in the area of the LNG yard, where surface activity is common. The 10 x's on the figure indicate proposed approximate sampling locations to provide more uniform and complete coverage.

Figure 40 shows that shallow PAH samples are fairly uniform, except that (a) geotechnical borings near the river are clumped and thus over-represent that area, (b) there are no samples in the office area of NWN, and (c) the south eastern corner is slightly under-represented, and since this corner has highest concentrations, this is not conservative. To address these issues we would recommend (a) leaving out 2 geotechnical boring samples (which have low concentrations) and adding 3 samples at the approximate locations shown with x's in the figure.

Figure 41 shows that shallow benzene samples provide fair coverage, but 8 x's indicate locations for new points that would result in more complete and uniform coverage. The sample in the eastern corner can be collected with installation of a new well planned near MW-5, and 3 of the other points are in

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roughly the same locations as those recommended above for shallow PAHs. Thus about 7 shallow samples appear useful for PAHs and benzene, in addition to samples taken during well installation.

We will learn more about possible data gaps while building distributions, but have identified 10 surface and 7 shallow soil samples that appear desirable based on the number and location of existing points.

7.3. Examples of Constructing Distributions

We will illustrate two approaches in surface CPAHs in the NWN area:

1. Fitting of parametric distribution
2. Smoothed empirical distribution

7.3.1. Parametric Fit for Surface CPAHs in the NWN Area.

Figure 42 shows a histogram surface carcinogenic PAH data for the NWN area. We do not know what distribution is appropriate a-prior, but the histogram appears similar to the overlaid lognormal distribution[9]. We will now consider measures of the lognormal fit.

A probability-probability plot for a lognormal fit is shown, suggesting a fairly good fit (points lie close to diagonal line). Table 10 summarizes numerical tests of fit for a lognormal distribution. The Shapiro-Wilks W test of the normality does not reject the hypothesis of normality of the log transformed data[10]. The fit measure most sensitive to tails (Anderson-Darling) is also consistent with a good fit. However, the lognormal distribution that is fit, by selecting parameters to maximize the likelihood of observed values, has a mean of 176, versus the actual mean of 123 for data points. As discussed below, this results from fitting a distribution with a tail extending to infinitely high concentrations, and can be addressed by truncating the tail at a point well beyond the highest observed values.

Given the visual comparison (perhaps most important, e.g. EPA 1997) and numerical results, aside from the infinite tail, the lognormal distribution appears to be a fairly good representation for surface CPAHs in the NWN area.

Table 10. Lognormal Fit (mean 176, SD 664) to Surface CPAHs in NWN Area.

Measure of Fit	Fit Parameter Value	Common threshold for "good" fit
Shapiro-Wilks W test of normality (on log-transformed data), p-value	p=0.71 W=.96	p>0.05
Chi-squared	Undefined	p>0.5
Anderson-Darling	0.22	<1.5
Kolmogorov-Smirnov	0.10	<0.03

[9] This is somewhat appealing in that dilution and degradation processes can be viewed as yielding concentrations that are the product of random numbers, yielding a lognormal distribution. However many data sets from the site do not appear to fit any parametric distribution.

[10] The Shapiro-Wilk test is considered one of the best methods for testing for normality, and is sensitive to departures from normality in the tails of distributions. When the statistic is significant (e.g. $p < 0.05$) normality can be rejected and when insignificant normality can be accepted.

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With a small data set, even if we accept that the distribution is lognormal, there is uncertainty regarding the true mean and standard deviations of the distribution. Thus using the best fitting distribution directly is not sufficiently conservative. We can address this by using a tiered simulation approach in which (a) we estimate distributions for parameters (mean and sd), (b) sample from these parameter distributions to construct a family of distributions, and (c) sample from this family of concentration distributions for estimating risk. This procedure reflects both uncertainty in the population distribution parameters (mean, sd) and variability in what an individual might encounter at the site. We carried this out and the ultimate result is also a lognormal distribution, but with a slightly increased uncertainty relative to the best-fit distribution (sd increased from 664 to 783).

Finally, we note that the tail length and shape for the fit is an artifact of the choice of distributions, and does not reflect information in the data. For example, a tail extending to infinity, as does the lognormal, is not realistic. We also note that the mean of the data is the best unbiased estimate of the population mean, so we would like the fit to have similar mean to the data. Further, we would like the fit distribution to have a SD at least similar to the data. In this case we find that truncating the tail at 3.5 times the highest data value (i.e. at 2,012 ppm, which is at 98.8% for the distribution) yields a distribution with mean 125 and SD 241, which are similar to these parameter values for the data.

7.3.2. Smoothed Empirical Distribution for CPAHs in Surface NWN Soil.

Another approach to obtaining a distribution from empirical data is to simply sample from the data itself. While this is simple and seemingly avoids assumptions, it has two primary weaknesses. First, the population distribution (i.e. real distribution) is in fact continuos - we could undoubtedly find some soil sample with virtually any concentration between zero and our highest value. Using our few discrete points in place of a continuous distribution could introduce unrealistic patterns into results.

Second, and more importantly, it makes no provision for the likelihood that there are in fact concentrations that are higher than we found - i.e., that there is a tail beyond our highest value. One way to address this issue is through the use of non-parametric tolerance limits, which estimate the certainty with which our highest value exceeds a given percentage of all values. For example, Montgomery (1996) provides a method for calculating tolerance limits for nonparametric distributions. Using this approach, we find that with 16 samples we can say with 75% certainty that our highest value exceeds 92% of all values. Thus if we place 8% of the probability density beyond our highest value we have a 75% chance that we have over, rather than under, represented the number of samples beyond our highest value. However, there is no magic way to guess where those last 8% should be, so we would need to select some shape for the tail we are adding[11].

An alternative approach that uses empirical data, but avoids both of the above problems, is to smooth the data (e.g. Silverman, 1986). This is commonly done by replacing each empirical data point with a probability distribution ("kernel") scaled down to have the probability of that point (1/n). Since the distributions overlap and extend beyond the highest point, the combined distribution is smoothed and extends beyond the highest point. Various kernel distributions are used, including some with tails extending to infinity ("infinite support") such as the normal distributions, and others with finite support. The primary impact of kernel choice for our application will be tail shape and length. In this example we will use the normal distribution, keeping in mind that we will want to truncate the tail, as we did above for the lognormal parametric fit.

[11] In any case it is difficult to estimate rare events, or the tail of a distribution, without very large data sets. If we select a parametric distribution we sidestep the issue by taking the particular tail of that distribution. But as noted above, these tails are often unrealistic - e.g. extending to infinity - so require truncation or other adjustment.

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Having selected a kernel, the challenges become selecting the broadness, or "bandwidth" of the kernel, and then correcting for the known increase in variance resulting from smoothing. A systematic way of selecting bandwidth that has theoretical appeal is called "cross validation." This is done by calculating the likelihood of each observation, given that kernels of a particular bandwidth replace other observations. Bandwidth is then adjusted to maximize the product of these likelihoods. To correct for variance added to the data by the smoothing the distribution is "shrunk." Finally, we will truncate the infinite tail for realism and to obtain a mean equal to the data mean[12].

To summarize, empirical smoothing is a method for selecting a nonparametric distribution that maximizes the probability of existing data. Assumptions include (a) the kernel does not introduce un-correctable bias and provides a reasonable tail shape, (b) bandwidth should be uniform across kernels, and (c) the maximum likelihood selection of bandwidth is appropriate.

In our case we performed the smoothing on the log-transformed data, reflecting our expectation that the general shape will be asymmetric, will not extend below zero, and will have a significant tail. For fitting the surface CPAHs in the NWN area we found that truncating the tail at 2 times the highest value (beyond 96.4%) gives a mean of 124 and SD of 190, which closely match our data.

Figure 43 shows the best fitting smoothed empirical distribution with a solid line and the lognormal parametric fit (previous subsection) with a dotted line. The distributions have very similar shape, but with the smoothed empirical distribution being slightly more uniform versus the parametric fit having slightly more emphasis on the lowest and highest values.

Table 11. Comparison of Distribution Fits to Surface PAHs in NWN Area (approximate values, based on 10,000 trial simulation).

Distribution Parameter	Data	Fit Developed from Lognormal Parametric	Fit of Smoothed, Empirical Distribution
Mean	123	125	124
Standard Deviation (SD)	171	241	190

In this example the reasonable visual fits and close similarity of fits from two different methods gives us some confidence that we have been able to construct reasonable distributions from available data. This may not be the case with other needed distributions for which less data exists. By constructing all of the needed distributions we will discover more about where further data is needed.

[12] Fitting a kernel to data is known to increase the variance by the variance of the kernel (i.e., the bandwidth squared). To correct for this the distance between the mean and the mean of each kernel is shrunk by multiplication by the correction p=((Vd/(Vd+BW^2))^0.5 to keep the mean and variance of the smoothed distribution equal to those values for the original distribution. We apply this shrinking factor to the log-transformed data, to which we fit our kernels. We still get an uncorrected increase in variance when exponentiating back to our final distribution. This bias, and the infinite tail length, are addressed by truncating the tail.

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8. Summary and Conclusions

Conclusions of this preliminary analysis of available soil data include:

- There is substantial small-scale variability superimposed on site-scale trends. The variability is consistent with placement of fill, mixing of soils, and preferential transport of contaminants in rootlets and other channels. This variability is likely to continue to be large for future sampling.
- There appear to be significant differences in concentrations and variability by area and depth. For PAHs site-scale trends include increasing contamination towards the eastern corner of the site and lower and less variable concentrations at the surface. For benzene, concentrations differ by area and appear consistent with a shallow source spreading down gradient and deeper.
- The mix of PAHs differs between surface soil and subsurface soil. For surface soils the PAH mix is fairly constant across the site, while subsurface PAHs show diversity in mix.
- PAH concentrations are related to soil description (odor, sheen, and presence of product). Benzene concentrations tend to be elevated when there is oil or sheen, but the relationship is weaker.
- Surface samples were placed essentially randomly. Sub-surface samples were collected in part based on soil appearance, and are therefore biased. We analyze this bias and estimate that it (1) increases representation of high-concentration PAH samples by about 25%, and (2) has no measurable impact on benzene values.
- 17 new soil data samples are identified that would improve the completeness and uniformity of samples. 10 approximate locations for additional surface samples for PAHs are identified, primarily in the PNO and office areas. 7 approximate locations for shallow soil samples for CPAHs and benzene are identified.
- Constructing concentration probability distributions requires agreement in selection of approach and in implementation. Examples are provided for two methods (fitting parametric distributions and smoothing of empirical) of fitting distributions to concentrations of CPAHs in surface soil on the NWN lease area. Other data needs may become apparent with similar construction of the additional 8 concentration probability distributions that are needed for assessing risk.

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9. Appendix 1. Detailed Results of Mann-Whitney U Tests for Difference Between Groups

Detailed results are shown for pair-wise comparisons of areas for:

- all depths together
- surface (<0.2 feet deep)
- shallow(0.2-15 feet deep), and
- deep soil (>15ft)

The areas breakdowns considered are, as defined in text and Table 1:

- 2-Area
- 3-Area
- 4-Area

3-Area Pair-wise Comparison by Area, All Depths:

Chemical	Group 1 N PNO	Group 2 N NWN	p value
Carc. PAHs	42	67	<.001
Total PAHs	42	67	<.001
Benzene	26	17	<.001

Chemical	N. Group 1 PNO	Group 2 N KOP	p value
Carc. PAHs	42	27	.01
Total PAHs	42	27	<.001
Benzene	26	15	<.001

Chemical	Group 1 N NWN	Group 2 N KOP	p value
Carc. PAHs	67	27	.29
Total PAHs	67	27	.98
Benzene	17	15	.94

3-Area Pair-wise Comparison by Area, Surface Samples (< 0.2 feet).:

Chemical	Group 1 N PNO	Group 2 N NWN	p value
Carc. PAHs	4	15	.05
Total PAHs	4	15	.05
Benzene	1	2	--

Chemical	Group 1 N PNO	Group 2 N KOP	p value
Carc. PAHs	4	4	.03
Total PAHs	4	4	.03
Benzene	1	2	--

Chemical	Group 1 N NWN	Group 2 N KOP	p value
Carc. PAHs	15	4	.47
Total PAHs	15	4	.36
Benzene	2	2	--

3-Area Pair-wise Comparison by Area, Shallow Depth Samples (Between 0.2 and 15 feet):

Chemical	Group 1 N PNO	Group 2 N NWN	p value
Carc. PAHs	16	12	.007
Total PAHs	16	12	.005
Benzene	10	6	.001

Chemical	Group 1 N PNO	Group 2 N KOP	p value
Carc. PAHs	16	8	.11
Total PAHs	16	8	.03
Benzene	10	5	<.001

Chemical	Group 1 N NWN	Group 2 N KOP	p value
Carc. PAHs	12	8	.21
Total PAHs	12	8	.27
Benzene	6	5	.25

3-Area Pair-wise Comparison by Area, Deep Samples (more than 15 feet):

Chemical	Group 1 N PNO	Group 2 N NWN	p value
Carc. PAHs	22	40	.005
Total PAHs	22	40	<.001
Benzene	15	9	.001

Chemical	Group 1 N PNO	Group 2 N KOP	p value
Carc. PAHs	22	15	.06
Total PAHs	22	15	.007
Benzene	15	8	.004

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Chemical	Group 1 N NWN	Group 2 N KOP	p value
Carc. PAHs	40	15	.43
Total PAHs	40	15	.93
Benzene	9	8	.54

4-Area Pair-wise Comparison by Area, All Depths:

Chemical	Group 1 N Oxide	Group 2 N PNO	p value
Carc. PAHs	14	25	<.001
Total PAHs	14	25	<.001
Benzene	2	22	.04

Chemical	Group 1 N Oxide	Group 2 N Pond	p value
Carc. PAHs	14	53	.55
Total PAHs	14	53	.32
Benzene	2	15	.24

Chemical	Group 1 N Oxide	Group 2 N Koppers	p value
Carc. PAHs	14	44	.39
Total PAHs	14	44	.84
Benzene	2	19	.24

Chemical	Group 1 N PNO	Group 2 N Pond	p value
Carc. PAHs	25	53	<.001
Total PAHs	25	53	<.001
Benzene	22	15	<.001

Chemical	Group 1 N PNO	Group 2 N Koppers	p value
Carc. PAHs	25	44	<.001
Total PAHs	25	44	<.001
Benzene	22	19	<.001

Chemical	Group 1 N Pond	Group 2 N Koppers	p value
Carc. PAHs	53	44	.03
Total PAHs	53	44	.25
Benzene	15	19	.66

4-Area Pair-wise Comparison by Area, Surface (<0.2 feet):

Chemical	Group 1 N Oxide	Group 2 N PNO	p value
Carc. PAHs	4	0	--
Total PAHs	4	0	--
Benzene	0	0	--

Chemical	Group 1 N Oxide	Group 2 N Pond	p value
Carc. PAHs	4	14	.05
Total PAHs	4	14	.05
Benzene	1	3	.66

Chemical	Group 1 N Oxide	Group 2 N Koppers	p value
Carc. PAHs	4	5	.03
Total PAHs	4	5	.03
Benzene	1	1	--

Chemical	Group 1 N PNO	Group 2 N Pond	p value
Carc. PAHs	0	14	--
Total PAHs	0	14	--
Benzene	0	3	--

Chemical	Group 1 N PNO	Group 2 N Koppers	p value
Carc. PAHs	0	5	--
Total PAHs	0	5	--
Benzene	0	0	--

Chemical	Group 1 N Pond	Group 2 N Koppers	p value
Carc. PAHs	14	5	.89
Total PAHs	14	5	1.0
Benzene	3	1	--

4-Area Pair-wise Comparison by Area, Shallow (0.2 to 15 feet):

Chemical	Group 1 N Oxide	Group 2 N PNO	p value
Carc. PAHs	5	10	.05
Total PAHs	5	10	.10
Benzene	1	9	--

Chemical	Group 1 N Oxide	Group 2 N Pond	p value
Carc. PAHs	5	7	.20
Total PAHs	5	7	.11
Benzene	1	4	--

Chemical	Group 1 N Oxide	Group 2 N Koppers	p value
Carc. PAHs	5	14	.44
Total PAHs	5	14	.82
Benzene	1	7	--

Chemical	Group 1 N PNO	Group 2 N Pond	p value
Carc. PAHs	10	7	<.001
Total PAHs	10	7	<.001
Benzene	9	4	<.001

Chemical	Group 1 N PNO	Group 2 N Koppers	p value
Carc. PAHs	10	14	.03
Total PAHs	10	14	.015
Benzene	9	7	<.001

Chemical	Group 1 N Pond	Group 2 N Koppers	p value
Carc. PAHs	7	14	.003
Total PAHs	7	14	.02
Benzene	4	7	.79

4-Area Pair-wise Comparison by Area, Deep (>15 feet):

Chemical	Group 1 N Oxide	Group 2 N PNO	p value
Carc. PAHs	5	15	.01
Total PAHs	5	15	<.001

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Benzene	0	13	--

Chemical	Group 1 N Oxide	Group 2 N Pond	p value
Carc. PAHs	5	32	.91
Total PAHs	5	32	.62
Benzene	0	8	--

Chemical	Group 1 N Oxide	Group 2 N Koppers	p value
Carc. PAHs	5	25	.52
Total PAHs	5	25	1.0
Benzene	0	11	--

Chemical	Group 1 N PNO	Group 2 N Pond	p value
Carc. PAHs	15	32	<.001
Total PAHs	15	32	<.001
Benzene	13	8	<.001

Chemical	Group 1 N PNO	Group 2 N Koppers	p value
Carc. PAHs	15	25	.008
Total PAHs	15	25	<.001
Benzene	13	11	<.001

Chemical	Group 1 N Pond	Group 2 N Koppers	p value
Carc. PAHs	32	25	.26
Total PAHs	32	25	.52
Benzene	8	11	.97

2-Area Pair-wise Comparison by Area, All Depths:

Chemical	Group 1 N Main Area	Group 2 N East Corner	p value
Carc. PAHs	93	43	.003
Total PAHs	93	43	.009
Benzene	47	11	.05

2-Area Pair-wise Comparison by Area, Surface:

Chemical	Group 1 N Main Area	Group 2 N East Corner	p value
Carc. PAHs	13	10	.21
Total PAHs	13	10	.21
Benzene	3	2	--

2-Area Pair-wise Comparison by Area, Shallow:

Chemical	Group 1 N Main Area	Group 2 N East Corner	p value
Carc. PAHs	30	6	<.001
Total PAHs	30	6	<.002
Benzene	18	3	.18

2-Area Pair-wise Comparison by Area, Deep:

Chemical	Group 1 N Main Area	Group 2 N East Corner	p value
Carc. PAHs	50	27	.05
Total PAHs	50	27	.07
Benzene	26	6	.21

Koppers022483

10. References

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Silverman, B.W., 1986, "Density estimation for statistics and data," Chapman and Hall.

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Koppers022484

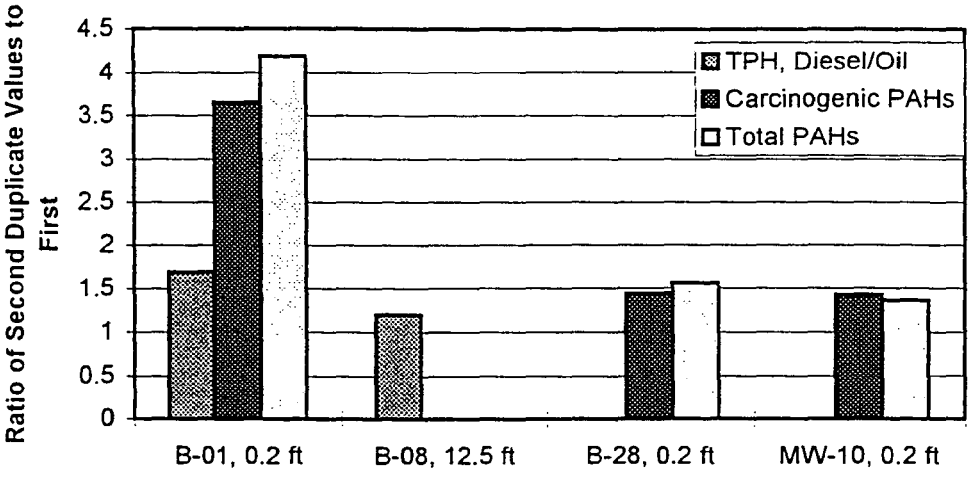
11. Figures

Koppers022485

Figure 1.

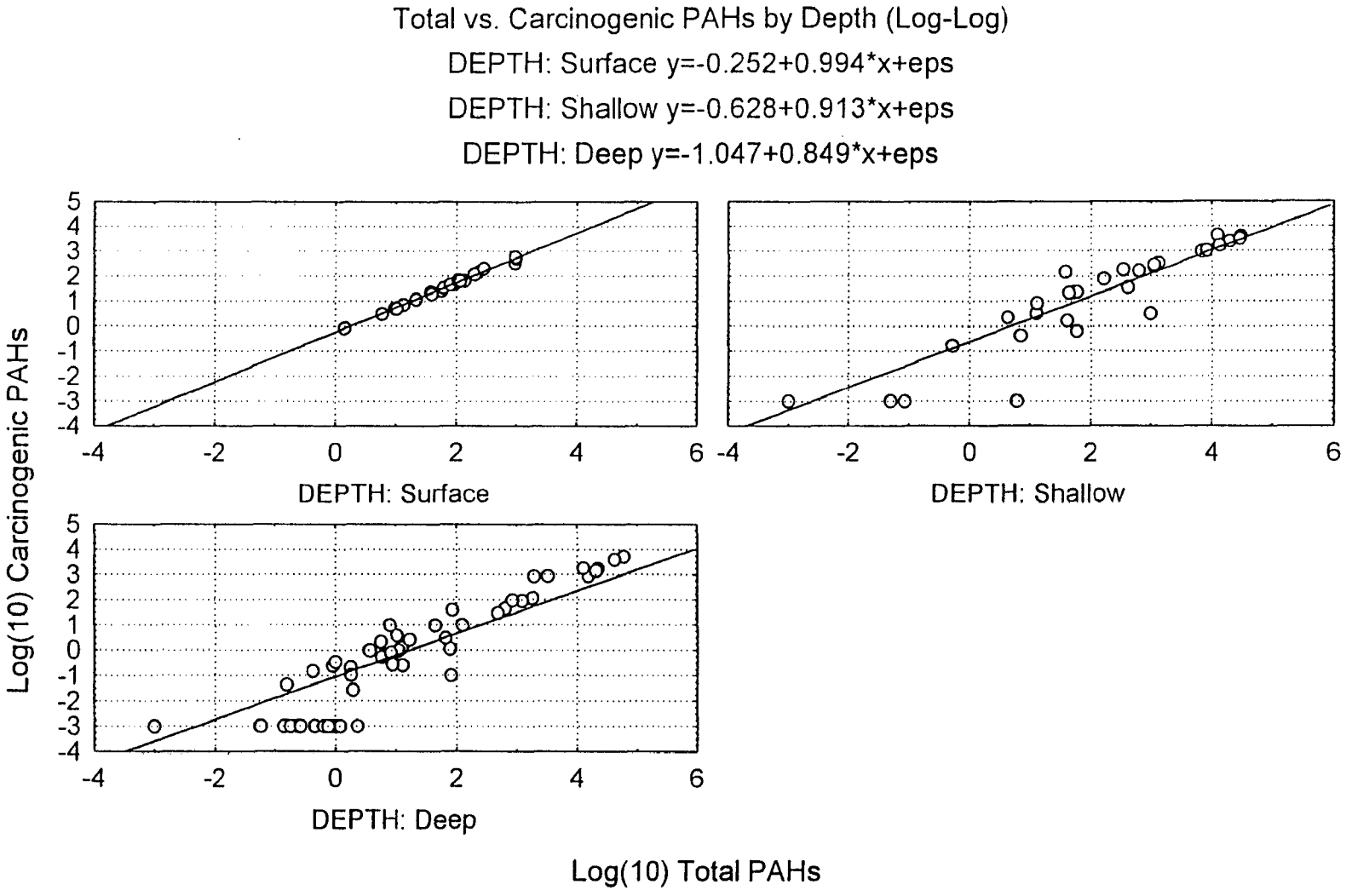
Comparison of Duplicate Results for Three Compounds

(B-31 & MW-03 samples were all ND or very low)



concs and variogram 98

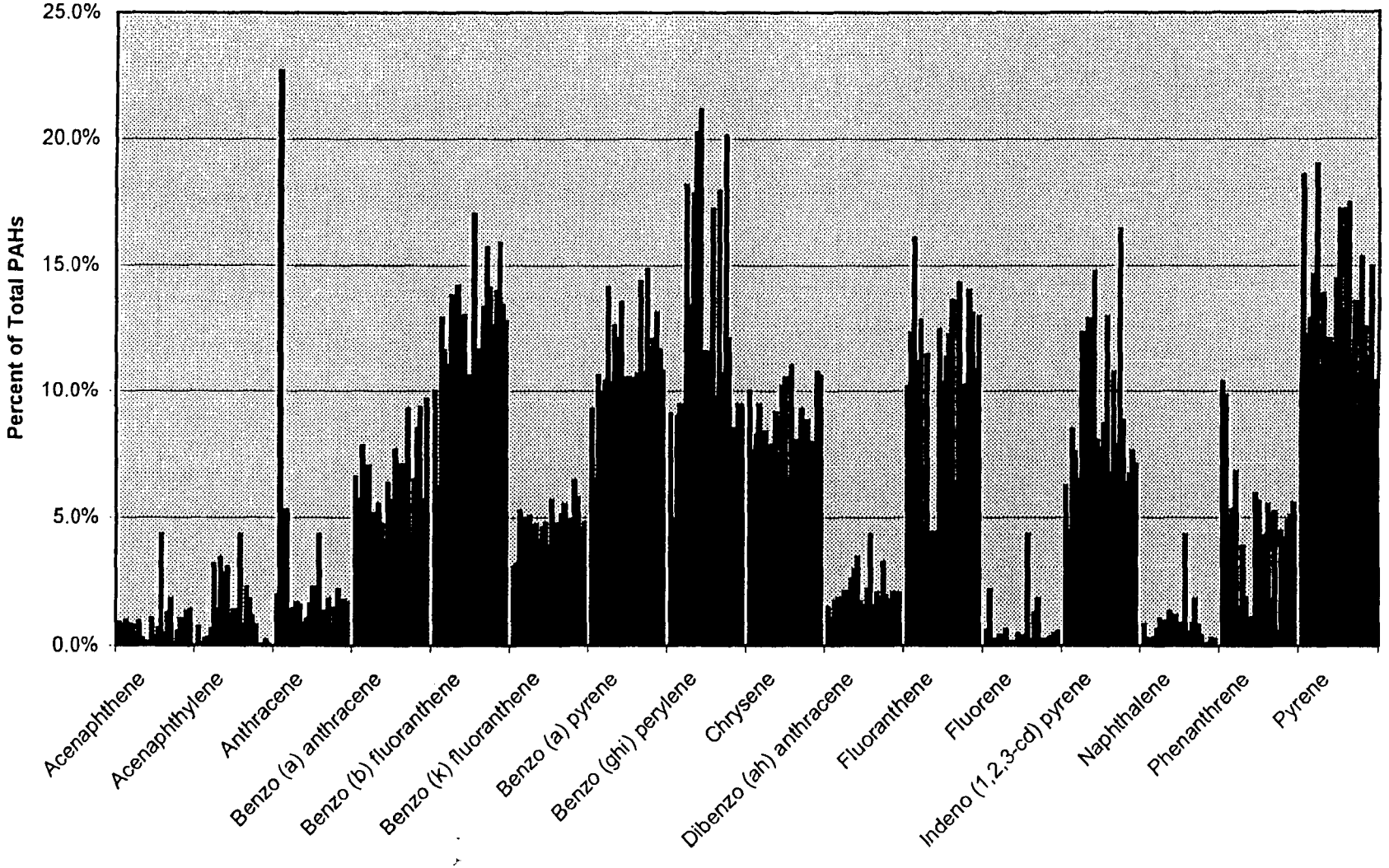
Figure 2.



Koppers022487

Figure 3.

Comparison of PAH Compound Mix in Surface Soil Samples



Koppers022488

Figure 4.

Comparison of PAH Compouind Mix in Shallow Soil Samples

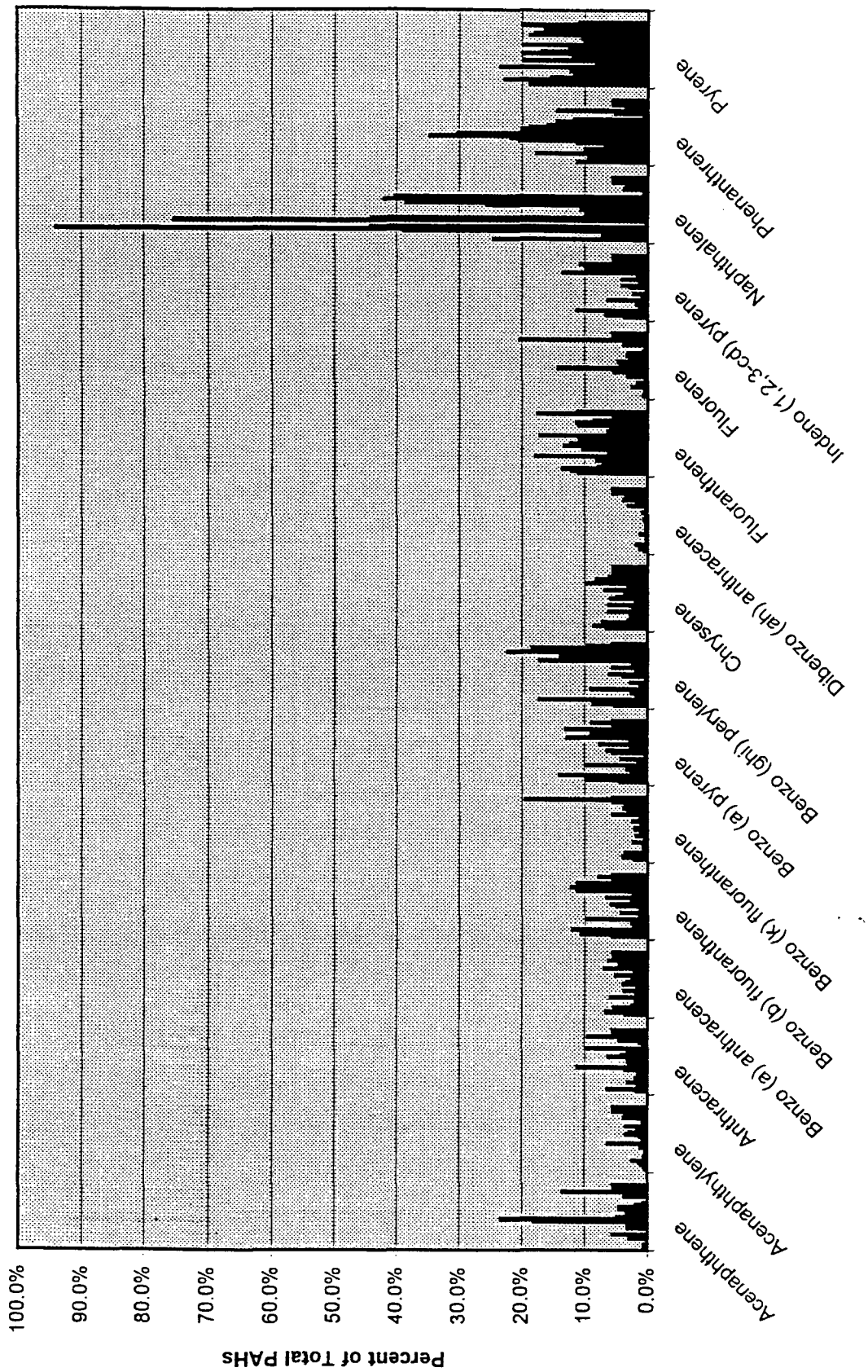
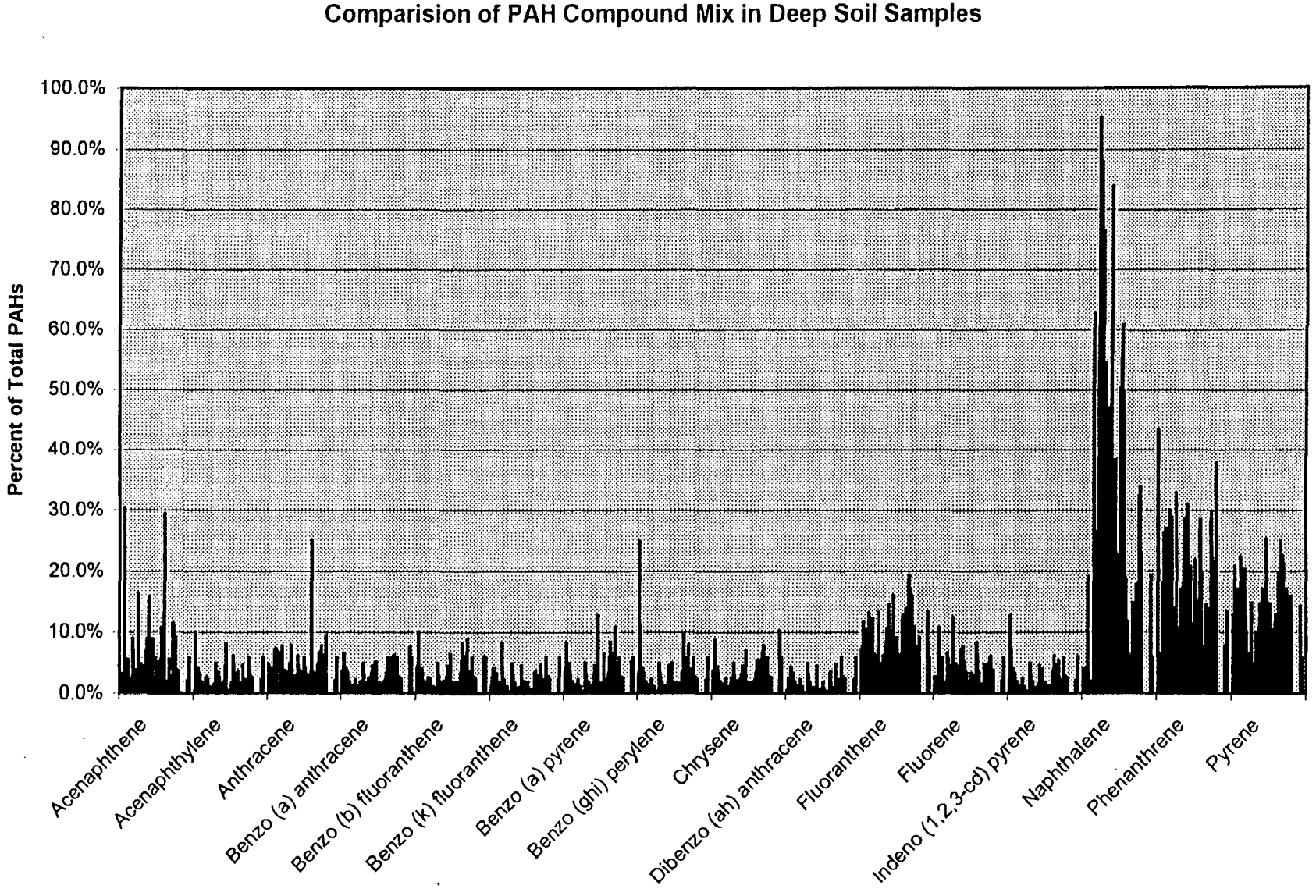


Figure 5.



Koppers022490

Figure 6.

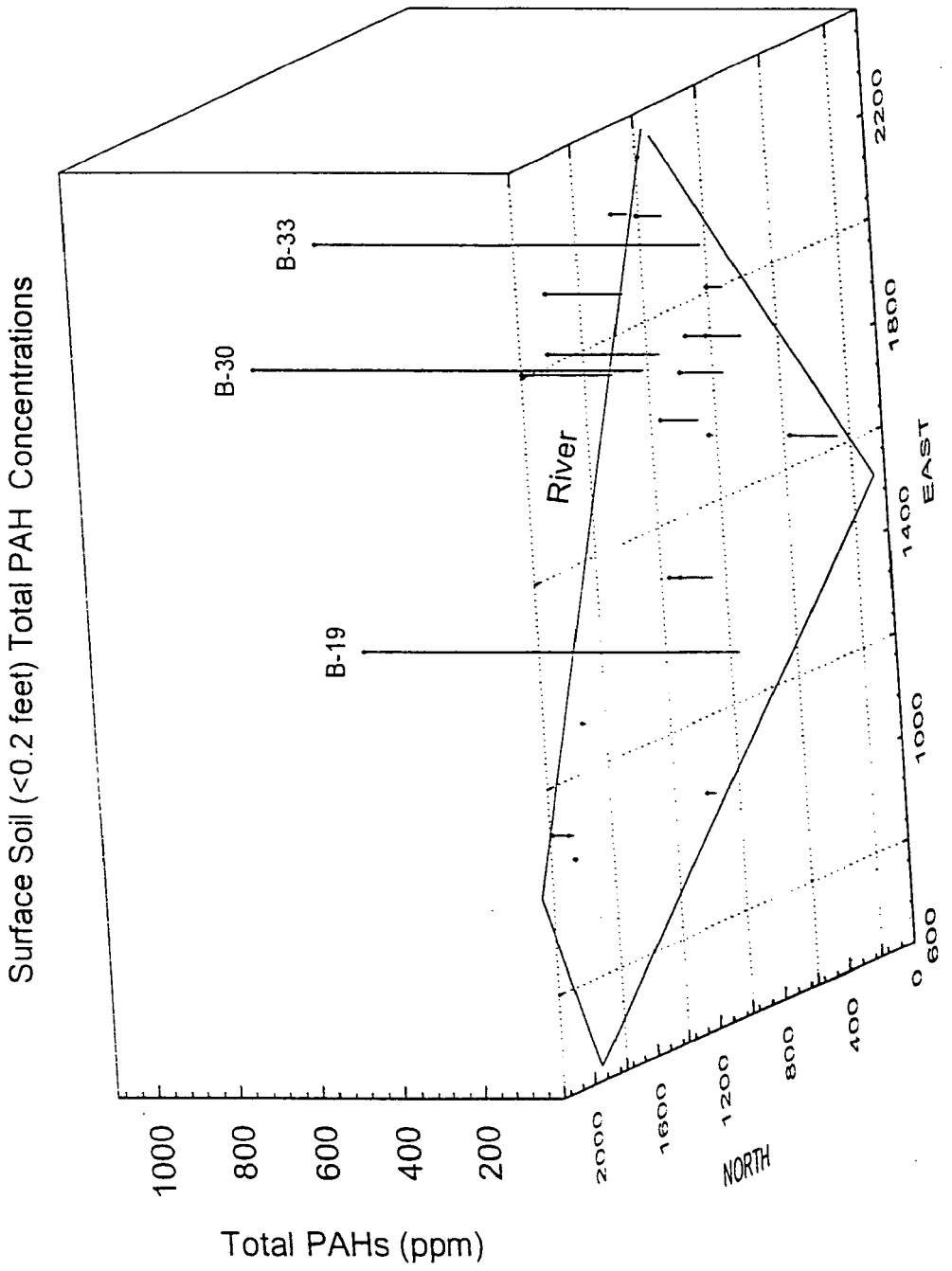
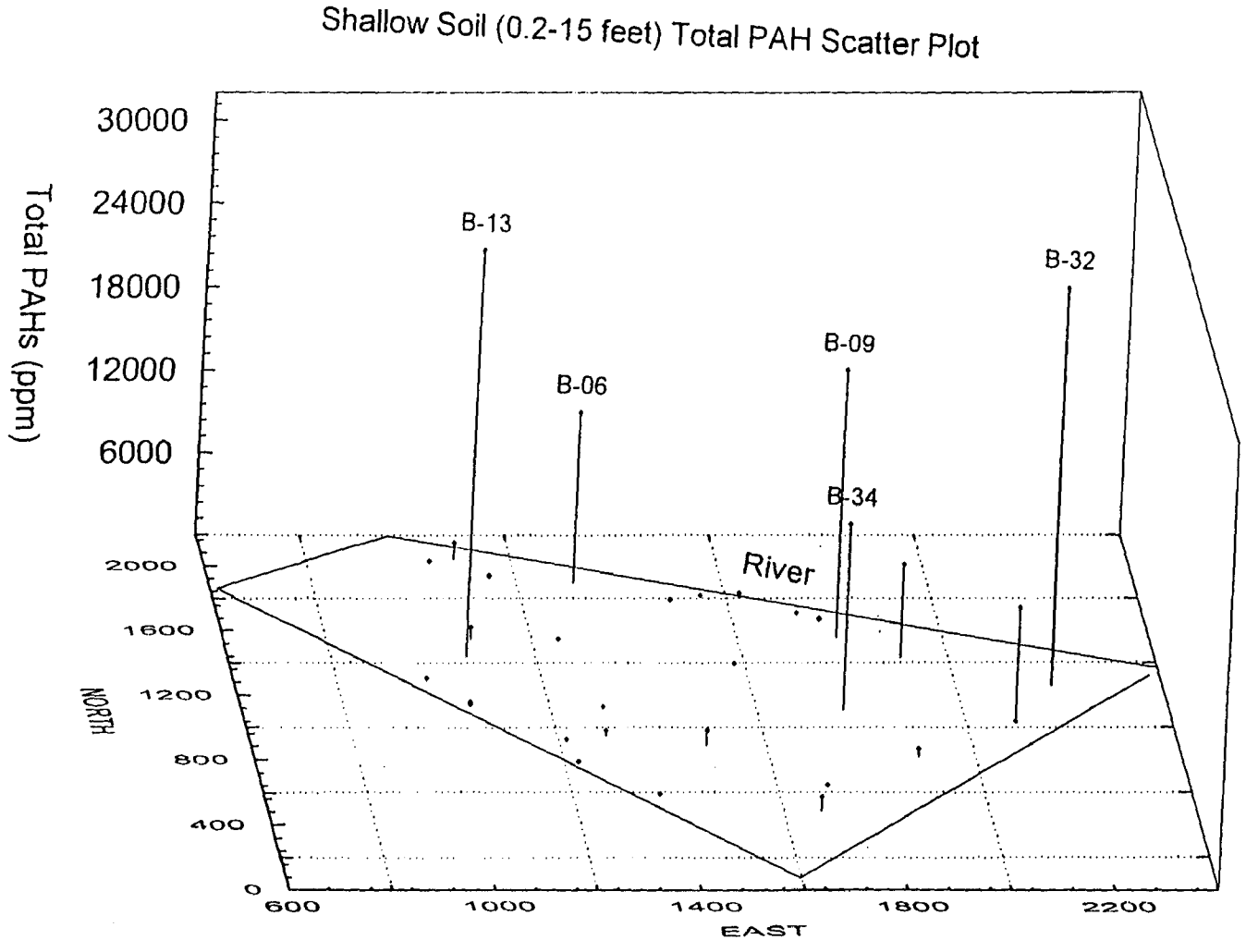

Surface Soil (<0.2 feet) Total PAH Concentrations
Total PAHs (ppm)
1000
800
600
400
200
B-33
B-30
B-19
River
NORTH
2000
1600
1200
800
400
0
EAST
600
1000
1400
1800
2200

Figure 7.



Koppers022402

Figure 8.

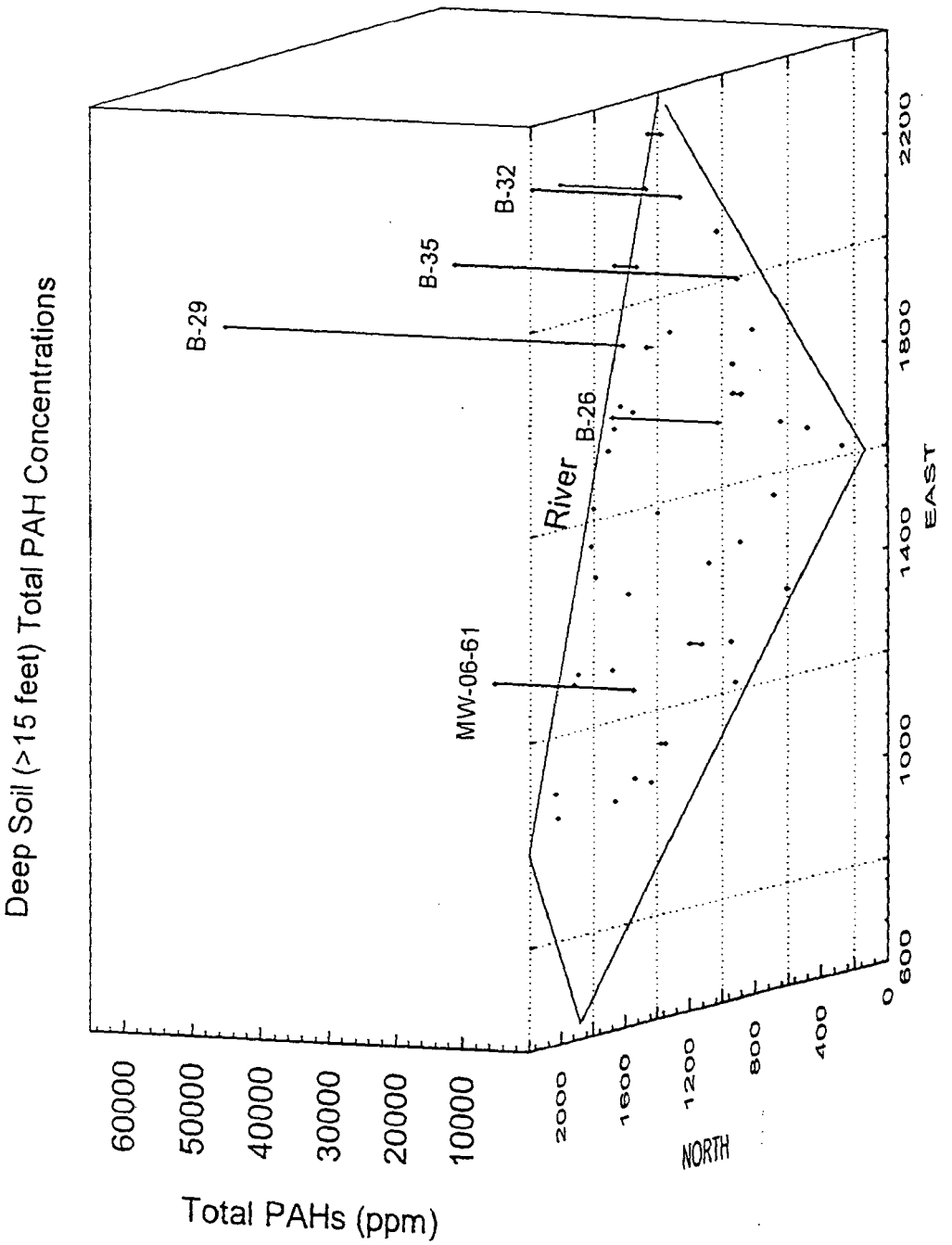

Deep Soil (>15 feet) Total PAH Concentrations
B-32
B-35
B-29
B-26
River
MW-06-61
60000
50000
40000
30000
20000
10000
Total PAHs (ppm)
2000
1600
1200
800
400
0
NORTH
600
1000
1400
1800
2200
EAST

Figure 9.

Surface Soil Concentrations of Carcinogenic PAHs

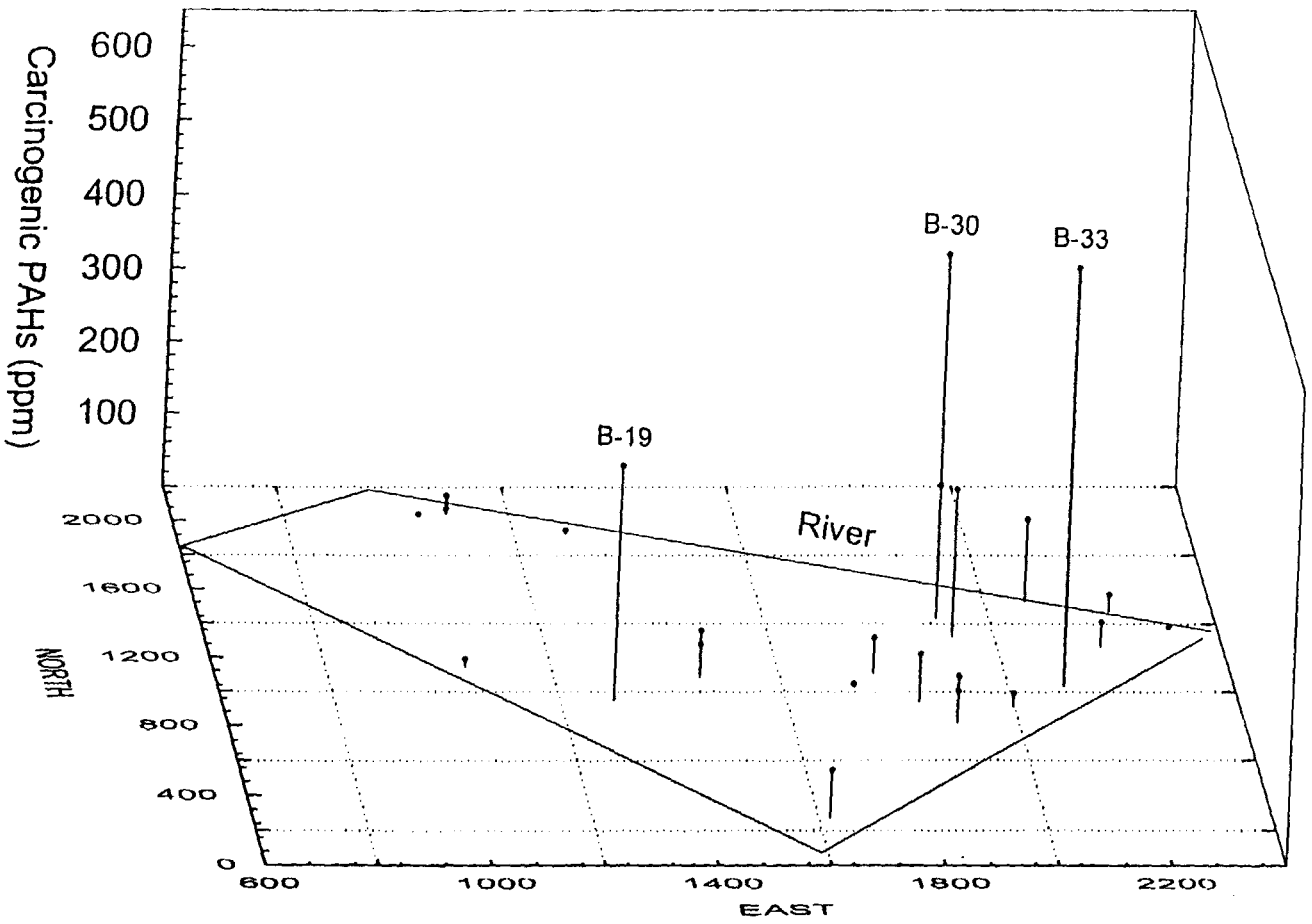


Figure 10.

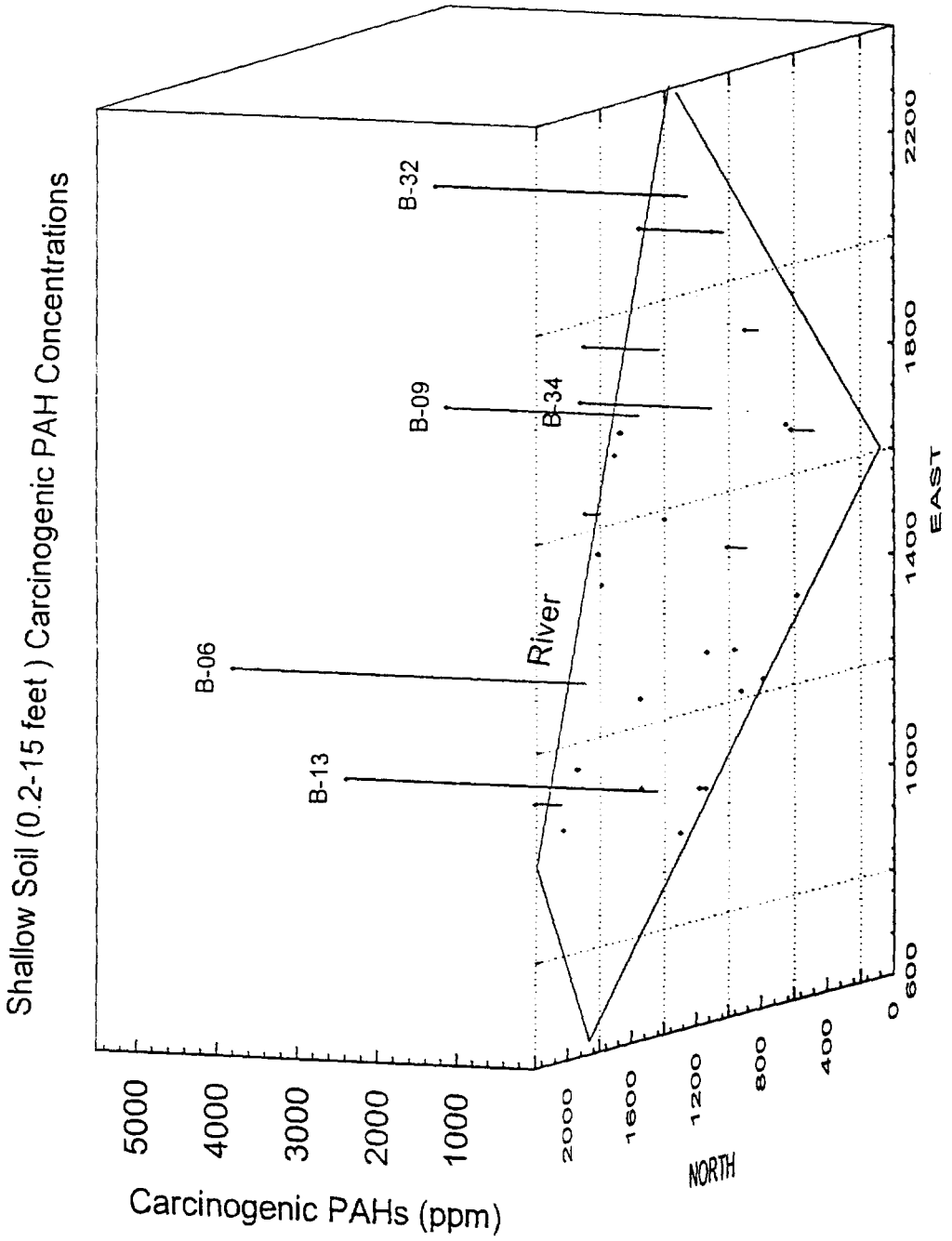

Shallow Soil (0.2-15 feet) Carcinogenic PAH Concentrations
B-32
B-09
B-34
B-06
B-13
River
5000
4000
3000
2000
1000
Carcinogenic PAHs (ppm)
2000
1600
1200
800
400
0
NORTH
600
1000
1400
1800
2200
EAST

Figure 11.

Deep Soil (>15 feet) Carcinogenic PAH Concentrations

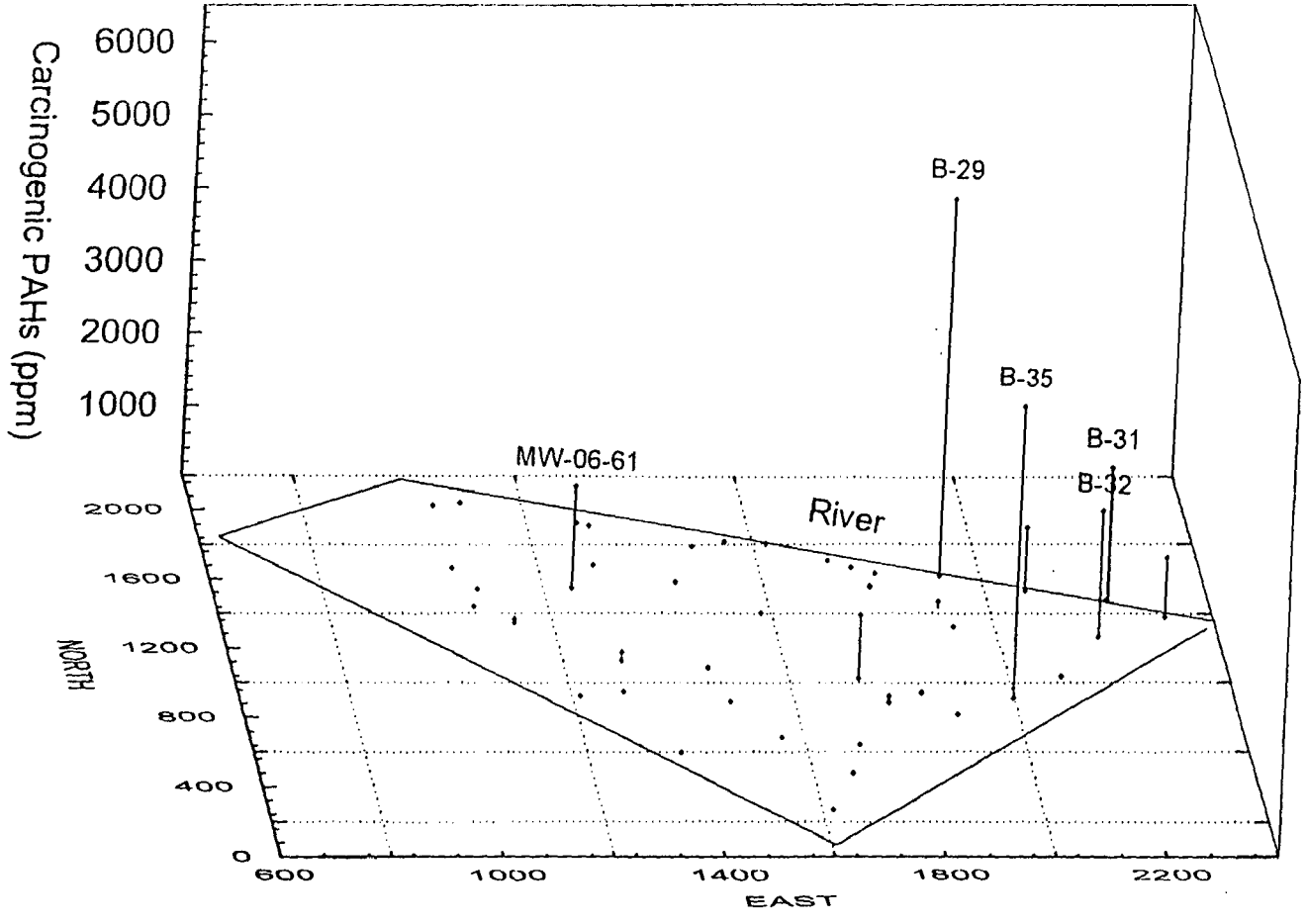
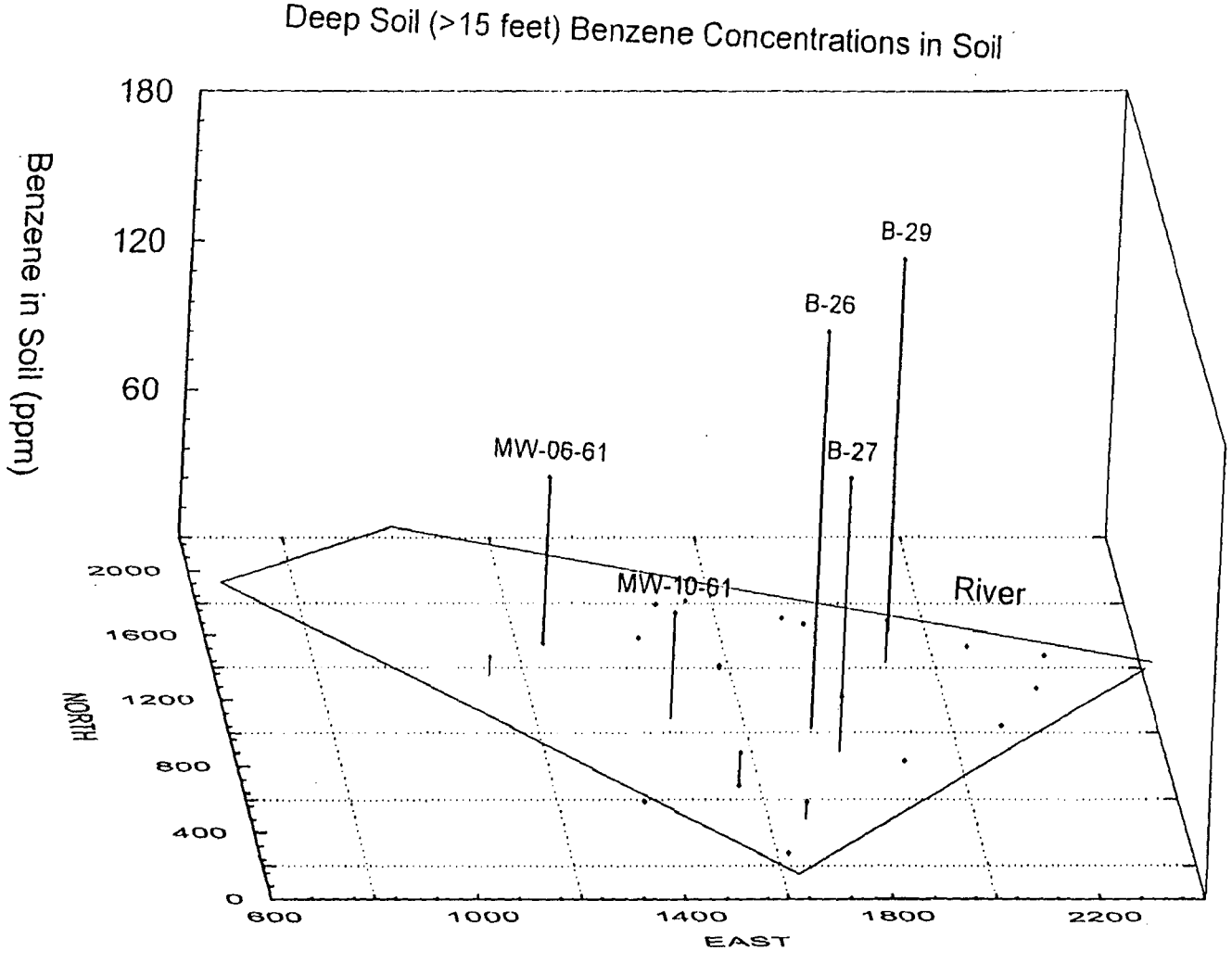


Figure 12.



Deep Soil (>15 feet) Benzene Concentrations in Soil
Benzene in Soil (ppm)
180
120
60
B-29
B-26
B-27
MW-06-61
MW-10-61
River
NORTH
2000
1600
1200
800
400
0
600
1000
1400
1800
2200
EAST

Figure 13.

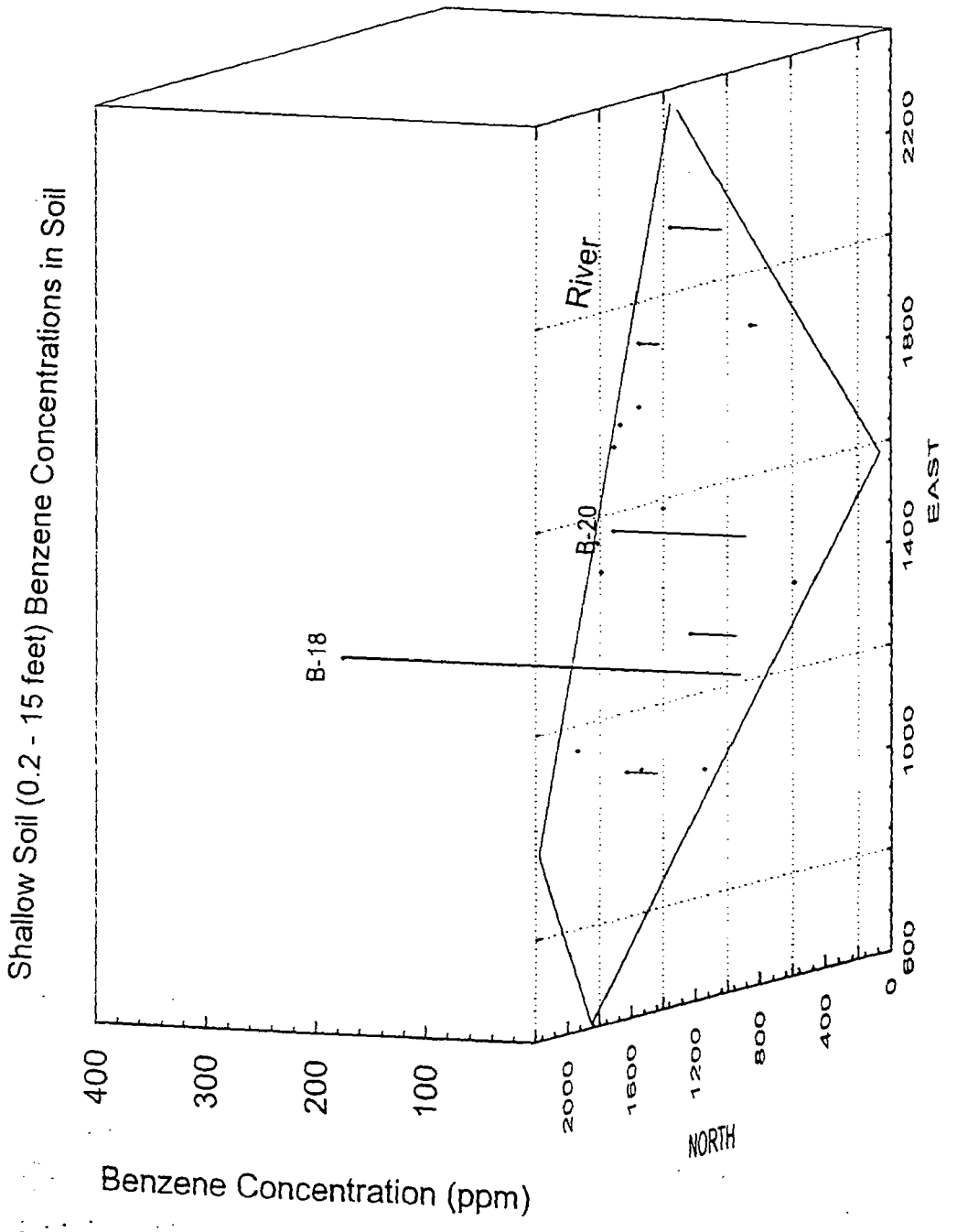
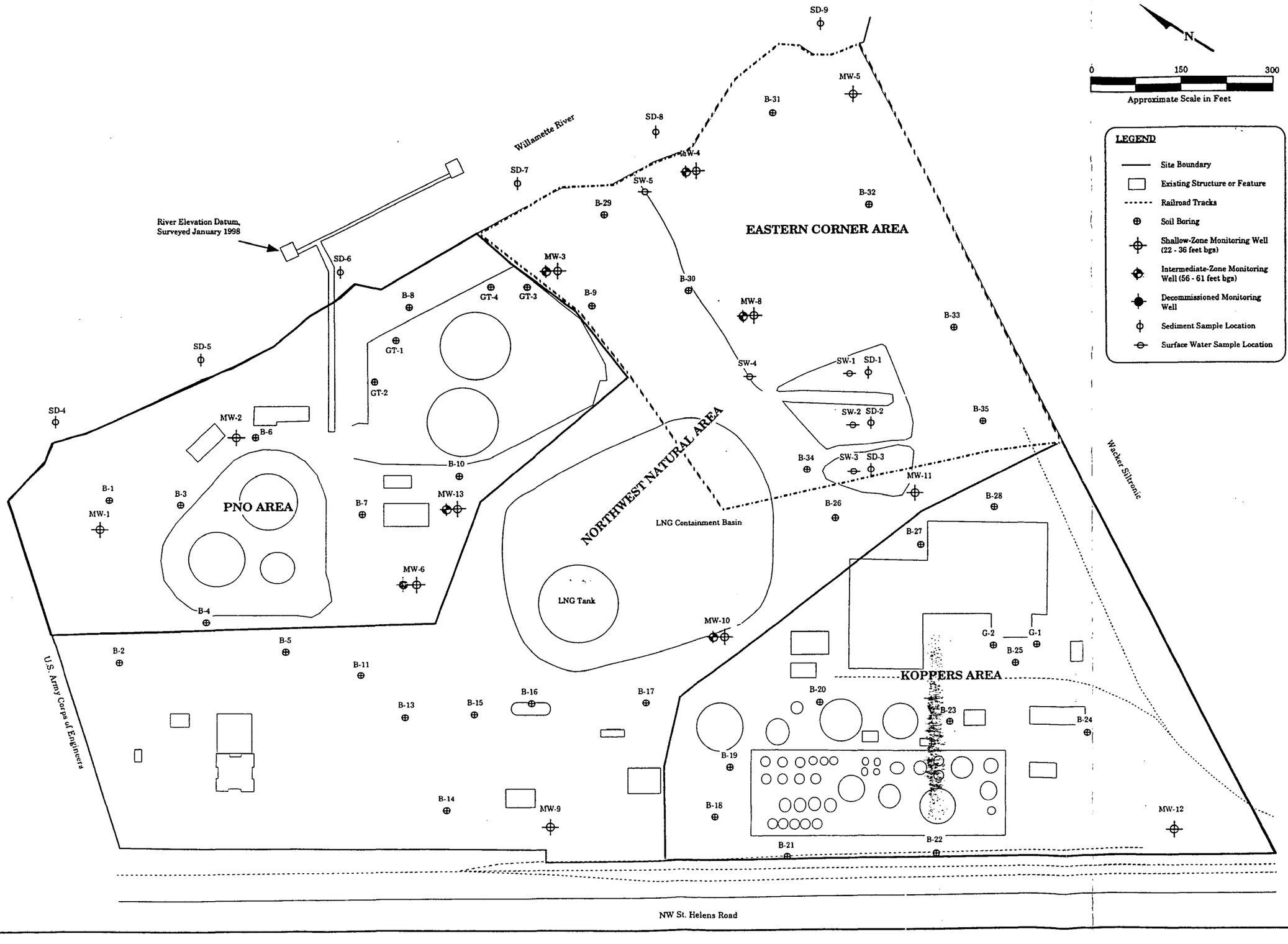

Shallow Soil (0.2 - 15 feet) Benzene Concentrations in Soil
Benzene Concentration (ppm)
400
300
200
100
B-18
B-20
River
2000
1600
1200
800
400
0
NORTH
600
1000
1400
1800
2200
EAST

Figure
14

Site Area Breakdown Map

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon



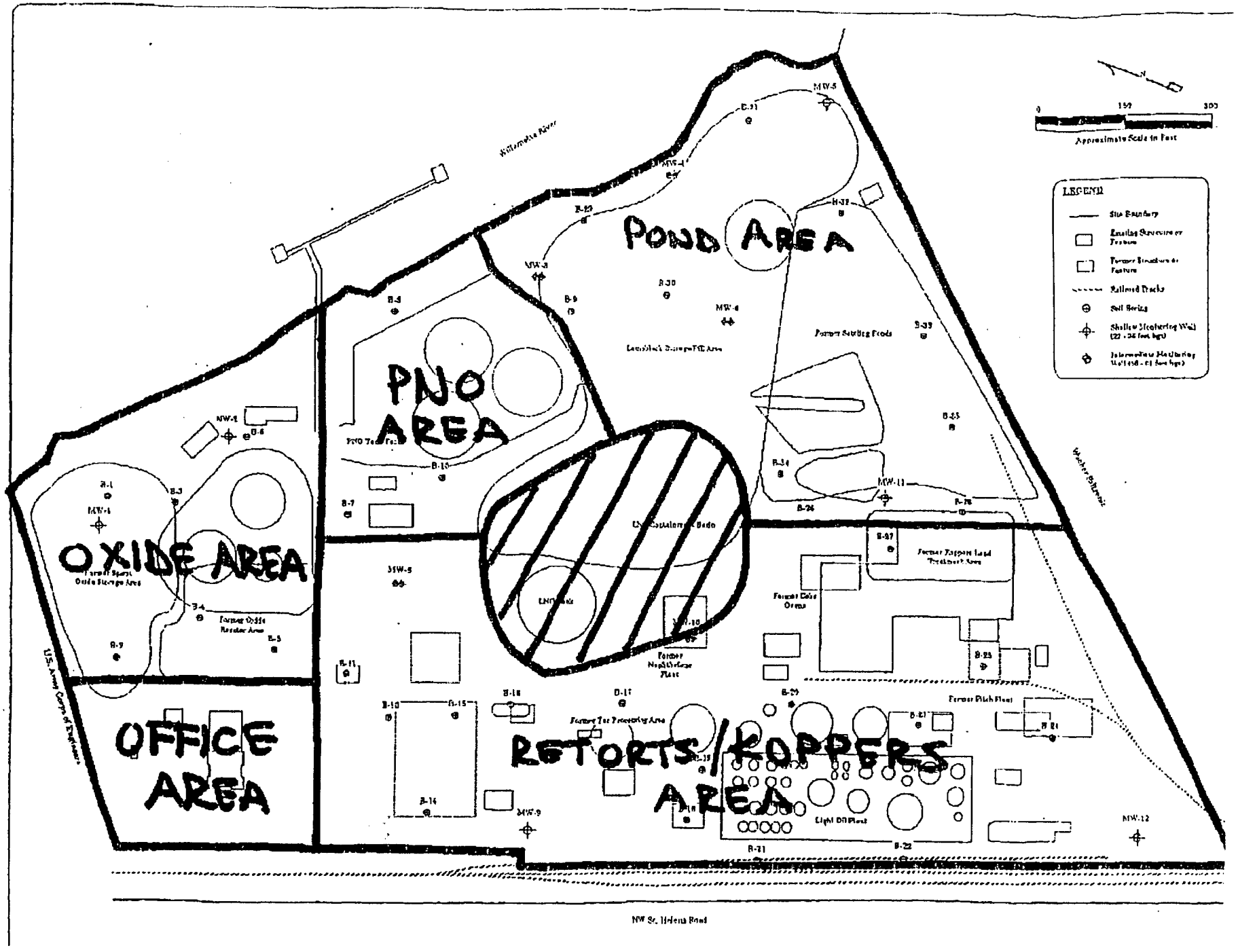
HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project #2708

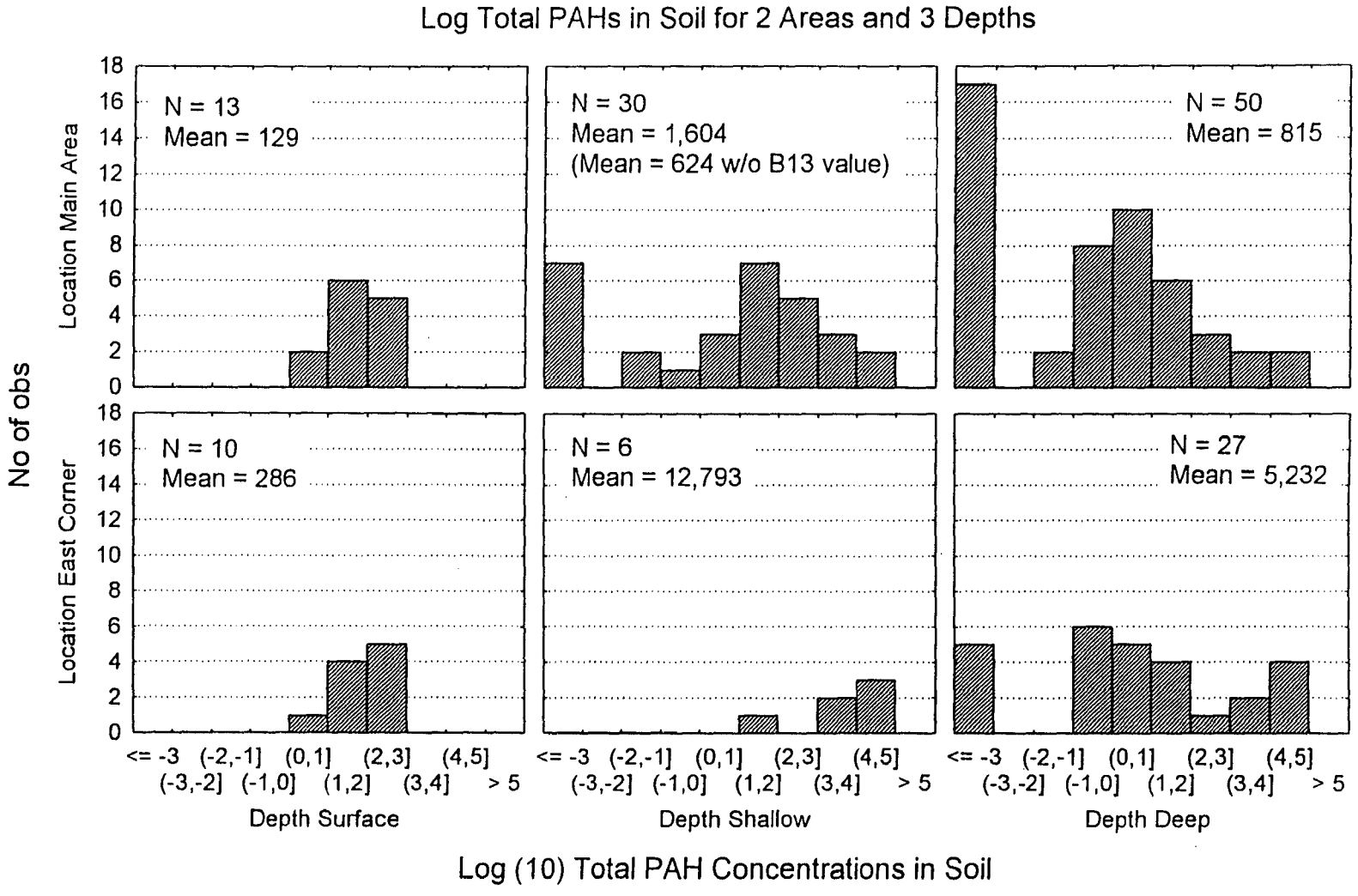
Koppers022499

Fig 14B



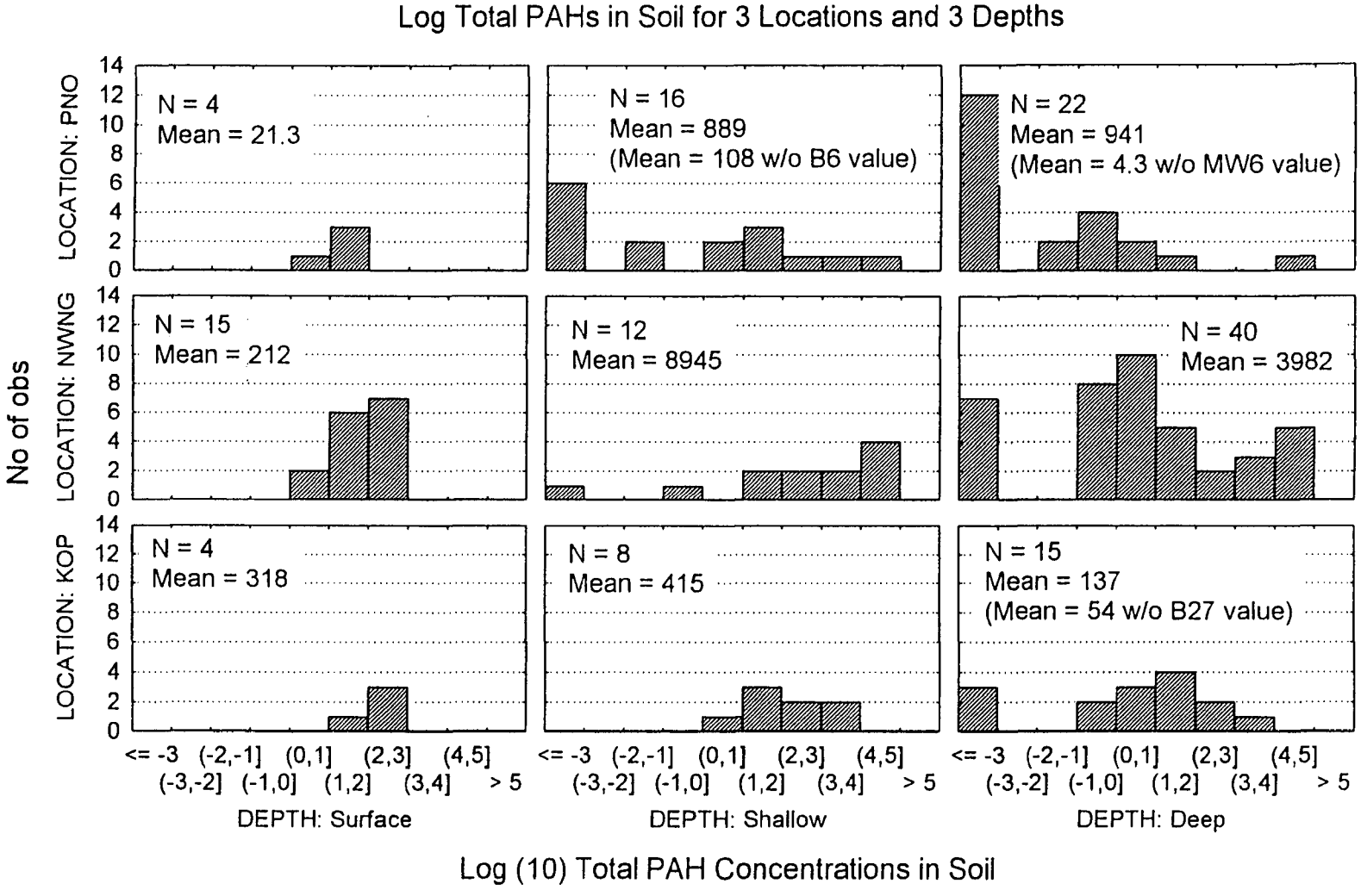
Koppers022500

Figure 15.



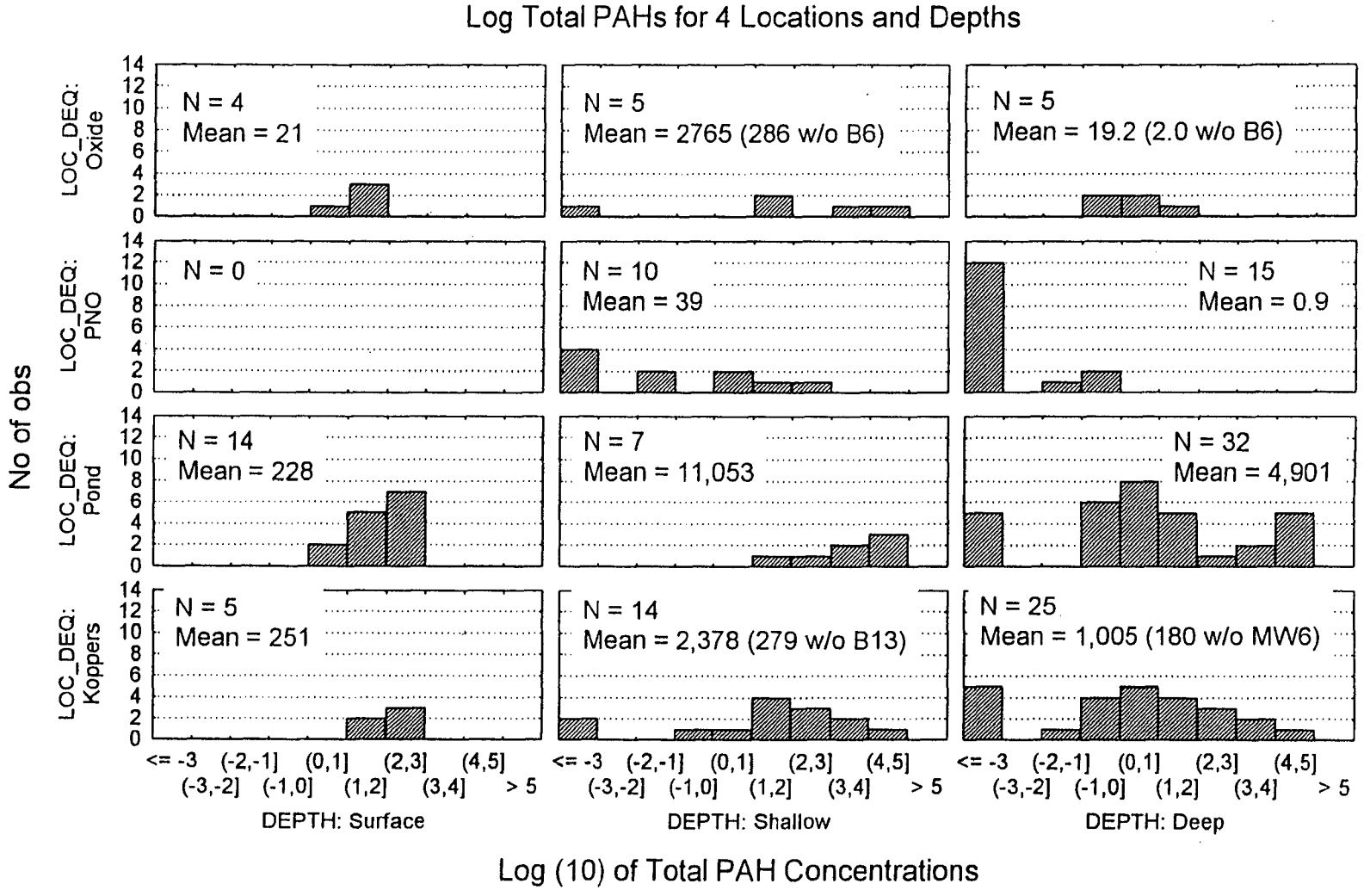
Koppers022501

Fig. 16.



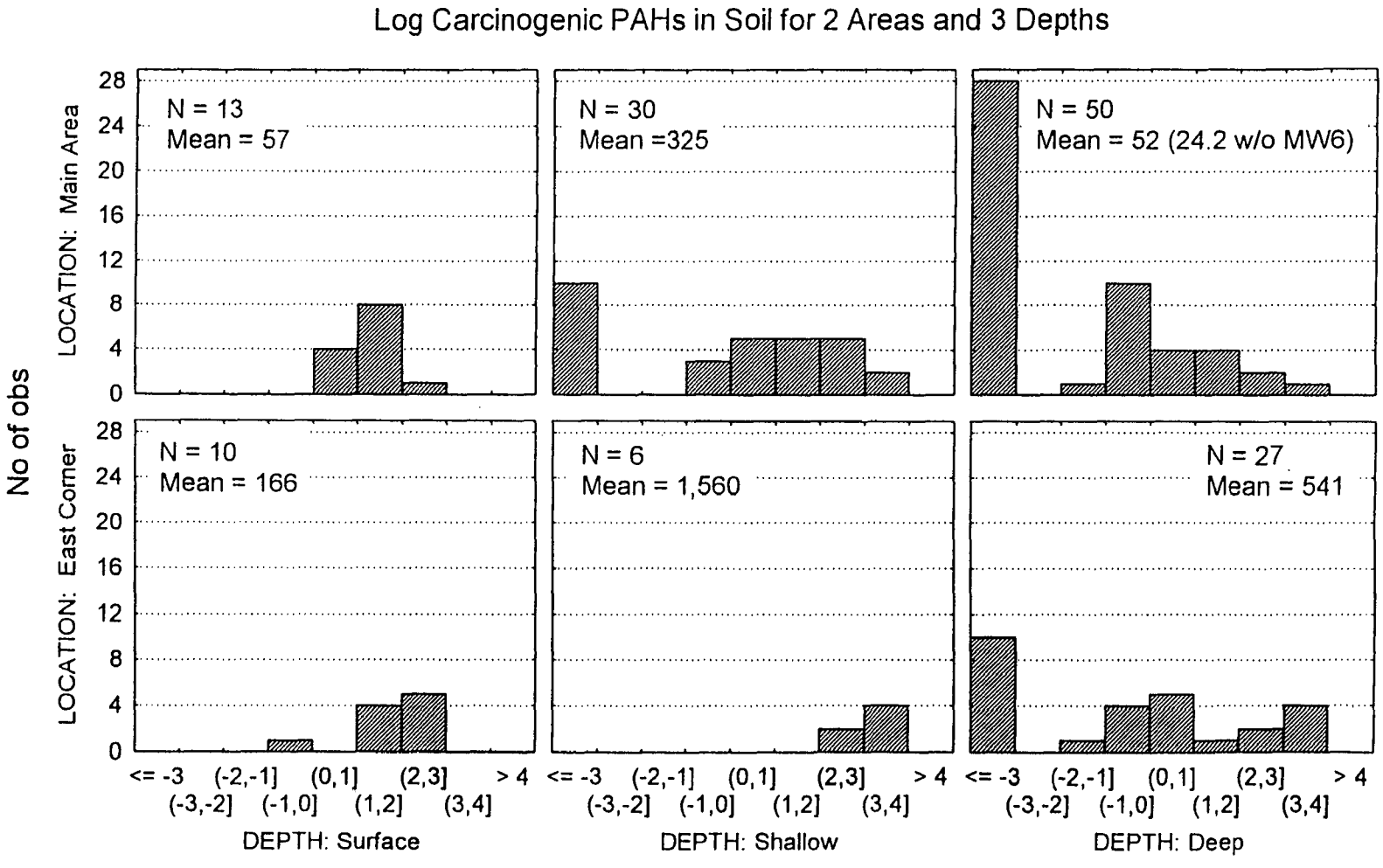
Koppers022502

ure 17.



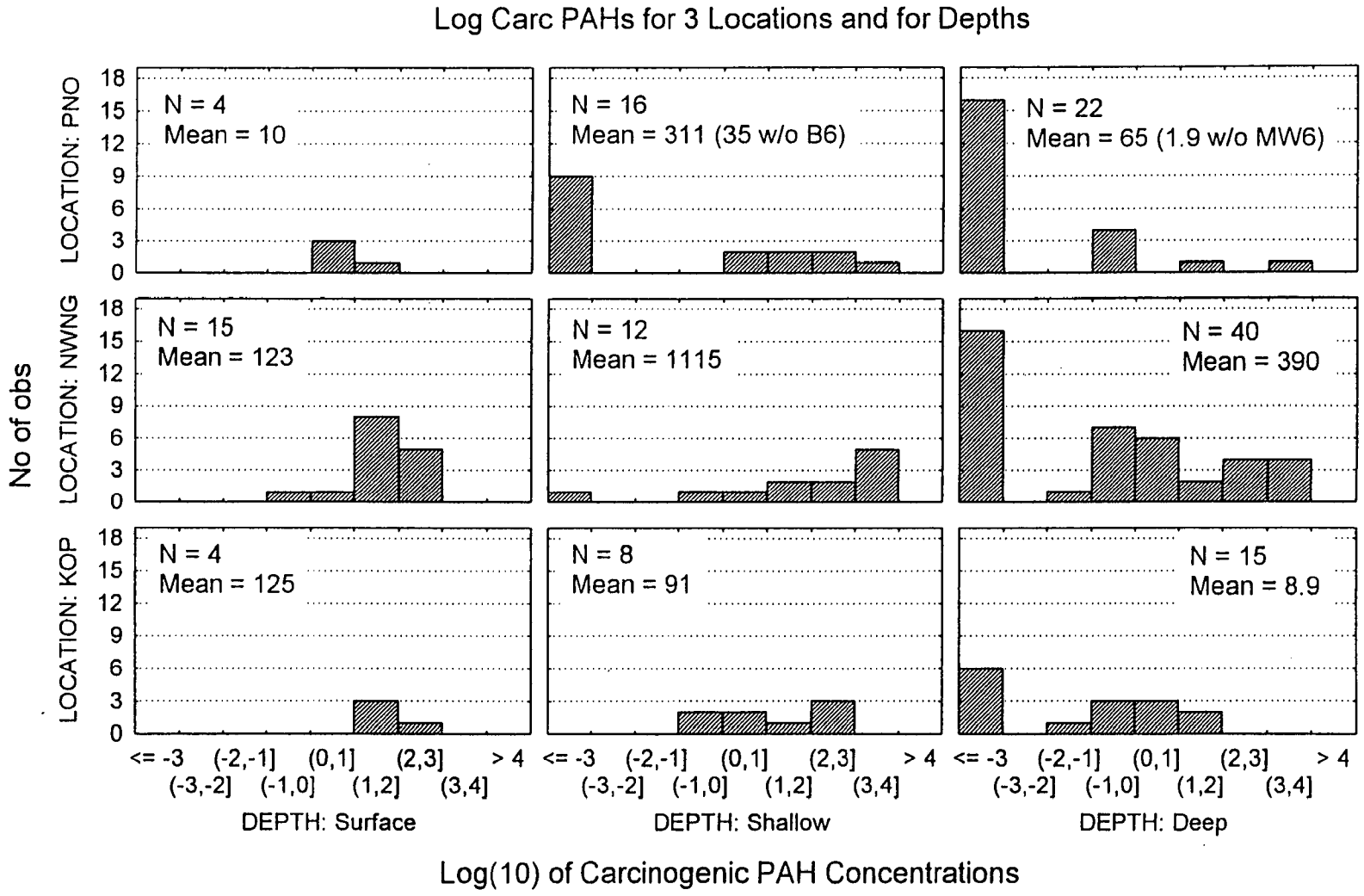
Koppers022503

Figure 18.



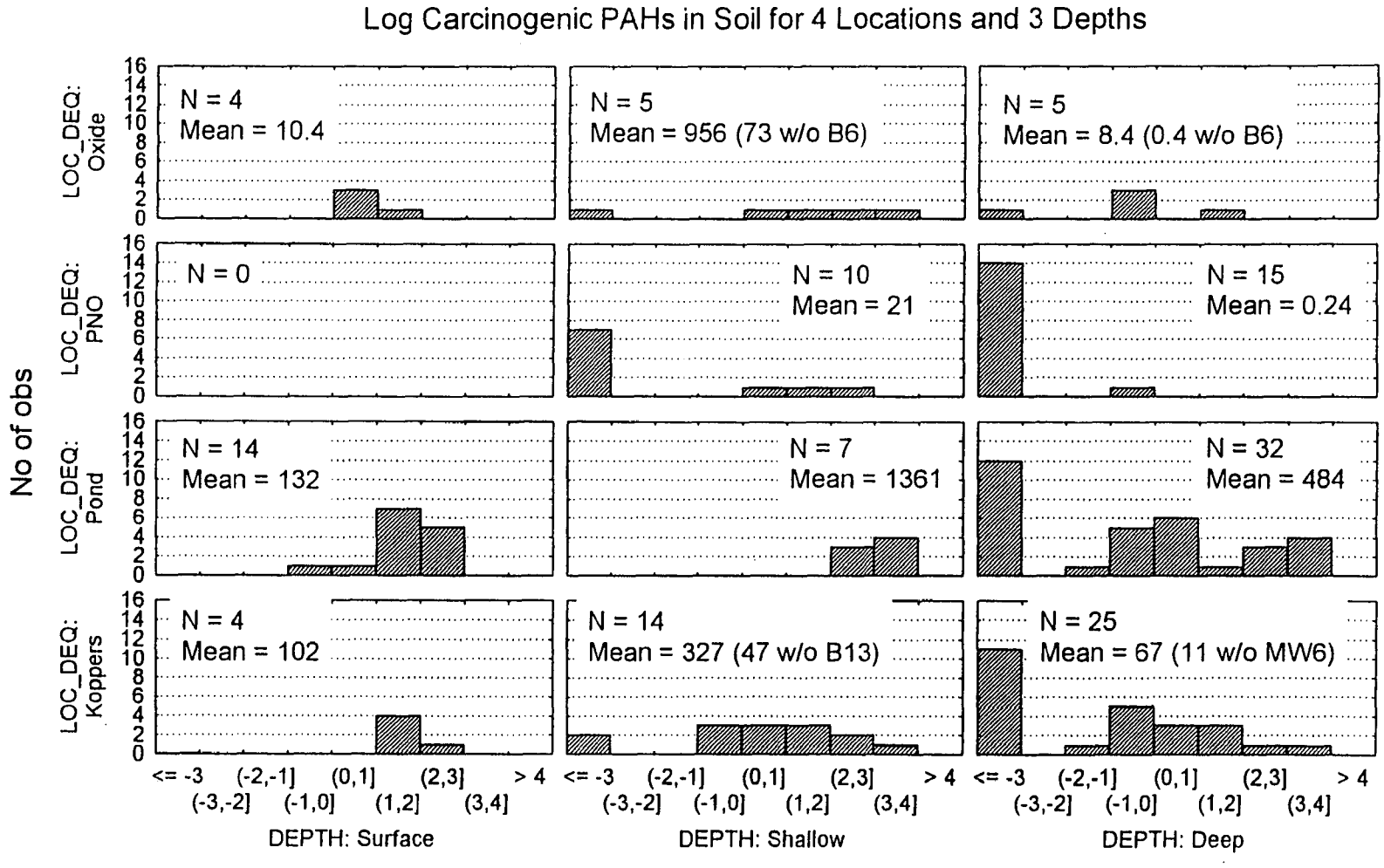
Koppers022504

Figure 19.



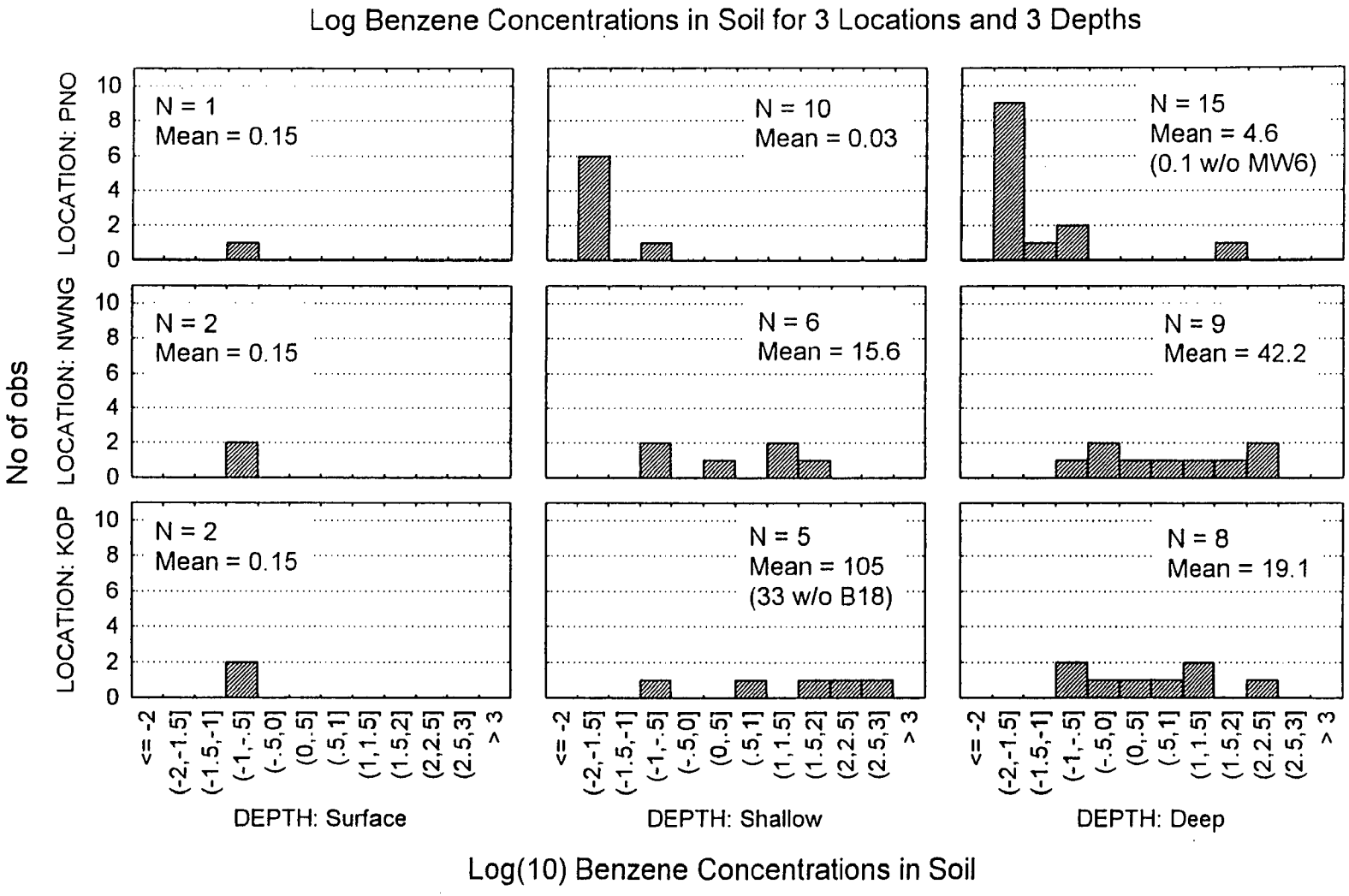
Koppers022505

. ıgure 20.



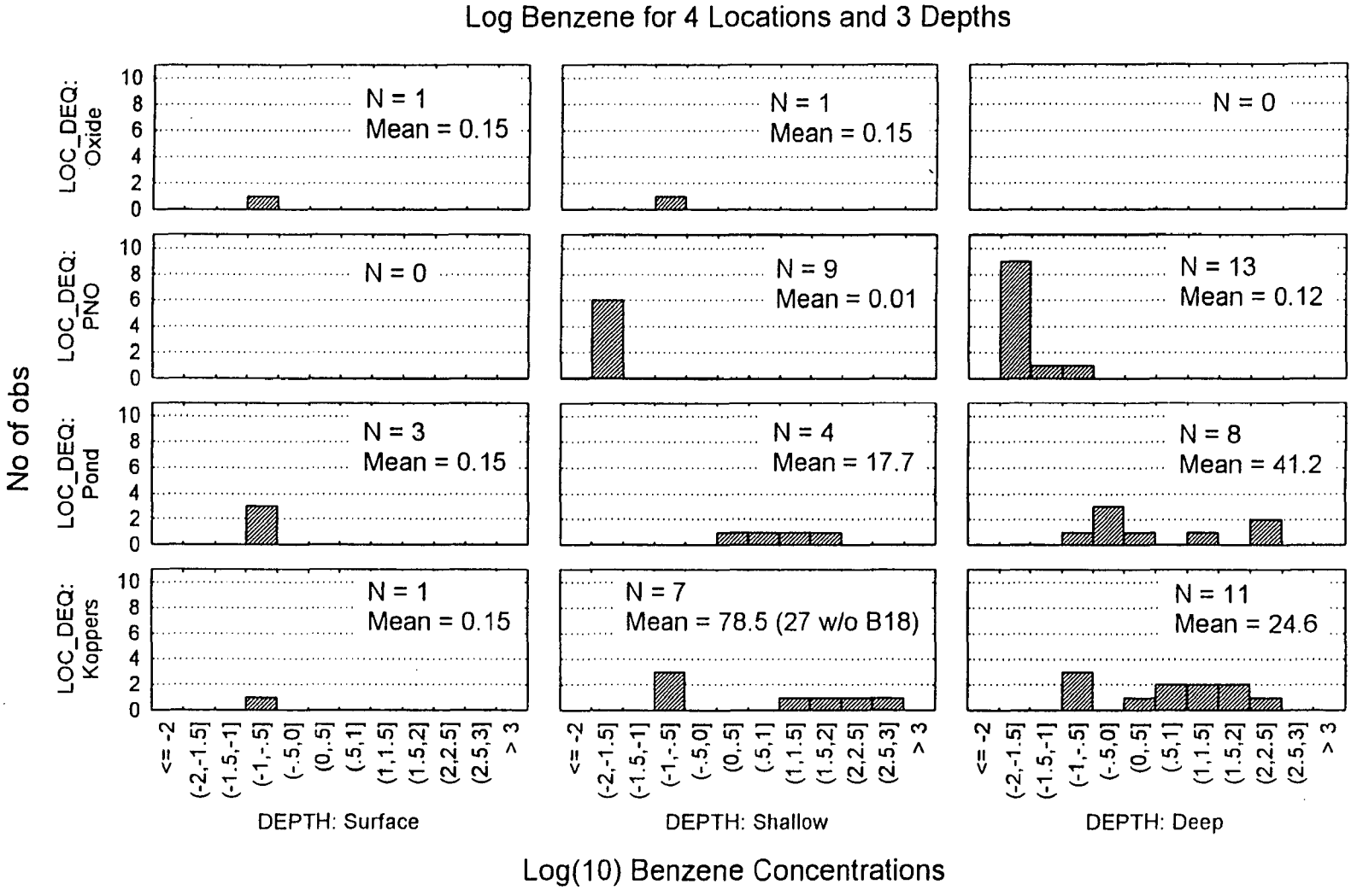
Koppers022506

Figure 21.



Koppers022507

Figure 22.



Koppers022508

Figure 23.

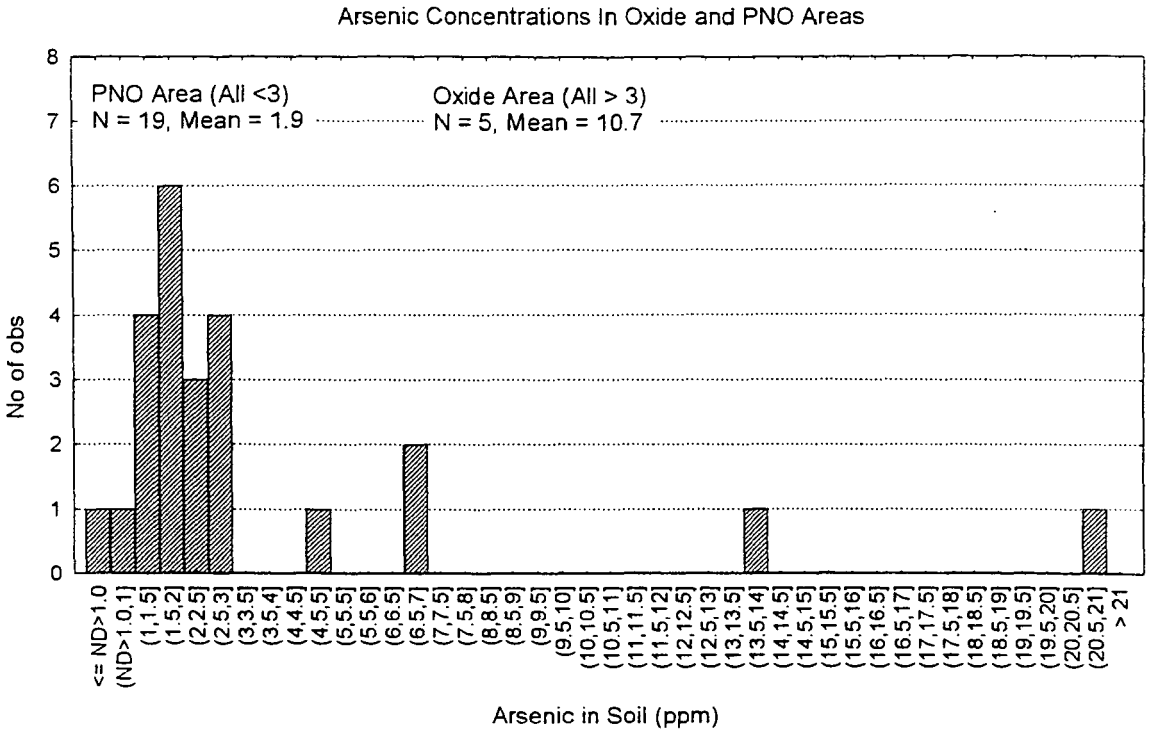
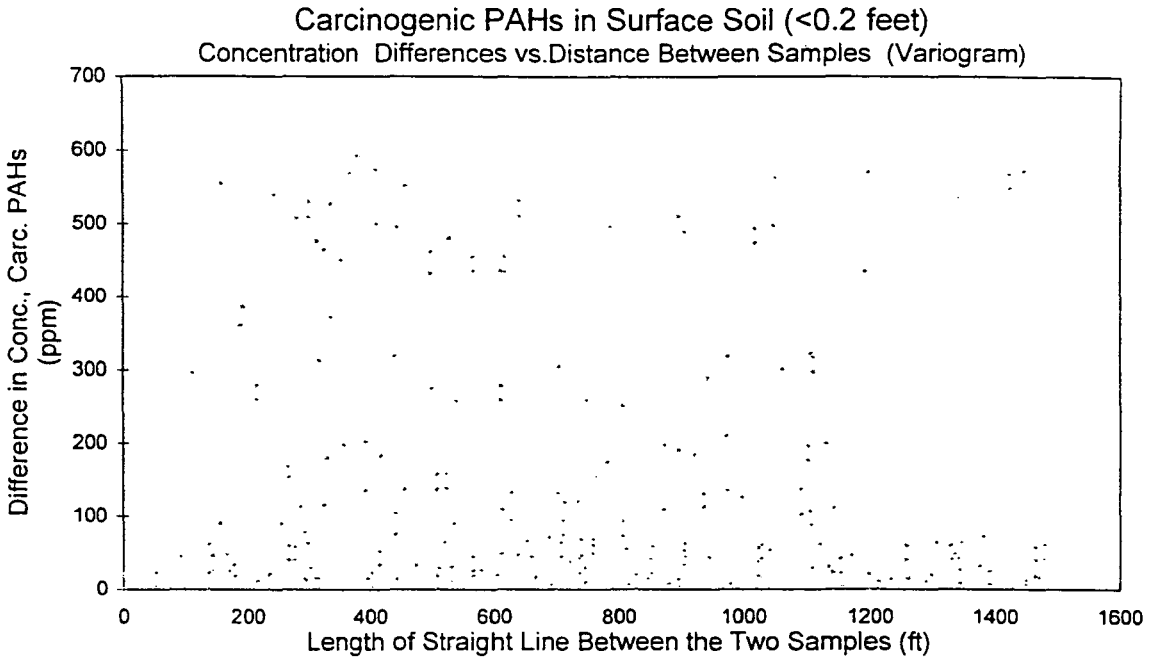
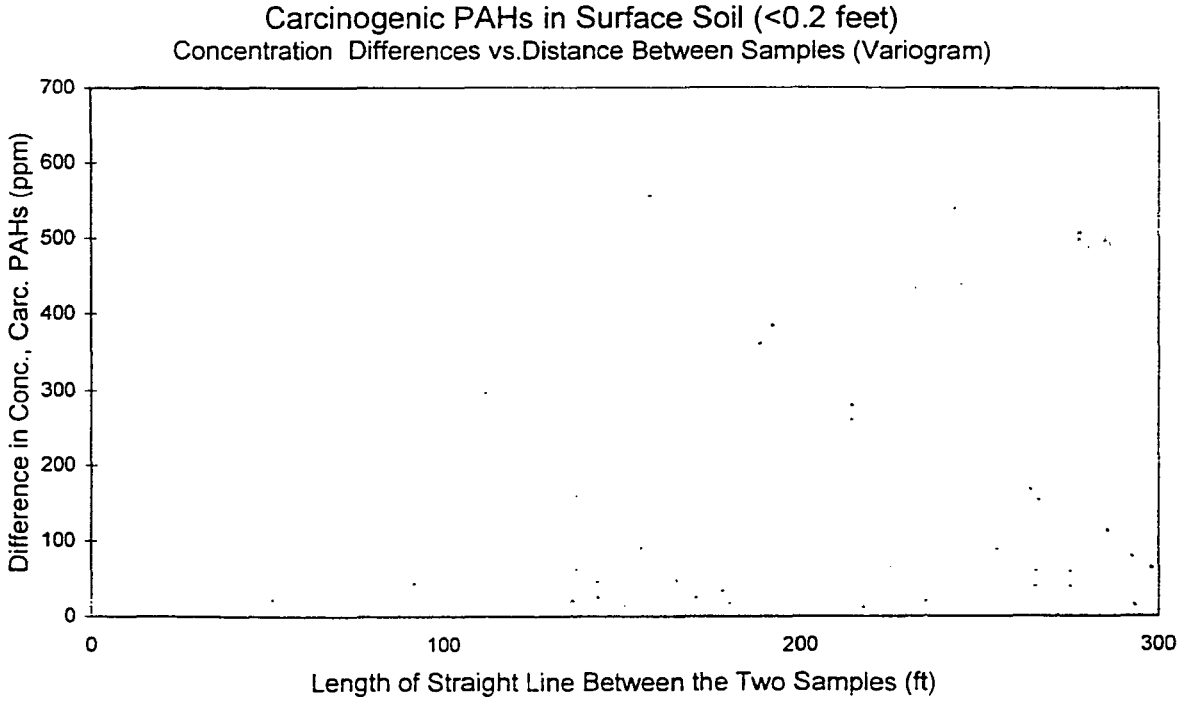

Arsenic Concentrations In Oxide and PNO Areas
PNO Area (All <3)
N = 19, Mean = 1.9
Oxide Area (All > 3)
N = 5, Mean = 10.7
No of obs
0
1
2
3
4
5
6
7
8
<= ND>1.0
(ND>1.0,1]
(1,1.5]
(1.5,2]
(2,2.5]
(2.5,3]
(3,3.5]
(3.5,4]
(4,4.5]
(4.5,5]
(5,5.5]
(5.5,6]
(6,6.5]
(6.5,7]
(7,7.5]
(7.5,8]
(8,8.5]
(8.5,9]
(9,9.5]
(9.5,10]
(10,10.5]
(10.5,11]
(11,11.5]
(11.5,12]
(12,12.5]
(12.5,13]
(13,13.5]
(13.5,14]
(14,14.5]
(14.5,15]
(15,15.5]
(15.5,16]
(16,16.5]
(16.5,17]
(17,17.5]
(17.5,18]
(18,18.5]
(18.5,19]
(19,19.5]
(19.5,20]
(20,20.5]
(20.5,21]
> 21
Arsenic in Soil (ppm)

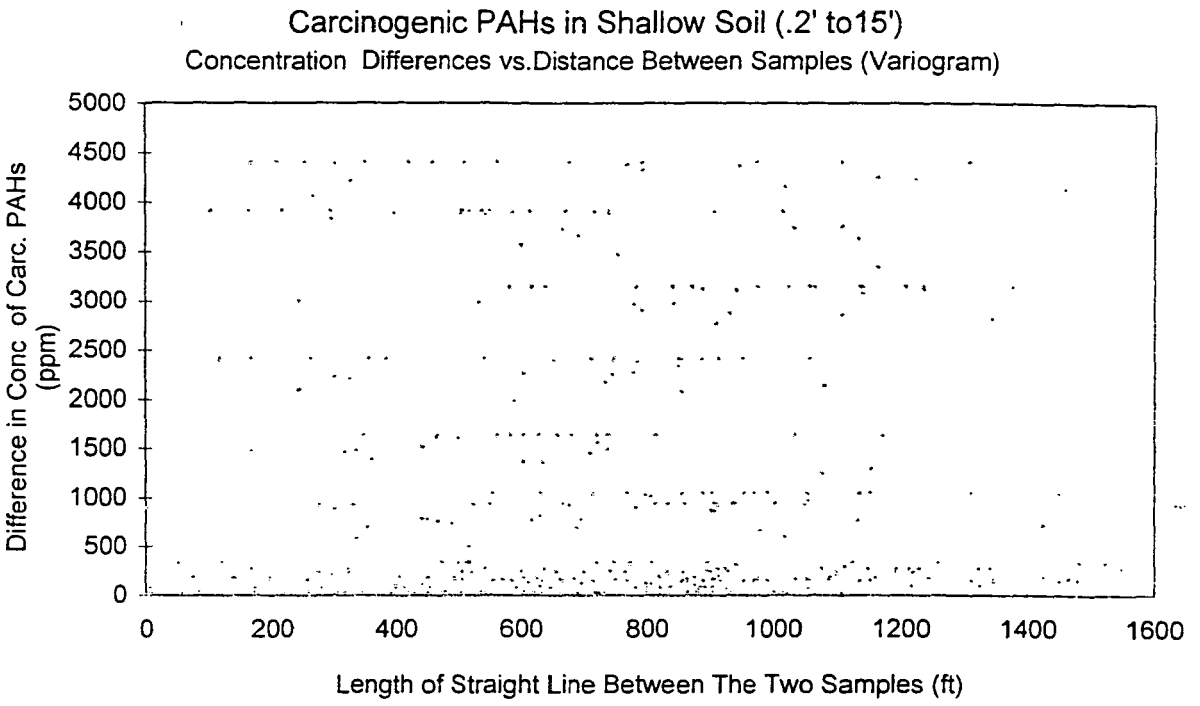
Figure 24.

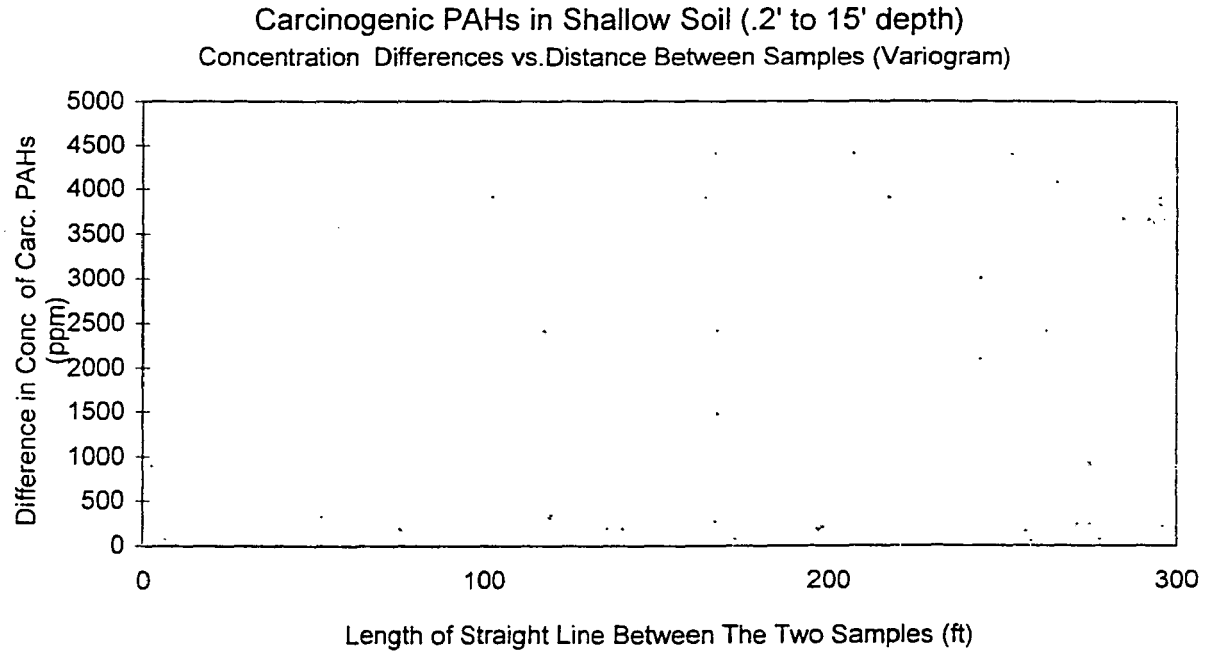




concs and variogram 98.xls

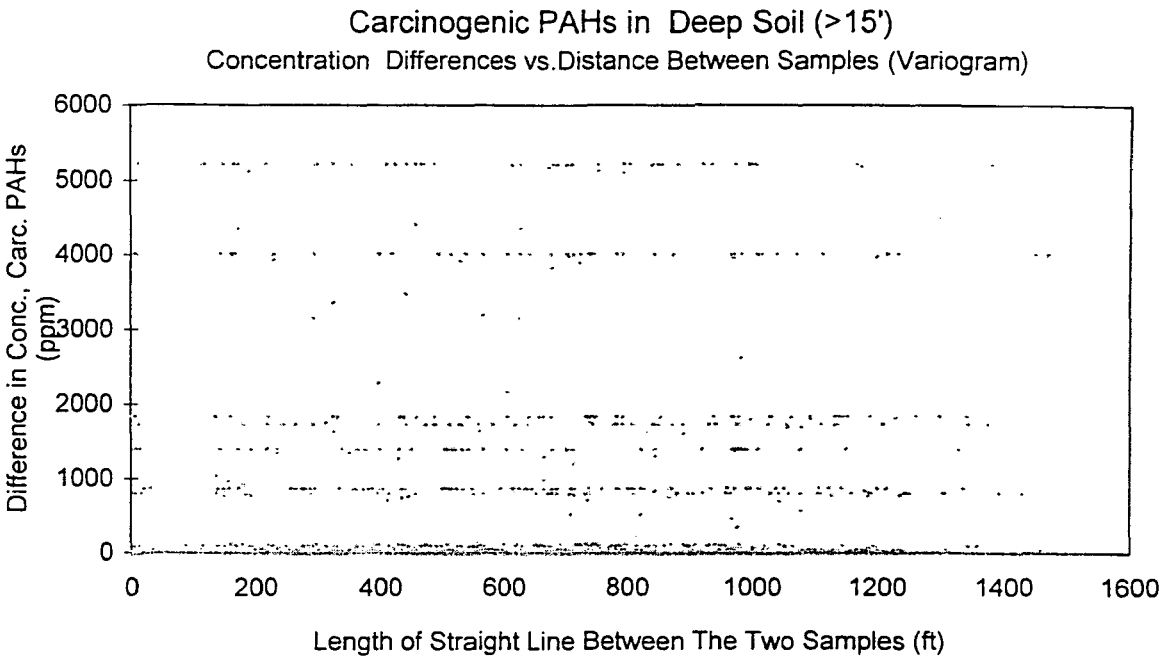
Figure 25.

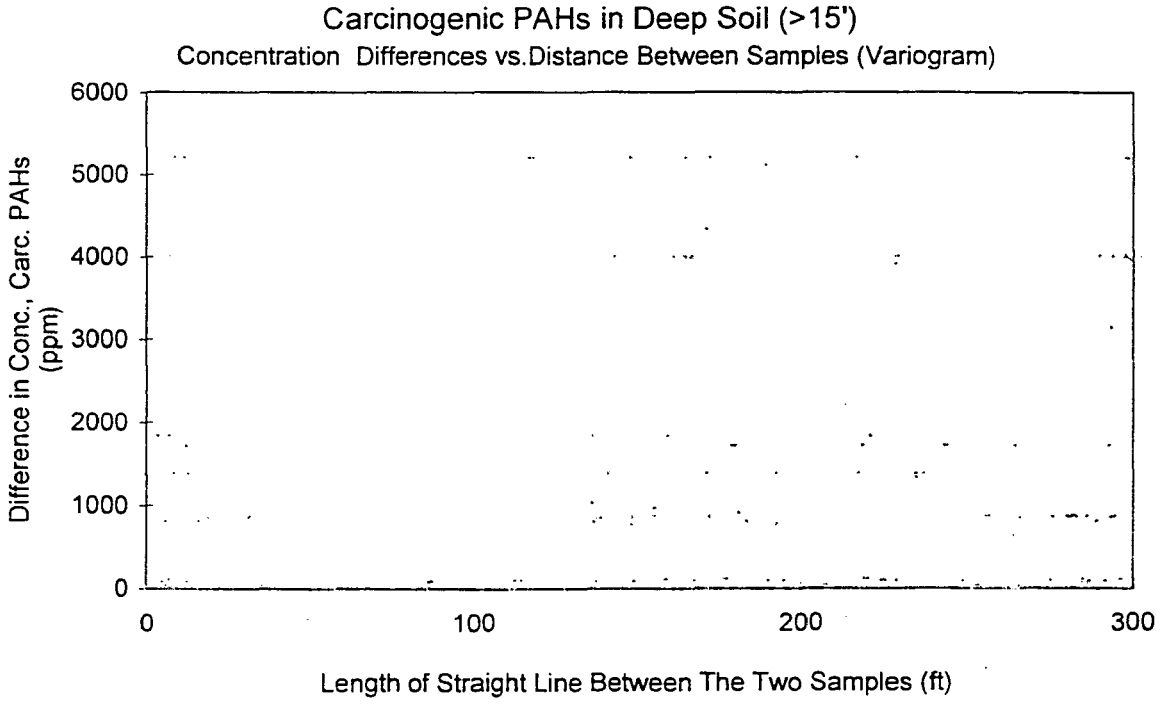




concs and variogram 98.xls

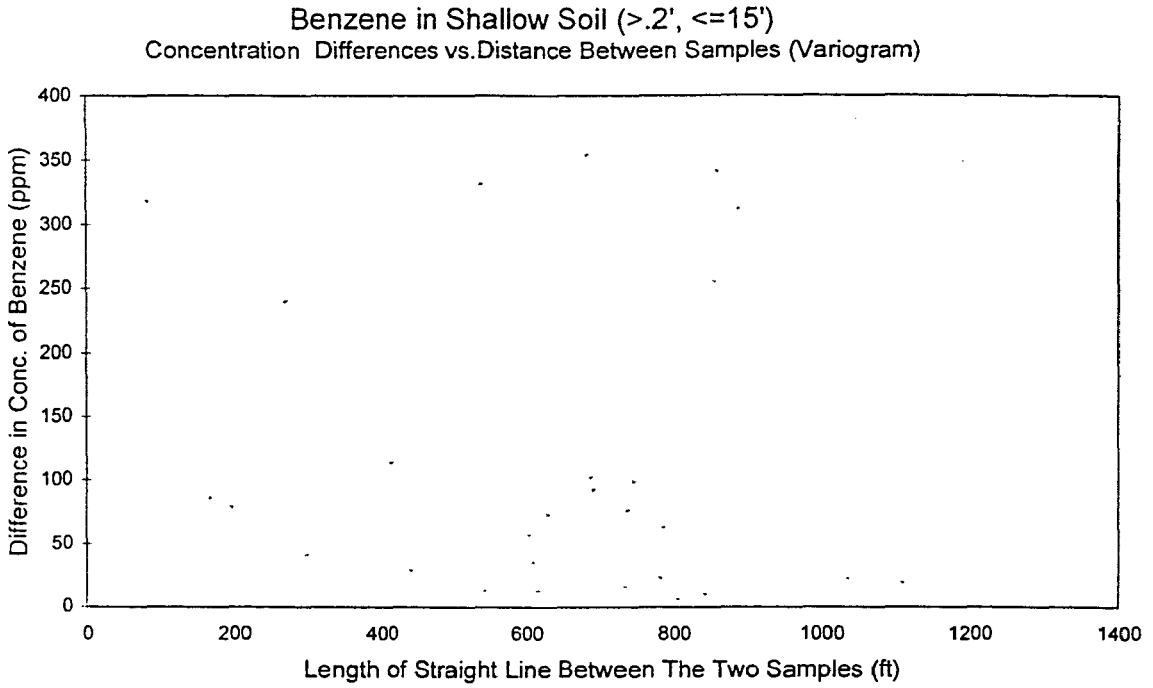
Figure 26.

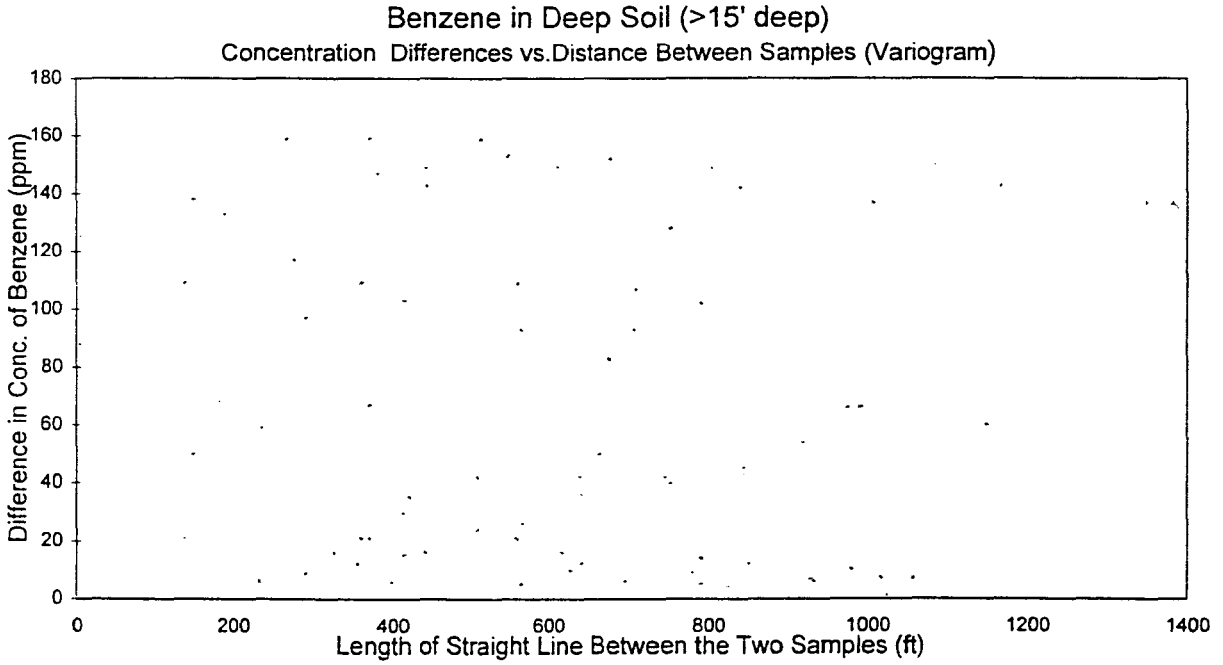




concs and variogram 98.xls

Figure 27.





concs and variogram 98.xls

Figure 28.

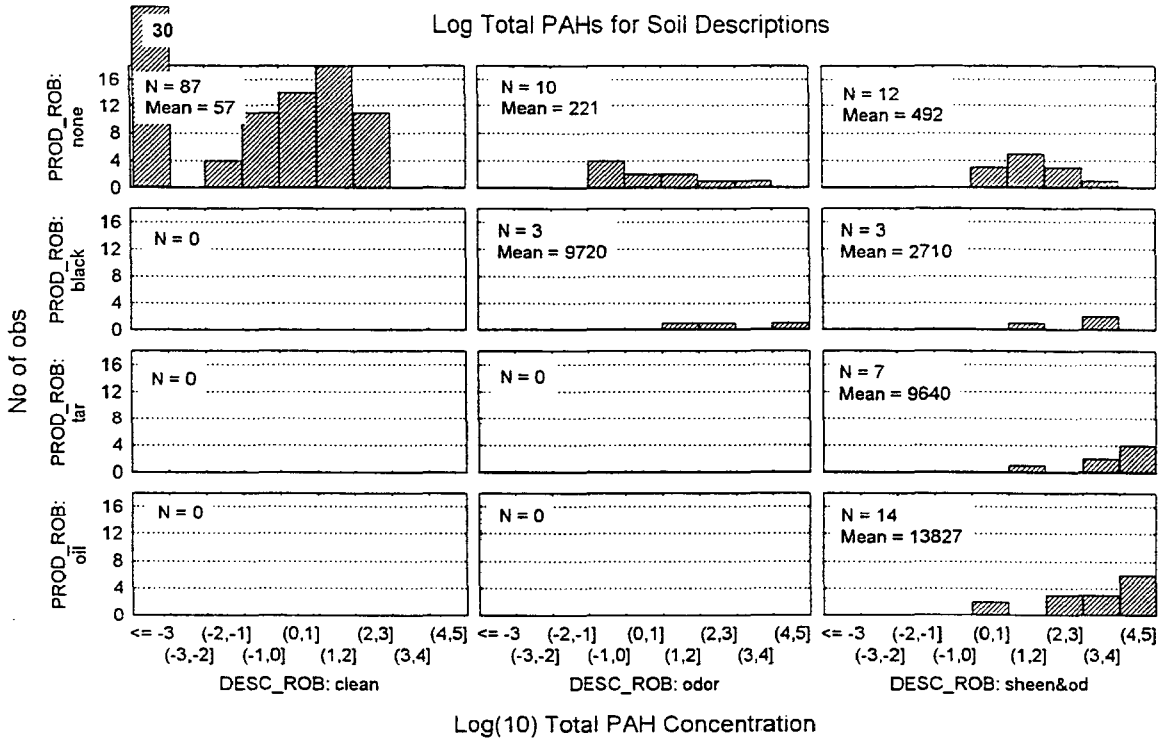

Log Total PAHs for Soil Descriptions
No of obs
PROD_ROB: none
PROD_ROB: black
PROD_ROB: tar
PROD_ROB: oil
N = 87
Mean = 57
N = 10
Mean = 221
N = 12
Mean = 492
N = 0
N = 3
Mean = 9720
N = 3
Mean = 2710
N = 0
N = 0
N = 7
Mean = 9640
N = 0
N = 0
N = 14
Mean = 13827
<= -3
(-3,-2]
(-2,-1]
(-1,0]
(0,1]
(1,2]
(2,3]
(3,4]
(4,5]
DESC_ROB: clean
DESC_ROB: odor
DESC_ROB: sheen&od
Log(10) Total PAH Concentration

Figure 29.

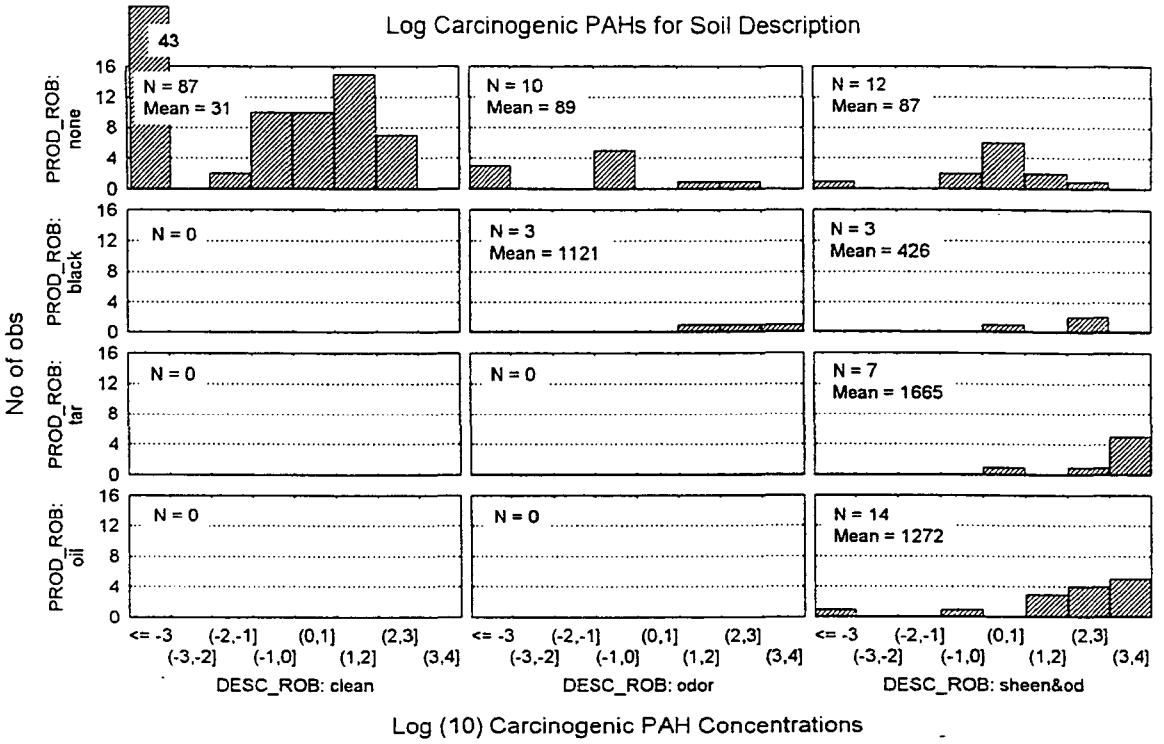

Log Carcinogenic PAHs for Soil Description
No of obs
PROD_ROB: none
PROD_ROB: black
PROD_ROB: tar
PROD_ROB: oil
43
N = 87
Mean = 31
N = 10
Mean = 89
N = 12
Mean = 87
N = 0
N = 3
Mean = 1121
N = 3
Mean = 426
N = 0
N = 0
N = 7
Mean = 1665
N = 0
N = 0
N = 14
Mean = 1272
0
4
8
12
16
<= -3
(-3,-2]
(-2,-1]
(-1,0]
(0,1]
(1,2]
(2,3]
(3,4]
DESC_ROB: clean
DESC_ROB: odor
DESC_ROB: sheen&od
Log (10) Carcinogenic PAH Concentrations

Figure 30.

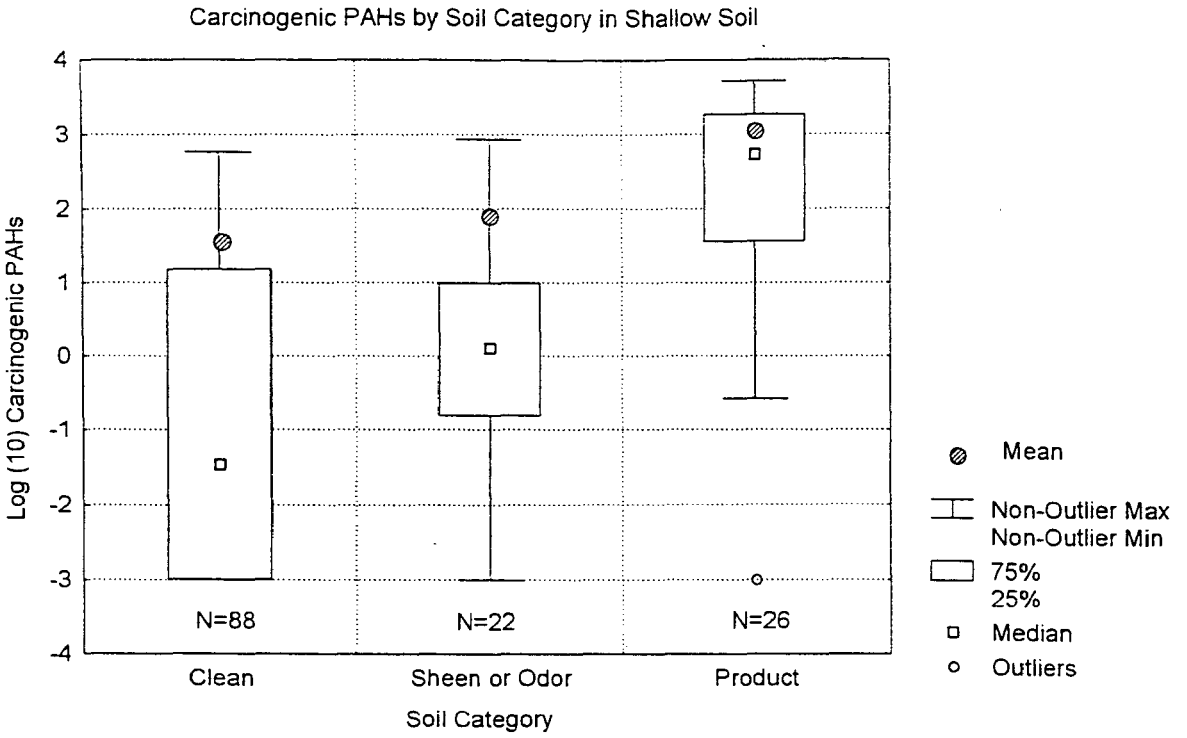

Carcinogenic PAHs by Soil Category in Shallow Soil
Log (10) Carcinogenic PAHs
4
3
2
1
0
-1
-2
-3
-4
N=88
N=22
N=26
Clean
Sheen or Odor
Product
Soil Category
Mean
Non-Outlier Max
Non-Outlier Min
75%
25%
Median
Outliers

Figure 31.

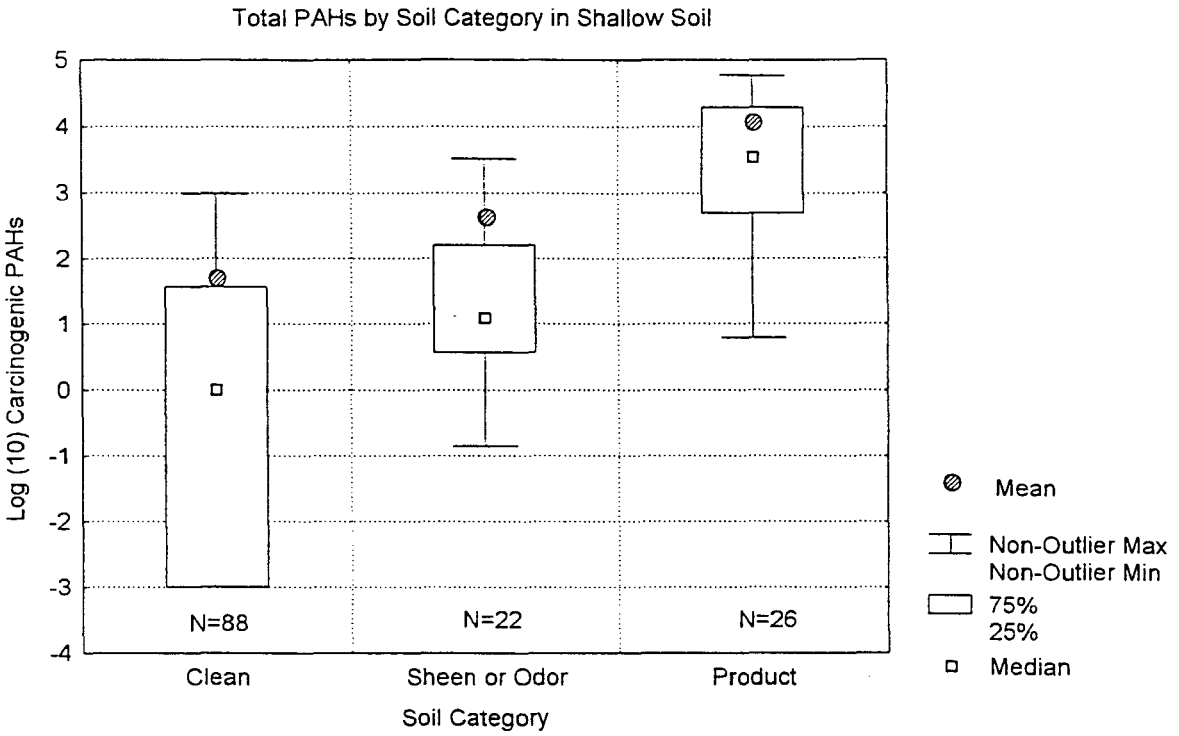

Total PAHs by Soil Category in Shallow Soil
Log (10) Carcinogenic PAHs
5
4
3
2
1
0
-1
-2
-3
-4
N=88
N=22
N=26
Clean
Sheen or Odor
Product
Soil Category
Mean
Non-Outlier Max
Non-Outlier Min
75%
25%
Median

Figure 32.

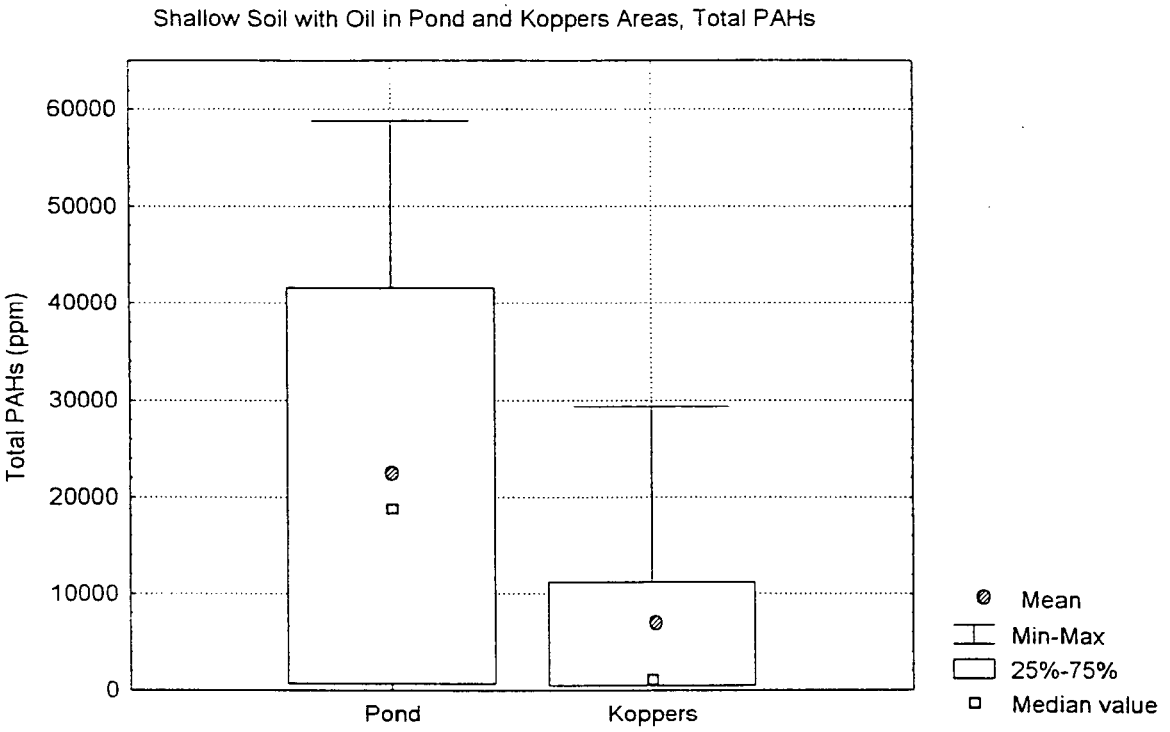

Shallow Soil with Oil in Pond and Koppers Areas, Total PAHs
Total PAHs (ppm)
60000
50000
40000
30000
20000
10000
0
Pond
Koppers
Mean
Min-Max
25%-75%
Median value

Figure 33.

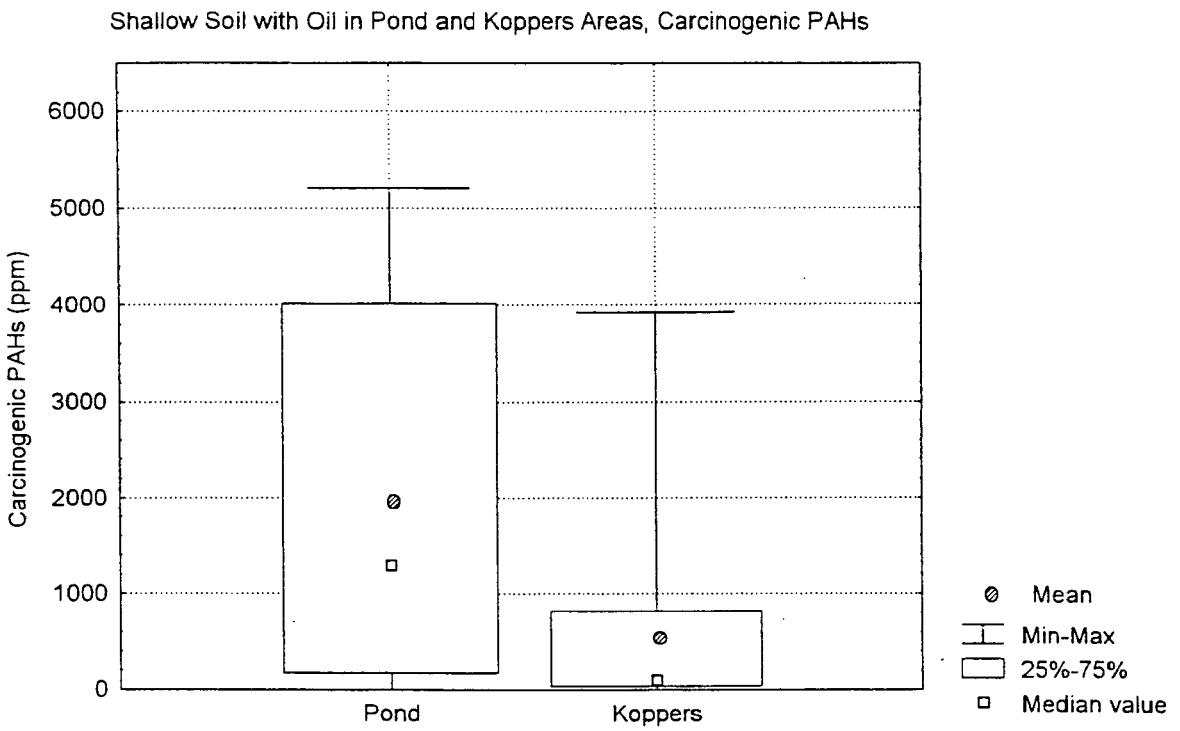

Shallow Soil with Oil in Pond and Koppers Areas, Carcinogenic PAHs
Carcinogenic PAHs (ppm)
6000
5000
4000
3000
2000
1000
0
Pond
Koppers
Mean
Min-Max
25%-75%
Median value

Figure 34.

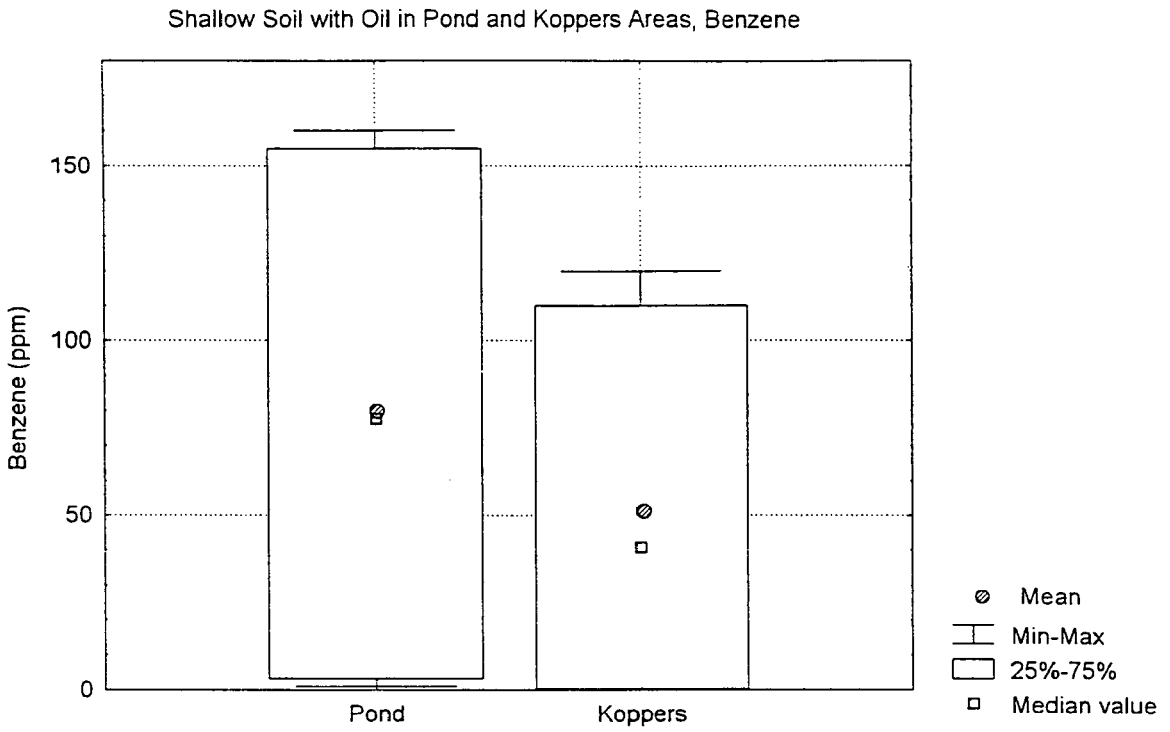

Shallow Soil with Oil in Pond and Koppers Areas, Benzene
Benzene (ppm)
150
100
50
0
Pond
Koppers
Mean
Min-Max
25%-75%
Median value

Figure 35.

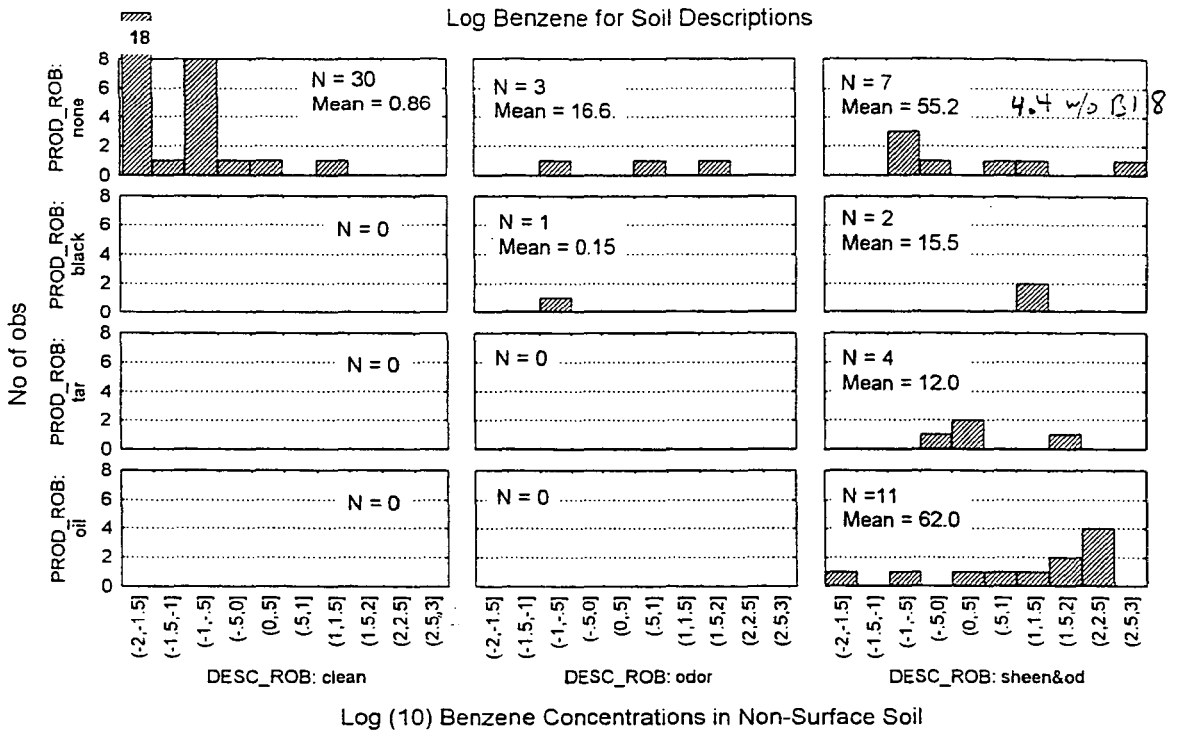
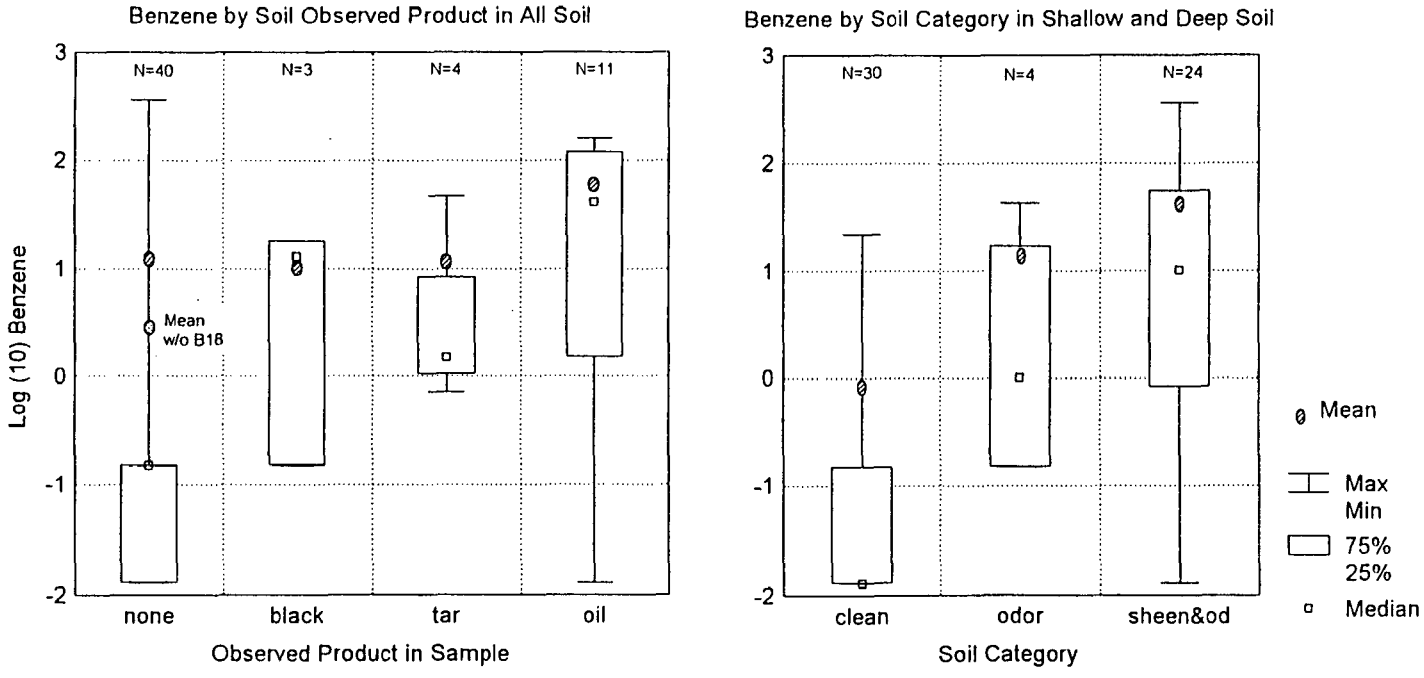

Log Benzene for Soil Descriptions
18
PROD_ROB: none
PROD_ROB: black
PROD_ROB: tar
PROD_ROB: oil
No of obs
N = 30
Mean = 0.86
N = 3
Mean = 16.6.
N = 7
Mean = 55.2
4.4 w/o 18
N = 0
N = 1
Mean = 0.15
N = 2
Mean = 15.5
N = 0
N = 0
N = 4
Mean = 12.0
N = 0
N = 0
N =11
Mean = 62.0
(-2,-1.5]
(-1.5,-1]
(-1,-.5]
(-.5,0]
(0,.5]
(.5,1]
(1,1.5]
(1.5,2]
(2,2.5]
(2.5,3]
DESC_ROB: clean
DESC_ROB: odor
DESC_ROB: sheen&od
Log (10) Benzene Concentrations in Non-Surface Soil

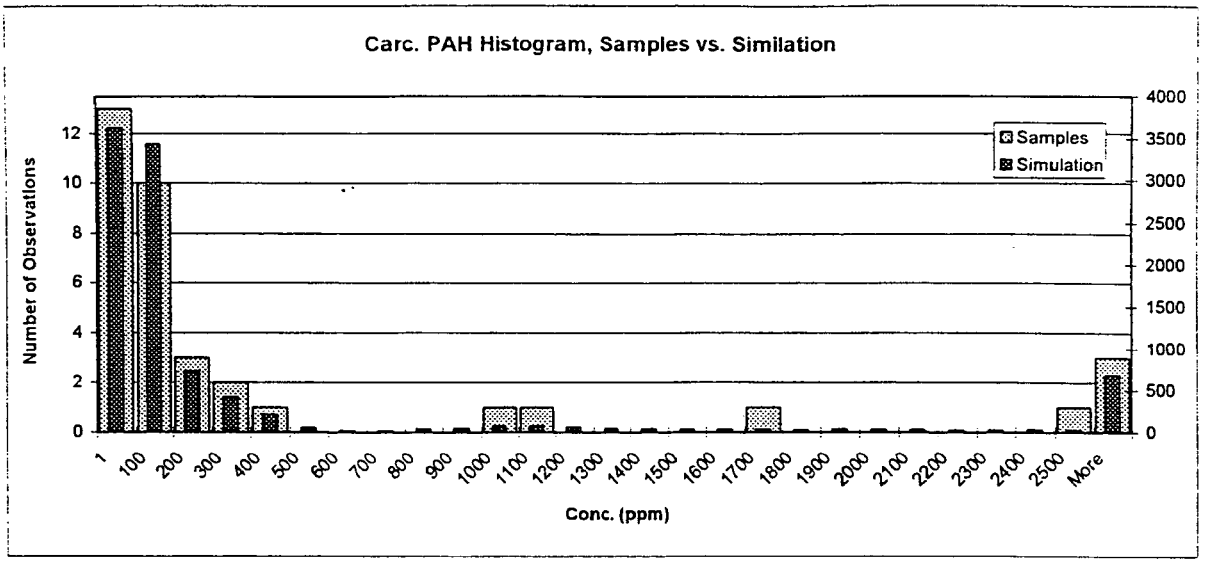
Figure 36.

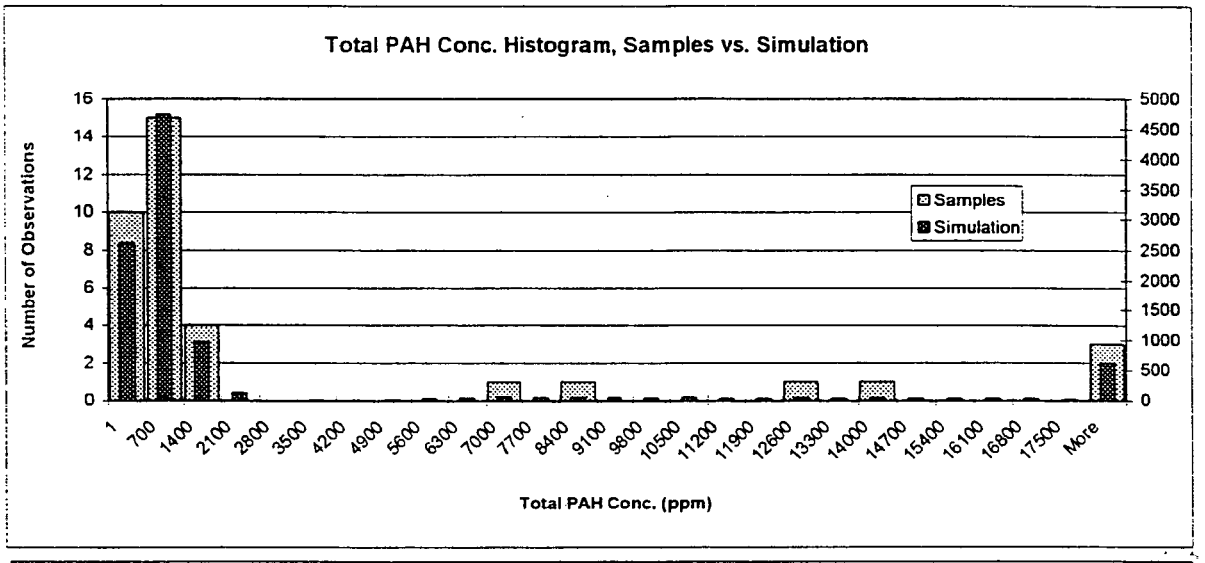
Benzene Concentrations by Soil Description, Shallow and Deep Soil

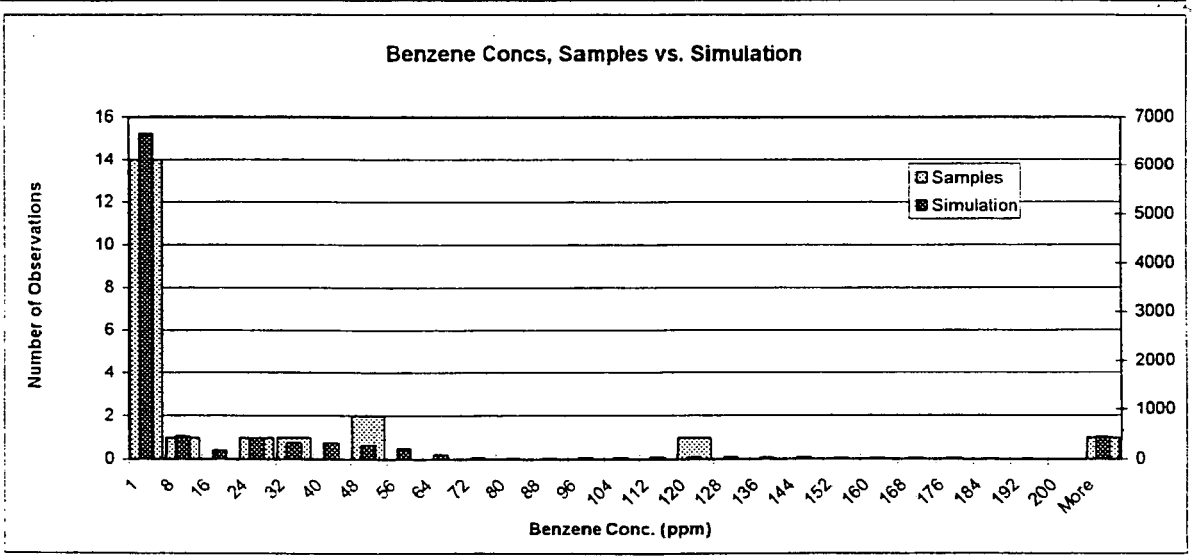


Koppers022522

Figure 37.







Distributions of Conc's for Samples and Simulation Based on Soil Descriptions

Simulate 98

Figure 38.

Frequency of Samples by Soil Description and Total Amount of Soil in Each Description

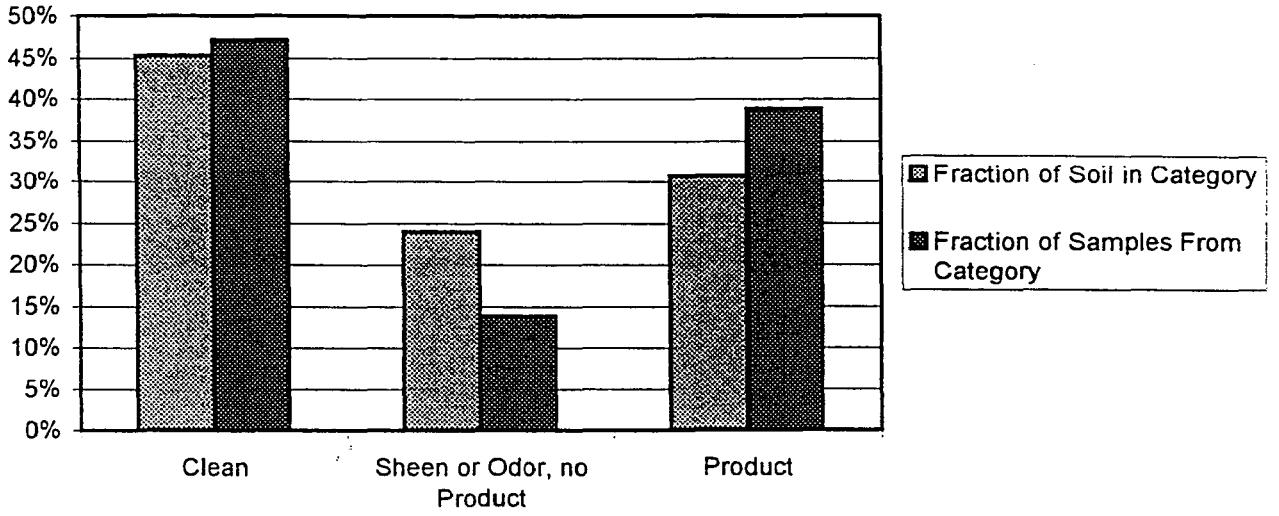


Figure 39.

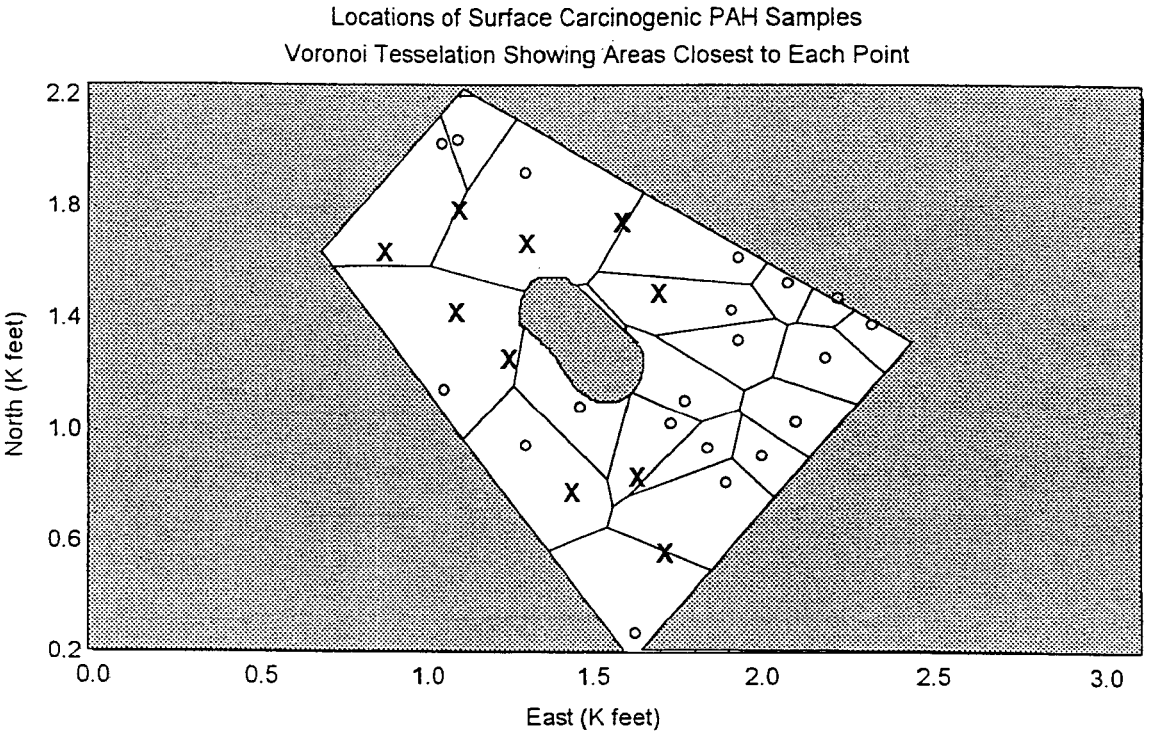

Locations of Surface Carcinogenic PAH Samples
Voronoi Tesselation Showing Areas Closest to Each Point
North (K feet)
East (K feet)
2.2
1.8
1.4
1.0
0.6
0.2
0.0
0.5
1.0
1.5
2.0
2.5
3.0

Figure 40.

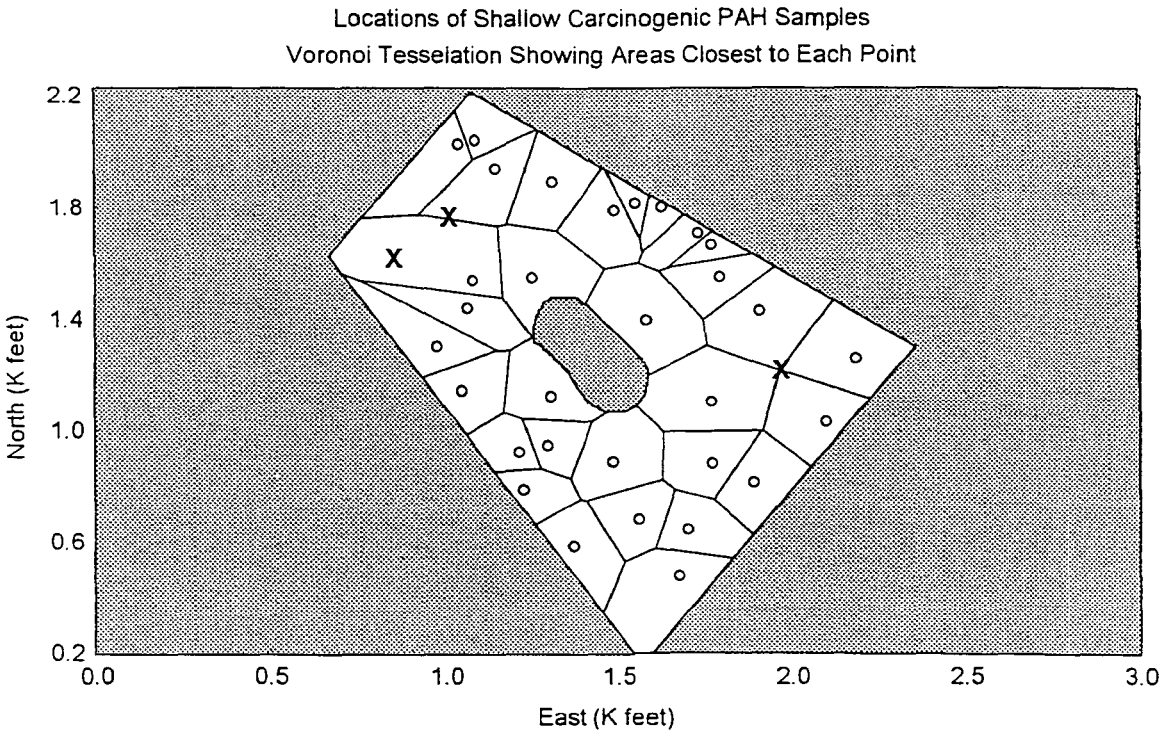

Locations of Shallow Carcinogenic PAH Samples
Voronoi Tesselation Showing Areas Closest to Each Point
North (K feet)
East (K feet)
2.2
1.8
1.4
1.0
0.6
0.2
0.0
0.5
1.0
1.5
2.0
2.5
3.0

Figure 41.

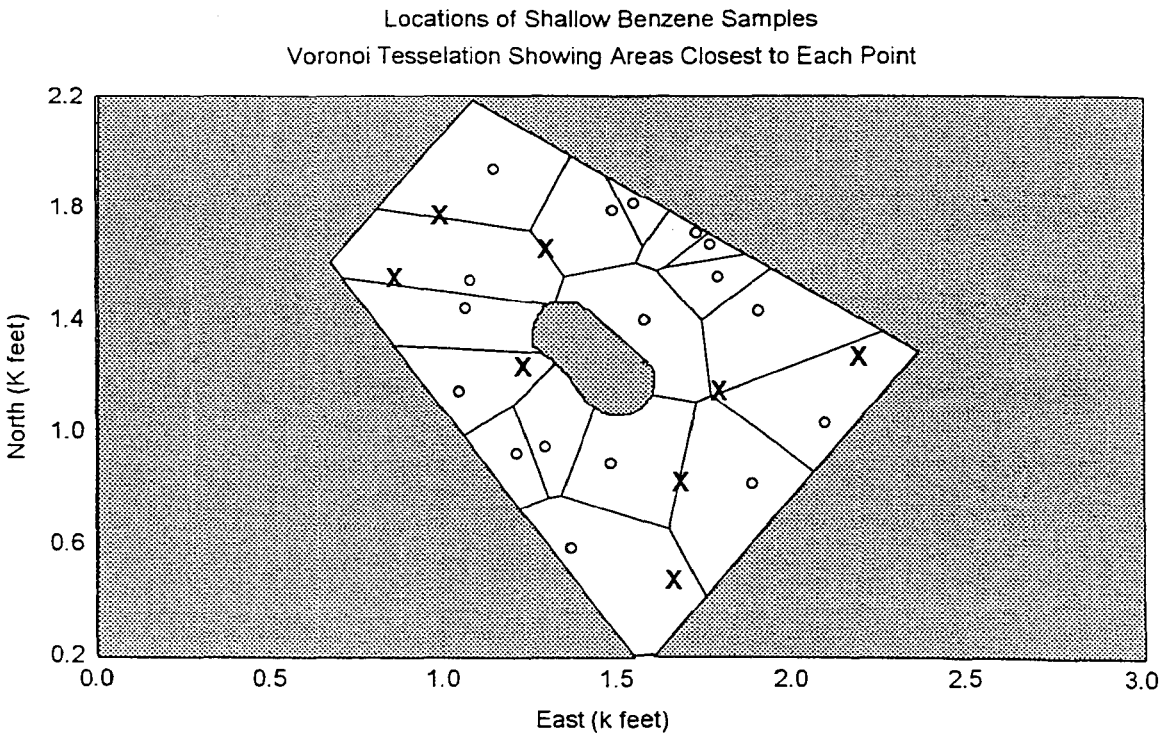
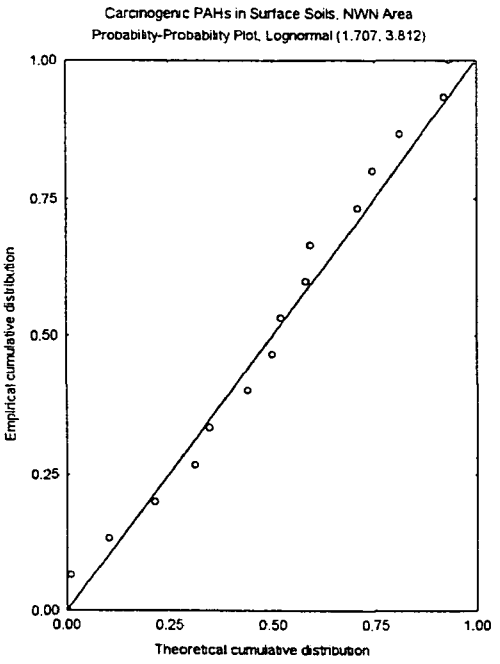

Locations of Shallow Benzene Samples
Voronoi Tesselation Showing Areas Closest to Each Point
North (K feet)
East (k feet)
2.2
1.8
1.4
1.0
0.6
0.2
0.0
0.5
1.0
1.5
2.0
2.5
3.0

Figure 42.


Carcinogenic PAHs in Surface Soils, NWN Area
Probability-Probability Plot, Lognormal (1.707, 3.812)
Empirical cumulative distribution
Theoretical cumulative distribution
0.00
0.25
0.50
0.75
1.00

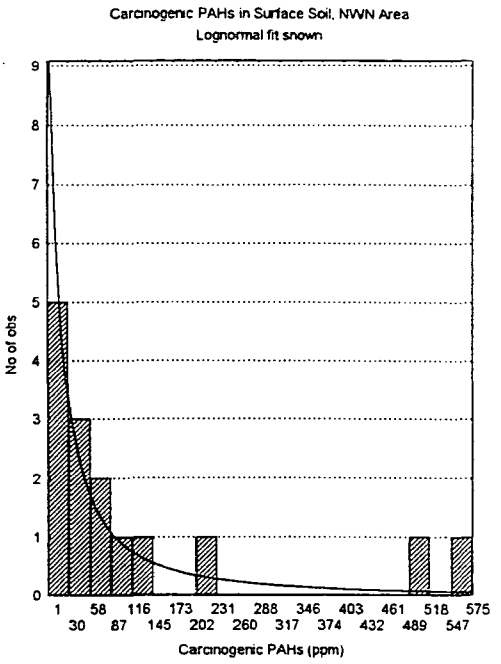
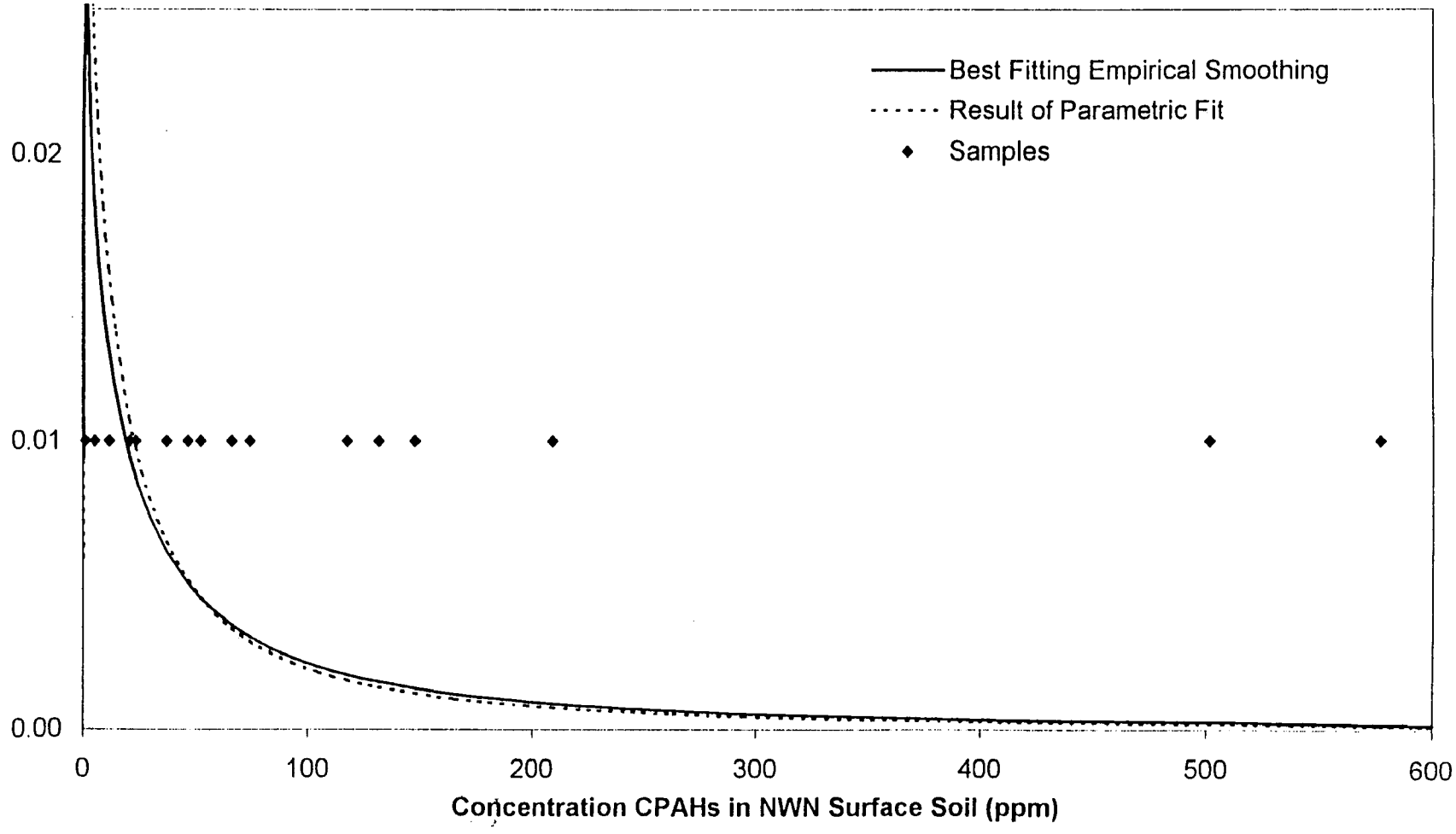

Carcinogenic PAHs in Surface Soil, NWN Area
Lognormal fit shown
No of obs
Carcinogenic PAHs (ppm)
0
1
2
3
4
5
6
7
8
9
1
30
58
87
116
145
173
202
231
260
288
317
346
374
403
432
461
489
518
547
575

Figure 43.

Probability Distribution Fits for Surface CPAHs in NWN Area

Best Fits Using Empirical Smoothing (solid) and Parametric (dotted)



Koppers022529

APPENDIX A

Soil Boring Logs

Koppers022530

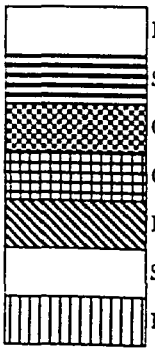
KEY TO BORING LOGS

Soil classification in this report is based upon visual and manual field observations which include moisture, consistency, plasticity and grading estimates and should not be construed to imply field or laboratory testing unless presented herein. Soils are classified in accordance with the Unified Soil Classification System. Stratigraphic boundaries are approximate representations only. No warranty is provided as to the continuity of soil strata between borings.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COURSE GRAINED SOILS	GRAVELS More Than Half the Course Fraction is Larger Than No. 4 Sieve Size	Clean Gravels With Little or No Fines	GW	Well Graded Gravels, Gravel-Sand Mixtures
			GP	Poorly Graded Gravels, Gravel-Sand Mixtures
		Gravels With Over 12% Fines	GM	Silty Gravels, Poorly Graded Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Poorly Graded Gravel-Sand-Clay Mixtures
More Than Half is Larger Than #200 Sieve	SANDS More Than Half the Course Fraction is Smaller Than No. 4 Sieve Size	Clean Sands With Little or No Fines	SW	Well Graded Sands, Gravelly Sands
			SP	Poorly Graded Sands, Gravelly Sands
		Sands With Over 12% Fines	SM	Silty Sands, Poorly Graded Sand-Silt Mixtures
			SC	Clayey Sands, Poorly Graded Sand-Clay Mixtures
FINE GRAINED SOILS	SILTS AND CLAYS Liquid Limit Less Than 50%		ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands, or Clayey Silts with Slight Plasticity
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL	Organic Clays and Organic Silty Clays of Low Plasticity
More Than Half is Smaller Than #200 Sieve	SILTS AND CLAYS Liquid Limit Greater Than 50%		MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic Silts
			CH	Inorganic Clays of High Plasticity, Fat Clays
			OH	Organic Clays of Medium to High Plasticity, Organic Silts
HIGHLY ORGANIC SOILS			Pt	Peat and Other Highly Organic Soils

LEGEND FOR BORING LOGS



ABBREVIATIONS

NA	Not Applicable
ND	Not Detected Above Detection Limit
NS	Not Sampled
PAH	Polynuclear Aromatic Hydrocarbons
ppm	Parts Per Million
SPT	Standard Penetration Test
▽	Measured Static Water Level in Well
▼	Estimated Water Level During Drilling

Updated: 7/2/98 RBE
File: Boring Log Key

HAHN AND ASSOCIATES, INC.

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-1**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	3" OD Split Spoon/4" OD Core Barrel	13:55	15:35
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/21/95	9/21/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
	B1-01	13:45	5.6	13					SM	Silty SAND with some Gravel - brown, dry (surface sample)
	B1-02 Dup	13:50	Dup	56			1			
					50/5"	90	2		GP	Sandy GRAVEL - brown, dry, very dense
							3			
							4			
	B1-03	14:05	8.2	-	21	100				
					10	10	5		ML	Sandy SILT - brown to yellow, moist, very stiff, slightly plastic, no hydrocarbon odor, no sheen
					14	0				
							6			
					9	100	7			Sandy SILT - brown to yellow, moist, stiff, slightly plastic, slight hydrocarbon odor, no sheen
	B1-04	14:10		-	6	100				
			4.7		5	60	8			
							9	9/21/95		Concrete encountered at 8.5 to 10 feet bgs.
							10			
3/4" Bentonite Chips					2	100			SM	Silty SAND with Gravel - wet, medium dense, very strong hydrocarbon odor, sheen, hard black material (lampblack?) from 11 to 11.5 feet bgs
	B1-05	14:30		1,280	27	100	11			
			44.6		38	50				
					2	100	12			
	B1-06	14:35		-	6	100				Silty GRAVEL - olive gray, wet, dense, strong hydrocarbon odor, no sheen
			26.5		28	100	13			
							14		GM	
					16	0				
					22	0	15			
					25	0				
							16			
					4	100	17			
	B1-07	14:50	16.8	-	40	60				SAND - black, wet, medium dense, poorly graded, strong hydrocarbon odor, no sheen, appears to be saturated with oily substance
					4	0	18		SP	
							19			
					6	100				
	B1-08	14:57	22.3	-	6	100	20			

Koppers022532

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-1**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 13:55	DRILL FINISH Time: 15:35
	SAMPLING METHOD:	3" OD Split Spoon/4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/21/95	Date: 9/21/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	30.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips					6	40	21		SP	SAND - black, wet, dense, strong hydrocarbon odor, wood fragments present at sand-silt boundary
	B1-09	15:20	21				22			Continuous core barrel sampling device used to collect soil samples from 20.5 to 24.5 feet bgs
			24.6				23		ML	
	B1-10	15:30	20.6	-			24			SILT with some Sand - olive gray, wet, slightly plastic, mild petroleum hydrocarbon odor, no sheen
							25			
							26			Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen at 20 to 23 feet bgs. Purged twelve gallons of water using a peristaltic pump prior to groundwater sampling. GROUNDWATER SAMPLE (2708-950921-BW1-01) collected at 17:30 hrs, 9/21/95. Well point was removed prior to abandonment.
							27			
							28			
							29			Drilled to 25 feet bgs Sampled to 24.5 feet bgs
							30			
							31			* Sample Number Prefix is 2708-950921-
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022533

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER**	**B-2**		
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 8:50	DRILL FINISH Time: 10:15
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/27/95	Date: 9/27/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.3 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B2-01	8:50	4.7	-	1	SM	Silty SAND with Gravel - brown, moist, organic matter (surface sample)
					2		
					3		
					4		Silty SAND with some Gravel - green to gray, moist, no sheen, organic matter (pieces of wood)
	B2-02	9:05	5.5	-	5		
					6		
	B2-03	9:10	3.9	-	7		Silty SAND with some Gravel - green to gray, mottled, slight hydrocarbon odor, slight sheen, tar (pieces of asphalt)
					8	SM	
					9		
					10		
					11	GM	Sandy GRAVEL with Silt - moist, no sheen, large pieces of brick, possible pieces of lampblack (hydrophobic material)
					12		
					13		
					14		
	B2-04	9:25	2.5	-	15	SP	SAND - brown, moist, poorly graded, medium grained, moderate hydrocarbon odor, no sheen
					16		SAND - black, moist, moderate hydrocarbon odor, no sheen, hydrophobic black powder is present, thin layer of silt at 15.5 feet bgs (15-17 feet bgs)
	B2-05	9:35	2.2	-	17		
	B2-06	9:38	2.7	-	18		
					19	SP	SAND - gray to green, moist, no sheen, black powder is no longer present in sample (17-17.5 feet bgs)
					20		

GROUNDWATER: 9/27/95

Koppers022534

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-2**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	4" OD Core Barrel	Time:	Time:
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	8:50	10:15
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/27/95	9/27/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.3 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B2-07	9:42	5.9	-			21		SP	SAND - gray to green, wet, poorly graded, medium grained, strong hydrocarbon odor, no sheen, (20-22 feet bgs)
							22			
							23			SAND - as above, no hydrocarbon odor, no sheen (22-24 feet bgs)
	B2-08	9:50	3.1	-			24			
							25		SP	Heaving sands encountered at 25 feet bgs - re-drill out hole to remove.
							26			
	B2-09	10:10	3.2	-			27			SAND - gray to green, wet, poorly graded, medium grained, no hydrocarbon odor, no sheen
							28			
							29			Drilled to 27.5 feet bgs Sampled to 27 feet bgs
							30			
							31			* Sample Number Prefix is 2708-950927-
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022535

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-3**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	Split Spoon	Time: 10:30	Time: 12:30
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/21/95	Date: 9/21/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B3-01	10:30		-					GP	Sandy GRAVEL - dry, road fill (surface sample)
			2.4				1			
							2		SP	
					10	100				
	B3-02	10:35		-	12	100	3			SAND with some Gravel - brown, moist, medium dense, poorly graded, fine to medium grained, no hydrocarbon odor, no sheen
			7.0		17	100				
							4			
					9	100	5			
	B3-03	10:40	7.4	-	10	70				SAND with some Gravel - brown, moist, medium dense, poorly graded, slight hydrocarbon odor, no sheen
					17	0	6			
							7		SP	
					10	100				
	B3-04	10:45		-	18	100	8			SAND - brown with gray mottling, moist, medium dense, slight hydrocarbon odor, no sheen
					18	0				
							9			
					12	100	10			
					21	100				SAND - brown, moist, medium dense, fine grained black sand at lower 4 inches of sample, black material has hydrocarbon odor and is hydrophobic (lampblack)
	B3-05	11:00	8.3	49	34	60	11			
							12		SP	
	B3-06	11:10	4.0	-	44	60				SAND - brown, moist, dense, large piece of wood stained black stuck in end of spoon - sands directly surrounding wood are coated black, slight hydrocarbon odor, no sheen
					27	0	13			
					34	0				
							14			
					13	100	15			
	B3-07	11:20		ND	16	100				SAND - brown, dry, medium dense, poorly graded, no hydrocarbon odor, no sheen
			8.0		13	100	16			
							17		SP	
					4	100				
	B3-08	11:30		-	9	100	18	9/21/95		SAND - green to gray, moist to wet, stiff, poorly graded, moderate hydrocarbon odor, no sheen
			5.3		9	100				
							19			
					14	100	20			

Koppers022536

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-3**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708	HAI LOGGER:	Rob Ede	DRILL START Time: 10:30 Date: 9/21/95	DRILL FINISH Time: 12:30 Date: 9/21/95
	SAMPLING METHOD:	Split Spoon		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James		
	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
	B3-09	11:40		-	17	100				SAND - green to gray, wet, medium dense, poorly graded, strong hydrocarbon odor, no sheen
			2.0		17	50	21			
							22		SP	
3/4" Bentonite Chips					3	100				SAND - green to gray, wet, medium dense, poorly graded, strong hydrocarbon odor, no sheen, Clayey SILT in bottom 6 inches of core
	B3-10	12:00		-	12	100	23			
			22.0		14	100				
							24			
					4	100	25			
	B3-11	12:05		-	6	100				Clayey SILT, green to gray, wet, loose, plastic, strong hydrocarbon odor, no sheen
			29.1		10	100	26		ML	
							27			
					4	100				SAND - green to gray, wet, stiff, poorly graded, fine grained, slight hydrocarbon odor, no sheen
	B3-12	12:24		-	5	100	28		SP	
			4.5		5	100				
							29			
							30			
							31			Drilled to 28.5 feet bgs Sampled to 28.5 feet bgs
							32			* Sample Number Prefix is 2708-950921-
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

Koppers022537

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-4**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 8:20	DRILL FINISH Time: 9:40
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/21/95	Date: 9/21/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B4-01	8:15	0.3	-			1		GP	Sandy GRAVEL - dry, roadbed material (surface sample)
							2			
							3		SP	
	B4-02	8:30		-			4			SAND with some Gravel - brown, dry, non-plastic, poorly graded, no hydrocarbon odor, no sheen
			8.9				5			
							6			
							7			
	B4-03	8:40		-			8			SAND with some Gravel - as above
			7.1				9		SP	
							10			
							11			
	B4-04	8:55		-			12			SAND with some Gravel - as above, moist
			7.7				13			
							14		SP	
							15			
							16			
	B4-05	9:05		-			17			SAND with some Gravel - as above
			15.0				18			
							19	9/21/95	SP	
							20			

Koppers022538

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-4**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 8:20	DRILL FINISH Time: 9:40
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/21/95	Date: 9/21/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B4-06	9:15	5.3	-			21		SP	SAND with some Gravel - as above, moist to wet
							22			
							23			
							24		SP	
							25			
							26			
	B4-07	9:25	2.5	-			27			SAND with some Gravel - as above, green to gray, wet, (25-27 feet bgs)
							28		ML	
	B4-08	9:30	2.0	-			29			Clayey SILT - gray, moist, stiff, plastic, no hydrocarbon odor, no sheen (27-30 feet bgs)
							30			
							31			
							32			Drilled to 30 feet bgs Sampled to 29.5 feet bgs
							33			
							34			* Sample Number Prefix is 2708-950921-
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022539

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-5**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill	13:35	14:50
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/28/95	9/28/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B5-01	13:30	1.4	-			1		SP	Silty SAND with some Gravel - brown, wet, no hydrocarbon odor, no sheen, (surface)
							2			
							3			SAND with some Gravel - brown, slightly moist, loose, non-plastic, poorly graded, medium grained, no hydrocarbon odor, no sheen
	B5-02	13:40	3.9	-			4			
							5			
							6			
	B5-03	13:50	3.3	-			7			SAND with some Gravel - as above, moist
							8			
							9		SP	
							10			
							11			
							12			
	B5-04	14:00	3.8	-			13			SAND with some Gravel - as above, moist
							14		SP	
							15			
	B5-05	14:08	4.3	3.6			16			SAND with some Gravel - as above, hydrocarbon odor, (15-17 feet bgs)
							17			
	B5-06	14:10	4.9	-			18		ML	SILT - green to gray, moist, hydrocarbon odor, sheen, wood fragments, (17-17.5 feet bgs)
	B5-07	14:12	3.6	-			19	9/28/95	SP	SAND - green to gray, moist, loose, slight hydrocarbon odor, no sheen, (17.5-19 feet bgs)
							20			

Koppers022540

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-5**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 13:35	DRILL FINISH Time: 14:50
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/28/95	Date: 9/28/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							21		SP	
							22			
	B5-08	14:15	3.5	-			23			SAND - green to gray, wet, loose, medium grained, no hydrocarbon odor, no sheen
							24			
							25			
							26		SP	Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen at 25 to 28 feet bgs. Purged 5 gallons of water using a peristaltic pump prior to groundwater sampling. GROUNDWATER SAMPLE (2708-950929-BW5-01) collected at 8:00 hrs, 9/28/95. Well point was removed prior to abandonment.
							27			
	B5-09	14:35	3.5	-			28			SAND - as above, alternating thin sand and silt beds in 4 inch layer above massive silt
							29		ML	
	B5-10	14:40	3.1	-			30			SILT with some Clay - green to gray, moist, stiff, plastic, no hydrocarbon odor, no sheen
							31			
							32			Drilled to 30 feet bgs Sampled to 30 feet bgs
							33			
							34			* Sample Number Prefix is 2708-950928-
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022541

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-6**			
PROJECT:	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
Northwest Natural Gas Co.	SAMPLING METHOD:	3"OD Split Spoon/4" OD Core Barrel	Time:	Time:
Gasco Facility	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	11:15	12:35
Portland, Oregon	EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
PROJECT #: 2708	DRILLER:	Brad James	9/27/95	9/27/95
	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.7 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	Recovery (%) or Sample Interval	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Concrete							1		GP	GRAVEL - old pavement at surface
							2		SP	SAND - brown, slightly moist, medium dense, poorly graded, fine to medium grained, no hydrocarbon odor, no sheen, (2.5-3 feet bgs)
					15	100	3			
	B6-01	11:20		-	30	100				Sandy GRAVEL - black, dense, pieces of lampblack (hydrophobic in water), no hydrocarbon odor, no sheen, (3-4 feet bgs)
			4.8		24	50	4			
							5		GP	
					9	10				Sandy GRAVEL - gray, moist, loose, no hydrocarbon odor, no sheen
					4	0	6			
					2	0				
							7			
					13	100	8		SP	
	B6-02	11:30	38.5	12,487	12	50				SAND with Gravel and Brick - black, moist, medium dense, grains stuck together by tarry substance, strong hydrocarbon odor, strong sheen
					10	0	9			
							10			
					7	10				Large Rock in end of sampler - blue matrix, concoidal fracture, specimen retained
					11	0	11			
					13	0				
							12		SP	
					5	50	13			Weathered Brick in end of tube - moist, stiff, no hydrocarbon odor, no sheen
					5	0				
					5	0	14			
							15			
					6	100				SAND - brown, slightly moist, loose, fine to medium grained, gravels from 16-16.5 feet bgs, no hydrocarbon odor, no sheen
	B6-03	12:00		87	16	100	16			
			8.0		9	80				
							17		SP	
							18			
	B6-04	12:10		-						SAND - as above, no gravel
			7.2				19			
3/4" Bentonite Chips							20	9/27/95		

Koppers022542

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-6**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	3"OD Split Spoon/4" OD Core Barrel	Time: 11:15	Time: 12:35
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/27/95	Date: 9/27/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.7 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	Recovery (%) or Sample Interval	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							21		SP	
	B6-05	12:20	9.4	-			22			SAND - green to gray, wet, poorly graded, fine to medium graded, no hydrocarbon odor, no sheen
							23			
	B6-06	12:25	8.3	-			24		ML	Sandy SILT - green to gray, stiff, slightly plastic, slight organic odor (anaerobic degradation), no sheen, sand content decreasing with depth
							25			
							26			
	B6-07	12:30	9.2	-			27			Sandy SILT - green to gray, wet, slightly plastic, no hydrocarbon odor, no sheen
							28		ML	
	B6-08	12:35	9.8	-			29			
							30			
							31			Drilled to 30 feet bgs Sampled to 29.5 feet bgs
							32			* Sample Number Prefix is 2708-950927-
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022543

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-7**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	3" OD Split Spoon/4"OD Core Barrel	13:30	14:30
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/27/95	9/27/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT(blows/6 in) or Core Interval	RECOVERY (%) or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Concrete							1		Concrete	
							2		SP	
					4	100	3			
	B7-01	13:35		-	6	100				SAND - brown, slightly moist, loose, poorly graded, fine to medium grained, no hydrocarbon odor, no sheen
			3.9		5	100	4			
							5			
					5	100				
	B7-02	13:45		-	5	100	6			SAND - as above
			5.0		5	100				
							7			
							8		SP	
	B7-03	13:50								SAND - as above, some pebbles, moist, no hydrocarbon odor, slight sheen
			4.6				9			
3/4" Bentonite Chips							10			
							11			
							12			
	B7-04	13:55		-						SAND - as above, moist, no hydrocarbon odor, slight sheen
			6.0				13			
							14			
							15			
							16		SP	
							17			
	B7-05	14:02		ND						SAND - as above, moist, no hydrocarbon odor, no sheen
			7.7				18			
							19			
							20			

Koppers022544

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-7**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	3" OD Split Spoon/4"OD Core Barrel	13:30	14:30
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/27/95	9/27/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT(blows/6 in) or Core Interval	RECOVERY (%) or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B7-06	14:10	8.4	-			21	9/27/95	SP	SAND - brown, wet, poorly graded, medium grained, slight hydrocarbon odor, no sheen, (20-21 feet bgs)
							22			
	B7-07	14:12	6.6	-			23			SAND - green to gray, wet, poorly graded, medium grained, no hydrocarbon odor, no sheen, (21-25 feet bgs)
							24			
							25			
							26		SP	
							27			
	B7-08	14:20	5.2	-			28			SAND - as above
							29		ML	
	B7-09	14:30	6.4	-			30			SILT - green to gray, moist, stiff, plastic, no hydrocarbon odor, no sheen, some brown organic matter
							31			
							32			Drilled to 30 feet bgs Sampled to 29.5 feet bgs
							33			* Sample Number Prefix is 2708-950927-
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022545

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-8**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	1.5" / 3" OD Split Spoon	9:30	12:10
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/18/95	9/18/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	23.0
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							1			
							2		GM	
					5	100	3			Silty GRAVEL - brown, moist, loose, non-plastic, slightly graded, no hydrocarbon odor or discoloration, spotty sheen
	B8-01	9:35	9.3	-	6	50				
					8	0	4			
							5			
	B8-02	9:42		-	4	100				Silty GRAVEL - brown, dry, loose, non-plastic, slightly graded, no hydrocarbon odor or discoloration, spotty sheen
			-		7	0	6			
					9	0			GM	
							7			
	B8-03	9:44	-	-	9	70	8			Silty GRAVEL - as above, wet, medium dense
					18	0				
					23	0	9			
							10			
3/4" Bentonite Chips	B8-04	9:50		338	17	100			GM	Sandy GRAVEL - brown, moist, medium dense, non-plastic, poorly graded, no hydrocarbon odor, no sheen, large pieces of slag in sampling tube
			7.5		23	20	11			
					17	0		9/18/95		
							12			
	B8-05	10:00	8.0	-	11	100	13	▼		
	B8-06 Dup	10:02			10	20				SAND - gray, wet, medium dense, non-plastic, poorly graded, fine grained, mild hydrocarbon odor, no sheen
					8	0	14			
							15			Note: Change to 1.5" Split Spoon sampling device
					3	100			SP	
	B8-07	10:05		-	4	100	16			SAND - gray, wet, loose, non-plastic, poorly graded, medium grained, mild hydrocarbon odor, no sheen
			7.3		6	50				
							17			
					3	100	18			
	B8-08	10:15		0.24	3	100				Sandy SILT - gray, wet, soft, slightly plastic, no hydrocarbon odor, no sheen
			6.5		3	100	19		ML	
							20			

Koppers022546

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER**	**B-8**		
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT:	SAMPLING METHOD:	1.5" / 3" OD Split Spoon		
Northwest Natural Gas Co.	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	Time:	Time:
Gasco Facility	EQUIPMENT TYPE	B-59 Mobile Drill	9:30	12:10
Portland, Oregon	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/18/95	9/18/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	23.0
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
					1	100				SAND - gray, wet, very loose, non-plastic, poorly graded, moderate petroleum hydrocarbon odor, slight sheen
3/4" Bentonite Chips	B8-09	10:20		-	1	100	21			
			6.1		2	100			SP	
							22			
					2	100	23			
					2	100				Silty SAND - dark gray, wet, very loose, non-plastic, poorly graded, fine grained, mild petroleum hydrocarbon odor
	B8-10	11:45	5.1	-	4	100	24		SM	
							25			
					1	100				
					2	100	26			Silty SAND - as above
	B8-11	12:00	4.1	-	3	100				
							27			Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen at 20.5 to 23.5 feet bgs. Purged two gallons of water using a peristaltic pump prior to groundwater sampling. GROUNDWATER SAMPLE (2708-950918-BW8-01) collected at 11:30 hrs, 9/18/95. Well point was removed prior to abandonment.
							28			
							29			
							30			Drilled to 26.5 feet bgs Sampled to 26.5 feet bgs
							31			
							32			* Sample Number Prefix is 2708-950918-
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022547

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-9**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 14:50	DRILL FINISH Time: 16:40
	SAMPLING METHOD:	1.5" OD Split Spoon/4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/18/95	Date: 9/18/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	31.6 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY (%) or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							1			
							2		SP	
							3			See boring log B-9A for 0 to 5 foot soil description.
							4			
							5			
	B9-01	14:50		-	8	100				SAND with some Gravel - black, dry, medium dense, very strong petroleum hydrocarbon odor, all pores filled with tar-like substance throughout
			8:10		10	20	6			
					11	0				
							7			
					18	10	8			
					33	0				SAND with some Gravel - as above, dense, large piece of gravel in end of sampler
3/4" Bentonite Chips					21	0	9		SP	
							10			
	B9-02	15:00	897	19,438	18	100				SAND with some Gravel - as above, moist, dense
					13	0	11			
					23	0				
							12			
	B9-03	15:10	278.0	-	16	100	13			Silty SAND with some Gravel - brown, moist, medium dense, poorly graded, strong petroleum hydrocarbon odor, some tar-like blebs
					6	0				
					17	0	14			
									SM	
							15			
	B9-04	15:20	118	-	4	100				Silty SAND with Gravel - brown with black mottles, dry, medium dense, tar-like substance mottled throughout, strong petroleum hydrocarbon odor
					7	0	16			
					11	0				
							17			
	B9-05	15:30	211	-	13	100	18			SAND with some Gravel - black, very dense, possible lampblack
					50?3"	5		9/18/95	SP	
							19			
	B9-06	15:40	363	-	3	100	20	▼		

Koppers022548

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-9**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 14:50	DRILL FINISH Time: 16:40
	SAMPLING METHOD:	1.5" OD Split Spoon/4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/18/95	Date: 9/18/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	31.6 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY (%) or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips					4	0			SP	SAND - black, wet, very loose, poorly graded, fine to medium grained, slight petroleum hydrocarbon odor
					4	0	21			
							22			
					2	100				SAND with some Gravel - black, wet, very loose, slightly graded, medium grained, strong petroleum hydrocarbon odor, strong sheen
	B9-07	1	100	-	3	100	23			
					6	100				
							24			
							25			
							26			
							27			
							28		SM	
	B9-08	16:10	504	-			29			Silty SAND - gray to black, wet, mild petroleum hydrocarbon odor, sheen
							30			
	B9-09	16:20	33.1	43.5			31			Silty SAND - dark gray, wet, poorly sorted, petroleum hydrocarbon odor, slight sheen
							32			
							33		SP	
							34			
	B9-10	16:21	9.1	0.46			35			SAND - green to gray, wet, poorly graded, fine grained, no petroleum hydrocarbon odor, no sheen
							36			
							37			Drilled to 35 feet bgs Sampled to 35 feet bgs
							38			* Sample Number Prefix is 2708-950918-
							39			
							40			

Koppers022549

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-9A**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 14:00	DRILL FINISH Time: 14:20
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/18/95	Date: 9/18/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	31.6 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
Bentonite Chips	B9A-01	14:00		-	1	SP	Gravelly SAND - black, dry, strong petroleum hydrocarbon odor, saturated with tar-like substance throughout
	B9A-02	14:02	614	-	2		
	B9A-03	14:05	274	-	3		
					4		Note: Stopped drilling at 14:20 due to lack of soil recovery from 5 to 15 feet bgs. Relocate to boring B-9.
					5		
					6		
					7		Drilled to 15 feet bgs Sampled to 3 feet bgs
					8		*Sample prefix is 2708-950918-
					9		
					10		
					11		
					12		
					13		
					14		
					15		
					16		
					17		
					18		
					19		
					20		

Koppers022550

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-10**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4" OD Core Barrel	11:50	12:50
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/25/95	9/25/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.2 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							1			
							2		SP	
							3			
	B10-01	12:10	-				4			SAND - brown, dry, poorly graded, medium grained, no hydrocarbon odor, no sheen
			102.0				5			
							6			
							7			
	B10-02	12:20	-				8		SP	SAND with some Pebbles - brown, moist, poorly graded, medium grained, no hydrocarbon odor, no sheen
			164.0				9			
							10			
							11			
							12			
	B10-03	12:30	-				13		SP	SAND - brown, slightly moist, poorly graded, medium grained, no hydrocarbon odor, no sheen, slight froth via sheen test
			165.0				14			
							15			
							16			
							17			SAND - brown, moist, poorly graded, medium grained, no hydrocarbon odor, no sheen
	B10-04	12:40		ND			18		SP	
			127.0				19			
							20			

Koppers022551

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	SOIL BORING NUMBER B-10			
PROJECT:	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
Northwest Natural Gas Co.	SAMPLING METHOD:	4" OD Core Barrel	Time:	Time:
Gasco Facility	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	11:50	12:50
Portland, Oregon	EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
PROJECT #: 2708	DRILLER:	Brad James	9/25/95	9/25/95
	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.2 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							21	9/25/95	SP	
							22			
	B10-05	12:50	-				23			SAND - green to gray, wet, poorly graded, medium grained, no hydrocarbon odor, no sheen
			167.0				24			
							25			
							26			Drilled to 25 feet bgs Sampled to 24 feet bgs
							27			* Sample Number Prefix is 2708-950925-
							28			
							29			
							30			
							31			
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022552

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-11**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	3" OD Split Spoon/4" OD Core Barrel	10:30	11:40
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/28/95	9/28/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B11-01	10:30	9.2	-			1		SP	Silty SAND with Gravel - brown, moist, no hydrocarbon odor, no sheen
							2			
					8	100	3			
	B11-01	10:40	7.2	-	15 18	100 70	4			SAND - brown, slightly moist, medium dense, poorly graded, medium grained, no hydrocarbon odor, no sheen
							5			
					8	100				
	B11-03	10:42	20	-	13 13	100 95	6 7		SP	SAND - dark gray, moist, medium dense, poorly graded, medium grained, hydrocarbon odor, sheen
	B11-04	10:45	21.6	-			8			SAND - dark gray, moist, loose, poorly graded, medium grained, hydrocarbon odor, sheen
							9			
	B11-05	10:48	119	-			10			SAND - as above, gray to black, strong hydrocarbon odor, strong sheen
							11			
							12		SP	
	B11-06	10:55	260	973			13			SAND - as above, strong hydrocarbon odor, strong sheen
							14			
							15			
							16			
							17		SP	
							18			
	B11-07	11:00	97	-			19	9/28/95		SAND - as above, moist to wet, strong hydrocarbon odor, strong sheen, brown product and froth formed when water was added to sample
							20			

Koppers022553

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-11**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 10:30	DRILL FINISH Time: 11:40
	SAMPLING METHOD:	3" OD Split Spoon/4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/28/95	Date: 9/28/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							21		SP	
	B11-08	11:10	17.1	-			22			SAND - as above, wet, (froth no longer present)
							23			
	B11-09	11:15	2.1	1.1			24			SAND - as above, no hydrocarbon odor, no sheen
							25			
							26		SP	
	B11-10	11:20	0.4	-			27			SAND - as above, hydrocarbon odor and sheen from 25' to 27' bgs
							28			
	B11-11	11:25	0.7	-			29			SAND - as above, no hydrocarbon odor, no sheen
	B11-12	11:30	0.5	-			30			SILT - green to gray, moist, stiff, no hydrocarbon odor, no sheen
							31		ML	
	B11-13	11:40	0	-			32			SILT - as above
							33			
							34			Drilled to 32 feet bgs Sampled to 32 feet bgs
							35			* Sample Number Prefix is 2708-950921-
							36			
							37			
							38			
							39			
							40			

Koppers022554

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-13**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 12:10	DRILL FINISH Time: 13:00
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/6/95	Date: 10/6/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.4 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B13-01	12:15	285.0	-			1-5		SP	SAND - brown, moist, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen
							6-7			
	B13-02	12:27	300.0	-			8-10		SP	SAND - olive gray, moist to wet, saturated with hydrocarbon product, strong sheen throughout core
	B13-03	12:33	368.0	29,378			11			SAND - black, wet, loose, saturated with hydrocarbon product, wood fragments at sand/silt interface
							12		ML	Sandy SILT - olive gray, moist, hydrocarbon odor, slight sheen, roots present, (11-11.5 feet bgs)
	B13-04	12:37	226.0	-						
	B13-05 Dup	12:39	203.0	-			13-15		SP	SAND - olive gray, moist, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen
	B13-06	12:44	552.0	-			16-18		ML	SILT - green with brown mottling, orange spots present throughout, stiff, black oily tar fingering through via root zones
	B13-07	12:50	124.0	ND			19-20			SILT - as above, black tar fingers not present, no sheen

Koppers022555

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-13**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4" OD Core Barrel	12:10	13:00
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	10/6/95	10/6/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.4 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips					21	10/6/95	ML	SILT - brown, moist, stiff, slightly plastic, no hydrocarbon odor, no sheen
					22		SP	SAND - brown, wet, poorly graded, no hydrocarbon odor, no sheen
					23		ML	SILT - brown, moist, stiff, slightly plastic, no hydrocarbon odor, no sheen
	B13-08	12:55	124.0	-	24			
	B13-09 Dup	12:58	98.1	-				
	B13-10	13:00	112.0	ND	25		SP	SAND - brown, wet, loose, poorly graded, fine grained, ho hydrocarbon odor, no sheen
					26			
					27			Drilled to 25 feet bgs Sampled to 24.5 feet bgs
					28			* Sample Number Prefix is 2708-951006-
					29			
					30			
					31			
					32			
					33			
					34			
					35			
					36			
					37			
					38			
					39			
					40			

Koppers022556

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-14**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 8:25	DRILL FINISH Time: 9:30
	SAMPLING METHOD:	3" OD Split Spoon/4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/28/95	Date: 9/28/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B14-01	8:20	4.6	-			1		SM	Silty SAND with Gravel - brown, moist (surface sample)
							2			
					11	100				
	B14-02	8:30		-	23	100	3		SP	Silty SAND with Gravel - olive gray, moist, dense, hydrocarbon odor, sheen
			8.4		35	90				
							4			
					5	100	5		ML	Sandy SILT - brown, moist, stiff, slightly plastic, no hydrocarbon odor, no sheen
	B14-03	8:35		ND	8	100				
			3.0		13	95	6			
							7			
					6	100			SP	SAND - olive gray, moist, loose, poorly graded, fine grained, no hydrocarbon odor, no sheen
	B14-04	8:40		-	6	100	8			
			3.4		7	90				
							9			
							10			
										SAND - as above, (10-11 feet bgs)
	B14-05	9:00		-			11			
			4.1						ML	SILT - brown, moist, stiff, slightly plastic, no hydrocarbon odor, no sheen, (11-12 feet bgs)
							12			
									SP	SAND - olive gray, moist, medium dense, poorly graded, fine grained, no hydrocarbon odor, no sheen, (12-13 feet bgs)
							13			
	B14-06	9:05		-						SILT - brown, moist, very stiff, slightly plastic, no hydrocarbon odor, no sheen
			4.6				14			
							15	9/28/95	ML	
	B14-07	9:20		-			16			Sandy SILT - brown and tan mottled, moist, no hydrocarbon odor, no sheen, (piece of bark present)
			3.7							
							17		SP	SAND with some Silt - brown, wet, medium dense, poorly graded, fine grained, no hydrocarbon odor, no sheen (16.5-17.5 feet bgs)
	B14-08	9:25		-						
			4.8				18		ML	SILT - brown, moist, stiff, no hydrocarbon odor, no sheen, (17.5-18 feet bgs)
	B14-09	9:30		-					SP	
			4.9				19			SAND - brown, wet, poorly graded, fine grained, no hydrocarbon odor, no sheen, (18-19 feet bgs)
							20			

Koppers022557

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	SOIL BORING NUMBER B-14			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 8:25	DRILL FINISH Time: 9:30
	SAMPLING METHOD:	3" OD Split Spoon/4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/28/95	Date: 9/28/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							21			Drilled to 20 feet bgs Sampled to 19 feet bgs * Sample Number Prefix is 2708-950928-
							22			
							23			
							24			
							25			
							26			
							27			
							28			
							29			
							30			
							31			
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

Koppers022558

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-15**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 13:45	DRILL FINISH Time: 15:05
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/6/95	Date: 10/6/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.5 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							1		SP	SAND - brown, moist, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen, (2.5-5 feet bgs)
							2			
							3		SP	
							4			
	B15-01	13:57	97.0	-			5			
							6		SM	Silty SAND with Gravel - olive gray, moist, hydrocarbon odor, sheen, (5-6 feet bgs - brick in end of sampler) (Switch to 1.5" OD Split Spoon sampling device)
							7			
					50/5"	60	8			Silty SAND - olive gray, moist, hydrocarbon odor, sheen, (7.5-8 feet bgs - wood fragment in end of sampler)
							9			
							10			(Switch back to 4" OD Core Barrel sampling device)
							11		ML	
	B15-02	14:17	21.1	-			12			SILT - green, moist, firm, no hydrocarbon odor, no sheen, rootlets throughout, (10-15 feet bgs)
							13			
	B15-03	14:20	59.9	-			14			
							15			
							16	10/6/95		SILT - as above (15-15.5 feet bgs)
							17			Sandy SILT - green with black patches of hydrocarbon product, moist, hydrocarbon odor, sheen, (15.5-17.5 feet bgs)
	B15-04	14:25	83.1	-			18		ML	SILT - wet, soft, saturated with product (17.5-18.5 feet bgs)
							19			SILT - green, hydrocarbon odor, sheen, (18.5-20 feet bgs)
							20			

Koppers022559

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-15**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill	13:45	15:05
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	10/6/95	10/6/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.5 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							21		ML	SILT - green, moist, firm, hydrocarbon odor, no sheen, (20-21 feet bgs
	B15-05	14:33	97.6	638			22		SM	Silty SAND - olive gray, wet, poorly graded, fine grained, hydrocarbon odor, sheen, (21-21.5 feet bgs)
							23		ML	SILT - brown and olive mottled, fingers of black oily substance in rootlet zones, (21.5-25 feet bgs)
	B15-06	14:38	-	-			24			
							25			SAND - olive gray, wet, loose, no hydrocarbon odor, no sheen, (25-27 feet bgs)
	B15-07	14:57	15.8	-			26		SM	Sandy SILT - olive gray, moist, stiff, hydrocarbon odor, no sheen, (27-27.5 feet bgs)
	B15-08	15:00	13.6	1.8			27		ML	SAND - olive gray, wet, loose, fine grained, no hydrocarbon odor, no sheen, (27.5-29 feet bgs)
							28		SP	SILT - brown, moist no hydrocarbon odor, no sheen, (29-29.5 feet bgs)
							29			SAND - brown, wet, loose, fine grained, no hydrocarbon odor, no sheen, (29.5-30 feet bgs)
	B15-09	15:04	31.3	-			30		ML SP	
							31			
							32			
							33			Drilled to 30 feet bgs Sampled to 30 feet bgs
							34			
							35			* Sample Number Prefix is 2708-951006-
							36			
							37			
							38			
							39			
							40			

Koppers022560

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-17**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 9:55	DRILL FINISH Time: 10:40
	SAMPLING METHOD:	1.5" OD Split Spoon/4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/29/95	Date: 9/29/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							1			Surface - GRAVEL fill (surface)
							2		SM	
					2	100	3			Silty SAND - brown, moist, no sheen
	B17-01	10:00		59	2	100				
			421		2	90	4			
							5		ML	
							6			Sandy SILT - olive gray, moist, firm, no sheen
	B17-02	10:10		-						
			603				7			
							8			
	B17-03	10:12		-			9			SAND - olive gray, moist, poorly graded, medium grained, no sheen
			213				10			
							11		SP	SAND - olive gray, poorly graded, strong sheen, brown product and froth when water added to sample, some wood fragments
	B17-04	10:20		-						
			1409				12			
							13			
							14			
							15			
							16		SP	
	B17-05	10:30		1,814			17			SAND - as above, wet, saturated with brown, oily product
			1478				18			
							19	9/29/95		
							20			

Koppers022561

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-17**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708	HAI LOGGER:	Rob Ede	DRILL START Time: 9:55	DRILL FINISH Time: 10:40
	SAMPLING METHOD:	1.5" OD Split Spoon/4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/29/95	Date: 9/29/95
	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							21		SP	SAND - as above, wet, contains brown product, strong sheen, many roots at sand/silt interface
	B17-06	10:35	145	-			22			
							23		ML	SILT - olive gray, moist, very stiff, no hydrocarbon odor, no sheen, some brown root casts
	B17-07	10:40	65.8	0.89			24			
							25			
							26			Drilled to 25 feet bgs Sampled to 24 feet bgs
							27			
							28			* Sample Number Prefix is 2708-950929-
							29			
							30			
							31			
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022562

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-18**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	Split Spoon	10:05	11:45
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/19/95	9/19/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.4 feet MSL
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							1			Sandy GRAVEL - dry, road fill (surface)
							2			
	B18-01	10:15	74	-	50/5"	80	3		ML	Sandy SILT - brown and olive gray, moist, hard, slightly plastic, slight sheen
							4			
					8	100				SILT - brown, gray mottling, moist, stiff, plastic, no sheen
	B18-02	10:20	1772	-	11	100	5			
					14	100				
							6			
							7			
					4	100			SM	Silty SAND with Clay - brown, moist, loose, plastic, slight sheen
	B18-03	10:30		-	7	100				
			2500		8	50	8			
							9			
3/4" Bentonite Chips					4	100				
	B18-04	10:35		-	4	100	10			Sandy SILT with some Clay - brown, moist, medium stiff, poorly graded, slightly plastic, slight sheen
			2500+		6	100				
							11		ML	
							12			
					2	100				Sandy SILT - as above
	B18-05	10:40		59.3	5	100				
			2500+		6	100	13			
							14	9/19/95		
					2	100				SAND - brown, wet, very loose, poorly graded, fine grained, sheen observed on surface of core
	B18-06	10:50		-	2	100	15	▼		
			2500+		4	100				
							16			
							17		SP	
					4	100				
	B18-07	11:00		-	5	100				SAND - as above
			2500+		5	100	18			
							19			
					4	100				SAND - olive gray, wet, loose, poorly graded, slight sheen on core
	B18-08	11:05		-	6	100	20			

Koppers022563

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-18**		
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER: Rob Ede SAMPLING METHOD: Split Spoon DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger EQUIPMENT TYPE B-59 Mobile Drill DRILLER: Brad James	DRILL START Time: 10:05 Date: 9/19/95	DRILL FINISH Time: 11:45 Date: 9/19/95
PROJECT #: 2708	DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.		

BORING DIAMETER: 8-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 36.4 feet MSL
TOP OF CASING ELEVATION: Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips			224		7	100	21		SP	SAND - as above, no sheen
					3	100	22			
	B18-09	11:10		-	8	100				
			2500+		12	100	23			
							24			
					7	100				SAND - as above
	B18-10	11:30		ND	17	100	25			
			14.4		14	100				
							26		SP	
					12	100	27			SAND - as above
	B18-11	11:40			21	100				
			24.0		16	100	28			
							29			Drilled to 28 feet bgs Sampled to 28 feet bgs
							30			
							31			* Sample Number Prefix is 2708-950919-
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022564

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-19**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708	HAI LOGGER: Rob Ede SAMPLING METHOD: 4" OD Core Barrel DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger EQUIPMENT TYPE B-59 Mobile Drill DRILLER: Brad James DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.	DRILL START Time: 13:30 Date: 9/19/95	DRILL FINISH Time: 9:30 Date: 9/20/95

BORING DIAMETER: 8-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 35.4
TOP OF CASING ELEVATION: Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B19-01	13:10	34.0	933	1	ML	Sandy SILT - brown, dry, (surface - just below sod root zone)
					2		
					3	SP	
					4		
	B19-02	13:40	382.0	-	5		SAND - black, moist, well graded, fine grained, grains appear to be coated with oily substance, sheen evident
					6		
	B19-03	13:55	623.0	408	7		SAND - as above
					8		
					9		Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen at 10 to 13 feet bgs. Purged zero gallons of water prior to groundwater sampling. GROUNDWATER SAMPLE (2708-950920-BW19-01) collected at 8:15 hrs, 9/20/95. Well point was removed and drilling was resumed.
					10		
					11	ML	Clayey SILT - brown, dry, very stiff, slight sheen
					12		
	B19-04	14:10	2500+	-	13		
					14	SP	SAND - black, moist to wet, poorly graded, sheen
	B19-05	14:20	2500+	-	15		
					16		
	B19-06	14:30	2500+	-	17		SILT - brown, dry, stiff, no sheen
					18	ML	
	B19-07	8:50	2500+	80	19		Sandy SILT - olive gray, moist, poorly graded, fine grained, no sheen
					20		

GROUNDWATER: 9/20/95

Koppers022565

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-19**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4" OD Core Barrel	13:30	9:30
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/19/95	9/20/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.4
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							21		ML	Sandy SILT - as above, wet
							22			
							23			
							24			
							25			Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen at 25 to 28 feet bgs. Purged eight gallons of water using a peristaltic pump prior to groundwater sampling. GROUNDWATER SAMPLE (2708-950920-BW19-02) collected at 12:05 hrs, 9/20/95. Well point was removed prior to abandonment.
							26		SP	
							27			Silty SAND - brown, wet, poorly graded, fine grained, coarsening downward
	B19-08	9:22	717.0	2.0			28			
							29			
							30			
							31			Drilled to 29 feet bgs Sampled to 29 feet bgs
							32			
							33			* Sample Number Prefix is 2708-950919- for samples B19-01 to B19-06. Sample Number Prefix is 2708-950920- for samples B19-07 and B19-08.
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022566

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-20**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 14:00	DRILL FINISH Time: 15:00
	SAMPLING METHOD:	1.5" OD Split Spoon/4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/29/95	Date: 9/29/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION	
Asphalt							1		Asphalt	Asphalt (surface)	
							2		SP		
					5	100	3				
	B20-01	14:05		-	5	100				SAND - brown, moist, loose, poorly graded, no sheen	
			355		5	50	4				
							5				
							6			SAND - as above, large rock in sand at depth of 7.5 feet bgs	
							7				
	B20-02	14:10		-			8		SP		
			1166				9			SAND - olive gray, moist, poorly graded, medium grained, no sheen	
3/4" Bentonite Chips							10				
										SAND - gray, wet, poorly graded, saturated with hydrocarbon product, metallic sheen, (10-11 feet bgs)	
	B20-03	14:15		1,093			11				
			2500+				12			SAND - brown, moist, poorly graded, fine grained, no product saturation, sheen is present, (11-13 feet bgs)	
	B20-04	14:20		-							
			2500+				13				
							14				
							15				
							16		SP		
							17	9/29/95		SAND - olive gray, moist to wet, sheen	
	B20-05	14:25		-			18				
			1270				19				
							20				

Koppers022567

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-20**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	1.5" OD Split Spoon/4" OD Core Barrel	Time: 14:00	Time: 15:00
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/29/95	Date: 9/29/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.4 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							21		SP	SAND - brown to metallic gray, wet, strong sheen
							22			
	B20-06	14:30	2500+	-			23		ML	SILT - brown, very stiff, brown pockets of organic material
	B20-07	14:35	1010	13			24			
							25			
							26			Drilled to 25 feet bgs Sampled to 24 feet bgs
							27			
							28			* Sample Number Prefix is 2708-950929-
							29			
							30			
							31			
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022568

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-21**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 8:50	DRILL FINISH Time: 9:40
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/3/95	Date: 10/3/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	38.0
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B21-01	9:00	3.4	-			1-5		ML	SILT - brown and green mottled, slightly moist, stiff, roots present, slight sheen
	B21-02	9:05	2.3	-			6-8		ML	SILT - as above, moist
	B21-03	9:10	1.7	-			9-10		SP	Silty SAND -brown, moist to wet, medium dense, poorly graded, fine grained, no sheen
	B21-04	9:15	34.2	-			11-12	10/3/95	ML	Sandy SILT - brown with olive gray mottling, moist, firm, slight sheen
	B21-05	9:20	23.2	-			13		SP	SAND - brown, wet, loose, poorly graded, fine grained, no sheen
							14-15		SM	Silty SAND - brown, moist, medium dense, fine grained, no sheen
	B21-06	9:30	1.5	-			16-17		SP	SAND - brown, wet, loose, poorly graded, fine grained, no sheen
	B21-07	9:35	1.5	-			18-20		SP	Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen from 15.5 to 19.5 feet bgs. Purged five gallons of water using a peristaltic pump prior to groundwater sampling. GROUNDWATER SAMPLE (2708-951003-BW21-01) collected at 10:48 hrs, 10/3/95. Well point was removed prior to abandonment.

Koppers022569

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	SOIL BORING NUMBER B-21			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	4" OD Core Barrel	Time:	Time:
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	8:50	9:40
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	10/3/95	10/3/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							21			Drilled to 30 feet bgs Sampled to 29.5 feet bgs * Sample Number Prefix is 2708-951003-
							22			
							23			
							24			
							25			
							26			
							27			
							28			
							29			
							30			
							31			
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	38.0
TOP OF CASING ELEVATION:	Not Applicable

Koppers022570

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-22**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 12:00	DRILL FINISH Time: 13:00
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/3/95	Date: 10/3/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	37.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B22-01	12:05	81.8	-	1–4	ML	SILT with Sand and Gravel - moist to wet, oily substance present, strong sheen, metal wire present
	B22-02	12:12	212.0	-	5–7		SILT - green with brown mottling, stiff, strong sheen
	B23-03	12:15	253.0	-	8–9	ML	
	B22-04	12:25	18.6	-	10–12		Sandy SILT - brown, moist, stiff, strong sheen
	B22-05	12:30	18.4	40	13–14		Sandy SILT - olive gray to green, moist to wet, stiff, strong sheen
	B22-06	12:35	15.8	-	15–16	ML	
	B22-07	12:40	4.8	-	17–19		SILT - olive gray, moist, stiff, strong sheen, black oily product throughout core)
					20		

GROUNDWATER: 10/3/95

Koppers022571

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-22**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708	HAI LOGGER:	Rob Ede	DRILL START Time: 12:00 Date: 10/3/95	DRILL FINISH Time: 13:00 Date: 10/3/95
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James		
	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	37.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B22-08	12:45	53.2	-			21		ML	SILT - as above, moist to wet, pockets of brown product within core
							22		SP	
							23			SAND - olive gray, wet, fine grained, black product at 24-25 feet bgs, (see photo 14)
							24			
	B22-09	12:50	16.0	485			25			
							26		ML	Sandy SILT - brown, moist, stiff, no sheen
	B22-10	12:55	8.7	-			27			SAND - brown, wet, loose, poorly graded, fine grained, muscovite present, no sheen
							28		SP	
	B22-11	1:00	8.4	-			29			
							30			Drilled to 30 feet bgs Sampled to 29.5 feet bgs
							31			* Sample Number Prefix is 2708-951003-
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022572

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-23**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 14:17	DRILL FINISH Time: 15:40
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/3/95	Date: 10/3/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Asphalt							1		Asphalt	Asphalt
							2		Concrete	Concrete
							3			
							4			
							5			
							6			
	B23-01	14:38	190.0	-			7		SP	SAND - brown, moist, loose, poorly graded, medium grained, slight sheen
							8			
3/4" Bentonite Chips							9			
							10			
	B23-02	14:47	2500+	-			11			
							12	10/3/95	ML	Sandy SILT - green with brown mottling, moist to wet, stiff, lower 6 inches of core is saturated with product, strong sheen
	B23-03	14:50	1439	-			13			
							14			
							15			
							16			
	B23-04	14:57	9.7	-			17			Sandy SILT - green with brown mottling, stiff, roots present, saturated with product 15-17 feet bgs, strong sheen
							18		ML	
	B23-05	15:00	589.0	-			19			
							20			

Koppers022573

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-23**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill	14:17	15:40
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	10/3/95	10/3/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B23-06	15:05	2500+	-			21		ML	SILT - brown with orange spots, moist, very stiff, sheen
							22			
							23			
							24			
	B23-07	15:10	682.0	-			25			
							26			
	B23-08	15:20	2500+	77			27		SP	SAND with some Silt - wet, fine grained, brown oily product present, sheen
							28		ML	
							29			
	B23-09	15:25	822.0	-			30			Sandy SILT - brown, moist, stiff, strong sheen
							31			
	B23-10	15:30	108.0	-			32			
							33			
	B23-11	15:35	292.0	-			34		SP	SAND - olive gray, wet, loose, fine grained, no sheen
	B23-12	15:38		ND			35		ML	SILT - brown, moist, stiff, no sheen
							36			Drilled to 35 feet bgs Sampled to 35 feet bgs
							37			* Sample Number Prefix is 2708-951003-
							38			
							39			
							40			

Koppers022574

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-24**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 9:15	DRILL FINISH Time: 10:15
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/2/95	Date: 10/2/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.5 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
									Concrete	Sidewalk at surface.
							1			
							2			
							3		SP	Lampblack - black, dry, hydrophobic, no sheen (2.5-3.0 feet bgs)
					9	100				
	B24-01	9:23	211.0	-	7	100				SAND - brown, dry, loose, poorly graded, medium grained, no sheen, (3-4 feet bgs)
					9	100	4			
							5			
							6			
	B24-02	9:30		-						
			40.0				7			SAND - as above, some pebbles, moist, no sheen, (5-10 feet bgs)
							8			
							9		SP	
							10			
3/4" Bentonite Chips										SAND - olive gray, moist, loose, black droplets of tar-like substance at base of sand, wood chips present (10-11.5 feet bgs)
	B24-03	9:40		1,092			11			
			1406							
							12			
										Sandy SILT - olive gray, moist, slightly plastic, slight sheen, (11.5-15 feet bgs)
	B24-04	9:45		-			13			
			71.1					10/2/95		
							14			
							15			
							16		ML	
										Sandy SILT - olive gray to green, moist, stiff, strong sheen, (15-20 feet bgs)
	B24-05	9:50		-			17			
			636.0				18			
							19			
	B24-06	9:53		-						
			796				20			

Koppers022575

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-24**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4" OD Core Barrel	9:15	10:15
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	10/2/95	10/2/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.5 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips					21	ML	Sandy SILT - brown with green mottles, moist, sheen on core - smeared from above, (20-22 feet bgs)
	B24-07	10:00	390	-	22		
					23	SP	SAND - brown, wet, loose, poorly graded, fine grained, no sheen (22-23 feet bgs)
	B24-08	10:03	907	-	24	ML	Sandy SILT -brown with green mottles, moist, no sheen (23-24 feet bgs)
					25		
					26		
	B24-09	10:05	1654	-	27	SP	SAND - brown, wet, loose, poorly graded, no sheen (24-30 feet bgs), 2 inch Silt zone at 27 feet bgs
					28		
					29		
	B24-10	10:10	834	0.14	30		Drilled to 30 feet bgs Sampled to 29.5 feet bgs
					31		
					32		
					33		
					34		
					35		
					36		
					37		
					38		
					39		
					40		

* Sample Number Prefix is 2708-951002-

Koppers022576

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-25**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 12:05	DRILL FINISH Time: 12:45
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/2/95	Date: 10/2/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.0 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							1		Asphalt	Asphalt at surface.
							2			
							3		SP	
	B25-01	12:15	262	-			4			SAND - brown to gray, moist, loose, poorly graded, medium grained, slight sheen, (2-5 feet bgs)
							5			
							6			
	B25-02	12:20	85.2	-			7			SAND - as above, moist, large piece of decayed wood in end of sampler, slight sheen, (5-10 feet bgs)
							8			
							9		SP	
							10			
							11			
							12	10/2/95		SAND - as above, wet at 14 feet bgs, strong sheen, brown froth appears via sheen test, (10-15 feet bgs)
	B25-03	12:30	90.6	12.5			13			
							14			
							15			
							16			
							17			SAND - as above, wet, strong sheen and froth to depth of 17 feet bgs, no sheen from 17-18.5 feet bgs
							18			
	B25-04	12:35	92.7	-			19		ML	SILT - olive gray, moist, no sheen (18-20 feet bgs)
							20			

Koppers022577

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-25**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4" OD Core Barrel	12:05	12:45
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	10/2/95	10/2/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.0 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B25-05	12:40	191	0.45			21		ML	Sandy SILT - olive gray, wet, slightly stiff, slightly plastic, no sheen, (20-22 feet bgs)
							22			
							23			
	B25-06	12:43	24.4	-			24		ML	SILT - olive gray with brown/orange spots, moist, stiff, plastic, no sheen, (22-25 feet bgs)
							25			
							26			
							27			
							28			
							29			
							30			Drilled to 25 feet bgs Sampled to 24 feet bgs
							31			* Sample Number Prefix is 2708-951002-
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022578

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-26**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 8:20	DRILL FINISH Time: 10:20
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/4/95	Date: 10/4/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
	B26-01	8:15	753	9.3			1		SM	Silty SAND with Gravel - brown, moist, no hydrocarbon odor
							2			
							3		SP	Lampblack - black, hydrophobic, slight sheen, slight hydrocarbon odor
	B26-02	8:30	1191	-			4			
							5			
					33	10	6			Brick in end of sampler, also pieces of hardened tar
					34	0				
					19	0	7			
							8			
3/4" Bentonite Chips	B26-03	8:45	771	-			9		SP	SAND - olive gray, moist, loose, medium grained, strong hydrocarbon odor, sheen
							10			
							11			
	B26-04	8:55	997	-			12			SAND - olive gray, moist, loose, medium grained, strong sheen, brown froth via sheen test, hydrocarbon odor
							13			
							14	10/4/95		
							15	▼		
							16			
	B26-05	9:08	1611	-			17		SP	SAND - olive gray, wet, loose, poorly graded, medium grained, saturated with product, strong sheen on sampler
							18			
							19			
							20			

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.9 feet MSL
TOP OF CASING ELEVATION:	Not Applicable

Koppers022579

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-26**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	4" OD Core Barrel	Time: 8:20	Time: 10:20
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/4/95	Date: 10/4/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.9 feet MSL
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B26-06	9:15	2500+	15,530			21		SP	SAND - olive gray, wet, loose, poorly graded, medium grained, strong sheen, much brown product, (20-23 feet bgs)
							22			
							23			
	B26-07	9:18	2500+	-			24			SILT - brown with dark gray mottling, moist, contains wood fragments, (23-24 feet bgs)
							25			
	B26-08	9:30	959	-			26		ML	SILT - brown, moist, stiff, strong sheen on sampler, root zones present, black, oily product appears to be migrating through root zones
							27			
							28			
	B26-09	9:45	2500+	-			29			
							30			
	B26-10	10:05	2500+	-			31			
							32		ML	Sandy SILT - olive gray to green, medium stiff, large amount of black staining appears to be migrating through root zones
							33			
	B26-11	10:10	2500+	-			34			
							35			
							36			
	B26-12	10:15	2500+	-			37			Sandy SILT - olive gray to green, medium stiff, sheen from 35-37 feet bgs, no sheen from 37-40 feet bgs
							38		ML	
							39			Drilled to 40 feet bgs Sampled to 40 feet bgs
	B26-13	10:20	771	1.1			40			* Sample Number Prefix is 2708-951002-

Koppers022580

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-27**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 12:40	DRILL FINISH Time: 13:30
	SAMPLING METHOD:	Split Spoon		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/20/95	Date: 9/20/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	37.0 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B27-01	12:15		-			1		GP	Sandy GRAVEL - brown, dry, fill (surface)
							2			
	B27-02	12:50		-	13	100	3		SM	Silty SAND - brown, dry, dense, pieces of coal? present, no petroleum odor, no sheen
			7.6		17	0				
					18	0	4			
							5			
					16	100			SP	SAND - brown, dry, medium dense, poorly graded, fine grained, some coal in upper 6 inches, no sheen, black colored hydrophobic particulates float via sheen test (lampblack?)
	B27-03	12:55		-	16	100	6			
			6.5		20	50				
							7			
					10	100	8			SAND - black, moist, medium dense, poorly graded, fine grained, strong petroleum hydrocarbon odor, sheen via sheen test
	B27-04	13:00		-	10	100				
			21.5		12	50	9			
							10			
					4	100				SAND - as above, loose, strong petroleum hydrocarbon odor, sheen via sheen test
	B27-05	13:03		-	8	70	11			
					8	0			SP	
							12			
					6	100	13			SAND - as above, strong petroleum hydrocarbon odor, sheen via sheen test
	B27-06	13:05		-	10	100		9/20/95		
			36.4		13	50	14			
							15	▼		
					4	100				SAND - olive gray to black, wet, loose, petroleum hydrocarbon odor, slight sheen via sheen test
	B27-07	13:10		-	6	100	16			
			13.2		8	60				
							17		SP	
					2	100	18			SAND - as above, slight petroleum hydrocarbon odor, no sheen via sheen test
	B27-08	13:15		-	4	100				
			35.2		7	100	19			
							20			

Koppers022581

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-27**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	Split Spoon	12:40	13:30
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/20/95	9/20/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	37.0 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
					11	100			SP	SAND - black, wet, dense, sheen on core, sheen via sheen test
	B27-09	13:30		-	24	100	21			
			2031		16	100				
							22			
					2	100	23			SAND - black, wet, loose, saturated with oily substance, (22.5-23.5 feet bgs)
	B27-10	13:40		1,243	3	100				
			2500+		3	100	24		ML	SILT - brown, wet, medium stiff, plastic, sheen via sheen test, (23.5-24 feet bgs)
							25			
					2	100			SP	SAND with some Silt - black, wet, loose, sheen on sampler, (25-25.5 feet bgs)
	B27-11	13:45		-	2	100	26			
			392		2	50				SILT with some Clay - brown, wet, soft, plastic, sheen via sheen test, (25.5-26.5 feet bgs)
							27			
					4	100	28		ML	Clayey SILT - brown, moist, medium stiff, plastic, no sheen via sheen test
	B27-12	13:55		125	5	100				
			120		5	70	29			
							30			
					3	100				Clayey SILT - as above, slight sheen via sheen test, (outside of core smeared with petroleum product from shallower depths)
	B27-13	14:05		-	3	100	31			
			861		5	100				
							32			
					3	100	33		ML	Clayey SILT - olive gray, moist, soft, sheen via sheen test, (outside of core smeared with petroleum product from shallower depths)
	B27-14	14:15		-	4	100				
			714		5	10	34			
							35			
					3	100				SILT - olive gray, moist, soft, no petroleum hydrocarbon odor, no sheen via sheen test
	B27-15	14:40		12.2	3	80	36			
			254		3	0				
							37			
							38			
										Drilled to 36.5 feet bgs Sampled to 36.5 feet bgs
							39			
										* Sample Number Prefix is 2708-950920-
							40			

3/4" Bentonite Chips

Koppers022582

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-28**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 14:00	DRILL FINISH Time: 15:00
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/2/95	Date: 10/2/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
	B28-01	13:45	614	87			1		SP	Silty SAND with Gravel - brown, moist, fine grained, non plastic, no hydrocarbon odor, no sheen via sheen test (surface)
	B28-02	13:47	105	135			2			
							3			
	B28-03	14:10	95.4	-			4			SAND with some Gravel and Lampblack - (black, very solid/hard pieces that are hydrophobic), slight hydrocarbon odor, no sheen via sheen test, (2.5-5 feet bgs)
							5			
							6			GRAVEL with Lampblack - black, dry, lampblack is hydrophobic, no hydrocarbon odor, no sheen via sheen test, (5-10 feet bgs)
	B28-04	14:15	111	-			7			
							8			
3/4" Bentonite Chips							9		GM	
							10			
	B28-05	14:20	36.2	-			11			GRAVEL with Lampblack - sticky, tar-like pieces present, hard, with sheen on surface, strong hydrocarbon odor (10-12 feet bgs)
							12			
	B28-06	14:25	71.4	-			13			
							14	10/2/95	SP	SAND - olive gray, moist, loose, poorly graded, strong hydrocarbon odor, sheen via sheen test, (12-15 feet bgs)
							15			
	B28-07	14:30	372	612			16		SM ML	SAND with some SILT - olive gray, wet, saturated with product, metallic sheen, (15-15.5 feet bgs) Sandy SILT - brown, moist, no sheen, (15.5-16 feet bgs)
							17			
							18		SP	SAND - olive gray, wet, loose, poorly graded, medium grained, no sheen via sheen test, (16-20 feet bgs)
	B28-08	14:35	53.7	-			19			
							20			

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.4 feet msl
TOP OF CASING ELEVATION:	Not Applicable

Koppers022583

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-28**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill	14:00	15:00
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	10/2/95	10/2/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
3/4" Bentonite Chips	B28-09	14:45	236	-			21		ML
							22		
	B28-10	14:50	462	-			23		
							24		
	B28-11	14:53	261	2.3			25		
							26		
							27		
							28		
							29		
							30		
							31		
							32		
							33		
							34		
							35		
							36		
							37		
							38		
							39		
							40		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.4 feet msl
TOP OF CASING ELEVATION:	Not Applicable

SOIL DESCRIPTION

Sandy SILT - olive gray with brown, metallic luster, saturated with product, strong sheen via sheen test (20-22 feet bgs)

Sandy SILT - as above, brown with brown/orange blebs, no sheen via sheen test, (22-23.5 feet bgs)

Sandy SILT - as above, olive gray, wet (23.5-25 feet bgs)

Drilled to 25 feet bgs
Sampled to 24.5 feet bgs

* Sample Number Prefix is 2708-951002-

Koppers022584

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-29**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Roger Brown	DRILL START Time: 14:15 Date: 9/22/95	DRILL FINISH Time: 9:30 Date: 9/25/95
	SAMPLING METHOD:	Split Spoon		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James		
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	31.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
	B29-01	14:08	-	230	-	-	1			Silty GRAVEL - brown, dry, fill, no sheen via sheen test (surface)
							2			
					27	100	3			
	B29-02	14:18			27	100			GM	Sandy Silty GRAVEL - gray/brown, damp, dense, non-plastic, well graded, no hydrocarbon odor, no sheen via sheen test
					32	0	4			
							5			
	B29-03				6	100				Sandy Silty GRAVEL - as above, no hydrocarbon odor, no sheen via sheen test
		14:22			9	0	6			
					5	0				
							7			
					11	100	8			
	B29-04	14:26			5	60			GW	Sandy GRAVEL with Silt - dark gray, moist to wet, medium dense, non-plastic, well graded, possible petroleum hydrocarbon odor, no sheen via sheen test
					11	0	9			
							10			
3/4" Bentonite Chips	B29-05				3	100				Silty Sandy GRAVEL - brown, wet, dense, slightly plastic, well graded, no petroleum hydrocarbon odor, no sheen via sheen test
		14:30			13	20	11			
					20	0				
							12		GM	
	B29-06	14:35			11	100	13			Silty Sandy GRAVEL - as above, slight naphthalene odor, turning to dark gray at 13.2 feet, no sheen via sheen test
					14	20				
					30	0	14			
							15			
					5	100				SILT with some Sand and Gravel - brown, moist, stiff, slightly plastic, possible petroleum hydrocarbon odor, no sheen via sheen test
	B29-07	15:05			8	100	16			
					12	100				
							17		ML	
					6	100	18			SILT with some Sand and Gravel - as above, more Gravel, brown with slight odor to 18.25 feet bgs, dark gray with distinct odor to 19 feet bgs with wood fragments and occasional tar globs, no sheen via sheen test
	B29-08	15:11			12	100				
					15	100	19			
							20			

Koppers022585

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-29**			
	HAI LOGGER:	Roger Brown	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	Split Spoon	Time: 14:15	Time: 9:30
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/22/95	Date: 9/25/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	31.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips					12	100			ML	Gravelly SILT - gray/brown with gray mottling, moist, very stiff, slightly plastic, slight petroleum hydrocarbon odor, no sheen via sheen test, tip of core is black
	B29-09	15:17			13	100	21			
					15	100				
							22		ML + tar	Gravelly SILT - black, moist, strong hydrocarbon odor, sheen via sheen test, tarry globs (22.5-22.75 feet bgs)
	B29-10A				-	100	23			SILT - gray with red-brown mottling, non-plastic, slight hydrocarbon odor (22.75-23 feet bgs)
		15:23			-	100				
	B29-10				-	100	24		SP	SAND - dark gray, moist to wet, poorly graded (23-24 feet bgs)
							25			
					3	100			tar	SILT and SAND - as above , tarry (25-25.25 feet bgs)
	B29-11	15:30			9	100	26		ML	SILT - gray, as above (25.25-26.25 feet bgs)
					12	100			tar	SILT and SAND - black, tarry, hydrocarbon odor, sheen via sheen test (26.25-27 feet bgs)
							27			
					3	100	28		ML	SILT - olive-gray with red-brown mottling, medium stiff, organic matter or root zones with brown product in them, petroleum hydrocarbon odor, sheen via sheen test, brown product present (27.5-29 feet bgs)
	B29-12	15:40			5	100		9/22/95		
					6	100	29			
							30			
					3	100			SM	Silty SAND with occasional Silt zones - olive-gray, loose, non-plastic, rootlets present, strong hydrocarbon odor, brown product via sheen test (30-31.5 feet bgs)
	B29-13	15:50			2	100	31			
					5	100				
							32			
					9	100	33		SP	SAND - black, wet, medium dense, poorly graded, entire core covered with brown product (32.5-34 feet bgs)
	B29-14	16:00			7	100				
					9	100	34			
							35			
					4	100				SAND - as above, product saturated throughout core (35-36.5 feet bgs)
	B29-15	16:08		58,822	9	100	36			
					12	100				Drilling resumes at 8:40, 9/25/95
							37			
							38			SAND - black, wet, saturated with product to 39 feet bgs, less staining from 39-40 feet bgs, some brown bedding or zones of oxidation, sheen throughout (36.5-40 feet bgs)
	B29-16	9:00					39			
							40			

Koppers022586

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-29**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Roger Brown	DRILL START Time: 14:15	DRILL FINISH Time: 9:30
	SAMPLING METHOD:	Split Spoon		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/22/95	Date: 9/25/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	31.1 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							41		SP	SAND - olive-gray, wet, sheen via sheen test, strong sheen on drill stem (40-44 feet bgs)
							42			
							43			
							44			
	B29-17	9:10	69.0	16.5			45			SAND with some Silt - gray, moist, no sheen via sheen test, no sheen on drill stem (44-45 feet bgs)
							46		SP	SAND with some Silt - moist to wet, poorly graded, fine to medium grained, no sheen via sheen test, no sheen on core (45-50 feet bgs)
							47			
	B29-18	9:25	28.1	0.18			48			
							49			
							50			Drilled to 50 feet bgs Sampled to 48 feet bgs * Sample Number Prefix is 2708-950922-
							51			
							52			
							53			
							54			
							55			
							56			
							57			
							58			
							59			
							60			

Koppers022587

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-30**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Hans Feige	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4" OD Core Barrel	10:15	12:40
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/22/95	9/22/95

BORING DIAMETER:	6-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	33.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TPH-G/418.1 M (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B30-04	10:20	345	-			6		GM	Silty GRAVEL with Sand - black, moist, some wet zones, plastic, hydrocarbon odor, sheen via sheen test
							8		GM	
	B30-05	10:25	28.4	-			10			Silty GRAVEL with Sand - as above, hydrocarbon odor, sheen via sheen test
	B30-06	10:35	52.4	6,776			12	9/22/9		Silty GRAVEL with Sand - black, wet, plastic, slight sheen
	B30-07	10:45	9.0	-			14			Silty GRAVEL with Sand - brown, wet, plastic, no sheen via sheen test
							16		GM	
	B30-08	10:55	17.6	-			18			Silty GRAVEL sith Sand - brown, wet, stiff, plastic, hydrocarbon odor
	B30-09	11:20	24.2	-			20			Silty GRAVEL with Sand - as above, hydrocarbon odor

Koppers022588

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-30**			
	HAI LOGGER:	Hans Feige	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	4" OD Core Barrel	Time: 10:15	Time: 12:40
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/22/95	Date: 9/22/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	6-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	33.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TPH-G/418.1 M (ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B30-10	11:30	35.1	-	21	GM	Silty GRAVEL with Sand - as above, hydrocarbon odor, no sheen via sheen test
					22		
					23	SP	SAND - gray/black, wet, dense, non-plastic, sheen via sheen test
	B30-11	11:40	337	-	24		SILT - gray, wet, stiff, plactic, hydrocarbon odor
					25	ML	
					26		SILT - gray, wet, stiff, slight plastic odor
					27		
					28		
	B30-12	11:50	202	853	29	ML	Sandy SILT - as above, strong sheen via sheen test
					30		
					31		
					32		
					33	SM	Silty SAND - brown, wet, dense, slightly plastic, hydrocarbon odor, no sheen via sheen test
	B30-13	12:20	184	-	34		
					35		
					36		Boring terminated at 35 feet bgs Sample to 34 feet bgs
					37		
					38		* Sample Number Prefix is 2708-950922-
					39		
					40		

Koppers022589

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER**	**B-30-A**		
PROJECT:	HAI LOGGER:	Hans Feige	DRILL START	DRILL FINISH
Northwest Natural Gas Co.	SAMPLING METHOD:	4" OD Core Barrel	Time:	Time:
Gasco Facility	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	9:00	9:40
Portland, Oregon	EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
PROJECT #: 2708	DRILLER:	Brad James	9/22/95	9/22/95
	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	6-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	33.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B30-01	8:55	20.6	965			1		ML	Surface sample
							2			
							3			
							4			Sandy SILT - black, moist, tarry, hydrocarbon odor
	B30-02	9:20	304	-			5			
							6			
							7			Fill material, low recovery in sampler
							8			
							9			
	B30-03	9:30	155	-			10		GP	
							11			
							12			Fill material - as above, little gravels, moist to wet, tarry, hydrocarbon odor
							13			
							14			
							15			
							16			Boring terminated at 15 feet bgs due to lack of recovery in sample barrels.
							17			
							18			* Sample Number Prefix is 2708-950922-
							19			
							20			

Koppers022590

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-31**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 14:20	DRILL FINISH Time: 15:45
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/25/95	Date: 9/25/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	25.4 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B31-01	13:50		38			1		GM	Silty SAND and GRAVEL - brown, dry, well graded, no hydrocarbon odor (surface sample)
							2			
							3			SILT with Gravel - brownish-yellow, moist, slightly plastic, no hydrocarbon odor, no sheen via sheen test (2-5 feet bgs)
	B31-02	14:30	57.5	-			4			
							5			
							6		ML	
	B31-03	14:35	41.2	-			7			SILT with Gravel - as above, no hydrocarbon odor, no sheen via sheen test (5-10 feet bgs)
							8			
							9			
							10			
							11			Sandy GRAVEL with Silt - gray, moist
	B31-04	14:50	117	-			12			
							13			
							14		GM	
							15			
							16			
							17			
							18			SAND with Gravel - olive-gray, moist to wet (17-18 feet bgs)
	B31-05	15:10	135	-			19		SP	Black, hard material (lampblack), coal-like, with slight petroleum hydrocarbon odor and slight sheen at 18-19.5 feet bgs
							20			

Koppers022591

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-31**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 14:20	DRILL FINISH Time: 15:45
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 9/25/95	Date: 9/25/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	25.4 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B31-06	15:20	697.0	12,666	21	9/25/9	SP	SAND - black, moist, tarry, poorly graded, hydrophobic, sheen via sheen test (20-21 feet bgs)
					22		ML	Sandy SILT - brown, moist, stiff, plastic, some organic matter, no hydrocarbon odor, no sheen via sheen test (21-24 feet bgs)
	B31-07	15:25	175	-	23			
					24			
	B31-08	15:30	207	5.5	25			SAND with some Silt - olive-gray, poorly graded, no hydrocarbon odor, no sheen via sheen test (24-25 feet bgs)
					26		SP	
	B31-09	15:35	61.1		27			SAND - brown, wet, poorly graded, fine grained, slight hydrocarbon odor (25-28 feet bgs)
	B31-10	15:40		ND	28			
	B31-11	15:45	59.2	ND			ML	Clayey SILT with some Sand - olive-gray, slightly plastic, no hydrocarbon odor, no sheen via sheen test (28-28.25 feet bgs)
					29		SP	SAND - olive-gray, wet, poorly graded, fine to medium grained, no hydrocarbon odor, no sheen via sheen test (28.25-30 feet bgs)
					30			
					31			Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen from 26 to 29 feet bgs. Purged twenty five gallons of water using a peristaltic pump prior to groundwater sampling. GROUNDWATER SAMPLE (2708-950925-BW31-01) collected at 17:20 hrs, 9/25/95. Well point was removed prior to abandonment.
					32			
					33			
					34			
					35			Boring terminated at 30 feet bgs Sample to 29 feet bgs
					36			* Sample Number Prefix is 2708-950925-
					37			
					38			
					39			
					40			

Koppers022592

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-32**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	Core Barrel	11:50	15:40
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	10/4/95	10/4/95

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B32-01	11:45	1067	61			1	10/4/95	GM	Silty SAND with Gravel - brown, moist, no hydrocarbon odor, no sheen via sheen test (surface)
							2			
					17	0	3			
					18	0				
					15	0	4			
							5			
					7	0			ML	Sandy SILT and GRAVEL - black, moist, slightly plastic, hydrocarbon odor, sheen via shen test (5-6.5 feet bgs)
					8	0	6			
					4	10				
							7		SM	Silty SAND with Gravel - olive-gray to black, moist, hydrocarbon odor (6.5-10 feet bgs)
	B32-02	12:08	-				8			
			296							
							9			
							10			
							11		GP	Sandy GRAVEL - brown, wet, no sheen via sheen test (10-11.5 feet bgs)
	B32-03	12:15	785	28,772			12			
	B32-04	12:18	-							
							13			SAND and GRAVEL with some Silt - black, matrix is tar material, highly viscous, strong sheen via sheen test (11.5-15 feet bgs)
							14			
							15			
							16			SAND and GRAVEL with some Silt - black, wet, matrix is tar material, highly viscous, strong sheen on sampling core (15-17 feet bgs)
	B32-05	12:25	-				17			Gravelly SILT - brown, wet, little tar (17-17.5 feet bgs)
			809						GP	
							18			
							19			
							20			

Koppers022593

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER**	**B-32**		
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	Core Barrel	Time: 11:50	Time: 15:40
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/4/95	Date: 10/4/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							21		ML + tar	
	B32-06	12:32	1072	-			22			SILT and TAR - black, moist, plastic, smooth texture, highly viscous (20-25 feet bgs)
	B32-07	12:34	-	-			23			
							24		ML + tar	
							25			
							26			Sandy SILT - black, wet, poorly graded, matrix is tar material, highly viscous, roots present (25-26 feet bgs)
							27			
							28		ML	Sandy SILT - olive-gray, moist, tar seams present - preferential in areas of roots, cracks (26-30 feet bgs)
	B32-08	12:46	1321	-			29			
							30			
							31			
	B32-09	13:15	1219	-			32			Sandy SILT - olive-gray to green, moist, firm, slightly plastic, pockets of brown product - lighter in color and less viscous than above, brown froth via sheen test (30-35 feet bgs)
							33			
	B32-10	13:20	1355	-			34			
							35		ML	
							36			Sandy SILT - brown with orange pockets, saturated with oily, black product (35-37.5 feet bgs)
	B32-11	13:29	499	-			37			
							38		SP	SAND - black, wet, poorly graded, fine grained, saturated with product, sheen via sheen test (35-37.5 feet bgs)
	B32-12	13:33	745.0	-			39		ML	Sandy SILT - brown with orange pockets, saturated with oily, black product, sheen via sheen test (38-40 feet bgs)
	B32-13	13:36	1041	-			40			

Koppers022594

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-32**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 11:50	DRILL FINISH Time: 15:40
	SAMPLING METHOD:	Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/4/95	Date: 10/4/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	36.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips					41	SM	Silty SAND - olive-gray, wet, firm, fine grained, strong sheen via sheen test (40-42.5 feet bgs)
					42		
					43	SP	SAND - olive-gray, wet, poorly graded, fine grained, saturated with oily product (42.5-43 feet bgs)
	B32-14	13:45	287	-	44	ML	Sandy SILT - olive-gray, wet, wood fragments present, saturated with oily product (43-44.5 feet bgs)
					45		
					46	SP	
	B32-15	14:26	1230	21,961	47		
					48		SAND - olive-gray, wet, poorly graded, fine grained, saturated with oily product (44.5-50.5 feet bgs)
					49		
					50		
					51		SAND with lenses of Silt - as above, saturated with oily product (50.5-52.5 feet bgs)
	B32-16	14:47	562	-	52	SP	
					53		SAND - olive-gray, wet, poorly graded, fine grained, saturated with oily product (52.5-54 feet bgs)
					54		
					55	SM	Silty SAND - olive-gray, moist, sheen via sheen test (54-55 feet bgs)
					56	SP	SAND - olive-gray, wet, saturated with product (55-56 feet bgs)
	B32-17	15:04	461	-	57	SM	Silty SAND - olive-gray, moist, no sheen via sheen test (56-57.5 feet bgs)
					58	SP	SAND - olive-gray, wet, loose, poorly graded, fine grained, slight sheen on core (57.5-59 feet bgs)
	B32-18	15:29	954	1.2	59		
					60		

* Sample Number Prefix is 2708-951004-

Koppers022595

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-33**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 13:50	DRILL FINISH Time: 9:10
	SAMPLING METHOD:	Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/5/95	Date: 10/6/96
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.8 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS Total PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B33-01	13:15	-	955			1		GM	Silty SAND with Gravel - brown, moist, no hydrocarbon odor, no sheen, no hydrocarbon odor (surface)
							2			
	B33-02	14:00		38	3	100	3			Sandy SILT and GRAVEL - olive grey, moist, loose, no sheen
			97		5	50				
					18	0	4			
							5			
					15	100			SM + tar	Tarry Silty SAND with Gravel - black, wet, medium dense, viscous tar seeps from cracks
	B33-03	14:03		8,238	15	100	6			
			219		16	50	7			
					50/5"	5	8			Rock in end of sampler - no recovery
							9			
							10			
							11			
	B33-04	14:28		-	12	100				
			318		11	50	12			Tarry Silty SAND with Gravel - black, moist, medium dense
					9	0			SM +tar	
							13			
					2	100	14			Tarry Silty SAND with Gravel - as above, loose
	B33-05	14:30	624	-	5	50				
					7	0	15			
							16			Tarry Gravels with Sand and Silt - black, moist, viscous tar zone at 16.5 feet bgs
	B33-06	14:42		-			17			
			646				18		GM + tar	
							19			
							20			

Koppers022596

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-33**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 13:50 Date: 10/5/95	DRILL FINISH Time: 9:10 Date: 10/6/96
	SAMPLING METHOD:	Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James		
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.8 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS Total PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B33-07	14:50	701	-			21–25		tar	TAR - some gravel and wood fragments at 21.5 feet bgs
	B33-08	15:00	2500+	-			26–27		SM	Silty SAND -black, moist,many rootlets and wood fragments, tar im matrix, strong sheen (25-27 feet bgs)
	B33-09	15:03	1475	-			28–30		ML	Sandy SILT - brown with green mottling, moist, stiff, rootlets and cracks contain wet, viscous tar (27-30 feet bgs)
	B33-10	15:34	1383	-			31–35		ML	Sandy SILT - brown with orange oxidation spots, moist, tar seams present - preferential in areas of rootlets and cracks
	B33-11	15:45	2500+	-			36–40		ML	Sandy SILT - green, moist, stiff, black tarry patches throughout core, tarry sand seam at 38.5 feet bgs

Koppers022597

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-33**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	Core Barrel	Time:	Time:
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	13:50	9:10
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	10/5/95	10/6/96

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.8 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS Total PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							41		ML	Sandy SILT - as above, moist, fingers of tar throughout core (40 - 43 feet bgs)
							42			
							43			
							44		SP	SAND - olive gray and green mottled, moist, medium dense, fine grained, strong sheen (43 - 45 feet bgs)
	B33-12	15:55	819.0	-			45			
							46			SAND with some Silt- olive gray, moist, medium dense, fingers of tar throughout core, sheen
							47			
							48			
							49			
	B33-13	16:05	692	-			50			
							51		SM	Silty SAND - olive gray, moist, medium dense, fine grained, fingers of tar throughout core, sheen
							52			
							53			
							54			
	B33-14	16:25	793	65			55			
							56		ML	Sandy SILT - olive gray, moist, thin fine grained sand lenses, roots at 57 feet bgs, less product than above
							57			
	B33-15	8:27	2500+	-			58			
							59			
							60			

Koppers022598

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	SOIL BORING NUMBER B-33			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 13:50	DRILL FINISH Time: 9:10
	SAMPLING METHOD:	Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/5/95	Date: 10/6/96
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.8 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS Total PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							61		ML	Sandy SILT - as above, black oily product within rootlet zones (60-62 feet bgs)
							62			
	B33-16	8:40	2500+	-			63		SP	SAND - olive gray to black, wet, saturated with black, oily product (62 - 63 feet bgs)
							64		ML	Sandy SILT - green, moist, stiff, many rootlets present, product within rootlet zones (63 - 65 feet bgs)
							65			
							66		SM	Silty SAND - olive gray and green mottled, wet, fine grained, saturated with brown/black product, sand lens at 67 feet bgs is saturated with product (65 - 67 feet bgs)
	B33-17	8:55	407	-			67			
							68		ML	SILT - olive gray, moist, stiff, bark and rootlets present, no product, no sheen (67 - 70 feet bgs)
							69			
	B33-18	9:00	133	5.7			70			
							71			
							72			
							73			
							74			
							75			
							76			
							77			
							78			
							79			
							80			

Drilled to 70 feet bgs
Sampled to 70 feet bgs

* Sample Number Prefix is 2708-951005-

Koppers022599

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-34**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4" OD Core Barrel	9:45	13:15
	DRILLING METHOD:	10 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/26/95	9/26/95

BORING DIAMETER:	12-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B34-01	8:45	-	94			1	9/26/95	SM	Silty SAND with Gravel - brown, moist, no hydrocarbon odor (surface)
	B34-02 (dup	8:50	-				2			
							3		GM	No Recovery-Gravels and Cobbles (0 to 5 feet bgs)
							4			
							5			Silty Sany GRAVEL with Cobbles, olive grey, moist, wood fragmernts, sheen
	B34-03	10:00	-	-			6			
							7			Silty Sandy GRAVEL with Cobbles, as above, brown, sheen, cobble fragment in end of sampler
							8			
	B34-04	10:20		-			9		GP + tar	Tarry Sandy GRAVEL - black, hard, sheen, large brick or slag at 9 feet bgs
			1344				10			
							11			Tarry Sandy GRAVEL - black, less hard than above, tar oozing from sand, large brick at 12.5 feet bgs
	B34-05	10:30		13,499			12			
			2,500+				13			
							14			
							15			
							16			Tarry Sandy with GRAVEL - black, moist, tar content less than above, aluminum strips from 17 to 17.5 feet bgs.
	B34-06	10:45		-			17			
			260				18		GP + tar	
							19			
							20			

Koppers022600

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	SOIL BORING NUMBER B-34			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4" OD Core Barrel	9:45	13:15
	DRILLING METHOD:	10 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/26/95	9/26/95

BORING DIAMETER:	12-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	34.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B34-07	11:35	-	1,107			21-25		SP	SAND - black, wet, loose, medium grained, poorly graded, sheen throughout, brick at 20.5 feet bgs.
	B34-08	12:00	-	1,422			26-27		SP	SAND - black to olive gray, wet, loose, wood fragments, sheen throughout (25 - 27.5 feet bgs)
	B34-09	12:05	-	2,500+			28-30		ML	Sandy SILT - light brown, moist, organic matter and oxidized zones, thin tarry beds throughout core (27.5 - 30 feet bgs)
	B34-10	12:30	-	2,500+			31-33		SM	Silty SAND - olive gray, wet, fine to medium grained, wood fragments, patches of black oil throughout
	B34-11	12:35	-	2,500+			34-35		SM	
	B34-12	13:00	-	2,500+			36-37		ML	SILT - green and gray mottled with brown oily pockets, sheen, product is more oil-like and less tar-like at this depth
							38-40			Drilled to 37 feet bgs Sampled to 37 feet bgs * Sample Number Prefix is 2708-950926-

Koppers022601

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-35**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 10:20	DRILL FINISH Time: 12:05
	SAMPLING METHOD:	4" OD Core Barrel		
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/5/95	Date: 10/5/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	33.8 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B35-01	10:20	38	39			1		GM	Sandy GRAVEL with Silt - brown, moist, no hydrocarbon odor (surface)
							2			
	B35-02	10:35	235	-	5	90	3			Sandy GRAVEL with Silt, brown, wet, hardened tar in end of sampler, no sheen
					5	0				
					7	0	4			
							5			
					31	5				No Recovery - Rock blocking end of sampler
					34	0	6			
							7			
	B35-03	10:44		-	7	100	8			Tarry SAND with Gravel and Silt, moist, black, tar throughout matrix, sheen
			520		5	10			SP + tar	
					8	0	9			
							10			
	B35-04	10:50		-			11			Tarry SAND with Gravel and Silt, as above
			715				12			
							13			
							14			
							15			
							16			No Recovery - rock blocking end of sampler
							17			
							18		SP + tar	
							19	9/26/05		
							20			

Koppers022602

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER B-35**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	4" OD Core Barrel	Time: 10:20	Time: 12:05
	DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 10/5/95	Date: 10/5/95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	33.8 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips					4	100			GP+ oil	Gravelly SILT with Sand, black, moist, many roots and wood fragments, saturated with black oily product
					6	100	21			
	B35-05	11:10	936	-	7	80			SP + oil	SAND - black, wet, medium grained, saturated with black oily product (21.5 - 22.5 feet bgs)
							22			
	B35-06	11:16		41,602						
			2,255				23			
										SILT - olive gray to green, upper 6-inches is tarry, no tar below (22.5-24 feet bgs)
	B35-07	11:20	499	-			24			
							25		ML	
										SILT - olive gray with orange oxidation spots, moist, medium stiff, some root zones present, no product, no sheen
	B35-08	11:32	98	-			26			
	B35-09	11:56		-			27			
			335							
							28			
							29			
	B35-10	12:02		9.3						
			299				30			
							31			
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Drilled to 30 feet bgs
Sampled to 30 feet bgs

* Sample Number Prefix is 2708-951005-

Koppers022603

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER GT-1**		
PROJECT: Northwest Natural - Gasco Facility 7900 NW St. Helens Road Portland, Oregon PROJECT #: 2708	HAI LOGGER: Rob Ede SAMPLING METHOD: 2" OD Split Spoon DRILLING METHOD: 4 1/4-inch OD Mud Rotary EQUIPMENT TYPE B-61 Mobile Drill DRILLER: Jim Clark DRILLING CONTRACTOR: Subterranean, Inc.	DRILL START Time: 9:30 Date: 11/17/97	DRILL FINISH Time: 12:30 Date: 11/17/97

BORING DIAMETER: 4 1/4-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 20.67 feet MSL
TOP OF CASING ELEVATION: Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite / Cement Grout							1		GM	Silty GRAVEL - as indicated from drill cuttings and drilling conditions.
							2			
					4	100	3		ML	Sandy SILT- brown, moist, soft, no hydrocarbon odor or discoloration, no sheen.
	001	10:20	2.3	4.3	7	50				
					10	0	4			SAND - brown, slightly moist, fine grained, medium dense, no hydrocarbon odor or discoloration, no sheen.
							5			
					7	100				SAND - as above, no hydrocarbon odor or discoloration, no sheen.
	002	10:30	3.7	-	7	100	6			
					7	0			SP	
							7			
					5	100	8			SAND - as above, hydrocarbon odor, sheen, liquid non-viscous black oily product from 8'4" to 8'6".
	003	10:39	16.2	-	5	100				
					5	0	9			
							10	▼		
					5	100				SAND - as above, wet, loose, saturated with oil-like product, petroleum odor, brown product obseved via sheen test.
	004	10:45	7.0	6.2	4	75	11			
					1	0				
							12			
					1	100	13			Silty SAND - olive grey, moist, very loose, non-plastic, no product, no sheen, petroleum odor exists.
	005	10:54	5.0	-	1	75				
					0	0	14			
							15			
					1	100				Silty SAND - as above, no sheen. hydrocarbon odor exists.
					1	100	16		SM	
	006	11:00	7.4	ND	3	50				
							17			
					1	100	18			Silty SAND - grey to olive grey, loose, wood fragment at 18' 6", no sheen, hydrocarbon odor exists.
	007	11:05		-	1	100				
			6.6		3	50	19			
							20			

Koppers022604

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER GT-1**		
PROJECT: Northwest Natural - Gasco Facility 7900 NW St. Helens Road Portland, Oregon PROJECT #: 2708	HAI LOGGER: Rob Ede SAMPLING METHOD: 2" OD Split Spoon DRILLING METHOD: 4 1/4-inch OD Mud Rotary EQUIPMENT TYPE B-61 Mobile Drill DRILLER: Jim Clark DRILLING CONTRACTOR: Subterranean, Inc.	DRILL START Time: 9:30 Date: 11/17/97	DRILL FINISH Time: 12:30 Date: 11/17/97

BORING DIAMETER: 4 1/4-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 20.67 feet MSL
TOP OF CASING ELEVATION: Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite / Cement Grout					3	100			SP	SAND - grey with some brown to orange oxidation zones, wet, medium dense, fine grained, no sheen, no hydrocarbon odor.
	008	11:12	2.6	ND	7	100	21			
					7	0				
							22			
							23			
							24			
							25			
					3	100				
					8	100	26			SAND - as above, brown to 26', grey below 26', muscovite present in gray sand, slight sheen and hydrocarbon odor below
	009	11:20	1.5	-	12	50				
							27			
							28			
							29			
							30			
					3	100				
	010	11:28	1.6	-	4	100	31			SAND - as above, grey, loose, fine grained, no sheen, slight reducing odor.
					4	0				
							32		SP	
							33			
							34			
							35			
					6	100				
	011	11:35	1.4	ND	6	100	36			SAND -as above, medium dense, no sheen, no hydrocarbon odor.
					11	0				
							37			
							38			Drilled to 35.0 feet bgs Sampled to 36.5 feet bgs
							39			* Sample Number Prefix is 2708-971117-
							40			

Koppers022605

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER GT-2**		
PROJECT: Northwest Natural - Gasco Facility 7900 NW St. Helens Road Portland, Oregon PROJECT #: 2708	HAI LOGGER: Rob Ede SAMPLING METHOD: 2" OD Split Spoon DRILLING METHOD: 4 1/4-inch OD Mud Rotary EQUIPMENT TYPE B-61 Mobile Drill DRILLER: Jim Clark DRILLING CONTRACTOR: Subterranean, Inc.	DRILL START Time: 14:30 Date: 11/17/97	DRILL FINISH Time: 16:00 Date: 11/17/97

BORING DIAMETER: 4 1/4-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 20.68 feet MSL
TOP OF CASING ELEVATION: Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite / Cement Grout							1		GM	Silty GRAVEL - as indicated from drill cuttings and drilling conditions.
							2			
					3	100	3			SAND - brown, moist, loose, fine grained, poorly graded, no hydrocarbon odor or discoloration, no sheen.
					4	100				
	012	1439	1.9	0.08	5	50	4			
							5			
					2	100				SAND - as above, no hydrocarbon odor or discoloration, no sheen.
					3	100	6			
	013	1442	2.7	-	4	50			SP	
							7			
	014	1453	2.1	-	5	75	8			SAND - as above, grey, no sheen, slight organic odor.
					5	0				
					2	0	9			
							10	▼		
					1	100				Sandy SILT - olive grey, moist to wet, very soft, slightly plastic, no hydrocarbon odor, no sheen.
					0	100	11			
	015	1500	2.5	-	1	100				
							12			
					1	100	13		ML	
	016	1505		-	0	100				Sandy SILT - as above, wet, no hydrocarbon odor, no sheen, some mica.
			2.4		0	25	14			
							15			
					1	100				SAND - grey, wet, very loose, fine grained, no hydrocarbon odor, no sheen, slight organic decay odor.
	017	1510		ND	1	100	16			
			2.9		2	25				
							17		SP	
							18			
							19			
							20			

Koppers022606

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER GT-2**			
PROJECT: Northwest Natural - Gasco Facility 7900 NW St. Helens Road Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	2" OD Split Spoon	14:30	16:00
	DRILLING METHOD:	4 1/4-inch OD Mud Rotary		
	EQUIPMENT TYPE	B-61 Mobile Drill		
	DRILLER:	Jim Clark	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Subterranean, Inc.	11/17/97	11/17/97

BORING DIAMETER:	4 1/4-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	20.68 feet MSL
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
					4	100				
					5	100	21			SAND - as above, medium dense, no hydrocarbon odor, no sheen, slight organic decay odor.
	018	1515	3.6	-	6	50				
							22			
							23		SP	
							24			
							25			
Bentonite / Cement Grout					4	100				
					4	100	26			SAND - as above, grey, few thin grey silt lenses, no sheen, slight organic decay odor.
	019	1521	3.6	-	7	50				
							27			
							28			
							29			
							30			
					2	100				
	020	1529		-	1	100	31			SAND - as above, many thin grey silt lenses, no hydrocarbon odor, no sheen.
			2.2		7	25				
							32			
									SP	
					7	100	33			SAND - as above, no hydrocarbon odor, no sheen.
	021	1534		ND	8	100				
			2.6		9	25	34			
							35			
					5	100				SAND - as above, no hydrocarbon odor, no sheen.
					10	100	36			
	022	1540	2.7	-	6	50				
							37			
							38			Drilled to 35.0 feet bgs Sampled to 36.5 feet bgs
							39			* Sample Number Prefix is 2708-971117-
							40			

Koppers022607

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER GT-3**		
PROJECT: Northwest Natural - Gasco Facility 7900 NW St. Helens Road Portland, Oregon PROJECT #: 2708	HAI LOGGER: Rob Ede SAMPLING METHOD: 2" OD Split Spoon DRILLING METHOD: 4 1/4-inch OD Mud Rotary EQUIPMENT TYPE B-61 Mobile Drill DRILLER: Jim Clark DRILLING CONTRACTOR: Subterranean, Inc.	DRILL START Time: 8:20 Date: 11/18/97	DRILL FINISH Time: 12:00 Date: 11/18/97

BORING DIAMETER: 4 1/4-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 19.44 feet MSL
TOP OF CASING ELEVATION: Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite / Cement Grout							1		GM	Silty GRAVEL - as indicated from drill cuttings and drilling conditions.
							2			
					2	100	3			
	023	847		43.1	3	100				SILT with fine Sand and Gravel - olive grey with some brown, moist, stiff, non-plastic, no hydrocarbon odor, no sheen, some wood fragments.
			0		7	25	4			
							5			
	024	850	0	-	4	50				
					5	0	6			SILT with fine Sand and Gravel - as above, brown, no hydrocarbon, no sheen.
					16	0				
							7		ML	
					3	100	8			
					8	100				SILT with fine Sand and Gravel - as above, no hydrocarbon odor, no sheen, some wood fragments.
	025	859	0	-	11	50	9			
							10			
					3	20				SILT with fine sand and gravel - as above, no hydrocarbon odor, no sheen, some wood fragments.
					2	0	11			
					1	0				
					1	100	12			Silty SAND - grey with brown oxidation spots, moist, fine grained, very loose, no hydrocarbon odor, no sheen.
					1	100			SM	
	026	911	0	0.05	1	100	13			
					1	10				Sandy SILT - grey, moist, very soft, non-plastic, no hydrocarbon odor, no sheen.
					1	0	14			
					1	0				
							15		ML	
							16			
					3	100	17			
					6	100				SAND - grey, moist, very loose, fine grained, non-plastic, no hydrocarbon odor, no sheen.
	027	922	0	-	6	75	18			
							19		SP	
							20			

Koppers022608

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER GT-3**			
PROJECT: Northwest Natural - Gasco Facility 7900 NW St. Helens Road Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 8:20	DRILL FINISH Time: 12:00
	SAMPLING METHOD:	2" OD Split Spoon		
	DRILLING METHOD:	4 1/4-inch OD Mud Rotary		
	EQUIPMENT TYPE	B-61 Mobile Drill		
	DRILLER:	Jim Clark	Date: 11/18/97	Date: 11/18/97
PROJECT #: 2708	DRILLING CONTRACTOR:	Subterranean, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
					6	100				SAND - as above, no hydrocarbon odor, slight organic decay odor, no sheen.
					7	100	21			
	028	928	0	-	8	75			SP	
							22			
					1	100	23			SAND - as above, moist to wet, no hydrocarbon odor, no sheen.
					6	100				
	029	935	0	-	7	50	24			
							25			
					2	100				SAND - as above, grey, moist to wet, no hydrocarbon odor, no sheen, fine grained, some grey silt lenses with rootlets.
					2	100	26			
	030	943	0	-	2	75				
							27			
							28			
							29			
							30			
					2	100				
	031	953		-	1	100	31			SAND - as above, many silt lenses, no hydrocarbon odor, no sheen, fine grained.
			0		3	75				
							32		SP	
							33			
							34			
							35			
					8	100				
					10	100	36			SAND -as above, wet, no sheen, no hydrocarbon odor.
	032	1000	0	ND	10	100				
							37			
							38			Drilled to 35.0 feet bgs Sampled to 36.5 feet bgs
							39			* Sample Number Prefix is 2708-971118-
							40			

Bentonite / Cement Grout

Koppers022609

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER GT-4**			
PROJECT: Northwest Natural - Gasco Facility 7900 NW St. Helens Road Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 12:45	DRILL FINISH Time: 16:00
	SAMPLING METHOD:	2" OD Split Spoon		
	DRILLING METHOD:	4 1/4-inch OD Mud Rotary		
	EQUIPMENT TYPE	B-61 Mobile Drill		
	DRILLER:	Jim Clark	Date: 11/18/97	Date: 11/18/97
PROJECT #: 2708	DRILLING CONTRACTOR:	Subterranean, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION	
							1		GM		
							2				
	-				8	10	3			Silty GRAVEL with brick fragments - no sheen, driller lost mud at 4.0 feet (voids in fill).	
					5	0					
					7	0	4				
							5				
	-				8	10				Silty GRAVEL with brick fragments - no hydrocarbon odor, no sheen.	
					12	0	6				
					9	0					
							7				
	-				7	20	8			Silty GRAVEL with brick fragments - grey and green silt, no hydrocarbon odor, no sheen.	
					14	0					
					16	0	9				
							10		GM		
					15	100				Sandy GRAVEL with brick - grey, fine grained sand, organic decay odor, no sheen.	
					30	100	11				
	033	1341	0	-	18	50				Driller indicates smoother drilling below 11.5 feet	
							12				
					1	100	13			SAND with silt lenses - grey, fine grained, no hydrocarbon odor, organic decay odor, no sheen, fine grained.	
					1	100					
	034	1350	0	ND	1	50	14				
							15				
							16		SP		
	-				2	0	17			No Recovery.	
					1	0					
					1	0	18				
							19				
							20				

Bentonite / Cement Grout

Koppers022610

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER GT-4**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural - Gasco Facility 7900 NW St. Helens Road Portland, Oregon	SAMPLING METHOD:	2" OD Split Spoon	Time: 12:45	Time: 16:00
	DRILLING METHOD:	4 1/4-inch OD Mud Rotary		
	EQUIPMENT TYPE	B-61 Mobile Drill		
	DRILLER:	Jim Clark	Date: 11/18/97	Date: 11/18/97
PROJECT #: 2708	DRILLING CONTRACTOR:	Subterranean, Inc.		

BORING DIAMETER:	4 1/4-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	19.64 feet MSL
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite / Cement Grout	-		0		4	20				SAND - brown, fine grained, medium dense, no hydrocarbon odor, no sheen, appears to be oxidized.
					5	0	21			
					7	0			SP	
							22			
							23			
					6	0				No Recovery.
					12	0	24			
					12	0				
							25			
	035	1417		-	5	100				SAND - as above, grey, no hydrocarbon odor, no sheen, fine grained, appears to be oxidized.
			0		8	25	26			
					7	0				
							27			
							28			
							29			
							30			
					4	100				SAND - grey, organic decay odor, no hydrocarbon odor, no sheen, fine grained, appears to be oxidized.
	036	1427		-	5	100	31			
			0		7	25				
							32		SP	
							33			
							34			
							35			
					5	100				SAND - as above, no hydrocarbon odor, no sheen.
	037	1439		-	5	100	36			
			0		7	25				
							37			
							38			
							39			
							40			

Koppers022611

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER GT-4**			
PROJECT: Northwest Natural - Gasco Facility 7900 NW St. Helens Road Portland, Oregon	HAI LOGGER: Rob Ede SAMPLING METHOD: 2" OD Split Spoon DRILLING METHOD: 4 1/4-inch OD Mud Rotary EQUIPMENT TYPE B-61 Mobile Drill DRILLER: Jim Clark	DRILL START Time: 12:45 Date: 11/18/97	DRILL FINISH Time: 16:00 Date: 11/18/97	
PROJECT #: 2708	DRILLING CONTRACTOR: Subterranean, Inc.			

BORING DIAMETER: 4 1/4-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 19.64 feet MSL
TOP OF CASING ELEVATION: Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite / Cement Grout					8	100				
	038	1517		ND	15	100	41			SAND - as above, dense, no hydrocarbon odor, no sheen.
			0		17	25			SP	
							42			
							43			
							44			
							45			
	039	1525		-	7	100				
			0		7	100	46			SAND - grey, fine grained, medium dense, some shell fragments, no hydrocarbon odor, no sheen.
					11	25				
							47			
							48			
							49		SP	
							50			
					8	100				SAND - as above, no hydrocarbon odor, no sheen.
					8	100	51			
					8	0				
							52			
							53			
							54			Drilled to 50.0 feet bgs Sampled to 51.5 feet bgs
							55			* Sample Number Prefix is 2708-971118-
							56			
							57			
							58			
							59			
							60			

Koppers022612

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER M-11**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 13:17	DRILL FINISH Time: 10:30
	SAMPLING METHOD:	3-inch Split Spoon/4-inch OD Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 2-Nov-95	Date: 3-Nov-95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	10-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.4 feet MSL
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite Chips	M11-01	1315	-	106			1		GP	Surface: Sandy Silty GRAVEL - brown, slightly moist, grass covered area.
							2			
							3			
					18	100	4		SP	SAND with gravel (3.5-4.0 Feet bgs) - brown, loose, moist, coarse grained, pieces of brick SAND with lampblack (4.0-5.0 feet bgs) - black, loose, hydrophobic, hydrocarbon odor, no sheen.
	M11-02	1330		-	27	100				
			11.5		21	70	5			
20 % Solids Bentonite Grout					14	100			GP	Sandy GRAVEL (5.0-6.5 feet bgs) - black (Lampblack), no sheen, pieces of brick, large pieces of slag looking material .
					8	100	6			
					7	30				
							7			
									SP	
					8	100	8			
	M11-03	1335		-	5	100				SAND with gravel (7.5-9.0 feet bgs) - black (Lampblack), pieces of brick, slag looking material (blue coloration), black, moist, hydrocarbon odor, no sheen.
			194		6	30	9			
							10			SAND (10.0-10.5 feet bgs) - Lampblack
										SAND (10.5-11.0 feet bgs) - brown, moist to wet, medium grained, loose, poorly graded, slight sheen.
							11			
							12			SAND (11.0-15.0 feet bgs) - black/metallic, moist to wet, strong hydrocarbon odor, sheen, brown froth via sheen test saturated with product, silt layers encountered at 12.5 and 13.5 feet bgs approximately 1 inch thick.
							13			
	M11-04	1350		-						
			2500+				14			
							15			
							16			SAND (15.0-20.0 feet bgs) - saturated with black oily product, wet, medium grained, loose, 2 inches of moist silt, olive grey with orange oxidation spots at 18.5 feet bgs.
	M11-05	1400		-			17			
			2500+							
							18		SP	
							19			
							20			

Koppers022613

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER M-11**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	3-inch Split Spoon/4-inch OD Core Barrel	Time:	Time:
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill	13:17	10:30
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	2-Nov-95	3-Nov-95

BORING DIAMETER:	10-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.4 feet MSL
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
20 % Solids Bentonite Grout	M11-06	1415	642	-			21		SP	SAND (20.0-23.0 feet bgs) - wet, loose, medium grained, poorly graded, sheen on core, saturated with oily product.
							22			
							23		ML	SILT (23.0-25.0 feet bgs) - olive grey, moist, root zones, soft black viscous tarry material, some sand from 24-25 feet bgs.
							24			
							25			
							26		SP	SAND (25.0-30.0 feet bgs) - wet, medium-grained, poorly graded, loose, product saturated, froth via sheen test, saturated with product to 30.5 feet bgs.
							27			
							28			
	M11-07	1425	1511	-			29			
							30			
							31		ML	SILT (30.5-35.0 feet bgs) - green to grey, brown, moist, stiff, plastic (some clay content), oily product migrations through root zones/fractures.
							32			
	M11-08	1435	996	-			33			
							34			
							35			
							36			SILT (35.0-40.0 feet bgs) - green, moist, stiff, plastic (some clay content), no product observed within core, root zones clean, slight sheen.
							37			
							38			
							39		ML	
	M11-09	1450	29.3	7.9			40			

Koppers022614

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER M-11**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 13:17	DRILL FINISH Time: 10:30
	SAMPLING METHOD:	3-inch Split Spoon/4-inch OD Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 2-Nov-95	Date: 3-Nov-95
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	10-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.4 feet MSL
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
20 % Solids Bentonite Grout	M11-10	1500	23.1	10.9	41–45	ML	SILT (40.0-45.0 feet bgs) - olive grey, moist, stiff, root zones present, no sheen via sheen test.
					46–49		SILT (45.0-49.0 feet bgs) - olive grey, moist, stiff, root zones present, no product, no sheen, large 6-inch tree limb/trunk at 45 feet bgs.
	M11-11	1513	-	-	50		Sandy SILT (49.0-50.0 feet bgs) - as above.
					51		Sandy SILT (50.0-51.0 feet bgs) - olive grey, soft, moist to wet, sheen?.
					52		SILT (51.0-53.0 feet bgs) - olive grey, moist, stiff, root zones, wood fragments.
					53		SILT (53.0-55.0 feet bgs) - green, slightly moist, stiff, no sheen.
					54		1540 - stop for day 11/3/95 - start drilling at 0825.
	M11-12	1524	-	-	55		
					56–58	ML	SILT (55.0-60.0 feet bgs) - green, slightly moist, stiff, no sheen, no product, 6-inch sandy silt zone at 58 feet bgs.
	M11-13	840	3.8	-	59–60		

Koppers022615

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER M-11**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	3-inch Split Spoon/4-inch OD Core Barrel	Time:	Time:
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill	13:17	10:30
	DRILLER:	Brad James	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	2-Nov-95	3-Nov-95

BORING DIAMETER:	10-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.4 feet MSL
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
20 % Solids Bentonite Grout							61		ML	Sandy SILT (60.0-65.0 feet bgs) - olive grey, moist, stiff, sheen on outside of core from water in hole, no sheen inside core.
							62			
							63			
							64			
							65			Sandy SILT (65.0-67.5 feet bgs) - olive grey, moist, stiff, sheen on outside of core from water in hole, no sheen inside core, approximately 1/4-inch of sand in end of core.
							66			Silty SAND (66.0-66.5 feet bgs) - olive grey,wet, moderately dense, no sheen.
	M11-14	1020	7.8	-			67		SM ML	
							68		SM	SAND (67.5-68.5 feet bgs) - brown, wet, moderately dense, no sheen, fine grained.
							69			
	M11-15	1030	2.3	-			70		SP	SAND (68.5-70.0 feet bgs) - brown, wet, loose, poorly graded, no sheen, fine grained.
							71			
							72			Boring terminated at 70.0 feet bgs.
							73			*Sample prefix is 2708-951102-
							74			
							75			
							76			
							77			
							78			
							79			
							80			

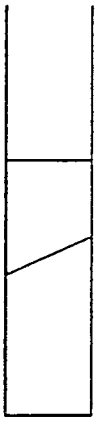
Koppers022616

G:\ACAD\DETAILS\GTKBR300

LABORATORY TESTS:

AL	Atterberg limits
CP	Compaction
CS	Consolidation
DS	Direct Sheer
GS	Grain – size
%F	Percent fines
HA	Hydrometer analysis
SK	Permeability
SM	Moisture content
MD	Moisture and density
SP	Swelling pressure
TX	Triaxial compression
UC	Unconfiend compression
CA	Chemical analysis

SOIL GRAPH:



SM Soil Group Symbol (See Note 2)

Distinct Contact Between Soil Strata

Gradual or Approximate Location of Change Between Soil Strata

Water Level

Bottom of Boring

BLOW-COUNT/SAMPLE DATA:

Blows required to drive a 2.4–inch I.D. split–barrel sampler 12 inches or other indicated distances using a 300–pound hammer falling 30 inches.

22 ■ Location of relatively undisturbed sample

12 ⊠ Location of disturbed sample

17 □ Location of sampling attempt with no recovery

Blows required to drive a 1.5–inch I.D. (SPT) split–barrel sampler 12 inches or other indicated distances using a 140–pound hammer falling 30 inches.

10 ◨ Location of sample obtained in general accordance with Standard Penetration Test (ASTM D 1586) procedures

26 ◫ Location of SPT sampling attempt with no recovery

"P" indicates sampler pushed with weight of hammer or against weight of drill rig.

P ⌶ Location of relatively undisturbed sample obtained using a 3–inch–diameter thin–wall sample tube. Sample obtained in general accordance with ASTM D 1587.

Location of grab sample

NOTES:

1. The reader must refer to the discussion in the report text, the Key to Boring Log Symbols and the exploration logs for a proper understanding of subsurface conditions.
2. Soil classification system is summarized in Figure 3.

GEI 121–90

Geo Engineers

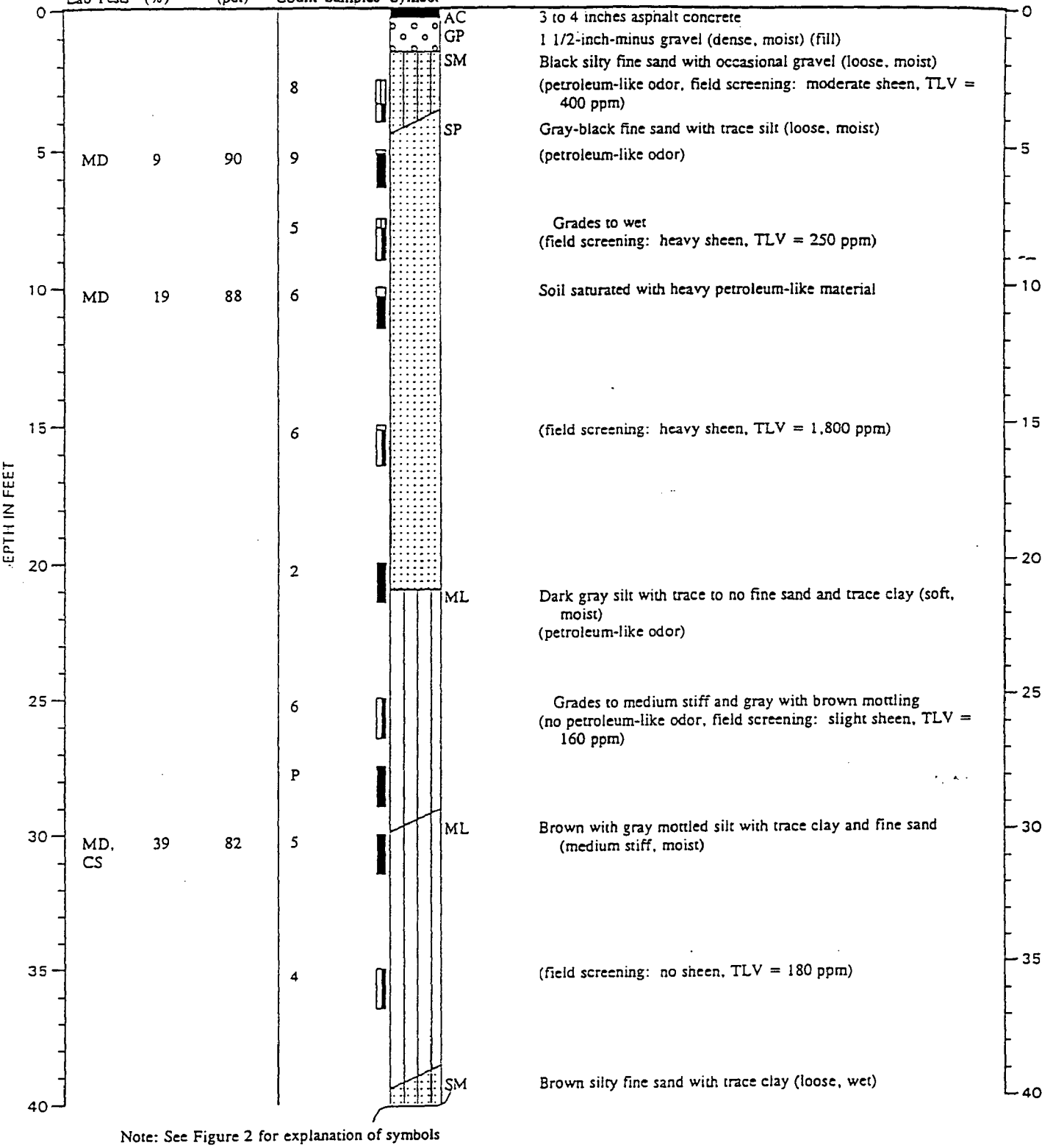
KEY TO BORING LOG SYMBOLS

FIGURE 4

Koppers022617

TEST DATA

BORING G-1



Note: See Figure 2 for explanation of symbols

GeoEngineers

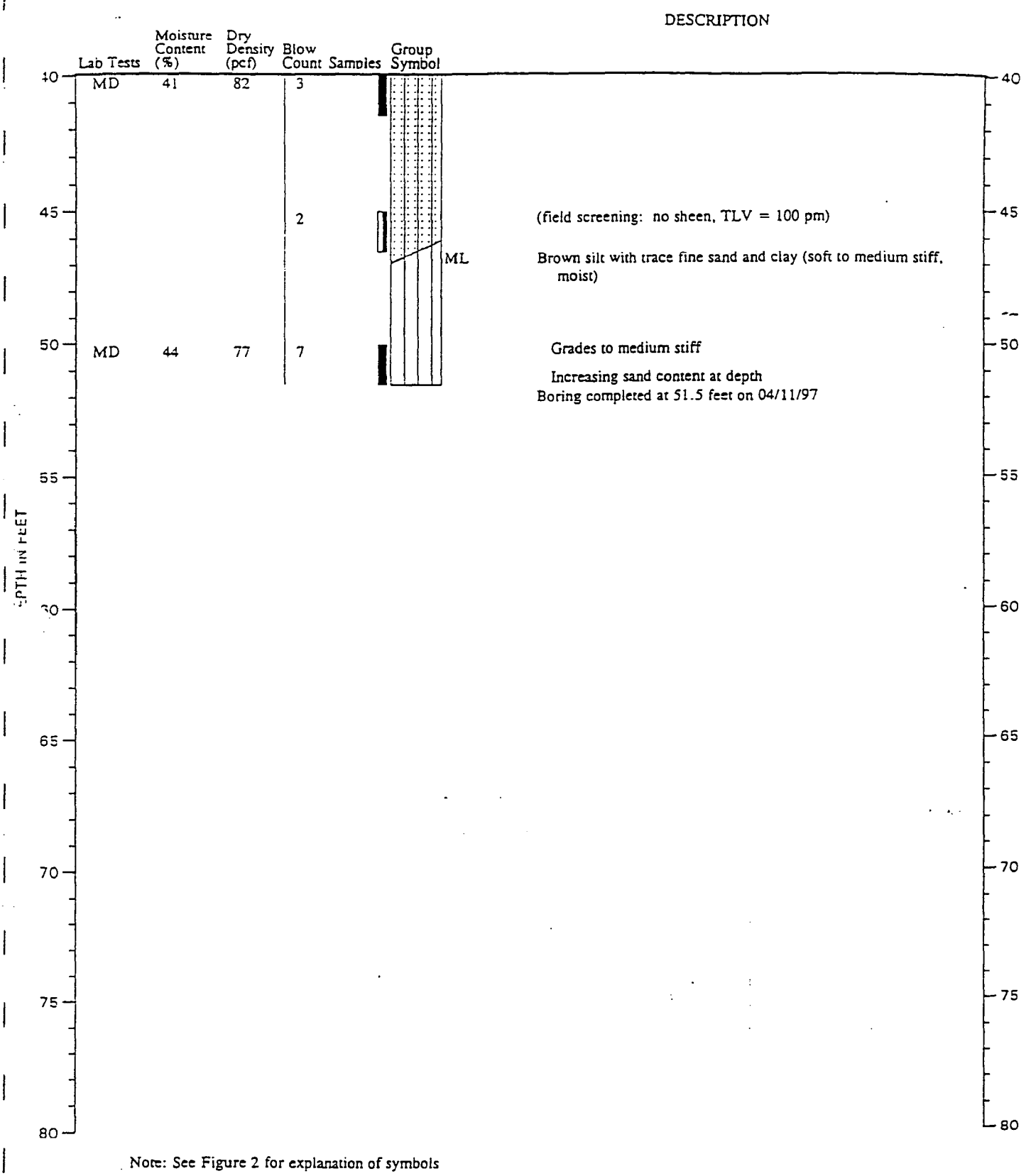
LOG OF BORING

FIGURE 5

Koppers022618

TEST DATA

BORING G-1
(Continued)



Note: See Figure 2 for explanation of symbols

Geo Engineers

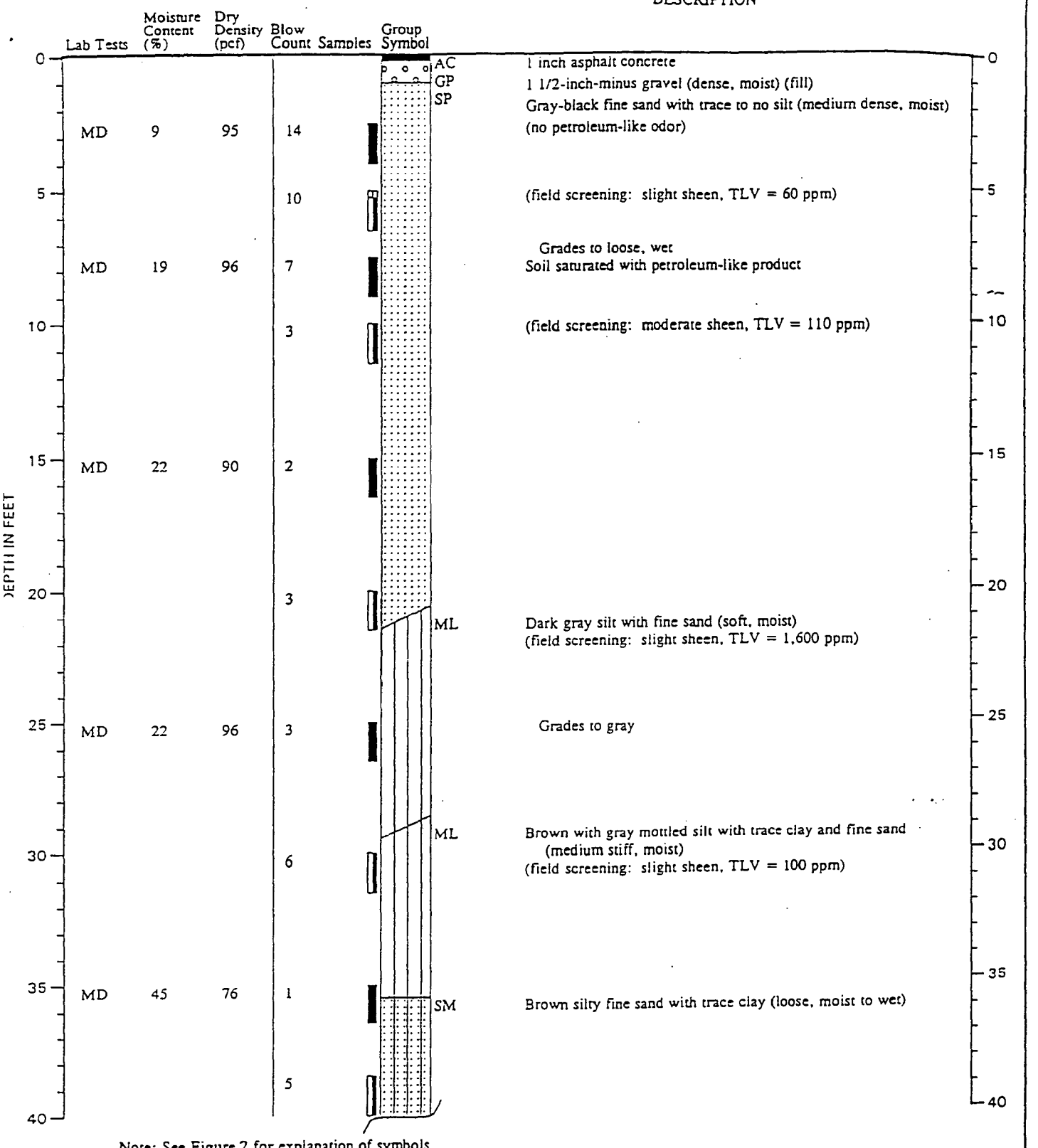
LOG OF BORING

FIGURE 5

Koppers022619

TEST DATA

BORING G-2



Note: See Figure 2 for explanation of symbols

GeoEngineers

LOG OF BORING

FIGURE 6

Koppers022620

TEST DATA

BORING G-2
(Continued)

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
						(field screening: no sheen, TLV = 100 ppm)
			9			
			15			(field screening: slight sheen, TLV = 100 ppm)
SM	32		28		SP	Gray-brown fine sand with silt (medium dense, wet) (field screening: no sheen, TLV = 40 ppm)
			50/1"		GM	Dark gray silty fine gravel (weathered bedrock) (very dense, wet) Boring completed at 58.6 feet on 04/12/97 because of refusal

DEPTH IN FEET

40 45 50 55 60 65 70 75 80

Note: See Figure 2 for explanation of symbols

Geo Engineers

LOG OF BORING

FIGURE 6

Koppers022621

Vandehey Soil Ex LLC

Operator : S.VAN/S.MES/W.MC CPT Date : 04-12-97 11:01 Sounding : SND433 Pg 1 / 1

Location : P1/KOPPERS PORT Client : GEO ENGINEERS Job No. : 582?

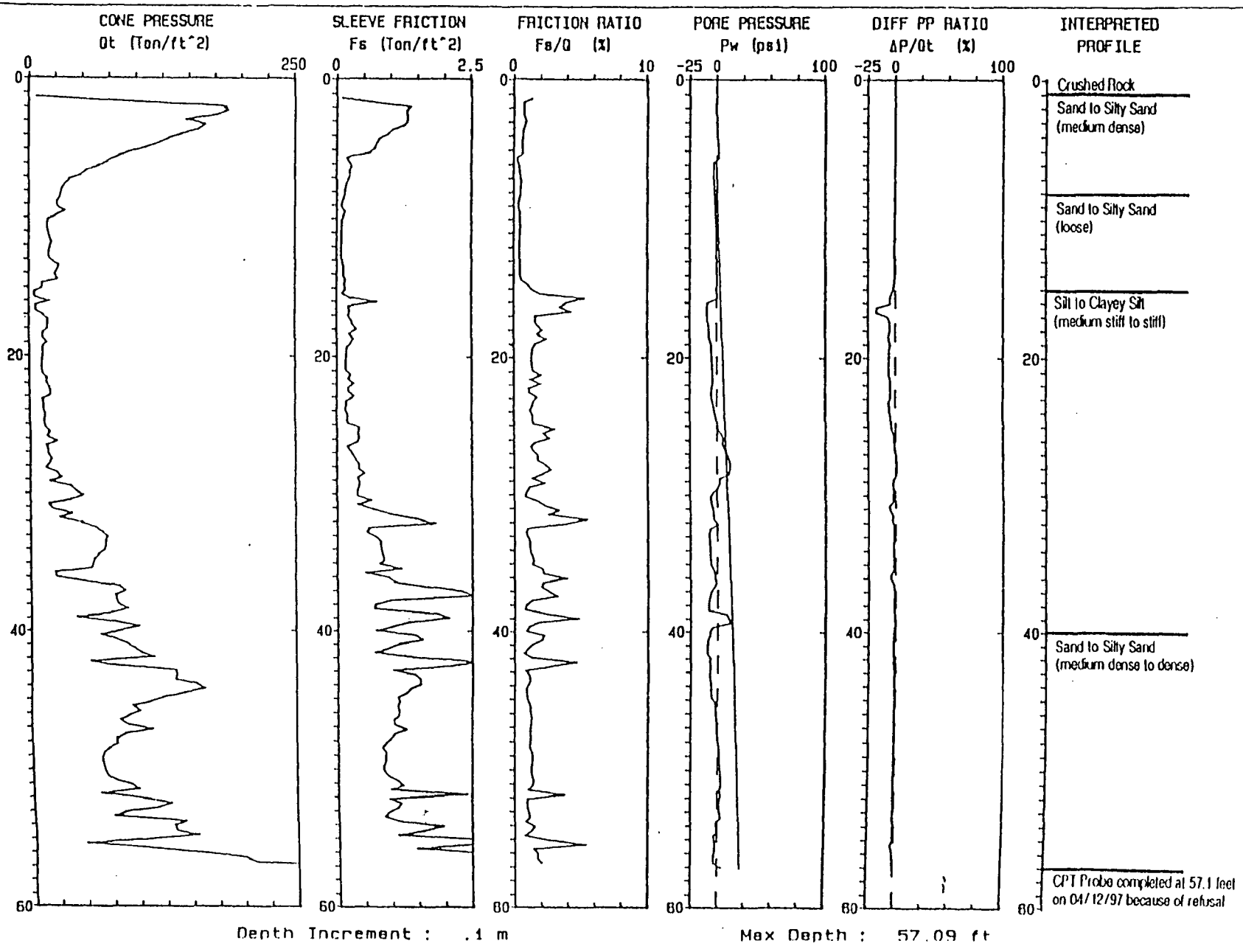


FIGURE 7

Koppers022622

Vandehey Soil Ex LLC

Operator : S.VAN/S.MES/W.MC CPT Date : 04-12-97 14:59 Sounding : SND434 Pg 1 / 1

Location : P2/KOPPERS PORT Client : GEO ENGINEERS Job No. : 5823-001-43

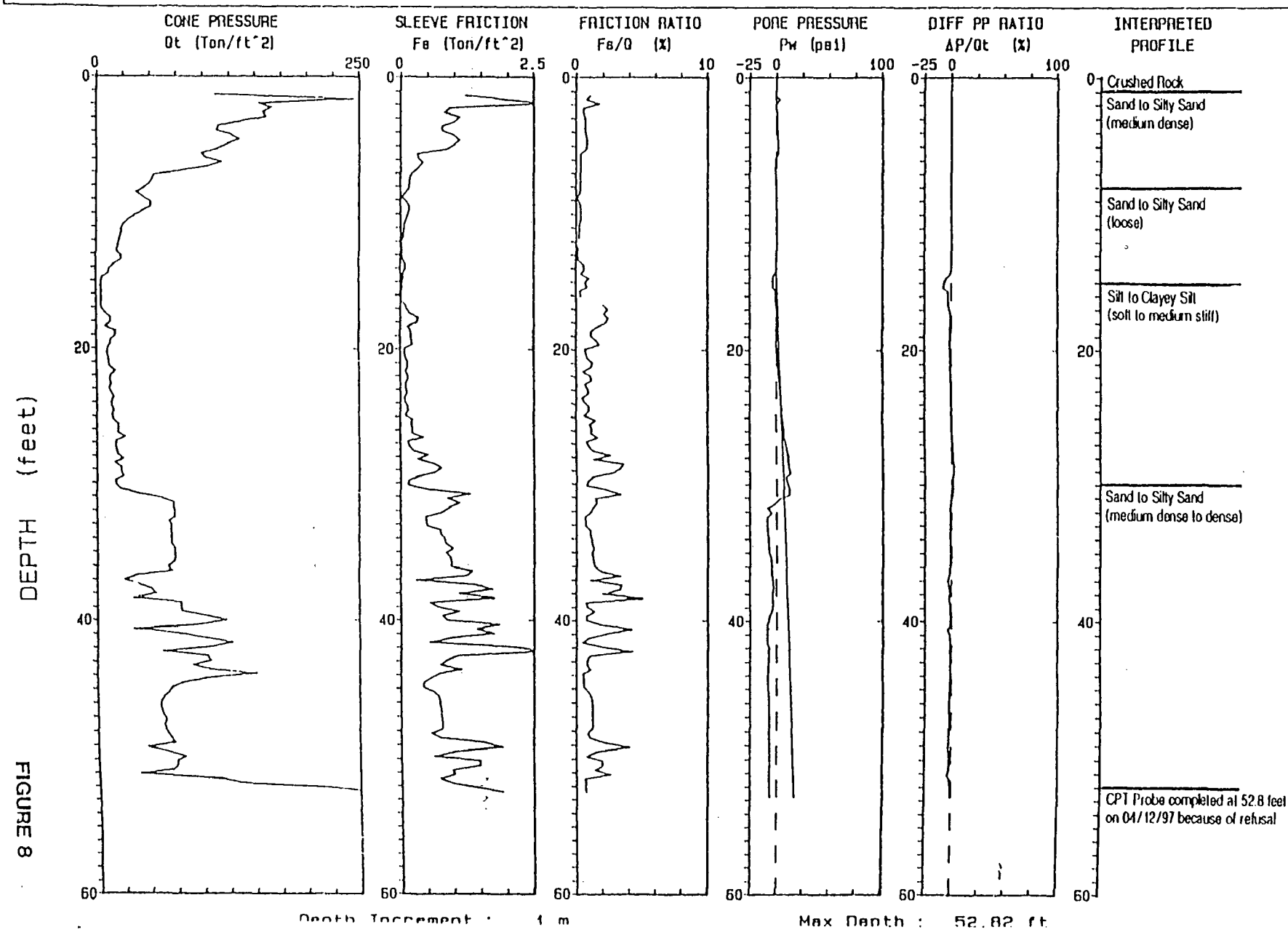


FIGURE 8

Koppers022623

APPENDIX B

Monitoring Well Construction Summary

Monitoring Well Logs

Koppers022624

TABLE B1 - Monitoring Well Construction Summary

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

Project #2708

Well Number	Date Installed	Date Decom-missioned	Installation Method	Monument Type	Screen Type	Slot Size	Sand Pack	Well Diam.	Ground Surface	Top of Casing		Boring Depth		Top Screen		Base Screen		Water Level 1-Jun-98		Top Silt Unit	
						(inches)	(Colorado)	(inches)	(feet msl)	(feet msl)	(feet bgs)	(feet bgs)	(feet msl)	(feet bgs)	(feet msl)	(feet bgs)	(feet msl)	(feet btc)	(feet msl)	(feet bgs)	(feet msl)
MW-1-22	24-Oct-95	-	Hollow-Stem Auger	Above-grade	Slotted PVC	0.020	10-20	2	32.0	34.75	(2.8)	22.0	10.0	11.0	21.0	21.0	11.0	14.49	20.26	22.5	9.5
MW-2-32	6-Nov-95	-	Hollow-Stem Auger	Flush	Slotted PVC	0.020	10-20	2	35.8	34.46	1.3	32.5	3.3	21.5	14.3	31.5	4.3	16.97	17.49	31.5	4.3
MW-3-26	1-Nov-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	31.2	34.11	(2.9)	26.0	5.2	15.0	16.2	25.0	6.2	16.61	17.50	25.0	6.2
MW-3-56	1-Nov-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	31.2	34.07	(2.9)	56.0	-24.8	45.0	-13.8	55.0	-23.8	16.51	17.56	25.0	6.2
MW-4-35	31-Oct-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	31.7	34.54	(2.8)	35.0	-3.3	24.0	7.7	34.0	-2.3	16.90	17.64	25.0	6.7
MW-4-57	30-Oct-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	31.7	34.53	(2.8)	57.0	-25.3	46.0	-14.3	56.0	-24.3	17.00	17.53	25.0	6.7
MW-5-32	27-Oct-95	-	Hollow-Stem Auger	Above-grade	Slotted PVC	0.020	10-20	2	25.1	27.83	(2.7)	32.0	-6.9	21.0	4.1	31.0	-5.9	10.33	17.50	16.0	9.1
MW-6-32	9-Nov-95	-	Hollow-Stem Auger	Flush	Continuous wrap stainless steel	0.020	10-20	2	35.8	35.51	0.3	32.0	3.8	21.0	14.8	31.0	4.8	15.75	19.76	30.5	5.3
MW-6-61	7-Nov-95	22-Dec-97	Hollow-Stem Auger	Flush	Continuous wrap stainless steel	0.020	10-20	2	35.8	34.50	1.3	61.0	-25.2	50.0	-14.2	60.0	-24.2	-	-	30.5	5.3
MW-8-29	26-Oct-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	36.5	39.09	(2.6)	29.0	7.5	18.0	18.5	28.0	8.5	20.05	19.04	27.5	9.0
MW-8-56	25-Oct-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	36.5	39.13	(2.6)	56.0	-19.5	45.0	-8.5	55.0	-18.5	21.63	17.50	27.5	9.0
MW-9-29	23-Oct-95	-	Hollow-Stem Auger	Flush	Slotted PVC	0.020	10-20	2	37.9	37.65	0.3	29.0	8.9	18.0	19.9	28.0	9.9	7.25	30.40	11.0	26.9
MW-10-25	9-Nov-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	36.5	39.22	(2.7)	25.0	11.5	14.0	22.5	24.0	12.5	14.63	24.59	23.5	13.0
MW-10-61	8-Nov-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	36.5	39.33	(2.8)	61.0	-24.5	50.0	-13.5	60.0	-23.5	14.36	24.97	23.5	13.0
MW-11-32	3-Nov-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	35.4	38.39	(3.0)	32.0	3.4	21.0	14.4	31.0	4.4	12.85	25.54	30.5	4.9
MW-12-36	23-Oct-95	-	Hollow-Stem Auger	Above-grade	Slotted PVC	0.020	10-20	2	35.9	38.69	(2.8)	36.0	-0.1	25.0	10.9	35.0	0.9	9.83	28.86	4.5	31.4
MW-13-30	19-Dec-97	-	Hollow-Stem Auger	Flush	Continuous wrap stainless steel	0.020	10-20	2	35.2	34.86	0.4	30.0	5.2	19.0	16.2	29.0	6.2	15.69	19.17	28.5	6.7
MW-13-61	18-Dec-97	-	Hollow-Stem Auger	Flush	Continuous wrap stainless steel	0.020	10-20	2	35.2	34.78	0.4	61.0	-25.8	50.0	-14.8	60.0	-24.8	17.11	17.67	28.5	6.7

Note: bgs = below ground surface btc = below top of casing msl = mean sea level PVC = polyvinyl chloride

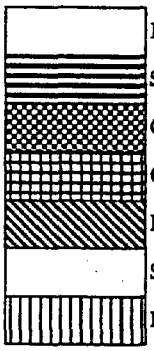
Koppers022625

KEY TO BORING LOGS

Soil classification in this report is based upon visual and manual field observations which include moisture, consistency, plasticity and grading estimates and should not be construed to imply field or laboratory testing unless presented herein. Soils are classified in accordance with the Unified Soil Classification System. Stratigraphic boundaries are approximate representations only. No warranty is provided as to the continuity of soil strata between borings.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)					
MAJOR DIVISIONS			GROUP SYMBOLS		TYPICAL NAMES
COURSE GRAINED SOILS	GRAVELS More Than Half the Course Fraction is Larger Than No. 4 Sieve Size	Clean Gravels With Little or No Fines	GW		Well Graded Gravels, Gravel-Sand Mixtures
			GP		Poorly Graded Gravels, Gravel-Sand Mixtures
		Gravels With Over 12% Fines	GM		Silty Gravels, Poorly Graded Gravel-Sand-Silt Mixtures
			GC		Clayey Gravels, Poorly Graded Gravel-Sand-Clay Mixtures
More Than Half is Larger Than #200 Sieve	SANDS More Than Half the Course Fraction is Smaller Than No. 4 Sieve Size	Clean Sands With Little or No Fines	SW		Well Graded Sands, Gravelly Sands
			SP		Poorly Graded Sands, Gravelly Sands
		Sands With Over 12% Fines	SM		Silty Sands, Poorly Graded Sand-Silt Mixtures
			SC		Clayey Sands, Poorly Graded Sand-Clay Mixtures
FINE GRAINED SOILS	SILTS AND CLAYS Liquid Limit Less Than 50%		ML		Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands, or Clayey Silts with Slight Plasticity
			CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL		Organic Clays and Organic Silty Clays of Low Plasticity
More Than Half is Smaller Than #200 Sieve	SILTS AND CLAYS Liquid Limit Greater Than 50%		MH		Inorganic Silts, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic Silts
			CH		Inorganic Clays of High Plasticity, Fat Clays
			OH		Organic Clays of Medium to High Plasticity, Organic Silts
HIGHLY ORGANIC SOILS			Pt		Peat and Other Highly Organic Soils

LEGEND FOR BORING LOGS



- Blank Casing
- Slotted Screen
- Cement Grout
- Concrete
- Bentonite
- Sand Pack
- Fill Material

ABBREVIATIONS

NA	Not Applicable
ND	Not Detected Above Detection Limit
NS	Not Sampled
PAH	Polynuclear Aromatic Hydrocarbons
ppm	Parts Per Million
SPT	Standard Penetration Test
▽	Measured Static Water Level in Well
▼	Estimated Water Level During Drilling

Updated: 7/2/98 RBE
File: Boring Log Key

HAHN AND ASSOCIATES, INC.

Koppers022626

HAHN & ASSOCIATES, INC.	MONITORING WELL NUMBER	MW-1-22		
434 NW Sixth Avenue	OWRD #			
Portland, Oregon				
(503) 796-0717	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT:	SAMPLING METHOD:	Core Barrel		
Northwest Natural Gas Co.	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	Time:	Time:
Gasco Facility	EQUIPMENT TYPE	B-59 Mobile Drill	11:30	13:10
Portland, Oregon	DRILLER:	Brad James	Date:	Date:
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations	24-Oct-95	24-Oct-95

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	32.0 Feet MSL
TOP OF CASING ELEVATION:	34.75 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS Total PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Steel Monument							-3 to -1			Ground surface
Concrete; 3/8-inch Bentonite; 2-inch ID PVC Casing	M1-01	1135	0.9	5.8			1			Surface: Sandy, Silty, GRAVEL - brown, moist, pieces of brick.
							2			
							3			Sandy GRAVEL (3.0-3.5 feet bgs) - brown, moist.
	M1-02	1150	1.1	12.8		3"	4			Sandy GRAVEL with silt (3.5-5.0 feet bgs) - brown, moist, no hydrocarbon odor, no sheen, lampblack at 4.0-4.5 feet bgs.
							5		GP	
							6			Sandy GRAVEL with small cobbles and bricks (5.0-10.0 feet bgs) - olive grey, moist to wet, no hydrocarbon odor, no sheen, lampblack from 5.0-5.4 feet bgs.
	M1-03	1158	4.1	-			7			
							8			
							9			
							10			
							11			Gravelly SAND with silt and pieces of brick (10.0-12.5 feet bgs) - moist, hydrocarbon odor, no sheen, wood fragments.
2-inch ID 0.010-inch PVC Slotted Screen	M1-04	1205	-	-			12			
							13			Gravelly SAND with silt and pieces of brick (10.0-12.5 feet bgs) - olive grey with blue staining, moist to wet, hydrocarbon odor, no sheen.
Colorado 10-20Sand Pack							14	10/24/95		
							15	▽	SP	Silty SAND with gravel (15.0-16.0 feet bgs) - brown with turquoise blue staining,wet, strong hydrocarbon odor.
							16			
							17			SAND (16.0-20.0 feet bgs) - olive grey, wet, fine grained, strong metallic sheen on core, black staining.
	M1-05	1220	1.4	-			18			
							19			
							20			

Koppers022627

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-1-22 OWRD #			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 11:30	DRILL FINISH Time: 13:10
	SAMPLING METHOD:	Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 24-Oct-95	Date: 24-Oct-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	32.0 Feet MSL
TOP OF CASING ELEVATION:	34.75 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS Total PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
10-20 Sand / Cap					21					
					9		21		SP	SAND (20.0-21.4 feet bgs) - black, wet, loose, poorly graded, fine grained, oily product coated, wood fragments. SILT (21.4-21.5 feet bgs) - moist, slight sheen?, wood fragments.
					20					
							22			
							23			SILT (21.5-25.0 feet bgs) - olive grey, moist, slightly plastic, no sheen, mild hydrocarbon odor
3/8-inch Bentonite										
	M1-06	1252		0.46			24		ML	
			0.7							
							25			
							26			Boring terminated at 20.0 feet bgs Boring sampled to 20.5 feet Monitoring well installed to 20.0 feet bgs Materials: 10 feet 2-inch diameter, 0.010-inch PVC slotted screen 15 feet 2-inch diameter PVC blank casing 14 50# bags 10/20 sand 6 50# bags bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts Well depth is 25.0 feet below top of casing
							27			
							28			
							29			
							30			
							31			
							32			* Sample Prefix Number is 2708-951024
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Koppers022628

HAHN & ASSOCIATES, INC.	MONITORING WELL NUMBER	MW-2-32	
434 NW Sixth Avenue	OWRD # 84235		
Portland, Oregon	HAI LOGGER: Rob Ede	DRILL START	DRILL FINISH
(503) 796-0717	SAMPLING METHOD: 3-inch Split Spoon/4-inch Core Barrel	Time:	Time:
PROJECT:	DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger	11:20	13:00
Northwest Natural Gas Co.	EQUIPMENT TYPE B-59 Mobile Drill		
Gasco Facility	DRILLER: Brad James	Date:	Date:
Portland, Oregon	DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.	6-Nov-95	6-Nov-95
PROJECT: 2708			

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch
SURFACE ELEVATION:	35.8 feet MSL
TOP OF CASING ELEVATION:	34.46 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS Total PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Flush Monument										Ground surface
Concrete	M2-01	1115	9.3	10.3			1		GM	Surface: Sandy, Silty, GRAVEL - moist, brown, well graded, stone for parking lot.
							2			
							3			SAND (1.5-4.0 feet bgs) - brown, slightly moist, loose, poorly graded, fine/medium grained, no hydrocarbon odor, slight sheen?.
	M2-02	1125		-			4			
			40.4				5		SP	
					9	60	6			SAND with gravel (5.0-6.5 feet bgs) - brown, slightly moist, loose, poorly graded, fine/medium grained, no hydrocarbon odor, slight sheen, lampblack in end of sampler.
					7	0				
					7	0	7			Sandy, Silty, GRAVEL (6.5-7.5 feet bgs) - lampblack, pieces of brick, concrete.
	M2-03	1135		-						
			43.7				8			Driller notes large concrete pieces at 8.5 feet bgs.
							9			
							10		GM	
					7	50				Sandy, Silty, GRAVEL (10.0-11.5 feet bgs) - as above, some lampblack, hydrocarbon odor, slight sheen.
					9	0	11			
					9	0	12			
							13			
					5	50				Sandy GRAVEL (12.5-14.0 feet bgs) - olive grey, moist, loose, hydrocarbon odor, sheen, brick in end of sampler.
					9	0				
					6	0	14			
							15		GP	
					6					Sandy GRAVEL (15.0-16.5 feet bgs) - large pieces of brick material, loose, hydrocarbon odor, sheen.
					9		16			
					50/5"					
							17			
							18			
	M2-04	1200	25.9	-	7	70				Gravelly Sand (17.5-19.0 feet bgs) - yellow/brown, moist, poorly graded, fine grained, no hycdrocarbon odor, no sheen, minor olive grey silt lenses.
					11	0				
					15	0	19		SP	
							20			

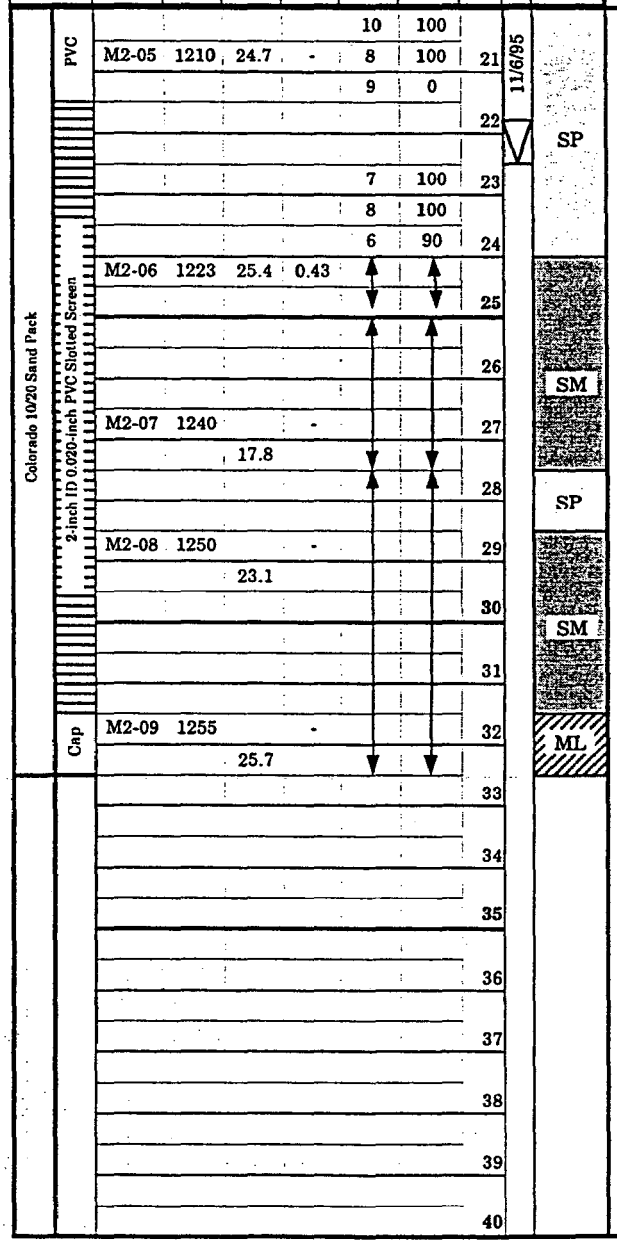
Bentonite Chips

2-inch ID Blank PVC Casing

Koppers022629

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-2-32 OWRD # 84235			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 11:20	DRILL FINISH Time: 13:00
	SAMPLING METHOD:	3-inch Split Spoon/4-inch Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 6-Nov-95	Date: 6-Nov-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch
SURFACE ELEVATION:	35.8 feet MSL
TOP OF CASING ELEVATION:	34.46 feet MSL



SOIL DESCRIPTION

SAND (20.0-21.5 feet bgs) - orange/brown, moist, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen.

SAND (22.5-23.0 feet bgs) - as above, wet, no hydrocarbon odor, no sheen.

SAND (23.0-24.0 feet bgs) - olive grey, wet, loose, fine grained, no hydrocarbon odor, no sheen.

Silty SAND (24.0-25.0 feet bgs) - wet, slightly dense, hydrocarbon odor?, no sheen, olive grey silt lenses.

Silty SAND (25.0-27.5 feet bgs) - wet, slightly dense, fine grained, slight hydrocarbon odor?, no sheen.

Silty SAND (27.5-28.5 feet bgs) - olive grey, wet, loose, fine grained, no hydrocarbon odor, no sheen.

Sandy SILT (31.5-32.5 feet bgs) - olive grey, orange oxidation spots, no hydrocarbon odor, no sheen, thin lenses of fine grained sand.

Boring terminated at 32.5 feet bgs
Boring sampled to 32.5 feet
Monitoring well installed to 31.5feet bgs
Well depth is 31.5 feet below top of casing

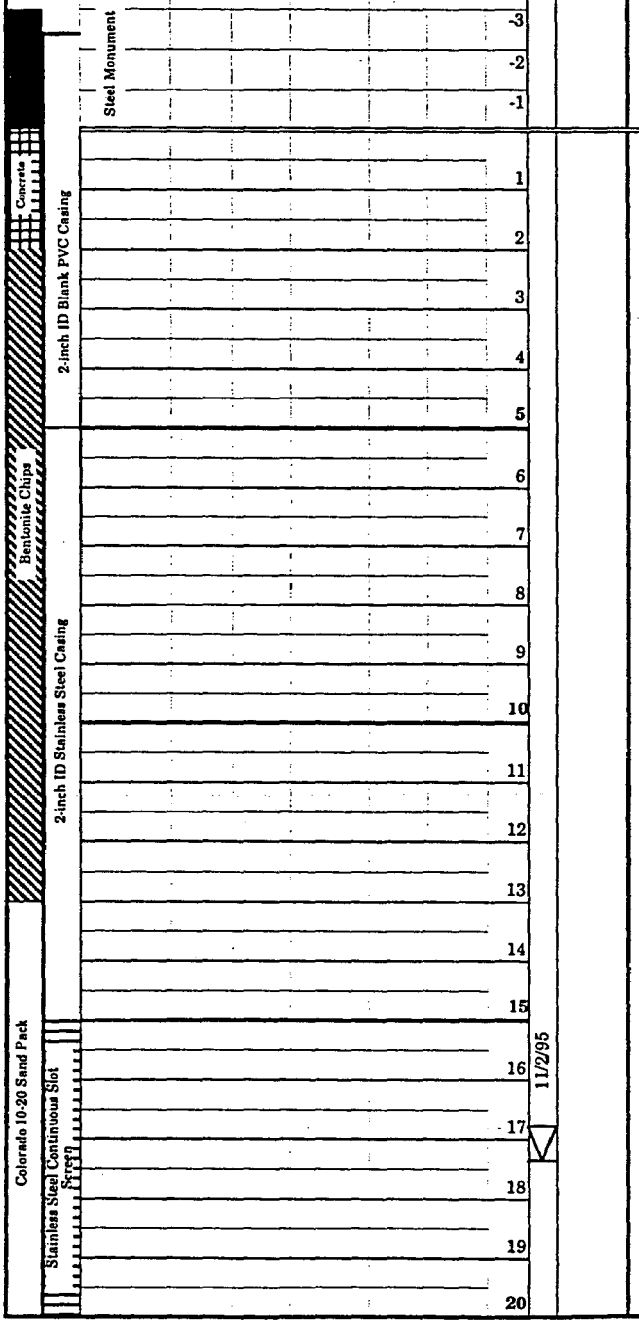
Materials:
10 feet 2-inch diameter, 0.020-inch PVC slotted screen
21.5 feet 2-inch diameter PVC blank casing
12 50# bags 10/20 sand
13 50# bags bentonite chips
1 end cap
1 locking cap
Flush steel monument

* Sample Prefix Number is 2708-951106-

Koppers022630

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW-3-26** **OWRD # 84232**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 15:10	DRILL FINISH Time: 9:00
	SAMPLING METHOD:	Not Sampled		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 1-Nov-95	Date: 2-Nov-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	31.20 feet MSL
TOP OF CASING ELEVATION:	34.11 feet MSL



SOIL DESCRIPTION

Ground surface

See boring log for well MW-3-56 for soil description.

Koppers022631

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-3-26 OWRD # 84232			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	Not Sampled	15:10	9:00
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations	1-Nov-95	2-Nov-95

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	31.20 feet MSL
TOP OF CASING ELEVATION:	34.11 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Colorado 10-20 Sand Pack 2-inch 20 Slot Stainless Screen Cap							21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40			Boring terminated at 26.0 feet bgs Monitoring well installed to 26.0 feet bgs Materials: 15 feet 2-inch diameter, 0.010-inch stainless steel slotted screen 10 feet 2-inch diameter stainless steel blank casing 5 feet 2-inch diameter PVC blank casing 12 50# bags 10/20 sand 7 50# bags bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts

Koppers022632

HAHN & ASSOCIATES, INC.	MONITORING WELL NUMBER	MW-3-56		
434 NW Sixth Avenue	OWRD # 84231			
Portland, Oregon				
(503) 796-0717	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT:	SAMPLING METHOD:	Core Barrel		
Northwest Natural Gas Co.	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	Time:	Time:
Gasco Facility	EQUIPMENT TYPE	B-59 Mobile Drill	8:00	11:00
Portland, Oregon	DRILLER:	Brad James	Date:	Date:
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations	1-Nov-95	1-Nov-95

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	31.20 feet MSL
TOP OF CASING ELEVATION:	34.07 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Steel Monument							-3			
							-2			
							-1			Ground surface
Concrete	M3-01	758	1.7				1			Surface - Sandy Silty Gravel - brown, moist, no hydrocarbon odor, no sheen, grassy area.
							2		GM	
Bentonite Chips					11	0	3			No Recovery (2.5-4.0 feet bgs).
2-inch ID Blank PVC Casing					12	0				
					15	0	4			
							5			
	M3-02	810	251		16	100				Sandy Silty GRAVEL (5.0-6.5 feet bgs) - brown with black tarry staining, moist, hydrocarbon odor, sheen, pockets of moist tar.
	M3-03	812	282		17	70	6			
					14	0				
							7			
	M3-04	817			9	100	8			Sandy Silty GRAVEL (7.5-9.0 feet bgs) - black and tarry, moist, hydrocarbon odor, sheen.
			247		11	100				
					17	50	9			
							10			
							11			
					50/3"	0				Large Gravels.
							12			
					50/3"	0	13			
							14			
							15			
Bentonite Grout	M3-05	840			16	100				Sandy GRAVEL with silt (15.0-16.5 feet bgs) - black, slightly moist, loose, hydrocarbon odor, sheen, brick and wood fragments.
2-inch ID Blank Stainless Steel Casing			59.7		38	100	16			
					50/3"	0			GM	
							17	11/1/95		
										Sandy GRAVEL (17.5-19.0 feet bgs) - olive grey,wet, loose, slight hydrocarbon odor, slight sheen, brick and wood fragments.
	M3-06	850			12	100	18			
			15.9		7	30				
					4	0	19		GP	Sandy Gravel (19.0-20.5 feet bgs) - as above, hydrocarbon odor, sheen.
					17	100				
	M3-07	9:00			18	100	20			

Koppers022633

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-3-56 **OWRD # 84231**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	Core Barrel	8:00	11:00
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations	1-Nov-95	1-Nov-95

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	31.20 feet MSL
TOP OF CASING ELEVATION:	34.07 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
			7.9		20	100				
					8	20	21			SILT with some gravel (20.5-21.0 feet bgs) - brown, moist, stiff, slight hydrocarbon odor, sheen.
							22		ML	SILT with gravel (21.0-25.0 feet bgs) - black tarry substance, moist to wet, hydrocarbon odor, sheen, 22.5-23.0 feet bgs is wet and tarry.
	M3-08	910								
			45.7				23		GP	
							24			
							25			
							26		ML	Sandy SILT (25.0-29.9 feet bgs) - olive grey with orange oxidized zones, moist, no hydrocarbon odor, no sheen, sand lens at 25.5 feet bgs.
							27			
	M3-09	915					28			
			5.8				29			
							30			
							31		SP	SAND (29.9-34.0 feet bgs) - olive grey, wet, loose, medium grained, slight hydrocarbon odor, slight sheen, sand lens at 25.5 feet bgs.
	M3-10	925								
			9.8				32			
							33			
							34			
	M3-11	930								SAND (34.0-35.0 feet bgs) - brown, wet, loose, fine grained, no hydrocarbon odor, no sheen, thin silt lenses present.
			2.8				35			SAND (35.0-37.5 feet bgs) - olive grey, wet, loose, poorly graded, fine grained, no hydrocarbon odor, no sheen.
							36			
	M3-12	955								
			9.8				37			
							38			SAND (37.5-39.0 feet bgs) - brown, wet, medium dense, fine grained, no hydrocarbon odor, no sheen, silt layers
	M3-13	1000								
			5.9				39			
							40		SM	Silty SAND (39.0-40.0 feet bgs) - brown, moist to wet, dense, fine grained, no hydrocarbon odor, no sheen.

Bentonite Grout
2-inch ID Blank Stainless Steel Casing
Bent.

Koppers022634

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW-3-56** **OWRD # 84231**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	8:00	11:00
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations	1-Nov-95	1-Nov-95

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	31.20 feet MSL
TOP OF CASING ELEVATION:	34.07 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bent. Chips / 2-inch Blank Stainless Steel Casing							41		SP	SAND (40.0-41.5 feet bgs) - olive grey, wet, loose, medium grained, no hydrocarbon odor, no sheen.
	M3-14	1010	19.0				42			SAND (41.5-45.0 feet bgs) - olive grey, wet, fine grained, silt layers.
							43			
	M3-15	1015	3.1				44			
							45			
Colorado 10-20Sand Pack / 2-inch ID 0.020-inch Stainless Steel Slotted Screen							46			SAND (45.0-49.0 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen.
							47			
							48			
	M3-16	1025	6.7				49			SAND (49.0-50.0 feet bgs) - as above, silt layers, no hydrocarbon odor, no sheen.
							50			SAND (50.0-55.0 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen, olive grey silt layers. Heaving sands reported by driller.
							51			
							52			Boring terminated at 56.5 feet bgs Boring sampled to 56.5 feet Monitoring well installed to 55 feet bgs
							53			
	M3-17	1048	-				54		SP	Materials: 10 feet 2-inch diameter, 0.010-inch PVC slotted screen 6.5 feet 2-inch diameter PVC blank casing 39.5 feet 2-inch diameter stainless steel blank casing 12 50# bags 10/20 sand 3 50# bags bentonite chips 4 bags bentonite grout 1 end cap 1 locking cap above-grade steel monument 3 guard posts
	M3-18	1050	-				55			
Cap					3	100				
					5	100	56			
					16	100	57			
							58			
							59			* Sample Prefix Number is 2708-951101-
							60			

Koppers022635

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW-4-35** **OWRD # 84230**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	Not Sampled	Time: 10:30	Time: 13:17
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 31-Oct-95	Date: 31-Oct-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
										BORING DIAMETER: 10-inch CASING DIAMETER: 2-inch ID SURFACE ELEVATION: 31.70 feet MSL TOP OF CASING ELEVATION: 34.54 feet MSL
Steel Monument							-3 -2 -1			Ground surface
Concrete 2-inch ID PVC Casing Bentonite Chips 2-inch ID Stainless Steel Casing							1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20			See boring log for well MW-4-57 for soil description.

Koppers022636

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-4-35 OWRD # 84230			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT: 2708	HAI LOGGER:	Rob Ede	DRILL START Time: 10:30 Date: 31-Oct-95	DRILL FINISH Time: 13:17 Date: 31-Oct-95
	SAMPLING METHOD:	Not Sampled		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James		
	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	31.70 feet MSL
TOP OF CASING ELEVATION:	34.54 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite Blank Stainless Steel Casing Colorado 10-20 Sand Pack 2-inch ID 0.020-inch Stainless Steel Continuous Slot Screen Cap							21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40	10/31/95		Boring terminated at 35.0 feet bgs Monitoring well installed to 35.0 feet bgs Materials: 10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen 14 feet 2-inch diameter stainless steel blank casing 8 feet 2-inch diameter PVC blank casing 11 50# bags 10/20 sand 14 50# bags bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts * Sample Prefix Number is 2708-951031-

Koppers022637

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW-4-57** OWRD # 84229		DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede		
	SAMPLING METHOD:	3-inch Split Spoon/Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	Time: 10:15	Time: 13:15
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 30-Oct-95	Date: 30-Oct-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	31.7 feet MSL
TOP OF CASING ELEVATION:	34.53 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Steel Monument							-3 to -1			Ground surface
Concrete Bentonite 2-inch ID Blank PVC Casing	M4-01	1005	1.9	195			1		SM	Surface: Silty SAND with gravel - brown, moist, pieces of brick, grass covered area, no hydrocarbon odor, no sheen.
							2			
					50/5.5"	60	3		GM	Silty Sandy GRAVEL (2.5 feet bgs) - brown, moist, well graded, no hydrocarbon odor, no sheen.
							4			
							5			
					23	70			GP	Sandy GRAVEL (5.0-6.5 feet bgs) - dry, loose, poorly graded, no hydrocarbon odor, no sheen.
					27	0	6			
					27	0	7			Silty GRAVEL with sand (7.5-8.5 feet bgs) - brown, moist, well graded, no hydrocarbon odor, no sheen.
	M4-02	1035		-	4	100	8		GM	
			2.8		50/5.5"	50	9			Concrete (8.5-9.5 feet bgs)
Bentonite Slurry 2-inch ID Blank Stainless Steel Casing					38	0	10		GM	
							11			
							12			No recovery (12.5-14.5 feet bgs)
					7	0	13			
					6	0				
					6	0	14			
					5	0	15			
	M4-03	1104	-	-	2	100				Silty GRAVEL with sand (15.0-16.5 feet bgs) - olive grey with some black staining, wet, well graded, slight hydrocarbon odor, slight sheen.
					4	0	16			
					5	0	17			Silty GRAVEL with sand (16.5-20 feet bgs) - as above, moist, hydrocarbon odor, slight sheen, pieces of brick, switch to core barrel sampler.
							18			
	M4-04	1110		-						
			10.2				19		GM	
							20			

Koppers022638

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW-4-57** **OWRD # 84229**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT: 2708	HAI LOGGER:	Rob Ede	DRILL START Time: 10:15 Date: 30-Oct-95	DRILL FINISH Time: 13:15 Date: 30-Oct-95
	SAMPLING METHOD:	3-inch Split Spoon/Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James		
	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	31.7 feet MSL
TOP OF CASING ELEVATION:	34.53 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite Slurry Concrete 2-inch ID Blank Stainless Steel Casing	M4-05	1115	7.0	-			21 22 23 24 25		ML	SILT with sand and gravel (20.0-25.0 feet bgs) - brown, moist, slightly plastic, no hydrocarbon odor, no sheen.
	M4-06	1135	10.2	3,261			26 27		SM	Silty SAND (25.0-27.0 feet bgs) - olive grey, moist to wet, wood fragments, hydrocarbon odor, sheen.
							28		ML	Sandy SILT (27.0-28.0 feet bgs) - olive grey with brown and orange oxidation spots, root zones, no hydrocarbon odor, no sheen.
	M4-07	1140	2.1	-			29 30	10/30/95	SM	Silty SAND (28.0-30.0 feet bgs) - olive grey with brown mottling, moist to wet, fine grained, root zones, no hydrocarbon odor, no sheen.
	M4-08	1150	2.4	-			31 32		SP	SAND (30.0-32.5 feet bgs) - olive grey, wet, loose, poorly graded, fine grained, root zones, hydrocarbon odor, sheen.
							33		ML	SILT (32.5-33.0 feet bgs) - brown with orange oxidized zones, moist, slightly plastic, no hydrocarbon odor, no sheen.
	M4-09	1155	2.6	-			34 35		SM	Silty SAND (33.0-33.5 feet bgs) - brown with bright orange oxidized zones, moist to wet, dense, fine grained.
							36 37 38 39		ML	SILT (33.5-35.0 feet bgs) - olive grey, moist, stiff, no hydrocarbon odor, no sheen. SILT with fine sand (35.0-39.0 feet bgs) - olive grey, moist, stiff, root zones, no hydrocarbon odor, no sheen.
	M4-10	1210	-	-			40		SP	SAND (39.0-40.0 feet bgs) - olive grey, wet, loose, medium grained, no hydrocarbon odor, no sheen.

Koppers022639

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-4-57 OWRD # 84229			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 10:15	DRILL FINISH Time: 13:15
	SAMPLING METHOD:	3-inch Split Spoon/Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 30-Oct-95	Date: 30-Oct-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	31.7 feet MSL
TOP OF CASING ELEVATION:	34.53 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite Chip Seal; 20/40; 2-inch ID Blank Stainless Steel Casing							41			SAND (40.0-44.0feet bgs) - as above, no hydrocarbon odor, no sheen.
							42		SP	
							43			
	M4-11	1220	8.7	-			44			
	M4-12	1225	-	-			45		ML	Sandy SILT (44.0-45.0 feet bgs) - olive grey, moist, stiff, slightly plastic, no hydrocarbon odor, no sheen.
							46			SAND (45.0-49.0 feet bgs) - olive grey, wet, loose, medium grained, no hydrocarbon odor, no sheen, thin silt layers from 49.0-50.0 feet bgs.
							47		SP	
	M4-13	1238	31.9	-			48			
							49			
Colorado 10-20 Sand Pack; 2-inch ID 0.020-inch Stainless Steel Slotted Screen							50			
							51			SAND (50.0-55.0 feet bgs) - as above, no hydrocarbon odor, no sheen.
							52			
							53			
							54			
	M4-14	1245	178	-			55			
							56			SAND (55.0-58.0 feet bgs) - as above, no hydrocarbon odor, no sheen.
Ca p							57		SP	
	M4-15	1312	17.5	0.26			58			
							59			
							60			

Koppers022640

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW-4-57** **OWRD # 84229**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	3-inch Split Spoon/Core Barrel	10:15	13:15
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations	30-Oct-95	30-Oct-95

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							61			Boring terminated at 58.0 feet bgs Boring sampled to 58.0 feet Monitoring well installed to 58.0 feet bgs Materials: 10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen 40.5 feet 2-inch diameter stainless steel blank casing 5.5 feet 2-inch diameter PVC blank casing 13 50# bags 10/20 sand 5 50# bags bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts * Sample Prefix Number is 2708-951030-
							62			
							63			
							64			
							65			
							66			
							67			
							68			
							69			
							70			
							71			
							72			
							73			
							74			
							75			
							76			
							77			
							78			
							79			
							80			

Koppers022641

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-5-32 OWRD # 84228			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT: 2708	HAI LOGGER:	Rob Ede	DRILL START Time: 13:03 Date: 27-Oct-95	DRILL FINISH Time: 15:00 Date: 27-Oct-95
	SAMPLING METHOD:	Split Spoon/Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James		
	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	25.1 feet MSL
TOP OF CASING ELEVATION:	28.05 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Steel Monument							-3 -2 -1			Ground surface
Concrete	M5-01	1306	1107	1.4			1			Surface: Silty GRAVEL - brown, moist, well graded, no hydrocarbon odor, no sheen.
							2		GP	
					50/5"	50	3			GRAVEL (2.5-3.0 feet bgs) - grey, damp, loose, poorly graded, no hydrocarbon odor, no sheen.
							4			
							5			
	M5-02	1320	874	-	10	100				
					6	0	6			Silty GRAVEL (5.0-6.0 feet bgs) - brown, moist, well graded, no hydrocarbon odor, no sheen.
					26	0	7	10/27/95	GM	
3/8-inch Bentonite Chips 2-inch ID Blank PVC Casing							8			GRAVEL (7.5-9.0 feet bgs) - brown, wet, loose, well graded, no hydrocarbon odor, no sheen.
					10	30				
					15	0	9			
					19	0	10			
	M5-03	1330	279	-	8	100			GP	GRAVEL with coarse sand and silt (10.0-13.0 feet bgs) - brown, wet, no hydrocarbon odor, no sheen.
					5	0	11			
					5	0				Switch to core barrel sampler.
							12			
	M5-04	1340	383	-			13			SAND with lampblack (13.0-15.0 feet bgs) - black, dry, hard, fine grained, hydrophobic, hydrocarbon odor.
							14			
							15			
	M5-05	1350	81.1	1,942			16		SP	SAND (15.0-20.0 feet bgs) - dark grey, moist, medium dense, poorly graded, fine grained, pieces of bark, hydrocarbon odor?, olive grey sandy silt on core bottom.
							17			
							18			
							19			
							20			

Koppers022642

HAHN & ASSOCIATES, INC.	MONITORING WELL NUMBER	MW-5-32		
434 NW Sixth Avenue	OWRD # 84228			
Portland, Oregon				
(503) 796-0717	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT:	SAMPLING METHOD:	Split Spoon/Core Barrel		
Northwest Natural Gas Co.	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	Time:	Time:
Gasco Facility	EQUIPMENT TYPE	B-59 Mobile Drill	13:03	15:00
Portland, Oregon	DRILLER:	Brad James	Date:	Date:
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations	27-Oct-95	27-Oct-95

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	25.1 feet MSL
TOP OF CASING ELEVATION:	28.05 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
	M5-06	1357	117	-			21		ML	Sandy SILT (20.0-22.0 feet bgs) - brown with orange mottling, moist, non-plastic, no hydrocarbon odor, no sheen, some root zones.
	M5-07	1400	18.1	0.91			22			SAND (22.5-22.5 feet bgs) - brown, wet, fine grained, no hydrocarbon odor, no sheen.
							23			SAND (22.5-23.5 feet bgs) - as above, no hydrocarbon odor, no sheen.
							24			Silty SAND (23.5-25.0 feet bgs) - brown with orange oxidation spots, wet, loose, no hydrocarbon odor, no sheen.
	M5-08	1406	62.1	-			25		SP	SAND (25.0-26.5 feet bgs) - brown with orange oxidation spots, wet, loose, fine grained, some thin silt layers no hydrocarbon odor, no sheen.
							26			
							27			SAND (26.5-27.5 feet bgs) - olive grey, wet, loose, poorly graded, some thin silt layers, no hydrocarbon odor, no sheen.
							28			SAND with thin silt layers (27.5-30.0 feet bgs) - olive grey, wet, loose, no hydrocarbon odor, no sheen.
	M5-09	1425	177	-			29			
							30			
					1	100				SAND with thin silt (30.0-32.0 feet bgs) - olive grey, wet, loose, poorly graded, fine grained, no hydrocarbon odor, no sheen.
					3	100	31			
					4	100				
	M5-10	1448	29.4	ND	4	70	32			Boring terminated at 32.0 feet bgs Boring sampled to 32.0 feet Monitoring well installed to 32.0 feet bgs
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Colorado 10-20 Sand Pack

2-inch ID 0.020-inch PVC Slotted Screen

Cap

Materials:
10 feet 2-inch diameter, 0.020-inch PVC slotted screen
21 feet 2-inch diameter PVC blank casing
12.5 50# bags 10/20 sand
10 50# bags 3/8-inch bentonite chips
1 end cap
1 locking cap
above-grade steel monument
3 guard posts

* Sample Prefix Number is 2708-951027-

Koppers022643

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-6-32 OWRD # 84239			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT: 2708	HAI LOGGER:	Rob Ede	DRILL START Time: 11:40 Date: 9-Nov-95	DRILL FINISH Time: 14:00 Date: 9-Nov-95
	SAMPLING METHOD:	Not Sampled		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James		
	DRILLING CONTRACTOR:	Geo-Tech Explorations		

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm) ~~LAB RESULTS~~ TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
									BORING DIAMETER: 10-inch CASING DIAMETER: 2-inch ID SURFACE ELEVATION: 35.8 feet MSL TOP OF CASING ELEVATION: 35.51 feet MSL
Flush Monument									Ground surface
Concrete 2-inch ID Blank PVC Casing 3/8-inch Bentonite Chips Stainless Steel Casing 10-20						1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20			See boring log for well MW-6-61 for soil description.

Koppers022644

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-6-32 OWRD # 84239			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 11:40 Date: 9-Nov-95	DRILL FINISH Time: 14:00 Date: 9-Nov-95
	SAMPLING METHOD:	Not Sampled		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James		
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.8 feet MSL
TOP OF CASING ELEVATION:	35.51 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Colorado 10-20 Sand Pack 2-inch ID 0.020 Stainless Steel Continuous Slotted Screen Cap							21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40			Boring terminated at 32.0 feet bgs Monitoring well installed to 32.0 feet bgs Materials: 15 feet 2-inch diameter, 0.020-inch stainless steel slotted screen 5 feet 2-inch diameter stainless steel blank casing 16 feet 2-inch diameter PVC blank casing 9.5 50# bags 10/20 sand 12 50# bags bentonite chips 1 end cap 1 locking cap flush steel monument 3 guard posts

Koppers022645

HAHN & ASSOCIATES, INC.	MONITORING WELL NUMBER	MW-6-61	
434 NW Sixth Avenue	OWRD # 84236	(ABANDONED)	
Portland, Oregon	HAI LOGGER: Rob Ede	DRILL START	DRILL FINISH
(503) 796-0717	SAMPLING METHOD: 4-inch Core Barrel		
PROJECT:	DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger	Time: 8:50	Time: 11:45
Northwest Natural Gas Co.	EQUIPMENT TYPE B-59 Mobil Drill		
Gasco Facility	DRILLER: Brad James	Date: 7-Nov-95	Date: 7-Nov-95
Portland, Oregon	DRILLING CONTRACTOR: Geo-Tech Explorations		
PROJECT: 2708			

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
										BORING DIAMETER: 10-inch
										CASING DIAMETER: 2-inch ID
										SURFACE ELEVATION: 35.8 feet MSL
										TOP OF CASING ELEVATION: 34.50 feet MSL
Flush Monument										Ground surface
Concrete										Surface: concrete.
Bentonite Chips							1			
							2			SAND (1.0-5.0 feet bgs) - brown, slightly moist, loose, poorly graded, medium grained, no hydrocarbon odor, slight sheen?.
	M6-01	905	16.9	ND			3		SP	
							4			
							5			
							6			SAND (5.0-10.0 feet bgs) - as above, no hydrocarbon odor, slight sheen?.
2-inch ID Blank PVC Casing	M6-02	910	17.0	-			7			
							8			
							9			
							10			
							11			SAND (10.0-16.5 feet bgs) - as above, no hydrocarbon odor, slight sheen?.
	M6-03	920	17.5	-			12			
							13			
							14			
							15			
Bentonite Slurry										
Blank Stainless Steel Casing	M6-04	930	15.1	-			16			
							17			
							18		SP	SAND (17.5-20.0 feet bgs) - as above, moist to wet, no hydrocarbon odor, no sheen, dark grey sand at 19.5 feet bgs.
							19	11/7/95		
	M6-05	940	11.0	-			20	▽		

Koppers022646

HAHN & ASSOCIATES, INC.	MONITORING WELL NUMBER	MW-6-61	
434 NW Sixth Avenue	OWRD # 84236	(ABANDONED)	
Portland, Oregon	HAI LOGGER: Rob Ede	DRILL START	DRILL FINISH
(503) 796-0717	SAMPLING METHOD: 4-inch Core Barrel	Time:	Time:
PROJECT:	DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger	8:50	11:45
Northwest Natural Gas Co.	EQUIPMENT TYPE B-59 Mobil Drill	Date:	Date:
Gasco Facility	DRILLER: Brad James	7-Nov-95	7-Nov-95
Portland, Oregon	DRILLING CONTRACTOR: Geo-Tech Explorations		
PROJECT: 2708			

BORING DIAMETER: 10-inch
CASING DIAMETER: 2-inch ID
SURFACE ELEVATION: 35.8 feet MSL
TOP OF CASING ELEVATION: 34.50 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite Slurry; 2-inch ID Blank Stainless Steel Casing							21		SP	SAND (20.0-24.0 feet bgs) - as above, wet, hydrocarbon odor, no sheen.
							22			
	M6-06	945	-				23			
			9.1				24			
							25			
							26			SAND (25.0-30.5 feet bgs) - as above, wet, hydrocarbon odor, brown product saturated from 28-30.5 feet bgs, also thin silt layers.
							27			
							28			
	M6-07	1000	-							
			115				29			
							30			
	M6-08	1015		20,614						
			634				31			SILT (30.5-34.0 feet bgs) - green, stiff, root zones, no product, wood fragments, slight sheen?.
							32			
	M6-09	1020	-				33			
			23.9				34			
							35		ML	
							36			SILT (35.0-38.0 feet bgs) - green with brown motting (35.0-36.0 feet bgs), olive grey (36.0-38.0 feet bgs), moist, stiff, root zones, no sheen, no product.
							37			
							38			Sandy SILT (38.0-39.0 feet bgs) - olive grey, stiff, no sheen.
	M6-10	1040		1.5			39			Sandy SILT (39.0-40.0 feet bgs) - olive grey, wet, stiff.
			14.8				40			

Koppers022647

HAHN & ASSOCIATES, INC.	MONITORING WELL NUMBER	MW-6-61	
434 NW Sixth Avenue	OWRD # 84236	(ABANDONED)	
Portland, Oregon			
(503) 796-0717	HAI LOGGER: Rob Ede	DRILL START	DRILL FINISH
PROJECT:	SAMPLING METHOD: 4-inch Core Barrel		
Northwest Natural Gas Co.	DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger	Time: 8:50	Time: 11:45
Gasco Facility	EQUIPMENT TYPE B-59 Mobil Drill		
Portland, Oregon	DRILLER: Brad James	Date: 7-Nov-95	Date: 7-Nov-95
PROJECT: 2708	DRILLING CONTRACTOR: Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.8 feet MSL
TOP OF CASING ELEVATION:	34.50 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
Bentonite Slurry; Bentonite Chip Seal; 20/40 Sand; 2-inch ID Blank Stainless Steel Casing					41	ML	SILT (40.0-49.0 feet bgs) - olive grey, moist, medium stiff, fine grained sand lenses, no sheen.
					42		
					43		
	M6-11	1050	14.8	0.06	44		
					45		
					46		
					47		
					48		
	M6-12	1100	12.8	-	49		
					50	SP	SAND (49.0-52.0 feet bgs) - olive grey, wet, loose, poorly graded, fine grained, no sheen.
Coloroado 10-20 Sand Pack; 2-inch ID 0.020-inch Stainless Steel Slotted Screen					51		
					52		
					53		SAND (52.0-55.0 feet bgs) - as above, thin, brown silt layers, no sheen.
	M6-13	1120	8.4	-	54		
					55		
					56		SAND (55.0-60.0 feet bgs) - as above, thin olive grey silt layers, no sheen
					57		
	M6-14	1140	7.8	-	58		
					59		
					60		

Koppers022648

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER**	**MW-6-61**
	OWRD # 84236	(ABANDONED)
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER: Rob Ede SAMPLING METHOD: 4-inch Core Barrel DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger EQUIPMENT TYPE B-59 Mobil Drill DRILLER: Brad James	DRILL START Time: 8:50 Date: 7-Nov-95 DRILL FINISH Time: 11:45 Date: 7-Nov-95
PROJECT: 2708	DRILLING CONTRACTOR: Geo-Tech Explorations	

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
Sand / Cap							61		
							62		
							63		
							64		
							65		
							66		
							67		
							68		
							69		
							70		
							71		
							72		
							73		
							74		
							75		
							76		
							77		
							78		
							79		
							80		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.8 feet MSL
TOP OF CASING ELEVATION:	34.50 feet MSL

SOIL DESCRIPTION

Boring terminated at 61.0 feet bgs
Boring sampled to 60.0 feet
Monitoring well installed to 61.0 feet bgs
Well depth is 61.0 feet below top of casing

Materials:
10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen
35 feet 2-inch diameter stainless steel blank casing
15 feet 2-inch diameter PVC casing
1 50# bags 20/40 sand
11 50# bags 10/20 sand
5 50# bags bentonite chips
5 bags bentonite grout
1 end cap
1 locking cap
Flush steel monument

* Sample Prefix Number is 2708-951107-

Koppers022649

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW-8-29** **OWRD # 84226**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 8:30	DRILL FINISH Time: 11:15
	SAMPLING METHOD:	Not Sampled		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 26-Oct-95	Date: 26-Oct-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	39.09 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Steel Monument							-3 -2 -1			Ground surface
Concrete 2-inch ID Blank PVC Casing 3/8-inch Bentonite Chips 2-inch ID Blank Stainless Steel Casing Colorado 10-20 Sand Pack							1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20			See boring log for well MW-8-56 for soi description.

Koppers022650

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW-8-29** **OWRD # 84226**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 8:30	DRILL FINISH Time: 11:15
	SAMPLING METHOD:	Not Sampled		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 26-Oct-95	Date: 26-Oct-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	39.09 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Colorado 10-20 Sand Pack 2-inch ID 0.020-inch Stainless Steel Slotted Screen Cap							21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40			Boring terminated at 29.0 feet bgs Monitoring well installed to 29.0 feet bgs Materials: 10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen 13 feet stainless steel blank casing 3 feet 2-inch diameter PVC blank casing 12 50# bags 10/20 sand 13 50# bags 3/8-inch bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts

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HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW-8-56** **OWRD # 84226**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	3-inch Split Spoon/Core Barrel	Time:	Time:
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	905	1410
	EQUIPMENT TYPE	B-59 Mobil Drill	Date:	Date:
	DRILLER:	Brad James	25-Oct-95	25-Oct-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	39.13 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Steel Monument							-3 to -1			Ground surface
Concrete; 2-inch ID Blank PVC Casing	M8-01	900	5.9	281			1		SM	Surface: Silty SAND with gravel - brown, moist, no hydrocarbon odor, no sheen.
							2			
					6	100	3			Tarry GRAVEL - black, moist, strong hydrocarbon odor, liquied-viscous tar from 5-6.5 feet bgs, sand and silt mix from 8.5-10.5 feet bgs.
					15	0				
					29	0	4			
							5			
2-inch ID Blank Stainless Steel Casing	M8-02	915		-	6	100				
			84.8		7	20	6			
					12	0			GP	
							7			
							8			
	M8-03	945	-	-	5	100	9			
					9	10				
					10	0	10			
					8	100				
					15	100	11			
					13	0				Silty GRAVEL (10.5-11.5 feet bgs) - brown and tan mottled, some black staining, moist, hydrocarbon odor.
							12			
							13			Silty GRAVEL (12.5-13.0 feet bgs) - olive grey, moist, slight hydrocarbon odor, no sheen.
	M8-04	1002	-	-	10	100				Silty GRAVEL (13.0-14.0 feet bgs) - loose, pieces of brick, moist, slight hydrocarbon odor, no sheen.
					11	100	14			
					13	50				
							15		GM	
						0				No Recovery (15.0-16.0 feet bgs).
						0	16	10/25/95		
					11					Silty GRAVEL (16.0-17.0 feet bgs) - black, hydrophobic, lampblack?, poor recovery.
					50/1"		17			
							18			Silty GRAVEL (17.5-20.0 feet bgs) - brown, wet, no hydrocarbon odor, no sheen, brick and wood fragments.
	M8-05	1025	-	-			19			
3/4-inch Bentonite Chips							20			

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HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-8-56 OWRD # 84226			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT: 2708	HAI LOGGER:	Rob Ede	DRILL START Time: 905 Date: 25-Oct-95	DRILL FINISH Time: 1410 Date: 25-Oct-95
	SAMPLING METHOD:	3-inch Split Spoon/Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James		
	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	39.13 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4-inch Bentonite Chips 2-inch ID Blank Stainless Steel Casing							21		GM	Silty GRAVEL (20.0-22.0 feet bgs) - brown, wet, brick and wood fragments, no hydrocarbon odor, no sheen.
	M8-06	1034	5.0	-			22			
	M8-07	1044	13.3	-	9 50/3"	100 100	23 24 25		SP lampblack	SAND (22.0-25.0 feet bgs) - black, wet, loose, coarse grained, lampblack throughout, hydrocarbon odor, sheen, becoming solid and brittle with a slight sheen from 23.0-23.3 feet bgs.
							26		ML	Tarry SILT (25.0-27.5 feet bgs) - black, wet, stiff, mostly tar, strong sheen, vegetation throughout sample.
	M8-08	1115	225	-			27 28 29 30			SILT (27.5-30.0 feet bgs) - olive grey, moist, stiff, vegetation, tar within root zones, sheen.
							31 32 33 34			SILT (30.0-35.0 feet bgs) - olive grey, moist, stiff, semi-viscous tar within root zones.
3/4-inch Bentonite Chips 2-inch ID Blank Stainless Steel Casing	M8-09	1134	81.5	-			35 36 37 38		ML	Sandy SILT (35.0-40.0 feet bgs) - brown, orange-mottled, moist, stiff, tar within root zones.
	M8-10	1152	-	-			39 40			

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HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-8-56 OWRD # 84226		DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	Time: 905	Time: 1410
	SAMPLING METHOD:	3-inch Split Spoon/Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James	Date: 25-Oct-95	Date: 25-Oct-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	39.13 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
3/4-inch Bentonite Chips; 2-inch ID Blank Stainless Steel Casing					41	ML	Sandy SILT (40.0-42.0 feet bgs) - as above.
					42	SP	SAND (42-42.3 feet bgs) - olive grey, medium grained, black product saturated, less viscous than tar.
					43	ML	SILT (42.3-42.8 feet bgs) - olive grey, medium grained, black product saturated.
					44		
	M8-11	1202	112	8.1	45	SP	SAND (42.8-45 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, no product, slight sheen.
					46		SAND (45.0-47.5 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, no sheen.
	M8-12	1245		-	47		
			43.7		48		SAND (47.5-50.0 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, some thin silt layers, no sheen.
Colorado 10-20 Sand Pack; 2-inch ID 0.020-inch Stainless Steel Slotted Screen					49		
	M8-13	1314	-	-	50		
					51		SAND (50.0-54.0 feet bgs) - as above, no hydrocarbon odor, no sheen.
	M8-14	1320	-	-	52		
					53		
					54		
					55	SP	SAND (54.0-56.0 feet bgs) - as above, no hydrocarbon odor, no sheen.
Cap	M8-15	1400	-	0.64	56		
					57		
					58		
					59		
					60		

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HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW-8-56** **OWRD # 84226**		
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT: 2708	HAI LOGGER: Rob Ede SAMPLING METHOD: 3-inch Split Spoon/Core Barrel DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger EQUIPMENT TYPE B-59 Mobil Drill DRILLER: Brad James DRILLING CONTRACTOR: Geo-Tech Explorations	DRILL START Time: 905 Date: 25-Oct-95	DRILL FINISH Time: 1410 Date: 25-Oct-95

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
							61		
							62		
							63		
							64		
							65		
							66		
							67		
							68		
							69		
							70		
							71		
							72		
							73		
							74		
							75		
							76		
							77		
							78		
							79		
							80		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	39.13 feet MSL

SOIL DESCRIPTION

Boring terminated at 56.0 feet bgs
Boring sampled to 56.0 feet
Monitoring well installed to 56.0 feet bgs

Materials:
10 feet 2-inch diameter, 0.020-inch stainless steel slotted screen
40.5 feet 2-inch diameter stainless steel blank casing
4.5 feet 2-inch diameter PVC blank casing
11 50# bags 10/20 sand
26 50# bags bentonite chips
1 end cap
1 locking cap
above-grade steel monument
3 guard posts

* Sample Prefix Number is 2708-951025-

Koppers022655

HAHN & ASSOCIATES, INC.	MONITORING WELL NUMBER	MW-9-29	
434 NW Sixth Avenue	OWRD # 84223		
Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START / DRILL FINISH
(503) 796-0717	SAMPLING METHOD:	3-inch Split Spoon	
PROJECT:	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	Time: 9:30 / Time: 12:30
Northwest Natural Gas Co.	EQUIPMENT TYPE	B-59 Mobile Drill	
Gasco Facility	DRILLER:	Brad James	Date: 23-Oct-95 / Date: 23-Oct-95
Portland, Oregons	DRILLING CONTRACTOR:	Geo-Tech Explorations	
PROJECT: 2708			

BORING DIAMETER:	10-inch OD
CASING DIAMETER:	2-inch
SURFACE ELEVATION:	37.9 feet MSL
TOP OF CASING ELEVATION:	37.65 MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Flush Monument										Ground surface
Concrete	M9-01	855	0.4	21.5			1		GW	Surface: Sandy GRAVEL - grey gravel, olive grey sand, moist, non-plastic, well graded, no hydrocarbon odor, no sheen.
							2			
					9	100			GM	Sandy, Silty GRAVEL (2.0-3.0 feet bgs) - brown, moist, loose, non-plastic, well graded, slight hydrocarbon odor, slight sheen.
	M9-02	935	5.5	-	15	100	3			SAND (3.0-3.5 feet bgs) - brown, moist, loose, poorly graded, fine grained.
					14	50			SP	
					2	100	4		ML	Gravelly SILT (3.5-4.5 feet bgs) - brown, moist, stiff, poorly graded, wire present, no hydrocarbon odor, no sheen.
	M9-03	940	0.7	-	5	100				SAND (4.5-5.0 feet bgs) - brown, moist, loose, poorly graded, fine grained, no hydrocarbon odor, no sheen.
					7	70	5		SP	
	M9-04	950	1.3	163	2	100				Sandy SILT (5.0-6.5 feet bgs) - orange/brown with black and blue/grey staining, moist, slight hydrocarbon odor?, sheen is blue/green in color.
					5	0	6		ML	
					50/2"	0				
							7			
							8			CONCRETE
Bentonite Chips							9			
2-inch ID Blank PVC Casing							10			
							11			
										Sandy SILT (11.5-13.0 feet bgs) - brown, moist to wet, slightly plastic, very fine sand, no hydrocarbon odor, no sheen.
	M9-05	1045		0.52	13	100	12			
			6.7		8	30				SILT (13.0-15.0 feet bgs) - brown, moist to wet, stiff, slightly plastic, no hydrocarbon odor, no sheen.
					5	0	13			
					3	100			ML	SILT (15.0-15.5 feet bgs) - as above, no hydrocarbon odor, no sheen.
	M9-06	1055		-	3	100	14			
			8.8		4	100				Sandy SILT (15.5-16.0 feet bgs) - brown, moist to wet, slightly stiff, no hydrocarbon odor, no sheen.
					8	50	15	10/23/95		
20-40					2	0				
					2	100	16			
	M9-07	1120		-	3	100				SAND with muscovite (16.0-17.0 feet bgs) - brown, wet, no hydrocarbon odor, no sheen.
			20.9		6	100	17			
					2	100			SP	SAND (17.0-18.5 feet bgs) - as above, no hydrocarbon odor, no sheen.
					3	100	18			
Colorado 10-20 Sand Pack					5	100				
					2	100	19			SILT (18.5-20.0 feet bgs) - brown, moist to wet, stiff, no hydrocarbon odor, no sheen.
					4	100			ML	
					8	100	20			

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HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-9-29 OWRD # 84223			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregons PROJECT: 2708	HAI LOGGER: Rob Ede SAMPLING METHOD: 3-inch Split Spoon DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger EQUIPMENT TYPE B-59 Mobile Drill DRILLER: Brad James DRILLING CONTRACTOR: Geo-Tech Explorations	DRILL START Time: 9:30 Date: 23-Oct-95	DRILL FINISH Time: 12:30 Date: 23-Oct-95

BORING DIAMETER:	10-inch OD
CASING DIAMETER:	2-inch
SURFACE ELEVATION:	37.9 feet MSL
TOP OF CASING ELEVATION:	37.65 MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Colorado 10-20 Sand Pack 2-inch ID 0.010-inch PVC Slotted Screen Cap					2	100				
					3	100	21			SAND (20.0-24.0 feet bgs) - brown, wet, stiff, fine grained, muscovite present 20.0-21.5 feet bgs, no hydrocarbon odor, no sheen.
	M9-08	1140		-	3	100				
			9.5		2	100	22		SP	
					2	100				
					9	90	23			
					3	100				
					6	100	24			
	M9-09	1200	-	-	16	100				
					25	90	25		ML	Sandy SILT (24.0-25.0 feet bgs) - brown, moist to wet, stiff, no hydrocarbon odor, no sheen.
					5	100				
					8	100	26		SP	SAND (25.0-26.0 feet bgs) - olive grey, wet, loose, fine grained, no hydrocarbon odor, no sheen.
					12	70			ML	Sandy SILT (26.0-26.5 feet bgs) - brown, wet, stiff, slighlty plastic, no hydrocarbon odor, no sheen.
					3	100	27		SP	SAND (26.7-27.5 feet bgs) - brown, wet, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen.
	M9-10	1210		-	5	100				SILT (27.5-28.0 feet bgs) - brown, moist to wet, stiff, no hydrocarbon odor, no sheen.
			2.0		12	80	28		ML	
							29			
							30			
							31			Boring terminated at 29.0 feet bgs Boring sampled to 28.0 feet Monitoring well installed to 29.0 feet bgs
							32			
							33			Materials: 10 feet 2-inch diameter, 0.010-inch PVC slotted screen 18 feet 2-inch diameter PVC blank casing 1 50# bags 20/40 sand 12 50# bags 10/20 sand 10 50# bags bentonite chips 1 end cap 1 locking cap Flush steel monument
							34			
							35			
							36			* Sample Prefix Number is 2708-961023-
							37			
							38			
							39			
							40			

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HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-10-25 OWRD # 84238		
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT: 2708	HAI LOGGER: Rob Ede SAMPLING METHOD: Not Sampled DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger EQUIPMENT TYPE B-59 Mobil Drill DRILLER: Brad James DRILLING CONTRACTOR: Geo-Tech Explorations	DRILL START Time: 9:00 Date: 9-Nov-95	DRILL FINISH Time: 10:00 Date: 9-Nov-95

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
										BORING DIAMETER: 10-inch CASING DIAMETER: 2-inch ID SURFACE ELEVATION: 36.5 feet MSL TOP OF CASING ELEVATION: 39.22 feet MSL
Steel Monument							-3 -2 -1			Ground surface
Concrete 2-inch ID Blank PVC Casing							1 2 3 4 5			See boring log for well MW-10-61 for soi description.
Bentonite Chips 2-inch ID Blank Stainless Steel Casing							6 7 8 9 10 11 12 13 14			
Colorado 10-20 Sand Pack 20 Slot Stainless Steel Continuous Screen							15 16 17 18 19 20			

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HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW-10-25** **OWRD # 84238**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 9:00	DRILL FINISH Time: 10:00
	SAMPLING METHOD:	Not Sampled		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James	Date: 9-Nov-95	Date: 9-Nov-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	39.22 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Colorado 10-20 Sand Pack 20-Slot Stainless Steel Screen Cap							21 22 23 24 25			Boring terminated at 25.0 feet bgs Monitoring well installed to 25.0 feet bgs Materials: 10 feet 2-inch diameter, 0.020-inch stainless steel slotted screen 5 feet 2-inch diameter PVC blank casing 9 feet stainless steel blank casing 11 bags 10/20 sand 6 50# bags bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts * Sample Prefix Number is 2708-951109-
							26 27 28 29 30			
							31 32 33 34 35			
							36 37 38 39 40			

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HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-10-61 OWRD # 84237			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 9:00	DRILL FINISH Time: 12:30
	SAMPLING METHOD:	4-inch Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James	Date: 8-Nov-95	Date: 8-Nov-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	39.33 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Steel Monument							-3 to -1			Ground surface
Concrete; 2-inch ID Blank PVC Casing; Bentonite Grout Slurry	M10-01	850	26.2	78.7			1		GM	Silty Sandy GRAVEL - grey/brown, wet.
	M10-02	855	57.1	107			2			
							3		SP	SAND (2.5-3.0 feet bgs) - brown, moist, poorly graded, loose, medium grained.
	M10-03	905	102	-			4			SAND (3.0-4.0 feet bgs) - black, poorly graded, loose, medium grained, hydrocarbon odor, sheen.
							5			
2-inch ID Blank Stainless Steel Casing; Bentonite Grout Slurry							6			SAND with gravel (5.0-10.0 feet bgs) - black, moist, moderately dense, hydrocarbon odor, strong sheen, tar from 7-8 foot depth, lampblack present?, brick at 8 feet bgs.
	M10-04	920	566	-			7			
							8			
							9			
							10			
							11			Tarry SAND with gravel (10.0-15.0 feet bgs) - wet oozing tar saturated sand and gravel from 10-12 feet bgs,very hard tar matrix from 12-15 feet bgs.
	M10-05	930	241	-			12			
							13		SP	
							14			
							15			
							16		ML	Tarry SILT with gravel (15.0-16.5 feet bgs) - black, moist, oozing tar, silts are saturated with oily tar, silts repel water.
							17			SAND (17.0-20.0 feet bgs) - olive grey, moist to wet, fine grained, product saturated (brown), froth via sheen, large piece of wood in end of sampling core.
							18			
							19	11/8/95	SP	
	M10-06	950	2500+	-			20	▽		

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HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-10-61 OWRD # 84237			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 9:00 Date: 8-Nov-95	DRILL FINISH Time: 12:30 Date: 8-Nov-95
	SAMPLING METHOD:	4-inch Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James		
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	39.33 feet MSL

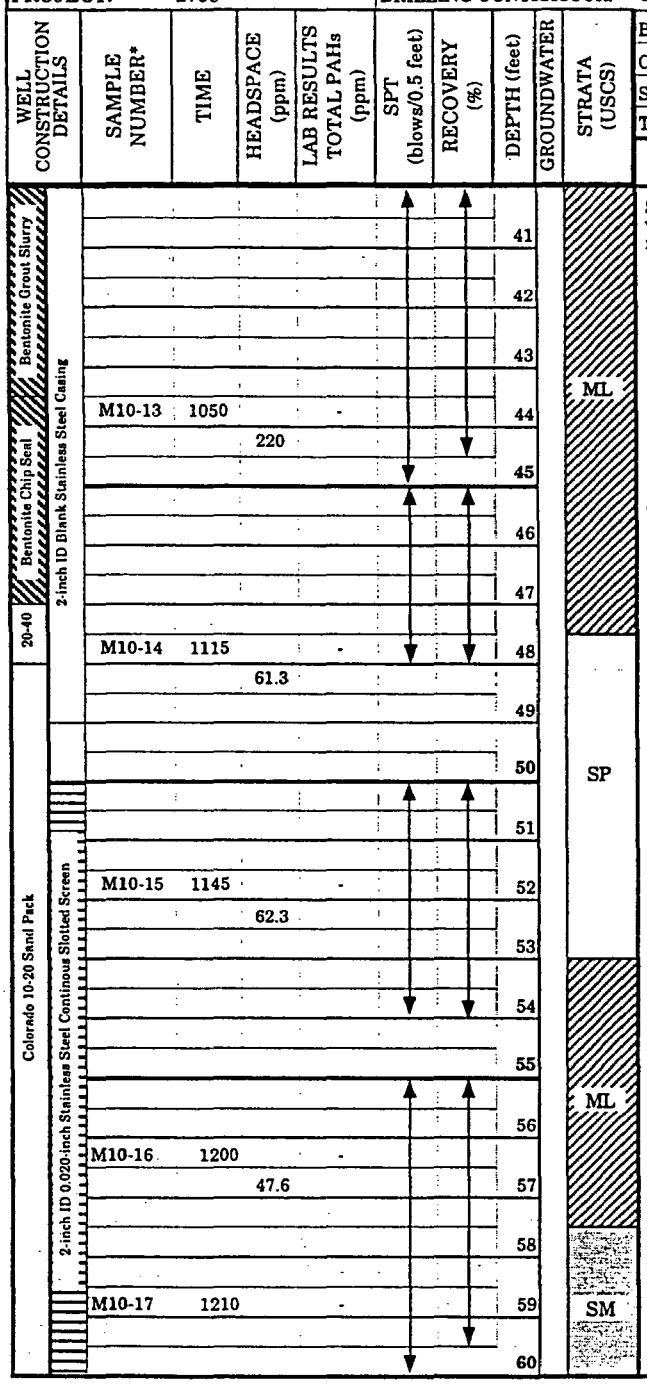
WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							21		SP	SAND (20.0-23.5 feet bgs) - brown, wet, loose, poorly graded, medium grained, product saturated (oozes out of pore spaces)
	M10-07	1005	2500+	-			22			
							23			
							24			SILT (23.5-25.0 feet bgs) - brown, moist, stiff, root zones, no product, no sheen.
	M10-08	1010	1204	-			25		ML	
							26			SILT (25.0-30.0 feet bgs) - brown, moist, stiff, root zones, some black and brown spots (organic looking), no obvious product.
							27			
							28			
	M10-09	1018	943	0.76			29			
							30			
							31			SILT (30.0-35.0 feet bgs) - olive grey with orange spots, , root zones, no product, no sheen, poor sample recovery.
	M10-10	1025	-	-			32			
							33			
							34			
							35			
							36			SILT (35.0-40.0 feet bgs) - olive grey to green, root zones, small piece of bark, no sheen.
	M10-11	1035	65.3	-			37			
	M10-12	1040	68.3	-			38		ML	
							39			
							40			

Bentonite Grout Slurry
2-inch ID Blank Stainless Steel Casing
Bentonite Grout Slurry
2-inch ID Blank Stainless Steel Casing

Koppers022661

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-10-61 OWRD # 84237			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT: 2708	HAI LOGGER:	Rob Ede	DRILL START Time: 9:00 Date: 8-Nov-95	DRILL FINISH Time: 12:30 Date: 8-Nov-95
	SAMPLING METHOD:	4-inch Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James		
	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	39.33 feet MSL



SOIL DESCRIPTION

SILT (40.0-45.0 feet bgs) - olive grey to green (transition to green with depth), moist, stiff, non-plastic, slightly brittle from 44-45 feet bgs, root zones, bark, sandy silt from 43.5-44 feet bgs.

SILT (45.0-47.5 feet bgs) - olive green to 46.5 feet bgs, tan to 47.5 feet bgs, moist, hard/slightly brittle, no sheen.

SAND (47.5-53.0 feet bgs) - tan, wet, loose, poorly graded, fine grained, no sheen, some muscovite from 50-53 feet bgs.

Sandy SILT (53.0-57.5 feet bgs) - tan, moist, medium stiff, interbedded with fine grained sands from 55.0-57.5 feet bgs.

Tree trunk at 57.5 feet bgs surrounded by olive grey sands.

Silty SAND (57.5-60.0 feet bgs).

Koppers022662

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-10-61 OWRD # 84237			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 9:00 Date: 8-Nov-95	DRILL FINISH Time: 12:30 Date: 8-Nov-95
	SAMPLING METHOD:	4-inch Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James		
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Cap							61			
							62			
							63			
							64			
							65			
							66			
							67			
							68			
							69			
							70			
							71			
							72			
							73			
							74			
							75			
							76			
							77			
							78			
							79			
							80			

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	36.5 feet MSL
TOP OF CASING ELEVATION:	39.33 feet MSL

Boring terminated at 61.0 feet bgs
Boring sampled to 60.0 feet
Monitoring well installed to 61.0 feet bgs

Materials:
10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen
5 feet 2-inch diameter PVC blank casing
45 feet stainless steel blank casing
1 50# bags 20/40 sand
11 bags 10/20 sand
2 50# bags bentonite chips
5 bags bentonite grout
1 end cap
1 locking cap
above-grade steel monument
3 guard posts

* Sample Prefix Number is 2708-951108-

Koppers022663

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER MW-11-32** **OWRD # 84232**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 1350 Date: 3-Nov-95	DRILL FINISH Time: 1430 Date: 3-Nov-95
	SAMPLING METHOD:	Not Sampled		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James		
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
										BORING DIAMETER: 10-inch CASING DIAMETER: 2-inch ID SURFACE ELEVATION: 35.4 feet MSL TOP OF CASING ELEVATION: 38.39 feet MSL
Steel Monument							-3 -2 -1			Ground surface
Concrete Bentonite Chips 2-inch ID Blank PVC Casing							1 2 3 4 5 6			See boring log for boring M-11 for soil description.
Stainless Steel Casing Bentonite Chips							7 8 9 10 11 12 13 14 15 16 17 18 19 20			

Koppers022664

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER MW-11-32** OWRD # 84232			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 1350 Date: 3-Nov-95	DRILL FINISH Time: 1430 Date: 3-Nov-95
	SAMPLING METHOD:	Not Sampled		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James		
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Colorado 10-20 Sand Pack 2-inch ID 0.020-inch Stainless Steel Continuous Slotted Screen Cap							21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40			Boring terminated at 32.0 feet bgs Monitoring well installed to 32.0 feet bgs Materials: 10 feet 2-inch diameter, 0.020-inch stainless steel slotted screen 15 feet stainless steel casing 6 feet 2-inch diameter PVC blank casing 13 50# bags 10/20 sand 12 50# bags bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.4 feet MSL
TOP OF CASING ELEVATION:	38.39 feet MSL

Koppers022665

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER MW-12-36** **OWRD # 84224**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 1410	DRILL FINISH Time: 1550
	SAMPLING METHOD:	4-inch OD Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James	Date: 23-Oct-95	Date: 23-Oct-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.9 feet MSL
TOP OF CASING ELEVATION:	38.69 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Steel Monument							-3 -2 -1			Ground surface
Concrete Bentonite Chips 2-inch ID Blank PVC Casing	M12-01	1415	0.1	116			1 2		GP	Surface: Sandy GRAVEL, (placed for ground cover) - moist, no hydrocarbon odor, no sheen.
	M12-02	1420	0.5	-			3 4		SP	SAND (2.0-4.5 feet bgs) - brown, moist, fine grained, loose, some thin silty zones present, no hydrocarbon odor, slight sheen.
	M12-03	1428	3.9	-			5 6 7 8 9 10		ML	SILT (4.5-9.5 feet bgs) - moist to wet, olive grey, very soft, strong hydrocarbon odor, strong sheen.
	M12-04	1440	46.3	-			11 12 13 14 15	10/23/95	ML	SILT (9.5-14.5 feet bgs) - olive grey/green mottled with orange spots (oxidized zones), moist, stiff, strong hydrocarbon odor, sheen, brown oil-like substance in upper 2 feet of core.
Bentonite Chips 2-inch ID Blank PVC Casing	M12-05	1450	69.6	-			16 17 18 19 20		SP ML SP	SILT (14.5-15 feet bgs) - olive grey, brown mottled, stiff, strong hydrocarbon odor, sheen via sheen test. SAND (15-16.5 feet bgs) - brown, wet, fine grained, poorly graded, strong hydrocarbon odor, sheen. SILT (16.5-19.5 feet bgs) - olive grey and brown mottled, stiff, strong hydrocarbon odor, sheen via sheen test, stained soil from 16.5-17.5 feet bgs.

Koppers022666

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER MW-12-36** OWRD # 84224			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	4-inch OD Core Barrel	1410	1550
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James	Date:	Date:
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations	23-Oct-95	23-Oct-95

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.9 feet MSL
TOP OF CASING ELEVATION:	38.69 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite; 2-inch ID Blank PVC Casing; Colorado 10-20 Sand Pack; 2-inch ID 0.010-inch PVC Slotted Screen; Cap							21		SP	SAND (19.5-24.5 feet bgs) - olive grey, wet, fine grained, sheen on core, hydrocarbon odor, loose, 1-inch silt layer encountered at 21.0 feet bgs, some product staining on silts.
	M12-06	1458	72.4	8.6			22			
							23			
							24			
							25			SAND (24.5-29.5 feet bgs) - olive grey changing to brown with depth, wet, fine grained, loose, muscovite present, no hydrocarbon odor, no sheen.
							26			
	M12-07	1510	1.0	ND			27			
							28			
							29			
							30			SAND (30.0-34.5 feet bgs) - brown, wet, fine to medium grained, loose, no hydrocarbon odor, no sheen, muscovite present.
							31			
							32			
	M12-08	1530	0.7	-			33		SP	
							34			
							35			SAND (34.5-36.0 feet bgs) - brown, wet, medium grained, loose, no hydrocarbon odor, no sheen, muscovite present.
	M12-09	1550	0.9	-			36			Bedrock encountered at 36 feet bgs (augers grinding on hard surface).
							37			
							38			
							39			
							40			

Koppers022667

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER MW-12-36** OWRD # 84224			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 1410	DRILL FINISH Time: 1550
	SAMPLING METHOD:	4-inch OD Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James	Date: 23-Oct-95	Date: 23-Oct-95
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							41			Boring terminated at 36.0 feet bgs Boring sampled to 36.0 feet Monitoring well installed to 36.0 feet bgs Materials: 10 feet 2-inch diameter, 0.010-inch PVC slotted screen 10 feet 2-inch diameter PVC blank casing 16 50# bags 10/20 sand 14 50# bags bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts * Sample Prefix Number is 2708-951023-
							42			
							43			
							44			
							45			
							46			
							47			
							48			
							49			
							50			
							51			
							52			
							53			
							54			
							55			
							56			
							57			
							58			
							59			
							60			

Koppers022668

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-13-30 OWRD # 100685			
PROJECT: Northwest Natural Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 8:36	DRILL FINISH Time: 10:00
	SAMPLING METHOD:	Not Sampled		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobile Drill		
	DRILLER:	Brad James	Date: 19-Dec-97	Date: 19-Dec-97
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (mm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Flush Monument										Ground surface
Concrete 2-inch ID Blank PVC Casing 3/8-inch Bentonite Chips Stainless Steel Casing 10-20							1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20		Concrete SP SP	See boring log for well MW-13-61 for soil description.

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.23 feet MSL
TOP OF CASING ELEVATION:	34.86 feet MSL

Koppers022669

HAHN & ASSOCIATES, INC.	MONITORING WELL NUMBER	MW-13-30		
434 NW Sixth Avenue	OWRD # 100685			
Portland, Oregon				
(503) 796-0717	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT:	SAMPLING METHOD:	Not Sampled		
Northwest Natural	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	Time:	Time:
Gasco Facility	EQUIPMENT TYPE	B-59 Mobile Drill	8:36	10:00
Portland, Oregon	DRILLER:	Brad James	Date:	Date:
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations	19-Dec-97	19-Dec-97

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.23 feet MSL
TOP OF CASING ELEVATION:	34.86 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm) LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Colorado 10-20 Sand Pack; 2-inch ID 0.020 Stainless Steel Continuous Slotted Screen; Cap						21–40		SP; ML	Boring terminated at 30.0 feet bgs Monitoring well installed to 30.0 feet bgs Materials: 1 foot stainless steel sump/well cap 10 feet 2-inch diameter, 0.020-inch stainless steel slotted screen 10 feet 2-inch diameter stainless steel blank casing 9 feet 2-inch diameter PVC blank casing 9.5 50# bags 10/20 sand 12 50# bags bentonite chips 1 end cap 1 locking cap flush steel monument

Koppers022670

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-13-61 **OWRD # 100684**			
PROJECT: Northwest Natural Gasco Facility Portland, Oregon PROJECT: 2708	HAI LOGGER:	Rob Ede	DRILL START Time: 9:30	DRILL FINISH Time: 14:40
	SAMPLING METHOD:	4-inch Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James	Date: 18-Dec-97	Date: 18-Dec-97
	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.23 feet MSL
TOP OF CASING ELEVATION:	34.78 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Flush Monument										Ground surface
Concrete							1		Concrete	Surface: concrete.
							2			
							3			
	M13-01	10:04	6.4	-			4		SP	SAND (3.5-5.5 feet bgs) - light brown, dry to slightly moist, fine grained, few rounded gravels, no hydrocarbon odor, no sheen (fill).
							5			
2-inch ID Blank PVC Casing							6			SAND (5.5-8.0 feet bgs) - light to rust brown, slightly moist, fine grained, poorly graded, no gravels, no hydrocarbon odor, no sheen (fill).
	M13-02	10:08	5.0	ND			7			
							8			SAND (8.0-11.5 feet bgs) - as above, no hydrocarbon odor, no sheen (fill).
							9			
							10			
	M13-03	10:20	5.5	ND			11			SAND (11.5-15.0 feet bgs) - as above, no hydrocarbon odor, no sheen (fill).
							12			
							13			
Blank Stainless Steel Casing	M13-04	10:27	5.2	ND			14			SAND (15.0-19.0 feet bgs) - as above, wet below 18.0 feet bgs, no hydrocarbon odor, no sheen (fill).
							15			
Bentonite Grout							16			
							17	12/18/97		
							18	▽	SP	
	M13-05	10:38	8.1	1.0			19			SAND (19.0-21.0 feet bgs) - as above, wet, dark grey with organic reducing (decay) odor below 20.5 feet bgs, no hydrocarbon odor, no sheen (fill).
							20			

Koppers022671

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** **MW-13-61** **OWRD # 100684**		DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	Time: 9:30	Time: 14:40
	SAMPLING METHOD:	4-inch Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James	Date: 18-Dec-97	Date: 18-Dec-97
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.23 feet MSL
TOP OF CASING ELEVATION:	34.78 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite Grout 2-inch ID Blank Stainless Steel Casing	M13-06	10:47	12.1	-			21		SP	SAND (21.0-23.0 feet bgs) - dark grey, fine grained with few shell fragments, potential hydrocarbon odor, no sheen (fill).
							22			
	M13-07	11:00	14.4	-			23			
							24			
	M13-08	11:10	15.6	ND			25			
	M13-09	11:14	(Dup)	-			26			SAND (23.0-28.0 feet bgs) - as above but with no shell fragments, potential hydrocarbon odor, no sheen (fill).
							27			
							28			
	M13-10	11:30	20	0.058			29			SAND (28.0-28.5 feet bgs) - as above, no hydrocarbon odor, no sheen (fill). SILT (28.5-29.0 feet bgs) - greenish grey, moist, preferentially parts along several thin dark grey layers in upper 4-inches of silt, stiff, no hydrocarbon odor, no sheen.
							30			
							31			Clayey SILT (29.0-32.5 feet bgs) - olive grey becoming yellowish orange and grey mottled below 31.0 feet bgs, moist, stiff, plastic, no hydrocarbon odor, no sheen.
	M13-11	11:38		ND						
			2.1				32		ML	
							33			Sandy SILT (32.5-39.0 feet bgs) - light grey and light brown mottling, becoming dark grey below 36.0 feet bgs, moist, oxidation spots and some fine grained muscovite present, stiff, no hydrocarbon odor, no sheen.
							34			
							35			
	M13-12	11:56		-						
			2.7				36			
							37			
							38			
							39			
	M13-13	12:20		-						
			4.8				40		SM	Silty SAND (39.0-42.5 feet bgs) - dark grey with olive grey silt lenses, wet, root fragments, no hydrocarbon odor, no sheen.

Koppers022672

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER**		**MW-13-61**	
	OWRD # 100684			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT:	SAMPLING METHOD:	4-inch Core Barrel		
Northwest Natural	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	Time:	Time:
Gasco Facility	EQUIPMENT TYPE	B-59 Mobil Drill	9:30	14:40
Portland, Oregon	DRILLER:	Brad James	Date:	Date:
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations	18-Dec-97	18-Dec-97

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.23 feet MSL
TOP OF CASING ELEVATION:	34.78 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite Grout							41		SM	
							42			
							43		SP	SAND (42.5-44.0 feet bgs) - dark grey, wet, fine grained, shell fragments, rootlets, no hydrocarbon odor, no sheen.
							44			
Bentonite Chip Plug; 2-inch ID Blank Stainless Steel Casing							45		ML	Sandy SILT (44.0-47.5 feet bgs) - grey, slightly moist, few thin clayey silt lenses, shell fragments and rootlets, no hydrocarbon odor, no sheen.
	M13-14	12:27	18.3	-			46			
							47			
							48		SM	Silty SAND (47.5-51.0 feet bgs) - with olive grey silt lenses and dark grey fine sand lenses throughout, wet, shell fragments and rootlets, no hydrocarbon odor, no sheen.
							49			
							50			
Colorado 10-20 Sand Pack; 2-inch ID 0.020-inch Stainless Steel Slotted Screen							51		SP	SAND (51.0-51.5.0 feet bgs) - grey, wet, fine grained, no hydrocarbon odor, no sheen.
	M13-15	13:45	4.4	-			52		SM	Silty SAND (51.5-55.5 feet bgs) - dark grey, moist to wet, few silt lenses throughout and a 3-inch fine sand lens at 47.5 feet bgs, shell fragments, root fragments, no hydrocarbon odor, no sheen.
							53			
							54			
	M13-16	14:00	12.4	-			55			
							56		SP	SAND (55.5-61.0 feet bgs) - dark grey, wet, fine grained, few silt lenses, slight reducing odor within silt lenses, no hydrocarbon odor, no sheen.
							57			
	M13-17	14:18	4.7	ND			58			
							59			
	M13-18	14:30	-	-			60			

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**MONITORING WELL NUMBER** MW-13-61 **OWRD # 100684**			
PROJECT: Northwest Natural Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 9:30	DRILL FINISH Time: 14:40
	SAMPLING METHOD:	4-inch Core Barrel		
	DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger		
	EQUIPMENT TYPE	B-59 Mobil Drill		
	DRILLER:	Brad James	Date: 18-Dec-97	Date: 18-Dec-97
PROJECT: 2708	DRILLING CONTRACTOR:	Geo-Tech Explorations		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.23 feet MSL
TOP OF CASING ELEVATION:	34.78 feet MSL

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Sand / Cap					↕	↕	61		SP	Boring terminated at 61.0 feet bgs Boring sampled to 61.0 feet Monitoring well installed to 61.0 feet bgs
							62			
							63			
							64			
							65			Materials: 1 foot stainless steel sump/end cap 10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen 40 feet 2-inch diameter stainless steel blank casing 10 feet 2-inch diameter PVC casing 12 50# bags 10/20 Colorado sand 5 50# bags bentonite chips 5 bags bentonite grout 3 centralizers 1 locking cap Flush steel monument
							66			
							67			
							68			
							69			
							70			* Sample Prefix Number is 2708-971218-
							71			
							72			
							73			
							74			
							75			
							76			
							77			
							78			
							79			
							80			

Koppers022674

APPENDIX C

Sediment Core Logs

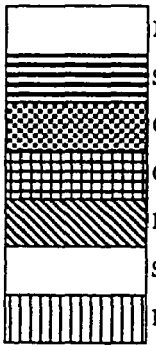
Koppers022675

KEY TO BORING LOGS

Soil classification in this report is based upon visual and manual field observations which include moisture, consistency, plasticity and grading estimates and should not be construed to imply field or laboratory testing unless presented herein. Soils are classified in accordance with the Unified Soil Classification System. Stratigraphic boundaries are approximate representations only. No warranty is provided as to the continuity of soil strata between borings.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)					
MAJOR DIVISIONS			GROUP SYMBOLS		TYPICAL NAMES
COURSE GRAINED SOILS	GRAVELS More Than Half the Course Fraction is Larger Than No. 4 Sieve Size	Clean Gravels With Little or No Fines	GW		Well Graded Gravels, Gravel-Sand Mixtures
			GP		Poorly Graded Gravels, Gravel-Sand Mixtures
		Gravels With Over 12% Fines	GM		Silty Gravels, Poorly Graded Gravel-Sand-Silt Mixtures
			GC		Clayey Gravels, Poorly Graded Gravel-Sand-Clay Mixtures
More Than Half is Larger Than #200 Sieve	SANDS More Than Half the Course Fraction is Smaller Than No. 4 Sieve Size	Clean Sands With Little or No Fines	SW		Well Graded Sands, Gravelly Sands
			SP		Poorly Graded Sands, Gravelly Sands
		Sands With Over 12% Fines	SM		Silty Sands, Poorly Graded Sand-Silt Mixtures
			SC		Clayey Sands, Poorly Graded Sand-Clay Mixtures
FINE GRAINED SOILS	SILTS AND CLAYS Liquid Limit Less Than 50%		ML		Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands, or Clayey Silts with Slight Plasticity
			CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL		Organic Clays and Organic Silty Clays of Low Plasticity
More Than Half is Smaller Than #200 Sieve	SILTS AND CLAYS Liquid Limit Greater Than 50%		MH		Inorganic Silts, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic Silts
			CH		Inorganic Clays of High Plasticity, Fat Clays
			OH		Organic Clays of Medium to High Plasticity, Organic Silts
HIGHLY ORGANIC SOILS			Pt		Peat and Other Highly Organic Soils

LEGEND FOR BORING LOGS



- Blank Casing
- Slotted Screen
- Cement Grout
- Concrete
- Bentonite
- Sand Pack
- Fill Material

ABBREVIATIONS

NA	Not Applicable
ND	Not Detected Above Detection Limit
NS	Not Sampled
PAH	Polynuclear Aromatic Hydrocarbons
ppm	Parts Per Million
SPT	Standard Penetration Test
▽	Measured Static Water Level in Well
▼	Estimated Water Level During Drilling

Updated: 7/2/98 RBE
File: Boring Log Key

HAHN AND ASSOCIATES, INC.

Koppers022676

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER SD-4**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 9:33	DRILL FINISH Time: 9:50
	SAMPLING METHOD:	3.75"OD Disposable Core Barrel		
	DRILLING METHOD:	Vibration/Push		
	EQUIPMENT TYPE	VibraCore attached to barge		
	DRILLER:	Bill Jaworski	Date: 1/23/96	Date: 1/23/96
PROJECT #: 2708	DRILLING CONTRACTOR:	Marine Sampling Systems		

BORING DIAMETER:	3.75-inch
CASING DIAMETER:	3.75-inch
SURFACE ELEVATION:	Not Surveyed
TOP OF CASING ELEVATION:	Not Applicable

SAMPLE NUMBER*	TIME (1/25/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
SD-4-01	12:25	2.3	165/ND				ML	SILT-brown, wet, very soft, roots, sheen, hydrocarbon odor (0"-6")
SD-4-02	12:30	4.0	-			1		
SD-4-03	12:36	9.5	-			2		Sandy SILT-grey, wet, soft, roots, sheen, hydrocarbon odor (6"-3')
SD-4-04	12:47	13.6	-			3		Sandy SILT with gravel and wood chips-brown, wet, sheen, hydrocarbon odor (3'-4')
SD-4-05	12:54	24.3	-			4		
SD-4-06	13:00	23.4	-			5		Sandy SILT with fine grained sand seams-grey, moist, rootlets throughout, much vegetative material from 4' to 5', sheen within sand seams only, hydrocarbon odor (4'-6')
SD-4-07	13:30	16.7	-			6		
SD-4-08	13:32	15.6	-			7	SM	Silty SAND-grey, moist, fine grained, root fragments, no sheen, hydrocarbon odor (6'-7')
SD-4-09	13:36	13.9	-			8		Silty SAND-as above, many root fragments, no sheen, hydrocarbon odor (7'-9.5')
SD-4-10	13:38	12.3	-			9		
SD-4-11	13:40	11.6	0.15/ND			10		
						11		
						12		
						13		
						14		
						15		
						16		
						17		
						18		
						19		
						20		

* Sample Number Prefix is 2708-960123-

Core collected and sealed 1/23/96
Core opened and sampled 1/25/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

Koppers022677

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER SD-5**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	3.75"OD Disposable Core Barrel	10:23	10:40
	DRILLING METHOD:	Vibration/Push		
	EQUIPMENT TYPE	VibraCore attached to barge		
	DRILLER:	Bill Jaworski	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Marine Sampling Systems	1/23/96	1/23/96

	SAMPLE NUMBER*	TIME (1/25/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)		
	SD-5-01	14:30	4.7	118/ND				SM		
	SD-5-02	14:33	4.4	-			1			
	SD-5-03	14:35	3.5	-			2	ML		
	SD-5-04	14:40	3.7	-			3			
	SD-5-05	14:45	3.4	-			4			
	SD-5-06	14:50	9.6	-			5			
	SD-5-07	15:00	9.4	-			6			
	SD-5-08	15:05	19.0	-			7	ML		
	SD-5-09	15:10	17.4	1,154/ND			8			
							9			
							10			
							11			
							12			
							13			
							14			
							15			
							16			
							17			
							18			
							19			
							20			

BORING DIAMETER:	3.75-inch
CASING DIAMETER:	3.75-inch
SURFACE ELEVATION:	Not Surveyed
TOP OF CASING ELEVATION:	Not Applicable

SOIL DESCRIPTION

Silty SAND-brown, wet, loose,very fine grained, sheen (0"-6")

SILT with silty sand lenses-brown, wet, medium stiff, roots, strong sheen (6"-2')

SILT-olive grey, wet, very soft, wood chips at 2', slight sheen (2'-3')

Sandy SILT-dark brown, moist, medium stiff, rootlets, many wood fragments and dark grey to black discoloration from 6' to 8', sheen (3'-8')

* Sample Number Prefix is 2708-960123-

Core collected and sealed 1/23/96
Core opened and sampled 1/25/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

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HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER SD-6**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time: 11:02	DRILL FINISH Time: 11:20
	SAMPLING METHOD:	3.75"OD Disposable Core Barrel		
	DRILLING METHOD:	Vibration/Push		
	EQUIPMENT TYPE	VibraCore attached to barge		
	DRILLER:	Bill Jaworski	Date: 1/23/96	Date: 1/23/96
PROJECT #: 2708	DRILLING CONTRACTOR:	Marine Sampling Systems		

	SAMPLE NUMBER*	TIME (1/25/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)
	SD-6-01	15:46	6.5	101/ND				
	SD-6-02	15:48	14.6	-			1	
								SP
	SD-6-03	15:50	12.0	-			2	
	SD-6-04	15:52	6.8	-			3	
	SD-6-05	15:55	2.6	-			4	
								SM
	SD-6-06	16:05	4.0	-			5	
	SD-6-07	16:10	9.1	-			6	
	SD-6-08	16:13	5.3	-			7	
								SP
	SD-6-09	16:15	3.1	2.2/ND			8	
							9	
							10	
							11	
							12	
							13	
							14	
							15	
							16	
							17	
							18	
							19	
							20	

BORING DIAMETER:	3.75-inch
CASING DIAMETER:	3.75-inch
SURFACE ELEVATION:	Not Surveyed
TOP OF CASING ELEVATION:	Not Applicable

SOIL DESCRIPTION

SAND-brown, wet, loose, medium grained, wood fragments, slight sheen (0"-1')

SAND-as above, moist to wet, many wood fragments from 2' to 2.5' with an associated strong sheen (1'-4')

Silty SAND-brown, moist to wet, loose, much root material, increasing silt content with depth, sheen (4'-5')

SAND with interbedded Silts-grey, moist to wet, loose, silts are dark grey, moist, soft, root material and sheen in sands only(5'-8')

* Sample Number Prefix is 2708-960123-

Core collected and sealed 1/23/96
Core opened and sampled 1/25/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

Koppers022679

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER SD-7**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	3.75"OD Disposable Core Barrel	Time: 9:33	Time: 9:50
	DRILLING METHOD:	Vibration/Push		
	EQUIPMENT TYPE	VibraCore attached to barge		
	DRILLER:	Bill Jaworski	Date: 1/23/96	Date: 1/23/96
PROJECT #: 2708	DRILLING CONTRACTOR:	Marine Sampling Systems		

BORING DIAMETER: 3.75-inch
CASING DIAMETER: 3.75-inch
SURFACE ELEVATION: Not Surveyed
TOP OF CASING ELEVATION: Not Applicable

SAMPLE NUMBER*	TIME (1/26/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
SD-7-01	8:32	55.8	26,408/54		ML	SILT-brown, wet, very soft, no sheen (0"-2")
SD-7-02	8:35	318	-	1	GP	Tarry, Sandy GRAVEL, black, tar is hard to slightly plastic, much vegetation, rootlets, decreasing tar content with depth, sheen (2"-1')
					SP	
SD-7-03	8:37	5.5	-	2		SAND, dark grey, medium grained, loose, some tar in matrix, sheen (1'-2')
SD-7-04	8:40	4.6	-	3	ML	Sandy SILT with fine grained sand seams-grey, moist, slightly stiff, rootlets and wood fragments, no sheen (2'-4')
SD-7-05	9:00	4.1	-	4		
SD-7-06	9:04	1.8	-	5		Silty SAND-grey, moist, fine grained, bedded brown vetetative material, no sheen (4'-6.5')
SD-7-07	9:08	2.1	-	6	SM	
SD-7-08	9:18	1.5	-	7		
SD-7-09	9:23	1.2	-	8	ML	Sandy SILT-grey, moist, medium stiff, shell material, root fragments, no sheen (6.5'-9')
SD-7-10	9:25	1.2'	10.9/ND	9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		
				18		
				19		
				20		

* Sample Number Prefix is 2708-960123-

Core collected and sealed 1/23/96
Core opened and sampled 1/26/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

Koppers022680

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER SD-8**			
	HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
PROJECT:	SAMPLING METHOD:	3.75"OD Disposable Core Barrel		
Northwest Natural Gas Co.	DRILLING METHOD:	Vibration/Push	Time:	Time:
Gasco Facility	EQUIPMENT TYPE	VibraCore attached to barge	9:33	9:50
Portland, Oregon	DRILLER:	Bill Jaworski	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Marine Sampling Systems	1/23/96	1/23/96

BORING DIAMETER:	3.75-inch
CASING DIAMETER:	3.75-inch
SURFACE ELEVATION:	Not Surveyed
TOP OF CASING ELEVATION:	Not Applicable

SAMPLE NUMBER*	TIME (1/26/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
SD-8-01	9:50	14.3	875/ND					Sandy SILT-brown, wet, very soft, some medium grained sand lenses, root material, no sheen (0-2')
SD-8-02	9:52	12.9	-			1		
SD-8-03	9:56	12.1	-			2	ML	Sandy SILT-as above, some gravel, slight sheen (2'-4')
SD-8-04	10:00	11.9	-			3		
SD-8-05	10:03	12.3	-			4		Sandy SILT with fine grained sand seams-olive grey, moist, medium stiff, rootlets throughout, much vegetative material, slight sheen (4'-5')
SD-8-06	10:15	13.0	-			5		
SD-8-07	10:18	13.3	-			6	SP	SAND-grey, moist, medium grained, loose, wood fragments, strong sheen (5'-7')
SD-8-08	10:23	30.4	-			7		
SD-8-09	10:30	172.0	-			8	ML	Tarry Sandy SILT-olive grey, moist, stiff, seams of black viscous tar and hardened tar (7'-8')
SD-8-10	10:32	59.7	3,254/2.6			9		Sandy SILT-as above, no tar, strong sheen (8'-9')
						10		
						11		
						12		* Sample Number Prefix is 2708-960123-
						13		Core collected and sealed 1/23/96 Core opened and sampled 1/26/96
						14		
						15		
						16		BTEX = benzene, toluene, ethyl benzene, xylene PAHs = polynuclear aromatic hydrocarbons ppm = parts per million ND = non-detect
						17		
						18		
						19		
						20		

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER SD-9**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Rob Ede	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	3.75"OD Disposable Core Barrel	13:25	14:00
	DRILLING METHOD:	Vibration/Push		
	EQUIPMENT TYPE	VibraCore attached to barge		
	DRILLER:	Bill Jaworski	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Marine Sampling Systems	1/24/96	1/24/96

BORING DIAMETER:	3.75-inch
CASING DIAMETER:	3.75-inch
SURFACE ELEVATION:	Not Surveyed
TOP OF CASING ELEVATION:	Not Applicable

SAMPLE NUMBER*	TIME (1/26/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
SD-9-01	10:50	15.8	125/ND	1	ML	Sandy SILT-brown, wet, very soft, some medium grained sand lenses, root material , no sheen (0-2')
SD-9-2 (dup)	10:55	13.8	94/ND			
SD-9-03	10:58	13.0	-	2		
SD-9-04	11:00	13.4	-	3	GP	Gravel-wet, loose, angular, no sheen (2'-3'.5)
SD-9-05	11:02	17.3	-	4	SM	Silty SAND-wet, loose, medium grained, root fragments, strong metallic sheen (3.5'-4')
SD-9-06	11:06	110	5,471/14	5	SP	Tarry SAND-wet, medium grained, root fragments, bits of solidified tar, sheen (4'-5')
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		
				18		
				19		
				20		

* Sample Number Prefix is 2708-960124-

Core collected and sealed 1/24/96
Core opened and sampled 1/26/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

Koppers022682

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER**	**SD-10**		
	HAI LOGGER:	Steve Johnson (FES)	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	SAMPLING METHOD:	3.75"OD Disposable Core Barrel	Time:	Time:
	DRILLING METHOD:	Vibration/Push	15:04	15:30
	EQUIPMENT TYPE	VibraCore attached to barge		
	DRILLER:	Bill Jaworski	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Marine Sampling Systems	1/23/96	1/23/96

SAMPLE NUMBER*	TIME (1/26/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)
SD-10-01	12:50	2.5	ND/283				
SD-10-02	12:55	2.4	-			1	ML
SD-10-03	13:00	4.4	-			2	
SD-10-04	13:05	7.1	-			3	
SD-10-05	13:08	3.6	-			4	
SD-10-06	13:25	3	-			5	SP
SD-10-07	13:28	2.3	-			6	
SD-10-08	13:22	0.6	-			7	
SD-10-09	13:30	3.2	ND/9.6			8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	

BORING DIAMETER:	3.75-inch
CASING DIAMETER:	3.75-inch
SURFACE ELEVATION:	Not Surveyed
TOP OF CASING ELEVATION:	Not Applicable

SOIL DESCRIPTION

SILT-dark brown, wet, soft, some medium grained sand lenses, some plant material and wood chips, slight hydrocarbon odor and sheen from 0 to 0.5 feet (0-2')

SAND-wet, loose, medium grained, wood chips, no hydrocarbon odor or sheen (2'-3')

SAND-as above, some gravel, no hydrocarbon odor or sheen (3'-5')

SAND- dark brown, loose, medium grained, some silt, wood chips, slight hydrocarbon odor, no sheen (5'-7.5')

* Sample Number Prefix is 2708-960123-

Core collected and sealed 1/23/96
Core opened and sampled 1/26/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

Koppers022683

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER SD-11**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Steve Johnson (FES)	DRILL START Time: 16:00	DRILL FINISH Time: 16:25
	SAMPLING METHOD:	3.75"OD Disposable Core Barrel		
	DRILLING METHOD:	Vibration/Push		
	EQUIPMENT TYPE	VibraCore attached to barge		
	DRILLER:	Bill Jaworski	Date: 1/23/96	Date: 1/23/96
PROJECT #: 2708	DRILLING CONTRACTOR:	Marine Sampling Systems		

BORING DIAMETER:	3.75-inch
CASING DIAMETER:	3.75-inch
SURFACE ELEVATION:	Not Surveyed
TOP OF CASING ELEVATION:	Not Applicable

SAMPLE NUMBER*	TIME (1/26/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
SD-11-01	13:53	366	5.6/ND				SP	SAND-brown, wet, loose, medium grained, wood chips on surface, hydrocarbon odor, sheen (0'-1')
SD-11-02	13:55	34.2	-			1		
							ML	SILT-dark brown, stiff, medium grained sand lenses, strong hydrocarbon odor and sheen (1'-2')
SD-11-03	14:00	13.3	569/ND			2		
								SAND-dark brown, loose, medium grained, some silt, wood chips, hydrocarbon odor and sheen (2'-3')
SD-11-04	14:03	7.8	-			3		
							SP	
SD-11-05	14:11	6.3	-			4		SAND- as above, no wood chips, brick fragments from 5' to 5.5', slight hydrocarbon odor, no sheen, (3'-6')
SD-11-06	14:14	12.6	-			5		
SD-11-07	14:16	6.3	-			6		
						7		
						8		
						9		
						10		
						11		
						12		* Sample Number Prefix is 2708-960123-
						13		Core collected and sealed 1/23/96 Core opened ans sampled 1/26/96
						14		
						15		
						16		BTEX = benzene, toluene, ethyl benzene, xylene PAHs = polynuclear aromatic hydrocarbons ppm = parts per million ND = non-detect
						17		
						18		
						19		
						20		

Koppers022684

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER**	**SD-12**		
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Steve Johnson (FES)	DRILL START Time:	DRILL FINISH Time:
	SAMPLING METHOD:	3.75"OD Disposable Core Barrel	9:01	9:30
	DRILLING METHOD:	Vibration/Push		
	EQUIPMENT TYPE	VibraCore attached to barge		
	DRILLER:	Bill Jaworski	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Marine Sampling Systems	1/24/96	1/24/96

BORING DIAMETER:	3.75-inch
CASING DIAMETER:	3.75-inch
SURFACE ELEVATION:	Not Surveyed
TOP OF CASING ELEVATION:	Not Applicable

SAMPLE NUMBER*	TIME (1/26/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
SD-12-01	10:40	0.0	0.72/ND			1	SM	Silty SAND-gray, wet, loose, fine grained, no hydrocarbon odor, no sheen (0'-1')
SD-12-02	10:45	0.0	-			2		Silty SAND-as above, wet, wood chips from 2' to 3', slight hydrocarbon odor, no sheen (1'-4')
SD-12-03	10:50	0.3	-			3		
SD-12-04	11:00	0.1	8.4/ND			4		
SD-12-05	11:05	0.0	-			5	CL	Clay, greenish gray, moist, some silt, plastic, no hydrocarbon odor, no sheen (4'-5.5')
SD-12-06	11:08	0.0	-			6	ML	Sandy SILT- light brown, moist, no hydrocarbon odor, no sheen (5.5'-8')
SD-12-07	11:25	0.0	-			7		
SD-12-08	11:28	0.3	-			8		
SD-12-09	11:41	0.6	-			9	SP	SAND, light brown, moist, fine grained,no hydrocarbon odor, no sheen, (8.'-10')
SD-12-10	11:45	0.9	-					
SD-12-11	11:50	3.0	-			10		
						11		
						12		* Sample Number Prefix is 2708-960124-
						13		Core collected and sealed 1/24/96 Core opened and sampled 1/26/96
						14		
						15		
						16		
						17		BTEX = benzene, toluene, ethyl benzene, xylene PAHs = polynuclear aromatic hydrocarbons ppm = parts per million ND = non-detect
						18		
						19		
						20		

Koppers022685

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER SD-13**			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon	HAI LOGGER:	Steve Johnson (FES)	DRILL START Time: 9:43	DRILL FINISH Time: 10:15
	SAMPLING METHOD:	3.75"OD Disposable Core Barrel		
	DRILLING METHOD:	Vibration/Push		
	EQUIPMENT TYPE	VibraCore attached to barge		
	DRILLER:	Bill Jaworski	Date: 1/24/96	Date: 1/24/96
PROJECT #: 2708	DRILLING CONTRACTOR:	Marine Sampling Systems		

BORING DIAMETER:	3.75-inch
CASING DIAMETER:	3.75-inch
SURFACE ELEVATION:	Not Surveyed
TOP OF CASING ELEVATION:	Not Applicable

SAMPLE NUMBER*	TIME (1/26/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
SD-13-01	10:10	0.7	1.4/ND	1	SM	Silty SAND-dark brown to gray, wet, loose, fine grained, no hydrocarbon odor, no sheen (0'-1')
SD-13-02	10:15	2.4	-	2	ML	sandy SILT-dark brown to gray, roots from 1' to 2, large wood chips from 1' to 3', slight hydrocarbon odor from 2' to 3', no sheen (1'-3')
SD-13-03	10:20	4.5	-	3		
SD-13-04	10:25	5.8	-	4	SP	SAND-dark gray, medium grained, hydrocarbon odor, no sheen (3'-3.5')
				5		
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		
				18		
				19		
				20		

* Sample Number Prefix is 2708-960124-

Core collected and sealed 1/24/96
Core opened and sampled 1/26/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

Koppers022686

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717	**SOIL BORING NUMBER SD-14**			
	HAI LOGGER:	Steve Johnson (FES)	DRILL START	DRILL FINISH
PROJECT:	SAMPLING METHOD:	3.75"OD Disposable Core Barrel		
Northwest Natural Gas Co.	DRILLING METHOD:	Vibration/Push	Time:	Time:
Gasco Facility	EQUIPMENT TYPE	VibraCore attached to barge	12:16	12:25
Portland, Oregon	DRILLER:	Bill Jaworski	Date:	Date:
PROJECT #: 2708	DRILLING CONTRACTOR:	Marine Sampling Systems	1/24/96	1/24/96

BORING DIAMETER:	3.75-inch
CASING DIAMETER:	3.75-inch
SURFACE ELEVATION:	Not Surveyed
TOP OF CASING ELEVATION:	Not Applicable

SAMPLE NUMBER*	TIME (1/25/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
SD-14-01	9:00	0.1	0.15/ND			1	ML	SILT-dark brown, wet, root material, no hydrocarbon odor, no sheen (0'-1')
SD-14-02	9:10	1.5	-			2		SILT-as above, some fine grained sand lenses,no hydrocarbon odor, no sheen (1'-2')
SD-14-03	9:20	1.8	-			3	SM	Silty SAND-medium grained, large wood chips, no hydrocarbon odor, no sheen (2'-3.5')
SD-14-04	9:25	2.4				4		Silty SAND-fine grained, small wood chips, no hydrocarbon odor, no sheen (3.5'-4')
SD-14-05	9:35	-	-			5	ML	SILT- light brown, moist, painted wood fragment at 4.5', small wood fragments from 5' to 6', shell fragments from 6' to 7', decaying wood odor, no hydrocarbon odor, no sheen (4'-7.5')
SD-14-06	9:40	0.5	-			6		
SD-14-07	9:50	0.2	-			7		
SD-14-08	9:55	0.4	-			8	SP	SAND, light brown, moist, medium grained, no hydrocarbon odor, no sheen, (7.5.'-8.5')
SD-14-09	10:00	5.8	181/ND			9		
						10		
						11		
						12		
						13		
						14		
						15		
						16		
						17		
						18		
						19		
						20		

* Sample Number Prefix is 2708-960124-

Core collected and sealed 1/24/96
Core opened and sampled 1/25/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

APPENDIX D

Water Well Logs and Cathodic Protection Well Logs

Koppers022688

9-189
(Oct. 1939)

NOTEBOOK SHEET

Name ..... Date .....

Port. Gas & Coke.
Under St. Johns bridge.
basalt at
int. 60 ft.
400 ft. lap.
12" casing
Sheet 4-8 Mar 1954
Pumps 159 gpm at 200 ft.

Flowed when drilled 1941
made 400 gpm.

U. S. GOVERNMENT PRINTING OFFICE 16—12406-1

9-185
(August 1949)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date 1 April, 1954 Field
Record by RAY Office
Source of data Mr Wright, Engineer

1. *Location:* State Oregon County Mult
Map Hillsboro
..... ¼ ..... ¼ sec. ..... T ..... N/S R .....
2. *Owner:* Portland Gas & Coke Address 7900 NW
Tenant ..... Address .....
Driller A.M. Jannsen Address Redi
3. *Topography* Valley plain
4. *Elevation* 30 ft. above/below S.L. Map
5. *Type:* Dug, drilled, driven, bored, jetted 1948
6. *Depth:* Rept. 382' ft. Meas. ..... ft.
7. *Casing:* Diam. 12 in., to 8 in., Type Iron
Depth 63'-12", Finish 140'-8" Perf.
8. *Chief Aquifer* Sand? From 241 ft
Others .....
9. *Water level* ..... ft. rept./meas. ..... 19.....
..... which is .....
10. *Pump:* Type ..... Capacity .....
Power: Kind ..... Horsepower .....
11. *Yield:* Flow ..... G. M., Pump 140 G. M., Meas.
Drawdown ..... ft. after ..... hours pumping .....
12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs. Cooling
Adequacy, permanence Not adequate
13. *Quality* ok Temp .....
Taste, odor, color ..... Sampl
Unfit for .....
14. *Remarks:* (Log, Analyses, etc.) Well lost about
of production soon after beginning
Well was dryied twice a day a

U. S. GOVERNMENT PRINTING OFFICE 16—59355-1

(over)

Koppers022689

increase in production was noticed. Any production over 140 gpm will cause present pump set at 180 ft. to break suction.

Skeleton log:

0-61	sand (12" casing to 63')
61-241	Rock (basalt?; not cased)
241-246	Sand and broken rock
246-258	Sand
253?-370	Basalt, broken, soft.

382' bottom of well

Mr. Wright promised to send complete log. R.A.G. 18 Apr. 1954

Koppers022690

St. Helens Rd

Log on Ground Information

Material	Depth
Grey clay-dirt	0 - 4
Brown-black sand	4 - 9
Brown clay	9 - 43
Broken black rock-decomposed in places	43 - 102
Broken black rock w/brown clay layers	102 - 114
Black rock	114 - 128
Broken black rock w/layers black lava rock	128 - 162
Black rock	162 - 189
Grey rock	189 - 199
Black lava rock w/thin layer grey clay	199 - 212
Black rock, broken in places	212 - 281
Broken black rock-grey sandy clay	281 - 305
Black lava rock	305 - 344
Black rock/layers grey clay	344 - 350
Black rock-broken in places	350 - 400

Portland

Log on Ground Information

Material	Depth
14 anodes 17ft. center 164' to 392 Coke at 140' , gravel to 80ft. Cement to 50 ft. gravel to 0	
Gravel	0 - 1
Clay	1 - 2
Sand	2 - 10
Brown clay	10 - 40
Sand	40 - 50
Broken rock	50 - 78
Black basalt hard some broken lava rock layers	78 - 290
Broken multi colored rock & sandstone, little clay	290 - 310
Black basalt hard	310 - 370
Broken rock sandy clay	370 - 390
Black basalt Hard	390 - 400

Koppers022691

OTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

WATER WELL REPORT
STATE OF OREGON
(Please type or print)

State Well No. 1N/1W-12N
State Permit No.

OWNER:
Portland Gas & Coke Company
dress

(2) LOCATION OF WELL:
unty Multnomah Driller's well number
SW ¼ SW ¼ Section 12 T. 1N R. 1W W.M.
aring and distance from section or subdivision corner

(3) TYPE OF WORK (check):
w Well ☐ Deepening ☐ Reconditioning ☐ Abandon ☐
abandonment, describe material and procedure in Item 12.

(4) PROPOSED USE (check):
omestic ☐ Industrial ☐ Municipal ☒
rrigation ☐ Test Well ☐ Other ☐

(5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

(6) CASING INSTALLED: Threaded ☐ Welded ☐
12 " Diam. from 0 ft. to 63 ft. Gage
8 " Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(7) PERFORATIONS: Perforated? ☐ Yes ☐ No
Type of perforator used
ize of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(8) SCREENS: Well screen installed? ☐ Yes ☐ No
Manufacturer's Name
ype Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(9) CONSTRUCTION:
Well seal—Material used in seal
Depth of seal ft. Was a packer used?
Diameter of well bore to bottom of seal in.
Were any loose strata cemented off? ☐ Yes ☐ No Depth
Was a drive shoe used? ☐ Yes ☐ No
Was well gravel packed? ☐ Yes ☐ No Size of gravel:
Gravel placed from ft. to ft.
Did any strata contain unusable water? ☐ Yes ☐ No
of water? depth of strata
Method of sealing strata off

(10) WATER LEVELS:
Static level 48 ft. below land surface Date 1954
Artesian pressure lbs. per square inch Date

(USE ADDITI 10 IF NECESSARY)

(11) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☐ No If yes, by whom?
Yield: 140 gal./min. with ft. drawdown after hrs.
150 - with drawdown to 200 feet
Baller test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☐ No

(12) WELL LOG: Diameter of well below casing
Depth drilled ft. Depth of completed well 382 ft.
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Sand	0	61
Rock (basalt)	61	241
Sand and broken rock	241	246
Sand	246	258
Basalt, broken, soft	258	370
Data from USGS		

Work started 19 Completed 1948
Date well drilling machine moved off of well 19

(13) PUMP:
Manufacturer's Name
Type: H.P.

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME A. M. Jannsen
(Person, firm or corporation) (Type or print)
Address
Drilling Machine Operator's License No.
[Signed]
(Water Well Contractor)
ntractor's License No. Date 19

Koppers022692

6711 N. E. 58th Ave.
Vancouver, Wash. 98661
Phone: 694-6242
034-3370

HANSEN DRILLING CO., Inc.

LOG

Name Northwest Natural Gas

Address Gasco Regulator Station St. Helens Rd.

Date Started 11-23-76 Date Finished 12-10-76

DESCRIPTION:

(a) Well Depth 400 ft. Diameter 10"

(b) Depth from ground surface to water level before pumping _____ ft. Bailer tested _____ GPM

(c) Drawdown of water level is _____ feet. (pumping level minus static water level)

(d) Casing - screen - perforation - shoe - etc.

10" casing from 0 - 20'
1" pipe from 0 - 400'
4 sks. cement 37 sks. mud

Time:
67 hrs...Drilling time
7 hrs....Down time
10 hrs...Set up & clean up
6½ hrs...Circulate anodes, coke, etc..

Desmet
Rotary

PRINTED PTS. IN

Sec. 12 T1N R1W wm

6711 N. E. 58th Ave.
Vancouver, Wash. 98661
Phone: 694-6242

HANSEN DRILLING CO., Inc.

LOG

Name Northwest Natural Gas Co. Rect. # 226

Address Gasco Reg. Station Portland

Date Started 10-16-85 Date Finished 10-22-85

DESCRIPTION:

(a) Well Depth 400 ft. Diameter 8 3/4

(b) Depth from ground surface to water level before pumping Ø ft. Bailer tested Ø GPM

(c) Drawdown of water level is Ø feet. (pumping level minus static water level)

(d) Casing - screen - perforation - shoe - etc.

10" casing 0 - 20
19 sks. cment 100 sks. 50# coke 99
35 sks. gel (mud) 18 sks. 50# #496
400 ft. 1" pipe 2 yds. gravel
100 ft. 2" sche. 40 vent pipe
30 ft. 2" monitor pipe

7 Hrs. Mob.,demob.,clean-up & surface seal
24 Hrs. Drilling & chasing
5 Hrs. extra time cementing & setting vent tube & monitor pipe
7 Hrs. anodes, circulate, coke, graphite & gravel

PRINTED PTS. IN

260/ Hansen over

Koppers022693

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

NOV 1 1985
WATER RESOURCES DEPT.
SALEM, OREGON

006108

PLEASE TYPE or PRINT IN INK

1N/1W-12
(for official use only)

(1) OWNER:
Northwest Natural Gas Co. Rect. #226
Address 220 NW, Second Ave.
City Portland State Oregon

(2) TYPE OF WORK (check): Cathodic Protection Ground bed
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12

(3) TYPE OF WELL:
Rotary Air ☐ Driven ☐
Rotary Mud ☒ Dug ☐
Cable ☐ Bored ☐

(4) PROPOSED USE (check):
Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Thermal: Withdrawal ☐ Reinjection ☐
Other: Piezometric ☐ Grounding ☒ Test ☐

NOT A WATER WELL

(5) CASING INSTALLED: Steel ☒ Threaded ☐ Plastic ☒ Welded ☐
10" Diam. from 0 ft. to 20 ft. Gauge .250
2" Diam. from 0 ft. to 100 ft. Gauge sche. 40

LINER INSTALLED: Steel ☐ Threaded ☐ Plastic ☐ Welded ☐
..... Diam. from ..... ft. to ..... ft. Gauge .....

(6) PERFORATIONS: Perforated? ☐ Yes ☐ No
Size of perforations ..... in. by ..... in.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.

SCREENS: Well screen installed? ☐ Yes ☒ No
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot Size ..... Set from ..... ft. to ..... ft.
Diam. ..... Slot Size ..... Set from ..... ft. to ..... ft.

NOT A WATER WELL

(8) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☐ No If yes, by whom?
Yield: ..... gal./min. with ..... ft. drawdown after ..... hrs.
Air test ..... gal./min. with drill stem at ..... ft. ..... hrs.
Bailer test ..... gal./min. with ..... ft. drawdown after ..... hrs.
Artesian flow ..... g.p.m.
Temperature of water ..... Depth artesian flow encountered ..... ft.

(9) CONSTRUCTION: Special standards: Yes ☐ No ☐
Well seal—Material used Cement
Well sealed from land surface to 20 / 50'-80' ft.
Diameter of well bore to bottom of seal 14 / 83/4 in.
Diameter of well bore below seal 8 3/4 in.
Amount of sealing material 19 sacks ☒ pounds ☐
How was cement grout placed? Pipe
Was pump installed? ..... Type ..... HP ..... Depth ..... ft.
drive shoe used? ☐ Yes ☐ No Plugs ..... Size: location ..... ft.
Did any strata contain unusable water? ☐ Yes ☐ No
Type of Water? ..... depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☐ No Size of gravel: .....
Gravel placed from ..... ft. to ..... ft.

NOT A WATER WELL

(10) LOCATION OF WELL by legal description:
County Multnomah ..... ¼ ..... ¼ of Section 12 of
Township 1 N (Township is North or South) Range 1 W (Range is East or West) WM.
Tax Lot ..... Lot ..... Block ..... Subdivision .....
MAILING ADDRESS OF WELL (or nearest address)
Site: Cascd Reg. Station St Helen Rd.

(11) WATER LEVEL of COMPLETED WELL:
Depth at which water was first found ..... ft.
Static level ..... ft. below land surface. Date .....
Artesian pressure ..... lbs. per square inch. Date .....

(12) WELL LOG: Diameter of well below casing 8 3/4
Depth drilled 400 ft. Depth of completed well 0 ft.
Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
Gravel	0	1	GL
Clay	1	2	CC
Sand	2	10	SL
Brown clay	10	40	CC
Sand	40	50	SL
Broken rock	50	78	RC
Black basalt hard some broken lava rock layers	78	290	RC
Broken multi colored clay & sandstone little clay	290	310	SS
Black basalt hard	310	370	RC
Broken rock sandy clay	370	390	SC
Black basalt hard	390	400	RC

Date work started Oct. 10, 1985 completed Oct. 22, 1985
Date well drilling machine moved off of well Oct. 22, 1985 19

(unbonded) Water Well Constructor Certification (if applicable):
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
Signed ..... Date ....., 19 .....

(bonded) Water Well Constructor Certification:
Bond 63-0130-11384-SP-1 (number) Issued by: UFSEG (Surety Company Name)
On behalf of Jim Hansen / Hansen Drilling Co. Inc. (type or print name of Water Well Constructor)

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief:
(Signed) Jim J Hansen (Water Well Constructor)
(Dated) Oct. 23, 1985

NOTICE TO WATER WELL CONSTRUCTOR WATER RESOURCES DEPARTMENT SP*46866-690

Koppers022694

PHASE I REMEDIAL INVESTIGATION SUMMARY REPORT AND PRELIMINARY ANALYSIS OF SOIL DATA (As Appendix 1)

Volume 2

Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

October 9, 1998

Prepared for:

Northwest Natural
Portland, Oregon

Prepared by:

Hahn and Associates, Inc.
Portland, Oregon

and

Decision Management Associates LLC
Portland, Oregon
(Appendix 1)

HAI Project No. 2708

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APPENDIX E

Groundwater Level Data

Aquifer Characteristic Data

Groundwater Elevation Maps

Groundwater Hydrographs

Koppers022697

TABLE E-1 - Summary of Water Level Measurements and Groundwater Elevations

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Elevation of Top of Casing

Date of Elevation Survey	Elevation of Top of Casing (feet msl)*																	River Benchmark (feet msl)*
	MW-1-22	MW-2-32	MW-3-26	MW-3-56	MW-4-35	MW-4-57	MW-5-32	MW-6-32	MW-6-61	MW-8-29	MW-8-56	MW-9-29	MW-10-25	MW-10-61	MW-11-32	MW-12-36	MW-13-30	MW-13-61	
7-Dec-95	34.75	34.46	34.11	34.07	34.54	34.53	27.83	35.51	34.50	39.09	39.13	37.65	39.22	39.33	38.39	38.69	34.86	34.78	32.12

Measured Water Level

Date Measured	Measured Water Level (feet btc)																	River Level (feet bbm)**
	MW-1-22	MW-2-32	MW-3-26	MW-3-56	MW-4-35	MW-4-57	MW-5-32	MW-6-32	MW-6-61	MW-8-29	MW-8-56	MW-9-29	MW-10-25	MW-10-61	MW-11-32	MW-12-36	MW-13-30	MW-13-61	
5-Dec-95	14.15	15.23	15.58	15.79	16.12	16.39	9.46	16.71	15.77	19.75	20.61	6.20	14.98	13.42	12.69	9.37	-	-	-
5-Jan-96	14.47	20.04	19.47	21.85	22.47	22.38	15.57	14.84	21.58	19.01	26.74	7.33	15.20	16.32	12.19	10.82	-	-	-
12-Feb-96	7.74	8.61	8.52	8.63	9.09	9.10	2.41	9.55	8.97	16.99	13.56	3.32	11.11	8.92	8.95	5.27	-	-	-
18-Mar-96	12.44	18.03	17.87	19.66	20.24	20.21	13.37	12.10	19.39	15.22	24.54	6.13	11.95	14.47	9.42	9.01	-	-	-
16-Apr-96	13.65	18.83	18.13	19.47	20.26	20.07	13.36	13.42	19.51	15.58	24.44	6.93	12.63	15.07	10.12	9.69	-	-	-
10-May-96	13.75	19.47	18.98	22.01	22.58	22.60	15.78	13.30	21.55	15.77	26.93	6.94	12.98	15.90	10.40	10.24	-	-	-
17-Jun-96	13.88	17.40	17.40	18.21	18.61	18.73	11.96	13.40	18.13	16.00	23.15	5.03	13.51	13.96	10.90	9.98	-	-	-
16-Jul-96	15.51	20.71	20.07	24.41	24.30	24.93	17.91	14.60	23.55	17.26	29.05	6.65	15.90	17.21	11.93	12.43	-	-	-
21-Aug-96	16.51	21.80	22.24	26.99	26.77	27.51	20.46	16.17	26.27	19.18	31.93	8.47	16.58	19.43	13.40	14.53	-	-	-
17-Sep-96	17.06	22.06	20.61	28.02	27.15	28.53	21.27	16.94	26.81	20.13	32.63	7.52	16.80	19.30	14.02	14.86	-	-	-
30-Sep-96	17.17	22.24	23.32	27.04	27.46	27.61	20.68	17.08	27.01	20.19	32.45	8.70	16.89	19.84	14.26	14.97	-	-	-
15-Nov-96	16.38	22.02	20.76	26.48	26.85	27.00	19.84	17.00	25.71	20.63	31.37	6.61	16.42	18.38	14.20	13.85	-	-	-
24-Feb-97	12.41	18.71	18.61	20.48	20.82	21.02	14.17	12.83	19.79	18.43	25.33	4.35	14.85	14.33	11.18	9.71	-	-	-
10-Jun-97	12.89	14.23	13.80	14.20	14.70	14.56	7.97	13.81	14.61	18.56	19.25	4.84	16.01	12.20	12.50	8.49	-	-	-
26-Aug-97	15.38	21.70	22.61	26.10	26.56	25.84	19.63	18.53	25.58	20.31	31.13	11.71	17.10	20.16	14.30	14.13	-	-	-
25-Nov-97	14.42	21.50	19.25	24.64	25.14	24.80	18.23	16.29	24.33	20.85	29.85	7.85	16.36	17.89	13.88	11.79	-	-	-
19-Dec-97	-	-	-	22.75	-	23.28	-	-	22.62	-	27.90	-	-	16.90	-	-	-	23.71	-
16-Feb-98	12.60	20.13	18.65	23.55	23.25	24.10	17.09	14.29	-	20.05	28.50	5.33	15.60	15.89	12.02	9.72	14.73	23.98	21.91
1-Jun-98	14.49	16.97	16.61	16.51	16.90	17.00	10.33	15.75	-	20.05	21.63	7.25	14.63	14.36	12.85	9.83	15.69	17.11	14.57

NOTE: * = City of Portland Datum
bbm = below bench mark
btc = below top of casing
msl = mean sea level

**Willamette River, Portland Harbor Stage, obtained from National Weather Service and adjusted to feet msl - City of Portland datum: December 1995 to December 1997. Post December 1997 River Stage data measured directly from surveyed bench mark located on north end of PNO Dock.

Koppers022698

TABLE E-1 - Summary of Water Level Measurements and Groundwater Elevations

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Groundwater Elevation

Date Measured	Groundwater Elevation (feet msl)*																		River Stage (feet msl)*
	MW-1-22	MW-2-32	MW-3-26	MW-3-56	MW-4-35	MW-4-57	MW-5-32	MW-6-32	MW-6-61	MW-8-29	MW-8-56	MW-9-29	MW-10-25	MW-10-61	MW-11-32	MW-12-36	MW-13-30	MW-13-61	
5-Dec-95	20.60	19.23	18.53	18.28	18.42	18.14	18.37	18.80	18.73	19.34	18.52	31.45	24.24	25.91	25.70	29.32	-	-	18.9
5-Jan-96	20.28	14.42	14.64	12.22	12.07	12.15	12.26	20.67	12.92	20.08	12.39	30.32	24.02	23.01	26.20	27.87	-	-	12.4
12-Feb-96	27.01	25.85	25.59	25.44	25.45	25.43	25.42	25.96	25.53	22.10	25.57	34.33	28.11	30.41	29.44	33.42	-	-	26.4
18-Mar-96	22.31	16.43	16.24	14.41	14.30	14.32	14.46	23.41	15.11	23.87	14.59	31.52	27.27	24.86	28.97	29.68	-	-	14.4
16-Apr-96	21.10	15.63	15.98	14.60	14.28	14.46	14.47	22.09	14.99	23.51	14.69	30.72	26.59	24.26	28.27	29.00	-	-	14.5
10-May-96	21.00	14.99	15.13	12.06	11.96	11.93	12.05	22.21	12.95	23.32	12.20	30.71	26.24	23.43	27.99	28.45	-	-	11.6
17-Jun-96	20.87	17.06	16.71	15.86	15.93	15.80	15.87	22.11	16.37	23.09	15.98	32.62	25.71	25.37	27.49	28.71	-	-	15.7
16-Jul-96	19.24	13.75	14.04	9.66	10.24	9.60	9.92	20.91	10.95	21.83	10.08	31.00	23.32	22.12	26.46	26.26	-	-	-
21-Aug-96	18.24	12.66	11.87	7.08	7.77	7.02	7.37	19.34	8.23	19.91	7.20	29.18	22.64	19.90	24.99	24.16	-	-	6.6
17-Sep-96	17.69	12.40	13.50	6.05	7.39	6.00	6.56	18.57	7.69	18.96	6.50	30.13	22.42	20.03	24.37	23.83	-	-	5.8
30-Sep-96	17.58	12.22	10.79	7.03	7.08	6.92	7.15	18.43	7.49	18.90	6.68	28.95	22.33	19.49	24.13	23.72	-	-	5.4
15-Nov-96	18.37	12.44	13.35	7.59	7.69	7.53	7.99	18.51	8.79	18.46	7.76	31.04	22.80	20.95	24.19	24.84	-	-	7.2
24-Feb-97	22.34	15.75	15.50	13.59	13.72	13.51	13.66	22.68	14.71	20.66	13.80	33.30	24.37	25.00	27.21	28.98	-	-	13.6
10-Jun-97	21.86	20.23	20.31	19.87	19.84	19.97	19.86	21.70	19.89	20.53	19.88	32.81	23.21	27.13	25.89	30.20	-	-	19.8
26-Aug-97	19.37	12.76	11.50	7.97	7.98	8.69	8.20	16.98	8.92	18.78	8.00	25.94	22.12	19.17	24.09	24.56	-	-	7.9
25-Nov-97	20.33	12.96	14.86	9.43	9.40	9.73	9.60	19.22	10.17	18.24	9.28	29.80	22.86	21.44	24.51	26.90	-	-	8.72
19-Dec-97	-	-	-	11.32	-	11.25	-	-	11.88	-	11.23	-	-	22.43	-	-	-	11.07	-
16-Feb-98	22.15	14.33	15.46	10.52	11.29	10.43	10.74	21.22	-	19.04	10.63	32.32	23.62	23.44	26.37	28.97	20.13	10.80	10.21
1-Jun-98	20.26	17.49	17.50	17.56	17.64	17.53	17.50	19.76	-	19.04	17.50	30.40	24.59	24.97	25.54	28.86	19.17	17.67	17.55

NOTE: * = City of Portland Datum
msl = mean sea level

**Willamette River, Portland Harbor Stage, obtained from National Weather Service and adjusted to feet msl - City of Portland datum: December 1995 to December 1997. Post December 1997 River Stage data measured directly from surveyed bench mark located on north end of PNO Dock.

Koppers022699

TABLE E-2 - Summary of Aquifer Characteristic Data: Slug Testing Results

Remedial Investigation
Former Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

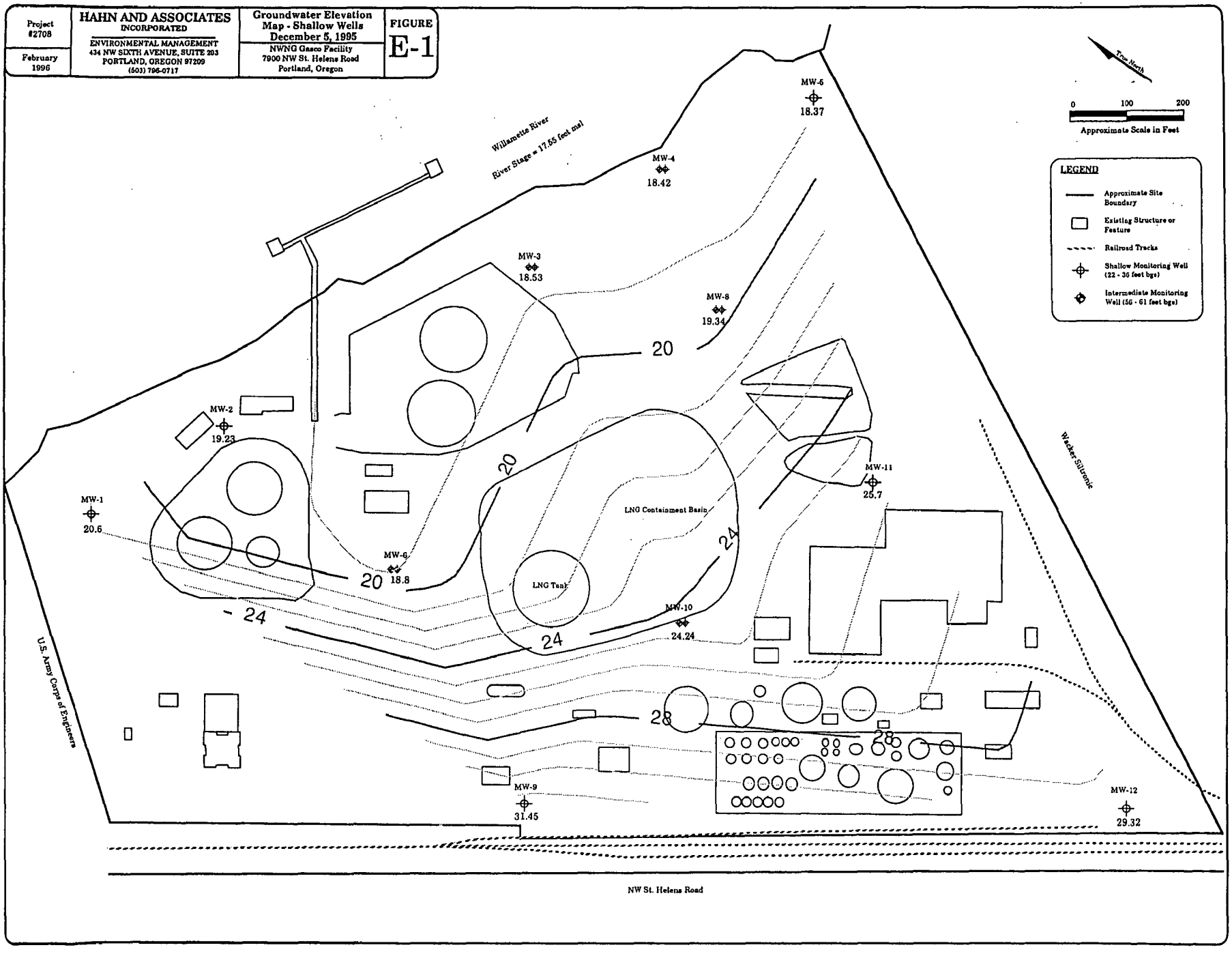
Monitoring Well	Date Installed	Screen Interval (feet msl)	Aquifer Zone Monitored	Aquifer Type (from boring log)	Calculated Hydraulic Conductivity (feet/day) (feet/day)	Effective Porosity (estimated)	Average Hydraulic Gradient	Seepage Velocity (feet/day)
MW-1-22	24-Oct-95	21.0 to 11.0	unconfined / shallow	gravely to silty sands (fill)	0.35	0.2	0.017	0.030
MW-2-32	6-Nov-95	14.3 to 4.3	unconfined / shallow	silty sands and fine sands (fill)	3.4	0.2	0.017	0.289
MW-3-26	1-Nov-95	16.2 to 6.2	unconfined / shallow	sandy gravels and silts (fill)	0.31	0.2	0.017	0.026
MW-3-56	1-Nov-95	-13.8 to -23.8	semi-confined / intermediate	medium grained sands	1.3	0.2	0.016	0.102
MW-4-35	31-Oct-95	7.7 to -2.3	unconfined / shallow	silts and sands (fill)	26	0.2	0.017	2.20
MW-4-57	30-Oct-95	-14.3 to -24.3	semi-confined / intermediate	medium grained sands	0.86	0.2	0.016	0.068
MW-5-32	27-Oct-95	4.1 to -5.9	unconfined / shallow	sands and silty sands (fill)	0.46	0.2	0.017	0.039
MW-6-32	9-Nov-95	14.8 to 4.8	unconfined / shallow	medium grained sands (fill)	-	0.2	0.017	-
MW-6-61	7-Nov-95	-14.2 to -24.2	semi-confined / intermediate	fine grained sands and silts	1.5	0.2	0.016	0.120
MW-8-29	26-Oct-95	18.5 to 8.5	unconfined / shallow	lampblack, tarry gravels and silts (fill)	0.0067	0.1	0.017	0.00114
MW-8-56	25-Oct-95	-8.5 to -18.5	semi-confined / intermediate	fine grained sands	0.08	0.2	0.016	0.0065
MW-9-29	23-Oct-95	19.9 to 9.9	unconfined / shallow	fine grained sands (fill)	0.28	0.2	0.017	0.023
MW-10-25	9-Nov-95	22.5 to 12.5	unconfined / shallow	tarry silts, fine grained sands (fill)	-	0.1	0.017	-
MW-10-61	8-Nov-95	-13.5 to -23.5	semi-confined / intermediate	fine grained sands and silty sands	0.23	0.2	0.016	0.018
MW-11-32	3-Nov-95	14.4 to 4.4	unconfined / shallow	silt and medium grained sands	-	0.2	0.017	-
MW-12-36	23-Oct-95	10.9 to 0.9	unconfined / shallow	fine grained sands	0.62	0.2	0.017	0.053

Koppers022700

Groundwater Elevation Maps
Surficial Fill Water Bearing Zone

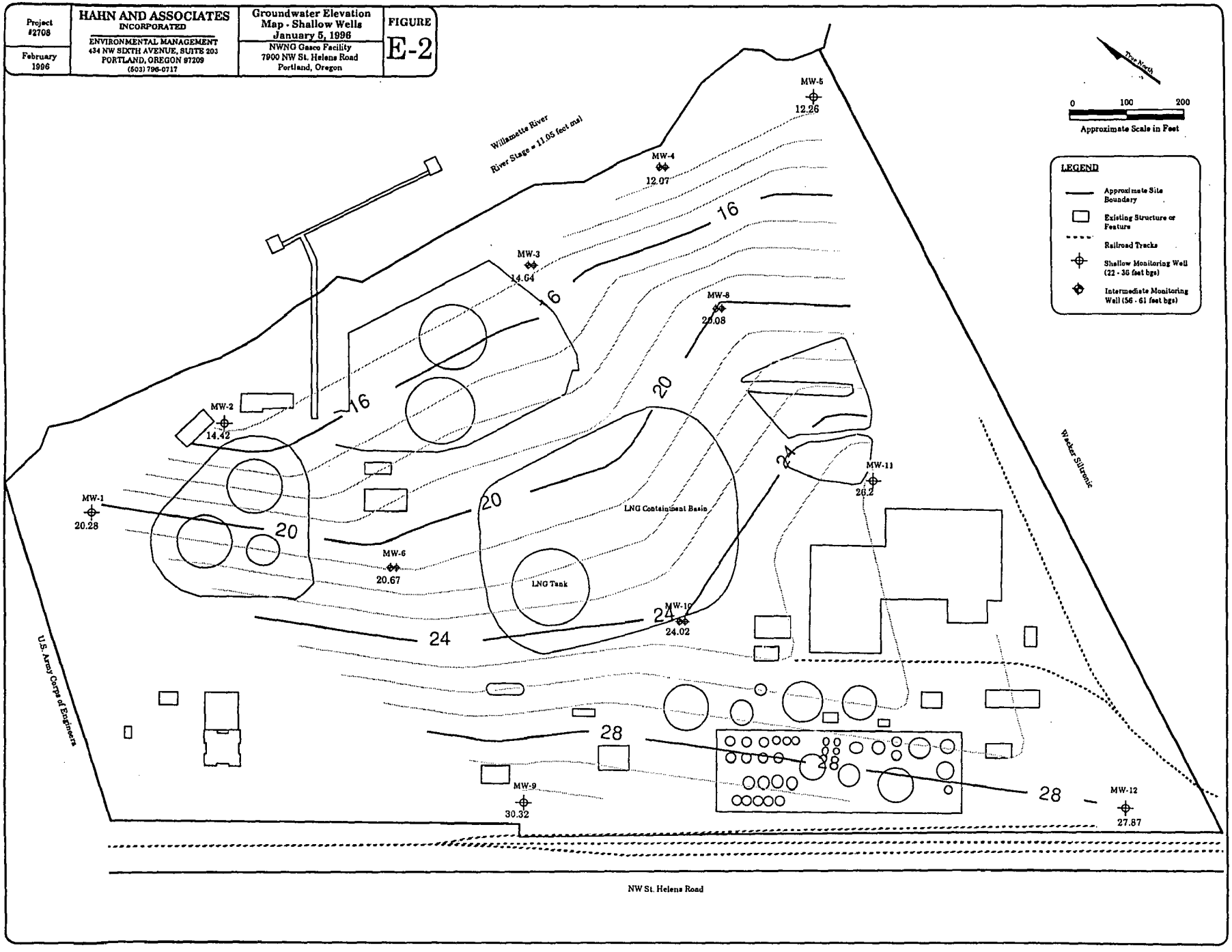
HAHN AND ASSOCIATES, INC.

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells December 5, 1995	FIGURE E-1
February 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



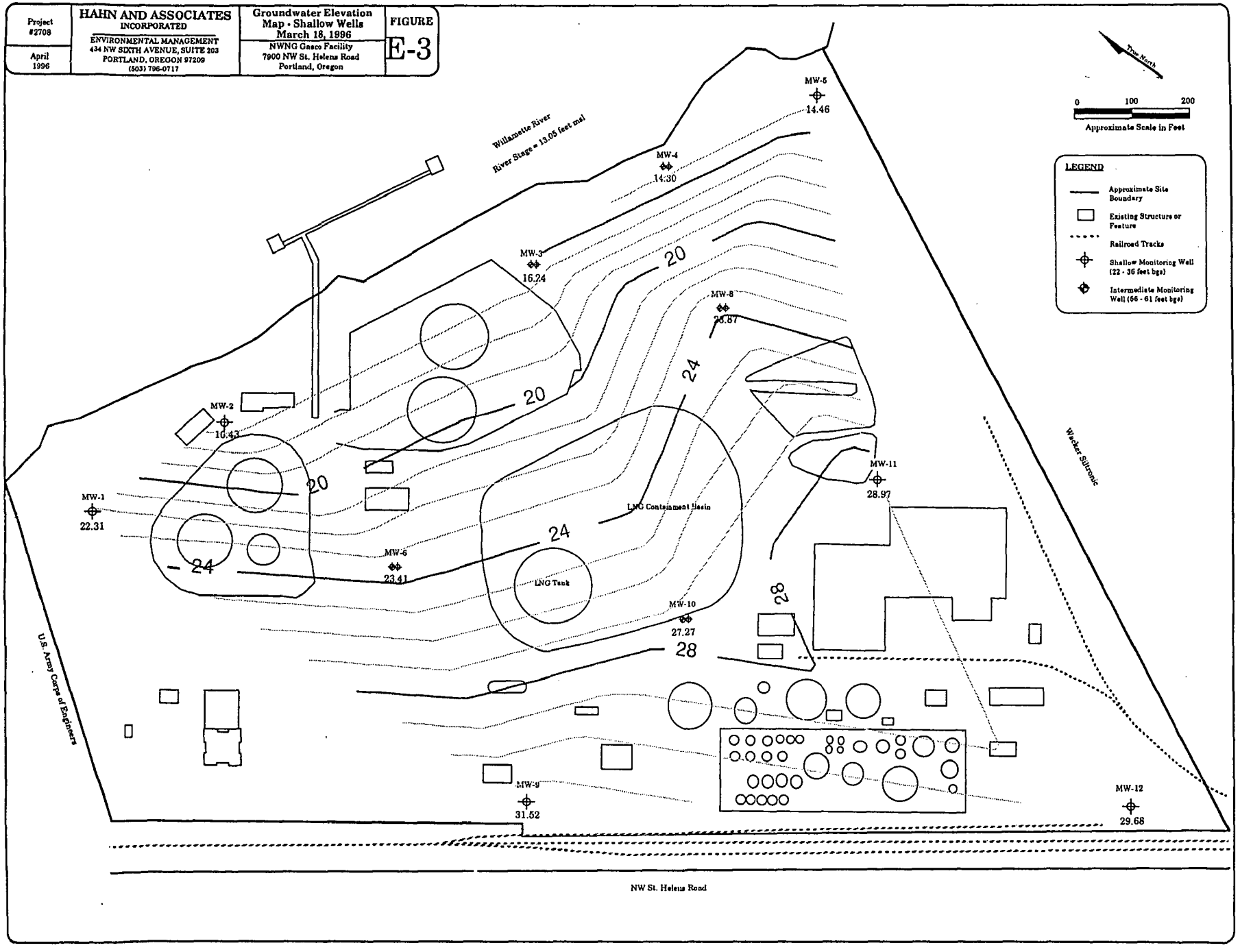
Koppers022702

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells January 5, 1996	FIGURE E-2
February 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



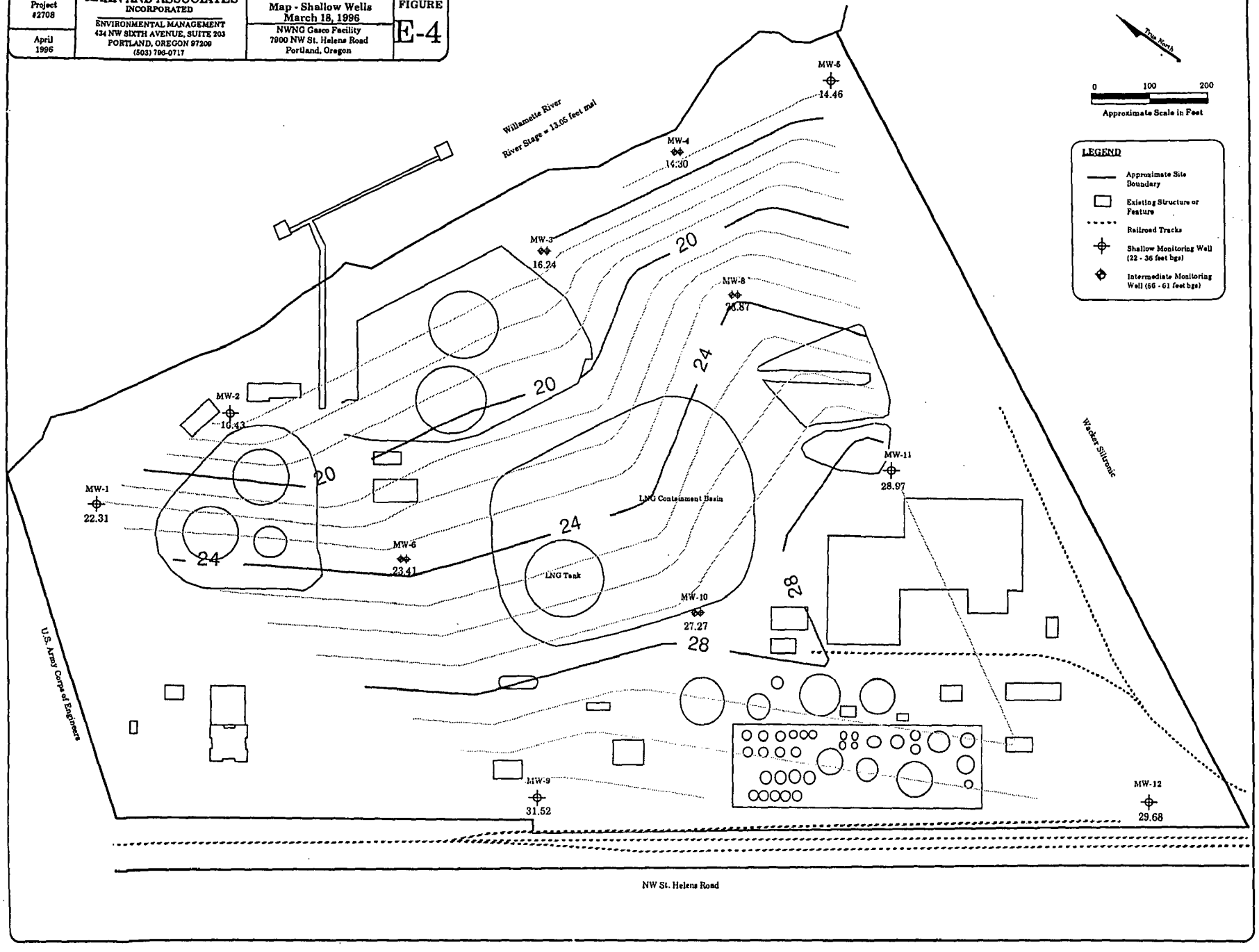
Koppers022703

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells March 18, 1996	FIGURE E-3
April 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



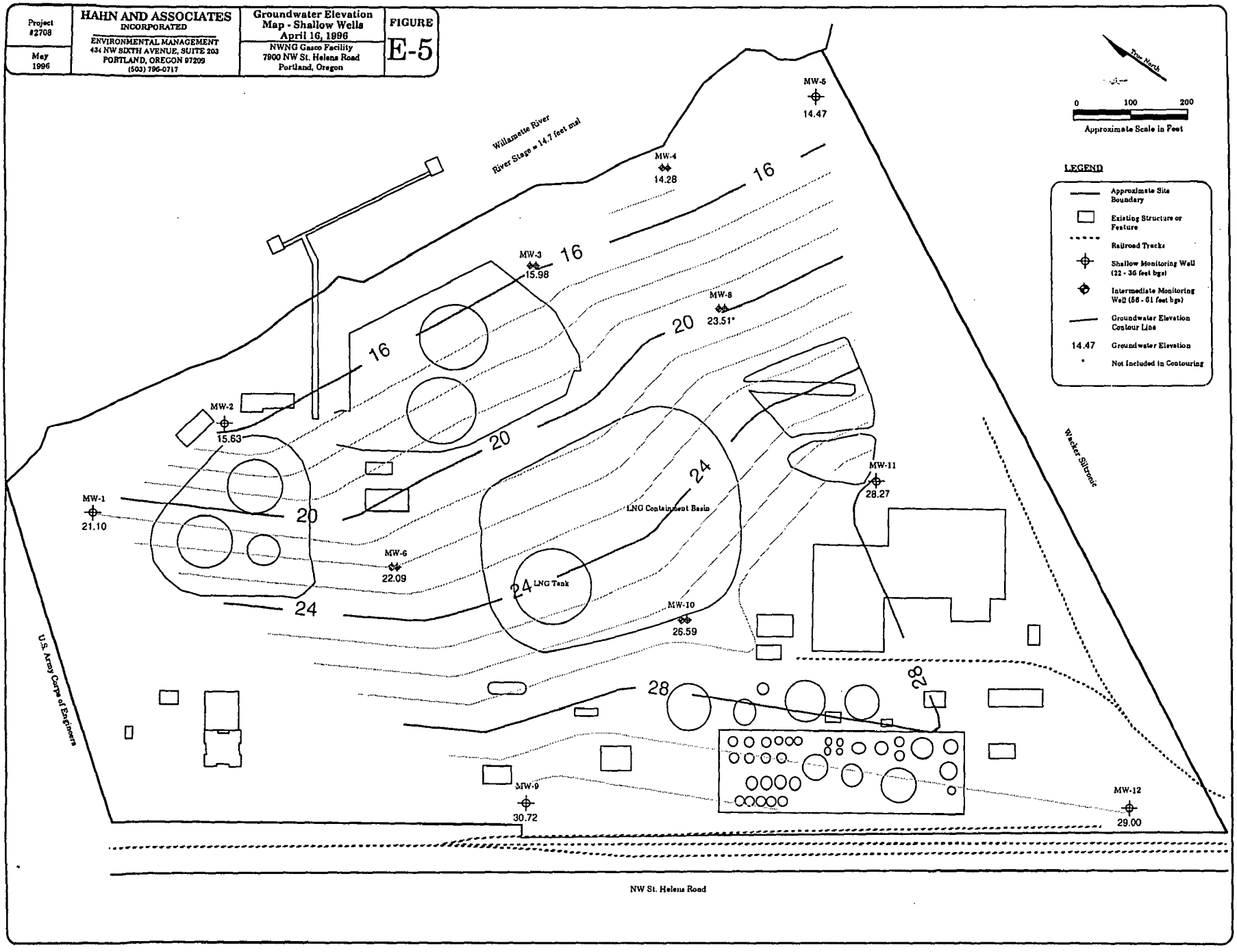
Koppers022704

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells March 18, 1996	FIGURE
April 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-4



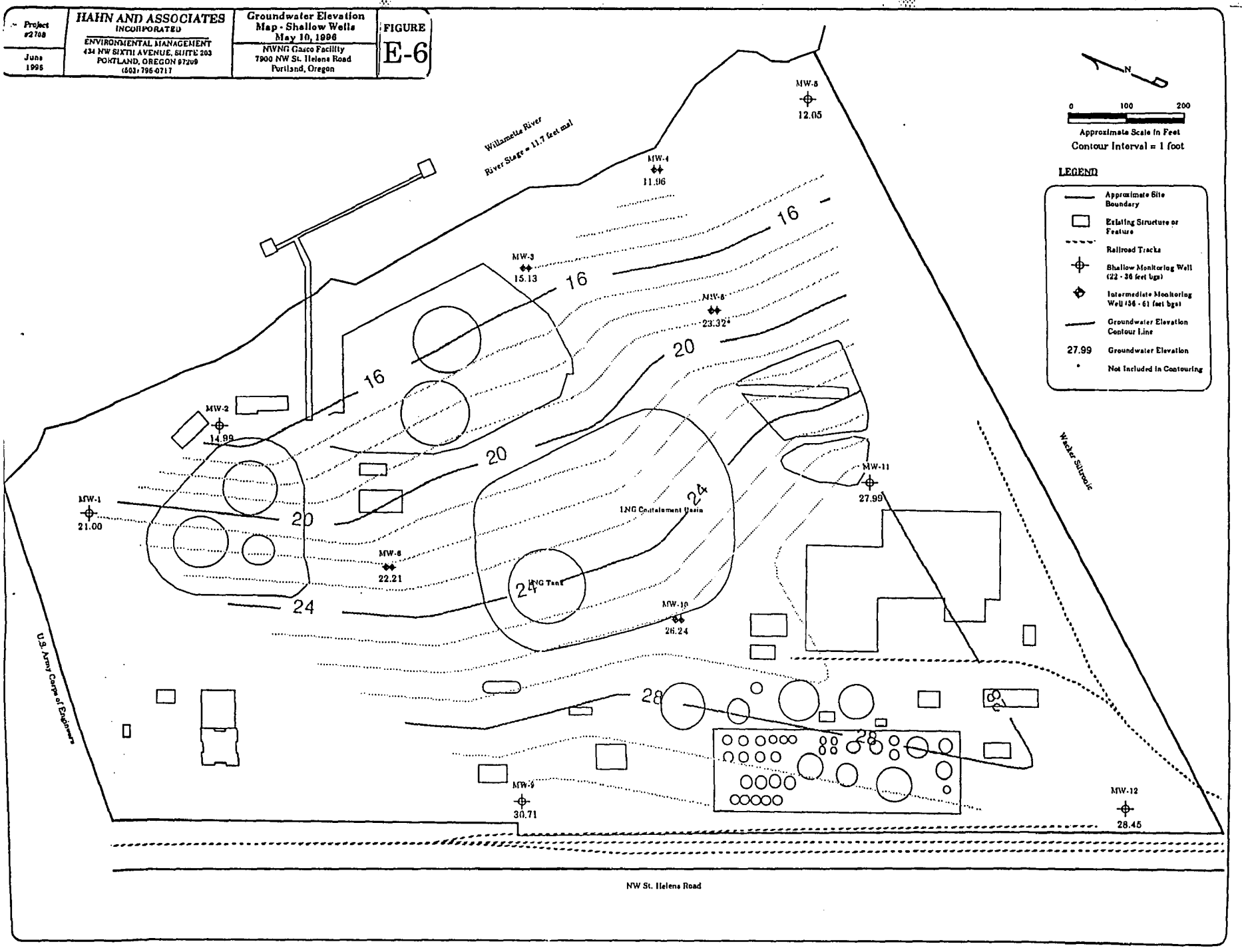
Koppers022705

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells April 16, 1996	FIGURE
May 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-5



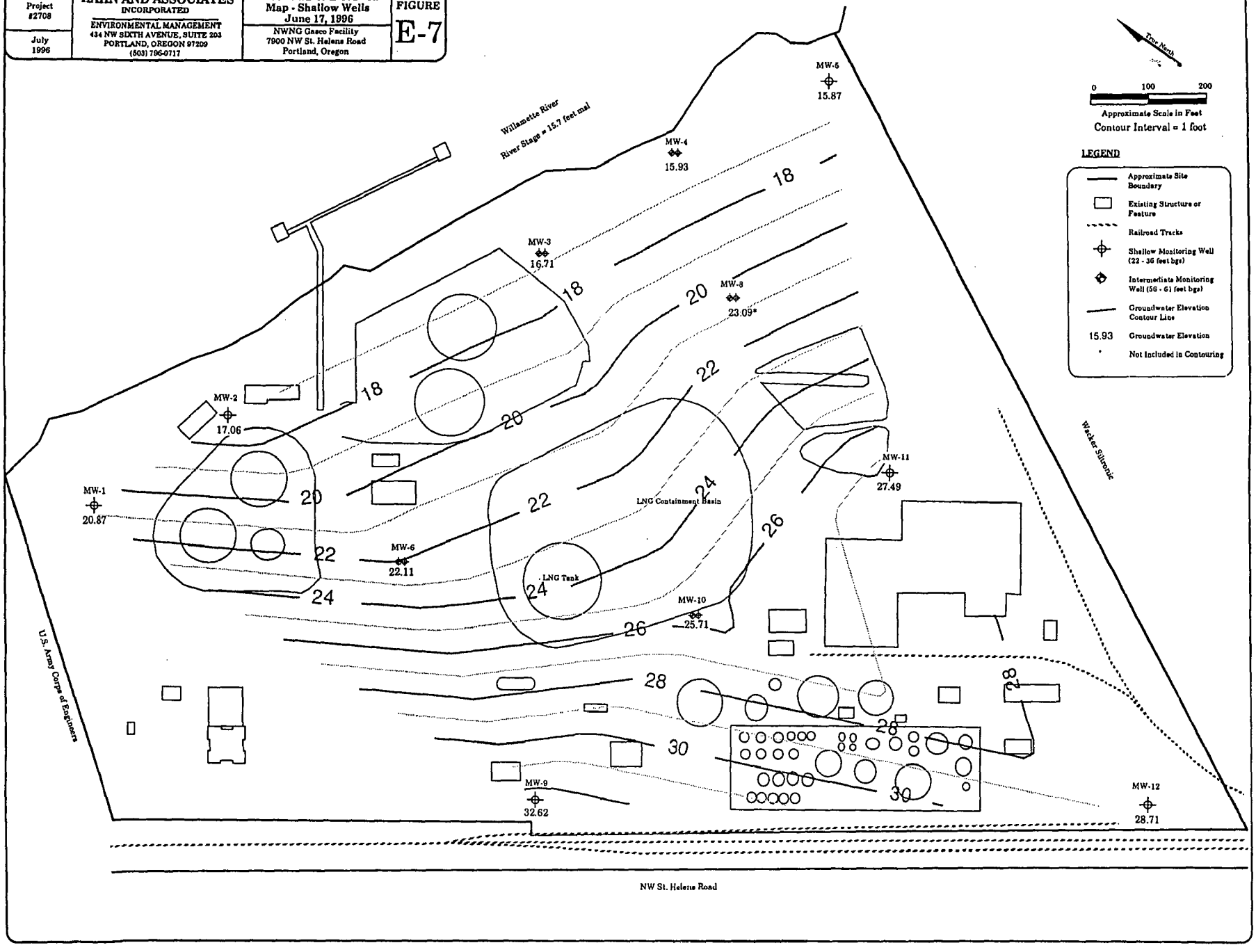
Koppers022706

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells May 10, 1996	FIGURE
June 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-6



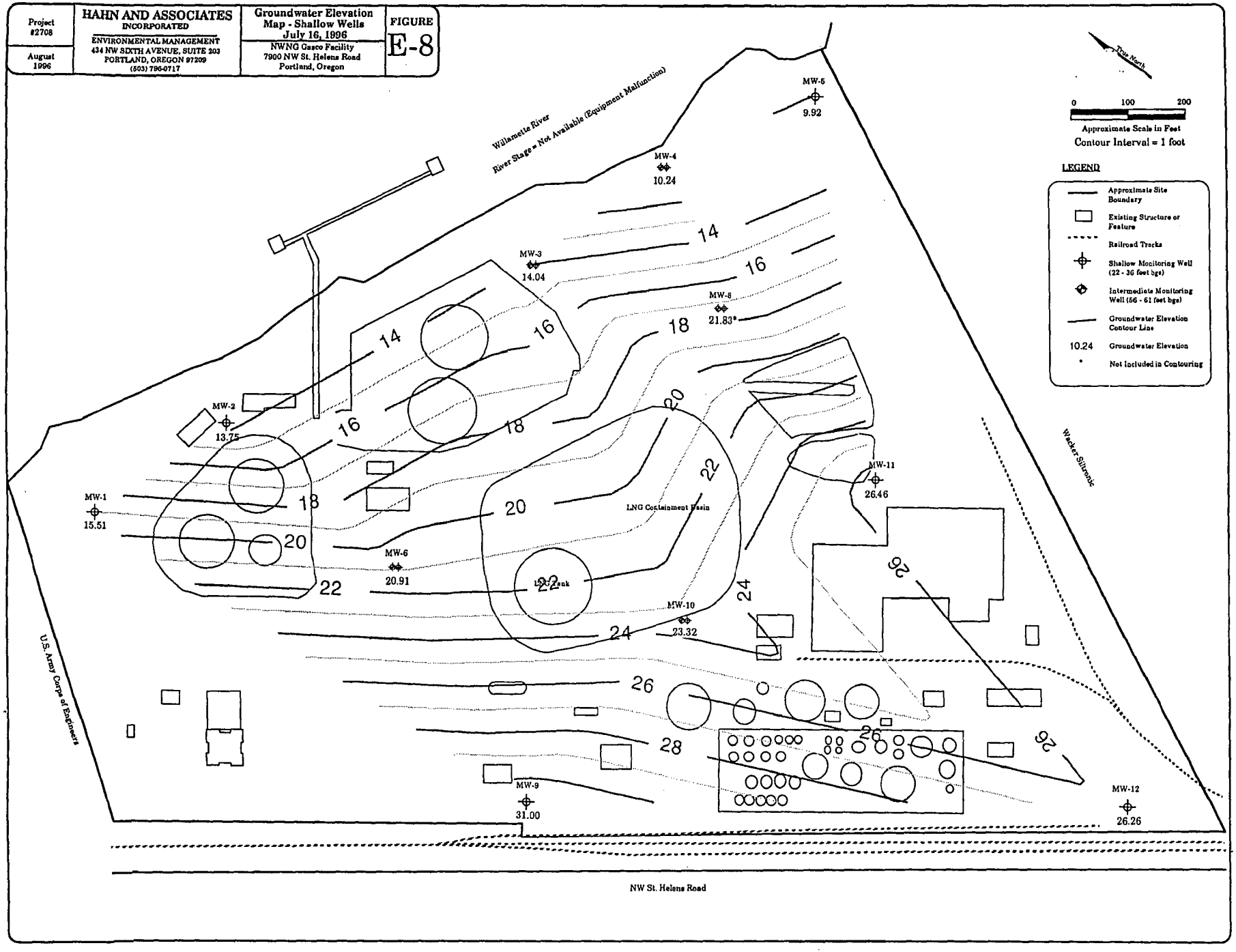
Koppers022707

Project #2708	HAHN AND ASSOCIATES INCORPORATED ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	Groundwater Elevation Map - Shallow Wells June 17, 1996 NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	FIGURE E-7
July 1996			



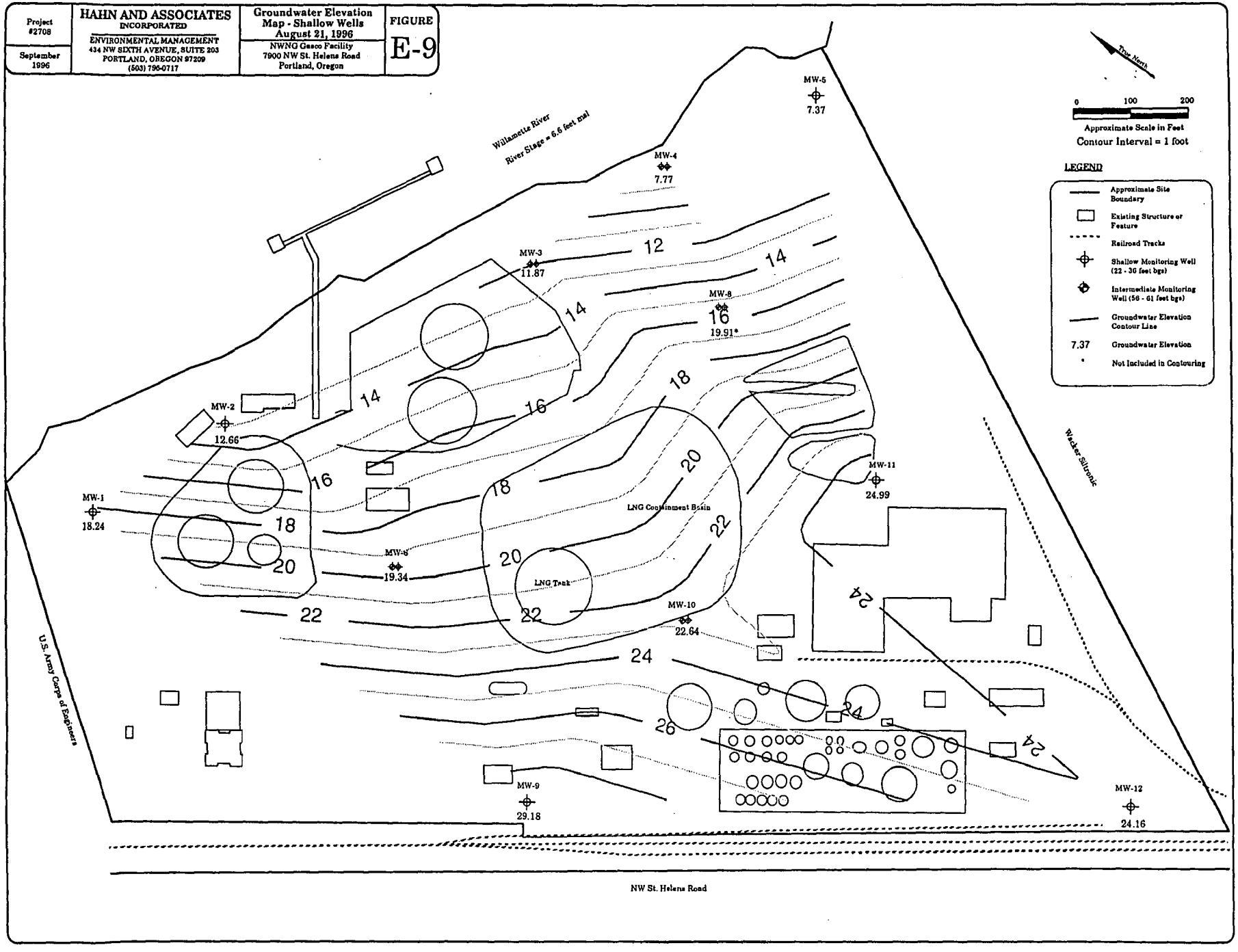
Koppers022708

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells July 16, 1996	FIGURE E-8
August 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



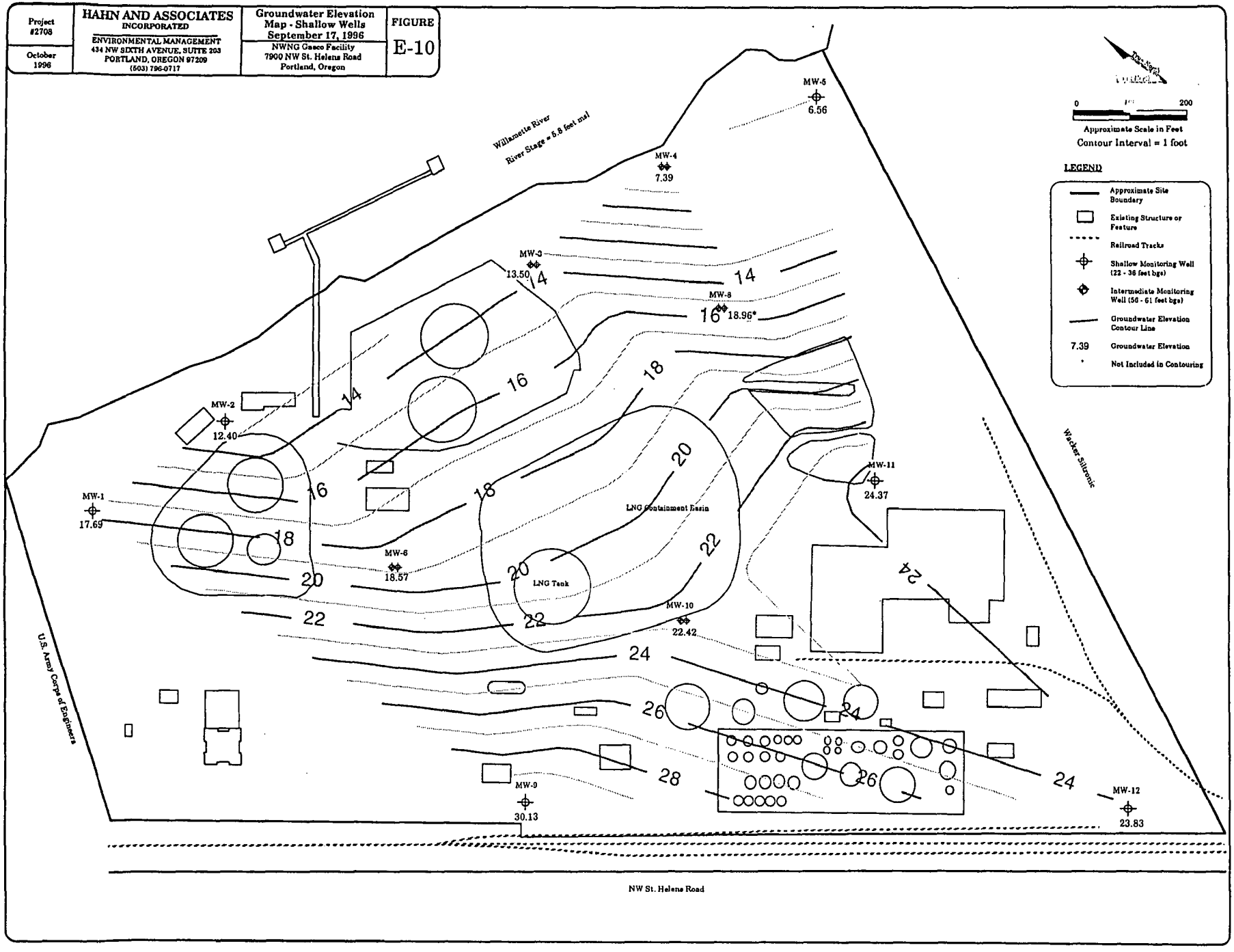
Koppers022709

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells August 21, 1996	FIGURE
September 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-9



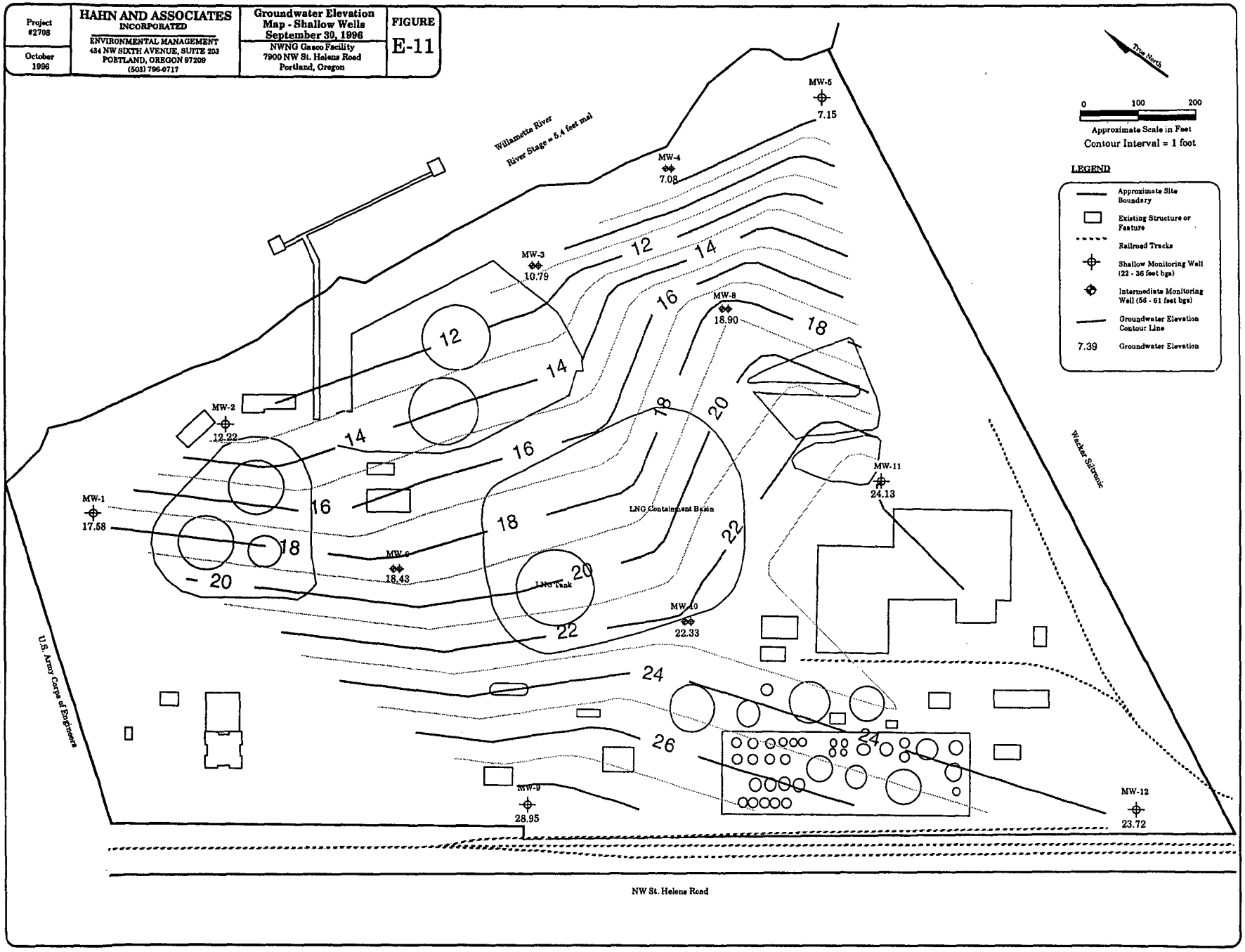
Koppers022710

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells September 17, 1996	FIGURE
October 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-10



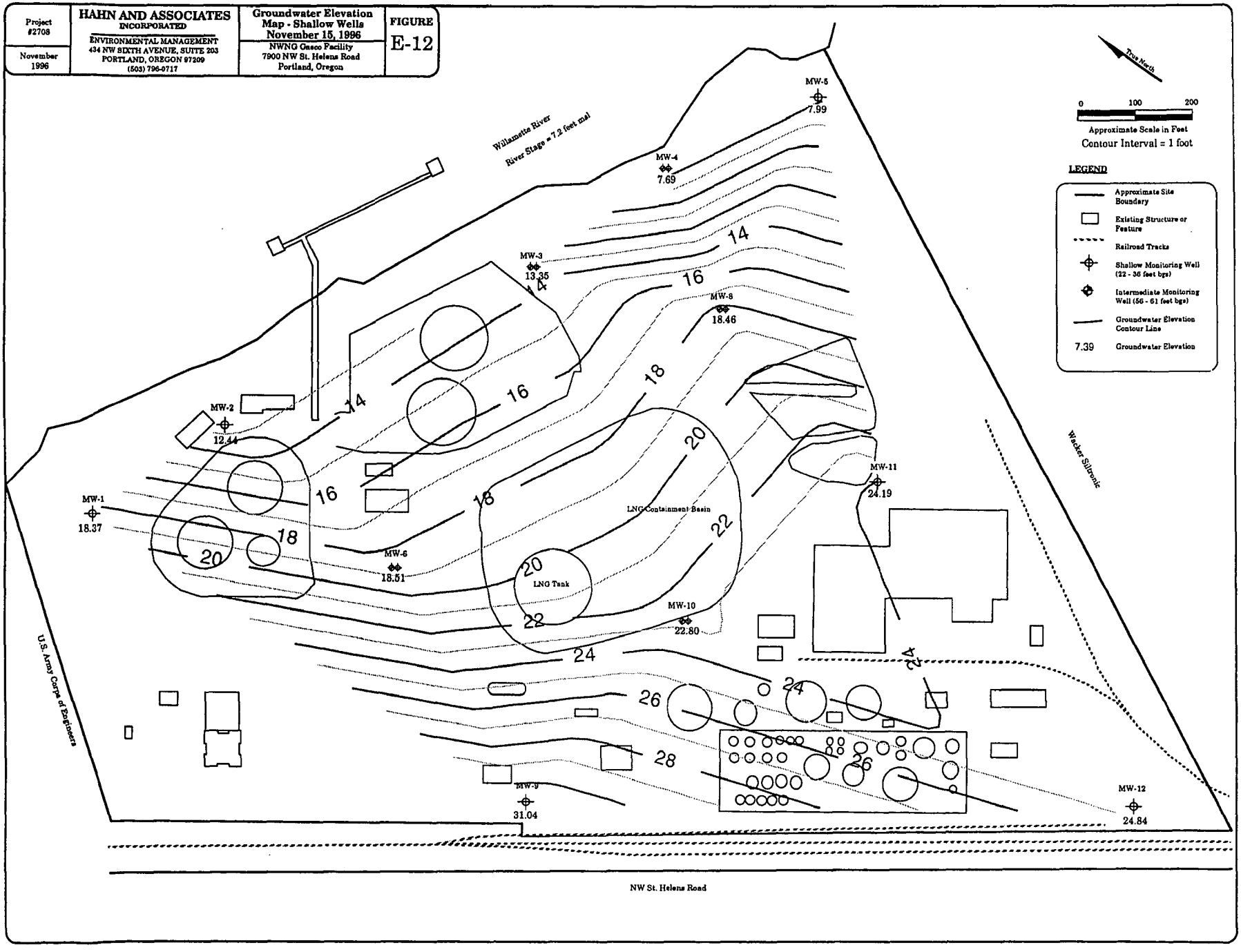
Koppers022711

Project #2708	HAHN AND ASSOCIATES INCORPORATED ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	Groundwater Elevation Map - Shallow Wells September 30, 1996 NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	FIGURE E-11
October 1996			



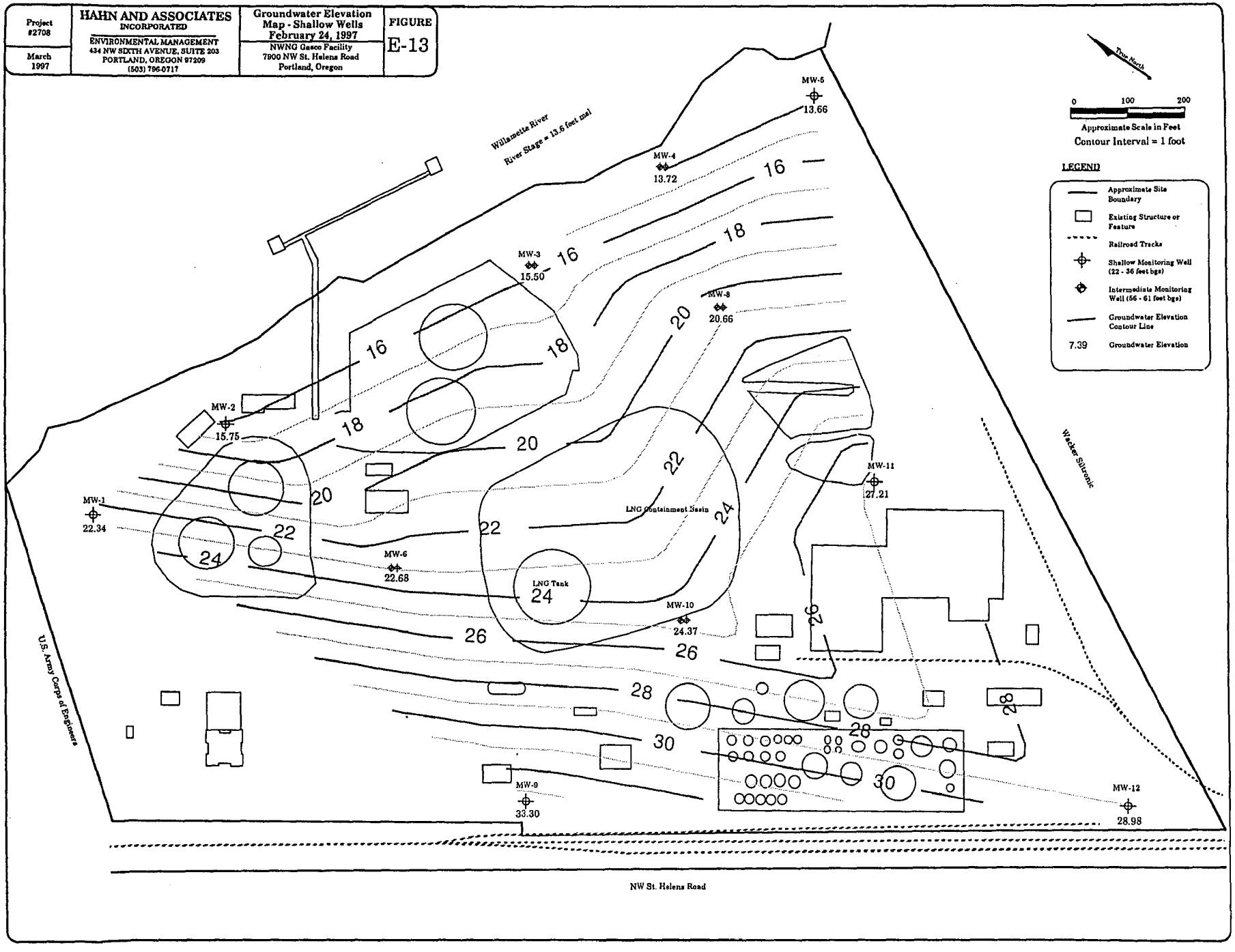
Koppers022712

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells November 15, 1996	FIGURE E-12
November 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



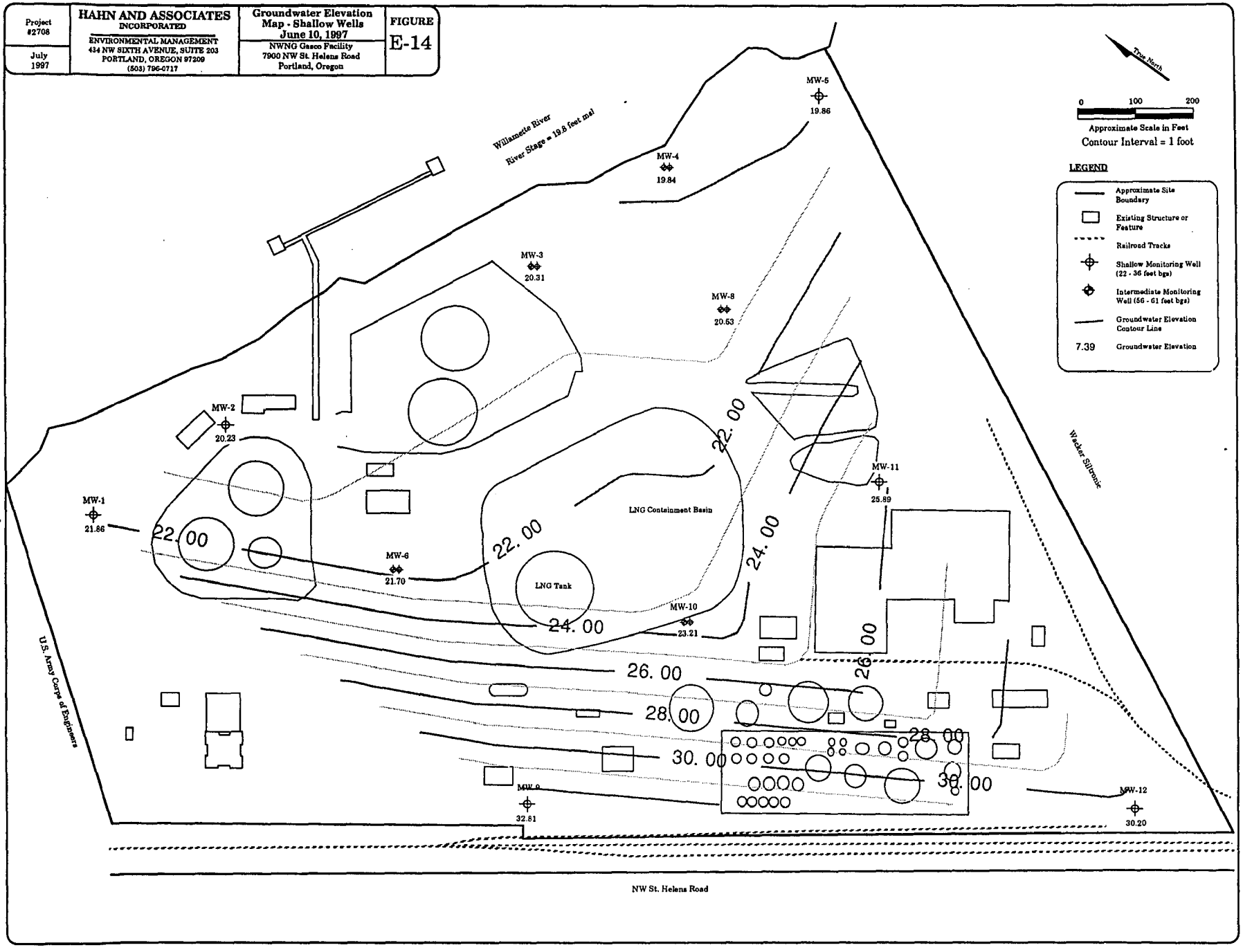
Koppers022713

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells February 24, 1997	FIGURE
March 1997	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-13



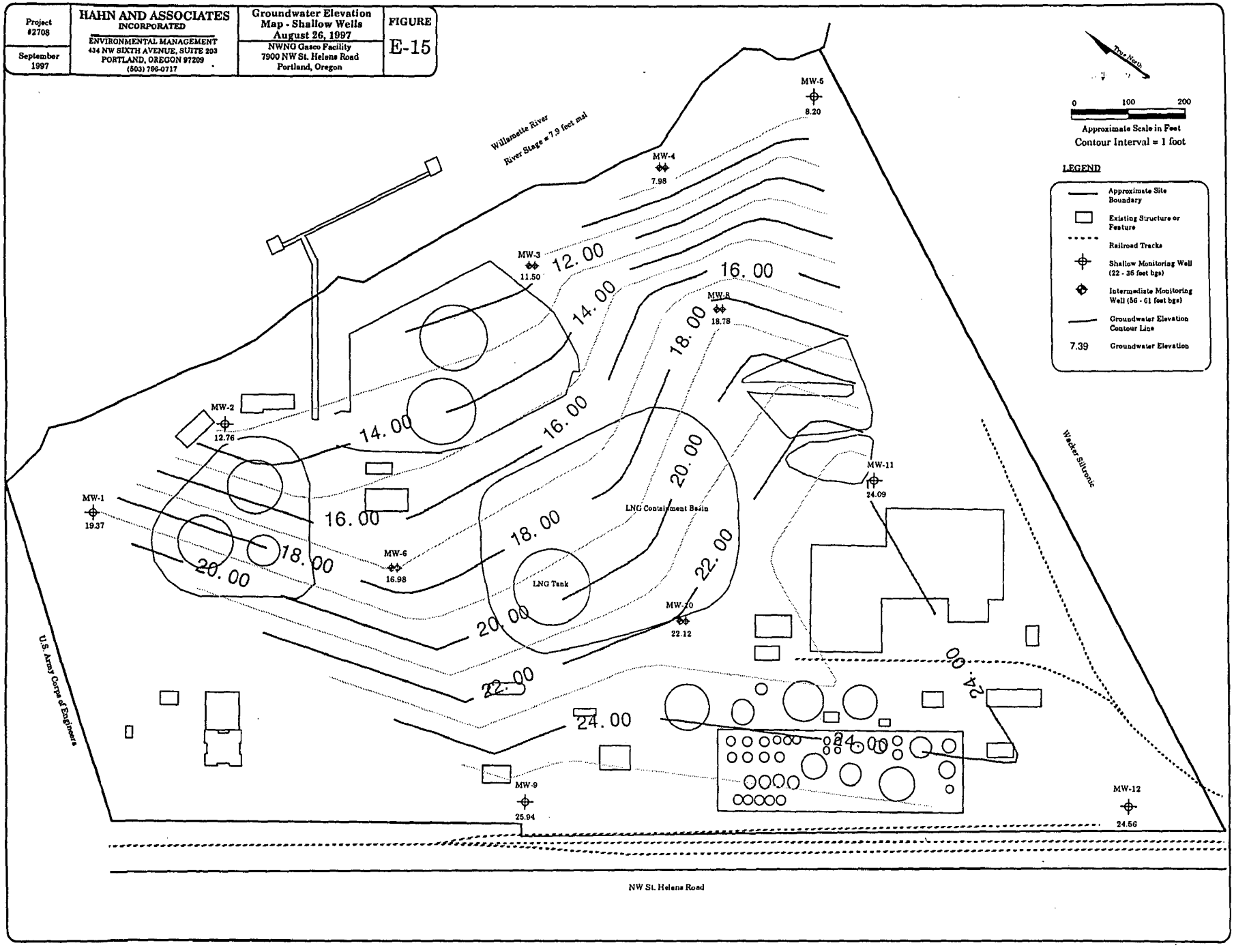
Koppers022714

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells June 10, 1997	FIGURE E-14
July 1997	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



Koppers022715

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Shallow Wells August 26, 1997	FIGURE E-15
September 1997	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



Koppers022716

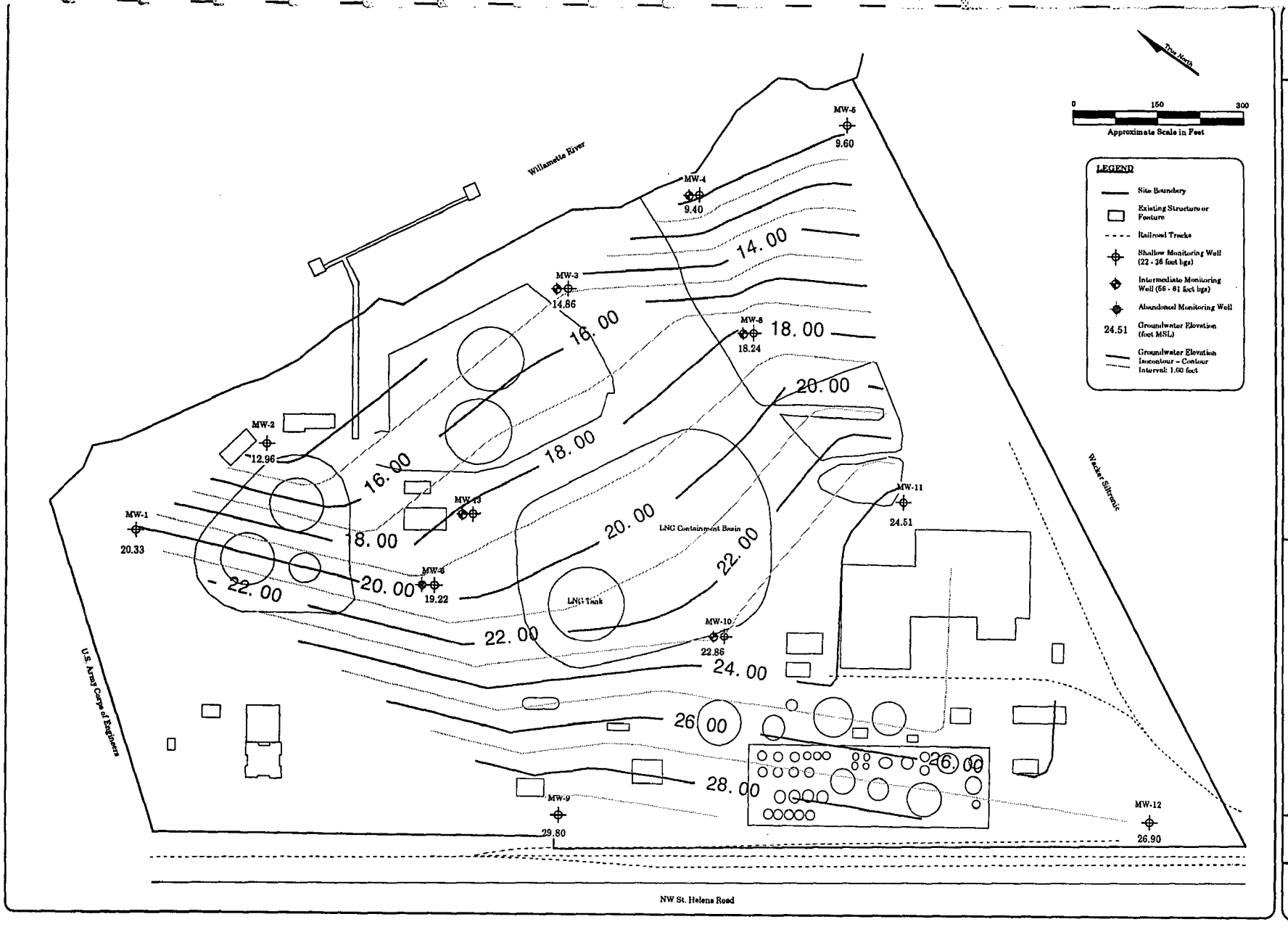


Figure
E-16

Groundwater Elevation Map - Shallow Wells
November 25, 1997

RI/FS
Northwest Natural - Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

February 1998

Project #2708

Koppers022717

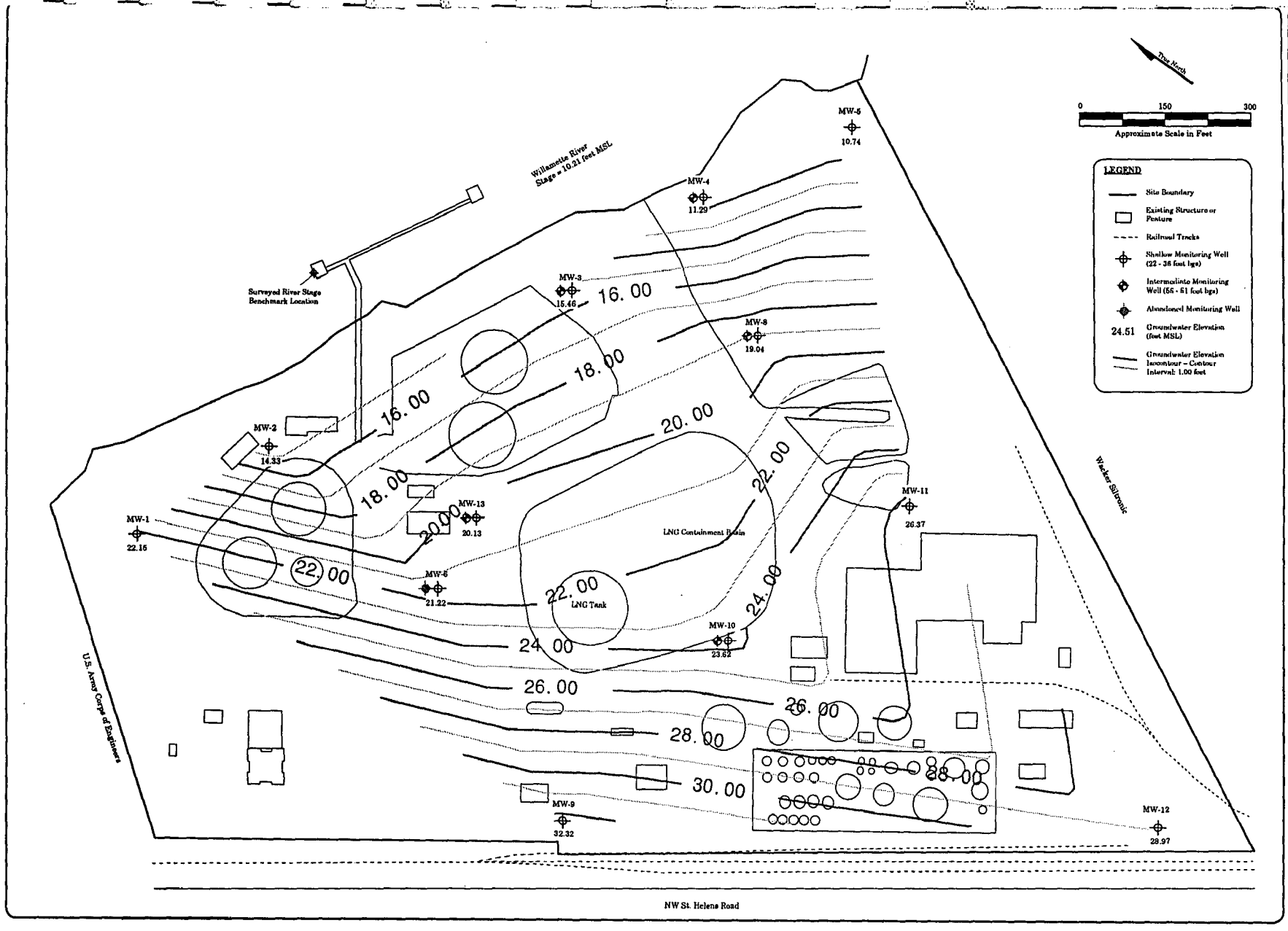


Figure
E-17

Groundwater Elevation Map - Shallow Wells
February 16, 1998

RI/FS
Northwest Natural - Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

April 1998

Project #2708

Koppers022718

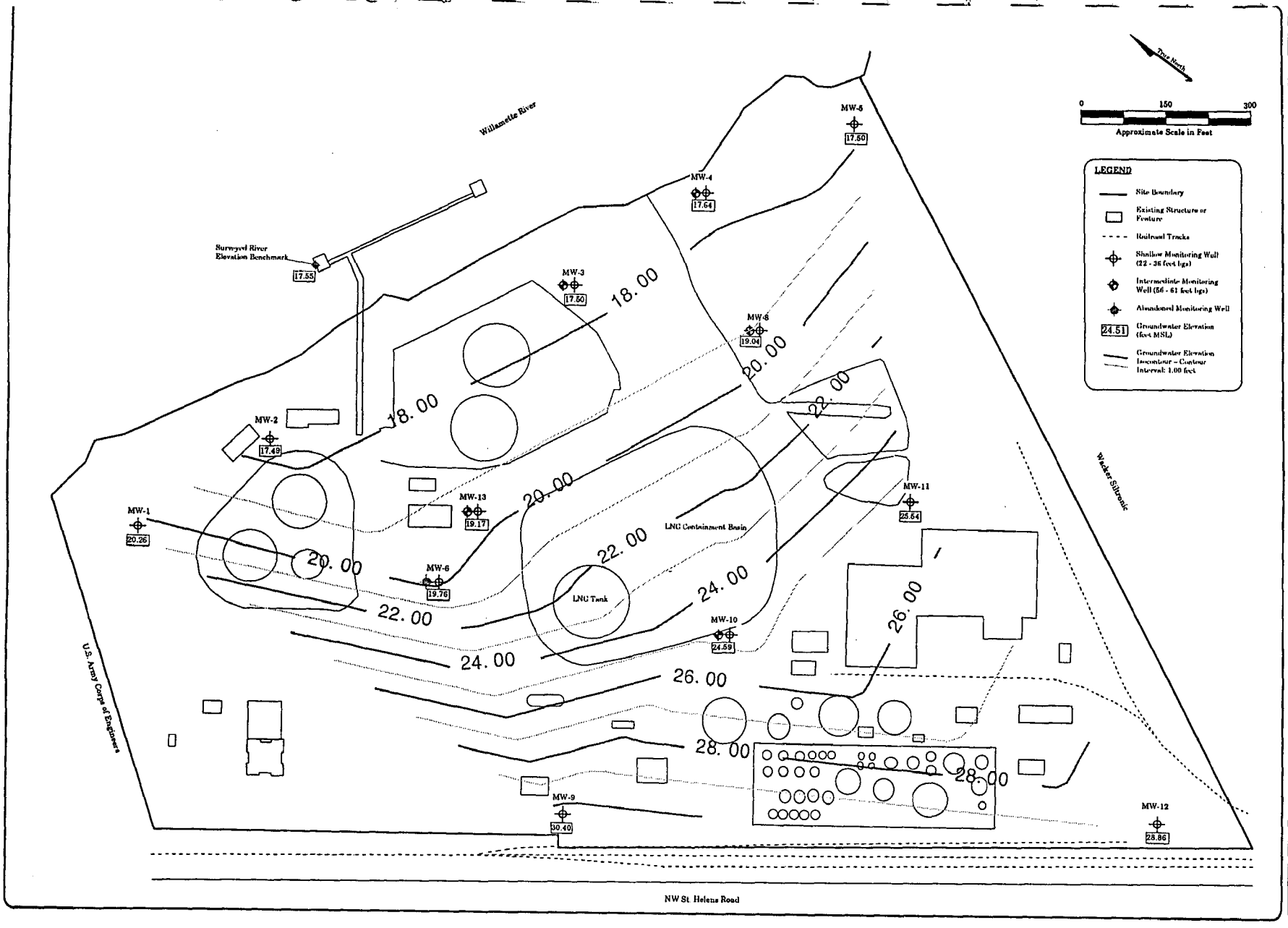


Figure
E-18

Groundwater Elevation Map - Shallow Wells
June 1, 1998

RI/FS Progress Report
Northwest Natural - Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

June 1998

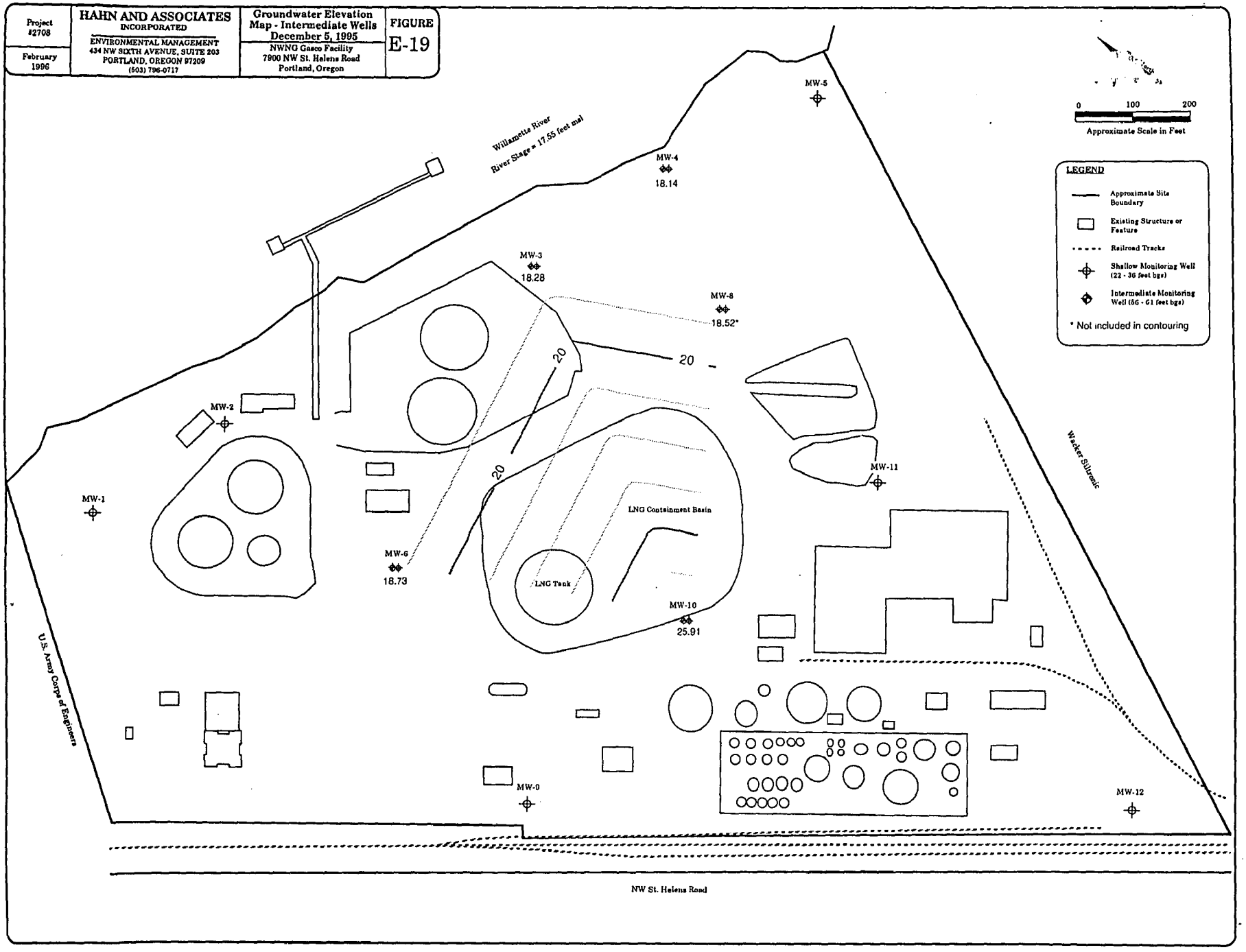
Project #2708

Koppers022719

Groundwater Elevation Maps
Alluvial Sand Water Bearing Zone-Intermediate Depth

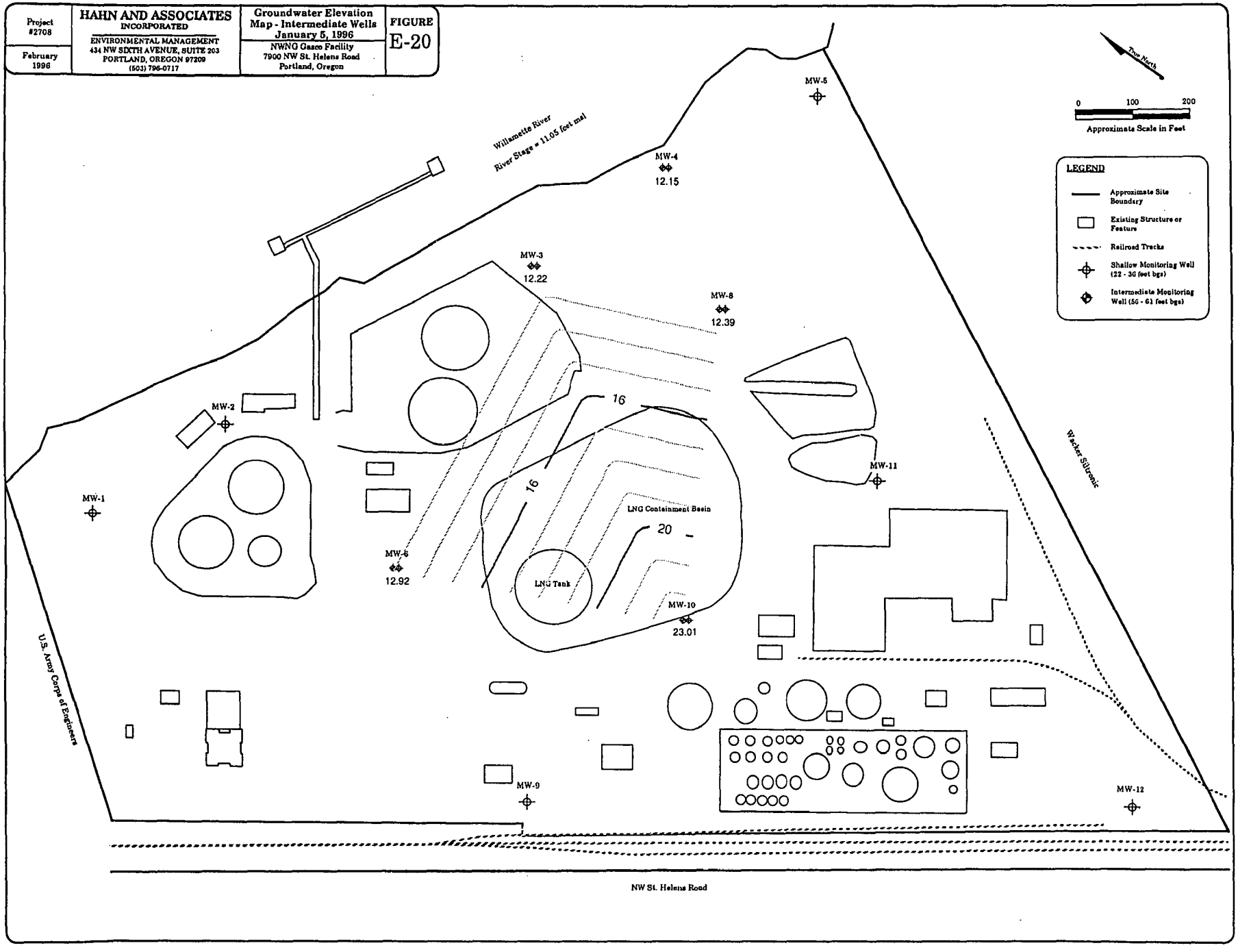
HAHN AND ASSOCIATES, INC.

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells December 5, 1995	FIGURE E-19
February 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



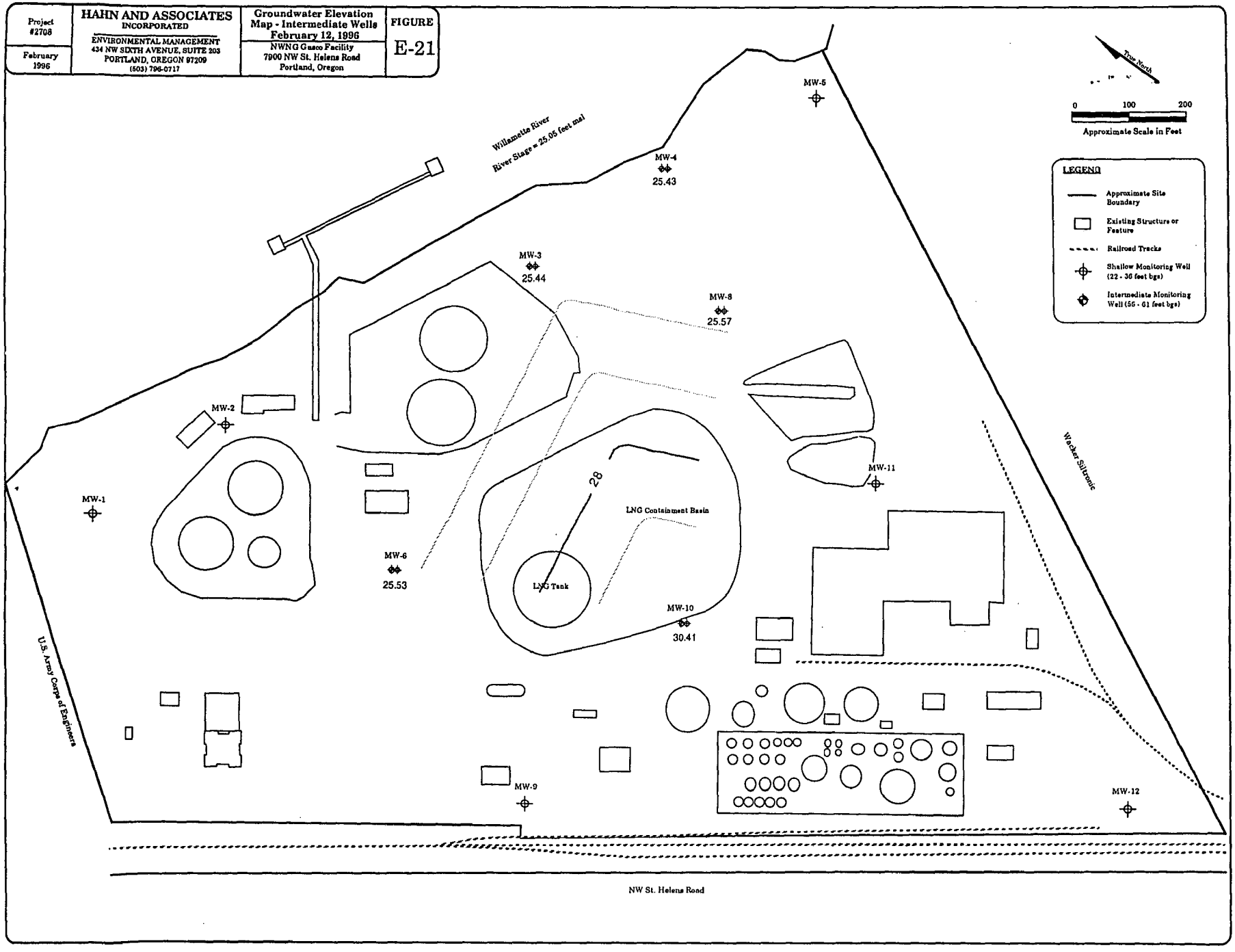
Koppers022721

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells January 5, 1996	FIGURE E-20
February 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



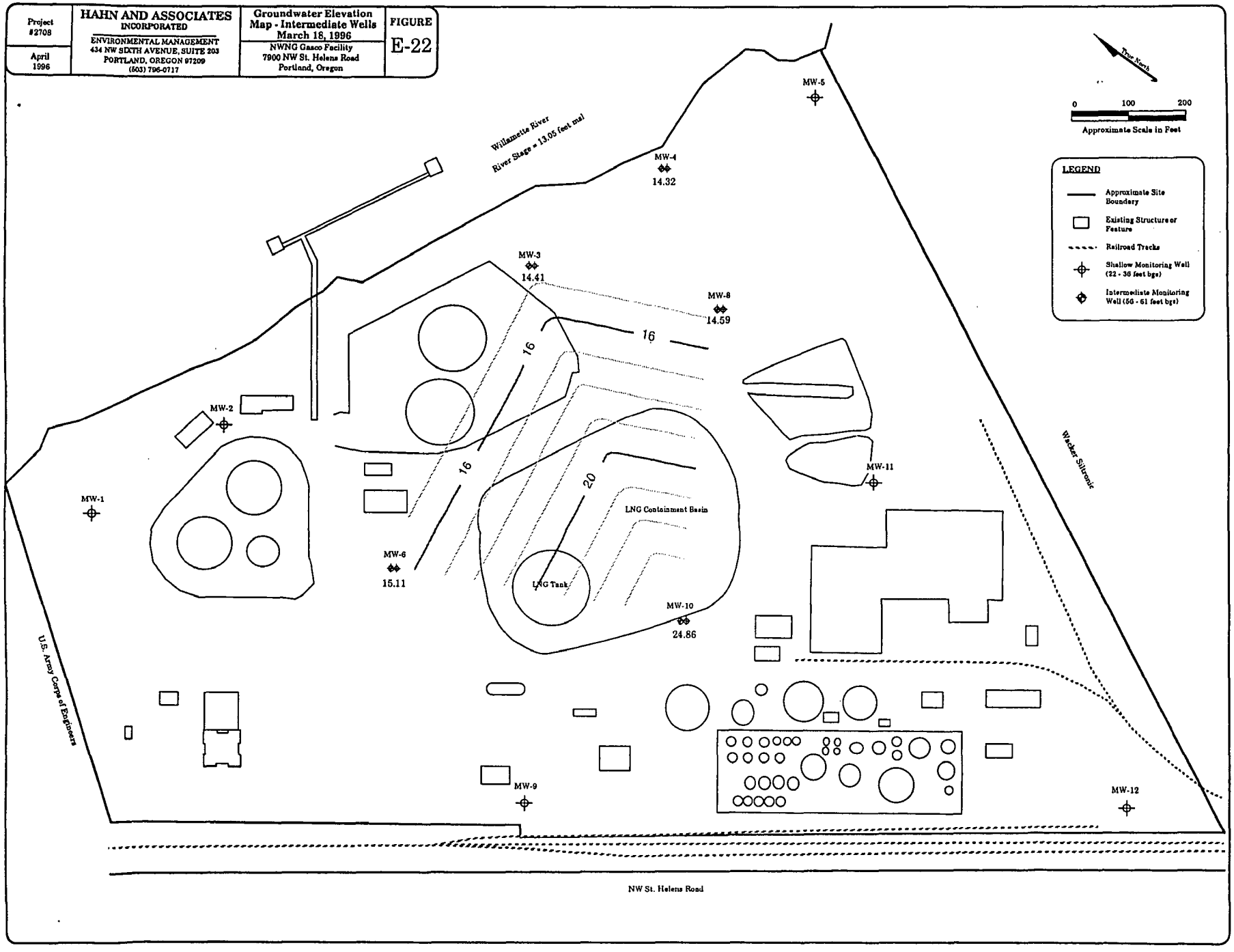
Koppers022722

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells February 12, 1996	FIGURE
February 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-21



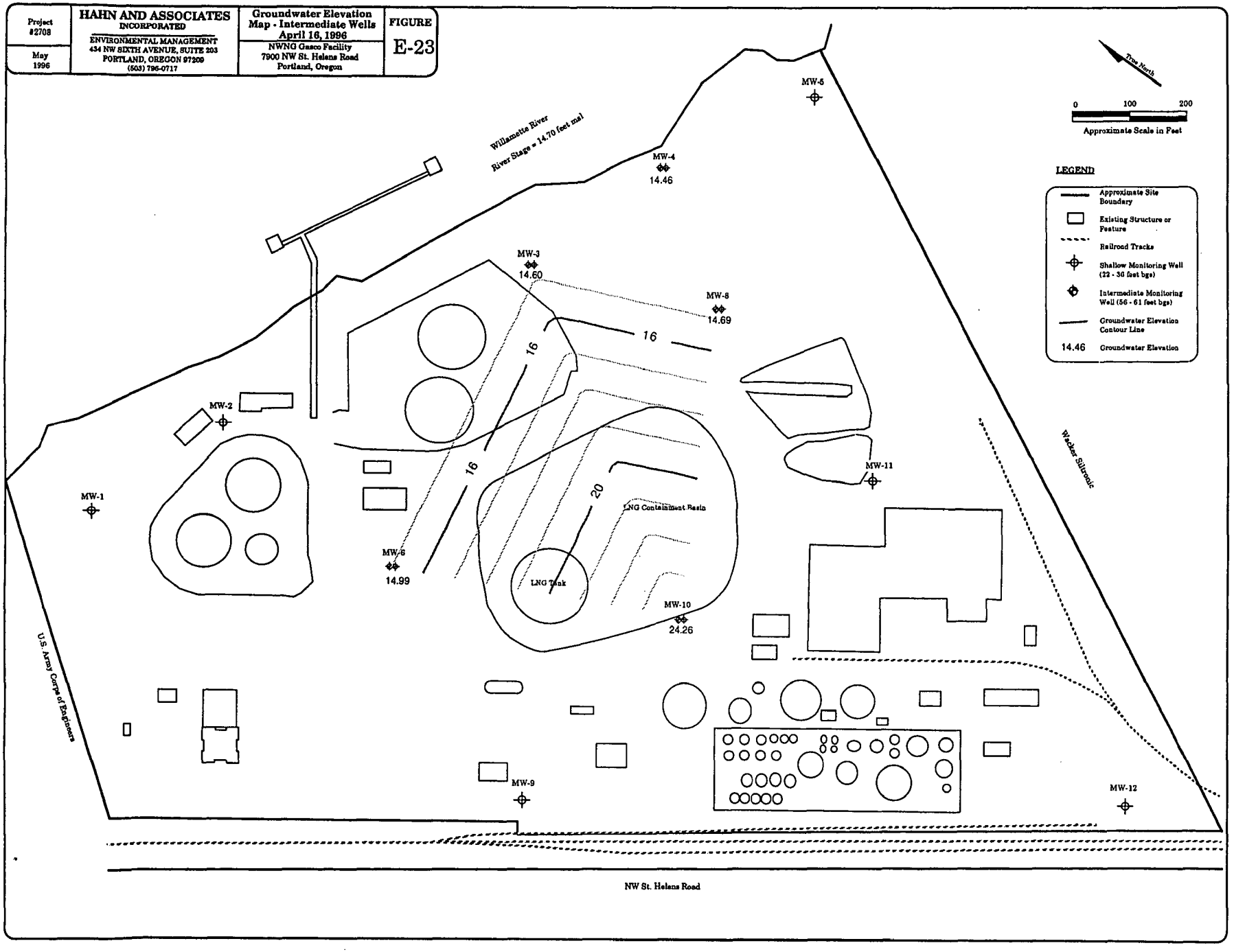
Koppers022723

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells March 18, 1996	FIGURE E-22
April 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



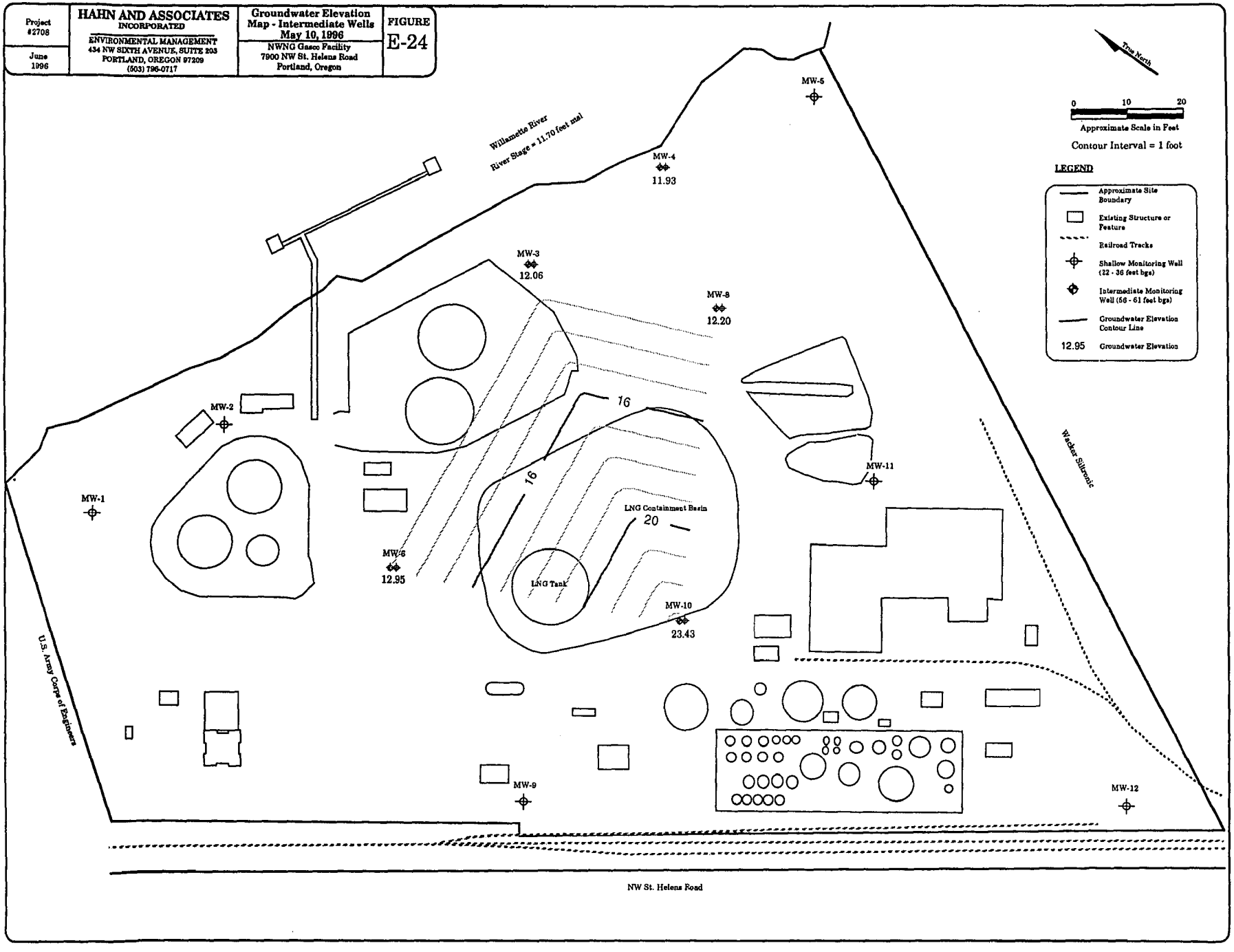
Koppers022724

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells April 16, 1996	FIGURE
May 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-23



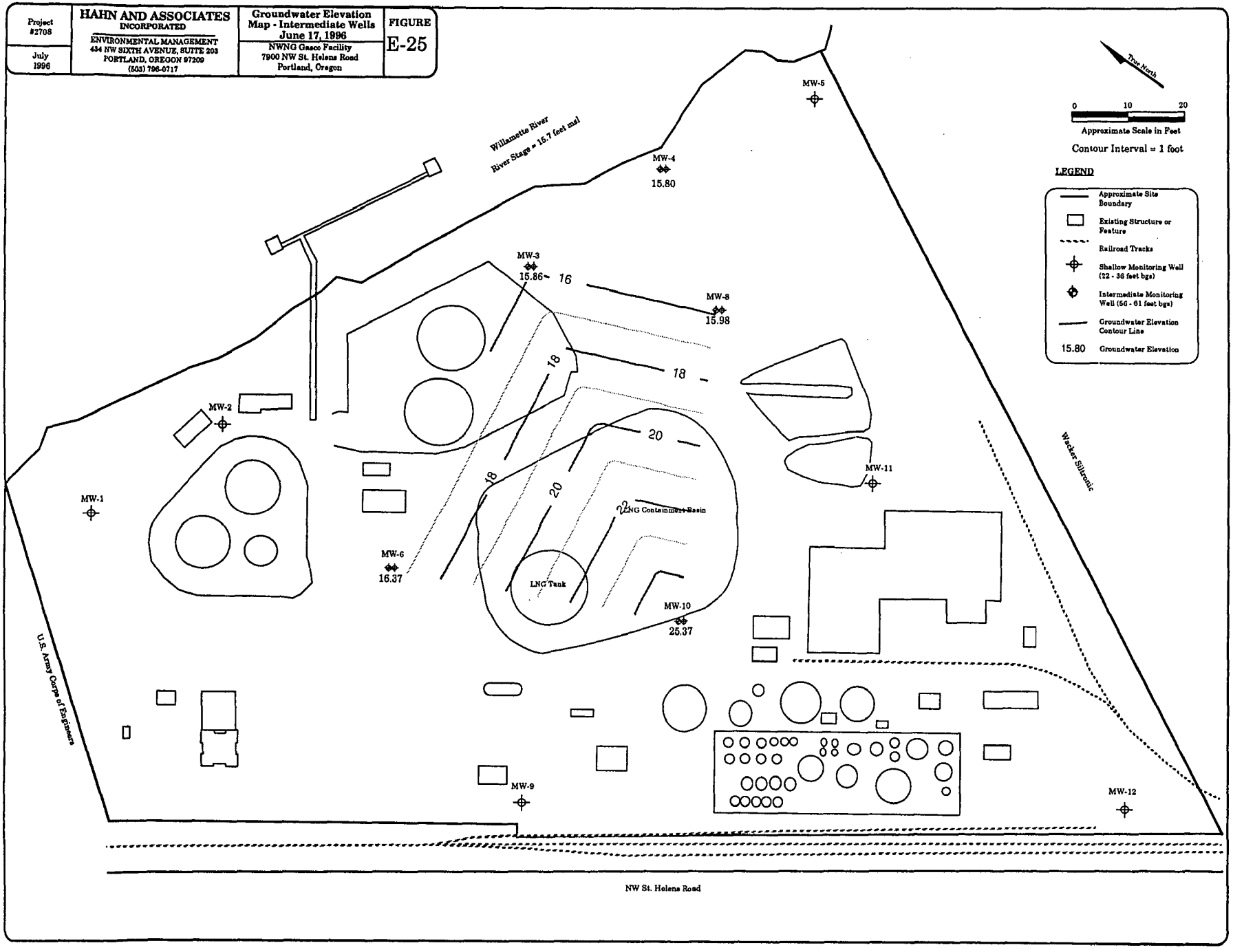
Koppers022725

Project #2708	HAHN AND ASSOCIATES INCORPORATED ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	Groundwater Elevation Map - Intermediate Wells May 10, 1996 NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	FIGURE E-24
June 1996			



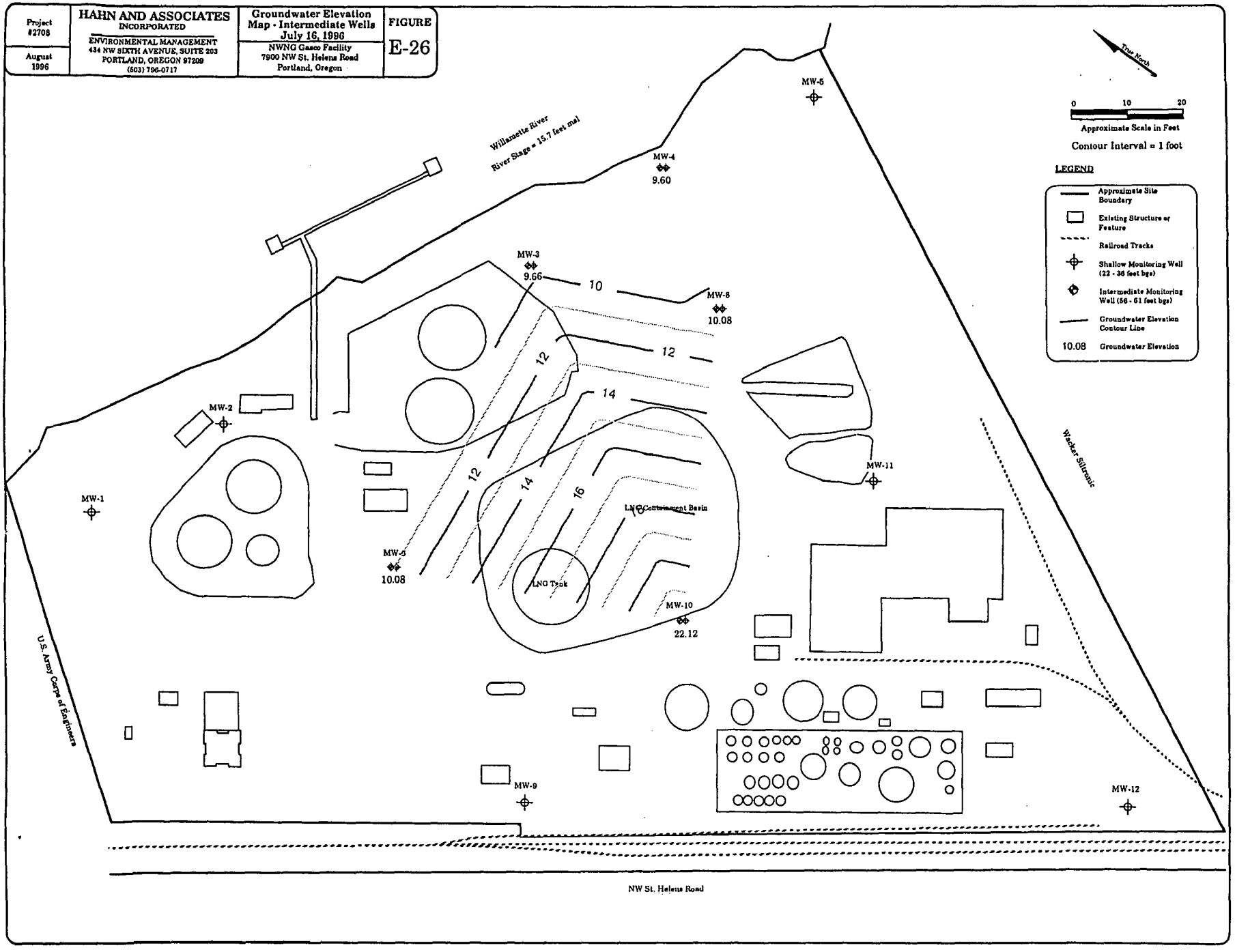
Koppers022726

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells June 17, 1996	FIGURE E-25
July 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



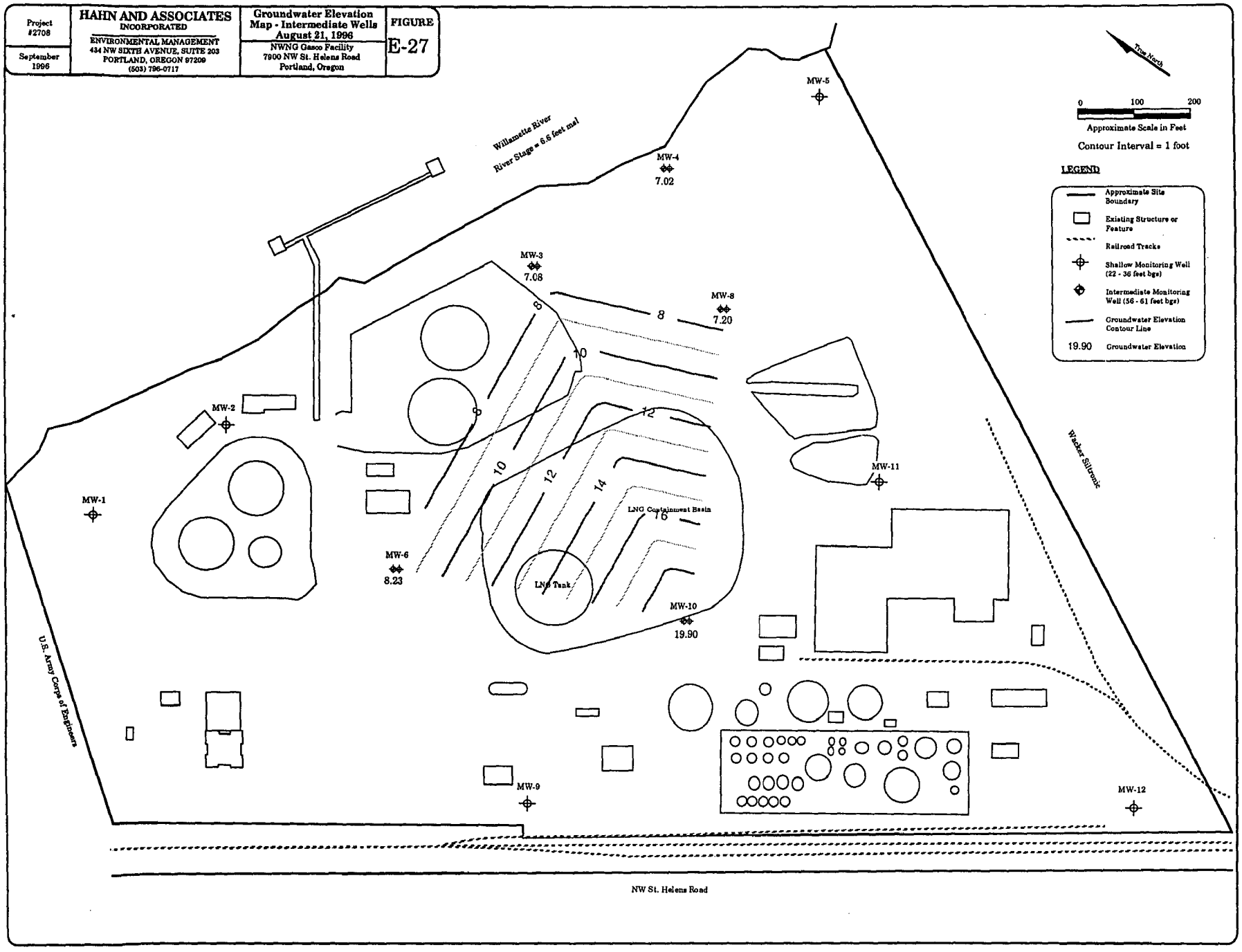
Koppers022727

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells July 16, 1996	FIGURE
August 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-26



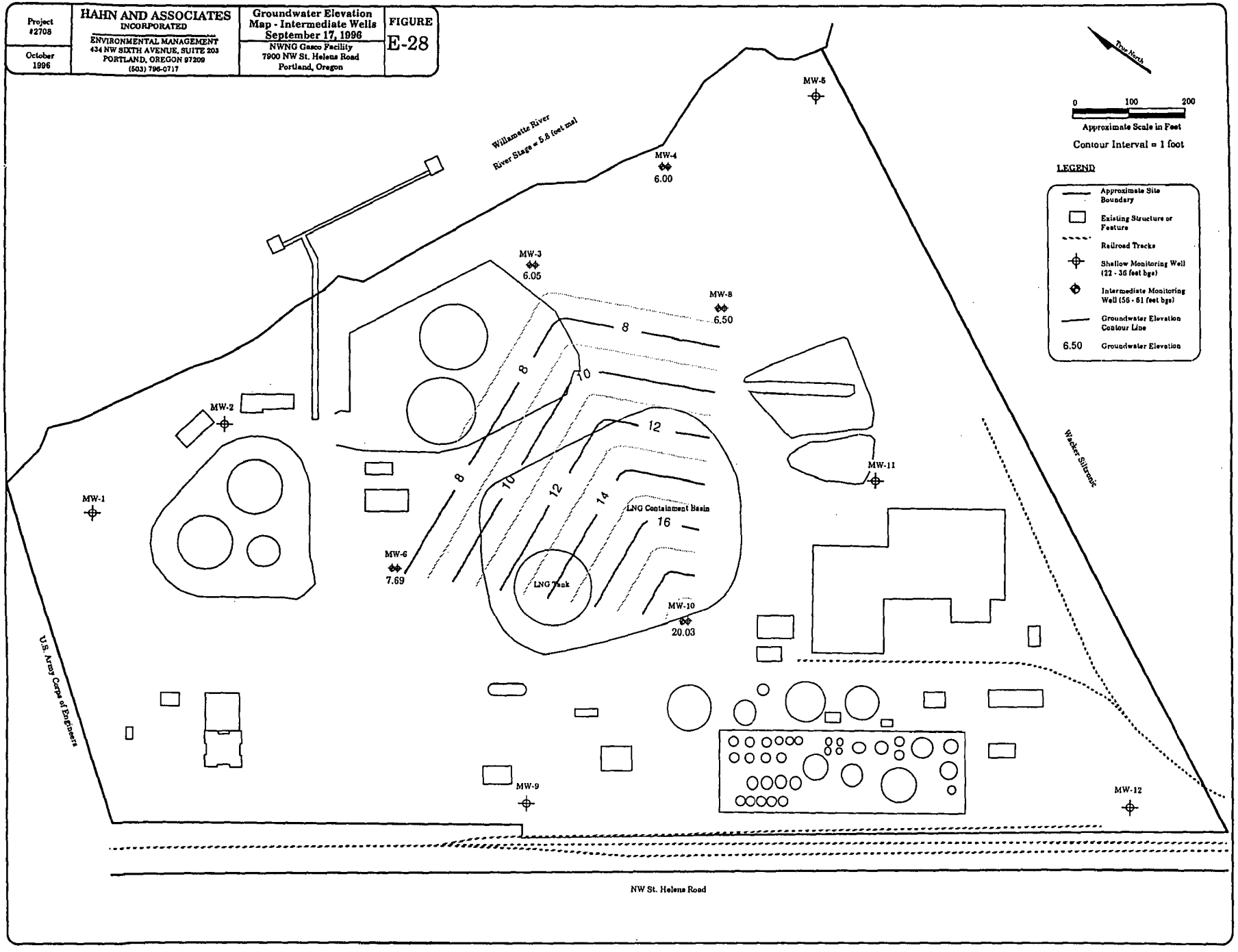
Koppers022728

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells August 21, 1996	FIGURE E-27
September 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



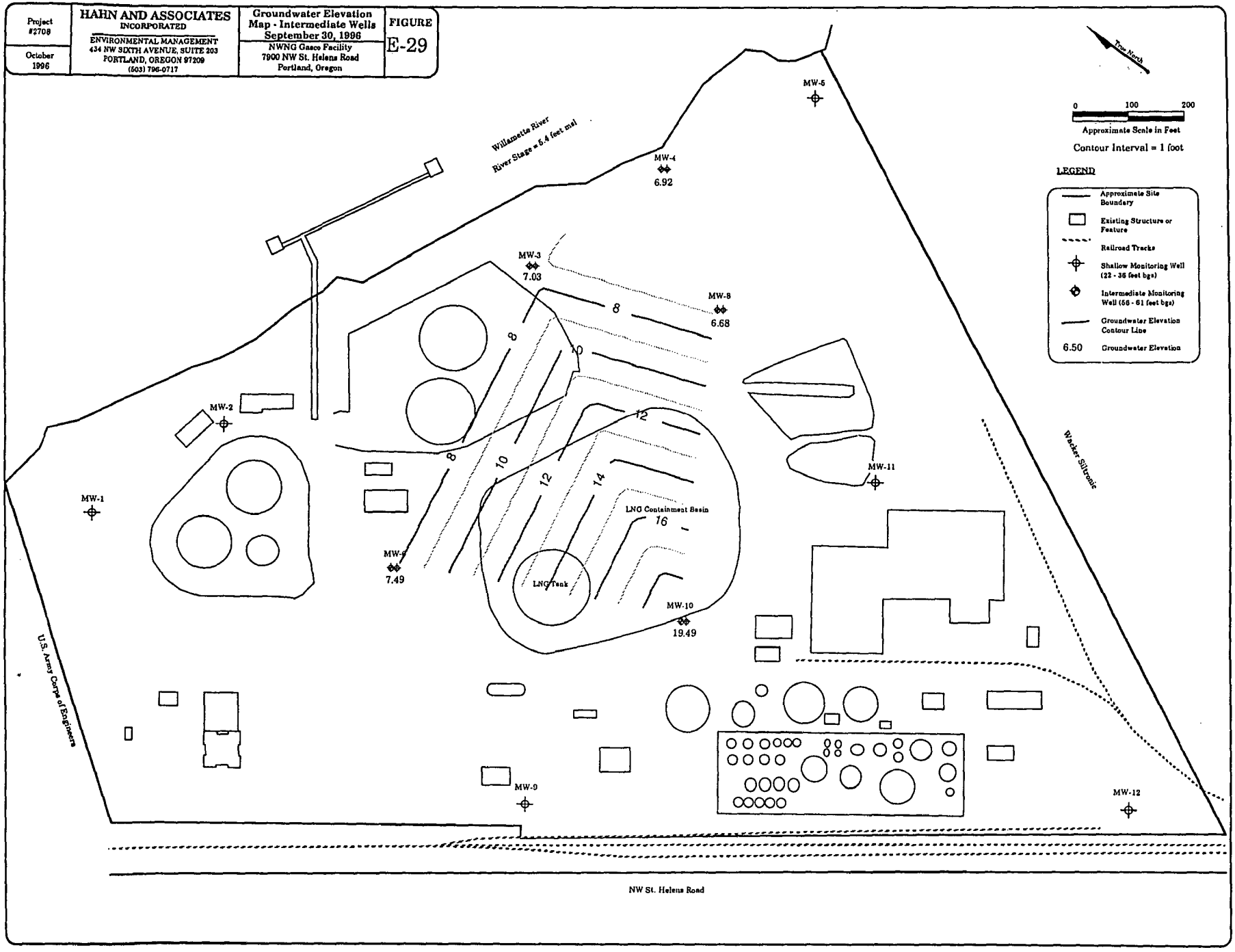
Koppers022729

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells September 17, 1996	FIGURE E-28
October 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	



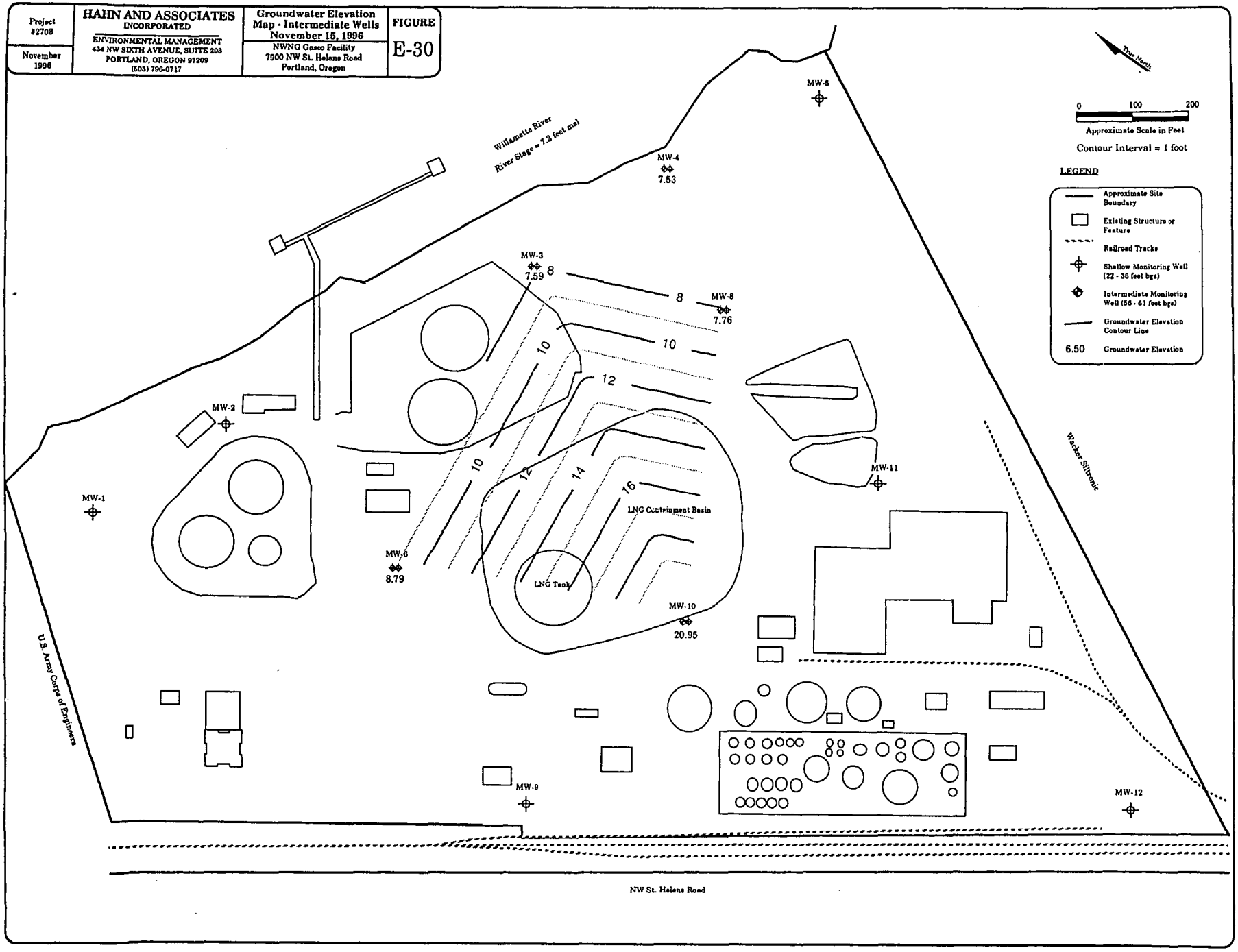
Koppers022730

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells September 30, 1996	FIGURE
October 1996	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-29



Koppers022731

Project #2708	HAHN AND ASSOCIATES INCORPORATED ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	Groundwater Elevation Map - Intermediate Wells November 15, 1996 NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	FIGURE E-30
November 1996			



Koppers022732

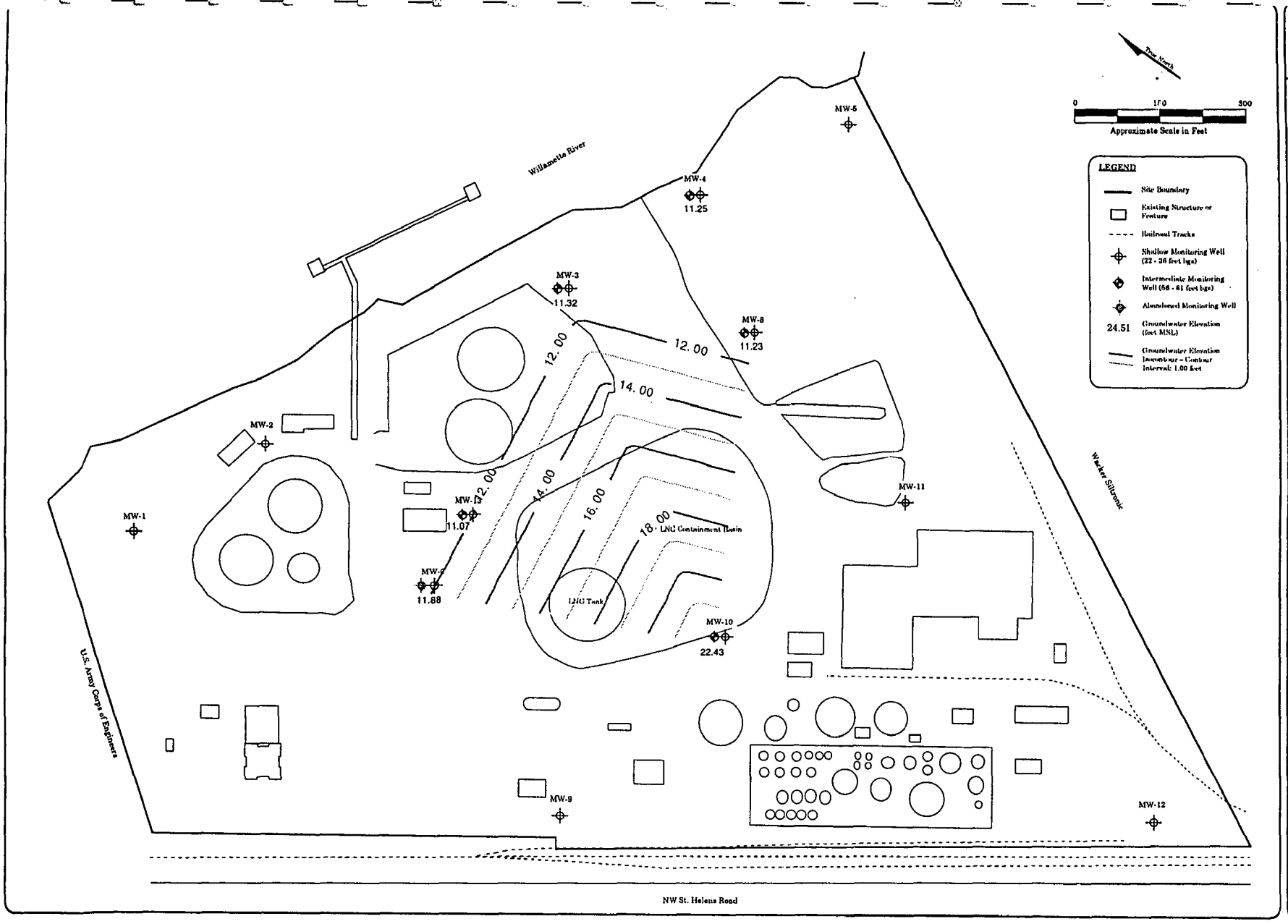


Figure
E-31

Groundwater Elevation Map - Intermediate Wells
December 19, 1997

RI/FS
Northwest Natural - Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

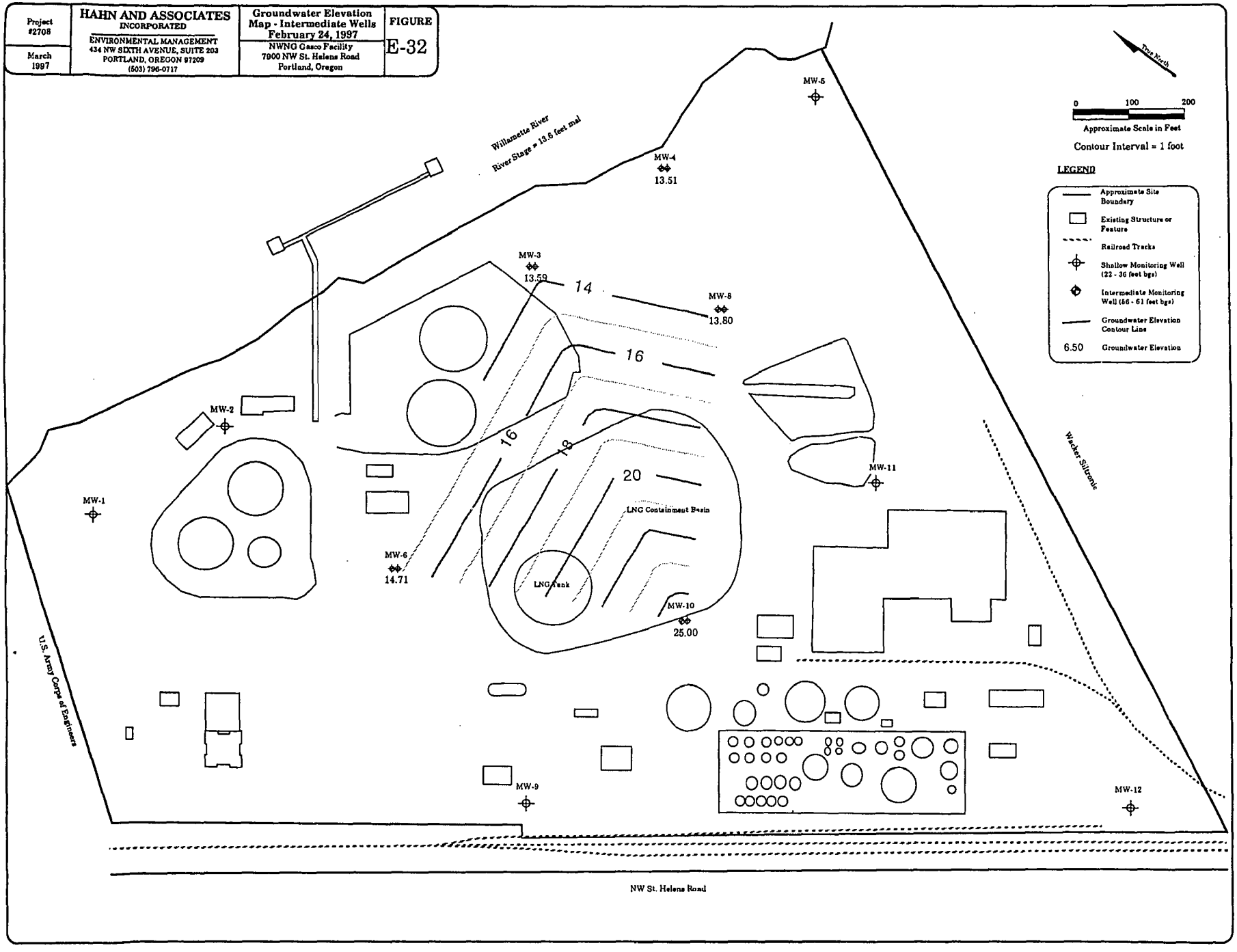
HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

February 1998

Project #2708

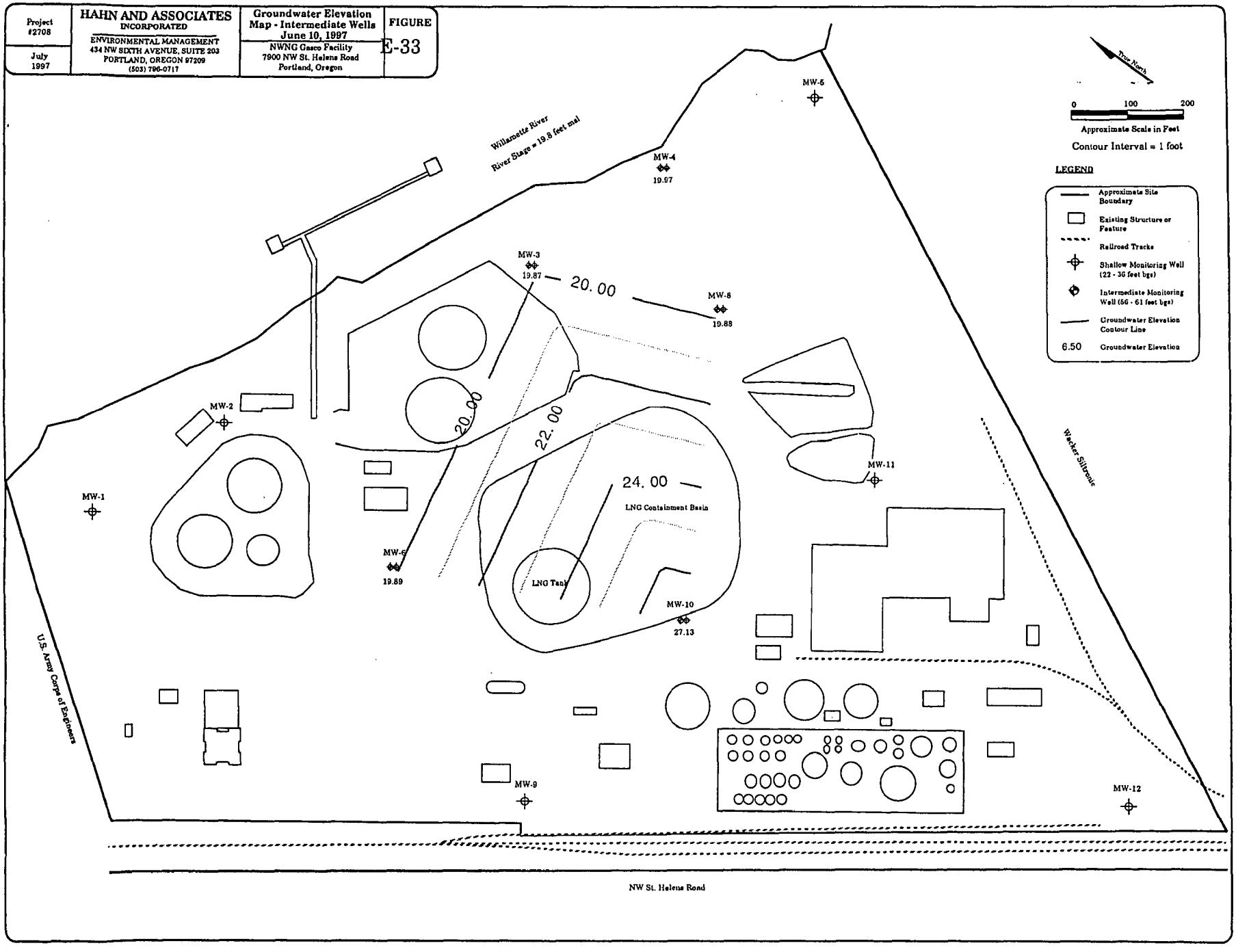
Koppers022733

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells February 24, 1997	FIGURE
March 1997	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-32



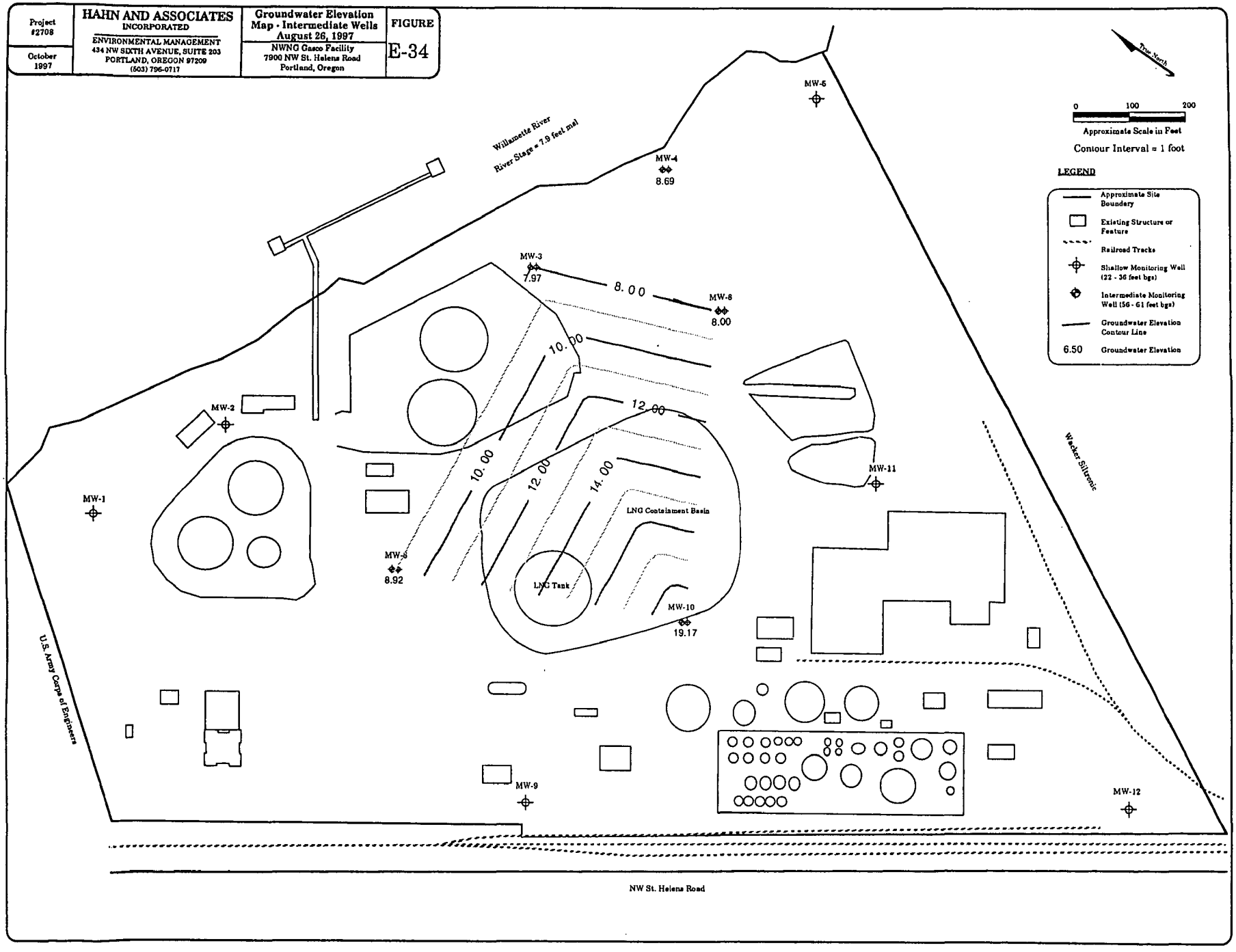
Koppers022734

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells June 10, 1997	FIGURE
July 1997	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-33



Koppers022735

Project #2708	HAHN AND ASSOCIATES INCORPORATED	Groundwater Elevation Map - Intermediate Wells August 26, 1997	FIGURE
October 1997	ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	NWNG Gasco Facility 7900 NW St. Helens Road Portland, Oregon	E-34



Koppers022736

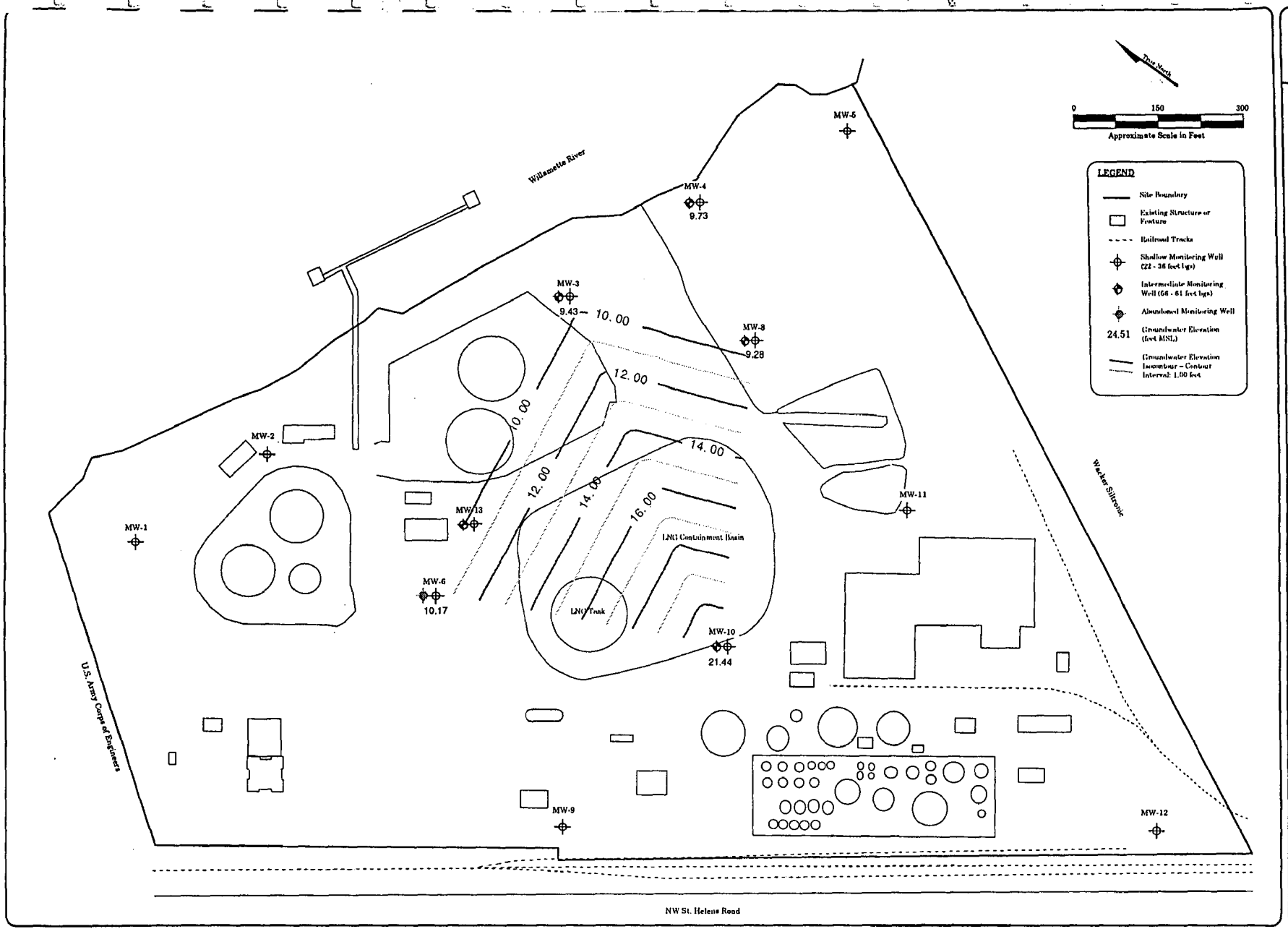


Figure
E-35

Groundwater Elevation Map - Intermediate Wells
November 25, 1997

RI/FS
Northwest Natural - Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

February 1998

Project #2708

Koppers022737

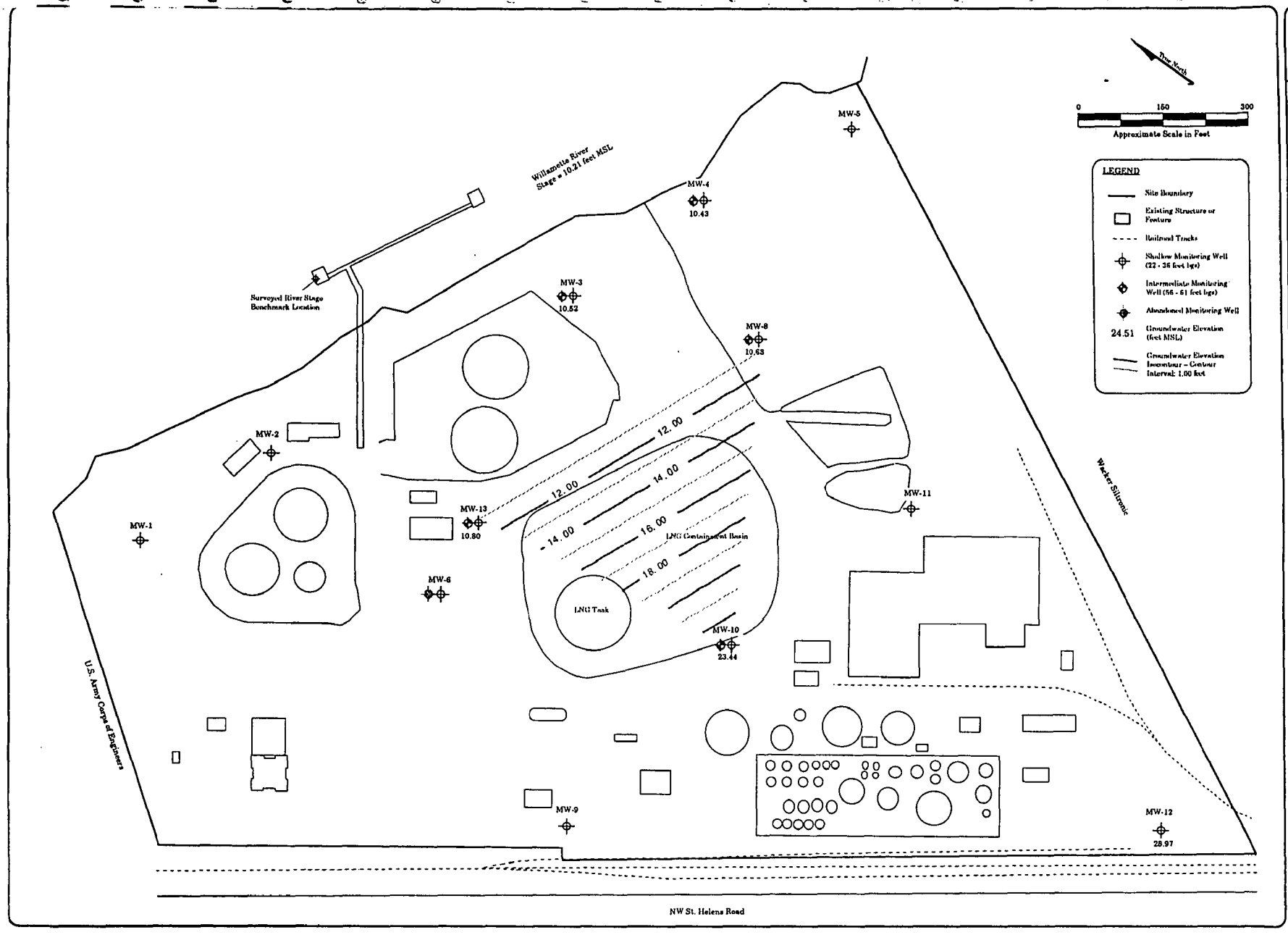


Figure
E-36

Groundwater Elevation Map - Intermediate Wells
February 16, 1998

RI/FS
Northwest Natural - Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

April 1998

Project #2708

Koppers022738

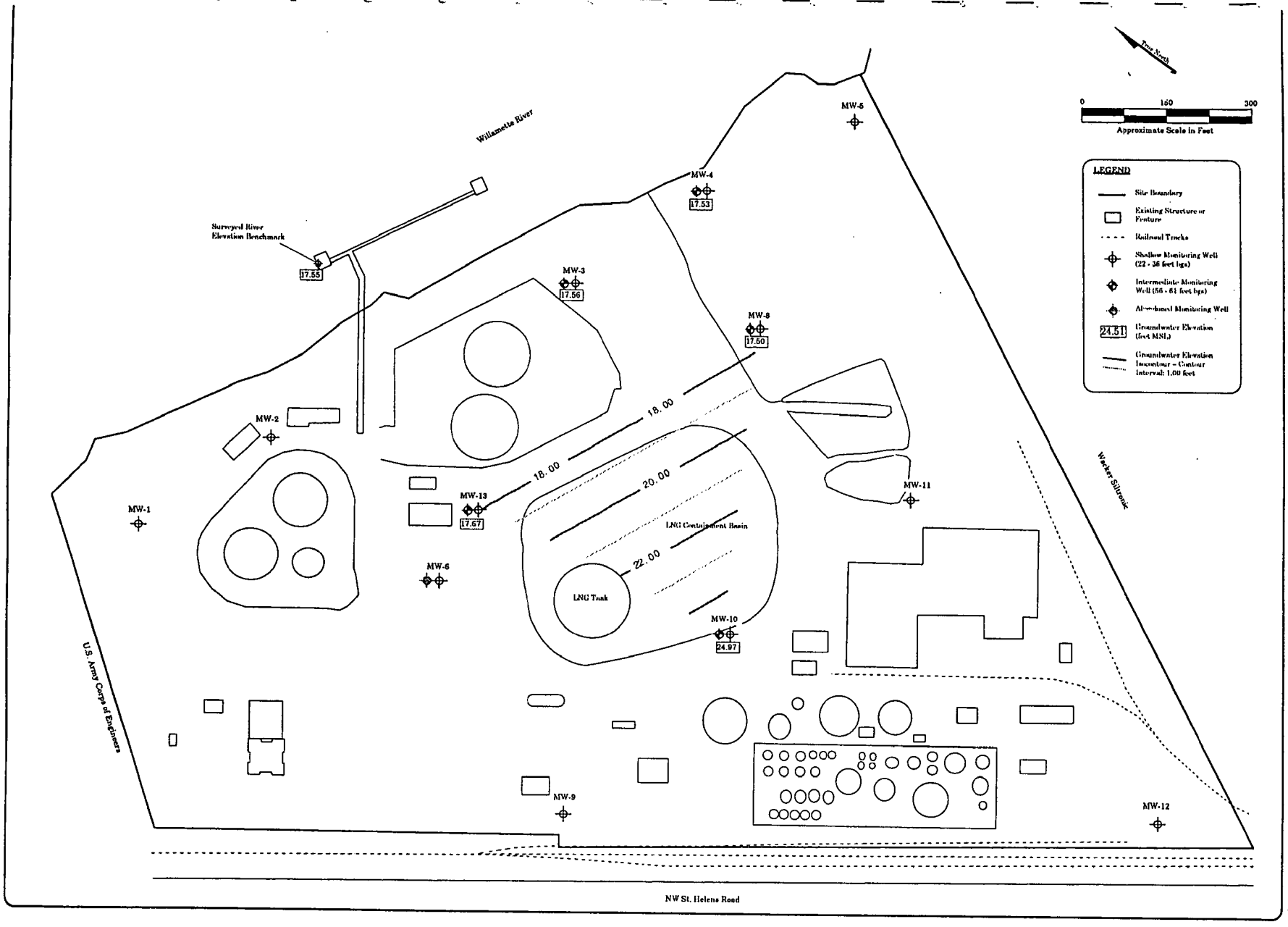


Figure
E-37

Groundwater Elevation Map - Intermediate Wells
June 1, 1998

RI/FS Progress Report
Northwest Natural - Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

June 1998

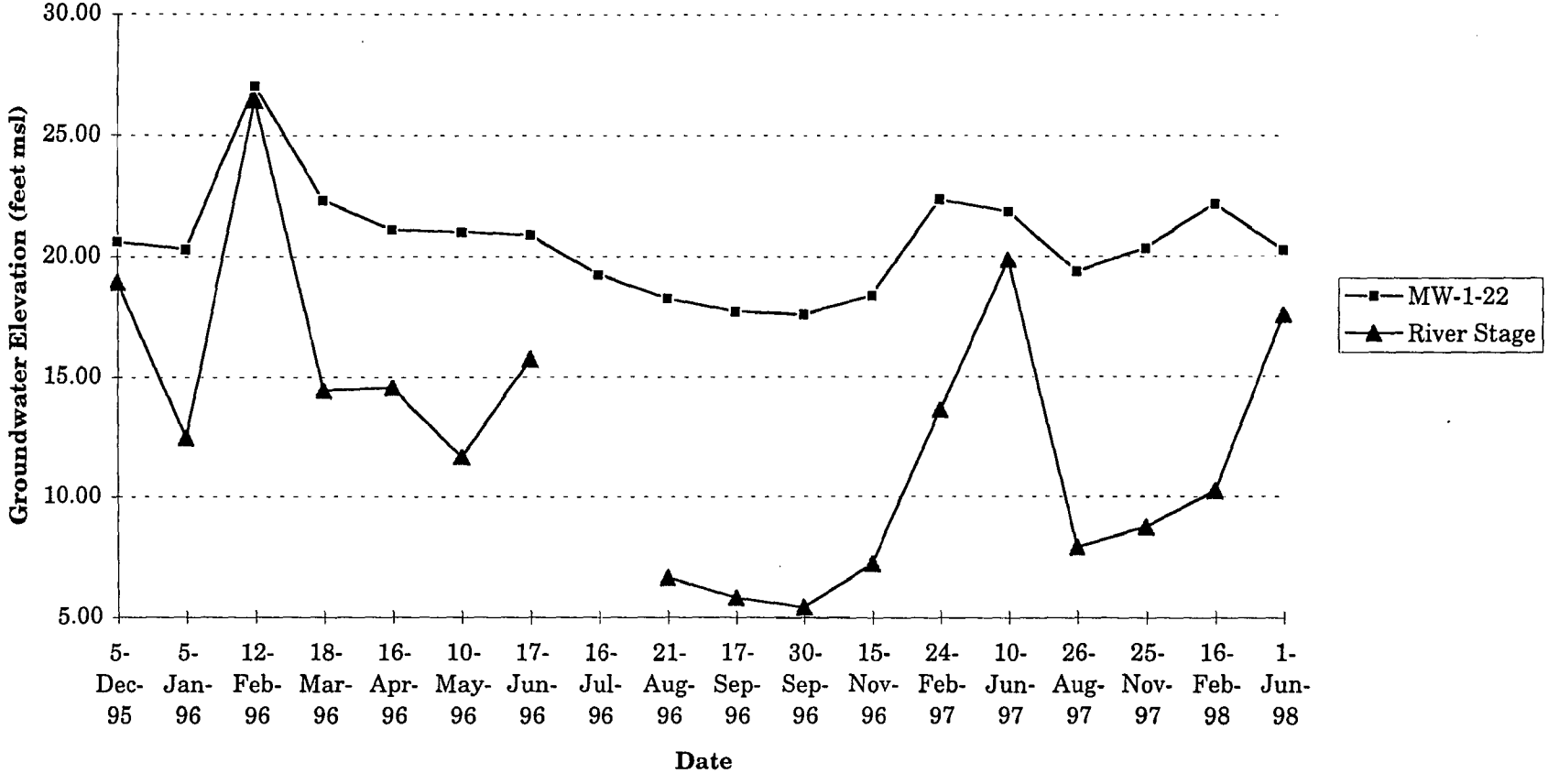
Project #2708

Koppers022739

Groundwater Elevation Hydrographs

Koppers022740

Groundwater Hydrograph
Well MW-1
Northwest Natural Gas Company - Gasco Facility

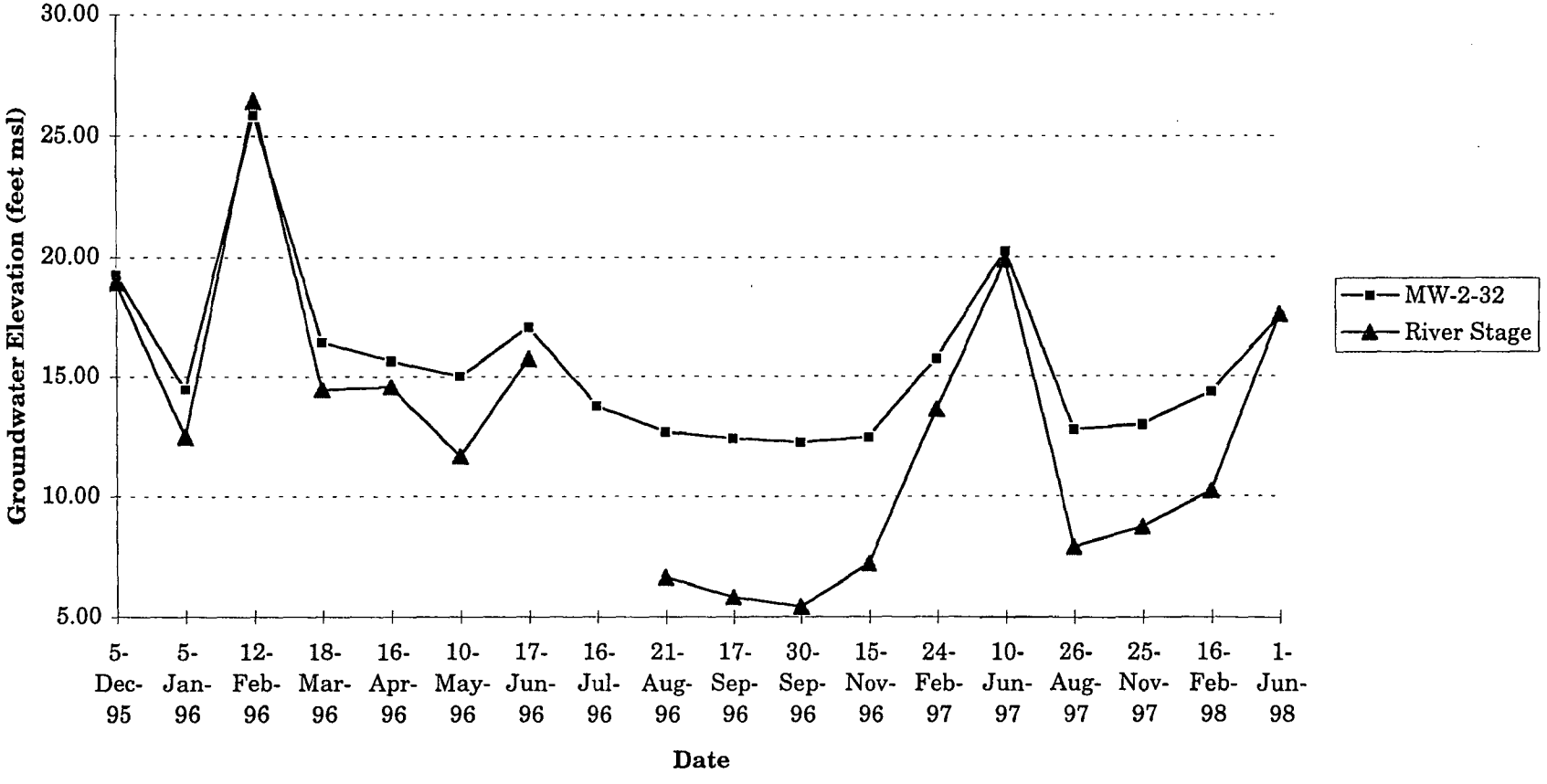


Updated: 9/21/98 RBE
File: 2708 GW Elevations/ MW-1

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022741

Groundwater Hydrograph
Well MW-2
Northwest Natural Gas Company - Gasco Facility

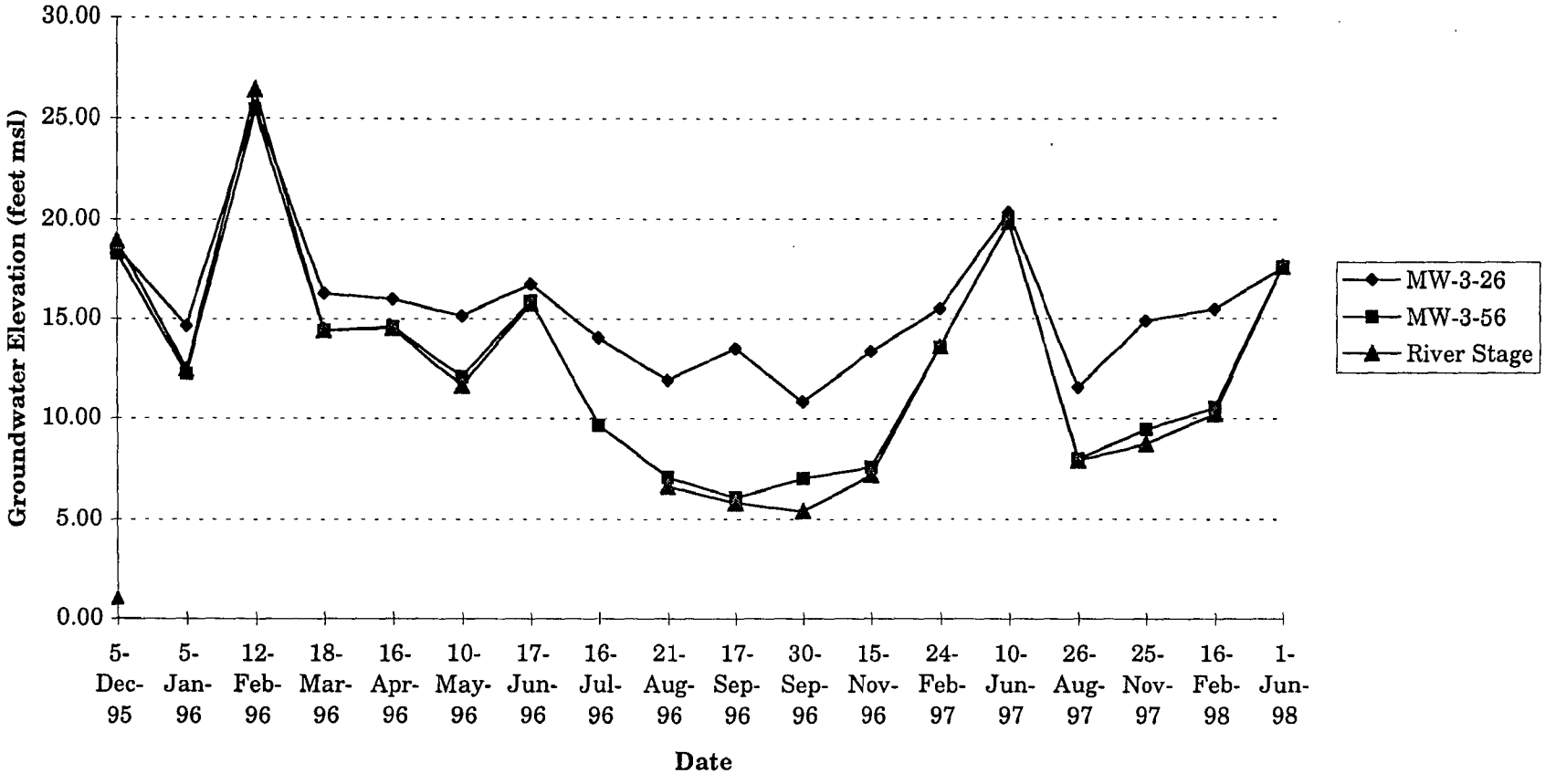


Updated: 9/21/98 RBE
File: 2708 GW Elevations/ MW-2

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022742

Groundwater Hydrograph
MW-3 Well Cluster
Northwest Natural Gas Company - Gasco Facility

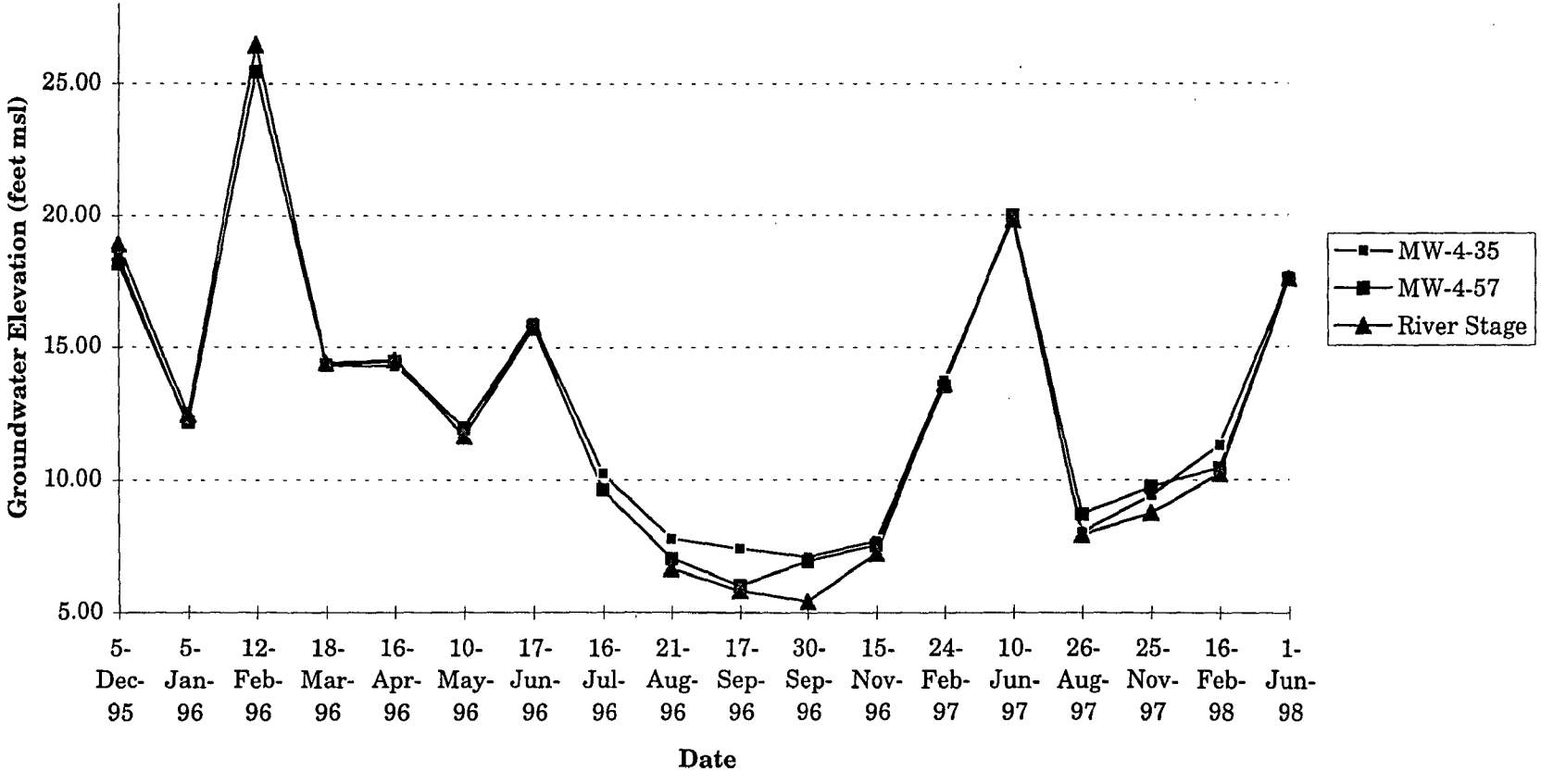


Updated: 9/21/98 RBE
File: 2708 GW Elevations/ MW-3

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022743

Groundwater Hydrograph
MW-4 Well Cluster
Northwest Natural Gas Company - Gasco Facility

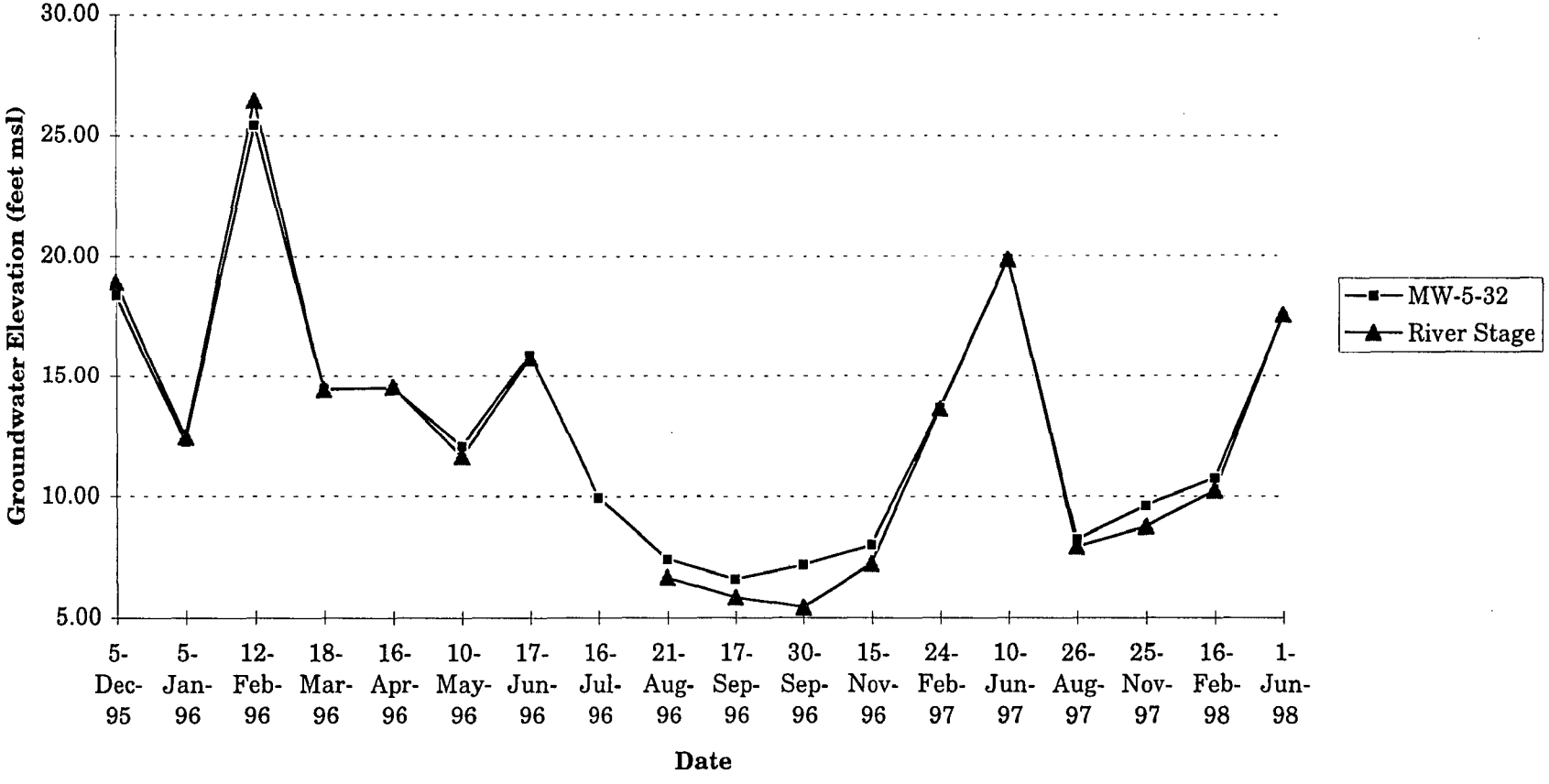


Koppers022744

Updated 9/21/98 RBE
File2708 GW Elevations

HAHN AND ASSOCIATES, INC.
Project # 2708

Groundwater Hydrograph
Well MW-5
Northwest Natural Gas Company - Gasco Facility

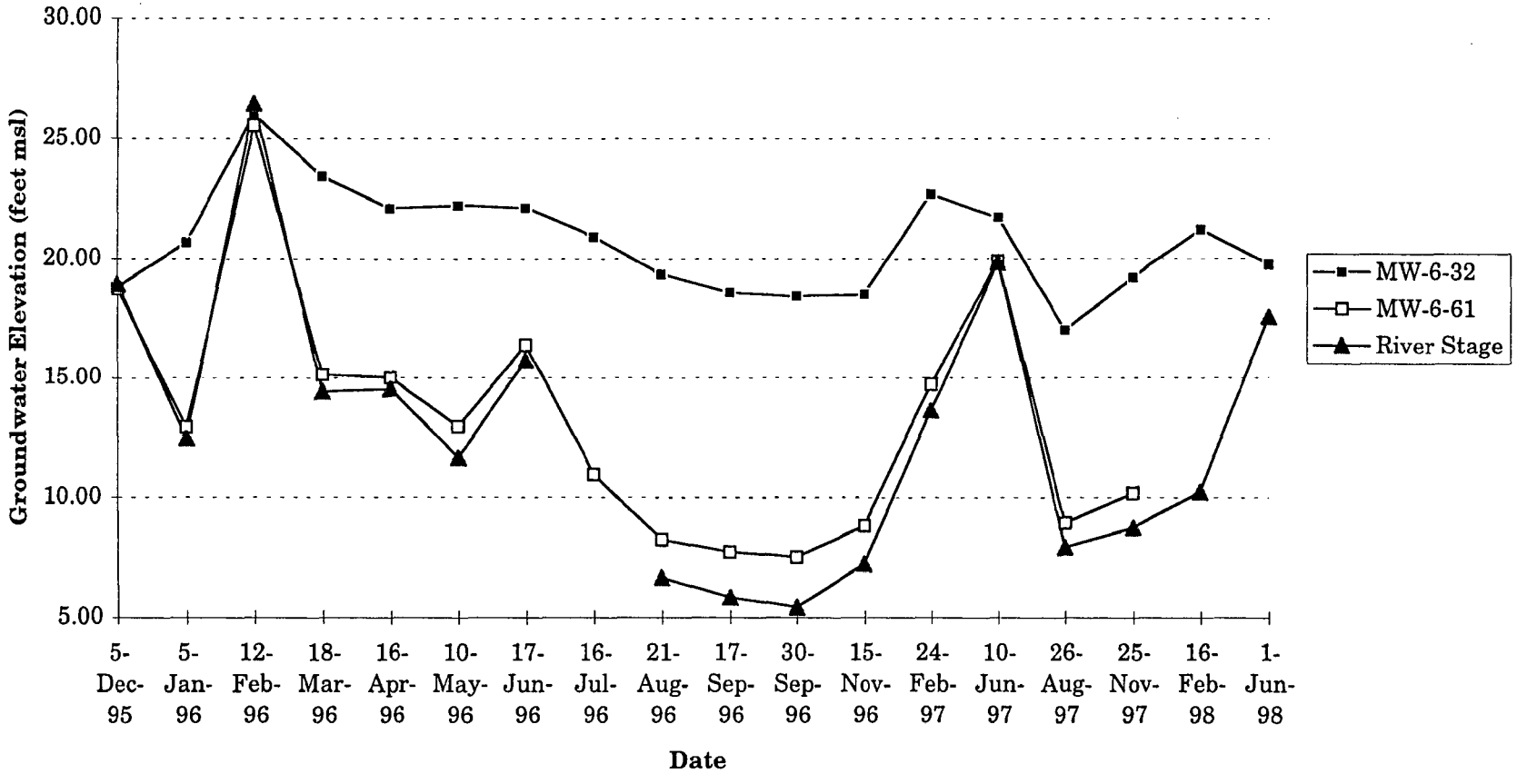


Updated: 9/21/98 RBE
File: 2708 GW Elevations/ MW-5

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022745

Groundwater Hydrograph
MW-6 Well Cluster
Northwest Natural Gas Company - Gasco Facility

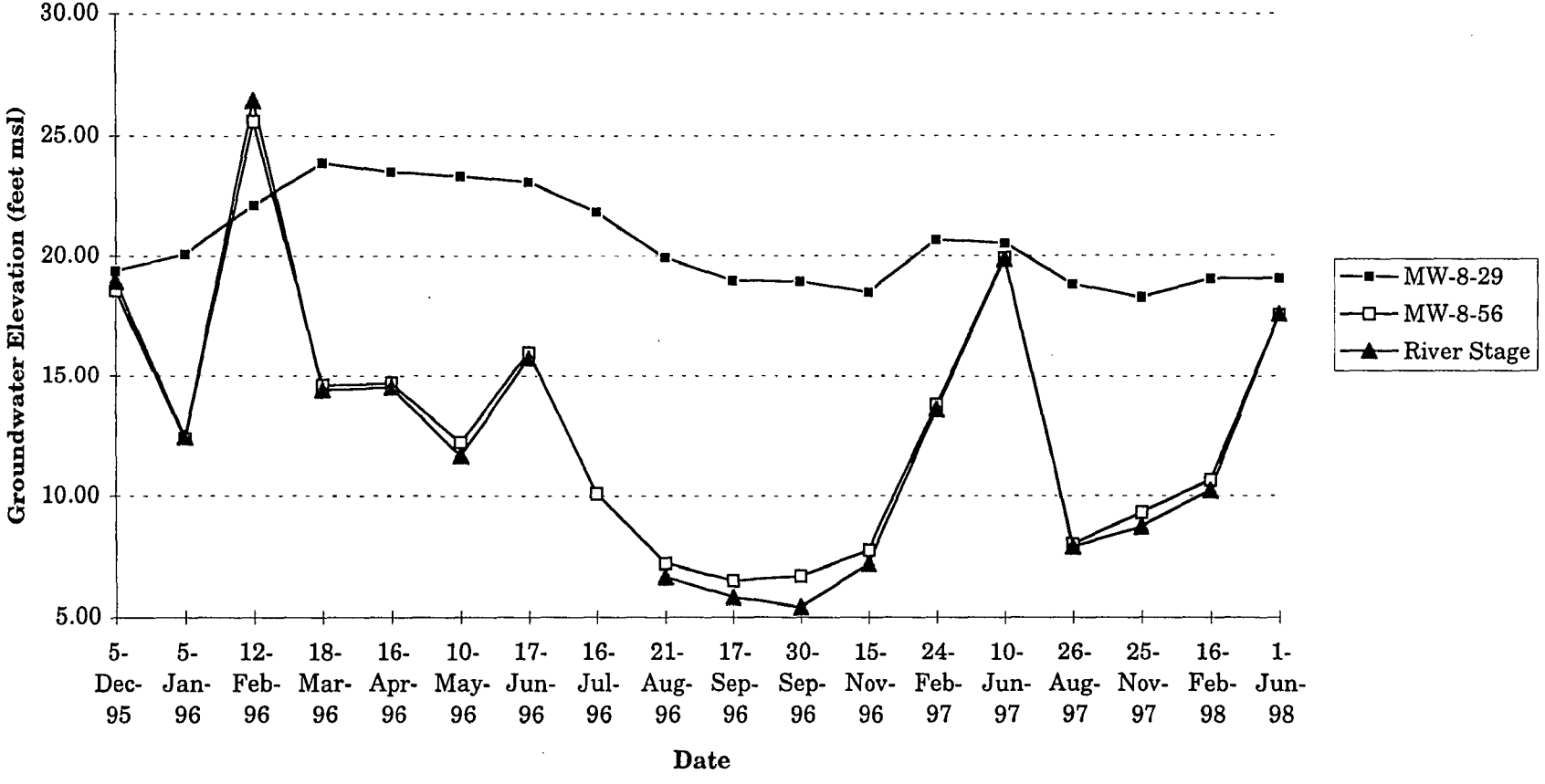


Updated: 9/21/98 RBE
File: 2708 GW Elevations/ MW-6

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022746

Groundwater Hydrograph
MW-8 Well Cluster
Northwest Natural Gas Company - Gasco Facility

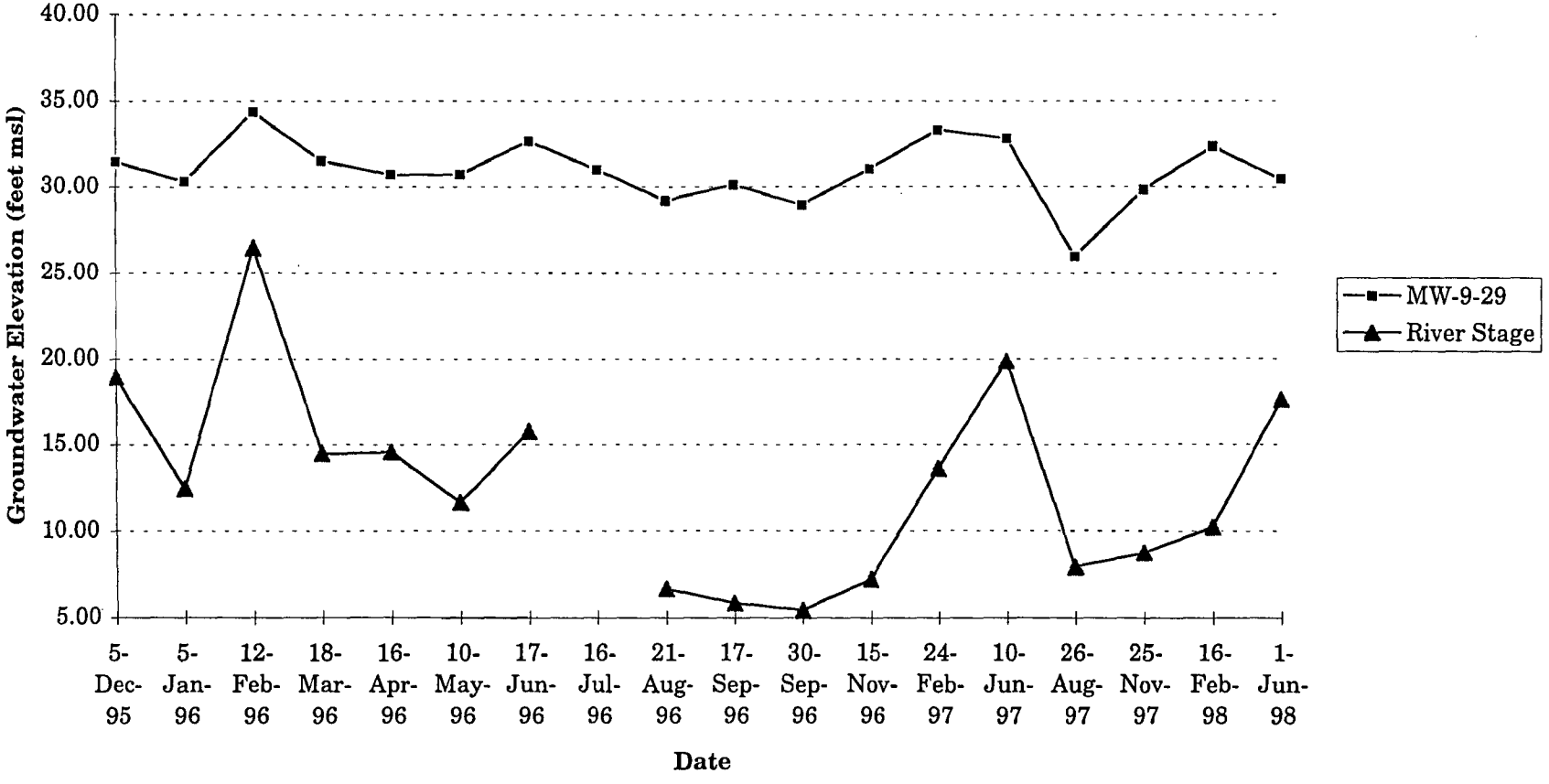


Updated: 9/21/98 RBE
File: 2708 GW Elevations/ MW-8

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022747

Groundwater Hydrograph
Well MW-9
Northwest Natural Gas Company - Gasco Facility

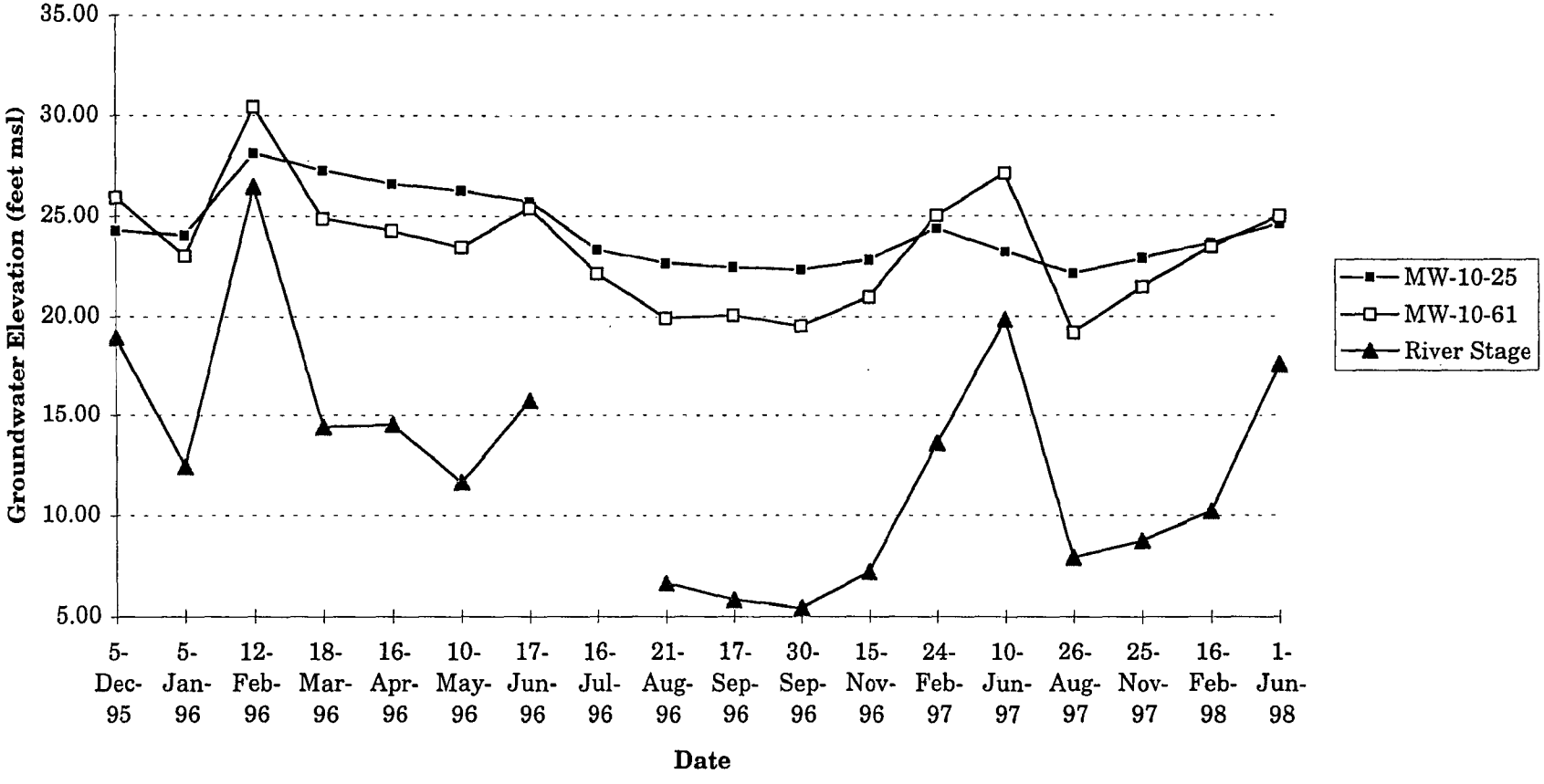


Updated: 9/21/98 RBE
File: 2708 GW Elevations/ MW-9

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022748

Groundwater Hydrograph
MW-10 Well Cluster
Northwest Natural Gas Company - Gasco Facility

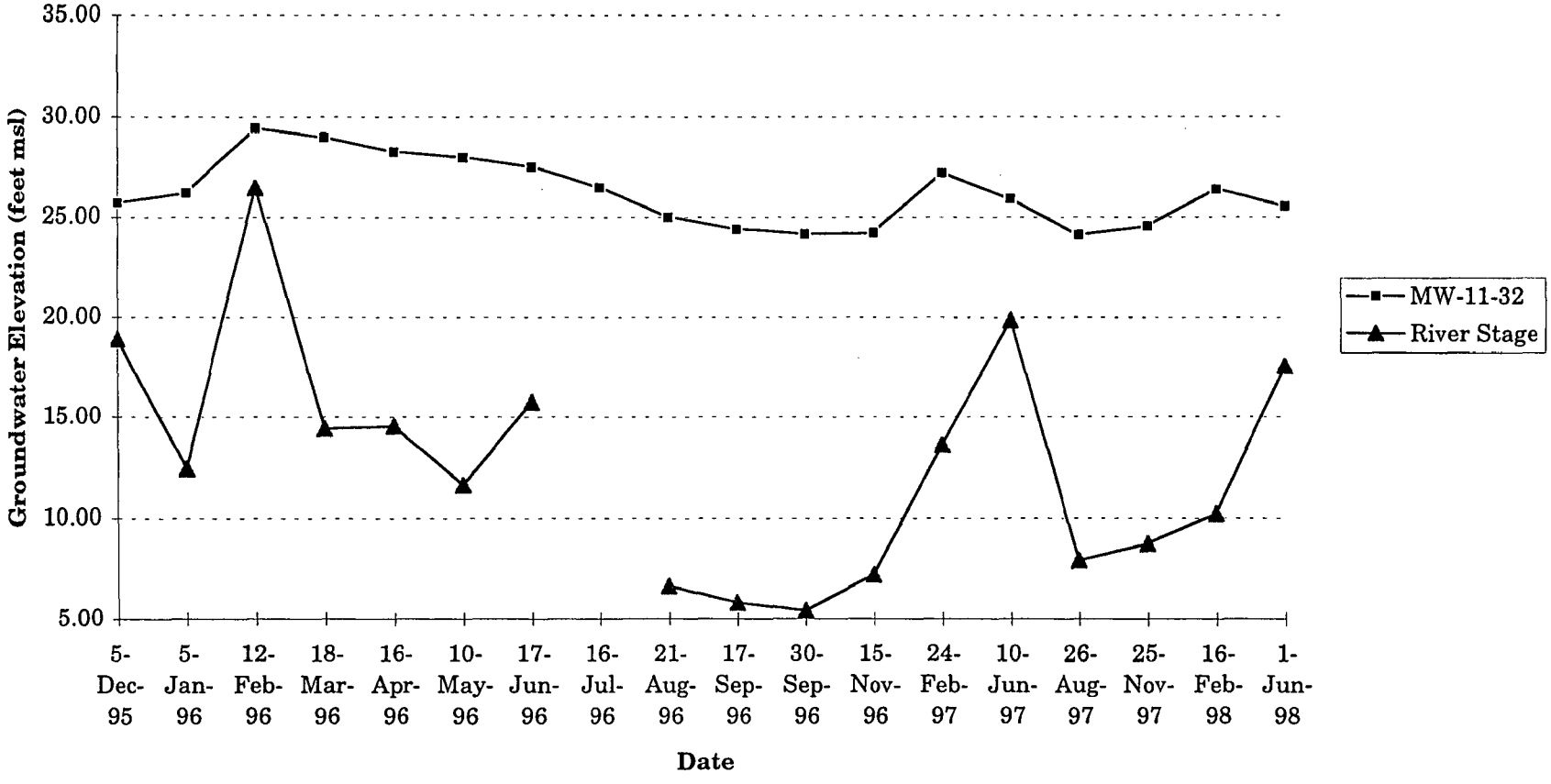


Updated: 9/21/98 RBE
File: 2708 GW Elevations/ MW-10

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022749

Groundwater Hydrograph
Well MW-11
Northwest Natural Gas Company - Gasco Facility

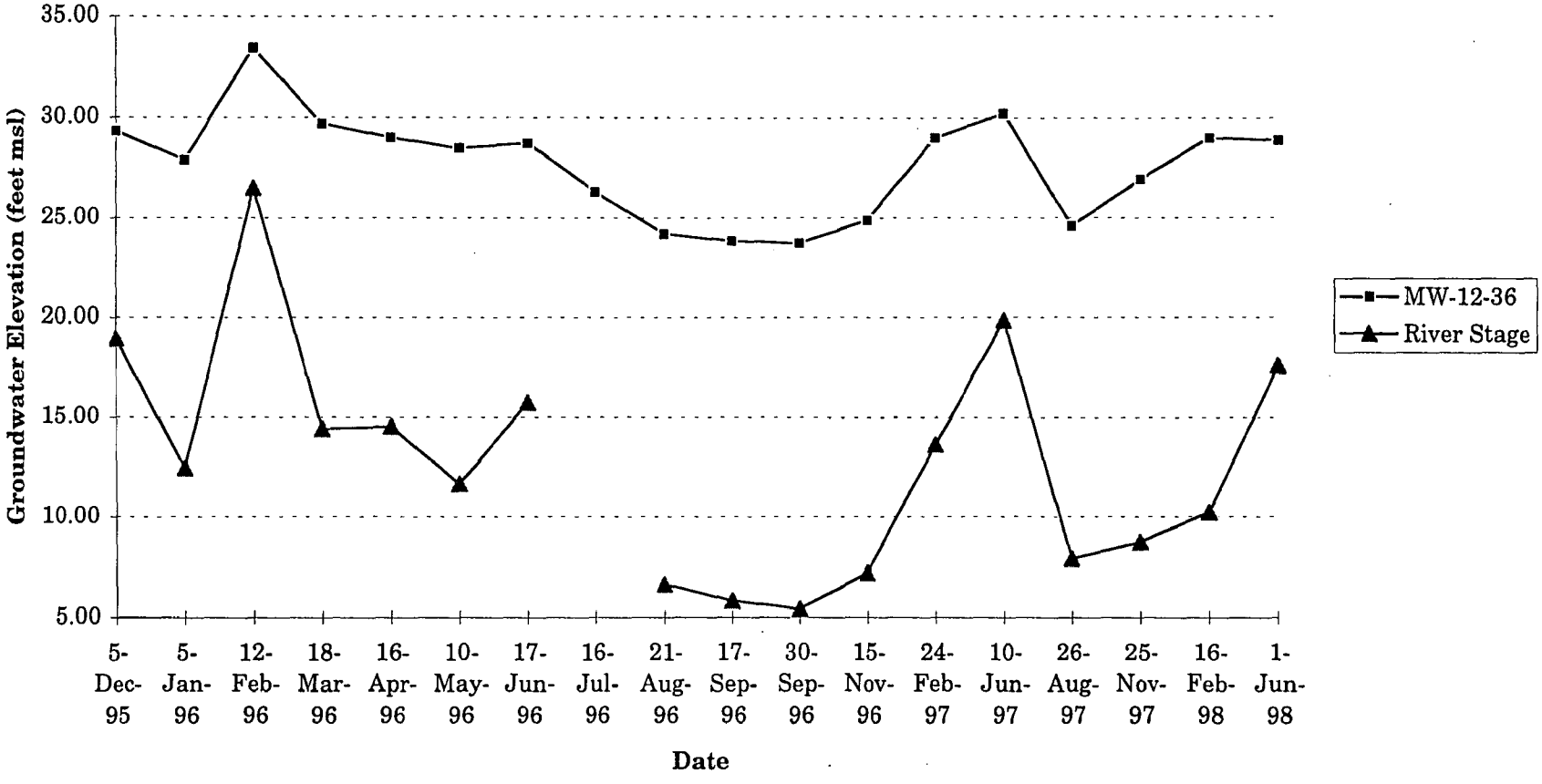


Updated: 9/21/98 RBE
File: 2708 GW Elevations/ MW-11

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022750

Groundwater Hydrograph
Well MW-12
Northwest Natural Gas Company - Gasco Facility

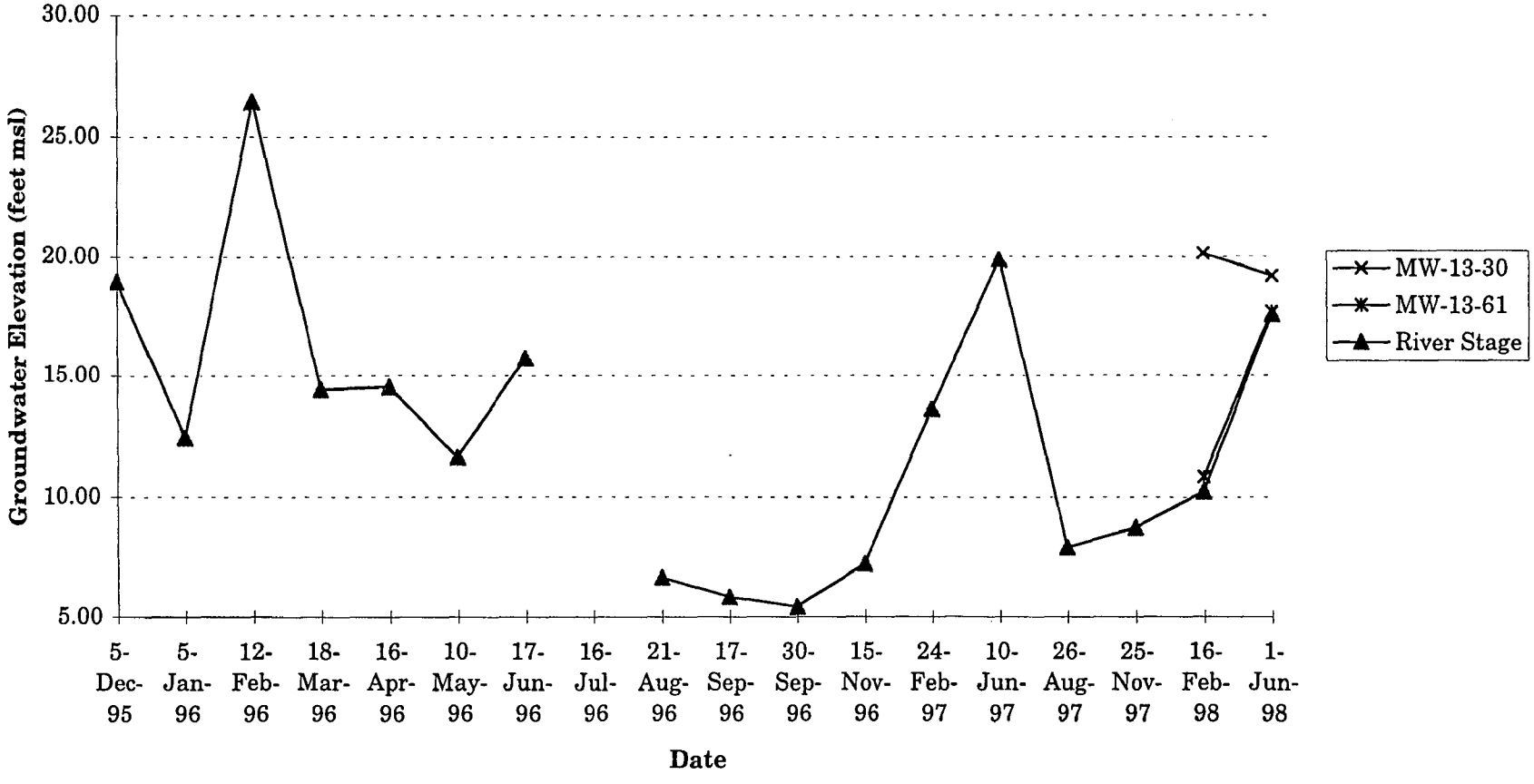


Updated: 9/21/98 RBE
File: 2708 GW Elevations/ MW-12

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022751

Groundwater Hydrograph
Well MW-13
Northwest Natural Gas Company - Gasco Facility

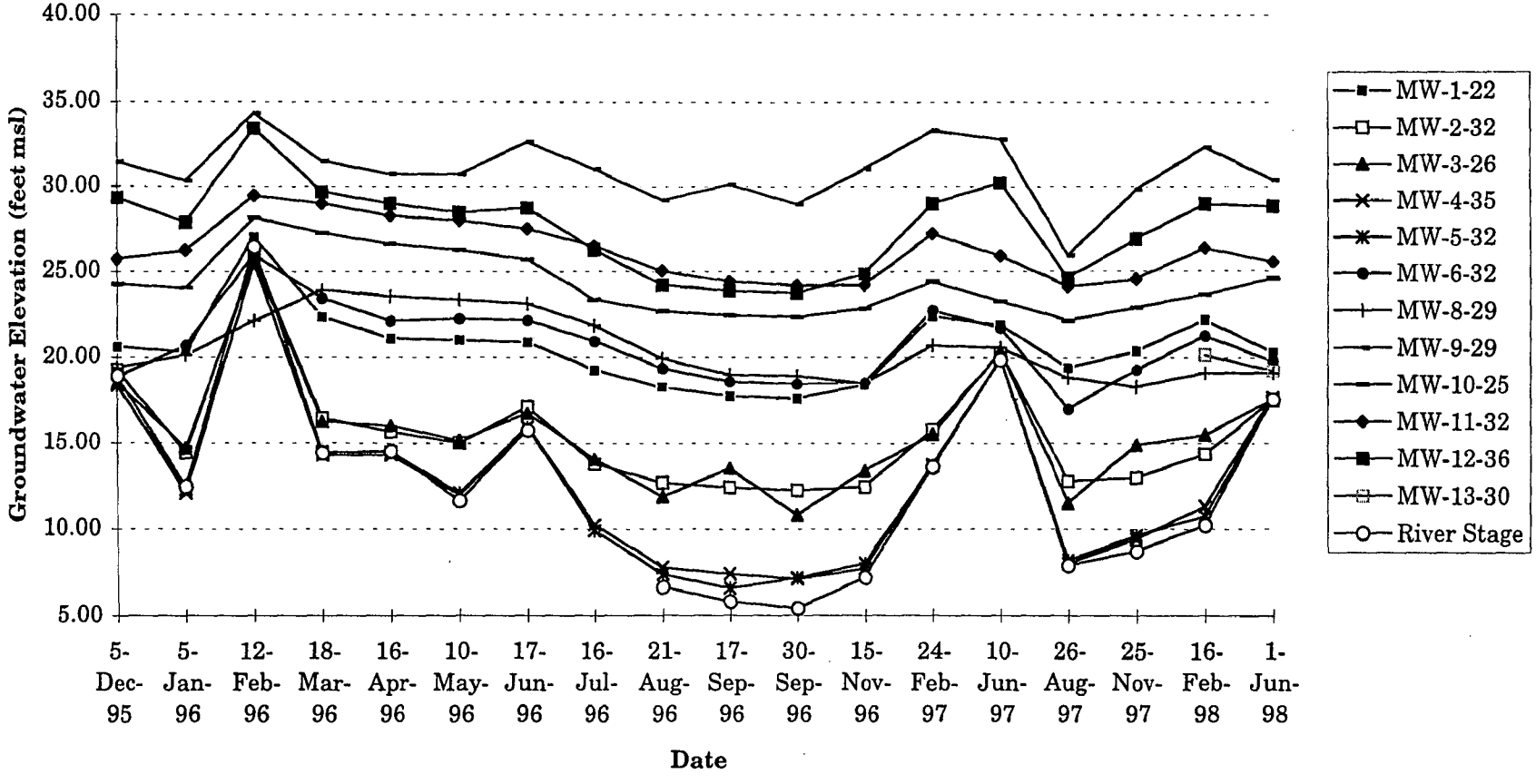


Updated: 9/21/98 RBE
File: 2708 GW Elevations/ MW-13

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022752

Groundwater Hydrograph
Shallow Depth Aquifer Zone Monitoring Wells
Northwest Natural Gas Company - Gasco Facility

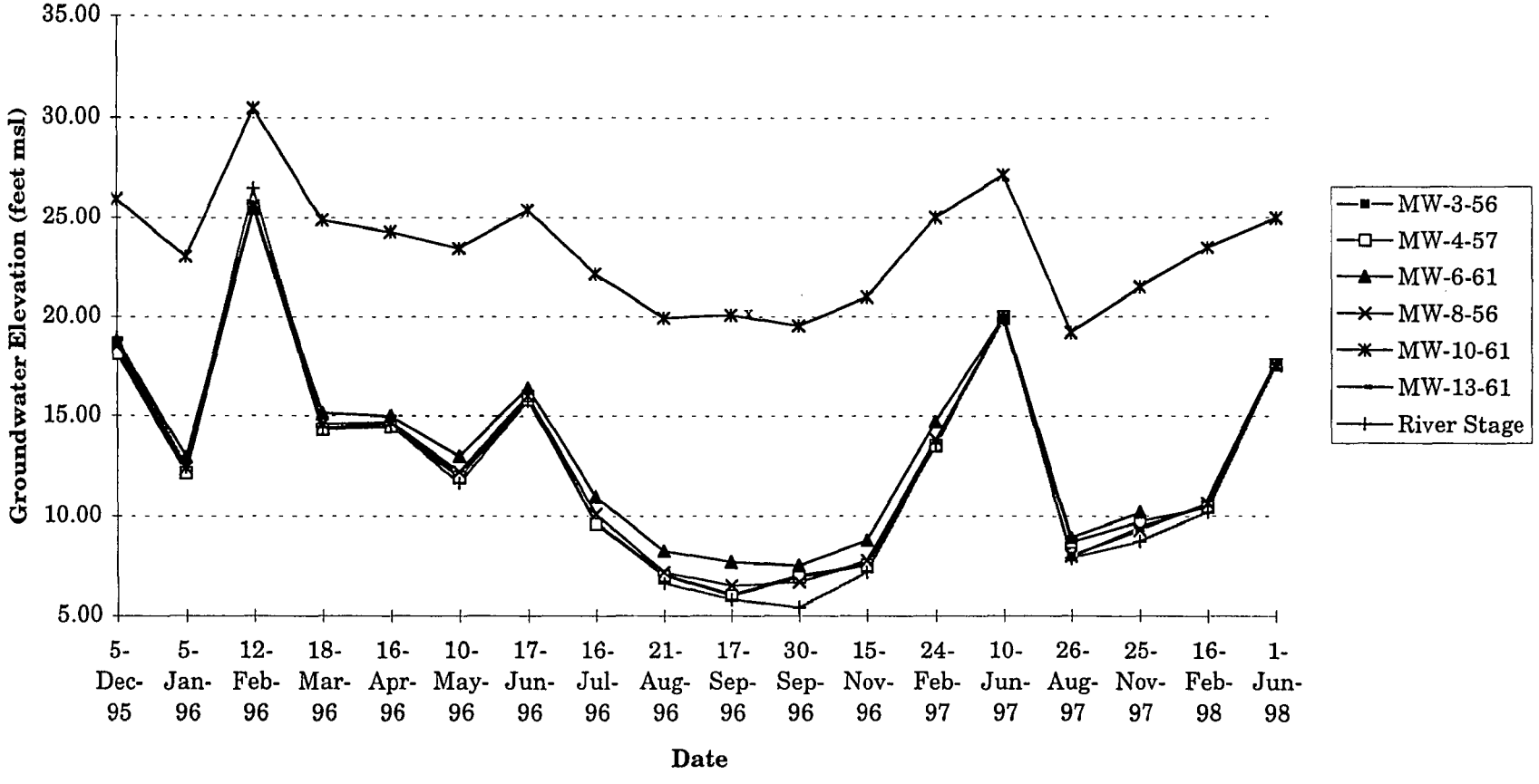


Koppers022753

Updated: 9/21/98 RBE
File: 2708 GW Elevations/ Hydrograph - Shallow

HAHN AND ASSOCIATES, INC.
Project # 2708

Groundwater Hydrograph
Intermediate Depth Aquifer Zone Monitoring Wells
Northwest Natural Gas Company - Gasco Facility



Updated: 9/21/98 RBE
File: 2708 GW Elevations/ Hydrograph - Deep

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022754

APPENDIX F

Residual Product Maps

Koppers022756

Figure
F-1

Residual Oil Tar/ DNAPL in Soil: Depth to Top (feet bgs)

Remedial Investigation
Northwest Natural - Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project #2708

N

0 150 300
Approximate Scale in Feet

LEGEND

- Site Boundary
- Existing Structure or Feature
- Railroad Tracks
- Soil Boring
- Shallow Monitoring Well (22 - 36 feet bgs)
- Intermediate Monitoring Well (56 - 61 feet bgs)
- Abandoned Monitoring Well
- 10'-11.5' — Depth interval of observed residual oil tar in soil (feet bgs)
- No residual oil tar identified within boring
- 40 ft — Isocontour indicating depth to top of residual oil tar in soil, feet bgs (Contour interval = 5 feet)

Willamette River
U.S. Army Corps of Engineers
Former Drainage Ditch (1940)
Wacker Siltronic
LNG Containment Basin
LNG Tank
Estimated Edge of Residual Oil Tar in Soil
NW St. Helens Road

MW-1 16'-21.5'
MW-2
MW-3
MW-4
MW-5
MW-6 28'-30.5'
MW-7
MW-8 41.5'-43'
MW-9
MW-10 16.5-23.5'
MW-11 11'-35'
MW-12 10'-12'
MW-13
B-1 16.5'-22'
B-2
B-3
B-4
B-5
B-6
B-7
B-8
B-9
B-10
B-11 15'-19'
B-12
B-13 7.5'-11'
B-14
B-15 15.5'-25'
B-17 10'-22'
B-18
B-19 3'-15'
B-20 10'-23'
B-21
B-22 2.5-25
B-23 12.5'-27'
B-24 10'-11.5'
B-25 10'-17'
B-26 15'-35'
B-27 22.5'-23.5'
B-28 20'-22'
B-29 27'-39'
B-30
B-31
B-32 30'-56'
B-33 60'-67'
B-34 30'- >37'
B-35 20'-22.5'
G-1 10'-21'
G-2 8'-22'
GT-1
GT-2
GT-3
GT-4

25 ft
30 ft
35 ft
40 ft
45 ft
50 ft
55 ft
40 ft
35 ft
30 ft
25 ft
20 ft
15 ft
10 ft
5 ft
20 ft
15 ft

Koppers022757

Figure
F-2

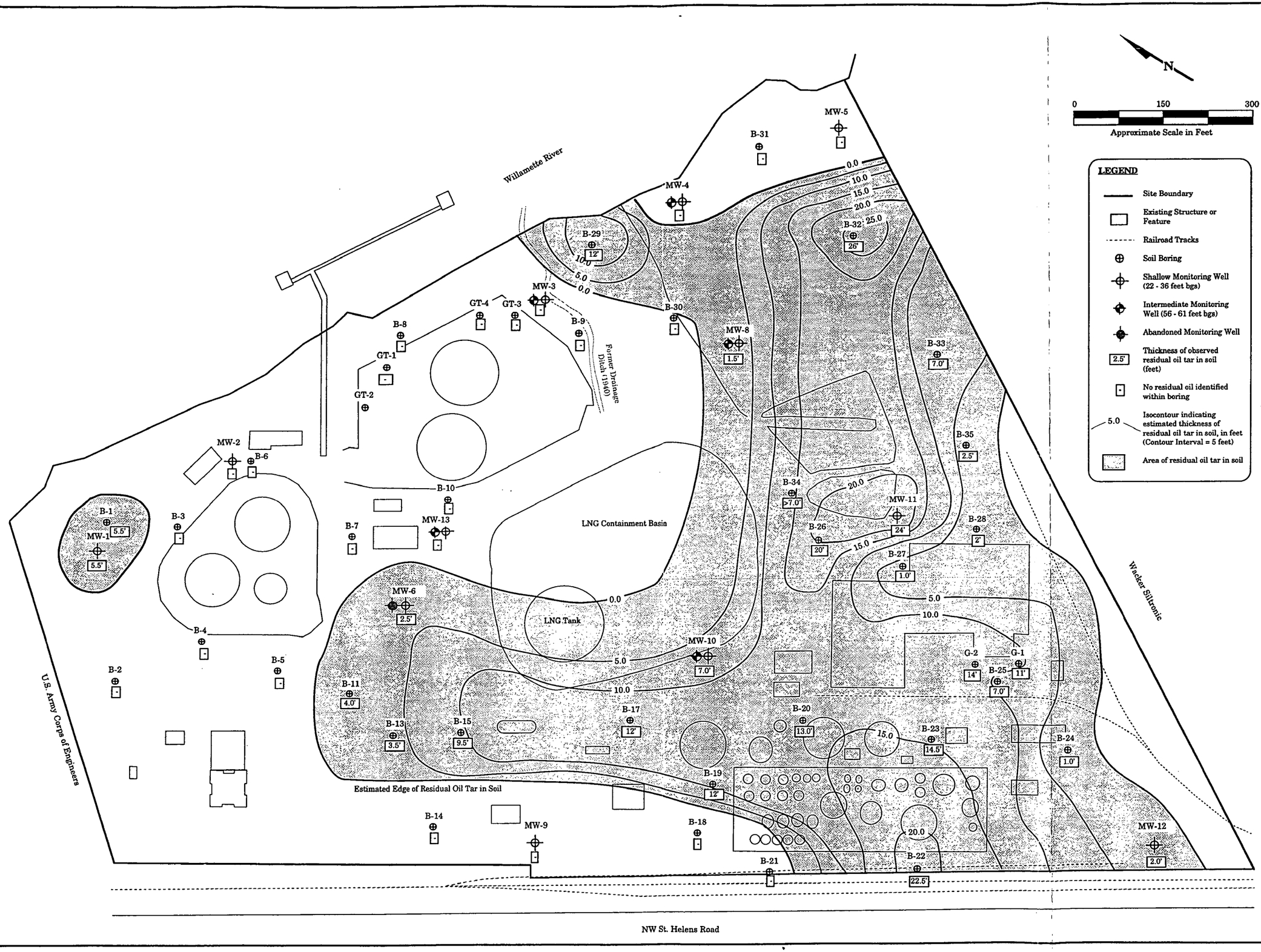
Residual Oil Tar/ DNAPL in Soil: Thickness and Isopach Map

Remedial Investigation
Northwest Natural - Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project #2708



Koppers022758

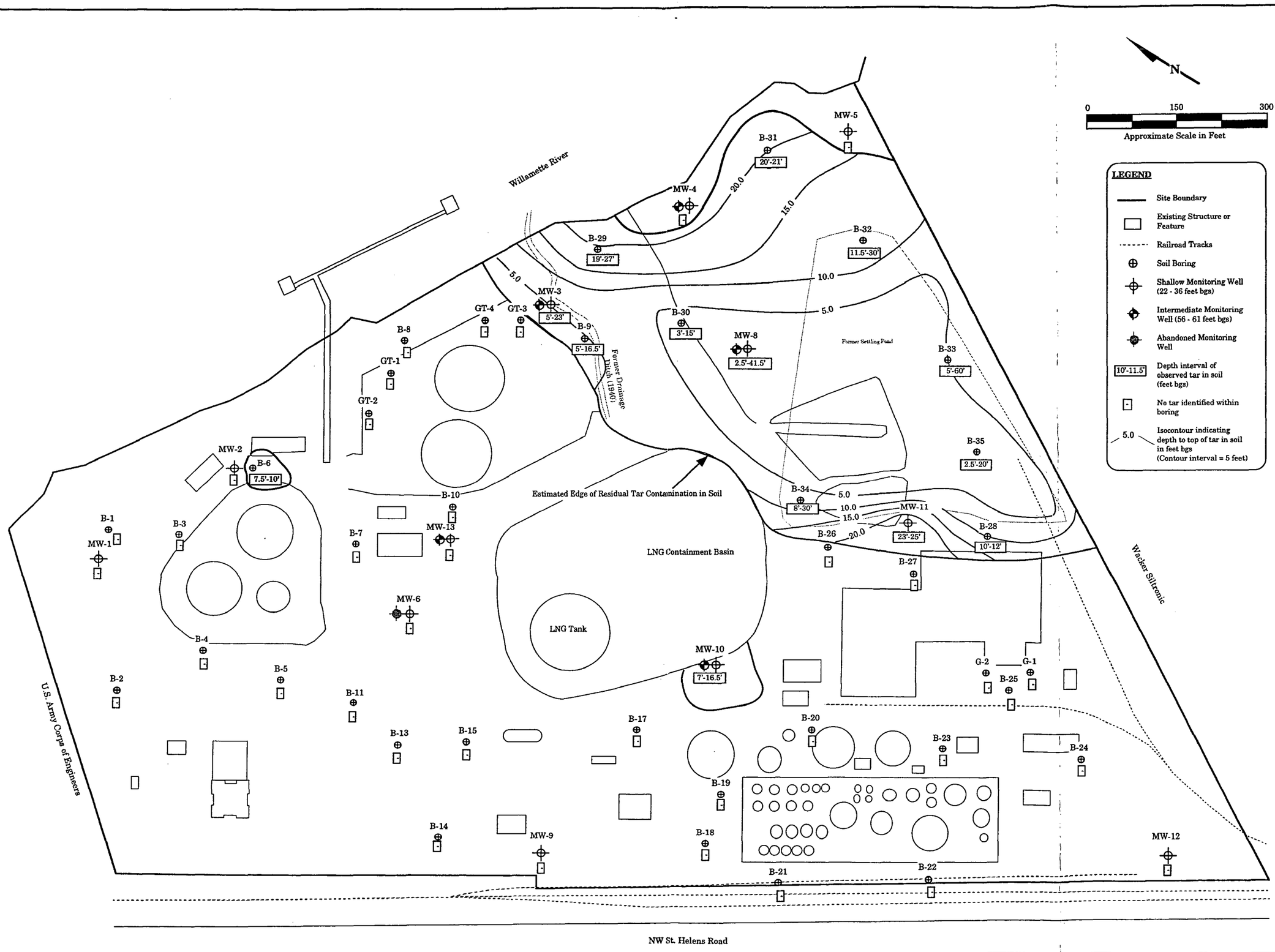


Figure
F-3

Tar in Soil: Depth to Top (feet bgs)

Remedial Investigation
Northwest Natural - Gasco Facility
7990 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

February 1998

Project #2708

Koppers022759

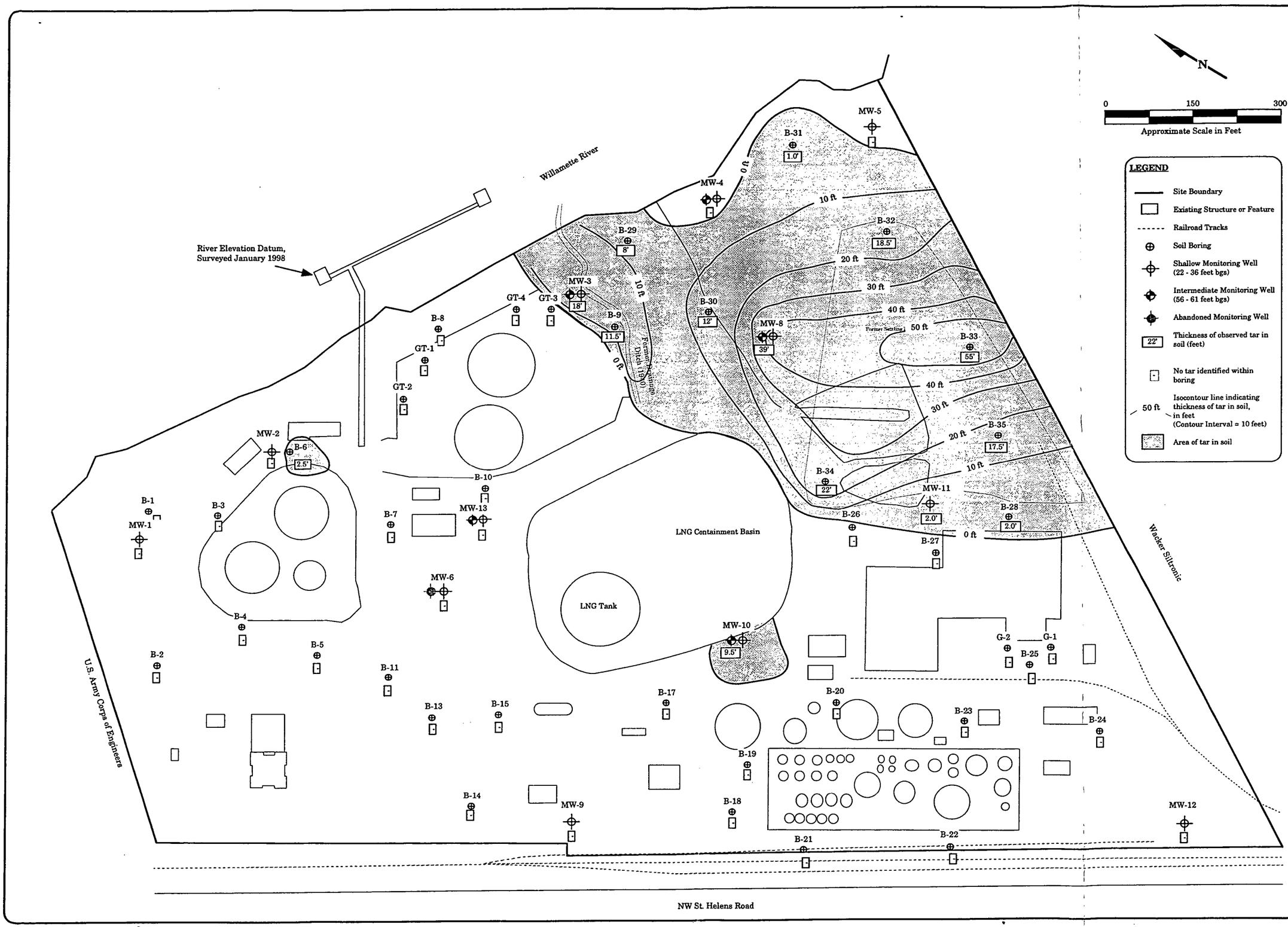


Figure F-4

Tar in Soil: Thickness and Isopach Map

Remedial Investigation
Northwest Natural - Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

February 1998

Project #2708

Koppers022760

APPENDIX G

Soil Quality Data

Summary Figures

Summary Tables

Koppers022762

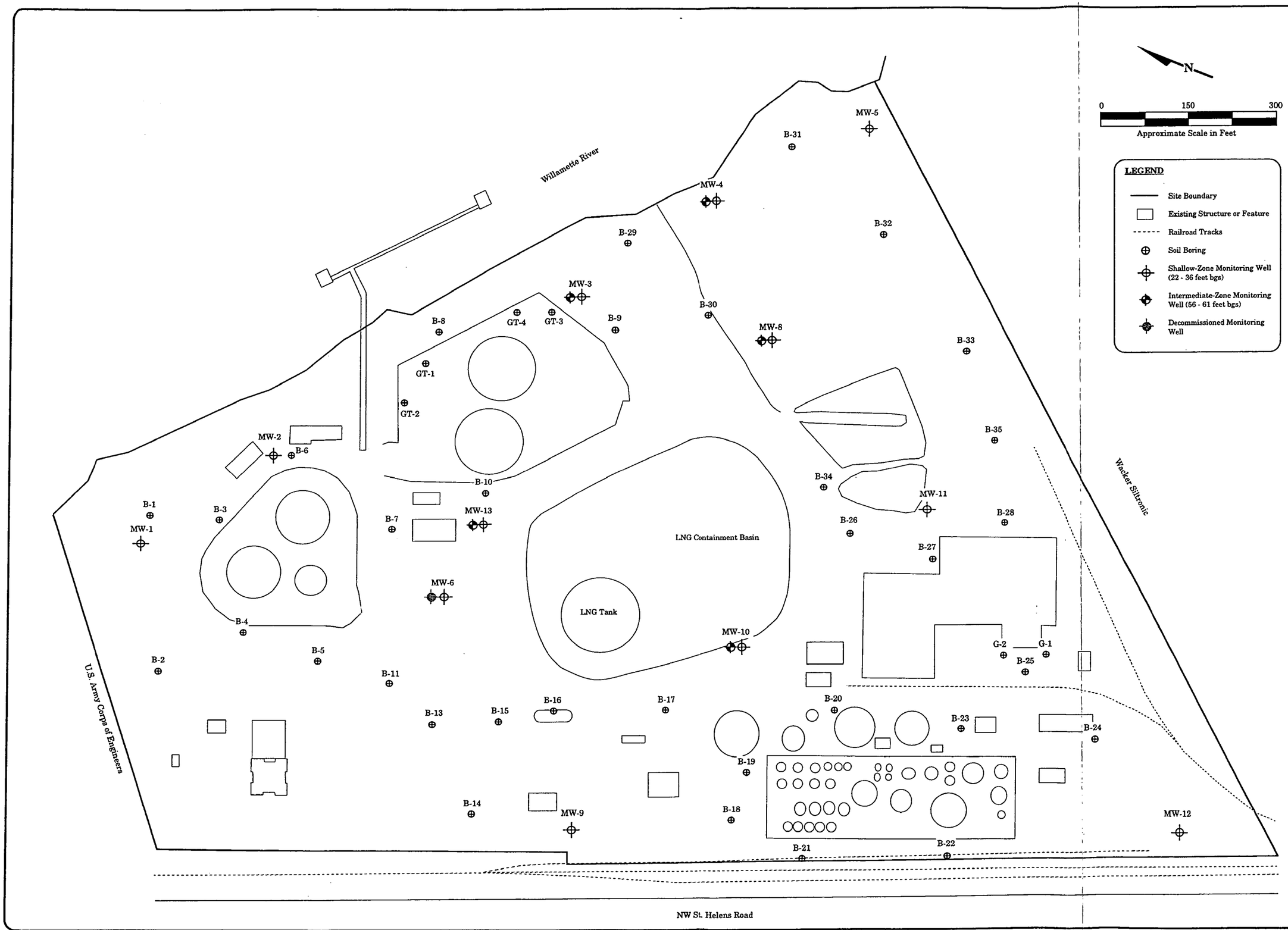


Figure G-1

Monitoring Well and Soil Boring Location Map

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
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434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project #2708

Koppers022763

Figure
G-2

Soil Sampling Results Map: Total PAHs

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project #2708

N

0 150 300

Approximate Scale in Feet

LEGEND

- Site Boundary
- Existing Structure or Feature
- Railroad Tracks
- Soil Boring
- Shallow Monitoring Well (22 - 36 feet bgs)
- Intermediate Monitoring Well (56 - 61 feet bgs)
- Decommissioned Monitoring Well
- 25 @ 0.2' — Total PAH concentration in ppm at depth below ground surface in feet
- ND — Not detected

Willamette River

River Elevation Datum, Surveyed January 1998

U.S. Army Corps of Engineers

Wacker Siltronic

LNG Containment Basin

LNG Tank

NW St. Helens Road

B-1: 56 @ 0.2' / 1,280 @ 10.5' / 5 @ 21.0'
MW-1: 5.8 @ 0.2' / 13 @ 3.5' / 0.46 @ 13'
B-2
B-3: 49 @ 10.5' / ND @ 15'
B-4
B-5: 3.6 @ 15.5'
MW-2
B-6: 10 @ 0.2' / 0.43 @ 24'; 12,487 @ 8' / 86.5 @ / 15.5'
B-7: ND @ 17'
B-8: 338 @ 10' / 0.24 @ 18'
GT-1: 4.3@3.0' / 6.2@10.5' / ND@16' / ND@20.5' / ND@33.5'
GT-2: 0.08@3.5' / ND@15.5' / ND>33'
GT-3: 43.1@3.0' / 0.05@12.5' / ND@36'
GT-4: ND@13.5' / ND@40.5'
B-9: 19,438 @ 10' / 43.5 @ 30.5' / 0.46 @ 34'
B-10: ND @ 17.5'
B-11: 973 @ 12.5' / 1.1 @ 23'
B-13: 29,387 @ 10.5' / ND @ 10.5' / ND @ 24'
B-14: ND @ 5.0'
B-15: 638 @ 21' / 1.8 @ 27'
B-16
B-17: 59.1 @ 3' / 1,814 @ 16.5' / 0.89 @ 23.5'
MW-3: 10 @ 31' / ND @ 38' / ND @ 53.5'
MW-4: 195 @ 0.2' / 3,261 @ 25.5' / 0.26 @ 57
MW-5: 1.4 @ 0.2' / 1,942 @ 15.5' / 0.91 @ 21.5' / ND @ 31.5'
MW-6: ND @ 2.5' / 20.614 @ 30' / 1.8 @ 38.5' / 0.06 @ 43'
MW-8: 281 @ 0.2' / 8.1 @ 44' / 0.64 @ 55'
MW-9: 21 @ 0.2' / 163 @ 5' / 0.52 @ 11.5'
MW-10: 107 @ 0.2' / 0.76 @ 28'
MW-11: 106 @ 0.2' / 7.9 @ 39' / 1.1 @ 43.5
MW-12: 116 @ 0.2' / 8.6 @ 22' / ND @ 26.5'
MW-13: ND @ 6.0' / ND@10' / ND@13.5' / 1.0 @ 18' / ND@24.5' / 0.058@28' / ND@31' / ND@57'
B-18: 59.3 @ 12' / ND @ 24.5'
B-19: 933 @ 0.2' / 408 @ 6.5' / 80 @ 18' / 2.0 @ 27'
B-20: 1,093 @ 10.5' / 12.7 @ 23.5'
B-21: 7.1 @ 11.5'
B-22: 40 @ 13.5' / 485 @ 24'
B-23: 77 @ 26.5' / ND @ 34.5'
B-24: 1,092 @ 10.5' / 0.14 @ 29'
B-25: 12.5 @ 12.5' / 0.45 @ 20'
B-26: 9.3 @ 0.2' / 15,530 @ 20.5' / 1.1 @ 39.5
B-27: 1,243 @ 23' / 125 @ 28' / 12.2 @ 35.5'
B-28: 135 @ 0.2' / 612 @ 15' / 2.3 @ 24'
B-29: 230 @ 0.2' / 58,822 @ 35.5' / 16.5 @ 44'
B-30: 965 @ 0.2' / 6,766 @ 11.5' / 853 @ 28.5'
B-31: 38 @ 0.2' / 12,666 @ 21' / 5.5 @ 24.5' / ND @ 28'
B-32: 61 @ 0.2' / 28,772 @ 11.5' / 21,961 @ 46.5' / 1.2 @ 58.5'
B-33: 955 @ 0.2' / 38 @ 3' / 65 @ 54' / 5.7 @ 69'
B-34: 94 @ 0.2' / 13,499 @ 11.5'
B-35: 39 @ 0.2' / 41,602 @ 22' / 9.3 @ 29
G-1
G-2

Koppers022764

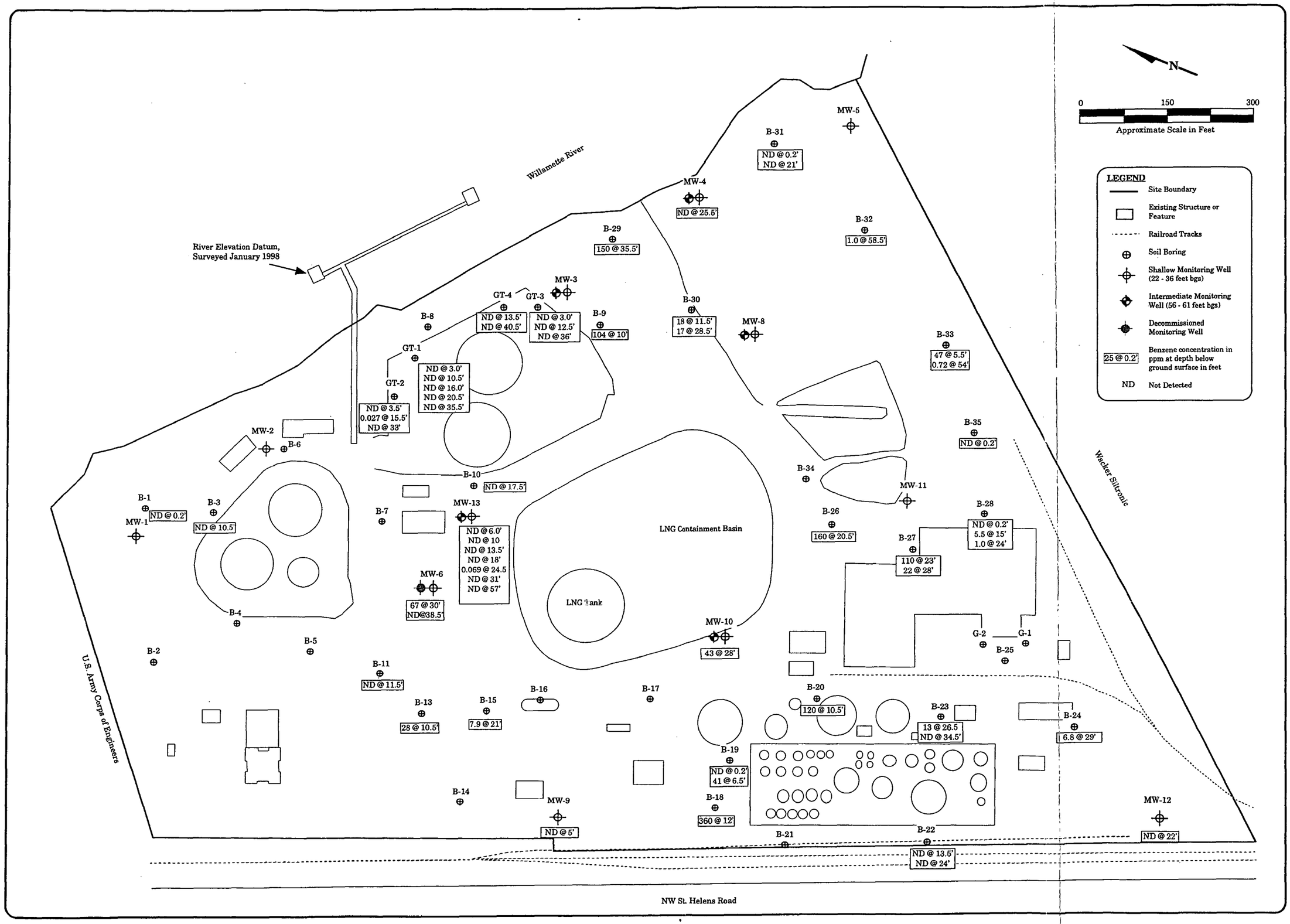

Figure
G-3

Soil Sampling Results Map: Benzene

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project #2708

Koppers022765

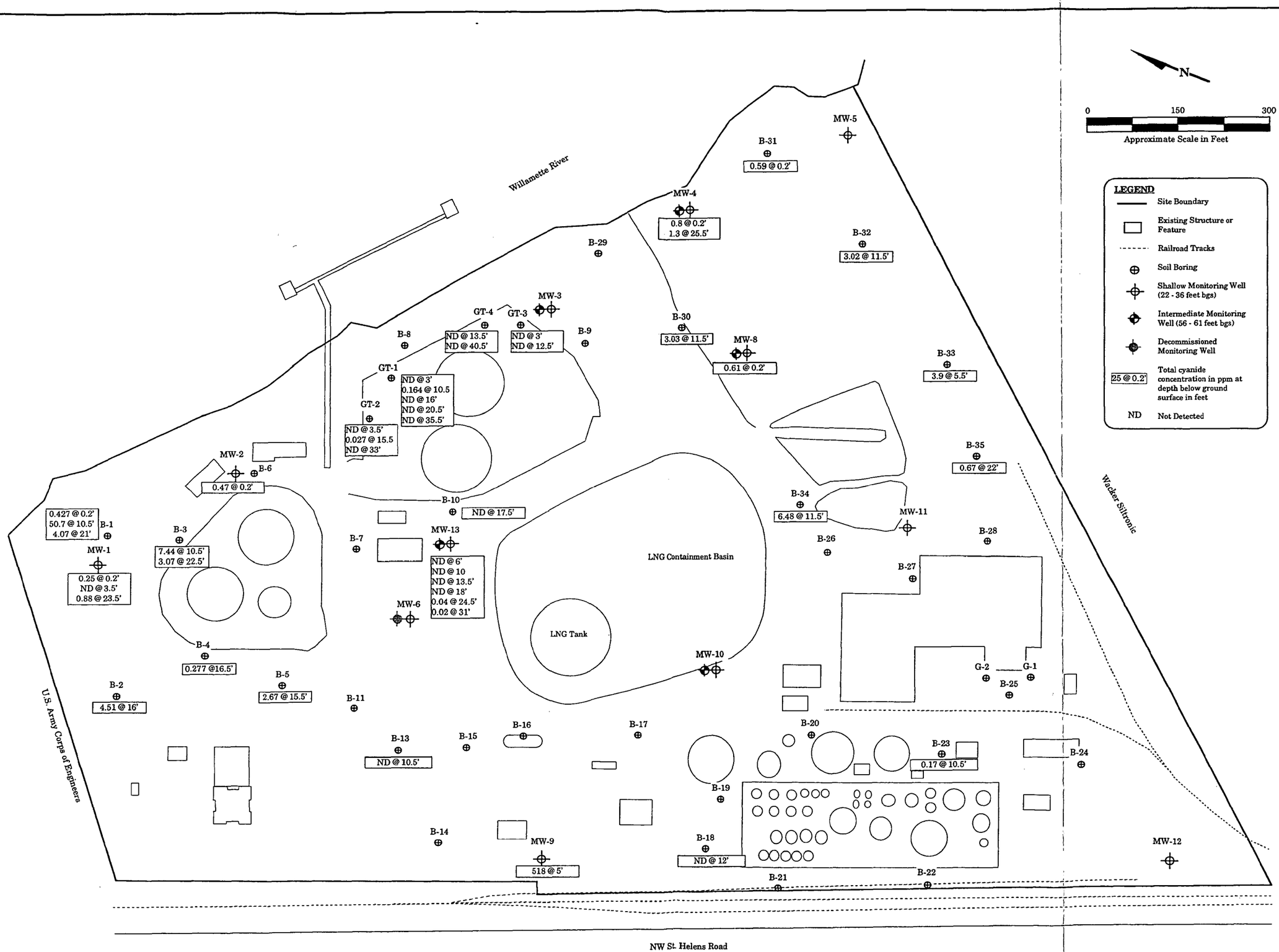

Figure
G-4

Soil Sampling Results Map: Total Cyanide

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project #2708

Koppers022766

TABLE G-1 – Summary of Analytical Results for Soil Samples
TPH, BTEX, Total PAHs, Total Phenols, Cyanide, and Lead
Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Soil Boring Number	Sample Number[1]	Chain of Custody Number	Sample Date	Depth (feet bgs)	Field Observation				Analytical Results mg/kg (ppm)											
									ODEQ Method		EPA Method 8270 SIM		EPA Method 8020					EPA Method 8270	EPA Method 9010	EPA Method 6010
									TPH-G	TPH-418.1M										
					Sheen	Oil Tar	Tar	Lamp Black	Gasoline	Diesel/Oil	Carcinogenic PAHs	Total PAHs	Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Total Phenols	Total Cyanide	Total Lead
B-01	950921-B1-01	2708-S009	21-Sep-95	0.2					ND>10	130.	7.17	13.358	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND		0.427	60.
	950921-B1-02	2708-S009	21-Sep-95	0.2 (dup)						220.	26.14	55.96							0.382	58.
	950921-B1-05	2708-S009	21-Sep-95	10.5	X			X		**640.**	336.7	1,279.7							50.7	130.
	950921-B1-06	2708-S009	21-Sep-95	12.0						**560.**										
	950921-B1-09	2708-S009	21-Sep-95	21.0							0.926	5.026							4.07	
B-02	950927-B2-05	2708-S016	27-Sep-95	16.0				X											4.51	15.
	950927-B2-07	2708-S016	27-Sep-95	20.5																
B-03	950921-B3-05	2708-S007	21-Sep-95	10.5				X		120.	23.04	49.04	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	ND	7.44	22.
	950921-B3-07	2708-S007	21-Sep-95	15.0						5.9	ND	ND								
	950921-B3-10	2708-S007	21-Sep-95	22.5															3.07	
B-04	950921-B4-05	2708-S008	21-Sep-95	16.5															0.277	
B-05	950928-B5-05	2708-S021	28-Sep-95	15.5						**780.**	0.94	3.64							2.67	
B-06	950927-B6-02	2708-S016	27-Sep-95	8.0	X		X			**810.**	4,413.	12,486.8								
	950927-B6-03	2708-S016	27-Sep-95	15.5						54.	40.2	86.45								
B-07	950927-B7-05	2708-S017	27-Sep-95	17.0							ND	ND								
B-08	950918-B8-04	2708-S001	18-Sep-95	10.0				X		54.	185.	338.49								
	950918-B8-05	2708-S001	18-Sep-95	12.5						15.										
	950918-B8-06	2708-S001	18-Sep-95	12.5 (dup)						18.										
	950918-B8-08	2708-S001	18-Sep-95	18.0							ND	0.243								
B-09	950918-B9-02	2708-S002	18-Sep-95	10.0	X		X		**1,200.**	25.	2,421.5	19,437.5	**104.**	44.2	78.2	102.6	329.			
	950918-B9-08	2708-S002	18-Sep-95	28.0	X				**270.**	**1,600.**										
	950918-B9-09	2708-S002	18-Sep-95	30.5	X						9.48	43.54								
	950918-B9-10	2708-S002	18-Sep-95	34.0							ND	0.464								
B-10	950925-B10-04	2708-S013	25-Sep-95	17.5							ND	ND	ND>0.3	ND>0.3	ND>0.3	ND>0.3		ND	ND>0.5	2.
B-11	950928-B11-01	2708-S019	28-Sep-95	0.2						**1,600.**										
	950928-B11-06	2708-S020	28-Sep-95	12.5	X					**1,700.**	3.26	972.87	ND>0.3	ND>0.3	3.4	3.	6.4			
	950928-B11-09	2708-S020	28-Sep-95	23.0							ND	1.051								
B-13	951006-B13-03	2708-S035	6-Oct-95	10.5	X	X			**1,000.**	**2,700.**	3,915.9	29,386.9	**28.**	ND>20	**110.**	22.	160.	ND	ND>0.1	1.9
	951006-B13-07	2708-S035	6-Oct-95	18.5							ND	ND								
	951006-B13-10	2708-S036	6-Oct-95	24.0					ND>10	ND>5	ND	ND								
B-14	950928-B14-01	2708-S019	28-Sep-95	0.2																
	950928-B14-02	2708-S019	28-Sep-95	2.5	X					280.										
	950928-B14-03	2708-S019	28-Sep-95	5.0							ND	ND								
B-15	951006-B15-05	2708-S036	6-Oct-95	21.0	X				70.	200.	45.9	637.6	**7.9**	ND>0.3	3.9	2.5	14.3			
	951006-B15-08	2708-S036	6-Oct-95	27.0							0.21	1.791								
ODEQ Soil Cleanup Levels [2]					#	#	#	#	80 [4]	500 [4]	see Table G-2	see Table G-2	2.0	80	100	800	#	see Table G-3	40,000 [5]	2,000 [5]
EPA PRGs for Industrial Soil [3]					#	#	#	#	#	#	see Table G-2	see Table G-2	1.37	880	230	320	#	see Table G-3	13,626	1,000

NOTE: 1 = Sample number prefix: 2708-
2 = Reference Levels are Soil Cleanup Levels in the Soil Cleanup Table (OAR 340-122-045), unless otherwise noted
3 = Reference Levels are EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil
4 = Reference Levels are ODEQ UST Level 2 Soil Cleanup Standards (OAR 340-122-335)
5 = Reference Levels are Industrial Maximum Allowable Soil Concentrations in the Soil Cleanup Table (OAR 340-122-045)

# = not established
BTEX = benzene, toluene, ethylbenzene, and xylenes
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = not detected above detection limit indicated

ODEQ = Oregon Department of Environmental Quality
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
TPH = total petroleum hydrocarbons
BOLD = Detected above Reference Level

Koppers022767

TABLE G-1 – Summary of Analytical Results for Soil Samples
TPH, BTEX, Total PAHs, Total Phenols, Cyanide, and Lead
Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Soil Boring Number	Sample Number[1]	Chain of Custody Number	Sample Date	Depth (feet bgs)	Field Observation				Analytical Results mg/kg (ppm)											
									ODEQ Method		EPA Method 8270 SIM		EPA Method 8020						EPA Method 8270	EPA Method 9010	EPA Method 6010
									TPH-G	TPH-418.1M											
					Sheen	Oil Tar	Tar	Lamp Black	Gasoline	Diesel/Oil	Carcinogenic PAHs	Total PAHs	Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Total Phenols	Total Cyanide	Total Lead
B-17	950929-B17-01	2708-S022	29-Sep-95	3.0							24.07	59.079								
	950929-B17-05	2708-S022	29-Sep-95	16.5	X	X			**2,400.**	**4,700.**	114.1	1,814.						ND		
	950929-B17-07	2708-S022	29-Sep-95	23.5							ND	0.888								
B-18	950919-B18-05	2708-S003	19-Sep-95	12.0	X				**3,100.**	99.	0.659	59.306	**360.**	**280.**	31.	220.	891.	0.36	ND>0.25	13.
	950919-B18-08	2708-S003	19-Sep-95	19.5	X				**850.**	44.										
	950919-B18-09	2708-S003	19-Sep-95	22.0					24.	380.										
	950919-B18-10	2708-S003	19-Sep-95	24.5							ND	ND								
B-19	950919-B19-01	2708-S003	19-Sep-95	0.2						68.	324.2	933.22	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	ND		57.
	950919-B19-03	2708-S004	19-Sep-95	6.5	X	X			**1,600.**	**1,500.**	35.76	408.26	**41.**	**120.**	39.	160.	360.	ND		1.6
	950919-B19-04	2708-S004	19-Sep-95	10.5	X				**3,200.**	**1,500.**										11.
	950919-B19-05	2708-S004	19-Sep-95	12.0					**1,900.**	**6,800.**										
	950920-B19-07	2708-S005	20-Sep-95	18.0					**130.**	**760.**	0.101	80.001								
	950920-B19-08	2708-S005	20-Sep-95	27.0							0.027	1.956								
B-20	950929-B20-03	2708-S022	29-Sep-95	10.5	X	X			**940.**	340.	244.507	1,092.607	**120.**	64.	16.	60.	260.	ND		4.5
	950929-B20-07	2708-S023	29-Sep-95	23.5					**220.**	11.	0.255	12.686								
B-21	951003-B21-04	2708-S027	3-Oct-95	11.5							0.418	7.107								9.8
B-22	951003-B22-01	2708-S027	3-Oct-95	3.5	X	X				**530.**										
	951003-B22-05	2708-S027	3-Oct-95	13.5	X						1.727	40.268	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	ND		5.9
	951003-B22-09	2708-S028	3-Oct-95	24.0	X	X				**600.**	30.23	485.234	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	ND		2.5
	951003-B22-10	2708-S028	3-Oct-95	26.5						12.										
B-23	951003-B23-02	2708-S028	3-Oct-95	10.5	X				**1,300.**	**930.**									0.17	
	951003-B23-05	2708-S029	3-Oct-95	18.5	X					16.										
	951003-B23-08	2708-S029	3-Oct-95	26.5	X			X		110.	1.117	76.897	**13.**	ND>0.3	ND>0.3	1.3	14.3	ND		5.2
	951003-B23-10	2708-S029	3-Oct-95	31.5	X															
	951003-B23-12	2708-S029	3-Oct-95	34.5							ND	ND	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND			
B-24	951002-B24-03	2708-S024	2-Oct-95	10.5	X		X		**1,500.**	**640.**	276.5	1,091.8								
	951002-B24-10	2708-S024	2-Oct-95	29.0							ND	0.14	**6.8**	2.3	ND>0.3	0.34	9.44			
B-25	951002-B25-03	2708-S025	2-Oct-95	12.5	X				**120.**	35.	3.328	12.458								
	951002-B25-05	2708-S025	2-Oct-95	20.0							ND	0.45								
B-26	951003-B26-01	2708-S030	4-Oct-95	0.2							5.13	9.319								
	951003-B26-06	2708-S030	4-Oct-95	20.5	X	X			**1,300.**	**1,600.**	861.7	15,529.7	**160.**	**110.**	16.	90.	376.	ND		10.
	951003-B26-13	2708-S030	4-Oct-95	39.5					ND>10	ND>5	ND	1.12								
B-27	950920-B27-06	2708-S005	20-Sep-95	13.0	X					8.5										1.9
	950920-B27-08	2708-S005	20-Sep-95	18.0																
	950920-B27-10	2708-S005	20-Sep-95	23.0	X	X			**700.**	**570.**	90.5	1,243.4	**110.**	46.	ND>30	ND>30	156.	ND		5.2
	950920-B27-12	2708-S006	20-Sep-95	28.0					**94.**	ND>5	9.605	125.405	**22.**	3.6	ND>0.6	1.2	26.8			
	950920-B27-15	2708-S006	20-Sep-95	35.5							1.211	12.241								
ODEQ Soil Cleanup Levels [2]					#	#	#	#	80 [4]	500 [4]	see Table G-2	see Table G-2	2.0	80	100	800	#	see Table G-3	40,000 [5]	2,000 [5]
EPA PRGs for Industrial Soil [3]					#	#	#	#	#	#	see Table G-2	see Table G-2	1.37	880	230	320	#	see Table G-3	13,626	1,000

NOTE: 1 = Sample number prefix: 2708-
2 = Reference Levels are Soil Cleanup Levels in the Soil Cleanup Table (OAR 340-122-045), unless otherwise noted
3 = Reference Levels are EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil
4 = Reference Levels are ODEQ UST Level 2 Soil Cleanup Standards (OAR 340-122-335)
5 = Reference Levels are Industrial Maximum Allowable Soil Concentrations in the Soil Cleanup Table (OAR 340-122-045)

# = not established
BTEX = benzene, toluene, ethylbenzene, and xylenes
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = not detected above detection limit indicated

ODEQ = Oregon Department of Environmental Quality
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
TPH = total petroleum hydrocarbons
BOLD = Detected above Reference Level

Updated: 9/22/98 RBE
File Name: 2708-G1 Soil Quality Table

Koppers022768

TABLE G-1 – Summary of Analytical Results for Soil Samples
TPH, BTEX, Total PAHs, Total Phenols, Cyanide, and Lead
Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Soil Boring Number	Sample Number[1]	Chain of Custody Number	Sample Date	Depth (feet bgs)	Field Observation				Analytical Results mg/kg (ppm)											
									ODEQ Method		EPA Method 8270 SIM		EPA Method 8020					EPA Method 8270	EPA Method 9010	EPA Method 6010
									TPH-G	TPH-418.1M										
					Sheen	Oil Tar	Tar	Lamp Black	Gasoline	Diesel/Oil	Carcinogenic PAHs	Total PAHs	Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Total Phenols	Total Cyanide	Total Lead
B-28	951002-B28-01	2708-S025	2-Oct-95	0.2					ND>10	35.	45.5	86.836	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	ND		21.
	951002-B28-02	2708-S025	2-Oct-95	0.2 (dup)							65.5	135.19								
	951002-B28-07	2708-S025	2-Oct-95	15.0	X	X			24.	200.	167.2	611.5	**5.5**	ND>2	ND>2	2.3	7.8	ND		5.6
	951002-B28-11	2708-S026	2-Oct-95	24.0					ND>10	ND>5	ND	2.298	0.99	ND>0.3	ND>0.3	ND>0.3	0.99			
B-29	950922-B29-01	2708-S011	22-Sep-95	0.2						190.	138.8	230.07								
	950922-B29-08	2708-S011	22-Sep-95	18.0			X													
	950922-B29-10	2708-S011	22-Sep-95	23.5					ND>10	9.3										
	950922-B29-12	2708-S012	22-Sep-95	28.0	X	X			53.	220.										
	950922-B29-15	2708-S012	22-Sep-95	35.5	X	X			**1,800.**	**4,800.**	5,214.1	58,821.7	**150.**	**140.**	35.	110.	435.	ND		1.7
	950925-B29-17	2708-S013	25-Sep-95	44.0					ND>10	44.	2.614	16.454								
	950925-B29-18	2708-S013	25-Sep-95	47.0							ND	0.18								
B-30A	950922-B30-01	2708-S010	22-Sep-95	0.2						390.	500.	964.5								
B-30	950922-B30-06	2708-S010	22-Sep-95	11.5	X			X	**320.**	**3,200.**	938.7	6,775.7	**18.**	1.9	12.	20.	51.9	ND	3.03	25.
	950922-B30-08	2708-S010	22-Sep-95	17.0																
	950922-B30-12	2708-S010	22-Sep-95	28.5	X				**150.**	120.	94.3	853.	**17.**	ND>3	2.8	ND>3	19.8			
	950922-B30-13	2708-S011	22-Sep-95	33.5					12.	ND>5										
B-31	950925-B31-01	2708-S013	25-Sep-95	0.2						240.	22.98	38.148	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND		0.59	14.
	950925-B31-06	2708-S014	25-Sep-95	21.0	X		X	X	**250.**	**2,200.**	1,846.1	12,665.7	ND>3	ND>3	9.1	9.6	18.7	ND		12.
	950925-B31-08	2708-S014	25-Sep-95	24.5					ND>10	34.	2.089	5.494								
	950925-B31-10	2708-S014	25-Sep-95	28.0							ND	ND								
	950925-B31-11	2708-S014	25-Sep-95	28.0 (dup)							ND	ND								
B-32	951003-B32-01	2708-S031	4-Oct-95	0.2						66.	34.8	61.21								
	951003-B32-03	2708-S031	4-Oct-95	11.5				X	**760.**	**6,600.**	3,156.3	28,772.3							3.02	
	951003-B32-15	2708-S032	4-Oct-95	46.5	X	X			**1,400.**	**4,100.**	1,728.	21,961.								
	951003-B32-18	2708-S032	4-Oct-95	58.5	X						ND	1.202	0.95	ND>.3	ND>.3	ND>.3	1.			
B-33	951005-B33-01	2708-S033	5-Oct-95	0.2						170.	575.3	955.4								
	951005-B33-02	2708-S033	5-Oct-95	3.0						140.	151.77	37.51								
	951005-B33-03	2708-S034	5-Oct-95	5.5	X		X		**430.**	**2,700.**	1,054.4	8,238.4	**47.**	22.	29.	28.	126.	ND	3.9	20.
	951005-B33-11	2708-S034	5-Oct-95	38.5	X		X		**1,700.**	**7,600.**										
	951005-B33-14	2708-S034	5-Oct-95	54.0	X		X		36.	230.	3.02	65.04	0.72	0.82	1.	1.1	3.64	ND		2.1
	951006-B33-18	2708-S035	6-Oct-95	69.0							0.525	5.682								
B-34	950926-B34-01	2708-S015	26-Sep-95	0.2						41.	49.2	94.09								
	950926-B34-05	2708-S015	26-Sep-95	11.5	X		X		**3,400.**	**4,200.**	1,639.	13,499.							6.48	
	950926-B34-12	2708-S015	26-Sep-95	36.5	X	X			**1,900.**	69.										
B-35	951005-B35-01	2708-S033	5-Oct-95	0.2						27.	19.49	38.94	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	ND		
	951005-B35-06	2708-S033	5-Oct-95	22.0	X	X			**2,200.**	**7,700.**	4,013.5	41,601.5							0.67	
	951005-B35-10	2708-S033	5-Oct-95	29.0							0.784	9.294								
ODEQ Soil Cleanup Levels [2]					#	#	#	#	80 [4]	500 [4]	see Table G-2	see Table G-2	2.0	80	100	800	#	see Table G-3	40,000 [5]	2,000 [5]
EPA PRGs for Industrial Soil [3]					#	#	#	#	#	#	see Table G-2	see Table G-2	1.37	880	230	320	#	see Table G-3	13,626	1,000

NOTE: 1 = Sample number prefix: 2708-
2 = Reference Levels are Soil Cleanup Levels in the Soil Cleanup Table (OAR 340-122-045), unless otherwise noted
3 = Reference Levels are EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil
4 = Reference Levels are ODEQ UST Level 2 Soil Cleanup Standards (OAR 340-122-335)
5 = Reference Levels are Industrial Maximum Allowable Soil Concentrations in the Soil Cleanup Table (OAR 340-122-045)

# = not established
BTEX = benzene, toluene, ethylbenzene, and xylenes
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = not detected above detection limit indicated

ODEQ = Oregon Department of Environmental Quality
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
TPH = total petroleum hydrocarbons
BOLD = Detected above Reference Level

Updated: 9/22/98 RBE
File Name: 2708-G1 Soil Quality Table

Koppers022769

TABLE G-1 – Summary of Analytical Results for Soil Samples
TPH, BTEX, Total PAHs, Total Phenols, Cyanide, and Lead
Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Soil Boring Number	Sample Number[1]	Chain of Custody Number	Sample Date	Depth (feet bgs)	Field Observation				Analytical Results mg/kg (ppm)											
									ODEQ Method		EPA Method 8270 SIM		EPA Method 8020					EPA Method 8270	EPA Method 9010	EPA Method 6010
									TPH-G	TPH-418.1M										
					Sheen	Oil Tar	Tar	Lamp Black	Gasoline	Diesel/Oil	Carcinogenic PAHs	Total PAHs	Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Total Phenols	Total Cyanide	Total Lead
M-11	951102-M11-01	2708-S047	2-Nov-95	0.2						14.	67.4	105.83								9.9
	951102-M11-09	2708-S047	2-Nov-95	39.0	X						9.723	7.876								
	951102-M11-10	2708-S047	2-Nov-95	43.5							0.966	10.915								
MW-01-22	951024-M1-01	2708-S039	24-Oct-95	0.2							3.07	5.78							0.25	
	951024-M1-02	2708-S039	24-Oct-95	3.5						460.	8.35	12.84							ND>.5	
	951024-M1-06	2708-S039	24-Oct-95	23.5						ND>5	ND	0.461							0.88	
MW-02-32	951106-M2-01	2708-S049	6-Nov-95	0.2							5.2	10.293							0.47	4.9
	951106-M2-06	2708-S049	6-Nov-95	24.0						ND>5	0.152	0.432								
MW-03-56	951101-M3-10	2708-S045	1-Nov-95	31.0	X						3.718	10.128								
	951101-M3-13	2708-S046	1-Nov-95	38.0							ND	ND								
	951101-M3-17	2708-S046	1-Nov-95	53.5							ND	ND								
	951101-M3-18	2708-S046	1-Nov-95	53.5 (dup)							0.044	0.157								
MW-04-57	951030-M4-01	2708-S043	30-Oct-95	0.2						57.	114.	195.1						ND	0.8	29.
	951030-M4-06	2708-S043	30-Oct-95	25.5	X						872.	3,261.	ND>.3	ND>.3	ND>.3	ND>.3	ND	ND	1.3	15.
	951030-M4-15	2708-S044	30-Oct-95	57.0							ND	0.263								
MW-05-32	951027-M5-01	2708-S042	27-Oct-95	0.2							0.817	1.43								
	951027-M5-05	2708-S042	27-Oct-95	15.5					ND>10	350.	810.	1,942.1								
	951027-M5-07	2708-S042	27-Oct-95	21.5							0.242	0.908								
	951027-M5-10	2708-S042	27-Oct-95	31.5							ND	ND								
MW-06-61	951107-M6-01	2708-S050	7-Nov-95	2.5							ND	ND								
	951107-M6-08	2708-S050	7-Nov-95	30.0	X	X					1,389.	20,614.	**67.**	ND>30	**140.**	56.	263.			
	951107-M6-10	2708-S050	7-Nov-95	38.5							0.108	1.819	ND>.3	ND>.3	ND>.3	ND>.3	ND			
	951107-M6-11	2708-S050	7-Nov-95	43.0							ND	0.056								
MW-08-56	951025-M8-01	2708-S040	25-Oct-95	0.2							203.4	280.8							0.61	
	951025-M8-11	2708-S040	25-Oct-95	44.0	X						0.783	8.063								
	951025-M8-15	2708-S041	25-Oct-95	55.0							ND	0.642								
MW-09-29	951023-M9-01	2708-S037	23-Oct-95	0.2							11.7	21.502								
	951023-M9-04	2708-S037	23-Oct-95	5.0						19.	78.5	163.02	ND>.3	ND>.3	ND>.3	ND>.3	ND		518.	
	951023-M9-05	2708-S037	23-Oct-95	11.5							0.163	0.521								
MW-10-61	951108-M10-01	2708-S052	8-Nov-95	0.2							45.	78.741						ND		6.4
	951108-M10-02	2708-S052	8-Nov-95	0.2 (dup)							64.1	106.99								
	951108-M10-09	2708-S052	8-Nov-95	28.0							ND	0.764	**43.**	3.	0.73	ND>.3	46.73			
MW-12-36	951023-M12-01	2708-S037	23-Oct-95	0.2						29.	65.5	116.21								
	951023-M12-06	2708-S038	23-Oct-95	22.0	X	X			**160.**	30.	0.27	8.6	ND>3	8.2	3.5	21.	32.7	ND		2.9
	951023-M12-07	2708-S038	23-Oct-95	26.5							ND	ND								
ODEQ Soil Cleanup Levels [2]					#	#	#	#	80 [4]	500 [4]	see Table G-2	see Table G-2	2.0	80	100	800	#	see Table G-3	40,000 [5]	2,000 [5]
EPA PRGs for Industrial Soil [3]					#	#	#	#	#	#	see Table G-2	see Table G-2	1.37	880	230	320	#	see Table G-3	13,626	1,000

NOTE:
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5 = Reference Levels are Industrial Maximum Allowable Soil Concentrations in the Soil Cleanup Table (OAR 340-122-045)

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EPA = U.S. Environmental Protection Agency
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ppm = parts per million
TPH = total petroleum hydrocarbons
BOLD = Detected above Reference Level

Koppers022770

TABLE G-1 – Summary of Analytical Results for Soil Samples
TPH, BTEX, Total PAHs, Total Phenols, Cyanide, and Lead
Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Soil Boring Number	Sample Number[1]	Chain of Custody Number	Sample Date	Depth (feet bgs)	Field Observation				Analytical Results mg/kg (ppm)											
									ODEQ Method		EPA Method 8270 SIM		EPA Method 8020					EPA Method 8270	EPA Method 9010	EPA Method 6010
									TPH-G	TPH-418.1M										
					Sheen	Oil Tar	Tar	Lamp Black	Gasoline	Diesel/Oil	Carcinogenic PAHs	Total PAHs	Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Total Phenols	Total Cyanide	Total Lead
MW-13-61	971218-M13-02	2708-S058	18-Dec-97	6.0							ND	ND	ND>0.025	ND>0.025	ND>0.025	ND>0.075	ND		ND>0.02	
	971218-M13-03	2708-S058	18-Dec-97	10.0							ND	ND	ND>0.025	ND>0.025	ND>0.025	ND>0.075	ND		ND>0.02	
	971218-M13-04	2708-S058	18-Dec-97	13.5							ND	ND	ND>0.025	ND>0.025	ND>0.025	ND>0.075	ND		ND>0.02	
	971218-M13-05	2708-S058	18-Dec-97	18.0							0.342	1.	ND>0.025	ND>0.025	ND>0.025	ND>0.075	ND		ND>0.02	
	971218-M13-08	2708-S058	18-Dec-97	24.5							ND	ND	0.069	ND>0.025	ND>0.025	ND>0.075	0.069		0.04	
	971218-M13-10	2708-S058	18-Dec-97	28.0							ND	0.058								
	971218-M13-11	2708-S058	18-Dec-97	31.0							ND	ND	ND>0.025	ND>0.025	ND>0.025	ND>0.075	ND		0.02	
	971218-M13-17	2708-S059	18-Dec-97	57.0							ND	ND	ND>0.025	ND>0.025	ND>0.025	ND>0.075	ND			
GT-1	971117-001	2708-S054	17-Nov-97	3.0							2.24	4.34	ND>0.025	ND>0.025	ND>0.025	ND>0.075	ND		ND>0.02	
	971117-004	2708-S054	17-Nov-97	10.5	X	X			**300** [6]	**13,400** [6]	ND	6.17	ND>0.025	ND>0.025	0.034	0.13	0.164		ND>0.03	
	971117-006	2708-S054	17-Nov-97	16.0							ND	ND	ND>0.025	ND>0.025	ND>0.075	ND>0.075	ND		ND>0.02	
	971117-008	2708-S054	17-Nov-97	20.5							ND	ND	ND>0.025	ND>0.025	ND>0.075	ND>0.075	ND		ND>0.02	
	971117-011	2708-S054	17-Nov-97	35.5							ND	ND	ND>0.025	ND>0.025	ND>0.075	ND>0.075	ND		ND>0.02	
GT-2	971117-012	2708-S054	17-Nov-97	3.5							ND	0.084	ND>0.025	ND>0.025	ND>0.075	ND>0.075	ND		ND>0.02	
	971117-017	2708-S055	17-Nov-97	15.5							ND	ND	0.027	ND>0.025	ND>0.075	ND>0.075	0.027		ND>0.02	
	971117-021	2708-S055	17-Nov-97	33.0							ND	ND	ND>0.025	ND>0.025	ND>0.075	ND>0.075	ND		ND>0.02	
GT-3	971118-023	2708-S056	18-Nov-97	3.0							21.9	43.09	ND>0.025	ND>0.025	ND>0.075	ND>0.075	ND		ND>0.02	
	971118-026	2708-S056	18-Nov-97	12.5							ND	0.05	ND>0.025	ND>0.025	ND>0.075	ND>0.075	ND		ND>0.02	
	971118-032	2708-S056	18-Nov-97	36.0							ND	ND	ND>0.025	ND>0.025	ND>0.075	ND>0.075	ND		ND>0.02	
GT-4	971118-034	2708-S056	18-Nov-97	13.5							ND	ND	ND>0.025	ND>0.025	ND>0.075	ND>0.075	ND		ND>0.02	
	971118-038	2708-S057	18-Nov-97	40.5							ND	ND	ND>0.025	ND>0.025	ND>0.075	ND>0.075	ND		ND>0.02	
ODEQ Soil Cleanup Levels [2]					#	#	#	#	80 [4]	500 [4]	see Table G-2	see Table G-2	2.0	80	100	800	#	see Table G-3	40,000 [5]	2,000 [5]
EPA PRGs for Industrial Soil [3]					#	#	#	#	#	#	see Table G-2	see Table G-2	1.37	880	230	320	#	see Table G-3	13,626	1,000

NOTE:
1 = Sample number prefix: 2708-
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3 = Reference Levels are EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil
4 = Reference Levels are ODEQ UST Level 2 Soil Cleanup Standards (OAR 340-122-335)
5 = Reference Levels are Industrial Maximum Allowable Soil Concentrations in the Soil Cleanup Table (OAR 340-122-045)
6 = Analyzed via Northwest Methods NW-TPH-G and NW-TPH-Dx

# = not established
BTEX = benzene, toluene, ethylbenzene, and xylenes
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = not detected above detection limit indicated

ODEQ = Oregon Department of Environmental Quality
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
TPH = total petroleum hydrocarbons
BOLD = Detected above Reference Level

Koppers022771

Table G-2 – Summary of Analytical Results for Soil Samples, PAHs by EPA Method 8270 (SIM)

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)					Analytical Results mg/kg (ppm)																	
					Carcinogenic PAHs							Non-carcinogenic PAHs										
Soil Boring	Sample Number	Chain of Custody No.	Sample Date	Sample Depth (feet bgs)	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
B-01	950921-B1-01	2708-S009	21-Sep-95	0.2	**1.**	**1.6**	**0.52**	**1.5**	**1.4**	**0.22**	**0.93**	0.14	ND [a]	0.14	1.3	1.3	0.055	0.073	0.88	2.3	7.17	6.188
	950921-B1-02	2708-S009	21-Sep-95	0.2	**3.7**	**5.6**	**1.7**	**5.2**	**5.6**	**0.84**	**3.5**	0.51	0.41	1.1	5.1	5.7	0.34	0.46	5.8	10.4	26.14	29.82
	950921-B1-05	2708-S009	21-Sep-95	10.5	**45.3**	**72.3**	**26.7**	**55.7**	**82.8**	**7.7**	**46.2**	6.1	5.8	**21.7**	65.8	140.	9.6	**313.**	142.	**239.**	336.7	943.
	950921-B1-09	2708-S009	21-Sep-95	21.0	**0.19**	**0.21**	0.056	**0.17**	**0.19**	ND [a]	**0.11**	0.13	ND [a]	0.24	0.17	0.36	0.14	0.21	2.2	0.65	0.926	4.1
B-03	950921-B3-05	2708-S007	21-Sep-95	10.5	**3.2**	**5.2**	**1.9**	**4.8**	**4.1**	**0.64**	**3.2**	0.3	0.14	3.1	4.2	5.9	0.2	0.16	3.1	8.9	23.04	26.
	950921-B3-07	2708-S007	21-Sep-95	15.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
B-05	950928-B5-05	2708-S021	28-Sep-95	15.5	ND [b]	**0.2**	ND [b]	**0.18**	ND [b]	ND [b]	**0.56**	0.14	0.44	0.19	1.1	0.34	ND [b]	ND [b]	ND [b]	0.49	0.94	2.7
B-06	950927-B6-02	2708-S016	27-Sep-95	8.0	**574.**	**972.**	**370.**	**767.**	**833.**	**159.**	**738.**	21.	124.	**191.**	1,080.	1,680.	73.8	**884.**	1,180.	**2,840.**	4,413.	8,073.8
	950927-B6-03	2708-S016	27-Sep-95	15.5	**5.7**	**8.8**	**3.5**	**7.1**	**7.6**	**1.1**	**6.4**	ND>1.0	0.55	2.1	9.6	10.2	ND>1.0	ND>1.0	5.5	18.3	40.2	46.25
B-07	950927-B7-05	2708-S017	27-Sep-95	17.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
B-08	950918-B8-04	2708-S001	18-Sep-95	10.0	**18.**	**40.**	**12.**	**47.**	**24.**	**6.**	**38.**	0.48	4.	2.8	58.	26.	0.71	2.3	7.2	52.	185.	153.49
	950918-B8-08	2708-S001	18-Sep-95	18.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.18	ND [a]	ND [a]	ND [a]	ND [a]	0.063	ND [a]	ND [a]	ND [a]	ND	0.243
B-09	950918-B9-02	2708-S002	18-Sep-95	10.0	**472.**	**420.**	**139.**	**487.**	**601.**	**56.5**	**246.**	**558.**	457.	**603.**	344.	1,350.	**464.**	**7,560.**	3,410.	**2,270.**	2,421.5	17,016.
	950918-B9-09	2708-S002	18-Sep-95	30.5	**1.6**	**1.8**	**0.66**	**2.1**	**1.9**	**0.22**	**1.2**	1.9	0.17	1.3	1.8	4.4	0.99	8.3	7.8	7.4	9.48	34.06
	950918-B9-10	2708-S002	18-Sep-95	34.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.054	ND [a]	0.08	ND [a]	ND [a]	0.2	0.13	ND	0.464
B-10	950925-B10-04	2708-S013	25-Sep-95	17.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
B-11	950928-B11-06	2708-S020	28-Sep-95	12.5	**0.83**	**0.5**	ND [a]	**0.53**	**1.4**	ND [a]	ND [a]	7.8	0.61	2.7	ND [a]	4.2	6.7	**915.**	25.2	7.4	3.26	969.61
	950928-B11-09	2708-S020	28-Sep-95	23.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.071	ND [a]	0.094	ND [a]	0.17	0.076	ND [a]	0.35	0.29	ND	1.051
B-13	951006-B13-03	2708-S035	6-Oct-95	10.5	**564.**	**752.**	**238.**	**942.**	**811.**	**89.9**	**519.**	**1,630.**	155.	**578.**	747.	2,350.	**481.**	**13,000.**	2,950.	**3,580.**	3,915.9	25,471.
	951006-B13-07	2708-S035	6-Oct-95	18.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	951006-B13-10	2708-S036	6-Oct-95	24.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
B-14	950928-B14-03	2708-S019	28-Sep-95	5.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
B-15	951006-B15-05	2708-S036	6-Oct-95	21.0	**6.8**	**9.7**	**3.2**	**9.3**	**9.7**	1.	**6.2**	16.1	4.1	**6.6**	9.	27.7	6.9	**400.**	80.	41.3	45.9	591.7
	951006-B15-08	2708-S036	6-Oct-95	27.0	ND [a]	0.05	0.16	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.053	0.13	ND [a]	0.24	0.038	0.13	0.59	0.4	0.21	1.581
B-17	950929-B17-01	2708-S022	29-Sep-95	3.0	**3.5**	**5.6**	**1.3**	**5.7**	**3.6**	0.67	**3.7**	0.026	0.22	0.92	5.3	10.5	0.15	0.093	4.	13.8	24.07	35.009
	950929-B17-05	2708-S022	29-Sep-95	16.5	**28.**	**15.**	**5.8**	**16.**	**44.**	**1.1**	**4.2**	**161.**	10.	**111.**	5.9	114.	**119.**	**478.**	477.	**224.**	114.1	1,699.9
	950929-B17-07	2708-S022	29-Sep-95	23.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.078	ND [a]	0.086	ND [a]	0.072	0.062	0.16	0.32	0.11	ND	0.888
B-18	950919-B18-05	2708-S003	19-Sep-95	12.0	**0.17**	0.09	0.032	0.074	**0.26**	ND [a]	0.033	1.9	0.16	0.44	0.047	1.1	1.8	**44.8**	6.7	1.7	0.659	58.647
	950919-B18-10	2708-S003	19-Sep-95	24.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
B-19	950919-B19-01	2708-S003	19-Sep-95	0.2	**53.1**	**57.6**	**29.6**	**61.**	**71.4**	**10.**	**41.5**	6.8	0.52	**212.**	46.	115.	20.1	2.9	91.7	**114.**	324.2	609.02
	950919-B19-03	2708-S004	19-Sep-95	6.5	**7.6**	**5.4**	**2.4**	**5.8**	**9.7**	**0.96**	**3.9**	13.4	4.6	**14.4**	5.1	25.4	13.	**180.**	83.3	33.3	35.76	372.5
	950920-B19-07	2708-S005	20-Sep-95	18.0	0.054	ND [a]	0.047	ND [a]	ND [a]	ND [a]	ND [a]	0.5	0.17	ND [a]	ND [a]	0.18	0.77	**76.3**	1.7	0.28	0.101	79.9
	950929-B19-08	2708-S005	20-Sep-95	27.0	0.027	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.081	ND [a]	0.081	ND [a]	0.13	0.097	1.1	0.3	0.14	0.027	1.929
B-20	950929-B20-03	2708-S022	29-Sep-95	10.5	**40.4**	**44.5**	**19.**	**45.**	**67.1**	**4.707**	**23.8**	35.8	9.4	**122.**	29.3	113.	57.8	27.8	239.	**214.**	244.507	848.1
	950929-B20-07	2708-S023	29-Sep-95	23.5	0.048	0.06	ND [a]	0.053	0.054	ND [a]	0.04	0.068	0.095	0.063	0.055	0.18	0.11	11.2	0.36	0.3	0.255	12.431
B-21	951003-B21-04	2708-S027	3-Oct-95	11.5	**0.12**	0.079	0.079	ND [a]	**0.14**	ND [a]	ND [a]	1.3	0.44	0.2	ND [a]	0.59	0.089	0.71	2.5	0.86	0.418	6.689
ODEQ Soil Cleanup Levels [2]					0.1	0.1	0.1	0.1	0.1	0.1	0.1	2,000.	#	20,000.	#	8,000.	2,000.	30.	#	6,000.	#	#
EPA PRGs for Industrial Soil [3]					2.61	2.61	26.13	0.26	7.2	0.26	2.61	110.	#	5.7	#	27,251.	90.	240.	#	100.	#	#

Note: DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = Not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million

# = Reference level not established
1 = Sample number prefix: 2708-
2 = Reference Levels are Soil Cleanup Levels in the Soil Cleanup Table (OAR 340-122-045)
3 = Reference Levels are EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil
Bold = Detected above Reference Levels

a = detection limit is 0.05 mg/kg (ppm)
b = detection limit is 0.2 mg/kg (ppm)
c = detection limit is 1 mg/kg (ppm)
d = detection limit is 100 mg/kg (ppm)
e = detection limit is 0.5 mg/kg (ppm)
f = detection limit is 0.7 mg/kg (ppm)

Updated: 9/22/98 RBE
File Name: 2708-G1 Soil Quality Table

Koppers022772

Table G-2 – Summary of Analytical Results for Soil Samples, PAHs by EPA Method 8270 (SIM)

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)					Analytical Results mg/kg (ppm)																	
					Carcinogenic PAHs							Non-carcinogenic PAHs										
Soil Boring	Sample Number	Chain of Custody No.	Sample Date	Sample Depth (feet bgs)	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
B-22	951003-B22-05	2708-S027	3-Oct-95	13.5	**0.63**	**0.19**	**0.12**	**0.15**	**0.58**	ND [a]	0.057	9.4	0.076	1.2	0.055	5.3	5.7	0.31	12.2	4.3	1.727	38.541
	951003-B22-09	2708-S028	3-Oct-95	24.0	**9.2**	**4.**	**1.7**	**2.6**	**12.**	0.15	**0.58**	78.8	0.504	**17.6**	0.49	65.4	59.9	0.41	160.2	71.7	30.23	455.004
B-23	951003-B23-08	2708-S029	3-Oct-95	26.5	**0.2**	**0.19**	0.097	**0.2**	**0.27**	ND [a]	**0.16**	0.87	1.2	0.52	0.19	1.4	3.	**58.8**	8.2	1.6	1.117	75.78
	951003-B23-12	2708-S029	3-Oct-95	34.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
B-24	951002-B24-03	2708-S024	2-Oct-95	10.5	**41.9**	**53.2**	**21.3**	**59.5**	**64.1**	**5.5**	**31.**	52.4	7.5	**34.9**	42.	132.	28.5	**115.**	186.	**217.**	276.5	815.3
	951002-B24-10	2708-S024	2-Oct-95	29.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.14	ND [a]	ND [a]	ND	0.14
B-25	951002-B25-03	2708-S025	2-Oct-95	12.5	**0.41**	**0.71**	**0.25**	**0.78**	**0.6**	0.078	**0.5**	0.41	0.15	0.29	0.75	1.2	0.53	1.2	2.5	2.1	3.328	9.13
	951002-B25-05	2708-S025	2-Oct-95	20.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.45	ND [a]	ND [a]	ND	0.45
B-26	951003-B26-01	2708-S030	4-Oct-95	0.2	**0.73**	**1.2**	**0.49**	**0.99**	**0.77**	**0.16**	**0.79**	0.092	ND [a]	0.097	0.84	1.5	ND [a]	ND [a]	0.46	1.2	5.13	4.189
	951003-B26-06	2708-S030	4-Oct-95	20.5	**124.**	**134.**	**57.**	**138.**	**265.**	**20.7**	**123.**	**608.**	449.	**1,220.**	171.	949.	**681.**	**6,420.**	2,630.	**1,540.**	861.7	14,668.
	951003-B26-13	2708-S030	4-Oct-95	39.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.059	0.046	0.051	ND [a]	0.066	0.059	0.55	0.19	0.099	ND	1.12
B-27	950920-B27-10	2708-S005	20-Sep-95	23.0	**17.2**	**16.3**	**6.2**	**18.3**	**21.**	**1.9**	**9.6**	53.	32.6	**21.9**	13.6	79.1	45.7	**586.**	208.	**113.**	90.5	1,152.9
	950920-B27-12	2708-S006	20-Sep-95	28.0	**1.9**	**1.6**	**0.78**	**1.7**	**2.6**	**0.11**	**0.915**	8.6	2.	3.1	1.3	9.9	6.5	**44.7**	26.4	13.3	9.605	115.8
	950920-B27-15	2708-S006	20-Sep-95	35.5	**0.31**	**0.26**	0.091	**0.16**	**0.28**	ND [a]	**0.11**	1.1	0.14	0.36	0.15	1.3	0.88	1.8	3.5	1.8	1.211	11.03
B-28	951002-B28-01	2708-S025	2-Oct-95	0.2	**6.1**	**10.1**	**4.3**	**8.6**	**8.2**	**1.6**	**6.6**	0.73	0.26	4.6	8.2	9.7	0.246	0.3	4.6	12.7	45.5	41.336
	951002-B28-02	2708-S025	2-Oct-95	0.2	**9.5**	**14.9**	**6.3**	**14.1**	**9.5**	**2.4**	**8.8**	1.1	0.86	1.8	12.3	17.3	0.55	0.88	9.2	25.7	65.5	69.69
	951002-B28-07	2708-S025	2-Oct-95	15.0	**19.1**	**33.4**	**12.6**	**42.7**	**30.2**	**3.6**	**25.6**	23.8	3.7	**11.2**	39.5	66.1	14.	**102.**	74.	**110.**	167.2	444.3
	951002-B28-11	2708-S026	2-Oct-95	24.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.057	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	2.2	0.041	ND [a]	ND	2.298
B-29	950922-B29-01	2708-S011	22-Sep-95	0.2	**10.5**	**31.7**	**11.6**	**32.5**	**19.3**	**4.8**	**28.4**	0.4	7.3	3.3	41.8	9.4	0.47	2.4	3.4	22.8	138.8	91.27
	950922-B29-15	2708-S012	22-Sep-95	35.5	**1,540.**	**758.**	**308.**	**571.**	**1,810.**	**46.1**	**181.**	**9,210.**	77.6	**1,650.**	230.	8,480.	**4,530.**	**7,400.**	15,500.	**6,530.**	5,214.1	53,607.6
	950925-B29-17	2708-S013	25-Sep-95	44.0	**0.56**	**0.45**	**0.12**	**0.51**	**0.68**	0.054	**0.24**	1.1	0.33	1.	0.3	1.6	0.84	0.77	5.1	2.8	2.614	13.84
	950925-B29-18	2708-S013	25-Sep-95	47.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.18	ND [a]	ND [a]	ND	0.18
B-30A	950922-B30-01	2708-S010	22-Sep-95	0.2	**49.8**	**110.**	**45.**	**99.6**	**75.4**	**20.2**	**100.**	9.2	13.4	**16.**	129.	110.5	5.9	9.4	37.3	**133.8**	500.	464.5
B-30	950922-B30-06	2708-S010	22-Sep-95	11.5	**167.**	**167.**	**71.9**	**182.**	**245.**	**16.5**	**89.3**	**220.**	228.	**417.**	125.	739.	**310.**	**1,730.**	1,260.	**808.**	938.7	5,837.
	950922-B30-12	2708-S010	22-Sep-95	28.5	**14.3**	**17.4**	**7.4**	**22.**	**19.8**	**1.8**	**11.6**	15.2	68.8	**28.7**	17.7	53.3	31.	**327.**	126.	91.	94.3	758.7
B-31	950925-B31-01	2708-S013	25-Sep-95	0.2	**2.1**	**5.4**	**1.8**	**4.8**	**3.**	**0.98**	**4.9**	0.11	1.3	0.59	6.8	1.6	0.058	0.3	0.71	3.7	22.98	15.168
	950925-B31-06	2708-S014	25-Sep-95	21.0	**319.**	**321.**	**119.**	**374.**	**394.**	**45.1**	**274.**	**1,120.**	50.6	**473.**	364.	1,290.	**422.**	**2,880.**	2,620.	**1,600.**	1,846.1	10,819.6
	950925-B31-08	2708-S014	25-Sep-95	24.5	**0.28**	**0.35**	**0.11**	**0.7**	**0.39**	0.039	**0.22**	0.072	ND [a]	0.18	0.27	0.88	0.063	ND>0.05	0.54	1.4	2.089	3.405
	950925-B31-10	2708-S014	25-Sep-95	28.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	950925-B31-11	2708-S014	25-Sep-95	28.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
B-32	951004-B32-01	2708-S031	4-Oct-95	0.2	**2.9**	**6.9**	**2.5**	**7.4**	**5.6**	**1.8**	**7.7**	0.09	1.7	0.53	12.4	2.7	0.11	0.82	0.66	7.4	34.8	26.41
	951004-B32-03	2708-S031	4-Oct-95	11.5	**495.**	**500.**	**292.**	**585.**	**824.**	**87.3**	**373.**	**990.**	807.	**1,190.**	529.	2,050.	**810.**	**11,100.**	4,560.	**3,580.**	3,156.3	25,616.
	951004-B32-15	2708-S032	4-Oct-95	38.5	**259.**	**285.**	**81.**	**386.**	**427.**	**52.**	**238.**	**1,330.**	39.	**1,280.**	354.	1,180.	**520.**	**11,100.**	2,440.	**1,990.**	1,728.	20,233.
	951004-B32-18	2708-S032	4-Oct-95	58.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.064	ND [a]	0.061	ND [a]	0.13	0.047	0.38	0.31	0.21	ND	1.202
ODEQ Soil Cleanup Levels [2]					0.1	0.1	0.1	0.1	0.1	0.1	0.1	2,000.	#	20,000.	#	8,000.	2,000.	30.	#	6,000.	#	#
EPA PRGs for Industrial Soil [3]					2.61	2.61	26.13	0.26	7.2	0.26	2.61	110.	#	5.7	#	27,251.	90.	240.	#	100.	#	#

Note:
DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = Not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million

# = Reference level not established
1 = Sample number prefix: 2708-
2 = Reference Levels are Soil Cleanup Levels in the Soil Cleanup Table (OAR 340-122-045)
3 = Reference Levels are EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil
Bold = Detected above Reference Levels

a = detection limit is 0.05 mg/kg (ppm)
b = detection limit is 0.2 mg/kg (ppm)
c = detection limit is 1 mg/kg (ppm)
d = detection limit is 100 mg/kg (ppm)
e = detection limit is 0.5 mg/kg (ppm)
f = detection limit is 0.7 mg/kg (ppm)

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Table G-2 – Summary of Analytical Results for Soil Samples, PAHs by EPA Method 8270 (SIM)
Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)					Analytical Results mg/kg (ppm)																	
					Carcinogenic PAHs							Non-carcinogenic PAHs										
Soil Boring	Sample Number	Chain of Custody No.	Sample Date	Sample Depth (feet bgs)	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
B-33	951005-B33-01	2708-S033	5-Oct-95	0.2	**34.6**	**124.**	**44.**	**129.**	**70.**	**32.7**	**141.**	1.3	29.1	**9.9**	202.	29.5	1.6	9.1	10.5	87.1	575.3	380.1
	951005-B33-02	2708-S033	5-Oct-95	2.5	**1.9**	**2.4**	**0.88**	**2.8**	**2.5**	**0.29**	**1.5**	1.7	0.23	0.96	2.1	6.4	0.85	1.5	4.1	7.4	12.27	25.24
	951005-B33-03	2708-S034	5-Oct-95	5.5	**181.**	**185.**	**72.1**	**225.**	**262.**	**21.3**	**108.**	**369.**	133.	**263.**	152.	527.	**266.**	**3,460.**	1,190.	**824.**	1,054.4	7,184.
	951005-B33-14	2708-S034	5-Oct-95	54.0	**0.65**	**0.57**	ND [c]	**0.7**	**1.1**	ND [c]	ND [c]	3.4	ND [c]	2.1	0.62	3.4	1.5	**37.**	8.6	5.4	3.02	62.02
	951006-B33-18	2708-S035	6-Oct-95	69.0	0.045	0.054	ND [a]	**0.37**	0.056	ND [a]	ND [a]	0.06	0.35	0.12	0.047	0.18	0.12	3.5	0.47	0.31	0.525	5.157
B-34	950926-B34-01	2708-S015	26-Sep-95	0.2	**6.**	**10.**	**4.5**	**9.9**	**9.6**	**1.6**	**7.6**	0.99	0.46	1.5	9.5	11.7	0.44	1.1	5.6	13.6	49.2	44.89
	950926-B34-05	2708-S015	26-Sep-95	11.5	**227.**	**256.**	**153.**	**356.**	**383.**	**41.**	**223.**	**253.**	452.	**1,289.**	318.	849.	**409.**	**5,420.**	1,580.	**1,290.**	1,639.	11,860.
B-35	951005-B35-01	2708-S033	5-Oct-95	0.2	**2.2**	**4.**	**1.5**	**4.1**	**4.1**	**0.59**	**3.**	0.14	0.54	0.88	4.5	4.	0.15	0.34	2.2	6.7	19.49	19.45
	951005-B35-06	2708-S033	5-Oct-95	22.0	**613.**	**780.**	**269.**	**954.**	**809.**	**91.5**	**497.**	**532.**	1,960.	**880.**	714.	2,600.	**982.**	**20,700.**	4,890.	**4,330.**	4,013.5	37,588.
	951005-B35-10	2708-S033	5-Oct-95	29.0	**0.13**	**0.14**	0.068	**0.17**	**0.18**	ND [a]	0.096	0.52	0.28	0.27	0.14	0.5	0.28	4.3	1.4	0.82	0.784	8.51
M-11	951102-M11-01	2708-S047	2-Nov-95	0.2	**8.1**	**18.**	**6.**	**10.**	**6.9**	**2.3**	**9.2**	0.73	0.91	0.82	12.	12.	0.3	0.37	4.2	14.	67.4	45.33
	951102-M11-09	2708-S047	2-Nov-95	39.0	**0.16**	**0.11**	0.046	0.077	**0.13**	ND [a]	0.047	0.85	0.083	0.21	0.063	0.94	0.65	1.5	2.1	0.91	9.723	7.306
	951102-M11-10	2708-S047	2-Nov-95	43.5	**0.26**	**0.14**	0.07	**0.16**	**0.26**	ND [a]	0.076	0.8	0.089	0.4	0.11	1.4	0.65	2.	3.1	1.4	0.966	9.949
MW-01-22	951024-M1-01	2708-S039	24-Oct-95	0.2	**0.41**	**0.66**	ND [a]	**0.61**	**0.64**	ND [a]	**0.75**	ND [a]	ND [a]	ND [a]	1.	0.71	ND [a]	ND [a]	ND [a]	1.	3.07	2.71
	951024-M1-02	2708-S039	24-Oct-95	3.5	**0.91**	**1.5**	**0.74**	**1.7**	**1.3**	**0.4**	**1.8**	ND [b]	ND [b]	ND [b]	2.3	0.79	ND [b]	ND [b]	ND [b]	1.4	8.35	4.49
	951024-M1-06	2708-S039	24-Oct-95	23.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.19	ND [a]	0.032	ND [a]	ND [a]	0.15	0.089	ND	0.461
MW-02-32	951106-M2-01	2708-S049	6-Nov-95	0.2	0.73	**1.2**	0.49	**1.1**	0.83	0.16	0.69	0.047	0.083	0.14	1.	1.4	ND>0.05	0.053	0.57	1.8	5.2	5.093
	951106-M2-06	2708-S049	6-Nov-95	24.0	0.039	0.036	ND [a]	0.04	0.037	ND [a]	ND [a]	0.2	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.08	ND [a]	ND [a]	0.152	0.28
MW-03-56	951101-M3-10	2708-S045	1-Nov-95	31.0	**0.53**	**0.83**	**0.3**	**0.84**	**0.51**	0.098	**0.61**	0.19	0.14	0.14	0.96	1.4	0.16	0.65	0.77	2.	3.718	6.41
	951101-M3-13	2708-S046	1-Nov-95	38.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	951101-M3-17	2708-S046	1-Nov-95	53.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	951101-M3-18	2708-S046	1-Nov-95	53.5 (dup)	ND [a]	0.044	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.04	0.031	ND [a]	ND [a]	ND [a]	0.042	0.044	0.113
MW-04-57	951030-M4-01	2708-S043	30-Oct-95	0.2	**10.**	**26.**	**10.**	**28.**	**15.**	**4.**	**21.**	ND>5.0	4.4	2.6	35.	12.	ND>5.0	1.7	3.4	22.	114.	81.1
	951030-M4-06	2708-S043	30-Oct-95	25.5	**190.**	**200.**	**68.**	**210.**	**180.**	**24.**	ND [d]	65.	ND [d]	**110.**	190.	640.	49.	**25.**	480.	**830.**	872.	2,389.
	951030-M4-15	2708-S044	30-Oct-95	57.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.03	ND [a]	ND [a]	ND [a]	0.053	ND [a]	0.08	0.033	0.067	ND	0.263
MW-05-32	951027-M5-01	2708-S042	27-Oct-95	0.2	**0.13**	**0.22**	0.077	**0.15**	**0.13**	ND [a]	**0.11**	ND [a]	ND [a]	ND [a]	0.15	0.2	ND [a]	ND [a]	0.073	0.19	0.817	0.613
	951027-M5-05	2708-S042	27-Oct-95	15.5	**115.**	**170.**	**58.**	**208.**	**130.**	**25.**	**104.**	19.	15.	**41.**	153.	330.	16.	**8.1**	113.	**437.**	810.	1,132.1
	951027-M5-07	2708-S042	27-Oct-95	21.5	0.067	0.039	ND [a]	0.051	0.085	ND [a]	ND [a]	ND [a]	ND [a]	0.072	0.044	0.17	ND [a]	ND [a]	0.15	0.23	0.242	0.666
	951027-M5-10	2708-S042	27-Oct-95	31.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
MW-06-61	951107-M6-01	2708-S050	7-Nov-95	2.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	951107-M6-08	2708-S050	7-Nov-95	30.0	**340.**	**170.**	**120.**	**190.**	**450.**	**25.**	**94.**	**2,350.**	25.	**1,420.**	130.	1,900.	**990.**	**3,650.**	5,780.	**2,980.**	1,389.	19,225.
	951107-M6-10	2708-S050	7-Nov-95	38.5	0.042	ND [a]	ND [a]	ND [a]	0.066	ND [a]	ND [a]	0.22	ND [a]	0.16	ND [a]	0.22	0.095	0.076	0.6	0.34	0.108	1.711
	951107-M6-11	2708-S050	7-Nov-95	43.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.056	ND [a]	ND	0.056
ODEQ Soil Cleanup Levels [2]					0.1	0.1	0.1	0.1	0.1	0.1	0.1	2,000.	#	20,000.	#	8,000.	2,000	30.	#	6,000.	#	#
EPA PRGs for Industrial Soil [3]					2.61	2.61	26.13	0.26	7.2	0.26	2.61	110.	#	5.7	#	27,251.	90.	240.	#	100.	#	#

Note: DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = Not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million

# = Reference level not established
1 = Sample number prefix: 2708-
2 = Reference Levels are Soil Cleanup Levels in the Soil Cleanup Table (OAR 340-122-045)
3 = Reference Levels are EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil
Bold = Detected above Reference Levels

a = detection limit is 0.05 mg/kg (ppm)
b = detection limit is 0.2 mg/kg (ppm)
c = detection limit is 1 mg/kg (ppm)
d = detection limit is 100 mg/kg (ppm)
e = detection limit is 0.5 mg/kg (ppm)
f = detection limit is 0.7 mg/kg (ppm)

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Table G-2 – Summary of Analytical Results for Soil Samples, PAHs by EPA Method 8270 (SIM)

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)					Analytical Results mg/kg (ppm)																		
					Carcinogenic PAHs							Non-carcinogenic PAHs									Total Carcinogenic PAHs	Total PAHs
Soil Boring	Sample Number1	Chain of Custody No.	Sample Date	Sample Depth (feet bgs)	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene		
MW-08-56	951025-M8-01	2708-S040	25-Oct-95	0.2	**12.**	**39.6**	**13.8**	**41.7**	**20.5**	**9.1**	**46.2**	ND>0.50	3.2	1.8	56.5	6.7	ND [a]	2.2	1.4	26.1	203.4	97.9
	951025-M8-11	2708-S040	25-Oct-95	44.0	0.17	0.12	0.053	0.15	0.21	ND [a]	0.08	0.74	0.3	0.22	0.13	0.6	0.48	2.6	1.5	0.71	0.783	7.28
	951025-M8-15	2708-S041	25-Oct-95	55.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.057	ND [a]	0.065	ND [a]	0.31	0.11	0.1	ND	0.642
MW-09-29	951023-M9-01	2708-S037	23-Oct-95	0.2	**1.4**	**2.7**	0.88	**2.5**	**1.9**	0.42	**1.9**	0.12	0.17	0.31	2.6	2.2	0.055	0.087	0.96	3.3	11.7	9.802
	951023-M9-04	2708-S037	23-Oct-95	5.0	**7.4**	**19.6**	**5.**	**14.4**	**13.3**	**2.7**	**16.1**	0.12	1.3	2.	22.6	17.9	0.4	1.2	8.6	30.4	78.5	84.52
	951023-M9-05	2708-S037	23-Oct-95	11.5	0.028	0.035	ND [a]	0.032	0.041	ND [a]	0.027	ND [a]	ND [a]	0.03	0.036	0.076	ND [a]	ND [a]	0.096	0.12	0.163	0.358
MW-10-61	951108-M10-01	2708-S052	8-Nov-95	0.2	**6.7**	**11.**	**5.1**	**9.5**	**6.3**	**1.4**	**5.**	0.83	ND [a]	1.7	6.7	11.	0.23	0.081	3.3	9.9	45.	33.741
	951108-M10-02	2708-S052	8-Nov-95	0.2 (dup)	**10.**	**17.**	**6.2**	**14.**	**7.5**	**2.2**	**7.2**	1.1	ND [a]	1.1	9.	14.	0.36	0.13	5.2	12.	64.1	42.89
	951108-M10-09	2708-S052	8-Nov-95	28.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.038	ND [a]	0.038	ND [a]	0.078	ND [a]	0.23	0.22	0.16	ND	0.764
MW-12-36	951023-M12-01	2708-S037	23-Oct-95	0.2	**8.5**	**15.3**	**5.2**	**13.3**	**12.3**	**2.2**	**8.7**	1.5	0.23	2.	10.8	12.4	0.54	0.34	5.8	17.1	65.5	50.71
	951023-M12-06	2708-S038	23-Oct-95	22.0	ND [a]	ND [a]	ND [a]	ND [a]	0.27	ND [a]	ND [a]	0.34	ND [a]	0.99	ND [a]	0.97	0.4	0.23	4.	1.4	0.27	8.33
	951023-M12-07	2708-S038	23-Oct-95	26.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
GT-1	971117-001	2708-S054	17-Nov-97	3.0	0.27	0.5	0.16	0.58	0.25	ND [a]	0.48	ND [a]	ND [a]	ND [a]	1.	0.38	ND [a]	ND [a]	0.06	0.66	2.24	2.1
	971117-004	2708-S054	17-Nov-97	10.5	ND [f]	ND [f]	ND [f]	ND [f]	ND [f]	ND [f]	ND [f]	**1.4**	ND [f]	0.97	ND [f]	ND [f]	2.1	ND [f]	ND [f]	1.7	ND	6.17
	971117-006	2708-S054	17-Nov-97	16.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	971117-008	2708-S054	17-Nov-97	20.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	971117-011	2708-S054	17-Nov-97	35.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
GT-2	971117-012	2708-S054	17-Nov-97	3.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.084	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	0.084
	971117-017	2708-S055	17-Nov-97	15.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	971117-021	2708-S055	17-Nov-97	33.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
GT-3	971118-023	2708-S056	18-Nov-97	3.0	**2.2**	**3.3**	**8.4**	**3.8**	**1.8**	ND [a]	**2.4**	0.33	0.29	0.11	4.1	7.5	ND [a]	0.14	0.12	8.6	21.9	21.19
	971118-026	2708-S056	18-Nov-97	12.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.05	ND [a]	ND [a]	ND [a]	0.049	ND	0.099
	971118-032	2708-S056	18-Nov-97	36.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
GT-4	971118-034	2708-S056	18-Nov-97	13.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	971118-038	2708-S057	18-Nov-97	40.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
MW-13	971218-M13-02	2708-S058	18-Dec-97	6.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	971218-M13-03	2708-S058	18-Dec-97	10.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	971218-M13-04	2708-S058	18-Dec-97	13.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	971218-M13-05	2708-S058	18-Dec-97	18.0	0.09	0.071	ND [a]	0.061	0.12	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.16	ND [a]	0.23	0.093	0.17	0.342	0.653
	971218-M13-08	2708-S058	18-Dec-97	24.5	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	971218-M13-10	2708-S058	18-Dec-97	28.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.058	ND [a]	ND	0.058
	971218-M13-11	2708-S058	18-Dec-97	31.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	971218-M13-17	2708-S059	18-Dec-97	57.0	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
ODEQ Soil Cleanup Levels [2]					0.1	0.1	0.1	0.1	0.1	0.1	0.1	2,000.	#	20,000.	#	8,000.	2,000.	30.	#	6,000.	#	#
EPA PRGs for Industrial Soil [3]					2.61	2.61	26.13	0.26	7.2	0.26	2.61	110.	#	5.7	#	27,251.	90.	240.	#	100.	#	#

Note: DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = Not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million

\# = Reference level not established
1 = Sample number prefix: 2708-
2 = Reference Levels are Soil Cleanup Levels in the Soil Cleanup Table (OAR 340-122-045)
3 = Reference Levels are EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil
Bold = Detected above Reference Levels

a = detection limit is 0.05 mg/kg (ppm)
b = detection limit is 0.2 mg/kg (ppm)
c = detection limit is 1 mg/kg (ppm)
d = detection limit is 100 mg/kg (ppm)
e = detection limit is 0.5 mg/kg (ppm)
f = detection limit is 0.7 mg/kg (ppm)

Updated: 9/22/98 RBE
File Name: 2708-G1 Soil Quality Table

Koppers022775

TABLE G-3 – Summary of Analytical Results for Soil Samples
Phenols by EPA Method 8270

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Phenols by EPA Method 8270					Analytical Results mg/kg (ppm)															
Soil Boring	Sample Number	Chain of Custody Number	Sample Date	Sample Depth (feet bgs)	4-Chloro-3-methylphenol	2-Chlorophenol	2,4-Dichlorophenol	2,4-Dimethylphenol	2,4-Dinitrophenol	2-Methyl-4,6-dinitrophenol	Cresols, Total	4-Methylphenol	2-Nitrophenol	4-Nitrophenol	2,3,4,6-Tetrachlorophenol	Pentachlorophenol	Phenol	2,4,5-Trichlorophenol	2,4,6-Trichlorophenol	Total Phenols
B-03	950921-B3-05	2708-S007	21-Sep-95	10.5	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>3.3	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND
B-10	950925-B10-04	2708-S013	25-Sep-95	17.5	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>9.9	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND
B-13	951006-B13-03	2708-S035	6-Oct-95	10.5	ND>51	ND>51	ND>51	ND>51	ND>99	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND
B-17	950929-B17-05	2708-S022	29-Sep-95	16.5	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>9.9	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND
B-18	950919-B18-05	2708-S003	19-Sep-95	12.0	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	**0.36**	ND>0.17	ND>0.17	ND>0.17	0.36
B-19	950919-B19-01	2708-S003	19-Sep-95	0.2	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.33	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND
B-19	950919-B19-03	2708-S004	19-Sep-95	6.5	ND>26	ND>26	ND>26	ND>26	ND>50	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND
B-20	950929-B20-03	2708-S022	29-Sep-95	10.5	ND>26	ND>26	ND>26	ND>26	ND>50	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND
B-22	951003-B22-05	2708-S027	3-Oct-95	13.5	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.33	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND
B-22	951003-B22-09	2708-S028	3-Oct-95	24.0	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>.33	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND>0.17	ND
B-23	951003-B23-08	2708-S029	3-Oct-95	26.5	ND>0.8	ND>0.8	ND>0.8	ND>0.8	ND>2.0	ND>0.8	ND>0.8	ND>0.8	ND>0.8	ND>0.8	ND>0.8	ND>0.8	ND>0.8	ND>0.8	ND>0.8	ND
B-26	951003-B26-06	2708-S030	4-Oct-95	20.5	ND>51	ND>51	ND>51	ND>51	ND>99	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND
B-27	950920-B27-10	2708-S005	20-Sep-95	23.0	ND>26	ND>26	ND>26	ND>26	ND>50	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND>26	ND
B-28	951002-B28-01	2708-S025	2-Oct-95	0.2	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>9.9	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND>5.1	ND
B-28	951002-B28-07	2708-S025	2-Oct-95	15.0	ND>51	ND>51	ND>51	ND>51	ND>99	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND
B-29	950922-B29-15	2708-S012	22-Sep-95	35.5	ND>51	ND>51	ND>51	ND>51	ND>99	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND
B-30	950922-B30-06	2708-S010	22-Sep-95	11.5	ND>51	ND>51	ND>51	ND>51	ND>99	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND
B-31	950925-B31-06	2708-S014	25-Sep-95	21.0	ND>51	ND>51	ND>51	ND>51	ND>99	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND
B-33	951005-B33-03	2708-S034	5-Oct-95	5.5	ND>51	ND>51	ND>51	ND>51	ND>99	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND
B-33	951005-B33-14	2708-S034	5-Oct-95	54.0	ND>17	ND>17	ND>17	ND>17	ND>33	ND>17	ND>17	ND>17	ND>17	ND>17	ND>17	ND>17	ND>17	ND>17	ND>17	ND
B-35	951005-B35-01	2708-S033	5-Oct-95	0.2	ND>.17	ND>.17	ND>.17	ND>.17	ND>.33	ND>.17	ND>.17	ND>.17	ND>.17	ND>.17	ND>.17	ND>.17	ND>.17	ND>.17	ND>.17	ND
MW-04-57	951030-M4-01	2708-S043	30-Oct-95	0.2	ND>51	ND>51	ND>51	ND>51	ND>99	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND
MW-04-57	951030-M4-06	2708-S043	30-Oct-95	25.5	ND>51	ND>51	ND>51	ND>51	ND>99	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND>51	ND
MW-10-60	951108-M10-01	2708-S052	8-Nov-95	0.2	ND>3.4	ND>3.4	ND>3.4	ND>3.4	ND>6.6	ND>3.4	ND>3.4	ND>3.4	ND>3.4	ND>3.4	ND>3.4	ND>3.4	ND>3.4	ND>3.4	ND>3.4	ND
MW-12-34	951023-M12-06	2708-S038	23-Oct-95	22.0	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>3.3	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND>1.7	ND
ODEQ Soil Cleanup Levels [2]					#	#	#	#	#	#	#	#	#	#	#	5	#	#	2	#
EPA PRGs for Industrial Soil [3]					#	367	2,044	13,625	1,363	#	34,063	3,406	#	#	20,438	7.95	100,000	68,126	173	#

Note: DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = Not detected above detection limit indicated

[1] = Sample number prefix: 2708-
[2] = Reference Levels are Soil Cleanup Levels in the Soil Cleanup Table (OAR 340-122-045)
[3] = Reference Levels are EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil
# = Reference level not established

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TABLE G-4 – Summary of Analytical Results for Soil Samples
Priority Pollutant Metals by EPA Methods 6010 and 7470

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Total Metals by EPA Method 6010 and 7470					Analytical Results mg/kg (ppm)												
Soil Boring	Sample Number	Chain of Custody Number	Sample Date	Sample Depth (feet bgs)	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
B-1	950921-B1-01	2708-S009	21-Sep-95	0.2	ND>1.0	**6.6**	ND>1.0	ND>1.0	26.	41.	60.	ND>0.10	21.	ND>1.0	ND>1.0	4.1	140.
	950921-B1-02	2708-S009	21-Sep-95	0.2	6.6	**21.**	ND>1.0	1.1	30.	60.	58.	ND>0.10	26.	ND>1.0	ND>1.0	7.6	160.
	950921-B1-05	2708-S009	21-Sep-95	10.5	ND>1.0	**14.**	ND>1.0	3.4	11.	80.	130.	ND>0.10	36.	ND>1.0	ND>1.0	3.	670.
B-2	950927-B2-05	2708-S016	27-Sep-95	16.0	ND>1.0	**4.9**	ND>1.0	4.3	12.	20.	15.	ND>0.10	31.	ND>1.0	ND>1.0	3.8	3,000.
B-3	950921-B3-05	2708-S007	21-Sep-95	10.5	ND>1.0	**7.**	ND>1.0	ND>1.0	30.	36.	22.	ND>0.10	41.	ND>1.0	ND>1.0	5.	120.
GT-1	971117-001	2708-S054	17-Nov-97	3.0		1.8											
	971117-004	2708-S054	17-Nov-97	10.5		1.8											
	971117-006	2708-S054	17-Nov-97	16.0		**2.4**											
	971117-008	2708-S054	17-Nov-97	20.5		1.5											
	971117-011	2708-S054	17-Nov-97	35.5		1.2											
GT-2	971117-012	2708-S054	17-Nov-97	3.5		1.1											
	971117-017	2708-S055	17-Nov-97	15.5		2.2											
	971117-021	2708-S055	17-Nov-97	33.0		ND>1.0											
GT-3	971118-023	2708-S056	18-Nov-97	3.0		**2.7**											
	971118-026	2708-S056	18-Nov-97	12.5		1.9											
	971118-032	2708-S056	18-Nov-97	36.0		1.											
GT-4	971118-034	2708-S056	18-Nov-97	13.5		2.											
	971118-038	2708-S057	18-Nov-97	40.5		1.3											
MW-13	971218-M13-02	2708-S058	18-Dec-97	6.0		**2.7**											
	971218-M13-03	2708-S058	18-Dec-97	10.0		**2.8**											
	971218-M13-04	2708-S058	18-Dec-97	13.5		**2.7**											
	971218-M13-05	2708-S058	18-Dec-97	18.0		**2.5**											
	971218-M13-08	2708-S058	18-Dec-97	24.5		1.8											
	971218-M13-10	2708-S058	18-Dec-97	28.0													
	971218-M13-11	2708-S058	18-Dec-97	31.0		1.8											
	971218-M13-17	2708-S059	18-Dec-97	57.0													
ODEQ Industrial Maximum Allowable Soil Concentration [2] ->					#	3.	1.	1,000.	1,500.	80,000.	2,000.	600.	40,000.	#	10,000.	#	#
EPA PRGs for Industrial Soil [3] ->					681.	2.38	1.11	850.	64.1	63,263.	1,000.	#	#	8,517.	8,517.	136.27	100,000.

Note: ODEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = not detected above detection limit indicated
ppm = parts per million
PRGs = EPA Region 9 Preliminary Remediation Goals

# = Reference level not established
1 = Sample number prefix: 2708-
2 = Reference Levels based on Oregon Soil Cleanup Table (OAR 340-122-045)
3 = Reference Levels are EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil
Bold and Shaded = Detected above Reference Level

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APPENDIX H

Groundwater Quality Data

Summary Figures

Summary Tables

Time Concentration Charts

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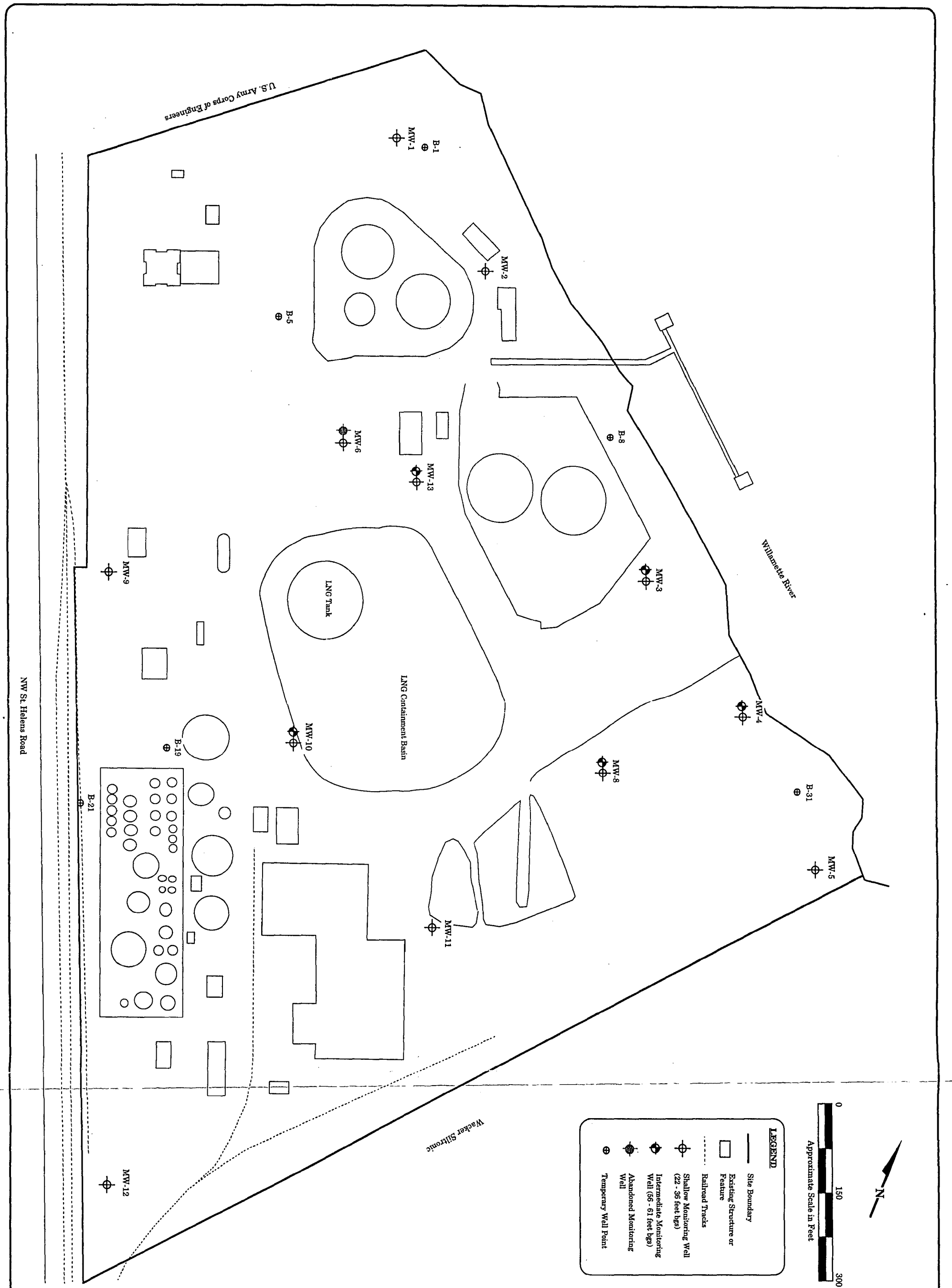

Project #2708	February 1998	**HAHN & ASSOCIATES, INC.** ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 503/796-0717	**Monitoring Well and Temporary Well Point Location Map** RI/FS Northwest Natural - Gasco Facility 7540 NW St. Helens Road Portland, Oregon	Figure **H-1**

Koppers022780

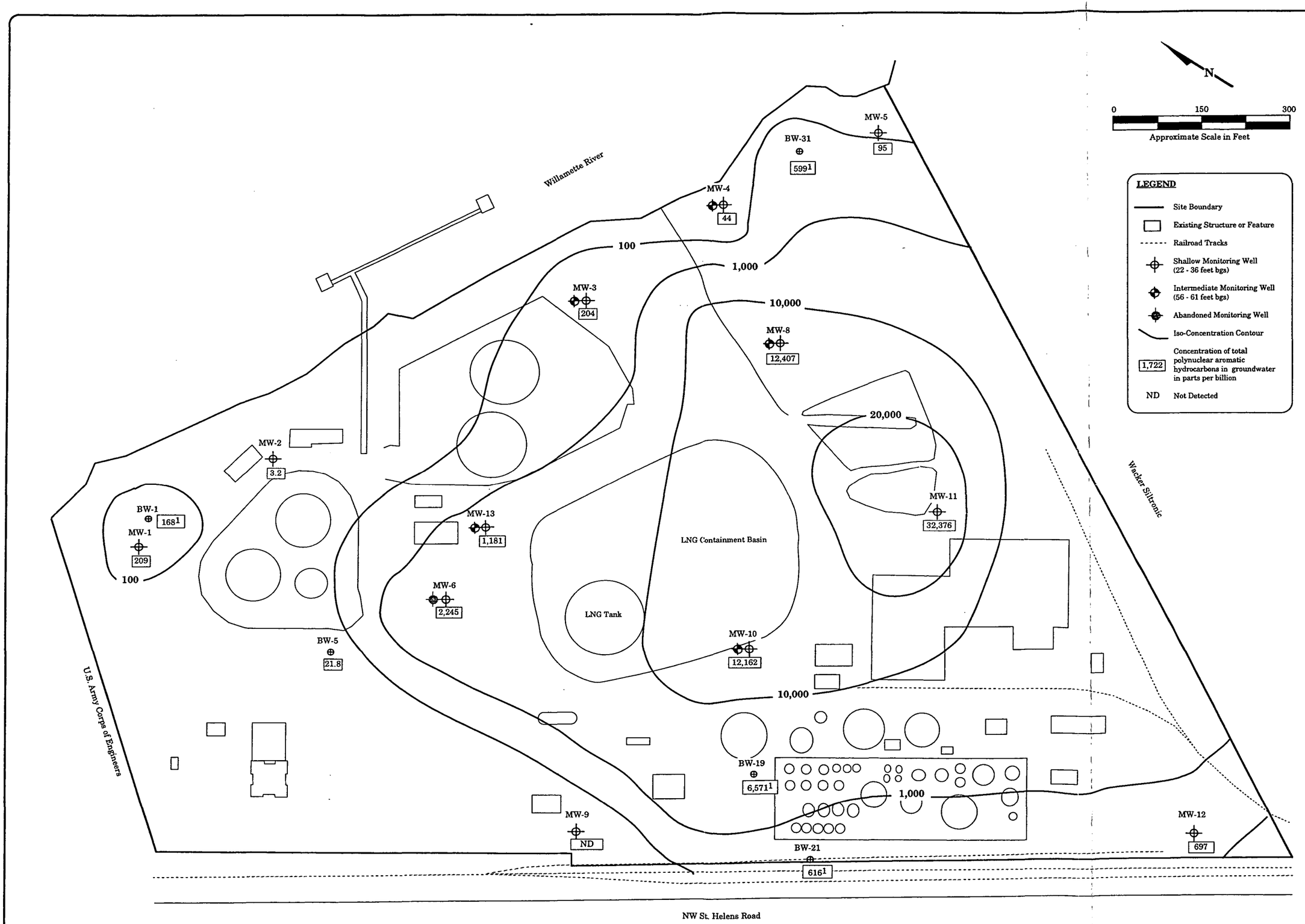

Figure H-2

Groundwater Iso-Concentration Map for Total PAHs: Surficial Fill Zone : June 1998

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project #2708

Koppers022781

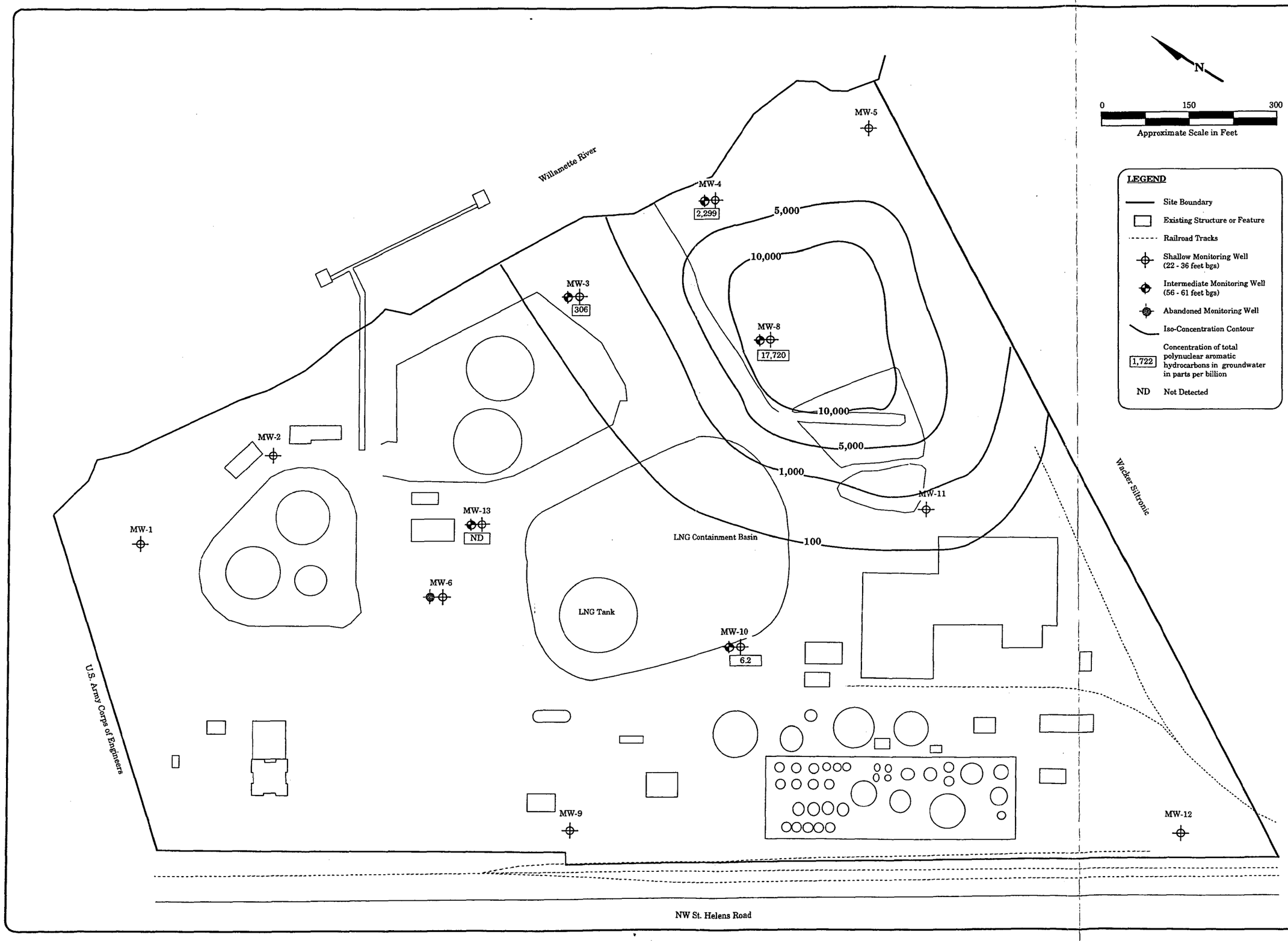

Figure
H-3

Groundwater Iso-Concentration Map for Total PAHs: Alluvial Sand Zone: (Intermediate-Depth) : June 1998

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project #2708

Koppers022782

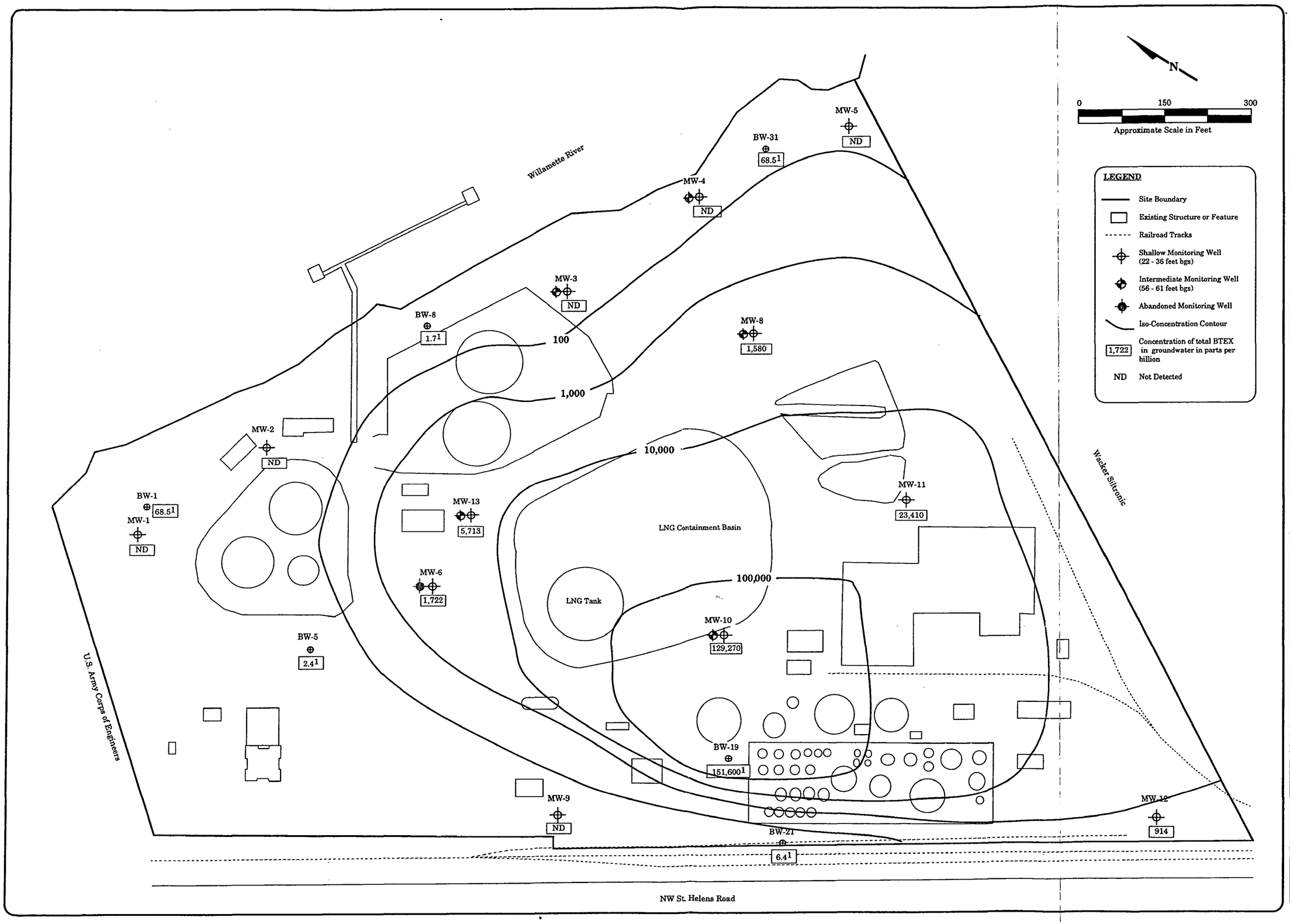

Figure H-4

Groundwater Iso-Concentration Map for Total BTEX: Surficial Fill Zone: June 1998

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project #2708

Koppers022783

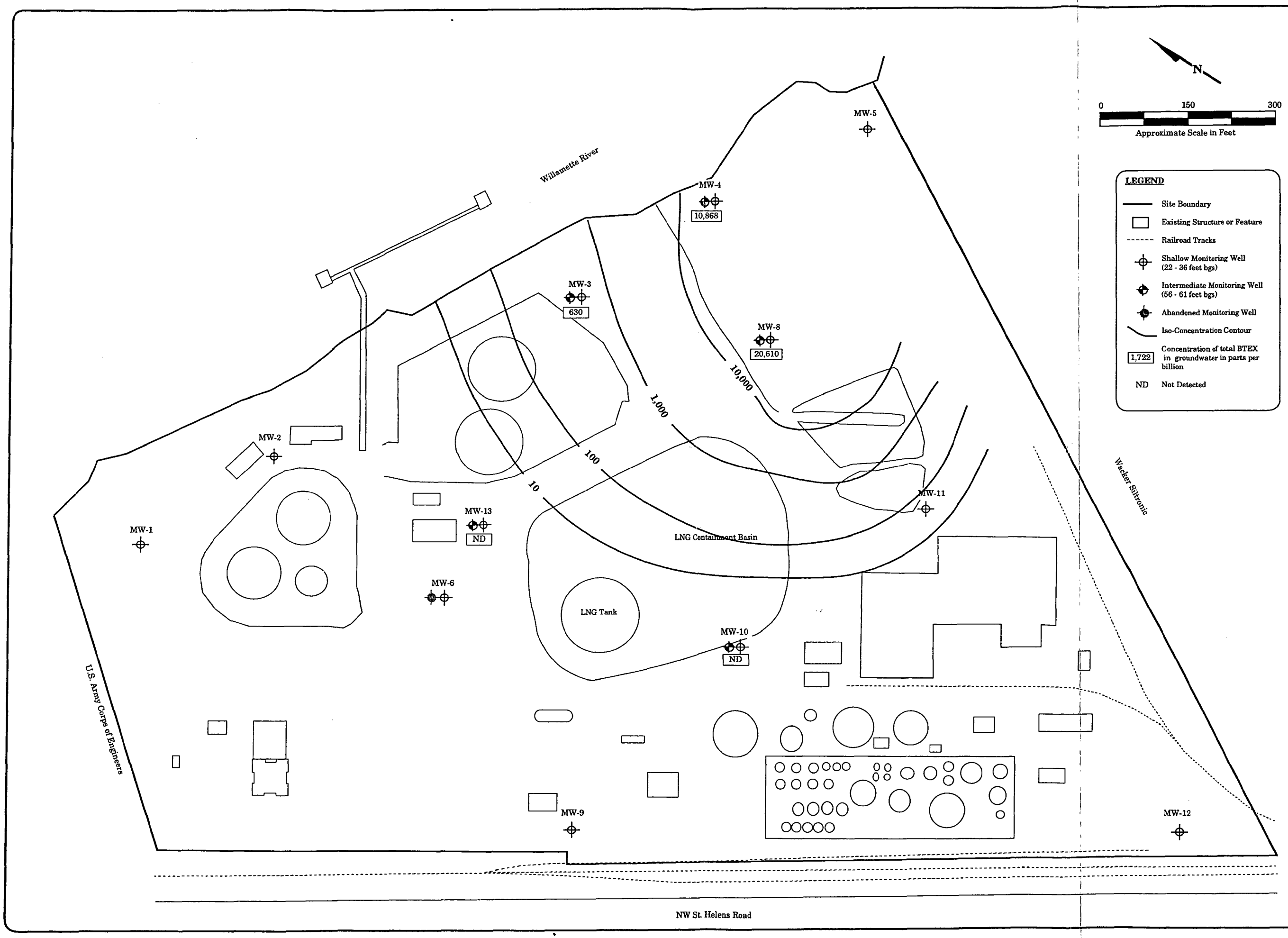

Figure H-5

Groundwater Iso-Concentration Map for Total BTEX: Alluvial Sand Zone: Intermediate Depth June 1998

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project #2708

Koppers022784

Table H-1 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells, December 1995 to Present
BTEX, Total PAHs, Total Phenols, and Cyanide

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Well Number	HAI Sample Number[1]	Chain of Custody Number	Sample Date	Analytical Results									
				EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA Method 8270 ug/l (ppb)	EPA Method 9010 mg/l (ppm)	EPA Method 901 mg/l (ppm)
				Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Phenols	Total Cyanide	Amenable Cyanide
MW01-22	951207-MW1-22-01	2708-W011	7-Dec-95	13.	2.	1.8	3.2	20.	93.4	465.3		1.08	
	960319-MW1-22-01	2708-W014	19-Mar-96	3.5	3.5	2.3	23.	32.3	4.71	140.45		0.86	
	960618-MW1-22-01	2708-W018	18-Jun-96	2.4	9.5	3.2	15.	30.1	2.2	112.		1.91	
	961001-MW1-22-01	2708-W021	1-Oct-96	8.5	9.	7.7	72.	97.2	6.2	720.17		5.7	
	970225-MW1-22-01	2708-W024	25-Feb-97	3.2	1.7	ND>0.5	8.5	13.4	0.91	67.		1.24	
	970225-MW1-22-02	2708-W024	25-Feb-97	1.5	1.6	0.7	11.	14.8	2.2	64.			
	970827-MW1-22-01	2708-W027	27-Aug-97	7.5	8.2	6.9	62.	84.6	20.	988.2		11.	
	970827-MW1-22-02	2708-W027	27-Aug-97	6.7	7.4	6.2	55.	75.3	28.1	737.5		10.	
	980217-MW1-22-01	2708-W030	17-Feb-98	ND>0.5	ND>0.5	ND>0.5	1.6	1.6	4.45	23.23		0.34	ND>0.01
	980602-MW1-32-11	2708-W033	2-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	93.	209.		0.46	0.045
MW02-32	951206-MW2-32-01	2708-W010	6-Dec-95	6.	ND>0.5	4.2	2.4	12.6	ND	51.55		0.353	
	960318-MW2-32-01	2708-W013	18-Mar-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	4.54		0.26	
	960618-MW2-32-01	2708-W018	18-Jun-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	2.6		0.44	
	961001-MW2-32-01	2708-W021	1-Oct-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	10.53		0.22	
	970225-MW2-32-01	2708-W024	25-Feb-97	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	1.6		0.16	
	970827-MW2-32-01	2708-W027	27-Aug-97	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.2	18.04		0.28	
	980217-MW2-32-01	2708-W030	17-Feb-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	5.02		0.16	ND>0.01
	980601-MW2-32-05	2708-W032	1-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	3.2		0.26	ND>0.01
MW03-26	951206-MW3-26-01	2708-W010	6-Dec-95	30.	0.98	0.65	1.4	33.03	21.04	85.24			
	960318-MW3-26-02	2708-W013	18-Mar-96	1,300.	5.	2.2	5.6	1,312.8	1.71	42.39		0.27	
	960618-MW3-26-01	2708-W018	18-Jun-96	2,300.	22.	ND>10	27.	2,349.	2.6	48.		0.25	
	961001-MW3-26-01	2708-W021	1-Oct-96	0.55	0.95	ND>0.5	2.4	3.9	182.	334.		0.34	
	970225-MW3-26-01	2708-W024	25-Feb-97	130.	ND>0.5	ND>0.5	ND>0.5	130.	4.9	11.9		0.28	
	970827-MW3-26-01	2708-W027	27-Aug-97	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	27.6	53.2		2.3	
	980217-MW3-26-01	2708-W030	17-Feb-98	2.	ND>0.5	ND>0.5	ND>1.5	2.	7.07	13.45		0.5	ND>0.01
	980602-MW3-26-09	2708-W033	2-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	100.	204.		0.76	ND>0.01
MW03-56	951206-MW3-56-01	2708-W010	6-Dec-95	1,200.	24.	34.	90.	1,348.	2.69	1,384.75	ND		
	960319-MW3-56-01	2708-W014	19-Mar-96	730.	16.	27.	66.	839.	2.34	1,926.62		0.19	
	960620-MW3-56-01	2708-W019	20-Jun-96	730.	7.1	26.	73.	836.1	1.6	1,491.		0.08	
	961002-MW3-56-01	2708-W022	2-Oct-96	450.	ND>5	11.	27.	488.	0.54	938.		0.094	
	970226-MW3-56-01	2708-W025	26-Feb-97	750.	ND>5	ND>5	ND>5	750.	0.62	618.		0.13	
	970828-MW3-56-01	2708-W028	28-Aug-97	340.	0.9	2.5	11.	354.4	0.82	195.52		0.11	
	980218-MW3-56-01	2708-W031	18-Feb-98	520.	0.89	2.9	15.	538.79	0.58	129.58		0.16	ND>0.01
	980218-MW3-56-02	2708-W031	18-Feb-98	520.	1.1	4.	19.	544.1	0.46	155.56			
	980602-MW3-56-14	2708-W033	2-Jun-98	580.	25.	ND>10	ND>30	605.	25.	316.		0.15	ND>0.01
	980602-MW3-56-15	2708-W033	2-Jun-98	630.	ND>10	ND>10	ND>30	630.	24.	306.			
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				5.	1,000.	700.	10,000.	#	#	#	#	0.2	#
EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water				0.39	723.	1,340.	1,431.	#	#	#	#	#	0.73
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water[2]				40.[3]	424.[3]	1,400.[3]	#	#	0.031[4]	#	#	0.0052[4]	#

Koppers022785

Table H-1 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells, December 1995 to Present
BTEX, Total PAHs, Total Phenols, and Cyanide

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Well Number	HAI Sample Number[1]	Chain of Custody Number	Sample Date	Analytical Results									
				EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA Method 8270 ug/l (ppb)	EPA Method 9010 mg/l (ppm)	EPA Method 901 mg/l (ppm)
				Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Phenols	Total Cyanide	Amenable Cyanide
MW04-35	951206-MW4-35-01	2708-W010	6-Dec-95	0.54	ND>0.5	ND>0.5	ND>0.5	0.54	0.69	54.49		0.079	
	960318-MW4-35-01	2708-W013	18-Mar-96	17.	0.96	ND>0.5	1.3	19.26	3.18	84.4		0.35	
	960318-MW4-35-02	2708-W013	18-Mar-96	18.	0.82	ND>0.5	2.1	20.92	2.41	79.1			
	960618-MW4-35-01	2708-W018	18-Jun-96	5.9	ND>0.5	ND>0.5	0.61	6.51	2.5	61.	ND	0.46	
	961001-MW4-35-01	2708-W021	1-Oct-96	5.9	ND>0.5	ND>0.5	1.4	7.3	1.7	42.33	ND	0.75	
	970225-MW4-35-01	2708-W024	25-Feb-97	14.	ND>0.5	ND>0.5	ND>0.5	14.	0.41	46.	ND	0.39	
	980827-MW4-57-01[5]	2708-W027	27-Aug-97	8.8	ND>0.5	ND>0.5	1.7	10.5	0.53	36.26	ND	0.8	
	980217-MW4-35-01	2708-W030	17-Feb-98	15.	ND>0.5	ND>0.5	ND>1.5	15.	0.25	31.85	ND	0.36	ND>0.01
	980601-MW4-35-06	2708-W032	1-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.48	44.		0.29	0.017
MW04-57	951205-MW4-57-01	2708-W009	5-Dec-95	9,600.	72.	590.	290.	10,552.	1.73	1,328.27		1.18	
	960321-MW4-57-01	2708-W016	21-Mar-96	11,000.	ND>50	520.	270.	11,790.	2.29	1,097.76		0.03	
	960620-MW4-57-01	2708-W019	20-Jun-96	10,000.	ND>200	480.	ND>200	10,480.	1.4	646.	2.8	0.88	
	961002-MW4-57-01	2708-W022	2-Oct-96	14,000.	ND>100	580.	400.	14,980.	0.64	1,707.	29.	1.	
	970226-MW4-57-01	2708-W025	26-Feb-97	16,000.	34.	630.	130.	16,794.	0.52	1,688.	4.8	1.52	
	970828-MW4-35-01[5]	2708-W028	28-Aug-97	12,000.	ND>50	360.	ND>150	12,360.	0.44	1,691.74	4.6	2.	
	980218-MW4-57-01	2708-W031	18-Feb-98	15,600.	35.	530.	240.	16,405.	0.28	2,357.88	47.	2.	ND>0.05
	980603-MW4-57-18	2708-W034	3-Jun-98	10,100.	58.	540.	170.	10,868.	0.77	2,299.		1.9	0.008[6]
MW05-32	951205-MW5-32-01	2708-W009	5-Dec-95	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	7.59	207.69		0.101	
	960319-MW5-32-01	2708-W014	19-Mar-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	29.81	268.91		0.11	
	960319-MW5-32-01 (dissolved)	2708-W014	19-Mar-96						ND	45.			
	960620-MW5-32-01	2708-W019	20-Jun-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	14.	83.		0.05	
	961001-MW5-32-01	2708-W021	1-Oct-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	277.	773.		0.14	
	970225-MW5-32-01	2708-W024	25-Feb-97	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	1.	9.7		0.11	
	970827-MW5-32-01	2708-W027	27-Aug-97	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	10.4	24.3		0.14	
	980217-MW5-32-01	2708-W030	17-Feb-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	3.23	7.57		0.17	ND>0.01
	980602-MW5-32-10	2708-W033	2-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	36.	95.		0.18	0.038
MW06-32	951207-MW6-32-01	2708-W011	7-Dec-95	3,000.	150.	960.	740.	4,850.	7,470.	199,570.	ND	0.091	
	960319-MW6-32-01	2708-W014	19-Mar-96	640.	22.	400.	270.	1,332.	6.56	2,346.46		0.21	
	960319-MW6-32-01 (dissolved)	2708-W014	19-Mar-96						ND	1,940.			
	960617-MW6-32-01	2708-W017	17-Jun-96	410.	40.	280.	410.	1,140.	16.	1,878.		0.23	
	960930-MW6-32-01	2708-W020	30-Sep-96	1,100.	34.	470.	320.	1,924.	203.5	4,757.7		0.02	
	970224-MW6-32-01	2708-W023	25-Feb-97	1,100.	22.	370.	80.	1,572.	ND	1,308.		0.22	
	970826-MW6-32-01	2708-W026	26-Aug-97	1,200.	27.	420.	280.	1,927.	15.	2,069.65		0.15	
	980216-MW6-32-01	2708-W029	16-Feb-98	1,700.	ND>250	650.	ND>750	2,350.	161.9	3,554.2		0.18	ND>0.01
	980601-MW6-32-04	2708-W032	1-Jun-98	1,200.	32.	300.	190.	1,722.	20.	2,245.		0.1	ND>0.01
MW06-61	951206-MW6-61-01	2708-W010	6-Dec-95	6.7	0.71	8.9	5.8	22.11	8.17	744.89	ND	0.228	
	960319-MW6-61-01	2708-W014	19-Mar-96	11.	0.68	9.2	5.3	26.18	3.29	196.96		0.28	
	960620-MW6-61-01	2708-W019	20-Jun-96	8.4	ND>0.5	6.	3.3	17.7	4.3	139.		0.27	
	961001-MW6-61-01	2708-W021	1-Oct-96	20.	0.93	16.	8.	44.93	3.8	152.9		0.3	
	970225-MW6-61-01	2708-W024	25-Feb-97	82.	6.1	79.	41.	208.1	ND	365.		0.35	
	970828-MW6-61-01	2708-W028	28-Aug-97	130.	11.	180.	120.	441.	4.88	1,451.5		0.41	
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				5.	1,000.	700.	10,000.	#	#	#	#	0.2	#
EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water				0.39	723.	1,340.	1,431.	#	#	#	#	#	0.73
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water[4]				40[3]	424[3]	1,400[3]	#	#	0.031[4]	#	#	0.0052[4]	#

Koppers022786

Table H-1 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells, December 1995 to Present
BTEX, Total PAHs, Total Phenols, and Cyanide

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Well Number	HAI Sample Number[1]	Chain of Custody Number	Sample Date	Analytical Results									
				EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA Method 8270 ug/l (ppb)	EPA Method 9010 mg/l (ppm)	EPA Method 901 mg/l (ppm)
				Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Phenols	Total Cyanide	Amenable Cyanide
MW08-29	951207-MW8-29-01	2708-W011	7-Dec-95	2,100.	510.	200.	320.	3,130.	315.	7,688.	114.	3.11	
	960321-MW8-29-01	2708-W016	21-Mar-96	1,700.	380.	170.	400.	2,650.	143.7	7,879.7		2.4	
	960619-MW8-29-01	2708-W019	20-Jun-96						5.4	2,087.			
	960619-MW8-29-02	2708-W019	20-Jun-96	1,300.	310.	170.	380.	2,160.	13.	2,166.	10.		
	961002-MW8-29-01	2708-W022	2-Oct-96	770.	210.	130.	270.	1,380.	25.9	6,086.4	ND	0.524	
	970226-MW8-29-01	2708-W025	26-Feb-97	860.	200.	150.	250.	1,460.	10.	6,204.	100.	1.46	
	970828-MW8-29-01	2708-W028	28-Aug-97	390.	130.	110.	190.	820.	171.7	11,712.7	36.	3.4	
	980218-MW8-29-01	2708-W031	18-Feb-98	620.	220.	170.	250.	1,260.	22.19	11,760.19	ND	2.6	ND>0.01
	980603-MW8-29-19	2708-W034	3-Jun-98	700.	320.	250.	310.	1,580.	196.	12,407.		4.9	0.022[5]
MW08-56	951207-MW8-56-01	2708-W011	7-Dec-95	13,000.	1,700.	850.	1,300.	16,850.	156.	21,200.		0.582	
	960321-MW8-56-01	2708-W016	21-Mar-96	17,000.	820.	730.	1,600.	20,150.	361.1	15,501.1		0.54	
	960620-MW8-56-01[7]	2708-W019	20-Jun-96	17,000.	650.	740.	1,100.	19,490.	35.	1,769.		0.31	
	961002-MW8-56-01	2708-W022	2-Oct-96	20,000.	690.	900.	1,800.	23,390.	114.	11,742.			
	970226-MW8-56-01	2708-W025	26-Feb-97	19,000.	630.	820.	1,100.	21,550.	ND	13,692.		0.7	
	970828-MW8-56-01	2708-W028	28-Aug-97	17,000.	350.	510.	810.	18,670.	20.	18,141.		0.66	
	980218-MW8-56-01	2708-W031	18-Feb-98	20,200.	410.	740.	1,100.	22,450.	11.18	12,944.88		0.74	ND>0.01
	980603-MW8-56-21	2708-W034	3-Jun-98	17,900.	470.	940.	1,300.	20,610.	68.	17,720.		0.77	0.018[5]
MW09-29	951205-MW9-29-01	2708-W009	5-Dec-95	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	1.29			
	960318-MW9-29-01	2708-W013	18-Mar-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	1.6		ND>0.01	
	960618-MW9-29-01	2708-W018	18-Jun-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	0.15		ND>0.01	
	961001-MW9-29-01	2708-W021	1-Oct-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	0.4		0.018	
	970225-MW9-29-01	2708-W024	25-Feb-97	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	ND		0.01	
	970827-MW9-29-01	2708-W027	27-Aug-97	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND		ND>0.02	
	980217-MW9-29-01	2708-W030	17-Feb-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND		ND>0.02	
	980602-MW9-29-07	2708-W033	2-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND		ND>0.02	
MW10-25	951207-MW10-25-01	2708-W011	7-Dec-95	120,000.	42,000.	2,000.	9,200.	173,200.	18.	13,316.5	2,560.		
	960320-MW10-25-01	2708-W015	20-Mar-96	32,000.	38,000.	3,100.	13,000.	86,100.	5.9	9,126.31	2,690.	0.07	
	960617-MW10-25-01	2708-W017	17-Jun-96	28,000.	32,000.	2,500.	8,600.	71,100.	6.8	10,266.	1,820.	ND>0.01	
	960930-MW10-25-01	2708-W020	30-Sep-96	17,000.	5,000.	ND>200	4,500.	26,500.	78.6	10,529.5	4,350.	0.204	
	970224-MW10-25-01	2708-W023	25-Feb-97	180,000.	54,000.	1,300.	6,800.	242,100.	74.	9,841.	ND>5,000	0.01	
	970827-MW10-25-01	2708-W027	27-Aug-97	168,000.	54,000.	850.	6,000.	228,850.	19.6	7,047.1	2,960.		
	980216-MW10-25-01	2708-W029	16-Feb-98	186,000.	51,100.	880.	6,500.	244,480.	58.1	9,165.2	2,620.	ND>0.02	
	980601-MW10-25-02	2708-W032	1-Jun-98	93,800.	30,900.	670.	3,900.	129,270.	35.	12,162.		0.21	
MW10-61	951206-MW10-61-01	2708-W010	6-Dec-95	75.	130.	26.	110.	341.	0.72	829.72	ND		
	960321-MW10-61-01	2708-W016	21-Mar-96	4.1	1.6	2.9	8.5	17.1	2.55	102.43		ND>0.01	
	960620-MW10-61-01	2708-W019	20-Jun-96	0.9	ND>0.5	1.1	1.7	3.7	2.	46.	ND	ND>0.01	
	960930-MW10-61-01	2708-W022	2-Oct-96	0.56	ND>0.5	0.69	1.1	2.35	1.5	25.15	ND	ND>0.01	
	970226-MW10-61-01	2708-W025	26-Feb-97	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	1.	18.	8.4	ND>0.01	
	970828-MW10-61-01	2708-W028	28-Aug-97	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.39	7.76	ND	ND>0.02	
	980218-MW10-61-01	2708-W031	18-Feb-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.4	3.8	ND	ND>0.02	
	980603-MW10-61-16	2708-W034	3-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	1.6	6.2		ND>0.02	
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				5.	1,000.	700.	10,000.	#	#	#	#	0.2	#
EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water				0.39	723.	1,340.	1,431.	#	#	#	#	#	0.73
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water[2]				40.[3]	424.[3]	1,400.[3]	#	#	0.031[4]	#	#	0.0052[4]	#

Updated: 9/24/98 RBE
File Name: * 2708-H GW Results (Master)

Koppers022787

Table H-1 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells, December 1995 to Present
BTEX, Total PAHs, Total Phenols, and Cyanide

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Well Number	HAI Sample Number[1]	Chain of Custody Number	Sample Date	Analytical Results									
				EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA Method 8270 ug/l (ppb)	EPA Method 9010 mg/l (ppm)	EPA Method 901 mg/l (ppm)
				Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Phenols	Total Cyanide	Amenable Cyanide
MW11-32	951207-MW11-32-01	2708-W011	7-Dec-95	25,000.	5,400.	480.	2,800.	33,680.	20.	22,365.2	2,520.		
	960320-MW11-32-01	2708-W015	20-Mar-96	24,000.	4,300.	970.	2,400.	31,670.	6.33	14,676.08	1,420.	0.24	
	960617-MW11-32-01	2708-W017	17-Jun-96	2,800.	2,000.	1,000.	1,940.	7,740.	14.	11,608.	960.	0.19	
	960930-MW11-32-01	2708-W020	30-Sep-96	17,000.	3,300.	900.	1,760.	22,960.	131.9	17,603.9	1,681.	0.249	
	960930-MW11-32-02	2708-W020	30-Sep-96						189.	18,894.			
	970224-MW11-32-01	2708-W023	25-Feb-97	21,000.	4,100.	750.	1,800.	27,650.	11.	11,536.	240.	0.22	
	970826-MW11-32-01	2708-W026	26-Aug-97	15,000.	4,400.	1,100.	2,500.	23,000.	20.5	17,075.8	961.	0.17	
	980216-MW11-32-01	2708-W029	16-Feb-98	12,600.	3,800.	930.	2,100.	19,430.	15.9	9,769.2	450.	0.2	ND>0.01
	980601-MW11-32-03	2708-W032	1-Jun-98	16,800.	4,000.	810.	1,800.	23,410.	112.	32,376.		0.21	ND>0.01
MW12-36	951207-MW12-36-01	2708-W011	7-Dec-95	95.	410.	170.	590.	1,265.	3.65	3,377.55			
	960321-MW12-36-01	2708-W016	21-Mar-96	170.	180.	110.	550.	1,010.	0.38	2,010.03	ND	ND>0.01	
	960620-MW12-36-01	2708-W019	20-Jun-96	250.	250.	120.	440.	1,060.	0.8	1,621.		ND>0.01	
	961002-MW12-36-01	2708-W022	2-Oct-96	330.	390.	130.	510.	1,360.	0.8	1,375.		ND>0.01	
	970226-MW12-36-01	2708-W025	26-Feb-97	260.	310.	120.	470.	1,160.	0.94	1,033.		ND>0.01	
	970828-MW12-36-01	2708-W028	28-Aug-97	230.	430.	110.	430.	1,200.	0.67	839.77		ND>0.02	
	980218-MW12-36-01	2708-W031	18-Feb-98	140.	370.	82.	280.	872.	0.69	708.		ND>0.02	
	980603-MW12-36-17	2708-W034	3-Jun-98	150.	350.	74.	340.	914.	ND	697.		ND>0.02	
MW-13-30	980217-MW13-30-01	2708-W030	17-Feb-98	6,900.	ND>50	370.	ND>150	7,270.	ND	426.1		0.28	ND>0.01
	980602-MW13-30-12	2708-W033	2-Jun-98	5,200.	13.	380.	120.	5,713.	ND	1,181.		0.28	ND>0.01
MW-13-61	980218-MW13-61-01	2708-W031	18-Feb-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND		0.14	ND>0.01
	980602-MW13-61-13	2708-W033	2-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND		0.13	ND>0.01
Temporary Well Point Samples 1995													
B-01 at 23'	950921-BW1-01	2708-W003	21-Sep-95	6.9	2.5	3.1	56.	68.5	0.09	175.71		7.8	
B-05 at 28'	950925-BW05-01	2708-W005	29-Sep-95	ND>0.5	0.97	ND>0.5	1.4	2.37	ND	34.78		ND>0.02	
B-08 at 20'	950918-BW8-01	2708-W001	18-Sep-95	ND>0.5	0.85	ND>0.5	0.86	1.71					
B-19 at 13'	950920-BW19-01	2708-W002	20-Sep-95								164.5		
B-19 at 28'	950920-BW19-02	2708-W002	20-Sep-95	100,000.	39,000.	1,600.	11,000.	151,600.	0.7	6,610.2			
B-21 at 19.5'	951003-BW21-01	2708-W006	3-Oct-95	ND>0.5	1.2	1.9	3.3	6.4	2.93	726.25	ND		
B-31 at 29'	950925-BW31-01	2708-W004	25-Sep-95	3.	1.6	10.	13.	27.6	13.28	694.58		ND>0.02	
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				5.	1,000.	700.	10,000.	#	#	#	#	0.2	#
EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water				0.39	723.	1,340.	1,431.	#	#	#	#	#	0.73
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water[2]				40.[3]	424.[3]	1,400.[3]	#	#	0.031[4]	#	#	0.0052[4]	#

Note: BTEX = benzene, toluene, ethylbenzene, and xylenes; DEQ = Oregon Department of Environmental Quality; EPA = U.S. Environmental Protection Agency; mg/l = milligrams/liter; ND = not detected above detection limit indicated; PAHs = polynuclear aromatic hydrocarbons; ppb = parts per billion; ppm = parts per million; ug/l = micrograms per liter; # = Reference Level not established; **Bold** and shaded = Detected above Lowest Identified Reference Level

1 = Sample number prefix: 2708-
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (OAR 340-41) based on Fresh Acute, Fresh Chronic (Aquatic Life Protection) and Fish Consumption (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
4 = Reference Level based on Human Fish Consumption Criteria of AWQC
5 = Due to mislabeling in the field or due to laboratory misidentification, the laboratory report transposed results for MW4-35 and MW-4-57 in August 1997. Tables attribute data to the correct well.
6 = Sample was analyzed outside of recommended holding time
7 = PAH results for sample 960620-MW8-56-01 should be considered qualitative due to an apparent error concerning sample identity.

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Table H-2 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells, December 1995 to Present
PAHs by EPA Method 8270

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)				Analytical Results ug/l (ppb)																		
				Carcinogenic PAHs							Non-carcinogenic PAHs											
Well Number	Sample Number	Chain of Custody Number	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
MW01-22	951207-MW1-22-01	2708-W011	7-Dec-95	24.	13.	4.8	12.	32.	1.3	6.3	11.	2.6	52.	9.3	74.	16.	39.	100.	68.	93.4	465.
	960319-MW1-22-01	2708-W014	19-Mar-96	1.2	0.7	0.28	0.64	1.6	ND •	0.29	9.6	0.33	4.1	0.41	4.4	7.3	90.	15.	4.6	4.7	140.
	960618-MW1-22-01	2708-W018	18-Jun-96	0.59	0.33	0.14	0.34	0.68	ND •	0.15	7.6	0.26	3.3	0.21	2.5	6.2	75.	12.	2.9	2.2	112.
	961001-MW1-22-01	2708-W021	1-Oct-96	1.7	1.4	ND •	1.3	1.8	ND •	ND •	55.	0.98	15.	0.99	7.	59.	440.	130.	6.	6.2	720.
	970225-MW1-22-01	2708-W024	25-Feb-97	0.36	0.13	ND •	0.12	0.3	ND •	ND •	3.7	ND •	1.6	ND •	1.8	3.1	47.	6.5	1.9	0.9	67.
	970225-MW1-22-02	2708-W024	25-Feb-97	0.72	0.34	0.12	0.31	0.64	ND •	0.1	3.2	ND •	1.6	0.13	2.1	2.9	44.	5.5	2.5	2.2	64.
	970827-MW1-22-01	2708-W027	27-Aug-97	3.8	4.	1.4	3.9	4.8	ND •	2.1	70.	1.6	16.	2.6	12.	75.	550.	230.	11.	20.	988.
	970827-MW1-22-02	2708-W027	27-Aug-97	5.2	5.4	2.	5.6	6.7	ND •	3.2	66.	ND •	19.	3.8	14.	73.	350.	170.	12.	28.1	736.
	980217-MW1-22-01	2708-W030	17-Feb-98	1.1	0.8	0.26	0.76	0.98	0.1	0.48	1.2	ND •	1.5	0.58	2.7	1.4	4.7	3.5	3.2	4.5	23.
	980602-MW1-32-11	2708-W033	2-Jun-98	15.	21.	6.7	18.	21.	1.8	9.6	3.3	0.89	14.	13.	25.	4.9	3.3	23.	29.	93.1	209.
MW02-32	951206-MW2-32-01	2708-W010	6-Dec-95	ND •	ND •	ND •	ND •	ND •	ND •	ND •	4.	0.29	0.28	ND •	0.48	0.32	45.	0.51	0.67	0.	51.6
	960318-MW2-32-01	2708-W013	18-Mar-96	ND •	ND •	ND •	ND •	ND •	ND •	ND •	4.	0.16	0.1	ND •	ND •	ND •	ND •	ND •	0.28	0.	4.5
	960618-MW2-32-01	2708-W018	18-Jun-96	ND •	ND •	ND •	ND •	ND •	ND •	ND •	1.5	0.23	0.15	ND •	ND •	0.22	0.09	ND •	0.41	0.	2.6
	961001-MW2-32-01	2708-W021	1-Oct-96	ND •	ND •	ND •	ND •	ND •	ND •	ND •	8.4	0.14	0.16	0.1	0.12	0.23	0.22	0.23	0.93	0.	10.5
	970225-MW2-32-01	2708-W024	25-Feb-97	ND •	ND •	ND •	ND •	ND •	ND •	ND •	1.1	ND •	ND •	ND •	ND •	0.15	ND •	ND •	0.37	0.	1.6
	970827-MW2-32-01	2708-W027	27-Aug-97	ND •	ND •	ND •	0.1	ND •	ND •	0.1	16.	0.17	0.19	0.14	ND •	0.21	0.17	ND •	0.96	0.2	18.
	980217-MW2-32-01	2708-W030	17-Feb-98	ND •	ND •	ND •	ND •	ND •	ND •	ND •	4.2	0.11	ND •	ND •	ND •	0.19	ND •	ND •	0.52	0.	5.
	980601-MW2-32-05	2708-W032	1-Jun-98	ND •	ND •	ND •	ND •	ND •	ND •	ND •	2.2	ND •	ND •	ND •	ND •	0.19	ND •	ND •	0.82	0.	3.2
MW03-26	951206-MW3-26-01	2708-W010	6-Dec-95	2.8	4.7	1.5	4.1	4.6	0.54	2.8	1.5	2.7	2.3	3.9	8.5	1.2	30.	4.7	9.4	21.	85.2
	960318-MW3-26-02	2708-W013	18-Mar-96	0.29	0.35	0.14	0.39	0.3	ND •	0.24	2.5	1.4	1.1	0.34	1.1	0.58	32.	0.36	1.3	1.7	42.4
	960618-MW3-26-01	2708-W018	18-Jun-96	0.49	0.47	0.17	0.56	0.55	ND •	0.31	5.5	2.6	1.5	0.42	1.3	1.3	30.	0.79	1.9	2.6	47.9
	961001-MW3-26-01	2708-W021	1-Oct-96	29.	41.	12.	47.	30.	ND •	23.	ND •	9.5	ND •	34.	36.	ND •	10.	8.6	54.	182.	334.
	970225-MW3-26-01	2708-W024	25-Feb-97	0.78	1.1	0.36	1.3	0.59	ND •	0.81	0.79	0.32	0.1	1.1	1.2	0.18	0.97	0.39	1.9	4.9	11.9
	970827-MW3-26-01	2708-W027	27-Aug-97	4.1	5.7	2.	7.7	3.9	ND •	4.2	1.3	1.7	1.1	5.6	6.7	ND •	ND •	1.4	7.8	27.6	53.2
	980217-MW3-26-01	2708-W030	17-Feb-98	0.68	1.5	0.39	1.8	0.44	0.35	1.9	0.18	0.5	0.24	2.4	1.	0.1	0.39	0.27	1.3	7.1	13.4
	980602-MW3-26-09	2708-W033	2-Jun-98	13.	24.	5.7	26.	11.	3.1	17.	0.3	1.6	1.5	25.	27.	0.47	1.8	3.8	43.	99.8	204.
MW03-56	951206-MW3-56-01	2708-W010	6-Dec-95	0.73	0.33	0.14	0.41	0.85	ND •	0.23	51.	46.	8.1	0.36	7.8	19.	1,200.	42.	7.8	2.7	1,385.
	960319-MW3-56-01	2708-W014	19-Mar-96	0.59	0.33	0.13	0.38	0.73	ND •	0.18	56.	70.	5.6	0.28	6.1	25.	1,700.	53.	8.3	2.3	1,927.
	960620-MW3-56-01	2708-W019	20-Jun-96	0.45	0.22	ND •	0.26	0.51	ND •	0.15	47.	56.	6.4	0.21	5.8	27.	1,300.	39.	8.1	1.6	1,491.
	961002-MW3-56-01	2708-W022	2-Oct-96	0.27	ND •	ND •	ND •	0.27	ND •	ND •	42.	62.	6.	ND •	6.7	27.	730.	58.	5.6	0.5	938.
	970226-MW3-56-01	2708-W025	26-Feb-97	0.33	ND •	ND •	ND •	0.29	ND •	ND •	42.	51.	ND •	ND •	3.2	21.	440.	53.	7.5	0.6	618.
	970828-MW3-56-01	2708-W028	28-Aug-97	0.28	0.13	ND •	0.13	0.28	ND •	ND •	21.	15.	7.3	ND •	7.	15.	85.	39.	5.4	0.8	196.
	980218-MW3-56-01	2708-W031	18-Feb-98	0.28	0.1	ND •	ND •	0.2	ND •	ND •	25.	14.	3.7	ND •	4.8	13.	22.	41.	5.5	0.6	130.
	980218-MW3-56-02	2708-W031	18-Feb-98	0.26	ND •	ND •	ND •	0.2	ND •	ND •	33.	17.	3.9	ND •	4.9	17.	26.	48.	5.3	0.5	156.
	980602-MW3-56-14	2708-W033	2-Jun-98	5.3	4.9	1.7	5.1	4.6	ND •	2.9	57.	19.	12.	4.3	20.	28.	37.	86.	28.	24.5	316.
	980602-MW3-56-15	2708-W033	2-Jun-98	5.1	4.7	1.9	5.3	4.5	ND •	2.8	54.	18.	12.	4.3	19.	28.	32.	86.	28.	24.3	306.
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				#	#	#	2	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
EPA Region 9 Preliminary Remedial Goals (PRGs) for Tap Water				0.09	0.09	0.92	0.01	9.2	0.01	0.09	365	#	1,825	#	1,460	243	243	#	182	#	#
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water[2]				#	#	#	#	#	#	#	520 •	#	#	#	54 •	#	620 •	#	#	0.031 •	#

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Table H-2 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells, December 1995 to Present
PAHs by EPA Method 8270

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)				Analytical Results ug/l (ppb)																	
				Carcinogenic PAHs							Non-carcinogenic PAHs										
Well Number	Sample Number	Chain of Custody Number	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
MW06-61	951206-MW6-61-01	2708-W010	6-Dec-95	2.7	0.77	0.34	0.73	3.4	ND [a]	0.23	160.	1.4	29.	0.32	24.	48.	250.	200.	24.	8.2	745.
	960319-MW6-61-01	2708-W014	19-Mar-96	1.1	0.33	0.13	0.33	1.4	ND [a]	ND [a]	29.	0.24	9.6	0.13	13.	9.7	66.	53.	13.	3.3	197.
	960620-MW6-61-01	2708-W019	20-Jun-96	1.4	0.48	0.25	0.5	1.5	ND [a]	0.14	21.	0.3	6.1	0.21	9.9	7.5	44.	30.	16.	4.3	139.
	961001-MW6-61-01	2708-W021	1-Oct-96	2.	ND [b]	ND [b]	ND [b]	1.8	ND [b]	ND [b]	16.	ND [b]	4.8	ND [b]	9.9	5.4	76.	25.	12.	3.8	153.
	970225-MW6-61-01	2708-W024	25-Feb-97	ND [c]	ND [c]	ND [c]	ND [c]	ND [c]	ND [c]	ND [c]	32.	ND [c]	4.	ND [c]	3.5	7.7	290.	23.	4.9	0.	365.
	970828-MW6-61-01	2708-W028	28-Aug-97	1.5	0.66	0.23	0.62	1.7	ND [a]	0.17	210.	2.4	17.	0.22	17.	47.	1,000.	130.	23.	4.9	1,452.
MW08-29	951207-MW8-29-01	2708-W011	7-Dec-95	65.	34.	16.	44.	81.	50.	25.	94.	200.	110.	36.	230.	83.	6,000.	400.	220.	315.	7,688.
	960321-MW8-29-01	2708-W016	21-Mar-96	28.	23.	9.8	31.	33.	2.9	16.	140.	260.	56.	23.	98.	89.	6,700.	270.	100.	143.7	7,880.
micro-purge	960619-MW8-29-01	2708-W019	20-Jun-96	1.2	0.88	0.3	1.1	1.2	0.12	0.61	100.	310.	15.	0.88	15.	70.	1,400.	150.	21.	5.4	2,087.
	960619-MW8-29-02	2708-W019	20-Jun-96	2.5	2.4	0.82	3.	2.7	0.3	1.6	26.	49.	5.1	2.3	9.4	14.	2,000.	32.	15.	13.3	2,166.
	961002-MW8-29-01	2708-W022	2-Oct-96	5.4	4.4	1.6	6.2	4.8	ND [b]	3.5	120.	240.	29.	4.5	30.	71.	5,400.	140.	26.	25.9	6,086.
	970226-MW8-29-01	2708-W025	26-Feb-97	3.1	2.1	ND [b]	2.	2.7	ND [b]	ND [b]	120.	250.	17.	ND [b]	22.	52.	5,600.	110.	23.	9.9	6,204.
	970828-MW8-29-01	2708-W028	28-Aug-97	32.	29.	11.	39.	38.	4.7	18.	370.	230.	56.	25.	150.	120.	10,000.	380.	210.	171.7	11,713.
	980218-MW8-29-01	2708-W031	18-Feb-98	4.3	3.7	1.2	4.9	4.1	0.69	3.3	340.	110.	13.	4.	24.	65.	11,000.	150.	32.	22.2	11,760.
	980603-MW8-29-19	2708-W034	3-Jun-98	37.	37.	13.	45.	39.	3.8	21.	420.	130.	51.	30.	140.	120.	10,700.	440.	180.	195.8	12,407.
MW08-56	951207-MW8-56-01	2708-W011	7-Dec-95	25.	14.	60.	17.	30.	ND [c]	10.	130.	250.	53.	15.	110.	86.	20,000.	290.	110.	156.	21,200.
	960321-MW8-56-01	2708-W016	21-Mar-96	68.	66.	23.	74.	83.	7.1	40.	220.	300.	110.	60.	200.	130.	13,300.	580.	240.	361.1	15,501.
	960620-MW8-56-01 [e]	2708-W019	20-Jun-96	6.6	5.7	2.2	7.9	7.3	0.81	4.3	28.	66.	9.8	6.	21.	17.	1,500.	56.	30.	34.8	1,769.
	961002-MW8-56-01	2708-W022	2-Oct-96	26.	24.	ND [d]	27.	22.	ND [d]	15.	120.	230.	42.	20.	92.	74.	10,700.	250.	100.	114.	11,742.
	970226-MW8-56-01	2708-W025	26-Feb-97	ND>20	ND>20	ND>20	ND>20	ND>20	ND>20	ND>20	120.	240.	34.	ND>20	34.	60.	13,000.	160.	44.	0.	13,692.
	970828-MW8-56-01	2708-W028	28-Aug-97	4.1	3.7	1.4	4.4	4.1	ND [b]	2.3	160.	240.	16.	3.	24.	80.	17,400.	170.	28.	20.	18,141.
	980218-MW8-56-01	2708-W031	18-Feb-98	2.6	2.	0.58	2.4	1.8	0.3	1.5	130.	220.	18.	1.7	20.	67.	12,300.	150.	27.	11.2	12,945.
	980603-MW8-56-21	2708-W034	3-Jun-98	13.	13.	5.	15.	13.	1.3	7.5	190.	310.	31.	11.	61.	100.	16,600.	280.	69.	67.8	17,720.
MW09-29	951205-MW9-29-01	2708-W009	5-Dec-95	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.1	0.15	ND [a]	0.12	ND [a]	0.44	0.37	0.11	ND	1.3
	960318-MW9-29-01	2708-W013	18-Mar-96	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.11	ND [a]	0.18	ND [a]	0.29	0.15	ND [a]	0.6	0.27	ND	1.6
	960618-MW9-29-01	2708-W018	18-Jun-96	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.15	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	0.2
	961001-MW9-29-01	2708-W021	1-Oct-96	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.12	ND [a]	ND [a]	ND [a]	0.28	ND [a]	ND [a]	ND	0.4
	970225-MW9-29-01	2708-W024	25-Feb-97	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	970827-MW9-29-01	2708-W027	27-Aug-97	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	980217-MW9-29-01	2708-W030	17-Feb-98	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	980602-MW9-29-07	2708-W033	2-Jun-98	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				#	#	#	2	#	#	#	#	#	#	#	#	#	#	#	#	#	#
EPA Region 9 Preliminary Remedial Goals (PRGs) for Tap Water				0.09	0.09	0.92	0.01	9.2	0.01	0.09	365	#	1,825	#	1,460	243	243	#	182	#	#
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water [3]				#	#	#	#	#	#	#	520 [3]	#	#	#	54 [4]	#	620 [3]	#	#	0.031 [4]	#

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Table H-2 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells, December 1995 to Present
PAHs by EPA Method 8270

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)				Analytical Results ug/l (ppb)																	
				Carcinogenic PAHs							Non-carcinogenic PAHs										
Well Number	Sample Number	Chain of Custody Number	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
MW10-25	951207-MW10-25-01	2708-W011	7-Dec-95	4.	2.9	1.3	3.4	4.6	ND [b]	1.8	31.	88.	16.	2.5	21.	33.	13,000.	85.	22.	18.	13,317.
	960320-MW10-25-01	2708-W015	20-Mar-96	1.3	1.2	0.55	1.4	0.78	ND>0.3	0.67	70.	98.	11.	0.91	8.8	39.	8,800.	86.	6.7	5.9	9,126.
	960617-MW10-25-01	2708-W017	17-Jun-96	1.1	1.2	0.62	1.8	0.87	0.25	0.95	75.	130.	14.	1.1	1.6	49.	9,900.	82.	6.6	6.8	10,266.
	960930-MW10-25-01	2708-W020	30-Sep-96	20.	12.	3.9	15.	19.	1.7	7.	140.	87.	39.	9.9	95.	90.	9,600.	310.	80.	78.6	10,530.
	970224-MW10-25-01	2708-W023	25-Feb-97	21.	13.	3.4	15.	16.	ND [b]	5.9	210.	81.	30.	11.	ND [b]	95.	9,000.	340.	ND>1.0	74.3	9,841.
	970827-MW10-25-01	2708-W027	27-Aug-97	4.4	3.5	1.2	4.3	4.2	ND [b]	2.	72.	59.	11.	2.5	22.	41.	6,700.	100.	20.	19.6	7,047.
	980216-MW10-25-01	2708-W029	16-Feb-98	14.	11.	3.6	12.	11.	1.1	5.4	100.	87.	19.	8.1	59.	62.	8,500.	210.	62.	58.1	9,165.
	980601-MW10-25-02	2708-W032	1-Jun-98	8.2	6.7	1.9	7.	7.2	0.7	3.4	140.	150.	26.	4.8	45.	82.	11,400.	230.	49.	35.1	12,162.
MW10-61	951206-MW10-61-01	2708-W010	6-Dec-95	0.39	ND •	ND •	ND •	0.33	ND •	ND •	39.	17.	12.	ND •	12.	28.	620.	90.	11.	0.7	830.
	960321-MW10-61-01	2708-W016	21-Mar-96	0.75	0.34	0.12	0.36	0.8	ND •	0.18	5.8	2.2	4.7	0.28	7.3	1.5	43.	28.	7.1	2.6	102.
	960620-MW10-61-01	2708-W019	20-Jun-96	0.54	0.24	0.12	0.28	0.68	ND •	0.14	2.1	0.98	2.2	0.22	4.4	0.22	13.	15.	5.4	2.	45.5
	961002-MW10-61-01	2708-W022	2-Oct-96	0.48	0.23	ND •	0.25	0.42	ND •	0.12	0.88	0.54	1.5	0.17	4.1	0.16	4.6	8.5	3.2	1.5	25.2
	970226-MW10-61-01	2708-W025	26-Feb-97	0.41	0.15	ND •	0.13	0.35	ND •	ND •	0.73	0.45	1.	ND •	3.5	0.1	3.3	4.1	3.8	1.	18.
	970828-MW10-61-01	2708-W028	28-Aug-97	0.21	ND •	ND •	ND •	0.18	ND •	ND •	0.33	0.11	0.55	ND •	2.2	ND •	0.78	1.1	2.3	0.4	7.8
	980218-MW10-61-01	2708-W031	18-Feb-98	0.24	0.16	ND •	ND •	ND •	ND •	ND •	0.13	ND •	0.12	ND •	1.1	ND •	0.29	0.22	1.5	0.4	3.8
	980603-MW10-61-16	2708-W034	3-Jun-98	0.42	0.27	0.11	0.27	0.36	ND •	0.12	0.18	ND •	0.13	0.21	1.7	ND •	0.26	0.15	2.	1.6	6.2
MW11-32	951207-MW11-32-01	2708-W011	7-Dec-95	5.5	2.6	1.3	2.8	6.3	ND [b]	1.5	340.	340.	32.	2.2	48.	190.	21,000.	360.	33.	20.	22,365.
	960320-MW11-32-01	2708-W015	20-Mar-96	1.6	1.2	0.49	1.2	1.3	ND>0.5	0.54	200.	180.	20.	0.75	16.	90.	14,000.	150.	13.	6.3	14,676.
	960617-MW11-32-01	2708-W017	17-Jun-96	2.9	2.3	1.	2.8	2.8	0.31	1.4	160.	160.	19.	1.8	19.	90.	11,000.	120.	25.	13.5	11,608.
	960930-MW11-32-01	2708-W020	30-Sep-96	31.	22.	9.9	27.	27.	2.	13.	270.	220.	62.	20.	150.	150.	16,000.	430.	170.	131.9	17,604.
	960930-MW11-32-02	2708-W020	30-Sep-96	41.	36.	14.	40.	33.	3.	22.	270.	250.	74.	31.	200.	180.	17,000.	510.	190.	189.	18,894.
	970224-MW11-32-01	2708-W023	25-Feb-97	4.2	3.2	ND [b]	ND [b]	3.3	ND [b]	ND [b]	150.	140.	1.4	ND [b]	ND [b]	68.	11,000.	140.	26.	10.7	11,536.
	970826-MW11-32-01	2708-W026	26-Aug-97	4.6	3.7	1.3	4.3	4.1	0.5	2.	260.	190.	21.	2.3	37.	120.	16,200.	200.	25.	20.5	17,076.
	980216-MW11-32-01	2708-W029	16-Feb-98	4.1	3.1	1.	3.2	2.9	ND [b]	1.6	150.	120.	16.	2.3	25.	65.	9,200.	140.	25.	15.9	9,759.
	980601-MW11-32-03	2708-W032	1-Jun-98	26.	25.	ND [d]	24.	24.	ND [d]	13.	510.	360.	56.	18.	130.	250.	30,200.	580.	160.	112.	32,376.
MW12-36	951207-MW12-36-01	2708-W011	7-Dec-95	1.5	0.36	0.17	0.22	1.4	ND •	ND •	400.	7.8	21.	0.1	28.	170.	2,500.	230.	17.	3.7	3,378.
	960321-MW12-36-01	2708-W016	21-Mar-96	0.38	ND •	ND •	ND •	0.35	ND •	ND •	250.	3.3	16.	ND •	18.	110.	1,400.	200.	12.	0.7	2,010.
	960620-MW12-36-01	2708-W019	20-Jun-96	0.4	ND •	ND •	ND •	0.4	ND •	ND •	160.	2.4	11.	ND •	18.	81.	1,200.	130.	18.	0.8	1,621.
	961002-MW12-36-01	2708-W022	2-Oct-96	0.47	ND •	ND •	ND •	0.33	ND •	ND •	140.	2.	10.	ND •	25.	59.	990.	130.	18.	0.8	1,375.
	970226-MW12-36-01	2708-W025	26-Feb-97	0.63	ND •	ND •	ND •	0.31	ND •	ND •	100.	1.7	ND •	ND •	24.	40.	760.	88.	18.	0.9	1,033.
	970828-MW12-36-01	2708-W028	28-Aug-97	0.43	ND •	ND •	ND •	0.24	ND •	ND •	79.	1.4	7.7	ND •	19.	33.	620.	61.	18.	0.7	840.
	980218-MW12-36-01	2708-W031	18-Feb-98	0.51	ND •	ND •	ND •	0.18	ND •	ND •	71.	0.78	2.6	ND •	17.	25.	530.	52.	9.2	0.7	708.
	980603-MW12-36-17	2708-W034	3-Jun-98	ND [b]	ND [b]	ND [b]	ND [b]	ND [b]	ND [b]	ND [b]	77.	1.1	5.9	ND [b]	22.	30.	480.	62.	19.	0.	697.
																				0.	
MW-13-30	980217-MW13-30-01	2708-W030	17-Feb-98	ND •	ND •	ND •	ND •	ND •	ND •	ND •	190.	1.6	7.3	ND •	3.5	52.	69.	100.	2.7	ND	426.
	980602-MW13-30-12	2708-W033	2-Jun-98	ND [b]	ND [b]	ND [b]	ND [b]	ND [b]	ND [b]	ND [b]	300.	ND>1	16.	ND [b]	5.1	85.	610.	160.	4.8	ND	1,181.
MW-13-61	980218-MW13-61-01	2708-W031	18-Feb-98	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND	ND
	980602-MW13-61-13	2708-W033	2-Jun-98	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND •	ND	ND
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				#	#	#	2	#	#	#	#	#	#	#	#	#	#	#	#	#	#
EPA Region 9 Preliminary Remedial Goals (PRGs) for Tap Water				0.09	0.09	0.92	0.01	9.2	0.01	0.09	365	#	1,825	#	1,460	243	243	#	182	#	#
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water [a]				#	#	#	#	#	#	#	520 [c]	#	#	#	54 [c]	#	620 [c]	#	#	0.031 [c]	#

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Table H-2 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells, December 1995 to Present
PAHs by EPA Method 8270

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)				Analytical Results ug/l (ppb)																	
				Carcinogenic PAHs							Non-carcinogenic PAHs										
Well Number	Sample Number	Chain of Custody Number	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
Temporary Well Point Samples 1995																					
B-01 at 23 '	950921-BW1-01	2708-W003	21-Sep-95	ND [a]	ND [a]	ND [a]	ND [a]	0.09	ND [a]	ND [a]	7.4	0.22	1.5	ND [a]	1.3	4.5	140.	19.	1.7	**0.1**	176.
B-05 at 28'	950925-BW05-01	2708-W005	29-Sep-95	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	13.	0.14	1.2	ND [a]	1.4	9.8	0.94	6.9	1.4	ND	34.8
B-19 at 28'	950920-BW19-02	2708-W002	20-Sep-95	**0.26**	**0.16**	ND [a]	ND [a]	0.28	ND [a]	ND [a]	39.	7.7	3.1	ND [a]	5.1	20.	**6,500.**	29.	5.6	**0.7**	6,610.
B-21 at 19.5'	951003-BW21-01	2708-W006	3-Oct-95	**0.53**	**0.66**	0.27	**0.34**	0.79	**0.07**	**0.27**	110.	1.83	2.66	0.37	5.04	21.	**560.**	17.	5.42	**2.9**	726.
B-31 at 29'	950925-BW31-01	2708-W004	25-Sep-95	**2.4**	**2.1**	**0.97**	**2.4**	3.9	**0.21**	**1.3**	96.	2.7	15.	1.6	16.	29.	**420.**	76.	25.	**13.3**	695.
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				#	#	#	2	#	#	#	#	#	#	#	#	#	#	#	#	#	#
EPA Region 9 Preliminary Remedial Goals (PRGs) for Tap Water				0.09	0.09	0.92	0.01	9.2	0.01	0.09	365	#	1,825	#	1,460	243	243	#	182	#	#
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water[2]				#	#	#	#	#	#	#	520 [3]	#	#	#	54 [4]	#	620 [3]	#	#	0.031 [4]	#

Note: # = Reference Level not established
EPA = U.S. Environmental Protection Agency
ND = not detected above detection limit indicated
ODEQ = Oregon Department of Environmental Quality

PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ug/l = micrograms per liter
Bold and shaded = Detected above lowest identified Reference Level

a = detection limit is 0.1 ug/l (ppb)
b = detection limit is 1. ug/l (ppb)
c = detection limit is 2. ug/l (ppb)
d = detection limit is 10. ug/l (ppb)

1 = Sample number prefix: 2708-
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (OAR 340-41) based on Fresh Acute, Fresh Chronic (Aquatic Life Protection) and Fish Consumption Only (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
4 = Reference Level based on Human Fish Consumption Criteria of AWQC
5 = Due to mislabeling in the field or due to laboratory misidentification, the laboratory report transposed results for MW4-35 and MW-4-57 in August 1997. Tables attribute data to the correct well.
6 = Results for sample 960620-MW-8-56-01 should be considered qualitative due to an apparent error concerning sample identity with respect to PAH container

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Table H-3 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells
Phenols by EPA Method 8270
December 1995 to Present

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Phenols by EPA Method 8270				Analytical Results ug/l (ppb)															
Well Number	HAI Sample Number [1]	Chain of Custody Number	Sample Date	4-Chloro-3-methylphenol	2-Chlorophenol	2,4-Dichlorophenol	2,4-Dimethylphenol	2,4-Dinitrophenol	2-Methyl-4,6-dinitrophenol	2-Methylphnol (o-cresol)	3 and 4-Methylphenol (cresols)	2-Nitrophenol	4-Nitrophenol	2,3,4,6-Tetrachlorophenol	Pentachlorophenol	Phenol	2,4,5-Trichlorophenol	2,4,6-Trichlorophenol	Total Phenols
MW03-56	951206-MW3-56-01	2708-W010	6-Dec-95	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND
MW04-35	960618-MW4-35-01	2708-W018	18-Jun-96	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND
	961001-MW4-35-01	2708-W021	1-Oct-96	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND
	970225-MW4-35-01	2708-W024	25-Feb-97	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND
	980827-MW4-57-01 [5]	2708-W027	27-Aug-97	ND>50	ND>50	ND>50	ND>20	ND>50	ND>50	ND>50	ND>50	ND>50	ND>50	ND>50	ND>10	ND>10	ND>50	ND>50	ND
	980217-MW4-35-01	2708-W030	17-Feb-98	ND>5.0	ND>5.0	ND>5.0	ND>20	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10	ND>10	ND>5.0	ND>5.0	ND
MW04-57	960620-MW4-57-01	2708-W019	20-Jun-96	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	2.8	ND>5.0	ND>5.0	2.8
	961002-MW4-57-01	2708-W022	2-Oct-96	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10.0	20.	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	9.	ND>5.0	ND>5.0	29.0
	970226-MW4-57-01	2708-W025	26-Feb-97	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	4.8	ND>5.0	ND>5.0	4.8
	970828-MW4-35-01 [5]	2708-W028	28-Aug-97	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>20	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10	4.6	ND>5.0	ND>5.0	4.6
	980218-MW4-57-01	2708-W031	18-Feb-98	ND>5.0	ND>5.0	ND>50	ND>50	ND>200	ND>50	ND>50	ND>50	ND>50	ND>5.0	ND>50	ND>10	47.	ND>50	ND>50	47.0
MW06-32	951207-MW6-32-01	2708-W011	7-Dec-95	ND>50	ND>50	ND>50	ND>50	ND>100	ND>50	ND>50	ND>50	ND>50	ND>50	ND>50	ND>50	ND>50	ND>50	ND>50	ND
MW06-61	951206-MW6-61-01	2708-W010	6-Dec-95	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND
MW08-29	960321-MW8-29-01	2708-W016	21-Mar-96	ND>50	ND>50	ND>50	69.	ND>50	ND>50	29.	15.	ND>50	ND>50	ND>50	ND>50	16.	ND>50	ND>50	129
	960619-MW8-29-02	2708-W019	20-Jun-96	ND>5.0	ND>5.0	ND>5.0	10.	ND>10.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	10
	961002-MW8-29-01	2708-W022	2-Oct-96	ND>500	ND>500	ND>500	ND>500	ND>1,000	ND>500	ND>500	ND>500	ND>500	ND>500	ND>500	ND>500	ND>500	ND>500	ND>500	ND
	970226-MW8-29-01	2708-W025	26-Feb-97	ND>5.0	ND>5.0	ND>5.0	82.	ND>10.0	ND>5.0	9.8	ND>5.0	ND>5.0	2.6	ND>5.0	ND>5.0	5.5	ND>5.0	ND>5.0	100
	970828-MW8-29-01	2708-W028	28-Aug-97	ND>50	ND>50	ND>50	23.	ND>20	ND>50	ND>50	ND>50	ND>50	ND>50	ND>50	ND>10	13.	ND>50	ND>50	36
	980218-MW8-29-01	2708-W031	18-Feb-98	ND>50	ND>50	ND>50	ND>50	ND>200	ND>50	ND>50	ND>50	ND>50	ND>50	ND>50	ND>100	ND>100	ND>50	ND>50	ND
MW10-25	951207-MW10-25-01	2708-W011	7-Dec-95	ND>50	ND>50	ND>50	490.	ND>100	ND>50	1,600.	**930.**	ND>50	ND>50	ND>50	ND>50	470.	ND>50	ND>50	3,490
	960320-MW10-25-01	2708-W015	20-Mar-96	ND>20	ND>20	ND>20	**760.**	ND>20	ND>20	1,300.	**810.**	ND>20	ND>20	ND>20	ND>20	630.	ND>20	ND>20	3,500
	960617-MW10-25-01	2708-W017	17-Jun-96	ND>500	ND>500	ND>500	440.	ND>1000	ND>500	1,100.	**670.**	ND>500	ND>500	ND>500	ND>500	280.	ND>500	ND>500	2,490
	960930-MW10-25-01	2708-W020	30-Sep-96	ND>50	ND>50	ND>50	550.	ND>100	ND>50	**2,800.**	**1,700.**	ND>50	ND>50	ND>50	ND>50	1,000.	ND>50	ND>50	6,050
	970224-MW10-25-01	2708-W023	25-Feb-97	ND>5,000	ND>5,000	ND>5,000	ND>5,000	ND>10,000	ND>5,000	ND>5,000	ND>5,000	ND>5,000	ND>5,000	ND>5,000	ND>5,000	ND>5,000	ND>5,000	ND>5,000	ND>5,000
	970827-MW10-25-01	2708-W027	27-Aug-97	ND>20	ND>20	ND>20	350.	ND>100	ND>20	730.	**1,200.**	ND>20	ND>20	ND>20	ND>50	680.	ND>20	ND>20	2,960
	980216-MW10-25-01	2708-W029	16-Feb-98	ND>50	ND>50	ND>50	250.	ND>200	ND>50	650.	**930.**	ND>50	ND>50	ND>50	ND>100	790.	ND>50	ND>50	2,620
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water				#	38.4	110	730	73	#	1,825	183	#	#	1,095	0.56	21,900	3,650	6.1	#
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water [2]				#	2,000 [4]	365 [4]	2,120 [3]	#	#	#	#	150 [4]	150 [4]	#	13 [4]	2,560 [4]	#	970 [4]	#

Note: EPA = U.S. Environmental Protection Agency
ND = Not detected above detection limit indicated
ppb = parts per billion
ug/l = micrograms/liter
= Reference Levels not established
Bold and shaded = Detected above lowest identified Reference Level

1 = Sample number prefix: 2708-
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (OAR 340-41) based on Fresh Acute, Fresh Chronic (Aquatic Life Protection) and Fish Consumption Only (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Acute Criteria of AWQC
4 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
5 = Due to mislabeling in the field or due to laboratory misidentification, the laboratory report transposed results for MW4-35 and MW-4-57 in August 1997. Tables attribute data to the correct well.

Koppers022793

Table H-3 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells
Phenols by EPA Method 8270
December 1995 to Present

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Phenols by EPA Method 8270				Analytical Results ug/l (ppb)																
Well Number	HAI Sample Number [1]	Chain of Custody Number	Sample Date	4-Chloro-3-methylphenol	2-Chlorophenol	2,4-Dichlorophenol	2,4-Dimethylphenol	2,4-Dinitrophenol	2-Methyl-4,6-dinitrophenol	2-Methylphnol (o-cresol)	3 and 4-Methylphenol (cresols)	2-Nitrophenol	4-Nitrophenol	2,3,4,6-Tetrachlorophenol	Pentachlorophenol	Phenol	2,4,5-Trichlorophenol	2,4,6-Trichlorophenol	Total Phenols
MW10-61	951206-MW10-61-01	2708-W010	6-Dec-95	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND
	960620-MW10-61-01	2708-W019	20-Jun-96	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND
	960930-MW10-61-01	2708-W022	2-Oct-96	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND
	970226-MW10-61-01	2708-W025	26-Feb-97	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	8.4	ND>5.0	ND>5.0	8.4
	970828-MW10-61-01	2708-W028	28-Aug-97	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>20	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10	ND>10	ND>5.0	ND>5.0	ND
	980218-MW10-61-01	2708-W031	18-Feb-98	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>20	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10	ND>10	ND>5.0	ND>5.0	ND
MW11-32	951207-MW11-32-01	2708-W011	7-Dec-95	ND>50	ND>50	ND>50	**1,200.**	ND>100	ND>50	1,200.	**590.**	ND>50	ND>50	ND>50	ND>50	120.	ND>50	ND>50	3,110
	960320-MW11-32-01	2708-W015	20-Mar-96	ND>20	ND>20	ND>20	**820.**	ND>20	ND>20	540.	**230.**	ND>20	ND>20	ND>20	ND>20	60.	ND>20	ND>20	1,650
	960617-MW11-32-01	2708-W017	17-Jun-96	ND>500	ND>500	ND>500	540.	ND>1,000	ND>500	420.	170.	ND>500	ND>500	ND>500	ND>500	ND>500	ND>500	ND>500	1,130
	960930-MW11-32-01	2708-W020	30-Sep-96	ND>100	ND>100	ND>100	650.	ND>200	ND>100	960.	**540.**	ND>100	ND>100	ND>100	ND>100	71.	ND>100	ND>100	2,221
	970224-MW11-32-01	2708-W023	25-Feb-97	ND>500	ND>500	ND>500	ND>500	ND>1,000	ND>500	240.	ND>500	ND>500	ND>500	ND>500	ND>500	ND>500	ND>500	ND>500	240
	970826-MW11-32-01	2708-W026	26-Aug-97	ND>20	ND>20	ND>20	600.	ND>100	ND>20	210.	120.	ND>20	ND>20	ND>20	ND>50	31.	ND>20	ND>20	961
	980216-MW11-32-01	2708-W029	16-Feb-98	ND>50	ND>50	ND>50	200.	ND>200	ND>50	130.	120.	ND>50	ND>50	ND>50	ND>100	ND>100	ND>50	ND>50	450
MW12-36	960321-MW12-36-01	2708-W016	21-Mar-96	ND>5	ND>5	ND>5	ND>5	ND>10	ND>5	ND>5	ND>5	ND>5	ND>5	ND>5	ND>5	ND>5	ND>5	ND>5	ND
Temporary Well Point Samples 1995																			
B-19 at 28'	950920-BW19-02	2708-W002	20-Sep-95	ND>5.0	ND>5.0	ND>5.0	120.	ND>10	ND>5.0	27.	ND>5.0	ND>5.0	ND>5.0	ND>5.0	1.5	16.	ND>5.0	ND>5.0	165
B-21 at 19.5'	951003-BW21-01	2708-W006	3-Oct-95	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>10	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water				#	38.4	110	730	73	#	1,825	183	#	#	1,095	0.56	21,900	3,650	6.1	#
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water[2]				#	2,000 [4]	365 [4]	2,120 [3]	#	#	#	#	150 [4]	150 [4]	#	13 [4]	2,560[4]	#	970[4]	#

Note: EPA = U.S. Environmental Protection Agency
ND = Not detected above detection limit indicated
1 = Sample number prefix: 2708-
ppb = parts per billion
ug/l = micrograms/liter
= Reference Levels not established
Bold and shaded = Detected above lowest identified Reference Level
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (OAR 340-41) based on Fresh Acute, Fresh Chronic (Aquatic Life Protection) and Fish Consumption Only (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Acute Criteria of AWQC
4 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
5 = Due to mislabeling in the field or due to laboratory misidentification, the laboratory report transposed results for MW4-35 and MW-4-57 in August 1997. Tables attribute data to the correct well.

Koppers022794

Table H-4 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells
Detected Volatiles by EPA Method 8260
December 1995 to Present

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Detected Volatiles by EPA Method 8260				Analytical Results ug/l (ppb)															
Well Number	HAI Sample Number	Chain of Custody Number	Sample Date	Benzene	Toluene	Ethyl benzene	m,p-Xylene	o-Xylene	Xylene (total)	Naphthalene	Styrene	sec-Butylbenzene	Isopropylbenzene	p-Isopropyltoluene	n-Propylbenzene	1,2,3-Trimethylbenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Tetrachloroethene
MW4-57	960321-MW4-57-01	2708-W016	21-Mar-96	**3,700.**	**35.**	540.	80.	140.	220.	**1,700.**	ND>10	ND>10	ND>10	ND>10	ND>10	22.	19.	13.	ND>10
MW5-32	951205-MW5-32-01	2708-W009	5-Dec-95	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	11.	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0	ND>5.0
MW8-56	951207-MW8-56-01	2708-W011	7-Dec-95	**18,600.**	**1,400.**	590.	600.	200.	800.	**13,300.**	ND>100	ND>100	ND>100	ND>100	ND>100	ND>100	110.	ND>100	ND>100
MW11-32	960320-MW11-32-01	2708-W015	20-Mar-96	**16,700.**	**3,300.**	620.	840.	400.	1,240.	**8,600.**	ND>2	9.	**42.**	35.	18.	110.	250.	79.	2.2
	960617-MW11-32-01	2708-W017	17-Jun-96	**2,800.**	**2,000.**	**1,000.**	1,300.	640.	**1,940.**	**4,100.**	ND>5	10.	**70.**	ND>5	17.	100.	260.	82.	ND>5
	960617-MW11-32-02	2708-W017	17-Jun-96	**4,100.**	**2,600.**	**960.**	1,200.	580.	**1,780.**	**5,600.**	ND>10	8.8	**59.**	ND>10	14.	86.	220.	70.	ND>10
	960930-MW11-32-01	2708-W020	30-Sep-96	**17,000.**	**3,300.**	**900.**	1,200.	560.	**1,760.**	**13,900.**	ND>1,200	ND>1,200	ND>1,200	ND>1,200	ND>1,200	ND>1,200	ND>1,200	ND>1,200	ND>1,200
MW12-36	951207-MW12-36-01	2708-W011	7-Dec-95	**92.**	**510.**	150.	460.	170.	630.	**2,300.**	100.	ND>50	ND>50	ND>50	ND>50	36.	88.	57.	ND>50
	960321-MW12-36-01	2708-W016	21-Mar-96	**210.**	220.	140.	310.	180.	490.	**1,900.**	**130.**	ND>10	ND>10	ND>10	ND>10	22.	51.	37.	ND>10
	960620-MW12-36-01	2708-W019	20-Jun-96	**250.**	250.	120.	280.	160.	440.	**1,500.**	**140.**	ND>10	ND>10	ND>10	ND>10	16.	42.	13.	ND>10
	961002-MW12-36-01	2708-W022	2-Oct-96	**330.**	390.	130.	330.	180.	510.	**1,100.**	**170.**	ND>50	ND>50	ND>50	ND>50	18.	42.	14.	ND>50
	970226-MW12-36-01	2708-W025	26-Feb-97	**260.**	310.	120.			470.	**960.**	**150.**	ND>1.0	4.	1.	3.	ND>1.0	31.	11.	ND>1.0
	970828-MW12-36-01	2708-W028	28-Aug-97	**230.**	**430.**	110.	280.	150.	430.	**820.**	**150.**	ND>1.0	4.2	1.9	2.8	12.	30.	8.5	ND>1.0
	980218-MW12-36-01	2708-W031	18-Feb-98	**140.**	370.	82.	180.	100.	280.	**530.**	94.	ND>1.0	2.2	1.1	1.8		22.	6.2	ND>1.0
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				5.0	1,000	700	10,000	10,000	10,000	#	100	#	#	#	#	#	#	#	5
EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water				0.39	723	1,340	1,431	1,431	1,431	243	1,641	#	18.5	#	#	#	#	#	1.08
DEQ Ambient Water Quality Criteria (AWQC) for Surface Water[2]				40 [4]	424 [4]	1,400 [4]	#	#	#	620 [3]	#	#	#	#	#	#	#	#	8.85 [4]

Note: EPA = U.S. Environmental Protection Agency
ND = Not detected above detection limit indicated
ODEQ = Oregon Department of Environmental Quality

ppb = parts per billion
ug/l = micrograms per liter

Bold and shaded = Detected above Reference Level
= Reference Level not established

1 = Sample number prefix: 2708-
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (OAR 340-41) based on Fresh Acute, Fresh Chronic (Aquatic Life Protection) and Fish Consumption Only (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
4 = Reference Level based on Human Fish Consumption Criteria of AWQC

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Table H-5 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells, December 1995 to Present
Priority Pollutant Metals by EPA Methods 6010, 200.7 and/or 7000 Series

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Priority Pollutant Metals by EPA Methods 6010, 7000, and 200 Series				Analytical Results mg/l (ppm)																	
Well Number	HAI Sample Number [1]	Chain of Custody Number	Sample Date	Antimony	Arsenic	Dissolved Arsenic	Beryllium	Cadmium	Dissolved Cadmium	Chromium	Dissolved Chromium	Copper	Lead	Dissolved Lead	Mercury	Nickel	Dissolved Nickel	Selenium	Silver	Thallium	Zinc
MW01-22	951207-MW1-22-01	2708-W011	7-Dec-95										0.041	ND [c]							
	960319-MW1-22-01	2708-W014	19-Mar-96	ND [c]	ND [c]		ND [b]	ND [b]		0.01		ND [c]	0.007	ND [c]	ND [a]	0.14	0.23	ND [b]	ND [b]	ND [d]	0.066
	960618-MW1-22-01	2708-W018	18-Jun-96		ND [c]					ND [c]		ND [c]	ND [c]			0.039					0.024
	961001-MW1-22-01	2708-W021	1-Oct-96		ND [c]					0.023	0.022	ND [c]	ND [c]	ND [c]		0.16	0.14				0.17
	970225-MW1-22-01	2708-W024	25-Feb-97		ND [c]					ND [c]		ND [c]	ND [c]			0.045					0.028
	970225-MW1-22-02	2708-W024	25-Feb-97		ND [c]					ND [c]		ND [c]	ND [c]			0.044					0.024
	970827-MW1-22-01	2708-W027	27-Aug-97		0.012					0.018		0.01	0.027	ND [c]		0.1	0.083				0.16
	970827-MW1-22-02	2708-W027	27-Aug-97		ND [c]					ND [c]		ND [c]	ND [c]	ND [c]		0.12	0.081				0.53
	980217-MW1-22-01	2708-W030	17-Feb-98		0.009					ND [c]		0.007	0.015	ND [c]		0.011					0.05
	980602-MW1-32-11	2708-W033	2-Jun-98		0.031					0.006			0.03	ND [c]		0.026					0.13
MW02-32	951206-MW2-32-01	2708-W010	6-Dec-95										ND [c]								
	960618-MW2-32-01	2708-W018	18-Jun-96		ND [c]					ND [c]		ND [c]	ND [c]			0.008					ND [c]
	961001-MW2-32-01	2708-W021	1-Oct-96		ND [c]					ND [c]		0.008	ND [c]			0.005					0.01
	970225-MW2-32-01	2708-W024	25-Feb-97		0.008					ND [c]		ND [c]	ND [c]			0.011					0.007
	970827-MW2-32-01	2708-W027	27-Aug-97		0.007					ND [c]		ND [c]	ND [c]			0.008					0.008
	980217-MW2-32-01	2708-W030	17-Feb-97		ND [c]					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	980601-MW2-32-05	2708-W032	1-Jun-98		ND [c]					ND [c]						0.006					
MW03-26	951206-MW3-26-01	2708-W010	6-Dec-95										0.007	ND [c]							
	960318-MW3-26-02	2708-W013	18-Mar-96		ND [c]			ND [b]		ND [c]		ND [c]	ND [c]			0.36	0.4				0.005
	960618-MW3-26-01	2708-W018	18-Jun-96		ND [c]					ND [c]		ND [c]	ND [c]			0.33	0.39				0.014
	961001-MW3-26-01	2708-W021	1-Oct-96		0.026					0.44	ND [c]	0.41	0.11	ND [c]		1.5	0.15				0.98
	970225-MW3-26-01	2708-W024	25-Feb-97		ND [c]					0.006		ND [c]	ND [c]			0.27	0.2				0.017
	970827-MW3-26-01	2708-W027	27-Aug-97		0.031					0.39	ND [c]	0.38	0.099	ND [c]		1.4	0.05				0.71
	980218-MW3-26-01	2708-W031	18-Feb-98		ND [c]					0.017		0.009	0.007			0.21	0.15				0.04
	980602-MW3-26-09	2708-W033	2-Jun-98		ND [c]					ND [c]		0.008	0.005			0.29					0.028
MW03-56	951206-MW3-56-01	2708-W010	6-Dec-95	ND [c]	ND [c]		ND [b]	ND [b]		ND [c]		ND [c]	ND [c]		ND [a]	0.007		ND [c]	ND [c]	ND [d]	0.005
	960319-MW3-56-01	2708-W014	19-Mar-96		ND [c]			ND [b]		ND [c]		ND [c]	ND [c]			0.013					ND [c]
	980602-MW3-56-14	2708-W033	2-Jun-98		ND [c]					0.007						0.017					
MW04-35	951206-MW4-35-01	2708-W010	6-Dec-95										ND [c]								
	960618-MW4-35-01	2708-W018	18-Jun-96		ND [c]					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	961001-MW4-35-01	2708-W021	1-Oct-96		0.007					ND [c]		ND [c]	ND [c]			ND [c]					0.008
	970225-MW4-35-01	2708-W024	25-Feb-97		0.006					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	980827-MW4-57-01 [5]	2708-W027	27-Aug-97		ND [c]					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	980217-MW4-35-01	2708-W030	17-Feb-98		ND [c]					0.007		ND [c]	ND [c]			0.005					0.005
	980601-MW4-35-06	2708-W032	1-Jun-98		ND [c]					ND [c]						ND [c]					
MW04-57	951205-MW4-57-01	2708-W009	5-Dec-95										ND [c]								
	960321-MW4-57-01	2708-W016	21-Mar-96		0.005			ND [b]		ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	960620-MW4-57-02	2708-W019	20-Jun-96		0.007					ND [c]		ND [c]	ND [c]			0.005					ND [c]
	961002-MW4-57-01	2708-W022	2-Oct-96		0.013					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	970226-MW4-57-01	2708-W025	26-Feb-97		0.01					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	970828-MW4-35-01 [5]	2708-W028	28-Aug-97		0.013					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	980218-MW4-57-01	2708-W031	18-Feb-98		0.011					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	980603-MW4-57-18	2708-W034	3-Jun-98		0.011					ND [c]						ND [c]					
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				0.006	0.05	0.05	0.004	0.005	0.005	0.1	0.1	1	0.15	0.15	0.002	0.1	0.1	0.05	0.1	0.002	5
EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water				0.0146	0.00004	0.00004	0.00002	0.018	0.018	0.183	0.183	1.356	0.004	0.004	#	0.73	0.73	0.183	0.183	0.0029	10.95
ODEQ Ambient Water Quality Criteria (AWQC) for Surface Water [2]				1.6 [3]	0.000017 [4]	0.000017 [4]	0.000117 [4]	0.0011 [3]	0.0011 [3]	0.011 [3]	0.011 [3]	0.012 [3]	0.0032 [3]	0.0032 [3]	0.000012 [3]	0.1 [4]	0.1 [4]	0.035 [3]	0.00012 [3]	0.04 [3]	0.11 [3]

Koppers022796

Table H-5 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells, December 1995 to Present
Priority Pollutant Metals by EPA Methods 6010, 200.7 and/or 7000 Series

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Priority Pollutant Metals by EPA Methods 6010, 7000, and 200 Series				Analytical Results mg/l (ppm)																	
Well Number	HAI Sample Number	Chain of Custody Number	Sample Date	Antimony	Arsenic	Dissolved Arsenic	Beryllium	Cadmium	Dissolved Cadmium	Chromium	Dissolved Chromium	Copper	Lead	Dissolved Lead	Mercury	Nickel	Dissolved Nickel	Selenium	Silver	Thallium	Zinc
MW05-32	951205-MW5-32-01	2708-W009	5-Dec-95										ND [c]								
	960620-MW5-32-01	2708-W019	20-Jun-96		ND [c]					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	961001-MW5-32-01	2708-W021	1-Oct-96		0.008					0.11	ND [c]	0.22	0.029	ND [c]		0.086					0.4
	970225-MW5-32-01	2708-W024	25-Feb-97		ND [c]					ND [c]		ND [c]	ND [c]			ND [c]					0.006
	970827-MW5-32-01	2708-W027	27-Aug-97		ND [c]					0.011		0.012	ND [c]			0.012					0.024
	980217-MW5-32-01	2708-W030	17-Feb-98		ND [c]					0.022		0.01	ND [c]			0.011					0.016
	980602-MW5-32-10	2708-W033	2-Jun-98		ND [c]					0.022						0.023					
MW06-32	951207-MW6-32-01	2708-W011	7-Dec-95	ND [c]	0.015		ND [b]	ND [b]		ND [c]		ND [c]	ND [c]		ND [a]	ND [c]		ND [c]	ND [c]	ND [d]	ND [c]
	960319-MW6-32-01	2708-W014	19-Mar-96		0.011			ND [b]		ND [c]		ND [c]	ND [c]			ND [c]					0.005
	960617-MW6-32-01	2708-W017	17-Jun-96		0.011					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	960930-MW6-32-01	2708-W020	30-Sep-96		0.007					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	970224-MW6-32-01	2708-W023	25-Feb-97		0.008					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	970826-MW6-32-01	2708-W026	26-Aug-97		0.007					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	980216-MW6-32-01	2708-W029	16-Feb-98		0.009					ND [c]		ND [c]	ND [c]			ND [c]					0.005
MW06-61	951206-MW6-61-01	2708-W010	6-Dec-95										ND [c]								
	960319-MW6-61-01	2708-W014	19-Mar-96	ND [c]	ND [c]			ND [c]		0.005		ND [c]	ND [c]			ND [c]					0.015
	960620-MW6-61-01	2708-W019	20-Jun-96		ND [c]					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	961001-MW6-61-01	2708-W021	1-Oct-96		0.006					ND [c]		0.01	ND [c]			ND [c]					0.01
	970225-MW6-61-01	2708-W024	25-Feb-97		0.006					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	970828-MW6-61-01	2708-W028	28-Aug-97		0.007					0.014		0.018	ND [c]			0.012					0.2
MW08-29	951207-MW8-29-01	2708-W011	7-Dec-95	ND [c]	ND [c]		ND [b]	ND [b]		0.031		0.023	0.011		ND [a]	0.075		ND [c]	ND [c]	ND [d]	0.3
	960321-MW8-29-01	2708-W016	21-Mar-96		ND [c]			ND [c]		0.008		0.005	ND [c]			0.015					0.26
	960619-MW8-29-02	2708-W019	20-Jun-96		ND [c]					ND [c]		ND [c]	ND [c]			0.008					0.014
	961002-MW8-29-01	2708-W022	2-Oct-96		ND [c]					ND [c]		ND [c]	ND [c]			0.008					ND [c]
	970226-MW8-29-01	2708-W025	26-Feb-97		ND [c]					ND [c]		ND [c]	ND [c]			0.007					0.01
	970828-MW8-29-01	2708-W028	28-Aug-97		ND [c]					ND [c]		ND [c]	ND [c]			0.011					0.2
	980218-MW8-29-01	2708-W031	18-Feb-98		ND [c]					ND [c]		ND [c]	ND [c]			0.009					0.21
MW08-56	951207-MW8-56-01	2708-W011	7-Dec-95	ND [c]	ND [c]		ND [b]	ND [b]		0.048		0.009	ND [c]		ND [a]	0.035		ND [c]	ND [c]	ND [d]	0.27
	960321-MW8-56-01	2708-W016	21-Mar-96		ND [c]			ND [b]		0.021		0.009	ND [c]			0.02					0.24
	960620-MW8-56-01	2708-W019	20-Jun-96		ND [c]					ND [c]		0.15	ND [c]			0.017					0.1
	961002-MW8-56-01	2708-W022	2-Oct-96		ND [c]					0.02		0.027	ND [c]			0.071					0.023
	970226-MW8-56-01	2708-W025	26-Feb-97		ND [c]					0.07		0.026	0.005			0.052					0.05
	970828-MW8-56-01	2708-W028	28-Aug-97		0.006					ND [c]		ND [c]	ND [c]			ND [c]					0.007
	980218-MW8-56-01	2708-W031	18-Feb-98		0.006					0.027		0.017	ND [c]			0.02					0.22
MW09-29	951205-MW9-29-01	2708-W009	5-Dec-95										0.022								
	960318-MW9-29-01	2708-W013	18-Mar-96	ND [c]	ND [c]		ND [b]	ND [b]		ND [c]		ND [c]	ND [c]		ND [a]	ND [c]		ND [c]	ND [c]	ND [d]	ND [c]
	960618-MW9-29-01	2708-W018	18-Jun-96		0.01					0.23		0.3	0.008			0.16	ND [c]				0.097
	961001-MW9-29-01	2708-W021	1-Oct-96		ND [c]					0.047		0.015	ND [c]			0.035					0.037
	970225-MW9-29-01	2708-W024	25-Feb-97		0.006					0.021		0.005	ND [c]			0.018					0.022
	970827-MW9-29-01	2708-W027	27-Aug-97		ND [c]					0.035		0.009	ND [c]			0.029					0.03
	980217-MW9-29-01	2708-W030	17-Feb-98		0.005					0.021		0.019	ND [c]			0.022					0.25
	980602-MW9-29-07	2708-W033	2-Jun-98		0.01					0.037						0.04					
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				0.006	0.05	0.05	0.004	0.005	0.005	0.1	0.1	1	0.15	0.15	0.002	0.1	0.1	0.05	0.1	0.002	5
EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water				0.0146	0.00004	0.00004	0.00002	0.018	0.018	0.183	0.183	1.356	0.004	0.004	#	0.73	0.73	0.183	0.183	0.0029	10.95
ODEQ Ambient Water Quality Criteria (AWQC) for Surface Water [2]				1.6 [3]	0.000017 [4]	0.000017 [4]	0.000117 [4]	0.0011 [3]	0.0011 [3]	0.011 [3]	0.011 [3]	0.012 [3]	0.0032 [3]	0.0032 [3]	0.000012 [3]	0.1 [4]	0.1 [4]	0.035 [3]	0.00012 [3]	0.04 [3]	0.11 [3]

Koppers022797

Table H-5 - Summary of Historical Analytical Results for Groundwater Samples - Monitoring Wells, December 1995 to Present
Priority Pollutant Metals by EPA Methods 6010, 200.7 and/or 7000 Series

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

Priority Pollutant Metals by EPA Methods 6010, 7000, and 200 Series				Analytical Results mg/l (ppm)																	
Well Number	HAI Sample Number [1]	Chain of Custody Number	Sample Date	Antimony	Arsenic	Dissolved Arsenic	Beryllium	Cadmium	Dissolved Cadmium	Chromium	Dissolved Chromium	Copper	Lead	Dissolved Lead	Mercury	Nickel	Dissolved Nickel	Selenium	Silver	Thallium	Zinc
MW10-25	951207-MW10-25-01	2708-W011	7-Dec-95	ND [c]	0.034		ND [b]	0.005		0.11		ND [c]	ND [c]		ND [a]	0.29		ND [c]	ND [c]	ND [d]	0.95
	960320-MW10-25-01	2708-W015	20-Mar-96		0.035			0.005	ND [b]	0.089		ND [c]	ND [d]			0.28	0.3				0.86
	960617-MW10-25-01	2708-W017	17-Jun-96		0.028					0.043		ND [c]	ND [c]			0.2					0.48
	960930-MW10-25-01	2708-W020	30-Sep-96		0.041					0.13		ND [c]	ND>0.02			0.43					1.3
	970224-MW10-25-01	2708-W023	25-Feb-97		0.058	0.052				0.17	0.16	ND [c]	ND [c]			0.41	0.37				1.3
	970827-MW10-25-01	2708-W027	27-Aug-97		0.045					0.36	0.23	ND [c]	ND [c]	ND [a]		0.83	0.53				3.
	980216-MW10-25-01	2708-W029	16-Feb-98		0.048					0.16	0.18	ND [c]	ND>0.015			0.39	0.46				1.5
	980601-MW10-25-02	2708-W032	1-Jun-98		0.031					0.12	0.12					0.29	0.28				
MW10-61	951206-MW10-61-01	2708-W010	6-Dec-95										ND [c]								
	960321-MW10-61-01	2708-W016	21-Mar-96		0.005			ND [b]		0.027		0.009	ND [c]			0.022					0.025
	960620-MW10-61-01	2708-W019	20-Jun-96		ND [c]					ND [c]		ND [c]	ND [c]			0.007					0.008
	960930-MW10-61-01	2708-W022	2-Oct-96		0.006					0.016		ND [c]	ND [c]			0.011					0.012
	970226-MW10-61-01	2708-W025	26-Feb-97		ND [c]					0.018		ND [c]	ND [c]			0.015					0.015
	970828-MW10-61-01	2708-W028	28-Aug-97		ND [c]					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	980218-MW10-61-01	2708-W031	18-Feb-98		ND [c]					0.01		ND [c]	ND [c]			0.009					0.015
	980603-MW10-61-16	2708-W034	3-Jun-98		0.006					0.009						0.009					
MW11-32	951207-MW11-32-01	2708-W011	7-Dec-95	ND [c]	ND [c]		ND [b]	ND [b]		ND [c]		ND [c]	ND [c]		ND [a]	ND [c]		ND [c]	ND [c]	ND [d]	ND [c]
	960320-MW11-32-01	2708-W015	20-Mar-96		ND [c]			ND [b]		ND [c]		ND [c]	ND [c]			ND [c]					0.008
	960930-MW11-32-01	2708-W020	30-Sep-96		ND [c]			ND [c]		ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	960930-MW11-32-02	2708-W020	30-Sep-96		ND [c]			ND [c]		ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	970224-MW11-32-01	2708-W023	25-Feb-97		ND [c]					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	970826-MW11-32-01	2708-W026	26-Aug-97		ND [c]					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
	980216-MW11-32-01	2708-W029	16-Feb-98		ND [c]					ND [c]		ND [c]	ND [c]			ND [c]					ND [c]
MW12-36	951207-MW12-36-01	2708-W011	7-Dec-95	ND [c]	ND [c]		ND [b]	ND [b]		ND [c]		0.006	ND [c]		ND [a]	ND [c]		ND [c]	ND [c]	ND [d]	0.012
MW13-30	980602-MW13-30-12	2708-W033	2-Jun-98		0.015					0.009		0.007	ND [c]			0.008					0.008
MW13-61	980602-MW13-61-13	2708-W033	2-Jun-98		0.007					0.013		0.015	ND [c]			0.017					0.028
EPA Maximum Contaminant Levels (MCLs) for Drinking Water				0.006	0.05	0.05	0.004	0.005	0.005	0.1	0.1	1	0.15	0.15	0.002	0.1	0.1	0.05	0.1	0.002	5
EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water				0.0146	0.00004	0.00004	0.00002	0.018	0.018	0.183	0.183	1.356	0.004	0.004	#	0.73	0.73	0.183	0.183	0.0029	10.95
ODEQ Ambient Water Quality Criteria (AWQC) for Surface Water [2]				1.6 [3]	0.000017 [4]	0.000017 [4]	0.000117 [4]	0.0011 [3]	0.0011 [3]	0.011 [3]	0.011 [3]	0.012 [3]	0.0032 [3]	0.0032 [3]	0.000012 [3]	0.1 [4]	0.1 [4]	0.035 [3]	0.00012 [3]	0.04 [3]	0.11 [3]

Note:
EPA = U.S. Environmental Protection Agency
mg/l = milligrams/liter
ND = not detected above detection limit indicated
ODEQ = Oregon Department of Environmental Quality
ppm = parts per million

a = detection limit is 0.0002 mg/l (ppm)
b = detection limit is 0.002 mg/l (ppm)
c = detection limit is 0.005 mg/l (ppm)
d = detection limit is 0.01 mg/l (ppm)
e = detection limit is 0.05 mg/l (ppm)

= Reference Levels not established
Bold and shaded = Detected above lowest identified Reference Level

1 = Sample number prefix: 2708-
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (OAR 340-41) based on Fresh Acute, Fresh Chronic (Aquatic Life Protection) and Fish Consumption Only (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
4 = Reference Level based on Human Fish Consumption Criteria of AWQC
5 = Due to mislabeling in the field or due to laboratory misidentification, the laboratory report transposed results for MW4-35 and MW-4-57 in August 1997. Tables attribute data to the correct well.

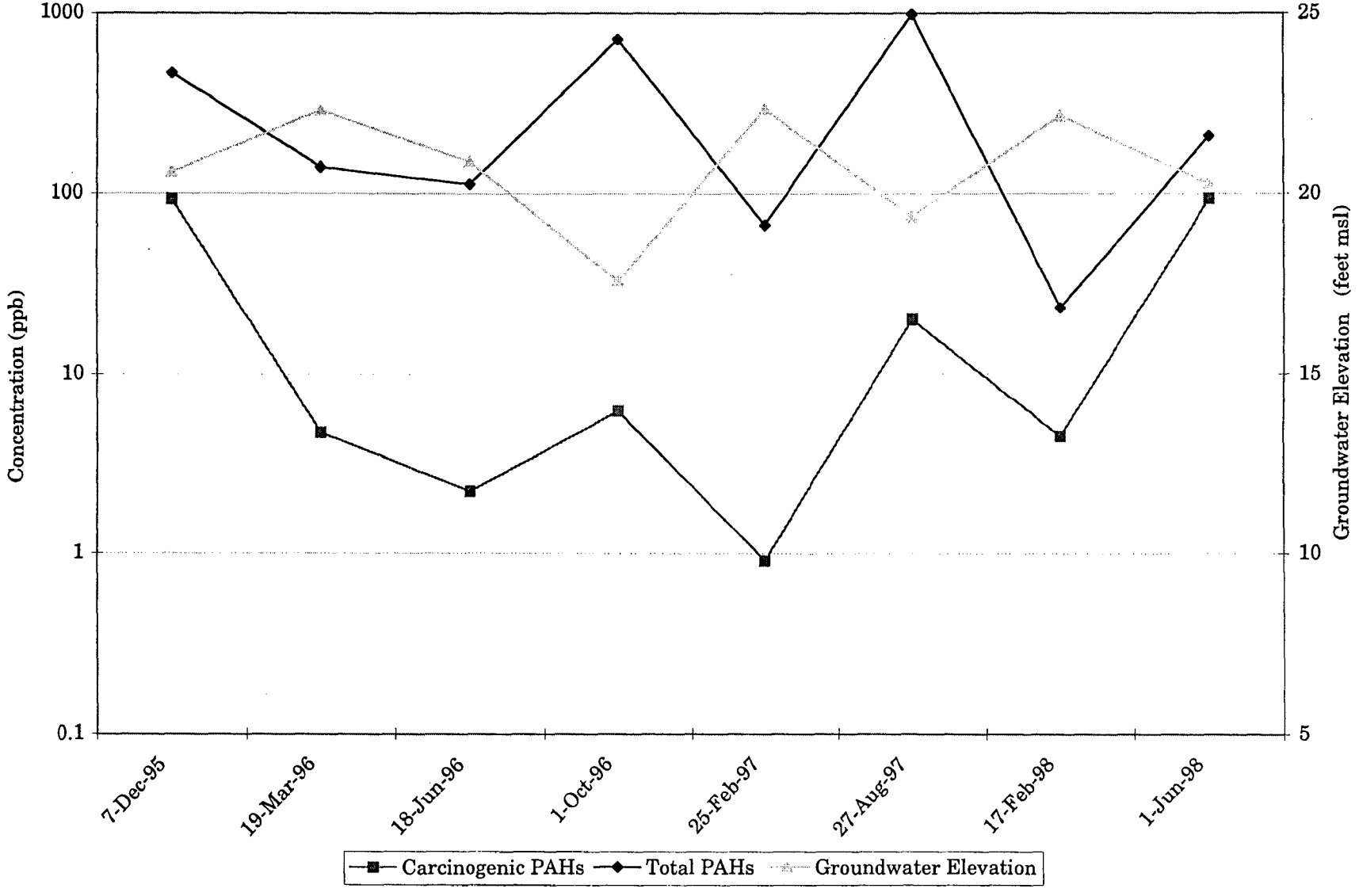
Koppers022798

Time -Concentration Charts
Polynuclear Aromatic Hydrocarbon Concentrations in Groundwater

HAHN AND ASSOCIATES, INC.

Koppers022799

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-1-26
Northwest Natural - Gasco Facility



Koppers022800

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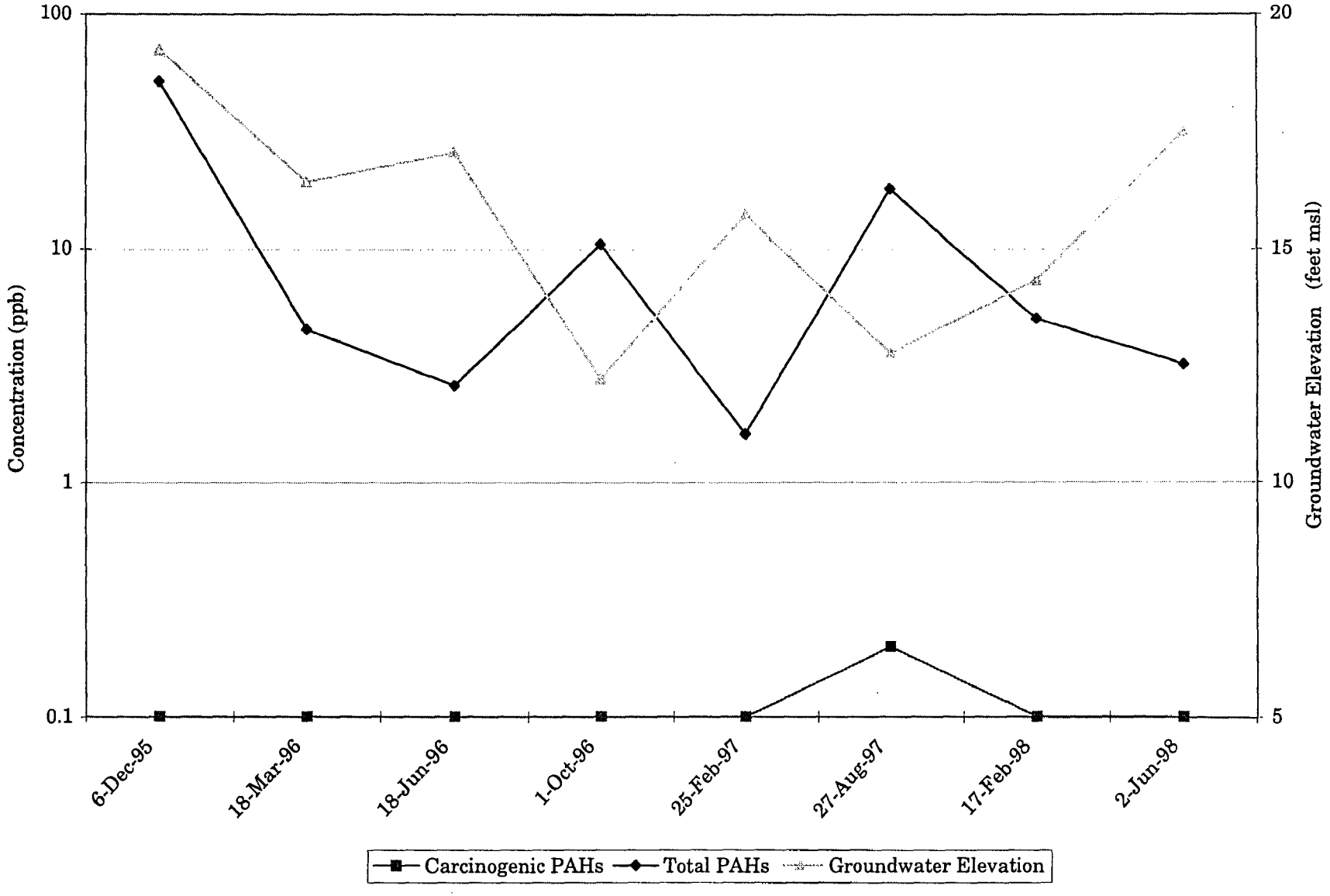
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-2-32
Northwest Natural - Gasco Facility

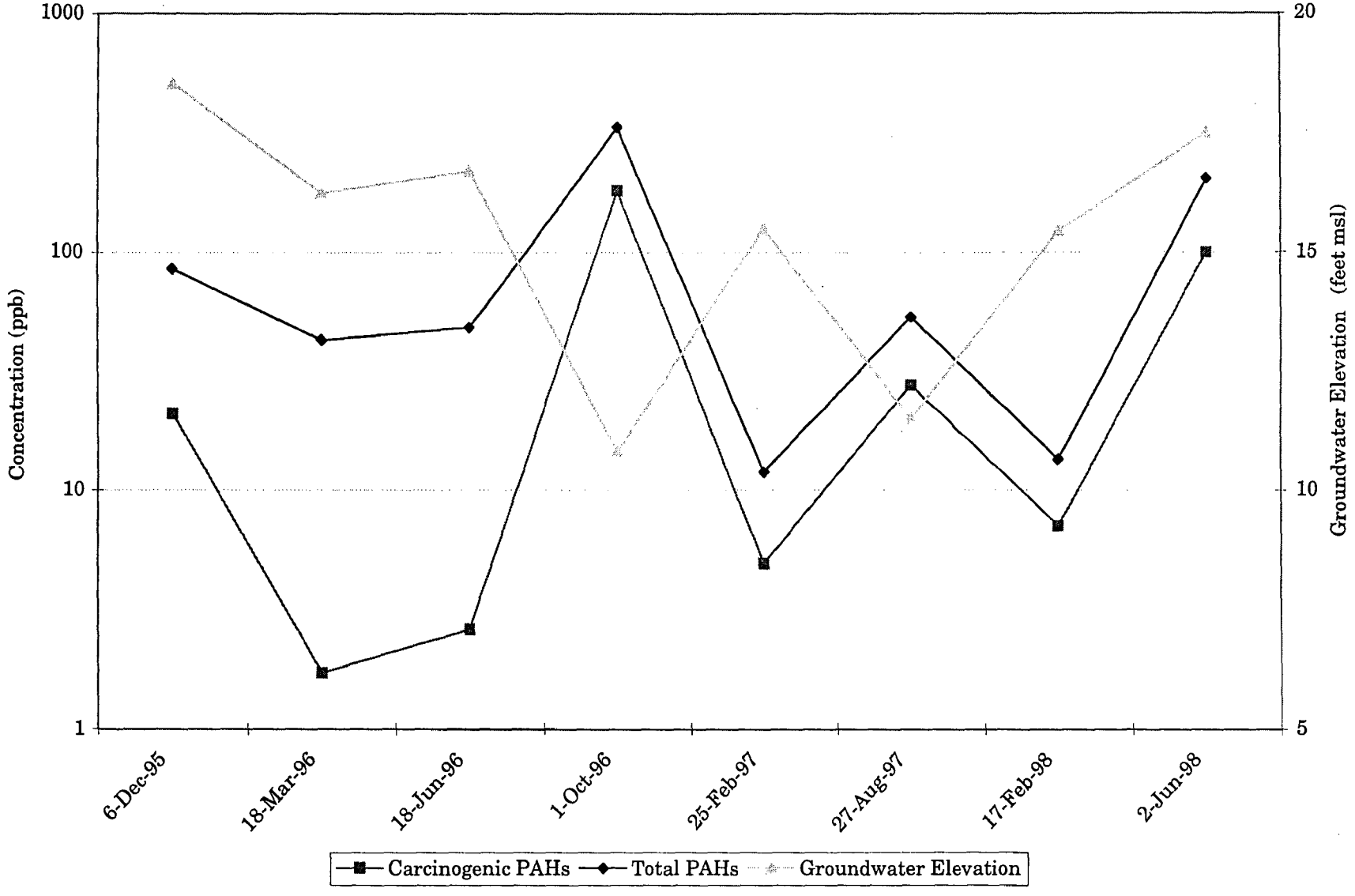


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022801

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-3-26
Northwest Natural - Gasco Facility



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File: 2708 GW conc graphs

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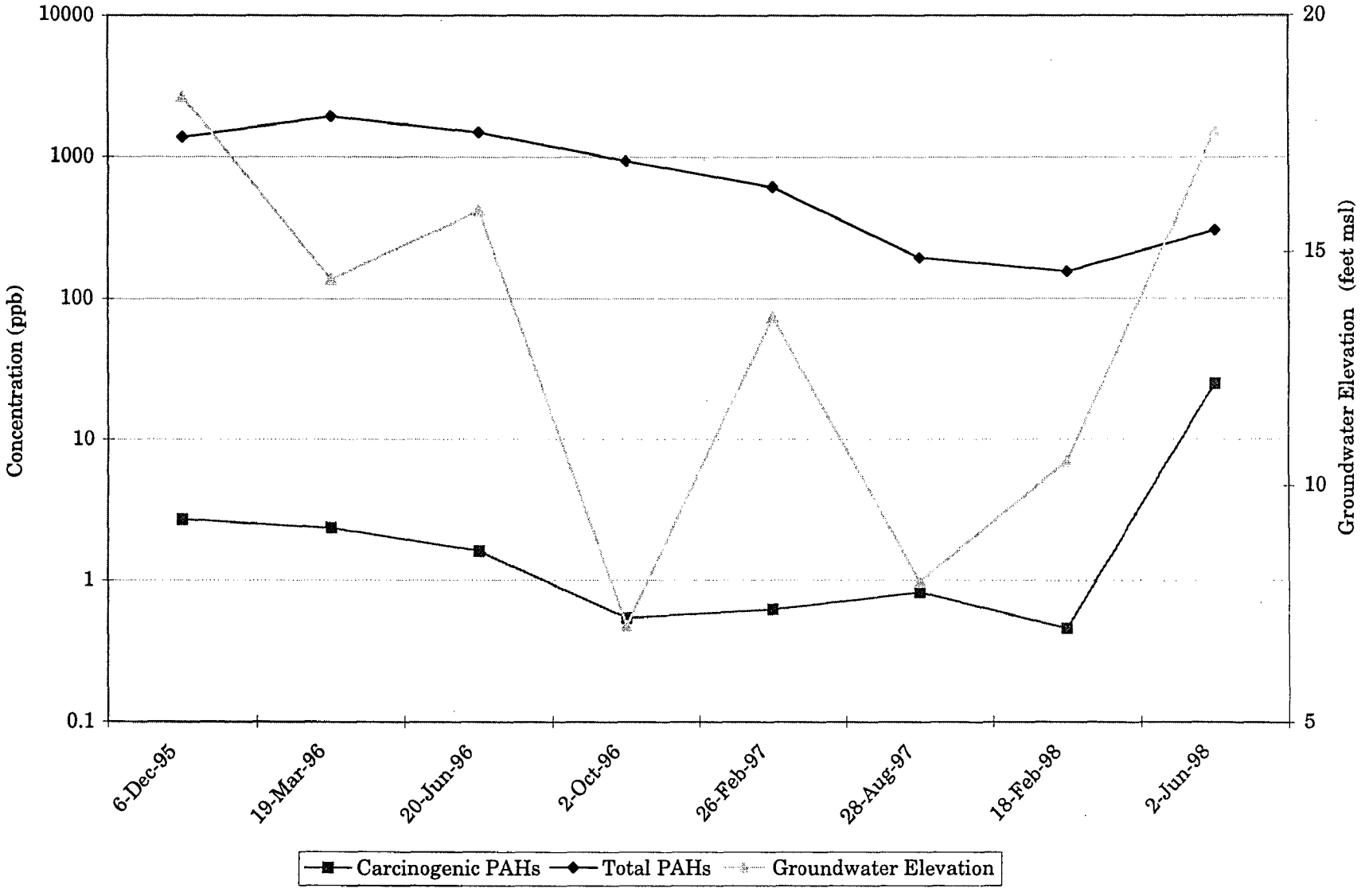
Project No. 2708

Koppers022802

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-3-56
Northwest Natural - Gasco Facility



Koppers022803

Updated: 9/25/98 RBE
File: 2708 GW conc graphs

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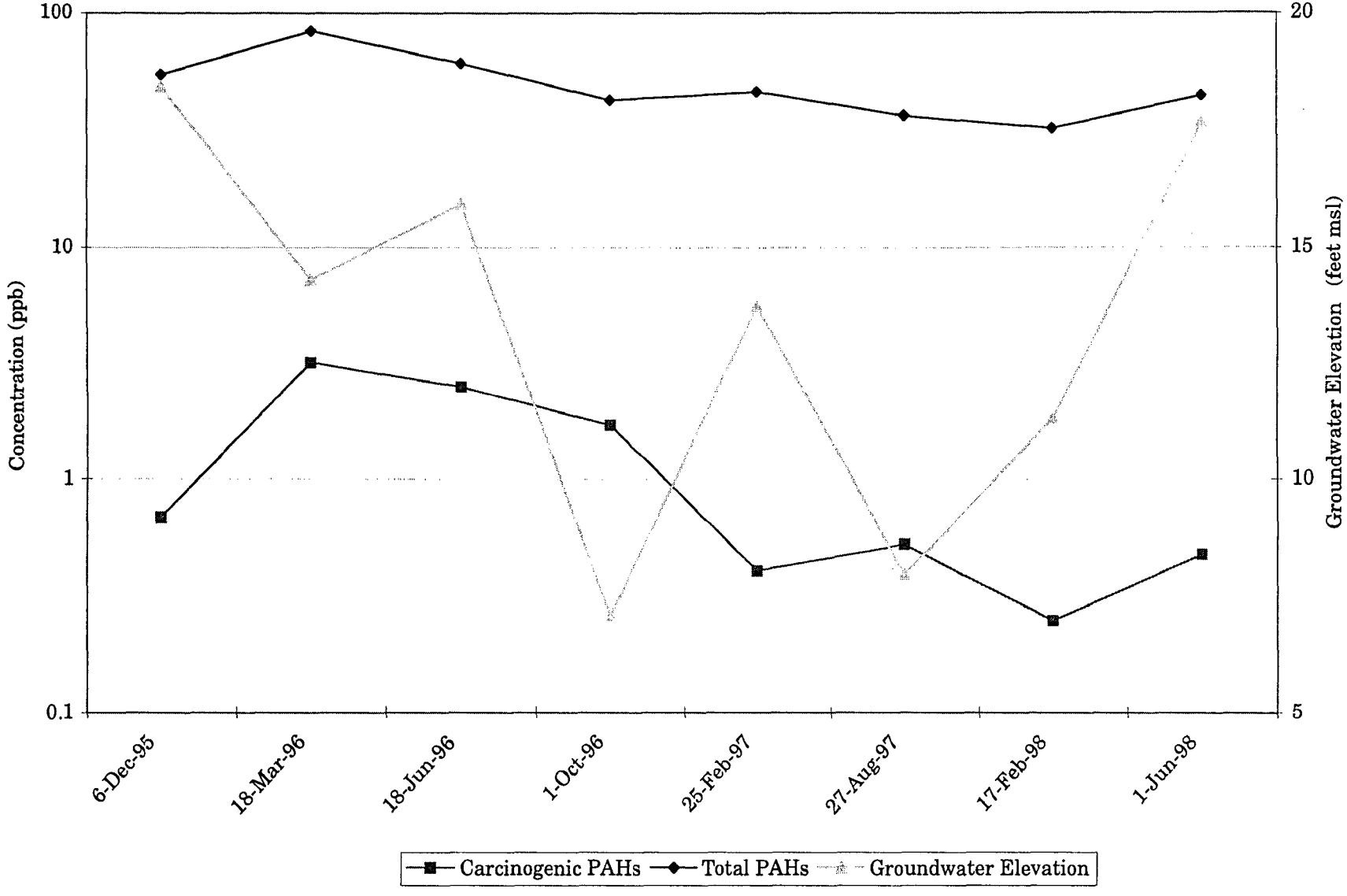
Project No. 2708

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-4-35
Northwest Natural - Gasco Facility



Koppers022804

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File: 2708 GW conc graphs

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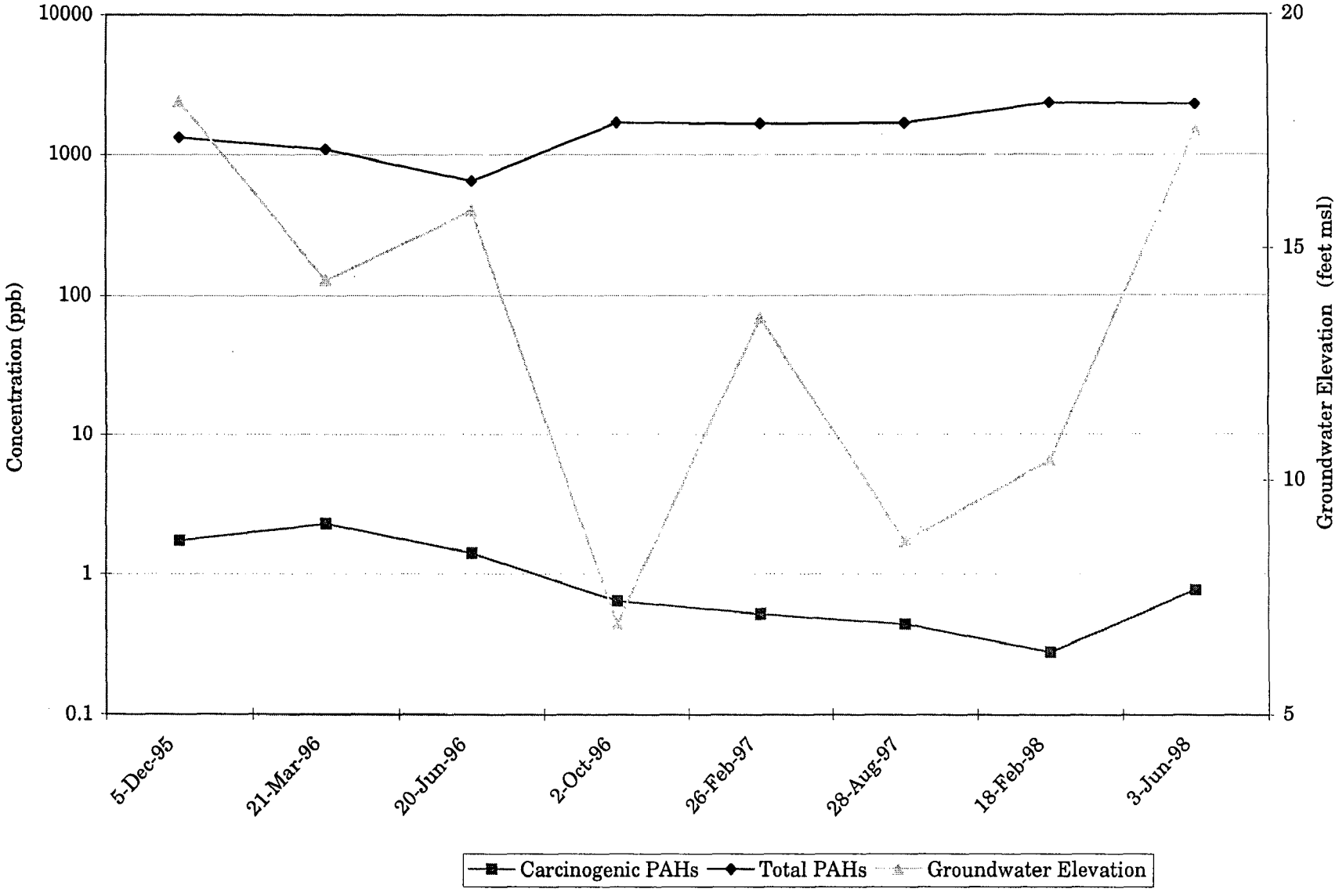
Project No. 2708

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-4-57
Northwest Natural - Gasco Facility



Koppers022805

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File: 2708 GW conc graphs

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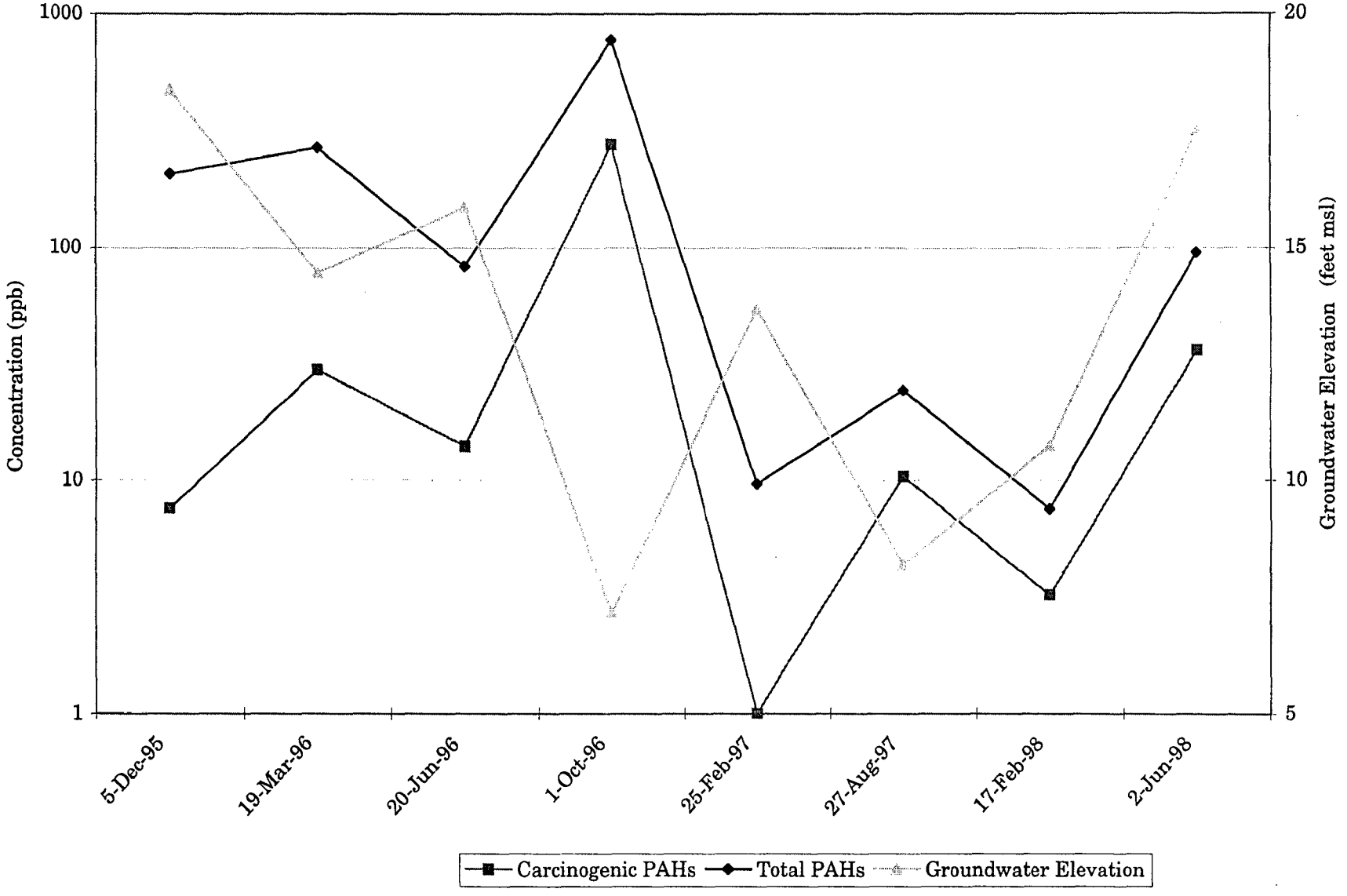
Project No. 2708

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-5-32
Northwest Natural - Gasco Facility



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File: 2708 GW conc graphs

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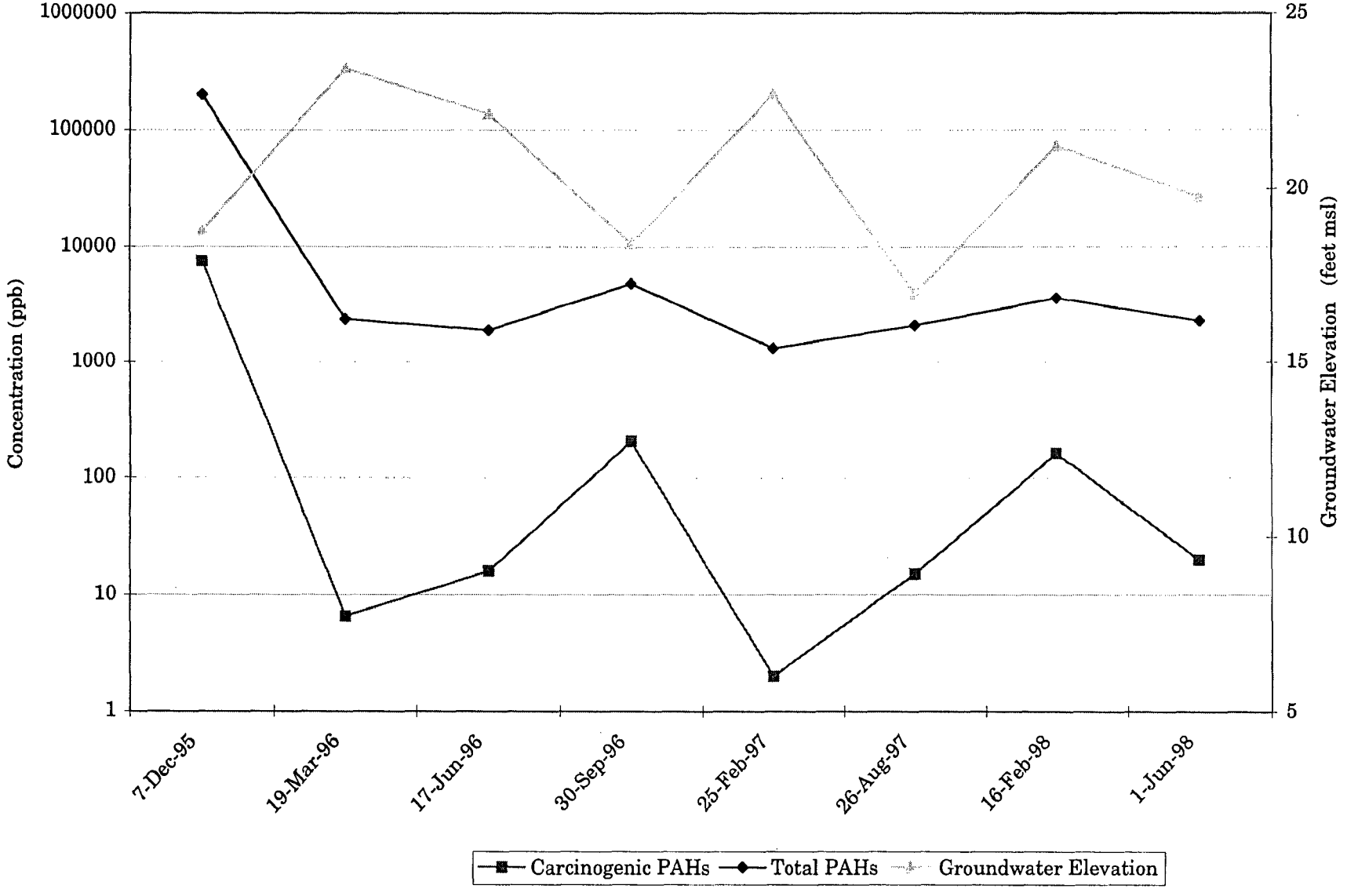
Project No. 2708

Koppers022806

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-6-32
Northwest Natural - Gasco Facility



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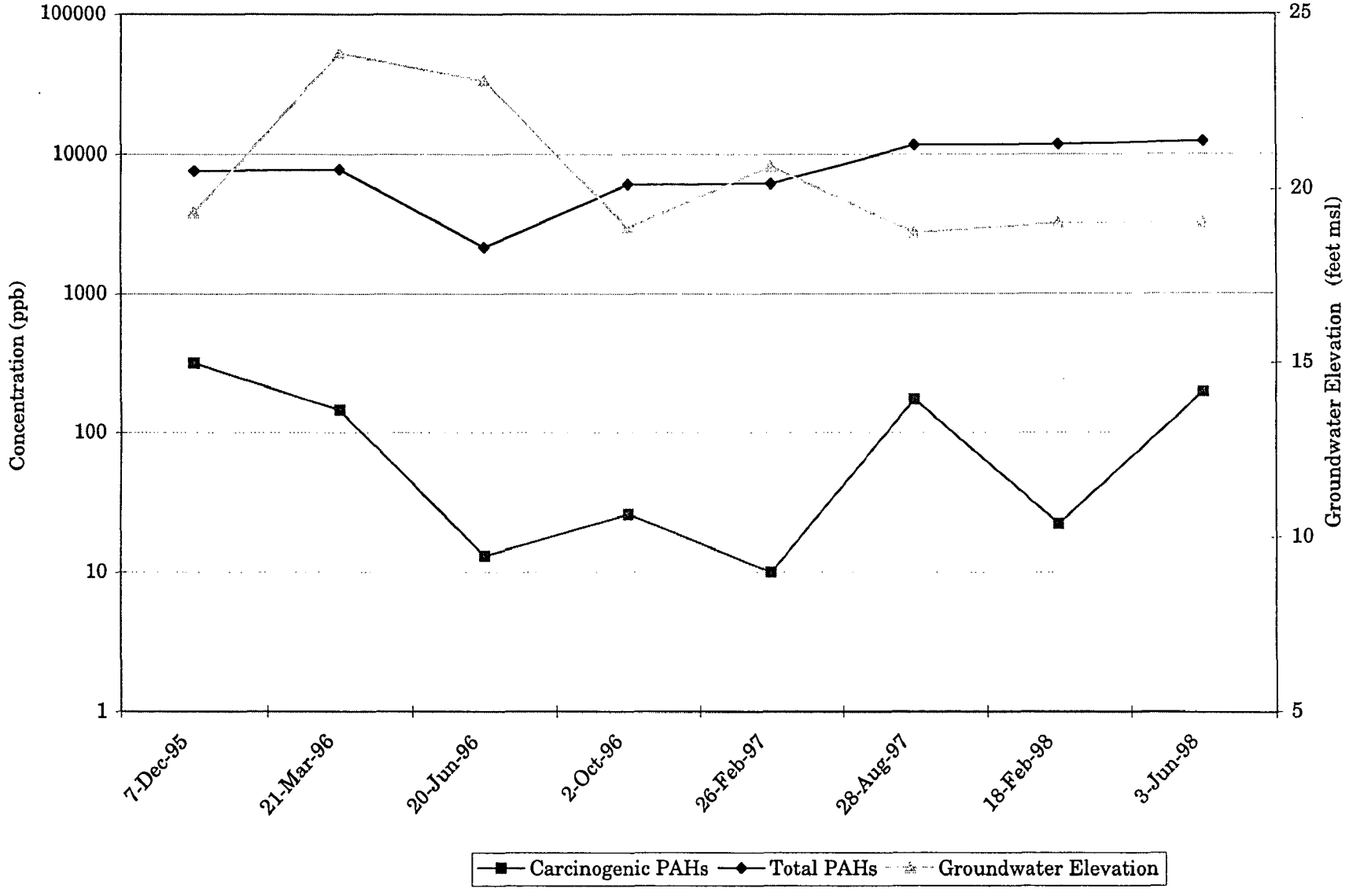
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022807

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-8-29
Northwest Natural - Gasco Facility



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Updated: 9/25/98 RBE
File: 2708 GW conc graphs

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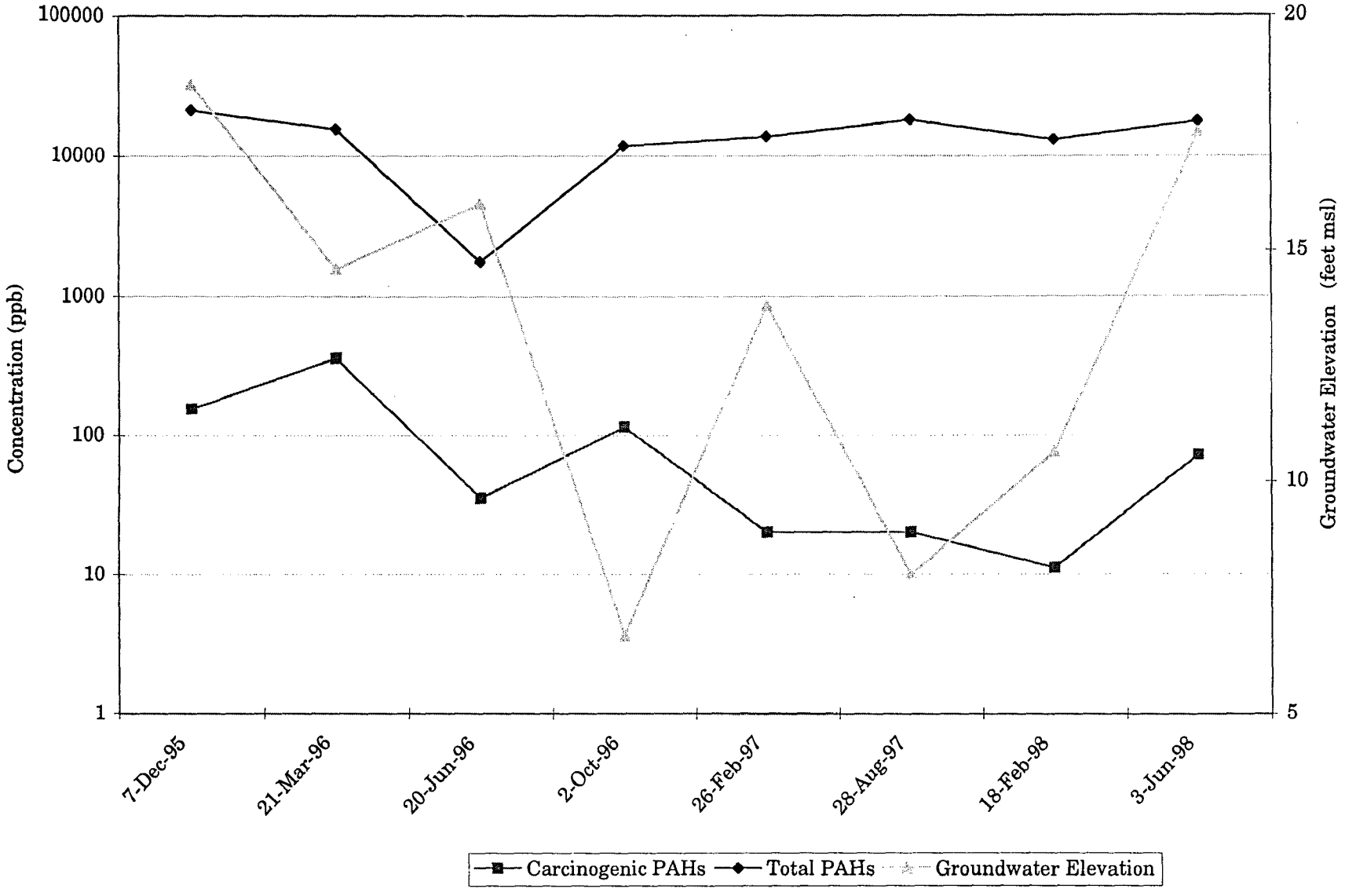
Project No. 2708

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-8-56
Northwest Natural - Gasco Facility



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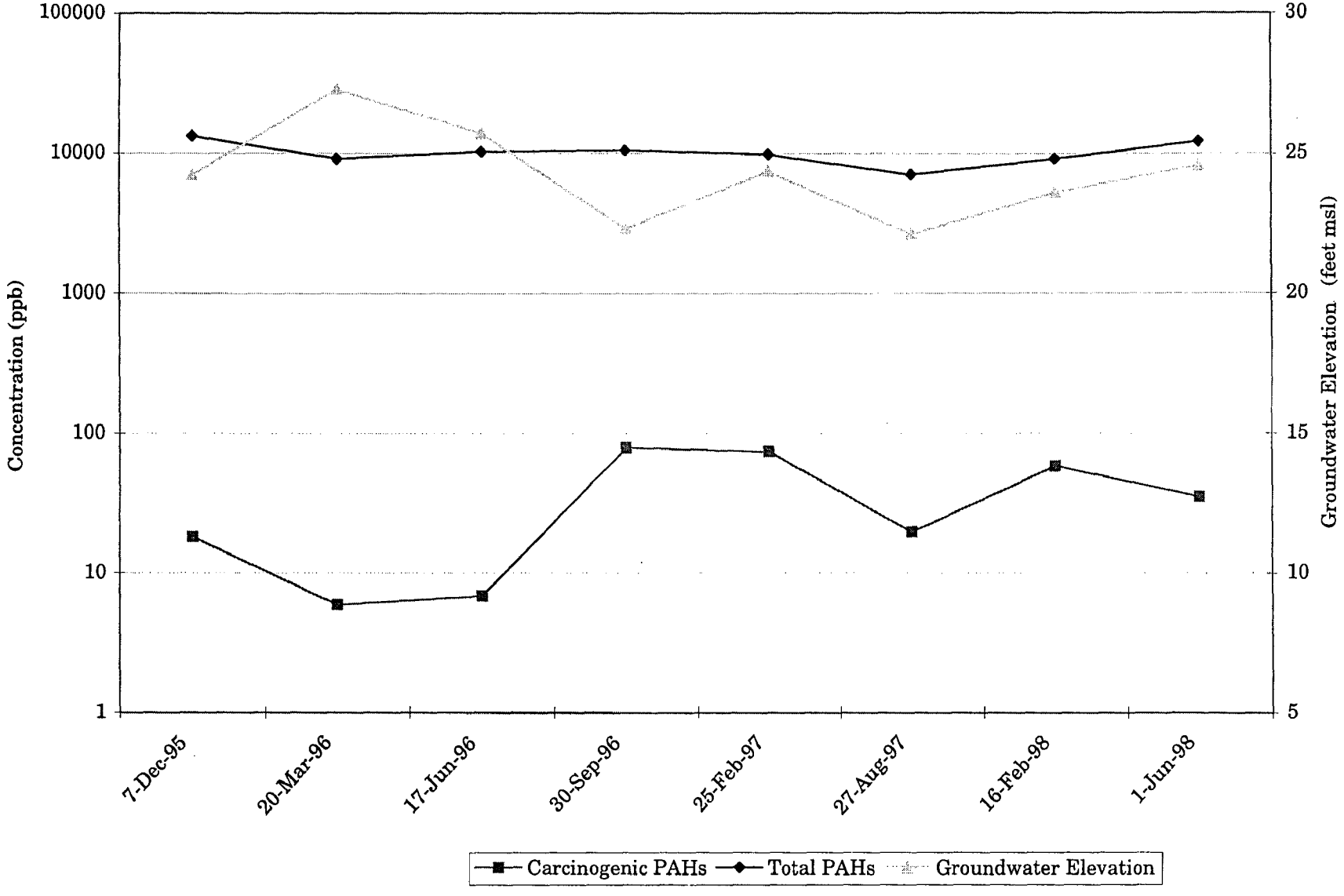
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022809

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-10-25
Northwest Natural - Gasco Facility

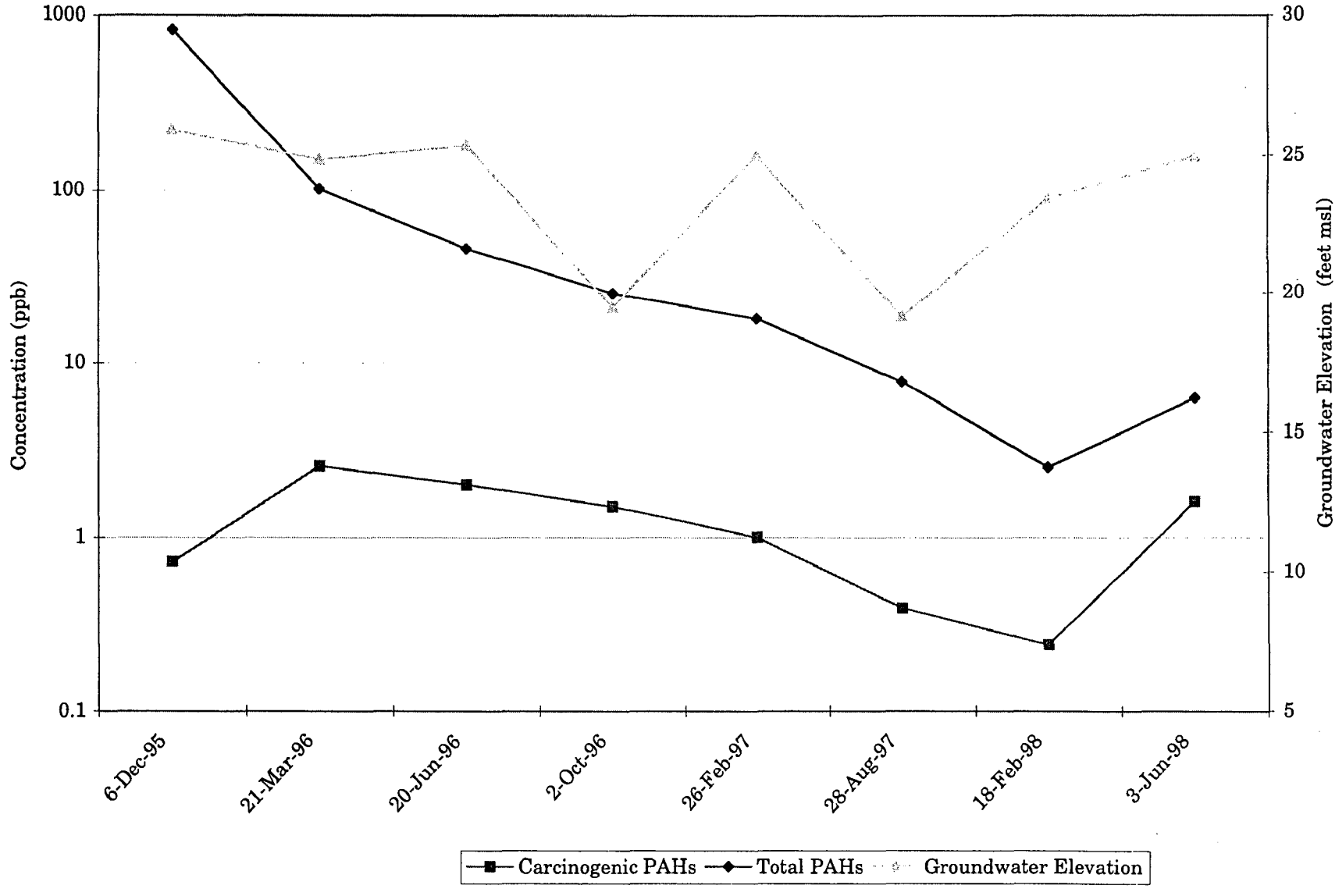


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022810

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-10-61
Northwest Natural - Gasco Facility

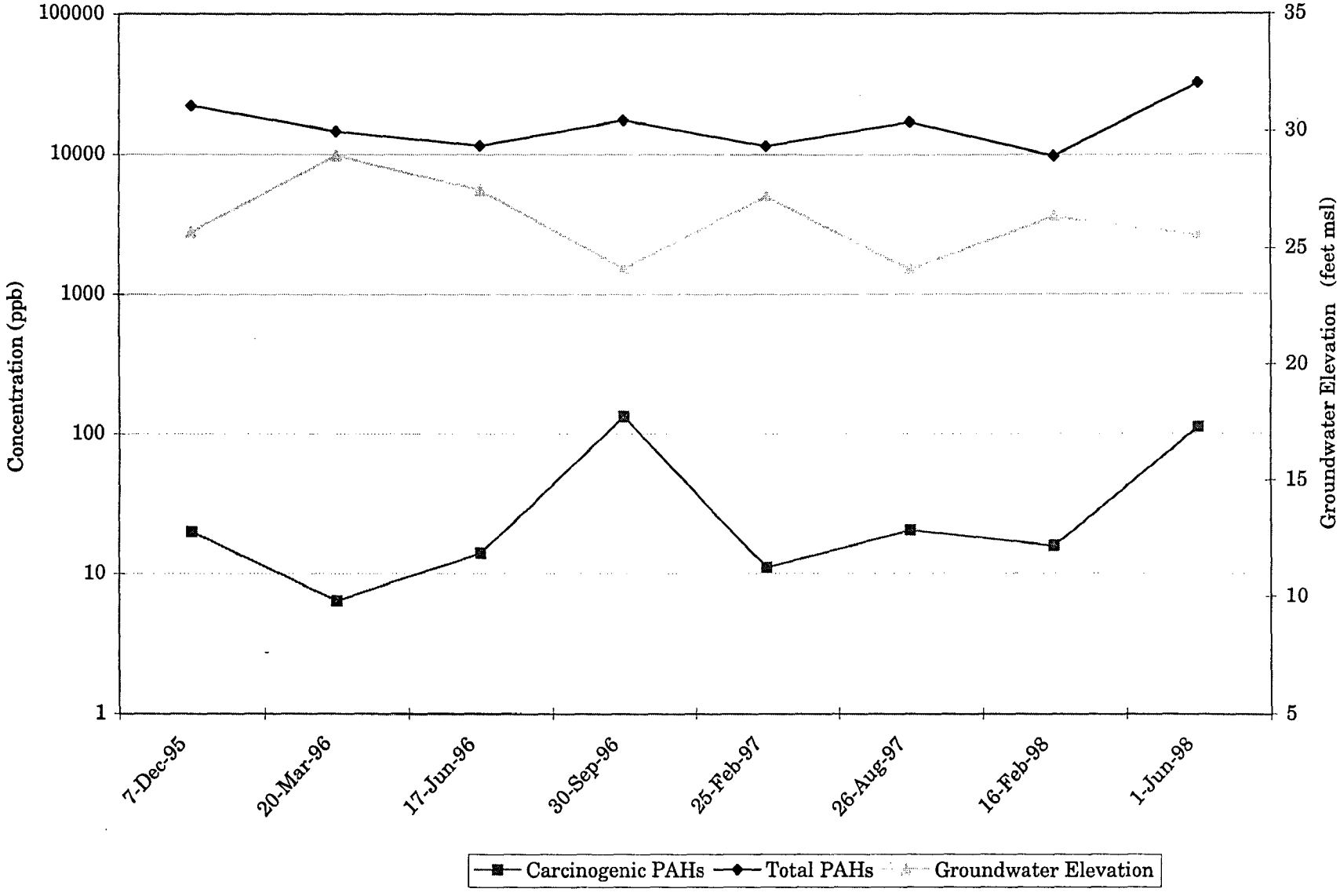


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022811

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-11-32
Northwest Natural - Gasco Facility

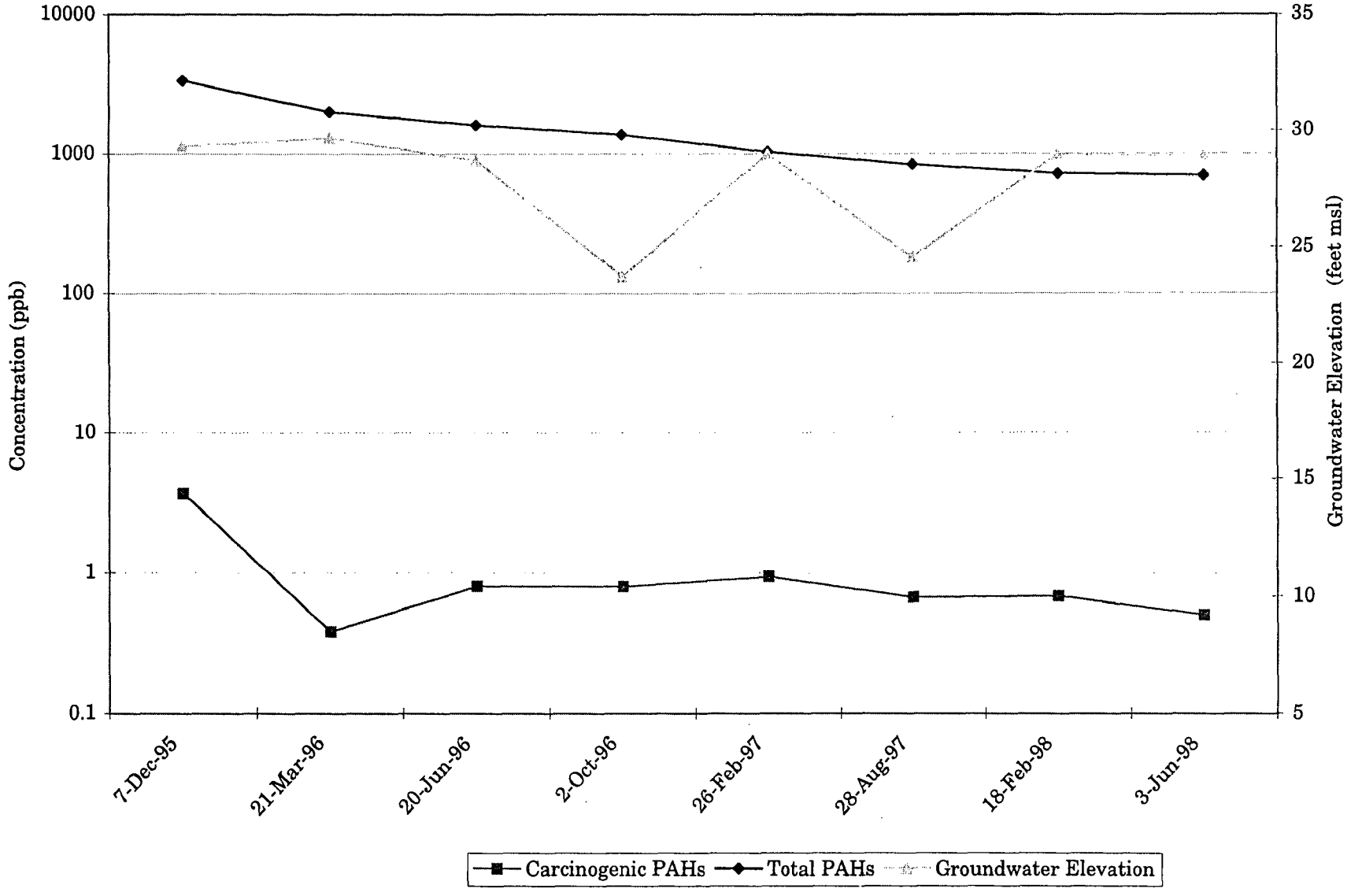


Koppers022812

Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Total PAH Concentration and Groundwater Elevation through Time
Monitoring Well MW-12-36
Northwest Natural - Gasco Facility



Koppers022813

Updated: 9/25/98 RBE
File: 2708 GW conc graphs

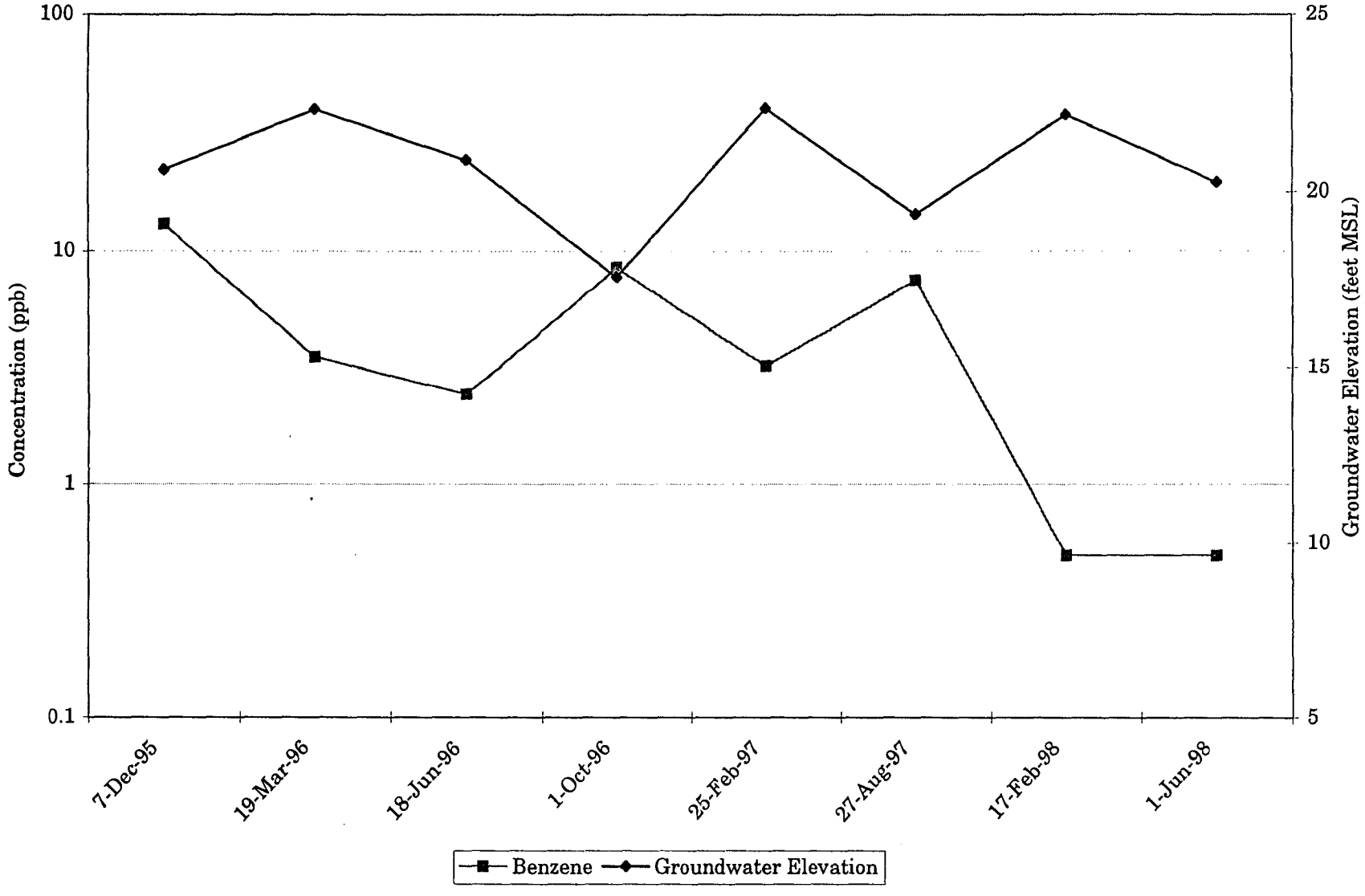
HAHN AND ASSOCIATES, INC.
Project No. 2708

Time-Concentration Charts
Benzene Concentrations in Groundwater

HAHN AND ASSOCIATES, INC.

Koppers022814

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-1-26
Northwest Natural - Gasco Facility

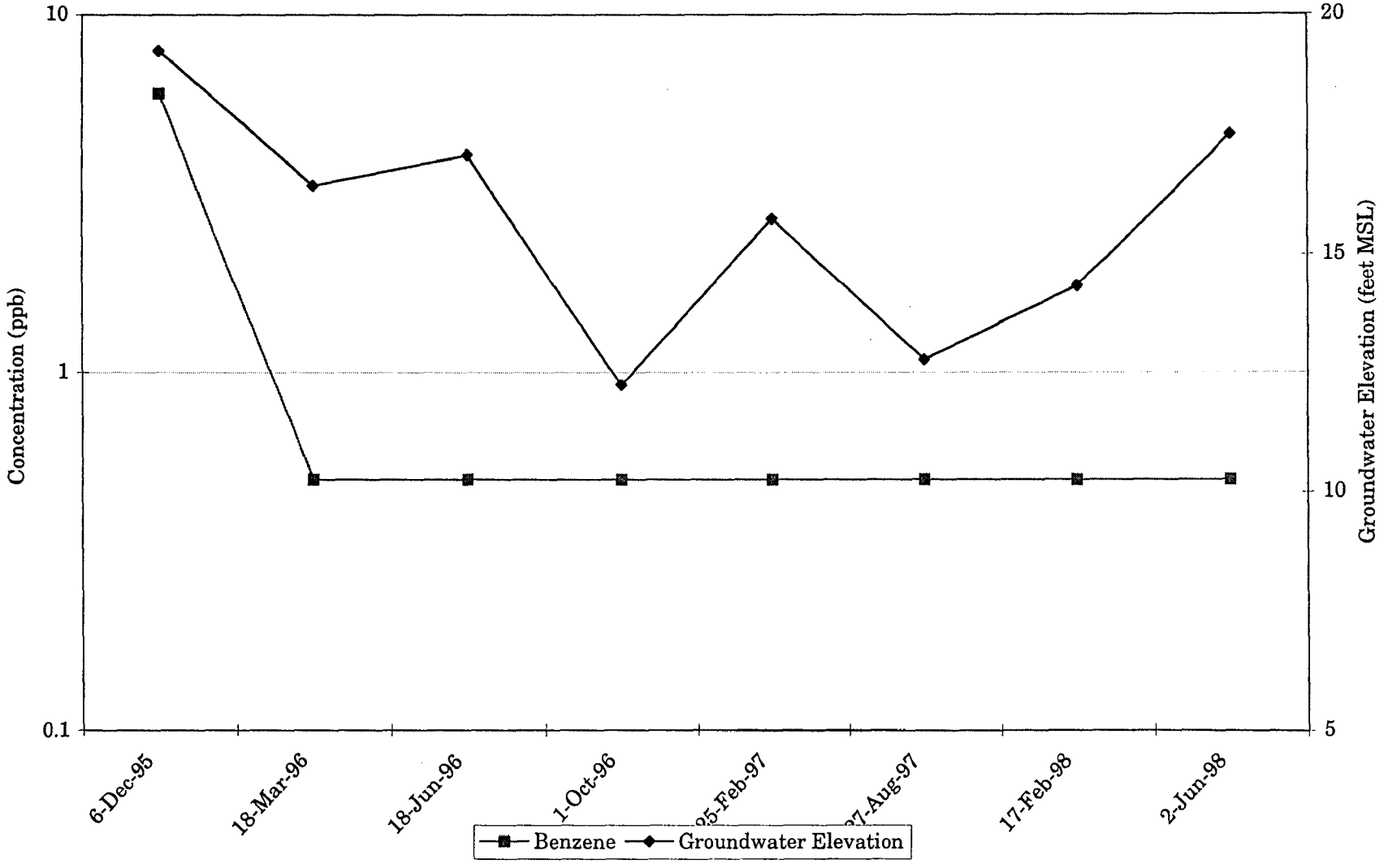


Koppers022815

Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-2-32
Northwest Natural - Gasco Facility

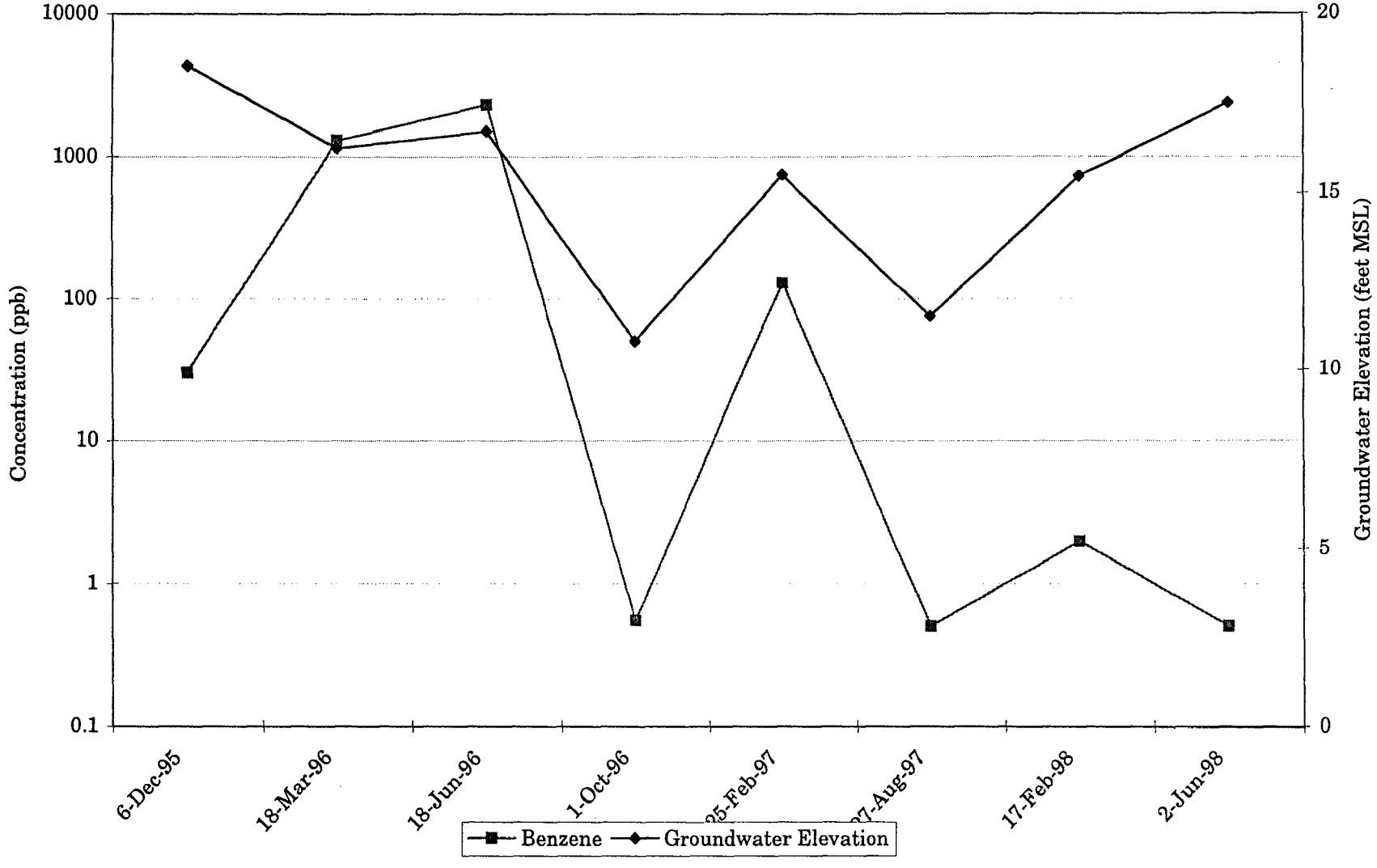


Koppers022816

Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-3-26
Northwest Natural - Gasco Facility

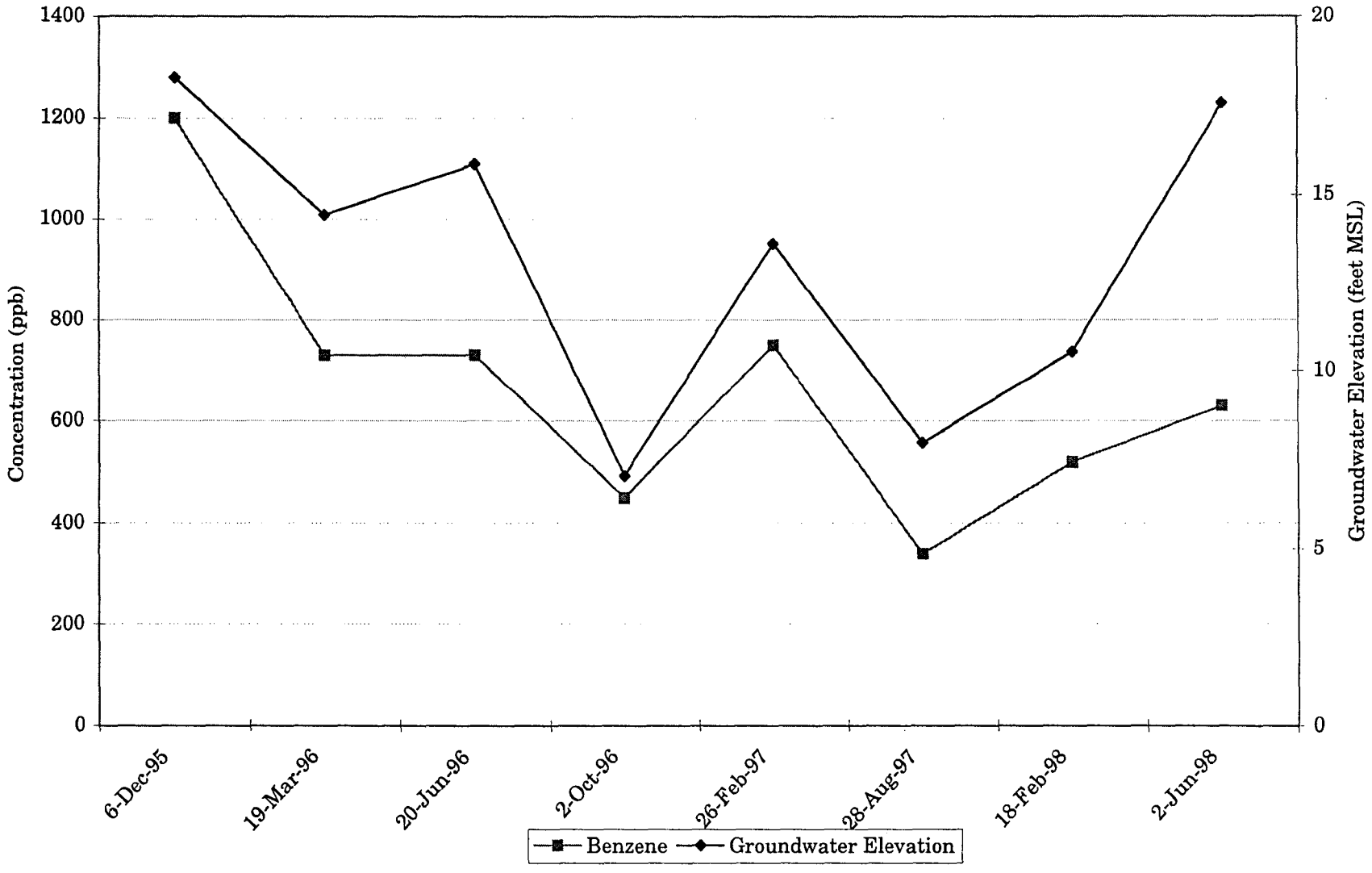


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022817

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-3-56
Northwest Natural - Gasco Facility

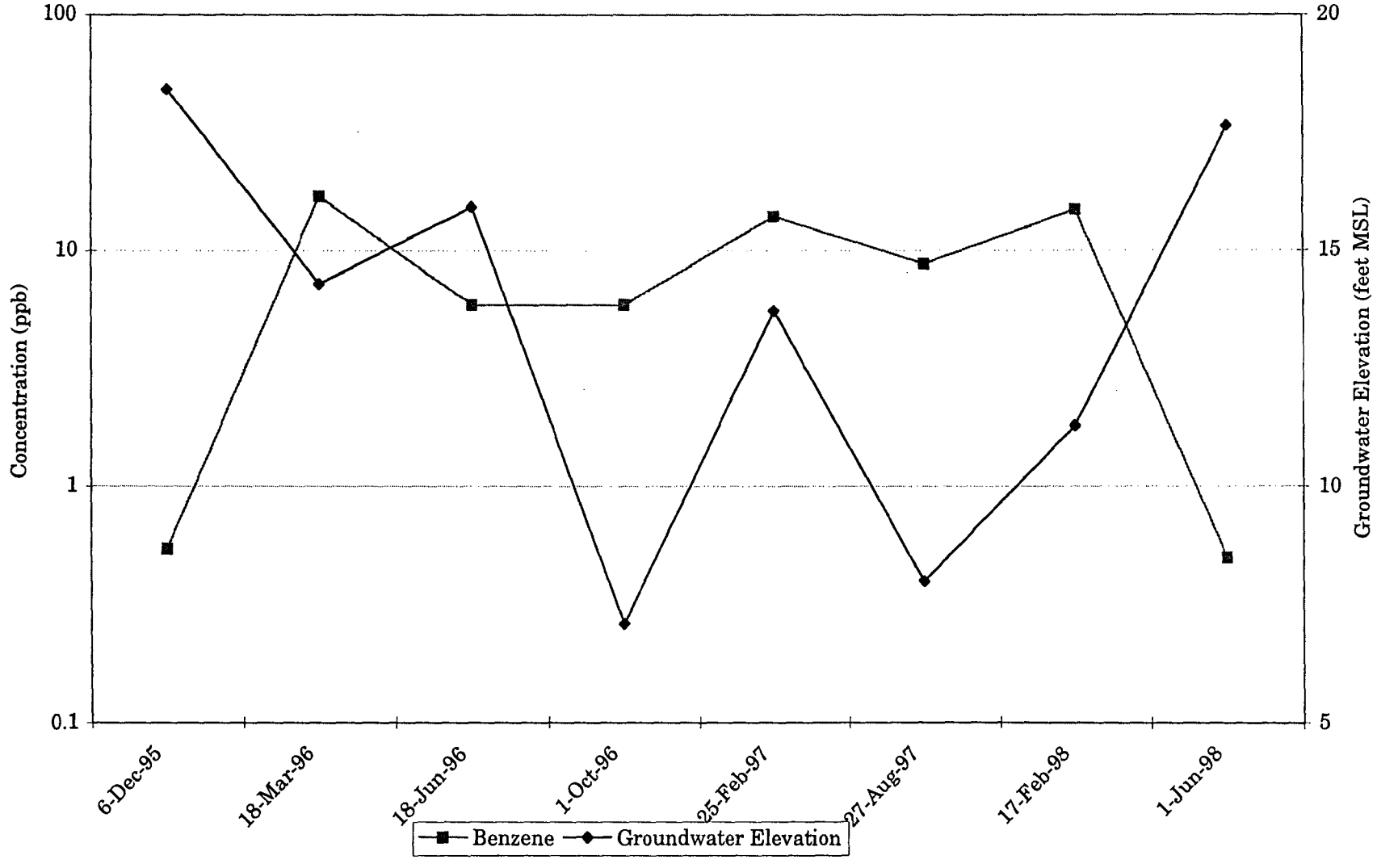


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022818

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-4-35
Northwest Natural - Gasco Facility

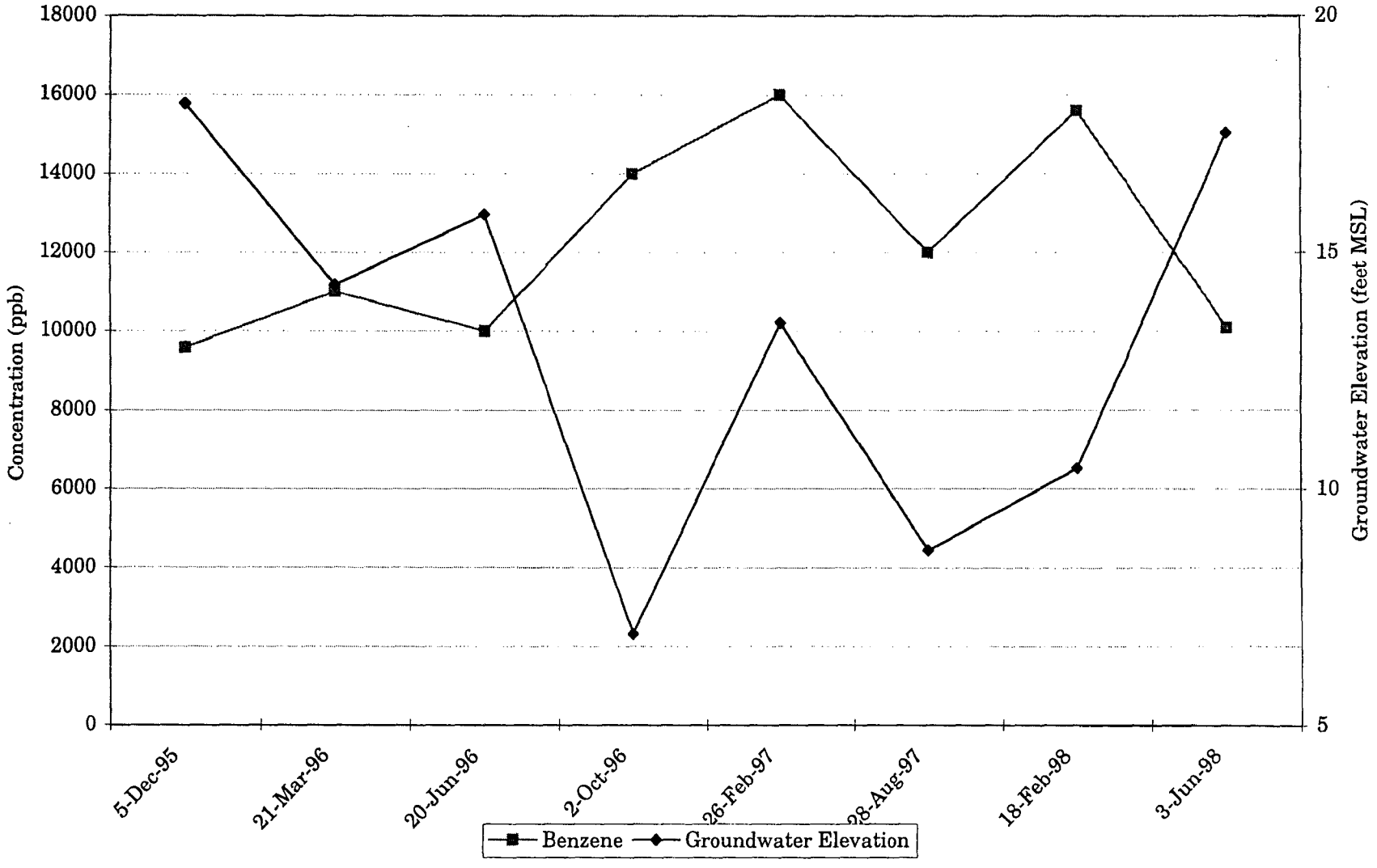


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022819

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-4-57
Northwest Natural - Gasco Facility

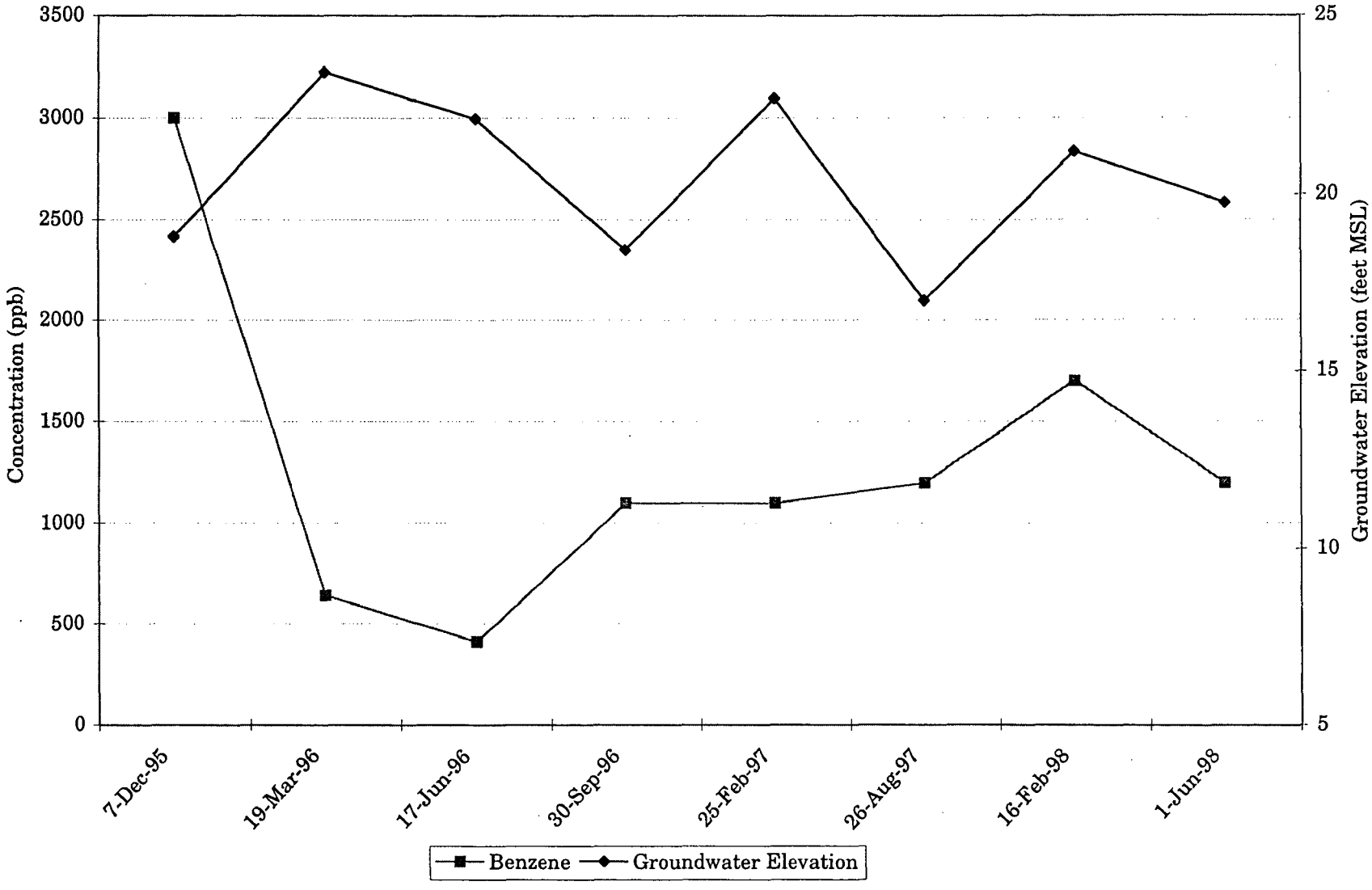


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022820

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-6-32
Northwest Natural - Gasco Facility

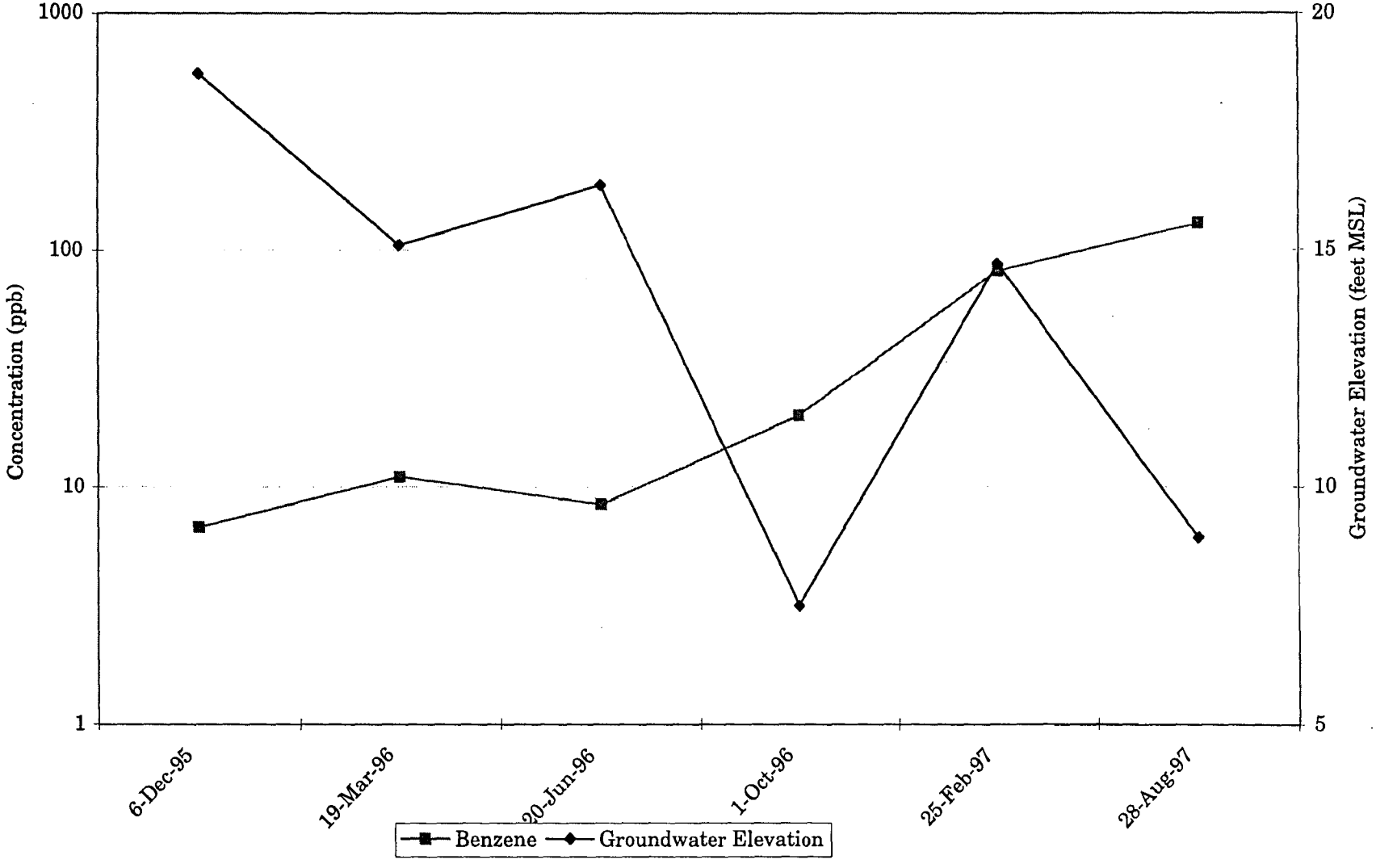


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022821

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-6-61
Northwest Natural - Gasco Facility

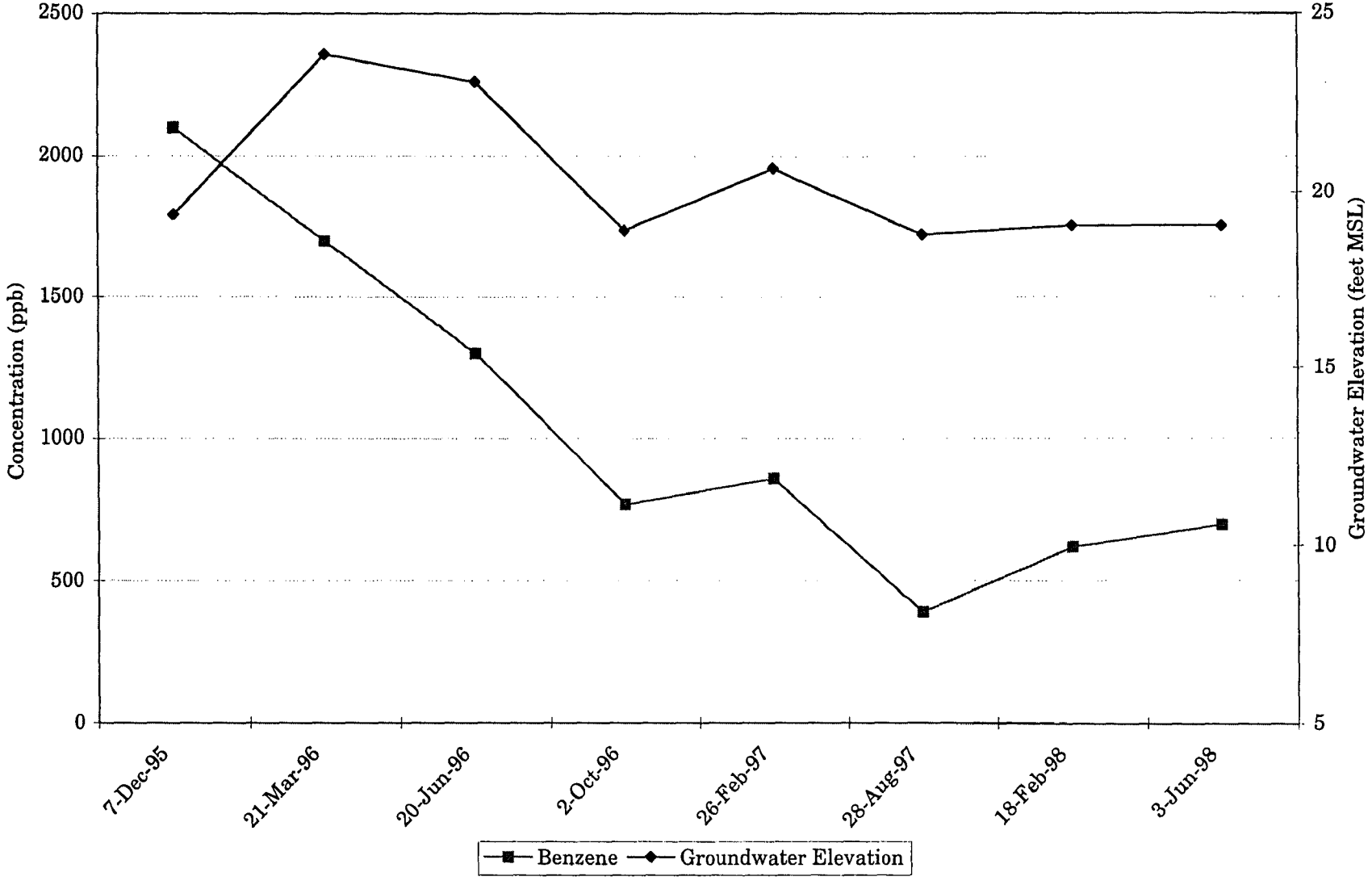


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022822

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-8-29
Northwest Natural - Gasco Facility

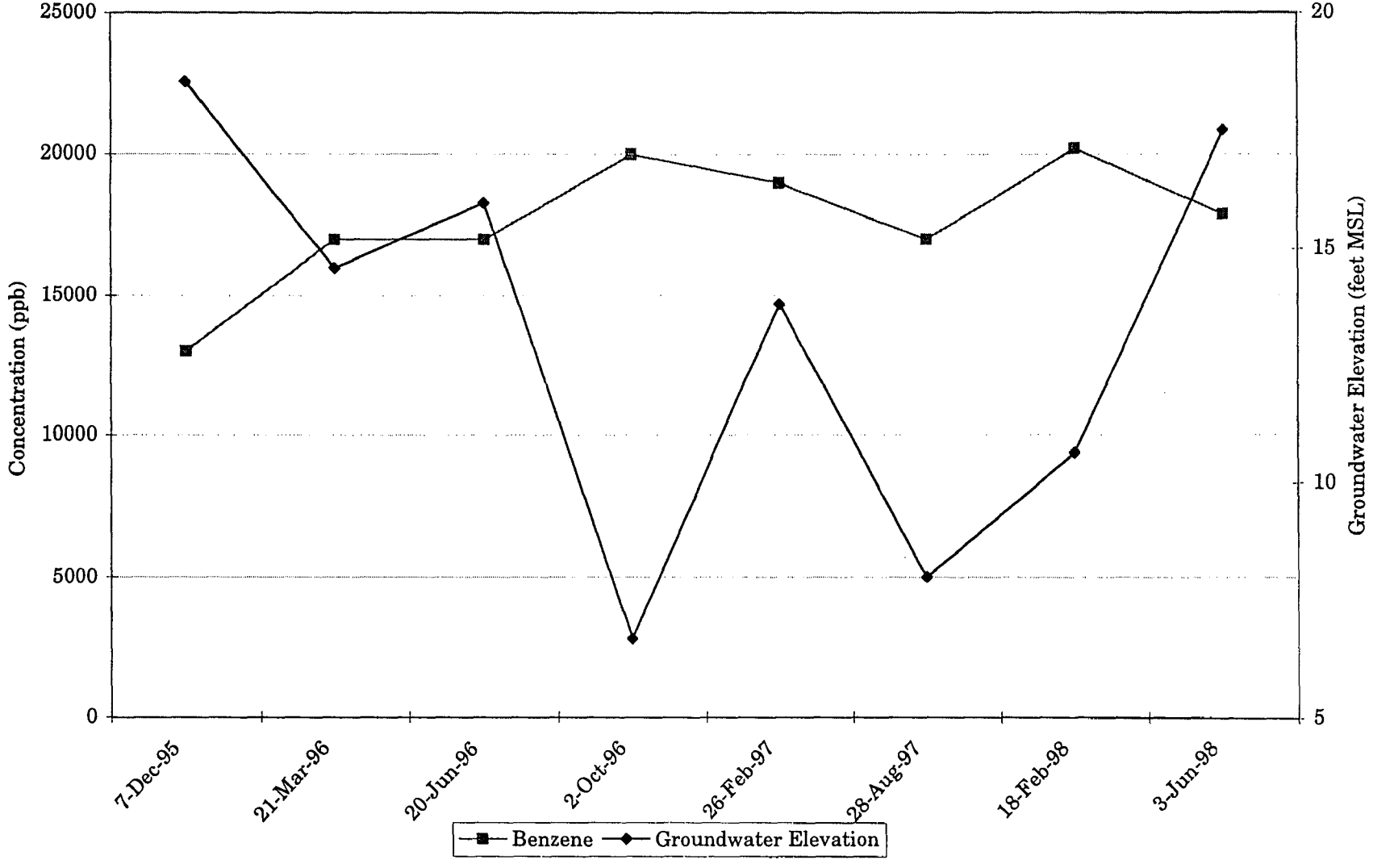


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022823

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-8-56
Northwest Natural - Gasco Facility

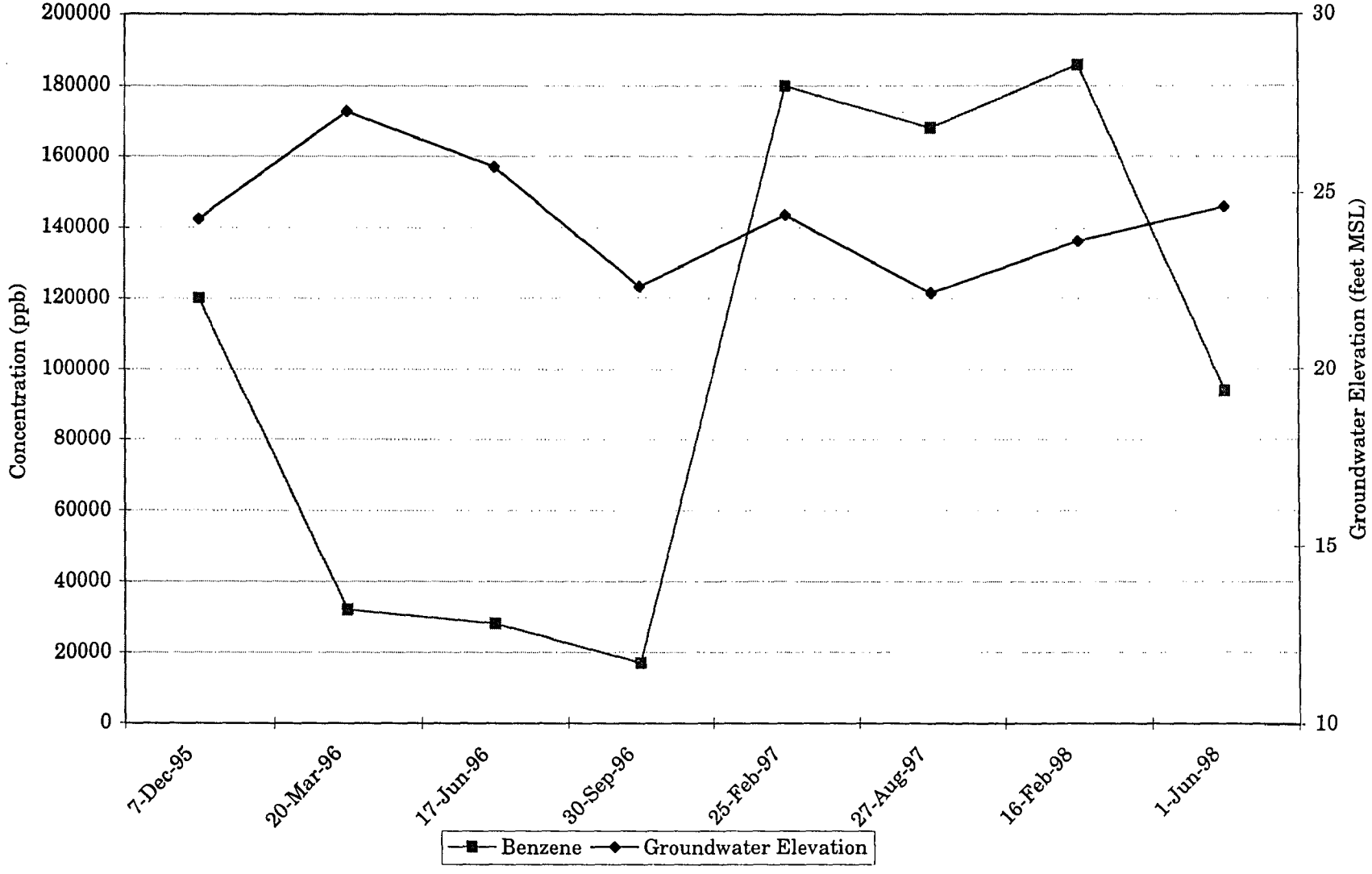


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022824

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-10-25
Northwest Natural - Gasco Facility

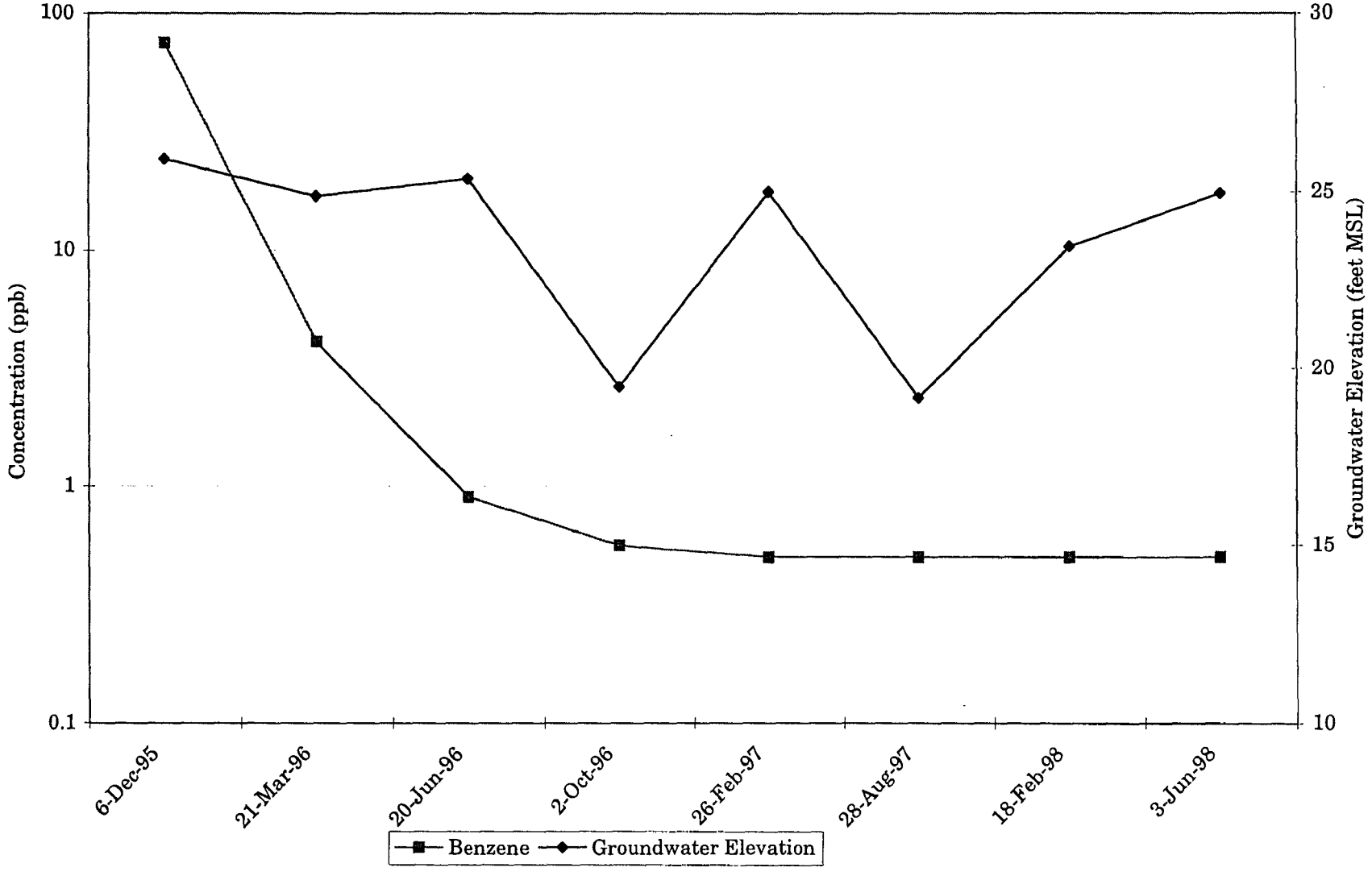


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022825

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-10-61
Northwest Natural - Gasco Facility

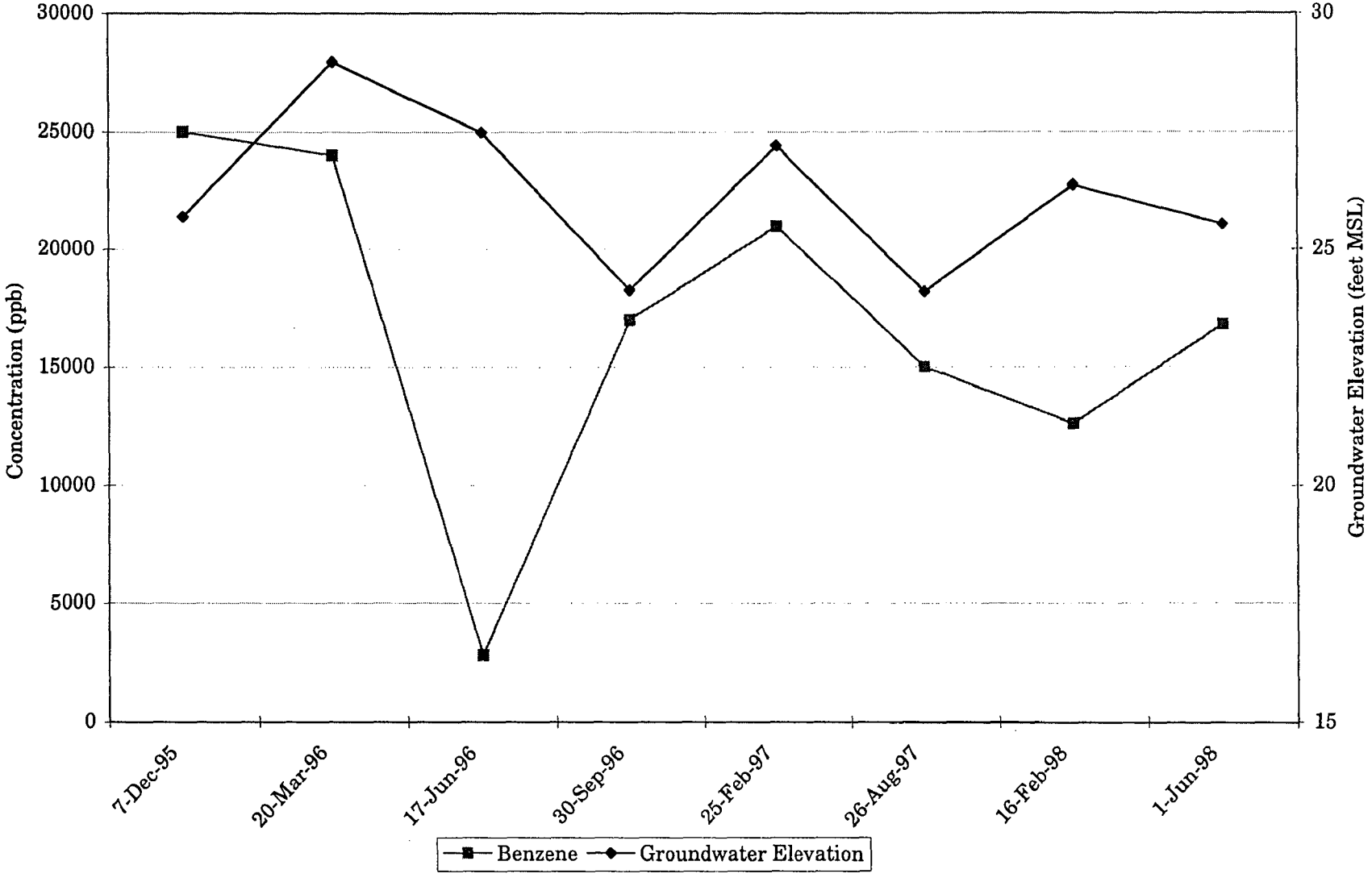


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022826

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-11-32
Northwest Natural - Gasco Facility

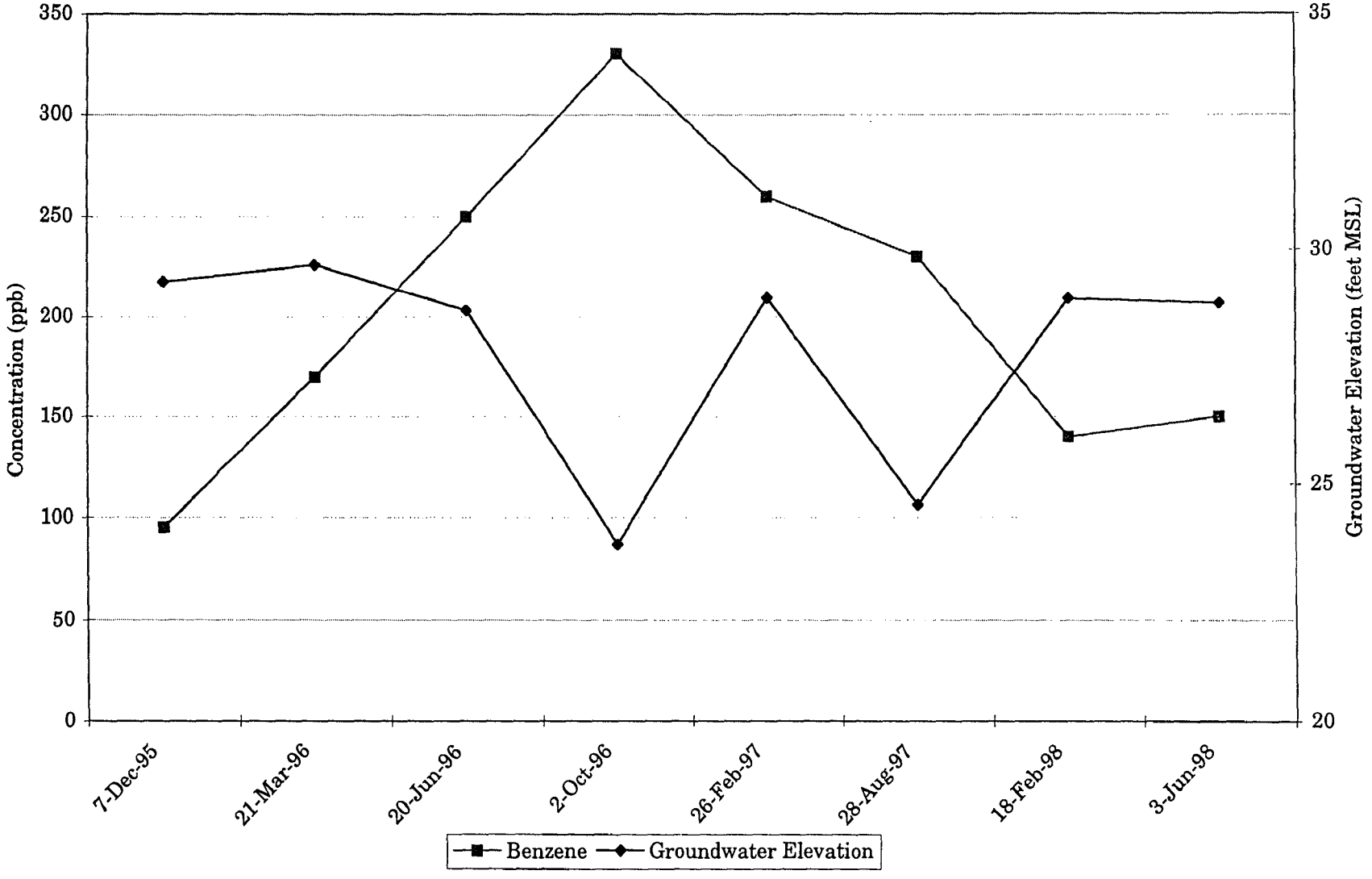


Koppers022827

Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-12-36
Northwest Natural - Gasco Facility

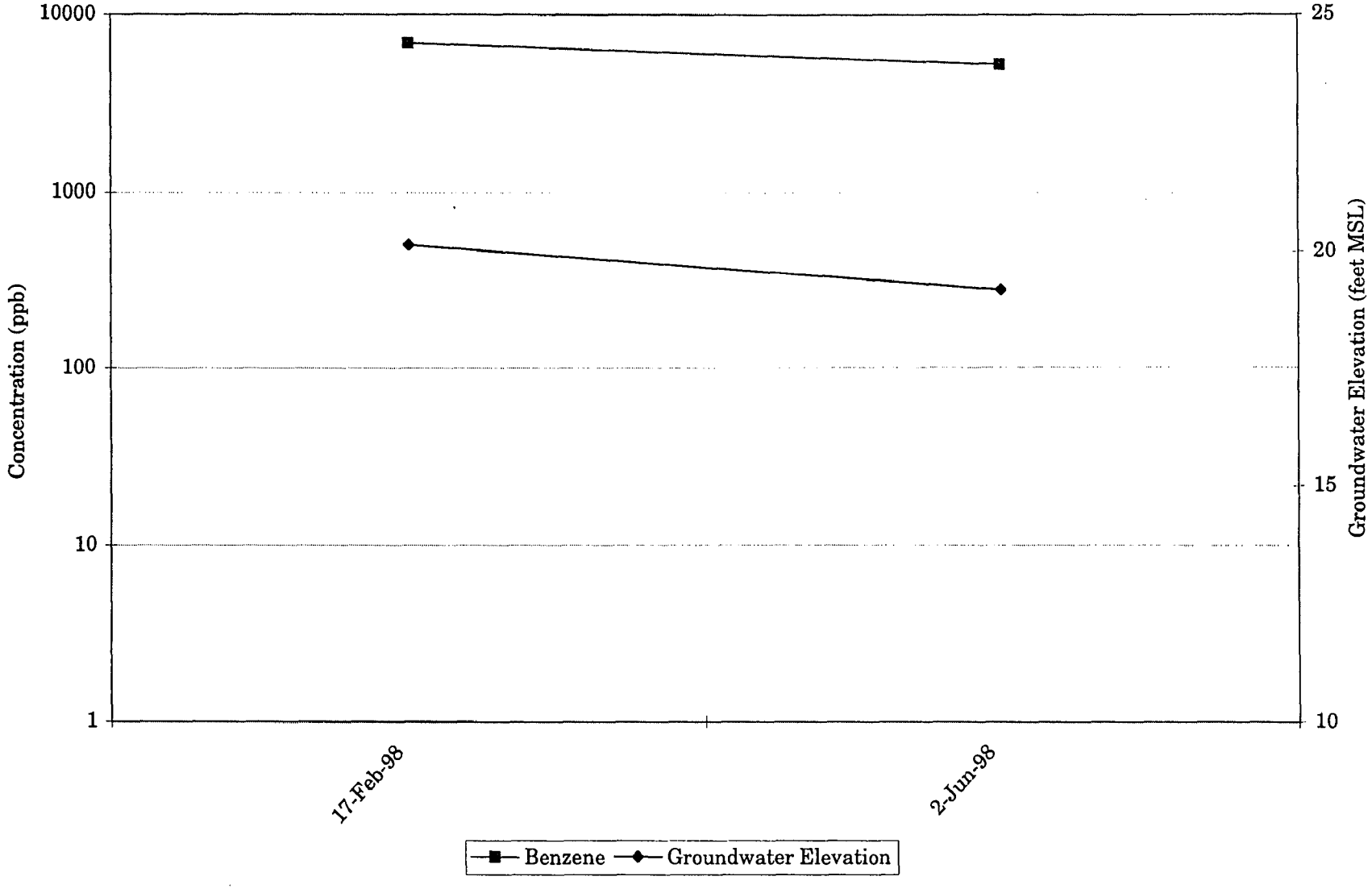


Updated: 9/25/98 RBE
File: 2708 GW conc graphs

HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022828

Benzene Concentration and Groundwater Elevation through Time
Monitoring Well MW-13-30
Northwest Natural - Gasco Facility



Updated: 9/25/98 RBE
File: 2708 GW conc graphs

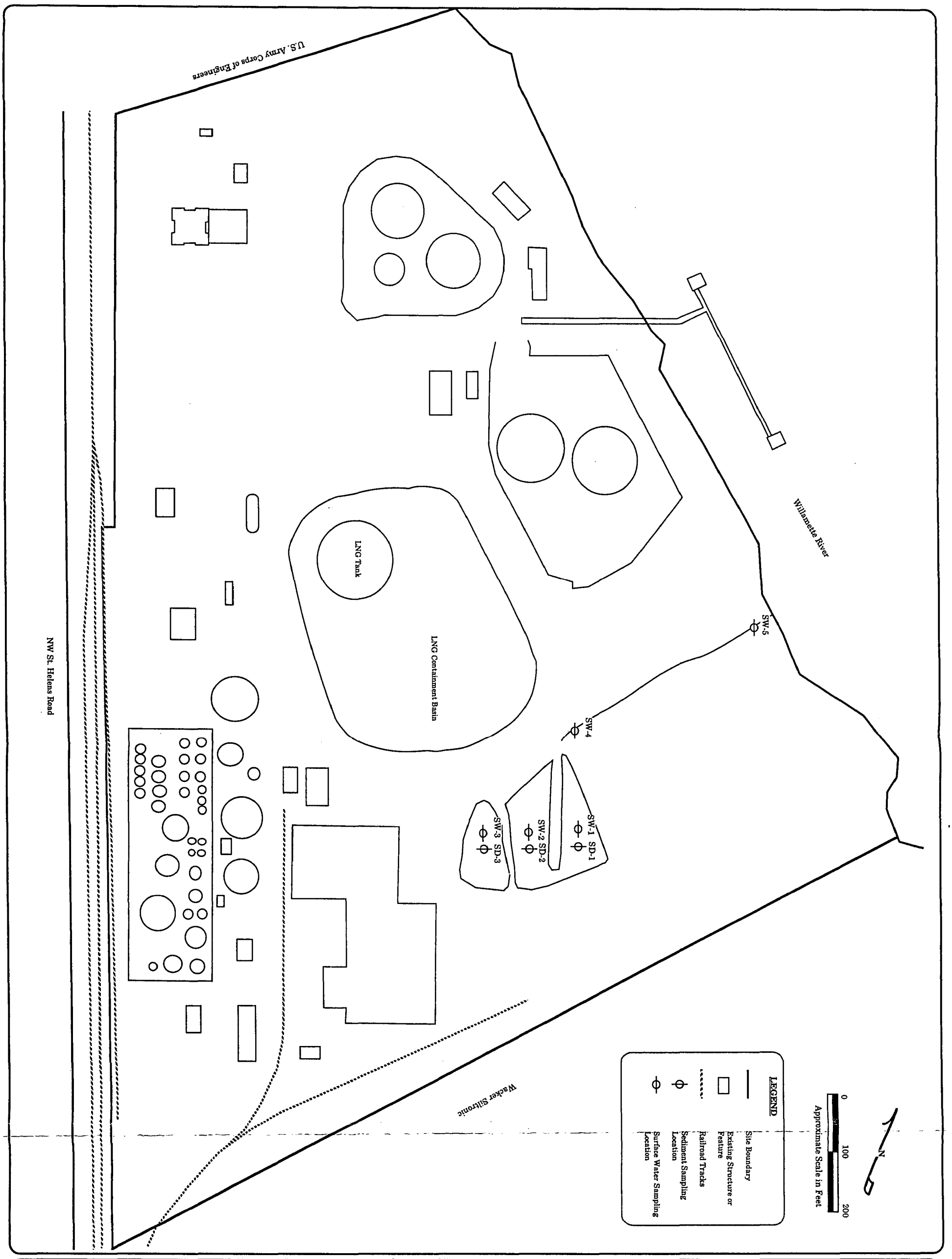
HAHN AND ASSOCIATES, INC.
Project No. 2708

Koppers022829

APPENDIX I

On-Site Surface Water and Sediment Quality Data

Koppers022831



Project #2708	July 1996	**HAHN & ASSOCIATES, INC.** ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 503/796-0717	**On-Site Sediment and Surface Water Sampling Location Map** RI/FS Northwest Natural Gas Company Gasco Facility 7540 NW St. Helens Road Portland, Oregon	**Figure I-1**

Koppers022832

TABLE I-1 – Summary of Analytical Results for On-Site Surface Water Samples
BTEX, Total PAHs, TPH, and Lead

Remedial Investigation
Northwest Natural Gas Company - Gasco Facility
Portland, Oregon

Project #2708

Sample Location ID	Sample Location	Sample Number*	Chain of Custody Number	Sample Date	Analytical Results								
					ug/l (ppb)							mg/l (ppm)	
					EPA Method 8020					EPA Method 8270 SIM		EPA Method 418.1	EPA Method 6010
					Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	TPH	Dissolved Lead
SW1	East Pond	SW1-01	2708-W012	30-Jan-96	0.92	ND>0.5	ND>0.5	ND>0.5	0.92	6.6	12.1	ND>0.5	ND>0.005
SW2	Middle Pond	SW2-01	2708-W012	30-Jan-96	3.1	ND>0.5	0.82	2.1	6.02	0.24	23.7	ND>0.5	ND>0.005
SW3	West Pond	SW3-01	2708-W012	30-Jan-96	0.92	ND>0.5	ND>0.5	ND>0.5	0.92	0.76	16.3	ND>0.5	ND>0.005
SW4	Ditch, West	SW4-01	2708-W012	30-Jan-96	**110.**	9.	0.55	ND>0.5	119.55	0.55	4.7	ND>0.5	ND>0.005
SW5	Ditch, East	SW5-01	2708-W012	30-Jan-96	6.2	0.75	ND>0.5	ND>0.5	6.95	0.62	20.1	22.	ND>0.005
SW5 (duplicate)	Ditch, East	SW1-02	2708-W012	30-Jan-96	-	-	-	-	-	0.69	22.6	-	ND>0.005
				Reference Levels [1] ->	40 [2]	424 [2]	1,400 [2]	#	#	#	#	#	0.0032 [3]

Note:
= Cleanup level not established
* = Sample number prefix: 2708-960130-
BTEX = benzene, toluene, ethylbenzene, and xylenes
EPA = U.S. Environmental Protection Agency
mg/l = milligrams/liter
ND = not detected above detection limit indicated
ODEQ = Oregon Department of Environmental Quality
PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ppm = parts per million
TPH = total petroleum hydrocarbons
ug/l = micrograms/liter

1 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (OAR 340-41)
2 = Reference Level based on Human Fish Consumption Criteria of Ambient Water Quality Criteria
3 = Reference Level based on Human Fish Consumption Criteria of AWQC

BOLD = Detected above Reference Level

Koppers022833

TABLE I-2 – Summary of Analytical Results for On-Site Surface Water Samples
PAHs by EPA Method 8270

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project #2708

PAHs by EPA Method 8270 (SIM)				Analytical Results ug/l (ppb)																
Sample Location ID	Sample Location	Sample Number*	Sample Date	Acenaphthene	Acenaphthylene	Anthracene	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Benzo (ghi) perylene	Chrysene	Dibenzo (ah) anthracene	Fluoranthene	Fluorene	Indeno (1,2,3-cd) pyrene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
SW1	East Pond	SW1-01	30-Jan-96	ND>0.3	0.6	0.87	0.75	1.8	0.64	1.1	1.8	1.1	ND>0.3	0.9	ND>0.3	1.2	ND>0.3	ND>0.3	1.3	6.59	12.1
SW2	Middle Pond	SW2-01	30-Jan-96	2.9	0.3	0.4	ND>0.1	0.13	ND>0.1	ND>0.1	0.1	0.11	ND>0.1	0.85	1.2	ND>0.1	16.	0.96	0.71	0.24	23.7
SW3	West Pond	SW3-01	30-Jan-96	2.8	0.48	0.56	0.11	0.19	ND>0.1	0.13	0.17	0.21	ND>0.1	1.1	1.3	0.12	7.2	1.1	0.86	0.76	16.3
SW4	Ditch, West	SW4-01	30-Jan-96	0.31	ND>0.1	ND>0.1	ND>0.1	0.17	ND>0.1	0.12	0.18	0.15	ND>0.1	0.28	0.22	0.11	2.5	0.4	0.28	0.55	4.7
SW5	Ditch, East	SW5-01	30-Jan-96	1.1	0.31	ND>0.1	0.1	0.16	ND>0.1	0.11	0.14	0.15	ND>0.1	0.32	0.41	0.1	16.	0.88	0.32	0.62	20.1
SW5 (duplicate)	Ditch, East	SW1-02	30-Jan-96	1.2	0.35	0.16	0.11	0.18	ND>0.1	0.12	0.17	0.16	ND>0.1	0.3	0.44	0.12	18.	1.	0.28	0.69	22.6
		Reference Levels [1] ->		520 [2]	#	#	520 [2]	#	#	#	#	#	#	54 [3]	#	#	620 [2]	#	#	#	#

Note: * = Sample number prefix: 2708-960130-
# = Cleanup level not established
DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
ND = Not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ug/l = micrograms/liter

1 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (OAR 340-41)
2 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
3 = Reference Level based on Human Fish Consumption Criteria of AWQC

Koppers022834

TABLE I-3 – Summary of Analytical Results for Sediment Samples: On-Site Ponds
TPH, BTEX, Total PAHs, Total Organic Carbon, and Lead

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project #2708

Soil Boring Number	Sample Number*	Chain of Custody Number	Sample Date	Depth (feet bgs)	ODEQ Method		EPA Method 8270 SIM		EPA Method 8020					EPA Method 415.1	EPA Method 6010	
					TPH-G	TPH-418.1M										
					Gasoline	Diesel/Oil	Carcinogenic PAHs	Total PAHs	Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Total Organic Carbon	Total	Lead
SD-1	960130-SD1-01	2708-SD010	30-Jan-96	0.5	ND>20 by HCID	140.	**1,062.9**	**1,934.7**	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	90,700.		14.
SD-2	960130-SD2-01	2708-SD010	30-Jan-96	0.5	16.	1,200.	**3,721.6**	**21,664.6**	ND>0.3	ND>0.3	ND>0.3	0.34	0.34	134,000.		6.8
SD-3	960130-SD3-01	2708-SD010	30-Jan-96	0.5	ND>10	1,100.	**2,628.1**	**10,669.9**	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	75,500.		18.
Reference Level [1] ->					-	-	See Table I-4	See Table I-4	-	-	-	-	-	-		450

Note: * = Sample number prefix: 2708-
BTEX = benzene, toluene, ethylbenzene, and xylenes
EPA = U.S. Environmental Protection Agency
HCID = hydrocarbon identification
mg/kg = milligrams/kilogram
ND = not detected above detection limit indicated
ODEQ = Oregon Department of Environmental Quality
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
TPH = total petroleum hydrocarbons
BOLD = Detected above Reference Level

1 = Reference Levels based on Sediment Screening Levels provided within Draft Dredged Material Evaluation Framework, Lower Columbia River Management Area, April 1998.

Koppers022835

TABLE I-4 – Summary of Analytical Results for Sediment Samples: On-Site Ponds
PAHs by EPA Method 8270

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)					Analytical Results mg/kg (ppm)																	
Soil Boring /Sample Station	Sample Number	Chain of Custody No.	Sample Date	Sample Depth (feet bgs)	Acenaphthene	Acenaphthylene	Anthracene	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Benzo (ghi) perylene	Chrysene	Dibenzo (ah) anthracene	Fluoranthene	Fluorene	Indeno (1,2,3-cd) pyrene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
SD-1	960130-SD1-01	2708-SD010	30-Jan-96	0.5	**5.7**	**41.3**	**24.**	**141.**	**246.**	**76.**	**205.**	**226.**	**215.**	**28.9**	**255.**	ND>5	**151.**	**8.1**	**14.7**	**297.**	1,063	1,935
SD-2	960130-SD2-01	2708-SD010	30-Jan-96	0.5	**1,408.**	**194.**	**1,030.**	**688.**	**695.**	**262.**	**729.**	**594.**	**899.**	**68.6**	**3,006.**	**1,038.**	**380.**	**1,437.**	**6,001.**	**3,235.**	3,722	21,665
SD-3	960130-SD3-01	2708-SD010	30-Jan-96	0.5	**397.**	**104.**	**419.**	**458.**	**498.**	**182.**	**472.**	**422.**	**693.**	**48.1**	**2,013.**	**304.**	**269.**	**12.8**	**2,230.**	**2,140.**	2,620	10,662
				Reference Level [1] ->	0.5	0.6	1.	1.3	3.2	3.2	1.6	0.7	1.4	0.2	1.7	0.5	0.6	2.1	1.5	2.6	#	#

Note: # = Cleanup level not established
bgs = below ground surface
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
BOLD = Detected above Reference Level

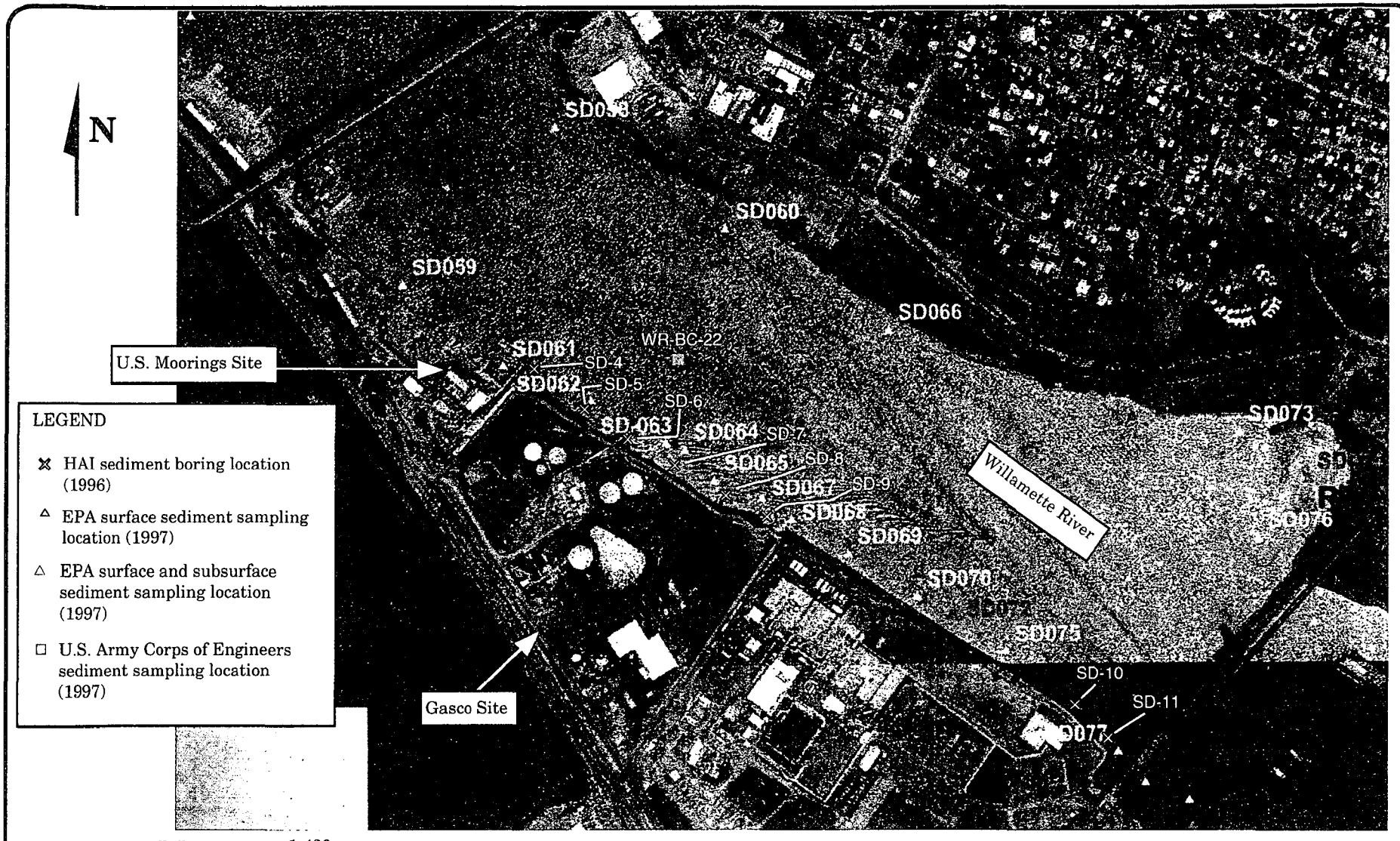
1 = Reference Levels based on Sediment Screening Levels provided within Draft Dredged Material Evaluation Framework, Lower Columbia River Management Area, April 1998.

Koppers022836

APPENDIX J

Willamette River Sediment Quality Data

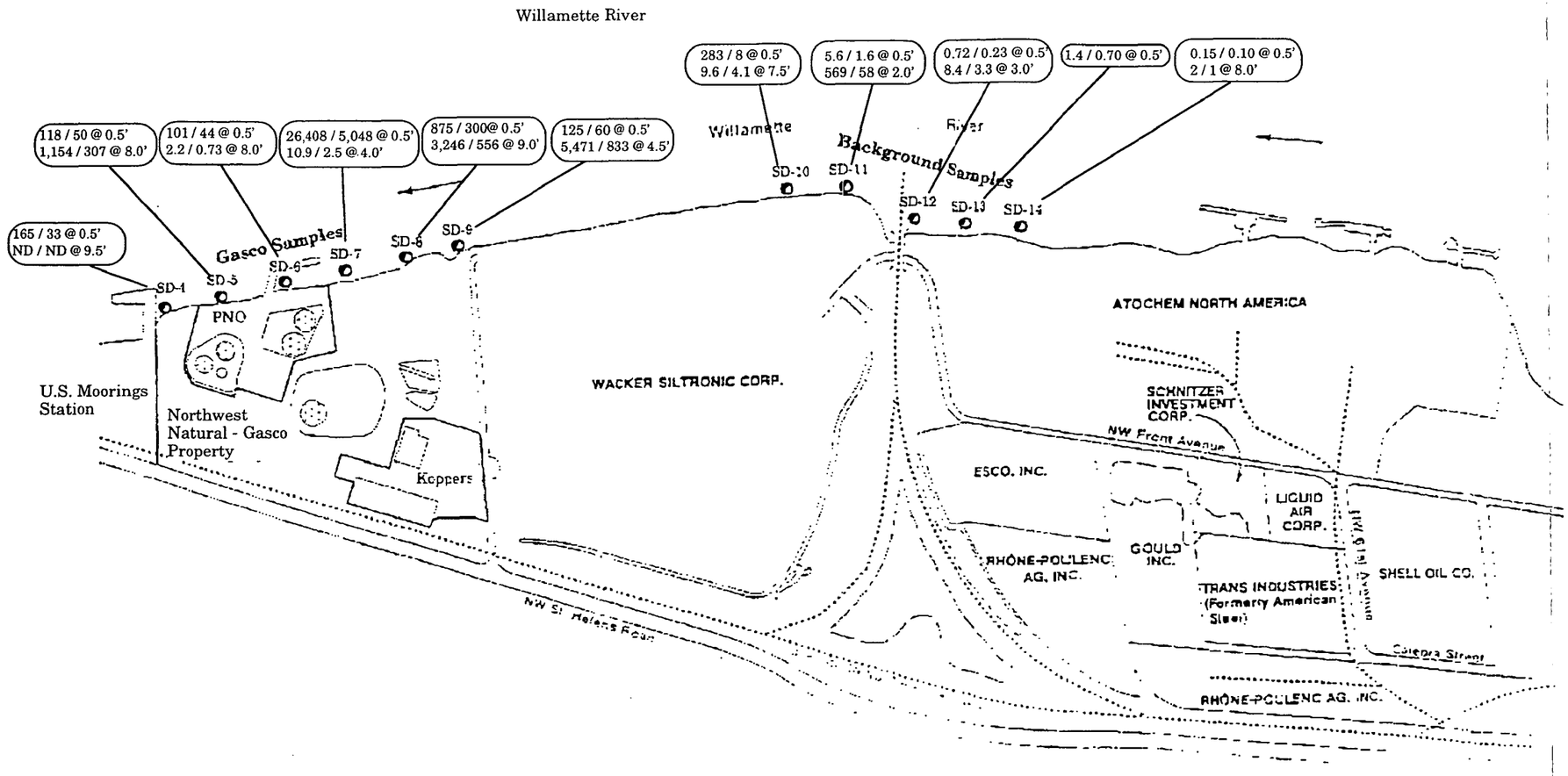
Koppers022838



Note: Aerial photograph from Portland Harbor Sediment Investigation Report, Multnomah County, Oregon (EPA 910/R-98-006), dated May 1998

Project No. 2708 September 1998	**HAHN AND ASSOCIATES INCORPORATED** ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	**SEDIMENT SAMPLE LOCATION MAP, WILLAMETTE RIVER** Northwest Natural Gasco Facility 7900 NW St. Helens Road Portland, Oregon	FIGURE **J-1**

Koppers022839



Note: Base Map from Geraghty & Miller, Inc. Hydrogeological Investigation of the Doane Lake Area, February 1991

Figure J-2

Willamette River: Site and Background Locations - PAHs

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

July 1996

Project #2708

Koppers022840

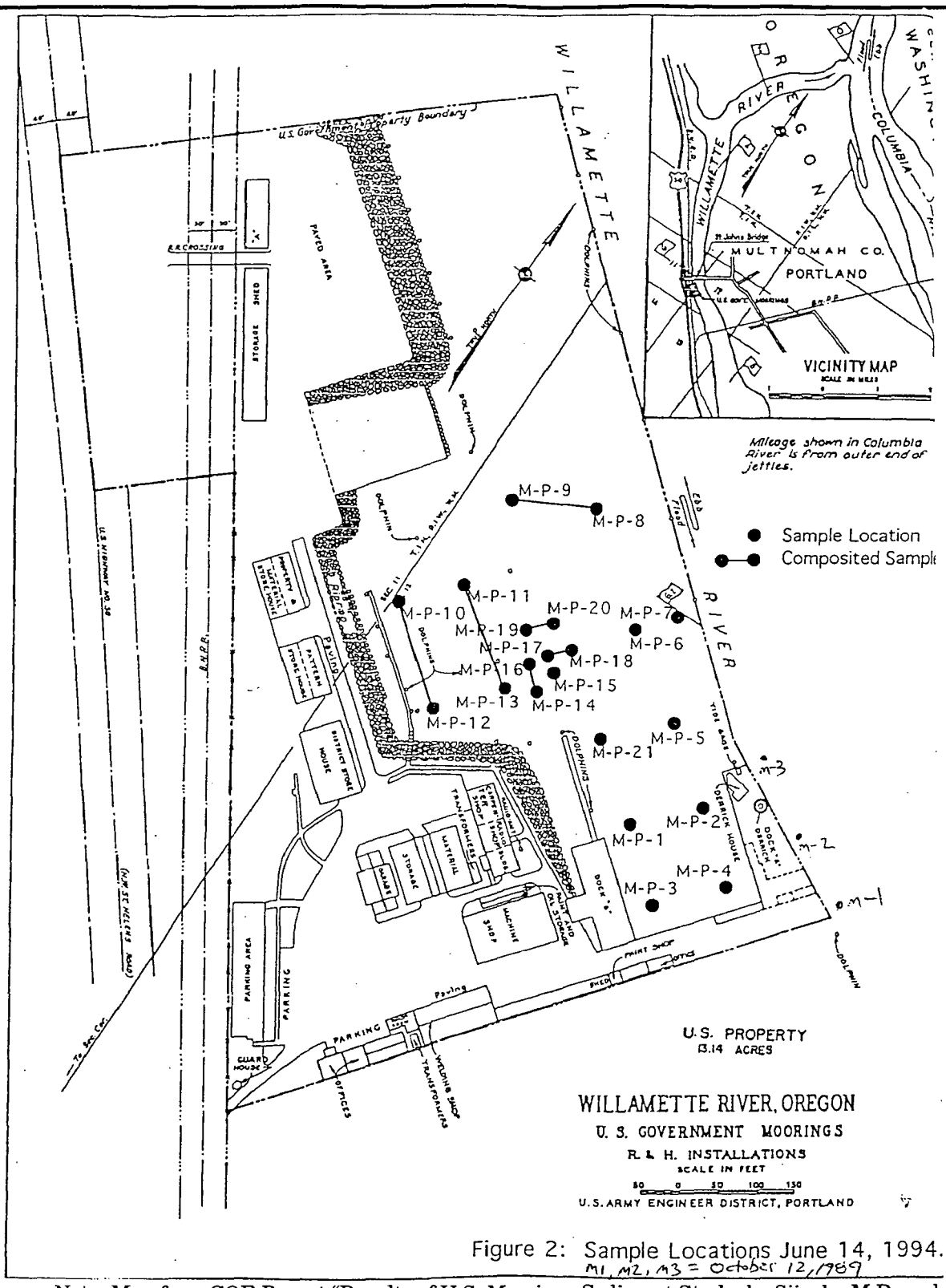


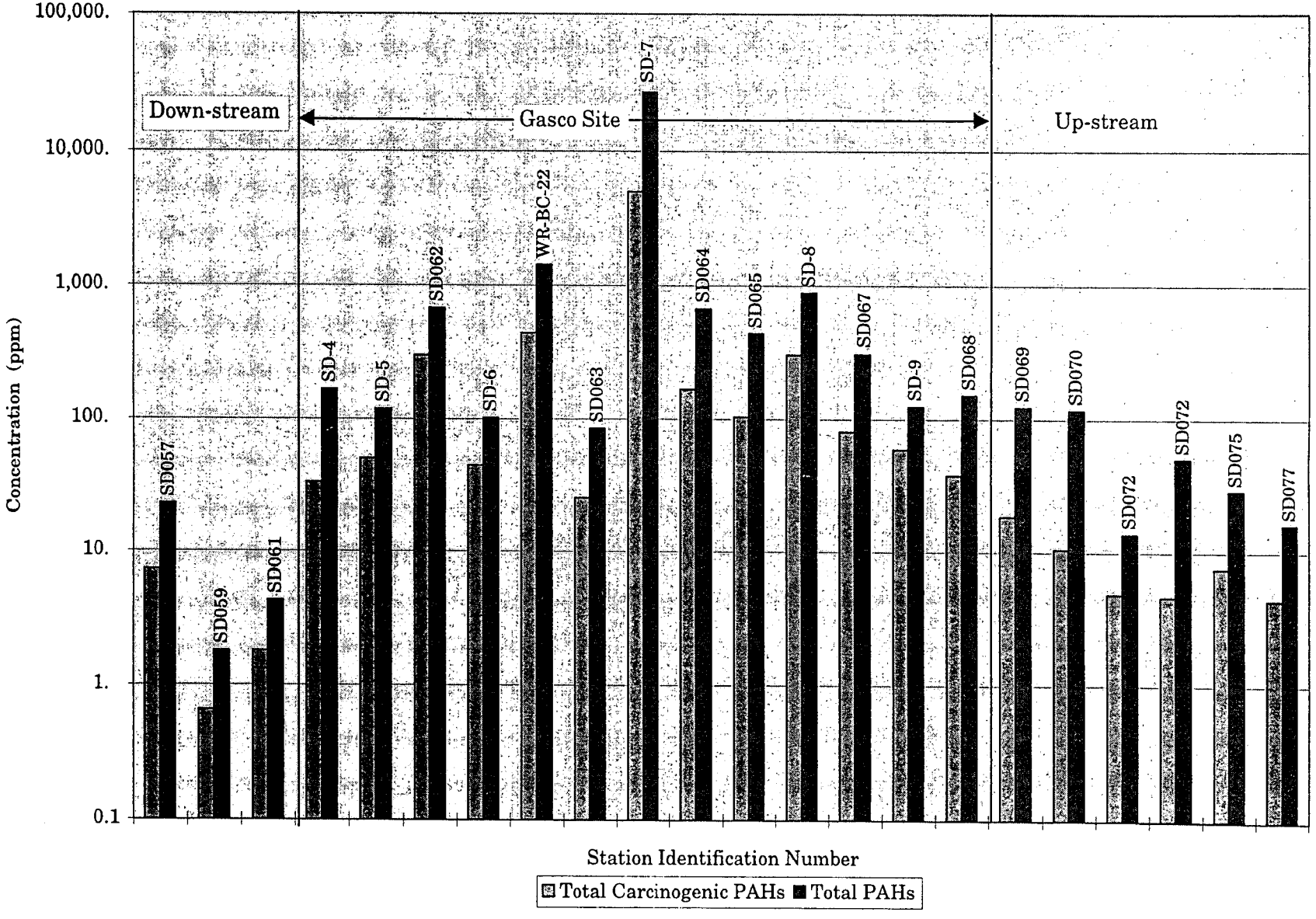
Figure 2: Sample Locations June 14, 1994.
M1, M2, M3 = October 12, 1989

Note: Map from COE Report "Results of U.S. Moorings Sediment Study, by Siipola, M.D. and Britton, J.L., June 14, 1994

Project No. 2708 September 1998	**HAHN AND ASSOCIATES** **INCORPORATED** ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 (503) 796-0717	**U.S. Moorings Sediment Sample Locations** Northwest Natural Gasco Facility 7900 NW St. Helens Road Portland, Oregon	**FIGURE** **J-3**

Koppers022841

Figure J-4
Total PAHs and Carcinogenic PAHs in Willamette River Surface Sediment
River Mile 6.0 - 7.0



2708-J Sed Chart: Updated9/28/98:RBE

HAHN AND ASSOCIATES, INC.

Koppers022842

TABLE J-1 – Summary of Analytical Results for Sediment Samples: Willamette River
TPH, BTEX, Total PAHs, Total Organic Carbon, and Lead

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project #2708

Sample Station ID	Sample Number*	Chain of Custody Number	Sample Date	Depth (feet brbs)	Analytical Results mg/kg (ppm)												
					ODEQ Method TPH-HCID			ODEQ Method		EPA Method 8270 SIM		EPA Method 8020					EPA Method 415.1	EPA Method 6010
								TPH-G	TPH-418.1M									
					Gasoline	Diesel	Oil	Gasoline	Diesel/Oil	Carcinogenic PAHs	Total PAHs	Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Total Organic Carbon	Total Lead
SD-4	960123-SD4-01	2708-SD003	23-Jan-96	0.5	ND>20	Detected	Detected		91.	32.95	164.94	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	17,000.	32.
SD-4	960123-SD4-11	2708-SD003	23-Jan-96	9.5	ND>20	ND>50	ND>100			0.1	0.15	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND		2.3
SD-5	960123-SD5-01	2708-SD003	23-Jan-96	0.5	ND>20	ND>50	ND>100			50.1	118.1	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	18,500.	9.3
SD-5	960123-SD5-09	2708-SD004	23-Jan-96	8.0				ND>10	160.	306.6	1,153.6	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND		20.
SD-6	960123-SD6-01	2708-SD004	23-Jan-96	0.5	ND>20	Detected	Detected		240.	44.16	101.43	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	5,400.	25.
SD-6	960123-SD6-09	2708-SD005	23-Jan-96	8.0	ND>20	ND>50	ND>100			0.73	2.2	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND		10.
SD-7	960123-SD7-01	2708-SD006	23-Jan-96	0.5	Detected	Detected	Detected	300.	5,100.	5,048.	26,408.	22.	4.2	10.	18.	54.2	120,000.	35.
SD-7	960123-SD7-05	2708-SD006	23-Jan-96	8.5	ND>20	ND>50	ND>100			2.46	10.89	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND		2.8
SD-8	960123-SD8-01	2708-SD006	23-Jan-96	0.5	ND>20	ND>50	ND>100			299.9	874.5	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	41,000.	47.
SD-8	960123-SD8-10	2708-SD007	23-Jan-96	9.0				44.	910.	556.	3,254.	ND>0.3	ND>0.3	1.3	1.3	2.6		26.
SD-9	960124-SD9-01	2708-SD007	24-Jan-96	0.5	ND>20	ND>50	ND>100			59.5	124.94	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	34,000.	20.
SD-9	960124-SD9-02 (Dup)	2708-SD007	24-Jan-96	0.5						44.	94.						28,000.	
SD-9	960124-SD9-06	2708-SD008	24-Jan-96	4.5				110.	380.	833.	5,471.	1.8	ND>0.3	6.2	6.	14.		10.
SD-10	960123-SD10-01	2708-SD008	23-Jan-96	0.5	ND>20	ND>50	ND>100			7.95	283.34	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	9,600.	2.8
SD-10	960123-SD10-09	2708-SD008	23-Jan-96	7.5	ND>20	Detected	ND>100		290.	4.13	9.57	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND		7.8
SD-11	960123-SD11-01	2708-SD008	23-Jan-96	0.5				ND>10	9.6	1.6	5.62	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	830.	5.1
SD-11	960123-SD11-03	2708-SD009	23-Jan-96	2.0					280.	58.4	569.38	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND		6.3
SD-12	960124-SD12-01	2708-SD002	24-Jan-96	0.5	ND>20	ND>50	ND>100			0.23	0.72	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	5,000.	10.
SD-12	960124-SD12-04	2708-SD002	24-Jan-96	3.0	ND>20	ND>50	ND>100			3.27	8.36	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND		6.6
SD-13	960124-SD13-01	2708-SD001	24-Jan-96	0.5	ND>20	ND>50	ND>100			0.7	1.37	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	4,800.	13.
SD-14	960124-SD14-01	2708-SD005	24-Jan-96	0.5	ND>20	Detected	ND>100		96.	0.1	0.15	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND	8,000.	13.
SD-14	960124-SD14-09	2708-SD005	24-Jan-96	8.0						0.69	1.5	ND>0.3	ND>0.3	ND>0.3	ND>0.3	ND		2.6
Reference Level [1] ->					-	-	-	-	-	-	-	-	-	-	-	-	-	450

Note:
* = Sample number prefix: 2708-
BTEX = benzene, toluene, ethylbenzene, and xylenes
brbs = below river bottom surface
EPA = U.S. Environmental Protection Agency
HCID = hydrocarbon identification
mg/kg = milligrams/kilogram
ND = not detected above detection limit indicated
ODEQ = Oregon Department of Environmental Quality
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
TPH = total petroleum hydrocarbons

1 = Reference Levels based on Sediment Screening Levels provided within Draft Dredged Material Evaluation Framework, Lower Columbia River Management Area, April 1998.

Koppers022843

Updated: 9/25/98 RBE
File Name: 2708-J Sed Results (W.R.)

TABLE J-2 – Summary of Analytical Results for Sediment Samples: Willamette River
PAHs by EPA Method 8270

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)				Analytical Results mg/kg (ppm)																	
				Carcinogenic PAHs							Non-carcinogenic PAHs										
Sample Station ID	Sample Number	Sample Date	Sample Depth (feet brbs)	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene 1	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
Northwest Natural Sediment Investigation Data																					
SD-4	2708-960123-SD4-01	23-Jan-96	0.5	5.6	6.8	2.7	**5.6**	**7.8**	**0.65**	**3.8**	**5.9**	**0.59**	**4.9**	**6.1**	**19.9**	**4.8**	**32.2**	**34.6**	**23.**	33.	165.
SD-4	2708-960123-SD4-11	23-Jan-96	9.5	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND	ND
SD-5	2708-960123-SD5-01	23-Jan-96	0.5	8.4	9.3	3.	**11.1**	**11.2**	**1.3**	**5.8**	**4.3**	ND>0.05	**4.**	**9.9**	**13.**	2.	1.6	**14.8**	**18.4**	50.1	118.
SD-5	2708-960123-SD5-09	23-Jan-96	8.0	52.7	56.8	**20.6**	**64.5**	**72.5**	**6.6**	**32.9**	**45.8**	**2.3**	**63.4**	**47.1**	**174.**	**28.9**	**6.5**	**266.**	**213.**	307.	1,154.
SD-6	2708-960123-SD6-01	23-Jan-96	0.5	6.6	9.4	**3.7**	**9.7**	**8.8**	**0.86**	**5.1**	**1.3**	**0.65**	**2.**	**8.**	**18.2**	**0.75**	0.37	**3.5**	**22.5**	44.2	101.4
SD-6	2708-960123-SD6-09	23-Jan-96	8.0	0.096	0.14	0.056	0.17	0.15	ND>0.05	0.12	0.054	ND>0.05	0.072	0.21	0.34	ND>0.05	0.06	0.26	0.47	0.7	2.2
SD-7	2708-960123-SD7-01	23-Jan-96	0.5	840.	930.	**350.**	**1,000.**	**1,300.**	**98.**	**530.**	**1,600.**	**140.**	**1,100.**	**820.**	3,000.	**800.**	**5,100.**	**5,400.**	**3,400.**	5,048.	26,408.
SD-7	2708-960123-SD7-05	23-Jan-96	8.5	0.37	0.45	0.18	0.52	0.64	ND>075	0.3	0.25	0.24	0.51	0.49	1.4	0.24	1.4	**2.1**	1.8	2.5	10.9
SD-8	2708-960123-SD8-01	23-Jan-96	0.5	49.	59.	**21.**	**69.**	**58.**	**6.9**	**37.**	**21.**	**6.7**	**28.**	**57.**	**160.**	**12.**	**3.9**	**96.**	**190.**	300.	875.
SD-8	2708-960123-SD8-10	23-Jan-96	9.0	120.	100.	**36.**	**110.**	**140.**	**10.**	**48.**	**170.**	**13.**	**190.**	**75.**	**340.**	**120.**	**580.**	**770.**	**440.**	564.	3,262.
SD-9	2708-960124-SD9-01	24-Jan-96	0.5	8.7	12.	**4.5**	**14.**	**11.**	**1.4**	**7.9**	**1.6**	**1.5**	**2.6**	**12.**	**18.**	**0.83**	0.81	**8.1**	**20.**	59.5	124.9
SD-9	2708-960124-SD9-02 (Dup)	24-Jan-96	0.5	6.5	8.6	**3.3**	**10.**	**8.8**	**1.1**	**5.9**	**1.1**	0.88	**1.5**	**9.6**	**14.**	0.45	0.73	**5.1**	**16.**	44.2	93.6
SD-9	960124-SD9-06	24-Jan-96	4.5	150.	160.	**57.**	**180.**	**180.**	**16.**	**90.**	**460.**	**28.**	**230.**	**140.**	**540.**	**190.**	**1,500.**	**1,000.**	**550.**	833.	5,471.
SD-10	2708-960123-SD10-01	23-Jan-96	0.5	2.1	1.3	0.5	1.1	**2.4**	0.1	0.46	**16.**	**190.**	**5.5**	0.69	**12.**	**11.**	0.096	**31.**	**9.1**	8.	283.
SD-10	2708-960123-SD10-09	23-Jan-96	7.5	0.64	0.82	0.29	0.84	1.	0.085	0.45	0.1	0.093	0.18	0.67	1.5	ND>0.068	ND>0.068	1.	1.9	4.1	9.6
SD-11	2708-960123-SD11-01	23-Jan-96	0.5	0.25	0.32	0.12	0.32	0.38	ND>0.066	0.21	0.34	ND>0.066	0.21	0.33	0.87	0.39	ND>66	1.1	0.78	1.6	5.6
SD-11	2708-960123-SD11-03	23-Jan-96	2.0	17.	8.1	**3.7**	**5.3**	**16.**	ND>0.074	**1.3**	**40.**	0.38	**58.**	**1.6**	**100.**	**66.**	ND>.074	**260.**	**74.**	51.4	651.4
SD-12	2708-960124-SD12-01	24-Jan-96	0.5	ND>0.05	0.067	ND>0.05	0.055	0.053	ND>0.05	0.055	ND>0.05	ND>0.05	ND>0.05	0.11	0.13	ND>0.05	ND>0.05	0.06	0.19	0.2	0.7
SD-12	2708-960124-SD12-04	24-Jan-96	3.0	0.38	0.66	0.22	0.83	0.53	0.063	0.59	0.055	0.049	0.13	**1.2**	1.1	ND>0.05	0.058	0.39	2.1	3.3	8.4
SD-13	2708-960124-SD13-01	24-Jan-96	0.5	0.097	0.15	0.066	0.13	0.17	ND>0.05	0.085	ND>0.05	ND>0.05	0.044	0.14	0.2	ND>0.05	ND>0.05	0.079	0.21	0.7	1.4
SD-14	2708-960124-SD14-01	24-Jan-96	0.5	ND>0.05	0.049	ND>0.05	0.051	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	0.054	ND>0.05	ND>0.05	ND>0.05	ND>0.05	ND>0.05	0.1	0.2
SD-14	2708-960124-SD14-09	24-Jan-96	8.0	0.16	0.12	0.054	0.13	0.18	ND>0.05	0.047	ND>0.05	ND>0.05	0.067	0.06	0.22	ND>0.05	ND>0.05	0.12	0.31	0.7	1.5
	Reference Level 1 ->			1.3	3.2	3.2	1.6	1.4	0.23	0.6	0.5	0.56	0.96	0.67	1.7	0.54	2.1	1.5	2.6	#	#

Note: # = Cleanup level not established
brbs = below river bottom surface
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
BOLD = Detected above Reference Level

1 = Reference Levels based on Sediment Screening Levels provided within Draft Dredged Material Evaluation Framework, Lower Columbia River Management Area, April 1998.

Updated: 9/25/98 RBE
File Name: 2708-J Sed Results (W.R.)

Koppers022844

TABLE J-2 – Summary of Analytical Results for Sediment Samples: Willamette River
PAHs by EPA Method 8270
Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)				Analytical Results mg/kg (ppm)																	
				Carcinogenic PAHs							Non-carcinogenic PAHs										
Sample Station ID	Sample Number	Sample Date	Sample Depth (feet brbs)	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
Selected EPA Portland Harbor Sediment Investigation Data																					
SD057	WR-SD-SD057-0000	20-Sep-97	0.1	0.16	0.17	0.17	0.23	0.22	0.045	0.14	0.11	ND>0.019	0.21	0.17	0.41	0.11	0.062	0.44	0.37	1.1	3.
SD057	WR-SD-SD057-0000A	20-Sep-97	0.0-2.5	0.95	1.2	1.	1.2	1.4	0.2	1.4	0.41	0.087	0.29	1.8	4.2	0.13	0.23	2.3	5.6	7.4	22.4
SD058	WR-SD-SD058-0000	20-Sep-97	0.1	0.19	0.18	0.22	0.31	0.23	0.053	0.19	0.045	0.02	0.041	0.24	0.34	0.033	0.09	0.15	0.38	1.4	2.7
SD059	WR-SD-SD059-0000	20-Sep-97	0.1	0.1	0.095	0.093	0.12	0.14	0.025	0.079	0.073	ND>0.02	0.055	0.097	0.29	0.061	0.054	0.27	0.25	0.7	1.8
SD060	WR-SD-SD060-0000	20-Sep-97	0.1	0.33	0.41	0.34	0.51	0.44	0.098	0.31	0.06	0.057	0.09	0.4	0.79	0.056	0.16	0.45	0.82	2.4	5.3
SD061	WR-SD-SD061-0000	20-Sep-97	0.1	0.29	0.31	0.24	0.33	0.38	0.065	0.19	0.063	0.024	0.082	0.22	0.91	0.061	0.04	0.42	0.69	1.8	4.3
SD062	WR-SD-SD062-0000	20-Sep-97	0.1	72.	33.	14.	57.	100.	9.2	12.	15.	0.56	2.4	40.	4.7	20.	1.9	150.	140.	297.	672.
SD063	WR-SD-SD063-0000	20-Sep-97	0.1	4.	3.1	3.2	5.1	5.6	1.	3.	2.6	0.37	3.4	3.6	11.	2.4	1.2	17.	18.	25.	84.6
SD064	WR-SD-SD064-0000	20-Sep-97	0.1	28.	23.	14.	40.	36.	6.2	19.	51.	3.4	26.	24.	110.	22.	130.	17.	120.	166.	670.
SD065	WR-SD-SD065-0000	20-Sep-97	0.1	18.	14.	12.	23.	23.	3.8	10.	15.	3.6	17.	13.	72.	10.	20.	100.	80.	104.	434.
SD066	WR-SD-SD066-0000	20-Sep-97	0.1	0.36	0.3	0.29	0.41	0.47	0.071	0.22	0.22	0.034	0.21	0.27	1.1	0.12	0.32	1.	0.99	2.1	6.4
SD067	WR-SD-SD067-0000	20-Sep-97	0.1	14.	12.	10.	15.	17.	2.5	9.5	11.	2.	13.	13.	45.	9.4	13.	64.	54.	80.	304.4
SD068	WR-SD-SD068-0000	20-Sep-97	0.1	6.3	3.9	5.4	8.	8.6	1.5	4.2	15.	0.74	6.	5.9	20.	4.9	0.79	33.	26.	37.9	150.2
SD069	WR-SD-SD069-0000	20-Sep-97	0.1	4.8	1.9	1.4	2.4	6.3	0.39	1.1	5.6	0.18	22.	1.1	22.	6.7	0.2	31.	17.	18.3	124.1
SD070	WR-SD-SD070-0000	20-Sep-97	0.1	2.9	1.1	1.2	1.4	3.2	0.21	0.52	11.	0.064	8.	0.46	19.	11.	0.51	40.	17.	10.5	117.6
SD071	WR-SD-SD071-0000	20-Sep-97	0.1	0.04	0.044	0.039	0.04	0.056	ND>0.02	0.022	ND>0.02	ND>0.02	ND>0.02	0.028	0.11	ND>0.02	0.036	0.06	0.087	0.2	0.6
SD071	WR-SD-SD071A-0000	20-Sep-97	0.0-2.5	0.13	0.15	0.092	0.1	0.21	0.023	0.056	0.22	ND>0.02	0.075	0.064	0.44	0.16	0.096	0.44	0.43	0.8	2.7
SD072	WR-SD-SD072-0000	20-Sep-97	0.1	0.7	0.8	0.63	0.98	1.1	0.16	0.56	1.5	0.085	0.44	0.6	1.5	0.96	0.21	1.8	1.6	4.9	13.6
SD072	WR-SD-SD072A-0000	20-Sep-97	0.0-2.5	1.1	0.46	0.69	0.66	1.5	ND>.11	0.31	7.2	ND>0.11	3.1	0.34	7.2	5.	0.2	16.	6.6	4.7	50.4
SD073	WR-SD-SD073-0000	20-Sep-97	0.1	0.024	0.025	0.028	0.024	0.036	ND>0.02	ND>0.02	ND>0.02	ND>0.02	ND>0.02	ND>0.02	0.071	ND>0.02	0.024	0.054	0.057	0.1	0.3
SD075	WR-SD-SD075-0000	20-Sep-97	0.1	1.5	1.1	1.1	1.3	1.7	0.22	0.73	3.8	0.14	1.3	0.81	3.5	2.4	0.35	5.5	3.3	7.7	28.8
SD077	WR-SD-SD077-0000	20-Sep-97	0.1	0.74	0.7	0.67	0.89	0.92	0.14	0.38	2.4	0.14	0.42	0.42	1.7	1.4	0.3	2.2	2.5	4.4	15.9
			Reference Level [1] ->	1.3	3.2	3.2	1.6	1.4	0.23	0.6	0.5	0.56	0.96	0.67	1.7	0.54	2.1	1.5	2.6	#	#

Note: # = Cleanup level not established
brbs = below river bottom surface
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
BOLD = Detected above Reference Level

1 = Reference Levels based on Sediment Screening Levels provided within Draft Dredged Material Evaluation Framework, Lower Columbia River Management Area, April 1998.

Koppers022845

TABLE J-2 – Summary of Analytical Results for Sediment Samples: Willamette River
PAHs by EPA Method 8270

Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon

Project No. 2708

PAHs by EPA Method 8270 (SIM)				Analytical Results mg/kg (ppm)																	
				Carcinogenic PAHs							Non-carcinogenic PAHs										
Sample Station ID	Sample Number	Sample Date	Sample Depth (feet brbs)	Benzo (a) anthracene	Benzo (b) fluoranthene [2]	Benzo (k) fluoranthene [2]	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
Selected US Army Corps of Engineers Sediment Investigation Data – Willamette River																					
WR-BC-22	WR-BC-22	25-Jul-97	0.25	67.	51.5	51.5	99.	86.	9.1	74.	79.	8.5	77.	76.	250.	44.	5.3	180.	260.	438.1	1,417.9
Selected US Army Corps of Engineers Sediment Investigation Data – U.S. Moorings Site																					
M-P-1	M-P-1	14-Jun-94	0.25	2.5	_ [2]	4.	2.5	3.1	0.33	2.3	-	0.17	0.81	1.5	6.	0.6	0.17	4.2	6.4	15.2	35.1
M-P-2	M-P-2	14-Jun-94	0.25	2.	_ [2]	3.5	2.3	2.3	0.34	2.1	-	0.17	0.86	1.4	5.1	0.47	0.18	4.4	5.6	12.5	30.7
M-P-3	M-P-3	14-Jun-94	0.25	4.2	_ [2]	7.6	4.6	4.7	0.73	4.9	-	0.35	1.2	3.	11.	0.64	0.32	5.1	11.	26.7	59.3
M-P-4	M-P-4	14-Jun-94	0.25	2.4	_ [2]	4.6	3.	2.8	0.47	2.8	-	0.19	0.89	1.8	5.8	0.3	0.28	2.8	6.	16.1	34.1
M-P-5	M-P-5	14-Jun-94	0.25	1.8	_ [2]	3.3	2.1	2.1	0.33	1.9	-	0.12	0.56	1.1	4.5	0.31	0.15	2.3	4.5	11.5	25.1
M-P-6	M-P-6	14-Jun-94	0.25	1.4	_ [2]	2.6	1.9	1.6	0.234	1.6	-	0.096	0.42	0.93	3.	0.18	0.13	1.5	3.2	9.3	18.8
M-P-7	M-P-7	14-Jun-94	0.25	1.1	_ [2]	2.2	1.6	1.2	0.3	1.7	-	0.077	0.4	1.1	2.4	0.12	0.092	1.2	2.7	8.1	16.2
M-P-8/9	M-P-8/9	14-Jun-94	0.25	1.3	_ [2]	2.4	1.7	1.4	0.24	1.5	-	0.088	0.32	0.79	2.4	0.14	0.11	1.2	2.6	8.5	16.2
M-P-10/12	M-P-10/12	14-Jun-94	0.25	2.2	_ [2]	4.3	2.7	2.1	0.5	2.3	-	0.053	0.42	1.1	3.5	0.22	0.099	1.7	3.4	14.1	24.6
M-P-11/13	M-P-11/13	14-Jun-94	0.25	0.91	_ [2]	1.8	1.2	1.	0.18	1.	-	0.05	0.21	0.51	1.8	0.11	0.065	0.89	1.7	6.1	11.4
M-P-14/16	M-P-14/16	14-Jun-94	0.25	1.	_ [2]	1.9	1.3	1.2	0.19	1.1	-	0.072	0.26	0.6	2.1	0.15	0.091	0.98	2.1	6.7	13.
M-P-15	M-P-15	14-Jun-94	0.25	3.3	_ [2]	4.4	2.2	3.5	0.23	1.5	-	0.099	0.92	0.76	12.	1.3	0.12	6.5	9.2	15.1	46.
M-P-17/18	M-P-17/18	14-Jun-94	0.25	0.96	_ [2]	1.8	1.2	1.1	0.09	9.9	-	0.055	0.5	0.51	2.2	0.15	0.1	1.	2.4	15.1	22.
M-P-19/20	M-P-19/20	14-Jun-94	0.25	0.63	_ [2]	1.2	0.78	0.73	0.061	0.63	-	0.05	0.16	0.37	1.4	0.092	0.061	0.64	1.5	4.	8.3
M-P-21	M-P-21	14-Jun-94	0.25	1.3	_ [2]	2.6	1.8	1.5	0.19	2.2	-	0.12	0.42	1.	3.5	0.21	0.15	1.7	1.	9.6	17.7
M-1	M-1	12-Oct-89	0-6.5	4.7	_ [2]	6.8	5.5	5.9	0.76	3.9	-	0.47	5.5	5.7	20.	5.3	21.	29.	27.	27.6	141.5
M-2	M-2	12-Oct-89	0-6.5	3.6	_ [2]	4.9	4.1	4.8	0.5	2.4	-	0.5	5.4	3.	13.	4.6	0.55	23.	19.	20.3	89.4
M-3	M-3	12-Oct-89	0-6.5	4.4	_ [2]	5.7	4.6	5.3	0.83	3.2	-	0.3	5.4	4.9	12.	3.9	0.84	21.	20.	24.	92.4
Reference Level [1] ->				1.3	3.2	3.2	1.6	1.4	0.23	0.6	0.5	0.56	0.96	0.67	1.7	0.54	2.1	1.5	2.6	#	#

Note: # = Cleanup level not established
brbs = below river bottom surface
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams/kilogram
ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
BOLD = Detected above Reference Level

1 = Reference Levels based on Sediment Screening Levels provided within Draft Dredged Material Evaluation Framework, Lower Columbia River Management Area, April 1998.
2 = All Pre-1997 U.S. Army Corps of Engineers Data combines Benzo(b) and (k) fluoranthene as one value.

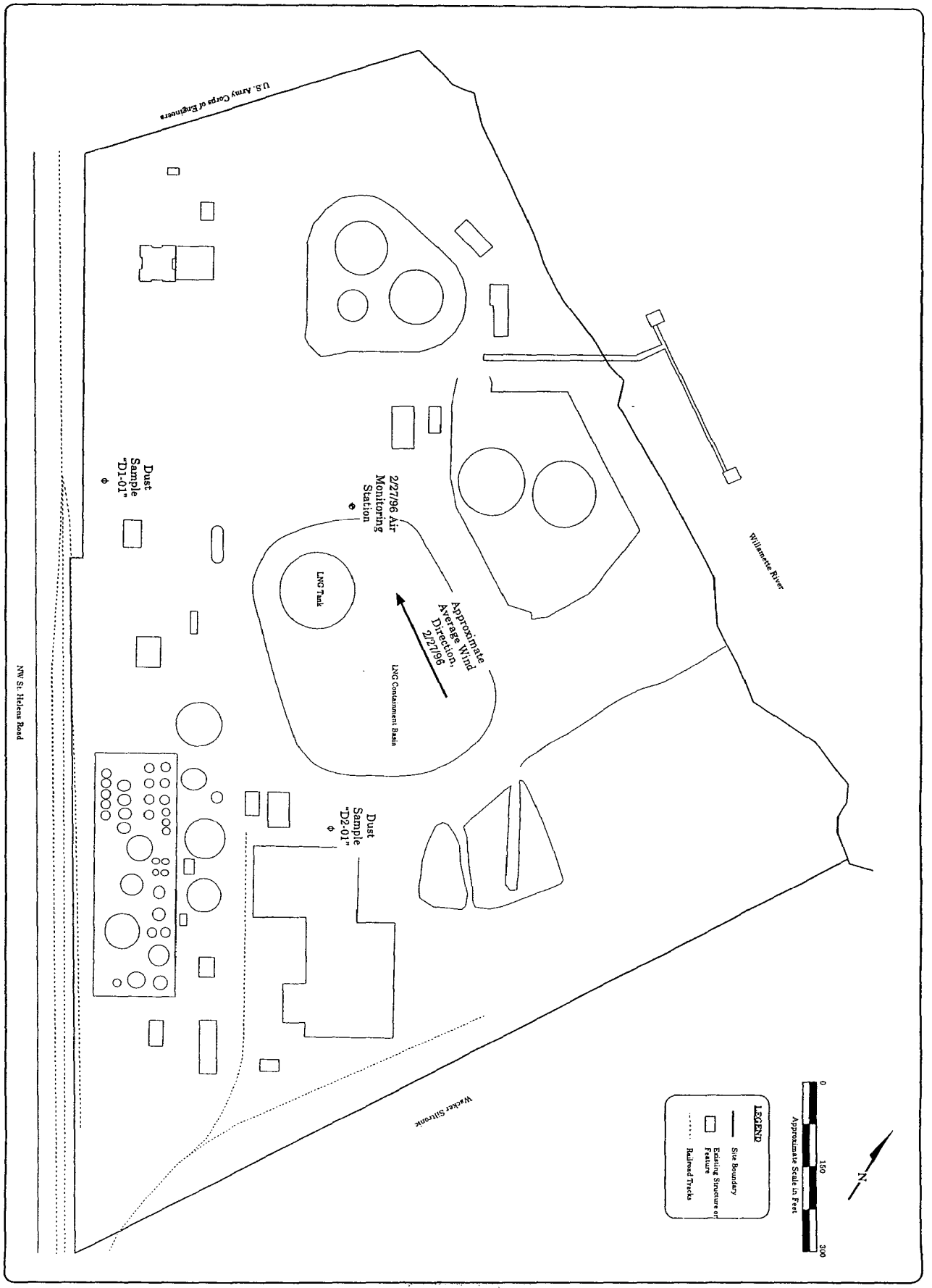
Koppers022846

K

APPENDIX K

Air Data

Koppers022848



Project #2708	September 1998	HAHN & ASSOCIATES, INC. ENVIRONMENTAL MANAGEMENT 434 NW SIXTH AVENUE, SUITE 203 PORTLAND, OREGON 97209 503/796-0717	**Dust and Air Sampling Locations** Remedial Investigation Northwest Natural - Gasco Facility 7900 NW St. Helens Road Portland, Oregon	Figure K-1

Koppers022849

Chemical Exposure Air Monitoring Report,
Paul Carlson and Associates, Inc.

HAHN AND ASSOCIATES, INC.

PAUL CARLSON ASSOCIATES, INC.
Industrial Hygiene Consultants
4511 S.E. Hawthorne Blvd.
Suite 213
Portland, Oregon 97215
(503) 232-0200 FAX (503) 230-0259

October 13, 1995

Rob Ede
Hahn and Associates, Inc.
434 NW 6th Avenue, Ste. 203
Portland, Oregon 97209

Re: Chemical Exposure Monitoring

INTRODUCTION

This report summarizes the results of exposure monitoring conducted September 19 - 21, 1995 during soil sample acquisition at the Northwest Natural Gas, Gasco Facility, 7900 NW St. Helen's Road in Portland, Oregon. Sampling was conducted to ensure adequate personal respiratory protection during drilling and sampling of potentially contaminated soil.

METHODOLOGY

Representative full-shift breathing zone concentrations of Polynuclear Aromatic Hydrocarbons (PAHs), Aromatic Hydrocarbons (BTEX), metals, total particulate, and cyanide were measured on personnel performing various tasks on the remedial site investigation. These included the driller, driller's helper, driller's third hand, and geologist. The specific test bore location, position monitored, and analyte were determined by Hahn and Associates, Inc.. Subsequent analysis was performed by Clayton Environmental Consultants, an AIHA accredited laboratory. Analytical results from the laboratory are attached.

LEGAL REQUIREMENTS

The Oregon Occupational Safety & Health Administration (OR-OSHA) has adopted Permissible Exposure Limits (PEL's) to protect the health of employees. Three types of limits have been established: Time Weighted Average (TWA), Excursion (E) and Ceiling (C) limits. The TWA's act as an eight hour average such that exposures over the TWA at times during the work shift can be compensated by exposure time below the TWA. Excursion's in worker exposure levels may exceed 3 times the TWA for no more than a total of 30 minutes during a workday, and under no circumstances exceed 5 times the TWA, provided that the TWA is not exceeded. The ceiling is assessed as a 15-minute time weighted average exposure and measured during peak exposure periods. Only the TWA applied in this survey since no job task during this project subjected workers to short duration peak exposures. The PEL's are expressed in units of milligrams (mg) or micrograms (ug) per cubic meter (mg/m^3 or ug/m^3) of air of dusts, gases, mists, and fumes, and parts per million parts (ppm) of air by volume of vapor or gas. Some of the PAH compounds have no established PEL as indicated in Table I.

Cyanide and toluene carry a "skin designation" in the PEL, meaning that skin absorption can contribute significantly to overall exposure. Appropriate skin protection should be considered when handling such chemicals.

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Arsenic, benzene, cadmium, and lead are regulated substances that require additional methods of compliance. OR-OSHA has established a 8HR-TWA "action level" for these substances, a level triggering other protective provisions such as exposure monitoring and medical surveillance. Generally, the provisions will require all affected employers to use engineering and other work practices as the primary method of compliance once an employee is exposed above the PEL on a total of 30 or more working days a year. In addition, where the PEL is exceeded, the employer shall establish and implement a written compliance program to reduce employee exposure at or below the PEL. Where engineering and work practice controls do not reduce employee exposures at or below the PEL, the employer shall supplement these controls with respirators, requiring a written respiratory protection program.

RESULTS

Chemical exposure sampling results have been tabulated as follows:

Table I - Polynuclear Aromatic Hydrocarbons (PAHs)
Table II - BTEX (benzene, toluene, ethyl benzene, xylene)
Table III - Metals (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, titanium, zinc)
Table IV - Total Particulate
Table V - Cyanide

Each sample record in the tables indicates the person monitored, job position, test bore number during sampling, analyte, exposure concentration, and applicable PEL. All exposures were below their respective PEL's and applicable "action level's", and at times below the limit of detection for the analytical method. The latter case is denoted by a "<" preceding the reported exposure concentration in the table. Sampling was not conducted continuously over an 8-hour work shift so daily average exposures would likely be lower.

FINDINGS AND RECOMMENDATIONS

Based on the results of the sampling, the following findings and recommendations are made:

1. All monitored chemicals were below their respective legal standards.

2. While Level C respiratory protection is not required based on the monitoring results, this level of protection is recommended where unknown hazards exist based on the level of ground contamination. This judgement should be made by the geologist or knowledgeable individual familiar with the hazards at this site.

3. As a minimum safeguard, it is recommended that workers wear appropriate body protection to reduce the hazard of chemical absorption through the skin.

It has been a pleasure assisting you on this project. Please call if you have any questions.

Brad Johnson

Brad Johnson

Enclosures

Table I
Hahn and Associates, Inc.

PAHs Exposure Summary
NIOSH Method 5506

Sample Date:	9/19/95			**Test Bore No:**	B18, B19	
Sample No.:	7083/7084			**Time On:**	10:00	
Name:	John Henson			**Time Off:**	15:16	
Position:	Driller's 3rd Hand			**Total Min:**	316	
	Sample Results (ug/m³)				**OR-OSHA PEL**	
Analyte	**Filter**	**Tube**	**Total**	**TWA (ug/m³)**	**E (ug/m³)**	**C (ug/m³)**
Acenaphthene	< 0.5	< 0.5	< 0.9	NE		
Acenapthylene	< 0.2	< 0.2	< 0.3	NE		
Anthracene	< 0.02	0.17	0.17	200	600	
Benzo (a) anthracene	0.03	< 0.02	0.03	NE		
Benzo (b) fluoranthene	0.03	< 0.03	0.03	NE		
Benzo (k) fluranthene	< 0.02	< 0.02	< 0.03	NE		
Benzo (g,h,i) perylene	0.05	< 0.02	0.05	NE		
Benzo (a) pyrene	0.03	< 0.02	0.03	200	600	
Chrysene	0.05	< 0.02	0.05	200	600	
Dibenzo (a,h) anthracene	< 0.02	< 0.02	< 0.03	NE		
Fluoranthene	0.08	< 0.02	0.08	NE		
Fluorene	< 0.02	< 0.02	1.9	NE		
Indeno(1,2,3-cd) pyrene	0.06	< 0.02	0.06	NE		
Naphthalene	< 0.2	80	80	50,000	150,000	
Phenanthrene	0.1	2.0	2.2	200	600	
Pyrene	0.08	0.02	0.09	200	600	

Sample Date:	9/20/95			**Test Bore No:**	B27	
Sample No.:	7087/7088			**Time On:**	12:36	
Name:	Jerry Rogers			**Time Off:**	15:27	
Position:	Driller's Helper			**Total Min:**	171	
	Sample Results (ug/m³)				**OR-OSHA PEL**	
Analyte	**Filter**	**Tube**	**Total**	**TWA (ug/m³)**	**E (ug/m³)**	**C (ug/m³)**
Acenaphthene	< 0.9	< 9	< 9	NE		
Acenapthylene	< 0.3	< 0.3	< 0.6	NE		
Anthracene	0.12	0.15	0.3	200	600	
Benzo (a) anthracene	0.45	< 0.03	0.45	NE		
Benzo (b) fluoranthene	0.66	< 0.06	0.66	NE		
Benzo (k) fluranthene	0.39	< 0.03	0.39	NE		
Benzo (g,h,i) perylene	1.7	< 0.03	1.7	NE		
Benzo (a) pyrene	0.93	< 0.03	0.93	200	600	
Chrysene	0.27	< 0.03	0.3	200	600	
Dibenzo (a,h) anthracene	1.1	< 0.03	1.1	NE		
Fluoranthene	0.93	< 0.03	0.93	NE		
Fluorene	0.06	< 0.03	0.06	NE		
Indeno(1,2,3-cd) pyrene	0.81	< 0.03	0.81	NE		
Naphthalene	< 0.3	360	360	50,000	150,000	
Phenanthrene	0.69	3.6	4.2	200	600	
Pyrene	1.4	< 0.03	1.4	200	600	

NE = PEL Not Established

Table II
Hahn and Associates, Inc.

BTEX Exposure Summary
NIOSH Method 1501

Sample Date:	9/19/95	**Test Bore No:**	B18, B19
Sample No.:	7081	**Time On:**	10:00
Name:	Jerry Rogers	**Time Off:**	15:20
Position:	Driller's Helper	**Total Min:**	320

Analyte	Sample Results ppm	OR-OSHA PEL TWA (ppm)	E (ppm)	C (ppm)
Benzene	0.018	1	5	
Toluene	0.007	100 (Skin)	300	500
Ethyl benzene	0.090	100	300	
Xylene	0.046	100	300	

Sample Date:	9/19/95	**Test Bore No:**	B18, B19
Sample No.:	7082	**Time On:**	10:00
Name:	Rob Ede	**Time Off:**	15:16
Position:	Geologist	**Total Min:**	316

Analyte	Sample Results ppm	OR-OSHA PEL TWA (ppm)	E (ppm)	C (ppm)
Benzene	0.064	1	5	
Toluene	< 0.007	100 (Skin)	300	500
Ethyl benzene	0.03	100	300	
Xylene	< 0.01	100	300	

Sample Date:	9/20/95	**Test Bore No:**	B27
Sample No.:	7086	**Time On:**	12:36
Name:	Jerry Rogers	**Time Off:**	15:27
Position:	Driller's Helper	**Total Min:**	171

Analyte	Sample Results ppm	OR-OSHA PEL TWA (ppm)	E (ppm)	C (ppm)
Benzene	0.11	1	5	
Toluene	< 0.01	100 (Skin)	300	500
Ethyl benzene	0.02	100	300	
Xylene	< 0.03	100	300	

Sample Date:	9/21/95	**Test Bore No:**	B4, B3, B1
Sample No.:	7091	**Time On:**	08:15
Name:	John Henson	**Time Off:**	15:27
Position:	Driller's 3rd Hand	**Total Min:**	432

Analyte	Sample Results ppm	OR-OSHA PEL TWA (ppm)	E (ppm)	C (ppm)
Benzene	0.02	1	5	
Toluene	< 0.005	100 (Skin)	300	500
Ethyl benzene	0.02	100	300	
Xylene	0.01	100	300	

Table III
Hahn and Associates, Inc.

Metals Exposure Summary
NIOSH Method 7300

Sample Date:	9/21/95	**Test Bore No:**	B4, B3
Sample No.:	7092	**Time On:**	08:17
Name:	Jerry Rogers	**Time Off:**	15:28
Position:	Driller's Helper	**Total Min:**	431

Analyte	Sample Results (mg/m^3)	OR-OSHA PEL TWA (mg/m^3)	OR-OSHA PEL E (mg/m^3)	OR-OSHA PEL C (mg/m^3)
Antimony	< 0.009	0.5	1.5	
Arsenic	< 0.0009	0.01	0.03	
Beryllium	< 0.0005	0.002	0.005	0.025
Cadmium	< 0.0002	0.005	0.015	
Chromium	< 0.002	0.5	1.5	
Copper	< 0.002	0.1	0.3	
Lead	< 0.0009	0.05	0.15	
Nickel	< 0.0005	1	3	
Selenium	< 0.002	0.2	0.6	
Silver	< 0.0005	0.01	0.03	
Titanium	0.005	10[1]	30	
Zinc	< 0.002	5[2]	15	

[1]As Titanium Oxide
[2]As Zinc Oxide

Lead Exposure Summary
NIOSH 7300

Sample Date:	9/19/95	**Test Bore No:**	B18, B19
Sample No.:	7080	**Time On:**	10:00
Name:	Bradley James	**Time Off:**	15:13
Position:	Driller	**Total Min:**	313

Analyte	Sample Results (mg/m^3)	OR-OSHA PEL TWA (mg/m^3)	OR-OSHA PEL E (mg/m^3)	OR-OSHA PEL C (mg/m^3)
Lead	< 0.001	0.01	0.03	

Table IV
Hahn and Associates, Inc.

Total Particulate Exposure Summary
NIOSH Method 0500

Sample Date: 9/19/95 **Sample No.:** 7079 **Name:** Area Sample **Position:** 6' Downwind of Drill Rig		**Test Bore No:** B18, B19 **Time On:** 10:00 **Time Off:** 15:18 **Total Min:** 318		
Analyte	**Sample Results (mg/m^3)**	**TWA (mg/m^3)**	**OR-OSHA PEL E (mg/m^3)**	**C (mg/m^3)**
Total Dust	< 0.2	10	30	

Table V
Hahn and Associates, Inc.

Cyanide Exposure Summary
NIOSH Method 7904

Sample Date: 9/21/95 **Sample No.:** 7093/7094 **Name:** Bradley James **Position:** Driller				**Test Bore No:** B4, B3, B1 **Time On:** 08:14 **Time Off:** 15:30 **Total Min:** 436			
Analyte	**Sample Results (mg/m^3) Filter**	**Impinger**	**Total**	**TWA (mg/m^3)**	**OR-OSHA PEL E (mg/m^3)**	**C (mg/m^3)**	
Cyanide	< 0.007	< 0.007	< 0.01	5 (Skin)	15		

Analytical Results
for
Paul Carlson Associates
Client Reference: HA16399
Clayton Project No. 95093.35

Sample Identification: 7083/7084
Lab Number: 9509335-11A
Sample Matrix/Media: FILT_SORBENT
Method Reference: NIOSH 5506

Date Sampled: 09/19/95
Date Received: 09/25/95
Date Analyzed: 09/27/95
Analyst: FHK
Air Volume: 639.9 (L)

Compound	Filter (ug)	Tube Front (ug)	Tube Back (ug)	Total (ug)	Concentration (ug/m3)	Method Detection Limit (ug)
Polynuclear Aromatic Hydrocarbons						
Acenaphthene	<0.3	<0.3	<0.3	<0.6	<0.9	0.3
Acenaphthylene	<0.1	<0.1	<0.1	<0.2	<0.3	0.1
Anthracene	<0.01	0.11	<0.01	0.11	0.17	0.01
Benzo(a)anthracene	0.02	<0.01	<0.01	0.02	0.03	0.01
Benzo(b)fluoranthene	0.02	<0.02	<0.02	0.02	0.03	0.02
Benzo(k)fluoranthene	<0.01	<0.01	<0.01	<0.02	<0.03	0.01
Benzo(g,h,i)perylene	0.03	<0.01	<0.01	0.03	0.05	0.01
Benzo(a)pyrene	0.02	<0.01	<0.01	0.02	0.03	0.01
Chrysene	0.03	<0.01	<0.01	0.03	0.05	0.01
Dibenzo(a,h)anthracene	<0.01	<0.01	<0.01	<0.02	<0.03	0.01
Fluoranthene	0.05	<0.01	<0.01	0.05	0.08	0.01
Fluorene	<0.01	1.2	<0.01	1.2	1.9	0.01
Indeno(1,2,3-cd)pyrene	0.04	<0.01	<0.01	0.04	0.06	0.01
Naphthalene	<0.1	48	3.4	51	80	0.1
Phenanthrene	0.07	1.3	<0.01	1.4	2.2	0.01
Pyrene	0.05	0.01	<0.01	0.06	0.09	0.01

< : Less than the indicated limit of detection
--: Information not available or not applicable

Clayton
ENVIRONMENTAL
CONSULTANTS

Analytical Results
for
Paul Carlson Associates
Client Reference: HA16399
Clayton Project No. 95092.85

Sample Identification: 7087/7088
Lab Number: 9509285-02A
Sample Matrix/Media: FILT_SORBENT
Method Reference: NIOSH 5506

Date Sampled: 09/20/95
Date Received: 09/21/95
Date Analyzed: 09/21/95
Analyst: FHK
Air Volume: 331.7 (L)

Compound	Filter (ug)	Tube Front (ug)	Tube Back (ug)	Total (ug)	Concentration (ug/m3)	Method Detection Limit (ug)
Polynuclear Aromatic Hydrocarbons						
Acenaphthene	<0.3	<3 a	<0.3	<3	<9	3 a
Acenaphthylene	<0.1	<0.1	<0.1	<0.2	<0.6	0.1
Anthracene	0.04	0.05	<0.01	0.09	0.3	0.01
Benzo(a)anthracene	0.15	<0.01	<0.01	0.15	0.45	0.01
Benzo(b)fluoranthene	0.22	<0.02	<0.02	0.22	0.66	0.02
Benzo(k)fluoranthene	0.13	<0.01	<0.01	0.13	0.39	0.01
Benzo(g,h,i)perylene	0.57	<0.01	<0.01	0.57	1.7	0.01
Benzo(a)pyrene	0.31	<0.01	<0.01	0.31	0.93	0.01
Chrysene	0.09	<0.01	<0.01	0.09	0.3	0.01
Dibenzo(a,h)anthracene	0.37	<0.01	<0.01	0.37	1.1	0.01
Fluoranthene	0.31	<0.01	<0.01	0.31	0.93	0.01
Fluorene	0.02	<0.01	<0.01	0.02	0.06	0.01
Indeno(1,2,3-cd)pyrene	0.27	<0.01	<0.01	0.27	0.81	0.01
Naphthalene	<0.1	110	11	120	360	0.1
Phenanthrene	0.23	1.2	<0.01	1.4	4.2	0.01
Pyrene	0.47	<0.01	<0.01	0.47	1.4	0.01

< : Less than the indicated limit of detection
--: Information not available or not applicable

[a] Detection limit increased due to matrix interference.

Clayton
ENVIRONMENTAL
CONSULTANTS

Analytical Results
for
Paul Carlson Associates
Client Reference: HA16399
Clayton Project No. 95092.58

Sample Identification: See Below
Lab Number: 9509258
Sample Matrix/Media: SM_CHAR_TUBE

Date Sampled: 09/19/95
Date Received: 09/20/95
Date Analyzed: 09/21/95
Analyst: FHK

Lab No.	Sample I.D.	Sample Volume (liters)	Compound	Front (mg)	Back (mg)	Total (mg)	Concentration (mg/m3)	Concentration (ppm)	Method Detection Limit (mg)
-01	7085-BLANK	--	Benzene	<0.002	<0.002	<0.002	--	--	0.002
			Ethyl benzene	<0.002	<0.002	<0.002	--	--	0.002
			Toluene	<0.002	<0.002	<0.002	--	--	0.002
			Xylene	<0.004	<0.004	<0.004	--	--	0.004
-02	7081	64.96	Benzene	0.037	<0.002	0.037	0.57	0.18	0.002
			Ethyl benzene	0.002	<0.002	0.002	0.03	0.007	0.002
			Toluene	0.022	<0.002	0.022	0.34	0.090	0.002
			Xylene	0.013	<0.004	0.013	0.20	0.046	0.004

ND: Not detected at or above limit of detection
--: Information not available or not applicable
Airborne concentrations are based on the air volumes provided
Results have been corrected using laboratory-derived desorption efficiencies

Compound	Method Reference
Benzene	NIOSH 1501
Ethyl benzene	NIOSH 1501
Toluene	NIOSH 1501
Xylene	NIOSH 1501

Analytical Results
for
Paul Carlson Associates
Client Reference: HA16399
Clayton Project No. 95093.35

Sample Identification: See Below
Lab Number: 9509335
Sample Matrix/Media: SM_CHAR_TUBE

Date Sampled: 09/19/95
Date Received: 09/25/95
Date Analyzed: 09/27/95
Analyst: FHK

Lab No.	Sample I.D.	Sample Volume (liters)	Compound	Front (mg)	Back (mg)	Total (mg)	Concentration (mg/m3)	Concentration (ppm)	Method Detection Limit (mg)
-01	7082	63.99	Benzene	0.013	<0.002	0.013	0.20	0.064	0.002
			Ethyl benzene	<0.002	<0.002	<0.002	<0.03	<0.007	0.002
			Toluene	0.007	<0.002	0.007	0.1	0.03	0.002
			Xylene	<0.004	<0.004	<0.004	<0.06	<0.01	0.004
-02	7086	35.65	Benzene	0.013	<0.002	0.013	0.36	0.11	0.002
			Ethyl benzene	<0.002	<0.002	<0.002	<0.06	<0.01	0.002
			Toluene	0.003	<0.002	0.003	0.08	0.02	0.002
			Xylene	<0.004	<0.004	<0.004	<0.1	<0.03	0.004
-03	7091	87.48	Benzene	0.005	<0.002	0.005	0.06	0.02	0.002
			Ethyl benzene	<0.002	<0.002	<0.002	<0.02	<0.005	0.002
			Toluene	0.006	<0.002	0.006	0.07	0.02	0.002
			Xylene	0.005	<0.004	0.005	0.06	0.01	0.004
-04	5482 BLANK	--	Benzene	<0.002	<0.002	<0.002	--	--	0.002
			Ethyl benzene	<0.002	<0.002	<0.002	--	--	0.002
			Toluene	<0.002	<0.002	<0.002	--	--	0.002
			Xylene	<0.004	<0.004	<0.004	--	--	0.004

ND: Not detected at or above limit of detection
--: Information not available or not applicable
Airborne concentrations are based on the air volumes provided
Results have been corrected using laboratory-derived desorption efficiencies

Compound	Method Reference
Benzene	NIOSH 1501
Ethyl benzene	NIOSH 1501
Toluene	NIOSH 1501
Xylene	NIOSH 1501

Analytical Results
for
Paul Carlson Associates
Client Reference: HA16399
Clayton Project No. 95093.35

Sample Identification: 7092
Lab Number: 9509335-08
Sample Matrix/Media: FILTER

Date Sampled: 09/21/95
Date Received: 09/25/95
Air Volume: 1081.8 (L)

Analyte	Amount (mg)	Concentration (mg/m3)	Method Detection Limit (mg)	Date Prepared	Date Analyzed	Prep/ Analysis Method
Antimony	<0.01	<0.009	0.01	09/27/95	09/28/95	NIOSH 7300
Arsenic	<0.001	<0.0009	0.001	09/27/95	09/28/95	NIOSH 7300
Beryllium	<0.0005	<0.0005	0.0005	09/27/95	09/28/95	NIOSH 7300
Cadmium	<0.0002	<0.0002	0.0002	09/27/95	09/28/95	NIOSH 7300
Chromium	<0.002	<0.002	0.002	09/27/95	09/28/95	NIOSH 7300
Copper	<0.002	<0.002	0.002	09/27/95	09/28/95	NIOSH 7300
Lead	<0.001	<0.0009	0.001	09/27/95	09/28/95	NIOSH 7300
Nickel	<0.0005	<0.0005	0.0005	09/27/95	09/28/95	NIOSH 7300
Selenium	<0.002	<0.002	0.002	09/27/95	09/28/95	NIOSH 7300
Silver	<0.0005	<0.0005	0.0005	09/27/95	09/28/95	NIOSH 7300
Titanium	0.005	0.005	0.002	09/27/95	09/28/95	NIOSH 7300
Zinc	<0.002	<0.002	0.002	09/27/95	09/28/95	NIOSH 7300

ND: Not detected at or above limit of detection
--: Information not available or not applicable

Metal results have been corrected using laboratory derived recovery coefficients

Analytical Results
for
Paul Carlson Associates
Client Reference: HA16399
Clayton Project No. 95093.35

Sample Identification: 7080
Lab Number: 9509335-07
Sample Matrix/Media: FILTER

Date Sampled: 09/19/95
Date Received: 09/25/95
Air Volume: 795 (L)

Analyte	Amount (mg)	Concentration (mg/m3)	Method Detection Limit (mg)	Date Prepared	Date Analyzed	Prep/ Analysis Method
Lead	<0.001	<0.001	0.001	09/27/95	09/28/95	NIOSH 7300

ND: Not detected at or above limit of detection
--: Information not available or not applicable

Metal results have been corrected using laboratory derived recovery coefficients

Analytical Results
for
Paul Carlson Associates
Client Reference: HA16399
Clayton Project No. 95093.35

Sample Identification: 7079
Lab Number: 9509335-05
Sample Matrix/Media: FILTER

Date Sampled: 09/19/95
Date Received: 09/25/95
Air Volume: 636 (L)

Analyte	Amount (mg)	Concentration (mg/m3)	Method Detection Limit (mg)	Date Prepared	Date Analyzed	Prep/ Analysis Method
Total Dust	<0.1	<0.2	0.1	--	09/28/95	NIOSH 0500

ND: Not detected at or above limit of detection
--: Information not available or not applicable

Clayton
ENVIRONMENTAL
CONSULTANTS

Analytical Results
for
PAUL CARLSON ASSOCIATES
Clayton Project No. 30988.00
Client Reference: HA16399

Sample Type:	Filter/Impinger	Date Sampled:	09/21/95
Analytical Method:	NIOSH 7904	Date Received:	09/22/95
Analyst:	SM	Date Analyzed:	09/25/95

Lab No.	Sample Identification	Cyanide Filter (mg)	Cyanide Impinger (mg)	Combined Total (mg)	Maximum LOD (mg)
001a	7093/7094	<0.003	<0.003	<0.006	<0.006
002a	7095/7096 BLANK	<0.003	<0.003	<0.006	<0.006

General Notes:
<: Less than the indicated limit of detection (LOD)
--: Information not available or not applicable

Ambient Air Quality Monitoring Report,
Paul Carlson and Associates, Inc.

HAHN AND ASSOCIATES, INC.

PAUL CARLSON ASSOCIATES, INC.
Industrial Hygiene Consultants
4511 S.E. Hawthorne Blvd.
Suite 213
Portland, Oregon 97215
(503) 232-0200 FAX (503) 230-0259

March 27, 1996

Rob Ede
Hahn and Associates, Inc.
434 NW 6th Avenue, Ste. 203
Portland, Oregon 97209

Re: Ambient Air Monitoring

INTRODUCTION

This report summarizes the results of ambient air monitoring conducted on February 27,1996 at the Northwest Natural Gas, Gasco Facility, 7900 NW St. Helen's Road in Portland, Oregon. Sampling was conducted to assess ambient air concentrations downwind of the collection pond located on the east side of the blue LNG Storage Tank.

METHODOLOGY

Ambient air concentrations of Polynuclear Aromatic Hydrocarbons (PAHs) in airborne dust, Aromatic Hydrocarbons (BTEX), and total particulate were measured at a location downwind of the collection pond located on the east side of the blue LNG Storage Tank. The specific location was determined by Hahn and Associates, Inc. Subsequent analysis was performed by Clayton Environmental Consultants, an AIHA accredited laboratory. Analytical results from the laboratory are attached.

LEGAL REQUIREMENTS

The Oregon Occupational Safety & Health Administration (OR-OSHA) has adopted Permissible Exposure Limits (PEL's) to protect the health of employees. Three types of limits have been established: Time Weighted Average (TWA), Excursion (E) and Ceiling (C) limits. The TWA's act as an eight hour average such that exposures over the TWA at times during the work shift can be compensated by exposure time below the TWA. Excursion's in worker exposure levels may exceed 3 times the TWA for no more than a total of 30 minutes during a workday, and under no circumstances exceed 5 times the TWA, provided that the TWA is not exceeded. The ceiling is assessed as a 15-minute time weighted average exposure and measured during peak exposure periods. Only the TWA applied in this survey since ambient air concentrations would be expected to be at a consistent level through out the sampling, with no anticipated peak, short duration exposure concentrations. The PEL's are expressed in units of milligrams (mg) or micrograms (ug) per cubic meter (mg/m^3 or ug/m^3) of air of dusts, gases, mists, and fumes, and parts per million parts (ppm) of air by volume of vapor or gas. Some of the PAH compounds have no established PEL as indicated in Table I.

Koppers022866

Toluene carries a "skin designation" in the PEL, meaning that skin absorption can contribute significantly to overall exposure. Appropriate skin protection should be considered when handling this chemical.

Benzene is a regulated substance that requires additional methods of compliance. OR-OSHA has established a 8HR-TWA "action level" for benzene of 0.5 ppm, a level triggering other protective provisions such as exposure monitoring and medical surveillance. Generally, the provisions will require all affected employers to use engineering and other work practices as the primary method of compliance once an employee is exposed above the PEL on a total of 30 or more working days a year. In addition, where the PEL is exceeded, the employer shall establish and implement a written compliance program to reduce employee exposure at or below the PEL. Where engineering and work practice controls do not reduce employee exposures at or below the PEL, the employer shall supplement these controls with respirators, requiring a written respiratory protection program.

RESULTS

Chemical exposure sampling results have been tabulated as follows:

Table I	-	Polynuclear Aromatic Hydrocarbons (PAHs)
Table II	-	BTEX (benzene, toluene, ethyl benzene, xylene)
Table III	-	Total Particulate

Each sample record in the tables indicates the analyte, exposure concentration, and applicable PEL. All exposures were below their respective PEL and applicable action level, and the limit of detection for the analytical method. The latter case is denoted by a "<" preceding the reported exposure concentration in the table.

FINDINGS AND RECOMMENDATIONS

Based on the results of the sampling, the following findings and recommendations are made:

1. All monitored chemicals were below their respective legal standards.

2. While Level C respiratory protection is not required based on the monitoring results, this level of protection is recommended where unknown hazards exist based on the level of ground contamination. This judgement should be made by the geologist or knowledgeable individual familiar with the hazards at this site, with particular attention given to appropriate respiratory protection when the contaminated soil is disturbed.

Koppers022867

3. As a minimum safeguard, it is recommended that workers wear appropriate body protection to reduce the hazard of chemical absorption through the skin during soil sample acquisitions.

It has been a pleasure assisting you on this project. Please call if you have any questions.

Brad Johnson

Enclosures

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Table I
Hahn and Associates, Inc.

PAHs Exposure Summary
NIOSH Method 5506

Sample Date:	2/27/96			Time On:	09:37	
Sample No.:	0316			Time Off:	15:27	
Type:	Area Sample			Total Min:	350	
	Sample Results (ug/m³)			OR-OSHA PEL		
Analyte	Filter	Tube	Total	TWA (ug/m³)	E (ug/m³)*	C (ug/m³)**
Acenaphthene	< 0.3	---	< 0.3	NE		
Acenapthylene	< 0.1	---	< 0.1	NE		
Anthracene	< 0.01	---	< 0.01	200	600	
Benzo (a) anthracene	< 0.01	---	< 0.01	NE		
Benzo (b) fluoranthene	< 0.02	---	< 0.02	NE		
Benzo (k) fluranthene	< 0.01	---	< 0.01	NE		
Benzo (g,h,i) perylene	< 0.01	---	< 0.01	NE		
Benzo (a) pyrene	< 0.01	---	< 0.01	200	600	
Chrysene	< 0.01	---	< 0.01	200	600	
Dibenzo (a,h) anthracene	< 0.01	---	< 0.01	NE		
Fluoranthene	< 0.01	---	< 0.01	NE		
Fluorene	< 0.01	---	< 0.01	NE		
Indeno(1,2,3-cd) pyrene	< 0.01	---	< 0.01	NE		
Naphthalene	< 0.1	---	< 0.1	50,000	150,000	
Phenanthrene	< 0.01	---	< 0.01	200	600	
Pyrene	< 0.01	---	< 0.01	200	600	

NE = PEL Not Established

Table II
BTEX Exposure Summary
NIOSH Method 1501

Sample Date:	2/27/96	Time On:	09:37	
Sample No.:	0314	Time Off:	15:27	
Type:	Area Sample	Total Min:	350	
Analyte	Sample Results ppm	OR-OSHA PEL TWA (ppm)	E (ppm)*	C (ppm)**
Benzene	< 0.005	1	5	
Toluene	< 0.005	100 (Skin)	300	500
Ethyl benzene	< 0.004	100	300	
Xylene	< 0.008	100	300	

* Excursion limit
** Ceiling Limit

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Table III
Total Particulate Exposure Summary
NIOSH Method 0500

Sample Date:	2/27/96	Time On:	09:37	
Sample No.:	0315	Time Off:	15:27	
Name:	Area Sample	Total Min:	350	
Analyte	**Sample Results (mg/m^3)**	**OR-OSHA PEL TWA (mg/m^3)**	**E (mg/m^3)***	**C (mg/m^3)****
Total Dust	< 0.1	10	30	

* Excursion limit
** Ceiling Limit

Koppers022870

Analytical Results
for
Paul Carlson Associates

Clayton Project No. 96023.26

Sample Identification: 0316
Lab Number: 9602326-03A
Sample Matrix/Media: FILTER

Date Sampled: 02/27/96
Date Received: 02/29/96
Date Analyzed: 03/05/96
Air Volume: 860.7 (L)

Compound	Filter (ug)	Tube Front (ug)	Tube Back (ug)	Total (ug)	Concentration (ug/m3)	Method Detection Limit (ug)
Polynuclear Aromatic Hydrocarbons						
Acenaphthene	<0.3	--	--	<0.3	<0.4	0.3
Acenaphthylene	<0.1	--	--	<0.1	<0.2	0.1
Anthracene	<0.01	--	--	<0.01	<0.01	0.01
Benzo(a)anthracene	<0.01	--	--	<0.01	<0.01	0.01
Benzo(b)fluoranthene	<0.02	--	--	<0.02	<0.02	0.02
Benzo(k)fluoranthene	<0.01	--	--	<0.01	<0.01	0.01
Benzo(g,h,i)perylene	<0.01	--	--	<0.01	<0.01	0.01
Benzo(a)pyrene	<0.01	--	--	<0.01	<0.01	0.01
Chrysene	<0.01	--	--	<0.01	<0.01	0.01
Dibenzo(a,h)anthracene	<0.01	--	--	<0.01	<0.01	0.01
Fluoranthene	<0.01	--	--	<0.01	<0.01	0.01
Fluorene	<0.01	--	--	<0.01	<0.01	0.01
Indeno(1,2,3-cd)pyrene	<0.01	--	--	<0.01	<0.01	0.01
Naphthalene	<0.1	--	--	<0.1	<0.1	0.1
Phenanthrene	<0.01	--	--	<0.01	<0.01	0.01
Pyrene	<0.01	--	--	<0.01	<0.01	0.01

< : Less than the indicated limit of detection
--: Information not available or not applicable

Clayton
ENVIRONMENTAL
CONSULTANTS

Analytical Results
for
Paul Carlson Associates

Clayton Project No. 96023.26

Sample Identification: See Below
Lab Number: 9602326
Sample Matrix/Media: SM_CHAR_TUBE

Date Sampled: 02/27/96
Date Received: 02/29/96
Date Analyzed: 03/04/96
Analyst: FHK

Lab No.	Sample I.D.	Sample Volume (liters)	Compound	Front (mg)	Back (mg)	Total (mg)	Concentration (mg/m3)	Concentration (ppm)	Method Detection Limit (mg)
-01	0314	114.3	Benzene	<0.002	<0.002	<0.002	<0.02	<0.005	0.002
			Ethyl benzene	<0.002	<0.002	<0.002	<0.02	<0.004	0.002
			Toluene	<0.002	<0.002	<0.002	<0.02	<0.005	0.002
			Xylene	<0.004	<0.004	<0.004	<0.03	<0.008	0.004
-02	0318-BLANK	--	Benzene	<0.002	<0.002	<0.002	--	--	0.002
			Ethyl benzene	<0.002	<0.002	<0.002	--	--	0.002
			Toluene	<0.002	<0.002	<0.002	--	--	0.002
			Xylene	<0.004	<0.004	<0.004	--	--	0.004

ND: Not detected at or above limit of detection
--: Information not available or not applicable
Airborne concentrations are based on the air volumes provided
Results have been corrected using laboratory-derived desorption efficiencies

Compound	Method Reference
Benzene	NIOSH 1501
Ethyl benzene	NIOSH 1501
Toluene	NIOSH 1501
Xylene	NIOSH 1501

Analytical Results
for
Paul Carlson Associates

Clayton Project No. 96023.26

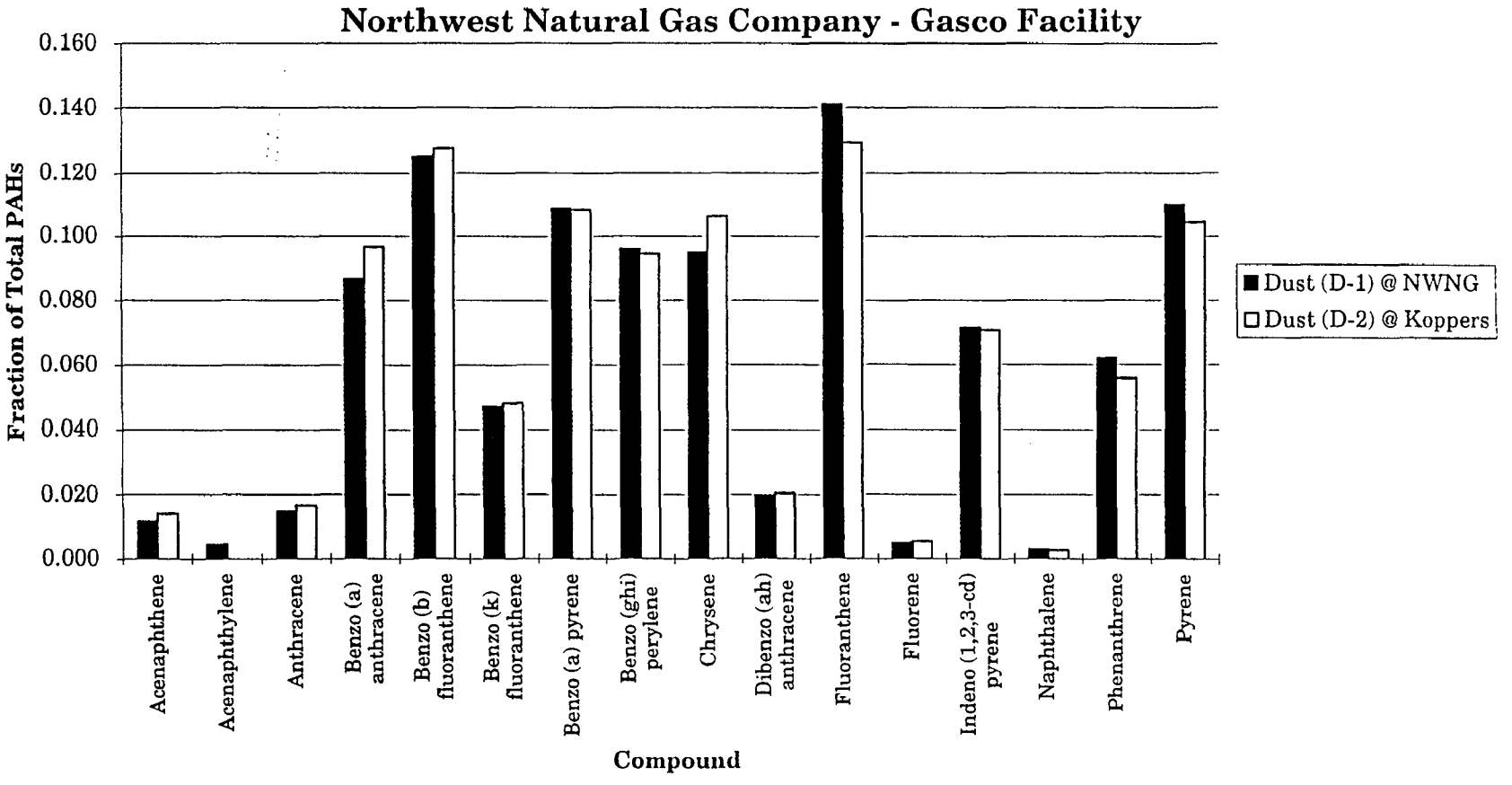
Sample Identification: See Below
Lab Number: 9602326
Sample Matrix/Media: FILTER
Method Reference: NIOSH 0500

Date Sampled: 02/27/96
Date Received: 02/29/96
Date Analyzed: 02/29/96

Lab Number	Sample Identification	Date Sampled	Volume (liters)	Total Dust (mg)	Total Dust (mg/m3)	Method Detection Limit (mg)
-05	0315	02/27/96	861.3	<0.1	<0.1	0.1

ND: Not detected at or above limit of detection
--: Information not available or not applicable

Comparison of PAH Compound Mix
Dust Samples



Updated: 6/12/96 RBE
File: 2708 Soil Results-Working/ Dust 1 vs Dust 2

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers022874

NATIONAL ENVIRONMENTAL TESTING, INC.

Portland Division
17400 SW Upper Boones Ferry Rd.
Suite #260
Portland, OR 97224
Tel: (503) 624-5449
Fax: (503) 639-6889

Roger Brown
Hahn & Associates
434 N.W. 6th Ave.
Suite 203
Portland, OR 97209

Date: 02/16/1996
NET Account No.: 13500
NET Job Number: 96.00363

Project: NWNG Gasco Site
Location: 2708

Sample analysis in support of the project referenced above has been completed and results are presented on the following pages. Should you have questions regarding procedures or results, please feel welcome to contact Client Services.

Sample Number	Sample Description	Matrix Type	Date Taken	Date Received
59783	2708-960212-D1-01	MISC. SOLID	02/12/1996	02/13/1996

(LNG Process Area Fire-hose Box)

Approved by:

Marty French
NET, INC. Division Manager

ANALYTICAL REPORT

Roger Brown
Hahn & Associates
434 N.W. 6th Ave.
Suite 203
Portland, OR 97209

02/16/1996
Job No.: 96.00363

Page: 2

Project Name: NWNG Gasco Site
Date Received: 02/13/1996

Sample Number	Sample Description
59783	2708-960212-D1-01

PARAMETERS	METHODS	RESULTS	REPORT LIMIT	UNITS	DATE ANALYZED	FLAG
PAH BY GC/MS SIM PREP		-			02/15/1996	
PAH BY GC/MS SIM (S)						
Dilution Factor	8270M	10+			02/15/1996	
Acenaphthene	8270M	4400	50	ug/Kg	02/15/1996	
Acenaphthylene	8270M	1700	50	ug/Kg	02/15/1996	
Anthracene	8270M	5600	50	ug/Kg	02/15/1996	
Benzo(a)anthracene	8270M	33,000	50	ug/Kg	02/15/1996	
Benzo(b)fluoranthene	8270M	47,600	50	ug/Kg	02/15/1996	
Benzo(k)fluoranthene	8270M	17,900	50	ug/Kg	02/15/1996	
Benzo(a)pyrene	8270M	41,400	50	ug/Kg	02/15/1996	
Benzo(ghi)perylene	8270M	36,500	50	ug/Kg	02/15/1996	
Chrysene	8270M	36,100	50	ug/Kg	02/15/1996	
Dibenzo(a,h)anthracene	8270M	7500	50	ug/Kg	02/15/1996	
Fluoranthene	8270M	53,700	50	ug/Kg	02/15/1996	
Fluorene	8270M	1900	50	ug/Kg	02/15/1996	
Indeno(1,2,3)pyrene	8270M	27,300	50	ug/Kg	02/15/1996	
Naphthalene	8270M	1100	50	ug/Kg	02/15/1996	
Phenanthrene	8270M	23,700	50	ug/Kg	02/15/1996	
Pyrene	8270M	41,900	50	ug/Kg	02/15/1996	

A sample result of ND indicates the parameter was Not Detected at the reporting limit.

NATIONAL ENVIRONMENTAL TESTING, INC.

Portland Division
17400 SW Upper Boones Ferry Rd.
Suite #260
Portland, OR 97224
Tel: (503) 624-5449
Fax: (503) 639-6889

Roger Brown
Hahn & Associates
434 N.W. 6th Ave.
Suite 203
Portland, OR 97209

Date: 03/04/1996
NET Account No.: 13500
NET Job Number: 96.00470

Project: NWNG Gasco Site
Location: 2708

Sample analysis in support of the project referenced above has been completed and results are presented on the following pages. Should you have questions regarding procedures or results, please feel welcome to contact Client Services.

Sample Number	Sample Description	Matrix Type	Date Taken	Date Received
60208	2708-960227-D2-01	other	02/27/1996	02/27/1996

(Koppers Pencil Pitch Warehouse Fire-hose Box)

Post-it® Fax Note 7671	Date 6/12	# of pages ▶
To ROB E.	From JC	
Co./Dept.	Co.	
Phone #	Phone #	
Fax #	Fax #	

Approved by:

Marty French
NET, INC. Division Manager

ANALYTICAL REPORT

Roger Brown
Hahn & Associates
434 N.W. 6th Ave.
Suite 203
Portland, OR 97209

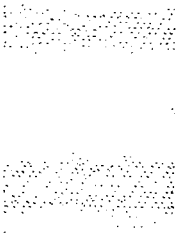
03/04/1996
Job No.: 96.00470

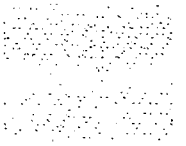
Project Name: NWNG Gasco Site
Date Received: 02/27/1996

Sample Number	Sample Description
60208	2708-960227-D2-01

PARAMETERS	METHODS	RESULTS	REPORT LIMIT	UNITS	DATE ANALYZED	FLAG
PAH BY GC/MS SIM PREP		-			02/29/1996	
PAH BY GC/MS SIM (S)						
Dilution Factor	8270M	400*			03/01/1996	-
Acenaphthene	8270M	375,000	20,000	ug/Kg	03/01/1996	
Acenaphthylene	8270M	ND	20,000	ug/Kg	03/01/1996	
Anthracene	8270M	444,000	20,000	ug/Kg	03/01/1996	
Benzo(a)anthracene	8270M	2,600,000	20,000	ug/Kg	03/01/1996	
Benzo(b)fluoranthene	8270M	3,436,000	20,000	ug/Kg	03/01/1996	
Benzo(k)fluoranthene	8270M	1,292,000	20,000	ug/Kg	03/01/1996	
Benzo(a)pyrene	8270M	2,915,000	20,000	ug/Kg	03/01/1996	
Benzo(ghi)perylene	8270M	2,543,000	20,000	ug/Kg	03/01/1996	
Chrysene	8270M	2,856,000	20,000	ug/Kg	03/01/1996	
Dibenzo(a,h)anthracene	8270M	547,000	20,000	ug/Kg	03/01/1996	
Fluoranthene	8270M	3,483,000	20,000	ug/Kg	03/01/1996	
Fluorene	8270M	145,000	20,000	ug/Kg	03/01/1996	
Indeno(1,2,3)pyrene	8270M	1,908,000	20,000	ug/Kg	03/01/1996	
Naphthalene	8270M	68,000	20,000	ug/Kg	03/01/1996	
Phenanthrene	8270M	1,501,000	20,000	ug/Kg	03/01/1996	
Pyrene	8270M	2,806,000	20,000	ug/Kg	03/01/1996	

A sample result of ND indicates the parameter was Not Detected at the reporting limit.





APPENDIX L

Geophysical Evaluation of Former Tar Ponds Area,
GeoPotential, Inc.

Koppers022880

GeoPotential

ENVIRONMENTAL & EXPLORATION GEOPHYSICS

437 N.E. LIBERTY AVE. GRESHAM, OR 97030 • PH (503) 665-7520 • FAX (503) 492-4404

RESULTS

GROUND PENETRATING SURVEY FOR TAR DEPOSITS AND SILT STRATA PILOT PROJECT

AT

NWNG GASCO FACILITY
PORTLAND, OREGON

PERFORMED FOR

HAI
434 NW 6TH AVENUE, SUITE 203
PORTLAND, OREGON 97209-3600

PERFORMED BY

GEOPOTENTIAL
437 NE LIBERTY AVENUE
GRESHAM, OREGON 97030

DECEMBER 5, 1995

INTRODUCTION

GeoPotential performed a GROUND PENETRATING RADAR SURVEY (GPR SURVEY) for HAI, Portland, Oregon.

TIMING

Field work was performed on November 22, 1995. Report and site diagram completed and mailed to HAI December 5, 1995.

PURPOSE

The subsurface locating survey was designed to test the ability of GPR to map the extent of tar deposits and silt strata.

SURVEY SITE

The SURVEY SITE consisted of the northeast portion of the NWNG Gasco Facility located at 7900 NW St. Helens Road in Portland, Oregon. The site has been used for hydrocarbon storage for many years and contains a variety of buried hydrocarbon materials including tar, lampblack and liquid hydrocarbons. Former settling ponds are also buried on the site.

In general, data supplied by HAI from lithology, indicates that the surficial materials consist of primarily sandy gravels grading downward into sandy silts and silts. Interspersed among these sediments are the hydrocarbon occurrences. These hydrocarbon occurrences and silt strata were the targets of this GPR pilot project.

The areas covered by the three GPR profiles (see map) are grass covered and slope gently up to the northeast until a 8 foot scarp is encountered at the northeast end of PROFILE ee'.

SURVEY SPECIFICATIONS

Three geophysical instruments were used for the survey:

1. AQUA-TRONICS A-6 ELECTROMAGNETIC TRACER (EM SURVEY).
2. SCHONSTEDT GA-52B MAGNETIC GRADIOMETER (MAG SURVEY).
3. MALA RAMAC GROUND PENETRATING RADAR (GPR SURVEY).

EM and MAG data were acquired along GPR PROFILES to aid in the interpretation of the GPR data.

Profile locations were selected to approximately coincide with HAI profiles AA' and EE' and are shown as yellow lines on the accompanying Well Location Map. The PROFILE along HAI PROFILE AA' had to be broken into two profiles aa' and ff' due to the scarp at a'. PROFILE ff' followed the gravel road to the bank of the Willamette River and is therefor offset from the northeast end of PROFILE AA'.

GPR data was acquired along each profile using a 50 MHz antenna and a 80 meter per microsecond sediment velocity. The data was filtered with a 3X3 moving average filter to suppress high frequency noise in the data. The maximum depth of penetration for this GPR configuration is about 45 feet.

MAG and EM data were acquired at 1 second intervals (approximately 3 to 4 feet intervals) along each GPR PROFILE and plotted as shown.

Each GPR PROFILE is presented twice; once with the EM and MAG profiles to compare the various data and once with the GPR alone to better show GPR features. The depth/length ratio for the GPR on composite profile is 2.2:1 and 5.1:1 on GPR only PROFILES.

RESULTS

The results are shown on the accompanying PROFILES.

PROFILE aa'

The GPR record shows three prominent horizons. The most shallow horizon occurs at a depth of about 10 feet and is the gradational layer from a sandy gravel to a silty sand. this horizon is not marked and is apparent on all three PROFILES.

A second horizon starts at a depth of 12 feet at the intersection of PROFILE ee' and dips down to a depth of 28 feet at a. This horizon is a silt/tar layer encountered in drill holes B-35 and B-33 . A second silty/tar horizon

occurs as shown on the GPR PROFILE. Both of these horizons go up and over a structurally shallow feature just to the northeast of the intersection of ee'. This feature is designated as F2 on the PROFILE. The MAG low and EM high anomalies over F2 indicate it is a sedimentary feature and may indicate a mound of hydrocarbon enriched sediments.

Feature F1 has a strong MAG response and a weak EM anomaly indicating metallic debris, buried structural foundations or utilities.

A EM/MAG positive anomaly at length 70 are caused by the well casing of B-35.

The positive MAG anomaly at length 120 is probably caused by a feature in the volcanic basement at a depth of 70 feet or more.

PROFILE ff'

The same three horizons identified on PROFILE aa' are interpreted to occur along profile ff' where the two silt/tar layers dip down to the northeast.

F2 is also identified on the southwest end of ff' where it is associated with a magnetic anomaly indicative of a scarp or fault in the deep volcanic basement. This may indicate that faulting in the basement may be responsible for feature F2.

F3 has a EM/MAG positive anomaly and may be a utility pipe.

The gradual slopes in the MAG and EM profile down to the northeast probably indicate deepening volcanic basement.

PROFILE EE'

The GPR data along this profile demonstrated very subtle layering. The silt-tar horizon interpreted along the profile is very tentative. The character of the reflections along this profile is identical to the character of the reflections over F2 on PROFILES aa' and ff'. Since this is near the location of the intersection of these PROFILES with ee' it is apparent that PROFILE ee' runs parallel to the strike of feature F2 and along or near the apex of the axis.

The observations of layering either side of ee' but not along ee' may indicate that the areas on either side of F2 were settling ponds which therefore produced more contiguous layering. The apparent onlap of the layers onto F2 would support this interpretation.

An EM/MAG positive anomaly on the southeast end of ee' is interpreted to be caused by buried pipes.

The MAG/EM anomalies to the northwest of length 420 show a general lowering of the fields with a series of low amplitude high frequency anomalies. This is interpreted to be caused by a combination of a deeper volcanic basement to the northwest and sandier soil containing volcanic gravels.

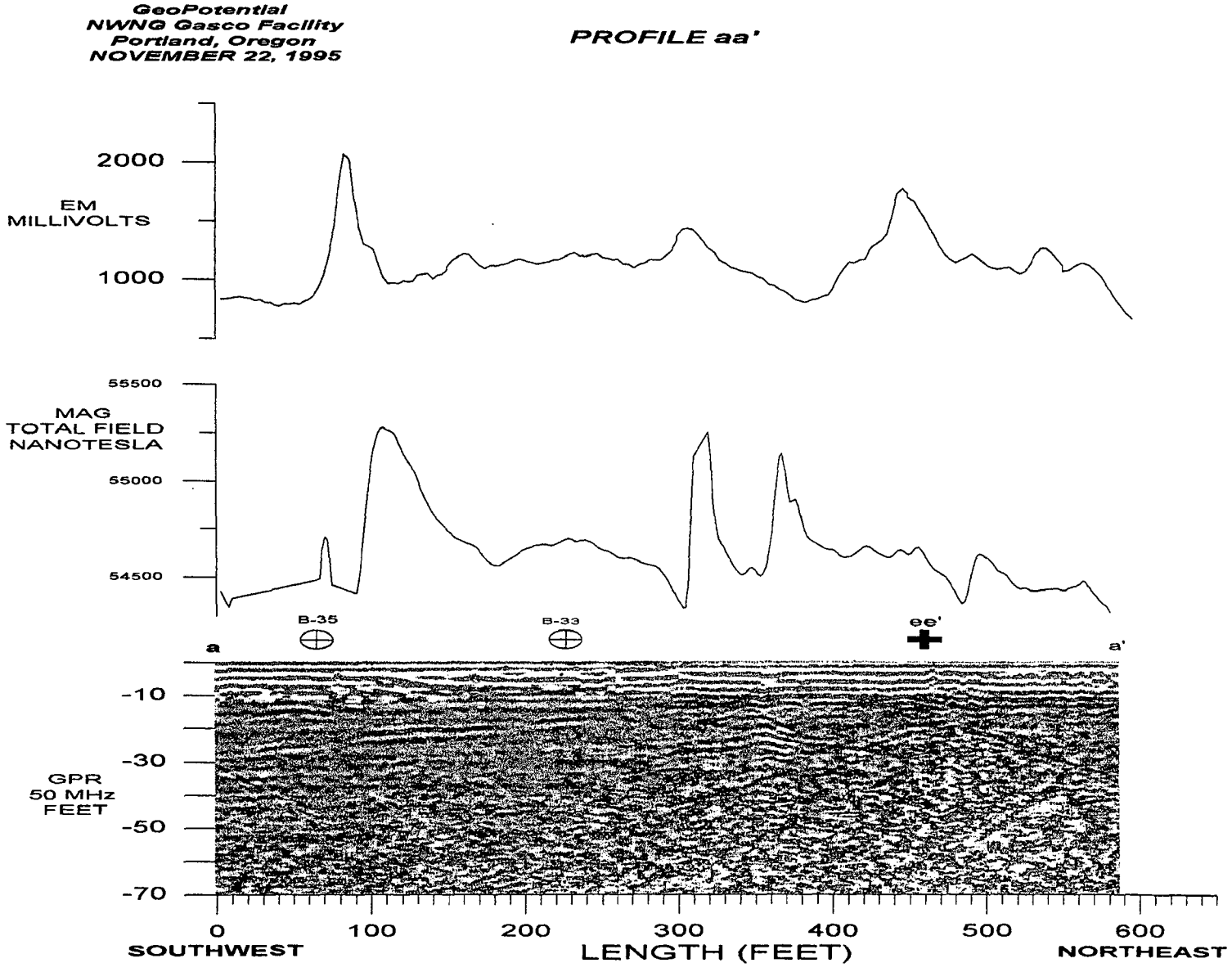
LIMITATIONS

Geophysical surveys consist of interpreting geophysical responses from subsurface objects. Since a variety of subsurface objects can produce identical geophysical responses it is necessary to perform intrusive investigations (drilling or excavating) to confirm the geophysical interpretation. In addition non-conductive utilities (e.g. plastic pipes, concrete pipes, tile pipes) are not detectable with geophysical methods.

Depths interpreted from GPR SURVEYS are a function of the soil velocities used during processing. Significant variations from these velocities can cause significant errors in interpreted depths.

The use of this geophysical interpretation is the sole responsibility of the client.

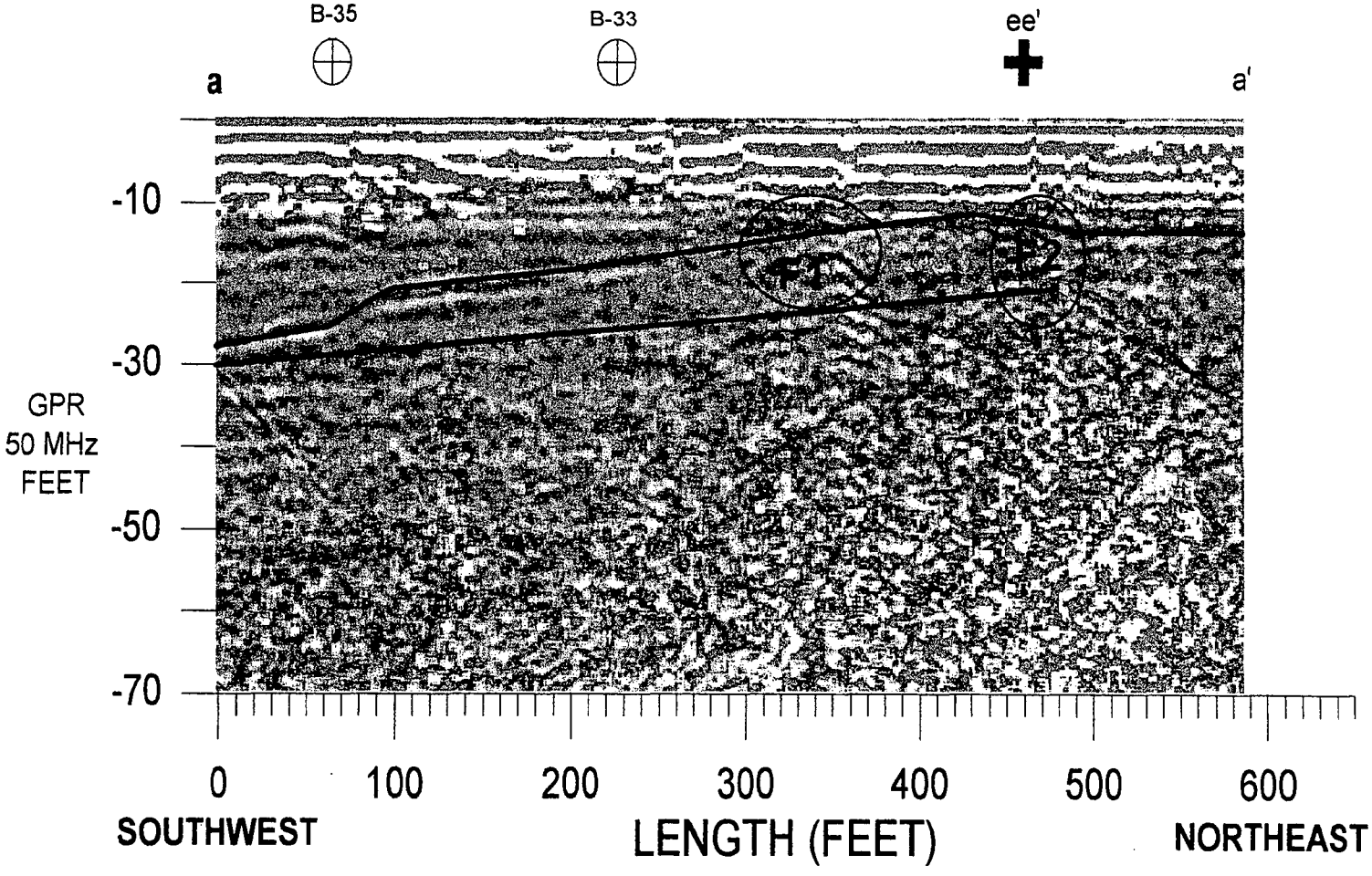
Ralph Soule ***December 5, 1995***
GeoPotential



Koppers022886

GeoPotential
NWNG Gasco Facility
Portland, Oregon
NOVEMBER 22, 1995

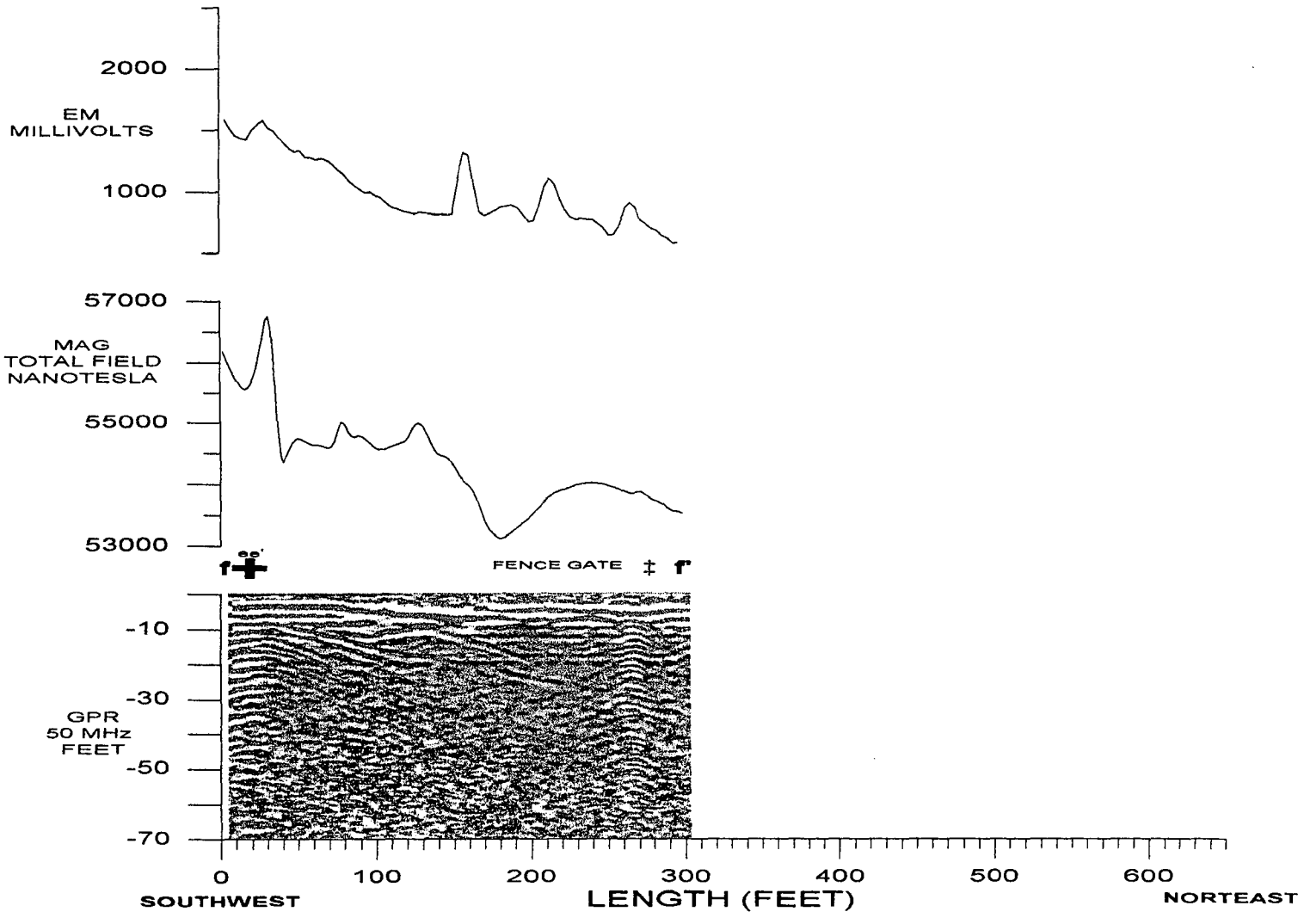
PROFILE aa'



Koppers022887

GeoPotential
NWNG Gasco Facility
Portland, Oregon
NOVEMBER 22, 1995

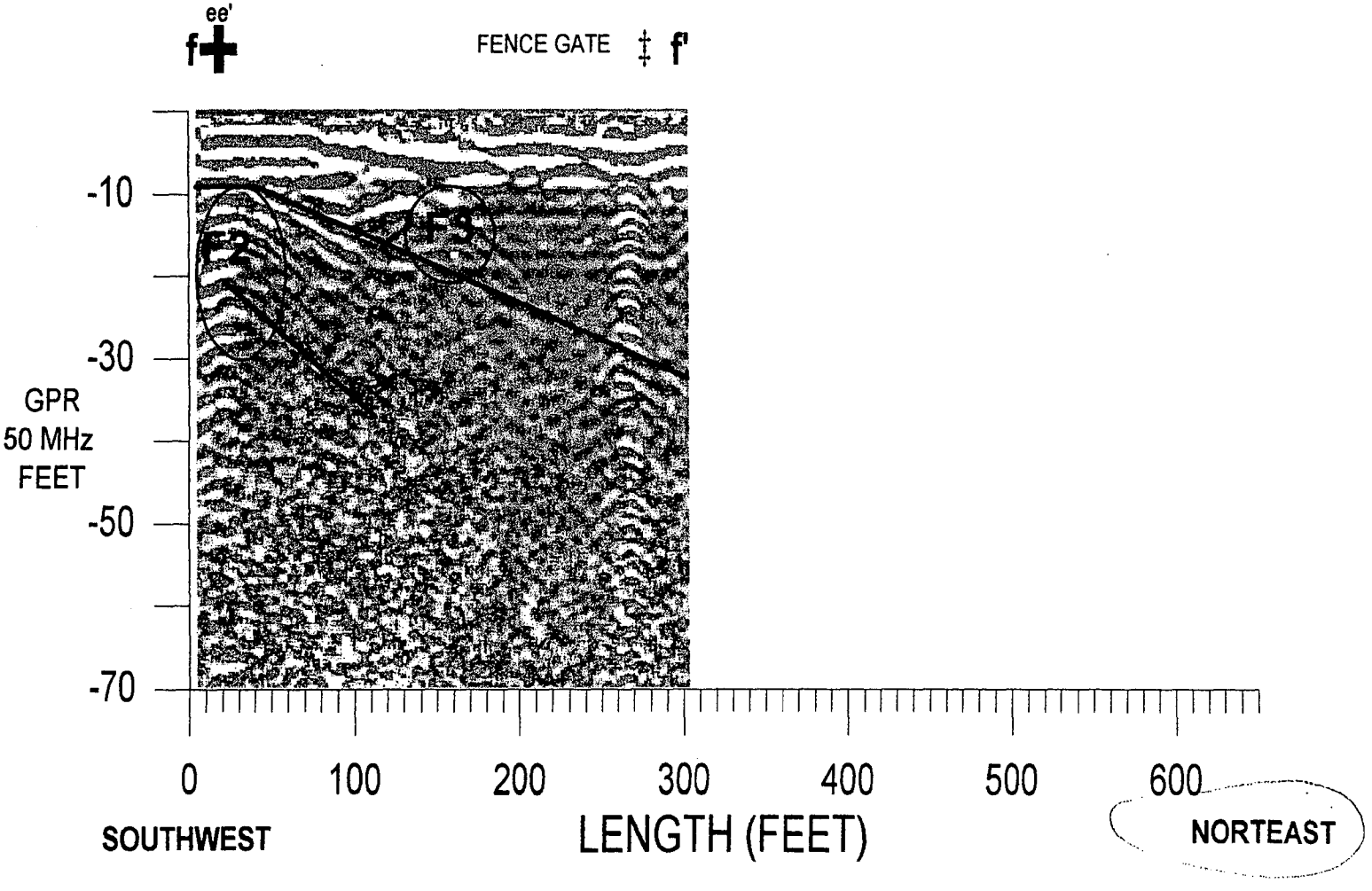
PROFILE ff'



Koppers022888

GeoPotential
NWNG Gasco Facility
Portland, Oregon
NOVEMBER 22, 1995

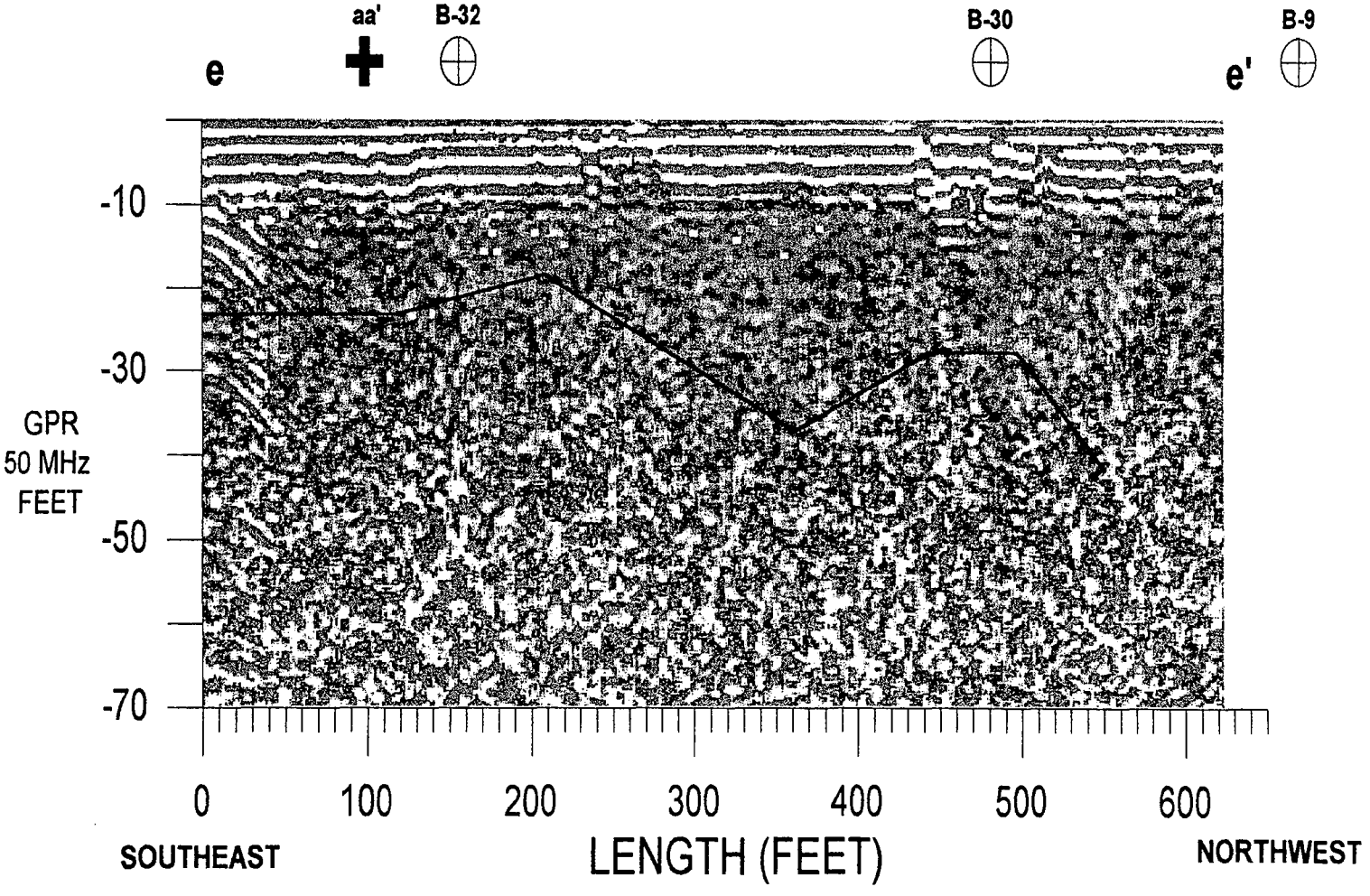
PROFILE ff'



Koppers022889

GeoPotential
NWNG Gasco Facility
Portland, Oregon
NOVEMBER 22, 1995

PROFILE ee'



Koppers022890

M

APPENDIX M

Geological Cross-Sections

Koppers022892

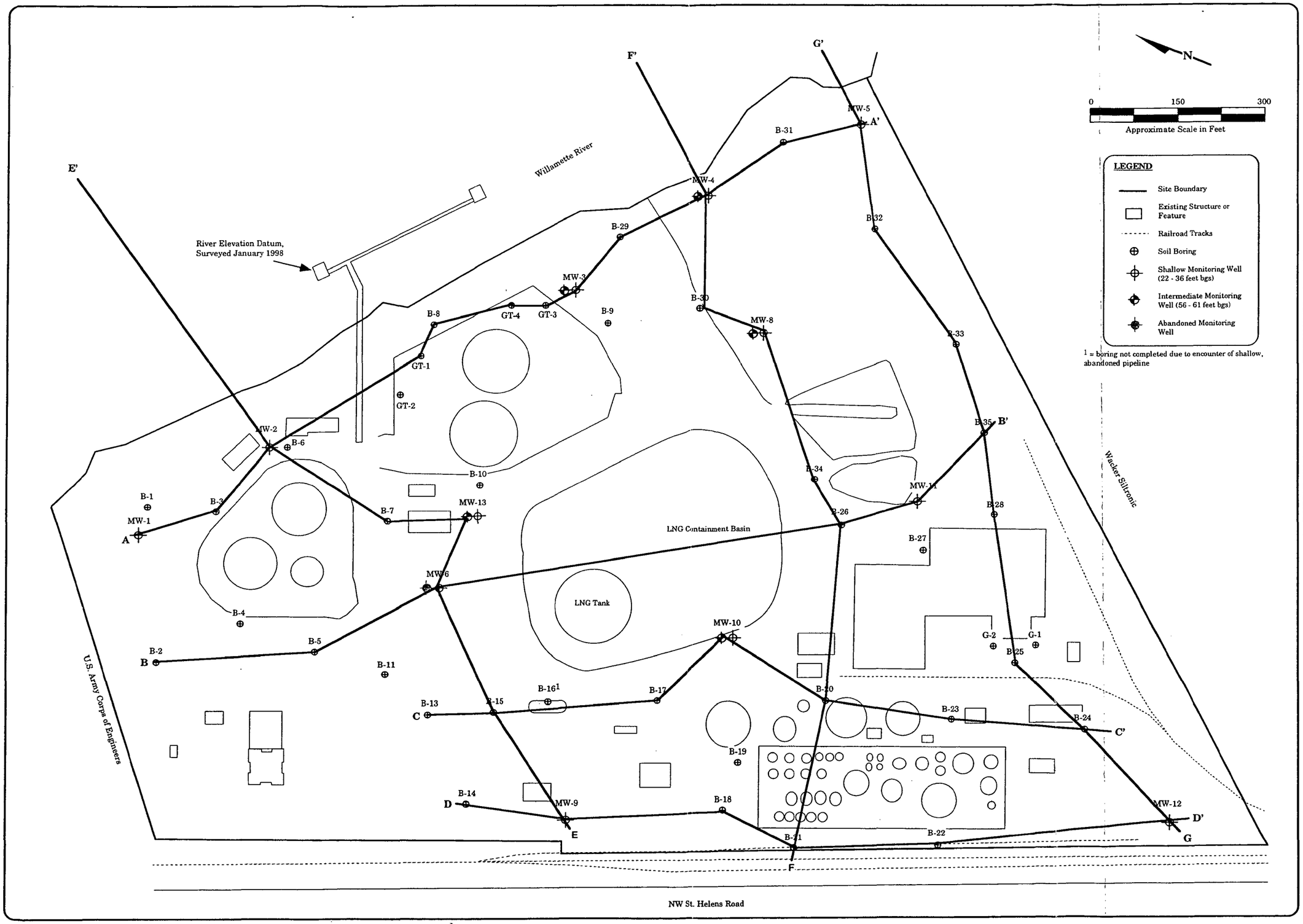


Figure
M-1

Cross-Section Line Location Map

RI/FS
Northwest Natural - Gasco Facility
7540 NW St. Helens Road
Portland, Oregon

HAHN & ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
503/796-0717

September 1998

Project No. 2708

Koppers022893

A
NW

A'
SE

Elevation (feet msl)

50
40
30
20
10
0
-10
-20
-30
-40

MW-1
B-3
MW-2
PNO Containment Basin
B-8
GT-1
GT-4
GT-3
MW-3-26
MW-3-56
B-29
MW-4-35
MW-4-57
B-31
MW-5-32

5.8
12.8
0.46
49
ND
10
0.43
Fill Unit
Silt Unit
4.3
6.2
ND
ND
ND
338
0.24
43.1
0.05
ND
10.1
ND
ND
ND
230
58,822
16
0.18
195
3,261
Silt Unit
38
12,666
5.5
ND
1.4
1,942
0.91
ND
0.26

Alluvial Unit

LEGEND

- Hydrogeologic Boundary
- MW- Monitoring Well / Boring Location
- Lithologic Log
- Sheen Observed in Soil at Indicated Depth Interval
- Soil Sample Location
- Residual Product Observed in Soil at Indicated Depth Interval
- Screened Interval
- Potentiometric Surface or Water Table (1/5/96)
- 338 Total PAHs detected in soil in parts per million

LITHOLOGY KEY

- Gravels/Gravel Sand Mixtures
- Silty Gravels
- Sands, Gravelly Sands
- Silty Sands
- Silts
- Residual Tar
- Residual Oil

0 100 200
Approximate Scale in Feet

Vertical Exaggeration 10X

Figure
M-2

Hydrogeologic Cross Section A - A'
Soil Quality - Total PAHs

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
(503) 796-0717

September 1998

Project No. 2708

Koppers022894

B
NW

B'
SE

Elevation (feet msl)

50
40
30
20
10
0
-10
-20
-30
-40

B-2
B-5
MW-6
B-26
MW-11
B-35

3.6
ND
9.3
106
39
15,530
41,602
20,614
9.3
1.8
1.1
7.9
0.06
11

Fill Unit
LNG Tank Containment Basin
Silt Unit
Alluvial Unit

LEGEND

- Hydrogeologic Boundary
- MW- Monitoring Well / Boring
- Lithologic Log
- Sheen Observed in Soil at Indicated Depth Interval
- Soil Sample Location
- Residual Product Observed in Soil at Indicated Depth Interval
- Screened Interval
- Potentiometric Surface or Water Table (1/5/96)
- 106 Total PAHs detected in soil in parts per million

LITHOLOGY KEY

- Gravels/Gravel Sand Mixtures
- Silty Gravels
- Sands, Gravelly Sands
- Silty Sands
- Silts
- Residual Tar
- Residual Oil

0 100 200
Approximate Scale in Feet

Vertical Exaggeration 10X

Figure
M-3

Hydrogeologic Cross Section B - B'
Soil Quality - Total PAHs

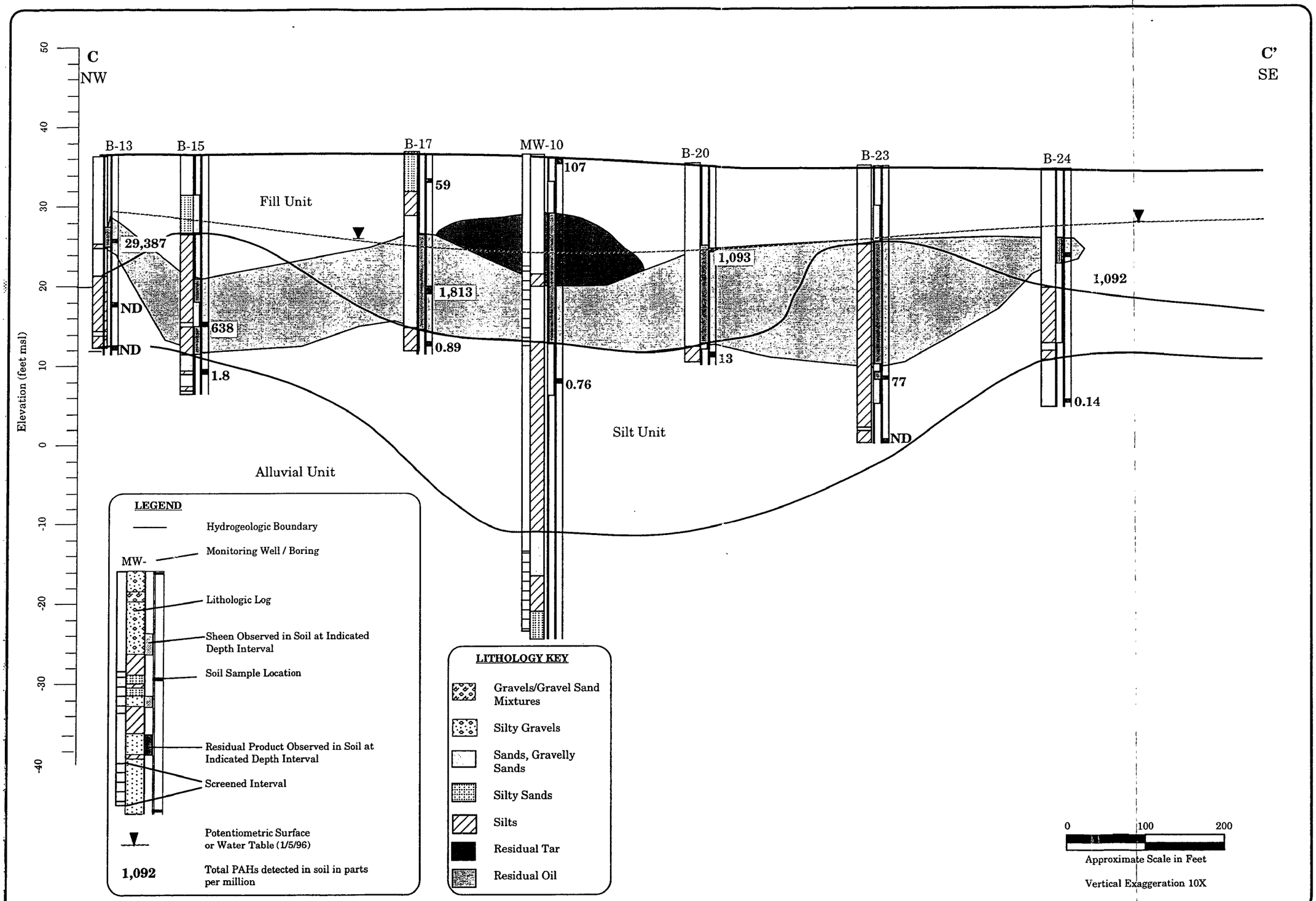
Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
(503) 796-0717

September 1998

Project No. 2708

Koppers022895



Figure

M-4

Hydrogeologic Cross Section C-C'
Soil Quality - Total PAHs

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
(503) 796-0717

September 1998

Project No. 2708

Koppers022896

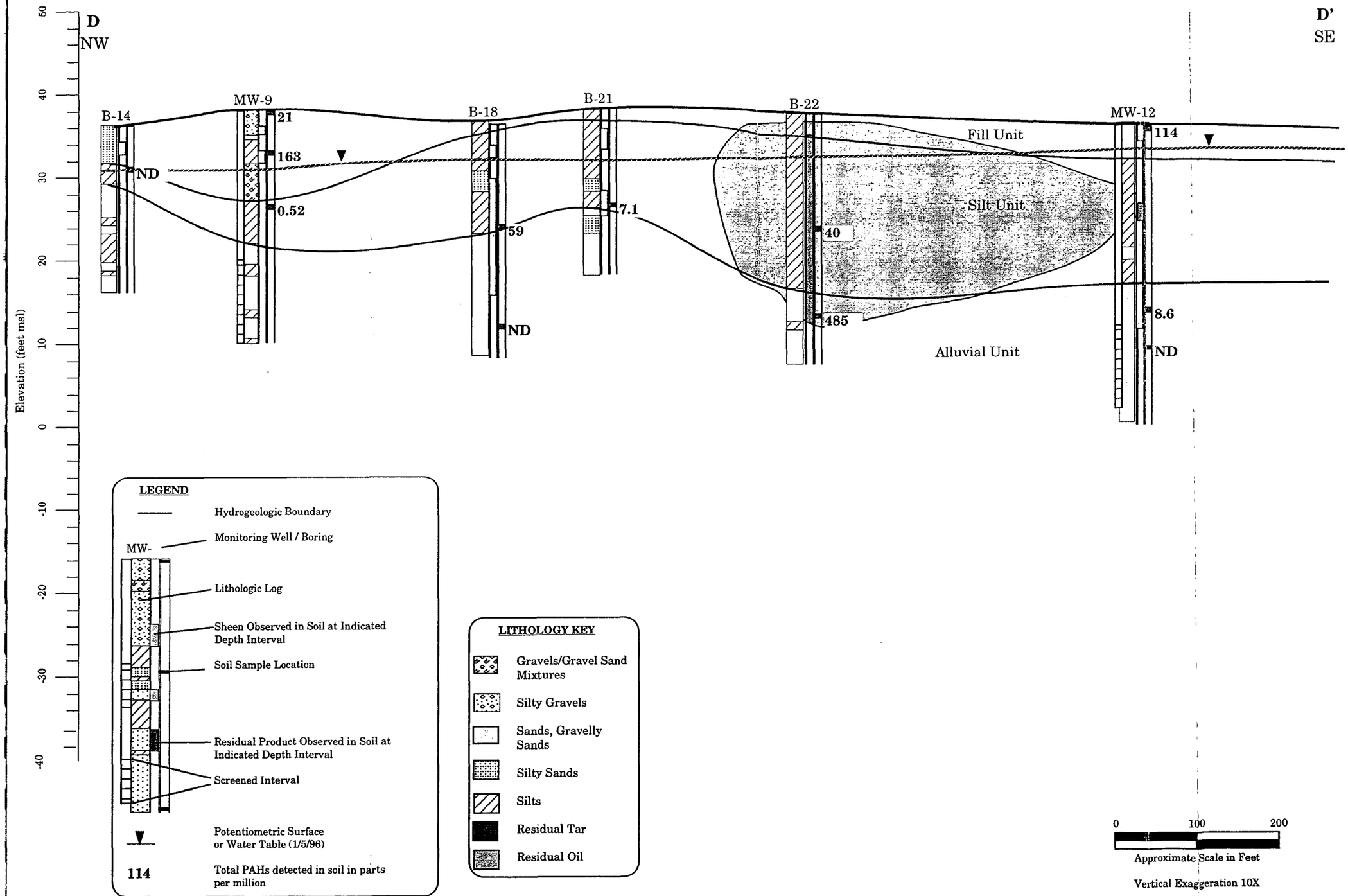


Figure
M-5

Hydrogeologic Cross Section D-D'
Soil Quality - Total PAHs

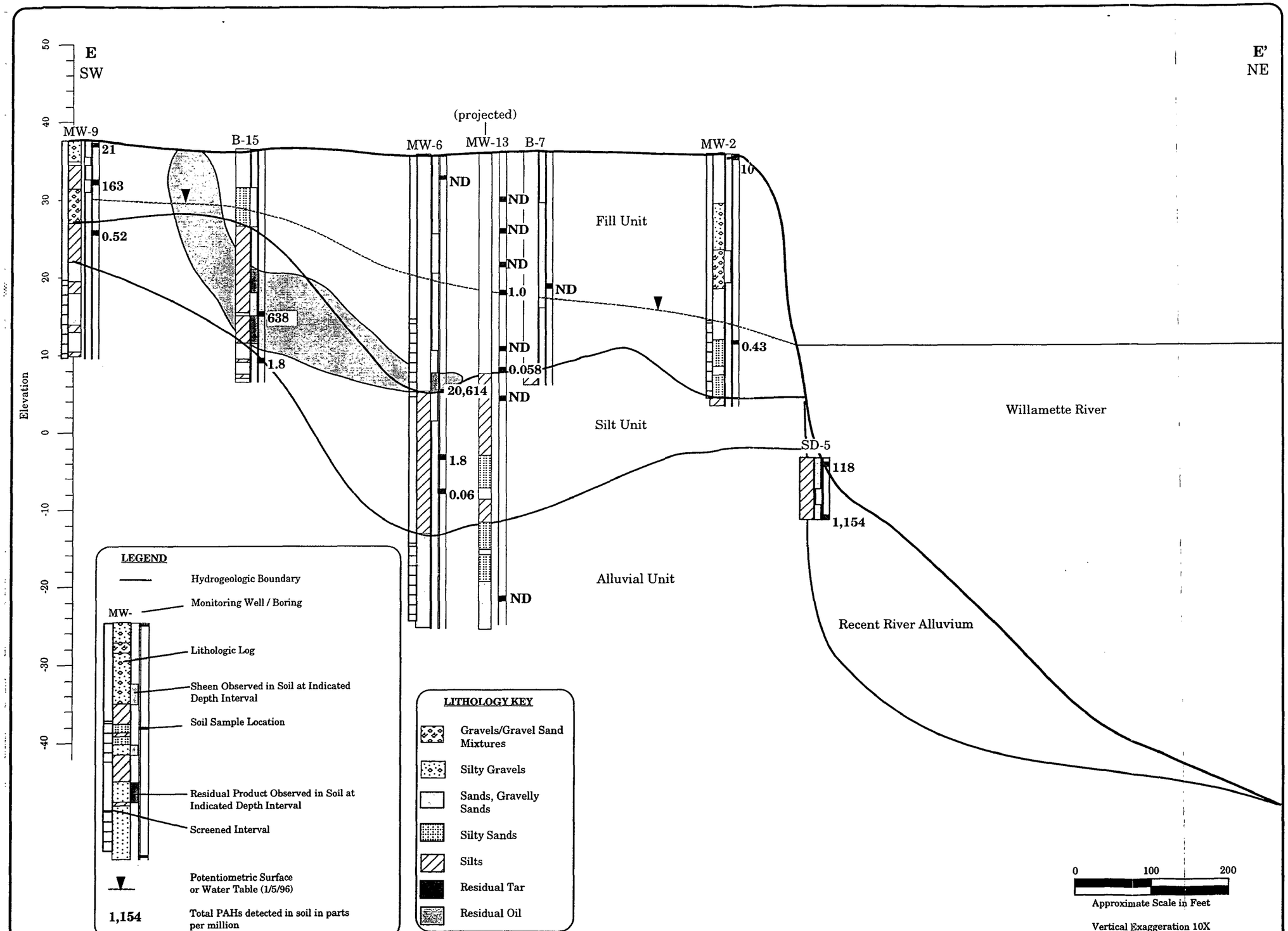
Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
(503) 796-0717

September 1998

Project No. 2708

Koppers022897



Figure

M-6

Hydrogeologic Cross Section E - E'
Soil Quality - Total PAHs

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
(503) 796-0717

September 1998

Project No. 2708

Koppers022898

F
SW

F'
NE

B-21
B-20
B-26
B-34
MW-8
B-30
MW-4
SD-8

7.1
1,093
13
9.3
94
1.1
13,499
15,530
281
965
6,776
853
8.1
0.64
195
3,261
875
3,254
0.26

Fill Unit
Silt Unit
Alluvial Sand Unit
Recent River Alluvium
Willamette River

Elevation (feet msl)
50
40
30
20
10
0
-10
-20
-30
-40

LEGEND

- Hydrogeologic Boundary
- MW- Monitoring Well / Boring
- Lithologic Log
- Sheen Observed in Soil at Indicated Depth Interval
- Soil Sample Location
- Residual Product Observed in Soil at Indicated Depth Interval
- Screened Interval
- Potentiometric Surface or Water Table (1/5/96)
- 3,254 Total PAHs detected in soil in parts per million

LITHOLOGY KEY

- Gravels/Gravel Sand Mixtures
- Silty Gravels
- Sands, Gravelly Sands
- Silty Sands
- Silts
- Residual Tar
- Residual Oil

0 100 200
Approximate Scale in Feet

Vertical Exaggeration 10X

Figure
M-7

Hydrogeologic Cross Section F - F'
Soil Quality - Total PAHs

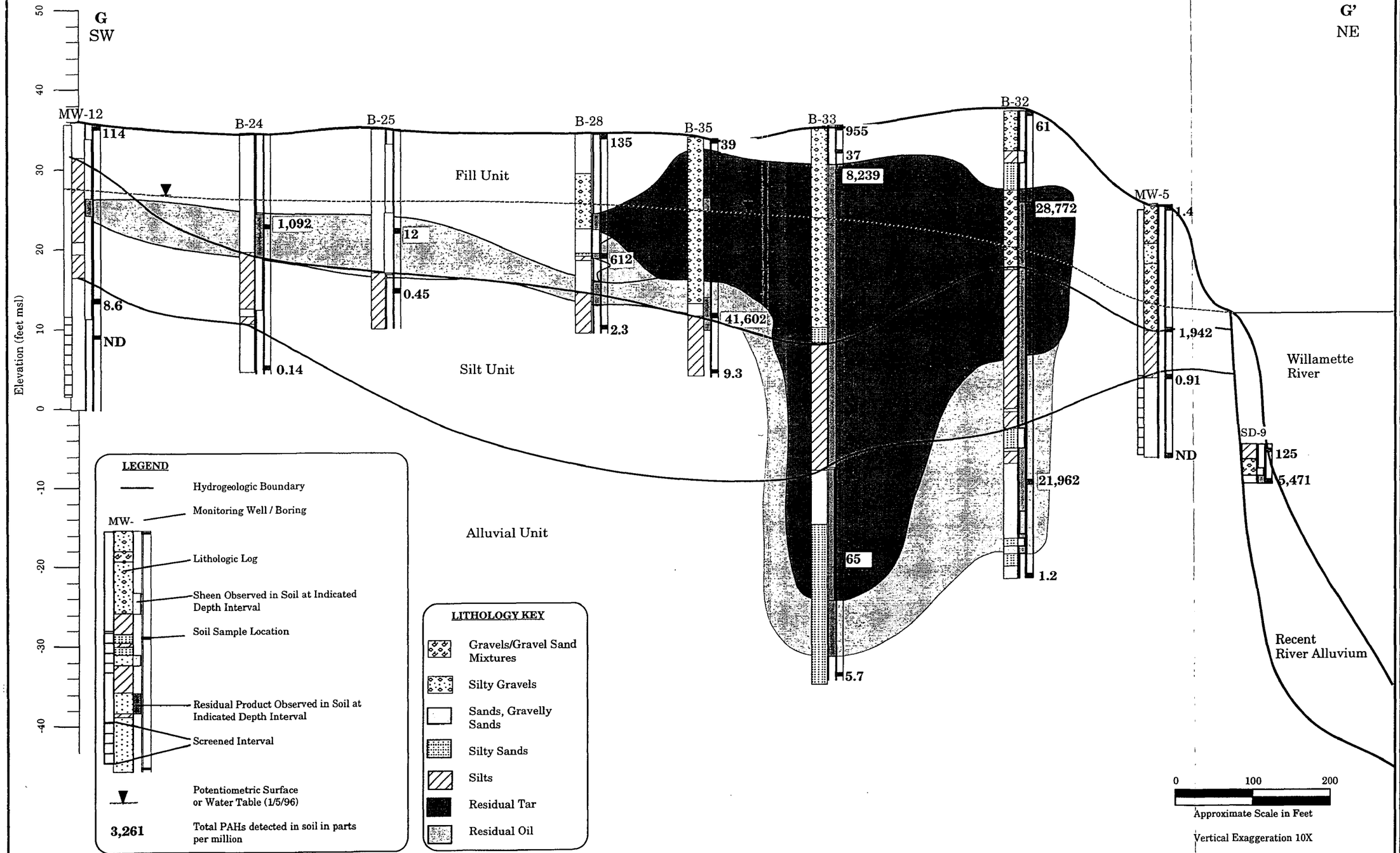
Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
(503) 796-0717

September 1998

Project No. 2708

Koppers022899



Figure

M-8

Hydrogeologic Cross Section G - G'
Soil Quality - Total PAHs

Remedial Investigation
Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.
ENVIRONMENTAL MANAGEMENT
434 NW SIXTH AVENUE, SUITE 203
PORTLAND, OREGON 97209
(503) 796-0717

September 1998

Project No. 2708

Koppers022900

Koppers022901

SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING REPORT

RAIL SPUR SETTLEMENT
PORTLAND, OREGON

PREPARED FOR:

KOPPERS COMPANY INC.

O-4334
APRIL 1987

Koppers022902

RZA
RITTENHOUSE-ZEMAN & ASSOCIATES, INC.
Geotechnical Consultants
8050 S.W. Cirrus Drive
Beaverton, Oregon 97005
(503) 644-9141

April 15, 1987 0-4334

Koppers Company Inc.
7540 N.W. St. Helens Rd.
Portland OR 97229

Attn: John Oxford

SUBJECT: GEOTECHNICAL EXPLORATION
RAILROAD SPUR SETTLEMENT
PORTLAND, OR.

Dear Mr. Oxford:

This report summarizes the results of the subject geotechnical study, as authorized by you on March 25, 1987.

It appears that the observed settlement is the result of a combination of factors, including inadequate ballast thickness, poor subgrade soils and high ground water. If a new rail section is proposed we recommend 12 inches of ballast over 30 inches of sub-ballast over filter fabric over an undisturbed subgrade.

We are available to answer any questions you may have concerning this report and would be happy to assist you during construction phases of this project.

Respectfully submitted,

RITTENHOUSE-ZEMAN & ASSOCIATES, INC.

Terry N. Craven, P.E.

R. Warren Krager, Geologist

1.0 INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering study for the proposed railroad spur improvement project. The study was authorized by Mr. John Oxford of Koppers Company Inc. on March 25, 1987. The railroad spur location is illustrated on the attached Site Plan, Plate 1.

The purpose of our study was to explore subsurface conditions for the purpose of railbed support. The scope of our work consisted of drilling and sampling 15 borings at about 30 feet on center along the most heavily failed portion of track.

This study has been accomplished in accordance with generally accepted geotechnical engineering practice for the exclusive use of Koppers Company, Inc. and their agents, for specific application to the above described project.

2.0 SITE AND PROJECT DESCRIPTION

The railroad spur is located northeast of N.W. St. Helens Rd. between the Burlington Northern Railroad and the Koppers Company tank farm. The area of tracks identified by Kopper's representative as requiring repairs is approximately 500 feet long. The approximate location is shown on the Site Plan, Plate 1.

Although longitudinal settlements have occurred, the principal concern is differential settlement between the rails. Figure 1 illustrates the approximate magnitude of the problem. On Figure 1 we have shown "Track Tilt", which is defined as the relative difference in elevation between the two tracks at selected locations. These measurements were made with a carpenter's level and straight edge and should be considered

approximate only. They are intended to illustrate the relative magnitude of the distress.

3.0 SUBSURFACE CONDITIONS

Subsurface explorations were performed on April 2nd and 3rd, 1987. Explorations were drilled with a trailer mounted solid stem auger to depths of 15 to 20 feet. Borings were drilled along the rail spur at about 30 feet on center at locations requested by Koppers Company. Borings were logged by an experienced geologist from our Beaverton office. Approximate surface elevations are presented on Figure 2. Elevations are based on an arbitrary reference of elevation 0.0 at B-12.

Borings indicated variable rail support as outlined below. Boring logs are attached.

Ballast: Ballast thicknesses encountered ranged from 10 inches to in excess of three and one half feet. Thicknesses are illustrated on Figure 3. Thicknesses are measured from the ground surface and actual thickness below ties is likely to be eight or nine inches less than the values shown. Ballast generally consisted of two inch minus rounded to subrounded gravel. In many areas the lower portion of the ballast contained large amounts of silt, probably indicating intrusion by soft subgrade soils (herein after referred to as dirty ballast). In a few areas, most notably where ballast thicknesses exceed about two feet, the lower portion of the ballast consisted of larger fractured rock. This may be the result of attempts to stabilize soft areas of subgrade at the time of initial rail construction.

Subgrade Soils: Subgrade soils were found to consist of variable, soft to stiff silts and sandy silts. Portions of the

alignment were underlain by up to 10 feet of fill, but in general the fills consisted of the same type of soil as native. Fills were generally indistinguishable from native soils except for soil fabric or occasional non-soil inclusions. In four borings organic topsoil or wood was encountered in the fill or at the boundary between fill and native soil.

Groundwater: Groundwater was encountered at depths ranging from 3 to 10 feet, but soil coloration indicated that ground water levels may approach the ground surface during prolonged wet weather.

4.0 CONCLUSIONS AND RECOMMENDATIONS

As discussed previously, Figure 1 illustrates approximate track tilt adjacent to each boring location. Track tilt is defined as the difference in surface elevation between the two rails at a specified location. This is considered to be the best measure of the type of rail distress that is a concern on this project. Track tilt was measured with a straight edge and carpenter's level and should be considered approximate only. Figure 2 illustrates approximate surface elevations at each boring location, and Figure 3 illustrates general subsurface conditions including ballast thickness and depth to ground water. As discussed previously, ballast thickness was measured from the ground surface and the thickness below ties is likely to be eight or nine inches less than the value shown.

As would be expected, comparisons of these three figures show a moderate correlation between track tilt and shallow ground water. Surprisingly there appears to be little or no correlation between ballast thickness and track tilt, although this effect is masked somewhat by the fact that the areas of thicker ballast tended to also have the highest ground water

levels and the ballast tended to contain large amounts of silt at depth (dirty ballast). The silt intrusion may indicate that the ballast in these areas pushed down into a soft subgrade at the time of construction or that prior settlement and reballasting has been performed in these locations.

We performed preliminary calculations of required ballast thickness in general accordance with the method developed by Talbot, and referenced by the AREA Manual for Railway Engineering. Based on a C.B.R. value of 1.0 for uncompacted silts, and a typical rail car wheel loading of 30 kips, a ballast layer of 3.0 to 4.0 feet would be appropriate for this site, with adequate drainage.

Based on the above comments we believe that the observed rail distress has resulted from a combination of factors including:

- Insufficient ballast thickness;
- Inadequate subsurface drainage;
- Intrusion into the ballast by underlying soft silts;
- Lateral shifting of ballast due to its rounded character;
- Consolidation of native silts under static railcar loads;
- Deterioration of wood/organics in fill underlying ballast;
- Possibly frost action.

Although the retaining wall near this track has rotated somewhat it does not appear that it has influenced the railroad track. It is possible, however, that if this wall undergoes significant rotation or failure it could cause major track distress. We would recommend that the causes of this wall movement be investigated.

Rail settlements are often progressive. As settlements become noticeable, effective loads increase due to eccentric loading conditions and dynamic wheel loads at the irregular areas. We concur with your judgment that repairs are necessary. Repairs can consist of either reballasting the existing track or construction of a new structural section. Although reballasting is a common approach it is normally only a temporary solution and periodic maintenance should be anticipated. If soft subgrade soils and dirty ballast are not removed it is probable that soft silts will eventually progress upward into new ballast. If reballasting should be selected as a remedy, the life to next maintenance could be extended by improving subsurface drainage at the same time. We understand that it is your present intent to reconstruct the railbed section and the remainder of our report is directed to that objective. We would be happy to discuss reballasting with you if desired.

5.0 NEW RAILBED SECTION

Based on the existing soft soil conditions we recommend that that the frequently applied dynamic subgrade stress not exceed about 1500 psf. For normal rail spur loading conditions (normal wheel load not exceeding 30 kips and max. speed of 5 mph) this would require about 3.5 feet of ballast below the ties. This could consist of 12 inches of crushed rock ballast over 30 inches of sub-ballast. Typical specifications for ballast and sub-ballast materials are attached. Both ballast and sub-ballast should be compacted to at least 95% relative compaction based on the modified AASHTO test method (T-180). In addition we recommend that a filter fabric (Fibretex 150 or equal) be placed between the sub-ballast and native soil to reduce silt infiltration due to internal erosion or pumping.

Prior to installing sub-ballast or filter fabric all existing dirty ballast, organic soils and underlying soft, disturbed subgrade soil should be removed. We expect that the depth of excavation necessary to install the required thickness of ballast will normally result in the removal of all existing dirty ballast or softened soil, but occasional deeper areas may be encountered. Of particular concern is the area near B-4 where substantial amounts of wood and interspersed voids were encountered in the upper 10 feet. In addition, care will be required during excavation to avoid causing further subgrade disturbance.

We also recommend that subsurface drainage be provided by installing at least one perforated drain pipe at the bottom of the sub-ballast. This pipe should drain by gravity to a suitable disposal away from the tracks. The above comments are illustrated on Figure 4.

We emphasize that ballast designed in accordance with AREA methods is intended to provide reasonably good service under most conditions. However it is not practical to construct a rock ballast that will be totally maintenance free. The possibility of some future need for releveling should be anticipated, but based on the apparently long performance of the existing section we believe that the proposed design should provide relatively trouble free performance for many years.

An alternative to the above solution, that would require less excavation consists of supporting the tracks on a concrete slab, probably 12 to 18 inches thick. The design of such a slab is beyond the scope of our current work, but we would be happy to pursue this solution if desired.

6.0 CHEMICAL CONTAMINATION

As we discussed with you, and as noted on our boring logs, it is possible that some ground contamination exists at this site. Representative soil samples have been turned over to you for analysis. We emphasize that our study is limited to soil support considerations and we neither sampled for nor tested for possible chemical contamination. Soil exploration borings were drilled using standard soil sampling techniques and no attempt was made to prevent the possible introduction of minor amounts of oil due to drilling procedures, nor to eliminate cross contamination between exploration holes.

If contamination exists it could affect design solutions concerning both disposal of excavated soil and subsurface drainage provisions (including suitable materials for drain pipes and suitable disposal locations for subsurface water). RZA has a highly competent chemical waste department if you wish assistance in this area.

7.0 FUTURE GEOTECHNICAL SERVICES

The recommendations contained in this report are based on information gathered during our field and laboratory study, and on design information provided by Koppers Company. We have not yet received a detailed copy of the plans for this project. We recommend that we be provided an opportunity to review the final plans and specifications when they become available. This will allow us to determine whether any change in concept may have affected the validity of our recommendations, and whether our recommendations have been correctly interpreted.

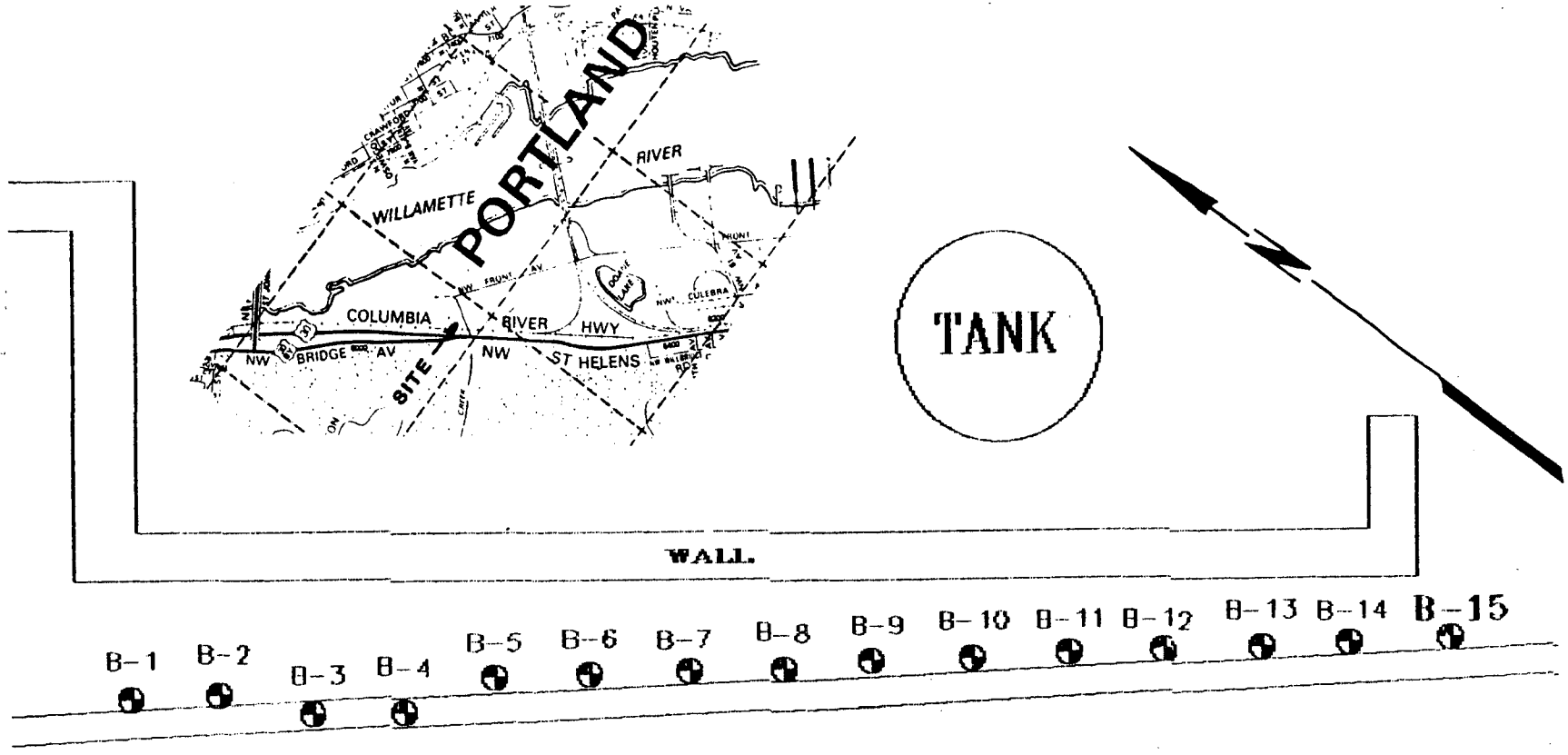
In order to correlate preliminary soil data with actual soil conditions encountered during construction and to check for construction conformance to our report, we also recommend that

we be retained for construction observation of stripping, grading, compaction and other soils related portions of this project.

RITTENHOUSE-ZEMAN & ASSOCIATES, INC.

R. Warren Krager, Geologist

Terry N. Craven, P.E.



B-9 Approximate Boring Locations Borings Spaced Approximately 30 Feet Apart

RITTENHOUSE-ZEMAN & ASSOCIATES, INC.
Geotechnical Consultants
8050 S.W. Cirrus Drive
Beaverton, Oregon 97005

RZA

KOPPERS CHEMICAL

SITE PLAN PLATE 1

W.O. O-4334
By SA
Date APRIL 1987
Scale NTS

Koppers022912

TRACK TILT
KOPPERS CHEMICAL

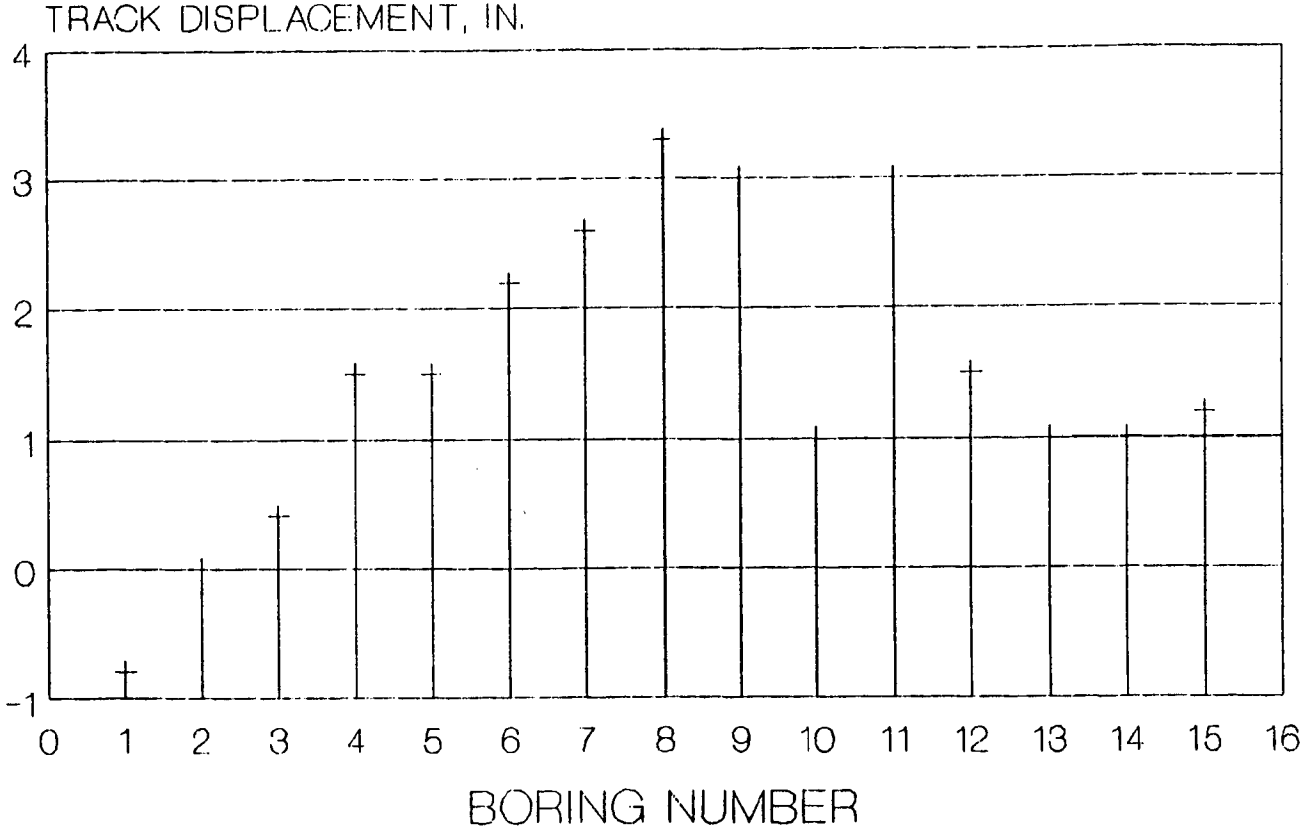


Figure 1.

Koppers022913

BORING ELEVATION
KOPPERS CHEMICAL

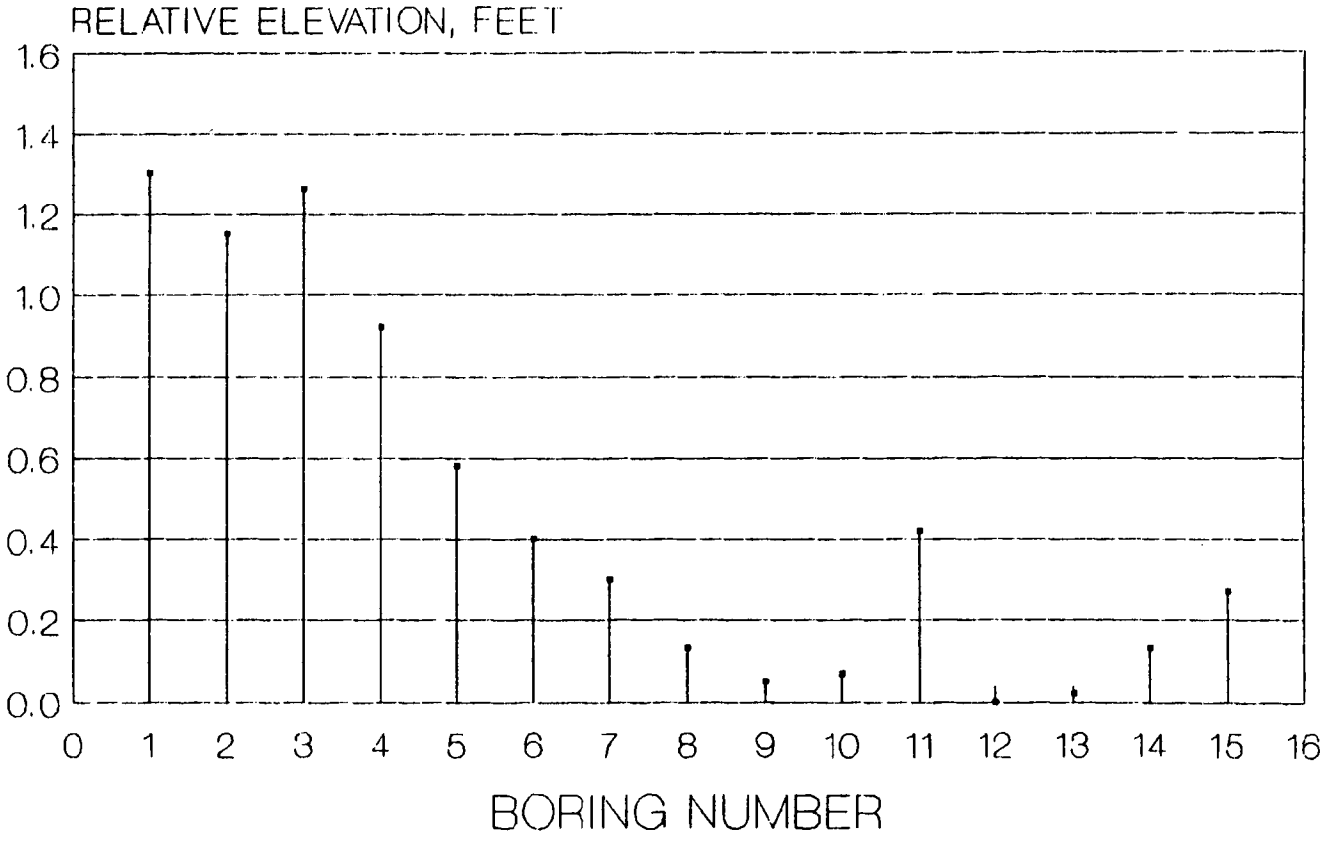


Figure 2.

Koppers022914

BALLAST & GROUND WATER
KOPPERS CHEMICAL

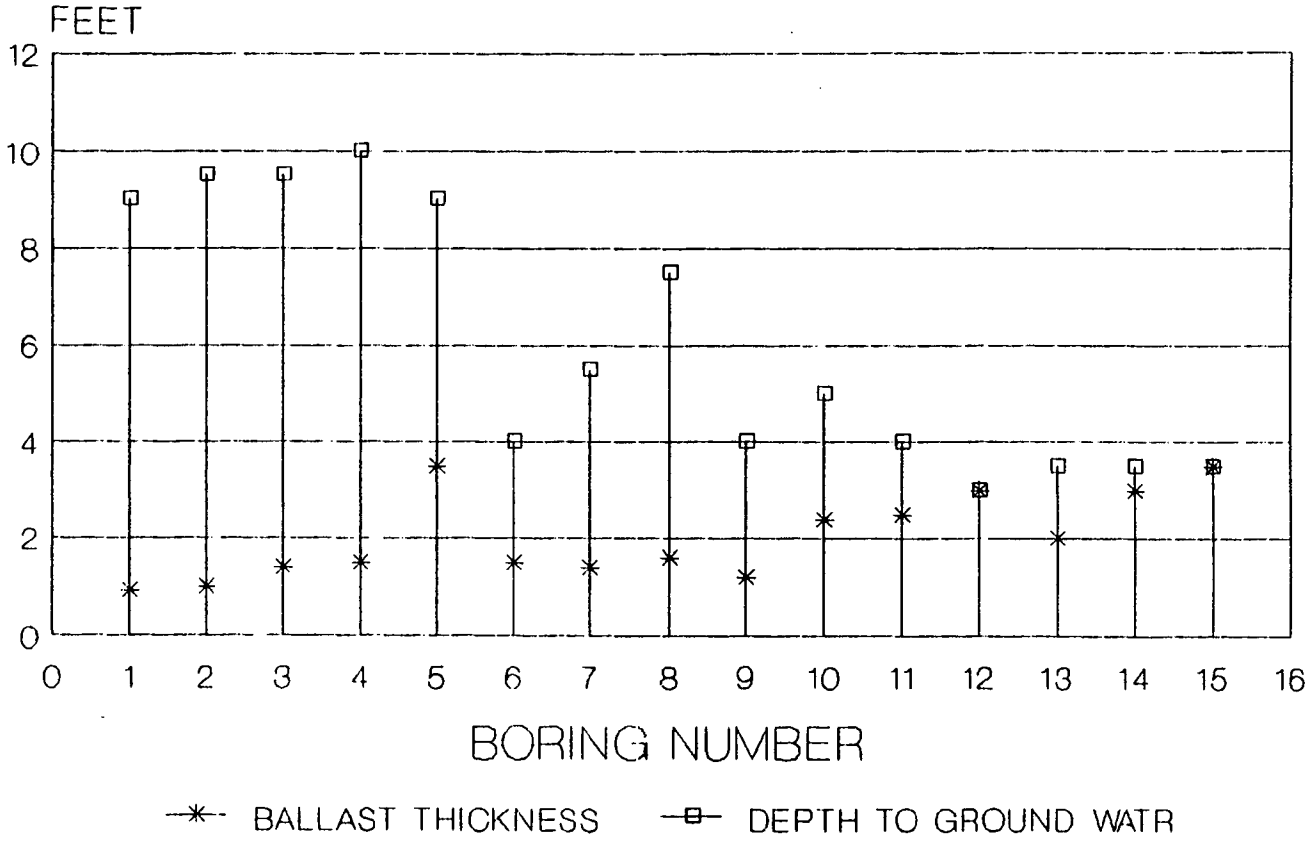


Figure 3.

Koppers022915

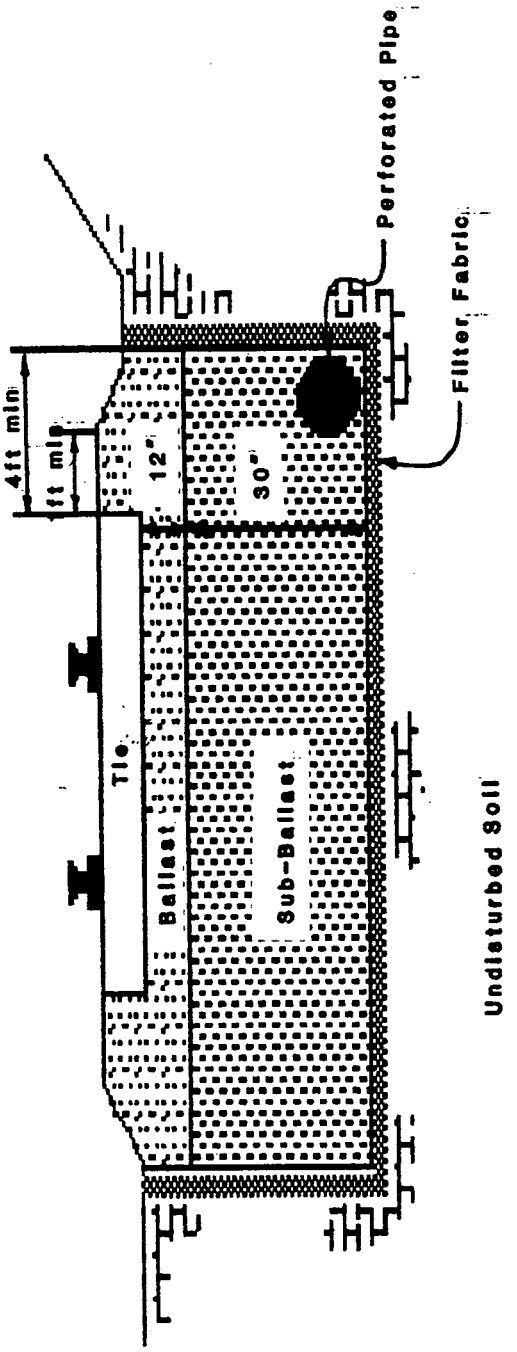


Figure 4

W.O. _____

By _____

Date _____

Scale _____

RITTENHOUSE-ZEMAN & ASSOCIATES, INC.

Geotechnical Consultants

8050 S.W. Cirrus Drive

Beaverton, Oregon 97005

RZA

MATERIAL FOR BALLAST AND SUB-BALLAST

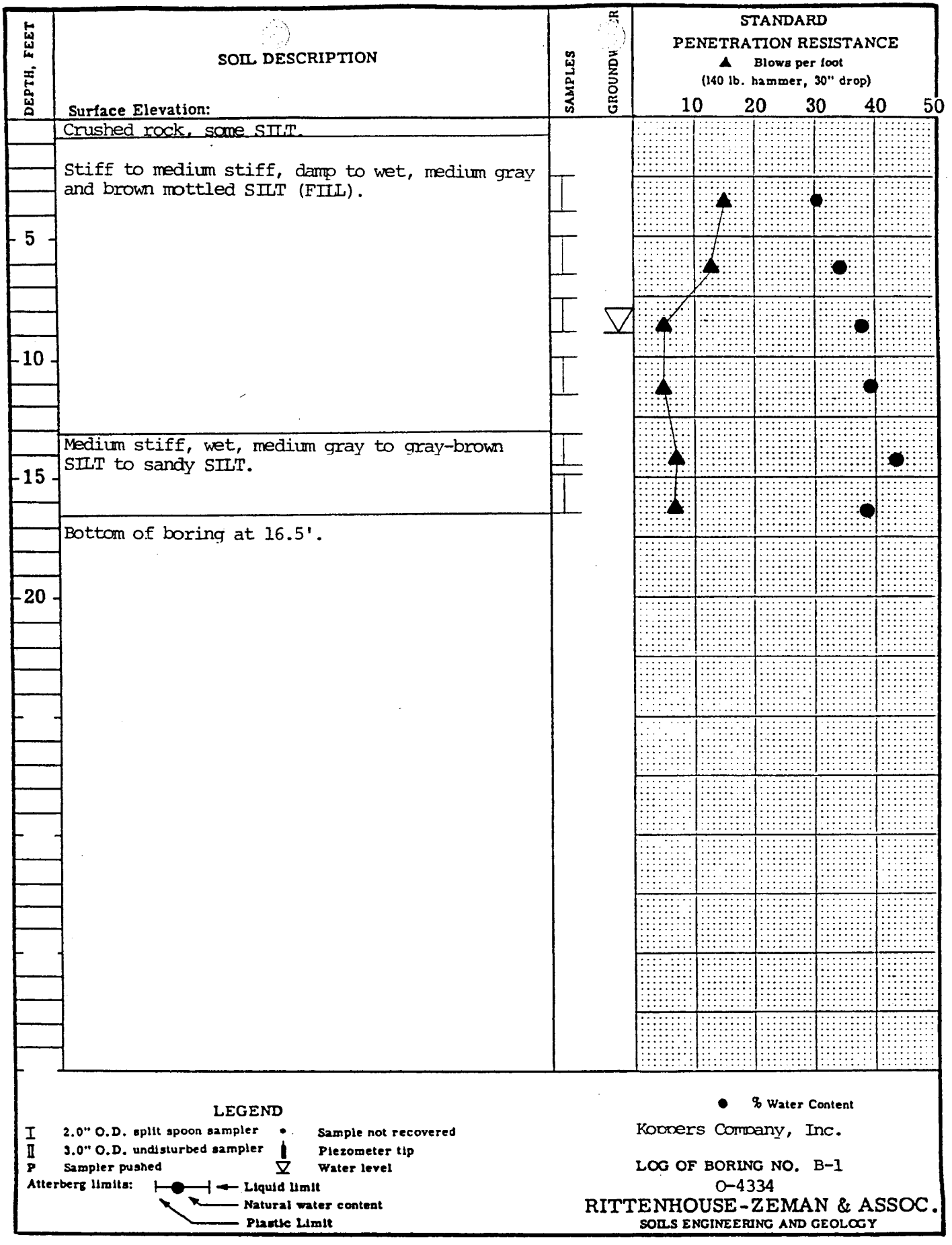
Ballast shall consist of crushed stone conforming to OSHD Standard Specifications (1984) Section 703.12 for Asphalt Macadam Aggregates, designated size 1 1/2"-3/4", unless otherwise approved by the engineer.

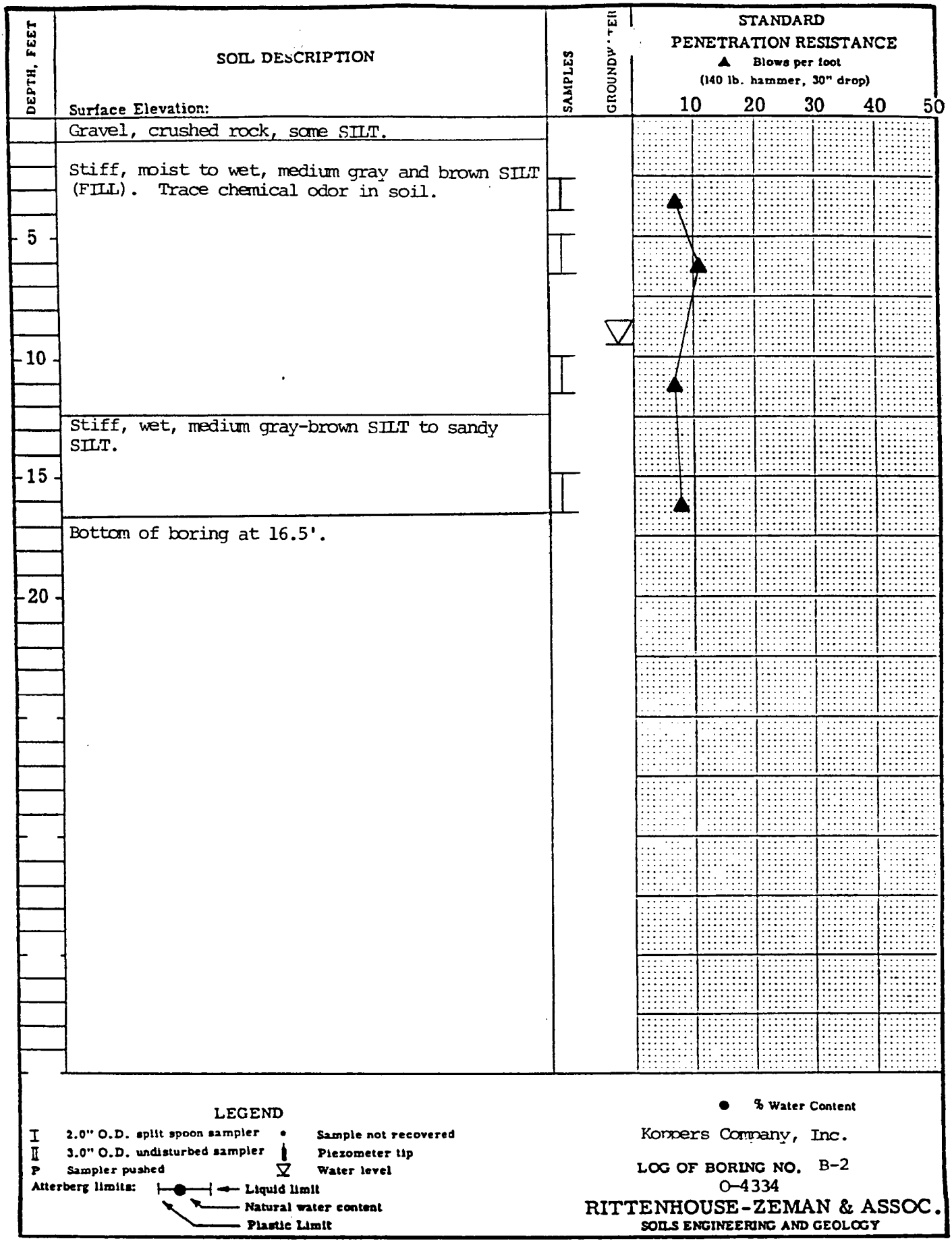
Sub-ballast shall consist of crushed stone conforming to OSHD Standard Specifications (1984) for Aggregate Subbase, Section 703.06, with the following additional specifications:

- Material shall have at least one mechanically fractured face on 70% (by weight) of the material retained on a 1/4 inch sieve and 50% (by weight) of the 1/4" to No. 10 material.

- Gradation shall fall within the following ranges unless otherwise approved by the engineer.

Sieve Size	Percent Passing by Weight
2"	100
1"	90-100
3/8"	50- 85
No. 10	25- 50
No. 40	10- 30
No. 200	0- 10


DEPTH, FEET
SOIL DESCRIPTION
Surface Elevation:
SAMPLES
GROUNDWATER
STANDARD
PENETRATION RESISTANCE
▲ Blows per foot
(140 lb. hammer, 30" drop)
10
20
30
40
50
Crushed rock, some SILT.
Stiff to medium stiff, damp to wet, medium gray and brown mottled SILT (FILL).
5
10
Medium stiff, wet, medium gray to gray-brown SILT to sandy SILT.
15
Bottom of boring at 16.5'.
20
LEGEND
I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
Sample not recovered
Piezometer tip
Water level
Atterberg limits:
Liquid limit
Natural water content
Plastic Limit
● % Water Content
Koppers Company, Inc.
LOG OF BORING NO. B-1
O-4334
RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY


DEPTH, FEET
SOIL DESCRIPTION
Surface Elevation:
SAMPLES
GROUNDWATER
STANDARD
PENETRATION RESISTANCE
▲ Blows per foot
(140 lb. hammer, 30" drop)
10 20 30 40 50
Gravel, crushed rock, some SILT.
Stiff, moist to wet, medium gray and brown SILT (FILL). Trace chemical odor in soil.
Stiff, wet, medium gray-brown SILT to sandy SILT.
Bottom of boring at 16.5'.
5
10
15
20
LEGEND
I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
Atterberg limits:
Sample not recovered
Piezometer tip
Water level
Liquid limit
Natural water content
Plastic Limit
● % Water Content
Koppers Company, Inc.
LOG OF BORING NO. B-2
O-4334
RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY

DEPTH, FEET	SOIL DESCRIPTION Surface Elevation:	SAMPLES	GROUND WATER	STANDARD PENETRATION RESISTANCE ▲ Blows per foot (140 lb. hammer, 30" drop) 10 20 30 40 50
	1-2" rounded gravel railroad ballast.			
	Stiff, damp to wet, medium gray and gray-brown SILT (FILL). Some organics present.			
5				
10			▽	
	Stiff, wet, medium brown, medium gray, sandy SILTS, silty SANDS.			
15				
	Bottom of boring at 16.5'.			
20				

LEGEND

I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
Atterberg limits: Liquid limit, Natural water content, Plastic Limit
• Sample not recovered
Piezometer tip
▽ Water level
● % Water Content

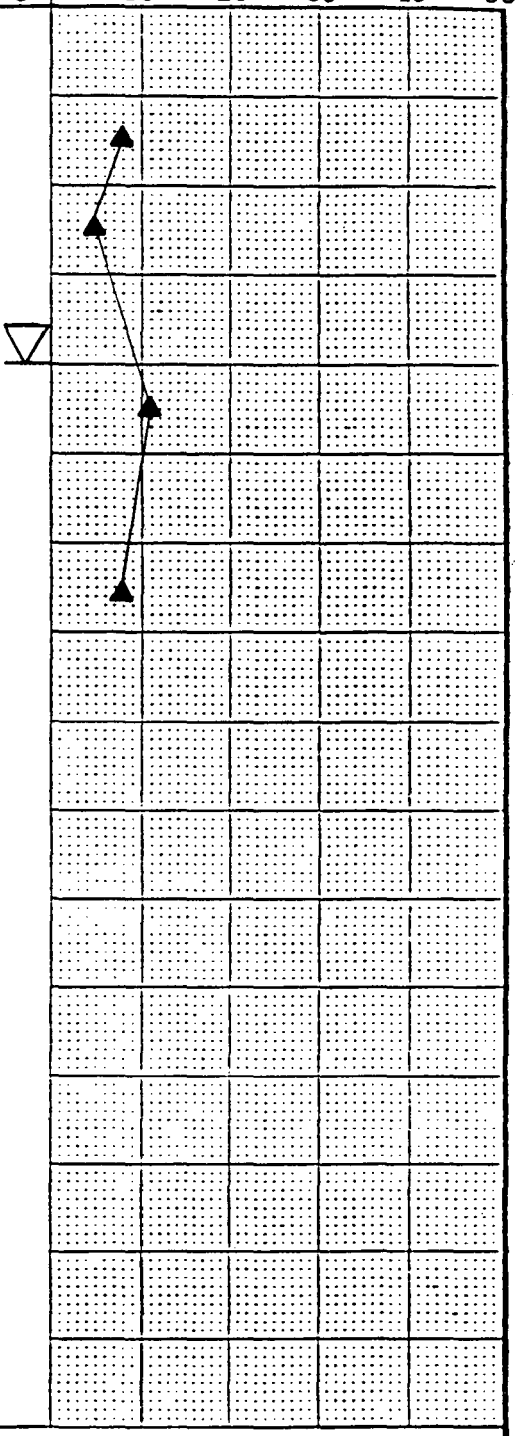
Koppers Company, Inc.

LOG OF BORING NO. B-3
O-4334

RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY

DEPTH, FEET	SOIL DESCRIPTION Surface Elevation:	SAMPLES	GROUNDWATER
	1-2" rounded gravel ballast, some organic SILTS.		
5	Stiff, moist to wet, medium gray, medium brown SILT (FILL). Wood debris between 5-10'. Voids of about 1' encountered at 7.0'.		
10			▽
15	Stiff, wet, medium brown mottled SILT and sandy SILT.		
20	Bottom of boring at 16.5'.		

STANDARD PENETRATION RESISTANCE
▲ Blows per foot
(140 lb. hammer, 30" drop)
10 20 30 40 50



LEGEND

I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
• Sample not recovered
Piezometer tip
▽ Water level
Atterberg limits: Liquid limit
Natural water content
Plastic Limit
● % Water Content

Koppers Company, Inc.

LOG OF BORING NO. B-4
O-4334

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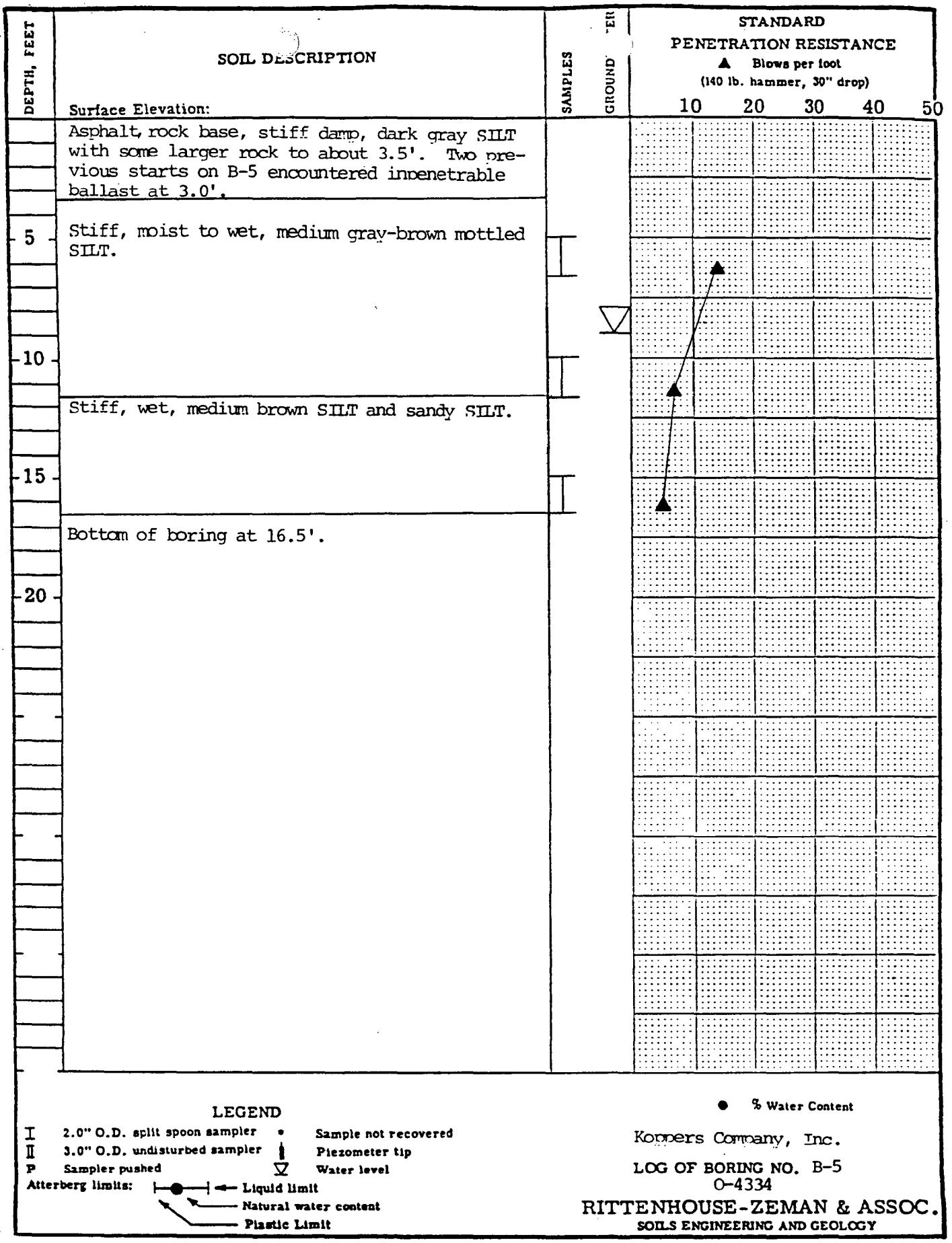
SOILS ENGINEERING AND GEOLOGY


DEPTH, FEET
SOIL DESCRIPTION
Surface Elevation:
SAMPLES
GROUND WATER
STANDARD PENETRATION RESISTANCE
▲ Blows per foot
(140 lb. hammer, 30" drop)
10 20 30 40 50
Asphalt, rock base, stiff damp, dark gray SILT with some larger rock to about 3.5'. Two previous starts on B-5 encountered impenetrable ballast at 3.0'.
Stiff, moist to wet, medium gray-brown mottled SILT.
Stiff, wet, medium brown SILT and sandy SILT.
Bottom of boring at 16.5'.
5
10
15
20
LEGEND
I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
Atterberg limits:
Liquid limit
Natural water content
Plastic Limit
• Sample not recovered
Piezometer tip
Water level
● % Water Content
Koppers Company, Inc.
LOG OF BORING NO. B-5
O-4334
RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY

DEPTH, FEET	SOIL DESCRIPTION Surface Elevation:	SAMPLES	GROUND WATER	STANDARD PENETRATION RESISTANCE ▲ Blows per foot (140 lb. hammer, 30" drop) 10 20 30 40 50
	1-2" rounded gravels. Below 1.5' dark gray SILT with some gravels.			
5	Medium stiff to stiff, wet, medium gray and brown mottled SILT, sandy SILT.			
10				
15				
	Bottom of boring at 16.5'.			
20				

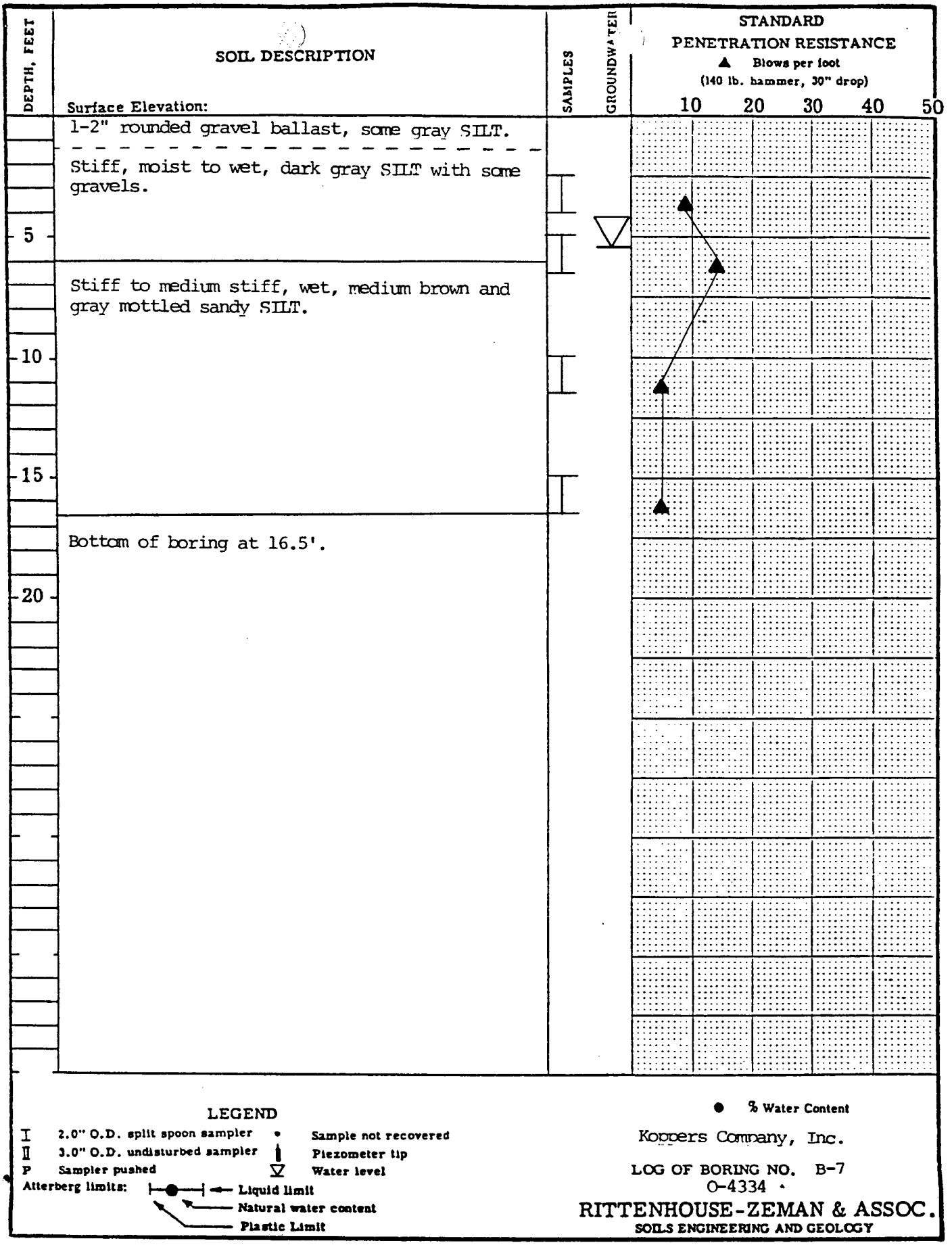
LEGEND

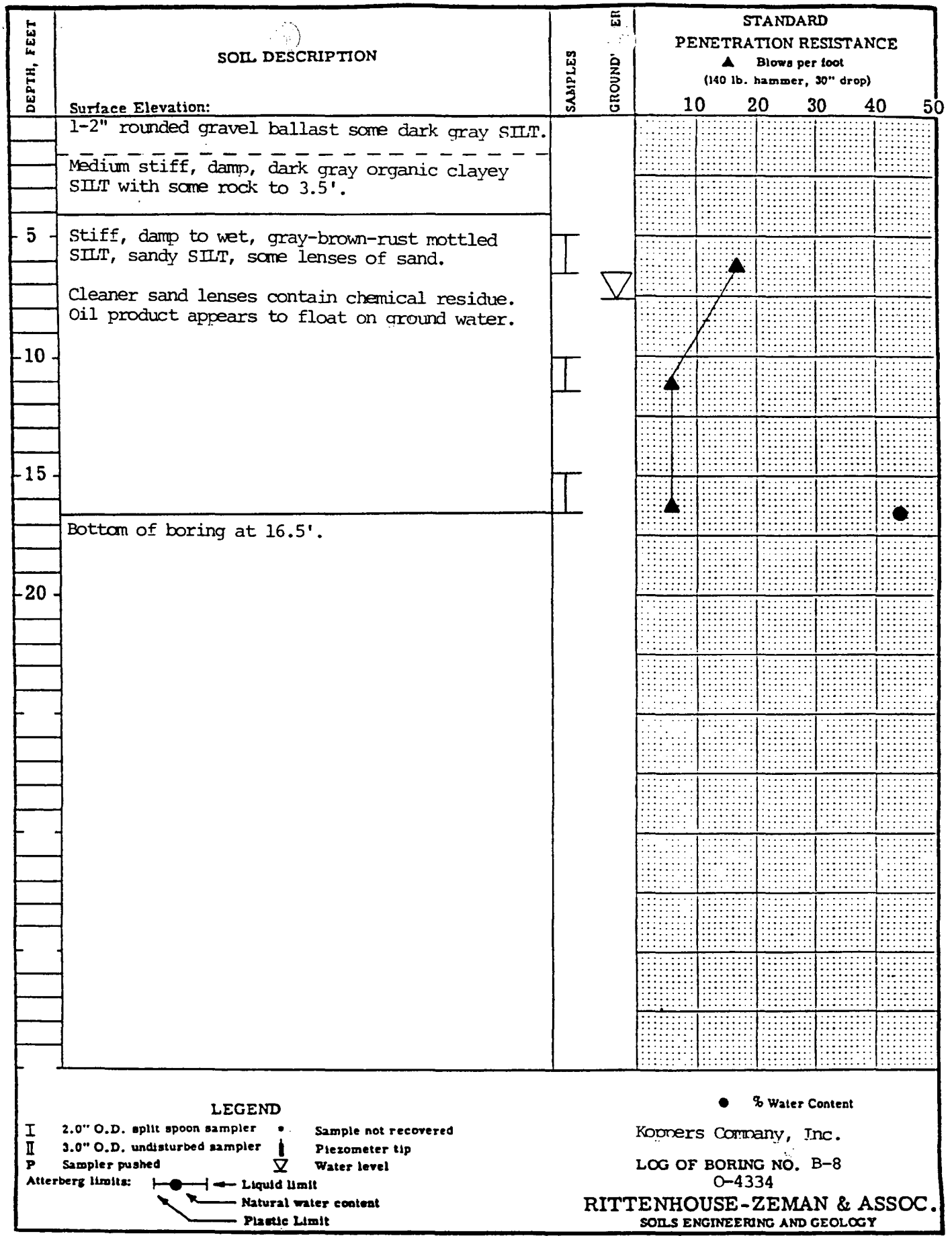
I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
Atterberg limits: Liquid limit, Natural water content, Plastic Limit
• Sample not recovered
Piezometer tip
Water level
● % Water Content

Koppers Company, Inc.

LOG OF BORING NO. B-6
0-4334

RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY


DEPTH, FEET
SOIL DESCRIPTION
Surface Elevation:
SAMPLES
GROUNDWATER
STANDARD
PENETRATION RESISTANCE
▲ Blows per foot
(140 lb. hammer, 30" drop)
10 20 30 40 50
1-2" rounded gravel ballast, some gray SILT.
Stiff, moist to wet, dark gray SILT with some gravels.
Stiff to medium stiff, wet, medium brown and gray mottled sandy SILT.
Bottom of boring at 16.5'.
5
10
15
20
LEGEND
I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
Sample not recovered
Piezometer tip
Water level
Atterberg limits:
Liquid limit
Natural water content
Plastic Limit
● % Water Content
Koppers Company, Inc.
LOG OF BORING NO. B-7
O-4334
RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY


DEPTH, FEET
SOIL DESCRIPTION
Surface Elevation:
SAMPLES
GROUND WATER
STANDARD PENETRATION RESISTANCE
▲ Blows per foot
(140 lb. hammer, 30" drop)
10 20 30 40 50
1-2" rounded gravel ballast some dark gray SILT.
Medium stiff, damp, dark gray organic clayey SILT with some rock to 3.5'.
5
Stiff, damp to wet, gray-brown-rust mottled SILT, sandy SILT, some lenses of sand.
Cleaner sand lenses contain chemical residue. Oil product appears to float on ground water.
10
15
Bottom of boring at 16.5'.
20
LEGEND
I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
Atterberg limits:
Liquid limit
Natural water content
Plastic Limit
Sample not recovered
Piezometer tip
Water level
● % Water Content
Koppers Company, Inc.
LOG OF BORING NO. B-8
O-4334
RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY

DEPTH, FEET	SOIL DESCRIPTION	SAMPLES	GROUNDWATER	STANDARD PENETRATION RESISTANCE ▲ Blows per foot (140 lb. hammer, 30" drop) 10 20 30 40 50
	Surface Elevation:			
	1-2" rounded gravel railroad ballast some black SILT.			
	Medium stiff, moist to wet, dark gray, black sandy SILT. Some gravels. Petroleum product saturated below 3.5'.		▽	
5				
	Stiff, wet, medium gray sandy SILT.			
	Oily substance visible on all samples and auguer flights.			
10				
15				
	Bottom of boring at 16.5'.			
20				

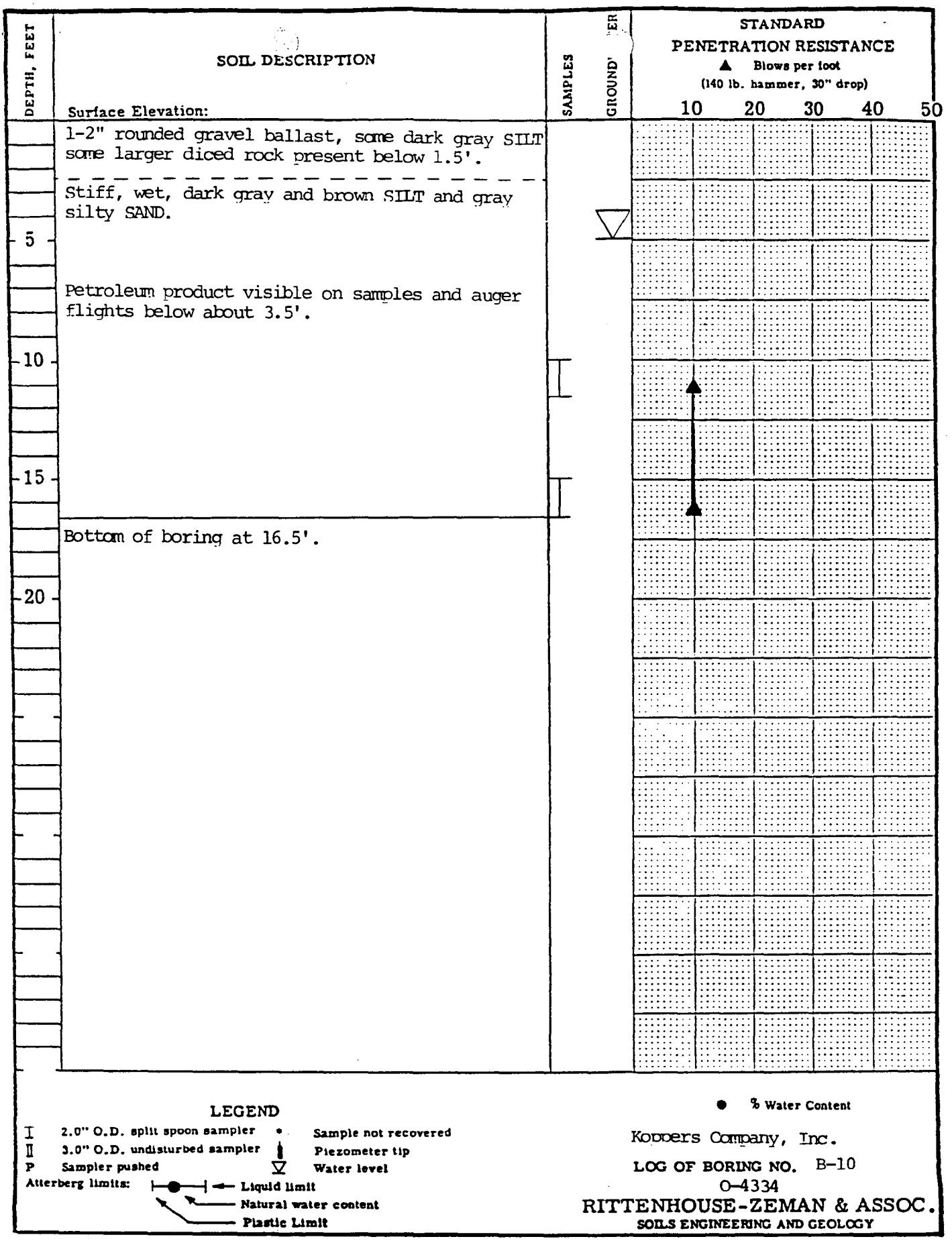
LEGEND

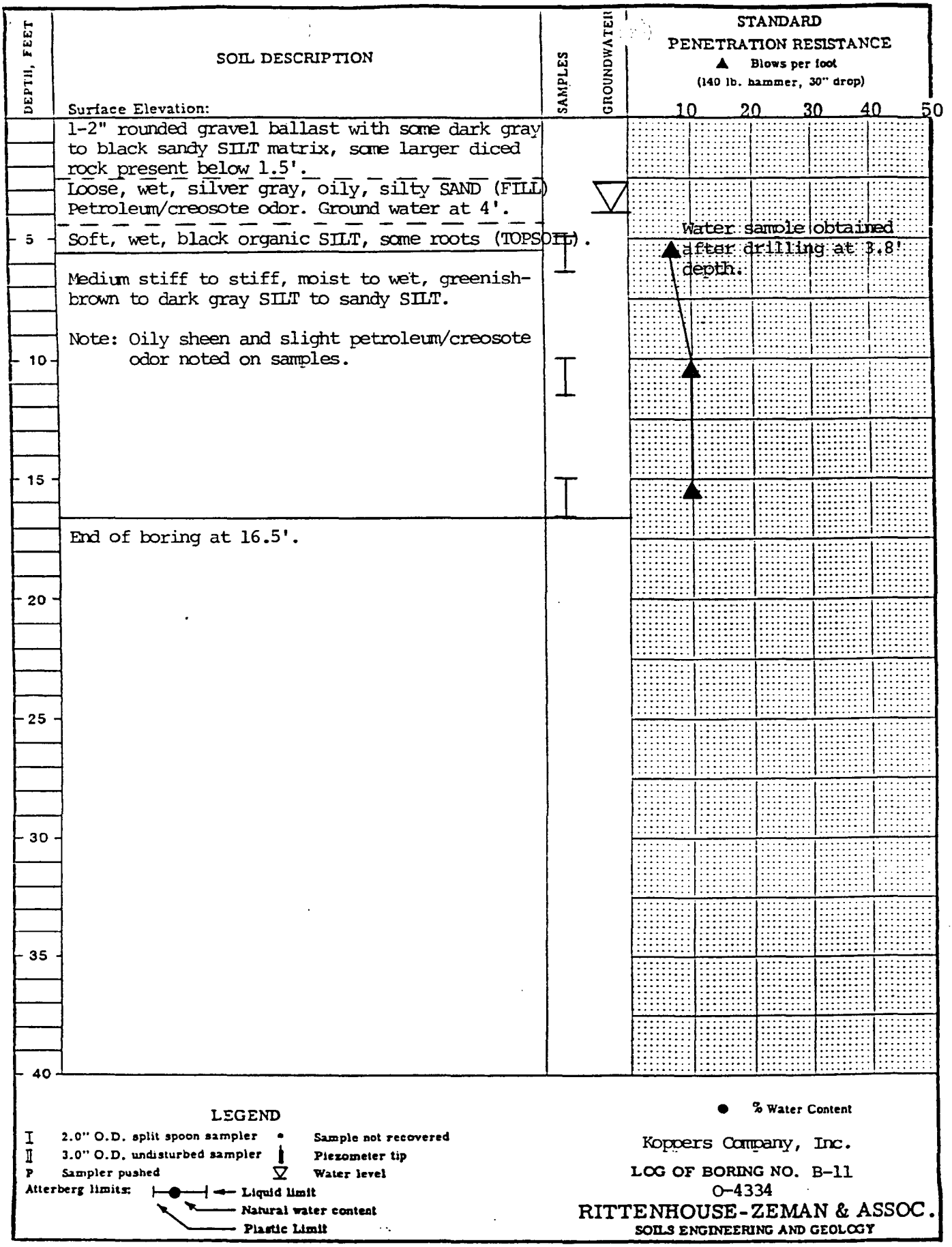
I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
Atterberg limits: Liquid limit, Natural water content, Plastic Limit
• Sample not recovered
Piezometer tip
▽ Water level
● % Water Content

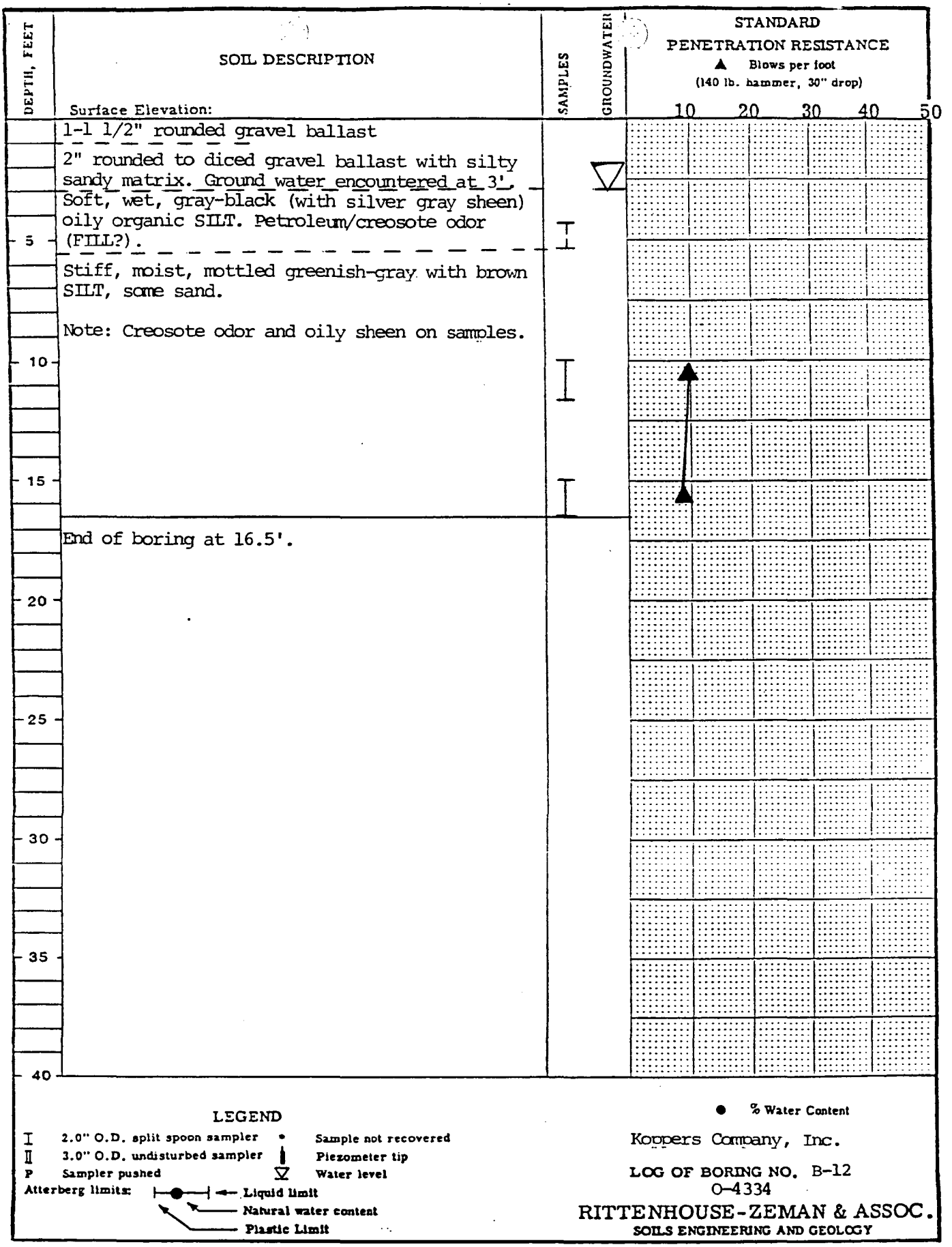
Koppers Company, Inc.

LOG OF BORING NO. B-9
O-4334

RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY


DEPTH, FEET
SOIL DESCRIPTION
Surface Elevation:
SAMPLES
GROUND WATER
STANDARD PENETRATION RESISTANCE
▲ Blows per foot
(140 lb. hammer, 30" drop)
10 20 30 40 50
1-2" rounded gravel ballast, some dark gray SILT some larger diced rock present below 1.5'.
Stiff, wet, dark gray and brown SILT and gray silty SAND.
Petroleum product visible on samples and auger flights below about 3.5'.
Bottom of boring at 16.5'.
5
10
15
20
LEGEND
I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
Sample not recovered
Piezometer tip
Water level
Atterberg limits:
Liquid limit
Natural water content
Plastic Limit
● % Water Content
Koppers Company, Inc.
LOG OF BORING NO. B-10
O-4334
RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY


DEPTH, FEET
SOIL DESCRIPTION
Surface Elevation:
SAMPLES
GROUNDWATER
STANDARD
PENETRATION RESISTANCE
▲ Blows per foot
(140 lb. hammer, 30" drop)
10 20 30 40 50
1-2" rounded gravel ballast with some dark gray to black sandy SILT matrix, some larger diced rock present below 1.5'.
Loose, wet, silver gray, oily, silty SAND (FILL) Petroleum/creosote odor. Ground water at 4'.
5
Soft, wet, black organic SILT, some roots (TOPSOIL).
Medium stiff to stiff, moist to wet, greenish-brown to dark gray SILT to sandy SILT.
Note: Oily sheen and slight petroleum/creosote odor noted on samples.
10
15
Water sample obtained after drilling at 3.8' depth.
End of boring at 16.5'.
20
25
30
35
40
LEGEND
I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
Atterberg limits:
Liquid limit
Natural water content
Plastic Limit
• Sample not recovered
Piezometer tip
Water level
● % Water Content
Koppers Company, Inc.
LOG OF BORING NO. B-11
O-4334
RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY


DEPTH, FEET
SOIL DESCRIPTION
Surface Elevation:
SAMPLES
GROUNDWATER
STANDARD
PENETRATION RESISTANCE
▲ Blows per foot
(140 lb. hammer, 30" drop)
10 20 30 40 50
1-1 1/2" rounded gravel ballast
2" rounded to diced gravel ballast with silty sandy matrix. Ground water encountered at 3'.
Soft, wet, gray-black (with silver gray sheen) oily organic SILT. Petroleum/creosote odor (FILL?).
Stiff, moist, mottled greenish-gray with brown SILT, some sand.
Note: Creosote odor and oily sheen on samples.
End of boring at 16.5'.
5
10
15
20
25
30
35
40
LEGEND
2.0" O.D. split spoon sampler
3.0" O.D. undisturbed sampler
P Sampler pushed
Sample not recovered
Piezometer tip
Water level
Atterberg limits:
Liquid limit
Natural water content
Plastic Limit
● % Water Content
Koppers Company, Inc.
LOG OF BORING NO. B-12
O-4334
RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY

DEPTH, FEET	SOIL DESCRIPTION Surface Elevation:	SAMPLES	GROUNDWATER	STANDARD PENETRATION RESISTANCE ▲ Blows per foot (140 lb. hammer, 30" drop) 10 20 30 40 50
	2" rounded river-run gravel ballast with sandy silt matrix. 2" diced reject rock noted to 2'.			
	Moist to wet, black, oily, silty fine to medium SAND. Petroleum/creosote odor (FILL). Water table encountered at 3.5'.		▽	
5	Stiff to medium stiff, wet to moist, mottled dark gray and brown SILT to sandy SILT.	I		▲
	Note: Creosote odor and oily sheen on samples.			
10				
15		I		
	Bottom of boring at 16.5'.			
20				
25				
30				
35				
40				

LEGEND

I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
Atterberg limits: Liquid limit, Natural water content, Plastic Limit
• Sample not recovered
Piezometer tip
▽ Water level
● % Water Content

Koppers Company, Inc.

LOG OF BORING NO. B-13

O-4334

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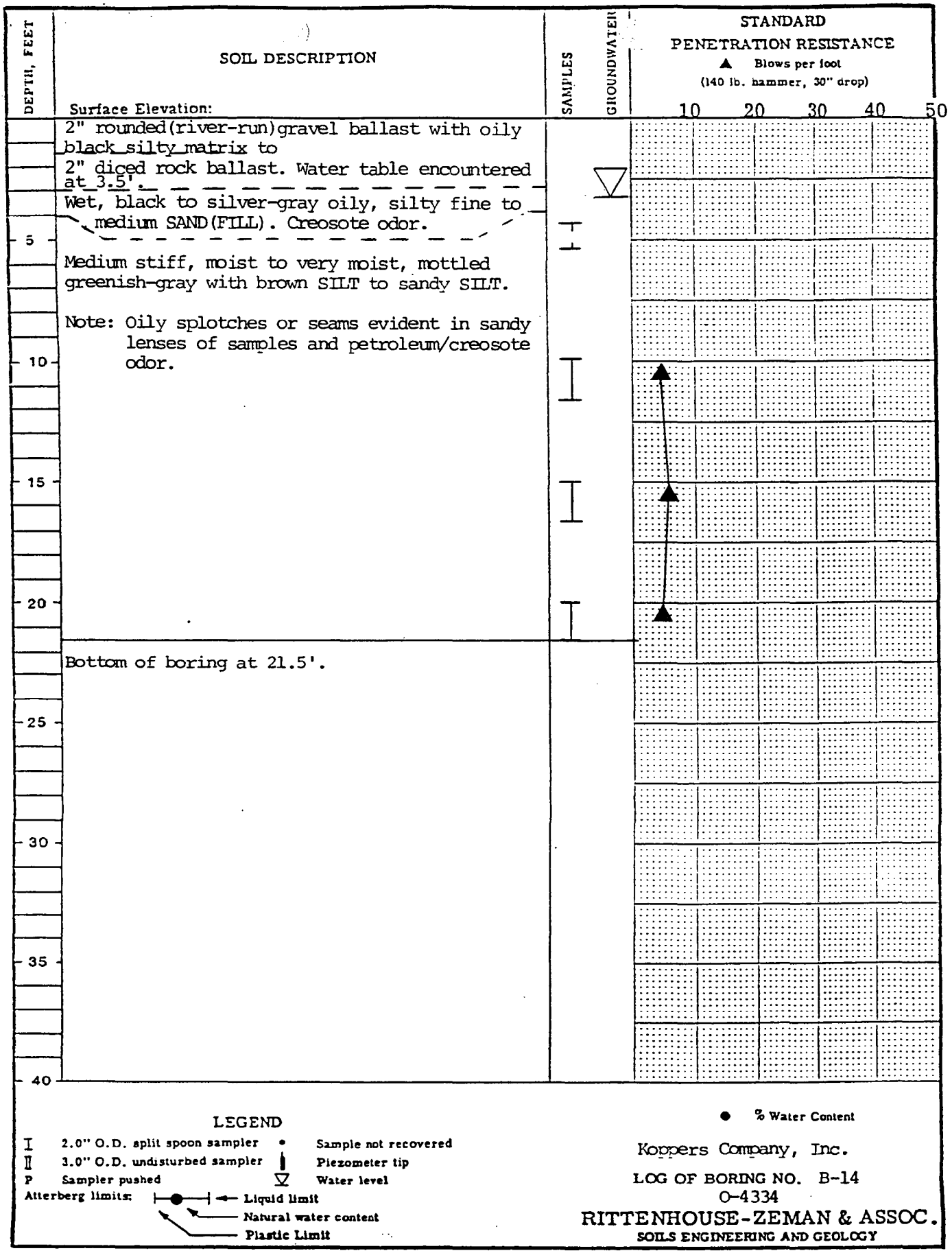
SOILS ENGINEERING AND GEOLOGY


DEPTH, FEET
SOIL DESCRIPTION
Surface Elevation:
SAMPLES
GROUNDWATER
STANDARD PENETRATION RESISTANCE
▲ Blows per foot
(140 lb. hammer, 30" drop)
10 20 30 40 50
2" rounded(river-run)gravel ballast with oily black silty matrix to
2" diced rock ballast. Water table encountered at 3.5'.
Wet, black to silver-gray oily, silty fine to medium SAND(FILL). Creosote odor.
Medium stiff, moist to very moist, mottled greenish-gray with brown SILT to sandy SILT.
Note: Oily splotches or seams evident in sandy lenses of samples and petroleum/creosote odor.
Bottom of boring at 21.5'.
5
10
15
20
25
30
35
40
LEGEND
I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
Sample not recovered
Piezometer tip
Water level
Atterberg limits:
Liquid limit
Natural water content
Plastic Limit
● % Water Content
Koppers Company, Inc.
LOG OF BORING NO. B-14
O-4334
RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY

DEPTH, FEET	SOIL DESCRIPTION Surface Elevation:	SAMPLES	GROUNDWATER	STANDARD PENETRATION RESISTANCE ▲ Blows per foot (140 lb. hammer, 30" drop) 10 20 30 40 50
	1-2" rounded river-run gravel ballast with oily black, sandy SILT. 4" diced rock ballast with oily black, fine to medium SAND (FILL).			
5	Bottom of boring at 3.5' due to inpenetrable conditions caused by large ballast clast size and caving conditions. Note: Four attempts to penetrate ballast in this area were unsuccessful.			
10				
15				
20				
25				
30				
35				
40				

LEGEND

I 2.0" O.D. split spoon sampler
II 3.0" O.D. undisturbed sampler
P Sampler pushed
• Sample not recovered
Piezometer tip
▽ Water level
Atterberg limits: Liquid limit, Natural water content, Plastic Limit

● % Water Content

Koppers Company, Inc.
LOG OF BORING NO. B-15
O-4334
RITTENHOUSE-ZEMAN & ASSOC.
SOILS ENGINEERING AND GEOLOGY

96-119(E) F

MEMORANDUM

MONTGOMERY WATSON

A.

To:	Eric Blischke, Oregon DEQ	**Date:**	August 16, 1996
From:	Steve Sonnen SS	**Job No.:**	4810.0010
cc:	Sandra Hart, NWNG		
	Frank Selker, Decision Focus		
	Richard Bach, Stoel Rives		
Subject:	Baseline Human Health Risk Assessment for Northwest Natural Gas Gasco Site - Conceptual Model		

This memorandum describes the conceptual model proposed for the baseline human health risk assessment for the Gasco Site, based on Site-related chemicals, exposure pathways, and receptors of likely concern as identified in the remedial investigation (RI; Hahn and Associates, 1996). Also included is a brief description of the methodology which will be employed to complete the risk assessment.

Methodology for Construction of the Conceptual Model

The conceptual model to be employed in the Gasco Site risk assessment will identify chemicals, exposure pathways, and receptors of potential concern and will be used to guide the implementation of the analysis and risk characterization phases of the risk assessment.

Chemicals of possible concern, as identified in the RI, have been initially evaluated to focus the risk assessment efforts on those chemicals having a potential to cause significant human health impacts. To focus the analysis, the maximum concentration of chemicals detected at the Site, within each environmental medium was compared to a possibly relevant regulatory standard. If the maximum concentration was greater than its medium-specific standard, it was retained for further evaluation.

At the Gasco Site, background data have been collected only for Willamette River sediments. Therefore, all chemicals for which there are no regulatory standards will be retained for further evaluation. Because there are no standards for the chemicals detected in the sediments, a background comparison will be used as the retention criterion. Chemicals retained through these focusing steps are deemed to be chemicals of potential concern (COPCs).

Possible exposure pathways will be evaluated to determine whether or not they are complete. As shown in Figure 1, a pathway will be deemed to be complete if all of the following are present: a contaminant source (current or historic), a release mechanism, an environmental transport or residency medium, an exposure route, and a receptor. Pathways which are incomplete at the Site and are expected to remain incomplete will be dismissed. Complete pathways will be retained and considered to be of potential concern. Such pathways will be subject to further evaluation.

Possible receptors will be evaluated to identify populations potentially exposed to COPCs. This evaluation will be based on current and reasonably likely future land and water uses.

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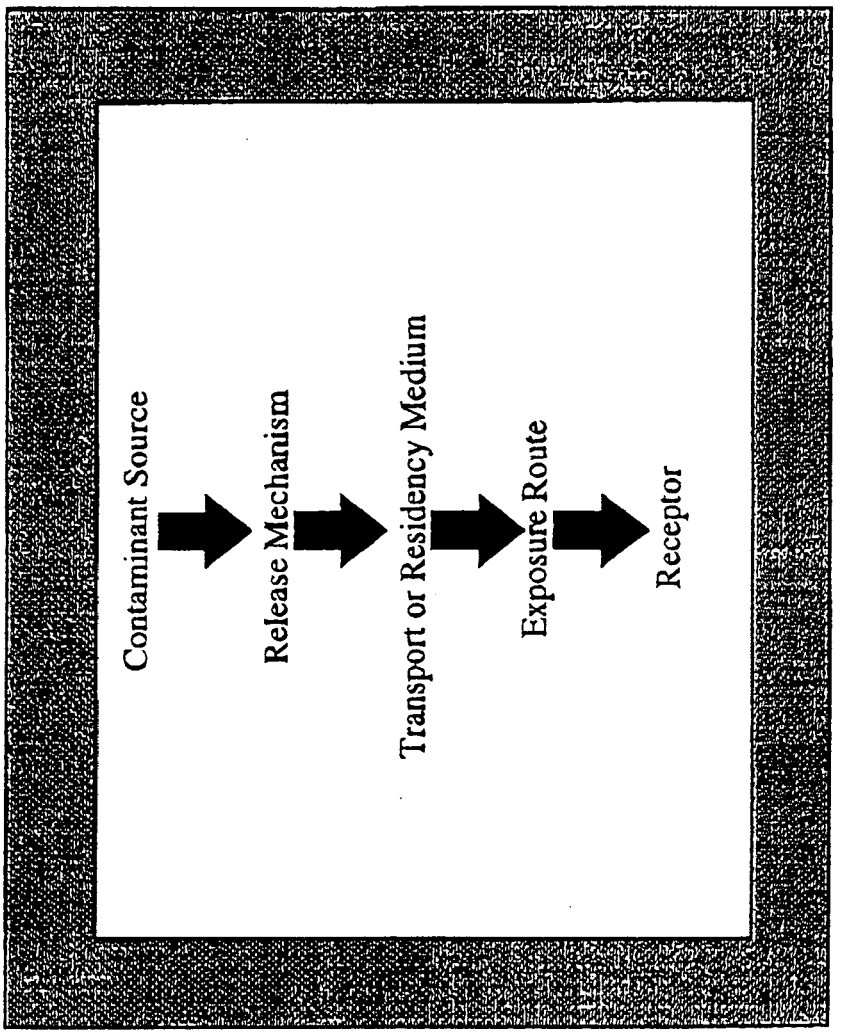
Figure 1. Conceptual Model Elements



11000

Populations identified as h ng exposure potential under appropria' nd use scenarios are regarded as being of potential concern and will be subjected to furthe. evaluation.

The process of identifying chemicals, exposure pathways, and receptors of potential concern will be iterative. Designation of COPCs, for example, will take information regarding likely exposure pathways and receptors into account. Likewise, pathways and receptors can not be identified in isolation of the other two components of the conceptual model.

This process of identification of chemicals, exposure pathways, and receptors of potential concern has provided the basis for the proposed conceptual model, with the understanding that the conceptual model may need to be updated and refined as information about the Gasco Site is analyzed and placed in perspective.

Designation of Chemicals of Potential Concern

The RI has identified the release of various chemicals to the soil, air, surface water, and sediments. The COPCs have been designated by environmental medium from the universe of chemicals detected during the RI, with consideration of pathways and receptors.

Each medium addressed below is accompanied by a table of information. The accompanying table lists each chemical analyzed for (excluding general indicator analytes), the maximum observed concentration in that medium during the RI, and the standard against which the maximum concentration has been compared. In the case of sediments, for which no standards are available, no table is provided.

Air

Table 1 provides the information used to designate COPCs in air for the Gasco Site. Air monitoring was conducted during drilling activities performed during the RI. More extensive air monitoring was also performed to assess ambient air concentrations downwind of the LNG Storage Tank Containment Basin. Only benzene, toluene, ethylbenzene, xylenes (BTEX), and titanium were detected during air monitoring performed while drilling for the RI, and the maximum concentrations of these chemicals are far below their respective regulatory standards. Thus, no COPCs are defined for air, and it is proposed that air be dismissed as being a pathway of potential concern (see Designation of Exposure Pathways of Potential Concern below). Dust is further evaluated separately below.

Surface Soil

Table 2 provides the information used to designate COPCs in surface soil for the Gasco Site. Shading in Table 2 indicates that the maximum concentration exceeds the medium-specific regulatory standard for that particular chemical and the chemical is, therefore, deemed to be a COPC.

As indicated in Table 2, the following compounds are deemed to be COPCs and are to be evaluated in the risk assessment:

- total petroleum hydrocarbons (TPH)-diesel/oil range
- arsenic
- benzo(a)anthracene
- benzo(b)fluoranthene
- benzo(k)fluoranthene
- benzo(a)pyrene

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Table 1. Maximum Concentration of Chemicals in at the Gasco Site

Chemical	Maximum Concentration	Oregon OSHA PEL[1]		
		TWA	E	C
VOCs	(ppm)	(ppm)	(ppm)	(ppm)
benzene	0.11	1	5.0	
toluene	0.007	100 (skin)	300	500
ethylbenzene	0.090	100	300	
xylenes	0.046	100	300	
Metals	(mg/m^3)	(mg/m^3)	(mg/m^3)	(mg/m^3)
antimony	<0.009[tt]	0.5	1.5	
arsenic	<0.0009[tt]	0.01	0.03	
beryllium	<0.0005[tt]	0.002	0.005	0.025
cadmium	<0.0002[tt]	0.005	0.015	
chromium	<0.002[tt]	0.5	1.5	
copper	<0.002[tt]	0.1	0.3	
lead	<0.0009[tt]	0.05	0.15	
nickel	<0.0005[tt]	1	3	
selenium	<0.002[tt]	0.2	0.6	
silver	<0.0005[tt]	0.0	0.0	
titanium	0.005	10[a]	30	
zinc	<0.002[tt]	5[a]	15	
Particulates	(mg/m^3)	(mg/m^3)	(mg/m^3)	(mg/m^3)
Total Airborne Dust	<0.2[tt]	10	30	
PAHs	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)
acenaphthene	<0.3[tt]			
acenaphthylene	<0.1[tt]			
anthracene	<0.01[tt]	200	600	
benzo(a)anthracene	<0.01[tt]			
benzo(b)fluoranthene	<0.02[tt]			
benzo(k)fluoranthene	<0.01[tt]			
benzo(a)pyrene	<0.01[tt]	200	600	
benzo(ghi)perylene	<0.01[tt]			
chrysene	<0.01[tt]	200	600	
dibenzo(ah)anthracene	<0.01[tt]			
fluoranthene	<0.01[tt]			
fluorene	<0.01[tt]			
indeno(1,2,3-cd)pyrene	<0.01[tt]			
naphthalene	<0.1[tt]	50,000	150,000	
phenanthrene	<0.01[tt]	200	600	
pyrene	<0.01[tt]	200	600	

[1]PEL-Permissible Exposure Limit, TWA-Time Weighted Average, E-Exposure Limit, C-Ceiling Limit.

[tt]Not detected. Value listed is the detection limit which was highest for all samples tested.

[a]Titanium TWA is as titanium oxide, zinc TWA is as zinc oxide.

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Table 2. Maximum Co. entrations of Chemicals in Surf. e Soils at the Gasco Site

Chemical	Maximum Concentration (mg/kg)	Regulatory Standard (mg/kg)
VOCs		
benzene	<0.3[f]	2[a]
toluene	<0.3[f]	6,000[a]
ethylbenzene	<0.3[f]	20,000[a]
xylenes	<0.3[f]	2,500[a]
TPH		
TPH-gasoline	<10[f]	80[b]
TPH-diesel/oil	1,600	500[b]
Metals		
antimony	6.6	280[d]
arsenic	21	3[g]
beryllium	<1.0[f]	1[a]
cadmium	1.1	1,000[a]
chromium	30	1,500[a]
copper	60	80,000[a]
lead	60	2,000[a]
mercury	<0.1[f]	600[a]
nickel	26	40,000[a]
selenium	<0.1[f]	100[e]
silver	<0.1[f]	10,000[a]
thallium	7.6	56[d]
zinc	160	7,500[c]
Phenols		
4-chloro-3-methylphenol	<51[h]	
2-chlorophenol	<51[h]	
2,4-dichlorophenol	<51[h]	
2,4-dimethylphenol	<51[h]	
2,4-dinitrophenol	<99[h]	
2-methyl-4,6-dinitrophenol	<51[h]	
cresols, total	<51[h]	
4-methylphenol	<51[h]	
2-nitrophenol	<51[h]	
4-nitrophenol	<51[h]	
2,3,4,6-tetrachlorophenol	<51[h]	
pentachlorophenol	<51[h]	50[a]
phenol	<51[h]	
2,4,5-trichlorophenol	<51[h]	
2,4,6-trichlorophenol	<51[h]	500[a]

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Table 2. Maximum Concentrations of Chemicals in Surface Soils at the Gasco Site

Chemical	Maximum Concentration (mg/kg)	Regulatory Standard (mg/kg)
PAHs		
acenaphthene	9.2	100,000[a]
acenaphthylene	29	
anthracene	212	600,000[a]
benzo(a)anthracene	55	1[c]
benzo(b)fluoranthene	124	1[c]
benzo(k)fluoranthene	45	1[c]
benzo(a)pyrene	129	1[c]
benzo(ghi)perylene	202	
chrysene	75	1[c]
dibenzo(ah)anthracene	33	1[c]
fluoranthene	115	80,000[a]
fluorene	20	80,000[a]
indeno(1,2,3-cd)pyrene	141	1[c]
naphthalene	9	8,000[a]
phenanthrene	92	
pyrene	134	60,000[a]

[a]Not detected. Value listed is the detection limit.
[b]Not detected. Value listed is the detection limit which was highest for all samples tested.
[c]Industrial Maximum Allowable Soil Concentration (OAR 340-122-045).
[d]UST Level 2 Cleanup Standard (OAR 340-122-335).
[e]40CFR 530.13(b)1.
[f]Risk-based calculation. Assumes 70 kg body weight, 100 mg/d soil ingestion rate, a hazard quotient of 1.0, and reference doses (RfDs) of 4E-4 and 8E-5 (mg/(kg*d)) for antimony and thallium, respectively. (Source: IRIS, April 1996.)

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- chrysene
- dibenzo(ah)anthracene
- indeno(1,2,3-cd)pyrene.

Three chemicals for which no soil standards exist were detected. All are non-carcinogenic polycyclic aromatic hydrocarbons, PAHs—acenaphthylene, benzo(ghi)perylene, and phenanthrene. Other non-carcinogenic PAHs detected at the Site have regulatory standards which exceed the maximum concentrations of these three by several orders of magnitude. If these other non-carcinogenic PAHs are considered to be surrogates for the three non-carcinogenic PAHs lacking standards, they can be dismissed. Further, given the extensive presence of carcinogenic PAHs in Site surface soils, the magnitude of risk contributed by PAHs will not be affected significantly by dismissing these three compounds from further analysis. Thus, acenaphthylene, benzo(ghi)perylene, and phenanthrene are not regarded as COPCs in surface soil.

Subsurface Soil

Table 3 provides the information used to designate COPCs in subsurface soil. Again, background data are not available at this time. Shading in Table 3 indicates that the maximum concentration exceeds the medium-specific regulatory standard for that particular chemical and the chemical is, therefore, deemed to be a COPC. The COPCs identified for this medium are:

- benzene
- TPH-gasoline range
- TPH-diesel/oil range
- arsenic
- benzo(a)anthracene
- benzo(b)fluoranthene
- benzo(k)fluoranthene
- benzo(a)pyrene
- chrysene
- dibenzo(ah)anthracene
- indeno(1,2,3-cd)pyrene
- naphthalene
- phenanthrene.

As was the case for surface soils, standards do not exist for all analytes listed in Table 3. By the same rationale as for surface soils, acenaphthylene and benzo(ghi)perylene in subsurface soils have not been retained for further analysis. Phenanthrene will, however, be retained as its maximum concentration exceeds the regulatory standard for naphthalene, a reasonable surrogate compound.

Dust

Wipe samples were taken at two locations during the RI. The concentrations of PAHs found in these samples are presented in Table 4. Because personal monitoring data for exposures to VOCs and dust were collected in association with drilling activities which took place during the RI and exposures to these compounds were well below permissible limits, dust will not be

Table 3. Maximum Concentrations of Chemicals in Subsurface Soils at the Gasco Site

Chemical	Maximum Concentration (mg/kg)	Regulatory Standard (mg/kg)
VOCs		
benzene	360	2[a]
toluene	280	6,000[a]
ethylbenzene	140	20,000[a]
xylenes	220	2,500[a]
TPH		
TPH-gasoline	2,400	80[c]
TPH-diesel/oil	7,700	500[b]
Metals		
antimony	<1.0[f]	280[d]
arsenic	14	3[a]
beryllium	<1.0[f]	1[a]
cadmium	4.3	1,000[a]
chromium	30	1,500[a]
copper	80	80,000[a]
lead	130	2,000[a]
mercury	<0.10[f]	600[a]
nickel	41	40,000[a]
selenium	<1.0[f]	100[c]
silver	<1.0[f]	10,000[a]
thallium	5.0	56[d]
zinc	3,000	7,500[c]
Phenols		
4-chloro-3-methylphenol	<51[ff]	
2-chlorophenol	<51[ff]	
2,4-dichlorophenol	<51[ff]	
2,4-dimethylphenol	<51[ff]	
2,4-dinitrophenol	<99[ff]	
2-methyl-4,6-dinitrophenol	<51[ff]	
cresols, total	<51[ff]	
4-methylphenol	<51[ff]	
2-nitrophenol	<51[ff]	
4-nitrophenol	<51[ff]	
2,3,4,6-tetrachlorophenol	<51[ff]	
pentachlorophenol	0.36	50[a]
phenol	<51[ff]	
2,4,5-trichlorophenol	<51[ff]	
2,4,6-trichlorophenol	<51[ff]	500[a]

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Table 3. Maximum Concentrations of Chemicals in Subsurface Soils at the Gasco Site

Chemical	Maximum Concentration (mg/kg)	Regulatory Standard (mg/kg)
PAHs		
acenaphthene	9,210	100,000[a]
acenaphthylene	1,960	
anthracene	1,650	600,000[a]
benzo(a)anthracene	1,540	1[e]
benzo(b)fluoranthene	972	1[e]
benzo(k)fluoranthene	370	1[e]
benzo(a)pyrene	954	1[e]
benzo(ghi)perylene	1,080	
chrysene	1,810	1[e]
dibenzo(ah)anthracene	159	1[e]
fluoranthene	8,480	80,000[a]
fluorene	4,530	80,000[a]
indeno(1,2,3-cd)pyrene	738	1[e]
naphthalene	20,700	8,000[f]
phenanthrene	15,500	
pyrene	6,530	60,000[a]

[i]Not detected. Value listed is the detection limit.

[ii]Not detected. Value listed is the detection limit which was highest for all samples tested.

[c]Industrial Maximum Allowable Soil Concentration (OAR 340-122-045).

[b]UST Level 2 Cleanup Standard (OAR 340-122-335).

[c]40CFR 530.13(b)1.

[d]Risk-based calculation. Assumes 70 kg body weight, 100 mg/d soil ingestion rate, a hazard quotient of 1.0, and reference doses (RfDs) of 4E-4 and 8E-5 (mg/(kg*d)) for antimony and thallium, respectively. (Source: IRIS, April 1996.)

[e]Exceeds naphthalene standard.

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Table 4. Concentrations of Chemicals in Dust Samples at Gasco Site

Chemical	Concentration - Koppers		Concentration - Gasco (mg/kg)	
	(mg/kg)	Fraction of Total	(mg/kg)	Fraction of Total
PAHs				
acenaphthene	380	0.014	4.4	0.012
acenaphthylene	<20[r]	0	1.7	0.004
anthracene	440	0.016	5.6	0.015
benzo(a)anthracene	2600	0.097	33	0.087
benzo(b)fluoranthene	3400	0.126	48	0.125
benzo(k)fluoranthene	1300	0.048	18	0.047
benzo(e)pyrene	2900	0.108	41	0.109
benzo(ghi)perylene	2500	0.093	37	0.096
chrysene	2900	0.108	36	0.095
dibenzo(ah)anthracene	550	0.020	7.5	0.020
fluoranthene	3500	0.130	54	0.141
fluorene	150	0.006	1.9	0.005
indeno(1,2,3-cd)pyrene	1900	0.071	27	0.072
naphthalene	68	0.003	1.1	0.003
phenanthrene	1500	0.056	24	0.062
pyrene	2800	0.104	42	0.110

[r] Not detected. Value listed is detection limit.

Shading indicates exceedance of soil standards (see Table 3).

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evaluated via the inhalation pathway. Dust will be considered, however, as part of the ingestion pathway (see Designation of Exposure Pathways of Potential Concern below).

The following chemicals are regarded as COPCs in dust:

- acenaphthene
- acenaphthylene
- anthracene
- benzo(a)anthracene
- benzo(b)fluoranthene
- benzo(k)fluoranthene
- benzo(a)pyrene
- benzo(ghi)perylene
- chrysene
- dibenzo(ah)anthracene
- fluoranthene
- fluorene
- indeno(1,2,3-cd)pyrene
- naphthalene
- phenanthrene
- pyrene.

Ground Water

The RI indicates that the ground water beneath the Gasco Site is contaminated with a variety of chemicals associated with the Site. However, the ground water in this area is not used as a potable source and it does not appear that there are any reasonably likely beneficial uses of groundwater. Thus, ground water will not be regarded as part of any direct exposure pathway of potential concern (see Designation of Exposure Pathways of Potential Concern below) and no COPCs for ground water are designated for the purpose of this risk assessment.

Surface Water

Given that direct surface water exposure pathways are not deemed to be complete (see Designation of Exposure Pathways of Potential Concern below), no COPCs have been designated for this medium. The only surface water on Site is within engineered waste water facilities, and the volume of water in the Willamette River would appear to result in considerable dilution of the permitted discharges and ground water seepage.

Sediments

Sediment samples were taken at several locations in the Willamette River, along, downstream, and upstream of the Gasco Site. The upstream samples will be regarded as Site-specific background samples. Given that no standards exist against which to compare maximum observed downstream chemical concentrations, all chemicals whose concentrations are elevated with respect to background are considered to be of potential concern and will be retained for further evaluation.

The data presented in the RI demonstrate that all chemicals detected in downstream sediment samples within the River are elevated with regard to background. Thus, all chemicals detected will be deemed to be of potential concern for this medium:

- TPH-gasoline range
- TPH-diesel/oil range
- benzene
- toluene
- ethylbenzene
- xylene
- acenaphthene
- acenaphthylene
- anthracene
- benzo(a)anthracene
- benzo(b)fluoranthene
- benzo(k)fluoranthene
- benzo(a)pyrene
- benzo(ghi)perylene
- chrysene
- dibenzo(ah)anthracene
- fluoranthene
- fluorene
- indeno(1,2,3-cd)pyrene
- naphthalene
- phenanthrene
- pyrene.

Because all on-Site sediments are located within engineered waste water facilities, exposure to such sediments is highly unlikely and will not be considered further (see Designation of Exposure Pathways of Potential Concern below).

Biota

Biota were not sampled during the RI. The most likely exposure pathway associated with biota that could be affected by chemicals released from the Site is ingestion of fish from the Willamette River (see Designation of Exposure Pathways of Potential Concern below). Chemical concentrations in fish will be estimated by modeling food chain uptake from sediment through the benthos or sediment-dwelling organisms that comprise the majority of the food resource for fish. Thus, the COPCs for biota are identical to those identified above for sediment in the River.

Designation of Exposure Pathways of Potential Concern

The conceptual model considers an exposure pathway to consist of an environmental medium and an exposure route. The universe of exposure pathways considered in this formulation include the following (categorized by medium, as discussed within Designation of Chemicals of Potential Concern above, within route):

- inhalation
  - air
  - dust
- ingestion
  - surface soil
  - subsurface soil
  - dust
  - ground water
  - surface water
  - sediment
  - biota
- dermal contact
  - surface soil
  - subsurface soil
  - dust
  - ground water
  - surface water
  - sediment.

Each of these possible exposure pathways is discussed below, by exposure route, to designate those of potential concern for the Gasco Site.

Inhalation

As indicated above within Designation of Chemicals of Potential Concern, no COPCs have been identified for air. These included both volatile compounds expected to be encountered within a vapor phase and relatively non-volatile compounds expected to be encountered within a particulate or dust phase.

Ingestion of soil and dust is considered to be an exposure pathway of potential concern (see Ingestion below). Thus, dismissing dust inhalation from further consideration is justified by not only the absence of detectable contamination in air while drilling (an activity deemed to have exposure potential similar to occasional excavation activities), but also by the fact that ingestion of soil and dust is expected to contribute orders of magnitude more to the risk estimate than is inhalation of these media.

Therefore, inhalation pathways will not be regarded as being of potential concern at the Gasco Site.

Ingestion

Incidental ingestion of surface soil and dust are deemed to be potentially operative pathways at this site. Subsurface soil can also be incidentally ingested during short-term exposure events such as excavation (see Designation of Receptors of Potential Concern below).

As noted above within Designation of Chemicals of Potential Concern, direct ground water exposure pathways are not complete at the Gasco Site. Although contaminants have been found in the ground water under the Site, the ground water is not in current beneficial use nor is it

expected to become a source of drinking water in the future. Therefore, ground water will not be included in the human health risk assessment in a direct sense. The effect of the ground water contamination will be evaluated, indirectly, through its impact on Willamette River sediment, the benthic community, and human ingestion of fish (see below).

Surface water is present on Site within engineered waste water facilities and adjacent to the Site within the channel of the Willamette River. Incidental direct ingestion of waste water is deemed to be highly unlikely. Incidental ingestion of Willamette River water, however, certainly does occur among recreational users of the River, but the volume of water in the Willamette is such that substantial dilution of the Site ground water seepage and permitted discharges to the River is inevitable. Thus, ingestion of surface water will not be regarded as being a pathway of potential concern for the Gasco Site.

Ingestion of sediment associated with the engineered waste water facilities on Site is deemed to be highly unlikely. While exposure to River sediments is more likely, the presence of boulders along the shore, the absence of a beach, and the steep and deep morphology of the Willamette channel next to the Site are not conducive to attracting recreational users. Moreover, the cleansing action of the overlying water column serves to mitigate any contact with sediment and lowers the opportunity for incidental ingestion considerably. Thus, incidental ingestion of sediment will not be regarded as a pathway of potential concern.

The final ingestion pathway under consideration is biotic ingestion. The Willamette River is a significant fishery. Fish can be exposed to Site chemicals through the ingestion of benthos dwelling on affected sediments. Thus, this pathway will be regarded as being of potential concern for this human health risk assessment. (It will also be considered in the ecological assessment).

In summary, the following ingestion pathways are deemed to be of potential concern for the Gasco Site and will be subjected to detailed analysis:

- surface soil
- dust
- subsurface soil
- fish.

Dermal Contact

With the exception of biota, the universe of possible dermal exposure pathways is identical to that for ingestion. Thus, in accordance with the rationale provided above, the dermal contact pathways of potential concern have been identified as the following:

- surface soil
- dust
- subsurface soil.

Designation of Receptors of Potential Concern

The final element of this conceptual model is the receptors — the population of individuals potentially exposed to the designated COPCs. The universe of receptors of possible concern to be considered in this formulation will be as follows:

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- on-Site employees
  - permanent
    - Northwest Natural Gas (NWNG)
    - Koppers Company (Koppers)
    - Pacific Northern Oil (PNO)
  - short-term contractors
    - NWNG
    - Koppers
    - PNO
- Site visitors and trespassers
- recreational users of the Willamette River
  - fishermen
  - swimmers.

Each of these possible receptors is discussed below to designate those of potential concern for further analysis in connection with the Gasco Site.

On-Site Employees

The primary receptor population at the Gasco Site consists of on-Site employees. This category includes both permanent full-time employees and contractors on the three parcels operated by NWNG, Koppers, and PNO. Given that there are three distinct operational parcels of land on the Site, each parcel will be evaluated separately as to its receptors of potential concern.

Operative pathways for permanent employees may include ingestion of and dermal contact with surface soil and dust. Contractors could experience significant but short-term exposures not likely to be experienced by the permanent staff, such as ingestion of and dermal contact with subsurface soil.

Site Visitors and Trespassers

A second set of receptors includes authorized visitors to the Site and trespassers who wander onto the Site without authorization. This set of receptors will not be analyzed explicitly, because visitors and trespassers spend far less time on the Site than do permanent full-time employees, any health effects for these occasionally exposed receptors will clearly be far less. Accordingly, Site visitors and trespassers will not be regarded as being of potential concern for purposes of the remaining analytical effort associated with this risk assessment.

Recreational Users of the Willamette River

The final set of possible receptors consists of recreational users of the Willamette River. As mentioned previously (see Designation of Chemicals of Potential Concern and Designation of Exposure Pathways of Potential Concern above), Site discharges to the River are highly diluted, there is no beach adjacent to the Site, and the cleansing effect of the water column serves to mitigate sediment exposures. Therefore, swimmers and similar types of recreational users (*e.g.*, jet skiers, water skiers, boaters, and wind surfers) are expected to experience minimal exposures to Site-related chemicals. This group of recreational users of the River will thus not be considered as being of potential concern. The category of individuals who ingest fish caught from the River, however, will be retained for further analysis.

Receptor Summary

Receptors of potential concern for the Gasco Site are thus deemed to be:

- permanent full-time and contractor employees on each of the three operating parcels
- fishermen.

Initial Conceptual Model and Methodology forAnalysis and Risk Characterization

The proposed initial conceptual model for the Gasco Site is depicted in Figure 2. As mentioned earlier, the conceptual model will be subject to update and refinement pending further review and incorporation of further information from either site characterization or data analysis efforts. Thus, risk conceptualization is best regarded as a dynamic, ongoing process throughout the duration of the risk assessment.

The next phases of the baseline risk assessment will be analysis and risk characterization. These phases, too, are best regarded as dynamic. The chemicals, exposure pathways, and receptors of potential concern designated above will be evaluated initially to further refine the conceptual model and focus the subsequent probabilistic evaluation.

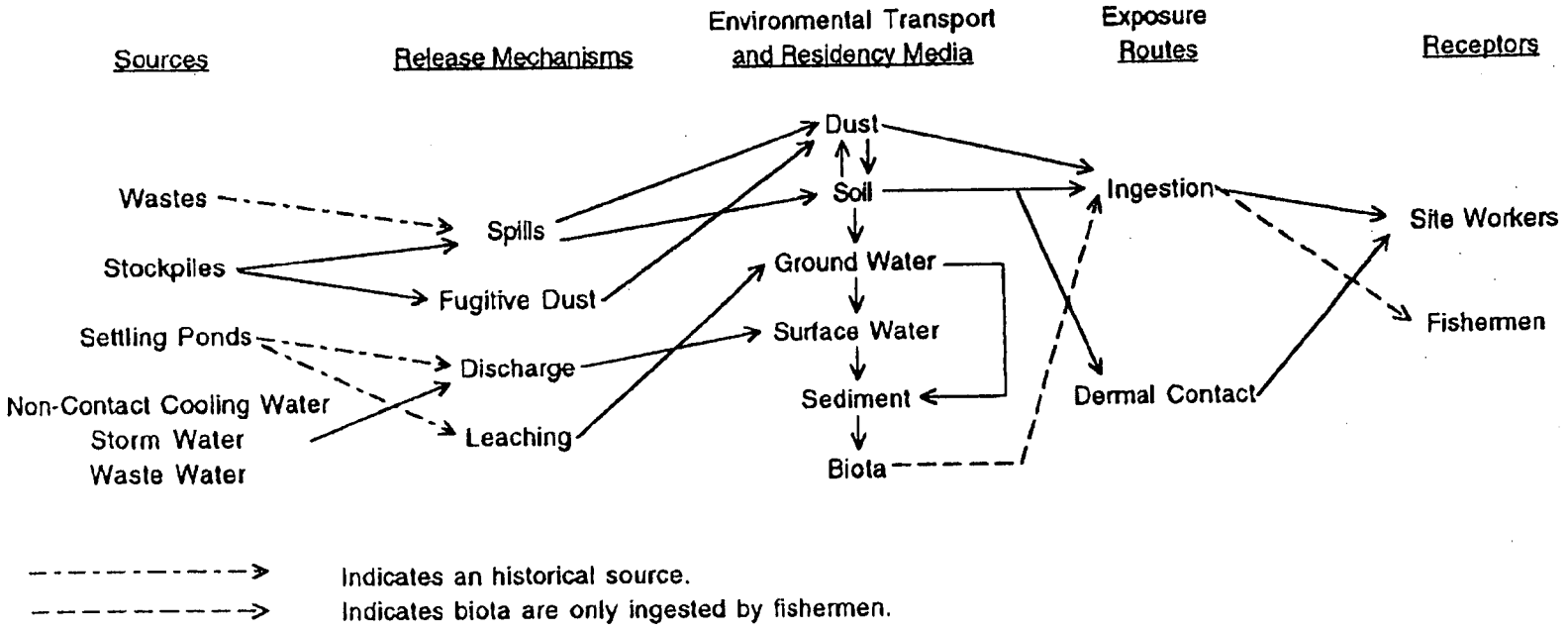
Additional technical memoranda will be produced to document model structure and input assumptions for the exposure and toxicity assessment subphases. If necessary, an interim risk characterization technical memorandum will document the results of the initial evaluation and refine the conceptual model. The final probabilistic evaluation will be documented by means of a risk assessment report.

In addition to the baseline human health risk assessment, a baseline ecological health risk assessment will be conducted. A separate conceptual model technical memorandum for this effort is under development.

References

Hahn and Associates, 1996, *Data Package for Remedial Investigation/Feasibility Study, Northwest Natural Gas Company Gasco Facility*, July 1996.

Figure 2. Proposed Initial Conceptual Model for the Gasco Facility



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HAHN AND ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS

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April 14, 2005

Mr. Matt McClincy
Oregon Department of Environmental Quality
Northwest Region, Portland Office
Portland Harbor Section
2020 SW Fourth Avenue, Suite 400
Portland Oregon 97201-4987

HAI Project No. 5237

SUBJECT: March 2005 Progress Report for Remedial Investigation (RI) Activities, Siltronic Corporation Property, 7200 NW Front Avenue, Portland, Oregon

Dear Mr. McClincy:

Hahn and Associates, Inc. (HAI) has prepared this Progress Report summarizing RI work activities conducted by NW Natural that have occurred relating to the Siltronic Corporation (Siltronic) property during the month of March 2005. RI field activities for the site have been conducted as per the approved Final Focused Remedial Investigation (RI) Work Plan[1] (RI Work Plan), as well as the approved Supplemental RI Work Plan[2]. This Progress Report has been prepared as per an Order (DEQ No. ECVC-NWR-00-27) issued jointly to both NW Natural and Siltronic by the Oregon Department of Environmental Quality (DEQ), dated October 4, 2000. As per the referenced Order, monthly progress reports are to be prepared by the 15th day of each month, with the reporting to continue for the duration of the project.

Phase I Site Characterization and Source Control Evaluation Reporting

Results of data submittals related to the most recent investigatory activities completed at the Siltronic property, prepared by Maul, Foster, and Alongi, Inc. (MFA) for Siltronic, were incorporated into revisions of the HAI report entitled *Phase I Site Characterization Report*, dated November 7, 2003 during March 2005.

As requested by DEQ, the locations of hydrogeological cross-sections proposed for inclusion within the updated Site Characterization Report were provided to DEQ in e-mail correspondence dated March 18, 2005 (Rob Ede to Matt McClincy). DEQ forwarded MFA comments on the proposed cross-sections in correspondence dated March 14, 2005 (Matt McClincy to Bob Wyatt and Tom McCue). As per a telephone conversation on March 15, 2005 (Rob Ede to Matt McClincy), modifications to proposed cross-sections were agreed to as follows:

[1] Hahn and Associates, Inc. (2001). *Final Focused Remedial Investigation Work Plan, Wacker Siltronic Corporation Property, 7200 NW Front Avenue, Portland, Oregon.* June 1, 2001.

[2] Hahn and Associates, Inc. (2002). *Supplemental Remedial Investigation Work Plan, Wacker Siltronic Corporation,, 7200 NW Front Avenue, Portland, Oregon.* March 7, 2002.

434 NW 6th AVENUE, SUITE 203 • PORTLAND, OREGON 97209-3651
503-796-0717 Telephone • 503-227-2209 Facsimile

- Section A-A' will be extended to the southwest to incorporate data from borings B-33, B-35, B-28, B-45, B-46, and MW-12.
- Section D-D' will be extended to the southwest to include borings B-100, B-101, and WS-4.
- Section F-F' will be extended to the east to incorporate data from borings B-5-8, and B-102-8.
- Section G-G' will be extended to the east to the RP-06/GP-27 location, with a break in section between the WS-27 location and the RP-06/GP-27 location.
- A new east/west cross-section, including boring locations B-101, WS-1, B-102, B-105, GP-11, WS-2, B-106, WS-3, and W-3-81, will be prepared..

Off-Site Ditch / City of Portland Outfall 22C Evaluation

Laboratory data were received during March 2005 from surface water and sediment sampling activities completed by HAI on February 24, 2005. These sampling activities comprised the "wet season / dry period" sampling event and were conducted on February 24, 2005 in accordance with the March 15, 2004 *Work Plan for Conducting an Off-Site Ditch / City of Portland Outfall 22C*. Data from the February 2005 sampling event were summarized and tabulated in March 2005, with summary tables and a figure depicting sampling locations attached.

Indoor Air Monitoring

Indoor air monitoring activities were conducted at the Siltronic property on January 25, 2005 by representatives of NW Natural in accordance with the revised *Work Plan for Ambient Indoor Air Evaluation, Rev. 1*, dated November 30, 2004. Data validation and report preparation related to these activities were conducted during March 2005.

Anticipated Activities in April and May 2005

With regard to the off-site ditch (North Doane Creek) / City of Portland Outfall 22C evaluation, HAI anticipates completion of the remaining wet season sampling activities (wet period event) during April or early May 2005, with these activities to be conducted as soon as weather trigger conditions as specified in the work plan are satisfied. Data summary tables from the February 2005 sampling event are attached.

With regard to indoor air monitoring for volatile organic compounds, data summary tables from the January 25, 2005 sampling activities were provided to representatives of

Siltronic in e-mail correspondence dated April 5, 2005 (Mark Whitson to Tom McCue), and to DEQ in e-mail correspondence dated April 6, 2005 (Rob Ede to Matt McClincy). A report, describing the sampling activities and discussing the results, is anticipated to be available for submittal to DEQ the week of April 18, 2005.

NW Natural will continue with revisions to the *Phase I Site Characterization Report* during March and April 2005, to include recently obtained results of Siltronic's investigatory activities obtained in February 2005. The updated Phase I Site Characterization Report is anticipated to be available for submittal to DEQ by May 16, 2005.

Should you have any questions, please contact the undersigned.

Sincerely,

Robert Ede, R.G.
Sr. Associate

robe@hahnasoc.com

c: Mr. Bob Wyatt, NW Natural
Ms. Patty Dost, Schwabe, Williamson & Wyatt
Mr. Carl Stivers, Anchor Environmental, L.L.C.
Mr. Tom McCue, Siltronic Corporation

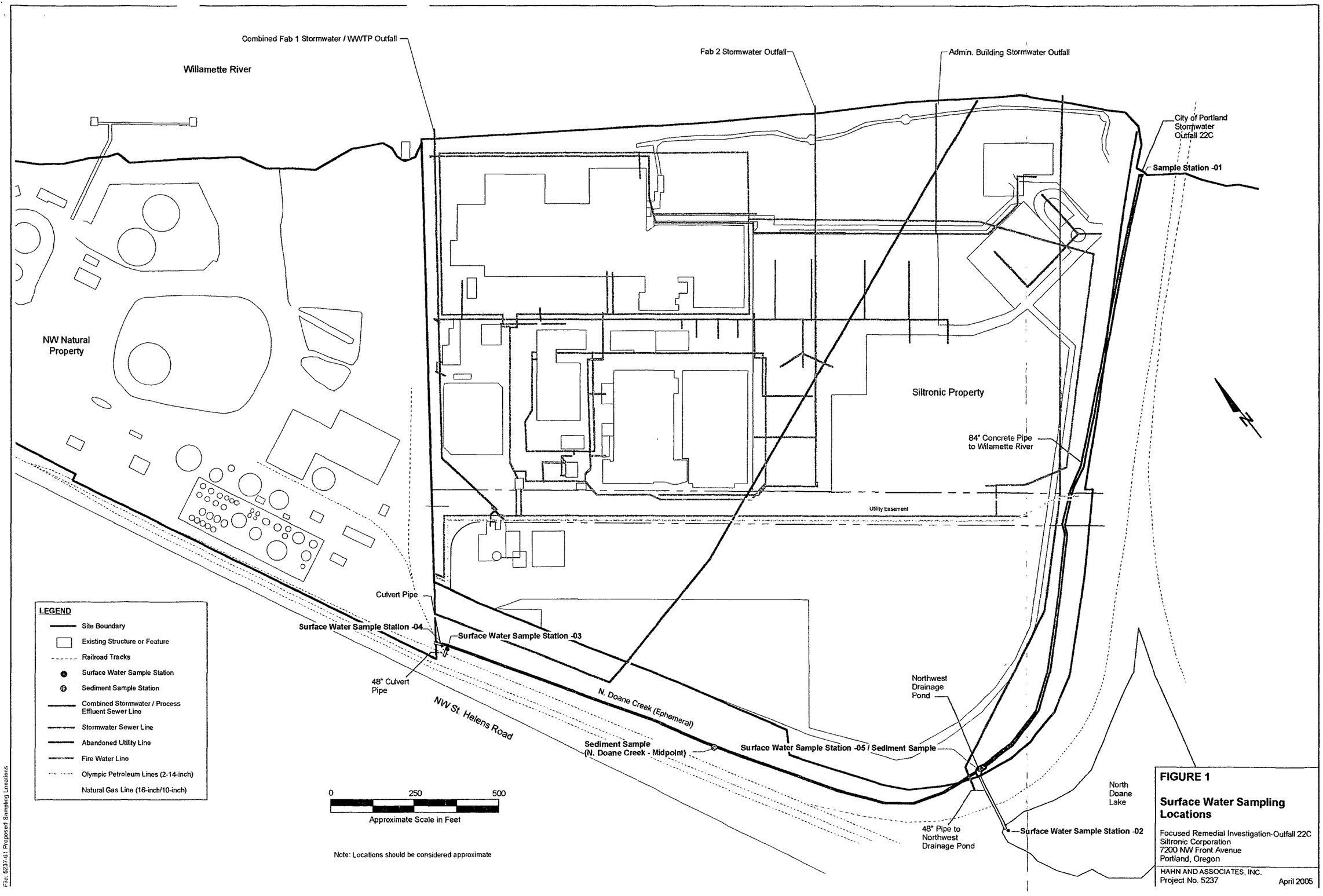

FIGURE 1

Surface Water Sampling Locations

Focused Remedial Investigation-Outfall 22C
Siltronic Corporation
7200 NW Front Avenue
Portland, Oregon

HAHN AND ASSOCIATES, INC.
Project No. 5237 April 2005

File: 5237-01 Proposed Sampling Locations

Koppers022953

TABLE 1 – Summary of Surface Water Testing Results

Analytical Parameters	Laboratory Analytical Testing Results in ug/L (ppb)								Screening Levels[5] in ug/L		
Sample Location ==>	City Outfall 22C (Station -01)			Northwest Drainage Pond (Station-05)		North Doane Lake Outlet (Station-02)	Forest Park Culvert (Station - 03)	Koppers Inc. Culvert (Station - 04)	Ambient Water Quality Criteria[2]	Ambient Water Quality Criteria[2]	DEQ Level II Screening Level[3]
Sample Number ==>	CO-22C-01	5237-05224-100	-05224-101 (DUP)	NDP-101-W	5327-05224-102	5237-05224-103	5237-05224-104	5237-05224-106			
Sampled By [1] ==>	AMEC	HAI	HAI	AMEC	HAI	HAI	HAI	HAI			
Sample Date ==>	13-Aug-02	24-Feb-05	24-Feb-05	13-Aug-02	24-Feb-05	24-Feb-05	24-Feb-05	24-Feb-05	(Human)	(Aquatic-CCC)	Values
General Chemistry by EPA 160.2, 2340B, 300,											
Total Suspended Solids	47,000	-	-	93,000	-	-	-	-	#	#	#
Hardness	290,000	-	-	110,000	-	-	-	-	#	#	#
Chloride	30,800	-	-	14,000	-	-	-	-	#	230,000	#
Cyanide-Total	-	**8.5**	**8.4**	-	5. U	5. U	5. U	**11.5**	220,000	5.2	52
Cyanide-Amenable	-	**6.**	**6.3**	-	5. U	5. U	5. U	**10.7**	220,000	5.2	52
Sulfate	4,710	-	-	1,560	-	-	-	-	#	#	#
Alkalinity	**360,000**	-	-	**160,000**	-	-	-	-	#	20,000	#
Volatile Organic Compounds (VOCs) by EPA 8260B											
Acetone	3.56	25.0 U	-	2.95	25.0 U	25.00 U	25.0 U	25.0 U	#	#	1,500
Benzene	3.15	1.00 U	-	1.47	1.00 U	1.00 U	1.00 U	1.00 U	51	#	130
Chlorobenzene	0.605	1.00 U	-	0.5 U	1.00 U	1.09	1.00 U	1.00 U	21,000	#	50
iso-Propylbenzene	0.577	2.00 U	-	0.5 U	2.00 U	2.00 U	2.00 U	2.00 U	#	#	#
Naphthalene	13.4	2.00 U	-	5.89	2.00 U	2.00 U	2.00 U	2.00 U	#	#	620
Toluene	0.5 U	1.00 U	-	0.563	1.00 U	1.00 U	1.00 U	1.00 U	200,000	#	9.80
All others	U	U	-	U	U	U	U	U	#	#	#
Semi-Volatile Organic Compounds (SVOCs) by EPA 8270C or by EPA 8270M-SIM											
Acenaphthene	32.5	4.15	4.51	9.53	0.109	0.167	0.0100 U	0.0325	990	#	520
Acenapthylene	0.182	0.0296	0.0277	0.0144 U	0.0100 U	0.0100 U	0.0100 U	0.0100 U	#	#	#
Anthracene	0.456	0.0552	0.0514	0.184	0.0348	0.0109 J	0.0100 U	0.0542	40,000	#	13
Benz(a)anthracene	**0.042** U	**0.0195** J	**0.0209**	**0.141**	0.0124 J	0.0109 J	0.0100 U	**0.213**	0.018	#	0.03
Benzo(a)pyrene	U	0.0145 J	**0.0192** J	U	0.0117 J	0.0125 J	0.0100 U	**0.282**	0.018		0.014
Benzo(ghi)perylene	0.033 U	0.0138 J	0.0180 J	0.163	0.0109 J	0.0114 J	0.0100 U	0.231	#	#	#
Benzo(k)flouranthene	U	0.0125 J	0.0157 J	U	0.0100 U	0.0100 U	0.0100 U	**0.210**	0.018		#
Benzo(b)fluoranthene	**0.037** U	0.0167 J	**0.0195** J	**0.453**	0.0130 J	0.0130 J	0.0100 U	**0.278**	0.018	#	#
Chrysene	**0.024** U	**0.0209**	**0.0227**	**0.25**	0.0155 J	0.0139 J	0.0100 U	**0.232**	0.018	#	#
Dibenzofuran	1.72	3.00 U	-	1.01	3.00 U	3.00 U	3.00 U	3.00 U	#	#	3.70
Dibenzo(a, h) anthracene	U	0.0100 U	0.0100 U	U	0.0100 U	0.0100 U	0.0100 U	**0.0726**	0.018		#
Fluoranthene	2.05	0.314	0.2640	1.59	0.0282	0.0318	0.0100 U	0.346	140	#	6.16
Fluorene	**6.26**	0.812	0.7410	1.16	0.0359	0.0654	0.0100 U	0.0198 J	5,300	#	3.90
Indeno(1,2,3-cd)pyrene	**0.029** U	0.0122 J	0.0159 J	**0.136**	0.0100 U	0.0100 U	0.0100 U	**0.201**	0.018	#	#
Naphthalene	0.688	0.281	0.2590	0.0211 U	0.0964	0.688	0.0200 U	0.0200 U	#	#	620
Phenanthrene	0.243	0.0476	0.0458	0.0211 U	0.0336	0.0447	0.0100 U	0.135	#	#	6.30
Pyrene	2.03	0.265	0.2720	1.57	0.0269	0.0293	0.0200 U	0.299	4,000	#	#
All others	U	U	U	U	U	U	U	U	#	#	#

Koppers022954

TABLE 1 – Summary of Surface Water Testing Results

Analytical Parameters	Laboratory Analytical Testing Results in ug/L (ppb)								Screening Levels[5] in ug/L		
Sample Location ==>	City Outfall 22C (Station -01)			Northwest Drainage Pond (Station-05)		North Doane Lake Outlet (Station-02)	Forest Park Culvert (Station - 03)	Koppers Inc. Culvert (Station - 04)	Ambient Water Quality Criteria[2]	Ambient Water Quality Criteria[2]	DEQ Level II Screening Level[3]
Sample Number ==>	CO-22C-01	5237-05224-100	-05224-101 (DUP)	NDP-101-W	5327-05224-102	5237-05224-103	5237-05224-104	5237-05224-106			
Sampled By [1] ==>	AMEC	HAI	HAI	AMEC	HAI	HAI	HAI	HAI			
Sample Date ==>	13-Aug-02	24-Feb-05	24-Feb-05	13-Aug-02	24-Feb-05	24-Feb-05	24-Feb-05	24-Feb-05	(Human)	(Aquatic-CCC)	Values
Total Metals by EPA 6010 or 6020											
Antimony	-	1.00 U	1.00 U	-	1.00 U	1.00 U	1.00 U	1.00 U	640	#	1,600
Arsenic	**1.14** J	1.00 U	1.00 U	**11.60** J	1.00 U	**1.02**	1.00 U	1.00 U	0.14	150	150
Aluminum	9.00 U	-	-	**1,780**	-	-	-	-	#	#	87
Barium	**56.90**	**20.8**	**20.3**	**96.40**	**12.3**	**21.40**	**7.42**	**28.20**	1,000	#	4.00
Boron	**73.70**	-	-	**121**	-	-	-	-	#	#	1.60
Cadmium[4]	0.01 U	1.00 U	1.00 U	0.016	1.00 U	1.00 U	1.00 U	1.00 U	#	0.09	2.20
Calcium	70,800	-	-	27,200	-	-	-	-	#	#	116,000
Chromium	0.04 U	1.00	1.00 U	4.04	1.00 U	1.00 U	1.00 U	1.00 U	#	11.00	11
Cobalt	2.74	-	-	9.52	-	-	-	-	#	#	23.0
Copper[4]	**45.00**	2.00 U	2.00 U	**11.10**	2.00 U	2.00 U	2.00 U	2.00 U	1,300	2.70	9.0
Iron	**19,100**	**3,230**	**3,180**	**22,300**	**648**	**1,180**	**458**	**653**	300	1,000	1,000
Lead[4]	0.082 U	1.00 U	1.00 U	**5.20**	1.00 U	**1.19**	1.00 U	1.00 U	#	0.54	2.50
Magnesium	26,700	-	-	9,380	-	-	-	-	#	#	82,000
Manganese	**3,470**	**341**	**340**	**2,660**	62.6	**192**	4.31	**675**	100	#	120
Mercury	-	0.200 U	0.200 U	-	0.200 U	0.200 U	0.200 U	0.200 U	#	0.77	0.012
Molybdenum	13.60	-	-	44.10	-	-	-	-	#	#	370
Nickel[4]	2.23	2.00 U	-	4.41	2.00 U	2.00 U	2.00 U	2.00 U	4,600	16.10	52
Potassium	4,770	-	-	2,270	-	-	-	-	#	#	53,000
Selenium	-	2.00 U	2.00 U	-	2.00 U	2.00 U	2.00 U	2.00 U	4,200	5.0	35
Silicon Dioxide	42,600	-	-	35,400	-	-	-	-	#	#	#
Silver	**1.18**	1.00 U	1.00 U	0.80 U	1.00 U	1.00 U	1.00 U	1.00 U	#	3.20	0.12
Sodium	36,100	-	-	25,300	-	-	-	-	#	#	680,000
Thallium	-	1.00 U	1.00 U	-	1.00 U	1.00 U	1.00 U	1.00 U	6.30	#	40
Vanadium	0.73 U	5.00 U	5.00 U	21 J	5.00 U	5.00 U	5.00 U	5.00 U	#	#	20
Zinc[4]	7.64 U	-	-	**345**	-	-	-	-	26,000	36.50	120

Note: 1 = AMEC Earth & Environmental, Inc., *Remaining Remedial Investigation Technical Memorandum, RPAC-Portland Site,* February 4, 2003.
2 = Lowest value provided in the Ambient Water Quality Criteria (EPA 822-R-02-047, November 2002) based on Fresh Acute, Fresh Cronic (Aquatic Life Protection) and Fish Consumption Only (Human Health) Pathway.
3 = Where no AWQC are available, DEQ Level II Screening Level Values for Ecological Risk Assessment were used, Revised December 2001.
4 = AWQC adjusted based on a hardness of 25 parts per million.
5 = Screening levels are used for comparative purposes only.

Bold = Concentration exceeds Reference Level
AWQC = Ambient Water Quality Criteria
DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
J = estimated concentration
ppb = parts per billion
U = not detected above concentration indicated
ug/l = micrograms/liter
= Reference Level not established

Koppers022955

TABLE 2 – Summary of Surface Sediment Testing Results

Analytical Parameters	Laboratory Analytical Testing Results				Screening Levels[2]
Sample Location ==>	Northwest Drainage Pond		North Doane Creek - Midpoint		DEQ Level II
Sample Number ==>	5327-05224-01		5327-05224-02		Screening
Sampled By ==>	HAI		HAI		Level[1]
Sample Date ==>	24-Feb-05		24-Feb-05		Values
Cyanide by EPA 9010A or 9010B in mg/kg					
Cyanide (amenable)	0.227	U	0.227	U	#
Cyanide (total)	0.227	U	0.227	U	#
Total Mercury by EPA 7471A in mg/kg					
Semivolatile Organic Compounds (SVOCs) by EPA 8270M-SIM or 8270C in Mg/kg					
Acenaphthene	**1.85**		0.134	U	0.33
Acenapthylene	0.268	U	0.134	U	0.33
Anthracene	**2.78**		0.134	U	0.032
Benz(a)anthracene	**1.66**		0.168		0.26
Benzo(a)pyrene	**1.29**		0.243		0.35
Benzo(ghi)perylene	**0.814**		0.197		0.29
Benzo(b)fluoranthene	1.31		0.243		#
Benzo(k)floranthene	**1.12**		0.189		0.24
Carbazole	**0.668**	J	0.139	U	0.14
Chrysene	**1.94**		0.207		0.5
Dibenzofuran	0.981	J	0.139	U	0.42
Dibenzo(a, h) anthracene	0.268	U	0.134	U	0.23
Fluoranthene	**4.43**		**0.244**		0.064
Fluorene	**2.64**		0.134	U	0.034
Indeno(1,2,3-cd)pyrene	**0.714**		**0.167**		0.078
Naphthalene	0.268	U	0.134	U	0.032
Phenanthrene	**6.05**		0.134	U	0.56
Pyrene	**3.66**		0.249		0.57
All Others		U		U	#
Total Metals by EPA 6010 or 6020 or 7471A in mg/kg					
Antimony	1.53		0.500	U	3.
Arsenic	5.45		0.500	U	12.
Barium	126		84.8		#
Cadmium	**2.45**	U	0.500	U	0.6
Chromium	21.1		4.10		56.
Copper	27.6		8.12		28.
Iron	26,400		20,200		#
Lead	**34.7**		7.39		34.
Manganese	452		578		1,600.
Mercury	0.0481	U	0.0532	U	0.56
Nickel	14.2		3.89		39.6
Selenium	0.500	U	0.500	U	#
Silver	0.500	U	0.500	U	4.5
Thallium	0.500	U	0.500	U	#
Vanadium	84.0		42.9		#

Note:

1 = DEQ Level II Screening Level Values for Ecological Risk Assessment, Revised December 2001.
2 = Screening levels are used for comparative purposes only.

Bold = Concentration exceeds Reference Level
DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
J = estimated concentration
ppm = parts per million
U = not detected above concentration indicated
mg/kg = milligram per kilogram
= Reference Level not established

KOPPERS INDUSTRIES

file Northwest / RA Analyses

INTEROFFICE CORRESPONDENCE

To: Larry Flaherty

From: John A. Oxford

Location: K-1750

Location: Portland Plant

Subject: Soil Sample

Date: July 30, 1992

Dear Larry:

Per your instructions and in conjunction with instructions from William Swearingen a soil sample from the building site for the new pitch storage building, was taken and submitted for analysis. This sample was given to Coffey Lab in Portland (a D.E.Q. Registered Lab) for T.C.L.P. and Characteristic Analysis. Results of sample show no detectible components for Pesticide or Organics. The only result was on the metals test, it showed a result of Barium in the amount of 0.4 P.P.M., the allowable amount is 100 P.P.M. for this element. yes!

I assume that this good news will allow us to proceed with our construction plans. A copy of the results will be sent to William Swearingen as soon as they are received.

Regards,

John

C.C. A. Kamerer Western Region
E. Bennett K-2050
W. Swearingen K-1800
W. Turner K-1600

Post-it™ brand fax transmittal memo 7671 | # of pages ▸ 1

To W Swearingen	From John
Co. K-1800	Co. Portland
Dept.	Phone #
Fax #	Fax #

7/31/92

Post-It™ brand fax transmittal memo 7671 | # of pages ▸ 3

To Wm Swearingen	From John Oxford
Co. K-1800	Co. Portland
Dept.	Phone #
Fax #	Fax #

Report Date: July 30, 1992
Job#: GE-920717N-1
PO#: VERBAL JOHN
Project#: None
Project: None

Attention: John Oxford
Koppers Industry
7540 NW St. Helens Rd.
Portland, OR 97210

SAMPLE INFORMATION:
Date Samples Were Received By Laboratory: 07/17/92

Lab No.	Field Identification	Sample Matrix	Date	Time
1	Building Site	Soil	07-17-92	1000

ANALYTICAL RESULTS ARE ON THE FOLLOWING PAGE(S)

Sincerely,

Renee Chauvin
Technical Director

RJC/mlh

This report is for the sole and exclusive use of the above-named client. Samples are retained 15 days from the report date, or until holding time expires. Results pertain only to samples submitted.

Job#: GE-920717N-1

Koppers Industry
Page 2

SUBJECT: TCLP Analysis

Sample ID: Building Site

ANALYTE	METHOD	DETECTION LIMIT	SAMPLE RESULTS	EPA LIMIT
Arsenic	*	0.8	ND	5.0
Barium	*	0.1	0.4	100
Cadmium	*	0.1	ND	1.0
Chromium	*	0.1	ND	5.0
Lead	*	0.4	ND	5.0
Mercury	*, 7470	0.05	ND	0.2
Selenium	*	0.8	ND	1.0
Silver	*	0.1	ND	5.0

* Leachate preparation by EPA SW-846 Method 1311. Analysis by EPA SW-846 Method 6010, ICP, unless otherwise noted.

Analysis Performed: Volatile organics in TCLP extract, by EPA Methods 8010/8020, GC/PID/HED.

ANALYTE	DETECTION LIMIT	LABORATORY BLANK	SAMPLE RESULTS	EPA LIMIT
Benzene	0.05	ND	ND	0.5
Carbon tetrachloride	0.05	ND	ND	0.5
Chlorobenzene	0.05	ND	ND	100
Chloroform	0.05	ND	ND	6.0
1,4-Dichlorobenzene	0.05	ND	ND	7.5
1,2-Dichloroethane	0.05	ND	ND	0.5
1,1-Dichloroethylene	0.05	ND	ND	0.7
Methyl ethyl ketone	0.50	ND	ND	200
Tetrachloroethylene	0.05	ND	ND	0.7
Trichloroethylene	0.05	ND	ND	0.5
Vinyl chloride	0.20	ND	ND	0.2

Results expressed as mg/L unless otherwise noted.

ND means none detected at or above the detection limit listed.

REPORT CONTINUES

Job#: GE-920717N-1

Koppers Industry
Page 3

Analysis Performed: Chlorinated semi-volatile organics in TCLP extract, by modified EPA Methods 8080/8150, GC/ECD

Sample ID: Building Site

ANALYTE	DETECTION LIMIT	LABORATORY BLANK	SAMPLE RESULTS	EPA LIMITS
Chlordane	0.03	ND	ND	0.03
Heptachlor	0.001	ND	ND	0.008
Hexachlorobenzene	0.001	ND	ND	0.13
Hexachloro-1,3-butadiene	0.02	ND	ND	0.5
Hexachloroethane	0.02	ND	ND	3.0
Endrin	0.004	ND	ND	0.02
Lindane	0.004	ND	ND	0.4
Methoxychlor	0.02	ND	ND	10.0
2,4-D	0.02	ND	ND	10.0
2,4,5-TP	0.02	ND	ND	1.0
Toxaphene	0.03	ND	ND	0.5

Results expressed as mg/L unless otherwise noted.

ND means none detected at or above the detection limit listed.

Analysis Performed: Phenols and miscellaneous semi-volatile organics in TCLP extract, by modified EPA Method 8040, GC/FID

ANALYTE	DETECTION LIMIT	LABORATORY BLANK	SAMPLE RESULTS	EPA LIMITS
m-Cresol	5.0	ND	ND	200
o/p Cresol	5.0	ND	ND	200
2,4-Dinitrotoluene	0.1	ND	ND	0.13
Nitrobenzene	0.1	ND	ND	2.0
Pentachlorophenol	5.0	ND	ND	100
Pyridine	1.0	ND	ND	5.0
2,4,5-Trichlorophenol	5.0	ND	ND	400
2,4,6-Trichlorophenol	0.2	ND	ND	2.0

Results expressed as mg/L unless otherwise noted.

ND means none detected at or above the detection limit listed.

ENVIRONMENTAL MONITORING REPORT
Third and Fourth Quarter 2005

NW Natural
Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

April 28, 2006

Prepared for:

NW Natural
Portland, Oregon

Prepared by:

Hahn and Associates, Inc.
Portland, Oregon

HAI Project No. 2708

CD to
Kuhesaurcen
8-25-06

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PROGRESS REPORT FOR FIRST HALF 2003 RI / FS ACTIVITIES

NW Natural
Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

November 21, 2003

HAHN AND ASSOCIATES, INC.
Environmental Consultants

434 NW 6th Avenue, Suite 203
Portland, Oregon 97209-3651
503/796-0717 • 503/227-2209 FAX

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Letter of Transmittal

To: Mr. ~~Amos~~ Kamerer TRAN self
Koppers Industries, Inc.
7540 NW St. Helens Road
Portland, Oregon 97210

From: Mr. Robert Ede, R.G.
Hahn and Associates, Inc.
434 NW Sixth Avenue, Suite 203
Portland, Oregon 97209

Date: February 23, 2004

HAI Project No. 2708

Re: Groundwater Monitoring Data and Report

We are sending the following items:

Copies	Description
1	Hahn and Associates, Inc. (2003). Progress Report for First Half 2003 RI / FS Activities, NW Natural – Gasco Facility, 7900 NW St. Helens Road, Portland, Oregon November 21, 2003.

These are transmitted:

For your information.

Comments:

PROGRESS REPORT FOR
FIRST HALF 2003
RI / FS ACTIVITIES

NW Natural
Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

November 21, 2003

Prepared for:

NW Natural
Portland, Oregon

Prepared by:

Hahn and Associates, Inc.
Portland, Oregon

HAI Project No. 2708

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1.0 INTRODUCTION

At the request of NW Natural, Hahn and Associates, Inc. (HAI) has prepared this Progress Report summarizing Remedial Investigation/Feasibility Study (RI/FS) work activities that have occurred at the NW Natural, Gasco facility (Figures 1 and 2) during the first half of 2003. This Progress Report has been prepared as per the Agreement for RI/FS (DEQ No. ECVC-WMCVC-NWR-94-13) between NW Natural and the Oregon Department of Environmental Quality (DEQ). This report provides a description of Remedial Investigation (RI) activities for the site that occurred during the months of January through June 2003, and provides a description of primary activities anticipated to occur through December 2003.

2.0 GROUNDWATER MONITORING ACTIVITIES

2.1 Water Level Monitoring

On March 17, 2003, and June 2, 2003, static water levels were collected from all monitoring wells at the site. All monitoring well measurements were collected with an electric water level indicator (conductive probe). A summary of all well elevations collected to date is included in Table 1.

Contoured groundwater elevation maps, depicting the Surficial Fill Water Bearing Zone (WBZ), as well as the intermediate and deep intervals of the Alluvial WBZ for the March and June monitoring events, are provided as Figures 3 through 8. Additionally, groundwater elevation hydrographs for all wells at the Gasco site are provided in Appendix A.

2.1.1 Surficial Fill Water Bearing Zone

As depicted in Figures 3 and 6, the interpreted groundwater flow direction within the Surficial Fill (shallow zone) WBZ was found to be to the north/northeast towards the Willamette River, with an average calculated hydraulic gradient of 0.013 for both the March and June 2003 monitoring events. This interpreted flow direction and gradient is consistent with historical interpretations.

2.1.2 *Alluvial Water Bearing Zone*

As depicted in Figures 4 and 7, overall groundwater flow direction within the intermediate depth Alluvial WBZ during March and June 2003 was northeast towards the Willamette River, with a flattening of the gradient within 300 feet of the riverbank. Specifically, hydraulic gradients of 0.020 and 0.016 (toward the river) were calculated for the central portion of the site during March and June, respectively. Gradients ranging from zero to 0.0012 (toward the river) were calculated along the shoreline for the portion of the site located within 300 feet of the river in March, while gradients ranging from 0.0002 and 0.0005 (toward the river) were measured for the same area in June 2003.

As depicted in Figures 5 and 8, overall groundwater flow direction within the deep Alluvial WBZ was found to be to the northeast towards the Willamette River, with an average hydraulic gradient of 0.0096 (March 2003) and 0.0068 (June 2003), as measured between wells MW-14-110 and MW-4-101.

Groundwater elevation data collected in March 2003 indicates a downward hydraulic potential between the perched Surficial Fill WBZ and the underlying Alluvial WBZ across the site, with the downward vertical gradient (potential) ranging from a low of 0.024 (wells MW-4-35 to MW-4-57) to a high of 0.325 (MW-8-29 to MW-8-56). Further, a slight downward hydraulic gradient of 0.0039 was present between intermediate-depth well MW-4-57 and deep well MW-4-101 within the Alluvial WBZ in March 2003, while a slight upward hydraulic gradient of -0.0011 was present between deep Alluvial WBZ wells MW-5-175 and MW-5-100 in March 2003.

Groundwater elevation data collected in June 2003 indicates a downward hydraulic potential between the perched Surficial Fill WBZ and the underlying Alluvial WBZ at a majority of locations across the site, with the downward vertical gradient (potential) ranging from a low of 0.0055 (wells MW-2-32 to MW-2-61) to a high of 0.229 (MW-8-29 to MW-8-56). A slight upward hydraulic gradient of -0.0027 was present between the Alluvial WBZ and the Surficial Fill WBZ as measured at wells MW-4-57 and MW-4-35. Further, a slight a slight upward gradient of -0.0018 was present at the same location across the upper Alluvial WBZ as measured between wells MW-4-101 and MW-4-57. Finally, a slight a slight upward gradient of –0.0012 was present between deep Alluvial Sand WBZ wells MW-5-175 and MW-5-100 in June 2003.

In summary, the preceding groundwater elevation data indicates that groundwater flow direction, as well as horizontal and vertical gradients measured during the March and June 2003 groundwater monitoring events, were found to be consistent with previous flow directions and gradients measured at the site.

2.2 Groundwater Sampling

First and second quarter groundwater monitoring events for monitoring wells at Gasco were initiated on March 17, 2003, and June 2, 2003, respectively. Fifteen wells were sampled during the March 2003 event, while three wells were sampled during the June 2003 sampling event. All groundwater sampling activities were completed in accordance with the DEQ-approved Groundwater Monitoring Plan dated September 27, 2001.

All sampling activities (March and June 2003) were completed with an electric submersible stainless steel pump in accordance with procedures outlined within the Final RI/FS Work Plan .

All groundwater samples were shipped to Environmental Services Laboratory, Inc. (ESL), in Portland, Oregon, and were analyzed in accordance with specifications provided in the approved groundwater monitoring plan.

A summary of analytical results from the March 2003 sampling event is included as Tables 2a through 2c, while a summary of analytical results from the June 2003 sampling event is included as Tables 3a through 3c. All historical water quality data for the site are included as Tables 4a through 4c. The laboratory reports and chain-of-custody documentation for the March 2003 and June 2003 sampling events are included in Appendices F and G, respectively.

Field data sheets that document sampling activities at each monitoring well during the March 2003 and June 2003 sampling events (including well purging and groundwater quality indicator measurements) are included in Appendices D and E, respectively.

Graphs showing benzene and total polynuclear aromatic hydrocarbon (PAH) concentrations in groundwater through time at the well locations sampled in March and June 2003 are included in Appendices D and E, respectively.

As summarized in Table 2c (March 2003 event), an equipment blank collected by passing laboratory-supplied deionized water through the decontaminated pump prior to sampling well MW-8-56 resulted in the identification of phenanthrene. The phenanthrene concentration identified in the equipment blank (0.14 µg/l) was lower than the concentration identified at well MW-8-56 (77 µg/l), as such it does not appear that the usability of the data are adversely impacted from possible pump-related influences.

As summarized in Table 3c (June 2003 event), an equipment blank collected by passing laboratory-supplied deionized water through the decontaminated pump prior to sampling well MW-15-66 resulted in the identification of naphthalene (0.25 µg/l), benzene (1.2 µg/l), and toluene (3.9 µg/l). Toluene and naphthalene were not identified in the sample subsequently collected from well MW-15-66, while benzene was identified at a higher concentration (31 µg/l). Based on the preceding, it does not appear the usability of the data from well MW-15-66 received significant adverse impacts from possible pump-related influences.

Based on the previous contaminant detections within equipment blanks during the preceding two monitoring events, corrective action activities in the form of disposal and re-stocking of HAI's supply of deionized water were completed. This action was taken due to the possibility that the integrity of HAI's deionized water supply had been compromised, thereby biasing the results of the equipment blank sampling.

3.0 FREE PRODUCT RECOVERY SYSTEM

Dense non-aqueous phase liquid (DNAPL), composed of oil tar, has been observed at the base of three monitoring wells at the Gasco site (MW-6-32, MW-10-25, MW-11-32) with typical overall thicknesses ranging from approximately 6 to 10 feet at MW-6-32, and from 0 to 2 feet at MW-10-25 and MW-11-32.

As described in a January 2001 DNAPL Recovery System Report, DNAPL recovery was initiated at well MW-6-32 in August 2000. Between August 10,

2000 through May 9, 2001, the DNAPL Recovery System was set to cycle on every 8 hours for 5 minutes of pumping, at an approximate pumping rate of between 0.05 and 0.1 gallon per minute (head dependent). Due to several problems with clogs within the product line, a screen was placed over the pump intake on April 27, 2001. This screen is meant to prevent large particulates or clumps of more viscous DNAPL from entering the pump and tubing, thereby preventing the future occurrence of clogging. At the time of screen placement, approximately 7 feet of DNAPL was measured within the base of the well, consistent with historical DNAPL thicknesses.

A large decrease in recovery rate was noted subsequent to the April 27, 2001 screen installation, with the new recovery rate measured at approximately 0.025 gallons per minute (gpm). Based on the preceding, on May 2, 2001 the pumping cycle duration was re-set for 10 minutes, with recovery of product found to occur throughout the entire cycle duration. Due to the slow pumping rate, and to the observed DNAPL recovery for the duration of each cycle, on May 9, 2001 the number of cycles per day was increased from 3 (every 8 hours) to 6 (every 4 hours). Theoretically, this new pumping scheme should provide for the recovery of approximately 1.5 gallons of DNAPL per day, a volume equivalent to the maximum estimated DNAPL recovery volume prior to the flow rate reduction.

DNAPL recovery volume is determined during each routine check of the recovery system by physically measuring the depth of liquid in the product storage tank with the use of a calibrated (in gallons) gauging stick. As of July 9, 2003, approximately 495 gallons of liquid, primarily composed of DNAPL (estimated at 90%, based on previous observations), have been recovered, with a total system operational time of 1,205 hours. Table 5 provides a summary of pump settings and volume of DNAPL recovered through time, while a chart depicting cumulative product recovery from the well is included as Figure 9.

On January 28, 2003, Spencer Environmental, Inc. (Spencer) of Portland, Oregon pumped 467 gallons of liquid from the DNAPL storage AST for re-refining. An invoice and a Certificate of Treatment, documenting Spencer's transport and recycling of the liquids from the DNAPL recovery system AST, are included herein in Appendix H.

Based on total system operation time and volume of liquid recovered between December 16, 2002 and July 9, 2003 an average recovery rate of

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0.14 gallons per day (pumping a total of one hour per day) was achieved during this timeframe. This recovery rate is a decrease from a 0.25 gallons per day average recovery rate for 2002.

An increase in number of cycles per day (from 6 to 12) will be evaluated in October 2003 in an effort to determine whether an increase to the currently declining DNAPL daily recovery rate is possible.

In addition to the above-described DNAPL recovery activities, an evaluation to ascertain the presence or absence of light or dense free phase liquid product within all wells was completed during the months of March and June 2003. The evaluation for light non-aqueous phase liquid (LNAPL) and for DNAPL was conducted by lowering a Waterra HS-1 Hydrocarbon Interface Sensor probe to the base of each evaluated well. The probe emits a steady signal upon encountering petroleum hydrocarbon product. Results of the above-described investigation did not indicate the presence of free product in any of the wells. It is noted that this evaluation did not include wells MW-6-32, MW-10-25, or MW-11-32, where DNAPL has previously been confirmed present.

4.0 WEATHER STATION MONITORING

Beginning December 16, 2001, weather parameters (wind speed, wind direction, outside temperature, and precipitation) have been collected at the Gasco site on a one-half hour basis (through February 2002) to an hourly basis (March 2002 to present) at a weather station mounted in the vicinity of the carbon treatment unit west of the former tar pond area. Daily and monthly summaries of weather data collected during the first half of 2003 are included in Appendix I. Additionally, a monthly summary of rainfall, average wind speed, and dominant wind direction, based on all data collected to date, is included as Table 6.

As indicated on the weather summary reports (Appendix I), and as included on Table 6, several gaps in data collection have occurred since start-up of the weather station. These data gaps have been attributed to brief power losses to the system which resulted in system resets and loss of data.

Corrective measures have since been implemented to prevent disconnection of the unit's power cord and to incorporate a back-up power supply into the weather station data recorder.

Weather station monitoring data collected to date indicate wind speeds at the site ranging from a monthly average low of 1.7 miles per hour (October 2002) to an monthly average high of 4.5 miles per hour (December 2001). Although the partial nature of the data set make interpretation difficult, to date it appears the predominant wind direction in late Winter and early Spring (December through March) is north, while the remainder of the year the predominant wind direction is south and southeast (Table 6).

Figure 10 presents a graph depicting the frequency of occurrence of wind direction at the Gasco as measured during each hourly monitoring event since March 15, 2002. As depicted on Figure 10, wind direction towards the southeastern quadrant (up-river) predominate during the monitoring period, with a northern wind direction being secondary.

5.0 RIVERFRONT INSPECTIONS

Weekly river surface inspections and monthly shoreline inspections at the Gasco site were conducted throughout the majority of 1998 and all of 1999. Because river and shoreline conditions were well documented at the site on a monthly basis throughout two overall seasonal cycles, the schedule for riverfront inspections (river surface and shoreline) was revised to a quarterly frequency. The shoreline / riverfront inspection for the First Quarter of 2003 was unintentionally omitted due to a scheduling oversight. The shoreline / riverfront inspection for the Second Quarter of 2003 was conducted by HAI on May 22, 2003. Results of this inspection did not result in the identification of any non-routine items. The shoreline inspection report is provided in Appendix J.

6.0 DOCUMENT SUBMITTAL AND RECEIPT

The following documents pertaining to RI activities at the subject site were received fro, or transmitted to, DEQ during the first half of 2003:

- Correspondence dated January 22, 2003 (Mr. Michael Rosen to Mr. Bob Wyatt) providing DEQ comments / summary of status concerning the RI and Risk Assessment, bank stabilization, the Basalt WBZ, the potential Former Tar Pond Area Removal Action, and Source Control.

- Correspondence dated February 21, 2003 (Mr. Bob Wyatt to Mr. Michael Rosen) responding to DEQ's correspondence dated January 22, 2003

- Correspondence dated April 7, 2002 (Mr. Matt McClincy to Mr. Bob Wyatt and Ms. Cathryn Young) providing notice regarding a switch in the DEQ Project Manager (from Mr. Eric Blischke to Mr. Matt McClincy) for the Gasco and Wacker Siltronic projects.

- *Progress Report for Second Half 2002 Remedial Investigation / Feasibility Study (RI / FS), NW Natural – Gasco Facility, 7900 NW St. Helens Road, Portland, Oregon*, Hahn and Associates, Inc. (April 30, 2003)

- Correspondence dated June 3, 2003 (Mr. Matt McClincy to Mr. Bob Wyatt) providing approval of the schedule for submittal of the draft human health and ecological risk assessments, the bank stabilization scoping document, and the removal action decision scoping document for the former tar pond area.

- *Removal Action Decision Scoping Document, Former Tar Pond Area, NW Natural – Gasco Facility,* 7900 NW St. Helens Road, Portland, Oregon, Hahn and Associates, Inc. (June 30, 2003)

- *Bank Stabilization Alternatives Analysis, Northwest Natural "Gasco" Site*, Anchor Environmental, L.L.C. (June 2003)

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- *Baseline Level III Ecological and Human Health Risk Assessment Report, Northwest Natural "Gasco" Site*, Anchor Environmental, L.L.C. (June 2003)

7.0 ANTICIPATED / COMPLETED ACTIVITIES IN SECOND HALF 2003

During the second half of 2003, the following project-related activities are anticipated to be, or have already been, completed:

- The shoreline inspection for the Third Quarter of 2003 was completed by HAI in August 2003. The Fourth Quarter shoreline inspection is anticipated to occur in December 2003.

- Groundwater monitoring events at the site are scheduled for completion by HAI during September and December 2003, respectively. These sampling events will include select wells across the site. All monitoring activities will be as provided within the approved Groundwater Monitoring Plan dated September 27, 2001.

- With regard to the DNAPL extraction system, an increase in number of cycles per day (from 6 to 12) of pump operation will be evaluated in October 2003 in an effort to determine whether an increase to the daily DNAPL recovery rate is feasible. The new recovery schedule would result in 2 hours of pump operation a day, occurring at 10 minute intervals every 2 hours.

- Results of the United Soil Recycling, Inc. (USR), M-1 Technology thermal desorption pilot test, conducted on contaminated soils at the Gasco site, will be submitted to the DEQ.

- A meeting with DEQ and representatives of NW Natural is anticipated in order to review and discuss risk assessment, bank stabilization, and the potential site re-development / removal action for the former tar pond area.

8.0 LIMITATIONS AND SIGNATURES

The information presented in this report was collected, analyzed, and interpreted following the standards of care, skill, and diligence ordinarily provided by a professional in the performance of similar services as of the time the services were performed. This report and the conclusions and/or recommendations contained in it are based solely upon research and/or observations, and physical sampling and analytical activities, if any, that were conducted at the Client's request.

The information presented in this report is based only upon activities witnessed by HAI or its contractors, and/or upon information provided to HAI by the Client and/or its contractors. The analytical data presented in this report, if any, document only the concentrations of the target analytes in the particular sample, and not the property as a whole.

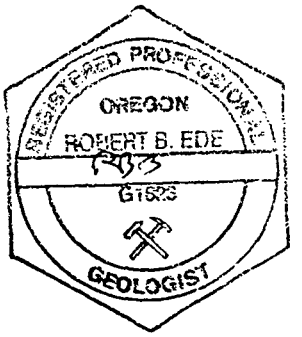
Unless otherwise specified in writing, this report has been prepared solely for the use by the Client and for use only in connection with the evaluation of the subject property. Any other use by the Client or any use by any other person shall be at the user's sole risk, and HAI shall have neither liability nor responsibility with respect to such use.

Hahn and Associates, Inc.

Prepared by:

Robert Ede, R.G.
Associate

Date 11-24-2003



9.0 GLOSSARY OF ABBREVIATIONS

DEQ	Oregon Department of Environmental Quality
DNAPL	dense non-aqueous phase liquid
ESL	Environmental Services Laboratory
gpm	gallons per minute
HAI	Hahn and Associates, Inc.
LNAPL	light non-aqueous phase liquid
PAHs	polynuclear aromatic hydrocarbons
RI/FS	Remedial Investigation / Feasibility Study
Spencer	Spencer Environmental, Inc.
WBZ	water-bearing zone
µg/l	micrograms per liter

TABLES

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TABLE 1 - Summary of Water Level Measurements and Groundwater Elevations

Elevation of Top of Casing

Date of Elevation Survey	Elevation of Top of Casing (feet msl)*																								River Benchmark (feet msl)**
	MW-1-22	MW-2-32	MW-2-61	MW-3-26	MW-3-56	MW-4-35	MW-4-57	MW-4-101	MW-5-32	MW-5-100	MW-5-175	MW-6-32	MW-6-61	MW-8-29	MW-8-56	MW-9-29	MW-10-25	MW-10-61	MW-11-32	MW-12-36	MW-13-30	MW-13-61	MW-14-110	MW-15-50	MW-15-66	
7-Dec-95	34.75	34.46	34.41	34.11	34.07	34.54	34.53	34.36	27.83	27.31	27.19	35.51	34.50	39.09	39.13	37.65	39.22	39.33	38.39	38.69	34.86	34.78	37.41	35.97[1]	36.06[1]	32.12

Measured Water Level

Date Measured	Measured Water Level (feet btc)																								River Level (feet bbm)
	MW-1-22	MW-2-32	MW-2-61	MW-3-26	MW-3-56	MW-4-35	MW-4-57	MW-4-101	MW-5-32	MW-5-100	MW-5-175	MW-6-32	MW-6-61	MW-8-29	MW-8-56	MW-9-29	MW-10-25	MW-10-61	MW-11-32	MW-12-36	MW-13-30	MW-13-61	MW-14-110	MW-15-50	MW-15-66	
5-Dec-95	14.15	15.23	-	15.58	15.79	16.12	16.39	-	9.46	-	-	16.71	15.77	19.75	20.61	6.20	14.98	13.42	12.69	9.37	-	-	-	-	-	-
5-Jan-96	14.47	20.04	-	19.47	21.85	22.47	22.38	-	15.57	-	-	14.84	21.58	19.01	26.74	7.33	15.20	16.32	12.19	10.82	-	-	-	-	-	-
12-Feb-96	7.74	8.61	-	8.52	8.63	9.09	9.10	-	2.41	-	-	9.55	8.97	16.99	13.56	3.32	11.11	8.92	8.95	5.27	-	-	-	-	-	-
18-Mar-96	12.44	18.03	-	17.87	19.66	20.24	20.21	-	13.37	-	-	12.10	19.39	15.22	24.54	6.13	11.95	14.47	9.42	9.01	-	-	-	-	-	-
16-Apr-96	13.65	18.83	-	18.13	19.47	20.26	20.07	-	13.36	-	-	13.42	19.51	15.58	24.44	6.93	12.63	15.07	10.12	9.69	-	-	-	-	-	-
10-May-96	13.75	19.47	-	18.98	22.01	22.58	22.60	-	15.78	-	-	13.30	21.55	15.77	26.93	6.94	12.98	15.90	10.40	10.24	-	-	-	-	-	-
17-Jun-96	13.88	17.40	-	17.40	18.21	18.61	18.73	-	11.96	-	-	13.40	18.13	16.00	23.15	5.03	13.51	13.96	10.90	9.98	-	-	-	-	-	-
16-Jul-96	15.51	20.71	-	20.07	24.41	24.30	24.93	-	17.91	-	-	14.60	23.55	17.26	29.05	6.65	15.90	17.21	11.93	12.43	-	-	-	-	-	-
21-Aug-96	16.51	21.80	-	22.24	26.99	26.77	27.51	-	20.46	-	-	16.17	26.27	19.18	31.93	8.47	16.58	19.43	13.40	14.53	-	-	-	-	-	-
17-Sep-96	17.06	22.06	-	20.61	28.02	27.15	28.53	-	21.27	-	-	16.94	26.81	20.13	32.63	7.52	16.80	19.30	14.02	14.86	-	-	-	-	-	-
30-Sep-96	17.17	22.24	-	23.32	27.04	27.46	27.61	-	20.68	-	-	17.08	27.01	20.19	32.45	8.70	16.89	19.84	14.26	14.97	-	-	-	-	-	-
15-Nov-96	16.38	22.02	-	20.76	26.48	26.85	27.00	-	19.84	-	-	17.00	25.71	20.63	31.37	6.61	16.42	18.38	14.20	13.85	-	-	-	-	-	-
24-Feb-97	12.41	18.71	-	18.61	20.48	20.82	21.02	-	14.17	-	-	12.83	19.79	18.43	25.33	4.35	14.85	14.33	11.18	9.71	-	-	-	-	-	-
10-Jun-97	12.89	14.23	-	13.80	14.20	14.70	14.56	-	7.97	-	-	13.81	14.61	18.56	19.25	4.84	16.01	12.20	12.50	8.49	-	-	-	-	-	-
26-Aug-97	15.38	21.70	-	22.61	26.10	26.56	25.84	-	19.63	-	-	18.53	25.58	20.31	31.13	11.71	17.10	20.16	14.30	14.13	-	-	-	-	-	-
25-Nov-97	14.42	21.50	-	19.25	24.64	25.14	24.80	-	18.23	-	-	16.29	24.33	20.85	29.85	7.85	16.36	17.89	13.88	11.79	-	-	-	-	-	-
19-Dec-97	-	-	-	-	22.75	-	23.28	-	-	-	-	-	22.62	-	27.90	-	-	16.90	-	-	-	23.71	-	-	-	-
16-Feb-98	12.60	20.13	-	18.65	23.55	23.25	24.10	-	17.09	-	-	14.29	-	20.05	28.50	5.33	15.60	15.89	12.02	9.72	14.73	23.98	-	-	-	21.91
1-Jun-98	14.49	16.97	-	16.61	16.51	16.90	17.00	-	10.33	-	-	15.75	-	20.05	21.63	7.25	14.63	14.36	12.85	9.83	15.69	17.11	-	-	-	14.57
25-Aug-98	17.62	22.74	-	23.68	27.79	27.32	28.36	-	21.14	-	-	17.73	-	20.89	32.46	12.67	14.32	21.19	14.29	14.97	17.56	28.22	-	-	-	25.72
16-Nov-98	18.42	24.59	28.36	22.20	27.57	27.32	28.10	28.29	20.99	21.19	21.05	18.23	-	21.19	32.13	12.10	14.30	20.81	14.45	14.92	17.78	28.11	24.84	-	-	26.32
15-Feb-99	11.97	19.02	23.94	18.27	23.20	23.94	23.71	23.75	16.75	16.72	16.54	12.35	-	17.66	27.97	5.11	12.41	15.34	10.03	9.51	13.04	23.62	20.35	-	-	21.94
11-May-99	14.32	20.19	22.99	18.76	22.44	22.92	22.99	22.94	16.06	15.87	15.68	13.41	-	16.56	27.31	8.50	15.82	16.94	10.82	11.11	14.03	22.91	20.62	-	-	21.21
20-Aug-99	17.37	22.16	26.95	21.92	26.31	25.98	26.81	26.87	19.73	19.80	19.62	19.80	-	19.65	31.04	12.04	15.00	20.46	14.25	14.40	17.18	26.81	23.93	15.05	15.37	25.80
25-Oct-99	18.48	24.73	28.77	24.40	28.05	28.02	28.49	28.44	21.56	21.36	21.11	19.00	-	20.83	32.78	13.86	16.40	22.15	15.60	16.51	18.52	28.63	25.68	16.92	17.28	26.49
27-Mar-00	12.88	20.09	26.94	19.24	26.27	25.69	26.80	26.91	19.36	19.83	19.64	14.05	-	19.43	31.08	6.25	17.70	17.32	12.90	11.65	14.45	26.71	23.11	14.05	14.68	25.30
15-Jun-00	16.26	21.18	24.08	20.01	23.56	24.42	24.14	24.10	17.40	17.07	16.86	16.05	-	19.53	28.42	10.15	14.74	18.55	13.36	13.11	15.82	24.10	22.02	14.14	14.96	21.70
4-Oct-00	18.15	23.24	28.92	22.12	28.42	28.02	28.95	28.92	21.93	21.88	21.69	-	-	20.31	33.46	13.67	14.09	22.31	14.15	16.85	17.32	28.98	26.31	17.81	18.66	26.00
20-Dec-00	17.98	22.73	27.13	19.50	26.89	26.13	27.27	26.76	20.33	19.63	19.31	-	-	19.24	32.12	12.22	13.02	20.20	13.09	15.17	16.70	27.70	26.05	16.25	17.08	25.00
27-Mar-01	16.91	21.94	28.05	20.86	27.35	27.01	27.91	28.10	20.66	21.05	20.88	-	-	19.19	32.07	11.91	13.74	20.85	13.63	14.96	16.81	27.86	25.24	16.40	17.23	25.70
28-Jun-01	18.02	23.49	28.58	24.14	28.11	27.51	28.52	28.25	21.59	21.23	20.97	-	-	21.14	33.04	13.31	17.27	22.92	15.25	16.06	18.06	28.72	25.88	17.32	18.11	27.01
8-Oct-01	19.24	26.16	29.85	25.45	29.10	29.05	29.68	28.72	22.67	22.60	22.45	-	-	21.99	34.11	15.50	18.28	23.89	17.10	18.45	19.41	29.78	27.51	19.41	20.19	28.15
12-Dec-01	16.73	22.68	26.54	20.49	25.81	24.12	26.33	26.46	19.01	19.41	19.21	-	-	21.58	30.43	9.71	16.50	19.00	16.00	13.67	17.89	26.34	23.66	15.05	15.86	24.44
2-Apr-02	14.98	20.47	25.78	20.61	25.33	26.38	25.84	25.59	18.71	18.56	18.34	-	-	20.24	30.61	7.99	16.77	18.46	13.16	12.48	15.35	25.85	23.59	14.56	15.42	23.60
10-Jul-02	17.18	21.78	25.31	21.42	24.69	25.12	25.22	25.13	18.28	18.10	17.92	-	-	20.43	29.73	11.61	16.20	19.92	14.00	13.98	17.09	25.31	23.29	15.91	15.22	23.16
29-Sep-02	18.44	24.95	29.44	24.73	28.65	28.25	29.27	29.44	22.14	22.41	22.23	-	-	21.41	33.35	14.27	-	22.83	-	17.42	18.63	29.15	26.55	18.34	19.11	27.52
17-Dec-02	19.34	24.41	24.61	20.25	25.05	23.61	25.42	25.06	18.92	18.02	17.99	-	-	21.79	31.16	12.93	16.20	20.80	17.30	13.05	19.02	25.75	24.11	16.20	16.86	22.30
17-Mar-03	14.90	20.71	24.92	19.79	24.35	24.38	24.91	24.91	17.82	17.87	17.67	-	-	20.69	29.51	6.87	16.40	17.05	13.50	17.47	15.92	24.92	22.22	13.50	14.31	22.79
2-Jun-03	15.17	20.02	21.63	20.25	21.19	21.82	21.75	21.50	15.04	14.50	14.29	-	-	20.15	26.30	9.45	16.60	17.39	13.60	12.22	15.71	21.80	20.47	13.08	13.72	19.45

Note: bbm = below bench mark btc = below top of casing msl = mean sea level

* = City of Portland Datum

**Willamette River, Portland Harbor Stage, obtained from National Weather Service and adjusted to feet msl - City of Portland datum. December 1995 to December 1997. Post December 1997 River Stage data measured directly from surveyed bench mark located on north end of FAMM Dock.

1 = Well casing raised in January 2000. Pre-2000 top of casing elevations are: MW-15-50 (35.15 feet); MW-15-66 (35.36 feet)

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TABLE 1 - Summary of Water Level Measurements and Groundwater Elevations

Groundwater Elevation

Date Measured	Groundwater Elevation (feet msl)*																								River Stage (feet msl)**
	MW-1-22	MW-2-32	MW-2-61	MW-3-26	MW-3-56	MW-4-35	MW-4-57	MW-4-101	MW-5-32	MW-5-100	MW-5-175	MW-6-32	MW-6-61	MW-8-29	MW-8-56	MW-9-29	MW-10-25	MW-10-61	MW-11-32	MW-12-36	MW-13-30	MW-13-61	MW-14-110	MW-15-50	MW-15-66	
5-Dec-95	20.60	19.23	-	18.53	18.28	18.42	18.14	-	18.37	-	-	18.80	18.73	19.34	18.52	31.45	24.24	25.91	25.70	29.32	-	-	-	-	-	18.9
5-Jan-96	20.28	14.42	-	14.64	12.22	12.07	12.15	-	12.26	-	-	20.67	12.92	20.08	12.39	30.32	24.02	23.01	26.20	27.87	-	-	-	-	-	12.4
12-Feb-96	27.01	25.85	-	25.59	25.44	25.45	25.43	-	25.42	-	-	25.96	25.53	22.10	25.57	34.33	28.11	30.41	29.44	33.42	-	-	-	-	-	26.4
18-Mar-96	22.31	16.43	-	16.24	14.41	14.30	14.32	-	14.46	-	-	23.41	15.11	23.87	14.59	31.52	27.27	24.86	28.97	29.68	-	-	-	-	-	14.4
16-Apr-96	21.10	15.63	-	15.98	14.60	14.28	14.46	-	14.47	-	-	22.09	14.99	23.51	14.69	30.72	26.59	24.26	28.27	29.00	-	-	-	-	-	14.5
10-May-96	21.00	14.99	-	15.13	12.06	11.96	11.93	-	12.05	-	-	22.21	12.95	23.32	12.20	30.71	26.24	23.43	27.99	28.45	-	-	-	-	-	11.6
17-Jun-96	20.87	17.06	-	16.71	15.86	15.93	15.80	-	15.87	-	-	22.11	16.37	23.09	15.98	32.62	25.71	25.37	27.49	28.71	-	-	-	-	-	15.7
16-Jul-96	19.24	13.75	-	14.04	9.66	10.24	9.60	-	9.92	-	-	20.91	10.95	21.83	10.08	31.00	23.32	22.12	26.46	25.26	-	-	-	-	-	-
21-Aug-96	18.24	12.66	-	11.87	7.08	7.77	7.02	-	7.37	-	-	19.34	8.23	19.91	7.20	29.18	22.64	19.90	24.99	24.16	-	-	-	-	-	6.6
17-Sep-96	17.69	12.40	-	13.50	6.05	7.39	6.00	-	6.56	-	-	18.57	7.69	18.96	6.50	30.13	22.42	20.03	24.37	23.83	-	-	-	-	-	5.8
30-Sep-96	17.58	12.22	-	10.79	7.03	7.08	6.92	-	7.15	-	-	18.43	7.49	18.90	6.68	28.95	22.33	19.49	24.13	23.72	-	-	-	-	-	5.4
15-Nov-96	18.37	12.44	-	13.35	7.59	7.69	7.53	-	7.99	-	-	18.51	8.79	18.46	7.76	31.04	22.80	20.95	24.19	24.84	-	-	-	-	-	7.2
24-Feb-97	22.34	15.75	-	15.50	13.59	13.72	13.51	-	13.66	-	-	22.68	14.71	20.66	13.80	33.30	24.37	25.00	27.21	28.98	-	-	-	-	-	13.6
10-Jun-97	21.86	20.23	-	20.31	19.87	19.84	19.97	-	19.86	-	-	21.70	19.89	20.53	19.88	32.81	23.21	27.13	25.89	30.20	-	-	-	-	-	19.8
26-Aug-97	19.37	12.76	-	11.50	7.97	7.98	8.69	-	8.20	-	-	16.98	8.92	18.78	8.00	25.94	22.12	19.17	24.09	24.56	-	-	-	-	-	7.9
25-Nov-97	20.33	12.96	-	14.86	9.43	9.40	9.73	-	9.60	-	-	19.22	10.17	18.24	9.28	29.80	22.86	21.44	24.51	26.90	-	-	-	-	-	8.72
19-Dec-97	-	-	-	-	11.32	-	11.25	-	-	-	-	-	11.88	-	11.23	-	-	22.43	-	-	-	11.07	-	-	-	-
16-Feb-98	22.15	14.33	-	15.46	10.52	11.29	10.43	-	10.74	-	-	21.22	-	19.04	10.63	32.32	23.62	23.44	26.37	28.97	20.13	10.80	-	-	-	10.21
1-Jun-98	20.26	17.49	-	17.50	17.56	17.64	17.53	-	17.50	-	-	19.76	-	19.04	17.50	30.40	24.59	24.97	25.54	29.86	19.17	17.67	-	-	-	17.55
25-Aug-98	17.13	11.72	-	10.43	6.28	7.22	6.17	-	6.69	-	-	17.78	-	18.20	6.67	24.98	24.90	18.14	24.10	23.72	17.30	6.56	-	-	-	6.40
16-Nov-98	16.33	9.87	6.05	11.91	6.50	7.22	6.43	6.07	6.84	6.12	6.14	17.28	-	17.90	7.00	25.55	24.92	18.52	23.94	23.77	17.08	6.67	12.57	-	-	5.80
15-Feb-99	22.78	15.44	10.47	15.84	10.87	10.60	10.82	10.61	11.08	10.59	10.65	23.16	-	21.43	11.16	32.54	26.81	23.99	28.36	29.18	21.82	11.16	17.06	-	-	10.18
11-May-99	20.43	14.27	11.42	15.35	11.63	11.62	11.54	11.42	11.77	11.44	11.51	22.10	-	22.53	11.82	29.15	23.40	22.39	27.57	27.58	20.83	11.87	16.79	-	-	10.91
20-Aug-99	17.38	12.30	7.46	12.19	7.76	8.56	7.72	7.49	8.10	7.51	7.57	15.71	-	19.44	8.09	25.61	24.22	18.87	24.14	24.29	17.68	7.97	13.48	20.10	19.99	6.32
25-Oct-99	16.27	9.73	5.64	9.71	6.02	6.52	6.04	5.92	6.27	5.95	6.08	16.51	-	18.26	6.35	23.79	22.82	17.18	22.79	22.18	16.34	6.15	11.73	18.23	18.08	5.63
27-Mar-00	21.87	14.37	7.47	14.87	7.80	8.85	7.73	7.45	8.47	7.48	7.55	21.46	-	19.66	8.05	31.40	21.52	22.01	25.49	27.04	20.41	8.07	14.30	21.92	21.38	6.82
15-Jun-00	18.49	13.28	10.33	14.10	10.51	10.12	10.39	10.26	10.43	10.24	10.33	19.46	-	19.56	10.71	27.50	24.48	20.78	25.03	25.58	19.04	10.68	15.39	21.83	21.10	10.42
4-Oct-00	16.60	11.22	5.49	11.99	5.65	6.52	5.58	5.44	5.90	5.43	5.50	-	-	18.78	5.67	23.98	25.13	17.02	24.24	21.84	17.54	5.80	11.10	18.16	17.40	6.12
20-Dec-00	16.77	11.73	7.28	14.61	7.18	8.41	7.26	7.60	7.50	7.68	7.88	-	-	19.85	7.01	25.43	26.20	19.13	25.30	23.52	18.16	7.08	11.36	19.72	18.98	7.12
27-Mar-01	17.84	12.52	6.36	13.25	6.72	7.53	6.62	6.26	7.17	6.26	6.31	-	-	19.90	7.06	25.74	25.48	18.48	24.76	23.73	18.05	6.92	12.17	19.57	18.83	6.42
28-Jun-01	16.73	10.97	5.83	9.97	5.96	7.03	6.01	6.11	6.24	6.08	6.22	-	-	17.95	6.09	24.34	21.95	16.41	23.14	22.63	16.80	6.06	11.53	18.65	17.95	5.11
8-Oct-01	15.51	8.30	4.56	8.66	4.97	5.49	4.85	5.64	5.16	4.71	4.74	-	-	17.10	5.02	22.15	20.94	15.44	21.29	20.24	15.45	5.00	9.90	16.56	15.87	3.97
12-Dec-01	18.02	11.78	7.87	13.62	8.26	10.42	8.20	7.90	8.82	7.90	7.98	-	-	17.51	8.70	27.94	22.72	20.33	22.39	25.02	16.97	8.44	13.75	20.92	20.20	7.68
2-Apr-02	19.77	13.99	8.63	13.50	8.74	8.16	8.69	8.77	9.12	8.75	8.85	-	-	18.85	8.52	29.66	22.45	20.87	25.23	26.21	19.51	8.93	13.82	21.41	20.64	8.52
10-Jul-02	17.57	12.68	9.10	12.69	9.38	9.42	9.31	9.23	9.55	9.21	9.27	-	-	18.66	9.40	26.04	23.02	19.41	24.39	24.71	17.77	9.47	14.12	20.06	20.84	8.96
23-Sep-02	16.31	9.51	4.97	9.38	5.42	6.29	5.26	4.92	5.69	4.90	4.96	-	-	17.68	5.78	23.38	-	16.50	-	21.27	16.23	5.63	10.86	17.63	16.95	4.60
17-Dec-02	15.41	10.05	9.80	13.86	9.02	10.93	9.11	9.30	8.91	9.29	9.20	-	-	17.30	7.97	24.72	23.02	18.53	21.09	22.64	15.84	9.03	13.30	19.77	19.20	9.82
17-Mar-03	19.85	13.75	9.49	14.32	9.72	10.16	9.62	9.45	10.01	9.44	9.52	-	-	18.40	9.62	30.78	22.82	22.28	24.89	21.22	18.94	9.86	15.19	22.47	21.75	9.33
2-Jun-03	19.58	14.44	12.78	13.86	12.88	12.72	12.78	12.86	12.79	12.81	12.90	-	-	18.94	12.83	28.20	22.62	21.94	24.79	26.47	19.15	12.98	16.94	22.89	22.34	12.67

Note: bbm = below bench mark btc = below top of casing msl = mean sea level

* = City of Portland Datum

**Willamette River, Portland Harbor Stage, obtained from National Weather Service and adjusted to feet msl - City of Portland datum: December 1995 to December 1997. Post December 1997 River Stage data measured directly from surveyed bench mark located on north end of FAMM Dock.

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Table 2a - Summary of Analytical Results for Groundwater Samples
March 2003 Sampling Event

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results																			
			EPA Method 8021 ug/l (ppb)					EPA Method 9010B mg/l (ppm)		Total (Unfiltered) Metals by EPA Method 6010B mg/l (ppm)						Dissolved (Filtered) Metals by EPA Method 6010B mg/l (ppm)						EPA Method 8270-SIM ug/l (ppb)	
			Select Aromatic VOCs (AVOCs)																			
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Total Cyanide	Amenable Cyanide	Arsenic	Chromium	Copper	Lead	Nickel	Zinc	Arsenic	Chromium	Copper	Lead	Nickel	Zinc	Carcinogenic PAHs	Total PAHs
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	0.0052[3]	#	0.00014[4]	0.011[3]	0.009[3]	0.0025[3]	0.052[4]	0.120[3]	0.00014[4]	0.011[3]	0.009[3]	0.0025[3]	0.052[4]	0.120[3]	#	#
MW2-61	18-MW2-61-104	18-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	**1.3**	ND>0.040	ND>0.010	ND>0.015	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	-	-	-	-	-	-	ND	ND
MW3-56	19-MW3-56-112	19-Mar-03	**430.**	ND>5.0	ND>5.0	ND>15	430.	**0.1**	ND>0.040	ND>0.010	ND>0.0030	ND>0.0030	ND>0.0060	0.0053	ND>0.020	ND>0.011	-	-	ND>0.0067	ND>0.0056	-	1.52	94.38
MW4-57	20-MW4-57-117	20-Mar-03	**17,000.**	ND>100	770.	ND>300	17,770.	**1.3**	ND>0.040	**0.016**	ND>0.0010	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	**0.02**	-	-	-	-	-	ND	2,233.4
MW4-57 DUP	20-MW4-57-118	20-Mar-03	**16,000.**	ND>100	760.	ND>300	16,760.	**1.3**	ND>0.040	**0.019**	ND>0.0010	ND>0.0030	ND>0.0060	0.0053	ND>0.020	-	-	-	-	-	-	ND	2,333.4
MW4-101	18-MW4-101-109	18-Mar-03	**120.**[A]	ND>2.5[A]	ND>2.5[A]	ND>7.5[A]	120.	**0.51**	ND>0.040	**0.017**	ND>0.015	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	**0.018**	-	-	-	-	-	ND	15.63
MW5-100	19-MW5-100-114	19-Mar-03	**6,600.**[A]	ND>25[A]	400.[A]	250.[A]	7,250.	**0.56**	ND>0.040	**0.011**	ND>0.0030	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	-	-	-	-	-	-	ND	5,614.
MW5-175	18-MW5-175-105	18-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND>0.040	ND>0.040	ND>0.010	ND>0.015	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	-	-	-	-	-	-	ND	ND
MW8-56	20-MW8-56-120	20-Mar-03	**20,000.**[A]	260.[A]	940.[A]	930.[A]	22,130.	**0.51**	ND>0.040	**0.012**	ND>0.0010	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	**0.019**	ND>0.0011	ND>0.0033	ND>0.0067	ND>0.0056	ND>0.022	4.2	7,712.2
MW9-29	18-MW9-29-103	18-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	**0.04**	ND>0.040	ND>0.010	ND>0.015	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	ND>0.011	-	-	-	-	-	ND	ND
MW10-61	19-MW10-61-111	19-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND>0.040	ND>0.040	ND>0.010	0.0062	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	ND>0.011	-	-	ND>0.0067	ND>0.0056	-	ND	0.95
MW12-36	19-MW12-36-113	19-Mar-03	**200.**	400.	290.	680.	1,570.	ND>0.040	ND>0.040	-	-	-	-	-	-	-	-	-	-	-	-	0.31	369.18
MW13-30	19-MW13-30-115	19-Mar-03	1,400.	9.2	330.	110.	1,849.2	**0.1**	ND>0.040	ND>0.010	ND>0.0030	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	**0.019**	-	-	-	-	-	ND	1,008.4
MW13-61	17-MW13-61-101	17-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	**0.13**	ND>0.040	ND>0.010	ND>0.015	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	-	-	-	-	-	-	ND	ND
MW14-110	18-MW14-110-108	18-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND>0.040	ND>0.040	**0.011**	ND>0.015	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	**0.018**	-	-	-	-	-	ND	ND
MW15-50	21-MW15-50-122	21-Mar-03	**49,000.**	310.	ND>250	ND>750	49,310.	**0.07**	ND>0.040	**0.012**	0.0056	**0.011**	**0.0095**	0.016	0.045	**0.017**	ND>0.0011	ND>0.0033	**0.0081**	ND>0.0056	0.056	ND	5,042.
MW15-66	18-MW15-66-107	18-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND>0.040	ND>0.080	ND>0.010	ND>0.015	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	-	-	-	-	-	-	ND	0.1

Note:
'-' = Not Analyzed
# = Reference Level not established
A = this analysis was performed on a VOA sample containing headspace
AWQC = Ambient Water Quality Criteria
Bold = Detected above Reference Level
BTEX = benzene, toluene, ethylbenzene, and xylenes
DEQ = Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
mg/l = milligrams per liter
ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ppm = parts per million
ug/l = micrograms per liter

1 = Sample Prefix: 2708-0303
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (EPA-822-R-02-047, November 2002) based on Freshwater Chronic (Aquatic Life Protection) and Fish Consumption (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC, November 2002 revision
4 = Reference Level based on Human Fish Consumption Criteria of AWQC, November 2002 revision

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Table 2b - Summary of Analytical Results for Groundwater Samples: PAHs
March 2003 Sampling Event

Well Number	HAI Sample Number [1]	Sample Date	PAHs by EPA Method 8270-SIM Analytical Results ug/l (ppb)																	
			Carcinogenic PAHs							Non-carcinogenic PAHs									Total Carcinogenic PAHs	Total PAHs
			Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene		
Ambient Water Quality Criteria (AWQC) for Surface Water [2]			0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	990. [3]	#	40,000[4]	#	140. [4]	5,300.[4]	620. [3]	#	4,000.[4]	#	#
MW2-61	18-MW2-61-104	18-Mar-03	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND	ND
MW3-56	19-MW3-56-112	19-Mar-03	**0.46**	**0.2**	ND>0.10	**0.23**	0.52	ND>0.10	**0.11**	38.	0.4	5.8	0.16	8.	12.	2.3	18.	8.2	**1.52**	94.38
MW4-57	20-MW4-57-117	20-Mar-03	ND>2.0	ND>2.0	ND>2.0	ND>2.0	ND>2.0	ND>2.0	ND>2.0	28.	ND>2.0	ND>2.0	ND>2.0	ND>2.0	ND>2.0	**2,200.**	5.4	ND>2.0	ND	2,233.4
MW4-57 DUP	20-MW4-57-118	20-Mar-03	ND>2.0	ND>2.0	ND>2.0	ND>2.0	ND>2.0	ND>2.0	ND>2.0	28.	ND>2.0	ND>2.0	ND>2.0	ND>2.0	ND>2.0	**2,300.**	5.4	ND>2.0	ND	2,333.4
MW4-101	18-MW4-101-109	18-Mar-03	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	0.63	ND>0.10	ND>0.10	ND>0.10	ND>0.10	15.	ND>0.10	ND>0.10	ND>0.10	ND	15.63
MW5-100	19-MW5-100-114	19-Mar-03	ND>2.0	ND>2.0	ND>2.0	ND>2.0	ND>2.0	ND>2.0	ND>2.0	14.	ND>2.0	ND>2.0	ND>2.0	ND>2.0	ND>2.0	**5,600.**	ND>2.0	ND>2.0	ND	5,614.
MW5-175	18-MW5-175-105	18-Mar-03	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND	ND
MW8-56	20-MW8-56-120	20-Mar-03	**2.2**	ND>2.0	ND>2.0	ND>2.0	**2.**	ND>2.0	ND>2.0	99.	61.	11.	ND>2.0	9.2	42.	**7,400.**	77.	8.8	**4.2**	7,712.2
MW9-29	18-MW9-29-103	18-Mar-03	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND	ND
MW10-61	19-MW10-61-111	19-Mar-03	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	0.45	ND>0.10	ND>0.10	ND>0.10	0.5	ND	0.95
MW12-36	19-MW12-36-113	19-Mar-03	**0.31**	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	35.	0.47	2.1	ND>0.10	5.9	16.	280.	24.	5.4	**0.31**	369.18
MW13-30	19-MW13-30-115	19-Mar-03	ND>1.0	ND>1.0	ND>1.0	ND>1.0	ND>1.0	ND>1.0	ND>1.0	160.	1.6	9.2	ND>1.0	3.9	48.	**700.**	83.	2.7	ND	1,008.4
MW13-61	17-MW13-61-101	17-Mar-03	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND	ND
MW14-110	18-MW14-110-108	18-Mar-03	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND	ND
MW15-50	21-MW15-50-122	21-Mar-03	ND>10	ND>10	ND>10	ND>10	ND>10	ND>10	ND>10	24.	36.	ND>10	ND>10	ND>10	32.	**4,900.**	50.	ND>10	ND	5,042.
MW15-66	18-MW15-66-107	18-Mar-03	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	0.1	ND	0.1

Note: ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ug/l = micrograms per liter
ug/l = micrograms per liter

1 = Sample Prefix: 2708-0303
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (EPA-822-R-02-047, November 2002) based on Freshwater Chronic (Aquatic Life Protection) and Fish Consumption (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC, revised November 2002
4 = Reference Level based on Human Fish Consumption Criteria of AWQC revised November 2002
Bold = Detected above Reference Level

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Table 3a - Summary of Analytical Results for Groundwater Samples
June 2003 Sampling Event

Well Number	HAI Sample Number [1]	Sample Date	Analytical Results																		
			EPA Method 8021 ug/l (ppb)					EPA Method 9010B mg/l (ppm)	Total (Unfiltered) Metals by EPA Method 6010B mg/l (ppm)						Dissolved (Filtered) Metals by EPA Method 6010B mg/l (ppm)						EPA Method 8270-SIM ug/l (ppb)	
			Select Aromatic VOCs (AVOCs)																		
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Amenable Cyanide	Arsenic	Chromium	Copper	Lead	Nickel	Zinc	Arsenic	Chromium	Copper	Lead	Nickel	Zinc	Carcinogenic PAHs	Total PAHs
Ambient Water Quality Criteria (AWQC) for Surface Water [2]			51. [4]	200,000. [4]	29,000. [4]	#	#	#	0.00014 [4]	0.011 [3]	0.009 [3]	0.0025 [3]	0.052 [4]	0.120 [3]	0.00014 [4]	0.011 [3]	0.009 [3]	0.0025 [3]	0.052 [4]	0.120 [3]	#	#
MW14-110	02-MW14-110-101	2-Jun-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND>0.040	**0.038**	ND>0.0010	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	**0.023**	ND>0.0011	ND>0.0033	ND>0.0067	ND>0.0056	ND>0.022	ND	ND
MW15-50	03-MW15-50-105	3-Jun-03	**47,000.**	300.	260.	1,300.	48,860.	0.15	**0.018**	ND>0.0010	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	**0.029**	ND>0.0011	ND>0.0033	ND>0.0067	ND>0.0056	ND>0.022	ND	3,405.
MW15-50 DUP	03-MW15-50-106	3-Jun-03	**46,000.**	290.	240.	1,200.	47,730.	ND>0.040	**0.018**	ND>0.0010	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	**0.033**	ND>0.0011	ND>0.0033	ND>0.0067	ND>0.0056	ND>0.022	ND	5,062.6
MW15-66	03-MW15-66-104	3-Jun-03	31.	ND>0.50	ND>0.50	ND>1.5	31.	ND>0.040	ND>0.010	ND>0.0010	ND>0.0030	ND>0.0060	ND>0.0050	ND>0.020	-	-	-	-	-	-	**4.**	7.41

Note:
'-' = Not Analyzed
# = Reference Level not established
AWQC = Ambient Water Quality Criteria
Bold = Detected above Reference Level

BTEX = benzene, toluene, ethylbenzene, and xylenes
DEQ = Department of Environmental Quality
EPA = U.S. Environmental Protection Agency

mg/l = milligrams per liter
ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons

ppb = parts per billion
ppm = parts per million
ug/l = micrograms per liter

1 = Sample Prefix: 2708-0306
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (EPA-822-R-02-047, November 2002) based on Freshwater Chronic (Aquatic Life Protection) and Fish Consumption (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC, November 2002 revision
4 = Reference Level based on Human Fish Consumption Criteria of AWQC, November 2002 revision

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Table 3b - Summary of Analytical Results for Groundwater Samples: PAHs
June 2003 Sampling Event

Well Number	HAI Sample Number [1]	Sample Date	PAHs by EPA Method 8270-SIM Analytical Results ug/l (ppb)																	
			Carcinogenic PAHs							Non-carcinogenic PAHs									Total Carcinogenic PAHs	Total PAHs
			Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (ah) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (ghi) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene		
Ambient Water Quality Criteria (AWQC) for Surface Water [2]			0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	990.[3]	#	40,000[4]	#	140.[4]	5,300.[4]	620.[3]	#	4,000.[4]	#	#
MW14-110	02-MW14-110-101	2-Jun-03	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND>0.10	ND	ND
MW15-50	03-MW15-50-105	3-Jun-03	ND>1.0	ND>1.0	ND>1.0	ND>1.0	ND>1.0	ND>1.0	ND>1.0	18.	32.	ND>1.0	ND>1.0	1.9	22.	**3,300.**	29.	2.1	ND	3,405.
MW15-50 DUP	03-MW15-50-106	3-Jun-03	ND>1.0	ND>1.0	ND>1.0	ND>1.0	ND>1.0	ND>1.0	ND>1.0	28.	50.	3.5	ND>1.0	2.9	33.	**4,900.**	43.	2.2	ND	5,062.6
MW15-66	03-MW15-66-104	3-Jun-03	**0.6**	**0.64**	**0.77**	**0.85**	**0.69**	ND>0.10	**0.45**	ND>0.10	ND>0.10	ND>0.10	0.77	1.2	ND>0.10	ND>0.10	0.34	1.1	**4.**	7.41

Note: ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ug/l = micrograms per liter
ug/l = micrograms per liter

1 = Sample Prefix: 2708-0306
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (EPA-822-R-02-047, November 2002) based on Freshwater Chronic (Aquatic Life Protection) and Fish Consumption (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC, November 2002 revision
4 = Reference Level based on Human Fish Consumption Criteria of AWQC, November 2002 revision
Bold = Detected above Reference Level

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Table 3c - Summary of Analytical Results for Quality Assurance / Quality Control (QA/QC) Samples
June 2003 Sampling Event

QA/QC Sample Type	HAI Sample Number [1]	Sample Date	Comment	Analytical Results ug/l (ppb)					
				EPA Method 8021 Select Aromatic VOCs (AVOCs)					EPA Method 8270
				Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Total PAHs
Trip Blank	02-MW7-100	2-Jun-03	Trip Blank	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	-
Trip Blank	03-MW7-102	3-Jun-03	Trip Blank	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	-
Equipment Blank	03-MW7-103	3-Jun-03	DI Water sampled from decontaminated pump after sampling MW14-110 and before sampling MW15-66	1.2	3.9	ND>0.50	ND>1.5	5.1	Naphthalene = 0.25 All Others = ND>0.10

Note:
'-' = not analyzed
BTEX = benzene, toluene, ethylbenzene, and xylenes
EPA = U.S. Environmental Protection Agency
ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ug/l = micrograms/liter

1 = Sample Prefix: 2708-0306

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Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW1-22	951207-MW1-22-01	7-Dec-95	13.	2.	1.8	3.2	20.	93.4	465.3	1.08	-	-
	960319-MW1-22-01	19-Mar-96	3.5	3.5	2.3	23.	32.3	4.71	140.45	0.86	-	-
	960618-MW1-22-01	18-Jun-96	2.4	9.5	3.2	15.	30.1	2.2	112.	1.91	-	-
	961001-MW1-22-01	1-Oct-96	8.5	9.	7.7	72.	97.2	6.2	720.17	5.7	-	-
	970225-MW1-22-01	25-Feb-97	3.2	1.7	ND>0.5	8.5	13.4	0.91	67.	1.24	-	-
	970225-MW1-22-02	25-Feb-97	1.5	1.6	0.7	11.	14.8	2.2	64.	-	-	-
	970827-MW1-22-01	27-Aug-97	7.5	8.2	6.9	62.	84.6	20.	988.2	11.	-	-
	970827-MW1-22-02	27-Aug-97	6.7	7.4	6.2	55.	75.3	28.1	737.5	10.	-	-
	980217-MW1-22-01	17-Feb-98	ND>0.5	ND>0.5	ND>0.5	1.6	1.6	4.45	23.23	0.34	ND>0.01	-
	980602-MW1-32-11	2-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	93.	209.	0.46	0.05	-
	980826-MW1-22-10	26-Aug-98	7.1	8.2	6.8	60.	82.1	517.	1,137.5	6.7	0.6	-
	981118-MW1-22-15	18-Nov-98	ND>10	ND>10	ND>10	ND>30	ND	3.4	569.	3.4	-	-
	990216-MW1-22-012	16-Feb-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	3.53	11.27	0.22	ND>0.02	-
	990513-MW1-22-11	13-May-99	0.64	0.7	ND>0.5	2.04	3.4	3.17	17.33	-	-	-
	990824-MW1-22-15	24-Aug-99	7.12	8.42	5.89	50.4	71.8	68.19	816.91	6.5	ND>0.02	-
	991028-MW1-22-16	28-Oct-99	7.64	10.6	7.24	40.8	66.3	8.69	424.98	6.7	ND>0.02	-
	000330-MW1-22-116	30-Mar-00	0.86	1.43	0.62	7.02	9.9	0.42	62.35	1.7	ND>0.02	-
	010329-MW1-22-115	29-Mar-01	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	13.36	51.06	0.19	0.19	-
MW2-32	951206-MW2-32-01	6-Dec-95	6.	ND>0.5	4.2	2.4	12.6	ND	51.55	0.35	-	-
	960318-MW2-32-01	18-Mar-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	4.54	0.26	-	-
	960618-MW2-32-01	18-Jun-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	2.6	0.44	-	-
	961001-MW2-32-01	1-Oct-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	10.53	0.22	-	-
	970225-MW2-32-01	25-Feb-97	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	1.6	0.16	-	-
	970827-MW2-32-01	27-Aug-97	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.2	18.04	0.28	-	-
	980217-MW2-32-01	17-Feb-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	5.02	0.16	ND>0.01	-
	980601-MW2-32-05	1-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	3.2	0.26	ND>0.01	-
	980825-MW2-32-04	25-Aug-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	1.21	7.1	0.28	0.09	-
	981117-MW2-32-10	17-Nov-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	0.08	0.02	-
	990216-MW2-32-008	16-Feb-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	18.45	0.12	0.03	-
	990513-MW2-32-10	13-May-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	9.02	0.11	-	-
	990824-MW2-32-10	24-Aug-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.11	6.29	0.16	ND>0.02	-
	991027-MW2-32-12	27-Oct-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	0.13	ND>0.02	-
	000329-MW2-32-112	29-Mar-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	2.23	0.08	ND>0.02	-
	010328-MW2-32-111	28-Mar-01	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	0.04	ND>0.02	-

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Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW2-61	981116-MW2-61-04	16-Nov-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	0.33	1.3	1.3	-
	990216-MW2-61-006	16-Feb-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	0.37	1.6	ND>0.04	-
	990512-MW2-61-05	12-May-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	0.54	1.1	ND>0.02	-
	990823-MW2-61-07	23-Aug-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	1.4	0.2	-
	991026-MW2-61-04	26-Oct-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	1.3	0.34	-
	000328-MW2-61-104	28-Mar-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	1.2	0.58	-
	001004-MW2-61-04	4-Oct-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	-	0.43	-
	010328-MW2-61-104	28-Mar-01	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	0.25	ND>0.02	-
	011009-MW2-61-104	9-Oct-01	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	ND	0.83	-	-
	020403-MW2-61-103	3-Apr-02	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	ND	2.38	ND>0.400	-
	020924-MW2-61-103	24-Sep-02	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	0.97	-	-
	030318-MW2-61-104	18-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	1.3	ND>0.040	-
MW3-26	951206-MW3-26-01	6-Dec-95	30.	0.98	0.65	1.4	33.	21.04	85.24	-	-	-
	960318-MW3-26-02	18-Mar-96	1,300.	5.	2.2	5.6	1,312.8	1.71	42.39	0.27	-	-
	960618-MW3-26-01	18-Jun-96	2,300.	22.	ND>10	27.	2,349.	2.6	48.	0.25	-	-
	961001-MW3-26-01	1-Oct-96	0.55	0.95	ND>0.5	2.4	3.9	182.	334.	0.34	-	-
	970225-MW3-26-01	25-Feb-97	130.	ND>0.5	ND>0.5	ND>0.5	130.	4.9	11.9	0.28	-	-
	970827-MW3-26-01	27-Aug-97	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	27.6	53.2	2.3	-	-
	980217-MW3-26-01	17-Feb-98	2.	ND>0.5	ND>0.5	ND>1.5	2.	7.07	13.45	0.5	ND>0.01	-
	980602-MW3-26-09	2-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	100.	204.	0.76	ND>0.01	-
	980826-MW3-26-08	26-Aug-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	409.	982.	1.3	0.72	-
	981117-MW3-26-12	17-Nov-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	32.2	59.	2.1	0.1	-
	990216-MW3-26-010	16-Feb-99	89.9	ND>0.5	ND>0.5	ND>1.5	89.9	0.97	3.56	0.33	ND>0.02	-
	990514-MW3-26-23	14-May-99	587.	1.11	ND>0.5	ND>1.5	588.1	4.42	13.21	0.3	-	-
	990824-MW3-26-12	24-Aug-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	1.67	25.12	0.57	ND>0.02	-
	991027-MW3-26-14	27-Oct-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	7.23	12.56	0.79	ND>0.02	-
	000330-MW3-26-113	30-Mar-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	2.44	6.32	0.36	0.21	-
	001005-MW3-26-11	5-Oct-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	2.96	6.15	-	0.04	-
	010328-MW3-26-113	28-Mar-01	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	5.42	11.9	0.22	0.21	-

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Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW3-56	951206-MW3-56-01	6-Dec-95	1,200.	24.	34.	90.	1,348.	2.69	1,384.75	-	-	ND
	960319-MW3-56-01	19-Mar-96	730.	16.	27.	66.	839.	2.34	1,926.62	0.19	-	-
	960620-MW3-56-01	20-Jun-96	730.	7.1	26.	73.	836.1	1.6	1,491.	0.08	-	-
	961002-MW3-56-01	2-Oct-96	450.	ND>5	11.	27.	488.	0.54	938.	0.09	-	-
	970226-MW3-56-01	26-Feb-97	750.	ND>5	ND>5	ND>5	750.	0.62	618.	0.13	-	-
	970828-MW3-56-01	28-Aug-97	340.	0.9	2.5	11.	354.4	0.82	195.52	0.11	-	-
	980218-MW3-56-01	18-Feb-98	520.	0.89	2.9	15.	538.8	0.58	129.58	0.16	ND>0.01	-
	980218-MW3-56-02	18-Feb-98	520.	1.1	4.	19.	544.1	0.46	155.56	-	-	-
	980602-MW3-56-14	2-Jun-98	580.	25.	ND>10	ND>30	605.	25.	316.	0.15	ND>0.01	-
	980602-MW3-56-15	2-Jun-98	630.	ND>10	ND>10	ND>30	630.	24.	306.	-	-	-
	980826-MW3-56-12	26-Aug-98	430.	0.96	2.8	13.	446.8	30.3	101.58	0.15	0.04	-
	981118-MW3-56-16	18-Nov-98	630.	ND>0.5	ND>0.5	ND>1.5	630.	0.97	119.	0.13	ND>0.01	-
	981118-MW3-56-17	18-Nov-98	610.	ND>0.5	ND>0.5	ND>1.5	610.	0.77	121.	-	-	-
	990217-MW3-56-015	17-Feb-99	760.	ND>5	ND>5	ND>15	760.	12.53	163.45	0.08	ND>0.02	-
	990514-MW3-56-24	14-May-99	90.2	ND>0.5	ND>0.5	2.32	92.5	2.65	157.21	0.11	-	-
	990824-MW3-56-16	24-Aug-99	610.	5.03	ND>5	20.8	635.8	0.6	99.66	0.12	0.02	-
	991028-MW3-56-17	28-Oct-99	390.	63.4	60.4	192.	705.8	0.59	98.98	0.1	ND>0.02	-
	000330-MW3-56-117	30-Mar-00	167.	ND>0.5	0.99	7.36	175.4	3.84	166.08	0.07	ND>0.02	-
	001005-MW3-56-13	5-Oct-00	53.2	ND>0.5	ND>0.5	2.09	55.3	12.63	136.	-	ND>0.02	-
	010329-MW3-56-116	29-Mar-01	157.	ND>50	115.	913.	1,185.	10.35	107.75	0.06	0.05	-
	020404-MW3-56-111	4-Apr-02	340.	ND>0.500	ND>0.500	7.8	347.8	2.62	98.13	0.15	0.05	-
	030319-MW3-56-112	19-Mar-03	430.	ND>5.0	ND>5.0	ND>15	430.	1.52	94.38	0.1	ND>0.040	-

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Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results										
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW4-35	951206-MW4-35-01	6-Dec-95	0.54	ND>0.5	ND>0.5	ND>0.5	0.5	0.69	54.49	0.08	-	-
	960318-MW4-35-01	18-Mar-96	17.	0.96	ND>0.5	1.3	19.3	3.18	84.4	0.35	-	-
	960318-MW4-35-02	18-Mar-96	18.	0.82	ND>0.5	2.1	20.9	2.41	79.1	-	-	-
	960618-MW4-35-01	18-Jun-96	5.9	ND>0.5	ND>0.5	0.61	6.5	2.5	61.	0.46	-	ND
	961001-MW4-35-01	1-Oct-96	5.9	ND>0.5	ND>0.5	1.4	7.3	1.7	42.33	0.75	-	ND
	970225-MW4-35-01	25-Feb-97	14.	ND>0.5	ND>0.5	ND>0.5	14.	0.41	46.	0.39	-	ND
	980827-MW4-57-01[5]	27-Aug-97	8.8	ND>0.5	ND>0.5	1.7	10.5	0.53	36.26	0.8	-	ND
	980217-MW4-35-01	17-Feb-98	15.	ND>0.5	ND>0.5	ND>1.5	15.	0.25	31.85	0.36	ND>0.01	ND
	980601-MW4-35-06	1-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.48	44.	0.29	0.02	-
	980826-MW4-35-06	26-Aug-98	10.	ND>0.5	ND>0.5	ND>1.5	10.	19.26	60.85	0.63	0.03	-
	980826-MW4-35-07	26-Aug-98	10.	ND>0.5	ND>0.5	ND>1.5	10.	20.23	64.65	0.81	0.17	-
	981117-MW4-35-11	17-Nov-98	17.	ND>0.5	0.99	ND>1.5	18.	5.3	51.	0.83	0.53	-
	990216-MW4-35-009	16-Feb-99	31.	ND>0.5	ND>0.5	ND>1.5	31.	0.4	23.41	0.22	ND>0.02	-
	990514-MW4-35-21	14-May-99	16.	ND>0.5	ND>0.5	ND>1.5	16.	0.32	24.83	0.26	-	-
	990824-MW4-35-11	24-Aug-99	ND>5	ND>0.5	ND>5	ND>1.5	ND	1.1	33.261	0.86	0.1	-
	991027-MW4-35-13	27-Oct-99	13.9	1.16	ND>0.5	2.45	17.5	5.75	97.39	0.98	ND>0.02	-
	000330-MW4-35-114	30-Mar-00	5.39	ND>0.5	ND>0.5	ND>1.5	5.4	0.42	45.26	0.61	0.04	-
	001005-MW4-35-10	5-Oct-00	10.4	ND>0.5	ND>0.5	ND>1.5	10.4	21.72	162.5	-	ND>0.02	-
	010328-MW4-35-112	28-Mar-01	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.4	25.55	0.19	0.18	-

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Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW4-57	951205-MW4-57-01	5-Dec-95	9,600.	72.	590.	290.	10,552.	1.73	1,328.27	1.18	-	-
	960321-MW4-57-01	21-Mar-96	11,000.	ND>50	520.	270.	11,790.	2.29	1,097.76	0.03	-	-
	960620-MW4-57-01	20-Jun-96	10,000.	ND>200	480.	ND>200	10,480.	1.4	646.	0.88	-	2.8
	961002-MW4-57-01	2-Oct-96	14,000.	ND>100	580.	400.	14,980.	0.64	1,707.	1.	-	29.
	970226-MW4-57-01	26-Feb-97	16,000.	34.	630.	130.	16,794.	0.52	1,688.	1.52	-	4.8
	970828-MW4-35-01[5]	28-Aug-97	12,000.	ND>50	360.	ND>150	12,360.	0.44	1,691.74	2.	-	4.6
	980218-MW4-57-01	18-Feb-98	15,600.	35.	530.	240.	16,405.	0.28	2,357.88	2.	ND>0.05	47.
	980603-MW4-57-18	3-Jun-98	10,100.	58.	540.	170.	10,868.	0.77	2,299.	1.9	0.008[6]	-
	980826-MW4-57-13	26-Aug-98	13,800.	37.	560.	280.	14,677.	22.34	2,471.34	1.4	0.1	-
	981119-MW4-57-20	19-Nov-98	11,100.	ND>25	470.	110.	11,680.	0.34	1,968.	1.8	0.5	-
	990217-MW4-57-016	17-Feb-99	14,400.	10.6	639.	220.	15,269.6	0.32	1,575.28	1.4	ND>0.02	-
	990514-MW4-57-22	14-May-99	15,900.	ND>50	750.	ND>150	16,650.	0.39	1,684.32	1.8	-	-
	990825-MW4-57-17	25-Aug-99	17,500.	54.8	493.	ND>150	18,047.8	0.4	2,305.4	1.7	ND>0.02	-
	991028-MW4-57-21	28-Oct-99	6,900.	12.	461.	144.	7,517.	ND	1,692.	0.65	ND>0.02	-
	000403-MW4-57-121	3-Apr-00	19,300.	8.64	452.	137.	19,897.6	0.47	2,765.74	0.74	0.17	-
	001006-MW4-57-19	6-Oct-00	15,000.	ND>100	574.	ND>300	15,574.	0.38	2,498.	-	ND>0.02	-
	010329-MW4-57-120	29-Mar-01	18,800.	ND>50	730.	ND>150	19,530.	0.43	3,063.35	0.7	ND>0.08	-
	020405-MW4-57-117	5-Apr-02	18,800.	ND>500	805.	ND>1,000	19,605.	0.21	2,249.96	3.43	ND>0.400	-
	030320-MW4-57-117	20-Mar-03	17,000.	ND>100	770.	ND>300	17,770.	ND	2,233.4	1.3	ND>0.040	-
MW4-101	981117-MW4-101-09	17-Nov-98	32.	ND>0.5	3.3	2.1	37.4	ND	20.	0.62	0.2	-
	990216-MW4-101-007	16-Feb-99	18.9	ND>0.5	1.9	ND>1.5	20.8	ND	8.3	0.64	0.03	-
	990514-MW4-101-19	14-May-99	95.	ND>0.5	10.4	2.05	107.5	ND	68.31	0.47	0.12	-
	990514-MW4-101-20	14-May-99	99.4	ND>0.5	13.	ND>1.5	112.4	ND	62.5	0.48	-	-
	990824-MW4-101-09	24-Aug-99	53.1	3.	4.76	ND>7.5	60.9	ND	190.64	0.56	0.03	-
	991027-MW4-101-11	27-Oct-99	7.25	ND>0.5	4.17	ND>1.5	11.4	ND	166.65	0.36	ND>0.02	-
	000329-MW4-101-111	29-Mar-00	3.96	ND>0.5	1.33	ND>1.5	5.3	ND	21.57	0.52	0.11	-
	001005-MW4-101-09	5-Oct-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	1.36	-	0.08	-
	010328-MW4-101-110	28-Mar-01	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	1.14	0.2	ND>0.02	-
	011009-MW4-101-103	9-Oct-01	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	1.18	0.66	-	-
	020404-MW4-101-110	4-Apr-02	5.17	ND>0.500	ND>0.500	ND>1.50	5.2	ND	5.97	0.43	ND>0.0400	-
	020924-MW4-101-102	24-Sep-02	43.	ND>0.50	ND>0.50	ND>1.5	43.	ND	12.63	0.49	-	-
	030318-MW4-101-109	18-Mar-03	120.[A]	ND>2.5[A]	ND>2.5[A]	ND>7.5[A]	120.	ND	15.63	0.51	ND>0.040	-

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Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW5-32	951205-MW5-32-01	5-Dec-95	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	7.59	207.69	0.1	-	-
	960319-MW5-32-01	19-Mar-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	29.81	268.91	0.11	-	-
	960319-MW5-32-01 (dissolved)	19-Mar-96	-	-	-	-	-	ND	45.	-	-	-
	960620-MW5-32-01	20-Jun-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	14.	83.	0.05	-	-
	961001-MW5-32-01	1-Oct-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	277.	773.	0.14	-	-
	970225-MW5-32-01	25-Feb-97	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	1.	9.7	0.11	-	-
	970827-MW5-32-01	27-Aug-97	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	10.4	24.3	0.14	-	-
	980217-MW5-32-01	17-Feb-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	3.23	7.57	0.17	ND>0.01	-
	980602-MW5-32-10	2-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	36.	95.	0.18	0.04	-
	980826-MW5-32-09	26-Aug-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	273.7	540.4	0.23	0.01	-
	981118-MW5-32-13	18-Nov-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	1.4	4.7	0.25	0.05	-
	990216-MW5-32-011	16-Feb-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	2.57	6.89	0.13	ND>0.02	-
	990514-MW5-32-17	14-May-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.8	2.4	0.15	-	-
	990824-MW5-32-13	24-Aug-99	0.75	0.74	0.68	1.74	3.9	8.82	21.15	0.18	0.03	-
	991027-MW5-32-15	27-Oct-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	6.68	16.16	0.19	ND>0.02	-
	000330-MW5-32-115	30-Mar-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	4.45	8.97	ND>0.02	ND>0.02	-
	001005-MW5-32-12	5-Oct-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	1.66	3.	-	0.04	-
	010329-MW5-32-114	29-Mar-01	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	10.12	19.65	0.18	0.17	-
MW5-100	981118-MW5-100-14	18-Nov-98	5,000.	ND>5.0	330.	320.	5,650.	ND	7,127.	0.66	ND>0.01	-
	990217-MW5-100-018	17-Feb-99	6,650.	ND>25	244.	242.	7,136.	ND	5,032.73	0.66	0.06	-
	990514-MW5-100-18	14-May-99	11,400.	6.75	613.	611.	12,630.8	ND	7,482.13	0.44	ND>0.02	-
	990825-MW5-100-18	25-Aug-99	11,800.	ND>250	534.	ND>750	12,334.	ND	13,330.3	0.84	ND>0.02	-
	991028-MW5-100-19	28-Oct-99	10,300.	ND>50	644.	552.	11,496.	ND	7,471.79	0.69	ND>0.02	-
	000330-MW5-100-119	30-Mar-00	9,550.	ND>25	575.	525.	10,650.	0.1	9,825.06	0.56	ND>0.02	-
	001006-MW5-100-15	6-Oct-00	9,180.	ND>50	513.	472.	10,165.	ND	10,104.	-	0.08	-
	001006-MW5-100-16	6-Oct-00	9,020.	ND>100	468.	412.	9,900.	ND	9,218.	-	0.09	-
	010329-MW5-100-118	29-Mar-01	9,560.	ND>100	436.	ND>300	9,996.	ND	9,619.8	0.14	0.14	-
	020405-MW5-100-114	5-Apr-02	8,750.	ND>500	ND>500	ND>1,000	8,750.	1.1	82,319.6	1.8	ND>0.400	-
	020405-MW5-100-115	5-Apr-02	8,950.	ND>500	ND>500	ND>1,000	8,950.	0.25	4,321.28	1.54	ND>0.080	-
	030319-MW5-100-114	19-Mar-03	6,600.[A]	ND>25[A]	400.[A]	250.[A]	7,250.	ND	5,614.	0.56	ND>0.040	-

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Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW5-175	981116-MW5-175-07	16-Nov-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.02	ND>0.01	-
	990215-MW5-175-003	15-Feb-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.02	ND>0.02	-
	990512-MW5-175-07	12-May-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.02	ND>0.02	-
	990823-MW5-175-03	23-Aug-99	ND>0.5	1.16	ND>0.5	ND>1.5	1.2	ND	0.2	ND>0.02	ND>0.02	-
	991026-MW5-175-06	26-Oct-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.02	ND>0.02	-
	000329-MW5-175-106	29-Mar-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.02	ND>0.02	-
	001004-MW5-175-05	4-Oct-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	-	ND>0.02	-
	010328-MW5-175-105	28-Mar-01	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.02	ND>0.02	-
	011009-MW5-175-102	9-Oct-01	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	ND	ND>0.02	-	-
	020404-MW5-175-105	4-Apr-02	ND>1.00	ND>1.00	ND>1.00	ND>2.00	ND	ND	ND	ND>0.0400	ND>0.0400	-
	020924-MW5-175-101	24-Sep-02	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	-	-	-
	030318-MW5-175-105	18-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	ND>0.040	ND>0.040	-
MW6-32	951207-MW6-32-01	7-Dec-95	3,000.	150.	960.	740.	4,850.	7,470.	199,570.	0.09	-	ND
	960319-MW6-32-01	19-Mar-96	640.	22.	400.	270.	1,332.	6.56	2,346.46	0.21	-	-
	960319-MW6-32-01 (dissolved)	19-Mar-96	-	-	-	-	-	ND	1,940.	-	-	-
	960617-MW6-32-01	17-Jun-96	410.	40.	280.	410.	1,140.	16.	1,878.	0.23	-	-
	960930-MW6-32-01	30-Sep-96	1,100.	34.	470.	320.	1,924.	203.5	4,757.7	0.02	-	-
	970224-MW6-32-01	25-Feb-97	1,100.	22.	370.	80.	1,572.	ND	1,308.	0.22	-	-
	970826-MW6-32-01	26-Aug-97	1,200.	27.	420.	280.	1,927.	15.	2,069.65	0.15	-	-
	980216-MW6-32-01	16-Feb-98	1,700.	ND>250	650.	ND>750	2,350.	161.9	3,554.2	0.18	ND>0.01	-
	980601-MW6-32-04	1-Jun-98	1,200.	32.	300.	190.	1,722.	20.	2,245.	0.1	ND>0.01	-
MW6-61	951206-MW6-61-01	6-Dec-95	6.7	0.71	8.9	5.8	22.1	8.17	744.89	0.23	-	ND
	960319-MW6-61-01	19-Mar-96	11.	0.68	9.2	5.3	26.2	3.29	196.96	0.28	-	-
	960620-MW6-61-01	20-Jun-96	8.4	ND>0.5	6.	3.3	17.7	4.3	139.	0.27	-	-
	961001-MW6-61-01	1-Oct-96	20.	0.93	16.	8.	44.9	3.8	152.9	0.3	-	-
	970225-MW6-61-01	25-Feb-97	82.	6.1	79.	41.	208.1	ND	365.	0.35	-	-
	970828-MW6-61-01	28-Aug-97	130.	11.	180.	120.	441.	4.88	1,451.5	0.41	-	-

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Table 2c - Summary of Analytical Results for Quality Assurance / Quality Control (QA/QC) Samples
March 2003 Sampling Event

QA/QC Sample Type	HAI Sample Number [1]	Sample Date	Comment	Analytical Results ug/l (ppb)					
				EPA Method 8021					EPA Method 8270
				Select Aromatic VOCs (AVOCs)					
				Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Total PAHs
Trip Blank	17-MW7-100	17-Mar-03	Trip Blank	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	-
Trip Blank	18-MW7-102	18-Mar-03	Trip Blank	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	-
Equipment Blank	18-MW7-106	18-Mar-03	DI Water sampled from decontaminated pump after sampling MW5-175 and before sampling MW15-66	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND>0.10
Trip Blank	19-MW7-110	19-Mar-03	Trip Blank	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	-
Trip Blank	20-MW7-116	20-Mar-03	Trip Blank	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	-
Equipment Blank	20-MW7-119	20-Mar-03	DI Water sampled from decontaminated pump after sampling MW4-57 and before sampling MW8-56	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	Phenanthrene = 0.14 All Others = ND>0.10
Trip Blank	21-MW7-121	21-Mar-03	Trip Blank	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	-

Note:
'-' = not analyzed
BTEX = benzene, toluene, ethylbenzene, and xylenes
EPA = U.S. Environmental Protection Agency
ND = not detected above detection limit indicated

1 = Sample Prefix: 2708-0303

PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ug/l = micrograms/liter

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Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW08-29	951207-MW8-29-01	7-Dec-95	2,100.	510.	200.	320.	3,130.	315.	7,688.	3.11	-	114.
	960321-MW8-29-01	21-Mar-96	1,700.	380.	170.	400.	2,650.	143.7	7,879.7	2.4	-	-
	960619-MW8-29-01	20-Jun-96	-	-	-	-	-	5.4	2,087.	-	-	-
	960619-MW8-29-02	20-Jun-96	1,300.	310.	170.	380.	2,160.	13.	2,166.	-	-	10.
	961002-MW8-29-01	2-Oct-96	770.	210.	130.	270.	1,380.	25.9	6,086.4	0.52	-	ND
	970226-MW8-29-01	26-Feb-97	860.	200.	150.	250.	1,460.	10.	6,204.	1.46	-	100.
	970828-MW8-29-01	28-Aug-97	390.	130.	110.	190.	820.	171.7	11,712.7	3.4	-	36.
	980218-MW8-29-01	18-Feb-98	620.	220.	170.	250.	1,260.	22.19	11,760.19	2.6	ND>0.01	ND
	980603-MW8-29-19	3-Jun-98	700.	320.	250.	310.	1,580.	196.	12,407.	4.9	0.022[6]	-
	981119-MW8-29-22	19-Nov-98	260.	80.	93.	130.	563.	11.1	5,377.	2.5	-	-
	990513-MW8-29-14	13-May-99	209.	64.7	58.6	92.5	424.8	10.73	6,444.82	2.6	-	-
	991029-MW8-29-23	29-Oct-99	168.	50.3	51.4	70.8	340.5	ND	3,302.	60.	2.	-
	000403-MW8-29-123	3-Apr-00	181.	49.5	46.2	ND>75	276.7	7.42	7,158.23	0.61	0.03	-
	010330-MW8-29-123	30-Mar-01	104.	17.4	19.	33.5	173.9	49.12	2,291.24	0.92	0.04	-
MW8-56	951207-MW8-56-01	7-Dec-95	13,000.	1,700.	850.	1,300.	16,850.	156.	21,200.	0.58	-	-
	960321-MW8-56-01	21-Mar-96	17,000.	820.	730.	1,600.	20,150.	361.1	15,501.1	0.54	-	-
	960620-MW8-56-01[7]	20-Jun-96	17,000.	650.	740.	1,100.	19,490.	35.	1,769.	0.31	-	-
	961002-MW8-56-01	2-Oct-96	20,000.	690.	900.	1,800.	23,390.	114.	11,742.	-	-	-
	970226-MW8-56-01	26-Feb-97	19,000.	630.	820.	1,100.	21,550.	ND	13,692.	0.7	-	-
	970828-MW8-56-01	28-Aug-97	17,000.	350.	510.	810.	18,670.	20.	18,141.	0.66	-	-
	980218-MW8-56-01	18-Feb-98	20,200.	410.	740.	1,100.	22,450.	11.18	12,944.88	0.74	ND>0.01	-
	980603-MW8-56-21	3-Jun-98	17,900.	470.	940.	1,300.	20,610.	68.	17,720.	0.77	0.018[6]	-
	981119-MW8-56-23	19-Nov-98	18,200.	350.	730.	890.	20,170.	ND	11,024.	0.36	-	-
	990513-MW8-56-15	13-May-99	20,600.	254.	663.	763.	22,280.	ND	11,960.	0.57	-	-
	991029-MW8-56-24	29-Oct-99	9,890.	352.	990.	1,100.	12,332.	4.23	12,537.17	2.1	ND>0.08	-
	000403-MW8-56-124	3-Apr-00	17,800.	228.	828.	830.	19,686.	31.1	14,016.8	0.58	ND>0.02	-
	010330-MW8-56-122	30-Mar-01	21,600.	ND>125	820.	458.	22,878.	40.42	14,953.54	0.27	ND>0.02	-
	020405-MW8-56-118	5-Apr-02	26,400.	ND>1.00	1,000.	ND>2.00	27,400.	1.94	7,143.	1.13	ND>0.0800	-
	030320-MW8-56-120	20-Mar-03	20,000.[A]	260.[A]	940.[A]	930.[A]	22,130.	4.2	7,712.2	0.51	ND>0.040	-

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Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW9-29	951205-MW9-29-01	5-Dec-95	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	1.29		-	-
	960318-MW9-29-01	18-Mar-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	1.6	ND>0.01	-	-
	960618-MW9-29-01	18-Jun-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	0.15	ND>0.01	-	-
	961001-MW9-29-01	1-Oct-96	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	0.4	**0.02**	-	-
	970225-MW9-29-01	25-Feb-97	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	ND	ND	**0.01**	-	-
	970827-MW9-29-01	27-Aug-97	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.02	-	-
	980217-MW9-29-01	17-Feb-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.02	-	-
	980602-MW9-29-07	2-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.02	-	-
	981116-MW9-29-02	16-Nov-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	**0.03**	-	-
	990511-MW9-29-03	11-May-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.02	-	-
	991026-MW9-29-02	26-Oct-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.02	ND>0.02	-
	000328-MW9-29-102	28-Mar-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.02	ND>0.02	-
	010327-MW9-29-102	27-Mar-01	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	**0.03**	ND>0.02	-
	020403-MW9-29-101	3-Apr-02	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	ND	ND>0.0400	ND>0.0400	-
	030318-MW9-29-103	18-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	**0.04**	ND>0.040	-
MW10-25	951207-MW10-25-01	7-Dec-95	**120,000.**	42,000.	2,000.	9,200.	173,200.	18.	13,316.5	-	-	2,560.
	960320-MW10-25-01	20-Mar-96	**32,000.**	38,000.	3,100.	13,000.	86,100.	5.9	9,126.31	**0.07**	-	2,690.
	960617-MW10-25-01	17-Jun-96	**28,000.**	32,000.	2,500.	8,600.	71,100.	6.8	10,266.	ND>0.01	-	1,820.
	960930-MW10-25-01	30-Sep-96	**17,000.**	5,000.	ND>200	4,500.	26,500.	78.6	10,529.5	**0.2**	-	4,350.
	970224-MW10-25-01	25-Feb-97	**180,000.**	54,000.	1,300.	6,800.	242,100.	74.	9,841.	**0.01**	-	ND>5,000
	970827-MW10-25-01	27-Aug-97	**168,000.**	54,000.	850.	6,000.	228,850.	19.6	7,047.1	-	-	2,960.
	980216-MW10-25-01	16-Feb-98	**186,000.**	51,100.	880.	6,500.	244,480.	58.1	9,165.2	ND>0.02	-	2,620.
	980601-MW10-25-02	1-Jun-98	**93,800.**	30,900.	670.	3,900.	129,270.	35.	12,162.	**0.21**	-	-

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Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water [2]			51. [4]	200,000. [4]	29,000. [4]	#	#	#	#	0.0052 [3]	#	#
MW10-61	951206-MW10-61-01	6-Dec-95	**75.**	130.	26.	110.	341.	0.72	829.72	-	-	ND
	960321-MW10-61-01	21-Mar-96	4.1	1.6	2.9	8.5	17.1	2.55	102.43	ND>0.01	-	-
	960620-MW10-61-01	20-Jun-96	0.9	ND>0.5	1.1	1.7	3.7	2.	46.	ND>0.01	-	ND
	960930-MW10-61-01	2-Oct-96	0.56	ND>0.5	0.69	1.1	2.4	1.5	25.15	ND>0.01	-	ND
	970226-MW10-61-01	26-Feb-97	ND>0.5	ND>0.5	ND>0.5	ND>0.5	ND	1.	18.	ND>0.01	-	8.4
	970828-MW10-61-01	28-Aug-97	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.39	7.76	ND>0.02	-	ND
	980218-MW10-61-01	18-Feb-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.4	3.8	ND>0.02	-	ND
	980603-MW10-61-16	3-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	1.6	6.2	ND>0.02	-	-
	981117-MW10-61-08	17-Nov-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	3.1	6.	ND>0.02	-	-
	990512-MW10-61-06	12-May-99	ND>0.5	0.69	ND>0.5	ND>1.5	0.7	0.57	1.3	ND>0.02	-	-
	991026-MW10-61-05	26-Oct-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.24	1.36	ND>0.02	ND>0.02	-
	000329-MW10-61-105	29-Mar-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.24	1.09	ND>0.02	ND>0.02	-
	011010-MW10-61-109	10-Oct-01	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	0.61	ND>0.02	-	-
	020404-MW10-61-109	4-Apr-02	ND>1.00	ND>1.00	ND>1.00	ND>2.00	ND	0.11	0.84	ND>0.0400	ND>0.0400	-
	020924-MW10-61-104	24-Sep-02	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	0.25	1.38	ND>0.040	-	-
	030319-MW10-61-111	19-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	0.95	ND>0.040	ND>0.040	-
MW11-32	951207-MW11-32-01	7-Dec-95	**25,000.**	5,400.	480.	2,800.	33,680.	20.	22,365.2	-	-	2,520.
	960320-MW11-32-01	20-Mar-96	**24,000.**	4,300.	970.	2,400.	31,670.	6.33	14,676.08	**0.24**	-	1,420.
	960617-MW11-32-01	17-Jun-96	**2,800.**	2,000.	1,000.	1,940.	7,740.	14.	11,608.	**0.19**	-	960.
	960930-MW11-32-01	30-Sep-96	**17,000.**	3,300.	900.	1,760.	22,960.	131.9	17,603.9	**0.25**	-	1,681.
	960930-MW11-32-02	30-Sep-96	-	-	-	-	-	189.	18,894.	-	-	-
	970224-MW11-32-01	25-Feb-97	**21,000.**	4,100.	750.	1,800.	27,650.	11.	11,536.	**0.22**	-	240.
	970826-MW11-32-01	26-Aug-97	**15,000.**	4,400.	1,100.	2,500.	23,000.	20.5	17,075.8	**0.17**	-	961.
	980216-MW11-32-01	16-Feb-98	**12,600.**	3,800.	930.	2,100.	19,430.	15.9	9,769.2	**0.2**	ND>0.01	450.
	980601-MW11-32-03	1-Jun-98	**16,800.**	4,000.	810.	1,800.	23,410.	112.	32,376.	**0.21**	ND>0.01	-

Koppers022999

Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW12-36	951207-MW12-36-01	7-Dec-95	95.	410.	170.	590.	1,265.	3.65	3,377.55	-	-	-
	960321-MW12-36-01	21-Mar-96	170.	180.	110.	550.	1,010.	0.38	2,010.03	ND>0.01	-	ND
	960620-MW12-36-01	20-Jun-96	250.	250.	120.	440.	1,060.	0.8	1,621.	ND>0.01	-	-
	961002-MW12-36-01	2-Oct-96	330.	390.	130.	510.	1,360.	0.8	1,375.	ND>0.01	-	-
	970226-MW12-36-01	26-Feb-97	260.	310.	120.	470.	1,160.	0.94	1,033.	ND>0.01	-	-
	970828-MW12-36-01	28-Aug-97	230.	430.	110.	430.	1,200.	0.67	839.77	ND>0.02	-	-
	980218-MW12-36-01	18-Feb-98	140.	370.	82.	280.	872.	0.69	708.	ND>0.02	-	-
	980603-MW12-36-17	3-Jun-98	150.	350.	74.	340.	914.	ND	697.	ND>0.02	-	-
	981119-MW12-36-18	19-Nov-98	140.	370.	99.	360.	969.	0.8	487.	ND>0.02	-	-
	990513-MW12-36-12	13-May-99	226.	621.	171.	554.	1,572.	0.53	491.4	1.1	-	-
	991028-MW12-36-18	28-Oct-99	309.	802.	293.	797.	2,201.	0.6	545.93	ND>0.02	ND>0.02	-
	000330-MW12-36-118	30-Mar-00	326.	675.	296.	700.	1,997.	1.74	648.98	ND>0.02	ND>0.02	-
	010329-MW12-36-117	29-Mar-01	99.3	380.	168.	307.	954.3	0.69	415.04	ND>0.02	ND>0.02	-
	020404-MW12-36-112	4-Apr-02	146.	351.	235.	501.	1,233.	0.5	375.88	ND>0.0400	ND>0.0400	-
	030319-MW12-36-113	19-Mar-03	200.	400.	290.	680.	1,570.	0.31	369.18	ND>0.040	ND>0.040	-
MW13-30	980217-MW13-30-01	17-Feb-98	6,900.	ND>50	370.	ND>150	7,270.	ND	426.1	0.28	ND>0.01	-
	980602-MW13-30-12	2-Jun-98	5,200.	13.	380.	120.	5,713.	ND	1,181.	0.28	ND>0.01	-
	980826-MW13-30-11	26-Aug-98	13,900.	20.	550.	220.	14,690.	ND	742.3	0.42	0.42	-
	981119-MW13-30-19	19-Nov-98	550.	4.3	110.	53.	717.3	ND	399.	0.28	0.02	-
	990217-MW13-30-014	17-Feb-99	2,360.	11.1	407.	229.	3,007.1	ND	770.59	0.1	ND>0.02	-
	990513-MW13-30-13	13-May-99	896.	8.9	261.	175.	1,340.9	ND	1,035.62	0.12	-	-
	991028-MW13-30-20	28-Oct-99	650.	ND>10	147.	56.5	853.5	ND	822.	0.02	ND>0.02	-
	000403-MW13-30-120	3-Apr-00	5,550.	5.67	175.	77.4	5,808.1	ND	720.84	0.14	ND>0.02	-
	001005-MW13-30-18	5-Oct-00	577.	ND>50	344.	302.	1,223.	ND	410.	-	ND>0.02	-
	010329-MW13-30-119	29-Mar-01	290.	ND>10	122.	ND>30	412.	ND	522.96	0.05	0.04	-
	020405-MW13-30-116	5-Apr-02	79.9	309.	227.	295.	910.9	ND	451.65	ND>0.0400	ND>0.0400	-
	030319-MW13-30-115	19-Mar-03	1,400.	9.2	330.	110.	1,849.2	ND	1,008.4	0.1	ND>0.040	-

Koppers023000

Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW13-61	980218-MW13-61-01	18-Feb-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	**0.14**	ND>0.01	-
	980602-MW13-61-13	2-Jun-98	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	**0.13**	ND>0.01	-
	980825-MW13-61-03	25-Aug-98	2.1	ND>0.5	ND>0.5	ND>1.5	2.1	ND	ND	**0.15**	0.09	-
	981116-MW13-61-03	16-Nov-98	1.4	ND>0.5	ND>0.5	ND>1.5	1.4	ND	0.2	**0.15**	0.15	-
	990512-MW13-61-04	12-May-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	0.26	**0.07**	-	-
	991026-MW13-61-03	26-Oct-99	1.39	ND>0.5	ND>0.5	ND>1.5	1.4	ND	0.62	**0.11**	ND>0.02	-
	000328-MW13-61-104	28-Mar-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	**0.09**	0.04	-
	001004-MW13-61-03	4-Oct-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	0.68	-	ND>0.02	-
	010327-MW13-61-103	27-Mar-01	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	**0.09**	ND>0.02	-
	011009-MW13-61-106	9-Oct-01	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	0.28	**0.19**	-	-
	020403-MW13-61-102	3-Apr-02	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	ND	**0.21**	ND>0.0400	-
	020924-MW13-61-106	24-Sep-02	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	-	-	-
	030317-MW13-61-101	17-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	**0.13**	ND>0.040	-
MW14-110	981116-MW14-110-06	16-Nov-98	3.2	ND>0.5	ND>0.5	ND>1.5	3.2	ND	ND	**0.05**		-
	990216-MW14-110-005	16-Feb-99	12.7	ND>0.5	0.6	ND>1.5	13.3	ND	0.11	**0.04**	ND>0.02	-
	990512-MW14-110-09	12-May-99	22.1	ND>0.5	1.88	2.4	26.4	ND	0.28	**0.03**	0.03	-
	990823-MW14-110-06	23-Aug-99	45.6	0.75	1.85	2.09	50.3	ND	0.41	**0.05**	ND>0.02	-
	991027-MW14-110-09	27-Oct-99	28.6	0.81	1.45	ND>1.5	30.9	ND	0.26	**0.04**	ND>0.02	-
	991027-MW14-110-10	27-Oct-99	29.7	0.57	1.52	ND>1.5	31.8	ND	0.27	**0.03**	ND>0.02	-
	000329-MW14-110-109	29-Mar-00	7.84	ND>0.5	0.73	ND>1.5	8.6	ND	0.42	**0.03**	ND>0.02	-
	000329-MW14-110-110	29-Mar-00	8.9	0.5	0.83	ND>1.5	10.2	ND	0.42	**0.03**	ND>0.02	-
	000615-MW14-110-102	15-Jun-00	4.85	ND>0.5	ND>0.5	ND>1.5	4.9	ND	0.2	-	ND>0.02	-
	001005-MW14-110-06	5-Oct-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	-	ND>0.02	-
	001220-MW14-110-102	20-Dec-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	0.14	-	ND>0.02	-
	010328-MW14-110-108	28-Mar-01	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	0.23	ND>0.02	ND>0.02	-
	010628-MW14-110-102	28-Jun-01	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	0.18	-	0.025	-
	011009-MW14-110-105	9-Oct-01	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	ND	**0.05**	-	-
	011213-MW14-110-101	13-Dec-01	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	ND	-	ND>0.0200	-
	020404-MW14-110-108	4-Apr-02	ND>1.00	ND>1.00	ND>1.00	ND>2.00	ND	ND	0.1	ND>0.0400	ND>0.0400	-
	020711MW14-110-101	11-Jul-02	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	ND	ND>0.0400	ND>0.0400	-
	020924-MW14-110-105	24-Sep-02	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	0.1	-	-	-
	021217-MW14-110-102	17-Dec-02	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	-	ND>0.040	-
	030318-MW14-110-108	18-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	ND>0.040	ND>0.040	-
	030602-MW14-110-101	2-Jun-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	-	ND>0.040	-

Koppers023001

Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW15-50	990728-MW15-50-04	28-Jul-99	95,100.	863.	223.	2,420.	98,606.	ND	18,460.	ND>0.020	ND>0.02	-
	991029-MW15-50-25	29-Oct-99	8,910.	134.	59.2	500.	9,603.2	ND	762.	0.15	ND>0.02	-
	000403-MW15-50-125	3-Apr-00	44,800.	620.	222.	2,300.	47,942.	3.31	5,610.74	0.07	ND>0.02	-
	000615-MW15-50-105	15-Jun-00	1,490.	14.3	6.62	42.	1,552.9	267.65	475.	-	ND>0.02	-
	000615-MW15-50-106	15-Jun-00	1,270.	10.	5.16	28.4	1,313.6	253.67	451.	-	ND>0.02	-
	001005-MW15-50-14	5-Oct-00	2,700.	5.65	3.83	15.2	2,724.7	74.38	128.96	-	ND>0.02	-
	001221-MW15-50-105	21-Dec-00	40,200.	356.	176.	1,620.	42,352.	158.93	9,661.17	-	0.03	-
	001221-MW15-50-106	21-Dec-00	46,200.	ND>125	ND>125	1,070.	47,270.	199.16	8,730.64	-	0.06	-
	010330-MW15-50-124	30-Mar-01	47,600.	270.	133.	1,250.	49,253.	87.50	7,233.48	0.15	0.09	-
	010628-MW15-50-105	28-Jun-01	2,580.	ND>25	ND>25	ND>75	2,580.	2.61	189.	-	0.089	-
	010628-MW15-50-106	28-Jun-01	3,420.	ND>25	ND>25	ND>75	3,420.	8.33	231.	-	0.105	-
	011010-MW15-50-111	10-Oct-01	44,000.	110.	208.	960.	45,278.	14.52	3,839.07	0.11	-	-
	011010-MW15-50-112	10-Oct-01	44,700.	109.	210.	970.	45,989.	48.20	59,423.3	0.07	-	-
	011214-MW15-50-104	14-Dec-01	64,000.	ND>500	ND>500	ND>1,500	64,000.	0.98	4,666.89	-	ND>0.0200	-
	011214-MW15-50-105	14-Dec-01	63,000.	ND>500	ND>500	ND>1,500	63,000.	1.27	6,034.96	-	ND>0.0200	-
	020405-MW15-50-119	5-Apr-02	57,000.	ND>1.00	ND>1.00	ND>2.00	57,000.	9.76	4,353.97	0.1	ND>0.0400	-
	020711-MW15-50-104	11-Jul-02	53,500.	ND>250	ND>250	ND>750	53,500.	15.50	3,796.	ND>0.0400	ND>0.0400	-
	020711-MW15-50-105	11-Jul-02	58,000.	ND>250	ND>250	ND>750	58,000.	24.80	5,788.	ND>0.0400	ND>0.0400	-
	020925-MW15-50-110	25-Sep-02	49,000.	320.	230.	1,300.	50,850.	65.30	8,044.4	0.072	-	-
	020925-MW15-50-111	25-Sep-02	50,000.	340.	250.	1,400.	51,990.	17.20	7,971.3	0.076	-	-
	021218-MW15-50-107	18-Dec-02	48,000.	450.	260.	1,600.	50,310.	42.00	7,494.	-	ND>0.040	-
	030321-MW15-50-122	21-Mar-03	49,000.	310.	ND>250	ND>750	49,310.	ND	5,042.	0.07	ND>0.040	-
	030603-MW15-50-105	3-Jun-03	47,000.	300.	260.	1,300.	48,860.	ND	3,405.	-	0.15	-

Koppers023002

Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
MW15-66	990728-MW15-66-03	28-Jul-99	3.61	ND>0.5	ND>0.5	ND>1.5	3.6	0.83	2.5	ND>0.020	ND>0.02	-
	990823-MW15-66-04	23-Aug-99	0.72	ND>0.5	ND>0.5	ND>1.5	0.7	-	-	-	-	-
	991026-MW15-66-07	26-Oct-99	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	ND	ND	ND>0.020	ND>0.02	-
	000329-MW15-66-108	29-Mar-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	3.91	6.93	ND>0.02	ND>0.02	-
	000615-MW15-66-104	15-Jun-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	12.17	22.1	-	ND>0.02	-
	001005-MW15-66-08	5-Oct-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	1.36	2.34	-	ND>0.02	-
	001221-MW15-66-104	21-Dec-00	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.8	1.34	-	ND>0.02	-
	010328-MW15-66-107	28-Mar-01	ND>0.5	ND>0.5	ND>0.5	ND>1.5	ND	0.61	1.1	ND>0.02	ND>0.02	-
	010628-MW15-66-104	28-Jun-01	1.65	ND>0.500	ND>0.500	ND>1.50	1.65	ND	0.28	-	ND>0.02	-
	011010-MW15-66-110	10-Oct-01	ND>0.500	ND>0.500	ND>0.500	ND>1.51	ND	ND	ND	ND>0.02	-	-
	011213-MW15-66-103	13-Dec-01	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	ND	-	ND>0.0200	-
	020404-MW15-66-107	4-Apr-02	ND>1.00	ND>1.00	ND>1.00	ND>2.00	ND	ND	0.12	ND>0.0400	ND>0.0400	-
	020711-MW15-66-103	11-Jul-02	ND>0.500	ND>0.500	ND>0.500	ND>1.50	ND	ND	ND	ND>0.0400	ND>0.0400	-
	020925-MW15-66-109	25-Sep-02	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	ND>0.040	-	-
	021218-MW15-66-105	18-Dec-02	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	-	ND>0.040	-
	021218-MW15-66-106	18-Dec-02	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	ND	-	ND>0.040	-
	030318-MW15-66-107	18-Mar-03	ND>0.50	ND>0.50	ND>0.50	ND>1.5	ND	ND	0.1	ND>0.040	ND>0.080	-
	030603-MW15-66-104	3-Jun-03	31.	ND>0.50	ND>0.50	ND>1.5	31.	4.	7.41	-	ND>0.040	-

Koppers023003

Table 4a - Summary of Historical Analytical Results for Groundwater Samples: BTEX, Total PAHs, Total Phenols, and Cyanide
December 1995 to Present

Well Number	HAI Sample Number[1]	Sample Date	Analytical Results									
			EPA Method 8020 ug/l (ppb)					EPA Method 8270 SIM ug/l (ppb)		EPA 9010 mg/l (ppm)		EPA 8270 ug/l (ppb)
			Benzene	Toluene	Ethyl benzene	Xylenes	Total BTEX	Carcinogenic PAHs	Total PAHs	Total Cyanide	Amenable Cyanide	Total Phenols
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			51.[4]	200,000.[4]	29,000.[4]	#	#	#	#	0.0052[3]	#	#
Temporary Well Point Samples 1995												
B-01 at 23'	950921-BW1-01	21-Sep-95	6.9	2.5	3.1	56.	68.5	0.09	175.71	7.8	-	-
B-05 at 28'	950925-BW05-01	29-Sep-95	ND>0.5	0.97	ND>0.5	1.4	2.4	ND	34.78	ND>0.02	-	-
B-08 at 20'	950918-BW8-01	18-Sep-95	ND>0.5	0.85	ND>0.5	0.86	1.7	-	-	-	-	-
B-19 at 13'	950920-BW19-01	20-Sep-95	-	-	-	-	-	-	-	-	-	164.5
B-19 at 28'	950920-BW19-02	20-Sep-95	100,000.	39,000.	1,600.	11,000.	151,600.	0.7	6610.20	-	-	-
B-21 at 19.5'	951003-BW21-01	3-Oct-95	ND>0.5	1.2	1.9	3.3	6.4	2.93	726.25	-	-	ND
B-31 at 29'	950925-BW31-01	25-Sep-95	3.	1.6	10.	13.	27.6	13.28	694.58	ND>0.02	-	-
HydroPunch Samples 1998												
M-4 at 86'	981014-BW4-01	14-Oct-98	12.	ND>0.5	ND>0.5	ND>1.5	12.	-	-	-	-	-
M-4 at 112'	981014-BW4-02	15-Oct-98	1.5	ND>0.5	ND>0.5	1.9	3.4	-	-	-	-	-
M-5 at 52.5'	981020-BW5-03	20-Oct-98	2,100.	3.7	39.	440.	2,582.7	-	-	-	-	-
M-5 at 52.5' DUP	981020-BW5-04	20-Oct-98	2,000.	ND>5.0	37.	470.	2,507.	-	-	-	-	-
M-5 at 72.5'	981020-BW5-05	20-Oct-98	8.5	ND>0.5	1.1	6.2	15.8	-	-	-	-	-
M-5 at 95'	981020-BW5-06	20-Oct-98	2,000.	3.2	150.	270.	2,423.2	-	-	-	-	-
M-5 at 122'	981020-BW5-07	21-Oct-98	5.3	ND>0.5	ND>0.5	ND>1.5	5.3	-	-	-	-	-
M-5 at 152	981020-BW5-08	21-Oct-98	18.	ND>0.5	1.8	ND>1.5	19.8	-	-	-	-	-

Note:
'-' = Not Analyzed
# = Reference Level not established
A = this analysis was performed on a VOA sample containing headspace
AWQC = Ambient Water Quality Criteria
Bold and shaded = Detected above Lowest Identified Reference Level
BTEX = benzene, toluene, ethylbenzene, and xylenes
DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
mg/l = milligrams per liter
ND = not detected above detection limit indicated
PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ppm = parts per million
ug/l = micrograms per liter

1 = Sample number prefix: 2708-
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (EPA-822-R-02-047, November 2002) based on Freshwater Chronic (Aquatic Life Protection) and Fish Consumption (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
4 = Reference Level based on Human Fish Consumption Criteria of AWQC
5 = Due to mislabeling in the field or due to laboratory misidentification, the laboratory report transposed results for MW4-35 and MW-4-57 in August 1997. Tables attribute data to the correct well.
6 = Sample was analyzed outside of recommended holding time
7 = PAH results for sample 960620-MW8-56-01 should be considered qualitative due to an apparent error concerning sample identity.

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Table 4b - Summary of Historical Analytical Results for Groundwater Samples: PAHs by EPA Method 8270
December 1995 to Present

PAHs by EPA Method 8270 (SIM)			Analytical Results ug/l (ppb)																		
			Carcinogenic PAHs							Non-carcinogenic PAHs											
Well Number	HAI Sample Number[1]	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (a,h) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (g,h,i) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	990.[3]	#	40,000[4]	#	140.[4]	5,300.[4]	620.[3]	#	4,000.[4]	#	#
MW1-22	951207-MW1-22-01	7-Dec-95	24.	13.	4.8	12.	32.	1.3	6.3	11.	2.6	52.	9.3	74.	16.	39.	100.	68.	93.4	465.
	960319-MW1-22-01	19-Mar-96	1.2	0.7	0.28	0.64	1.6	ND [5]	0.29	9.6	0.33	4.1	0.41	4.4	7.3	90.	15.	4.6	4.71	140.
	960618-MW1-22-01	18-Jun-96	0.59	0.33	0.14	0.34	0.68	ND [5]	0.15	7.6	0.26	3.3	0.21	2.5	6.2	75.	12.	2.9	2.23	112.
	961001-MW1-22-01	1-Oct-96	1.7	1.4	ND [5]	1.3	1.8	ND [5]	ND [5]	55.	0.98	15.	0.99	7.	59.	440.	130.	6.	6.2	720.
	970225-MW1-22-01	25-Feb-97	0.36	0.13	ND [5]	0.12	0.3	ND [5]	ND [5]	3.7	ND [5]	1.6	ND [5]	1.8	3.1	47.	6.5	1.9	0.91	67.
	970225-MW1-22-02	25-Feb-97	0.72	0.34	0.12	0.31	0.64	ND [5]	0.1	3.2	ND [5]	1.6	0.13	2.1	2.9	44.	5.5	2.5	2.23	64.
	970827-MW1-22-01	27-Aug-97	3.8	4.	1.4	3.9	4.8	ND [5]	2.1	70.	1.6	16.	2.6	12.	75.	550.	230.	11.	20.	988.
	970827-MW1-22-02	27-Aug-97	5.2	5.4	2.	5.6	6.7	ND [5]	3.2	66.	ND [5]	19.	3.8	14.	73.	350.	170.	12.	28.1	736.
	980217-MW1-22-01	17-Feb-98	1.1	0.8	0.26	0.76	0.98	0.1	0.48	1.2	ND [5]	1.5	0.58	2.7	1.4	4.7	3.5	3.2	4.48	23.
	980602-MW1-32-11	2-Jun-98	15.	21.	6.7	18.	21.	1.8	9.6	3.3	0.89	14.	13.	25.	4.9	3.3	23.	29.	93.1	209.
	980826-MW1-22-10	26-Aug-98	24.	37.	12.	32.	37.	3.6	16.	75.	2.9	51.	22.	55.	78.	390.	240.	62.	161.6	1,138.
	981118-MW1-22-15	18-Nov-98	0.61	0.7	0.29	0.72	0.78	ND [5]	0.32	58.	ND [5]	9.1	0.41	3.6	51.	340.	100.	3.2	3.42	569.
	990216-MW1-22-012	16-Feb-99	0.72	0.85	ND [5]	0.76	0.88	ND [5]	0.32	0.33	ND [5]	1.21	0.52	1.91	0.49	0.11	0.89	2.28	3.53	11.
	990513-MW1-22-11	13-May-99	0.66	0.66	0.25	0.55	0.75	ND>0.1	0.31	2.31	ND [5]	1.67	0.45	2.12	3.26	0.64	1.37	2.34	3.17	17.
	990824-MW1-22-15	24-Aug-99	10.6	9.2	7.97	12.1	17.3	2.08	8.94	62.3	1.42	16.2	11.3	24.6	64.1	340.	204.	24.8	68.19	817.
	991028-MW1-22-16	28-Oct-99	1.48	1.19	1.02	1.58	2.27	0.2	0.95	48.5	0.56	6.58	1.21	6.51	51.5	186.	109.	6.43	8.69	425.
	000330-MW1-22-116	30-Mar-00	0.21	ND [5]	ND [5]	ND [5]	0.21	ND [5]	ND [5]	4.52	ND [5]	2.22	ND [5]	2.84	4.63	42.4	3.03	2.29	0.42	62.
	010329-MW1-22-115	29-Mar-01	2.31	1.95	1.42	2.22	3.03	0.66	1.77	2.32	0.18	4.14	2.	6.73	3.35	3.97	6.78	8.23	13.36	51.
MW2-32	951206-MW2-32-01	6-Dec-95	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	4.	0.29	0.28	ND [5]	0.48	0.32	45.	0.51	0.67	ND	52.
	960318-MW2-32-01	18-Mar-96	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	4.	0.16	0.1	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.28	ND	4.5
	960618-MW2-32-01	18-Jun-96	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	1.5	0.23	0.15	ND [5]	ND [5]	0.22	0.09	ND [5]	0.41	ND	2.6
	961001-MW2-32-01	1-Oct-96	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	8.4	0.14	0.16	0.1	0.12	0.23	0.22	0.23	0.93	ND	10.5
	970225-MW2-32-01	25-Feb-97	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	1.1	ND [5]	ND [5]	ND [5]	ND [5]	0.15	ND [5]	ND [5]	0.37	ND	1.6
	970827-MW2-32-01	27-Aug-97	ND [5]	ND [5]	ND [5]	0.1	ND [5]	ND [5]	0.1	16.	0.17	0.19	0.14	ND [5]	0.21	0.17	ND [5]	0.96	0.2	18.
	980217-MW2-32-01	17-Feb-98	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	4.2	0.11	ND [5]	ND [5]	ND [5]	0.19	ND [5]	ND [5]	0.52	ND	5.
	980601-MW2-32-05	1-Jun-98	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	2.2	ND [5]	ND [5]	ND [5]	ND [5]	0.19	ND [5]	ND [5]	0.82	ND	3.2
	980825-MW2-32-04	25-Aug-98	0.17	0.37	ND [5]	0.35	0.2	ND [5]	0.3	4.	0.11	ND [5]	0.47	0.26	0.12	ND [5]	0.11	0.64	1.39	7.1
	981117-MW2-32-10	17-Nov-98	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND	ND
	990216-MW2-32-008	16-Feb-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	17.9	0.45	ND [5]	ND [5]	ND [5]	ND [5]	0.1	ND [5]	ND [5]	ND	18.5
	990513-MW2-32-10	13-May-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	8.08	0.1	ND [5]	ND [5]	ND [5]	0.26	ND [5]	ND [5]	0.58	ND	9.
	990824-MW2-32-10	24-Aug-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.11	5.08	ND [5]	0.12	0.18	ND [5]	0.15	ND [5]	0.11	0.54	0.11	6.3
	991027-MW2-32-12	27-Oct-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND	ND
	000329-MW2-32-112	29-Mar-00	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	1.55	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.26	ND [5]	0.42	ND	2.2
	010328-MW2-32-111	28-Mar-01	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND	ND
MW2-61	981116-MW2-61-04	16-Nov-98	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.33	ND [5]	ND [5]	ND	0.3
	990216-MW2-61-006	16-Feb-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.37	ND [5]	ND [5]	ND	0.4
	990512-MW2-61-05	12-May-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.54	ND [5]	ND [5]	ND	0.5
	990823-MW2-61-07	23-Aug-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND	ND
	991026-MW2-61-04	26-Oct-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND	ND
	000328-MW2-61-104	28-Mar-00	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND	ND
	001004-MW2-61-04	4-Oct-00	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND	ND
	010328-MW2-61-104	28-Mar-01	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND	ND
	011009-MW2-61-104	9-Oct-01	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND	ND
	020403-MW2-61-103	3-Apr-02	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND	ND
	020924-MW2-61-103	24-Sep-02	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND	ND
	030318-MW2-61-104	18-Mar-03	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND	ND

Koppers023005

Table 4b - Summary of Historical Analytical Results for Groundwater Samples: PAHs by EPA Method 8270
December 1995 to Present

PAHs by EPA Method 8270 (SIM)			Analytical Results ug/l (ppb)																		
			Carcinogenic PAHs							Non-carcinogenic PAHs											
Well Number	HAI Sample Number[1]	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (a,h) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (g,h,i) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	990.[3]	#	40,000[4]	#	140.[4]	5,300.[4]	620.[3]	#	4,000.[4]	#	#
MW3-26	951206-MW3-26-01	6-Dec-95	2.8	4.7	1.5	4.1	4.6	0.54	2.8	1.5	2.7	2.3	3.9	8.5	1.2	30.	4.7	9.4	21.04	85.
	960318-MW3-26-02	18-Mar-96	0.29	0.35	0.14	0.39	0.3	ND [5]	0.24	2.5	1.4	1.1	0.34	1.1	0.58	32.	0.36	1.3	1.71	42.
	960618-MW3-26-01	18-Jun-96	0.49	0.47	0.17	0.56	0.55	ND [5]	0.31	5.5	2.6	1.5	0.42	1.3	1.3	30.	0.79	1.9	2.55	48.
	961001-MW3-26-01	1-Oct-96	29.	41.	12.	47.	30.	ND [5]	23.	ND [5]	9.5	ND [5]	34.	36.	ND [5]	10.	8.6	54.	182.	334.
	970225-MW3-26-01	25-Feb-97	0.78	1.1	0.36	1.3	0.59	ND [5]	0.81	0.79	0.32	0.1	1.1	1.2	0.18	0.97	0.39	1.9	4.94	12.
	970827-MW3-26-01	27-Aug-97	4.1	5.7	2.	7.7	3.9	ND [5]	4.2	1.3	1.7	1.1	5.6	6.7	ND [5]	ND [5]	1.4	7.8	27.6	53.
	980217-MW3-26-01	17-Feb-98	0.68	1.5	0.39	1.8	0.44	0.35	1.9	0.18	0.5	0.24	2.4	1.	0.1	0.39	0.27	1.3	7.06	13.
	980602-MW3-26-09	2-Jun-98	13.	24.	5.7	26.	11.	3.1	17.	0.3	1.6	1.5	25.	27.	0.47	1.8	3.8	43.	99.8	204.
	980826-MW3-26-08	26-Aug-98	62.	130.	46.	160.	76.	16.	86.	ND [6]	19.	ND [6]	120.	90.	ND [6]	26.	21.	130.	576.	982.
	981117-MW3-26-12	17-Nov-98	3.9	7.1	2.1	9.2	3.7	0.93	5.3	ND [5]	1.7	ND [5]	7.5	6.6	ND [5]	1.8	0.9	8.1	32.23	59.
	990216-MW3-26-010	16-Feb-99	0.24	0.22	ND [5]	0.22	0.29	ND [5]	ND [5]	ND [5]	ND [5]	0.11	0.17	1.1	ND [5]	ND [5]	ND [5]	1.21	0.97	4.
	990514-MW3-26-23	14-May-99	0.46	1.04	0.26	1.14	0.42	0.16	0.95	1.57	0.4	0.3	1.36	1.04	0.93	1.25	0.5	1.44	4.42	13.
	990824-MW3-26-12	24-Aug-99	0.12	0.2	0.17	0.38	0.17	0.3	0.33	0.71	0.21	0.21	0.46	0.59	0.48	ND [5]	ND [5]	0.36	1.67	5.
	991027-MW3-26-14	27-Oct-99	0.77	1.14	0.94	1.9	1.08	0.23	1.17	ND [5]	0.3	0.18	1.57	1.14	0.33	0.19	0.17	1.45	7.23	13.
	000330-MW3-26-113	30-Mar-00	0.27	0.37	0.32	0.63	0.3	ND [5]	0.56	0.59	0.27	0.22	0.76	0.72	0.36	ND [5]	0.19	0.77	2.44	6.
	001005-MW3-26-11	5-Oct-00	0.22	0.69	0.24	0.89	0.26	0.11	0.55	0.13	0.29	0.24	0.71	0.65	0.16	0.2	0.11	0.7	2.96	6.
	010328-MW3-26-113	28-Mar-01	0.78	1.25	0.74	1.72	0.93	ND [5]	ND [5]	0.1	0.44	ND [5]	2.08	1.35	0.19	0.15	0.4	1.77	5.42	12.
MW03-56	951206-MW3-56-01	6-Dec-95	0.73	0.33	0.14	0.41	0.85	ND [5]	0.23	51.	46.	8.1	0.36	7.8	19.	1,200.	42.	7.8	2.69	1,385.
	960319-MW3-56-01	19-Mar-96	0.69	0.33	0.13	0.38	0.73	ND [5]	0.18	56.	70.	5.6	0.28	6.1	25.	1,700.	53.	8.3	2.34	1,927.
	960620-MW3-56-01	20-Jun-96	0.45	0.22	ND [5]	0.26	0.51	ND [5]	0.15	47.	56.	6.4	0.21	5.8	27.	1,300.	39.	8.1	1.59	1,491.
	961002-MW3-56-01	2-Oct-96	0.27	ND [5]	ND [5]	ND [5]	0.27	ND [5]	ND [5]	42.	62.	6.	ND [5]	6.7	27.	730.	58.	5.6	0.54	938.
	970226-MW3-56-01	26-Feb-97	0.33	ND [5]	ND [5]	ND [5]	0.29	ND [5]	ND [5]	42.	51.	ND [5]	ND [5]	3.2	21.	440.	53.	7.5	0.62	618.
	970828-MW3-56-01	28-Aug-97	0.28	0.13	ND [5]	0.13	0.28	ND [5]	ND [5]	21.	15.	7.3	ND [5]	7.	15.	85.	39.	5.4	0.82	196.
	980218-MW3-56-01	18-Feb-98	0.28	0.1	ND [5]	ND [5]	0.2	ND [5]	ND [5]	25.	14.	3.7	ND [5]	4.8	13.	22.	41.	5.5	0.58	130.
	980218-MW3-56-02	18-Feb-98	0.26	ND [5]	ND [5]	ND [5]	0.2	ND [5]	ND [5]	33.	17.	3.9	ND [5]	4.9	17.	26.	48.	5.3	0.46	156.
	980602-MW3-56-14	2-Jun-98	5.3	4.9	1.7	5.1	4.6	ND [5]	2.9	57.	19.	12.	4.3	20.	28.	37.	86.	28.	24.5	316.
	980602-MW3-56-15	2-Jun-98	5.1	4.7	1.9	5.3	4.6	ND [5]	2.8	54.	18.	12.	4.3	19.	28.	32.	86.	28.	24.3	306.
	980826-MW3-56-12	26-Aug-98	0.72	0.61	0.22	0.66	0.82	ND [5]	0.31	37.	8.5	ND [5]	0.44	4.1	18.	16.	6.	8.2	3.34	102.
	981118-MW3-56-16	18-Nov-98	0.33	0.16	ND [5]	0.16	0.32	ND [5]	ND [5]	35.	5.9	4.7	ND [5]	5.5	12.	9.3	40.	5.6	0.97	119.
	981118-MW3-56-17	18-Nov-98	0.29	0.11	ND [5]	0.1	0.27	ND [5]	ND [5]	35.	6.2	4.5	ND [5]	5.4	12.	12.	40.	5.6	0.77	121.
	990217-MW3-56-015	17-Feb-99	2.52	2.95	ND [5]	2.9	2.32	0.36	1.48	37.4	5.54	6.08	2.3	13.3	12.2	12.1	48.3	13.7	12.53	163.
	990514-MW3-56-24	14-May-99	0.66	0.46	0.16	0.51	0.59	0.59	0.27	50.2	4.02	8.8	0.37	6.05	17.2	16.	44.8	6.53	3.24	157.
	990824-MW3-56-16	24-Aug-99	0.26	ND [5]	ND [5]	ND [5]	0.34	ND [5]	ND [5]	33.	2.63	3.76	ND [5]	5.17	9.99	6.04	33.	5.47	0.6	100.
	991028-MW3-56-17	28-Oct-99	0.27	ND [5]	ND [5]	ND [5]	0.32	ND [5]	ND [5]	35.4	2.49	4.59	ND [5]	5.32	11.4	4.35	29.5	5.34	0.59	99.
	000330-MW3-56-117	30-Mar-00	0.87	0.43	0.36	0.73	1.	ND [5]	0.43	36.4	2.93	7.16	0.58	8.92	17.3	37.2	43.5	8.25	3.84	166.
	001005-MW3-56-13	5-Oct-00	2.2	2.3	0.86	2.76	2.71	0.3	1.5	36.5	1.65	7.83	1.89	12.4	15.5	1.58	29.1	16.5	12.63	136.
	010329-MW3-56-116	29-Mar-01	1.93	1.27	0.96	1.88	2.12	0.47	1.72	30.5	0.95	5.95	2.03	9.32	10.9	3.37	24.6	9.78	10.35	108.
	020404-MW3-56-111	4-Apr-02	0.53	0.26	0.2	0.47	0.75	ND [5]	0.41	37.9	0.41	5.32	0.46	7.53	13.5	2.08	22.7	5.61	2.62	98.
	030319-MW3-56-112	19-Mar-03	0.46	0.2	ND [5]	0.23	0.52	ND [5]	0.11	38.	0.4	5.8	0.16	8.	12.	2.3	18.	8.2	1.52	94.

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Table 4b - Summary of Historical Analytical Results for Groundwater Samples: PAHs by EPA Method 8270
December 1995 to Present

PAHs by EPA Method 8270 (SIM)			Analytical Results ug/l (ppb)																		
			Carcinogenic PAHs							Non-carcinogenic PAHs											
Well Number	HAI Sample Number[1]	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (a,h) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (g,h,i) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			0.018[3]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	990.[3]	#	40,000[4]	#	140.[4]	5,300.[4]	620.[3]	#	4,000.[4]	#	#
MW4-35	951206-MW4-35-01	6-Dec-95	0.34	ND[5]	ND[5]	ND[5]	0.35	ND[5]	ND[5]	13.	3.	2.5	ND[5]	9.7	6.1	2.	8.1	9.4	0.69	54.
	960318-MW4-35-01	18-Mar-96	0.74	0.5	0.18	0.54	0.94	ND[5]	0.26	35.	2.7	2.7	0.42	8.4	11.	3.2	7.9	9.9	3.18	84.
	960318-MW4-35-02	18-Mar-96	0.62	0.36	0.14	0.4	0.7	ND[5]	0.19	34.	2.8	2.8	0.29	8.1	9.2	2.5	7.9	9.1	2.41	79.
	960618-MW4-35-01	18-Jun-96	0.66	0.37	0.12	0.43	0.71	ND[5]	0.22	25.	3.5	2.	0.3	7.8	8.5	0.59	1.9	9.3	2.51	61.
	961001-MW4-35-01	1-Oct-96	0.41	0.3	0.1	0.3	0.46	ND[5]	0.13	19.	2.	1.2	0.18	6.1	4.9	0.41	0.34	6.5	1.7	42.
	970225-MW4-35-01	25-Feb-97	0.22	ND[5]	ND[5]	ND[5]	0.19	ND[5]	ND[5]	24.	2.6	0.78	ND[5]	5.	6.	1.2	0.36	5.3	0.41	46.
	980827-MW4-57-01[6]	27-Aug-97	0.21	0.1	ND[5]	ND[5]	0.22	ND[5]	ND[5]	16.	2.3	0.93	ND[5]	5.3	5.3	0.49	0.31	5.1	0.53	36.
	980217-MW4-35-01	17-Feb-98	0.15	ND[5]	ND[5]	ND[5]	0.1	ND[5]	ND[5]	16.	2.1	0.47	ND[5]	4.1	3.9	1.1	0.13	3.8	0.25	32.
	980601-MW4-35-06	1-Jun-98	0.25	ND[5]	ND[5]	ND[5]	0.23	ND[5]	ND[5]	20.	2.9	0.74	ND[5]	6.6	6.2	0.12	0.19	6.4	0.48	44.
	980826-MW4-35-06	26-Aug-98	0.58	0.63	0.21	0.64	0.64	ND[5]	0.32	28.	2.6	1.6	0.43	7.2	8.	2.	0.6	7.4	3.02	61.
	980826-MW4-35-07	26-Aug-98	0.78	0.94	0.35	0.95	0.91	ND[5]	0.44	29.	2.3	1.6	0.59	7.8	7.5	2.4	0.69	8.4	4.37	65.
	981117-MW4-35-11	17-Nov-98	0.91	1.1	0.33	1.2	0.96	0.13	0.69	17.	1.9	1.3	0.97	6.1	5.8	0.84	5.1	6.5	5.32	51.
	990216-MW4-35-009	16-Feb-99	0.21	ND[5]	ND[5]	ND[5]	0.19	ND[5]	ND[5]	9.33	1.12	0.69	ND[5]	3.57	2.65	1.87	ND[5]	3.78	0.4	23.
	990514-MW4-35-21	14-May-99	0.18	ND[5]	ND[5]	ND[5]	0.14	ND[5]	ND[5]	11.6	1.25	0.5	ND[5]	3.74	2.77	0.43	0.1	4.12	0.32	25.
	990824-MW4-35-11	24-Aug-99	0.24	0.12	0.12	0.19	0.31	ND[5]	0.12	14.9	2.28	0.81	0.16	4.47	3.91	0.86	0.18	4.59	1.1	33.
	991027-MW4-35-13	27-Oct-99	1.17	0.74	0.63	1.11	1.34	0.12	0.64	36.1	1.96	2.89	0.87	11.8	12.2	5.79	8.43	11.6	5.75	97.
	000330-MW4-35-114	30-Mar-00	0.21	ND[5]	ND[5]	ND[5]	0.21	ND[5]	ND[5]	19.7	2.54	1.15	ND[5]	6.03	6.29	2.46	1.33	5.34	0.42	45.
	001005-MW4-35-10	5-Oct-00	3.42	4.25	1.56	4.99	4.6	0.54	2.36	54.4	2.38	3.56	3.27	17.5	17.8	17.2	6.67	18.	21.72	163.
	010328-MW4-35-112	28-Mar-01	0.2	ND[5]	ND[5]	ND[5]	0.2	ND[5]	ND[5]	9.92	0.82	0.49	ND[5]	3.56	3.18	2.76	1.08	3.34	0.4	26.
MW4-57	951205-MW4-57-01	5-Dec-95	0.56	0.22	ND[5]	0.21	0.65	ND[5]	0.09	49.	2.2	5.8	0.14	7.8	11.	1,200.	42.	8.6	1.73	1,328.
	960321-MW4-57-01	21-Mar-96	0.59	0.34	0.12	0.36	0.71	ND[5]	0.18	35.	1.9	4.9	0.27	6.9	9.2	1,000.	31.	6.3	2.29	1,098.
	960620-MW4-57-01	20-Jun-96	0.45	0.19	ND[5]	0.21	0.46	ND[5]	0.11	39.	2.8	4.1	0.15	6.5	10.	540.	34.	8.5	1.42	646.
	961002-MW4-57-01	2-Oct-96	0.35	ND[5]	ND[5]	ND[5]	0.29	ND[5]	ND[5]	48.	5.6	4.7	ND[5]	7.2	7.6	1,600.	27.	6.1	0.64	1,707.
	970226-MW4-57-01	26-Feb-97	0.3	ND[5]	ND[5]	ND[5]	0.22	ND[5]	ND[5]	39.	3.3	3.4	ND[5]	6.2	6.	1,600.	24.	6.	0.52	1,688.
	970828-MW4-35-01[6]	28-Aug-97	0.24	ND[5]	ND[5]	ND[5]	0.2	ND[5]	ND[5]	49.	2.9	2.6	ND[5]	4.3	4.3	1,600.	24.	4.2	0.44	1,692.
	980218-MW4-57-01	18-Feb-98	0.17	ND[5]	ND[5]	ND[5]	0.11	ND[5]	ND[5]	45.	2.	1.6	ND[5]	3.6	3.4	2,280.	19.	3.	0.28	2,358.
	980603-MW4-57-18	3-Jun-98	0.35	0.1	ND[5]	ND[5]	0.32	ND[5]	ND[5]	51.	2.4	3.1	ND[5]	6.1	5.9	2,200.	23.	6.7	0.77	2,299.
	980826-MW4-57-13	26-Aug-98	0.22	0.1	ND[5]	ND[5]	0.22	ND[5]	ND[5]	43.	2.2	1.7	ND[5]	3.5	3.7	2,400.	13.	3.7	0.54	2,471.
	981119-MW4-57-20	19-Nov-98	0.18	ND[5]	ND[5]	ND[5]	0.16	ND[5]	ND[5]	42.	1.7	1.7	ND[5]	3.	3.3	1,900.	13.	2.9	0.34	1,968.
	990217-MW4-57-016	17-Feb-99	0.18	ND[5]	ND[5]	ND[5]	0.14	ND[5]	ND[5]	26.2	1.15	1.4	ND[5]	2.57	2.36	1,530.	8.69	2.59	0.32	1,575.
	990514-MW4-57-22	14-May-99	0.22	ND[5]	ND[5]	ND[5]	0.17	ND[5]	ND[5]	-	1.32	1.89	ND[5]	3.44	3.13	1,660.	10.7	3.45	0.39	1,684.
	990825-MW4-57-17	25-Aug-99	0.19	ND[5]	ND[5]	ND[5]	0.21	ND[5]	ND[5]	34.	1.11	1.48	ND[5]	3.17	2.7	2,250.	9.46	3.08	0.4	2,305.
	991028-MW4-57-21	28-Oct-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	42.	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	1,650.	ND[5]	ND[5]	ND	1,692.
	000403-MW4-57-121	3-Apr-00	0.24	ND[5]	ND[5]	ND[5]	0.23	ND[5]	ND[5]	38.8	1.42	2.34	ND[5]	3.95	3.21	2,700.	12.	3.55	0.47	2,766.
	001006-MW4-57-19	6-Oct-00	0.2	ND[5]	ND[5]	ND[5]	0.18	ND[5]	ND[5]	32.	1.61	0.9	ND[5]	1.88	2.2	2,450.	6.31	2.83	0.38	2,498.
	010329-MW4-57-120	29-Mar-01	0.23	ND[5]	ND[5]	ND[5]	0.2	ND[5]	ND[5]	32.6	1.35	1.43	ND[5]	2.52	3.08	3,010.	9.47	2.47	0.43	3,063.
	020405-MW4-57-117	5-Apr-02	0.1	ND[5]	ND[5]	ND[5]	0.11	ND[5]	ND[5]	20.	0.86	0.74	ND[5]	1.22	1.78	2,220.	4.14	1.01	0.21	2,250.
	030320-MW4-57-117	20-Mar-03	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	28.	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	2,200.	5.4	ND[5]	ND	2,233.

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Table 4b - Summary of Historical Analytical Results for Groundwater Samples: PAHs by EPA Method 8270
December 1995 to Present

PAHs by EPA Method 8270 (SIM)			Analytical Results ug/l (ppb)																			
			Carcinogenic PAHs							Non-carcinogenic PAHs												
Well Number	HAI Sample Number[1]	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (a,h) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (g,h,i) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	990.[3]	#	40,000[4]	#	140.[4]	5,300.[4]	620.[3]	#	4,000.[4]	#	#
MW4-101	981117-MW4-101-09	17-Nov-98	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	20.	ND [5]	ND [5]	ND	20.
	990216-MW4-101-007	16-Feb-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	8.3	ND [5]	ND [5]	ND	8.
	990514-MW4-101-19	14-May-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.21	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	68.1	ND [5]	ND [5]	ND	68.
	990514-MW4-101-20	14-May-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.2	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	62.3	ND [5]	ND [5]	ND	63.
	990824-MW4-101-09	24-Aug-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.64	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	190.	ND [5]	ND [5]	ND	191.
	991027-MW4-101-11	27-Oct-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.65	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	166.	ND [5]	ND [5]	ND	167.
	000329-MW4-101-111	29-Mar-00	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.97	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	20.6	ND [5]	ND [5]	ND	22.
	001005-MW4-101-09	5-Oct-00	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.72	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.64	ND [5]	ND [5]	ND	1.
	010328-MW4-101-110	28-Mar-01	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.56	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.58	ND [5]	ND [5]	ND	1.
	011009-MW4-101-103	9-Oct-01	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.47	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.71	ND [5]	ND [5]	ND	1.
	020404-MW4-101-110	4-Apr-02	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.51	ND [5]	ND [5]	ND [5]	ND [5]	5.46	ND [5]	ND [5]	ND	6.
	020924-MW4-101-102	24-Sep-02	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.63	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	12.	ND [5]	ND [5]	ND	13.
	030318-MW4-101-109	18-Mar-03	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.63	ND [5]	ND [5]	ND [5]	ND [5]	15.	ND [5]	ND [5]	ND [5]	ND	16.
MW5-32	951205-MW5-32-01	5-Dec-95	1.8	1.	0.41	1.1	2.6	0.12	0.56	12.	9.2	18.	0.9	15.	28.	11.	88.	18.	7.59	208.
	960319-MW5-32-01	19-Mar-96	5.7	4.7	1.7	5.5	8.5	0.61	3.1	4.2	2.1	20.	4.8	44.	10.	1.	100.	53.	29.81	269.
	960319-MW5-32-01 (dissolved)	19-Mar-96	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	2.5	1.1	4.4	ND [5]	0.96	5.3	0.61	29.	1.1	ND	45.
	960620-MW5-32-01	20-Jun-96	2.6	2.2	0.93	2.7	3.4	0.34	1.5	2.	1.1	9.2	2.3	12.	2.1	0.42	20.	20.	13.67	83.
	961001-MW5-32-01	1-Oct-96	50.	55.	18.	53.	51.	ND [4]	40.	ND [4]	ND [4]	47.	56.	160.	ND [4]	ND [6]	83.	150.	277.	773.
	970225-MW5-32-01	25-Feb-97	0.32	0.19	ND [5]	0.16	0.33	ND [5]	ND [5]	0.16	ND [5]	0.95	0.12	3.	0.23	0.16	0.29	3.8	1.	10.
	970827-MW5-32-01	27-Aug-97	2.	1.9	ND [5]	2.4	2.7	ND [5]	1.4	ND [5]	ND [5]	ND [5]	1.8	5.8	ND [5]	ND [5]	ND [5]	6.3	10.4	24.
	980217-MW-5-32-01	17-Feb-98	0.67	0.56	0.19	0.67	0.65	0.11	0.49	ND [5]	0.1	0.19	0.62	1.5	ND [5]	ND [5]	0.23	1.7	3.23	8.
	980602-MW5-32-10	2-Jun-98	7.	7.	1.9	7.6	7.	0.91	4.3	1.2	0.47	1.6	6.3	20.	0.57	0.67	4.2	24.	35.71	95.
	980826-MW5-32-09	26-Aug-98	42.	53.	17.	56.	58.	5.8	27.	ND [5]	4.5	8.5	36.	91.	1.2	3.4	17.	120.	258.8	540.
	981118-MW5-32-13	18-Nov-98	0.27	0.26	0.1	0.27	0.37	ND [5]	0.15	ND [5]	ND [5]	ND [4]	0.21	1.4	ND [5]	ND [5]	ND [5]	1.7	1.42	5.
	990216-MW5-32-011	16-Feb-99	0.51	0.51	ND [5]	0.57	0.61	0.14	0.23	ND [5]	ND [5]	0.18	0.41	1.66	ND [5]	ND [5]	0.17	1.9	2.57	7.
	990514-MW5-32-17	14-May-99	0.1	ND [5]	ND [5]	ND [5]	0.11	0.69	ND [5]	ND [5]	ND [5]	ND [4]	ND [4]	ND [5]	ND [5]	0.95	ND [5]	0.63	0.8	2.
	990824-MW5-32-13	24-Aug-99	1.43	0.93	0.93	1.89	2.08	0.47	1.29	ND [5]	0.19	0.33	1.79	4.03	ND [5]	0.12	0.51	5.36	8.82	21.
	991027-MW5-32-15	27-Oct-99	1.19	0.79	0.73	1.33	1.68	0.16	0.8	ND [5]	0.12	0.2	1.07	3.2	ND [5]	ND [5]	0.32	4.57	6.68	16.
	000330-MW5-32-115	30-Mar-00	0.72	0.58	0.49	0.93	1.	0.12	0.61	ND [5]	0.12	0.18	0.83	1.41	ND [5]	ND [5]	0.27	1.71	4.45	9.
	001055-MW5-32-12	5-Oct-00	0.28	0.34	0.11	0.37	0.37	ND [5]	0.19	ND [5]	ND [5]	0.12	0.25	0.54	ND [5]	ND [5]	ND [5]	0.73	1.66	3.
	0103295-MW5-32-114	29-Mar-01	1.61	1.33	1.12	1.94	2.12	0.52	1.48	ND [5]	0.2	0.4	1.75	2.63	ND [5]	0.13	0.61	3.81	10.12	20.
MW5-100	981118-MW5-100-14	18-Nov-98	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	7.2	6.2	1.1	ND [5]	1.1	2.7	7,100.	7.2	1.2	ND	7,127.
	990217-MW5-100-018	17-Feb-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	6.34	3.52	ND [5]	ND [5]	1.47	2.14	5,010.	7.87	1.39	ND	5,033.
	990514-MW5-100-18	14-May-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	12.3	1.6	1.3	ND [5]	16.3	1.73	7,440.	6.9	2.	ND	7,482.
	990825-MW5-100-18	25-Aug-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	18.	1.	1.	ND [5]	1.9	1.7	13,300.	6.7	ND [5]	ND	13,330.
	991028-MW5-100-19	28-Oct-99	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	12.9	0.4	0.67	ND [5]	1.29	0.96	7,450.	4.28	1.29	ND	7,472.
	000330-MW5-100-119	30-Mar-00	0.1	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	15.7	0.32	0.77	ND [5]	1.43	1.01	9,800.	4.42	1.31	0.1	9,825.
	001005-MW5-100-15	5-Oct-00	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.31	0.27	ND [5]	0.64	0.68	10,100.	1.49	0.64	ND	10,104.
	001005-MW5-100-16	5-Oct-00	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	15.	0.26	0.25	ND [5]	0.52	0.58	9,200.	1.27	0.53	ND	9,218.
	010329-MW5-100-118	29-Mar-01	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	19.8	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	9,600.	ND [5]	ND [5]	ND	9,620.
	020405-MW5-100-114	5-Apr-02	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	1.1	17.5	ND [5]	ND [5]	1.	ND [5]	ND [5]	82,300.	ND [5]	ND [5]	1.1	82,320.
	020405-MW5-100-115	5-Apr-02	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	0.14	0.11	8.9	ND [5]	0.14	ND [5]	0.36	0.49	4,310.	0.81	0.33	0.25	4,321.
	030319-MW5-100-114	19-Mar-03	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	14.	ND [5]	ND [5]	ND [5]	ND [5]	ND [5]	5,600.	ND [5]	ND [5]	ND	5,614.

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Table 4b - Summary of Historical Analytical Results for Groundwater Samples: PAHs by EPA Method 8270
December 1995 to Present

PAHs by EPA Method 8270 (SIM)			Analytical Results ug/l (ppb)																		
			Carcinogenic PAHs							Non-carcinogenic PAHs											
Well Number	HAI Sample Number[1]	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (a,h) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (g,h,i) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	990.[3]	#	40,000[4]	#	140.[4]	5,300.[4]	620.[3]	#	4,000.[4]	#	#
MW5-175	981116-MW5-175-07	16-Nov-98	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	990215-MW5-175-003	15-Feb-99	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	990512-MW5-175-07	12-May-99	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	990823-MW5-175-03	23-Aug-99	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	0.2	ND [a]	ND [a]	ND	0.2
	991026-MW5-175-06	26-Oct-99	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	000329-MW5-175-106	29-Mar-00	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	001004-MW5-175-05	4-Oct-00	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	010328-MW5-175-105	28-Mar-01	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	011009-MW5-175-102	9-Oct-01	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	020404-MW5-175-105	4-Apr-02	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	020924-MW5-175-101	24-Sep-02	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
	030318-MW5-175-105	18-Mar-03	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND	ND
MW6-32	951207-MW6-32-01	7-Dec-95	2,400.	750.	280.	690.	3,100.	50.	200.	23,000.	220.	14,000.	280.	22,000.	4,600.	42,000.	61,000.	25,000.	7,470.	199,570.
	960319-MW6-32-01	19-Mar-96	1.9	0.85	0.3	0.79	2.5	ND [a]	0.22	280.	2.6	24.	0.3	16.	61.	1,800.	140.	16.	6.56	2,346.
	960319-MW6-32-01 (dissolved)	19-Mar-96	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	220.	2.	5.1	ND [a]	1.3	42.	1,600.	68.	1.7	ND	1,940.
	960617-MW6-32-01	17-Jun-96	4.6	2.4	0.87	2.5	5.	0.23	0.74	310.	2.4	29.	0.9	27.	82.	1,200.	170.	40.	16.24	1,878.
	960930-MW6-32-01	30-Sep-96	66.	32.	12.	29.	63.	1.5	ND [a]	620.	7.8	190.	6.4	320.	210.	1,900.	970.	330.	203.5	4,758.
	970224-MW6-32-01	25-Feb-97	ND [c]	ND [c]	ND [c]	ND [c]	ND [c]	ND [c]	ND [c]	260.	2.7	13.	ND [c]	ND [c]	64.	830.	130.	8.5	ND	1,308.
	970826-MW6-32-01	26-Aug-97	4.4	2.2	0.82	2.2	4.8	ND>0.5	0.58	350.	ND>5	29.	0.65	33.	97.	1,300.	220.	25.	15.	2,070.
	980216-MW6-32-01	16-Feb-98	48.	27.	7.	24.	47.	1.7	7.2	560.	7.1	96.	9.2	220.	170.	1,200.	840.	290.	161.9	3,554.
	980601-MW6-32-04	1-Jun-98	6.2	3.	0.85	2.6	6.4	0.19	0.74	410.	ND [a]	50.	0.98	38.	100.	1,300.	280.	46.	19.98	2,245.
MW6-61	951206-MW6-61-01	6-Dec-95	2.7	0.77	0.34	0.73	3.4	ND [a]	0.23	160.	1.4	29.	0.32	24.	48.	250.	200.	24.	8.17	745.
	960319-MW6-61-01	19-Mar-96	1.1	0.33	0.13	0.33	1.4	ND [a]	ND [a]	29.	0.24	9.6	0.13	13.	9.7	66.	53.	13.	3.29	197.
	960620-MW6-61-01	20-Jun-96	1.4	0.48	0.26	0.5	1.5	ND [a]	0.14	21.	0.3	6.1	0.21	9.9	7.5	44.	30.	16.	4.27	139.
	961001-MW6-61-01	1-Oct-96	2.	ND [a]	ND [a]	ND [a]	1.8	ND [a]	ND [a]	16.	ND [a]	4.8	ND [a]	9.9	5.4	76.	25.	12.	3.8	153.
	970225-MW6-61-01	25-Feb-97	ND [c]	ND [c]	ND [c]	ND [c]	ND [c]	ND [c]	ND [c]	32.	ND [c]	4.	ND [c]	3.5	7.7	290.	23.	4.9	ND	365.
	970828-MW6-61-01	28-Aug-97	1.6	0.66	0.23	0.62	1.7	ND [a]	0.17	210.	2.4	17.	0.22	17.	47.	1,000.	130.	23.	4.88	1,452.
MW8-29	951207-MW8-29-01	7-Dec-95	65.	34.	16.	44.	81.	50.	25.	94.	200.	110.	36.	230.	83.	6,000.	400.	220.	315.	7,688.
	960321-MW8-29-01	21-Mar-96	28.	23.	9.8	31.	33.	2.9	16.	140.	260.	56.	23.	98.	89.	6,700.	270.	100.	143.7	7,880.
micro-purge	960619-MW8-29-01	20-Jun-96	1.2	0.88	0.3	1.1	1.2	0.12	0.61	100.	310.	15.	0.88	15.	70.	1,400.	150.	21.	5.41	2,087.
	960619-MW8-29-02	20-Jun-96	2.6	2.4	0.82	3.	2.7	0.3	1.6	26.	49.	5.1	2.3	9.4	14.	2,000.	32.	15.	13.32	2,166.
	961002-MW8-29-01	2-Oct-96	5.4	4.4	1.6	6.2	4.8	ND [a]	3.5	120.	240.	29.	4.5	30.	71.	5,400.	140.	26.	25.9	6,086.
	970226-MW8-29-01	26-Feb-97	3.1	2.1	ND [a]	2.	2.7	ND [a]	ND [a]	120.	250.	17.	ND [a]	22.	52.	5,600.	110.	23.	9.9	6,204.
	970828-MW8-29-01	28-Aug-97	32.	29.	11.	39.	38.	4.7	18.	370.	230.	56.	25.	150.	120.	10,000.	380.	210.	171.7	11,713.
	980218-MW8-29-01	18-Feb-98	4.3	3.7	1.2	4.9	4.1	0.69	3.3	340.	110.	13.	4.	24.	65.	11,000.	150.	32.	22.19	11,760.
	980603-MW8-29-19	3-Jun-98	37.	37.	13.	45.	39.	3.8	21.	420.	130.	51.	30.	140.	120.	10,700.	440.	180.	195.8	12,407.
	981119-MW8-29-22	19-Nov-98	2.2	1.9	0.69	2.6	2.3	0.22	1.2	190.	85.	15.	1.8	17.	47.	4,900.	91.	19.	11.11	5,377.
	990513-MW8-29-14	13-May-99	2.57	1.98	0.64	2.13	2.21	0.19	1.01	311.	31.2	262.	1.39	21.	64.5	5,580.	133.	30.	10.73	6,445.
	991029-MW8-29-23	29-Oct-99	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	ND [a]	210.	42.	28.	ND [a]	20.	54.	2,790.	138.	20.	ND	3,302.
	000403-MW8-29-123	3-Apr-00	1.78	0.93	0.79	1.47	1.66	0.14	0.65	320.	6.46	20.1	0.75	18.3	68.7	6,650.	143.	23.5	7.42	7,158.
	010330-MW8-29-123	30-Mar-01	6.97	6.4	5.16	10.	10.9	1.93	5.76	173.	4.84	22.6	6.48	31.2	47.	1,770.	151.	36.	49.12	2,291.

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Table 4b - Summary of Historical Analytical Results for Groundwater Samples: PAHs by EPA Method 8270
December 1995 to Present

PAHs by EPA Method 8270 (SIM)			Analytical Results ug/l (ppb)																		
			Carcinogenic PAHs							Non-carcinogenic PAHs											
Well Number	HAJ Sample Number[1]	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (a,h) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (g,h,i) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	990.[3]	#	40,000[4]	#	140.[4]	5,300.[4]	620.[3]	#	4,000.[4]	#	#
MW8-56	951207-MW8-56-01	7-Dec-95	25.	14.	60.	17.	30.	ND[4]	10.	130.	250.	53.	15.	110.	86.	20,000.	290.	110.	156.	21,200.
	960321-MW8-56-01	21-Mar-96	68.	66.	23.	74.	83.	7.1	40.	220.	300.	110.	60.	200.	130.	13,300.	580.	240.	361.1	15,501.
	960620-MW8-56-01[6]	20-Jun-96	6.6	5.7	2.2	7.9	7.3	0.81	4.3	28.	66.	9.8	6.	21.	17.	1,500.	56.	30.	34.81	1,769.
	961002-MW8-56-01	2-Oct-96	26.	24.	ND[4]	27.	22.	ND[4]	15.	120.	230.	42.	20.	92.	74.	10,700.	250.	100.	114.	11,742.
	970226-MW8-56-01	26-Feb-97	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	120.	240.	34.	ND[4]	34.	60.	13,000.	160.	44.	ND	13,692.
	970828-MW8-56-01	28-Aug-97	4.1	3.7	1.4	4.4	4.1	ND[5]	2.3	160.	240.	16.	3.	24.	80.	17,400.	170.	28.	20.	18,141.
	980218-MW8-56-01	18-Feb-98	2.6	2.	0.58	2.4	1.8	0.3	1.5	130.	220.	18.	1.7	20.	67.	12,300.	150.	27.	11.18	12,945.
	980603-MW8-56-21	3-Jun-98	13.	13.	5.	15.	13.	1.3	7.5	190.	310.	31.	11.	61.	100.	16,600.	280.	69.	67.8	17,720.
	981119-MW8-56	19-Nov-98	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	ND[5]	ND[4]	130.	180.	15.	ND[4]	12.	64.	10,500.	110.	13.	ND	11,024.
	990513-MW8-56-15	13-May-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	128.	168.	10.2	ND[5]	9.2	52.3	11,500.	88.2	9.9	ND	11,966.
	991029-MW8-56-24	29-Oct-99	0.97	0.52	0.45	0.81	1.04	-	0.44	148.	179.	19.1	0.56	8.94	58.8	12,000.	110.	8.54	4.23	12,537.
	000403-MW8-56-124	3-Apr-00	12.2	ND>11.1	ND>11.1	ND>11.1	18.9	ND>11.1	ND>11.1	188.	207.	50.	ND>11.1	66.7	82.2	13,000.	294.	97.8	31.1	14,017.
	010330-MW8-56-122	30-Mar-01	8.28	5.07	4.23	7.84	8.67	1.5	4.93	169.	165.	29.8	5.62	32.9	71.7	14,200.	202.	37.1	40.42	14,954.
	020405-MW8-56-118	5-Apr-02	0.45	0.19	0.21	0.35	0.53	ND[5]	0.21	91.6	77.6	9.61	0.27	7.61	48.6	6,830.	69.6	6.17	1.94	7,143.
	030320-MW8-56-120	20-Mar-03	2.2	ND[4]	ND[4]	ND[4]	2.	ND[4]	ND[4]	99.	61.	11.	ND[4]	9.2	42.	7,400.	77.	8.8	4.2	7,712.
MW9-29	951205-MW9-29-01	5-Dec-95	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.1	0.15	ND[5]	0.12	ND[5]	0.44	0.37	0.11	ND	1.3
	960318-MW9-29-01	18-Mar-96	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.11	ND[5]	0.18	ND[5]	0.29	0.15	ND[5]	0.6	0.27	ND	1.6
	960618-MW9-29-01	18-Jun-96	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.15	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	0.2
	961001-MW9-29-01	1-Oct-96	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.12	ND[5]	ND[5]	ND[5]	ND[5]	0.28	ND[5]	ND[5]	ND	0.4
	970225-MW9-29-01	25-Feb-97	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	970827-MW9-29-01	27-Aug-97	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	980217-MW9-29-01	17-Feb-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	980602-MW9-29-07	2-Jun-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	981116-MW9-29-02	16-Nov-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	990511-MW9-29-03	11-May-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	991026-MW9-29-02	26-Oct-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	000328-MW9-29-102	28-Mar-00	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	010327-MW9-29-102	27-Mar-01	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	020403-MW9-29-101	3-Apr-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	030318-MW9-29-103	18-Mar-03	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
MW10-25	951207-MW10-25-01	7-Dec-95	4.	2.9	1.3	3.4	4.6	ND[5]	1.8	31.	88.	16.	2.5	21.	33.	13,000.	85.	22.	18.	13,317.
	960320-MW10-25-01	20-Mar-96	1.3	1.2	0.55	1.4	0.78	ND>0.3	0.67	70.	98.	11.	0.91	8.8	39.	8,800.	86.	6.7	5.9	9,126.
	960617-MW10-25-01	17-Jun-96	1.1	1.2	0.62	1.8	0.87	0.25	0.95	75.	130.	14.	1.1	1.6	49.	9,900.	82.	6.6	6.79	10,266.
	960930-MW10-25-01	30-Sep-96	20.	12.	3.9	15.	19.	1.7	7.	140.	87.	39.	9.9	95.	90.	9,600.	310.	80.	78.6	10,530.
	970224-MW10-25-01	25-Feb-97	21.	13.	3.4	16.	16.	ND[5]	5.9	210.	81.	30.	11.	ND[5]	95.	9,000.	340.	ND[5]	74.3	9,841.
	970827-MW10-25-01	27-Aug-97	4.4	3.5	1.2	4.3	4.2	ND[5]	2.	72.	59.	11.	2.5	22.	41.	6,700.	100.	20.	19.6	7,047.
	980216-MW10-25-01	16-Feb-98	14.	11.	3.6	12.	11.	1.1	5.4	100.	87.	19.	8.1	59.	62.	8,500.	210.	62.	58.1	9,165.
	980601-MW10-25-02	1-Jun-98	8.2	6.7	1.9	7.	7.2	0.7	3.4	140.	150.	26.	4.8	45.	82.	11,400.	230.	49.	35.1	12,162.

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Table 4b - Summary of Historical Analytical Results for Groundwater Samples: PAHs by EPA Method 8270
December 1995 to Present

PAHs by EPA Method 8270 (SIM)			Analytical Results ug/l (ppb)																		
			Carcinogenic PAHs							Non-carcinogenic PAHs									Total Carcinogenic PAHs	Total PAHs
Well Number	HAI Sample Number[1]	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (a,h) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (g,h,i) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene		
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	990.[3]	#	40,000[4]	#	140.[4]	5,300.[4]	620.[3]	#	4,000.[4]	#	#
MW10-61	951206-MW10-61-01	6-Dec-95	0.39	ND[5]	ND[5]	ND[5]	0.33	ND[5]	ND[5]	39.	17.	12.	ND[5]	12.	28.	620.	90.	11.	0.72	830.
	960321-MW10-61-01	21-Mar-96	0.75	0.34	0.12	0.36	0.8	ND[5]	0.18	5.8	2.2	4.7	0.28	7.3	1.5	43.	28.	7.1	2.55	102.
	960620-MW10-61-01	20-Jun-96	0.54	0.24	0.12	0.28	0.68	ND[5]	0.14	2.1	0.98	2.2	0.22	4.4	0.22	13.	15.	5.4	2.	46.
	961002-MW10-61-01	2-Oct-96	0.48	0.23	ND[5]	0.25	0.42	ND[5]	0.12	0.88	0.54	1.5	0.17	4.1	0.16	4.6	8.5	3.2	1.5	25.
	970226-MW10-61-01	26-Feb-97	0.41	0.15	ND[5]	0.13	0.35	ND[5]	ND[5]	0.73	0.45	1.	ND[5]	3.5	0.1	3.3	4.1	3.8	1.04	18.
	970828-MW10-61-01	28-Aug-97	0.21	ND[5]	ND[5]	ND[5]	0.18	ND[5]	ND[5]	0.33	0.11	0.55	ND[5]	2.2	ND[5]	0.78	1.1	2.3	0.39	7.8
	980218-MW10-61-01	18-Feb-98	0.24	0.16	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.13	ND[5]	0.12	ND[5]	1.1	ND[5]	0.29	0.22	1.5	0.4	3.8
	980603-MW10-61-16	3-Jun-98	0.42	0.27	0.11	0.27	0.36	ND[5]	0.12	0.18	ND[5]	0.13	0.21	1.7	ND[5]	0.26	0.15	2.	1.55	6.2
	981117-MW10-61-08	17-Nov-98	0.56	0.61	0.2	0.78	0.57	ND[5]	0.34	ND[5]	0.15	ND[5]	0.58	0.86	ND[5]	0.1	ND[5]	1.1	3.06	5.9
	990512-MW10-61-06	12-May-99	0.18	0.1	ND[5]	0.11	0.18	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.73	ND[5]	ND[5]	ND[5]	ND[5]	0.57	1.3
	991026-MW10-61-05	26-Oct-99	0.11	ND[5]	ND[5]	ND[5]	0.13	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.54	ND[5]	ND[5]	ND[5]	0.58	0.24	1.4
	000329-MW10-61-105	29-Mar-00	0.11	ND[5]	ND[5]	ND[5]	0.13	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.48	ND[5]	ND[5]	ND[5]	0.37	0.24	1.1
	011010-MW10-61-109	10-Oct-01	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.28	ND[5]	ND[5]	ND[5]	0.33	ND	0.6
	020404-MW10-61-109	4-Apr-02	ND[5]	ND[5]	ND[5]	ND[5]	0.11	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.43	ND[5]	ND[5]	ND[5]	0.3	0.11	0.8
	020924-MW10-61-104	24-Sep-02	0.11	ND[5]	ND[5]	ND[5]	0.14	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.53	ND[5]	ND[5]	ND[5]	0.6	0.25	1.4
	030319-MW10-61-111	19-Mar-03	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.45	ND[5]	ND[5]	ND[5]	0.5	ND	1.
MW11-32	951207-MW11-32-01	7-Dec-95	5.6	2.6	1.3	2.8	6.3	ND[5]	1.5	340.	340.	32.	2.2	48.	190.	21,000.	360.	33.	20.	22,365.
	960320-MW11-32-01	20-Mar-96	1.6	1.2	0.49	1.2	1.3	ND>0.5	0.54	200.	180.	20.	0.75	16.	90.	14,000.	150.	13.	6.33	14,676.
	960617-MW11-32-01	17-Jun-96	2.9	2.3	1.	2.8	2.8	0.31	1.4	160.	160.	19.	1.8	19.	90.	11,000.	120.	25.	13.51	11,608.
	960930-MW11-32-01	30-Sep-96	31.	22.	9.9	27.	27.	2.	13.	270.	220.	62.	20.	150.	150.	16,000.	430.	170.	131.9	17,604.
	960930-MW11-32-02	30-Sep-96	41.	36.	14.	40.	33.	3.	22.	270.	250.	74.	31.	200.	180.	17,000.	510.	190.	189.	18,894.
	970224-MW11-32-01	25-Feb-97	4.2	3.2	ND[5]	ND[5]	3.3	ND[5]	ND[5]	150.	140.	1.4	ND[5]	ND[5]		68.	11,000.	140.	26.	10.7	11,536.
	970826-MW11-32-01	26-Aug-97	4.6	3.7	1.3	4.3	4.1	0.5	2.	260.	190.	21.	2.3	37.	120.	16,200.	200.	25.	20.5	17,076.
	980216-MW11-32-01	16-Feb-98	4.1	3.1	1.	3.2	2.9	ND[5]	1.6	150.	120.	16.	2.3	25.	65.	9,200.	140.	25.	15.9	9,759.
	980601-MW11-32-03	1-Jun-98	26.	25.	ND[4]	24.	24.	ND[4]	13.	510.	360.	56.	18.	130.	250.	30,200.	580.	160.	112.	32,376.
MW12-36	951207-MW12-36-01	7-Dec-95	1.5	0.36	0.17	0.22	1.4	ND[5]	ND[5]	400.	7.8	21.	0.1	28.	170.	2,500.	230.	17.	3.65	3,378.
	960321-MW12-36-01	21-Mar-96	0.38	ND[5]	ND[5]	ND[5]	0.35	ND[5]	ND[5]	250.	3.3	16.	ND[5]	18.	110.	1,400.	200.	12.	0.73	2,010.
	960620-MW12-36-01	20-Jun-96	0.4	ND[5]	ND[5]	ND[5]	0.4	ND[5]	ND[5]	160.	2.4	11.	ND[5]	18.	81.	1,200.	130.	18.	0.8	1,621.
	961002-MW12-36-01	2-Oct-96	0.47	ND[5]	ND[5]	ND[5]	0.33	ND[5]	ND[5]	140.	2.	10.	ND[5]	25.	59.	990.	130.	18.	0.8	1,375.
	970226-MW12-36-01	26-Feb-97	0.63	ND[5]	ND[5]	ND[5]	0.31	ND[5]	ND[5]	100.	1.7	ND[5]	ND[5]	24.	40.	760.	88.	18.	0.94	1,033.
	970828-MW12-36-01	28-Aug-97	0.43	ND[5]	ND[5]	ND[5]	0.24	ND[5]	ND[5]	79.	1.4	7.7	ND[5]	19.	33.	620.	61.	18.	0.67	840.
	980218-MW12-36-01	18-Feb-98	0.51	ND[5]	ND[5]	ND[5]	0.18	ND[5]	ND[5]	71.	0.78	2.6	ND[5]	17.	25.	530.	52.	9.2	0.69	708.
	980603-MW12-36-17	3-Jun-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	77.	1.1	5.9	ND[5]	22.	30.	480.	62.	19.	ND	697.
	981119-MW12-36-18	19-Nov-98	0.49	ND[5]	ND[5]	ND[5]	0.3	ND[5]	ND[5]	52.	0.64	2.4	ND[5]	14.	21.	350.	38.	8.3	0.79	487.
	990513-MW12-36-12	13-May-99	0.53	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	47.9	0.79	2.28	ND[5]	7.47	19.2	374.	31.3	7.93	0.53	491.
	991028-MW12-36-18	28-Oct-99	0.35	ND[5]	ND[5]	ND[5]	0.25	ND[5]	ND[5]	60.	0.95	2.2	ND[5]	7.52	23.7	409.	35.9	6.06	0.6	546.
	000330-MW12-36-118	30-Mar-00	0.59	0.14	0.16	0.21	0.51	ND[5]	0.13	63.8	1.21	3.9	0.18	9.51	25.5	490.	45.9	7.24	1.74	649.
	010329-MW12-36-117	29-Mar-01	0.4	ND[5]	ND[5]	ND[5]	0.29	ND[5]	ND[5]	51.5	0.69	3.11	ND[5]	7.34	21.6	284.	39.4	6.71	0.69	415.
	020404-MW12-36-112	4-Apr-02	0.28	ND[5]	ND[5]	ND[5]	0.22	ND[5]	ND[5]	37.5	0.46	1.98	ND[5]	5.14	16.6	287.	23.5	3.2	0.5	376.
	030319-MW12-36-113	19-Mar-03	0.31	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	35.	0.47	2.1	ND[5]	5.9	16.	280.	24.	5.4	0.31	369.

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Table 4b - Summary of Historical Analytical Results for Groundwater Samples: PAHs by EPA Method 8270
December 1995 to Present

PAHs by EPA Method 8270 (SIM)			Analytical Results ug/l (ppb)																		
			Carcinogenic PAHs							Non-carcinogenic PAHs									Total Carcinogenic PAHs	Total PAHs
Well Number	HAI Sample Number[1]	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (a,h) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (g,h,i) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene		
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	990.[3]	#	40,000[4]	#	140.[4]	5,300.[4]	620.[3]	#	4,000.[4]	#	#
MW13-30	980217-MW13-30-01	17-Feb-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	190.	1.6	7.3	ND[5]	3.5	52.	69.	100.	2.7	ND	426.
	980602-MW13-30-12	2-Jun-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	300.	ND[5]	16.	ND[5]	5.1	85.	610.	160.	4.8	ND	1,181.
	980826-MW13-30-11	26-Aug-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	160.	1.8	11.	ND[5]	3.7	45.	420.	98.	2.8	ND	742.
	981119-MW13-30-19	19-Nov-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	210.	1.4	16.	ND[5]	2.8	59.	7.6	100.	2.2	ND	399.
	990217-MW13-30-014	17-Feb-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	144.	1.13	9.6	ND[5]	2.54	34.8	506.	70.6	1.92	ND	771.
	990513-MW13-30-13	13-May-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	163.	1.59	10.6	ND[5]	2.73	51.8	735.	68.4	2.5	ND	1,036.
	991028-MW13-30-20	28-Oct-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	130.	ND[5]	132.	ND[5]	ND[5]	42.	460.	56.	ND[5]	ND	820.
	000403-MW13-30-120	3-Apr-00	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	297.	1.62	8.39	ND[5]	3.09	77.3	240.	90.5	2.94	ND	721.
	001005-MW13-30-18	5-Oct-00	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	142.	0.96	6.3	ND[5]	2.7	46.	146.	64.	2.34	ND	410.
	010329-MW13-30-119	29-Mar-01	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	147.	1.11	6.11	ND[5]	2.3	46.6	241.	77.3	1.54	ND	523.
	020405-MW13-30-116	5-Apr-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	149.	0.9	6.77	ND[5]	3.19	44.8	188.	57.1	1.89	ND	452.
	030319-MW13-30-115	19-Mar-03	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	160.	1.6	9.2	ND[5]	3.9	48.	700.	83.	2.7	ND	1,008.
MW13-61	980218-MW13-61-01	18-Feb-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	980602-MW13-61-13	2-Jun-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	980825-MW13-61-03	25-Aug-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	981116-MW13-61-03	16-Nov-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.2	ND[5]	ND[5]	ND	0.2
	990512-MW13-61-04	12-May-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.26	ND[5]	ND[5]	ND	0.3
	991026-MW13-61-03	26-Oct-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.14	ND[5]	ND[5]	ND[5]	ND[5]	0.48	ND[5]	ND>0.1	ND	0.6
	000328-MW13-61-104	28-Mar-00	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	001004-MW13-61-03	4-Oct-00	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.11	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.57	ND[5]	ND[5]	ND	0.7
	010327-MW13-61-103	27-Mar-01	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	011009-MW13-61-106	9-Oct-01	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.11	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.17	ND[5]	ND[5]	ND	0.3
	020403-MW13-61-102	3-Apr-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	020924-MW13-61-106	24-Sep-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	030317-MW13-61-101	17-Mar-03	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
MW14-110	981116-MW14-110-06	16-Nov-98	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	990216-MW14-110-005	16-Feb-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.11	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	0.1
	990512-MW14-110-09	12-May-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.14	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.14	ND[5]	ND[5]	ND	0.3
	990823-MW14-110-06	23-Aug-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.29	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.12	ND[5]	ND[5]	ND	0.4
	991027-MW14-110-09	27-Oct-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.26	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	0.3
	991027-MW14-110-09	27-Oct-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.26	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	0.3
	000329-MW14-110-109	29-Mar-00	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.42	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	0.4
	000329-MW14-110-110	29-Mar-00	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.42	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	0.4
	000615-MW14-110-102	15-Jun-00	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.18	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	0.2
	001005-MW14-110-06	5-Oct-00	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	001220-MW14-110-102	20-Dec-00	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.14	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	0.1
	010328-MW14-110-108	28-Mar-01	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.23	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	0.2
	011009-MW14-110-105	9-Oct-01	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	011213-MW14-110-101	13-Dec-01	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	020404-MW14-110-108	4-Apr-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.1	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	0.1
	020711-MW14-110-101	11-Jul-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	020924-MW14-110-105	24-Sep-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.1	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	0.1
	021217-MW14-110-102	17-Dec-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	030318-MW14-110-108	18-Mar-03	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	030602-MW14-110-101	2-Jun-03	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND

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Table 4b - Summary of Historical Analytical Results for Groundwater Samples: PAHs by EPA Method 8270
December 1995 to Present

PAHs by EPA Method 8270 (SIM)			Analytical Results ug/l (ppb)																		
			Carcinogenic PAHs							Non-carcinogenic PAHs											
Well Number	HAI Sample Number[1]	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (a,h) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (g,h,i) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	990.[3]	#	40,000[4]	#	140.[4]	5,300.[4]	620.[3]	#	4,000.[4]	#	#
MW15-50	990728-MW15-50-04	28-Jul-99	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	50.	8,510.	ND[4]	ND[4]	ND[4]	83.	9,700.	117.	ND[4]	ND	18,460.
	991029-MW15-50-25	29-Oct-99	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	20.	ND[4]	ND[4]	ND[4]	ND[4]	716.	26.	ND[4]	ND	762.
	000403-MW15-50-125	3-Apr-00	0.79	0.61	0.49	0.55	0.73	ND[4]	0.24	22.	41.6	2.91	0.25	6.01	23.6	5,480.	25.9	5.16	3.31	5,611.
	000615-MW15-50-105	15-Jun-00	43.6	45.5	38.5	57.1	40.5	8.95	33.5	2.91	0.59	4.11	41.8	69.7	1.66	1.23	25.	60.1	267.65	475.
	000615-MW15-50-106	15-Jun-00	40.	44.1	36.3	53.5	38.3	8.87	32.6	2.96	0.77	4.1	40.2	65.2	1.71	1.23	23.8	57.3	253.67	451.
	001005-MW15-50-14	5-Oct-00	10.7	19.7	6.97	16.4	9.88	2.52	8.21	1.51	0.96	1.47	8.14	15.5	1.06	2.8	6.44	16.7	74.38	129.
	001221-MW15-50-105	21-Dec-00	26.1	39.6	14.8	32.2	20.8	4.13	21.3	43.5	66.1	6.14	24.	40.1	74.6	9,200.	10.9	36.9	158.93	9,661.
	001221-MW15-50-106	21-Dec-00	33.1	48.7	18.1	40.8	26.5	4.96	27.	52.4	70.6	6.58	30.3	50.3	78.	8,180.	12.6	50.7	199.16	8,731.
	010330-MW15-50-124	30-Mar-01	11.2	11.8	18.9	13.4	12.4	5.4	14.4	35.4	59.	9.58	15.1	22.7	45.7	6,860.	76.1	22.4	87.5	7,233.
	011010-MW15-50-111	10-Oct-01	2.47	2.62	2.08	2.95	2.37	0.47	1.56	18.1	29.7	2.19	1.77	5.33	26.	3,700.	37.2	4.26	14.52	3,839.
	011010-MW15-50-112	10-Oct-01	7.6	8.4	7.4	9.3	8.	1.8	5.7	44.6	60.4	4.2	6.4	12.7	53.9	59,100.	78.3	14.6	48.2	59,423.
	011214-MW15-50-104	14-Dec-01	0.35	0.1	0.1	0.1	0.33	ND[4]	ND[4]	26.8	43.8	3.	ND[4]	3.29	34.3	4,510.	42.8	2.27	0.98	4,667.
	011214-MW15-50-105	14-Dec-01	0.42	0.14	0.13	0.17	0.41	ND[4]	ND[4]	27.8	45.9	3.1	ND[4]	3.28	36.1	5,870.	45.6	2.33	1.27	6,035.
	020405-MW15-50-119	5-Apr-02	1.57	1.33	1.39	1.76	1.81	0.61	1.29	20.	30.	3.29	1.5	5.75	26.	4,220.	34.	3.67	9.76	4,354.
	020711-MW15-50-104	11-Jul-02	2.5	2.6	2.7	2.9	3.1	ND[5]	1.7	19.7	31.3	4.	2.1	7.9	26.6	3,640.	41.2	7.6	15.5	3,796.
	020711-MW15-50-105	11-Jul-02	3.4	3.6	5.4	4.4	5.6	ND[5]	2.4	27.6	41.6	ND[5]	3.4	11.6	35.8	5,580.	52.6	10.6	24.8	5,788.
	020925-MW15-50-110	25-Sep-02	10.	11.	10.	15.	12.	ND[5]	7.3	38.	55.	8.	9.1	21.	47.	7,700.	82.	19.	65.3	8,044.
	020925-MW15-50-111	25-Sep-02	3.3	2.6	3.	3.2	3.7	ND[5]	1.4	40.	58.	6.3	1.8	12.	50.	7,700.	76.	10.	17.2	7,971.
	021218-MW15-50-107	18-Dec-02	ND>5.0	ND>5.0	ND>5.0	22.	ND>5.0	ND>5.0	20.	50.	78.	ND>5.0	25.	36.	70.	7,000.	160.	33.	42.	7,494.
	030321-MW15-50-122	21-Mar-03	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	ND[4]	24.	36.	ND[4]	ND[4]	ND[4]	32.	4,900.	50.	ND[4]	ND	5,042.
	030603-MW15-50-105	3-Jun-03	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	18.	32.	ND[5]	ND[5]	1.9	22.	3,300.	29.	2.1	ND	3,405.
MW15-66	990728-MW15-66-03	28-Jul-99	0.15	0.26	ND[5]	0.16	0.15	ND[5]	0.11	0.11	ND[5]	ND[5]	0.14	0.3	ND[5]	0.57	0.17	0.34	0.83	2.5
	991026-MW15-66-07	26-Oct-99	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	000329-MW15-66-108	29-Mar-00	0.57	0.59	0.6	0.77	0.67	0.18	0.63	ND[5]	ND[5]	0.11	0.66	0.96	ND[5]	ND[5]	0.33	0.96	3.91	6.9
	000615-MW15-66-104	15-Jun-00	1.93	1.96	1.61	2.64	1.91	0.57	1.55	0.14	ND[5]	0.39	2.04	3.32	ND[5]	ND[5]	1.07	2.92	12.17	22.1
	001005-MW15-66-08	5-Oct-00	0.23	0.4	0.17	0.32	0.24	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.41	ND[5]	ND[5]	0.14	0.43	1.36	2.3
	001221-MW15-66-104	21-Dec-00	0.14	0.19	0.1	0.16	0.12	ND[5]	0.1	ND[5]	ND[5]	ND[5]	0.13	0.21	ND[5]	ND[5]	ND[5]	0.2	0.8	1.3
	010328-MW15-66-107	28-Mar-01	0.11	0.11	0.12	0.14	0.13	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.2	ND[5]	ND[5]	0.1	0.19	0.61	1.1
	011010-MW15-66-110	10-Oct-01	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	011213-MW15-66-103	13-Dec-01	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	020404-MW15-66-107	4-Apr-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.12	ND[5]	ND[5]	ND[5]	ND[5]	ND	0.1
	020711-MW15-66-103	11-Jul-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	020925-MW15-66-109	25-Sep-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	021218-MW15-66-105	18-Dec-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	021218-MW15-66-106	18-Dec-02	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND	ND
	030318-MW15-66-107	18-Mar-03	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	0.1	ND	0.1
	030603-MW15-66-104	3-Jun-03	0.6	0.64	0.77	0.85	0.69	ND[5]	0.45	ND[5]	ND[5]	ND[5]	0.77	1.2	ND[5]	ND[5]	0.34	1.1	4.	7.4

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Table 4b - Summary of Historical Analytical Results for Groundwater Samples: PAHs by EPA Method 8270
December 1995 to Present

PAHs by EPA Method 8270 (SIM)			Analytical Results ug/l (ppb)																		
			Carcinogenic PAHs							Non-carcinogenic PAHs											
Well Number	HAI Sample Number[1]	Sample Date	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Chrysene	Dibenzo (a,h) anthracene	Indeno (1,2,3-cd) pyrene	Acenaphthene	Acenaphthylene	Anthracene	Benzo (g,h,i) perylene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	Total Carcinogenic PAHs	Total PAHs
Ambient Water Quality Criteria (AWQC) for Surface Water[2]			0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	0.018[4]	990.[3]	#	40,000[4]	#	140.[4]	5,300.[4]	620.[3]	#	4,000.[4]	#	#
Temporary Well Point Samples 1995																			ND	ND
B-01 at 23'	950921-BW1-01	21-Sep-95	ND[5]	ND[5]	ND[5]	ND[5]	0.09	ND[5]	ND[5]	7.4	0.22	1.5	ND[5]	1.3	4.5	140.	19.	1.7	0.09	176.
B-05 at 28'	950925-BW05-01	29-Sep-95	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	ND[5]	13.	0.14	1.2	ND[5]	1.4	9.8	0.94	6.9	1.4	ND	35.
B-19 at 28'	950920-BW19-02	20-Sep-95	0.26	0.16	ND[5]	ND[5]	0.28	ND[5]	ND[5]	39.	7.7	3.1	ND[5]	5.1	20.	6,500.	29.	5.6	0.7	6,610.
B-21 at 19.5'	951003-BW21-01	3-Oct-95	0.53	0.66	0.27	0.34	0.79	0.07	0.27	110.	1.83	2.66	0.37	5.04	21.	560.	17.	5.42	2.93	726.
B-31 at 29'	950925-BW31-01	25-Sep-95	2.4	2.1	0.97	2.4	3.9	0.21	1.3	96.	2.7	15.	1.6	16.	29.	420.	76.	25.	13.28	695.

Note:
= Reference Level not established
Bold and shaded = Detected above lowest identified Reference Level
EPA = U.S. Environmental Protection Agency
ND = not detected above detection limit indicated
ODEQ = Oregon Department of Environmental Quality
PAHs = polynuclear aromatic hydrocarbons
ppb = parts per billion
ug/l = micrograms per liter
a = detection limit is 0.1 ug/l (ppb)
b = detection limit is 1. ug/l (ppb)
c = detection limit is 2. ug/l (ppb)
d = detection limit is 10. ug/l (ppb)
e = detection limit is 20. ug/l (ppb)

1 = Sample number prefix: 2708-
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (EPA-822-R-02-047, November 2002) based on Freshwater Chronic (Aquatic Life Protection) and Fish Consumption (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
4 = Reference Level based on Human Fish Consumption Criteria of AWQC
5 = Due to mislabeling in the field or due to laboratory misidentification, the laboratory report transposed results for MW4-35 and MW-4-57 in August 1997. Tables attribute data to the correct well.
6 = Results for sample 960620-MW-8-56-01 should be considered qualitative due to an apparent error concerning sample identity with respect to PAH container

Koppers023014

Table 4c - Summary of Historical Analytical Results for Groundwater Samples: Priority Pollutant Metals by EPA Methods 6010, 200.7 and/or 7000 Series
December 1995 to Present

Priority Pollutant Metals by EPA Methods 6010, 7000, and 200 Series			Analytical Results mg/l (ppm)																		
Well Number	HAI Sample Number [1]	Sample Date	Antimony	Arsenic	Dissolved Arsenic	Beryllium	Cadmium	Dissolved Cadmium	Chromium	Dissolved Chromium	Copper	Dissolved Copper	Lead	Dissolved Lead	Mercury	Nickel	Dissolved Nickel	Selenium	Silver	Thallium	Zinc	Dissolved Zinc
Ambient Water Quality Criteria (AWQC) for Surface Water [2]			0.640 [4]	0.00014 [4]	0.00014 [4]	#	0.00025 [3]	0.00025 [3]	0.011 [3]	0.011 [3]	0.009 [3]	0.009 [3]	0.0025 [3]	0.0025 [3]	0.000077 [3]	0.052 [3]	0.052 [3]	0.005 [3]	0.0032 [3]	0.0063 [3]	0.12 [3]	0.12 [3]
MW1-22	951207-MW1-22-01	7-Dec-95											0.041	ND>0.005								
	960319-MW1-22-01	19-Mar-96	ND>0.005	ND>0.005		ND>0.002	ND>0.002		0.01		ND>0.005		0.007	ND>0.005	ND>0.0002	0.14	0.23	ND>0.002	ND>0.002	ND>0.01	0.066	
	960618-MW1-22-01	18-Jun-96		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.039					0.024	
	961001-MW1-22-01	1-Oct-96		ND>0.005					0.023	0.022	ND>0.005		ND>0.005	ND>0.005		0.16	0.14				0.17	
	970225-MW1-22-01	25-Feb-97		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.045					0.028	
	970225-MW1-22-02	25-Feb-97		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.044					0.024	
	970827-MW1-22-01	27-Aug-97		0.012					0.018		0.01		0.027	ND>0.005		0.1	0.083				0.16	
	970827-MW1-22-02	27-Aug-97		ND>0.05					ND>0.05		ND>0.05		ND>0.05	ND>0.005		0.12	0.081				0.53	
	980217-MW1-22-01	17-Feb-98		0.009					ND>0.005		0.007		0.015	ND>0.005		0.011					0.05	
	980602-MW1-32-11	2-Jun-98		0.031					0.006				0.03	ND>0.005		0.026					0.13	
	980826-MW1-22-10	26-Aug-98											ND>0.005			0.041					ND>0.005	
	981118-MW1-22-15	18-Nov-98		0.03	ND>0.005				0.008		0.022		0.091			0.11					0.086	
	990216-MW1-22-012	16-Feb-99											0.006			ND>0.005					0.051	
	990513-MW1-22-11	13-May-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.025	
	990824-MW1-22-15	24-Aug-99		0.061					0.02		0.044		0.15			0.19					0.52	
	991028-MW1-22-16	28-Oct-99		ND>0.005	ND>0.005				0.011	0.009	ND>0.005	ND>0.005	0.0081	ND>0.005		0.046	0.025				0.063	0.027
	000330-MW1-22-116	30-Mar-00		ND>0.005	ND>0.005				ND>0.005		ND>0.005		ND>0.005	ND>0.005		0.0329					0.0341	
	010329-MW1-22-115	29-Mar-01		0.018					ND>0.005		ND>0.01		0.0101			0.0128					0.0503	
MW2-32	951206-MW2-32-01	6-Dec-95											ND>0.005									
	960618-MW2-32-01	18-Jun-96		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.008					ND>0.005	
	961001-MW2-32-01	1-Oct-96		ND>0.005					ND>0.005		0.008		ND>0.005			0.005					0.01	
	970225-MW2-32-01	25-Feb-97		0.008					ND>0.005		ND>0.005		ND>0.005			0.011					0.007	
	970827-MW2-32-01	27-Aug-97		0.007					ND>0.005		ND>0.005		ND>0.005			0.008					0.008	
	980217-MW2-32-01	17-Feb-97		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	980601-MW2-32-05	1-Jun-98		ND>0.005					ND>0.005							0.006						
	981117-MW2-32-10	17-Nov-98		ND>0.005					ND>0.005							0.005						
	990513-MW2-32-10	13-May-99		ND>0.005					ND>0.005							ND>0.005						
	991027-MW2-32-12	27-Oct-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0 005	
	000329-MW2-32-112	29-Mar-00		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.0053					0 0158	
	010328-MW2-32-111	28-Mar-01		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.0147					ND>0 005	
MW2-61	981116-MW2-61-04	16-Nov-98		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0 005	
	990216-MW2-61-006	16-Feb-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND >0 03	
	990512-MW2-61-05	12-May-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0 005	
	990823-MW2-61-07	23-Aug-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.01	
	991026-MW2-61-04	26-Oct-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	000328-MW2-61-104	28-Mar-00		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	001004-MW2-61-04	4-Oct-00		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	010328-MW2-61-104	28-Mar-01		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	011009-MW2-61-104	9-Oct-01		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.01	
	020403-MW2-61-103	3-Apr-02		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.009	
	020924-MW2-61-103	24-Sep-02		ND>0.005					ND>0.005		ND>0.01		ND>0.01			ND>0.005					ND>0.005	
	030318-MW2-61-104	18-Mar-03		ND>0.010					ND>0.015		ND>0.0030		ND>0.0060			ND>0.0050					ND>0.020	

Koppers023015

Table 4c - Summary of Historical Analytical Results for Groundwater Samples: Priority Pollutant Metals by EPA Methods 6010, 200.7 and/or 7000 Series
December 1995 to Present

Priority Pollutant Metals by EPA Methods 6010, 7000, and 200 Series			Analytical Results mg/l (ppm)																	
Well Number	HAI Sample Number [1]	Sample Date	Antimony	Arsenic	Dissolved Arsenic	Beryllium	Cadmium	Dissolved Cadmium	Chromium	Dissolved Chromium	Copper	Dissolved Copper	Lead	Dissolved Lead	Mercury	Nickel	Dissolved Nickel	Selenium	Silver	Thallium	Zinc	Dissolved Zinc
Ambient Water Quality Criteria (AWQC) for Surface Water [2]			0.640 [4]	0.00014 [4]	0.00014 [4]	#	0.00025 [3]	0.00025 [3]	0.011 [3]	0.011 [3]	0.009 [3]	0.009 [3]	0.0025 [3]	0.0025 [3]	0.000077 [3]	0.052 [3]	0.052 [3]	0.005 [3]	0.0032 [3]	0.0063 [3]	0.12 [3]	0.12 [3]
MW3-26	951206-MW3-26-01	6-Dec-95											0.007	ND>0.005								
	960318-MW3-26-02	18-Mar-96		ND>0.005			ND>0.002		ND>0.005		ND>0.005		ND>0.005			0.36	0.4				0.005	
	960618-MW3-26-01	18-Jun-96		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.33	0.39				0.014	
	961001-MW3-26-01	1-Oct-96		0.026					0.44	ND>0.005	0.41		0.11	ND>0.005		1.5	0.15				0.98	
	970225-MW3-26-01	25-Feb-97		ND>0.005					0.006		ND>0.005		ND>0.005			0.27	0.2				0.017	
	970827-MW3-26-01	27-Aug-97		0.031					0.39	ND>0.005	0.38		0.099	ND>0.005		1.4	0.05				0.71	
	980218-MW3-26-01	18-Feb-98		ND>0.005					0.017		0.009		0.007			0.21	0.15				0.04	
	980602-MW3-26-09	2-Jun-98		ND>0.005					ND>0.005		0.008		0.005			0.29					0.028	
	980826-MW3-26-08	26-Aug-98							ND>0.005		ND>0.005		ND>0.005			0.083					0.005	
	981117-MW3-26-12	17-Nov-98		0.024	ND>0.005				0.22	ND>0.005	0.25		0.08	ND>0.005		1.2	0.1				0.61	
	990216-MW3-26-010	16-Feb-99							0.0078		0.041		ND>0.005			0.15					0.063	
	990514-MW3-26-23	14-May-99		ND>0.005					ND>0.005		ND>0.005		0.0097			0.14					0.024	
	990824-MW3-26-12	24-Aug-99							0.096		0.023		0.0054			0.21					0.064	
	991027-MW3-26-14	27-Oct-99		0.02	ND>0.005				1.	ND>0.005	0.28	ND>0.005	0.079	ND>0.005		1.5	0.079				0.59	ND>0.005
	000330-MW3-26-113	30-Mar-00		ND>0.005					ND>0.005		ND>0.005		ND>0.005	ND>0.005		0.085	0.0592				0.0713	
	001005-MW3-26-11	5-Oct-00		ND>0.005					0.0386		0.0298		0.0107			0.187					0.0696	
	010328-MW3-26-113	28-Mar-01		0.005					0.0149		0.0116		ND>0.005			0.191					0.0304	
MW3-56	951206-MW3-56-01	6-Dec-95	ND>0.005	ND>0.005		ND>0.002	ND>0.002		ND>0.005		ND>0.005		ND>0.005		ND>0.0002	0.007		ND>0.005	ND>0.005	ND>0.01	0.005	
	960319-MW3-56-01	19-Mar-96		ND>0.005			ND>0.002		ND>0.005		ND>0.005		ND>0.005			0.013					ND>0.005	
	980602-MW3-56-14	2-Jun-98		ND>0.005					0.007							0.017						
	981118-MW3-56-16	18-Nov-98		ND>0.005					ND>0.005							ND>0.005						
	990514-MW3-56-24	14-May-99		ND>0.005					0.0064							0.019						
	990824-MW3-56-16	24-Aug-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.0087					ND>0.01	
	991028-MW3-56-17	28-Oct-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.0058					ND>0.005	
	000330-MW3-56-117	30-Mar-00		0.0084					0.0457		0.0276		0.0121			0.0865					0.0631	
	001005-MW3-56-13	5-Oct-00		ND>0.005	ND>0.005				0.0064	ND>0.005	ND>0.005	ND>0.005	ND>0.005	ND>0.005		0.0151	ND>0.005				0.0129	0.0119
	010329-MW3-56-116	29-Mar-01		0.006					0.0053		ND>0.01		ND>0.005			0.013					0.0072	
	020404-MW3-56-111	4-Apr-02		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.0096					0.0082	
	030319-MW3-56-112	19-Mar-03		ND>0.010	ND>0.011				ND>0.0030		ND>0.0030		ND>0.0060	ND>0.0067		0.0053	ND>0.0056				ND>0.020	
MW4-35	951206-MW4-35-01	6-Dec-95											ND>0.005									
	960618-MW4-35-01	18-Jun-96		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	961001-MW4-35-01	1-Oct-96		0.007					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.008	
	970225-MW4-35-01	25-Feb-97		0.008					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	980827-MW4-57-01 [5]	27-Aug-97		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	980217-MW4-35-01	17-Feb-98		ND>0.005					0.007		ND>0.005		ND>0.005			0.005					0.005	
	980601-MW4-35-06	1-Jun-98		ND>0.005					ND>0.005							ND>0.005						
	981117-MW4-35-11	17-Nov-98		0.005					ND>0.005							ND>0.005						
	990514-MW4-35-21	14-May-99		ND>0.005					ND>0.005							ND>0.005						
	991027-MW4-35-13	27-Oct-99		0.006					0.044		0.033		0.016			0.037					0.067	
	000330-MW4-35-114	30-Mar-00		0.006	0.006				ND		ND		ND			ND					ND	
	001005-MW4-35-10	5-Oct-00		0.0134					0.111		0.123		0.0511			0.105					0.252	
	010328-MW4-35-112	28-Mar-01		0.0055					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	

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Table 4c - Summary of Historical Analytical Results for Groundwater Samples: Priority Pollutant Metals by EPA Methods 6010, 200.7 and/or 7000 Series
December 1995 to Present

Priority Pollutant Metals by EPA Methods 6010, 7000, and 200 Series			Analytical Results mg/l (ppm)																		
Well Number	HAI Sample Number [1]	Sample Date	Antimony	Arsenic	Dissolved Arsenic	Beryllium	Cadmium	Dissolved Cadmium	Chromium	Dissolved Chromium	Copper	Dissolved Copper	Lead	Dissolved Lead	Mercury	Nickel	Dissolved Nickel	Selenium	Silver	Thallium	Zinc	Dissolved Zinc
Ambient Water Quality Criteria (AWQC) for Surface Water [2]			0.640 [4]	0.00014 [4]	0.00014 [4]	#	0.00025 [3]	0.00025 [3]	0.011 [3]	0.011 [3]	0.009 [3]	0.009 [3]	0.0025 [3]	0.0025 [3]	0.000077 [3]	0.052 [3]	0.052 [3]	0.005 [3]	0.0032 [3]	0.0063 [3]	0.12 [3]	0.12 [3]
MW4-57	951205-MW4-57-01	5-Dec-95											ND>0.005									
	960321-MW4-57-01	21-Mar-96		0.005			ND>0.002		ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	960620-MW4-57-02	20-Jun-96		0.007					ND>0.005		ND>0.005		ND>0.005			0.005					ND>0.005	
	961002-MW4-57-01	2-Oct-96		0.013					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	970226-MW4-57-01	26-Feb-97		0.01					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	970828-MW4-35-01 [5]	28-Aug-97		0.013					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	980218-MW4-57-01	18-Feb-98		0.011					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	980603-MW4-57-18	3-Jun-98		0.011					ND>0.005							ND>0.005						
	981119-MW4-57-20	19-Nov-98		0.01					ND>0.005							ND>0.005						
	990514-MW4-57-22	14-May-99		0.011					ND>0.005							ND>0.005						
	990825-MW4-57-17	25-Aug-99		0.013					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.01	
	991026-MW4-57-21	28-Oct-99		0.013	ND>0.005				0.015	ND>0.005	0.008	ND>0.005	ND>0.005	ND>0.005		0.012	ND>0.005				0.014	ND>0.005
	000403-MW4-57-121	3-Apr-00		0.016	0.015				ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0259	
	001006-MW4-57-19	6-Oct-00		0.0137					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	010329-MW4-57-120	29-Mar-01		0.0183					ND>0.005		ND>0.01		ND>0.005			ND>0.005					ND>0.005	
	020405-MW4-57-117	5-Apr-02		0.0128	0.011				ND>0.005	ND>0.005	ND>0.005	ND>0.005	ND>0.005	ND>0.005		0.0079	ND>0.005				ND>0.005	ND>0.005
	030320-MW4-57-117	20-Mar-03		0.016	0.02				ND>0.0010		ND>0.0030		ND>0.0060			ND>0.0050					ND>0.020	
MW4-101	981117-MW4-101-09	17-Nov-98		0.007					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	990216-MW4-101-007	16-Feb-99		0.01					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.03	
	990514-MW4-101-20	14-May-99		0.011																		
	990514-MW4-101-20	14-May-99		0.008					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND[6]	
	990824-MW4-101-09	24-Aug-99		0.01					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.01	
	991027-MW4-101-11	27-Oct-99		0.01					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	000329-MW4-101-111	29-Mar-00		0.011					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0069	
	001005-MW4-101-09	5-Oct-00		0.0069					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	010328-MW4-101-110	28-Mar-01		0.0157					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	011009-MW4-101-103	9-Oct-01		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.01	
	020404-MW4-101-110	4-Apr-02		0.014	0.012				ND>0.005	ND>0.005	ND>0.005	ND>0.015	ND>0.005	ND>0.01		ND>0.005	ND>0.005				0.0054	ND>0.015
	020924-MW4-101-102	24-Sep-02		0.014	0.018				ND>0.005	ND>0.0056	ND>0.01	ND>0.011	ND>0.01	0.0073		ND>0.005	ND>0.0056				0.0077	0.0086
	030318-MW4-101-109	18-Mar-03		0.017	0.018				ND>0.015		ND>0.0030		ND>0.0060			ND>0.0050					ND>0.020	
MW5-32	951205-MW5-32-01	5-Dec-95											ND>0.005									
	960620-MW5-32-01	20-Jun-96		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	961001-MW5-32-01	1-Oct-96		0.008					0.11	ND>0.005	0.22		0.029	ND>0.005		0.088					0.4	
	970225-MW5-32-01	25-Feb-97		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.006	
	970827-MW5-32-01	27-Aug-97		ND>0.005					0.011		0.012		ND>0.005			0.012					0.024	
	980217-MW5-32-01	17-Feb-98		ND>0.005					0.022		0.01		ND>0.005			0.011					0.016	
	980602-MW5-32-10	2-Jun-98		ND>0.005					0.022							0.023						
	981118-MW5-32-13	18-Nov-98		0.008					0.099							0.091						
	990514-MW5-32-17	14-May-99		ND>0.005					ND>0.005	ND>0.005						ND>0.005						
	991027-MW5-32-15	27-Oct-99		0.018	ND>0.005				0.28	ND>0.005	0.38	ND>0.005	0.071	ND>0.005		0.23	0.0055				0.54	ND>0.005
	000330-MW5-32-115	30-Mar-00		ND>0.005	ND>0.005				0.014	ND>0.005	0.0177		ND>0.005			0.0161					0.0407	
	001005-MW5-32-12	5-Oct-00		ND>0.005					0.0458		0.0533		0.0129			0.0409					0.0963	
	010329-MW5-32-114	29-Mar-01		0.008					0.061		0.0651		0.0163			0.0524					0.117	

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Table 4c - Summary of Historical Analytical Results for Groundwater Samples: Priority Pollutant Metals by EPA Methods 6010, 200.7 and/or 7000 Series
December 1995 to Present

Priority Pollutant Metals by EPA Methods 6010, 7000, and 200 Series			Analytical Results mg/l (ppm)																		
Well Number	HAI Sample Number [1]	Sample Date	Antimony	Arsenic	Dissolved Arsenic	Beryllium	Cadmium	Dissolved Cadmium	Chromium	Dissolved Chromium	Copper	Dissolved Copper	Lead	Dissolved Lead	Mercury	Nickel	Dissolved Nickel	Selenium	Silver	Thallium	Zinc	Dissolved Zinc
Ambient Water Quality Criteria (AWQC) for Surface Water [2]			0.640 [4]	0.00014 [4]	0.00014 [4]	#	0.00025 [3]	0.00025 [3]	0.011 [3]	0.011 [3]	0.009 [3]	0.009 [3]	0.0025 [3]	0.0025 [3]	0.000077 [3]	0.052 [3]	0.052 [3]	0.005 [3]	0.0032 [3]	0.0063 [3]	0.12 [3]	0.12 [3]
MW5-100	981118-MW5-100-14	18-Nov-98		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.008					0.006	
	990217-MW5-100-017	17-Feb-99		0.007					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.028	
	990514-MW5-100-18	14-May-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0091	
	990825-MW5-100-18	25-Aug-99		0.006					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.01	
	991028-MW5-100-19	28-Oct-99		0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	000330-MW5-100-119	30-Mar-00		0.007					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	001005-MW5-100-15	5-Oct-00		0.0057					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	001005-MW5-100-16	5-Oct-00		0.0058					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	010329-MW5-100-118	29-Mar-01		0.0095					ND>0.005		ND>0.01		ND>0.005			ND>0.005					ND>0.005	
	020405-MW5-100-114	5-Apr-02		0.0073	0.005				ND>0.005	ND>0.005	ND>0.005	ND>0.005	ND>0.005	ND>0.005		ND>0.005	ND>0.005				0.0051	ND>0.005
	020405-MW5-100-115	5-Apr-02		0.0073					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0072	
	030319-MW5-100-114	19-Mar-03		0.011					ND>0.0030		ND>0.0030		ND>0.0060			ND>0.0050					ND>0.020	
MW5-175	981118-MW5-175-07	18-Nov-98		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	990215-MW5-175-003	15-Feb-99		0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.04	
	990512-MW5-175-07	12-May-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	990823-MW5-175-03	23-Aug-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.01	
	991026-MW5-175-06	26-Oct-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	000329-MW5-175-106	29-Mar-00		0.006					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	001004-MW5-175-05	4-Oct-00		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	010328-MW5-175-105	28-Mar-01		0.008					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	011009-MW5-175-102	9-Oct-01		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.01	
	020404-MW5-175-105	4-Apr-02		0.007					ND>0.005		ND>0.005		ND>0.005			0.0157					0.0055	
	020924-MW5-175-101	24-Sep-02		ND>0.005	0.014				ND>0.005	ND>0.0056	ND>0.01	ND>0.011	ND>0.01	0.0082		0.0061	ND>0.0056				0.015	0.0069
	030318-MW5-175-105	18-Mar-03		ND>0.010					ND>0.015		ND>0.0030		ND>0.0060			ND>0.0050					ND>0.020	
MW6-32	951207-MW6-32-01	7-Dec-95	ND>0.005	0.015		ND>0.002	ND>0.002		ND>0.005		ND>0.005		ND>0.005		ND>0.0002	ND>0.005		ND>0.005	ND>0.005	ND>0.01	ND>0.005	
	960319-MW6-32-01	19-Mar-96		0.011			ND>0.002		ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.005	
	960617-MW6-32-01	17-Jun-96		0.011					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	960930-MW6-32-01	30-Sep-96		0.007					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	970224-MW6-32-01	25-Feb-97		0.008					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	970826-MW6-32-01	26-Aug-97		0.007					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	980218-MW6-32-01	18-Feb-98		0.009					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.005	
MW6-61	951206-MW6-61-01	6-Dec-95											ND>0.005									
	960319-MW6-61-01	19-Mar-96	ND>0.005	ND>0.005			ND>0.005		0.005		ND>0.005		ND>0.005			ND>0.005					0.015	
	960620-MW6-61-01	20-Jun-96		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	961001-MW6-61-01	1-Oct-96		0.006					ND>0.005		0.01		ND>0.005			ND>0.005					0.01	
	970225-MW6-61-01	25-Feb-97		0.006					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	970828-MW6-61-01	28-Aug-97		0.007					0.014		0.018		ND>0.005			0.012					0.2	
MW6-29	951207-MW6-29-01	7-Dec-95	ND>0.005	ND>0.005		ND>0.002	ND>0.002		0.031		0.023		0.011		ND>0.0002	0.075		ND>0.005	ND>0.005	ND>0.01	0.3	
	960321-MW6-29-01	21-Mar-96		ND>0.005			ND>0.005		0.008		0.005		ND>0.005			0.015					0.26	
	960619-MW6-29-02	20-Jun-96		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.008					0.014	
	961002-MW6-29-01	2-Oct-96		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.008					ND>0.005	
	970226-MW6-29-01	26-Feb-97		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.007					0.01	
	970828-MW6-29-01	28-Aug-97		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.011					0.2	
	980218-MW6-29-01	18-Feb-98		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.009					0.21	

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Table 4c - Summary of Historical Analytical Results for Groundwater Samples: Priority Pollutant Metals by EPA Methods 6010, 200.7 and/or 7000 Series
December 1995 to Present

Priority Pollutant Metals by EPA Methods 6010, 7000, and 200 Series			Analytical Results mg/l (ppm)																		
Well Number	HAI Sample Number [1]	Sample Date	Antimony	Arsenic	Dissolved Arsenic	Beryllium	Cadmium	Dissolved Cadmium	Chromium	Dissolved Chromium	Copper	Dissolved Copper	Lead	Dissolved Lead	Mercury	Nickel	Dissolved Nickel	Selenium	Silver	Thallium	Zinc	Dissolved Zinc
Ambient Water Quality Criteria (AWQC) for Surface Water [2]			0.640 [4]	0.00014 [4]	0.00014 [4]	#	0.00025 [3]	0.00025 [3]	0.011 [3]	0.011 [3]	0.009 [3]	0.009 [3]	0.0025 [3]	0.0025 [3]	0.000077 [3]	0.052 [3]	0.052 [3]	0.005 [3]	0.0032 [3]	0.0063 [3]	0.12 [3]	0.12 [3]
MW8-56	951207-MW8-56-01	7-Dec-95	ND>0.005	ND>0.005		ND>0.002	ND>0.002		0.048		0.009		ND>0.005		ND>0.0002	0.035		ND>0.005	ND>0.005	ND>0.01	0.27	
	960321-MW8-56-01	21-Mar-96		ND>0.005			ND>0.002		0.021		0.009		ND>0.005			0.02					0.24	
	960620-MW8-56-01	20-Jun-96		ND>0.005					ND>0.005		0.15		ND>0.005			0.017					0.1	
	961002-MW8-56-01	2-Oct-96		ND>0.005					0.02		0.027		ND>0.005			0.071					0.023	
	970226-MW8-56-01	26-Feb-97		ND>0.005					0.07		0.026		0.005			0.052					0.05	
	970828-MW8-56-01	28-Aug-97		0.006					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.007	
	980218-MW8-56-01	18-Feb-98		0.008					0.027		0.017		ND>0.005			0.02					0.22	
	020405-MW8-56-118	5-Apr-02		0.005					0.0382		0.224		ND>0.005			0.0284					0.0362	
	030320-MW8-56-120	20-Mar-03		0.012	0.019				ND>0.0010	ND>0.0011	ND>0.0033		ND>0.0060	ND>0.0067		ND>0.0050	ND>0.0056				ND>0.020	ND>0.022
MW9-29	951205-MW9-29-01	5-Dec-95											0.022									
	960318-MW9-29-01	18-Mar-96	ND>0.005	ND>0.005		ND>0.002	ND>0.002		ND>0.005		ND>0.005		ND>0.005		ND>0.0002	ND>0.005		ND>0.005	ND>0.005	ND>0.01	ND>0.005	
	960618-MW9-29-01	18-Jun-96		0.01					0.23		0.3		0.008			0.16	ND>0.005				0.097	
	961001-MW9-29-01	1-Oct-96		ND>0.005					0.047		0.015		ND>0.005			0.035					0.037	
	970225-MW9-29-01	25-Feb-97		0.006					0.021		0.005		ND>0.005			0.018					0.022	
	970827-MW9-29-01	27-Aug-97		ND>0.005					0.035		0.009		ND>0.005			0.029					0.03	
	980217-MW9-29-01	17-Feb-98		0.005					0.021		0.019		ND>0.005			0.022					0.25	
	980602-MW9-29-07	2-Jun-98		0.01					0.037							0.04						
	981118-MW9-29-02	18-Nov-98		0.009					0.071							0.058						
	990511-MW9-29-03	11-May-99		ND>0.005					0.018							0.017						
	991026-MW9-29-02	26-Oct-99		0.015					0.22		0.048		0.014			0.16					0.14	
	000328-MW9-29-102	28-Mar-00		ND>0.005	ND>0.005				ND>0.005	ND>0.005	ND>0.005		ND>0.005			ND>0.005					ND>0 005	
	010327-MW9-29-102	27-Mar-01		0.012					0.225		0.0306		0.0089			0.158					0.0914	
	020403-MW9-29-101	3-Apr-02		ND>0.005	ND>0.005				0.0063	ND>0.005	ND>0.005	ND>0.015	ND>0.005	ND>0.01		0.0065	ND>0.005					0.0198	0.0186
	030319-MW9-29-103	18-Mar-03		ND>0.010	ND>0.011				ND>0.0015		ND>0.0030		ND>0.0060			ND>0.0050					ND>0.020	
MW10-25	951207-MW10-25-01	7-Dec-95	ND>0.005	0.034		ND>0.002	0.005		0.11		ND>0.005		ND>0.005		ND>0.0002	0.29		ND>0.005	ND>0.005	ND>0.01	0.95	
	960320-MW10-25-01	20-Mar-96		0.035			0.005	ND>0.002	0.089		ND>0.005		ND>0.01			0.28	0.3				0.88	
	960617-MW10-25-01	17-Jun-96		0.028					0.043		ND>0.005		ND>0.005			0.2					0.48	
	960930-MW10-25-01	30-Sep-96		0.041					0.13		ND>0.005		ND>0.02			0.43					1.3	
	970224-MW10-25-01	25-Feb-97		0.058	0.052				0.17	0.16	ND>0.005		ND>0.005			0.41	0.37				1.3	
	970827-MW10-25-01	27-Aug-97		0.045					0.36	0.23	ND>0.005		ND>0.05	ND>0.05		0.83	0.53				3.	
	980216-MW10-25-01	16-Feb-98		0.048					0.16	0.18	ND>0.005		ND>0.015			0.39	0.46				1.5	
	980601-MW10-25-02	1-Jun-98		0.031					0.12	0.12						0.29	0.28					
MW10-61	951206-MW10-61-01	6-Dec-95											ND>0.005									
	960321-MW10-61-01	21-Mar-96		0.005			ND>0.002		0.027		0.009		ND>0.005			0.022					0.025	
	960620-MW10-61-01	20-Jun-96		ND>0.005					ND>0.005		ND>0.005		ND>0.005			0.007					0.008	
	960930-MW10-61-01	2-Oct-96		0.006					0.016		ND>0.005		ND>0.005			0.011					0.012	
	970226-MW10-61-01	26-Feb-97		ND>0.005					0.018		ND>0.005		ND>0.005			0.015					0.015	
	970828-MW10-61-01	28-Aug-97		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	980218-MW10-61-01	18-Feb-98		ND>0.005					0.01		ND>0.005		ND>0.005			0.009					0.015	
	980603-MW10-61-16	3-Jun-98		0.008					0.009							0.009						
	981117-MW10-61-08	17-Nov-98		0.008					0.017							0.014						
	990512-MW10-61-06	12-May-99		ND>0.005					0.028							0.022						
	991026-MW10-61-05	26-Oct-99		ND>0.005					0.0084		ND>0.005		ND>0.005			0.0082					0.11	
	000329-MW10-61-105	29-Mar-00		0.007					0.0144		0.0148		ND>0.005			0.0145					0.0474	
	011010-MW10-61-109	10-Oct-01		ND>0.005					ND>0.0015		ND>0.001		ND>0.005			ND>0.003					ND>0.005	
	020404-MW10-61-109	4-Apr-02		0.008	ND>0.005				0.0321	ND>0.005	0.0091	ND>0.015	ND>0.005	ND>0.01		0.0293	ND>0.005					0.0339	ND>0.005
	020924-MW10-61-104	24-Sep-02		ND>0.005	ND>0.0056				0.0056	ND>0.0056	ND>0.01	ND>0.011	ND>0.01	0.0078		0.0064	ND>0.0056					0.014	0.0061
	030319-MW10-61-111	19-Mar-03		ND>0.010	ND>0.011				0.0062		ND>0.0030		ND>0.0060	ND>0.0067		ND>0.0050	ND>0.0056				ND>0.020	

Koppers023019

Table 4c - Summary of Historical Analytical Results for Groundwater Samples: Priority Pollutant Metals by EPA Methods 6010, 200.7 and/or 7000 Series
December 1995 to Present

Priority Pollutant Metals by EPA Methods 6010, 7000, and 200 Series			Analytical Results mg/l (ppm)																		
Well Number	HAI Sample Number [1]	Sample Date	Antimony	Arsenic	Dissolved Arsenic	Beryllium	Cadmium	Dissolved Cadmium	Chromium	Dissolved Chromium	Copper	Dissolved Copper	Lead	Dissolved Lead	Mercury	Nickel	Dissolved Nickel	Selenium	Silver	Thallium	Zinc	Dissolved Zinc
Ambient Water Quality Criteria (AWQC) for Surface Water [2]			0.640 [4]	0.00014 [4]	0.00014 [4]	#	0.00025 [3]	0.00025 [3]	0.011 [3]	0.011 [3]	0.009 [3]	0.009 [3]	0.0025 [3]	0.0025 [3]	0.000077 [3]	0.052 [3]	0.052 [3]	0.005 [3]	0.0032 [3]	0.0063 [3]	0.12 [3]	0.12 [3]
MW11-32	951207-MW11-32-01	7-Dec-95	ND>0.005	ND>0.005		ND>0.002	ND>0.002		ND>0.005		ND>0.005		ND>0.005		ND>0.0002	ND>0.005		ND>0.005	ND>0.005	ND>0.01	ND>0.005	
	960320-MW11-32-01	20-Mar-96		ND>0.005			ND>0.002		ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.008	
	960930-MW11-32-01	30-Sep-96		ND>0.005			ND>0.005		ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	960930-MW11-32-02	30-Sep-96		ND>0.005			ND>0.005		ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	970224-MW11-32-01	25-Feb-97		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	970826-MW11-32-01	26-Aug-97		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	980218-MW11-32-01	18-Feb-98		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
MW12-36	951207-MW12-36-01	7-Dec-95	ND>0.005	ND>0.005		ND>0.002	ND>0.002		ND>0.005		0.006		ND>0.005		ND>0.0002	ND>0.005		ND>0.005	ND>0.005	ND>0.01	0.012	
	991028-MW12-36-18	28-Oct-99		ND>0.005					0.0084		ND>0.005		ND>0.005			0.0082					0.011	
MW13-30	980602-MW13-30-12	2-Jun-98		0.015					0.009		0.007		ND>0.005			0.008					0.008	
	980826-MW13-30-11	26-Aug-98		0.015					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.014	
	981119-MW13-30-19	19-Nov-98		0.008					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	990217-MW13-30-014	17-Feb-99		0.014					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.018	
	990513-MW13-30-13	13-May-99		0.009					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	991028-MW13-30-20	28-Oct-99		0.01					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	000403-MW13-30-120	3-Apr-00		0.013					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	001005-MW13-30-18	5-Oct-00		0.0104					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	010329-MW13-30-119	29-Mar-01		0.013					ND>0.005		ND>0.01		ND>0.005			ND>0.005					ND>0.005	
	020405-MW13-30-116	5-Apr-02		0.0108	0.013				ND>0.005	ND>0.005	ND>0.005	ND>0.005	ND>0.005	ND>0.005		ND>0.005	ND>0.005				0.0122	ND>0.005
	030319-MW13-30-115	19-Mar-03		ND>0.010	0.019				ND>0.0030		ND>0.0030		ND>0.0060			ND>0.0050					ND>0.020	
MW13-61	980602-MW13-61-13	2-Jun-98		0.007					0.013		0.016		ND>0.005			0.017					0.028	
	980825-MW13-61-03	25-Aug-98		0.008					0.036		0.027		ND>0.005			0.03					0.042	
	981116-MW13-61-03	16-Nov-98		0.008	0.008				0.018		0.02		ND>0.005			0.019					0.044	
	990512-MW13-61-04	12-May-99		0.008					0.066		0.028		ND>0.005			0.054					0.038	
	991026-MW13-61-03	26-Oct-99		0.007					0.01		0.0066		ND>0.005			0.012					0.017	
	000328-MW13-61-104	28-Mar-00		0.009					0.0095		0.0074		ND>0.005			0.0116					0.0144	
	001004-MW13-61-03	4-Oct-00		0.009					0.017		0.0155		ND>0.005			0.0192					0.0253	
	010327-MW13-61-103	27-Mar-01		0.01					0.0148		0.0147		ND>0.005			0.0129					0.0166	
	011009-MW13-61-108	9-Oct-01		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0117	
	020403-MW13-61-102	3-Apr-02		0.006					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0479	
	020924-MW13-61-106	24-Sep-02		0.012	ND>0.0056				ND>0.005	ND>0.0056	ND>0.01	ND>0.011	ND>0.01	0.0082		ND>0.005	ND>0.0056				0.011	0.0079
	030317-MW13-61-101	17-Mar-03		ND>0.010					ND>0.015		ND>0.0030		ND>0.0060			ND>0.0050					ND>0.020	
MW14-110	981116-MW14-110-06	16-Nov-98		0.012					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	990216-MW14-110-005	16-Feb-99		0.013					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.03	
	990512-MW14-110-09	12-May-99		0.012					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	990823-MW14-110-06	23-Aug-99		0.011					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.01	
	991027-MW14-110-09	27-Oct-99		0.01					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	991027-MW14-110-10	27-Oct-99		0.01					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0054	
	000329-MW14-110-109	29-Mar-00		0.012					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0107	
	000329-MW14-110-110	29-Mar-00		0.012					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	000615-MW14-110-102	15-Jun-00		0.014					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	001005-MW14-110-06	5-Oct-00		0.041					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	001220-MW14-110-102	20-Dec-00		0.013					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	010328-MW14-110-108	28-Mar-01		0.013					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	011009-MW14-110-105	9-Oct-01		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.01	
	011213-MW14-110-101	13-Dec-01		ND>0.01					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0104	
	020404-MW14-110-108	4-Apr-02		0.01					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	020711-MW14-110-101	11-Jul-02		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	020924-MW14-110-105	24-Sep-02		ND>0.005					ND>0.005		ND>0.01		ND>0.01			ND>0.005					ND>0.005	
	021217-MW14-110-102	17-Dec-02		0.011					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	030318-MW14-110-108	18-Mar-03		0.011	0.018				ND>0.015		ND>0.0030		ND>0.0060			ND>0.0050					ND>0.020	
	030602-MW14-110-101	2-Jun-03		0.038	0.023				ND>0.0010	ND>0.0011	ND>0.0030	ND>0.0033	ND>0.0060	ND>0.0067		ND>0.0050	ND>0.0056				ND>0.020	ND>0.022

Koppers023020

Table 4c - Summary of Historical Analytical Results for Groundwater Samples: Priority Pollutant Metals by EPA Methods 6010, 200.7 and/or 7000 Series
December 1995 to Present

Priority Pollutant Metals by EPA Methods 6010, 7000, and 200 Series			Analytical Results mg/l (ppm)																		
Well Number	HAI Sample Number [1]	Sample Date	Antimony	Arsenic	Dissolved Arsenic	Beryllium	Cadmium	Dissolved Cadmium	Chromium	Dissolved Chromium	Copper	Dissolved Copper	Lead	Dissolved Lead	Mercury	Nickel	Dissolved Nickel	Selenium	Silver	Thallium	Zinc	Dissolved Zinc
Ambient Water Quality Criteria (AWQC) for Surface Water [2]			0.640 [4]	0.00014 [4]	0.00014 [4]	#	0.00025 [3]	0.00025 [3]	0.011 [3]	0.011 [3]	0.009 [3]	0.009 [3]	0.0025 [3]	0.0025 [3]	0.000077 [3]	0.052 [3]	0.052 [3]	0.005 [3]	0.0032 [3]	0.0063 [3]	0.12 [3]	0.12 [3]
MW15-50	991029-MW15-50-25	29-Oct-99		**0.011**					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0096	
	000403-MW15-50-125	3-Apr-00		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0202	
	000615-MW15-50-105	15-Jun-00		ND>0.005					0.008		ND>0.005		ND>0.005			0.0064					0.0359	
	000615-MW15-50-106	15-Jun-00		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0388	
	001005-MW15-50-14	5-Oct-00		**0.0054**					**0.0176**		0.0081		ND>0.005			0.0121					0.0393	
	001221-MW15-50-105	21-Dec-00		**0.0134**					**0.0585**		**0.0188**		**0.011**			0.042					0.0272	
	001221-MW15-50-106	21-Dec-00		**0.0123**					**0.0193**		**0.0402**		**0.0125**			0.0308					0.0334	
	010330-MW15-50-124	30-Mar-01		**0.0098**					0.0058		ND>0.005		ND>0.005			0.0067					0.0107	
	011010-MW15-50-111	10-Oct-01		ND>0.005					ND>0.0015		0.0063		ND>0.005			ND>0.003					0.0646	
	011010-MW15-50-112	10-Oct-01		ND>0.005					ND>0.0015		0.004		ND>0.005			ND>0.003					0.0412	
	011214-MW15-50-104	14-Dec-01		ND>0.01					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0089	
	011214-MW15-50-105	14-Dec-01		ND>0.01					ND>0.005		ND>0.005		ND>0.005			0.011					0.0084	
	020405-MW15-50-119	5-Apr-02		**0.008**					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0204	
	020711-MW15-50-104	11-Jul-02		**0.0116**					**0.0187**		**0.0183**		**0.0154**			0.0228					0.0929	
	020711-MW15-50-104	11-Jul-02		**0.0103**					**0.0189**		**0.0219**		**0.0166**			0.0232					0.0972	
	020925-MW15-50-110	25-Sep-02		**0.016**	**0.017**				**0.017**	ND>0.0056	**0.027**	ND>0.011	**0.018**	**0.008**		0.025	ND>0.0056				0.092	0.0068
	020925-MW15-50-111	25-Sep-02		**0.021**					**0.045**		**0.062**		**0.05**			**0.061**					**0.24**	
	021218-MW15-50-107	18-Dec-02		**0.012**	ND>0.0056				ND>0.005	ND>0.0056	0.0078	ND>0.0056	**0.0091**	ND>0.0056		0.013	ND>0.0056				0.034	0.012
	030321-MW15-50-122	21-Mar-03		**0.012**	**0.017**				0.0056	ND>0.0011	**0.011**	ND>0.0033	**0.0095**	**0.0081**		0.016	ND>0.0056				0.045	0.056
	030603-MW15-50-105	3-Jun-03		**0.018**	**0.029**				ND>0.0010	ND>0.0011	ND>0.0030	ND>0.0033	ND>0.0060	ND>0.0067		ND>0.0050	ND>0.0056				ND>0.020	ND>0.022
MW15-66	991026-MW15-66-07	26-Oct-99		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	000329-MW15-66-108	29-Mar-00		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	000615-MW15-50-104	15-Jun-00		**0.005**					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0214	
	001005-MW15-66-08	5-Oct-00		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	001221-MW15-66-104	21-Dec-00		**0.0055**					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	010328-MW15-66-107	28-Mar-01		**0.0066**					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	011010-MW15-66-110	10-Oct-01		ND>0.005					ND>0.0015		ND>0.001		ND>0.005			ND>0.003					0.0241	
	011213-MW15-66-103	13-Dec-01		ND>0.01					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0133	
	020404-MW15-66-107	4-Apr-02		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	020711-MW15-66-103	11-Jul-02		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	020925-MW15-66-109	25-Sep-02		ND>0.005					ND>0.005		ND>0.01		ND>0.01			ND>0.005					ND>0.005	
	021218-MW15-66-105	18-Dec-02		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					0.0057	
	021218-MW15-66-106	18-Dec-02		ND>0.005					ND>0.005		ND>0.005		ND>0.005			ND>0.005					ND>0.005	
	030318-MW15-66-107	18-Mar-03		ND>0.010					ND>0.015		ND>0.0030		ND>0.0060			ND>0.0050					ND>0.020	
	030603-MW15-66-104	3-Jun-03		ND>0.010					ND>0.0010		ND>0.0030		ND>0.0060			ND>0.0050					ND>0.020	

Note: # = Reference Levels not established
Bold and shaded = Detected above lowest identified Reference Level
EPA = U.S. Environmental Protection Agency
mg/l = milligrams/liter
ND = not detected above detection limit indicated
ODEQ = Oregon Department of Environmental Quality
ppm = parts per million

1 = Sample number prefix: 2708-
2 = Reference Level indicated is the lowest guidance value provided in the Ambient Water Quality Criteria (EPA-822-R-02-047, November 2002) based on Freshwater Chronic (Aquatic Life Protection) and Fish Consumption (Human Health Protection)
3 = Reference Level based on Aquatic Fresh Chronic Criteria of AWQC
4 = Reference Level based on Human Fish Consumption Criteria of AWQC
5 = Due to mislabeling in the field or due to laboratory misidentification, the laboratory report transposed results for MW4-35 and MW-4-57 in August 1997. Tables attribute data to the correct well.

Koppers023021

Table 5
Summary of DNAPL Recovery Volume: Well MW-6-32

NW Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAI Project No. 2708

Date	Pumping Cycles Per Day	Pumping Duration per Cycle (minutes)	Cumulative Pumping Time (hours)	Measured Volume of Liquid within AST (gallons)	Measured Volume of Liquid Recovered (gallons)	Estimated Volume of DNAPL Recovered[1] (gallons)
08-Aug-00	6	10	1.0	6	6	5
15-Aug-00	3	5	3.4	20	20	16
22-Aug-00	3	5	5.1	30	30	24
19-Sep-00	3	5	12.2	50	50	40
22-Sep-00	3	5	13.6	55	55	44
19-Oct-00	3	5	18.5	70	70	56
16-Nov-00	3	5	25.0	100	100	80
28-Nov-00	3	5	27.7	110	110	88
20-Dec-00	3	5	32.8	130	130	104
18-Jan-01	3	5	39.0	160	160	128
09-Feb-01	3	5	43.2	165	165	132
20-Feb-01	3	5	44.6	165	165	132
30-Mar-01	3	5	45.3	165	165	132
12-Jun-01	3	5	70.6	175	175	140
28-Jun-01	6	10	89.5	180	180	162
12-Jul-01	6	10	106.0	187	187	168
22-Aug-01	6	10	143.9	193	193	174
28-Sep-01	6	10	188.3	220	220	198
14-Nov-01	6	10	237.5	230	230	207
17-Jan-02	6	10	341.3	275	275	248
25-Feb-02	6	10	472.4	348	348	313
15-Mar-02	6	10	491.8	370	370	333
12-Apr-02	6	10	525.31	372	372	333
20-May-02	6	10	574.12	375	375	333
12-Jul-02	6	10	683.6	411	411	370
23-Aug-02	6	10	735.5	425	425	383
13-Sep-02	6	10	760.7	425	425	383
01-Nov-02	6	10	812.6	438	438	394
16-Dec-02	6	10	855.0	445	445	401
28-Jan-03	6	10	1035.0	467 [2]	467	420
05-Feb-03	6	10	1057.8	6	473	426
11-Mar-03	6	10	1063.3	8	475	428
04-Apr-03	6	10	1094.1	11	478	430
12-May-03	6	10	1144.8	19	486	437
09-Jul-03	6	10	1205.1	28	495	446

Notes: AST = above-ground storage tank
DNAPL = dense non-aqueous phase liquid

1 = DNAPL content is estimated to be 80% of the total liquid volume through June 12, 2001, and 90% subsequent to June 12, 2001 based on direct observations of recovered liquids during pumping.

2 = Contents of tank removed and transported off-site for re-refining by Spencer Environmental, Inc., Portland, Oregon

Koppers023022

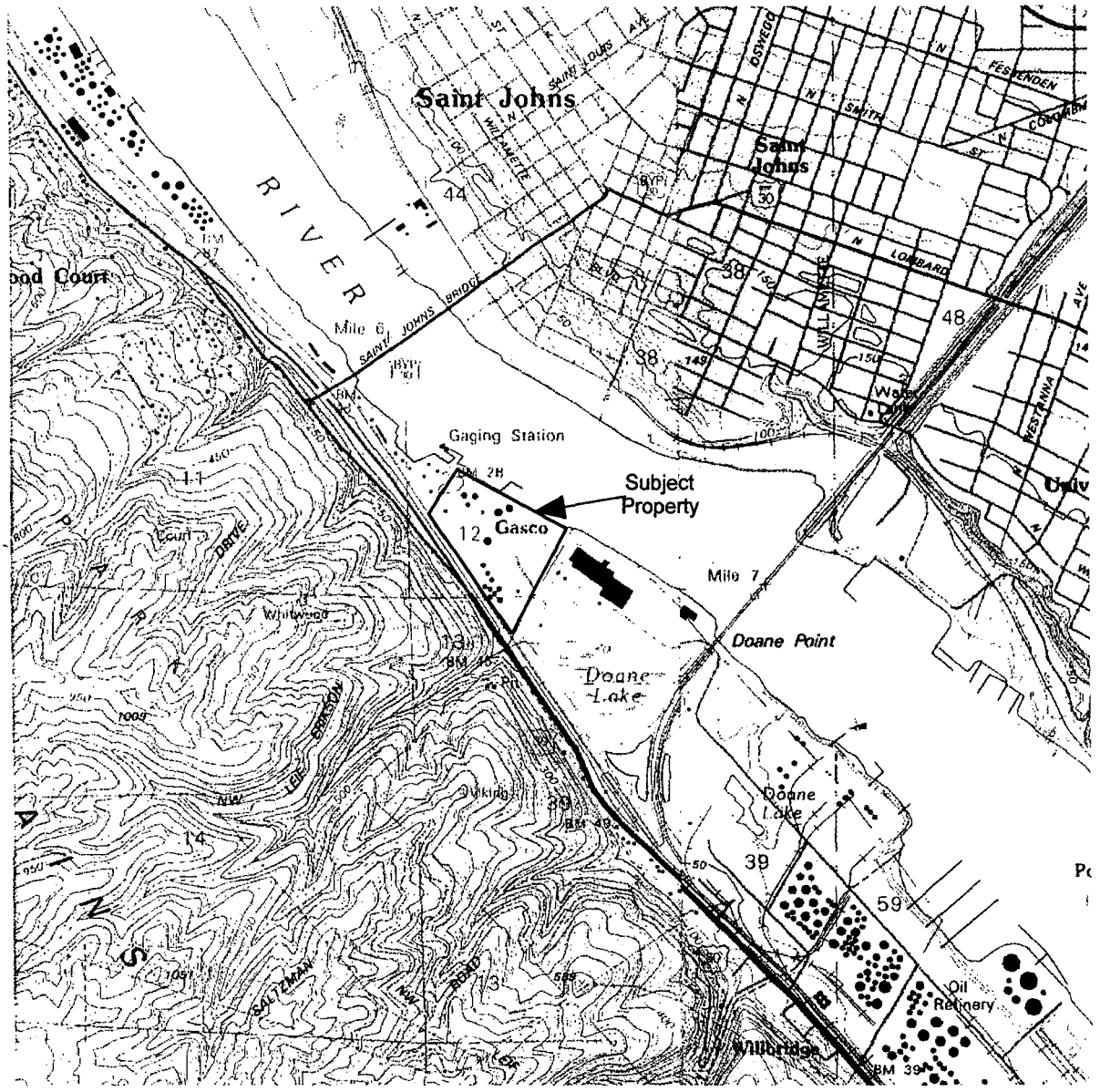
TABLE 6 – Climatological Summary, On-Site Weather Station

Month-Year	Days Recorded	Data Set Completeness	Measurement Frequency (minutes)	Rain (inches)	Average Wind Speed (mph)	Dominant Wind Direction
Dec-01	17	55%	30	2.13	4.5	N
Jan-02	31	100%	30	5.64	2.7	N
Feb-02	0	0%	-	-	-	-
Mar-02	5	16%	60	1.13	4.2	N
Apr-02	15	50%	60	0.59	2.7	SE
May-02	31	100%	60	2.04	2.7	S
Jun-02	30	100%	60	1.71	3.0	S
Jul-02	31	100%	60	0.20	3.5	S
Aug-02	31	100%	60	0.04	3.3	S
Sep-02	30	100%	60	0.79	2.6	SE
Oct-02	31	100%	60	0.40	1.7	SE
Nov-02	0	0%	-	-	-	-
Dec-02	0	0%	-	-	-	-
Jan-03	19	61%	60	6.30	2.5	N
Feb-03	28	100%	60	2.98	2.7	N
Mar-03	11	35%	60	2.62	2.0	N
Apr-03	0	0%	-	-	-	-
May-03	20	67%	60	0.87	2.5	S
Jun-03	30	100%	60	0.13	3.4	S

NOTE: mph = miles per hour

FIGURES

Koppers023024



Note: Base Map from Linnton (1990) and Portland (1990), Oregon, USGS 7.5-Minute Quadrangles

N

0 2,000 4,000

Approximate Scale in Feet
Contour Interval = 10 feet

FIGURE 1

Location Map

NW Natural Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.
Project No. 2708 September 2003

File: 2708-01 Location Map

Koppers023025

FIGURE 2

Monitoring Well Locations

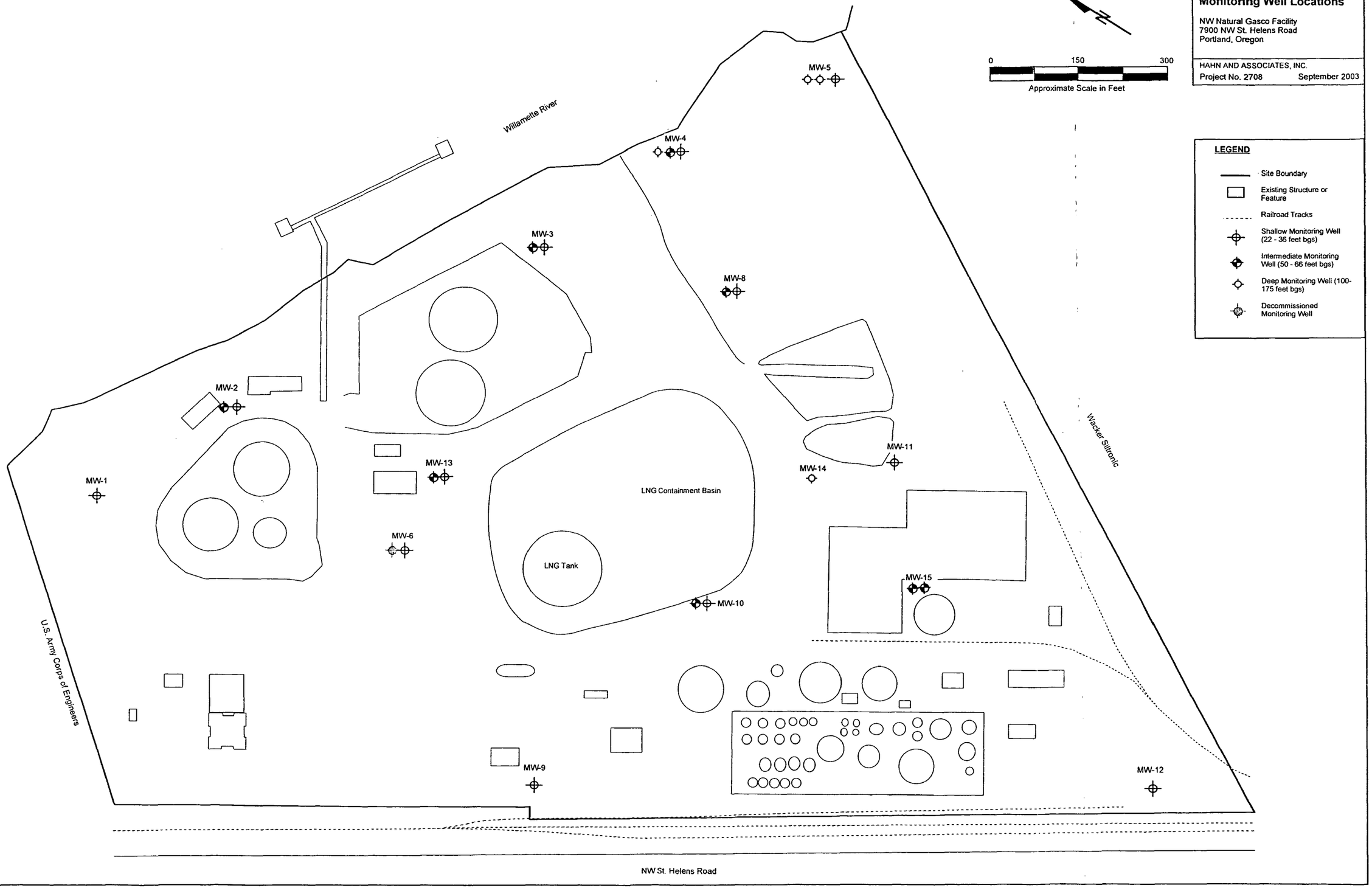
NW Natural Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.
Project No. 2708 September 2003

0 150 300
Approximate Scale in Feet

LEGEND

- Site Boundary
- Existing Structure or Feature
- Railroad Tracks
- Shallow Monitoring Well (22 - 36 feet bgs)
- Intermediate Monitoring Well (50 - 66 feet bgs)
- Deep Monitoring Well (100-175 feet bgs)
- Decommissioned Monitoring Well



Koppers023026

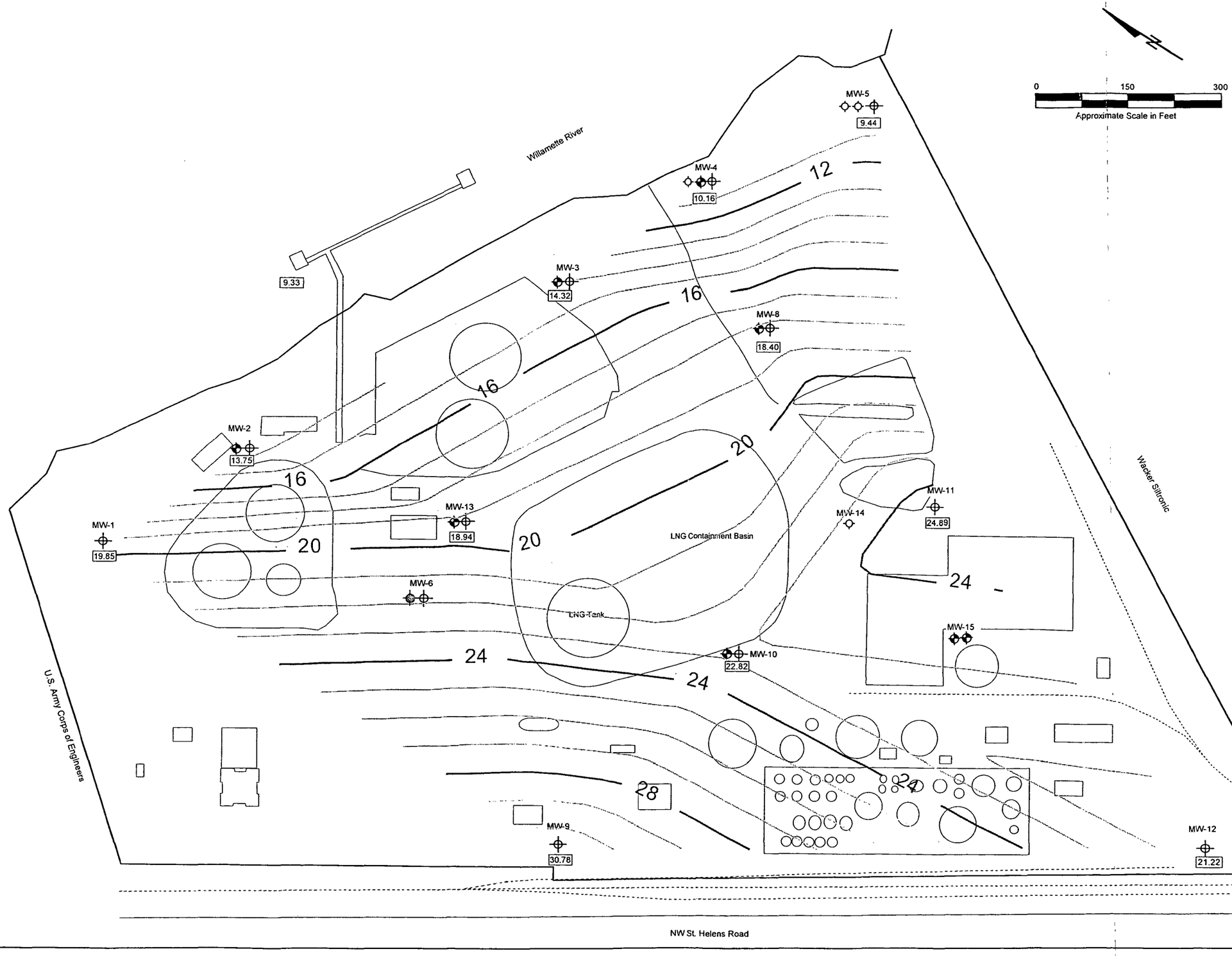
FIGURE 3

Groundwater Elevations- Shallow Wells (22 to 36 feet bgs) - March 17, 2003

NW Natural Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.

Project No. 2708 September 2003



LEGEND

- Site Boundary
- Existing Structure or Feature
- Railroad Tracks
- Shallow Monitoring Well (22 - 36 feet bgs)
- Intermediate Monitoring Well (50 - 66 feet bgs)
- Deep Monitoring Well (100-175 feet bgs)
- Decommissioned Monitoring Well
- Groundwater Elevation Isocontour (1 foot interval)

Koppers023027

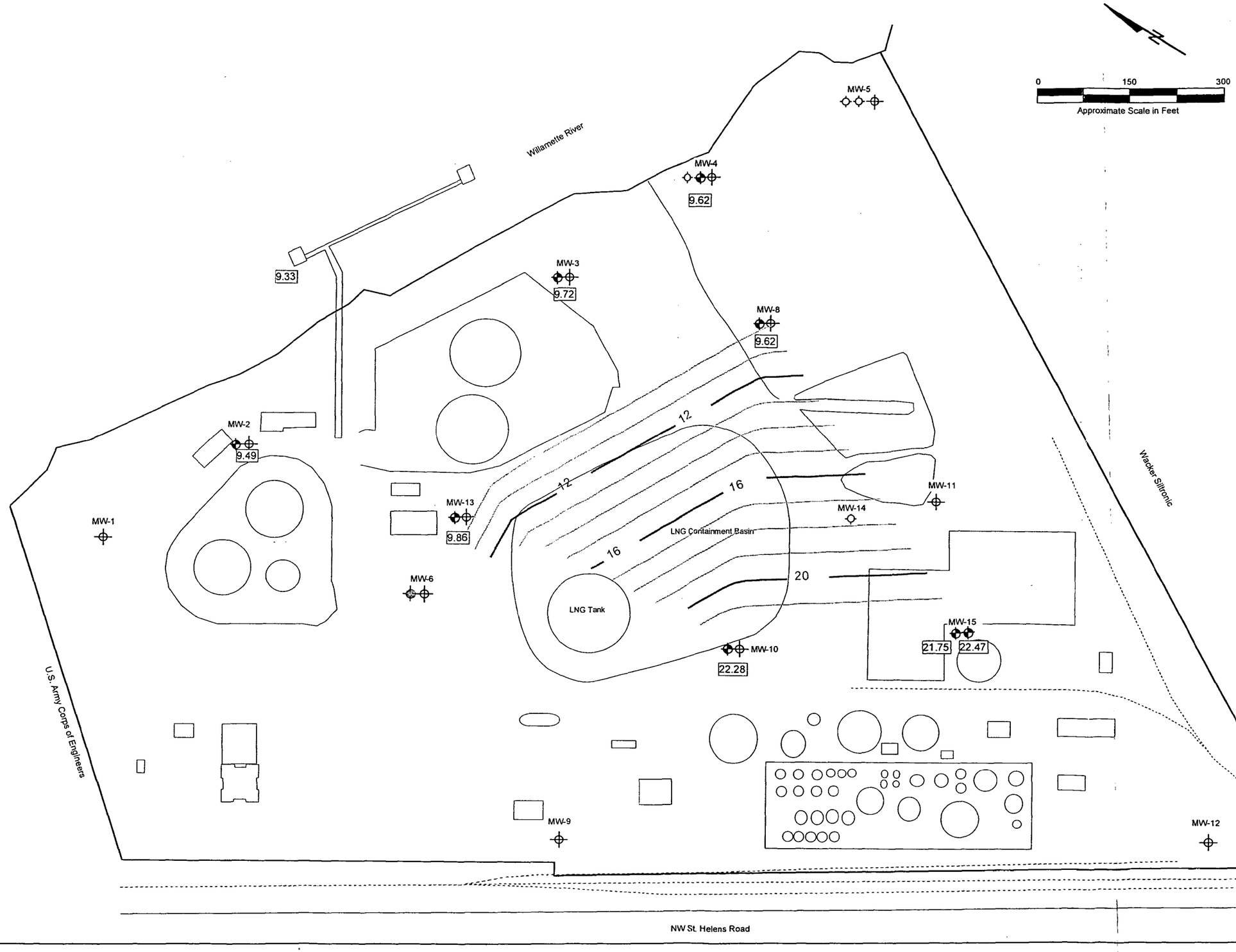
FIGURE 4

Groundwater Elevations- Intermediate Wells (50 to 61 feet bgs) - March 17, 2003

NW Natural Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.

Project No. 2708 September 2003



Koppers023028

FIGURE 5

Groundwater Elevations- Deep Wells (100 to 110 feet bgs) - March 17, 2003

NW Natural Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.

Project No. 2708 September 2003

0 150 300
Approximate Scale in Feet

LEGEND

- Site Boundary
- Existing Structure or Feature
- Railroad Tracks
- Shallow Monitoring Well (22 - 36 feet bgs)
- Intermediate Monitoring Well (50 - 66 feet bgs)
- Deep Monitoring Well (100-175 feet bgs)
- Decommissioned Monitoring Well
- Groundwater Elevation Isocontour (1 foot interval)

Willamette River
MW-5
9.44
MW-4
9.45
9.82
MW-3
MW-8
12
MW-2
MW-1
MW-13
MW-6
LNG Containment Basin
LNG Tank
MW-10
MW-14
15.19
MW-11
Wacker Siltronic
MW-15
U.S. Army Corps of Engineers
MW-9
MW-12
NW St. Helens Road

Koppers023029

FIGURE 6

Groundwater Elevations- Shallow Wells (22 to 36 feet bgs) - June 2, 2003

NW Natural Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.

Project No. 2708 September 2003

0 150 300
Approximate Scale in Feet

LEGEND

- Site Boundary
- Existing Structure or Feature
- Railroad Tracks
- Shallow Monitoring Well (22 - 36 feet bgs)
- Intermediate Monitoring Well (50 - 66 feet bgs)
- Deep Monitoring Well (100-175 feet bgs)
- Decommissioned Monitoring Well
- Groundwater Elevation Isocontour (1 foot interval)

Willamette River
MW-5 12.79
MW-4 12.72
12.67
MW-3 13.86
MW-8 18.94
16
16
20
20
MW-2 14.44
MW-13 19.15
MW-1 19.58
20
MW-6
LNG Containment Basin
LNG Tank
MW-14
MW-11 24.79
MW-15
MW-10 22.62
24
24
U.S. Army Corps of Engineers
Wacker Siltronic
MW-9 28.20
MW-12 26.47
NW St. Helens Road

Koppers023030

FIGURE 7

Groundwater Elevations- Intermediate Wells (50 to 61 feet bgs) - June 2, 2003

NW Natural Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

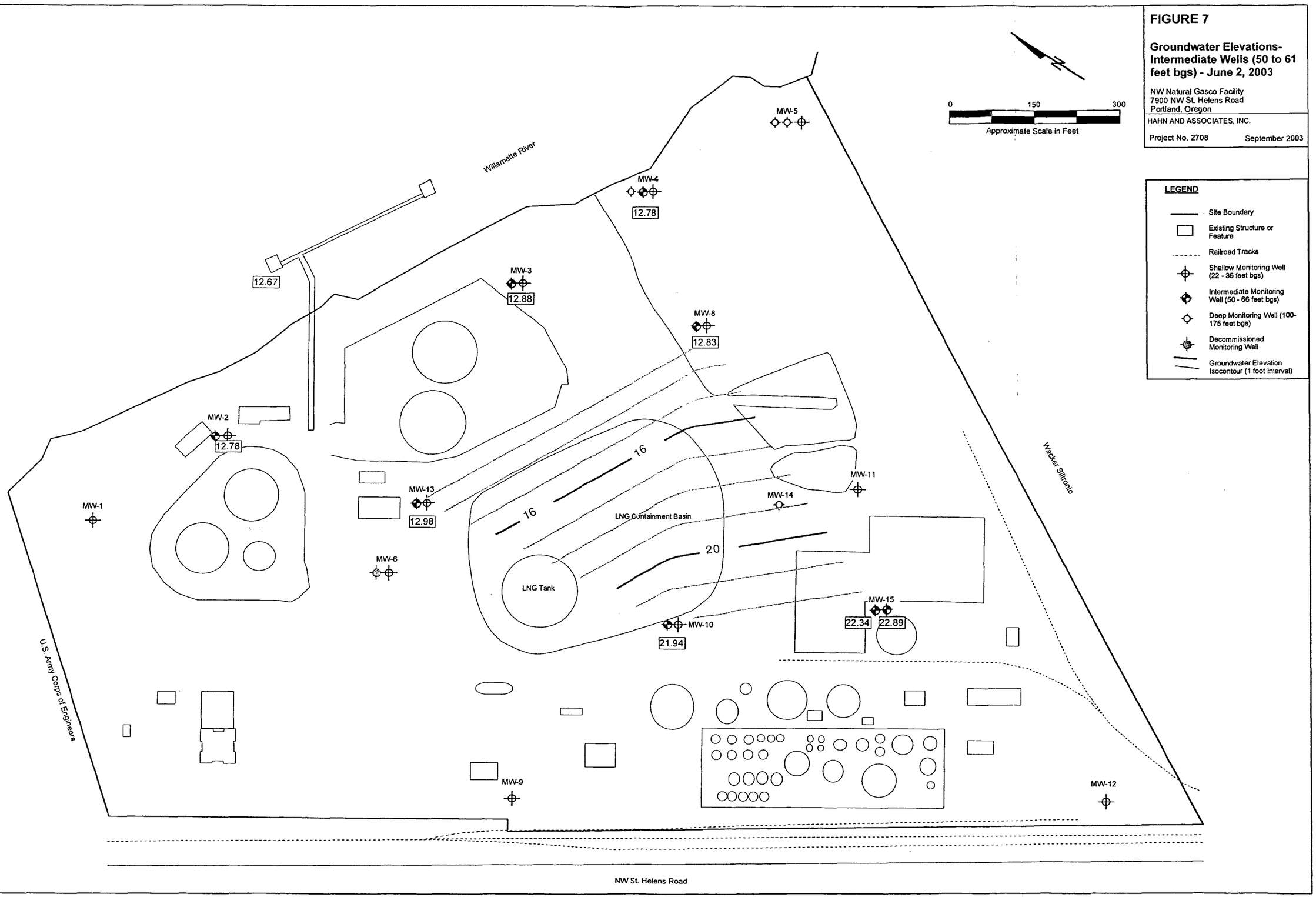
HAHN AND ASSOCIATES, INC.

Project No. 2708 September 2003

0 150 300
Approximate Scale in Feet

LEGEND

- Site Boundary
- Existing Structure or Feature
- Railroad Tracks
- Shallow Monitoring Well (22 - 36 feet bgs)
- Intermediate Monitoring Well (50 - 66 feet bgs)
- Deep Monitoring Well (100-175 feet bgs)
- Decommissioned Monitoring Well
- Groundwater Elevation Isocontour (1 foot interval)



Koppers023031

FIGURE 8

Groundwater Elevations- Deep Wells (100 to 110 feet bgs) - June 2, 2003

NW Natural Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

HAHN AND ASSOCIATES, INC.

Project No. 2708 September 2003

0 150 300
Approximate Scale in Feet

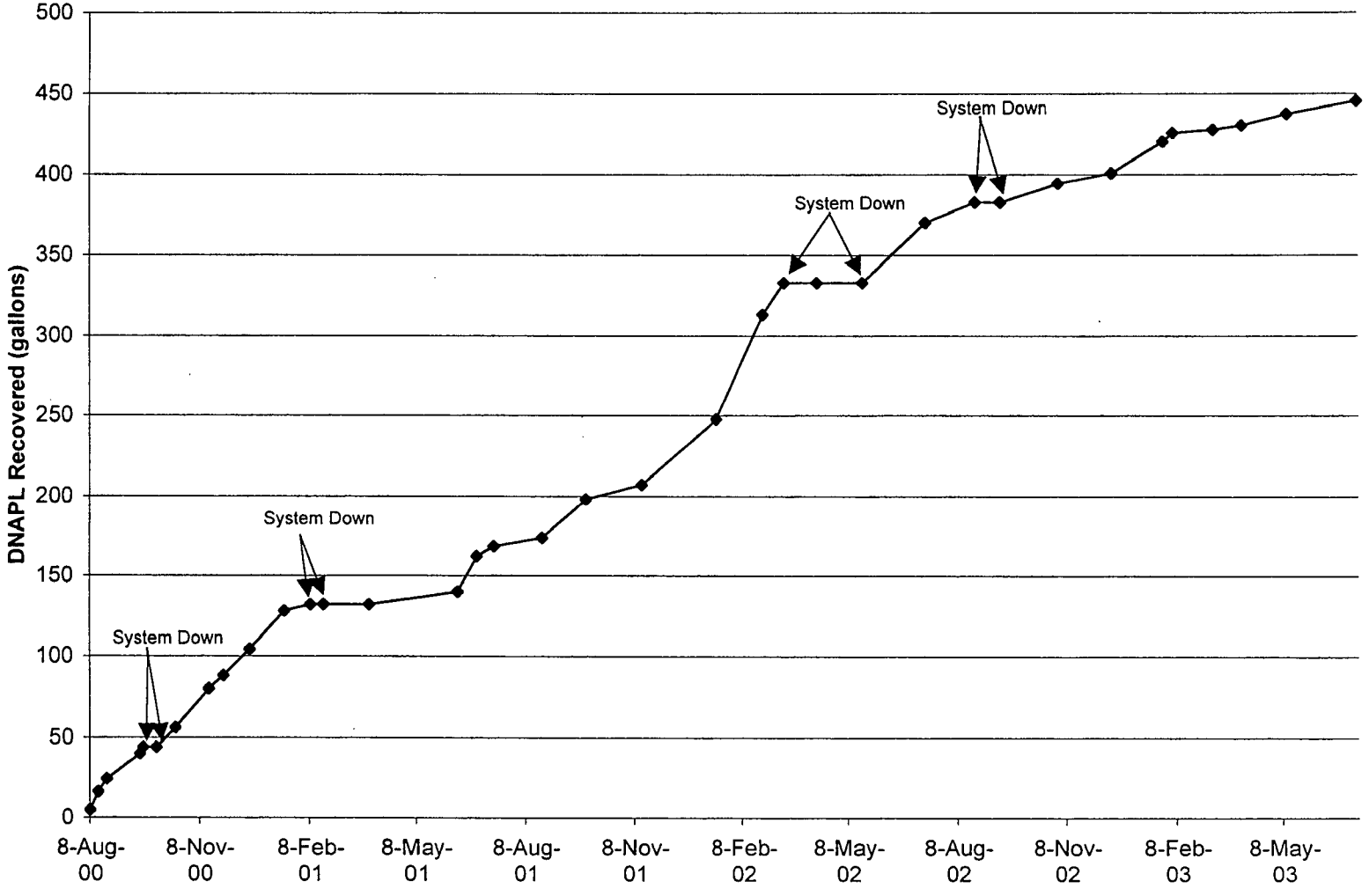
LEGEND

- Site Boundary
- Existing Structure or Feature
- Railroad Tracks
- Shallow Monitoring Well (22 - 36 feet bgs)
- Intermediate Monitoring Well (50 - 66 feet bgs)
- Deep Monitoring Well (100-175 feet bgs)
- Decommissioned Monitoring Well
- Groundwater Elevation Isocontour (1 foot interval)

Willamette River
MW-5
12.81
MW-4
12.86
12.67
MW-3
MW-8
MW-2
MW-1
MW-13
MW-6
LNG Containment Basin
LNG Tank
MW-10
MW-11
MW-14
16.94
MW-15
Wacker Siltronic
U.S. Army Corps of Engineers
MW-9
MW-12
NW St. Helens Road

Koppers023032

Figure 9
Cumulative DNAPL Recovery Volume Through Time: Well MW-6-32
NW Natural - Gasco Facility

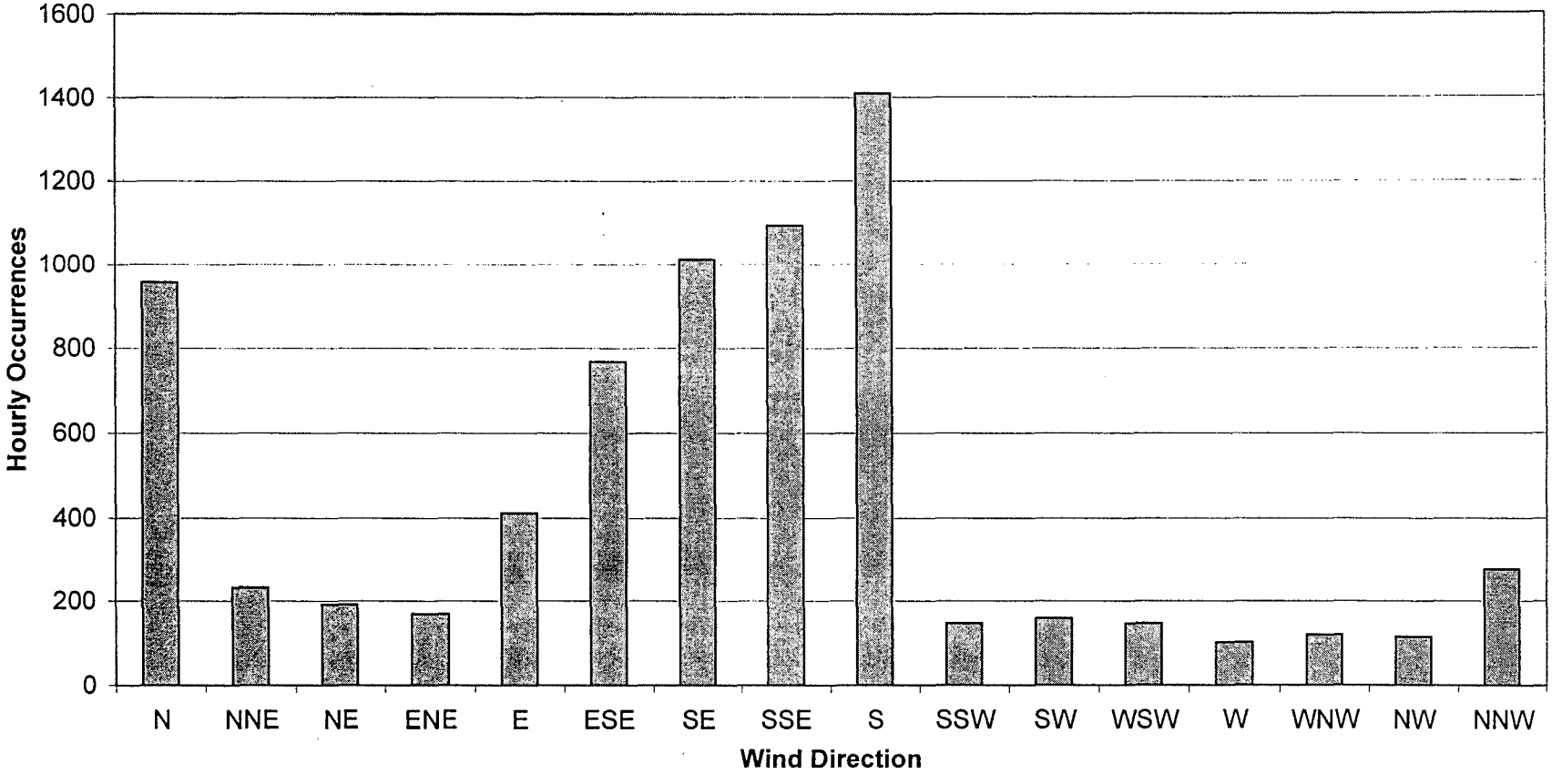


Updated: 9/29/03 RBE
File: MW-6 DNAPL Rcvry_thru 07_03/ Discharge Chart

HAHN AND ASSOCIATES, INC.
Project # 2708

Koppers023033

Figure 10
Wind Direction Summary
March 15, 2002 Through June 30, 2003
NW Natural Gasco Site
Portland, Oregon



Koppers023034

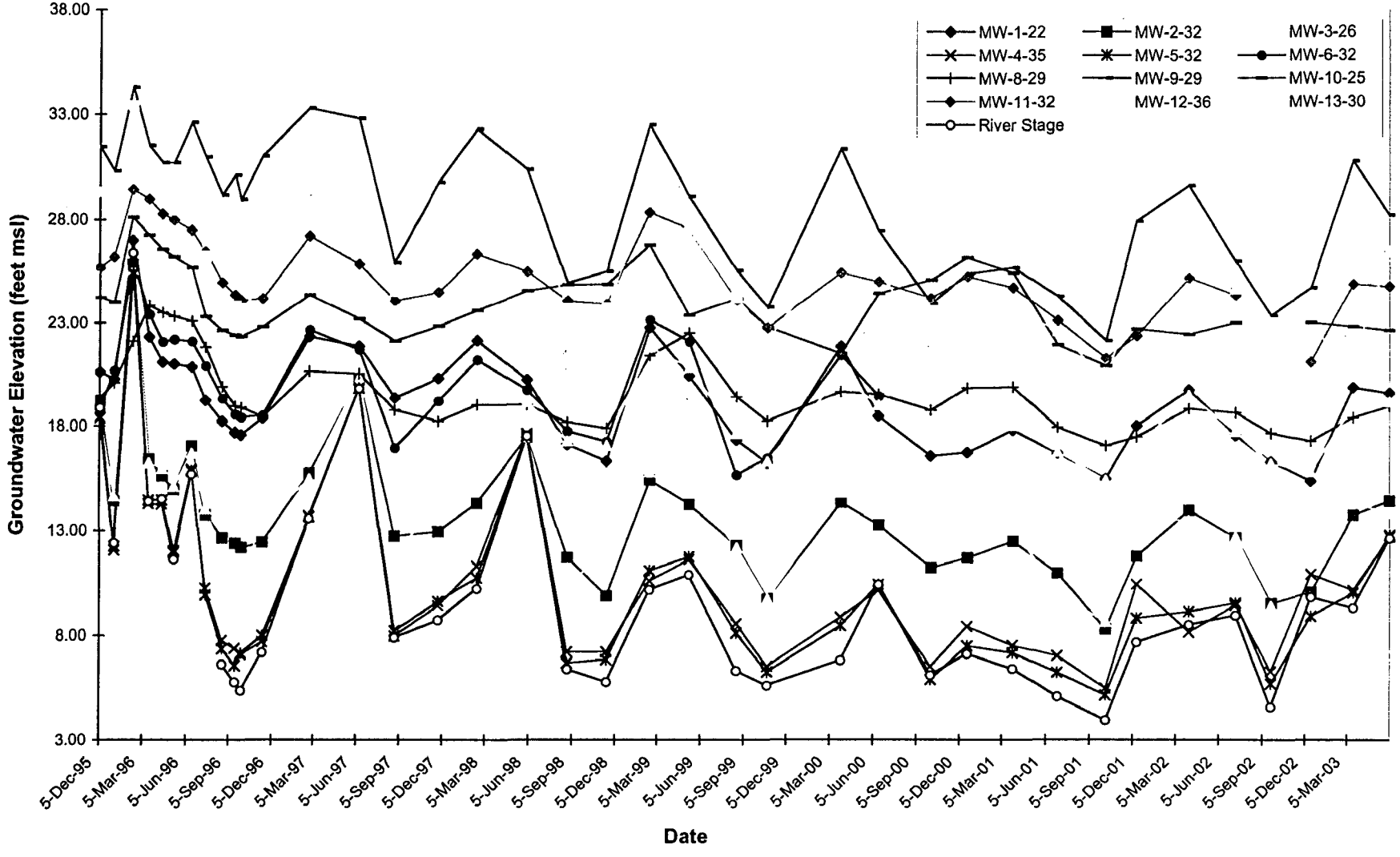
APPENDICES

A

APPENDIX A

Groundwater Elevation Hydrographs

Groundwater Hydrograph
Shallow Depth Surficial Fill Zone Monitoring Wells

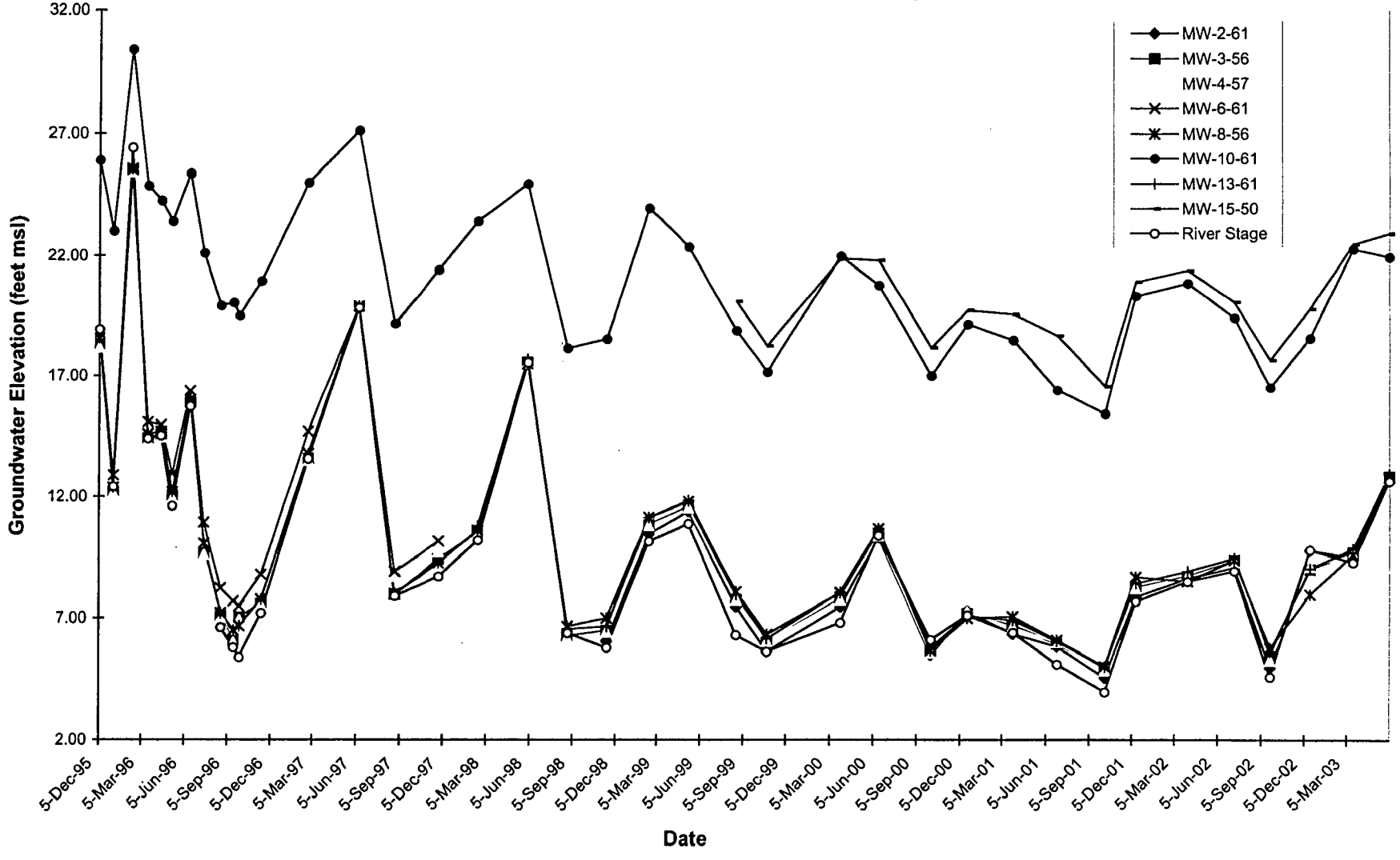


Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon
File: 2708 GW Elevations (to 06/03) ; Hydrograph-Shallow

Updated: 9/30/03 MSM
HAHN AND ASSOCIATES, INC.

Koppers023038

Groundwater Hydrograph
Intermediate Depth Alluvial Zone Monitoring Wells

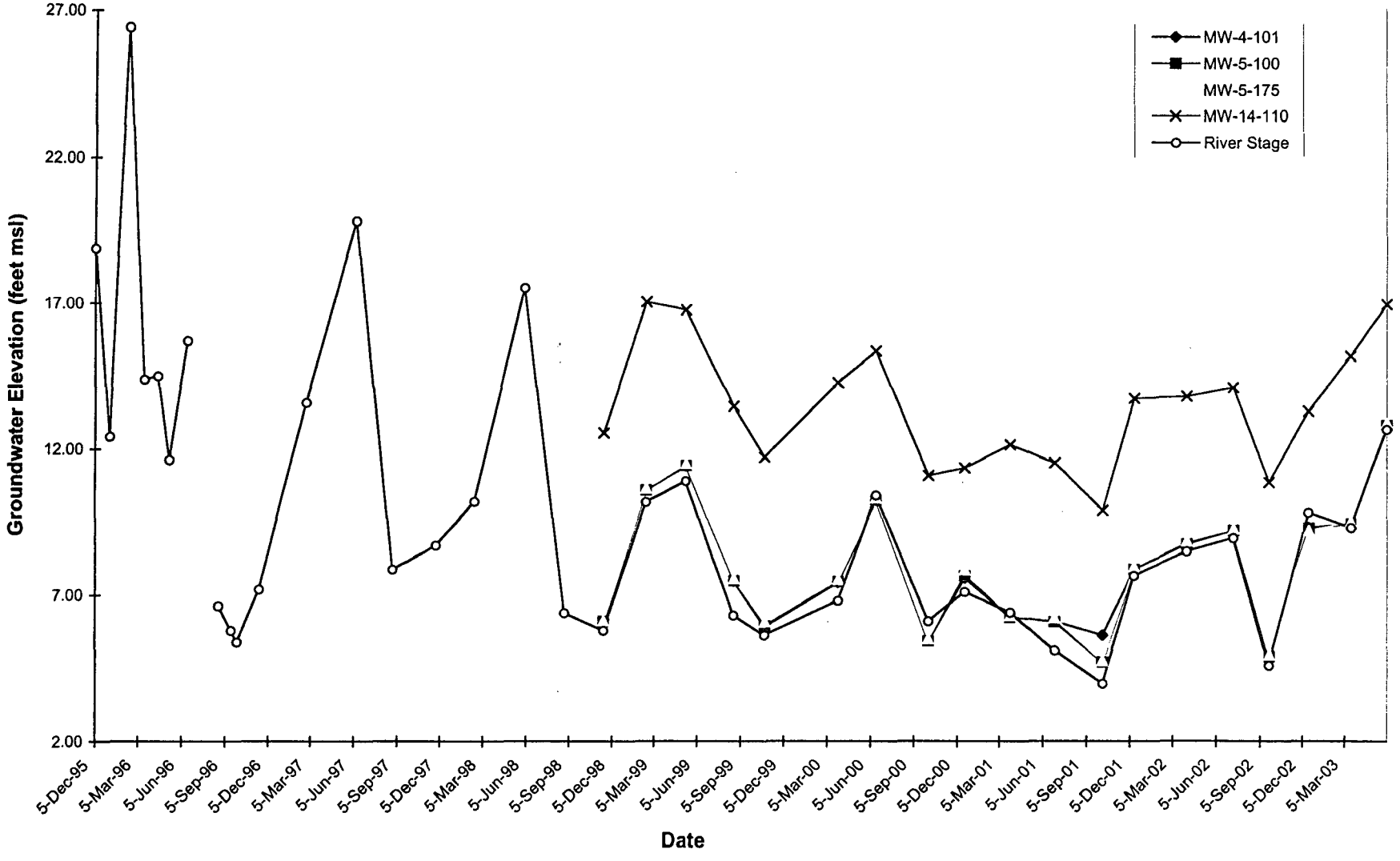


Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon
File: 2708 GW Elevations (to 06/03) ; Hydrograph-Intermediate

Updated: 9/30/03 MSM
HAHN AND ASSOCIATES, INC.

Koppers023039

Groundwater Hydrograph
Deep Alluvial Zone Monitoring Wells



Remedial Investigation
Northwest Natural - Gasco Facility
Portland, Oregon
File: 2708 GW Elevations (to 06/03) ; Hydrograph-Deep

Updated: 9/30/03 MSM
HAHN AND ASSOCIATES, INC.

Koppers023040

Groundwater Hydrograph
Well MW-1-22
NW Natural - Gasco Facility

Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-1-22

Project No. 2708
HAHN AND ASSOCIATES, INC.

Koppers023041

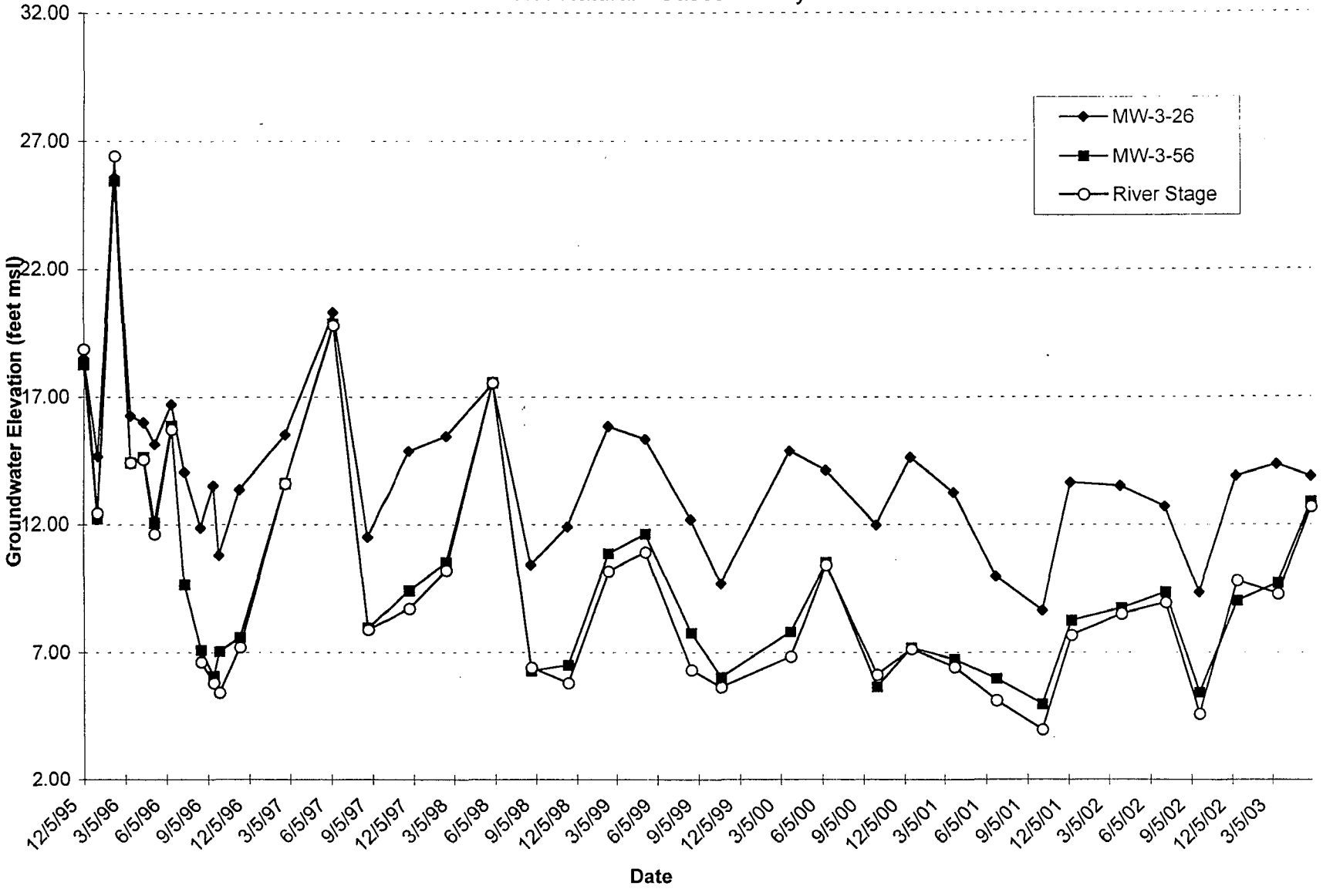
Groundwater Hydrograph
Well MW-2 Well Cluster
NW Natural - Gasco Facility

Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-2

Project No. 2708
HAHN AND ASSOCIATES, INC.

Koppers023042

Groundwater Hydrograph
MW-3 Well Cluster
NW Natural - Gasco Facility

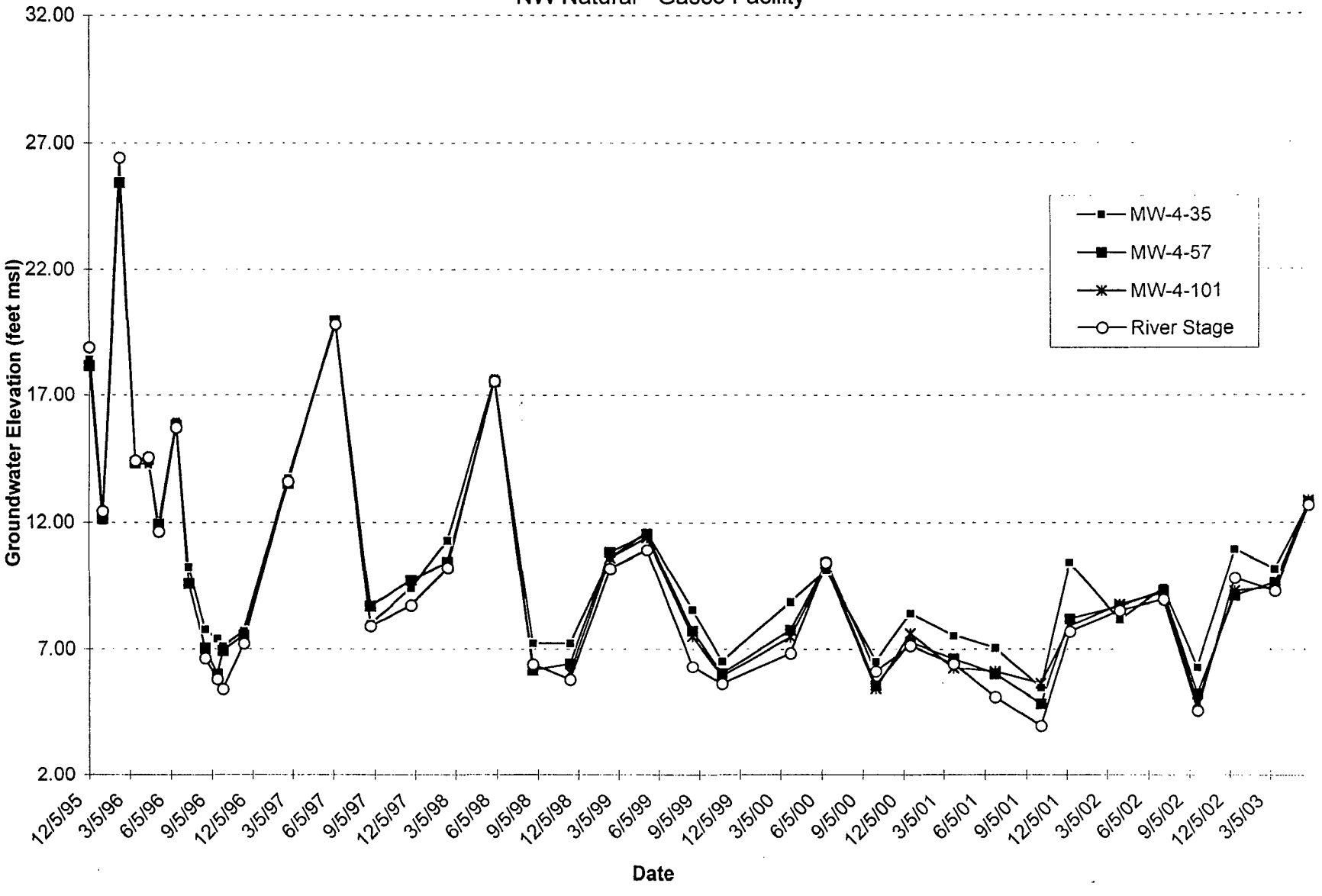


Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-3

Project No. 2708
'HAHN AND ASSOCIATES, INC.

Koppers023043

Groundwater Hydrograph
MW-4 Well Cluster
NW Natural - Gasco Facility

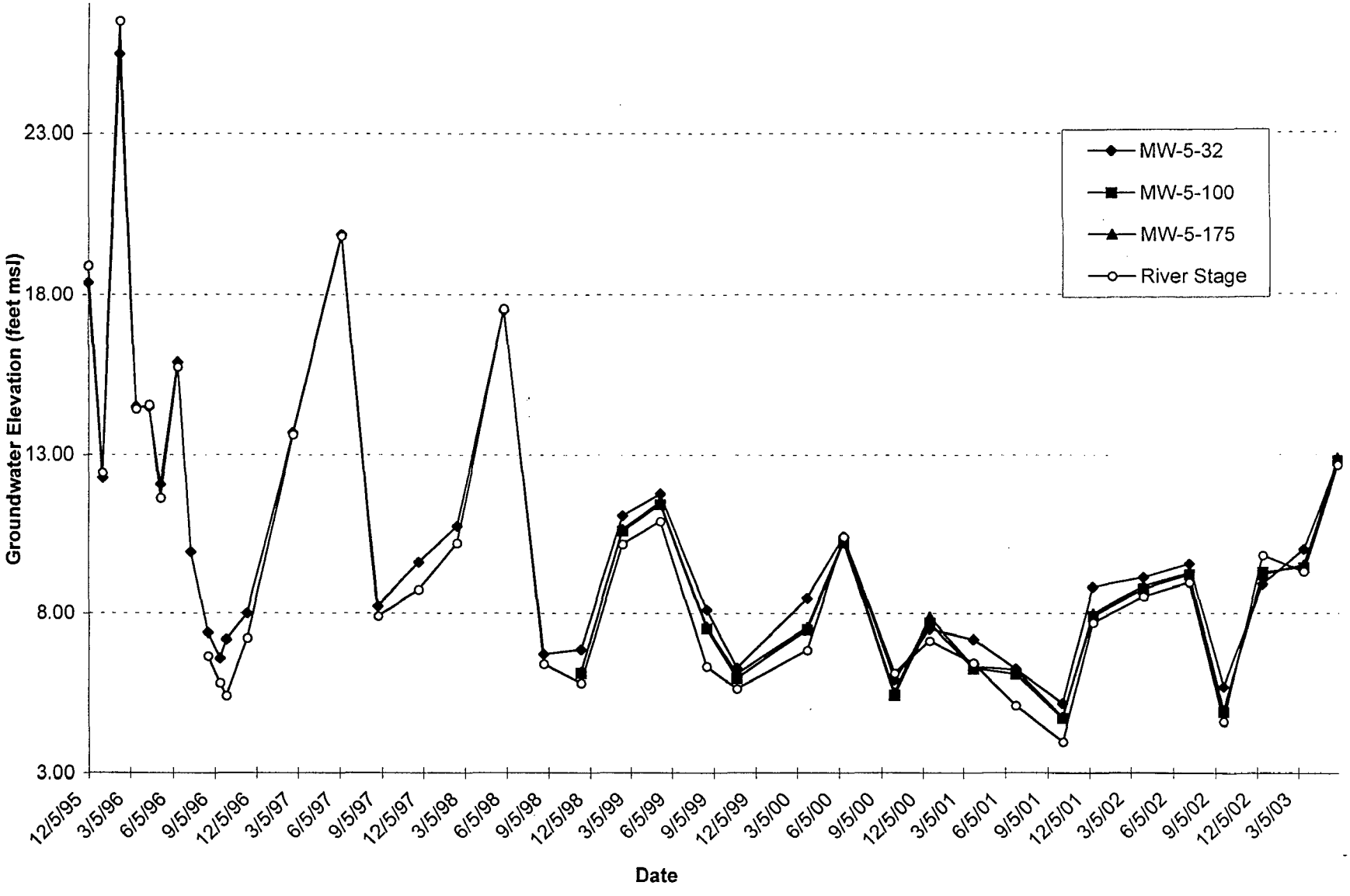


Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-4

Project No. 2708
HAHN AND ASSOCIATES, INC.

Koppers023044

Groundwater Hydrograph
Well MW-5 Cluster
NW Natural - Gasco Facility



Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-5

Project No. 2708
HAHN AND ASSOCIATES, INC.

Koppers023045

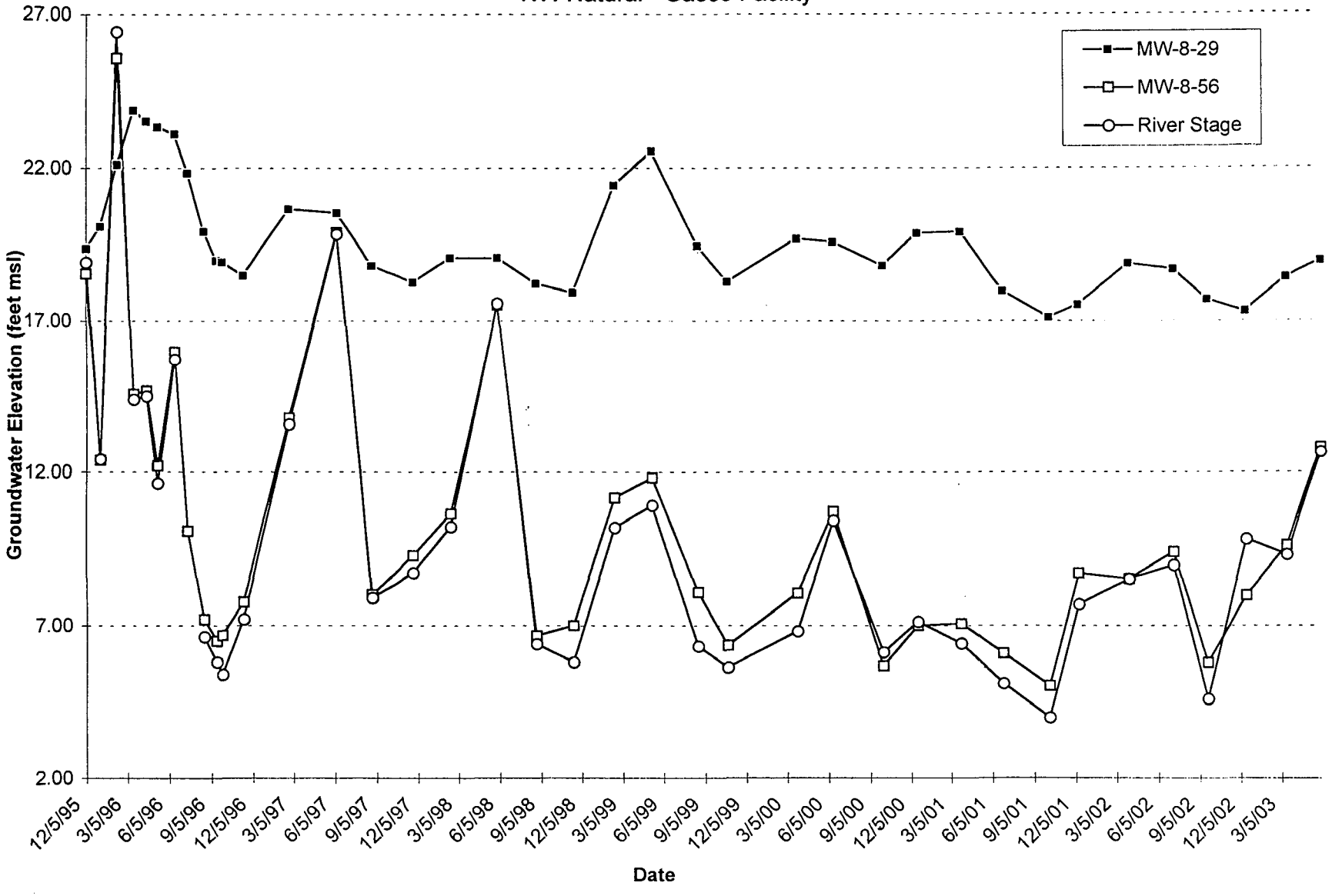
Groundwater Hydrograph
MW-6 Well Cluster
NW Natural - Gasco Facility

Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-6

Project No. 2708
HAHN AND ASSOCIATES, INC.

Koppers023046

Groundwater Hydrograph
MW-8 Well Cluster
NW Natural - Gasco Facility

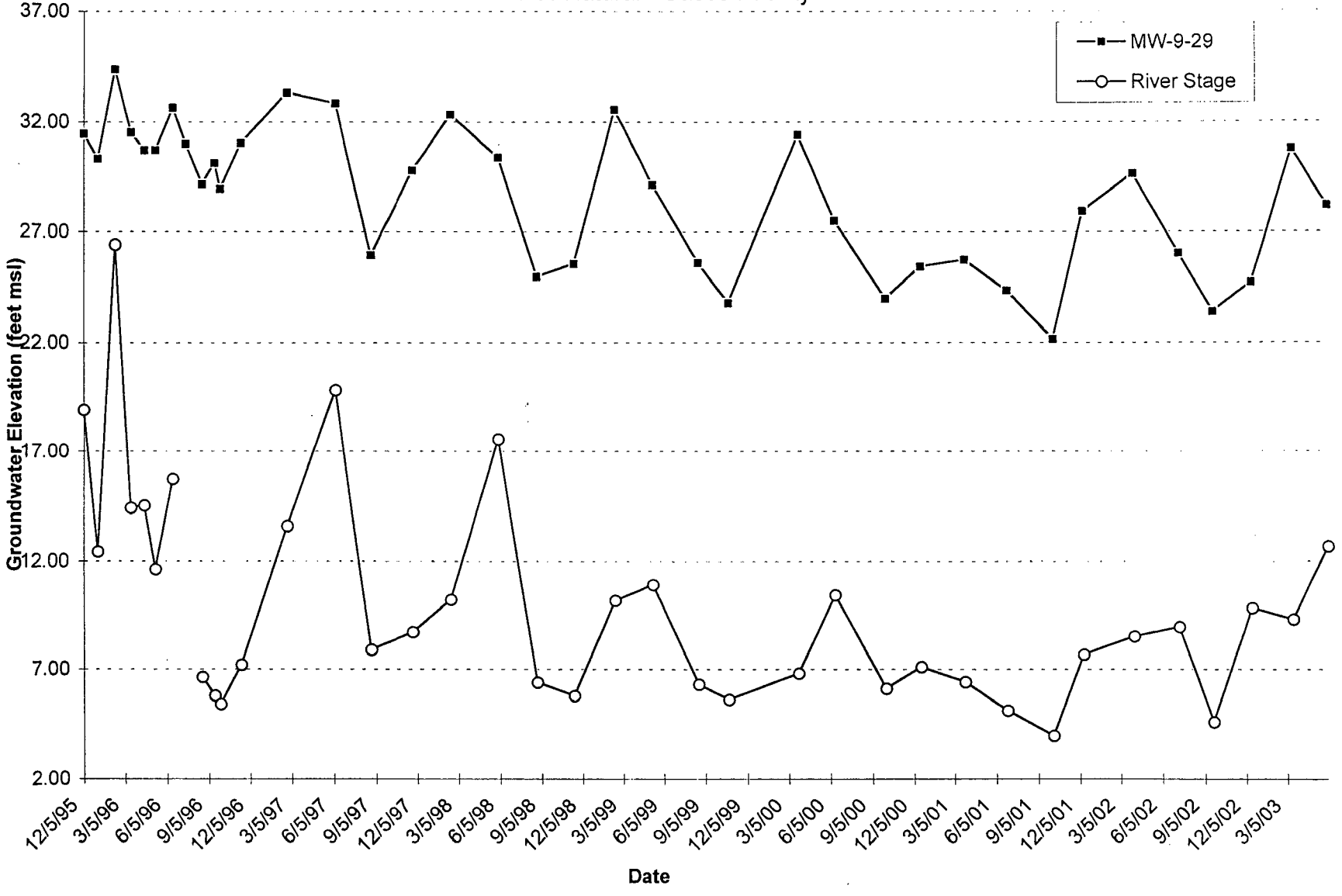


Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-8

Project No. 2708
HAHN AND ASSOCIATES, INC.

Koppers023047

Groundwater Hydrograph
Well MW-9
NW Natural - Gasco Facility

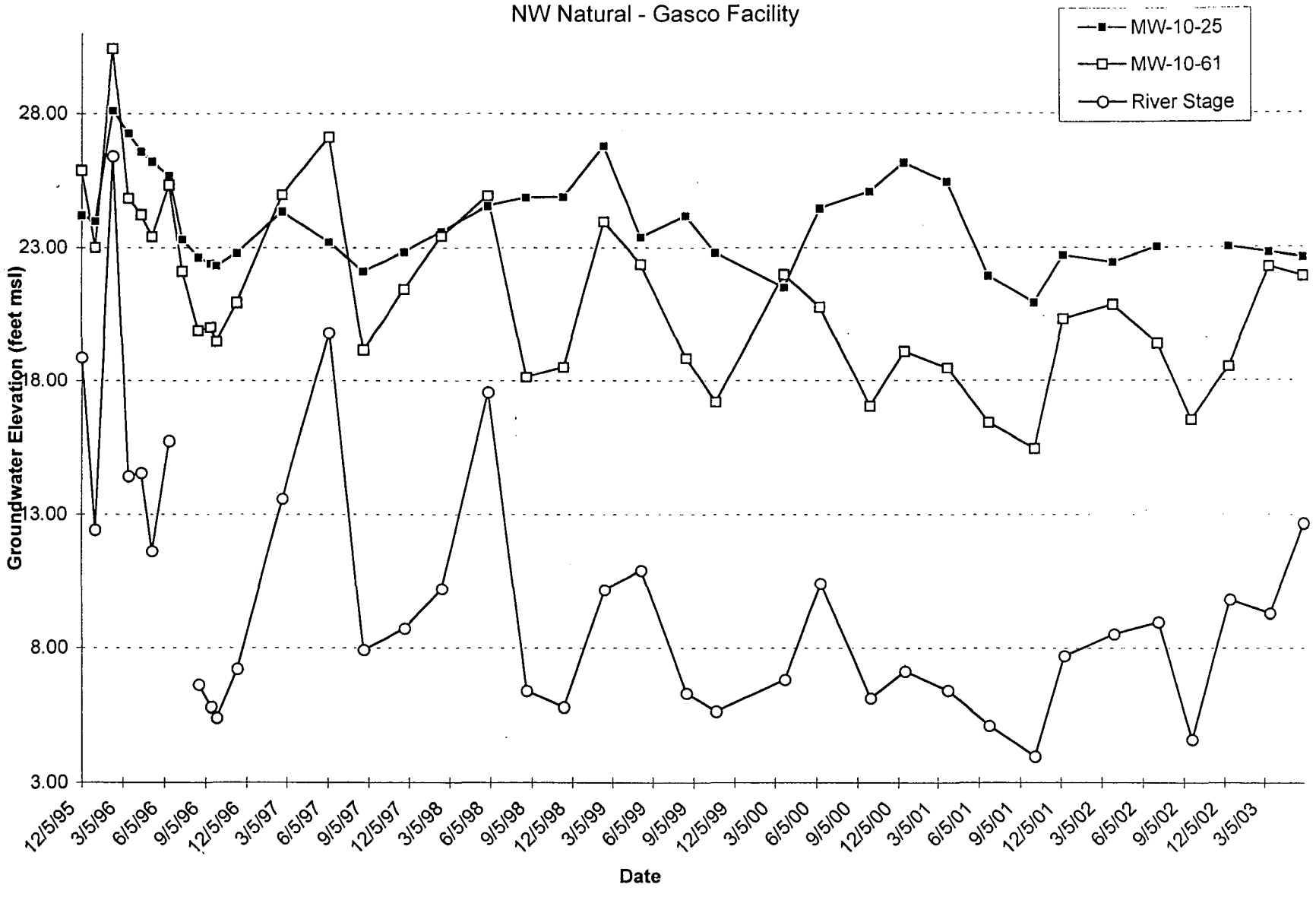


Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-9

Project No. 2708
HAHN AND ASSOCIATES, INC.

Koppers023048

Groundwater Hydrograph
MW-10 Well Cluster
NW Natural - Gasco Facility

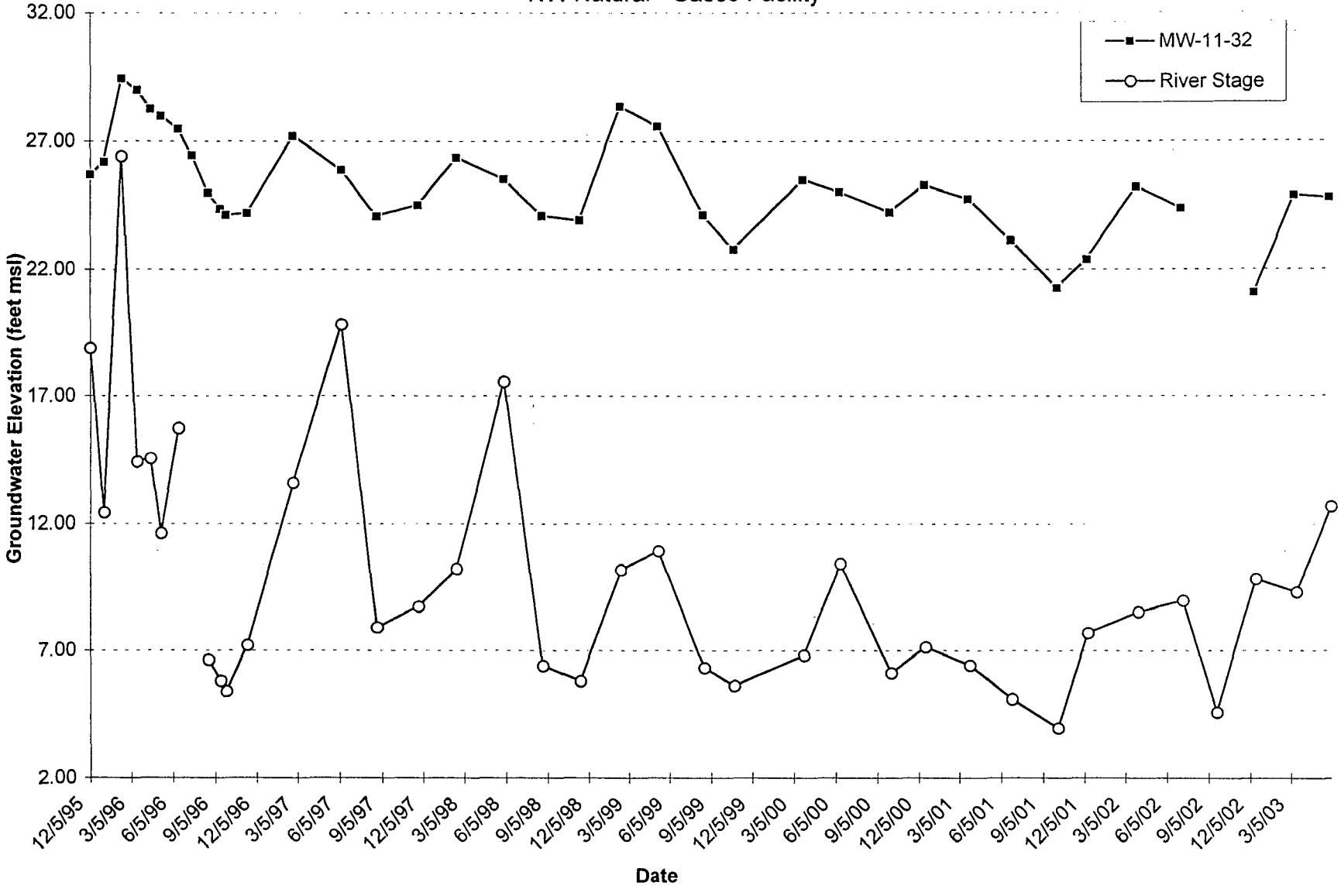


Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-10

Project No. 2708
HAHN AND ASSOCIATES, INC.

Koppers023049

Groundwater Hydrograph
Well MW-11
NW Natural - Gasco Facility

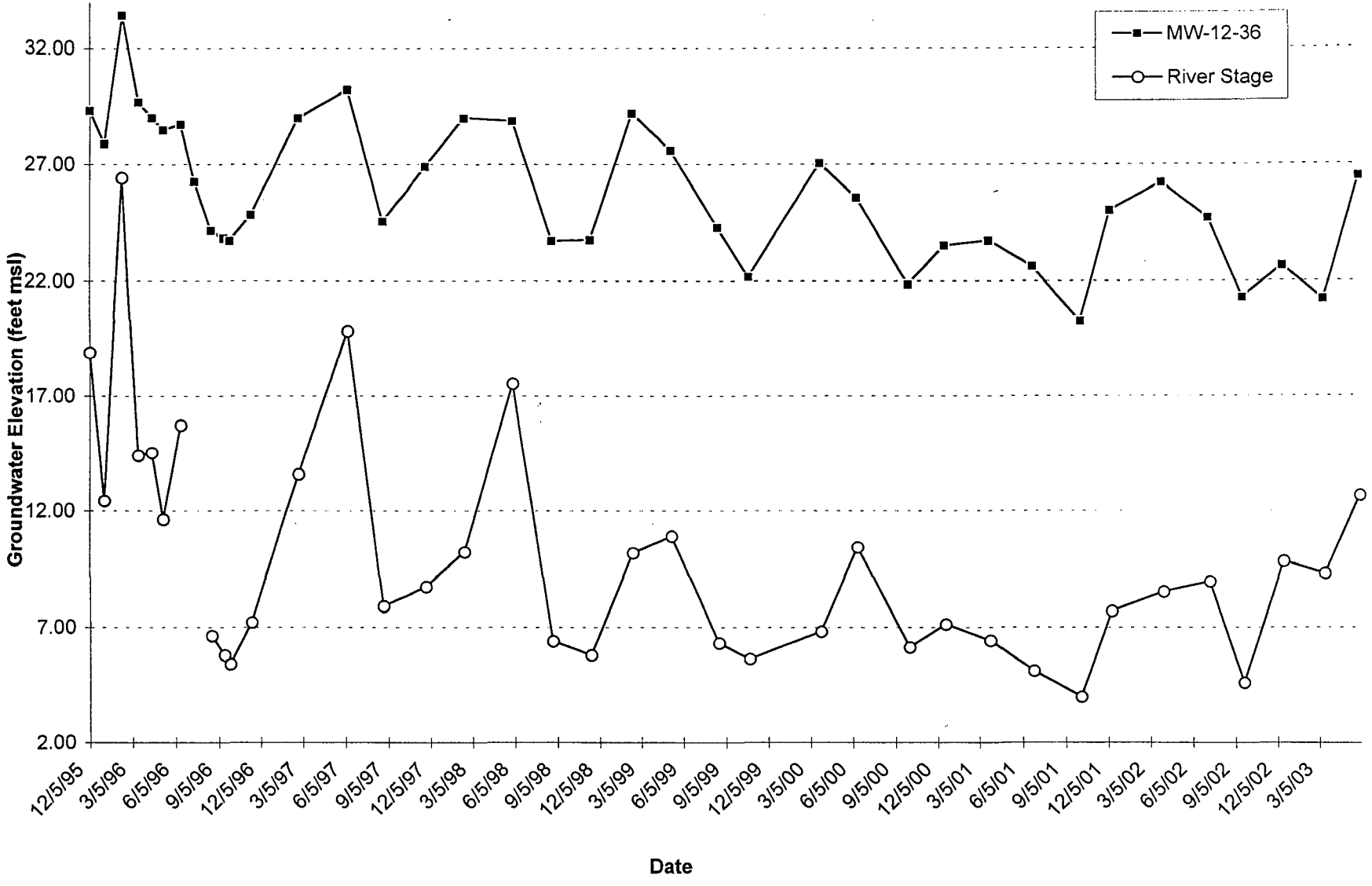


Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-11

Project No. 2708
HAHN AND ASSOCIATES, INC.

Koppers023050

Groundwater Hydrograph
Well MW-12
NW Natural - Gasco Facility

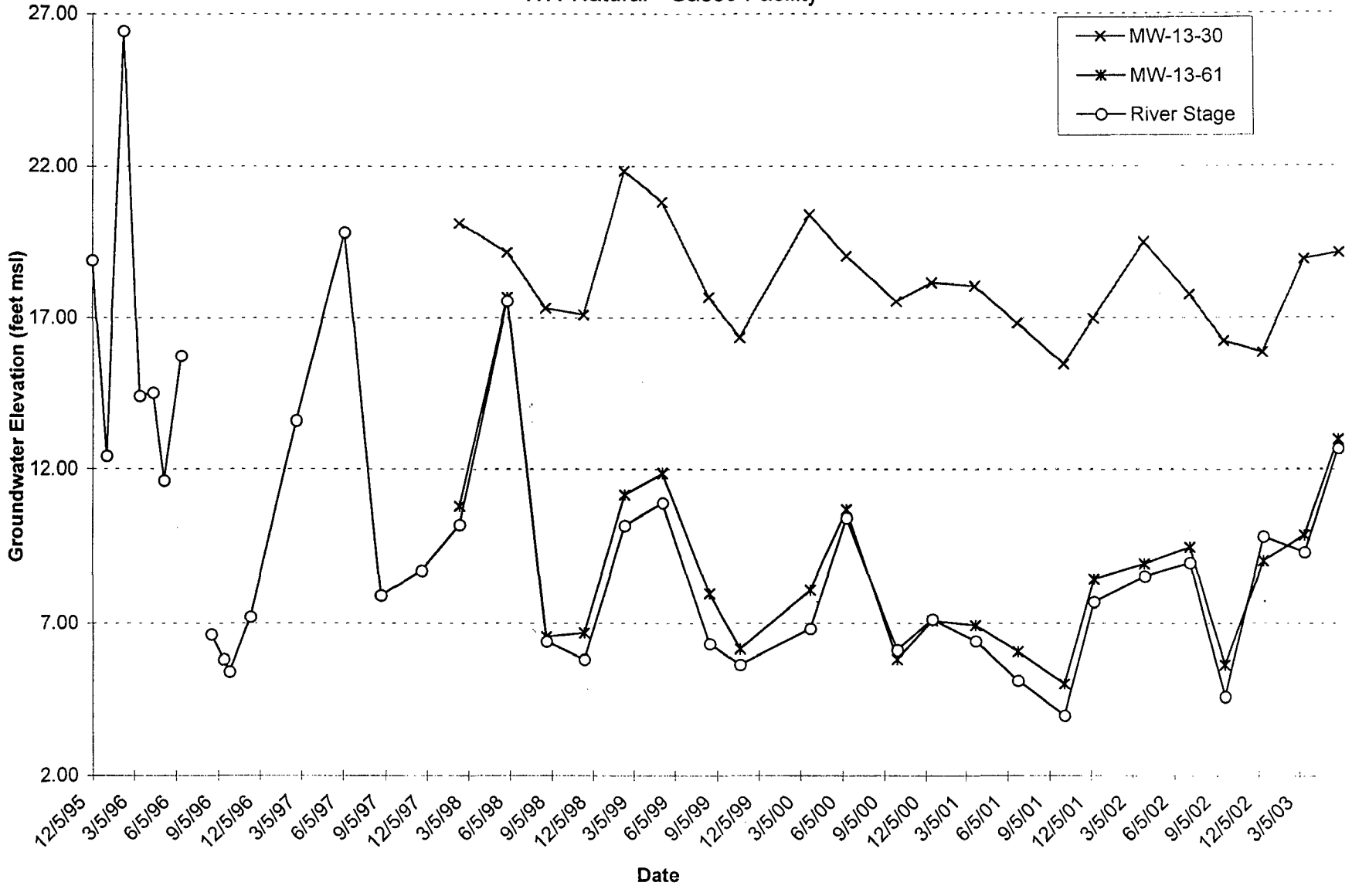


Koppers023051

Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-12

Project No. 2708
HAHN AND ASSOCIATES, INC.

Groundwater Hydrograph
Well MW-13 Cluster
NW Natural - Gasco Facility



Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-13

Project No. 2708
HAHN AND ASSOCIATES, INC.

Koppers023052

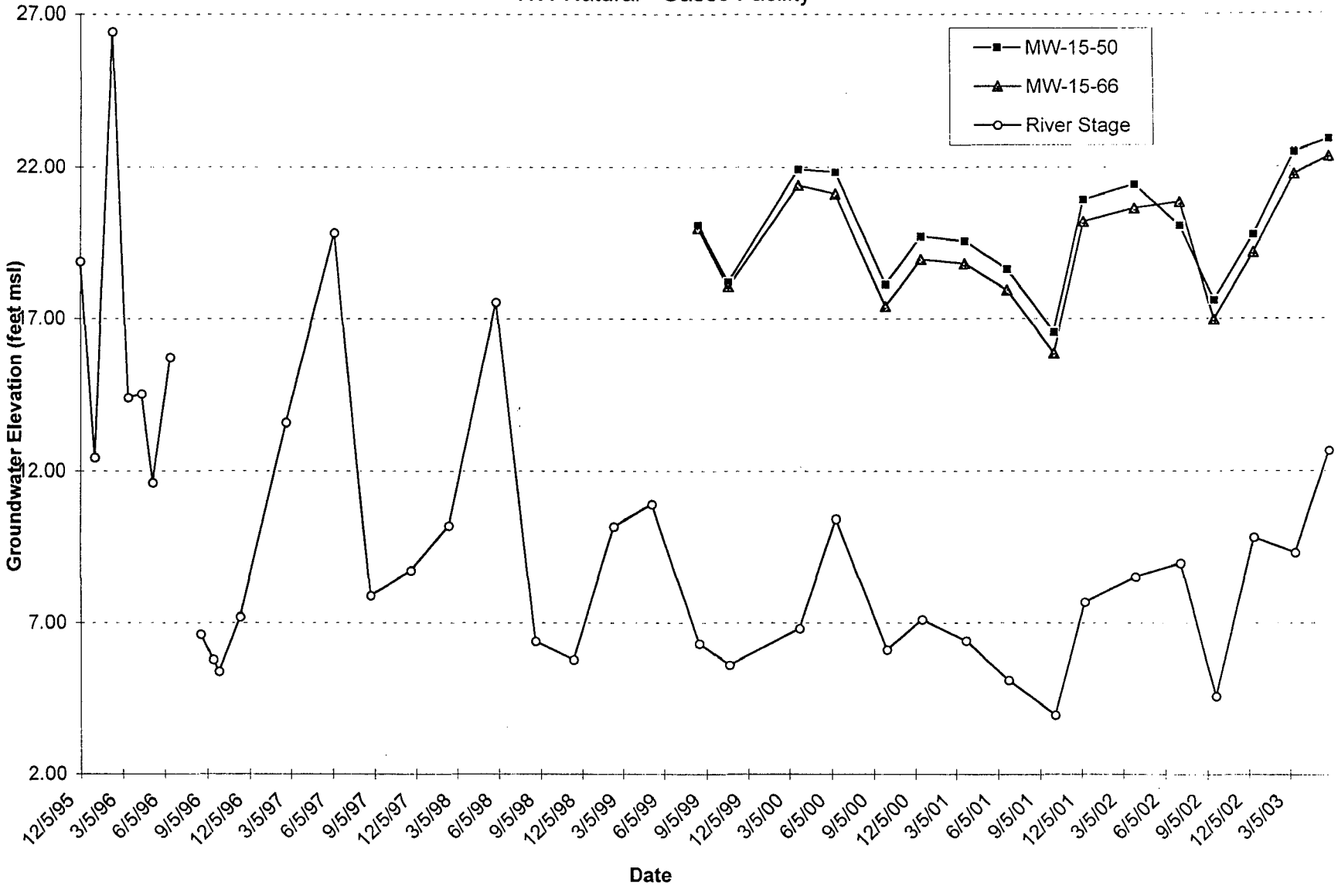
Groundwater Hydrograph
Well MW-14
NW Natural - Gasco Facility

Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-14

Project No. 2708
HAHN AND ASSOCIATES, INC.

Koppers023053

Groundwater Hydrograph
Well MW-15 Cluster
NW Natural - Gasco Facility



Updated: 9/30/03 MSM
File Name: 2708 GW Elevations (to 06/03) ; MW-15

Project No. 2708
HAHN AND ASSOCIATES, INC.

Koppers023054

B

APPENDIX B

Analytical Results and Chain-of-Custody Documentation:
March 2003 Groundwater Monitoring Event

HAHN AND ASSOCIATES, INC.
Environmental Management
434 NW Sixth Avenue, Suite 203 • Portland OR 97209
(503) 796-0717 • Fax (503) 227-2209

Laboratory: ESL INC. PORTLAND OR
Lab Project No.: 0303172

CHAIN OF CUSTODY

Chain of Custody No.: _____

Project Manager	Rob Ede
Project No.	2708-30
Project Name	NW Natural -> Gasco
Collected by	Matt Mudge & Mike O'Connor

Liquid with Sediment Sample
_____ Test Filtrate _____ Test Sediment _____ Test Both

Multi-Phase Sample
_____ Test One (which) _____ Test Separately _____ Shake

Samples Received at 4C (Y or N)	
Appropriate Containers Used (Y or N)	
Provide Verbal Results (Y or N)	
Provide Preliminary Fax Results	YES

Sample Number Prefix: 2708-030317-

Lab ID	Sample #	Date	Time	Sample Description	Matrix: Soil	Matrix: Water	Matrix: Other	Number of Containers	PAHs (EPA 8270 SIM)	BTEX (EPA 8021)	TSH CN (EPA 9012)	Amenable CN (EPA 9010)	Total Metals (6010) As, Cr, Cu, Pb, Ni, Zn	RUSH	Remarks
-01	100	3/17/03	15:00	MW7-100		X		2		X					
-02	101	↓	16:58	MW13-61-101		X		8	X	X	X	X	X		

Relinquished by	Company	Date	Time	Received by	Company
M.S. Mudge	HAHN & ASSOC	3/19/03	11:45	STH @ ESL	ESL
Relinquished by	Company	Date	Time	Received by	Company

Koppers023057

Environmental Services Laboratory, Inc.

E S L

17400 SW Upper Boones Ferry Road, Suite 270 • Portland, OR 97224 • (503) 670-8520

March 31, 2003

Mr. Rob Ede
Hahn and Associates
434 NW Sixth Avenue
Suite 203
Portland, OR 97209

TEL: (503)796-0717
FAX (503) 227-2209

RE: 2708-30/NW NATURAL/GASCO

Order No.: 0303172

Dear Mr. Rob Ede:

Environmental Services Laboratory received 2 samples on 3/19/03 for the analyses presented in the following report.

There were no analytical problems encountered and all associated QC data met EPA or laboratory specifications except where noted in a Case Narrative. Results apply only to the samples analyzed. Reproduction of this report is permitted only in its entirety, without the written approval of the laboratory. The following checked data sections are included in this report, and numbered to indicate total pages contained within each report section.

✓Base Sample Report ✓Method Blank Report ✓Sample Duplicate Report ✓Matrix Spike/Matrix Spike Duplicate Report ✓Laboratory Control Spike/Spike Duplicate Report ✓Continuing Calibration Verification Report ✓Initial Calibration Verification Report

If you have any questions regarding these tests results, please feel free to call.

Leslie Rush
Project Manager

Keith Hunter
Technical Review

Environmental Services Laboratory

Date: *31-Mar-03*

CLIENT:	Hahn and Associates	**Client Sample ID:**	100
Lab Order:	0303172	**Tag Number:**	
Project:	2708-30/NW NATURAL/GASCO	**Collection Date:**	3/17/03
Lab ID:	0303172-01A	**Matrix:**	AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
GAS/BTEX, AQUEOUS		**8015/8021**				Analyst: tln
Benzene	ND	0.50		µg/L	1	3/24/03
Ethylbenzene	ND	0.50		µg/L	1	3/24/03
Toluene	ND	0.50		µg/L	1	3/24/03
Xylenes, Total	ND	1.5		µg/L	1	3/24/03
Surr: Trifluorotoluene	104	70-130		%REC	1	3/24/03

Qualifiers:

ND - Not Detected at the Reporting Limit

J - Analyte detected below quantitation limits

B - Analyte detected in the associated Method Blank

* - Value exceeds Maximum Contaminant Level

S - Spike Recovery outside accepted recovery limits

R - RPD outside accepted recovery limits

E - Value above quantitation range

Koppers023059

Environmental Services Laboratory

Date: *31-Mar-03*

CLIENT:	Hahn and Associates	**Client Sample ID:**	101
Lab Order:	0303172	**Tag Number:**	
Project:	2708-30/NW NATURAL/GASCO	**Collection Date:**	3/17/03
Lab ID:	0303172-02A	**Matrix:**	AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
GAS/BTEX, AQUEOUS		**8015/8021**				Analyst: **tln**
Benzene	ND	0.50		µg/L	1	3/24/03
Ethylbenzene	ND	0.50		µg/L	1	3/24/03
Toluene	ND	0.50		µg/L	1	3/24/03
Xylenes, Total	ND	1.5		µg/L	1	3/24/03
Surr: Trifluorotoluene	105	70-130		%REC	1	3/24/03
ICP METALS		**EPA 6010B**		**(3005A)**		Analyst: **mal**
Arsenic	ND	0.010		mg/L	1	3/20/03
Chromium	ND	0.015		mg/L	1	3/20/03
Copper	ND	0.0030		mg/L	1	3/20/03
Lead	ND	0.0060		mg/L	1	3/20/03
Nickel	ND	0.0050		mg/L	1	3/20/03
Zinc	ND	0.020		mg/L	1	3/20/03
PAH BY SIM, AQUEOUS		**8270-SIM**		**(3510C)**		Analyst: **mrs**
Acenaphthene	ND	0.10		µg/L	1	3/21/03
Acenaphthylene	ND	0.10		µg/L	1	3/21/03
Anthracene	ND	0.10		µg/L	1	3/21/03
Benz(a)anthracene	ND	0.10		µg/L	1	3/21/03
Benzo(a)pyrene	ND	0.10		µg/L	1	3/21/03
Benzo(b)fluoranthene	ND	0.10		µg/L	1	3/21/03
Benzo(g,h,i)perylene	ND	0.10		µg/L	1	3/21/03
Benzo(k)fluoranthene	ND	0.10		µg/L	1	3/21/03
Chrysene	ND	0.10		µg/L	1	3/21/03
Dibenz(a,h)anthracene	ND	0.10		µg/L	1	3/21/03
Fluoranthene	ND	0.10		µg/L	1	3/21/03
Fluorene	ND	0.10		µg/L	1	3/21/03
Indeno(1,2,3-cd)pyrene	ND	0.10		µg/L	1	3/21/03
Naphthalene	ND	0.10		µg/L	1	3/21/03
Phenanthrene	ND	0.10		µg/L	1	3/21/03
Pyrene	ND	0.10		µg/L	1	3/21/03
Surr: 2-Fluorobiphenyl	59.0	43-116		%REC	1	3/21/03
Surr: 4-Terphenyl-d14	65.0	33-141		%REC	1	3/21/03
Surr: Nitrobenzene-d5	63.0	35-114		%REC	1	3/21/03
CYANIDE		**EPA 9014**				Analyst: **jca**
Cyanide	0.13	0.040		mg/L	1	3/28/03
CYANIDE		**EPA 9014**				Analyst: **jca**
Cyanide, Amenable	ND	0.040		mg/L	1	3/28/03

Qualifiers:

ND - Not Detected at the Reporting Limit

J - Analyte detected below quantitation limits

B - Analyte detected in the associated Method Blank

* - Value exceeds Maximum Contaminant Level

S - Spike Recovery outside accepted recovery limits

R - RPD outside accepted recovery limits

E - Value above quantitation range

Koppers023060

CLIENT: Hahn and Associates
Work Order: 0303172
Project: 2708-30/NW NATURAL/GASCO

ANALYTICAL QC SUMMARY REPORT

TestCode: 01 CN A

Sample ID: **MBLK**	SampType: **MBLK**	TestCode: **01 CN A**	Units: **mg/L**	Prep Date: **3/26/03**	Run ID: **HIT MAN_030328A**
Client ID: **ZZZZZ**	Batch ID: **R13420**	TestNo: **EPA 9014**		Analysis Date: **3/28/03**	SeqNo: **161324**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cyanide	ND	0.040									

Sample ID: **LCS**	SampType: **LCS**	TestCode: **01 CN A**	Units: **mg/L**	Prep Date: **3/26/03**	Run ID: **HIT MAN_030328A**
Client ID: **ZZZZZ**	Batch ID: **R13420**	TestNo: **EPA 9014**		Analysis Date: **3/28/03**	SeqNo: **161325**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cyanide	0.183	0.040	0.2	0	91.5	79.8	111	0	0		

Sample ID: **LCSD**	SampType: **LCSD**	TestCode: **01 CN A**	Units: **mg/L**	Prep Date: **3/20/03**	Run ID: **HIT MAN_030328A**
Client ID: **ZZZZZ**	Batch ID: **R13420**	TestNo: **EPA 9014**		Analysis Date: **3/28/03**	SeqNo: **161326**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cyanide	0.182	0.040	0.2	0	91	79.8	111	0.182	0	20	

Sample ID: **0303173-02A MS**	SampType: **MS**	TestCode: **01 CN A**	Units: **mg/L**	Prep Date: **3/28/03**	Run ID: **HIT MAN_030328A**
Client ID: **ZZZZZ**	Batch ID: **R13420**	TestNo: **EPA 9014**		Analysis Date: **3/28/03**	SeqNo: **161330**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cyanide	0.203	0.040	0.2	0.042	80.5	64.4	125	0	0		

Sample ID: **0303172-02A DUP**	SampType: **DUP**	TestCode: **01 CN A**	Units: **mg/L**	Prep Date: **3/28/03**	Run ID: **HIT MAN_030328A**
Client ID: **101**	Batch ID: **R13420**	TestNo: **EPA 9014**		Analysis Date: **3/28/03**	SeqNo: **161328**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cyanide	0.117	0.040	0	0	0	0	0	0.134	13.5	20	

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
B - Analyte detected in the associated Method Blank

Koppers023061

CLIENT: Hahn and Associates
Work Order: 0303172
Project: 2708-30/NW NATURAL/GASCO

ANALYTICAL QC SUMMARY REPORT

TestCode: 01 CN4 A

Sample ID: MBLK	SampType: MBLK	TestCode: 01 CN4 A	Units: mg/L	Prep Date: 3/26/03	Run ID: HIT MAN_030328B
Client ID: ZZZZZ	Batch ID: R13421	TestNo: EPA 9014		Analysis Date: 3/28/03	SeqNo: 161334

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cyanide, Amenable	ND	0.040									

Sample ID: LCS	SampType: LCS	TestCode: 01 CN4 A	Units: mg/L	Prep Date: 3/26/03	Run ID: HIT MAN_030328B
Client ID: ZZZZZ	Batch ID: R13421	TestNo: EPA 9014		Analysis Date: 3/28/03	SeqNo: 161335

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cyanide, Amenable	0.183	0.040	0.2	0	91.5	81	113	0	0		

Sample ID: LCSD	SampType: LCSD	TestCode: 01 CN4 A	Units: mg/L	Prep Date: 3/20/03	Run ID: HIT MAN_030328B
Client ID: ZZZZZ	Batch ID: R13421	TestNo: EPA 9014		Analysis Date: 3/28/03	SeqNo: 161336

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cyanide, Amenable	0.182	0.040	0.2	0	91	81	113	0.183	0.548	20	

Sample ID: 0303173-02A MS	SampType: MS	TestCode: 01 CN4 A	Units: mg/L	Prep Date: 3/28/03	Run ID: HIT MAN_030328B
Client ID: ZZZZZ	Batch ID: R13421	TestNo: EPA 9014		Analysis Date: 3/28/03	SeqNo: 161340

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cyanide, Amenable	0.203	0.040	0.2	0	102	75	120	0	0		

Sample ID: 0303172-02A DUP	SampType: DUP	TestCode: 01 CN4 A	Units: mg/L	Prep Date: 3/28/03	Run ID: HIT MAN_030328B
Client ID: 101	Batch ID: R13421	TestNo: EPA 9014		Analysis Date: 3/28/03	SeqNo: 161338

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cyanide, Amenable	ND	0.040	0	0	0	0	0	0	0	0	

Koppers023062

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
B - Analyte detected in the associated Method Blank

CLIENT: Hahn and Associates
Work Order: 0303172
Project: 2708-30/NW NATURAL/GASCO

ANALYTICAL QC SUMMARY REPORT

TestCode: 02 ICPA

Sample ID: MB-5534	SampType: MBLK	TestCode: 02 ICPA	Units: mg/L	Prep Date: 3/20/03	Run ID: ICP_030320A
Client ID: ZZZZZ	Batch ID: 5534	TestNo: EPA 6010B	(3005A)	Analysis Date: 3/20/03	SeqNo: 160434

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Antimony	ND	0.010									
Arsenic	ND	0.010									
Barium	ND	0.0010									
Beryllium	ND	0.0010									
Cadmium	ND	0.0010									
Chromium	ND	0.015									
Copper	ND	0.0030									
Lead	ND	0.0060									
Nickel	ND	0.0050									
Selenium	ND	0.015									
Silver	ND	0.0030									
Zinc	ND	0.020									

Sample ID: LCS-5534	SampType: LCS	TestCode: 02 ICPA	Units: mg/L	Prep Date: 3/20/03	Run ID: ICP_030320A
Client ID: ZZZZZ	Batch ID: 5534	TestNo: EPA 6010B	(3005A)	Analysis Date: 3/20/03	SeqNo: 160435

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Antimony	0.486	0.010	0.5	0	97.2	80	120	0	0		
Arsenic	0.486	0.010	0.5	0	97.2	80	120	0	0		
Barium	0.496	0.0010	0.5	0	99.2	80	120	0	0		
Beryllium	0.5	0.0010	0.5	0	100	80	120	0	0		
Cadmium	0.471	0.0010	0.5	0	94.2	80	120	0	0		
Chromium	0.498	0.015	0.5	0	99.6	80	120	0	0		
Copper	0.497	0.0030	0.5	0	99.4	80	120	0	0		
Lead	0.497	0.0060	0.5	0	99.4	80	120	0	0		
Nickel	0.499	0.0050	0.5	0	99.8	80	120	0	0		
Selenium	0.495	0.015	0.5	0	99	80	120	0	0		
Silver	0.504	0.0030	0.5	0	101	80	120	0	0		
Zinc	0.513	0.020	0.5	0	103	80	120	0	0		

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
B - Analyte detected in the associated Method Blank

Koppers023063

CLIENT: Hahn and Associates
Work Order: 0303172
Project: 2708-30/NW NATURAL/GASCO

ANALYTICAL QC SUMMARY REPORT

TestCode: 02 ICPA

Sample ID: **0303168-02A MS** SampType: **MS** TestCode: **02 ICPA** Units: **mg/L** Prep Date: **3/20/03** Run ID: **ICP_030320A**
Client ID: **ZZZZZ** Batch ID: **5534** TestNo: **EPA 6010B (3005A)** Analysis Date: **3/20/03** SeqNo: **160437**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Antimony	0.625	0.010	0.5	0.0926	106	75	125	0	0		
Arsenic, TCLP	0.572	0.20	0.5	0	114	75	125	0	0		
Barium, TCLP	0.651	0.020	0.5	0.171	96	75	125	0	0		
Beryllium	0.498	0.0010	0.5	0	99.6	75	125	0	0		
Cadmium, TCLP	0.486	0.020	0.5	0	97.2	75	125	0	0		
Chromium, TCLP	0.491	0.020	0.5	0	98.2	75	125	0	0		
Copper, TCLP	0.556	0.060	0.5	0	111	75	125	0	0		
Lead, TCLP	0.52	0.12	0.5	0	104	75	125	0	0		
Nickel, TCLP	0.972	0.10	0.5	0.468	101	75	125	0	0		
Selenium, TCLP	0.577	0.30	0.5	0	115	75	125	0	0		
Silver, TCLP	0.559	0.060	0.5	0	112	75	125	0	0		
Zinc, TCLP	0.781	0.40	0.5	0	156	75	125	0	0		S,MI

Sample ID: **0303168-02A MSD** SampType: **MSD** TestCode: **02 ICPA** Units: **mg/L** Prep Date: **3/20/03** Run ID: **ICP_030320A**
Client ID: **ZZZZZ** Batch ID: **5534** TestNo: **EPA 6010B (3005A)** Analysis Date: **3/20/03** SeqNo: **160438**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Antimony	0.631	0.010	0.5	0.0926	108	75	125	0.625	0.955	20	
Arsenic, TCLP	0.57	0.20	0.5	0	114	75	125	0.572	0.350	20	
Barium, TCLP	0.653	0.020	0.5	0.171	96.4	75	125	0.651	0.307	20	
Beryllium	0.5	0.0010	0.5	0	100	75	125	0.498	0.401	20	
Cadmium, TCLP	0.488	0.020	0.5	0	97.6	75	125	0.486	0.411	20	
Chromium, TCLP	0.489	0.020	0.5	0	97.8	75	125	0.491	0.408	20	
Copper, TCLP	0.558	0.060	0.5	0	112	75	125	0.556	0.359	20	
Lead, TCLP	0.524	0.12	0.5	0	105	75	125	0.52	0.766	20	
Nickel, TCLP	0.979	0.10	0.5	0.468	102	75	125	0.972	0.718	20	
Selenium, TCLP	0.575	0.30	0.5	0	115	75	125	0.577	0.347	20	
Silver, TCLP	0.561	0.060	0.5	0	112	75	125	0.559	0.357	20	
Zinc, TCLP	0.784	0.40	0.5	0	157	75	125	0.781	0.383	20	S,MI

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
B - Analyte detected in the associated Method Blank

Koppers023064

CLIENT: Hahn and Associates
Work Order: 0303172
Project: 2708-30/NW NATURAL/GASCO

ANALYTICAL QC SUMMARY REPORT

TestCode: 02 ICPA

Sample ID: **0303172-02A DUP** SampType: **DUP** TestCode: **02 ICPA** Units: **mg/L** Prep Date: **3/20/03** Run ID: **ICP_030320A**
Client ID: **101** Batch ID: **5534** TestNo: **EPA 6010B (3005A)** Analysis Date: **3/20/03** SeqNo: **160440**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Antimony	ND	0.010	0	0	0	0	0	0	0	20	
Arsenic	0.0131	0.010	0	0	0	0	0	0	200	20	R,T
Barium	0.0713	0.0010	0	0	0	0	0	0.0727	1.94	20	
Beryllium	ND	0.0010	0	0	0	0	0	0	0	20	
Cadmium	0.0015	0.0010	0	0	0	0	0	0.0013	14.3	20	
Chromium	ND	0.015	0	0	0	0	0	0	0	20	
Copper	ND	0.0030	0	0	0	0	0	0	0	20	
Lead	ND	0.0060	0	0	0	0	0	0	0	20	
Nickel	ND	0.0050	0	0	0	0	0	0	0	20	
Selenium	ND	0.015	0	0	0	0	0	0	0	20	
Silver	ND	0.0030	0	0	0	0	0	0	0	20	
Zinc	ND	0.020	0	0	0	0	0	0	0	20	

Sample ID: **CCV** SampType: **CCV** TestCode: **02 ICPA** Units: **mg/L** Prep Date: **12/18/02** Run ID: **ICP_030320A**
Client ID: **ZZZZZ** Batch ID: **5230** TestNo: **EPA 6010B** Analysis Date: **3/20/03** SeqNo: **160449**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Antimony	0.493	0.010	0.5	0	98.6	90	110	0	0		
Arsenic	0.496	0.010	0.5	0	99.2	90	110	0	0		
Barium	0.496	0.0010	0.5	0	99.2	90	110	0	0		
Beryllium	0.508	0.0010	0.5	0	102	90	110	0	0		
Cadmium	0.504	0.0010	0.5	0	101	90	110	0	0		
Chromium	0.496	0.015	0.5	0	99.2	90	110	0	0		
Copper	0.493	0.0030	0.5	0	98.6	90	110	0	0		
Lead	0.502	0.0060	0.5	0	100	90	110	0	0		
Nickel	0.506	0.0050	0.5	0	101	90	110	0	0		
Selenium	0.508	0.015	0.5	0	102	90	110	0	0		
Silver	0.506	0.0030	0.5	0	101	90	110	0	0		
Zinc	0.509	0.020	0.5	0	102	90	110	0	0		

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
B - Analyte detected in the associated Method Blank

Koppers023065

CLIENT: Hahn and Associates
Work Order: 0303172
Project: 2708-30/NW NATURAL/GASCO

ANALYTICAL QC SUMMARY REPORT

TestCode: 02 ICPA

Sample ID: **ICVLOW** SampType: **ICV** TestCode: **02 ICPA** Units: **mg/L** Prep Date: **3/20/03** Run ID: **ICP_030320A**
Client ID: **ZZZZZ** Batch ID: **5534** TestNo: **EPA 6010B** Analysis Date: **3/20/03** SeqNo: **160433**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Antimony	0.495	0.010	0.5	0	99	90	110	0	0		
Arsenic	0.501	0.010	0.5	0	100	90	110	0	0		
Barium	0.5	0.0010	0.5	0	100	90	110	0	0		
Beryllium	0.503	0.0010	0.5	0	101	90	110	0	0		
Cadmium	0.5	0.0010	0.5	0	100	90	110	0	0		
Chromium	0.509	0.015	0.5	0	102	90	110	0	0		
Copper	0.502	0.0030	0.5	0	100	90	110	0	0		
Lead	0.502	0.0060	0.5	0	100	90	110	0	0		
Nickel	0.505	0.0050	0.5	0	101	90	110	0	0		
Selenium	0.495	0.015	0.5	0	99	90	110	0	0		
Silver	0.505	0.0030	0.5	0	101	90	110	0	0		
Zinc	0.51	0.020	0.5	0	102	90	110	0	0		

Koppers023066

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
B - Analyte detected in the associated Method Blank

CLIENT: Hahn and Associates
Work Order: 0303172
Project: 2708-30/NW NATURAL/GASCO

ANALYTICAL QC SUMMARY REPORT

TestCode: 04 BG A

Sample ID: MBLK	SampType: MBLK	TestCode: 04 BG A	Units: µg/L	Prep Date:	Run ID: CRICK_030324A
Client ID: ZZZZZ	Batch ID: R13378	TestNo: 8015/8021		Analysis Date: 3/24/03	SeqNo: 160806

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Benzene	ND	0.50									
Ethylbenzene	ND	0.50									
Toluene	ND	0.50									
Xylenes, Total	ND	1.5									
Gasoline	ND	100									
Surr: Trifluorotoluene	102	0	100	0	102	70	130	0	0		

Sample ID: LCS	SampType: LCS	TestCode: 04 BG A	Units: µg/L	Prep Date:	Run ID: CRICK_030324A
Client ID: ZZZZZ	Batch ID: R13378	TestNo: 8015/8021		Analysis Date: 3/24/03	SeqNo: 160807

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Benzene	42.4	0.50	40	0	106	85	115	0	0		
Ethylbenzene	41.6	0.50	40	0	104	85	115	0	0		
Toluene	41.8	0.50	40	0	104	85	115	0	0		
Xylenes, Total	128	1.5	120	0	107	85	115	0	0		
Gasoline	1940	100	2000	0	97	80	120	0	0		
Surr: Trifluorotoluene	99.8	0	100	0	99.8	70	130	0	0		

Sample ID: LCSD	SampType: LCSD	TestCode: 04 BG A	Units: µg/L	Prep Date:	Run ID: CRICK_030324A
Client ID: ZZZZZ	Batch ID: R13378	TestNo: 8015/8021		Analysis Date: 3/24/03	SeqNo: 160808

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Benzene	41.8	0.50	40	0	104	85	115	42.4	1.43	20	
Ethylbenzene	41	0.50	40	0	103	85	115	41.6	1.45	20	
Toluene	41.2	0.50	40	0	103	85	115	41.8	1.45	20	
Xylenes, Total	126	1.5	120	0	105	85	115	128	1.57	20	
Gasoline	1960	100	2000	0	98	80	120	1940	1.03	20	
Surr: Trifluorotoluene	100	0	100	0	100	70	130	0	0	0	

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
B - Analyte detected in the associated Method Blank

Koppers023067

CLIENT: Hahn and Associates
Work Order: 0303172
Project: 2708-30/NW NATURAL/GASCO

ANALYTICAL QC SUMMARY REPORT

TestCode: 04 BG A

Sample ID: 0303172-02A MS	SampType: MS	TestCode: 04 BG A	Units: µg/L	Prep Date:	Run ID: CRICK_030324A
Client ID: 101	Batch ID: R13378	TestNo: 8015/8021		Analysis Date: 3/24/03	SeqNo: 160813

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Benzene	21.2	0.50	20	0	106	85	115	0	0		
Ethylbenzene	20.8	0.50	20	0	104	85	115	0	0		
Toluene	21.1	0.50	20	0	106	85	115	0	0		
Xylenes, Total	64.9	1.5	60	0	108	85	115	0	0		
Surr: Trifluorotoluene	99.5	0	100	0	99.5	70	130	0	0		

Sample ID: 0303172-02A DUP	SampType: DUP	TestCode: 04 BG A	Units: µg/L	Prep Date:	Run ID: CRICK_030324A
Client ID: 101	Batch ID: R13378	TestNo: 8015/8021		Analysis Date: 3/24/03	SeqNo: 160812

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Benzene	ND	0.50	0	0	0	0	0	0	0	20	
Ethylbenzene	ND	0.50	0	0	0	0	0	0	0	20	
Toluene	ND	0.50	0	0	0	0	0	0	0	20	
Xylenes, Total	ND	1.5	0	0	0	0	0	0	0	20	
Surr: Trifluorotoluene	105	0	100	0	105	50	150	0	0	20	

Sample ID: CCV	SampType: CCV	TestCode: 04 BG A	Units: µg/L	Prep Date:	Run ID: CRICK_030324A
Client ID: ZZZZZ	Batch ID: R13378	TestNo: 8015/8021		Analysis Date: 3/24/03	SeqNo: 160809

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Benzene	31.9	0.50	30	0	106	85	115	0	0		
Ethylbenzene	31.5	0.50	30	0	105	85	115	0	0		
Toluene	31.7	0.50	30	0	106	85	115	0	0		
Xylenes, Total	96.6	1.5	90	0	107	85	115	0	0		
Gasoline	1500	100	1500	0	100	80	120	0	0		
Surr: Trifluorotoluene	103	0	100	0	103	70	130	0	0		

Koppers023068

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
B - Analyte detected in the associated Method Blank

CLIENT: Hahn and Associates
Work Order: 0303172
Project: 2708-30/NW NATURAL/GASCO

ANALYTICAL QC SUMMARY REPORT

TestCode: 06 PAH A

Sample ID: **MB-5536**	SampType: **MBLK**	TestCode: **06 PAH A**	Units: **µg/L**	Prep Date: **3/20/03**	Run ID: **HEISENBURG_030321A**
Client ID: **ZZZZZ**	Batch ID: **5536**	TestNo: **8270-SIM**	**(3510C)**	Analysis Date: **3/21/03**	SeqNo: **160627**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Acenaphthene	ND	0.10									
Acenaphthylene	ND	0.10									
Anthracene	ND	0.10									
Benz(a)anthracene	ND	0.10									
Benzo(a)pyrene	ND	0.10									
Benzo(b)fluoranthene	ND	0.10									
Benzo(g,h,i)perylene	ND	0.10									
Benzo(k)fluoranthene	ND	0.10									
Chrysene	ND	0.10									
Dibenz(a,h)anthracene	ND	0.10									
Fluoranthene	ND	0.10									
Fluorene	ND	0.10									
Indeno(1,2,3-cd)pyrene	ND	0.10									
Naphthalene	ND	0.10									
Phenanthrene	ND	0.10									
Pyrene	ND	0.10									
Surr: 2-Fluorobiphenyl	0.67	0	1	0	67	43	116	0	0		
Surr: 4-Terphenyl-d14	0.72	0	1	0	72	33	141	0	0		
Surr: Nitrobenzene-d5	0.71	0	1	0	71	35	114	0	0		

Sample ID: **LCS-5536**	SampType: **LCS**	TestCode: **06 PAH A**	Units: **µg/L**	Prep Date: **3/20/03**	Run ID: **HEISENBURG_030321A**
Client ID: **ZZZZZ**	Batch ID: **5536**	TestNo: **8270-SIM**	**(3510C)**	Analysis Date: **3/21/03**	SeqNo: **160628**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Acenaphthene	0.72	0.10	1	0	72	47	145	0	0		
Acenaphthylene	0.74	0.10	1	0	74	33	145	0	0		
Anthracene	0.83	0.10	1	0	83	27	133	0	0		
Benz(a)anthracene	0.82	0.10	1	0	82	33	143	0	0		
Benzo(a)pyrene	0.78	0.10	1	0	78	17	163	0	0		
Benzo(b)fluoranthene	0.76	0.10	1	0	76	24	159	0	0		
Benzo(g,h,i)perylene	0.63	0.10	1	0	63	1	219	0	0		

Qualifiers: ND - Not Detected at the Reporting Limit; J - Analyte detected below quantitation limits; S - Spike Recovery outside accepted recovery limits; R - RPD outside accepted recovery limits; B - Analyte detected in the associated Method Blank

Koppers023069

CLIENT: Hahn and Associates
Work Order: 0303172
Project: 2708-30/NW NATURAL/GASCO

ANALYTICAL QC SUMMARY REPORT

TestCode: 06 PAH A

Sample ID: LCS-5536	SampType: LCS	TestCode: 06 PAH A	Units: µg/L	Prep Date: 3/20/03	Run ID: HEISENBURG_030321A
Client ID: ZZZZZ	Batch ID: 5536	TestNo: 8270-SIM	(3510C)	Analysis Date: 3/21/03	SeqNo: 160628

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Benzo(k)fluoranthene	0.82	0.10	1	0	82	11	162	0	0		
Chrysene	0.82	0.10	1	0	82	17	168	0	0		
Dibenz(a,h)anthracene	0.65	0.10	1	0	65	1	227	0	0		
Fluoranthene	0.82	0.10	1	0	82	26	137	0	0		
Fluorene	0.74	0.10	1	0	74	59	121	0	0		
Indeno(1,2,3-cd)pyrene	0.64	0.10	1	0	64	1	171	0	0		
Naphthalene	0.77	0.10	1	0	77	21	133	0	0		
Phenanthrene	0.84	0.10	1	0	84	54	120	0	0		
Pyrene	0.84	0.10	1	0	84	52	115	0	0		
Surr: 2-Fluorobiphenyl	0.67	0	1	0	67	43	116	0	0		
Surr: 4-Terphenyl-d14	0.71	0	1	0	71	33	141	0	0		
Surr: Nitrobenzene-d5	0.7	0	1	0	70	35	114	0	0		

Sample ID: LCSD-5536	SampType: LCSD	TestCode: 06 PAH A	Units: µg/L	Prep Date: 3/20/03	Run ID: HEISENBURG_030321A
Client ID: ZZZZZ	Batch ID: 5536	TestNo: 8270-SIM	(3510C)	Analysis Date: 3/21/03	SeqNo: 160629

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Acenaphthene	0.67	0.10	1	0	67	47	145	0.72	7.19	30	
Acenaphthylene	0.69	0.10	1	0	69	33	145	0.74	6.99	30	
Anthracene	0.76	0.10	1	0	76	27	133	0.83	8.81	30	
Benz(a)anthracene	0.76	0.10	1	0	76	33	143	0.82	7.59	30	
Benzo(a)pyrene	0.72	0.10	1	0	72	17	163	0.78	8.00	30	
Benzo(b)fluoranthene	0.71	0.10	1	0	71	24	159	0.76	6.80	30	
Benzo(g,h,i)perylene	0.56	0.10	1	0	56	1	219	0.63	11.8	30	
Benzo(k)fluoranthene	0.78	0.10	1	0	78	11	162	0.82	5.00	30	
Chrysene	0.77	0.10	1	0	77	17	168	0.82	6.29	30	
Dibenz(a,h)anthracene	0.57	0.10	1	0	57	1	227	0.65	13.1	30	
Fluoranthene	0.76	0.10	1	0	76	26	137	0.82	7.59	30	
Fluorene	0.73	0.10	1	0	73	59	121	0.74	1.36	30	
Indeno(1,2,3-cd)pyrene	0.56	0.10	1	0	56	1	171	0.64	13.3	30	
Naphthalene	0.67	0.10	1	0	67	21	133	0.77	13.9	30	

Qualifiers: ND - Not Detected at the Reporting Limit; J - Analyte detected below quantitation limits; S - Spike Recovery outside accepted recovery limits; R - RPD outside accepted recovery limits; B - Analyte detected in the associated Method Blank

Koppers023070

CLIENT: Hahn and Associates
Work Order: 0303172
Project: 2708-30/NW NATURAL/GASCO

ANALYTICAL QC SUMMARY REPORT

TestCode: 06 PAH A

Sample ID: LCSD-5536	SampType: LCSD	TestCode: 06 PAH A	Units: µg/L	Prep Date: 3/20/03	Run ID: HEISENBURG_030321A
Client ID: ZZZZZ	Batch ID: 5536	TestNo: 8270-SIM	(3510C)	Analysis Date: 3/21/03	SeqNo: 160629

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Phenanthrene	0.78	0.10	1	0	78	54	120	0.84	7.41	30	
Pyrene	0.81	0.10	1	0	81	52	115	0.84	3.64	30	
Surr: 2-Fluorobiphenyl	0.61	0	1	0	61	43	116	0	0	30	
Surr: 4-Terphenyl-d14	0.68	0	1	0	68	33	141	0	0	30	
Surr: Nitrobenzene-d5	0.62	0	1	0	62	35	114	0	0	30	

Sample ID: 0303172-02A MS	SampType: MS	TestCode: 06 PAH A	Units: µg/L	Prep Date: 3/20/03	Run ID: HEISENBURG_030321A
Client ID: 101	Batch ID: 5536	TestNo: 8270-SIM	(3510C)	Analysis Date: 3/21/03	SeqNo: 160637

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Acenaphthene	0.76	0.10	1	0	76	47	145	0	0		
Acenaphthylene	0.7	0.10	1	0	70	33	145	0	0		
Anthracene	0.79	0.10	1	0	79	27	133	0	0		
Benz(a)anthracene	0.77	0.10	1	0	77	33	143	0	0		
Benzo(a)pyrene	0.72	0.10	1	0	72	17	163	0	0		
Benzo(b)fluoranthene	0.7	0.10	1	0	70	24	159	0	0		
Benzo(g,h,i)perylene	0.59	0.10	1	0	59	1	219	0	0		
Benzo(k)fluoranthene	0.75	0.10	1	0	75	11	162	0	0		
Chrysene	0.76	0.10	1	0	76	17	168	0	0		
Dibenz(a,h)anthracene	0.61	0.10	1	0	61	1	227	0	0		
Fluoranthene	0.76	0.10	1	0	76	26	137	0	0		
Fluorene	0.75	0.10	1	0	75	59	121	0	0		
Indeno(1,2,3-cd)pyrene	0.59	0.10	1	0	59	1	171	0	0		
Naphthalene	0.9	0.10	1	0	90	21	133	0	0		
Phenanthrene	0.81	0.10	1	0	81	54	120	0	0		
Pyrene	0.83	0.10	1	0	83	52	115	0	0		
Surr: 2-Fluorobiphenyl	0.6	0	1	0	60	43	116	0	0		
Surr: 4-Terphenyl-d14	0.68	0	1	0	68	33	141	0	0		
Surr: Nitrobenzene-d5	0.67	0	1	0	67	35	114	0	0		

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
B - Analyte detected in the associated Method Blank

Koppers023071

CLIENT: Hahn and Associates
Work Order: 0303172
Project: 2708-30/NW NATURAL/GASCO

ANALYTICAL QC SUMMARY REPORT

TestCode: 06 PAH A

Sample ID: **CCV**	SampType: **CCV**	TestCode: **06 PAH A**	Units: **µg/L**	Prep Date:	Run ID: **HEISENBURG_030321A**
Client ID: **ZZZZZ**	Batch ID: **R13363**	TestNo: **8270-SIM**		Analysis Date: **3/21/03**	SeqNo: **160633**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Acenaphthene	0.84	0.10	1	0	84	80	120	0	0		
Acenaphthylene	0.87	0.10	1	0	87	80	120	0	0		
Anthracene	0.91	0.10	1	0	91	80	120	0	0		
Benz(a)anthracene	0.91	0.10	1	0	91	80	120	0	0		
Benzo(a)pyrene	0.89	0.10	1	0	89	80	120	0	0		
Benzo(b)fluoranthene	0.89	0.10	1	0	89	80	120	0	0		
Benzo(g,h,i)perylene	0.8	0.10	1	0	80	80	120	0	0		
Benzo(k)fluoranthene	0.97	0.10	1	0	97	80	120	0	0		
Chrysene	0.94	0.10	1	0	94	80	120	0	0		
Dibenz(a,h)anthracene	0.8	0.10	1	0	80	80	120	0	0		
Fluoranthene	0.93	0.10	1	0	93	80	120	0	0		
Fluorene	0.84	0.10	1	0	84	80	120	0	0		
Indeno(1,2,3-cd)pyrene	0.8	0.10	1	0	80	80	120	0	0		
Naphthalene	0.92	0.10	1	0	92	80	120	0	0		
Phenanthrene	0.92	0.10	1	0	92	80	120	0	0		
Pyrene	0.95	0.10	1	0	95	80	120	0	0		
Surr: 2-Fluorobiphenyl	0.95	0	1	0	95	43	116	0	0		
Surr: 4-Terphenyl-d14	0.94	0	1	0	94	33	141	0	0		
Surr: Nitrobenzene-d5	0.94	0	1	0	94	35	114	0	0		

Koppers023072

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
B - Analyte detected in the associated Method Blank

ENVIRONMENTAL SERVICES LABORATORY – GLOSSARY OF FLAGS

QUALIFIER	DESCRIPTION
AA	This sample was analyzed after the holding time had expired.
AB	The hydrocarbon pattern in this sample is not typical of gasoline.
AC	The hydrocarbon pattern in this sample is not typical of diesel.
AD	The hydrocarbon pattern in this sample is not typical of oil.
AE	The hydrocarbon pattern in this sample extends into the gasoline range.
AF	The hydrocarbon pattern in this sample extends into the diesel range.
AG	The hydrocarbon pattern in this sample extends into the oil range.
A	This analysis was performed on a VOA sample containing headspace.
B	Analyte detected in the Method Blank above the reporting level.
C	The Relative Percent Difference (RPD) for the primary result and confirmation result was greater than 40%. The higher result was reported.
D	The sample was supplied in an inappropriate container according to method criteria.
E	This value is above the quantitation limit. It is considered an estimate.
H	The Matrix Spike/Matrix Spike Duplicate (MS/MSD) result was outside control limits. The Laboratory Control Standard/Duplicate (LCS/LCSD) result was in control validating the batch.
J	The result is above the Method Detection Limit (MDL) and below the Reporting level (RL). It is considered an estimate.
M	The MS/MSD recoveries are not calculable due to a high amount of analyte in sample.
MI	This indicates a high level of matrix interference affecting the spike or surrogate recovery.
N	See case narrative.
O	Detection Limits are elevated due to sample dilution. See case narrative.
Q	Further inspection of the sample confirms a non-homogenous sample matrix affecting RPD result.
R	The RPD result is outside method control limits. See other qualifiers or case narrative.
S	The spike recovery is outside method control limits. See other qualifiers or case narrative.
T	The RPD between the sample result and duplicate result was greater than 20%. The original result was less than three times the reporting level, therefore the RPD is not applicable.
X	Unable to quantitate surrogate recovery due to sample dilution.

Koppers023073

HAHN AND ASSOCIATES, INC.
Environmental Management
434 NW Sixth Avenue, Suite 203 • Portland OR 97209
(503) 796-0717 • Fax (503) 227-2209

Laboratory: ESL, INC. PORTLAND OR
Lab Project No.: 0303173

CHAIN OF CUSTODY
Chain of Custody No. _____

Project Manager: Rob Eale
Project No.: 2708-30
Project Name: NW Natural -> Gasco
Collected by: Matt Mudge & Mike O'Connor

Liquid with Sediment Sample: ____ Test Filtrate ____ Test Sediment ____ Test Both
Multi-Phase Sample: ____ Test One (which) ____ Test Separately ____ Shake

Samples Received at 4C (Y or N) _____
Appropriate Containers Used (Y or N) _____
Provide Verbal Results (Y or N) _____
Provide Preliminary Fax Results YES

Sample Number Prefix: 2708-030318-~~XX~~

Lab ID	Sample #	Date	Time	Sample Description	Matrix: Soil	Matrix: Water	Matrix: Other	Number of Containers	Analyses to be Performed: PAHs (EPA 8270 SIM)	BTEX (EPA 8021)	Total CN (EPA 9010)	Amenable CN (EPA 9010)	TOTAL METALS (6010) As, Cr, Cu, Pb, Ni, Zn	FP metals (Dissolved) ARSENIC				RUSH	Remarks
-01	102	3/18/03	8:03	MW7-102		X		2		X									
-02	103	↓	9:23	MW9-29-103		X		8	X	X	X	X	X	X					
-03	104		10:40	MW2-61-104		X		7	X	X	X	X	X						
-04	105		12:09	MW5-175-105		X		↓	X	X	X	X	X						
-05	106		13:16	MW7-106		X		5	X	X									
-06	107		14:22	MW15-66-107		X		7	X	X	X	X	X						
-07	108		15:53	MW14-110-108		X		8	X	X	X	X	X	X					
-08	109	↓	17:04	MW4-101-109		X		↓	X	X	X	X	X	X					

Relinquished by	Company	Date	Time	Received by	Company
M. T. Mudge	HAHN & ASSOC	11:45	3/18/03	[signature]	ESL
Relinquished by	Company	Date	Time	Received by	Company

Environmental Services Laboratory, Inc.

E S L

17400 SW Upper Boones Ferry Road, Suite 270 • Portland, OR 97224 • (503) 670-8520

March 31, 2003

Mr. Rob Ede
Hahn and Associates
434 NW Sixth Avenue
Suite 203
Portland, OR 97209

TEL: (503)796-0717
FAX (503) 227-2209

RE: 2708-30/NW NATURAL/GASCO

Order No.: 0303173

Dear Mr. Rob Ede:

Environmental Services Laboratory received 8 samples on 3/19/03 for the analyses presented in the following report.

There were no analytical problems encountered and all associated QC data met EPA or laboratory specifications except where noted in a Case Narrative. Results apply only to the samples analyzed. Reproduction of this report is permitted only in its entirety, without the written approval of the laboratory. The following checked data sections are included in this report, and numbered to indicate total pages contained within each report section.

✓Base Sample Report ✓Method Blank Report ✓Sample Duplicate Report ✓Matrix Spike/Matrix Spike Duplicate Report ✓Laboratory Control Spike/Spike Duplicate Report ✓Continuing Calibration Verification Report ✓Initial Calibration Verification Report

If you have any questions regarding these tests results, please feel free to call.

Jessie Rush
Project Manager

Keith Hunter
Technical Review

Environmental Services Laboratory

Date: *31-Mar-03*

CLIENT:	Hahn and Associates	**Client Sample ID:**	102
Lab Order:	0303173	**Tag Number:**	
Project:	2708-30/NW NATURAL/GASCO	**Collection Date:**	3/18/03
Lab ID:	0303173-01A	**Matrix:**	AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
GAS/BTEX, AQUEOUS		**8015/8021**				Analyst: tln
Benzene	ND	0.50		µg/L	1	3/25/03
Ethylbenzene	ND	0.50		µg/L	1	3/25/03
Toluene	ND	0.50		µg/L	1	3/25/03
Xylenes, Total	ND	1.5		µg/L	1	3/25/03
Surr: Trifluorotoluene	102	70-130		%REC	1	3/25/03

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

Koppers023076

Environmental Services Laboratory

Date: *31-Mar-03*

CLIENT:	Hahn and Associates	**Client Sample ID:**	103
Lab Order:	0303173	**Tag Number:**	
Project:	2708-30/NW NATURAL/GASCO	**Collection Date:**	3/18/03
Lab ID:	0303173-02A	**Matrix:**	AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
GAS/BTEX, AQUEOUS		**8015/8021**				Analyst: **tln**
Benzene	ND	0.50		µg/L	1	3/24/03
Ethylbenzene	ND	0.50		µg/L	1	3/24/03
Toluene	ND	0.50		µg/L	1	3/24/03
Xylenes, Total	ND	1.5		µg/L	1	3/24/03
Surr: Trifluorotoluene	102	70-130		%REC	1	3/24/03
ICP METALS		**EPA 6010B**		**(3005A)**		Analyst: **mal**
Arsenic	ND	0.010		mg/L	1	3/20/03
Chromium	ND	0.015		mg/L	1	3/20/03
Copper	ND	0.0030		mg/L	1	3/20/03
Lead	ND	0.0060		mg/L	1	3/20/03
Nickel	ND	0.0050		mg/L	1	3/20/03
Zinc	ND	0.020		mg/L	1	3/20/03
PAH BY SIM, AQUEOUS		**8270-SIM**		**(3510C)**		Analyst: **mrs**
Acenaphthene	ND	0.10		µg/L	1	3/21/03
Acenaphthylene	ND	0.10		µg/L	1	3/21/03
Anthracene	ND	0.10		µg/L	1	3/21/03
Benz(a)anthracene	ND	0.10		µg/L	1	3/21/03
Benzo(a)pyrene	ND	0.10		µg/L	1	3/21/03
Benzo(b)fluoranthene	ND	0.10		µg/L	1	3/21/03
Benzo(g,h,i)perylene	ND	0.10		µg/L	1	3/21/03
Benzo(k)fluoranthene	ND	0.10		µg/L	1	3/21/03
Chrysene	ND	0.10		µg/L	1	3/21/03
Dibenz(a,h)anthracene	ND	0.10		µg/L	1	3/21/03
Fluoranthene	ND	0.10		µg/L	1	3/21/03
Fluorene	ND	0.10		µg/L	1	3/21/03
Indeno(1,2,3-cd)pyrene	ND	0.10		µg/L	1	3/21/03
Naphthalene	ND	0.10		µg/L	1	3/21/03
Phenanthrene	ND	0.10		µg/L	1	3/21/03
Pyrene	ND	0.10		µg/L	1	3/21/03
Surr: 2-Fluorobiphenyl	55.0	43-116		%REC	1	3/21/03
Surr: 4-Terphenyl-d14	65.0	33-141		%REC	1	3/21/03
Surr: Nitrobenzene-d5	63.0	35-114		%REC	1	3/21/03
CYANIDE		**EPA 9014**				Analyst: **jca**
Cyanide	0.042	0.040		mg/L	1	3/28/03
CYANIDE		**EPA 9014**				Analyst: **jca**
Cyanide, Amenable	ND	0.040		mg/L	1	3/28/03

Qualifiers:

ND - Not Detected at the Reporting Limit

J - Analyte detected below quantitation limits

B - Analyte detected in the associated Method Blank

* - Value exceeds Maximum Contaminant Level

S - Spike Recovery outside accepted recovery limits

R - RPD outside accepted recovery limits

E - Value above quantitation range

Koppers023077