BWRAR 1.4 V1
CBPDD 2.2 V1
CBNSF 26.9.1.7 V1 AR 1.4

~~26.7.5.5A~~

Final Investigation Report
Blair Backup Property
Port of Tacoma, Washington

Volume II
Appendices A through L

Prepared for
Port of Tacoma

January 29, 1992
J-2350-07

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APPENDIX A
FIELD EXPLORATION AND SAMPLING METHODS

This appendix provides a description of the specific sampling and analysis procedures for data collection during the site characterization work on the Blair Backup property in Tacoma, Washington. Explorations conducted at the site involved soil borings, test pits, and groundwater monitoring wells. Analyses and testing included chemical analysis of soil and groundwater, hydraulic conductivity testing, and water level monitoring.

Drilling Procedures

This section presents the field procedures used to install soil borings at the site.

The equipment and procedures used for hollow-stem auger and cable tool drilling, sampling, decontamination, and borehole closure are discussed below.

Hollow-Stem Auger Drilling Methods

Geoboring, Inc., installed a total of 17 soil borings and shallow monitoring wells from December 11 through 15, 1989, using a hollow-stem auger (HSA) rig (Mobil Drill B-61). Between August 1990 and October 1990, McDonald Holt Drilling Inc. completed 9 additional soil borings which included 4 more shallow monitoring wells (HC-9S, HC-21S, HC-24S, and HC-25S).

Standard auger drilling techniques were followed. No grease was used on the auger sections joints or accessory tooling. When heaving soil conditions were encountered and all other standard methods (e.g., spinning the auger, using a plug, etc.) failed to allow proper placement of well screen or advancement of the hole, water was used to flush down the hole to remove heaving soils. A sample of this water was collected for chemical analysis.

Equipment Decontamination

Before any work began, the drill rig, auger sections, steel casing, and the downhole equipment were steam cleaned. Between each boring the downhole drilling and soil sampling equipment was steam cleaned using potable water or another source of clean water.

All downhole soil sampling equipment was decontaminated using the following procedures before each sample was taken.

- First, the sampler was washed with clean water;
- Then an Alconox solution was used to wash the sampler; and,
- Last, the sampler was rinsed in successive baths of tap water and a deionized water spray.

Soil Sampling

Soil samples were collected during drilling as follows:

- Soil samples were taken at 2- to 5-foot-depth intervals using a split-barrel sampler. The samples obtained by the HSA drill rig were obtained as described in ASTM Standard D 1586 "Penetration Test and Split-Barrel Sampling of Soils."
- A 3-inch outside diameter, 18-inch long split-spoon sampler was driven into the soil a distance of 18 inches using a 300-pound hammer, free-falling 30 inches. In several wells, a 1.5-inch inside diameter sampler was used with a 140-pound hammer. The number of blows required to drive the sample the last 12 inches is the Standard Penetration resistance and is a measure of the relative density of granular soils and consistency of cohesive soils.
- After the sampler was retrieved, the sampler was placed on a clean surface.
- The split-barrel was opened and the soil sample split longitudinally. A portion of the sample was placed in the sampling jar supplied by the laboratory (samples were split longitudinally again if duplicate samples were collected).

Cable Tool Drilling Methods

Holt Drilling, Inc., installed 11 soil borings and intermediate monitoring wells from December 14, 1989 to January 4, 1990, using a cable tool drill rig (Bucyrus-Erie).

The wells were constructed through a series of steps designed to reduce the likelihood of cross-contamination between the Shallow and Intermediate Aquifer during drilling. The method employed three casing sizes and required grouting a casing into the upper aquitard before drilling through this unit. The following procedure was used.

- Drilling was initiated with 12-inch steel casing. This casing was advanced to the bottom of the Shallow Aquifer and approximately one foot or less into the Upper Aquitard. The borehole was advanced by driving casing and bailing out the soil plug. Some water was required to remove the soil plug in the unsaturated zone, however, most of the added water was removed as the soil slurry was bailed from the casing.

- Once the Upper Aquitard was encountered and all soil was removed from the casing, a new 8-inch black steel casing was telescoped through the 12-inch casing and driven a few inches beyond the bottom of the hole. The 12-inch casing was then withdrawn as a cement-bentonite grout was tremied into the annular space, grouting the 8-inch casing into the Upper Aquitard.

- A 6-inch casing was then telescoped through the 8-inch casing and drilling continued to the Intermediate Aquifer. If the hole remained open, drilling was continued without using the 6-inch casing.

- A grout pump, steam cleaning unit, and service truck with water tank was on-site for use. All grout was mixed and placed in accordance with WAC 173-160. The 12-inch casing was reused following decontamination as described under the ***Equipment Decontamination*** section.

All water and material produced from bailing during advance of the borehole were collected in 55-gallon drums.

- The sample jar was wiped clean and capped with a Teflon-lined lid, then placed in a cooled ice chest.

- The remaining portion of the sample was placed in a clean glass sample jar, covered with tin foil and capped for sample jar headspace vapor measurements and soil description.

Sample Jar Headspace Vapor Measurement

Soil samples for sample jar headspace vapor measurements were collected as described above. To take measurements:

- The sample jar was allowed to equilibrate with ambient temperature conditions for a standing time of at least 10 minutes;

- An H-Nu Photoionization Detector, Model PID 101, with a 10.2 eV lamp was used to take the measurements;

- The sample jar lid was unscrewed; and the tip of H-Nu Detector extension probe punctured the tin foil seal into headspace area of sample jar;

- The field headspace vapor measurements for the soil sample was then measured from the H-Nu meter;

- Sample jar was recapped; and

- H-Nu meter measurement was recorded on the field boring log for the appropriate sample.

Soil Description

A record of drilling and sampling operations was maintained on a field boring log form. Soil descriptions were prepared using the system shown on Figure A-1, Key to Exploration Logs. Interpretive logs and monitoring well construction diagrams are presented in this appendix on Figures A-2 through A-38. The descriptions were used to determine the occurrence and contacts between expected hydrogeologic units. Other pertinent data recorded on the logs included:

- Sample interval, type, and recovery;

- Blow count (penetration resistance) from drive samples;
- Sample jar headspace measurements; and
- Drill action.

Once the soil from the sample was described, the soil from the field headspace jar was emptied from the jar into the drill cutting container.

Hole Abandonment

Boreholes which were not completed as monitoring wells were closed by grouting with cement-bentonite grout. The surface was restored with appropriate pavement or surfacing material. Holes were abandoned in accordance with Chapter 173-160 WAC "Minimum Standards for Construction and Maintenance of Wells".

Drill Cuttings

Cuttings from borings were placed in barrels pending chemical analysis. Drums were stored in a covered secure area. After the results of chemical analyses are received, a waste disposal contractor will remove the drums for appropriate disposal.

Test Pit Excavation

Test pits were generally excavated using a backhoe to approximately one to two feet below the groundwater table or to a maximum depth of 11 feet if groundwater was not encountered. Several test pits excavations collapsed before encountering groundwater or before reaching the maximum 11-foot depth. A stainless steel spoon was used to remove sample material from the center of the backhoe bucket. Samples were composited in a covered stainless steel bowl or within the backhoe bucket before placing in sample jars. Samples collected for sample jar headspace vapor and volatile organic analyses were placed directly from the backhoe bucket into sampling jars.

Sampling equipment and the backhoe bucket were cleaned after each test pit excavation. The backhoe bucket and a portion of the connection boom were thoroughly steam cleaned. Sampling equipment was hand washed using an Alconox solution followed by successive rinses of tap and deionized water.

Test pits were backfilled with the excavated soil using the backhoe. A stake was used to mark the test pit location. Test pit construction diagrams are presented on Figures B-39 through B-56.

Ditch Sediment Sampling Procedures

Ditch sediment samples, designated DS-100 through DS-109 were collected at two different ditch locations (Ohio Ferro-Alloy Ditch and the Pennwalt Ag-Chem Ditch) spaced at approximately 100-foot intervals at the bottom of each ditch. At the time of sampling, September 7, 1990, the OFA Ditch was wet and the Pennwalt Ag-Chem Ditch was dry.

Samples were collected with a 4-inch stainless steel hand auger at depth intervals of 0 to 1.5 feet, 1.5 to 3.0 feet, and 3.0 to 3.5 feet. All soils from the same depth were emptied into a stainless steel bowl and described. Soils were sampled discreetly by depth, mixed with stainless steel spoons in stainless steel bowls, placed into teflon-lined glass jars and transferred to coolers immediately. The chemical lab was instructed to composite all samples from the same depth before analysis. Holes were backfilled with original soil.

Groundwater Monitoring Well Installation

Groundwater monitoring wells were generally installed in conformance with Chapter 173-160 WAC "Minimum Standards for Construction and Maintenance of Wells." Variances were obtained from the Washington State Department of Ecology for shallow wells not conforming to these standards. Monitoring well installation diagrams are shown on Figures A-2 through A-38.

Well Installation Procedures

All monitoring wells were constructed with flush-threaded 2-inch-diameter PVC and 2.5- to 10-foot-long screens (0.020-inch slot). Of the 32 wells installed, 21 shallow wells were completed at depths ranging from 7.5 to 15 feet. Eleven intermediate wells were completed at depths ranging from 22.5 to 40 feet. The following procedure was used to install the wells:

- Two-inch inside diameter, flush-threaded, schedule 40 PVC screen (0.020-inch slots) and riser pipes were lowered down through the hollow-stem auger, open hole, or through the 6-inch casing.

- As the auger or 6-inch casing was pulled out, Colorado silica sand (Number 10 to 20) was placed around and approximately 1 to 2 feet above the screen section. The depth to the top of the sand pack was recorded by sounding inside the annular space with a weighted measuring tape.

- Bentonite seals were used above the sand pack. In the shallow wells this seal consisted of bentonite pellets or chips placed dry and moistened with clean water. In the intermediate wells, the seal consisted of bentonite grout. A 2-foot-thick bentonite pellet or chip seal was placed dry on top of the sand pack. Bentonite grout was then placed on top of this dry bentonite layer using a tremie pipe.

- The grout extended from the top of the sand pack to the base of the surface monument.

- A concrete surface seal was then placed above the bentonite grout seal at ground surface.

- A steel flush-to-the-ground water-proof or stick-up monument (depending on the well locations), set in concrete, was placed over the finished groundwater monitoring well installation for security protection.

- If a stick-up type of monument was installed, three steel posts were placed around the monitoring well monument for traffic protection.

- Each well was then vented and secured with a padlock.

Groundwater Monitoring Well Development

In order to increase the hydraulic connection between well and formation, and to decrease the turbidity content of the groundwater samples, monitoring wells were developed before sampling as follows:

- Bottom filling bailer was used to surge and remove the sediment in the screened section of the groundwater monitoring well;

- Hand bailing or pumping (using a peristaltic pump) was continued until at least ten casing volumes of groundwater were removed or until the well was bailed dry twice;

- All water flushed down the well during well installation was removed;

- All equipment that went into the well were decontaminated before use as described in the ***Equipment Decontamination*** section;

- A new length of polypropylene rope was used for the bailer at each well site; and

- Well development data was documented on Hart Crowser's Field Well Development Data Form.

Groundwater Monitoring Well Vertical Control Survey

The top of casing for each of the new groundwater monitoring wells was surveyed by the Port of Tacoma to the Port of Tacoma datum (Mean Lower Low Water) with an accuracy of 0.01 foot.

Groundwater Sampling

The following sections discuss the equipment and procedures used for sampling and handling of groundwater samples.

Equipment

The following equipment was used for groundwater sampling:

- pH, temperature, EC meter, dissolved oxygen meter, and redox probe;
- Electronic well sounder;
- Dedicated PVC bailers;
- Filtering equipment;
- New polypropylene rope;
- Appropriate sampling containers;
- Ice and cooler; and
- Sample Custody Record.

Groundwater Sampling Procedure

Groundwater samples were collected using the following procedure:

- The general condition of the well and immediate area was noted and recorded.

- The depth to water level from the top of casing was measured as described in ***Sample Handling Protocol*** section.

- Prior to sampling, three to five casing volumes of water were removed from the well using a dedicated PVC bailer or non-dedicated stainless steel bailers in existing EPA wells. Water purged from the wells were placed into a 55-gallon drum.

- Groundwater samples were generally collected with a dedicated PVC bailer. The bailer was lowered into the well with polypropylene rope. Stainless steel bailers with new polypropylene rope was used to sample the existing EPA wells.

- Groundwater retrieved from the monitoring well was poured into clean, labeled, sampling containers supplied by Laucks and capped. Sampling containers not containing preservatives were rinsed with the water to be sampled before collecting the sample. Samples for volatile analysis were collected first. Volatile sample containers were slowly filled with water, capped, inverted, and tapped to check for remaining air bubbles. If samples contain bubbles, the procedure was repeated. Sample containers were filled slowly to minimize turbulence. Groundwater samples collected for dissolved metal analysis were filtered in the field using a peristaltic pump and an in-line 0.45 micron filter before being placed in the appropriate sample containers. Field blanks were collected in similar manner.

- Groundwater samples were immediately placed in a cooled ice chest. Samples collected for volatile analysis were placed in plastic sealable bags to minimize cross contamination. Samples suspected of containing high concentrations of organic contaminants were stored in a separate cooler.

- After samples for chemical analysis had been collected, a sample was obtained for field measurement of temperature, pH, electrical conductivity, dissolved oxygen, and redox potential.

- Groundwater sampling activities were documented on Hart Crowser's field Groundwater Sampling Data form.

- Samples collected for chemical analysis were transported to the analytical laboratory within 24 hours from the time they were collected using chain of custody procedures (see ***Sample Handling Protocol*** section).

Sample Handling Protocol

Appropriate sample containers provided by Laucks were used. Each container was labeled with an indelible marker or pre-applied labels supplied by the analytical laboratory. Time, date, initials of sampler, site location, and well name was written on the labels. Sampling activities were recorded on the record form or log. A chain of custody record was completed.

Immediately after sampling, samples were placed with appropriate packing in cooled transport containers provided by Laucks. Samples from similarly contaminated areas were kept in the same coolers to further prevent cross contamination.

The chain of custody record was completed when samples were delivered to Laucks. At a minimum, the following was included:

- Client identification information;
- Name of person receiving the samples;
- Condition of transport and sample containers;
- Verification of sample containers and chain of custody record;
- Time and data samples delivered to analytical laboratory;
- Allocation of samples; and
- Required sample analysis.

A copy of the chain of custody record was retained and provided to the appropriate QA officer.

Water Level Monitoring and Tidal Response Assessment

Measurements of the water level in the wells were conducted concurrently with development of tidal records for selected shallow and intermediate wells. Water levels were also collected at several surface water locations. Water level and tidal cycle monitoring were conducted in February and September 1990, and January 1991. All the wells were measured within a 2-hour period during a high tide cycle. Water level data are presented in Table A-1. In February 1990, three shallow wells (HC-14S, HC-6S, and HC-12S) and three intermediate wells (HC-14I, HC-6I, and HC-12I) were continuously monitored with an automated data acquisition system during one tidal cycle. These data were used to assess the affects of tidal variations on the aquifers (Figures A-57 and A-58). We assumed tide elevations based on published tide tables as well as data collected at a tide monitoring station located in the Blair Waterway Marine Railway Dock.

Manual water level measurements were made using a calibrated electric well probe. The measurements were recorded to 0.01 foot.

Hydraulic Conductivity Testing

In situ hydraulic conductivity testing (specifically slug tests and bailer tests), were conducted in 22 selected wells. Rising head and falling tests were conducted in the shallow wells and these data were analyzed using the Bouwer and Rice or Hvorslev methods (Table A-2). Rising head data were analyzed for wells with unsaturated screens and falling head data were analyzed for wells with fully saturated screens. Rising head and falling head tests were conducted in the intermediate wells and these data were analyzed using the Hvorslev method. The tests were accomplished using a slug rod or bailer to displace the water in the well. An automated data acquisition system was used to record the water level changes with time.

Grain Size Analysis (GS)

Grain size distribution was analyzed on selected soil samples from the borings in general accordance with ASTM D 422. Wet sieve analysis was used to determine the size distribution greater than the U.S. No. 200 mesh sieve. The size distribution for particles smaller than the No. 200 mesh sieve was determined by the hydrometer method for a

selected number of samples. The results of the tests are presented as curves on Figures A-59 and A-60 plotting percent finer by weight versus grain size.

Previous Explorations by Others

This appendix also presents logs of explorations by other consultants for reference. Logs developed by Ecology and Engineering, Inc., for wells EE-6 through EE-10 are presented on Figures A-61 through A-68. Logs developed by Shannon and Wilson for wells P-10SS, P-10S, and P-10D are presented on Figures A-69 through A-71. These explorations are shown on Figure 5 as P-10S, P-10I, and P-10D, respectively. Shannon & Wilson also developed logs for MW-SS,I; MW-10S,I,D; and MW-11S,I which are presented on Figures A-72 through A-78. Logs developed by CH2M Hill for wells MW-11D; MW-13S,I,D; MW-16S,I; MW-27S; MW-28I; MW-29I; MW-30I; MW-32S; MW-33S; MW-36I; MW-39I; and MW-43S are presented on Figures A-79 through A-93.

Table A-1 - Blair Backup Groundwater and Surface Water Elevation Data

Monitoring Location	Reference Elevation	1/19/90-1/19/90 Depth to Water	1/19/90-1/19/90 Water Elev.	2/2/90 - High Tide Depth to Water	2/2/90 - High Tide Water Elev.	2/7/90 - 2/9/90 Depth to Water	2/7/90 - 2/9/90 Water Elev.	9/11/90-High Tide Depth to Water	9/11/90-High Tide Water Elev.	1/25/91-High Tide Depth to Water	1/25/91-High Tide Water Elev.
Shallow Wells											
HC-1S	24.23	8.32	15.91	7.62	16.61	----	----	dry	----	8.39	15.84
HC-2S	27.57	9.95	17.62	10.36	17.21	8.80	18.77	dry	----	9.10	18.47
HC-3S	24.68	9.60	15.08	9.16	15.52	8.80	15.88	dry	----	12.65	12.03
HC-4S	18.81	3.95	14.86	3.84	14.97	4.35	14.46	5.55	13.26	4.30	14.51
HC-5S	16.82	1.28	15.54	1.65	15.17	----	----	3.55	13.27	1.96	14.86
HC-6S	16.05	0.59	15.46	0.64	15.41	0.07	15.98	2.34	13.71	1.42	14.63
HC-7S	19.31	4.65	14.66	4.59	14.72	4.70	14.61	6.02	13.29	4.80	14.51
HC-8S	18.80	2.80	16.00	2.81	15.99	2.60	16.20	5.78	13.02	3.27	15.53
HC-9S	19.12	----	----	----	----	----	----	6.57	12.55	3.88	15.24
HC-10S	15.32	1.27	14.05	1.47	13.85	1.80	13.52	3.05	12.27	1.67	13.65
HC-11S	17.93	2.46	15.47	2.46	15.47	----	----	4.28	13.65	2.52	15.41
HC-12S	20.70	5.00	15.70	5.14	15.56	4.95	15.75	7.15	13.55	5.03	15.67
HC-13S	27.55	8.93	18.62	9.09	18.46	8.60	18.95	12.96	14.59	9.47	18.08
HC-14S	22.71	3.25	19.46	3.22	19.49	3.05	19.66	7.72	14.99	3.41	19.30
HC-15S	17.72	3.10	14.62	3.45	14.27	3.30	14.42	5.13	12.59	3.01	14.71
HC-16S	17.05	4.85	12.20	4.42	12.63	5.62	11.43	5.66	11.39	3.13	13.92
HC-17S	21.70	3.03	18.67	2.89	18.81	----	----	7.71	13.99	3.88	17.82
HC-18S	22.97	3.55	19.42	3.39	19.58	3.45	19.52	7.40	15.57	3.79	19.18
HC-21S	17.74	----	----	----	----	----	----	5.50	12.24	2.05	15.69
HC-24S	15.78	----	----	----	----	----	----	----	----	1.68	14.10
HC-25S	15.55	----	----	----	----	----	----	----	----	1.27	14.28
Intermediate Wells											
HC-2I	27.29	17.93	9.36	16.34	10.95	----	----	----	----	16.92	10.37
HC-3I	24.59	13.75	10.84	13.32	11.27	----	----	15.06	9.53	14.95	9.64
HC-4I	18.10	7.45	10.65	6.95	11.15	6.75	11.35	8.20	9.90	7.28	10.82
HC-6I	16.21	5.75	10.46	4.68	11.53	5.05	11.16	----	----	5.18	11.03
HC-10I	15.47	3.90	11.57	4.06	11.41	4.00	11.47	5.46	10.01	4.62	10.85
HC-12I	20.06	10.24	9.82	10.12	9.94	10.00	10.06	11.38	8.68	10.78	9.28
HC-13I	27.27	19.20	8.07	16.34	10.93	----	----	17.72	9.55	16.82	10.45
HC-14I	22.68	12.65	10.03	12.01	10.67	----	----	13.32	9.36	12.28	10.40
HC-15I	17.67	7.18	10.49	6.85	10.82	6.75	10.92	8.03	9.64	7.20	10.47
HC-16I	17.47	7.21	10.26	6.97	10.50	----	----	8.13	9.34	7.16	10.31
HC-17I	21.35	10.25	11.10	9.98	11.37	----	----	11.60	9.75	10.47	10.88

Note: Elevations are reported in feet relative to the Port of Tacoma Datum of Mean Lower Low Tide

Table A-1 - Blair Backup Groundwater and Surface Water Elevation Data

Monitoring Location	Reference Elevation	1/10/90-1/19/90 Depth to Water	1/10/90-1/19/90 Water Elev.	2/2/90-High Tide Depth to Water	2/2/90-High Tide Water Elev.	9/11/90-High Tide Depth to Water	9/11/90-High Tide Water Elev.	1/25/91-High Tide Depth to Water	1/25/91-High Tide Water Elev.
EPA Wells									
EPA-6I	18.72	7.91	10.81	7.70	11.02	8.88	9.84	8.09	10.63
EPA-7S	19.00	3.48	15.52	3.56	15.44	5.42	13.58	3.40	15.60
EPA-8I	18.40	7.90	10.50	7.55	10.85	8.90	9.50	7.88	10.52
EPA-9S	18.44	3.69	14.75	3.45	14.99	5.52	12.92	3.39	15.05
EPA-10I	16.86	6.45	10.41	6.05	10.81	7.16	9.70	6.33	10.53
Pennwalt Wells									
P-10-SS(S)	18.26	----	----	5.11	13.15	6.13	12.13	----	----
P-10-S(I)	17.49	----	----	6.56	10.93	7.70	9.79	----	----
K26-SS	19.33	----	----	----	----	4.54	14.79	----	----
K27-SS	18.19	----	----	----	----	5.80	12.39	----	----
K28-SS	19.02	----	----	5.33	13.69	6.58	12.41	----	----
Kaiser Wells									
N-S	20.51	----	----	1.63	18.88	5.13	15.38	----	----
N-I	21.03	----	----	9.78	11.25	11.72	9.31	----	----
Surface Water									
HC-SWL-1	17.18	----	----	1.45	15.73	----	----	----	----
HC-SWL-2	17.89	----	----	2.82	15.07	----	----	----	----
HC-SWL-3	14.72	----	----	2.70	12.02	----	----	----	----
HC-SWL-4	21.61	----	----	----	----	----	----	----	----
HC-SWL-5	14.86	----	----	1.15	13.71	1.91	12.95	2.02	12.84
HC-SWL-6a	13.94	----	----	----	----	1.45	12.49	2.31	11.63
HC-SWL-6b	15.84	----	----	2.15	13.69	----	----	----	----
HC-SWL-7a	13.17	----	----	----	----	----	----	2.89	10.28
HC-SWL-7b	15.16	----	----	1.6	13.56	2.69	12.47	----	----
HC-SWL-8	24.45	----	----	2.80	21.65	----	----	----	----

Note: Elevations are reported in feet relative to the Port of Tacoma Datum of Mean Lower Low Tide

Table A-1 - Blair Backup Groundwater and Surface Water Elevation Data

Monitoring Location	Reference Elevation	2/2/90 - High Tide Depth to Water	2/2/90 - High Tide Water Elev.	9/11/90-High Tide Depth to Water	9/11/90-High Tide Water Elev.	1/25/91-High Tide Depth to Water	1/25/91-High Tide Water Elev.
Reichhold Wells							
MW-10S	20.66	----	----	10.48	10.18	7.22	13.44
MW-10I	20.68	----	----	11.43	9.25	9.38	11.30
MW-11S2	18.19	3.01	15.18	dry	----	3.81	14.38
MW-11I2	20.18	8.25	11.93	11.53	8.65	9.11	11.07
MW-12S	18.09	1.24	16.85	6.18	11.91	1.14	16.95
MW-12I	17.21	4.27	12.94	6.81	10.40	4.71	12.50
MW-13S	19.73	4.39	15.34	----	----	4.92	14.81
MW-13I	19.78	8.53	11.25	----	----	9.02	10.76
MW-16S	18.83	2.14	16.69	5.88	12.95	2.56	16.27
MW-16I	19.00	7.09	11.91	9.21	9.79	7.56	11.44
MW-21S	19.21	----	----	----	----	2.17	17.04
MW-22S	19.04	2.86	16.18	6.21	12.83	3.15	15.89
MW-22I	18.89	7.05	11.84	9.04	9.85	7.52	11.37
MW-25S	19.12	----	----	----	----	1.68	17.44
MW-28I	23.14	11.77	11.37	14.18	8.96	12.48	10.66
MW-29I	21.41	10.16	11.25	12.44	8.97	10.92	10.49
MW-32S	19.27	3.13	3.13	----	----	3.01	16.26
MW-36I	18.85	8.10	10.75	----	----	8.58	10.27
MW-40I	17.34	6.35	10.99	8.24	9.10	7.25	10.09
MW-44I	16.99	4.43	12.56	6.91	10.08	6.01	10.98
MW-54S	----	----	----	----	----	----	15.20

Note: Elevations are reported in feet relative to the Port of Tacoma Datum of Mean Lower Low Tide

TBLA-1.WK1/CLK

Table A-2 – Well Screen Depth and Hydraulic Conductivity Estimates

Well Number	Screened Interval bgs in Feet	Material Type	Estimated Hydraulic Conductivity (*) Bouwer and Rice (1989)	Hvorslev (1951)	Hazens D10 (1892)
Shallow Wells					
HC-1S	4 to 14	SILTY SAND & SANDY SILT	----	----	----
HC-2S	5 to 10	SILTY SAND & SANDY GRAVEL	4.9x10-3	----	----
HC-3S	5 to 10	SILTY SAND & SAND	4.9x10-4	----	----
HC-4S	4 to 9	SAND WITH SILT LENSES	2.3x10-4	----	----
HC-5S	4 to 9	SAND	----	----	----
HC-6S	3 to 8	SILTY SAND	2.4x10-3	----	----
HC-7S	5 to 7.5	SILTY SAND	5.5x10-4	----	----
HC-8S	2.5 to 7.5	SILTY SAND	1.2x10-3	----	----
HC-9S	2 to 7.5	SILTY SAND	----	1.1x10-3	----
HC-10S	6.5 to 9	SILTY SAND	4.9x10-4	----	----
HC-11S	5 to 7.5	GRAVELLY SAND	----	----	----
HC-12S	5 to 10	GRAVELLY SAND & SILTY SAND	3.2x10-4	----	----
HC-13S	7.5 to 15	GRAVELLY SAND & SAND	1.4x10-4	----	8.4x10-3
HC-14S	5 to 10	SILTY SAND	4.3x10-4	----	----
HC-15S	2.5 to 7.5	SAND	9.5x10-4	----	----
HC-16S	2.5 to 7.5	GRAVELLY SAND & SAND	1.4x10-4	----	----
HC-17S	5 to 7.5	SILTY SAND	----	----	----
HC-18S	5 to 10	SILTY SAND	1.1x10-3	----	----
HC-21S	2 to 6	SILTY SAND	----	4.4x10-4	----
Intermediate Wells					
HC-2I	35 to 40	SAND	----	----	----
HC-3I	28 to 33	SAND	----	----	1.x10-2
HC-4I	18 to 23	SAND WITH SILT LENSES	----	1.2x10-3	----
HC-6I	19 to 24	SAND	----	1.3x10-4	----
HC-10I	8 to 13	SAND	----	5.7x10-3	6.x10-3
HC-12I	21 to 26	SAND WITH SILT LENSES	----	6.6x10-5	9.x10-4
HC-13I	31 to 36	SAND	----	----	----
HC-14I	23 to 28	SAND	----	----	----
HC-15I	17.5 to 22.5	SAND WITH SILT LENSES	----	2.5x10-3	----
HC-16I	18 to 23	SAND & SANDY SILT	----	----	----
HC-17I	17.5 to 22.5	SAND	----	----	----

Notes:
(*) Hydraulic conductivity units are expressed in centimeters per second (cm/sec).
bgs Below ground surface.

TBLA-2.WK1/CLK

Key to Exploration Logs

Sample Descriptions

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

SAND or GRAVEL Density	Standard Penetration Resistance in Blows/Foot	SILT or CLAY Consistency	Standard Penetration Resistance in Blows/Foot	Approximate Shear Strength in TSF
Very loose	0 - 4	Very soft	0 - 2	<0.125
Loose	4 - 10	Soft	2 - 4	0.125 - 0.25
Medium dense	10 - 30	Medium stiff	4 - 8	0.25 - 0.5
Dense	30 - 50	Stiff	8 - 15	0.5 - 1.0
Very dense	>50	Very stiff	15 - 30	1.0 - 2.0
		Hard	>30	>2.0

Moisture

Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content
Wet	Much perceptible moisture, probably above optimum

Minor Constituents

	Estimated Percentage
Not identified in description	0 - 5
Slightly (clayey, silty, etc.)	5 - 12
Clayey, silty, sandy, gravelly	12 - 30
Very (clayey, silty, etc.)	30 - 50

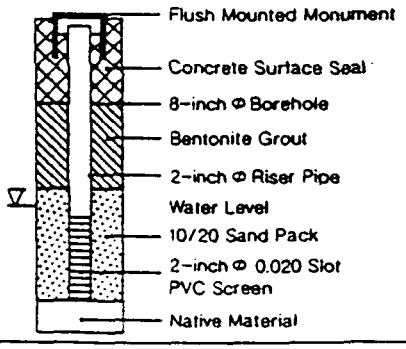
Legends

Sampling

BORING SAMPLES

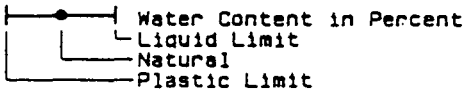
⊠	Split Spoon
⧅	Shelby Tube
▥	Cuttings
*	No Sample Recovery
P	Tube Pushed, Not Driven

Monitoring Well Observations



Test Symbols

GS	Grain Size Classification
CN	Consolidation
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained
QU	Unconfined Compression
DS	Direct Shear
K	Permeability
PP	Pocket Penetrometer Approximate Compressive Strength in TSF
TV	Torvane Approximate Shear Strength in TSF
CBR	California Bearing Ratio
MD	Moisture Density Relationship
AL	Atterberg Limits



HARTCROWSER
J-2350-07 6/91
Figure A-1

Boring Log and Construction Data for Monitoring Well HC-1S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 22.10

0

Loose, moist, brown, very silty, fine SAND with iron staining and some organic matter.
(Shallow Aquifer)

5

Loose, moist, black, silty SAND with multicolored grains.

Medium stiff to soft, wet, gray and black, very sandy SILT to clayey SILT with plant remains.
(Upper Aquitard)

10

Bottom of Boring at 11.5 Feet.
Completed 12/15/89.

15

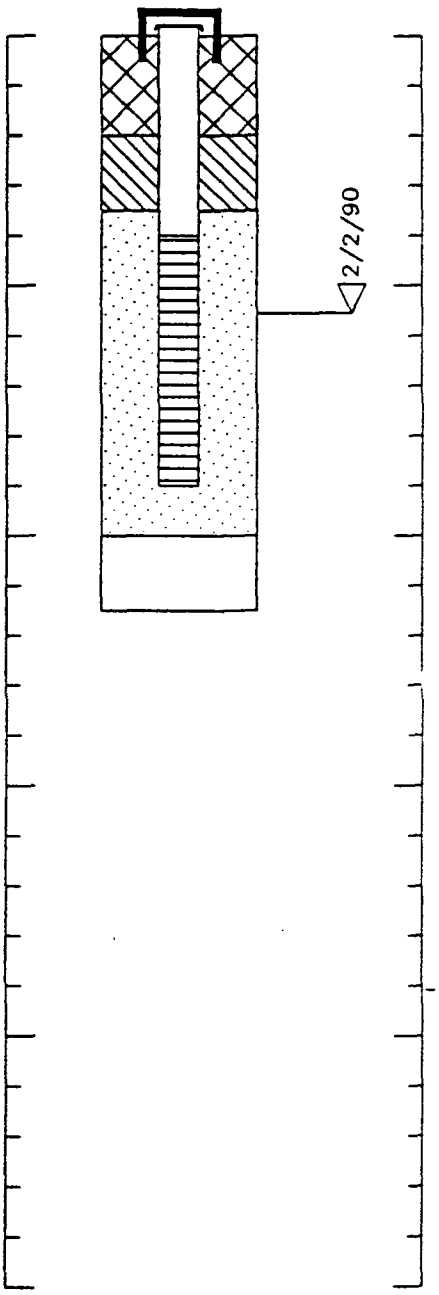
20

25

Sample	N	H-Nu
S-1	10	ND
S-2	5	ND
S-3	6	ND
S-4	2	ND

Monitoring Well Design

Casing Stickup in Feet 2.1
Top of PVC in Feet 24.23



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A-2

Boring Log and Construction Data for Monitoring Well HC-2S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 25.50

0 — Medium dense, moist to wet, gray, very gravelly SAND to very sandy GRAVEL with concrete and asphalt debris. (Shallow Aquifer)

5 — Loose, wet, brownish gray, silty SAND with iron staining.

Medium dense, wet, brownish gray to gray, very sandy GRAVEL to very gravelly SAND.

10 — Loose, wet, black, silty SAND with multicolored grains and some plant remains.

Medium stiff, wet, dark gray and black, clayey SILT with some plant remains and a thin layer of very silty, fine sand. (Upper Aquitard)

15

Bottom of Boring at 17.0 Feet. Completed 12/15/89.

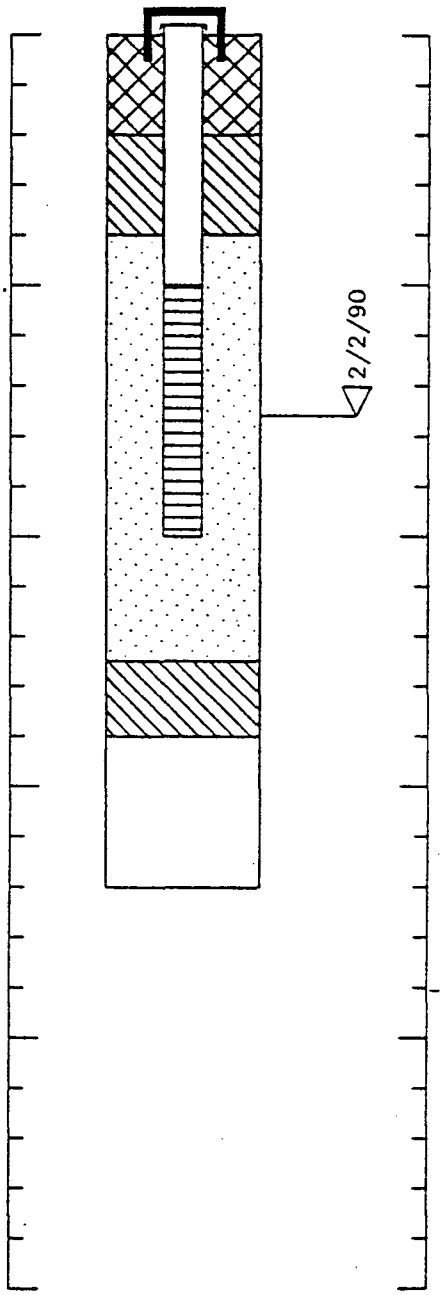
20

25

Sample	N	H-Nu
S-1	23	ND
S-2	9	ND
S-3	23	ND
S-4	10	ND
S-5	8	ND

Monitoring Well Design

Casing Stickup in Feet 2.1
Top of PVC in Feet 27.57



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A-3

Boring Log and Construction Data for Monitoring Well HC-3S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 22.52

0 — Moist, brown, gravelly SAND with roots and iron staining. (Shallow Aquifer)

Medium dense to loose, moist, brown, slightly silty to silty SAND with iron staining.

5

Loose, moist to wet, black, slightly gravelly, slightly silty to clean, medium to fine multicolored grains and iron staining.

10

Soft, wet, dark gray to black, slightly clayey to very clayey SILT with abundant plant remains. (Upper Aquitard)

Bottom of Boring at 14.0 Feet. Completed 12/15/89.

15

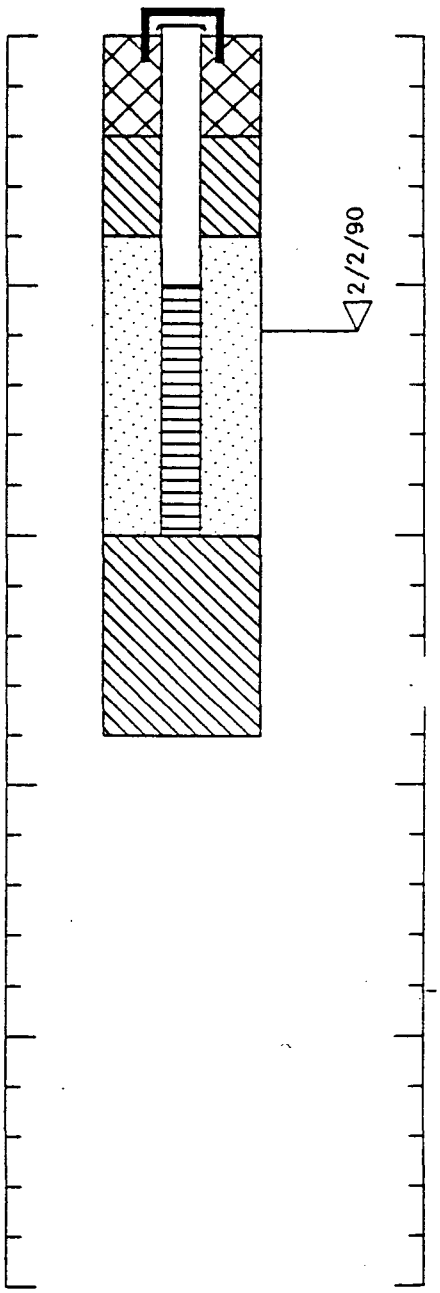
20

25

Sample	N	H-Nu
S-1	12	ND
S-2	10	ND
S-3	11	ND
S-4	4	ND

Monitoring Well Design

Casing Stickup in Feet 2.2
Top of PVC in Feet 24.68



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/8

Figure A-4

Boring Log and Construction Data for Monitoring Well HC-4S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 16.51

0

Moist, brown, very gravelly SAND. (Shallow Aquifer)

Medium dense, moist, greenish gray SAND with plant roots.

Medium dense, moist to wet, black, slightly silty SAND with multicolored grains and gray SILT lenses.

5

Very loose, wet, dark gray and brown, clayey SILT with abundant plant remains. (Upper Aquitard)

10

Bottom of Boring at 11.5 Feet. Completed 12/14/89.

15

20

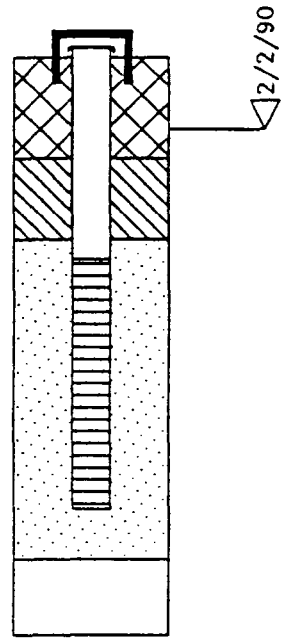
25

Sample	N	H-Nu
S-1	26	2
S-2	8	5
S-3	6	1
S-4	2	ND

Monitoring Well Design

Casing Stickup in Feet 2.3

Top of PVC in Feet 18.81



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A-5

Boring Log and Construction Data for Monitoring Well HC-5S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 17.23

0 — Moist, brown, very gravelly SAND.

Soft, wet, dark gray and black, clayey SILT.

Loose, wet, black SAND with multicolored grains.

Loose, wet, greenish gray SAND.

5 — Medium stiff, wet, dark gray and black, clayey SILT.

Very loose, wet, black, slightly silty SAND with multicolored grains.

Very loose, wet, black, slightly silty, fine SAND.

10 — Very soft, wet, dark gray and brown, clayey SILT with abundant plant remains. (Upper Aquifer)

Bottom of Boring at 11.5 Feet.
Completed 12/14/89.

15

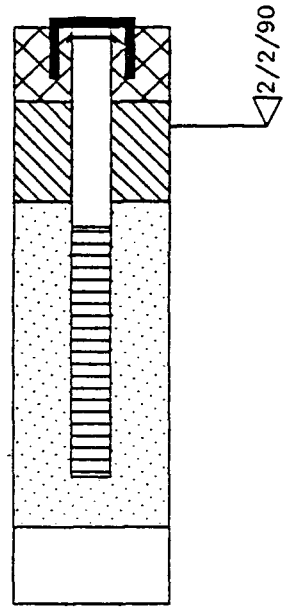
20

25

Sample	N	H-Nu
S-1	5	ND
S-2	12	2
S-3	2	ND
S-4	2	ND

Monitoring Well Design

Casing Stickup in Feet -0.4
Top of PVC in Feet 16.82



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A-6

Boring Log and Construction Data for Monitoring Well HC-6S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 16.57

0 — Moist, grayish brown, very gravelly SAND with 2 to 3-inch cobbles. (Shallow Aquifer)

Loose to very loose, wet, black, slightly silty SAND with multicolored grains.

5

10 — Soft, wet, dark gray and brown, sandy SILT with abundant plant remains. (Upper Aquitard)

Bottom of Boring at 11.5 Feet. Completed 12/15/89.

15

20

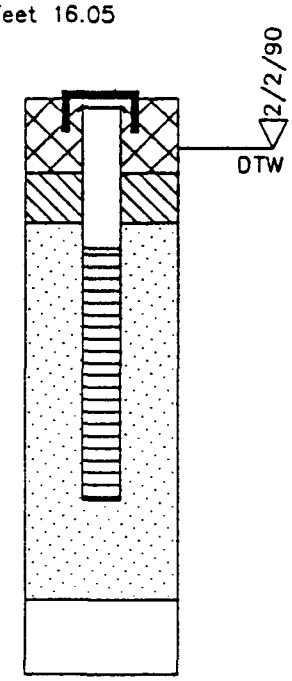
25

Sample	N	Lab Test	H-Nu
S-1	8		ND
S-2	4		ND
S-3	3		ND
S-4	3	GS	ND

Monitoring Well Design

Casing Stickup in Feet -0.5

Top of PVC in Feet 16.05



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A-7

Boring Log and Construction Data for Monitoring Well HC-7S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 17.37

0 — Moist, brown, very gravelly SAND. (Shallow Aquifer)

Loose, moist, dark gray, slightly silty to silty SAND with multicolored grains.

5

Very soft, wet, dark gray, slightly sandy, clayey SILT with plant remains. (Upper Aquitard)

10

Bottom of Boring at 11.5 Feet. Completed 12/11/89.

15

20

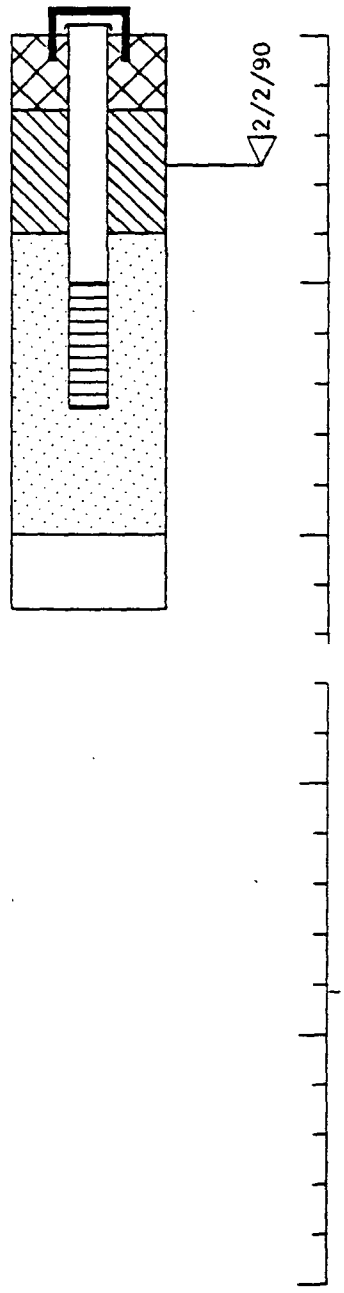
25

Sample	N	H-Nu
S-1	7	ND
S-2	6	ND
S-3	1	ND
S-4	2	ND

Monitoring Well Design

Casing Stickup in Feet 1.9

Top of PVC in Feet 19.31



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A-8

Boring Log and Construction Data for Monitoring Well HC-8S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 16.63

0

Moist, dark brown SAND. (Shallow Aquifer)

Very loose, wet, black, slightly silty to silty SAND with plant remains and multicolored grains.

5

Very soft, wet, dark gray and brown, very clayey SILT with abundant plant remains. (Upper Aquitard)

10

Bottom of Boring at 9.0 Feet. Completed 12/12/89.

15

20

25

Sample N

S-1 2

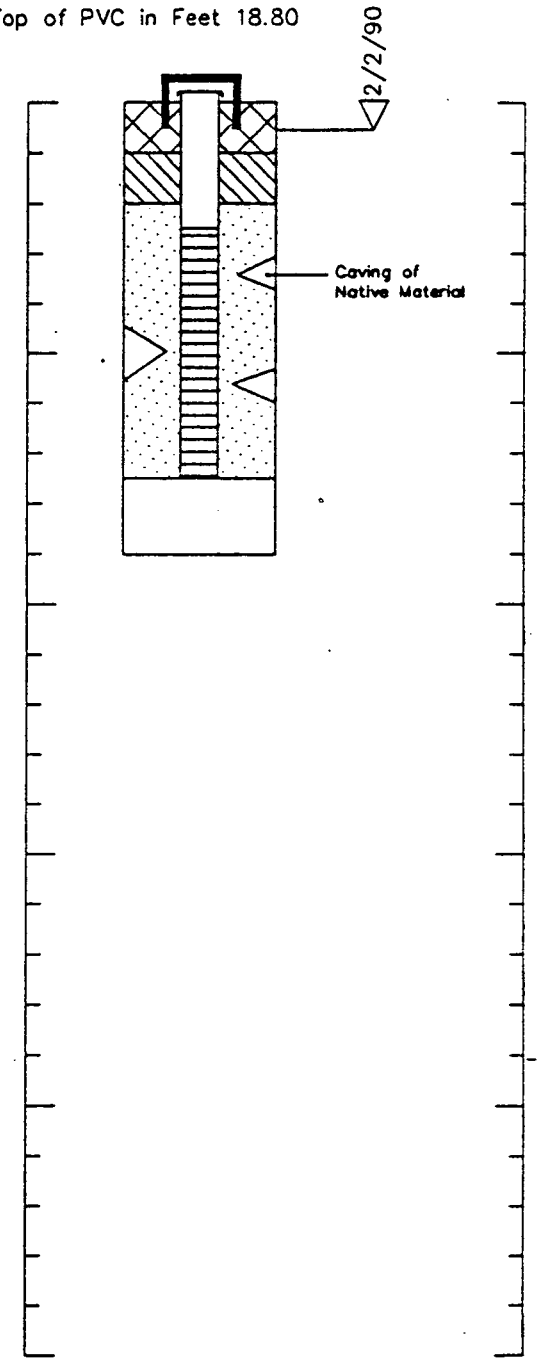
S-2 4

S-3 2

Monitoring Well Design

Casing Stickup in Feet 2.2

Top of PVC in Feet 18.80



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A-9

Boring Log and Construction Data for Monitoring Well HC-9S

Geologic Log

Depth in feet

Approx. Ground Surface Elevation in Feet 17.3

0 — Loose, dry, sandy GRAVEL.

Loose, moist, brown, medium to fine SAND. (Shallow Aquifer)

Soft, moist to wet, black, clayey SILT with abundant plant fragments.

5 — Loose, wet, black, slightly silty to silty SAND with plant remains (roots).

Soft, wet, black and brown SILT with abundant plant fragments. (Upper Aquitard)

Bottom of Boring at 9.0 Feet. Completed 8/14/90.

10

15

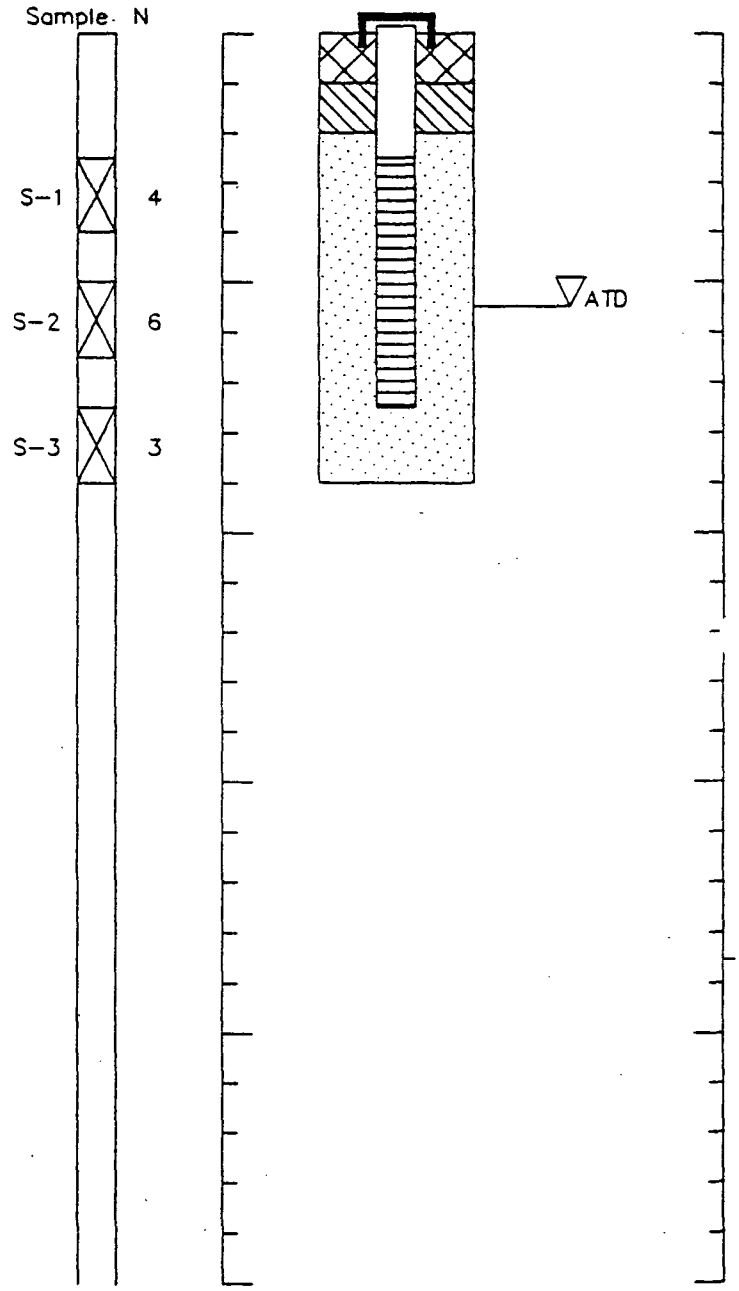
20

25

Monitoring Well Design

Casing Stickup in Feet 1.8

Top of PVC in Feet 19.12



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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J-2350-07 8/90

Figure A-10

Boring Log and Construction Data for Monitoring Well HC-10S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 15.67

0 — Moist, brown, gravelly SAND with iron staining and cobbles. (Shallow Aquifer)

Soft, moist, dark gray and black, clayey SILT with plant remains.

5 — Very loose to loose, wet, dark gray, silty, fine SAND with thin layers of clayey silt and plant remains.

10 — Very loose, wet, dark gray to black, clayey, very silty, fine SAND with shell fragments and lenses of black, clayey SILT. (Upper Aquitard)

Very loose, wet, dark gray to black, wet, very silty SAND with thin lenses of gray, clayey SILT.

15 — Medium dense, wet, dark gray to black, fine to medium SAND. (Intermediate Aquifer)

Bottom of Boring at 16.5 Feet. Completed 12/14/89.

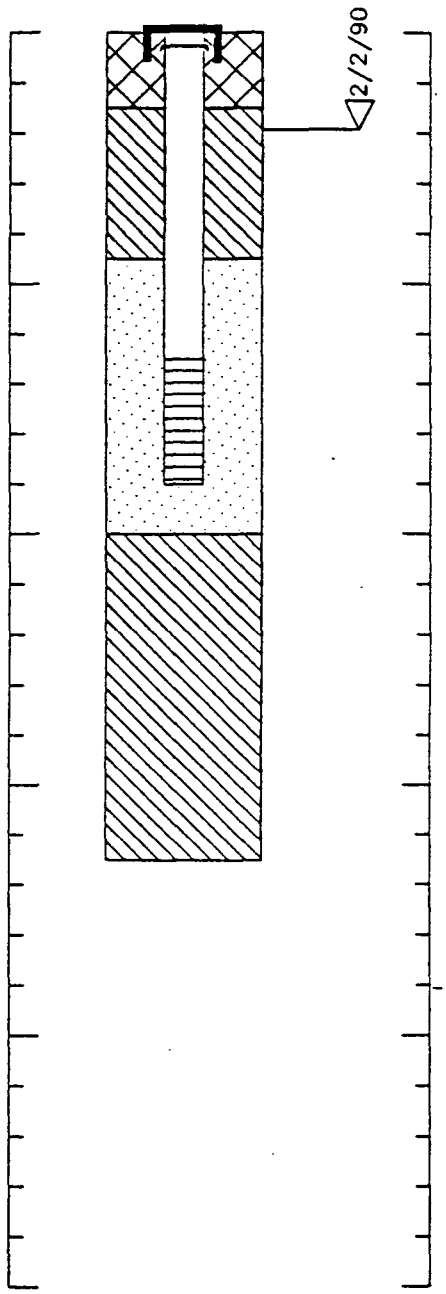
20

25

Sample	N	H–Nu
S–1	3	ND
S–2	2	ND
S–3	9	ND
S–4	3	ND
S–5	2	ND
S–6	12	ND

Monitoring Well Design

Casing Stickup in Feet –0.4
Top of PVC in Feet 15.32



1. Refer to Figure B–1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A–11

Boring Log and Construction Data for Monitoring Well HC-11S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 15.83

0

WOOD CHIPS and moist to wet, dark brown, very gravelly SAND with slag, ore, and quartz. (Shallow Aquifer)

Medium dense, wet, very gravelly to gravelly SAND with wood, ore, and slag.

5

No Recovery.

Bottom of Boring at 9.0 Feet.
Completed 12/12/89.

10

15

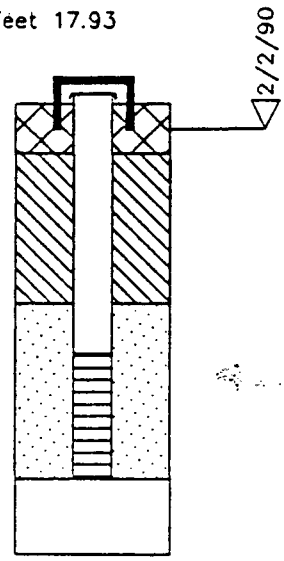
20

25

Sample	N	H-Nu
S-1	24	–
S-2	15	ND

Monitoring Well Design

Casing Stickup in Feet 2.1
Top of PVC in Feet 17.93



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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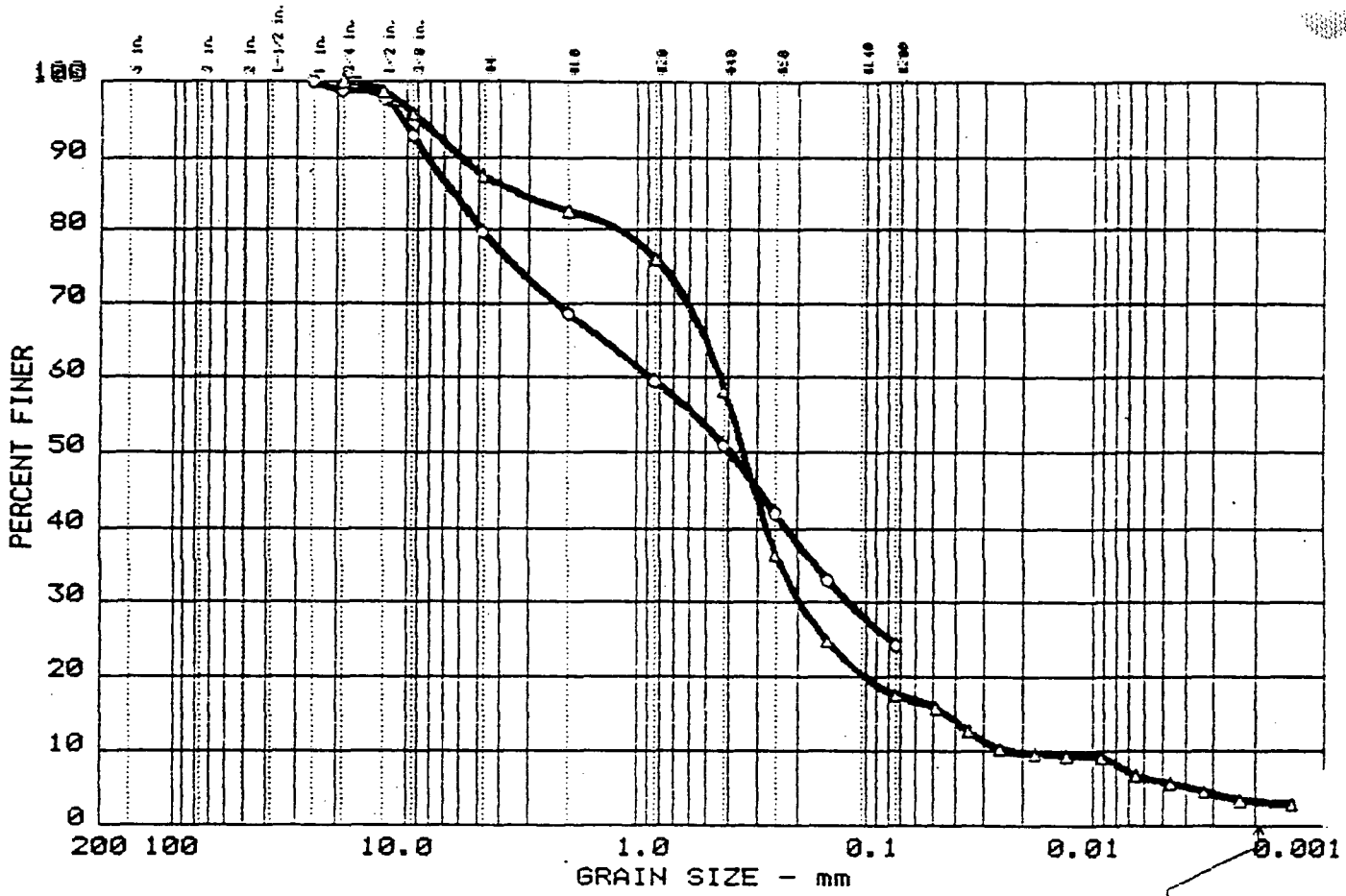
Figure A-12

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	20.3	55.5	24.2	
△	0.0	12.5	70.0	14.3	3.2

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			6.38	0.87	0.39	0.120				
△			3.35	0.44	0.34	0.198	0.0439	0.0223	4.03	19.7

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
○ Gravelly, silty, SAND	SM	69%
△ Gravelly, silty, SAND	SM	18%

Remarks:

Project: P.O.T. TRIBAL AUDITS
○ Location: COMPOSITE #4
△ Location: COMPOSITE #5

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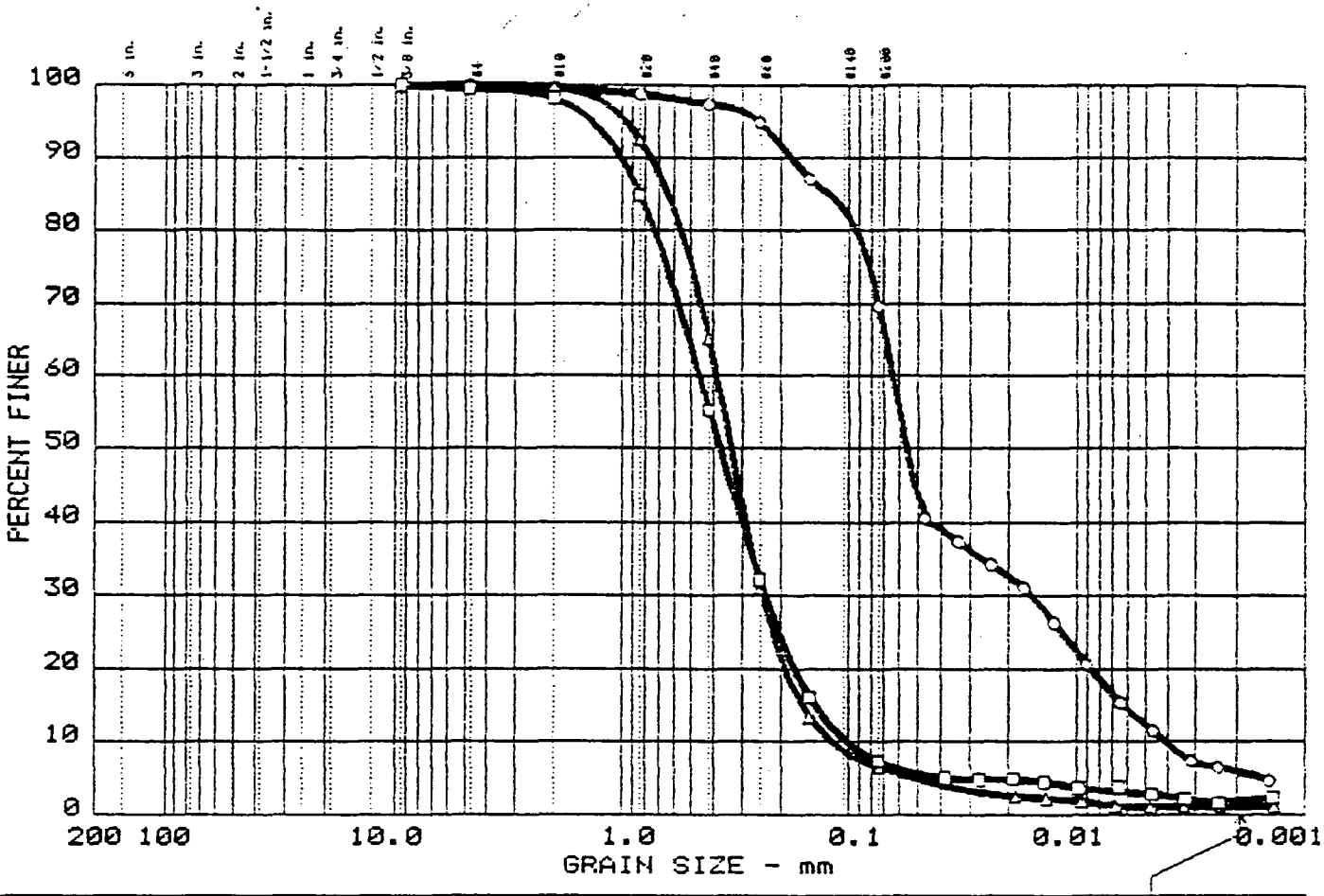
Figure A-60

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.1	30.2	63.6	6.1
△	0.0	0.0	93.4	6.6	
□	0.0	0.5	92.1	7.4	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.12		0.06	0.016	0.0063	0.0041	0.95	15.9
△			0.64	0.39	0.33	0.245	0.1601	0.1174	1.32	3.3
□			0.84	0.46	0.38	0.236	0.1408	0.1008	1.20	4.6

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
○ Slightly clayey, very sandy, SILT	ML	50%
△ Slightly silty SAND	SP-SM	21%
□ Slightly silty SAND	SP-SM	9%

Remarks:

Project: P.O.T. TRIBAL AUDITS
○ Location: COMPOSITE #1
△ Location: COMPOSITE #2
□ Location: COMPOSITE #3

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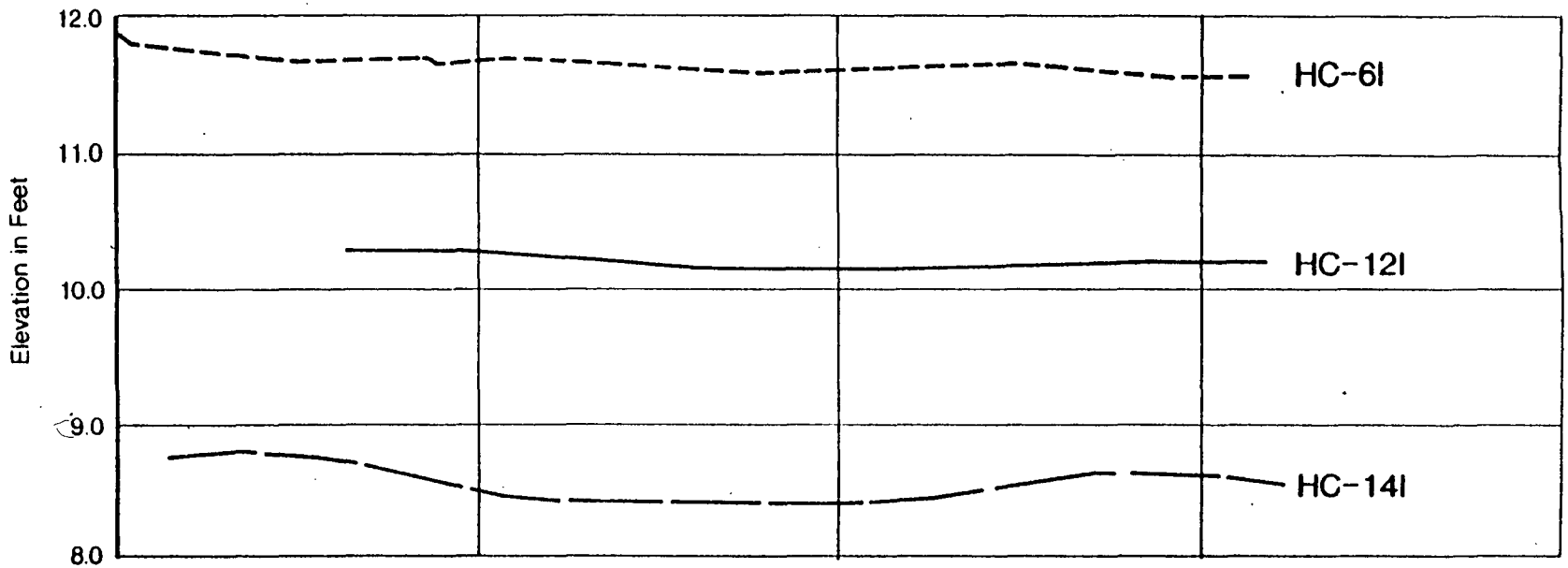
Figure A-59

Groundwater and Tidal Elevations with Time

Intermediate Aquifer – February 1st and 2nd, 1990



Tide in Blair Waterway

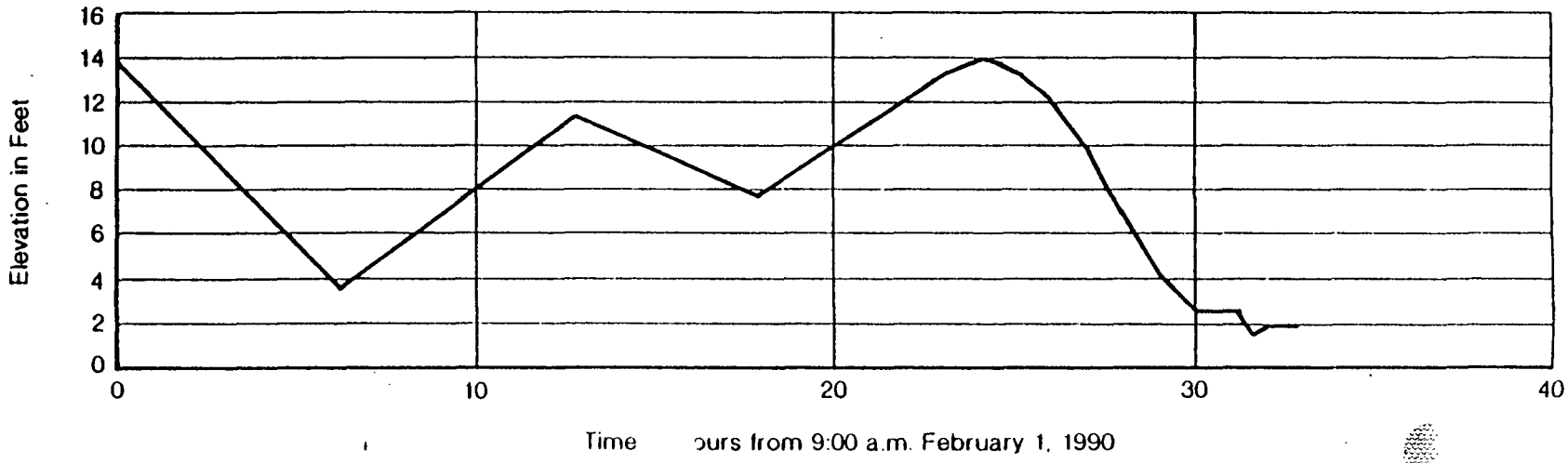


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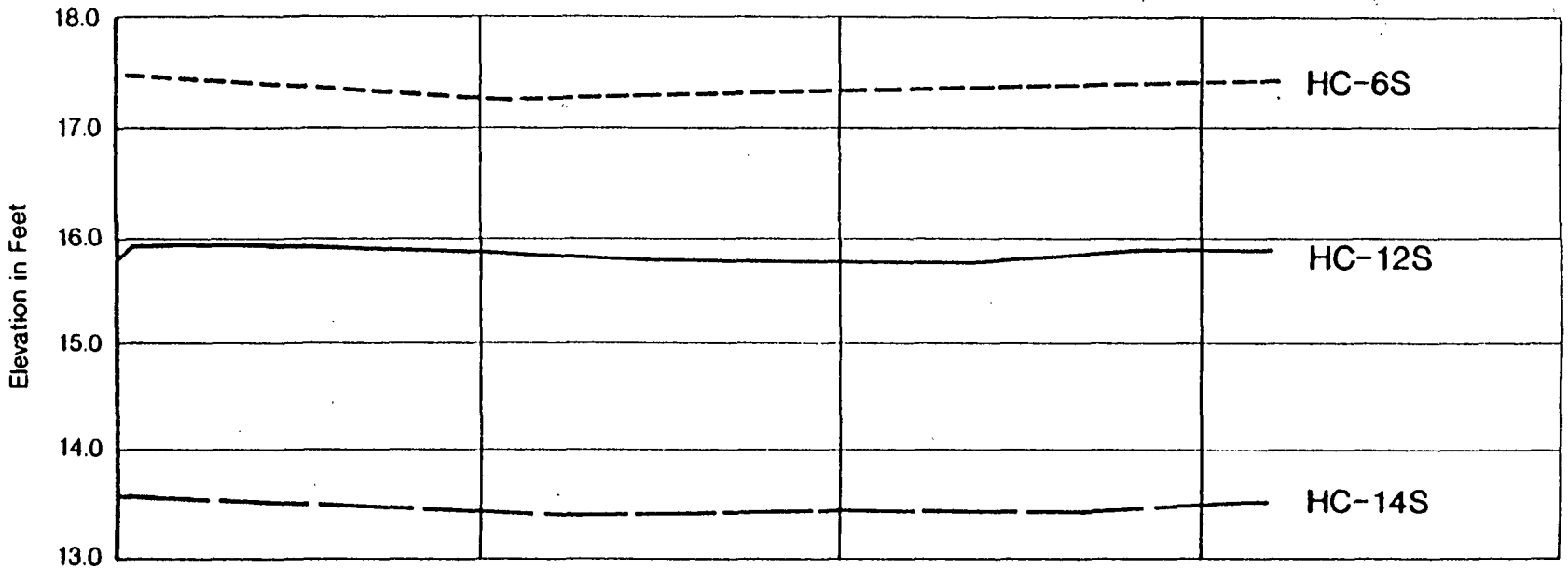
Figure A-58

Groundwater and Tidal Elevations with Time

Shallow Aquifer – February 1st and 2nd, 1990



Tide in Blair Waterway

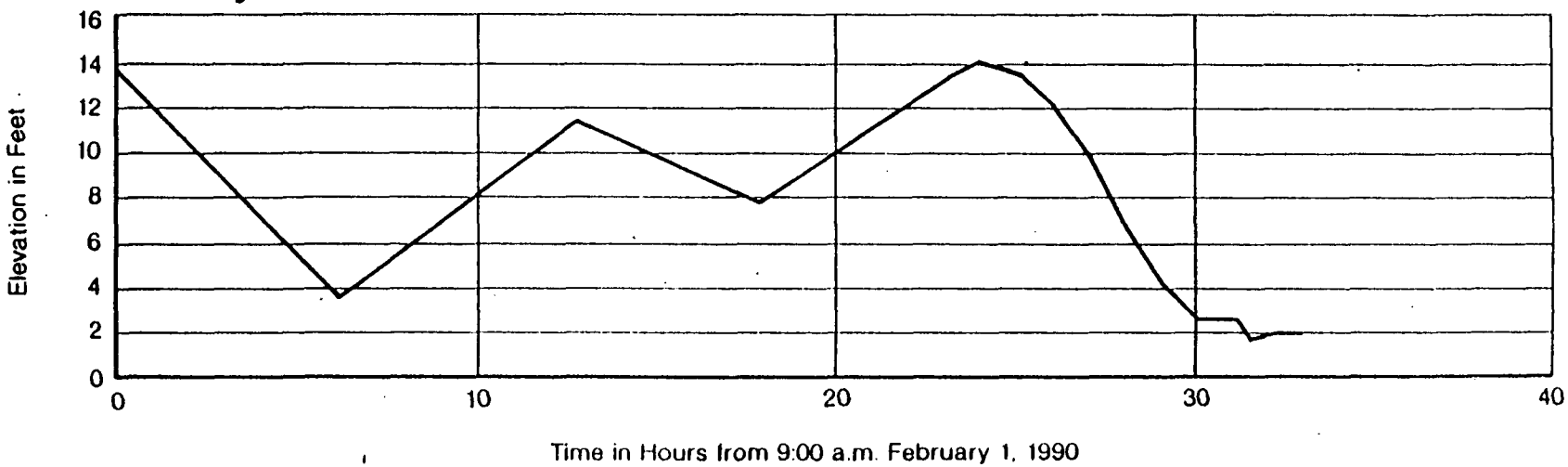


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Figure A-57

Test Pit Log TP-209

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 16-1/2
S-1			0–2	Dry to moist, light brown, very gravelly SAND with river rock.
			3–5	Moist to wet, black SAND with multicolored grains.
			6–9	Bottom of Test Pit at 5-1/2 Feet. Completed 9/5/90.

Test Pit Log TP-210

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 15-3/4
S-1			0–1	Dry to moist, light brown, very gravelly SAND (gravel ballast).
			1–2	Moist, black, gravelly SAND with slag and coal fragments.
			2–3	Moist to wet, green, gravelly SAND with pink Ohio Ferro Alloy slag, charcoal, quartz, and coal.
			3–4	Wet, grayish black, gravelly SAND with small rounded grains, pink slag, and quartz.
			5–9	Bottom of Test Pit at 3-1/2 Feet. Completed 9/5/90.

Test Pit Log TP-211

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 17
			0–2	Moist, light brown, very gravelly SAND with river rock ballast.
S-1			3	Moist, greenish gray, gravelly SAND.
S-2			4–5	Moist, black, clayey SILT with abundant plant remains.
			6–9	Bottom of Test Pit at 5-1/2 Feet. Completed 9/5/90.

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at time of excavation. Conditions may vary with time.

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Figure A-58

Test Pit Log TP-206

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 16
			0–1	Moist, grayish brown, very gravelly SAND with abundant wood chips and Asarco slag.
S-1			2	Moist, tan and gray, very gravelly SAND with iron staining.
			3–4	Moist to wet, grayish black, gravelly SAND with Asarco and pink Ohio Ferro Alloy slag.
	O		5–6	Grading into black, gravelly to slightly gravelly SAND with multicolored grains.
			7–8–9	Bottom of Test Pit at 7 Feet. Completed 9/5/90.

Test Pit Log TP-207

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 15
			0–1	Damp to moist, light brown and gray, very gravelly SAND with wood debris and rock ballast (cobbles).
S-1	O		2–3	Moist, grayish black, gravelly SAND with abundant coal fragments, wood debris, charcoal briquets, and some Ohio Ferro Alloy slag and quartz. Creosote-like odor.
			4–5–6–7–8–9	Bottom of Test Pit 3-1/2 Feet. Completed 9/6/90.

Test Pit Log TP-208

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 15-1/2
			0–1	Damp to moist, light brown, very gravelly SAND with cobbles and wood debris.
S-1			2	Moist, black, gravelly SAND with charcoal fragments and coal.
S-2	O		3	Moist to wet, gray, slightly gravelly SAND with small rounded grains and pink Ohio Ferro Alloy slag.
			4	Wet, black, slightly gravelly SAND with multicolored grains.
			5–6–7–8–9	Bottom of Test Pit at 4 Feet. Completed 9/6/90.

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at time of excavation. Conditions may vary with time.

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Figure A-55

Test Pit Log TP-203

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 16
			0–1	Damp to moist, brownish gray, gravelly, fine to medium SAND with wood chips.
S–1			2–4	Moist to wet, grayish black, silty to very silty, fine SAND with wood fragments, Ohio Ferro Alloy slag and black, coal–like material, with shiny surfaces.
			5–9	Bottom of Test Pit at 4–1/2 Feet. Completed 9/5/90.

Test Pit Log TP-204

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 16
			0–1	Moist, grayish brown, very gravelly, fine SAND with abundant wood chips.
			2–3	Moist, tan and gray, very gravelly SAND with river rock and quartz fragments.
S–1			4–6	Moist to wet, black, slightly gravelly to gravelly SAND with increasing multicolored grains.
			7–9	Bottom of Test Pit at 6–1/2 Feet. Completed 9/5/90.

Test Pit Log TP-205

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 16–1/2
			0–1	Damp to moist, grayish brown, very gravelly SAND with abundant wood fragments and quartz.
S–1			2–3	Moist, blackish gray, gravelly SAND with quartz, wood fragments, and coal fragments.
S–2			4–5	Moist to wet, light gray, gravelly coarse SAND (mainly quartz and black coal fragments). Creosote–like odor.
			6–9	Bottom of Test Pit at 5 Feet. Completed 9/5/90.

1. Refer to Figure B–1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at time of excavation. Conditions may vary with time.

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Figure A–54

Test Pit Log TP-200

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 14-1/2
S-1			0–2	(Very dense), moist, very gravelly, fine to medium SAND with wood chips, wood fragments, river rock cobbles, and pink Ohio Ferro Alloy slag. Creosote-like odor.
			3	Wet, greenish gray, very gravelly SAND with cobbles.
			4–9	Bottom of Test Pit at 3 Feet. Completed 9/5/90.

Test Pit Log TP-201

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 14-3/4
S-1			0–1	Damp to moist, grayish brown, slightly gravelly to gravelly, fine SAND with abundant wood chips and Ohio Ferro Alloy slag fragments.
			2–3	(Very dense), moist, blackish-gray, very gravelly to gravelly SAND with large concrete blocks, wire, and silver, metallic Ohio Ferro Alloy slag.
			4–9	Bottom of Test Pit at 2 Feet. Completed 9/5/90. Note: Met refusal at bottom of excavation.

Test Pit Log TP-202

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 15-3/4
S-1			0–1	Moist, brownish gray, gravelly, fine to medium SAND with wood chips.
			2	Moist to wet, tan and dark gray, very gravelly SAND with iron staining.
			3–4	Wet, greenish gray, very gravelly SAND.
			5–9	Bottom of Test Pit at 4-1/2 Feet. Completed 9/5/90.

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at time of excavation. Conditions may vary with time.

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Figure A-53

Test Pit Log TP-133

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0	Wood chip ballast with gravel.
			1	Moist, olive green, gravelly SAND.
S-1			2	
			3	Moist to wet, gray, slightly silty, fine SAND.
S-2			4	
			5	Bottom of Test Pit at 5 Feet. Completed 12/6/89.
			6	
			7	
			8	
			9	

Test Pit Log TP-134

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0	Wood chips and gravel ballast with river rock, quartz, and slag
			1	(Dense), moist, tan, very gravelly SAND.
S-1			2	Moist to wet, black, very gravelly SAND with multicolored slag and quartz.
			3	
			4	Bottom of Test Pit at 4 Feet. Completed 12/6/89.
			5	
			6	
			7	
			8	
			9	

Test Pit Log TP-135

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0	Moist, brown, gravelly SAND with multicolored grains, wood chips, wood and concrete debris.
			1	
S-1			2	Moist to wet, brown, very gravelly SAND with some organics.
			3	
			4	Bottom of Test Pit at 4 Feet. Completed 12/6/89.
			5	
			6	
			7	
			8	
			9	

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

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Figure A-52

Test Pit Log TP-130

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–1	Moist, brown, very gravelly to gravelly SAND with wood chips.
S-1			1–2	Moist, gray, gravelly SAND with slag material and a layer of white, fine-grained material.
S-2			2–5 (○ at 3)	Moist to wet, black, gravelly SAND with multicolored grains and thin layers of white, fine-grained material.
			5–9	Bottom of Test Pit at 5 Feet. Completed 12/6/89.

Test Pit Log TP-131

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–2	Moist, brown, very gravelly to gravelly SAND with wood chips and pieces of quartz, ore, and multicolored slag.
S-1			2–5 (○ at 5)	(Very dense), moist to wet, gray, very gravelly SAND with multicolored slag.
			5–9	Bottom of Test Pit at 5 Feet. Completed 12/6/89.

Test Pit Log TP-132

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
S-1			0–1 (○ at 1)	Moist to wet, brown, gravelly SAND with abundant wood chips and some slag. Creosote-like odor in soils.
			2–9	Bottom of Test Pit at 1-1/2 Feet. Completed 12/6/89.

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

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Figure A-51

Test Pit Log TP-127

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 17.2
			0	Wood chips and rock ballast including pieces of slag and quartz.
			1	(Very dense), moist, tan, very sandy GRAVEL.
S-1			2	Moist to wet, dark gray to black, very gravelly SAND with cobbles, quartz fragments, and some slag.
			3	
			4	Bottom of Test Pit at 3-1/2 Feet. Completed 12/6/89.
			5	
			6	
			7	
			8	
			9	

Test Pit Log TP-128

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 18.1
			0	Wood chips and rock ballast including quartz, ore, slag, and river rock.
			1	
			2	
S-1			3	Wood chips with moist to wet, dark brown, gravelly SAND with some crushed quartz and slag material.
			4	
			5	
			6	Bottom of Test Pit at 5-1/2 Feet. Completed 12/6/89.
			7	
			8	
			9	

Test Pit Log TP-129

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground surface Elevation in Feet 15.0
S-1			0	Wood chips and rock ballast (rocks consisting of river rock, quartz, and slag material).
			1	
			2	(Very dense), moist to wet, brown and tan, sandy GRAVEL (mainly river rock).
			3	
			4	(Dense), moist to wet, black SAND with small fragments of silver metallic-like material.
			5	Bottom of Test Pit at 4 Feet. Completed 12/6/89.
			6	
			7	
			8	
			9	

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

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Figure A-50

Test Pit Log TP-124

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 16.2
			0	River rock ballast.
S-1			1–3	Moist to wet, black, very gravelly SAND with wood debris, charcoal briquets, and cobbles. Creosote-like odor. (○ at 2)
			4–9	Bottom of Test Pit at 3-1/2 Feet. Completed 12/5/89.

Test Pit Log TP-125

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 16.3
			0–1	Wood chip ballast with cobbles.
S-1			1–4	Moist, gray, very gravelly SAND with large quartz cobbles and wood debris.
S-2			4–5	Moist to wet, dark gray to black, sandy GRAVEL with small quartz fragments and angular black, coal-like material. (○ at 4)
			6–9	Bottom of Test Pit at 5-1/2 Feet. Completed 12/5/89.

Test Pit Log TP-126

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 15.9
			0	Wood chip ballast.
S-1			1–4	Moist, grayish white, very gravelly to gravelly SAND consisting mainly of white quartz.
S-2			4–5	Wet, dark gray to black, medium SAND with multicolored grains. (○ at 4)
			6–9	Bottom of Test Pit at 5-1/2 Feet. Completed 12/5/89.

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

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Figure A-49

Test Pit Log TP-121

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–1	Moist, brown, slightly silty, medium SAND with iron staining – containing nodules of silty sand with iron staining over surface.
S–1			1–5	Moist to wet, dark brown to black SAND with multicolored grains
			5–9	Bottom of Test Pit at 5–1/2 Feet. Completed 12/6/89.

Test Pit Log TP-122

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–3	Moist, gray, slightly silty, fine to medium SAND with multicolored grains and some iron staining.
S–1			3–5	Moist, dark gray to black, silty SAND with multicolored grains.
			5–9	Bottom of Test Pit at 5–1/2 Feet. Completed 12/6/89. Note: Water entering excavation from surface.

Test Pit Log TP-123

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–1	Moist, brown, gravelly SAND with silty sand nodules and iron staining.
S–1			1–7	Dark brown to black, silty SAND with multicolored grains.
S–2			7–9	Bottom of Test Pit at 7–1/2 Feet. Completed 12/6/89. Note: Water rapidly entering excavation from surface.

1. Refer to Figure B–1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

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Figure A–48

Test Pit Log TP-119

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 18.4
S-1			0–2	Moist, brown, very gravelly SAND with black sand blast grit on surface and cobbles.
			3	Moist, greenish gray, gravelly SAND.
S-2		○	4–9	Moist to wet, black, slightly silty to silty SAND with plant remains on top of unit, multicolored grains, and clayey silt inclusions.
			9–15	Bottom of Test Pit at 9 Feet. Completed 12/7/89.

Test Pit Log TP-120

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 19.3
			0–2	Moist, brown, slightly silty, medium SAND with iron staining – containing nodules of silty sand coated on surface with iron staining.
S-1			3–6	Moist to wet, black, silty, fine to medium SAND with multicolored grains.
			7–15	Bottom of Test Pit at 6–1/2 Feet. Completed 12/6/89. Note: Water entering excavation from surface.

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

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Figure A-47

Test Pit Log TP-117

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0	Moist, black and greenish black SAND with yellow flakes. (SAND BLAST GRIT)
S-1			1	
			2	Moist to wet, reddish brown, slightly gravelly SAND with iron staining.
			3	Moist to wet, dark gray, silty, fine SAND with multicolored grains interbedded with dark gray and black mottled, very clayey SILT.
S-2			4	
			5	
			6	
			7	
			8	
			9	Moist to wet, gray with black mottling, very clayey SILT with abundant organic matter.
			10	Bottom of Test Pit at 10 Feet. Completed 12/7/89.
			11	
			12	
			13	
			14	
			15	

Test Pit Log TP-118

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0	Moist, brown, very gravelly SAND with black, sand blast grit and wood chips on surface.
S-1			1	
			2	
			3	Moist, greenish gray, gravelly SAND.
S-2			4	Moist to wet, black, slightly silty to silty SAND with plant remains on top of unit, multicolored grains, and clayey silt inclusions.
			5	
			6	
			7	
			8	
			9	Moist to wet, gray and black mottled, clayey SILT with abundant organic matter.
S-3			10	Bottom of Test Pit at 10 Feet. Completed 12/7/89.
			11	
			12	
			13	
			14	
			15	

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

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Figure A-46

Test Pit Log TP-114

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–2	Moist, dark brownish gray SAND with multicolored grains.
S-1			3–8	Moist to wet, dark grayish black, silty SAND with multicolored grains and thin lenses of clayey SILT.
			9	Bottom of Test Pit at 8 Feet. Completed 12/7/89. Note: Water rapidly entering excavation from surface.

Test Pit Log TP-115

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–2	Moist, reddish gray, slightly clayey, silty, fine SAND with iron staining.
S-1			3–5 (○)	Moist to wet, black, very clayey SILT with abundant plant fragments.
			6	Bottom of Test Pit at 5 Feet. Completed 12/7/89.

Test Pit Log TP-116

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–3	Moist, dark brownish gray, slightly silty SAND with multicolored grains.
S-1			4–7	Moist to wet, dark grayish black, slightly silty to silty SAND with multicolored grains and 1/2-foot to 1-foot layers of black, clayey, silty, fine SAND.
S-2			8	Bottom of Test Pit at 7-1/2 Feet. Completed 12/7/89.

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

HARTCROWSER
J-2350-07 12/89
Figure A-45

Test Pit Log TP-111

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 16.9
			0–2	Moist, brown, very gravelly to gravelly SAND with cobbles
S-1 S-3			2–5	Moist to wet, dark gray, slightly silty SAND with muticolored grains and gray, clayey SILT inclusions and concrete debris and small amount of greenish gray sand.
			5–9	Bottom of Test Pit at 5-1/2 Feet. Completed 12/7/89.

Test Pit Log TP-112

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 16.7
			0–1	Crushed rock ballast including slag material.
			1–2	Moist, brown, very gravelly SAND with large cobbles.
S-1			2–3	Moist, dark gray to black, silty SAND with multicolored grains and plant remains at top of unit.
			3–5	Moist to wet, dark gray to black, slightly silty to silty SAND with multicolored grains.
			5–9	Bottom of Test Pit at 5-1/2 Feet. Completed 12/7/89.

Test Pit Log TP-113

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 16.7
			0–1	Moist, brown, very gravelly SAND.
S-1			1–6	Moist to wet, dark brownish gray, slightly silty SAND with multicolored grains and thin lenses of gray, clayey SILT.
			6–9	Bottom of Test Pit at 6 Feet. Completed 12/7/89.

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

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Figure A-44

Test Pit Log TP-109

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–2	Moist, brown, gravelly to very gravelly SAND.
S-1			3	Moist to wet, black, slightly silty SAND with multicolored grains and abundant plant remains at top of unit.
			4–15	Bottom of Test Pit at 4 Feet. Completed 12/7/89.

Test Pit Log TP-110

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
S-1			0–2	Moist, brown, very gravelly SAND with large cobbles (2 to 7-inches).
S-2			3	Moist, greenish gray, gravelly SAND.
			4–8	Moist to wet, slightly silty to silty SAND with plant remains at upper contact.
S-3			8–9	Moist, gray, silty, fine SAND with greenish black, silty, fine SAND.
S-4			9–10	Moist, brown and black mottling, very clayey SILT with abundant organic matter (tide flat odor).
			10–15	Bottom of Test Pit at 10 Feet. Completed 12/7/89. Note: Slow water seepage at 5-foot depth. Water entering east sidewall was foamy.

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

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Figure A-43

Test Pit Log TP-107

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–2	Moist, brown, very gravelly SAND with wood and asphalt debris.
S-1			2–4	Moist, gray, very gravelly SAND with decomposed organics and solvent-like odor.
S-2			4–6	Moist to wet, gray, slightly silty, fine SAND with iron staining.
S-3			6–9	Moist to wet, gray, gravelly SAND with wood debris and slight odor.
			9–15	Bottom of Test Pit at 8-1/2 Feet. Completed 12/7/89. Note: Slow water seepage at 4-1/2-foot depth.

Test Pit Log TP-108

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–2	Moist, brown, gravelly SAND with iron staining.
S-1			2–4	Moist, dark gray to black, clayey SILT with organics.
S-2			4–7	Moist to wet, dark gray to black, silty SAND with multicolored grains.
			7–15	Bottom of Test Pit at 7-1/2 Feet. Completed 12/6/89.

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

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J-2350-07 12/89

Figure A-42

Test Pit Log TP-105

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–3	Moist, brown, very gravelly SAND with large asphalt debris.
S–1			3–5	Moist, gray, silty, fine SAND with iron staining.
S–2			5–9	(Dense), moist, gray, very gravelly SAND.
S–3			9–11	Moist, black SAND with multicolored grains and thin lenses of greenish gray SAND.
			11–15	Bottom of Test Pit at 10–1/2 Feet. Completed 12/7/89. Note: Water seeping into excavation from surface.

Test Pit Log TP-106

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
			0–4	Moist to wet, brown, gravelly SAND with chunks of asphalt, wood, and cloth debris.
S–1			4–15	Bottom of Test Pit at 4–1/2 Feet. Completed 12/7/89.

1. Refer to Figure B–1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

Denotes depth at which water was observed seeping into the excavation.

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J-2350-07 12/89

Figure A–41

R

Test Pit Log TP-103

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
S-1			0–7	Moist, brownish gray SAND with iron staining, plant remains (roots), and multicolored grains.
S-2			7–10	Moist to wet, gray, slightly clayey, silty, fine SAND with some organics.
			10–15	Bottom of Test Pit at 10 Feet. Completed 12/8/89.

Test Pit Log TP-104

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
S-1			0–7	Moist, brown, slightly silty SAND with some plant remains (roots) and iron staining.
S-2			8–9	Moist to wet, dark grayish black SAND with multicolored grains and some iron staining.
			9–15	Bottom of Test Pit at 9 Feet. Completed 12/8/89.

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

HARTCROWSER

J-2350-07 12/89

Figure A-40

Test Pit Log TP-101

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
S-1			0–6	Moist, brownish gray, slightly silty SAND with lenses of gray, silty, fine SAND with iron staining and plant remains (roots).
S-2			7–9	Moist, dark brown, slightly silty, fine SAND with iron staining.
		○	9–10	Moist to wet, dark grayish black SAND with multicolored grains.
			10–15	Bottom of Test Pit at 10 Feet. Completed 12/8/89.

Test Pit Log TP-102

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet 0.0
S-1			0–6	Moist, brown to brownish gray, slightly silty SAND with iron staining, plant remains (roots) and gray, silty SAND lenses with iron staining on surface.
S-2		○	7–8	Moist to wet, brownish gray SAND with multicolored grains and iron staining.
			9–15	Bottom of Test Pit at 8–1/2 Feet. Completed 12/8/89.

1. Refer to Figure B–1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

○ Denotes depth at which water was observed seeping into the excavation.

HARTCROWSER

J-2350-07 12/89

Figure A–39

Boring Log and Construction Data for Monitoring Well HC-17I

Geologic Log

Depth in feet

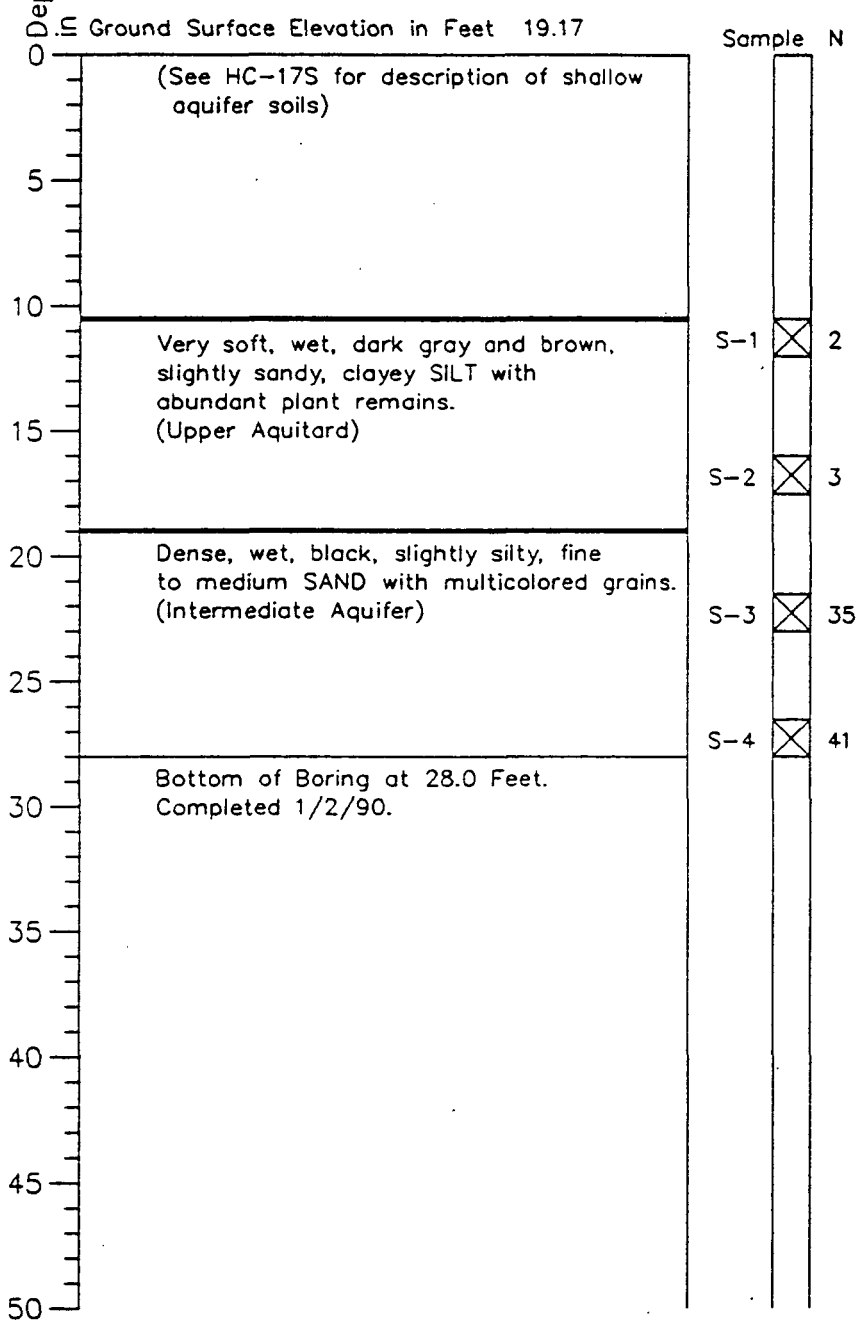
Ground Surface Elevation in Feet 19.17

(See HC-17S for description of shallow aquifer soils)

Very soft, wet, dark gray and brown, slightly sandy, clayey SILT with abundant plant remains. (Upper Aquitard)

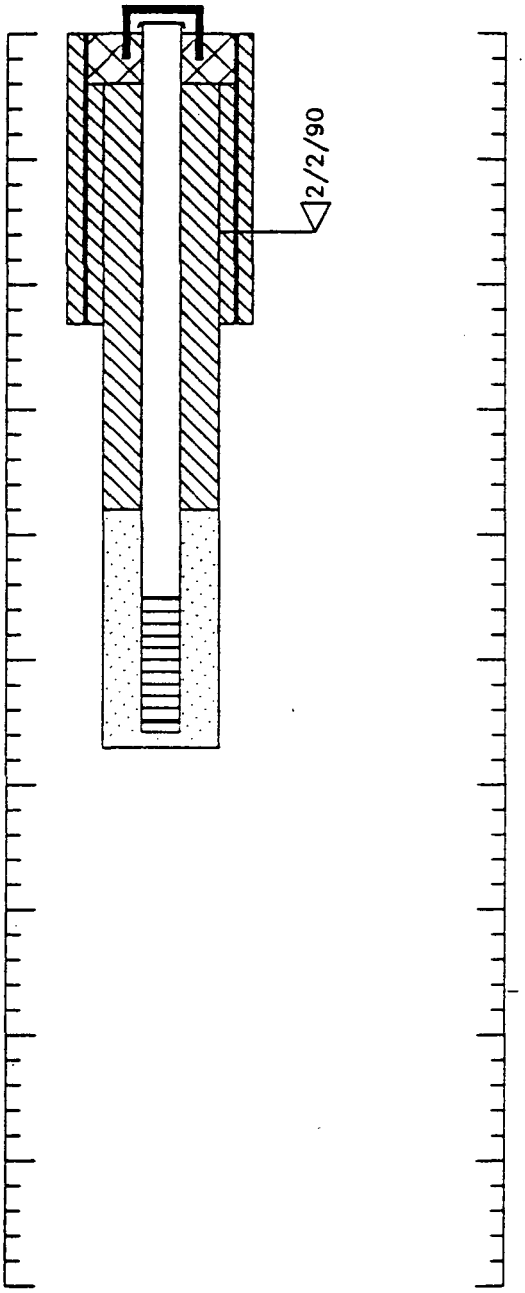
Dense, wet, black, slightly silty, fine to medium SAND with multicolored grains. (Intermediate Aquifer)

Bottom of Boring at 28.0 Feet. Completed 1/2/90.



Monitoring Well Design

Casing Stickup in Feet 2.2
Top of PVC in Feet 21.35



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

HARTCROWSER

J-2350-07 1/90

Figure A-38

Boring Log and Construction Data for Monitoring Well HC-16I

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 15.67

(See HC-16S for description of shallow aquifer soils)

Soft, moist to wet, gray and black, clayey to very clayey SILT with abundant plant remains. (Upper Aquitard)

Very dense, wet, black, silty, medium to fine SAND with multicolored grains. (Intermediate Aquifer)

Stiff to loose, wet, gray, sandy SILT to very silty SAND grading to peat. (Lower Aquitard)

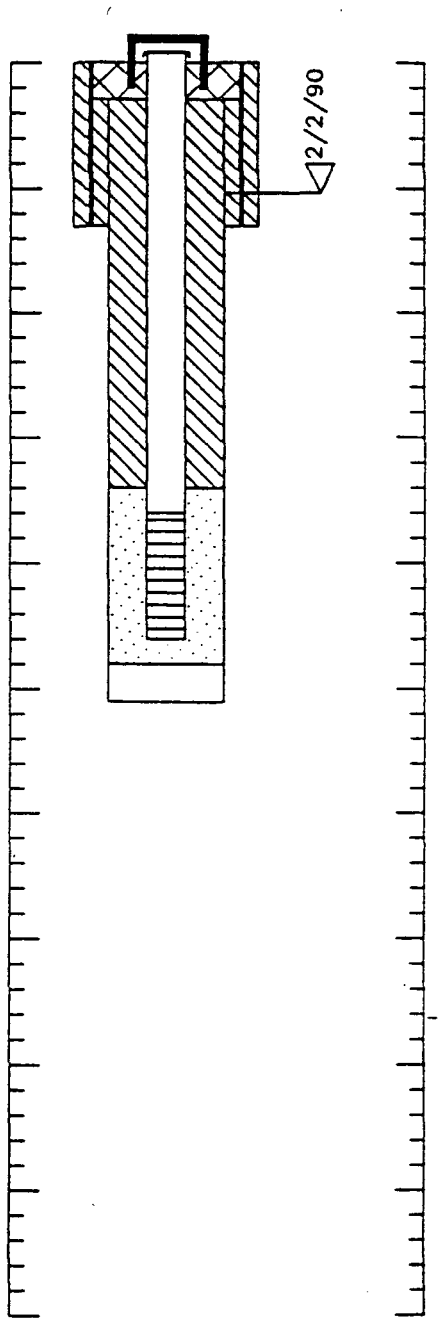
Bottom of Boring at 25.5 Feet. Completed 12/27/89.

Sample	N	Lab Test
S-2	32	
S-2	32	
S-3	70	GS
S-4	8	

Monitoring Well Design

Casing Stickup in Feet 1.8

Top of PVC in Feet 17.47



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

HARTCROWSER

J-2350-07 12/89

Figure A-37

Boring Log and Construction Data for Monitoring Well HC-15I

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 15.79

(See HC-15S for description of shallow aquifer soils)

Very soft, moist to wet, brown, clayey SILT with abundant plant remains. (Upper Aquitard)

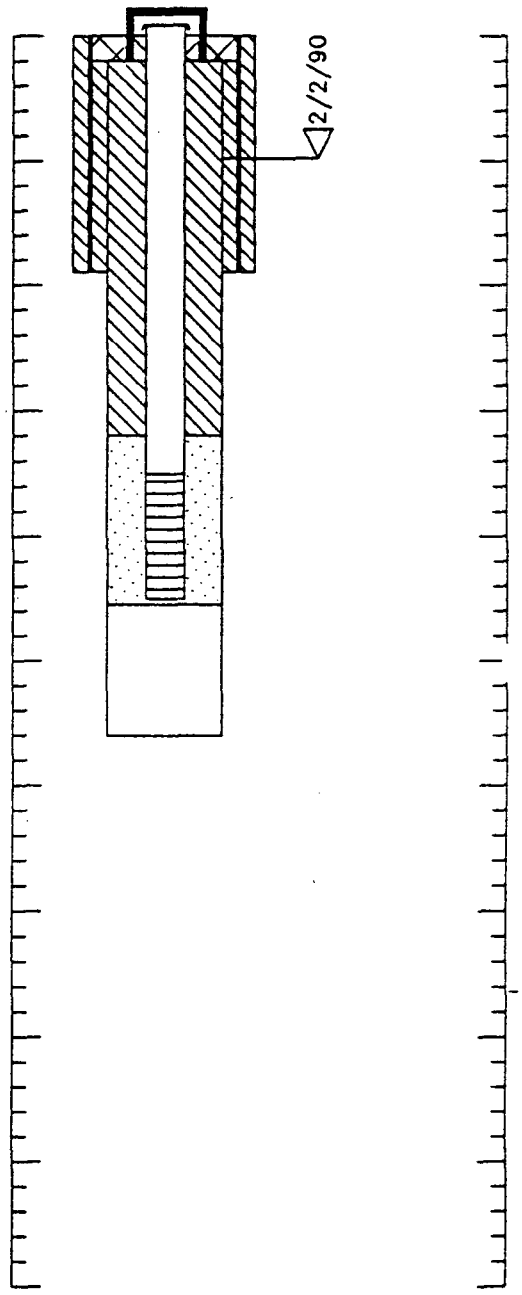
Loose to very dense, wet, black, slightly silty to silty SAND with multicolored grains and lenses of silty SAND and clayey SILT. (Intermediate Aquifer)

Bottom of Boring at 28.0 Feet. Completed 12/27/89.

Sample	N
S-1	16
S-2	4
S-3	1
S-5	58
S-6	8
S-7	50

Monitoring Well Design

Casing Stickup in Feet 1.9
Top of PVC in Feet 17.67



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A-36

Boring Log and Construction Data for Monitoring Well HC-14I

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 20.46

(See HC-14S for description of shallow aquifer soils)

Very soft, wet, gray and brown, very clayey SILT with abundant plant remains. (Upper Aquitard)

Medium dense, wet, black, slightly silty to silty, medium to fine SAND with multicolored grains and thin clay and silt laminations. (Intermediate Aquifer)

Bottom of Boring at 29.0 Feet. Completed 1/2/90.

Sample N

S-1 2

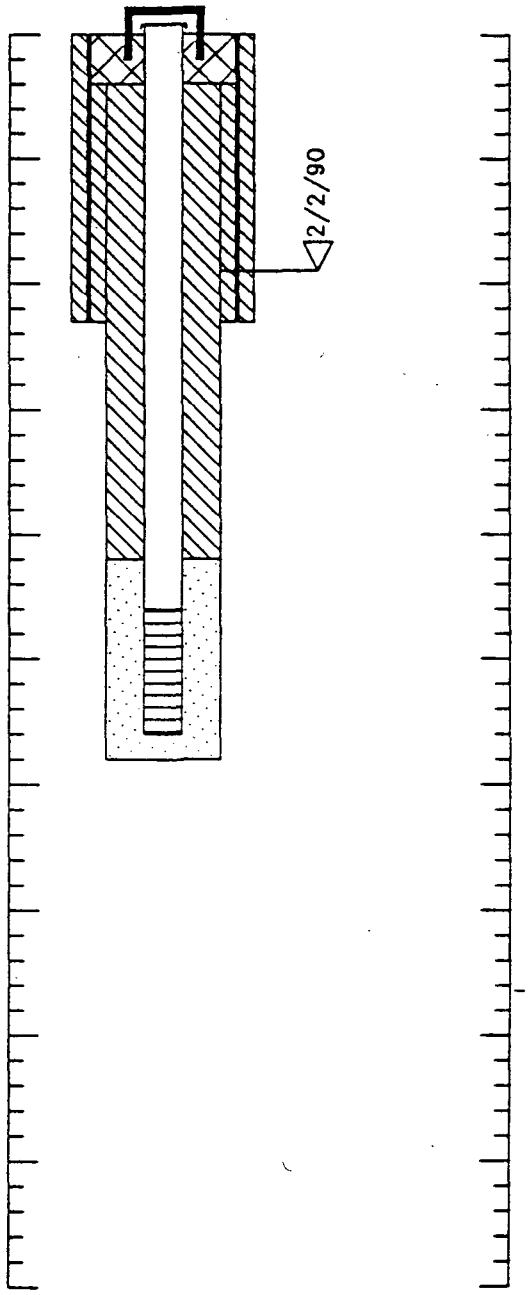
S-2

S-3 30

Monitoring Well Design

Casing Stickup in Feet 2.2

Top of PVC in Feet 22.68



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A-35

Boring Log and Construction Data for Monitoring Well HC-13I

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 24.92

(See HC-13S for description of shallow aquifer soils)

Medium stiff, moist to wet, dark gray and black, very clayey SILT with abundant plant remains. (Upper Aquitard)

Medium dense, wet, black, fine to medium SAND. (Intermediate Aquifer)

Bottom of Boring at 37.0 Feet. Completed 12/29/89.

0 5 10 15 20 25 30 35 40 45 50

Sample N

S-1 35

S-2 6

S-3 4

S-4 25

Monitoring Well Design

Casing Stickup in Feet 2.3

Top of PVC in Feet 27.27

2/2/90

1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A-34

Boring Log and Construction Data for Monitoring Well HC-12I

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 18.75

(See HC-12S for description of shallow aquifer soils)

Soft, moist, dark gray and brown, clayey SILT with abundant plant remains. (Upper Aquitard)

Very dense, wet, gray, silty, gravelly, medium to fine SAND with multicolored grains. (Intermediate Aquifer)

Medium dense, wet, gray, silty, fine SAND with layers of brown, clayey SILT.

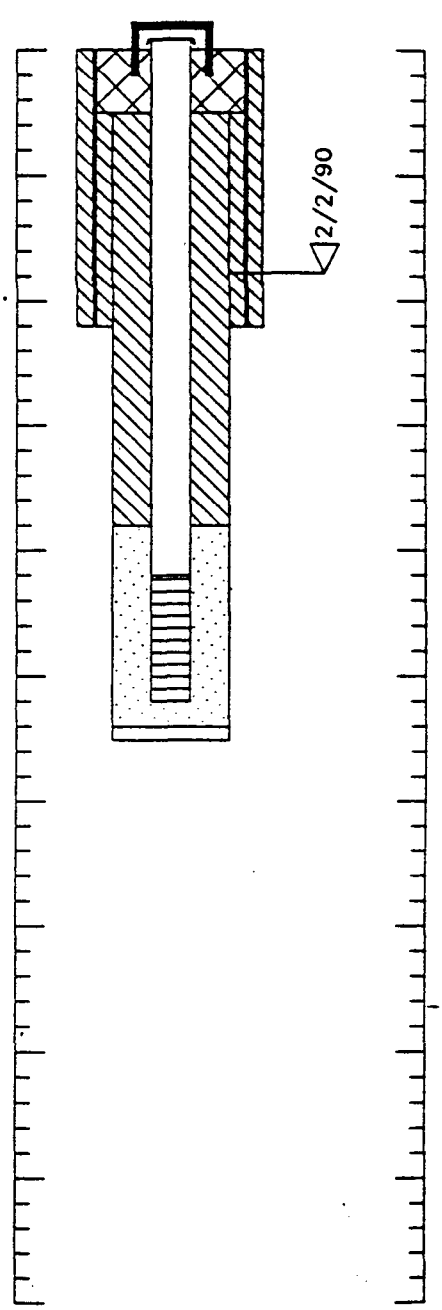
Bottom of Boring at 27.5 Feet. Completed 12/28/89.

Sample	N	Lab Test
S-1	12	
S-2	3	
S-3		
S-4	1	
S-5	85	GS
S-6	18	

Monitoring Well Design

Casing Stickup in Feet 1.3

Top of PVC in Feet 20.06



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A-33

Boring Log and Construction Data for Monitoring Well HC-10I

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 15.63

(See HC-10S for description of shallow aquifer soils)

Very soft, moist to wet, dark gray and brown, clayey SILT grading to sandy SILT.
(Upper Aquitard)

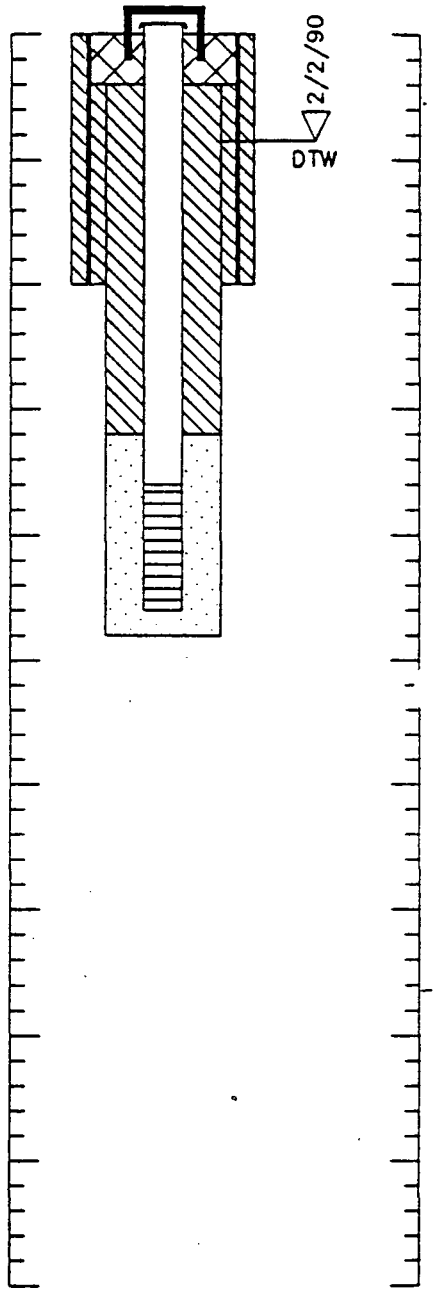
Medium dense, wet, dark gray to black, slightly silty, fine to medium SAND with multicolored grains.
(Intermediate Aquifer)

Bottom of Boring at 24.0 Feet.
Completed 12/28/89.

Sample	N	Lab Test
S-1	1	
S-2	1	
S-3	25	
S-4	8	GS

Monitoring Well Design

Casing Stickup in Feet -0.2
Top of PVC in Feet 15.64



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/8

Figure A-32

Boring Log and Construction Data for Monitoring Well HC-6I

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 16.41

0 — (See HC-6S for description of shallow aquifer soils)

10 — Very soft to soft, moist to wet, dark gray and brown, very silty CLAY with abundant plant remains. (Upper Aquitard)

15 — Loose, moist to wet, black, silty, fine to medium SAND grading to gray, slightly sandy SILT. (Intermediate Aquifer)

20 — Very dense to medium, wet, black, fine to medium SAND.

25 — Very stiff, wet, gray and black, slightly sandy SILT with organics. (Lower Aquitard)

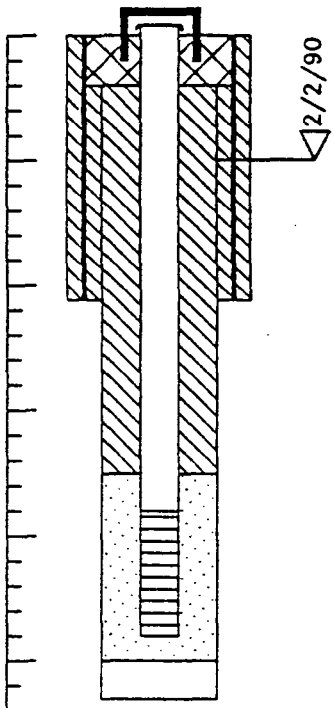
Bottom of Boring at 26.5 Feet.
Completed 12/29/89.

30 35 40 45 50

Sample	N
S-1	2
S-2	1
S-3	3
S-4	90
S-5	17

Monitoring Well Design

Casing Stickup in Feet −0.2
Top of PVC in Feet 16.21



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

HARTCROWSER

J-2350-07 12/89

Figure A-31

Boring Log and Construction Data for Monitoring Well HC-4I

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 16.27

(See HC-4S for description of shallow aquifer soils)

Very soft, moist to wet, dark gray and brown, clayey SILT with abundant plant remains. (Upper Aquitard)

Medium dense, gray, wet, slightly silty, fine to medium SAND with multicolored grains and thin lenses of brown, clayey SILT. (Intermediate Aquifer)

Bottom of Boring at 24.0 Feet. Completed 12/28/89.

Sample N

S-1 2

S-2 1

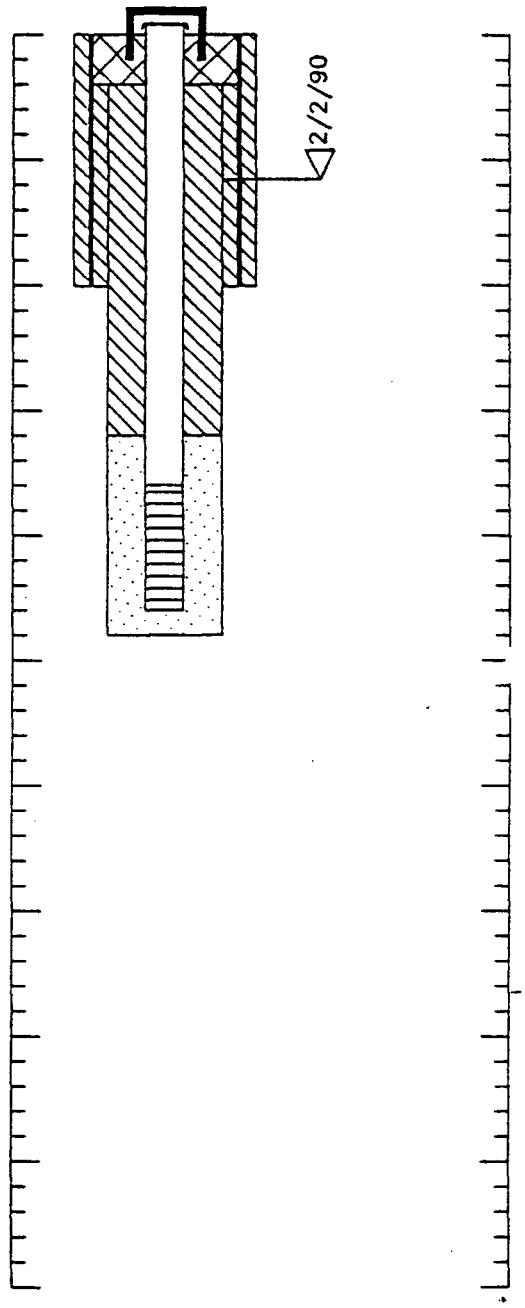
S-3 25

S-4 17

Monitoring Well Design

Casing Stickup in Feet 1.9

Top of PVC in Feet 18.10



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

HARTCROWSER

J-2350-07 12/89

Figure A-30

Boring Log and Construction Data for Monitoring Well HC-3I

Geologic Log

Ground Surface Elevation in Feet 22.46

(See HC-3S for description of shallow aquifer soils)

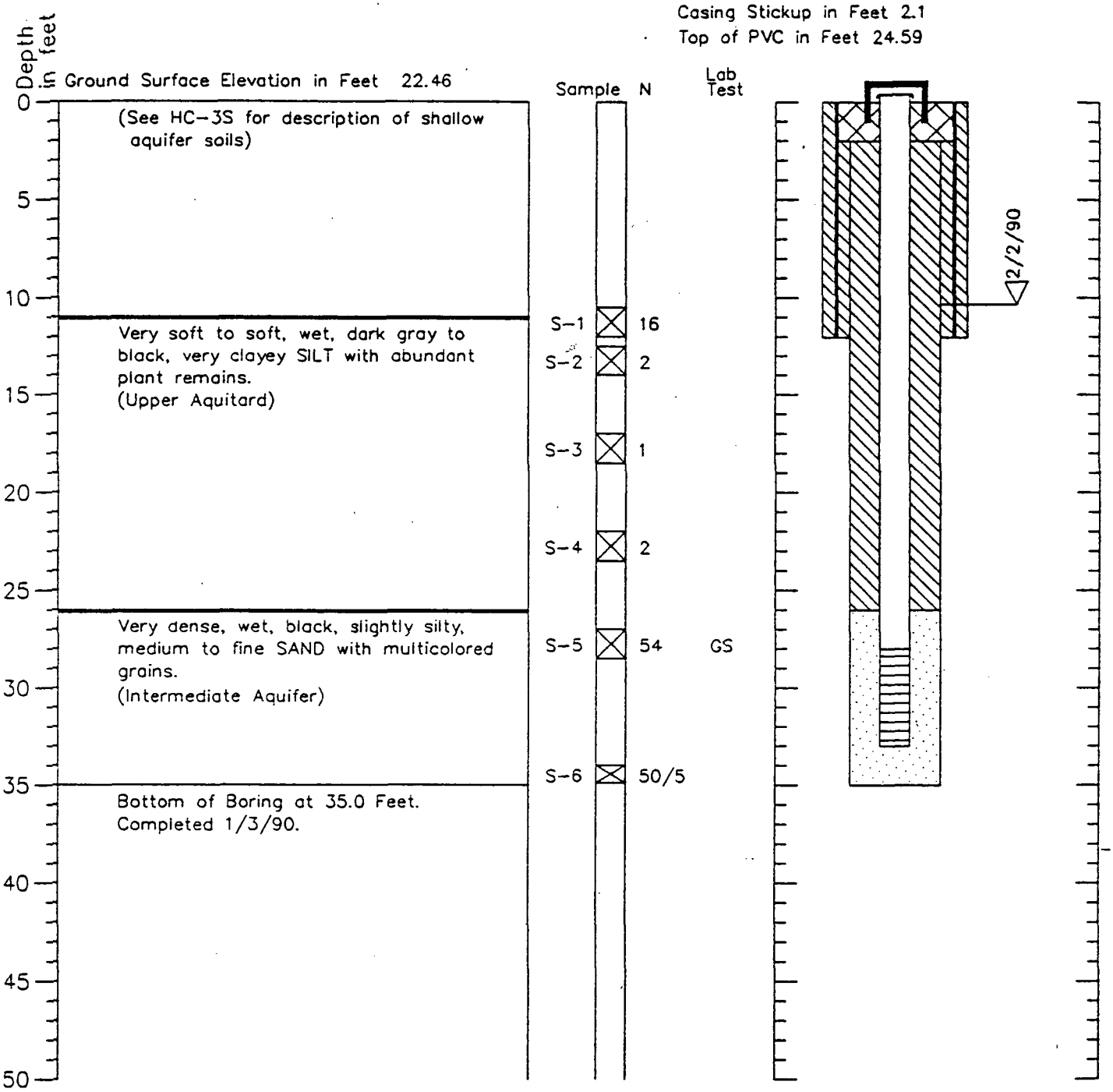
Very soft to soft, wet, dark gray to black, very clayey SILT with abundant plant remains.
(Upper Aquitard)

Very dense, wet, black, slightly silty, medium to fine SAND with multicolored grains.
(Intermediate Aquifer)

Bottom of Boring at 35.0 Feet.
Completed 1/3/90.

Monitoring Well Design

Casing Stickup in Feet 2.1
Top of PVC in Feet 24.59



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

HARTCROWSER

J-2350-07 1/90

Figure A-29

Boring Log and Construction Data for Monitoring Well HC-2I

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 25.14

(See HC-2S for description of shallow aquifer soils)

Very soft to medium stiff, wet, gray, slightly sandy, clayey to very clayey SILT with abundant plant remains. (Upper Aquitard)

Very dense, wet, black, slightly silty to very silty, fine SAND with multicolored grains. (Intermediate Aquifer)

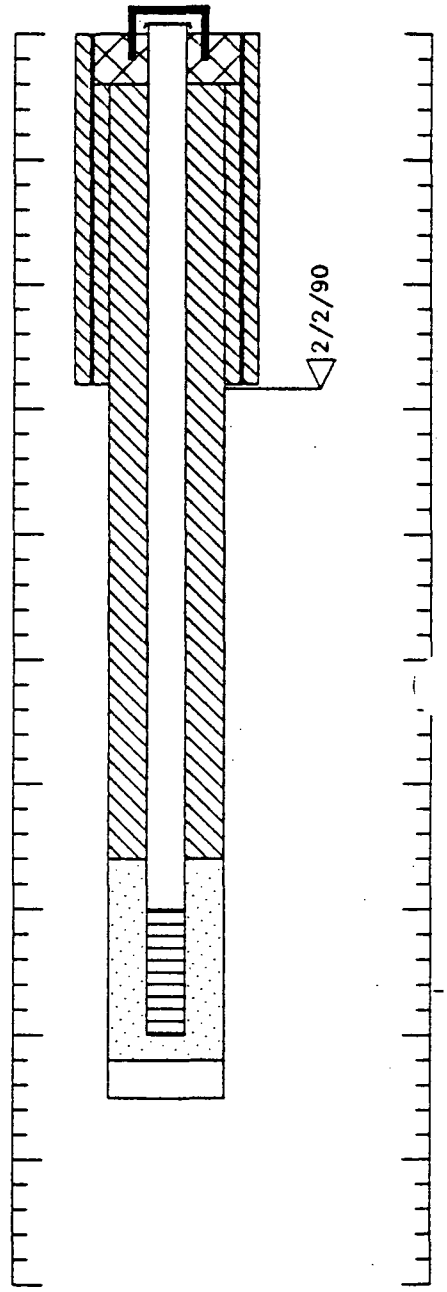
Bottom of Boring at 42.5 Feet. Completed 1/2/90.

Sample	N	Lab Test
S-1	7	
S-2	2	
	7	
S-3	1	
S-4	3	
S-5	15	
S-6		GS
S-7	70	

Monitoring Well Design

Casing Stickup in Feet 2.1

Top of PVC in Feet 27.29



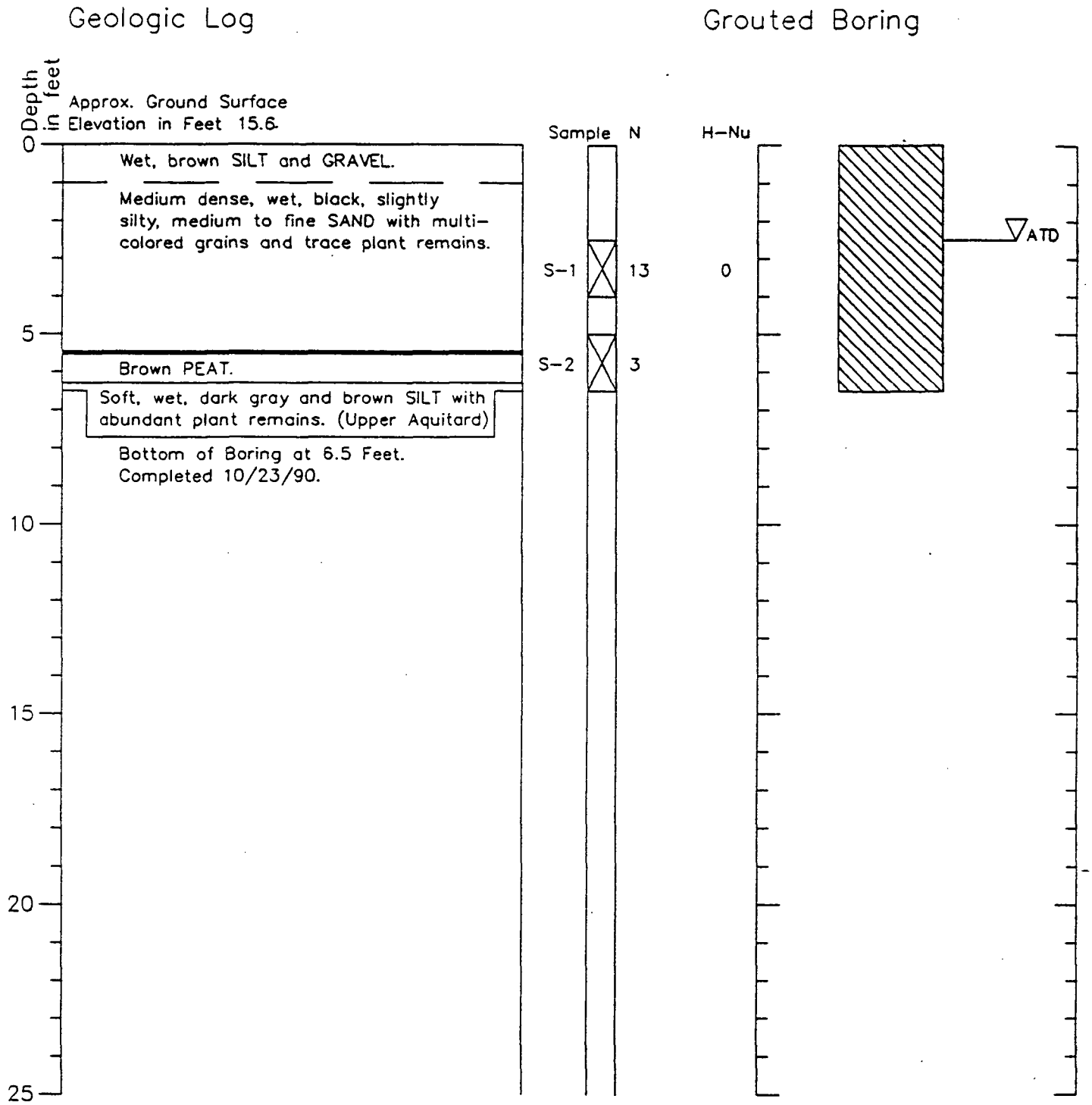
1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

HARTCROWSER

J-2350-07 12/

Figure A-28

Boring Log HC-26



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2350-07 10/90

Figure A-27

Boring Log and Construction Data for Monitoring Well HC-25S

Geologic Log

Depth in feet

Approx. Ground Surface Elevation in Feet 15.99

0 — Loose, wet, brown, silty, very gravelly SAND. (Shallow Aquifer)

Loose to medium dense, wet, black, slightly silty, fine SAND with multi-colored grains.

5

Moist, black and brown PEAT.

Soft, wet, gray and brown SILT with abundant plant remains. (Upper Aquitard)

Bottom of Boring at 8.0 Feet. Completed 10/23/90.

10

15

20

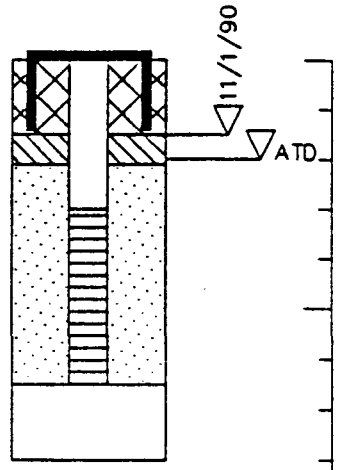
25

Sample	N	H-Nu
S-1	9	0
S-2	20	
S-3	4	

Monitoring Well Design

Casing Stickup in Feet -0.45

Top of PVC in Feet 15.55



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2350-07 10/90

Figure A-26

Boring Log and Construction Data for Monitoring Well HC-24S

Geologic Log

Depth in feet

Approx. Ground Surface Elevation in Feet 16.37

0

3 inches of asphalt over wet, brown, slightly silty SAND. (Shallow Aquifer)

Medium dense, wet, black, slightly silty, medium to fine SAND with multi-colored grains and trace plant remains.

5

Soft, wet, brown SILT with abundant plant remains. (Upper Aquitard)

Wet, black, medium to fine SAND with multicolored grains and thin silt lenses.

Bottom of Boring at 8.0 Feet.
Completed 10/23/90.

10

15

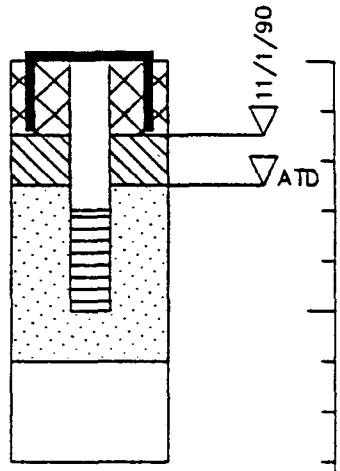
20

25

Sample	N	H-Nu
S-1	13	0
S-2	13	
S-3	5	

Monitoring Well Design

Casing Stickup in Feet -0.6
Top of PVC in Feet 15.78



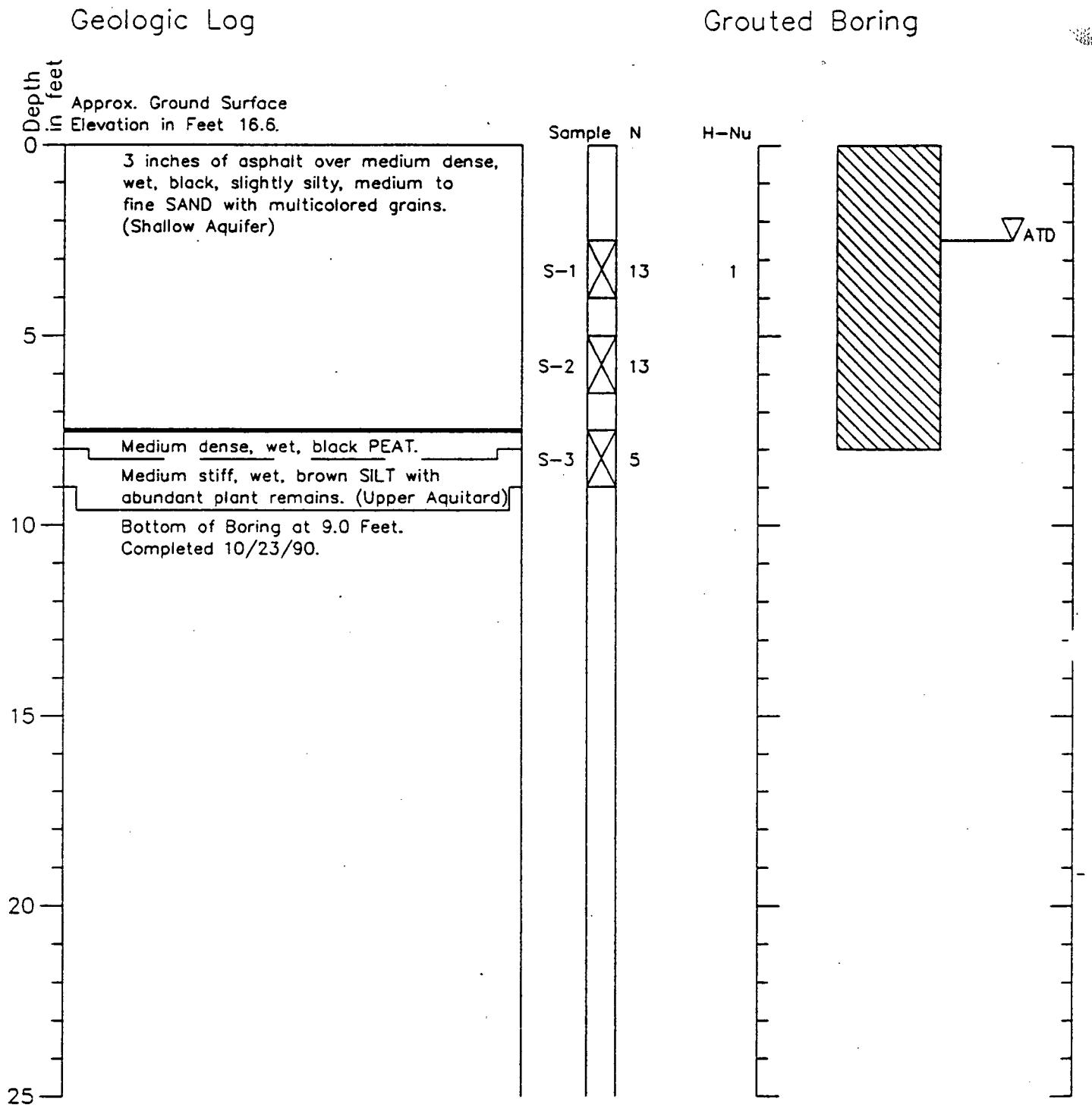
1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2350-07 10/90

Figure A-25

Boring Log HC-23



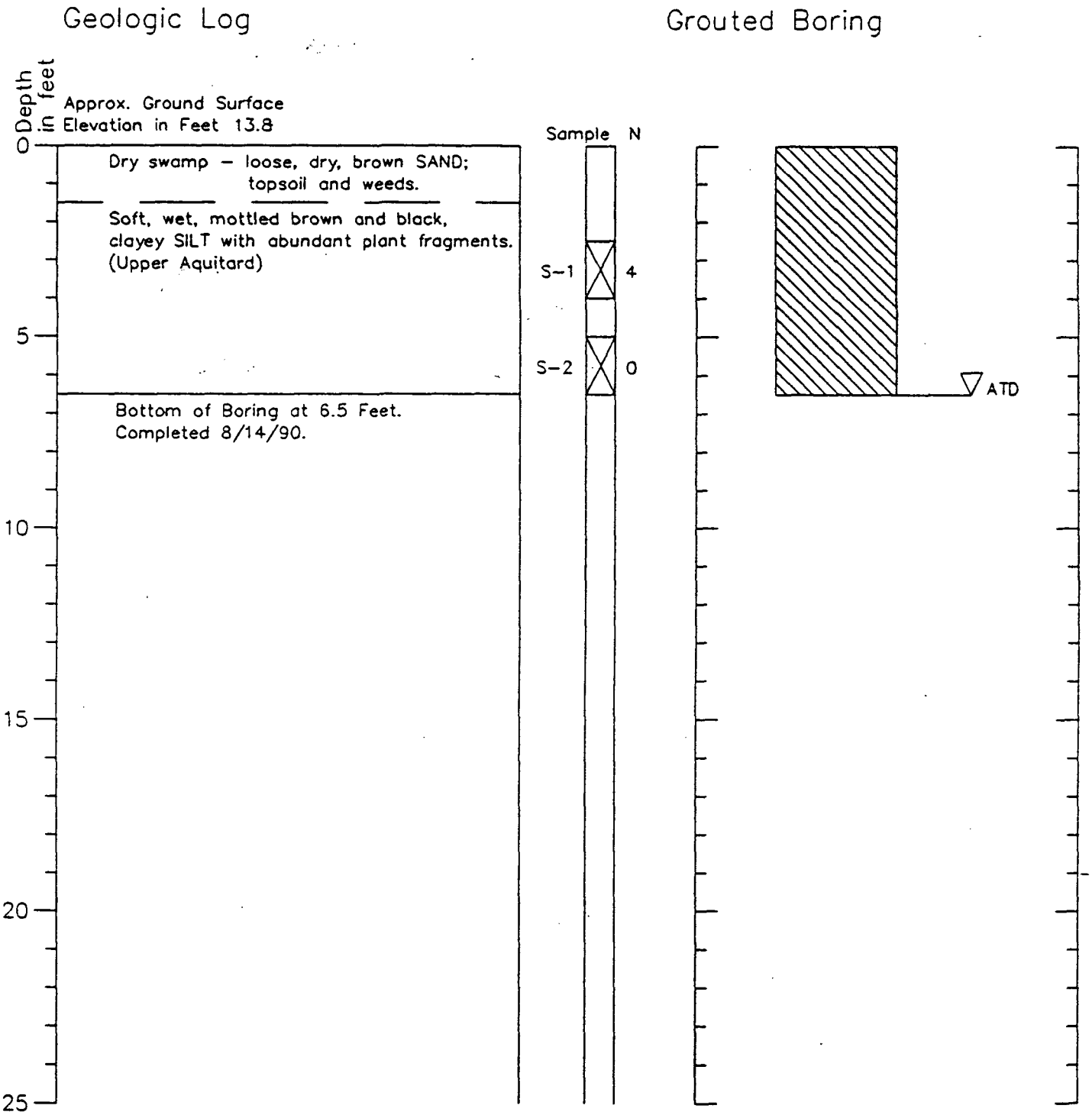
1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2350-07 10/9

Figure A-24

Boring Log HC-22



1. Refer to Figure B–1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2350-07 8/90

Figure A–23

Boring Log and Construction Data for Monitoring Well HC-21S

Geologic Log

Depth in feet

Approx. Ground Surface Elevation in Feet 15.4

0 — Loose, wet, black, silty SAND with multicolored grains and trace of plant remains. (Shallow Aquifer)

Soft, wet, black, clayey SILT with abundant plant fragments (roots).

5 — Loose, wet, brown with black sriations, silty SAND multicolored grains and trace of plant fragments.

Soft, wet, gray, clayey SILT with plant fragments. (Upper Aquitard)

Bottom of Boring at 6.5 Feet.
Completed 8/14/90.

10

15

20

25

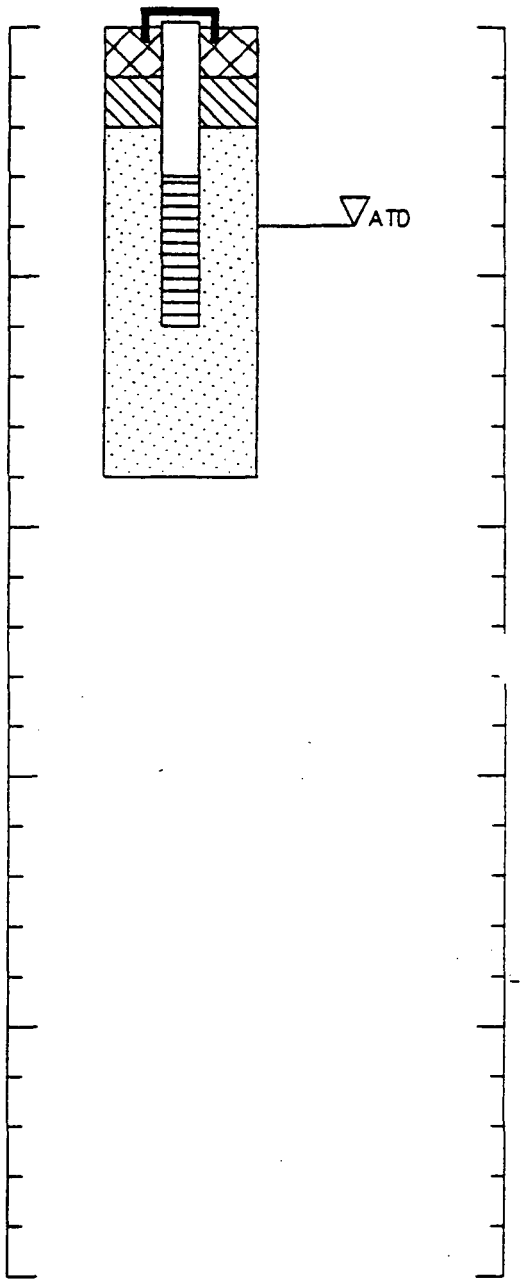
Sample N

S-1 3

S-2 4

Monitoring Well Design

Casing Stickup in Feet 2.3
Top of PVC in Feet 17.74



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2350-07 8/90

Figure A-22

Boring Log HC-20

Geologic Log

Grouted Boring

Depth in feet

Approx. Ground Surface Elevation in Feet 13.7

0

Dry swampland; topsoil and weeds.

Soft, wet, brown and black SILT with abundant roots and plant fragments. (Upper Aquitard)

1-inch-layer of roots and wood fragments.

5

Very soft, wet, gray, clayey SILT with trace plant fragments.

Bottom of Boring at 9.0 Feet.
Completed 8/14/90.

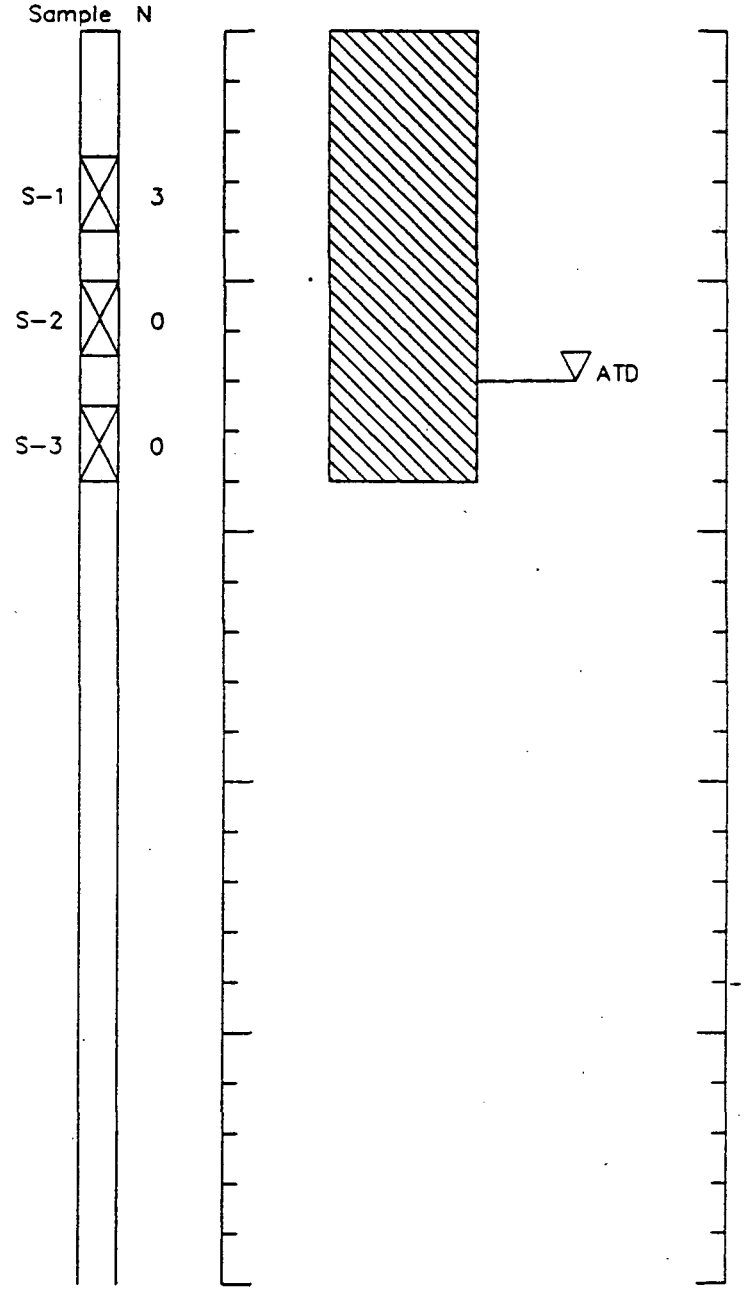
Note: At depth of 5.0 feet sampler sank before driving.

10

15

20

25



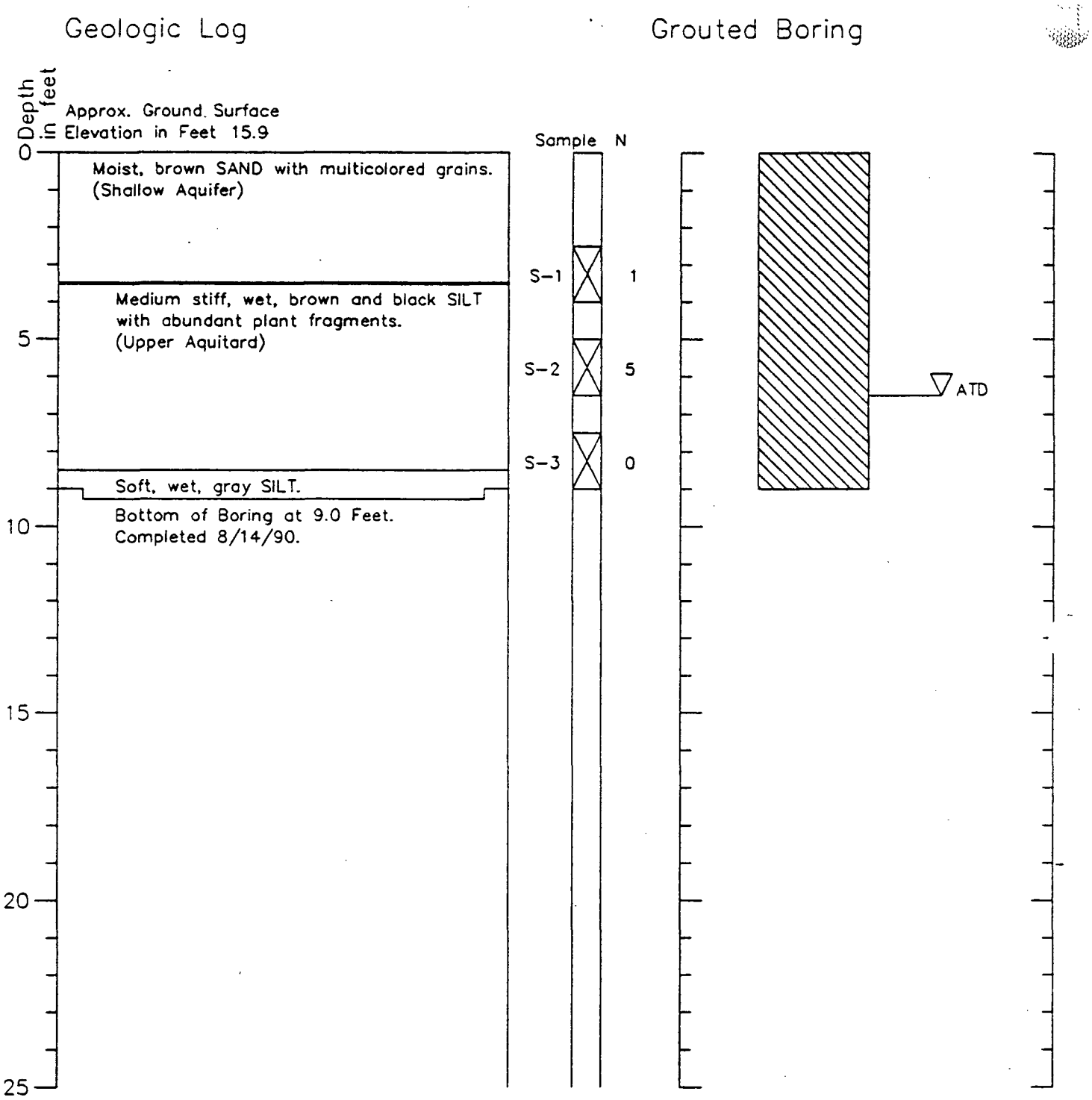
1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2350-07 8/90

Figure A-21

Boring Log HC-19



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2350-07 8/9

Figure A-20

Boring Log and Construction Data for Monitoring Well HC-18S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 20.58

0 — Moist, black, very gravelly SAND with wood chips. (Shallow Aquifer)

Moist, gray, slightly silty SAND with iron staining.

Loose to very loose, moist to wet, trace to silty SAND with multicolored grains.

5

10

Very loose, wet, dark gray and brown, slightly sandy, clayey SILT with abundant plant fragments. (Upper Aquitard)

15 — Bottom of Boring at 14.0 Feet. Completed 12/13/89.

20

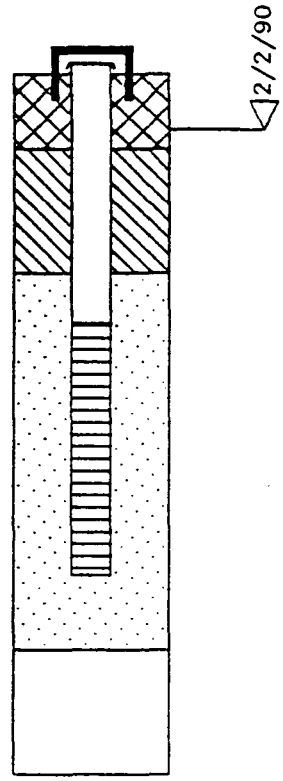
25

Sample	N	H-Nu
S-1	6	ND
S-2	6	ND
S-3	7	ND
S-4	3	ND
S-5	2	ND

Monitoring Well Design

Casing Stickup in Feet 2.4

Top of PVC in Feet 22.97



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

HARTCROWSER

J-2350-07 12/89

Figure A-19

Boring Log and Construction Data for Monitoring Well HC-17S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 19.45

0 — Moist to wet, black, slightly silty SAND with multicolored grains.

Very loose, wet, black, slightly clayey, silty, fine SAND with multicolored grains.

5

Very loose, wet, black, clayey, very silty, fine SAND.

(Shallow Aquifer)

10

Very soft, wet, dark gray, slightly sandy, clayey SILT with abundant plant fragments. (Upper Aquitard)

Bottom of Boring at 11.5 Feet.
Completed 12/13/89.

15

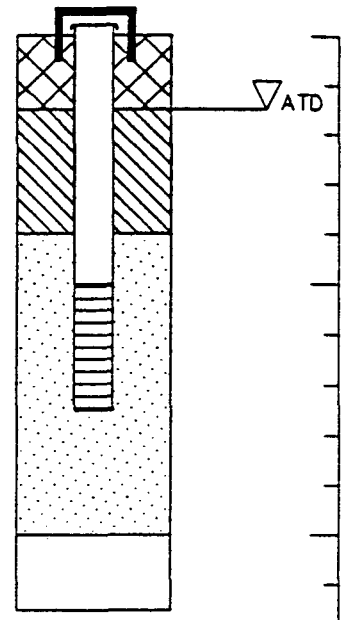
20

25

Sample	N	H-Nu
S-1	3	ND
S-2	2	ND
S-3	2	ND
S-4	2	ND

Monitoring Well Design

Casing Stickup in Feet 2.3
Top of PVC in Feet 21.70



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

HARTCROWSER

J-2350-07 12/89

Figure A-18

Boring Log and Construction Data for Monitoring Well HC-16S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 15.36

0

Moist, dark gray to black, very gravelly, slightly silty to silty SAND with wood chips, slag, and ore. (Shallow Aquifer)

Dense to medium dense, wet, greenish gray, very gravelly to gravelly SAND with quartz fragments.

5

Medium dense, wet, dark gray, silty SAND with multicolored grains.

Soft, wet, gray and black, clayey to very clayey SILT with abundant plant remains. (Upper Aquitard)

10

Bottom of Boring at 9.0 Feet.
Completed 12/11/89.

15

20

25

Sample N

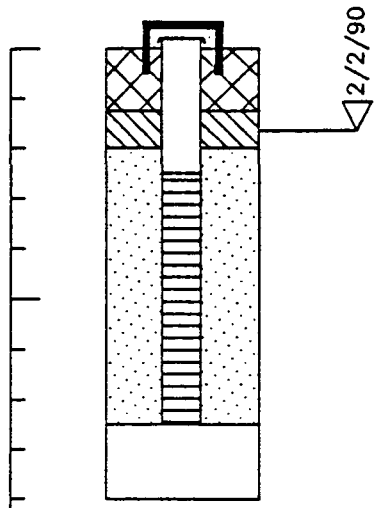
S-1 32

S-2 30

S-3 4

Monitoring Well Design

Casing Stickup in Feet 1.7
Top of PVC in Feet 17.05



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

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J-2350-07 12/89

Figure A-17

Boring Log and Construction Data for Monitoring Well HC-15S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 15.70

0

WOOD CHIPS and moist, dark brown, very gravelly SAND with slag, ore, and quartz. (Shallow Aquifer)

Very dense to loose, wet, dark gray to black SAND with multicolored grains.

5

Very soft, wet, gray and black, clayey SILT with abundant organic matter. (Upper Aquitard)

10

Bottom of Boring at 9.0 Feet.
Completed 12/11/89.

15

20

25

Sample N

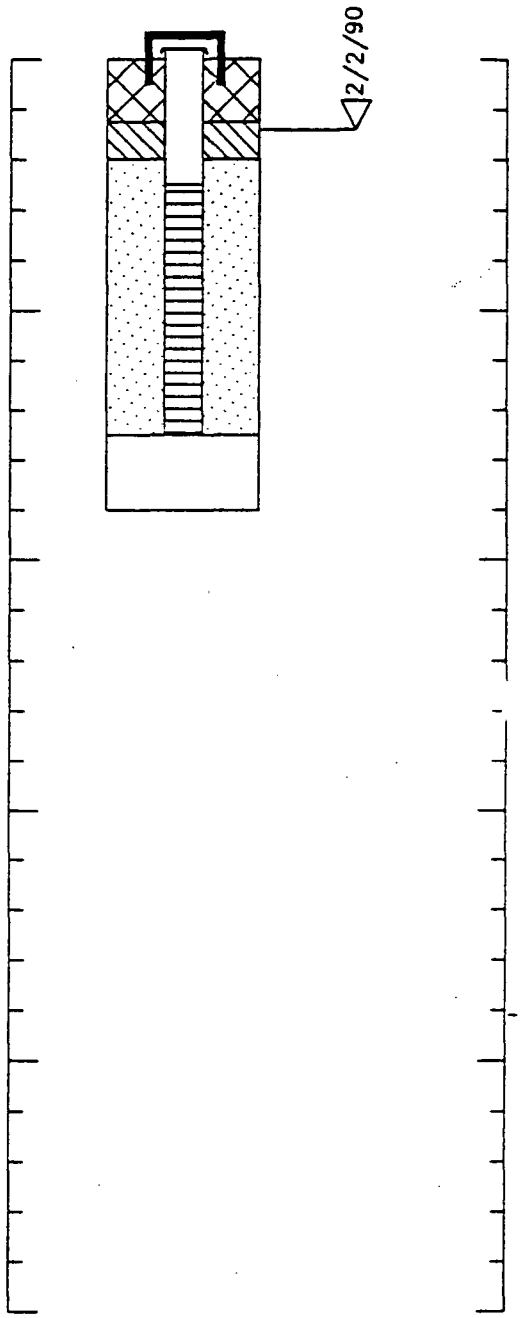
S-1 61

S-2 8

S-3 1

Monitoring Well Design

Casing Stickup in Feet 2.0
Top of PVC in Feet 17.72



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

HARTCROWSER

J-2350-07 12/89

Figure A-16

Boring Log and Construction Data for Monitoring Well HC-14S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 20.59

0 — Moist, black SAND with multicolored grains. (Shallow Aquifer)

Very loose, wet, black, slightly silty to silty SAND with multicolored grains.

5

Loose to very loose, wet, black, trace to slightly clayey, slightly silty to silty, fine SAND with some plant remains.

10

Very soft, wet, gray and brown, very clayey SILT with abundant plant fragments. (Upper Aquitard)

Bottom of Boring at 14.0 Feet. Completed 12/13/89.

15

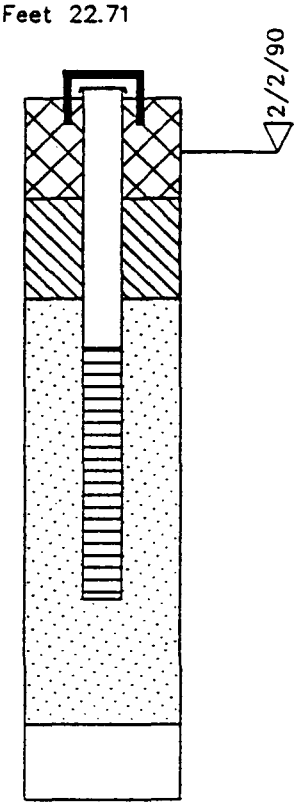
20

25

Sample	N	H-Nu
S-1	3	ND
S-2	4	ND
S-3	5	ND
S-4	1	ND
S-5	2	ND

Monitoring Well Design

Casing Stickup in Feet 2.1
Top of PVC in Feet 22.71



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

HARTCROWSER

J-2350-07 12/89

Figure A-15

Boring Log and Construction Data for Monitoring Well HC-13S

Geologic Log

Depth in feet

Ground Surface Elevation in Feet 25.45

0 — Moist, brown, gravelly SAND with wood chips. (Shallow Aquifer)

Loose, moist, dark gray, silty SAND.

5 — Medium dense, moist, tan, slightly clayey SILT with organics.

Soft, moist, tan, slightly clayey iron staining.

Loose, moist, greenish gray, slightly gravelly SAND.

Loose to very loose, moist to wet, black, slightly silty, medium to fine SAND with multicolored grains.

10

15

Soft, wet, dark gray and black, very clayey SILT with abundant plant remains. (Upper Aquitard)

Bottom of Boring at 19.0 Feet.
Completed 12/13/89.

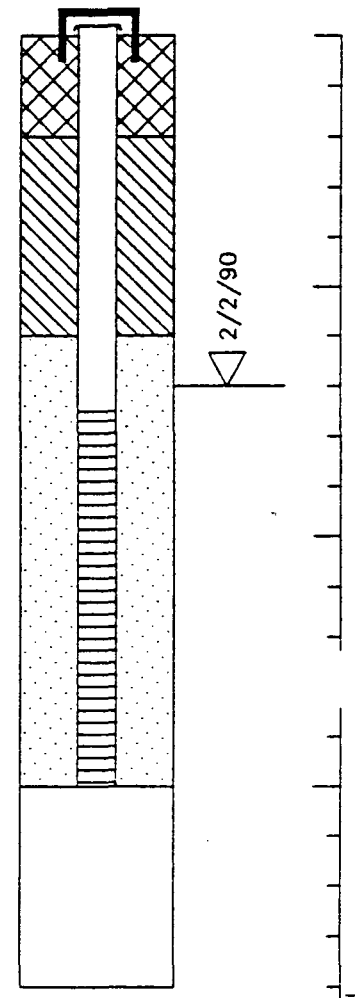
20

25

Sample	N	Lab Test	H-Nu
S-1	9		ND
S-2	18		ND
S-3	6		ND
S-4	8		ND
S-5	9	GS	ND
S-6	3		ND
S-7	3		ND

Monitoring Well Design

Casing Stickup in Feet 2.1
Top of PVC in Feet 27.55



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

HARTCROWSER

J-2350-07 12/8

Figure A-14

Boring Log and Construction Data for Monitoring Well HC-12S

Geologic Log

Depth in feet

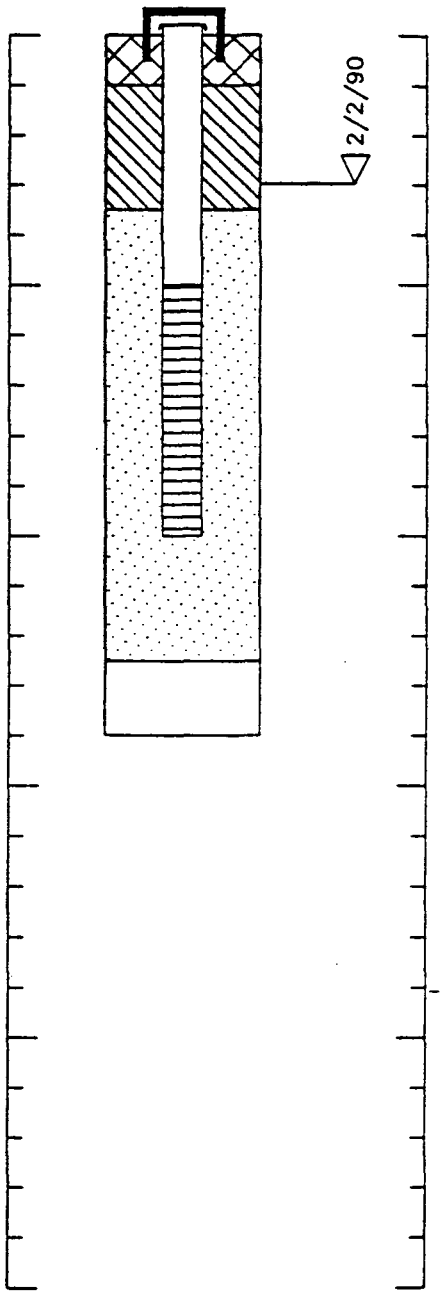
Ground Surface Elevation in Feet 18.56

Depth	Description	Sample	N	H-Nu
0	WOOD CHIPS and moist, dark gray, gravelly, silty SAND with slag and ore. (Shallow Aquifer)			
	Loose, moist, dark gray to black, slightly silty to silty, fine SAND with wood debris.	S-1	9	ND
5	Dense, moist, dark gray to black, gravelly, slightly silty, fine SAND with slag and ore fragments.	S-2	32	ND
	Loose, wet, dark gray to black, slightly silty to silty, fine SAND.	S-3	8	ND
10		S-4	6	ND
	Soft, moist, dark gray and brown, slightly clayey to clayey SILT with abundant plant remains. (Upper Aquitard)	S-5	4	ND
15	Bottom of Boring at 14.0 Feet. Completed 12/12/89.			
20				
25				

Monitoring Well Design

Casing Stickup in Feet 2.1

Top of PVC in Feet 20.70



1. Refer to Figure B-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Bold line indicates boundary between major hydrogeologic units shown parenthetically.

HARTCROWSER

J-2350-07 12/89

Figure A-13

GRAIN SIZE DISTRIBUTION TEST DATA

Composite #1
TP-114, TP-116 North Site Area

Composite #2
TP-117, TP-118, TP-113 North Site Area

Composite #3
SS-5, SS-6, SS-9 Sand Blast Grit

Composite #4
SS-3, SS-17, SS-2 & TP-127 Ohio Ferro-Alloy

Composite #5
HC-14, HC-25 & TP-104, TP-107, TP-201 General Fill Area

PREVIOUS EXPLORATION LOGS BY OTHERS

Hart Crowser
J-2350-07

GEOLOGIC LOG AND
DETAILED WELL DIAGRAM
EE-6 THROUGH EE-10
ECOLOGY & ENVIRONMENT, INC.

ecology & environment, inc.

GEOLOGIC LOG

Well No.: EE6

Project: Nearshore/Tideflats

Logged By: T. Syverson

Date Completed: February 16, 1987

DEPTH (Feet)	THICK-NESS	SAMPLE EE6 #	DESCRIPTION
0-3	3'	-	FILL - Slag, 60%, 2-10cm, steel gray; Gravel, 20%, sub-rounded, lithics; Sand, 15%, medium grained, gray lithics; Wood, 5%.
3-6	3'	5'	FILL - Sand, 70%, medium-to-coarse grained, gray-tan; Gravel, 10%, coarse grained lithics 2-4cm, slag cobbles 1-3cm, dark gray; Wood, 5%; Silt, 5%, dark gray; Clay, 5%, light gray, saturated.
6-11	5'	10'	SHELL SAND - Sand, 55%, medium-to-coarse grained, sub-rounded, gray-tan, lithics, sub-angular white quartz grains; Shells, 25%, 1mm round-to-broken, pink, white; Silt, 10%, dark gray; Pebbles, 10%, sub-rounded lithics; Saturated.
11-16	5'	15'	WOODY CLAY - Clay, 70%, tan-brown; Wood, 20%; Silt, 10%, brown; Moist.
16-24'	8'	20'	SAND - Sand, 80-90%, medium-to-coarse grained, sub-angular, rust, tan, gray, lithics; Silt, 10-15%, gray; Wood, trace to 5%; Saturated.
TOTAL DEPTH: 24'			

Figure A-61

ecology & environment, inc.

GEOLOGIC LOG

Well No.: EE7
Project: Nearshore/Tideflats

Logged By: T. Syverson
Date Completed: February 17, 1987

DEPTH (Feet)	THICK-NESS	SAMPLE EE7 #	DESCRIPTION
0-3	3'	-	FILL - Slag, 60%, steel gray, pebbles and cobbles 1-5cm; Wood, 20%, bark; Gravel, 15%, sub-rounded lithics; Sand, 5%, fine-to-coarse grained, brown.
3-6	3'	-	FILL - Sand, 70%, medium-to-coarse grained, gray-tan; Gravel, 10%, coarse grained, sub-rounded lithics; Wood, 5%, bark; Silt, 5%, dark gray; Clay, 5%, gray; Trace slag pebbles; Saturated.
6-11	5'	10'	SHELL SAND - Sand, 70%, medium-to-coarse grained, sub-rounded to sub-angular, tan, rust, gray, lithics; Shells, 15% pink, white, tan, 1-2mm, whole and broken; Silt, 15%, dark gray; Saturated.
11-12	1'	-	WOODY CLAY - Wood, 60%; Clay, 40%, light-to-medium brown.
TOTAL DEPTH: 12'			

Figure A-62

ecology & environment, inc.

GEOLOGIC LOG

Well No.: EE8

Project: Nearshore/Tideflats

Logged By: T. Syverson

Date Completed: February 17, 1987

DEPTH (Feet)	THICK-NESS	SAMPLE EE8 #	DESCRIPTION
0-5	5'	-	FILL - Gravel, 50%; sub-rounded to sub-angular, pebbles and cobbles, tan, gray, brown lithics, including angular white quartz; Slag, 30%, 1-3cm, steel gray; Sand, 10%, medium-to-coarse grained, gray; Silt, 5%, dark gray; Wood, 5%.
5-11	6'	5'	SAND - Sand, 95%, fine-to-medium grained, sub-angular, rust, tan, gray, lithics, frosted and clear quartz; Silt, 5%, dark gray; Saturated.
11-17	6'	10' 15'	WOODY CLAY - Clay, 55%, medium-to-light gray; Wood, 45%; Wet. - % wood decreases with depth.
17-21	4'	20'	SILTY SAND - Sand, 80%, medium grained, sub-angular to angular, rust, tan, white, gray, lithics, clear and frosted quartz; Silt, 10%, dark gray; Sand, 5%, fine grained, light gray; Organics, 5%, wood, root material; Saturated.
21-25	4'	25'	SILTY CLAY - Clay, 80%, light brown-to-medium gray; Silt, 15%, dark brown; Sand, 5%, fine grained, light-gray; Wet.
TOTAL DEPTH: 25'			

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GEOLOGIC LOG

Well No.: EE9

Project: Nearshore/Tideflats

Logged By: T. Syverson

Date Completed: February 18, 1987

DEPTH (Feet)	THICK-NESS	SAMPLE EE9 #	DESCRIPTION
0-7	7'	-	FILL - Gravel, 40%, sub-rounded, pebbles and cobbles, rust, gray, tan, lithics, angular white quartz; Slag, 25%, 1-3cm, steel gray; Wood, 25%, bark; Sand, 10%, medium-to-coarse grained, brown-gray. - % slag increases to 3', then decreases. - % sand increases with depth.
7-10	3'	10'	PEBBLEY SAND - Sand, 85%, medium-to-coarse grained, angular to sub-angular, rust, gray, tan, lithics, white and clear quartz; Pebbles, 10%, sub-rounded, gray, tan, lithics; Silt, 5%, dark gray, saturated.
10-11	1	10'	WOODY CLAY - Clay, 55%, brown-to-medium gray; Wood, 45%; Wet.
TOTAL DEPTH: 11'			

Figure A-64

ecology & environment, inc.

GEOLOGIC LOG

Well No.: EE10

Project: Nearshore/Tideflats

Logged By: T. Syverson

Date Completed: February 18, 1987

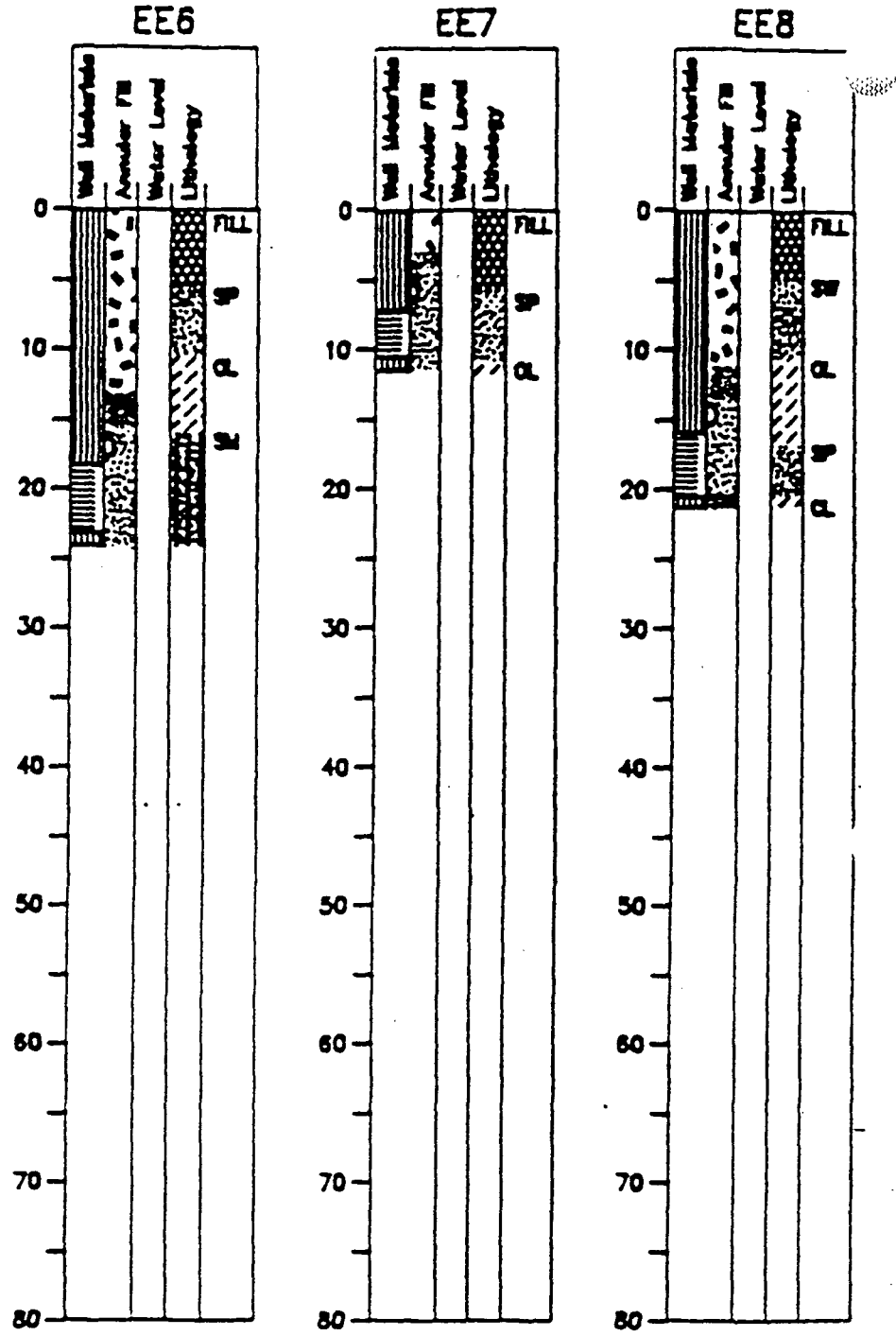
DEPTH (Feet)	THICK-NESS	SAMPLE EE10#	DESCRIPTION
0-1	1'	-	FILL - Bark, 85%, dark brown; Sand, 10%, medium-to-coarse grained, brown; Gravel, 5%, sub-rounded lithics.
1-4'	3'	-	FILL - Gravel, 55%, sub-rounded lithics; Sand, 25%, medium-to-coarse grained, dark brown-gray; Silt, 10%, dark gray; Slag, 5%, 1-3cm, steel gray; Wood, 5%.
4-12'	8'	10'	WOODY CLAY - Clay, 60%, light brown; Wood, 30%; Pebbles, 10%, sub-rounded lithics; Wet.
12-17'	5'	-	SAND - Sand, 95%, medium-to-coarse grained, angular to sub-rounded, gray, black, rust, tan, lithics; Sand, 5%, fine grained, gray, saturated.
TOTAL DEPTH: 17'			

Figure A-65

SOIL TYPE AND WELL CONSTRUCTION MATERIALS LEGEND

SOIL TYPE SYMBOLS	WELL CONSTRUCTION MATERIALS
Clean Gravel (GW,GP)	Well Casing
Silty Gravel (GM)	Well Screen
Clayey Gravel (GC)	Sand Pack
Clean Sand (SW,SP)	Gravel Pack
Silty Sand (SM)	Borehole Collapse
Clayey Sand (SC)	Bentonite Slurry
Silt (ML)	Bentonite Pellets/Chi
Clay (CL)	Cement
Organic Silts (OL)	Cement with Bentonite
Peat (PT)	Backfill Material
Artificial Fill	

Figure A–66



LEGEND

EE1 Monitoring well designation

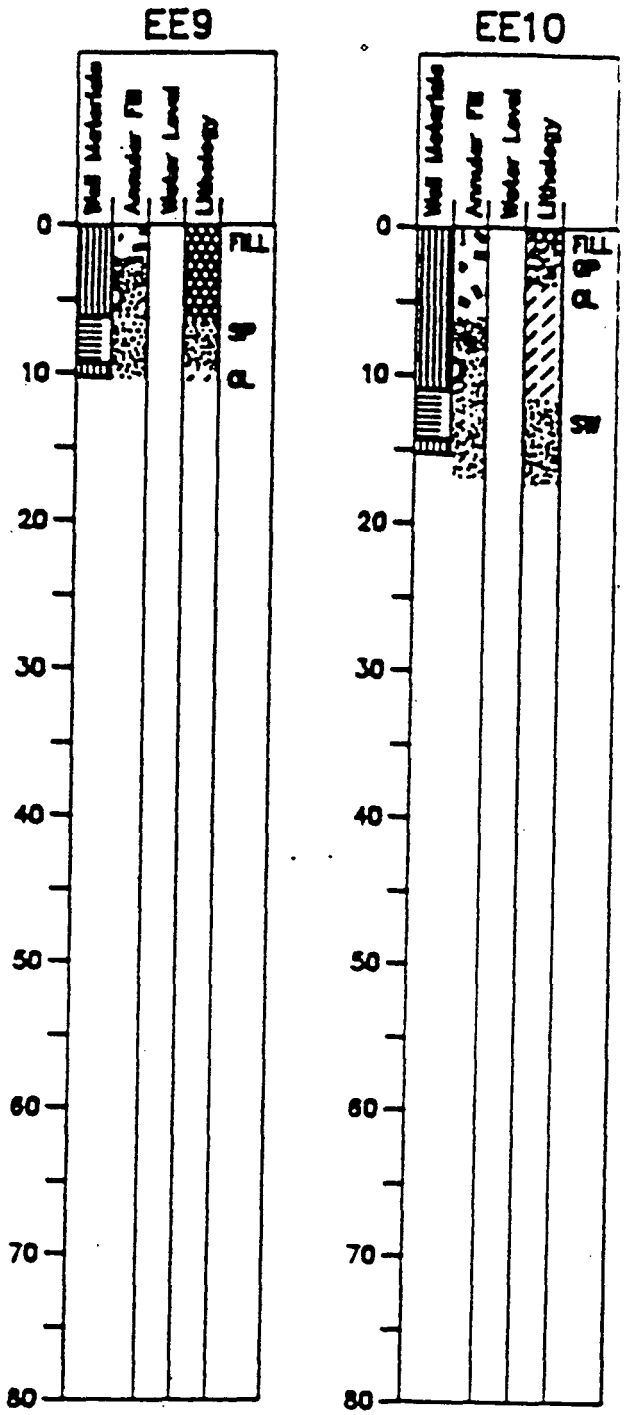
SP Lithologic letter designation

) Centralizers

ecology & environment, inc.	
Job: F10-8812-12	Waste Site: WA 0044
Drawn by: D. P.	Date: April 28, 1987

DETAILED WELL DIAGRAM
TACOMA NEARSHORE TIDEFLATS
Tacoma, WA

Figure A-67



LEGEND

EE1 Monitoring well designation

SP Lithologic letter designation

) Centralizers

Figure A-68

BORING LOGS AND WELL DIAGRAMS FOR P-10SS, P-10S, AND P-10D SHANNON & WILSON, INC.

LOG & AS-BUILT DIAGRAM

GEOLOGIC LOG*

DRILLER: KRING DRILLING COMPANY
COMPLETION DATE: AUGUST 7, 1981
ALTITUDE: 21.3 FEET, SURVEYED

GROUND SURFACE

Silty, gravelly SAND: medium rounded gravel, sand grades from very fine to coarse, black, brown and gray.

TOTAL DEPTH 6.4 FEET

*Wentworth-Lane Classification

NOTE: 1) Vertical scale changed from previous logs to show detail in as-built drawings.

2) ▼ Near high high tide

▽ Near low low tide

3) 0.3 gallons pumped from well on 8/13/81 prior to obtaining water quality sample.

HYDROLOGIC UNIT

LOG DEPTH IN FEET

0

5

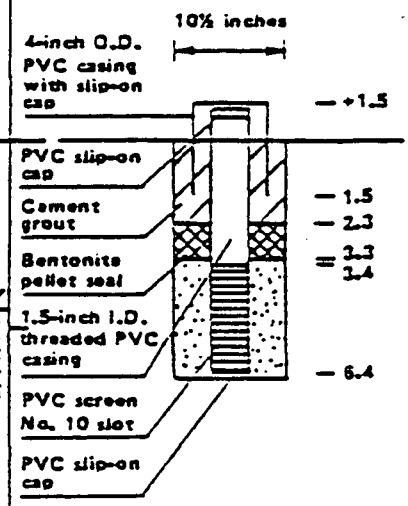
10

WATER LEVEL

8/11/81 ▽

8/11/81 ▼

AS BUILT



SHANNON & WILSON, INC.
GROUNDWATER SECTION
SEATTLE, WASHINGTON
(206) 632-8020

PENNWALT CORPORATION
TACOMA WASHINGTON PLANT

GROUNDWATER MONITORING WELL
P-10SS

W-3819-06

AUGUST 1981

Figure A-69

LOG & AS-BUILT DIAGRAM

GEOLOGIC LOG*

DRILLER: KRING DRILLING COMPANY
COMPLETION DATE: APRIL 16, 1981
ALTITUDE: 21.3 FEET, SURVEYED

GROUND SURFACE

Silty, gravelly SAND: medium rounded gravel, sand grades from very fine to coarse, black, brown and gray.

Organic, clayey SILT: fibrous organics (peat), trace sand, brown and gray.

Sandy SILT: very fine sand, layers of silty fine sand 1/2 inch thick.

WATER BEARING, slightly silty, fine SAND: sand grades from very fine to medium, gray.

Very silty, very fine SAND: sand grades from very fine to fine, gray.

Organic clayey SILT: layered fibrous organics (peat), trace fine sand, brown and gray.

TOTAL DEPTH 33.0 FEET

*Wentworth-Lane Classification

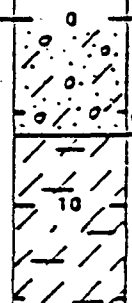
NOTE: 1) 5 gallons pumped from well on 4/28/81 prior to obtaining initial water quality sample on 4/29/81.

2) ▼ near high high tide

▽ near low low tide

HYDROLOGIC UNIT

LOG DEPTH IN FEET

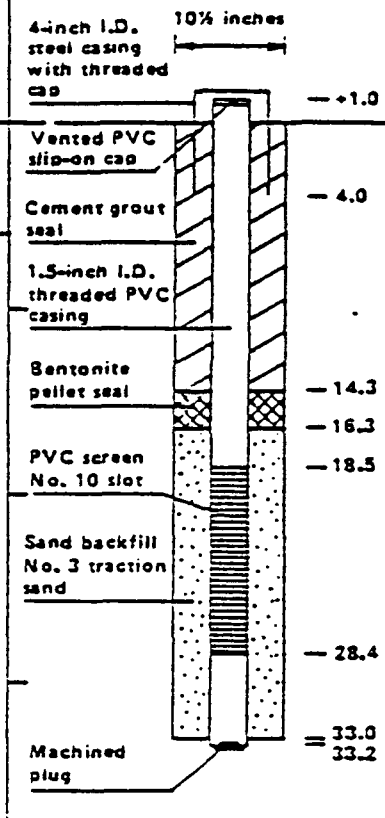


WATER LEVEL

4/30/81 21:16

5/1/81 03:01

AS BUILT



SHANNON & WILSON, INC.
GROUNDWATER SECTION
SEATTLE, WASHINGTON
(206) 632-8020

PENNWALT CORPORATION
TACOMA WASHINGTON PLANT

GROUNDWATER MONITORING WELL
P-10S

W-3819-00

JULY 1981

Figure A-70

LOG & AS-BUILT DIAGRAM

GEOLOGIC LOG*

DRILLER: KRING DRILLING COMPANY
COMPLETION DATE: APRIL 16, 1981
ALTITUDE: 21.3 FEET, SURVEYED

GROUND SURFACE

Silty, gravelly SAND: medium rounded gravel, sand grades from very fine to coarse, black, brown and gray.

Organic, clayey SILT: fibrous organics (peat), trace sand, brown and gray.

Sandy SILT: very fine sand, layers of silty, fine sand 1/2 inch thick.

WATER BEARING, slightly silty, fine SAND: sand grades from very fine to medium, gray.

Very silty, very fine SAND: sand grades from very fine to fine, gray.

Organic clayey SILT: layered fibrous organics (peat), trace fine sand, brown and gray.

WATER BEARING, slightly silty and silty, fine SAND: sand grades from very fine to medium, numerous shell fragments, gray and dark gray.

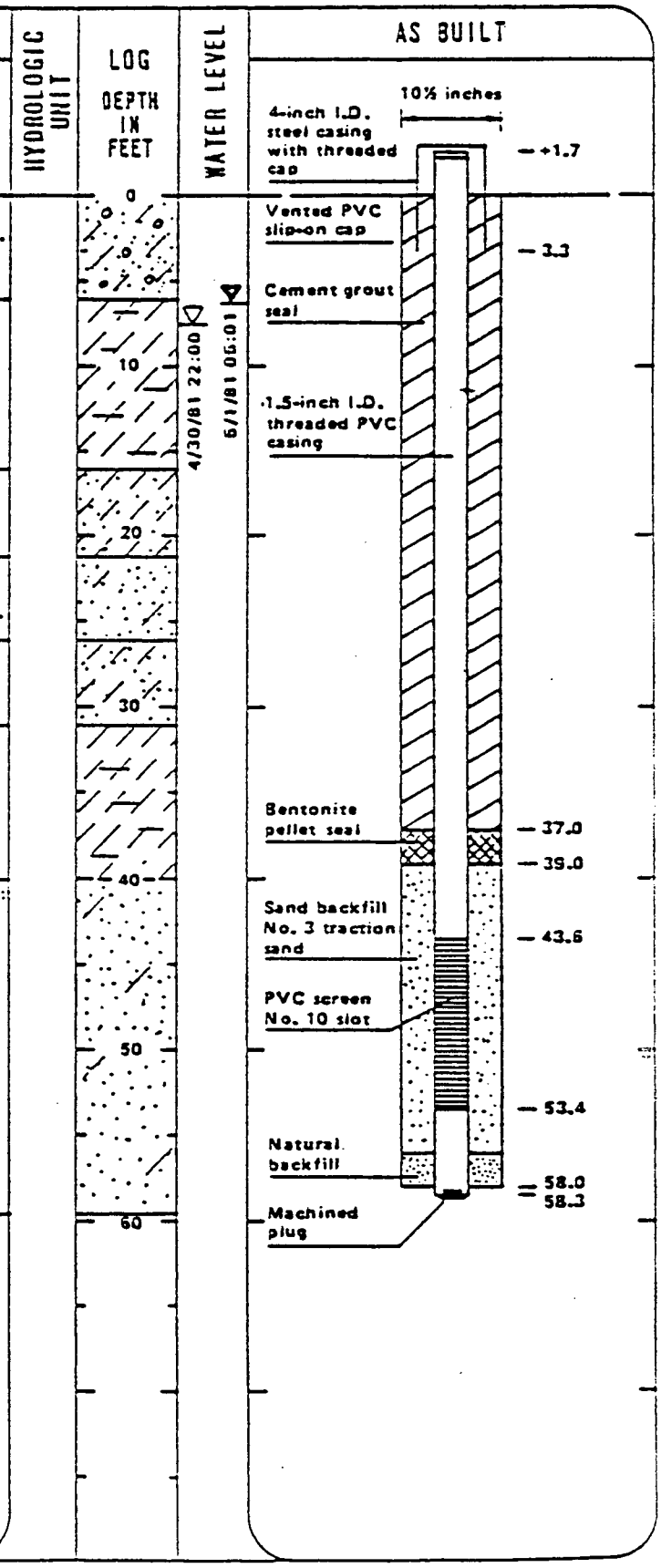
TOTAL DEPTH 59.5 FEET

*Wentworth-Lane Classification

NOTE: 1) 20 gallons pumped from well on 4/28/81 prior to obtaining initial water quality sample on 4/29/81.

2) ▼ near high high tide

▽ near low low tide



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GROUNDWATER SECTION
SEATTLE, WASHINGTON
(206) 632-8020

PENNWALT CORPORATION
TACOMA WASHINGTON PLANT

GROUNDWATER MONITORING WELL
P-10D

W-3819-00

JULY 1981

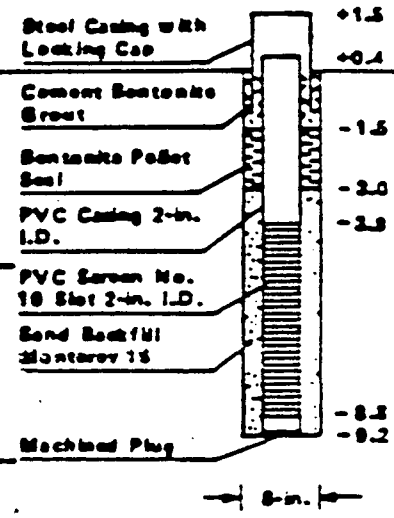
Figure A-71

Hart Crowser
J-2350-07

LOG & AS-BUILT DIAGRAM
MW-5S,I; MW-10S,I,D; MW-11S,I
SHANNON & WILSON, INC.

LOG & AS-BUILT DIAGRAM

GEOLOGIC LOG	HYDROLOGIC UNIT	LOG DEPTH IN FEET	WATER LEVEL	AS BUILT
DRILLER: KRING DRILLING COMPANY COMPLETION DATE: September 25, 1985 ALTITUDE: 12.50 Feet, MSL, Surveyed (Top of PVC Casing)				
GROUND SURFACE		0		
Silty fine to medium SAND: Sand grades from fine to medium, brown at surface grading to grey, thin silty clay layers, water bearing below 7 feet.	Shallow Aquifer	5	10-16-85	
Silty CLAY with fine sand: grey.	Aquitard	10		
TOTAL DEPTH 9.2 FEET				



SHANNON & WILSON, INC.
WASTE MANAGEMENT SERVICES
SEATTLE, WASHINGTON
(206) 632-8020

REICHHOLD CHEMICALS, INC.
TACOMA, WASHINGTON

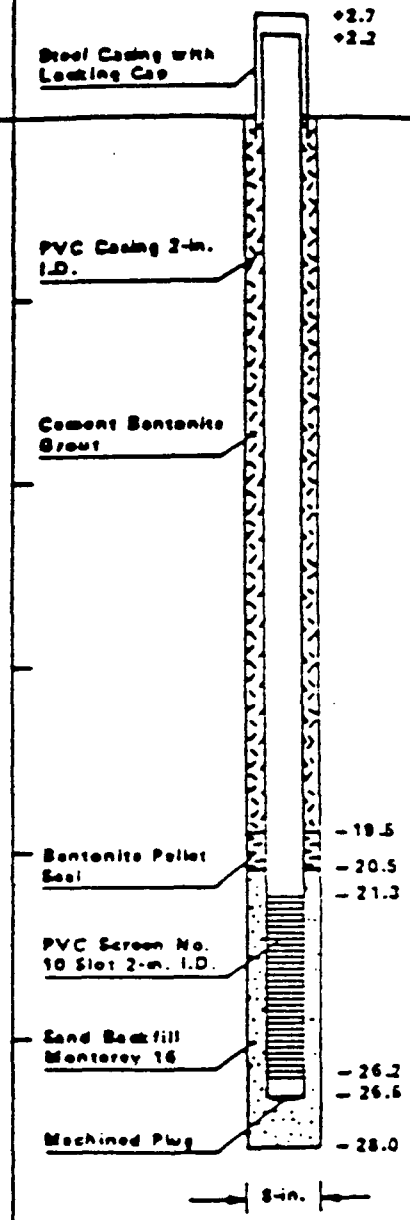
GROUNDWATER MONITORING WELL
MW-5S

W-4446-01
NOVEMBER 1985

Figure A-72

LOG & AS-BUILT DIAGRAM

GEOLOGIC LOG	HYDROLOGIC UNIT	LOG DEPTH IN FEET	WATER LEVEL
DRILLER: KRING DRILLING COMPANY COMPLETION DATE: September 27, 1985 ALTITUDE: 16.24 Feet, MSL, Surveyed (Top of PVC Casing)			
GROUND SURFACE		0	
Silty fine to medium SAND: sand grades from fine to medium, brown at surface grading to gray, thin silty clay layers, water bearing below 7 feet.	Shallow Aquifer	5	
Silty CLAY or clayey SILT: gray.	Aquitard	10 15 20	10-1-85
Silty fine SAND: grades to fine to medium sand.	Intermediate Aquifer	25	
Silty CLAY: gray.	Aquitard		
TOTAL DEPTH 28.0 FEET		30	



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(206) 632-8020

REICHHOLD CHEMICALS, INC.
TACOMA, WASHINGTON

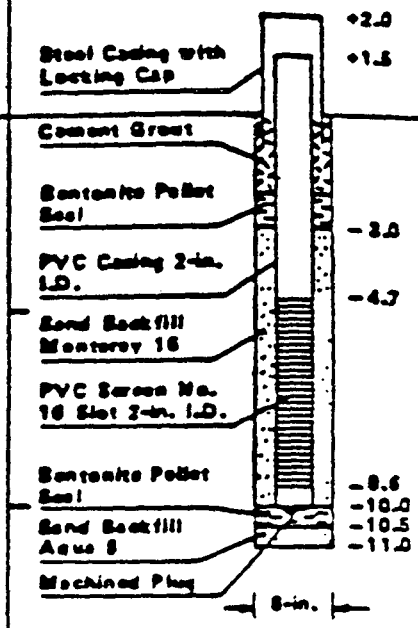
GROUNDWATER MONITORING WELL
MW-5I

W-4446-01
NOVEMBER 1985

Figure A-73

LOG & AS-BUILT DIAGRAM

GEOLOGIC LOG	HYDROLOGIC UNIT	LOG DEPTH IN FEET	WATER LEVEL	AS BUILT
DRILLER: KRING DRILLING COMPANY COMPLETION DATE: October 1, 1985 ALTITUDE: 12.56 Feet, MSL, Surveyed (Top of PVC Casing)				
GROUND SURFACE		0		
Fine to medium SAND: brown grading to grey, with clayey silt layers and peat, water bearing below 4 feet.	Shallow Aquifer	5	10-2-85	
Clayey SILT: brown, with peat.	Aquitard	10		
TOTAL DEPTH 11.0 FEET				



SHANNON & WILSON, INC.
WASTE MANAGEMENT SERVICES
SEATTLE, WASHINGTON
(206) 632-8020

REICHHOLD CHEMICALS, INC.
TACOMA, WASHINGTON

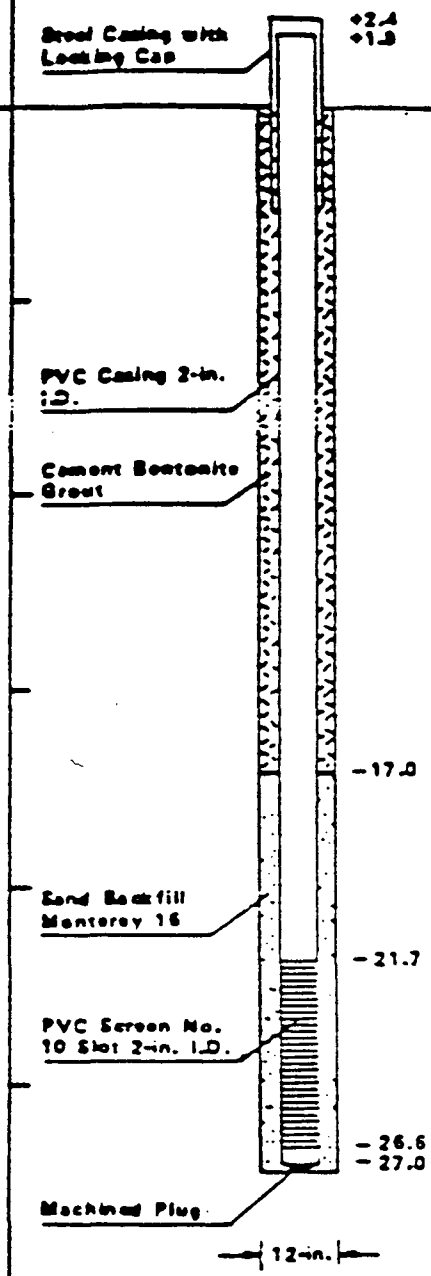
GROUNDWATER MONITORING WELL
MW-10S

W-4445-01
NOVEMBER 1985

Figure A-74

LOG & AS-BUILT DIAGRAM

GEOLOGIC LOG	HYDROLOGIC UNIT	LOG DEPTH IN FEET	WATER LEVEL	AS BUILT
DRILLER: KRING DRILLING COMPANY COMPLETION DATE: October 9, 1985 ALTITUDE: 12.58 Feet, MSL, Surveyed (Top of PVC Casing)				
GROUND SURFACE		0		
Fine to medium SAND: brown grading to gray, with layers of clayey silt and peat, water bearing below 4 feet.	Shallow Aquifer	5		
Clayey SILT: gray, thin layers of silty fine sand, with peat.	Aquitard	10	10-10-85	
Fine to medium SAND: gray, silty layers, clayey silt at 21 feet, grades to medium sand at 23 feet, water bearing.	Intermediate Aquifer	15 20 25		
Clayey SILT: gray.	Aquitard			
TOTAL DEPTH 27.0 FEET		30		



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(206) 632-8020

REICHHOLD CHEMICALS, INC.
TACOMA, WASHINGTON

GROUNDWATER MONITORING WELL
MW-101

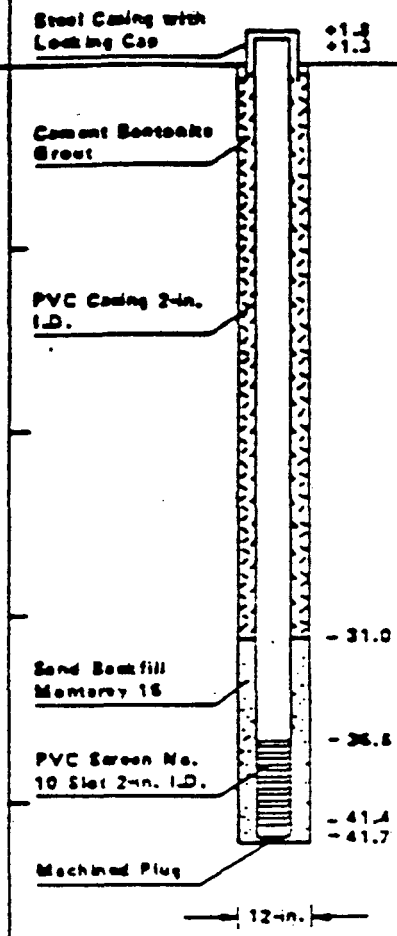
W-4446-01
NOVEMBER 1985

Figure A-75

LOG & AS-BUILT DIAGRAM

GEOLOGIC LOG	HYDROLOGIC UNIT	LOG DEPTH IN FEET	WATER LEVEL
DRILLER: KRING DRILLING COMPANY COMPLETION DATE: October 9, 1985 ALTITUDE: 12.46 Feet, MSL, Surveyed (Top of PVC Casing)			
GROUND SURFACE		0	
Fine to medium SAND: brown and gray, layers of clayey silt, with peat, water bearing below 4 feet.	Shallow Aquifer		
Clayey SILT: gray, thin layers of fine sand, with peat.	Aquitard	10	
Silty fine to medium SAND: gray, layers of clayey silt, grades to medium sand, water bearing.	Intermediate Aquifer	20	10-10-85
Clayey SILT: gray.	Aquitard	30	
Medium SAND: gray, thin layers of silty fine sand, water bearing.	Deep Aquifer		
CLAY: light gray-green, with peat.	Aquitard	40	
TOTAL DEPTH 41.7 FEET		50	

AS BUILT



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(206) 632-8020

REICHHOLD CHEMICALS, INC.
TACOMA, WASHINGTON

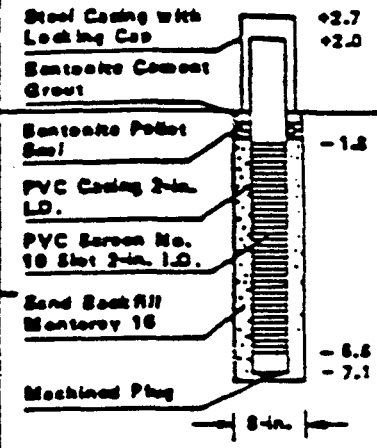
GROUNDWATER MONITORING WELL
MW-100

W-4446-01
NOVEMBER 1985

Figure A-76

LOG & AS-BUILT DIAGRAM

GEOLOGIC LOG	HYDROLOGIC UNIT	LOG DEPTH IN FEET	WATER LEVEL	AS BUILT
DRILLER: KRING DRILLING COMPANY COMPLETION DATE: October 3, 1985 ALTITUDE: 12.34 Feet, MSL, Surveyed (Top of PVC Casing)				
GROUND SURFACE		0		
Silty fine to medium SAND: brown, water bearing below 3.5 feet.	Shallow Aquifer			
Silty CLAY: brown with black staining, abundant peat.	Aquitard	5	10-4-85	
TOTAL DEPTH 7.1 FEET		10		



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WASTE MANAGEMENT SERVICES
SEATTLE, WASHINGTON
(206) 632-8020

REICHHOLD CHEMICALS, INC.
TACOMA, WASHINGTON

GROUNDWATER MONITORING WELL
MW-11S

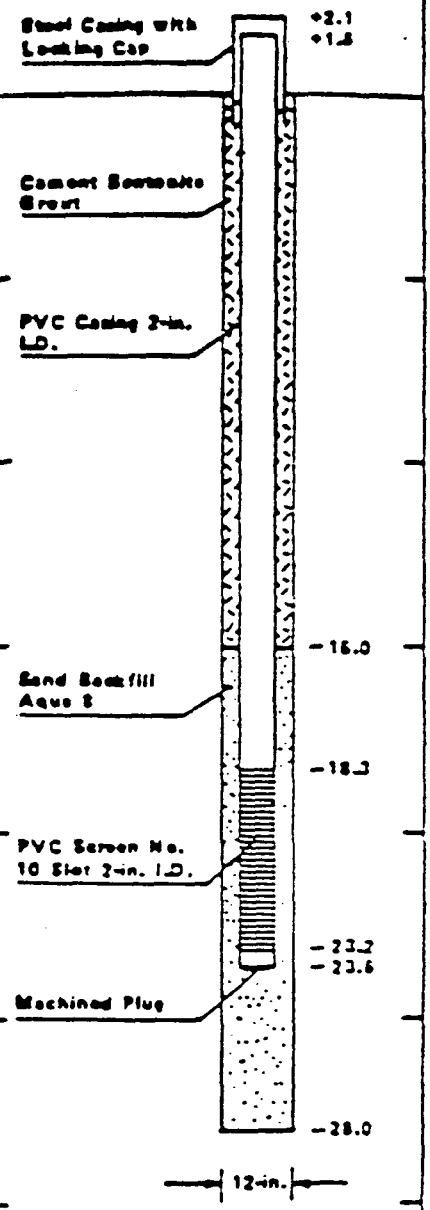
W-4446-01
NOVEMBER 1985

Figure A-77

LOG & AS-BUILT DIAGRAM

GEOLOGIC LOG	HYDROLOGIC UNIT	LOG DEPTH IN FEET	WATER LEVEL
DRILLER: ERING DRILLING COMPANY COMPLETION DATE: October 3, 1985 ALTITUDE: 12.33 Feet, MSL, Surveyed (Top of PVC Casing)			
GROUND SURFACE		0	
Silty fine to medium SAND: brown, water bearing below 3.5 feet.	Shallow Aquifer		
Silty CLAY: brown with black mottling, abundant peat.	Aquitard	5	
Fine to coarse SAND: gray, alternating fine and coarse sand layers, water bearing.	Intermediate Aquifer	10 15 20 25	10-4-85
Clayey SILT: gray.	Aquitard	30	
TOTAL DEPTH 28.0 FEET			

AS BUILT



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SEATTLE, WASHINGTON
(206) 632-8020

REICHHOLD CHEMICALS, INC.
TACOMA, WASHINGTON

GROUNDWATER MONITORING WELL
MW-111

W-4445-01
NOVEMBER 1985

Figure A-78

Hart Crowser
J-2350-07

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG
MW-11D; MW-13S,I,D; MW-16S,I; MW-27S, MW-28I;
MW-29I; MW-30I; MW-32S, MW-33S; MW-36I; MW-39I;
AND MW-43S

CH2M HILL

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
521487.F1	MW-11D	SHEET 1 OF 2

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 12.76 SURFACE ELEVATION, NGVD 10.8

WATER LEVEL ELEVATION, NGVD 3.76 (12/10/86) START DATE 09/24/86

DRILLING CONTRACTOR Staco Well Service Inc. FINISH DATE 09/29/86

DRILLING METHOD Bucyrus Erie 22-W Cable Tool - Continuous Split Spoon

DEPTH (Ft)	SAMPLE Recovery %	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
			SAND, fine to medium, trace to little clay nodules, brown to dark brown (SP), some iron stained grains, silty zones (SM)	Shallow Aquifer
5	100	1-1-1	SILT AND CLAYEY SILT, grey to brown, stiff (ML), some organics (twigs), grades downward to dark grey to black clayey silt and peat (ML-OL), abundant carbonaceous material	Upper Aquitard
	50	1-0-1		
	100	0-1-3		
10	33	2-3-2	SILTY SAND, very fine to fine, brown to dark grey (SM), some organics, grades downward to less silt	Intermediate Aquifer
	66	2-2-2		
	90	3-3-2	wood chips at 14.0 feet and scattered to 19.0 feet	
	100	2-2-2		
15	66	0-0-1	SAND, medium to coarse, some fine, trace silt, dark grey to black (SP), grades downward to fine to medium sand at 19.0 feet	
	100	0-0-1		
	66	0-1-2		
20	17	0-1-1		
	100	0-1-2	occasional interbeds of coarse sand and silty sands	
	100	3-3-3		
	0	0-0-4		
25	0	0-2-1		
	100	0-0-0	SILT, trace to little sand, grey-brown (ML), grades downward to silty sand at 29.5 feet (SM)	Lower Aquitard
	100	0-1-2		

WELL CONSTRUCTION

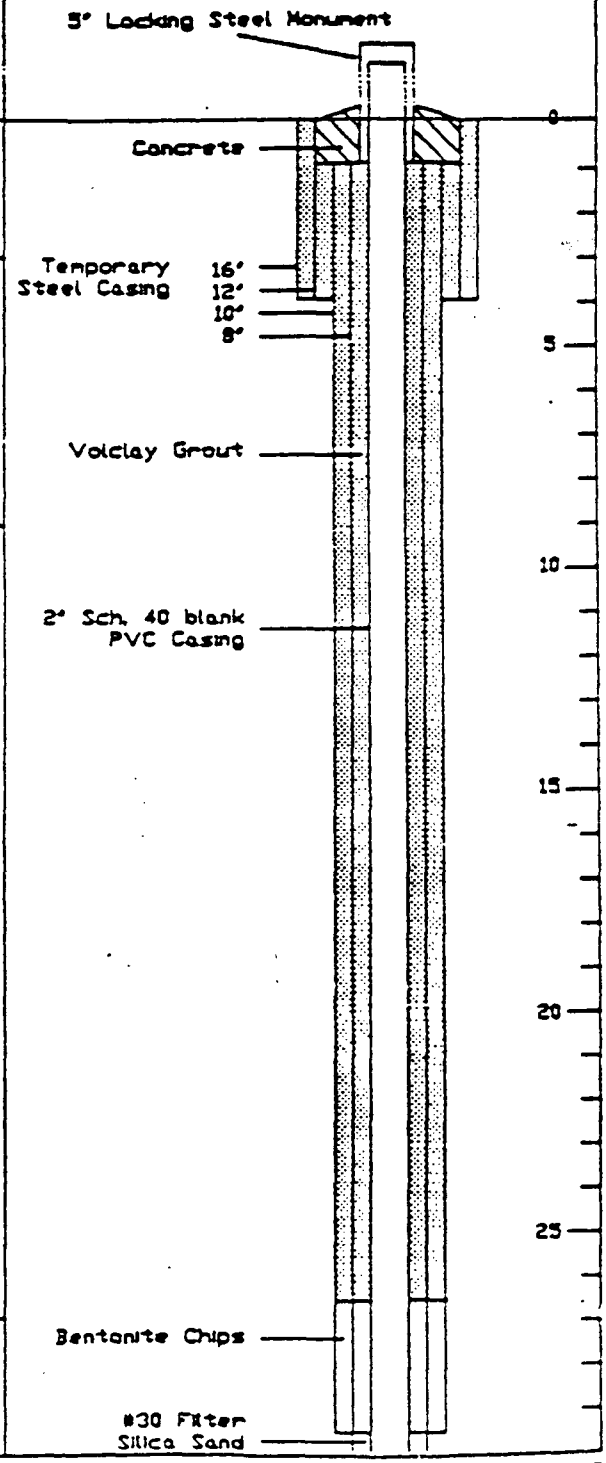


Figure A-79 1/2

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F1	MW-11D	SHEET 2 OF 2

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 12.76 SURFACE ELEVATION, NGVD 10.8

WATER LEVEL ELEVATION, NGVD 3.76 (12/10/86) START DATE 09/24/86

DRILLING CONTRACTOR Staco Well Service Inc. FINISH DATE 09/29/86

DRILLING METHOD Bucyrus Erie 22-W Cable Tool - Continuous Split Spoon

DEPTH (Ft)	SAMPLE Recovery %	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT	WELL CONSTRUCTION
	100	0-2-4			30
	100	0-4-4	SAND, fine to very fine, occasional silt interbeds, dark grey to black (SP-SM)	Deep Aquifer	Centering Guides; 2" Sch. 40 Slotted PVC Casing (0.010" slots)
	100	2-5-8			#16 Filter Monterey Sand
35	100	0-3-5	SAND, fine, grey, sharp contact with silt interbeds (SP) 35		35; Centering Guides
	100	2-1-1			2" Sch. 40 blank PVC Casing
	100	1-0-1	ORGANIC SILT, grey, with peat and fine sand stringers (OL)	Aquitard	
40			40		40
45			45		45
50			50		50
55			55		55

NTS

Figure A-79 2/2

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F1	MW-13S	SHEET 1 OF 1

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 12.63 SURFACE ELEVATION, NGVD 10.6

WATER LEVEL ELEVATION, NGVD 8.22 (12/10/86) START DATE 11/13/86

DRILLING CONTRACTOR Geo-Tech Explorations, Inc. FINISH DATE 11/13/86

DRILLING METHOD CME - 75 with 6-inch ID hollow stem auger

DEPTH (ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
			SILTY SAND, fine to medium, trace clay nodules (SM)	Shallow Aquifer
	72	2-2-4		
	44	3-4-5	SAND, fine to medium, dark brown (SP), oily sheen on sample from 4.5 to 6 feet	
5	67	1-1-1		
	56	2-2-1		
	67	0-1-1	CLAYEY SILT, brown, abundant organic material (ML)	
10				
15				
20				
25				

WELL CONSTRUCTION

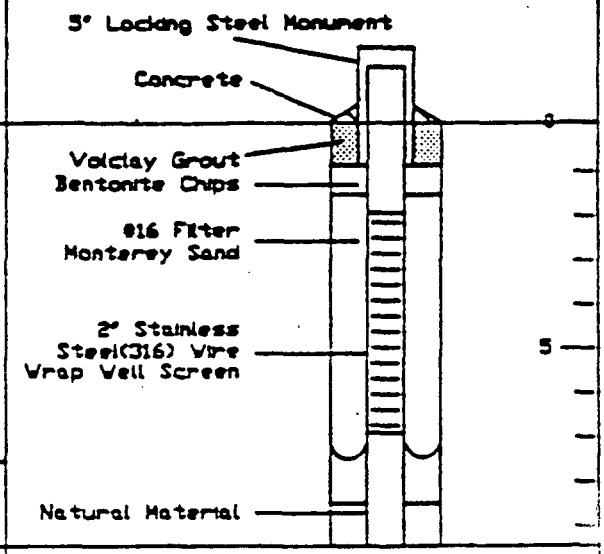


Figure A-80

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F1	MW-13I	SHEET 1 OF 1

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 12.68 SURFACE ELEVATION, NGVD 10.7

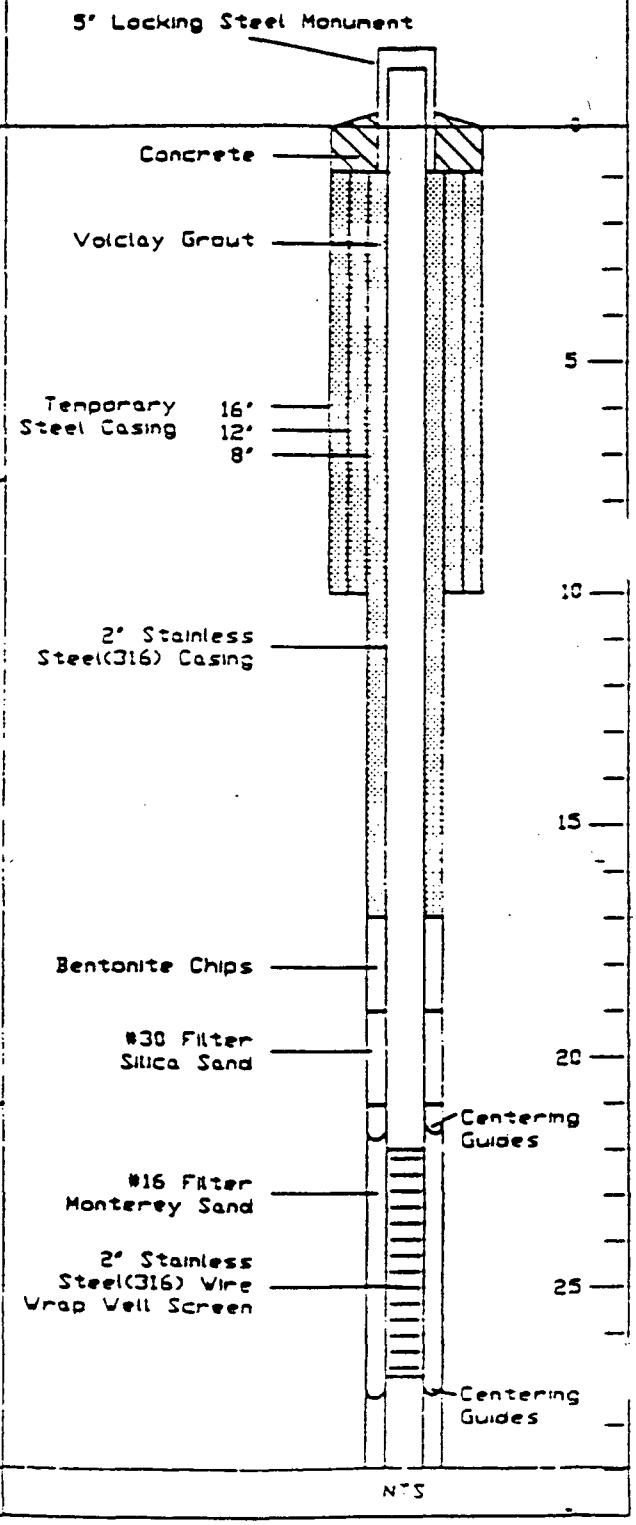
WATER LEVEL ELEVATION, NGVD 3.39 (12/10/86) START DATE 10/28/86

DRILLING CONTRACTOR Staco Well Service Inc. FINISH DATE 10/29/86

DRILLING METHOD Bucyrus Erie 22-W Cable Tool - Continuous Split Spoon

DEPTH (ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
			SILTY SAND, fine to medium, trace clay nodules (SM)	Shallow Aquifer
	72	2-2-4		
	44	3-4-5	SAND, fine to medium, dark brown (SP), oily sheen on sample from 4.5 to 6 feet	
5	67	1-1-1		
	56	2-2-1		
	67	0-1-1	CLAYEY SILT, brown, abundant organic material (ML)	Upper Aquitard
10	67	1-0-1		
	100	0-0-1		
	100	0-0-1	Peat from 13.5 to 13.8 feet	
	100	0-0-1		
15	100	0-1-1		
	100	0-0-1		
	100	0-0-1	SILT AND SILTY SAND, very fine, brown to grey-brown, interbedded, trace organics (ML and SM)	
20	100	0-0-1		
	100	0-2-2	SILTY SAND, fine, dark grey (SM)	Intermediate Aquifer
	67	2-3-4		
	78	6-6-4	SAND, SILTY SAND AND SANDY SILT interbedded, fine to medium sand, trace organics and shell fragments (SP, SM and ML)	
25				
	67	3-4-1		
	100	0-0-1		

WELL CONSTRUCTION



NTS

Figure A-81

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F1	MW-13D	SHEET 1 OF 2

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 12.59 SURFACE ELEVATION, NGVD 10.6

WATER LEVEL ELEVATION, NGVD 2.63 (12/10/86) START DATE 10/21/86

DRILLING CONTRACTOR Staco Well Service Inc. FINISH DATE 10/27/86

DRILLING METHOD Bucyrus Erie 22-W Cable Tool - Continuous Split Spoon

DEPTH (ft)	SAMPLE Recovery %	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
			SILTY SAND, fine to medium, trace clay nodules (SM)	Shallow Aquifer
	72	2-2-4		
	44	3-4-5	SAND, fine to medium, dark brown (SP), oily sheen on sample from 4.5 to 6 feet	
5	67	1-1-1	5	
	56	2-2-1		
	67	0-1-1	CLAYEY SILT, brown, abundant organic material (ML)	Upper Aquitard
10	67	1-0-1	10	
	100	0-0-1		
	100	0-0-1	Peat from 13.5 to 13.8 feet	
	100	0-0-1		
15	100	0-1-1	15	
	100	0-0-1		
	100	0-0-1	SILT AND SILTY SAND, very fine, brown to grey-brown, interbedded, trace organics (ML and SM)	
20	100	0-0-1	20	
	100	0-2-2	SILTY SAND, fine, dark grey (SM)	Intermediate Aquifer
	67	2-3-4	SAND, SILTY SAND AND SANDY SILT, interbedded, fine to medium sand, trace organics and shell fragments (SP, SM and ML)	
25	78	6-6-4	25	
	67	3-4-1		
	100	0-0-1		
	100	0-0-1	CLAYEY SILT, light brown (ML)	

WELL CONSTRUCTION

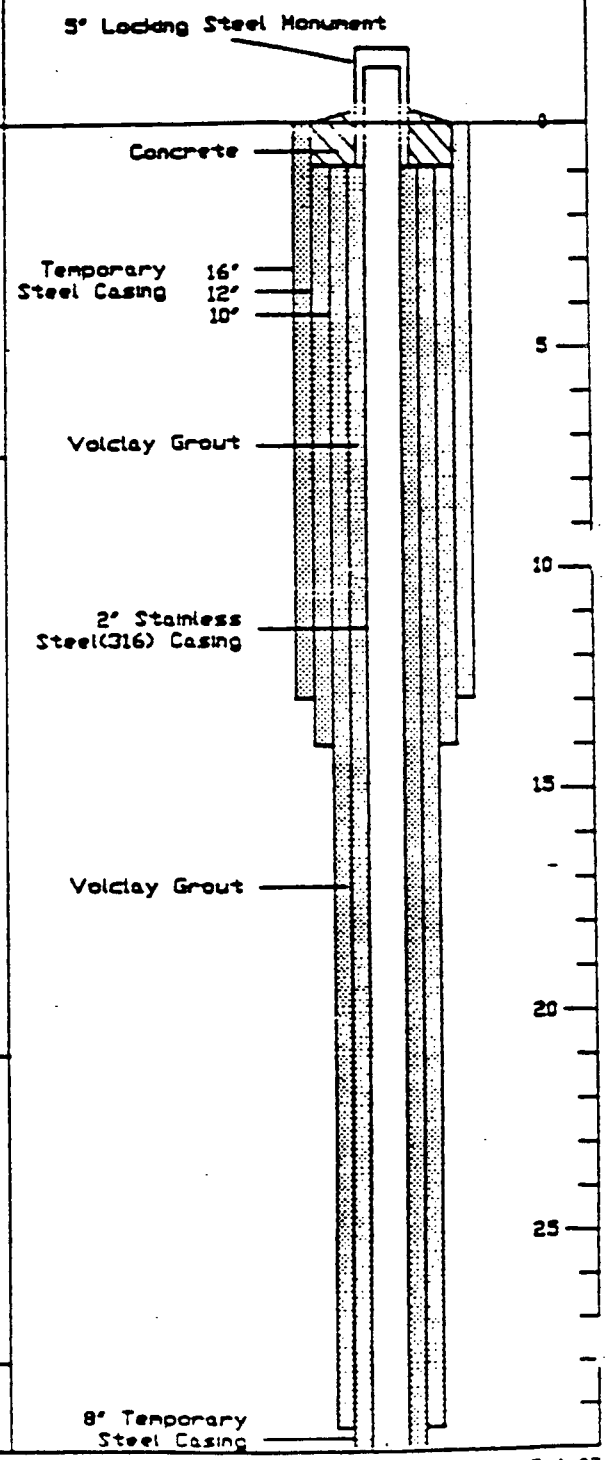


Figure A-82 1/2

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

CH2M HILL

PROJECT NUMBER	WELL NUMBER	
S21487.F1	MW-13D	SHEET 2 OF 2

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 12.59 SURFACE ELEVATION, NGVD 10.6

WATER LEVEL ELEVATION, NGVD 2.63 (12/10/86) START DATE 10/21/86

DRILLING CONTRACTOR Staco Well Service Inc. FINISH DATE 10/27/86

DRILLING METHOD Bucyrus Erie 22-V Cable Tool - Continuous Split Spoon

DEPTH (Ft)	SAMPLE Recovery %	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
	44	0-0-1	CLAYEY SILT, light brown, abundant organics (ML)	Lower Aquitard
	44	0-0-1		
	100	1-1-1	1 to 2-inch thick interbeds of peat	
35	100	0-0-1		
	100	0-0-1		
	100	0-0-1	SILT, trace fine sand, brown (ML), grades downward to increasing sand and trace shell fragments	
40	100	0-0-1		
	67	0-0-1	SAND, medium, trace silt, dark grey (SP)	Deep Aquifer
	67	2-2-2		
	100	2-2-3	zone of brown silty sand	
45	100	1-6-8		
	100	5-4-6		
	100	7-8-9		
50	100	6-8-8	grades to medium to coarse sand	
55				

WELL CONSTRUCTION

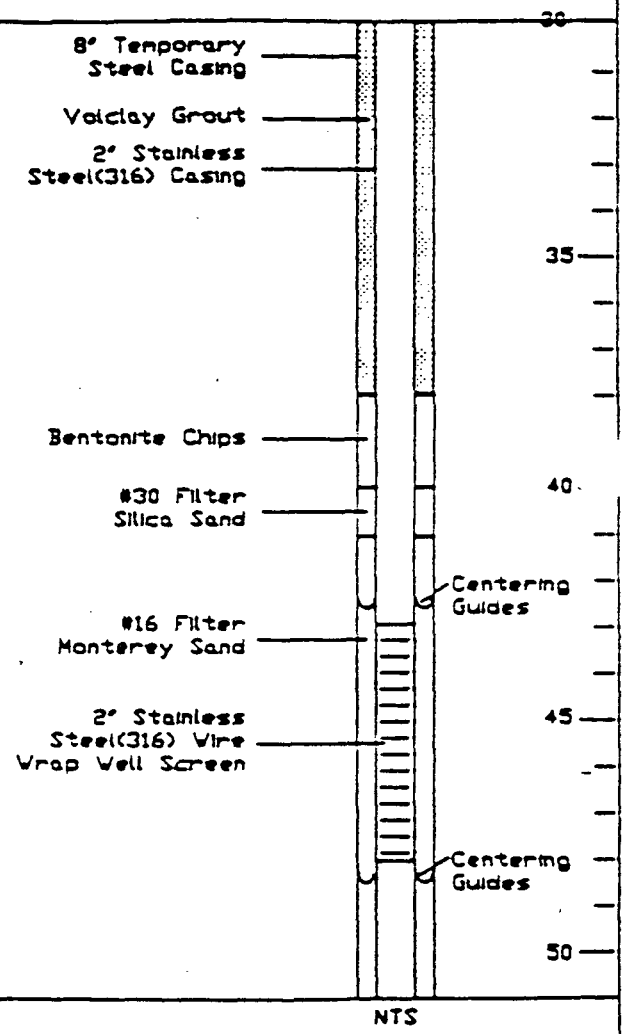


Figure A-82 2/2

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F1	MW-16S	SHEET 1 OF 1

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 11.73 SURFACE ELEVATION, NGVD 10.0

WATER LEVEL ELEVATION, NGVD 8.99 (12/10/86) START DATE 10/29/86

DRILLING CONTRACTOR Geo-Tech Explorations, Inc. FINISH DATE 10/29/86

DRILLING METHOD CME - 75 with 6-inch ID hollow stem auger

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
			SAND, medium, some silty sand zones, grey to dark brown (SP-SM)	Shallow Aquifer
	78	4-3-3	SAND, fine to medium, trace silt, dark grey to black, zones of abundant shell fragments present (SP), grades siltier at 7.0 feet	
5	67	1-1-1		
	67	2-1-0	ORGANIC SILT, brown to black, abundant carbonaceous material, soft (OL)	
	100	0-0-1		
10				
15				
20				
25				

WELL CONSTRUCTION

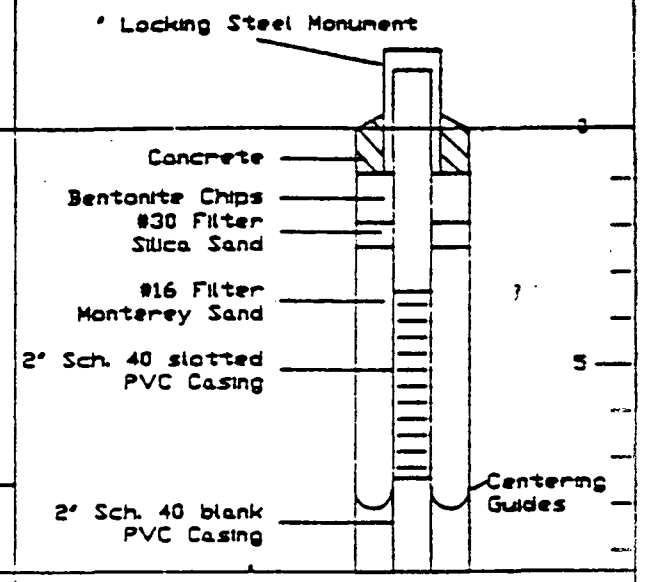


Figure A-83

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
321487.F1	MW-16I	SHEET 1 OF 1

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 11.90 SURFACE ELEVATION, NGVD 9.8

WATER LEVEL ELEVATION, NGVD 4.47 (12/10/86) START DATE 10/06/86

DRILLING CONTRACTOR Staco Well Service Inc. FINISH DATE 10/07/86

DRILLING METHOD Bucyrus Erie 22-W Cable Tool - Continuous Split Spoon

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
			SAND, medium, some silty sand zones, grey to dark brown (SP-SM)	Shallow Aquifer
	78	4-3-3	SAND, fine to medium, trace silt, dark grey to black, zones of abundant shell fragments present (SP), grades siltier at 7.0 feet	
5	67	1-1-1		
	67	2-1-0	ORGANIC SILT, brown to black, abundant carbonaceous material, soft (OL)	Upper Aquitard
	100	0-0-1		
10			CLAYEY SILT, light brown to grey, organic material (wood) present (ML), grades downward to less organics	
	100	0-0-1		
	100	0-0-1		
	100	0-0-1		
15	89	0-0-1	similar as above, trace fine sand, increasing fine sand content	
	100	0-0-1		
	100	1-2-5		
			SAND, fine, trace silt, dark grey to black (SP)	Intermediate Aquifer
20	89	2-3-5		
	94	4-4-8		
	94	3-4-7		
	76	7-7-9		
25	100	4-7-10		
	100	1-1-1		
	133	0-1	CLAYEY SILT, light brown, soft (ML)	

WELL CONSTRUCTION

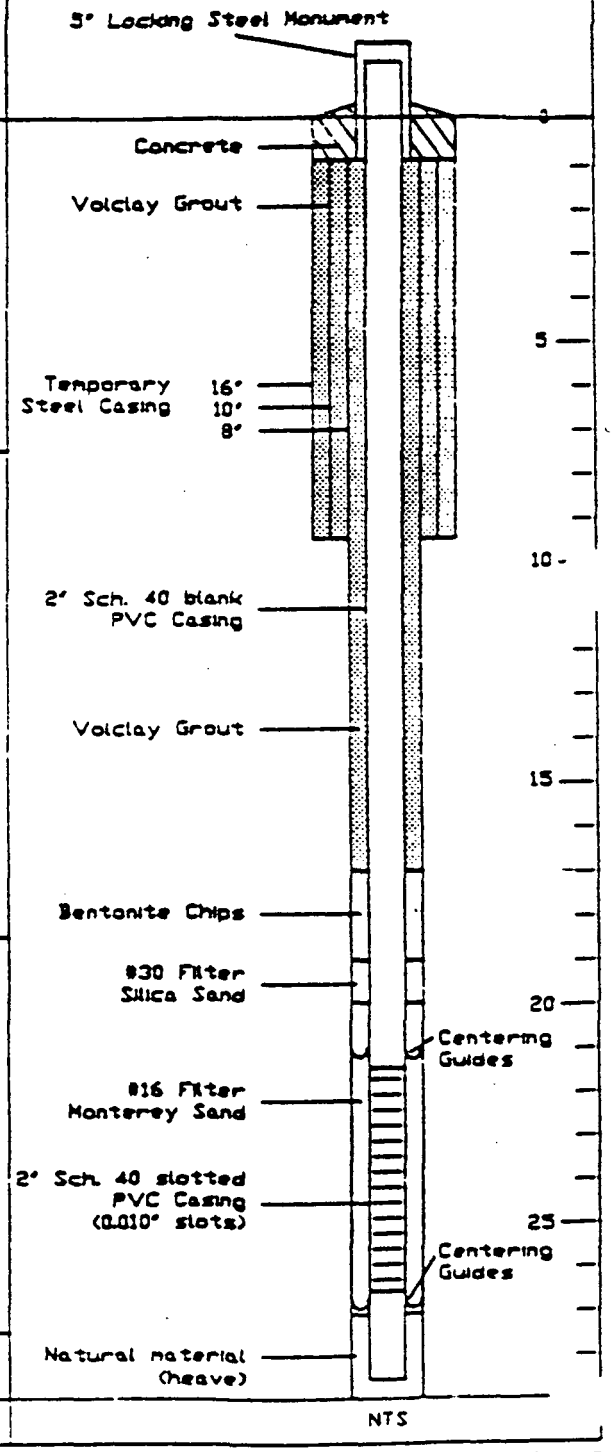


Figure A-84

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F5	MW-27S	SHEET 1 OF 1

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, VA

ELEVATION, NGVD (Top of Well Casing) 12.47 Ft. SURFACE ELEVATION, NGVD 10.5 Ft.

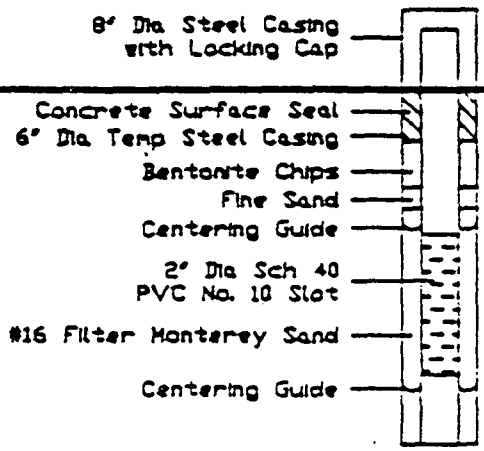
WATER LEVEL ELEVATION, NGVD 8.03 Ft. (05/29/87) START DATE 05/01/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 05/01/87

DRILLING METHOD Mobile B-61 6" I.D. Hollow Stem Auger

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
	56	4-7-5	SILTY SAND, fine, gray to brown, moist with some silt (20%) (SM)	SHALLOW AQUIFER
	100	3-3-2	SILTY SAND, gray, wet (SM)	
	100	3-2-2	SILTY CLAY, brown with black streaking, moist, trace (10%) amounts of organic matter.	
5	44	1-1-1	CLAYEY SILT, light brown with black streaking, moist, med plasticity with some (20%) organic material (ML-OL)	UPPER AQUITARD
	89	1-1-1	END BORING AT 7.5 FT	
10				
15				
20				
25				

WELL CONSTRUCTION



MVI F 1-87

Figure A-85

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F5	MW-28I	SHEET 1 OF 2

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, Va

ELEVATION, NGVD (Top of Well Casing) 16.04 Ft. SURFACE ELEVATION, NGVD 14.2 Ft.

WATER LEVEL ELEVATION, NGVD 2.36 Ft. (05/28/87) START DATE 05/07/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 05/11/87

DRILLING METHOD Koehring Speedstar 71 8" Dia Cable Tool

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
	44	22-20-12	FILL-SAND & SILT, fine-coarse, brown and gray, dry, trace of gravel 1/4" to 1.5" dia. (SP-SM)	UPPER AQUIFER
5	33	10-6-8	SILTY SAND, fine, dry-moist, gray-brown with some (35%) silt (SM)	UPPER AQUIFER
	33	2-1-5		UPPER AQUIFER
	28	5-4-7	SAND, poorly graded, med-coarse, gray, moist, trace amounts of silt (SP-SM)	UPPER AQUIFER
	100	3-2-3	SILT, black and brown, moist, with little (15%) amounts of organic matter (roots and wood chips), odorous (ML)	UPPER AQUITARD
10	67	2-4-2		UPPER AQUITARD
	100	6-12-7		UPPER AQUITARD
	56	5-6-3	SAND, poorly graded, fine-med, black to gray with trace of red sand, wet, with trace (10%) amounts of silt (SP-SM)	UPPER AQUITARD
15	44	12-13-10		INTERMEDIATE AQUIFER
	44	1-3/12		INTERMEDIATE AQUIFER
20				INTERMEDIATE AQUIFER
	56	3-5-3		INTERMEDIATE AQUIFER
25				INTERMEDIATE AQUIFER
	44	5-6-19	SAND, poorly graded, fine, black to gray, wet, trace (10%) amounts of silt (SP-SM)	INTERMEDIATE AQUIFER

WELL CONSTRUCTION

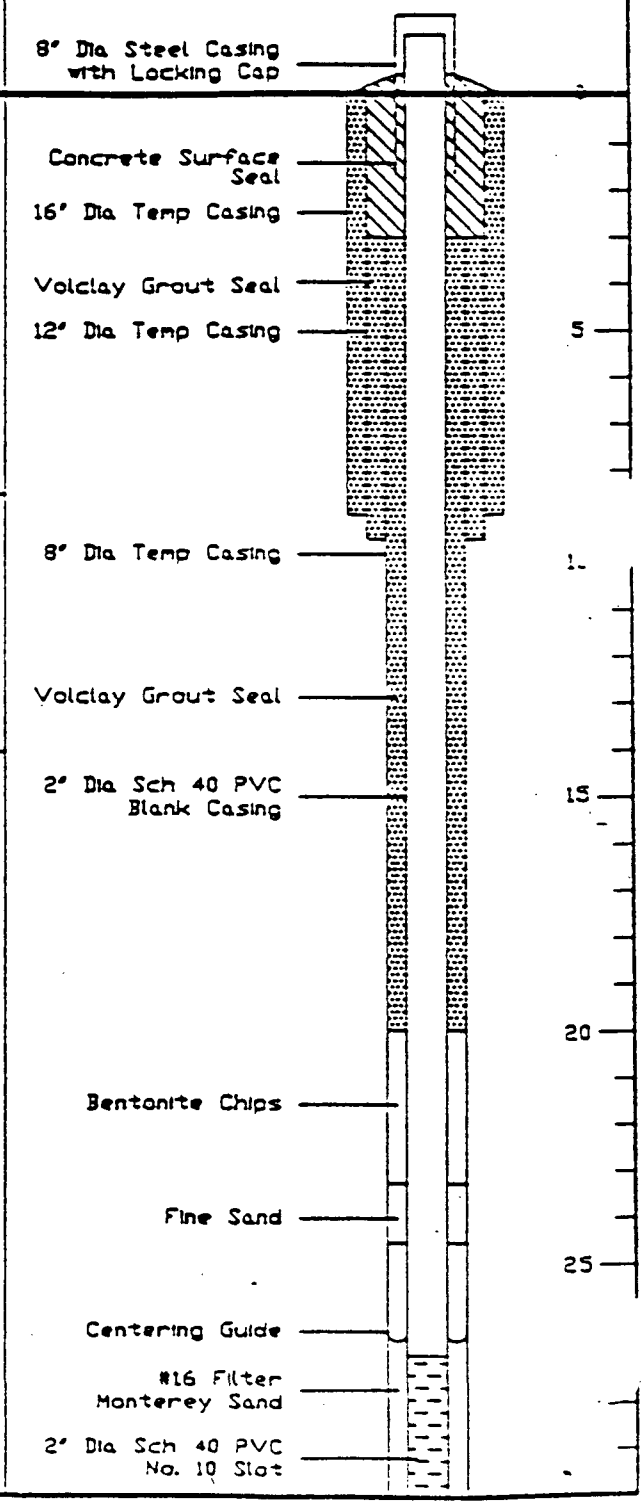


Figure A-86 1/2

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F5	MW-28I	SHEET 2 OF 2

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 16.04 Ft. SURFACE ELEVATION, NGVD 14.2 Ft.

WATER LEVEL ELEVATION, NGVD 2.36 Ft. (05/29/87) START DATE 05/07/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 05/11/87

DRILLING METHOD Koehring Speedstar 71 8" Dia Cable Tool

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT	WELL CONSTRUCTION
	44	7-7-6	SAND, poorly graded, fine, black, wet, with trace amounts of silt (SP-SM)	INTERMEDIATE AQUIFER	Centering Guide
35	89	3-2-2	SILT, gray, wet, slight plasticity (ML)	LOWER AQUITARD	
			END BORING AT 36 FT		
40					
45					
50					
55					

HVLF, 1-87

Figure A-86 2/2

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F5	MW-291	SHEET 1 OF 2

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 14.08 Ft. SURFACE ELEVATION, NGVD 12.3 Ft.

WATER LEVEL ELEVATION, NGVD 2.38 Ft. (05/28/87) START DATE 05/12/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 05/13/87

DRILLING METHOD Koehring Speedstar 71 8" Dia Cable Tool

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
	44	4-7-6	SILTY SAND, fine, gray-brown with iron stained interbedded lenses of same, moist with little (20%) amounts of silt (SM)	UPPER AQUIFER
5	44	5-3-6		
	22	1/18	SILT, black-brown, dry, with trace organic matter (roots) (ML)	
	78	1-1-1	SILT, gray, moist, with some (35%) fine sand (SM)	UPPER AQUITARD
	78	2-5-3		
10	100	2/18	SILT, gray with interbedded iron stained lenses of same, moist, slight plasticity, trace organic material (roots) (ML)	
	78	1-1-1		
15	100	1-1-1		
	100	3/18		
	100	0/18		
20	100	1-3-3	SILT, brown, wet, slight plasticity (ML)	
			SAND & SILT, fine, black with trace of red sand, wet, (ML and SM)	INTERMEDIATE AQUIFER
25	100	3-2-6	SILTY SAND, fine, gray, wet (SM)	
	100	1-1-3	Trace amounts of shell fragments.	

WELL CONSTRUCTION

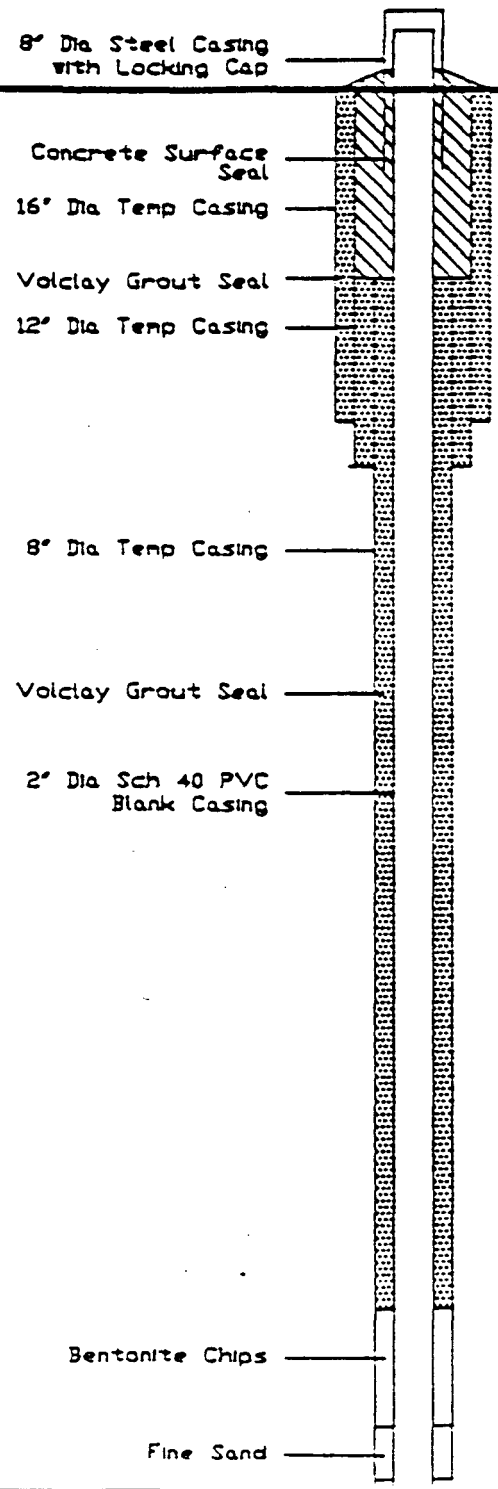


Figure A-87 1/2

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F5	MW-291	SHEET 2 OF 2

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, VA

ELEVATION, NGVD (Top of Well Casing) 14.08 Ft. SURFACE ELEVATION, NGVD 12.3 Ft.

WATER LEVEL ELEVATION, NGVD 2.38 Ft. (05/28/87) START DATE 05/12/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 05/13/87

DRILLING METHOD Koehring Speedstar 71 8" Dia Cable Tool

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT	WELL CONSTRUCTION
	44	0/18	SILTY SAND, fine, gray, saturated with some (35%) fines (SM)	INTERMEDIATE AQUIFER	Centering Guide
35					2" Dia Sch 40 PVC No. 10 Slot
	44	1-1-1	SILTY SAND, fine, gray, saturated with little (15%) fines (SM)		#16 Filter Monterey Sand
	44	0/18	SILT, gray with light brown mottling and organic matter (grasses), moist, slight-low plasticity, soft (ML)	LOWER AQUITARD	Centering Guide
40			END BORING AT 40 FT		
45					
50					
55					

HVLF, 1-87

Figure A-87 2/2

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F5	MW-301	SHEET 1 OF 1

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 13.66 Ft. SURFACE ELEVATION, NGVD 12.0 Ft

WATER LEVEL ELEVATION, NGVD 2.58 Ft. (05/28/87) START DATE 05/14/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 05/15/87

DRILLING METHOD Koehring Speedstar 71 8" Dia Cable Tool

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
				UPPER AQUIFER
	44	6-6-7	SILTY SAND, fine, gray-brown with interbedded oxidized lenses of same, dry, some (30%) fines (SM)	
	17	2/12-1/16	SILTY SAND, fine, transition to gray, some (30%) fines (SM)	
5				
	56	6-4-3	SAND & SILT, interbedded lenses of each to 3" thick, fine sand, gray with 30% fines, SILT, brown with black mottling, wet, slight plasticity (SM and ML)	
	100	1-1-1	SILT, gray with black organic mottling, moist, slight plasticity, PEAT lense 1/2" thick at 8', black-brown (ML)	UPPER AQUITARD
10	100	2-1/18	SAND & SILT, interbedded lenses of each to 5" thick, SAND, is fine, gray, moist SILT, gray, moist, slight plasticity, 10% organics (SM-ML)	
	100	1/18		
	100	2-2-9	SAND, poorly graded, fine, gray with trace of red sand, saturated, trace (10%) fines (SP-SM)	INTERMEDIATE AQUIFER
	67	5-5-9		
15				
	78	3-3-12	Increasing red sand (35%)	
20				
	44	9-17-20	Decreasing red sand (20%)	
25				
	44	6-7-8		
	67	1-1-1	SILT, brown, wet, with trace amounts of wood chips (ML)	LOWER AQUITARD
			END BORING AT 29.5 FT	

WELL CONSTRUCTION

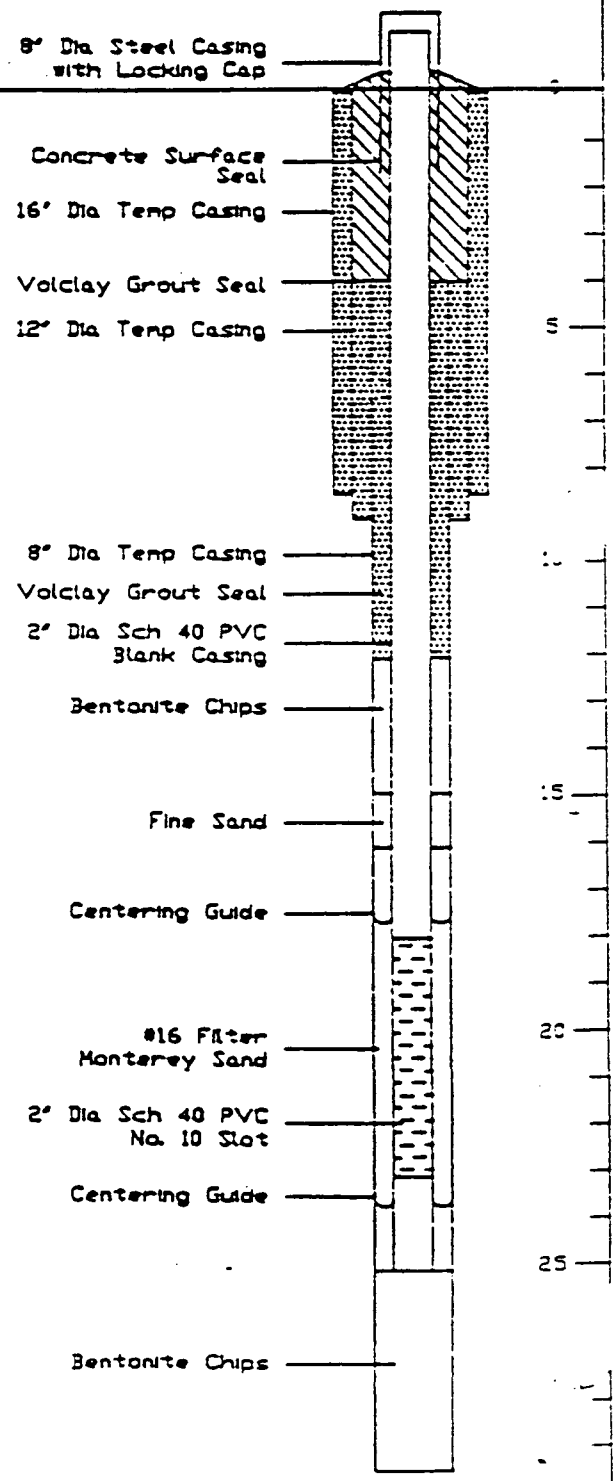


Figure A-88

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F5	MW-32S	SHEET 1 OF 1

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 12.17 Ft. SURFACE ELEVATION, NGVD 10.7 Ft.

WATER LEVEL ELEVATION, NGVD 6.29 Ft. (05/28/87) START DATE 05/28/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 05/28/87

DRILLING METHOD Mobile B-61 6" I.D. Hollow Stem Auger

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
	33	3-5-15	SILTY SAND, poorly graded, fine, gray, dry-moist, loose, with 25% fines, some oxidized lenses of same between 3-4.5 ft. (SM)	SHALLOW AQUIFER
	89	2-3-3		
	50	2-2-2		
5	56	1-3-2	SILT & SAND, interbedded lenses of each 3-5' thickness, gray, moist, med firm, 2' thickness wood chip lense at 5.75 ft. (SM)	
	100	3-2-2	Water bearing at 6.5-6.75 ft.	
	100	1-1-1	SILT, black, dry, very firm with 10% organic matter, 4' thick (ML) SILT, light brown with black organic mottling, moist, med firm, slight plasticity (ML)	LOWER AQUITARD
10			END BORING AT 9.0 FT	
15				
20				
25				

WELL CONSTRUCTION

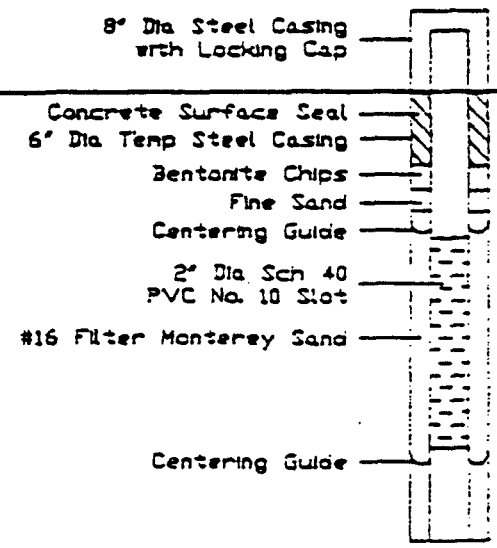


Figure A-89

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F5	MW-33S	SHEET 1 OF 1

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 11.96 Ft. SURFACE ELEVATION, NGVD 10.2 Ft.

WATER LEVEL ELEVATION, NGVD 5.02 Ft. (05/28/87) START DATE 05/28/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 05/28/87

DRILLING METHOD Mobile B-61 6" I.D. Hollow Stem Auger

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
	33	2-6-7	SILT, light brown, dry, loose, little fine sand (SM)	SHALLOW AQUIFER
			SAND, gray-brown, dry, loose, some fines (SM)	
	78	4-3-1	SAND, poorly graded fine sand, gray with oxidized lenses of same, dry with 20% fines (SM)	
	6	1-1-1	Interbedded SAND & SILT lenses to 3" thickness. Water bearing.	
5	6	2-3-3	5	
	67	1-1-1	SAND, poorly graded, fine, black-gray with trace of red sand and shell fragments, wet (10% fines (SP-SM)	
	28	2-2-4	SILT, light brown, wet, soft, slight plasticity transition to black, dry, dense, (10% organic matter (ML)	UPPER AQUITARD
10			SILT, brown with black organic mottling, dry-moist, firm (ML) 10	
			END BORING AT 9.5 FT	
15			15	
20			20	
25			25	

WELL CONSTRUCTION

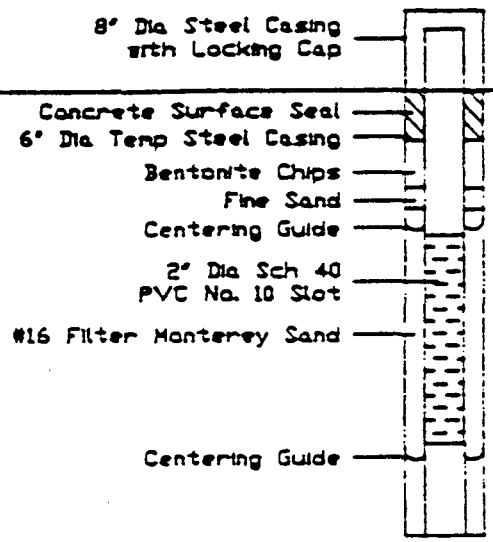


Figure A-90

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F5	MW-36I	SHEET 1 OF 2

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 11.75 Ft. SURFACE ELEVATION, NGVD 10.3 Ft.

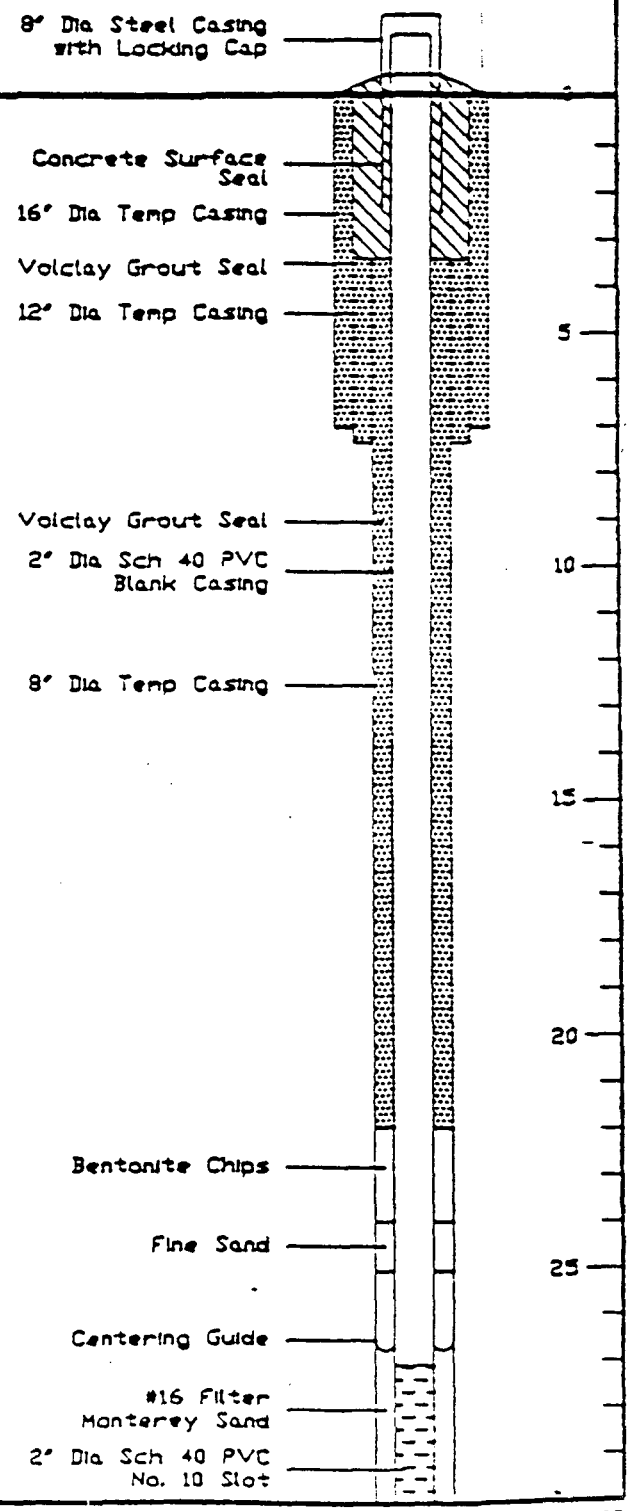
WATER LEVEL ELEVATION, NGVD 2.29 Ft. (06/28/87) START DATE 06/01/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 06/02/87

DRILLING METHOD Koehring Speedstar 71 8" Dia Cable Tool

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
5				SHALLOW AQUIFER
			PEAT dark brown to black, med firm (PT)	
	100	1/18	SILT light brown with black organic mottling, wet, soft, low plasticity (OL)	UPPER AQUITARD
10				
	100	2-2-2	SILT light gray with black organic mottling, trace amounts of wood chips, soft, slight plasticity (ML) Grades to Silty Sand at 11 ft. (SM)	
15	100	2-2-2	SILTY SAND gray, wet, soft (SM)	
20	100	1-1-2	SANDY SILT fine sand with some (25%) med sand and 25% silt (SM)	
	100	1-2-4	Same, becoming more dense	
25				
	89	2-6-8	SILT brown-gray, wet, soft (ML)	
			SILTY SAND fine, dark gray with trace red sand, med firm, saturated, 15% fines (SM)	INTERMEDIATE AQUITARD

WELL CONSTRUCTION



MWLF, 1-87

Figure A-91 1/2

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F5	MW-36I	SHEET 2 OF 2

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, Va

ELEVATION, NGVD (Top of Well Casing) 11.75 Ft. SURFACE ELEVATION, NGVD 10.3 Ft.

WATER LEVEL ELEVATION, NGVD 2.09 Ft. (06/28/87) START DATE 06/01/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 06/02/87

DRILLING METHOD Koehring Speedstar 71 8" Dia Cable Tool

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT	WELL CONSTRUCTION
	100	4-5-3	Trace amounts of shell fragments	INTERMEDIATE AQUIFER	Centering Guide
			SILT, dry, dark brown, dense (ML)		
	100	1-3-3	PEAT, light brown, dense (PT)	LOWER AQUITARD	
			SILT, brown to gray, soft, moist, med plasticity (MH)		
35			END BORING AT 34.5 FT		
40					
45					
50					
55					

MVLF, 1-87

Figure A-91 2/2

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F5	MW-39I	SHEET 1 OF 2

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 11.23 Ft. SURFACE ELEVATION, NGVD 11.7 Ft.

WATER LEVEL ELEVATION, NGVD 2.55 Ft. (06/28/87) START DATE 06/16/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 06/17/87

DRILLING METHOD Koehring Speedstar 71 8" Dia Cable Tool

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
			FILL GRAVEL rounded and crushed to 2" dia.	SHALLOW AQUIFER
			SAND poorly graded, med with 20% fine, gray, moist, <10% fines (SP-SM)	SHALLOW AQUIFER
5			SAND black to brown well graded, wet, <10% fines (SW-SM) 5	SHALLOW AQUIFER
	67	9-20-12	PEAT black-brown dry, stiff (PT)	SHALLOW AQUIFER
	50	0/18	SILT light brown with black organic mottling soft, slight plasticity, <10% organic material (ML)	UPPER AQUITARD
	100	0/18	SILT & PEAT interbedded lenses of each 1/4"-6" thickness. Silt, light brown with black organic mottling fibrous, soft, slight plasticity (ML-OL) Peat, black to brown dry, stiff (PT)	UPPER AQUITARD
10			10	UPPER AQUITARD
	89	1-1-2		UPPER AQUITARD
	94	1-1/12		UPPER AQUITARD
	78	2-2-1	SILTY SAND fine, gray, moist, <20% fines (SM)	UPPER AQUITARD
15			15	INTERMEDIATE AQUIFER
	78	2-2-3		INTERMEDIATE AQUIFER
20	100	1-2-5	Trace of red sand (SM) 20	INTERMEDIATE AQUIFER
	67	5-3-3	Increasing med sand 20% water bearing	INTERMEDIATE AQUIFER
25			25	INTERMEDIATE AQUIFER
	50	1-2-5	SAND poorly graded, wet, loose, <5% fines (SP)	INTERMEDIATE AQUIFER

WELL CONSTRUCTION

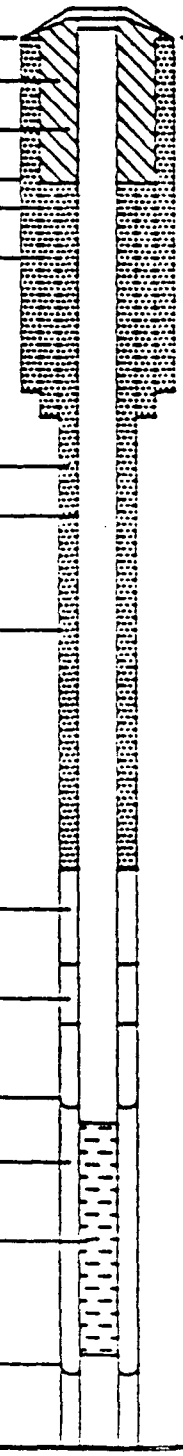


Figure A-92 1/2

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	
S21487.F3	MW-391	SHEET 2 OF 2

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, VA

ELEVATION, NGVD (Top of Well Casing) 11.23 Ft. SURFACE ELEVATION, NGVD 11.7 Ft.

WATER LEVEL ELEVATION, NGVD 2.53 Ft. (06/28/87) START DATE 06/16/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 06/17/87

DRILLING METHOD Koehring Speedstar 71 8" Dia Cable Tool

DEPTH (Ft)	SAMPLE Recovery (")	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT	WELL CONSTRUCTION
	10"	1/12-1	SILTY SAND, gray, wet, soft with <30% fines (SM)	INTERMEDIATE AQUIFER	Bentonite Chips
35	12"	1-2-4	SILT, brown to gray with black organic mottling, dry-moist, firm, low plasticity, fibrous (ML-OL)	LOWER AQUITARD	
			END BORING AT 36.5 FT		
40					
45					
50					
55					

Figure A-92 2/2

HVLF, 1-87

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
S21487.F5	MW-43S	SHEET 1 OF 1

PROJECT Reichhold Chemicals Inc. LOCATION Tacoma, WA

ELEVATION, NGVD (Top of Well Casing) 8.91 Ft. SURFACE ELEVATION, NGVD 9.2 Ft.

WATER LEVEL ELEVATION, NGVD 6.15 Ft. (06/28/87) START DATE 06/11/87

DRILLING CONTRACTOR Hokkaido Drilling & Development FINISH DATE 06/11/87

DRILLING METHOD Mobile B-61 6" I.D. Hollow Stem Auger

DEPTH (Ft)	SAMPLE Recovery (%)	SAMPLE Blows	GEOLOGIC LOG & USCS DESIGNATION	HYDROLOGIC UNIT
	67	1-1/12	SAND, poorly graded, gray, saturated, fine, loose (SP)	SHALLOW AQUIFER
			SANDY SILT, gray, fine, soft (SM)	
5	22	0/18	SILT, brown, dry, soft with 30% organic matter (OL)	
	100	1-1/12	SILT, brown with black organic mottling, soft, slight plast. (ML)	UPPER AQUITARD
			END BORING AT 7 FT	
10				
15				
20				
25				

WELL CONSTRUCTION

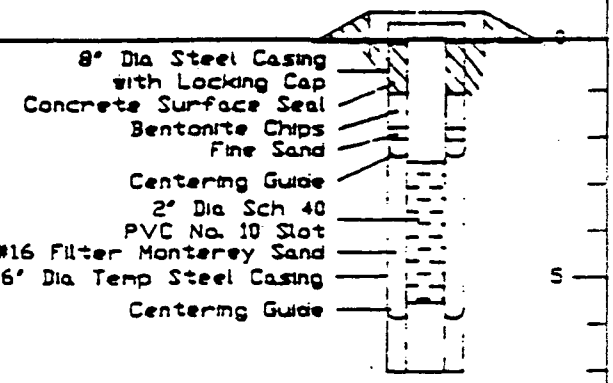


Figure A-93

Appendix B

APPENDIX B
DATA VALIDATION REPORTS

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ATTACHMENT B-1
DATA VALIDATION REPORT
SOIL AND SURFACE WATER QUALITY DATA
LAUCKS TESTING LABORATORIES, INC.

ATTACHMENT B-2
DATA VALIDATION REPORT
GROUNDWATER QUALITY DATA
LAUCKS TESTING LABORATORIES, INC.

APPENDIX B
DATA VALIDATION REPORTS

This appendix presents data validation reports for chemical analysis of soil and groundwater samples collected during Phase I and Phase II of our Blair Backup property field investigations (December 1989 through March 1990 and August 1990 through April 1991, respectively). This work was conducted as part of the Draft Final Investigation report compiled for the Blair Backup property located in the Port of Tacoma, Washington. The review of the Laboratory Data Reports was performed in general accordance with Laboratory Data Validation Functional Guidelines (EPA, 1988a and 1988b), as appropriate. Laboratory in-house control limits were used to evaluate duplicate results as well as surrogate and matrix spike recoveries.

This appendix is organized into two main sections detailing the two phases of investigation. The first section presents our review of the Phase I soil and water quality data. The second section discusses our review of the Phase II soil and water quality data. Two attachments, B-1 and B-2, presented at the end of this appendix are laboratory data validation reports prepared by Laucks Testing Laboratories, Inc. for soil and surface water data, and groundwater data, respectively.

PHASE I DATA VALIDATION REPORT

In order to assess the validity of the analytical laboratory testing results, soil and water quality data generated during Phase I were evaluated using EPA data validation criteria (EPA, 1988a and 1988b). This review included evaluating laboratory and field quality control data including sample holding times, method and field blank results, surrogate and matrix spike recoveries, and duplicate relative percent differences.

Laucks Testing Laboratories, Inc. (Laucks) evaluated the soil and water quality analytical results based on laboratory quality control data. Summaries of the Laucks data quality evaluations for soil and water samples are presented in Attachments B-1 and B-2 at the end of this appendix. A Hart Crowser environmental chemist reviewed the Laucks data quality evaluations and the field quality control results. Based on

this review, soil and water quality data were qualified according to EPA data validation criteria. A summary of qualified data is presented below.

Soil Quality Data

Analytical Methods and Reporting Units

A total of 64 soil samples and were analyzed for various organic and/or inorganic analyses. A detailed summary of soil analyses performed on Phase I samples is presented in Table 1 located in Volume I. Samples were analyzed by Analytical Technologies, Inc (ATI), Friedman and Bruya, Inc. (FBI), and Laucks Testing Laboratories, Inc. (Laucks).

Results were reported on a dry weight basis. Organic concentrations were generally reported using micrograms per kilogram (μg/kg) or ppb units. Inorganics data were reported using milligrams per kilogram (mg/kg) or ppm units.

Sample Collection and Handling

Samples collection methods are described in Appendix A. Samples were collected in clean glass bottles (with teflon-lined caps) supplied by the analytical laboratories. Samples were collected in a manner to limit headspace in the bottles.

Upon collection of each sample, the sample number, date, time, and sampling personnel initials were recorded on the label of each container. Samples were stored in insulated coolers packed with "blue ice" and maintained in Hart Crowser's custody until samples were delivered to the laboratories.

Data Qualifications

- Acetone and bis(2-ethylhexyl)phthalate were detected in method and/or field blanks associated with the surface and subsurface soil samples. Both of these compounds are common laboratory contaminants (EPA, 1988a). Reported acetone and bis(2-ethylhexyl)phthalate soil concentrations which were below 10 times the method blank concentrations were qualified a not detected (U).

- GC-FID screening analysis detected hydrocarbons in the method blank associated with soil samples collected from borings installed on East-West Road and Taylor Way properties (TW-1 through TW-5). Reported GC-FID screening concentrations which were below 5 times the method blank concentration were qualified as not detected (U).

- Chlorinated pesticide and PCB data for sample TP-114/S-1 were qualified as estimated (J) due to poor surrogate recovery.

- Organophosphorus pesticide data for sample HC-5/S-2 were qualified as estimated (J) due to poor surrogate recovery.

- All soil herbicide results were qualified as unusable due to poor surrogate recoveries and holding time exceedences. Samples were reanalyzed by Laucks and were also qualified as unusable based on poor surrogate recoveries and holding time exceedences.

- Volatile organic results reported for sample TP-124/S-1 were qualified as estimated (J) due to surrogate recoveries above the acceptable control limits.

- Total arsenic results reported for soil samples collected from test pits TP-115 through TP-119, and TP-124 on the Blair Backup property as well as samples collected from test pits (TP-1 through TP-10) installed on the East-West Road and Taylor Way properties were qualified as estimated (J) due to low matrix spike recoveries.

- EP Tox copper, lead, chromium, zinc, and arsenic results were flagged as estimated (J) based on high matrix spike recoveries or exceedence of RPD control limit (lead).

- Soil samples analyzed for cyanide exceeded the 14-day holding time and were qualified as estimated (J).

- Field sampling equipment blanks indicate decontamination procedures were effective.

- Soil sample duplicate results are presented in Table C-13. RPDs generally indicate the overall precision of the data was adequate. Nickel and lead results reported in samples SS-2 and SS-17 are

inconsistent, indicating that the surface sample may not have been homogeneous.

Surface Water Quality Data

Analytical Methods and Reporting Units

A total of 3 surface water samples were analyzed for total metals. One sample collected from the Pennwalt Ag-Chem Ditch was also analyzed for GC-FID screening (modified EPA method 8015) and chlorinated herbicides (EPA Method 8150). Samples were analyzed by Laucks.

Results are reported using micrograms per liter (μg/L) or ppb units.

Sample Collection and Handling

Sample collection methods are described in Appendix A. Samples were collected in clean containers supplied by the laboratory. Preservatives were added by the laboratory to volatile organic, hardness, hydrogen sulfide, and dissolved metal sample bottles. Bottles filled for volatile organic analysis were filled slowly and were devoid of headspace. Dissolved metal samples were filtered in the field using in-line 0.45 micron filters.

Upon collection of each sample, the sample number, preservative, date, time, and sampling personnel initials were recorded on the label of each container. Samples were stored in insulated coolers packed with "blue ice". Hart Crowser maintained custody of the samples until delivery to the analytical laboratories.

Data Qualifications

- Total suspended and dissolved solids results were qualified as estimated (J) due to exceedence of the 7-day holding time criterion.

- Reported antimony and thallium concentrations were flagged as estimated (J) based on low matrix spike recoveries and exceedence of RPD control limit.

Groundwater Quality Data

Analytical Methods

Thirty-three groundwater samples plus additional quality control samples were analyzed by Laucks Testing Laboratory for selected organic and inorganic parameters listed in Table 3 in the main body of the text. Formaldehyde analysis using the draft RCRA method 8315 and hexavalent chromium testing were performed by ATI. Arsenic speciation analysis was performed by Battelle Pacific Northwest Laboratory.

Organic compound and trace metal analytical results were quantitated using micrograms per liter (μg/L) or ppb units. All other parameters were reported using milligrams per liter (mg/L) or ppm units.

Sample Handling

Samples collection methods are described in Appendix A. Samples were collected in clean containers supplied by the analytical laboratories. Preservatives were added by the laboratory to volatile organic, hardness, hydrogen sulfide, and dissolved metal sample bottles. Bottles filled for volatile organic analysis were filled slowly and were devoid of headspace. Dissolved metal samples were filtered in the field using in-line 0.45 micron filters.

Upon collection of each sample, the sample number, preservative, date, time, and sampling personnel initials were recorded on the label of each container. Samples were stored in insulated coolers packed with "blue ice". Hart Crowser maintained custody of the samples until delivery to the analytical laboratories.

Data Qualifications

- Bis(2-ethylhexyl)phthalate was detected in a laboratory method blank associated with nine groundwater samples collected on the Blair Backup property. Reported bis(2-ethylhexyl)phthalate concentrations in these samples which were below 10 times the method blank concentrations were qualified as not detected (U). Detected bis(2-ethylhexyl)phthalate concentrations in the remaining groundwater samples collected on the Blair Backup property were

below 10 times the maximum trip blank concentration and were flagged as estimated (J).

- Acetone was detected in 3 of the 9 trip blanks associated with the groundwater samples but was not detected in any laboratory water method blanks. Detected acetone concentrations in groundwater samples collected at the Blair Backup property were below 10 times the maximum trip blank concentration and were qualified as estimated (J).

- Detected formaldehyde concentrations are flagged as tentatively identified (X). Water samples cannot be analyzed for formaldehyde using conventional EPA methods. The formaldehyde analysis performed in this study (Hantzsch Reaction) may be affected by the turbidity of the samples as well as the presence of other constituents in the water samples and cannot positively identify the presence of formaldehyde without a second confirmation analysis. Unfortunately, other methods used to detect formaldehyde that we have evaluated (including the NIOSH chronotropic acid procedure) are also subject to matrix interferences and misidentification of formaldehyde. We will continue to evaluate alternative analytical methods, including an HPLC procedure, that can confirm the presence of formaldehyde in groundwater.

- Nickel, cadmium, and chromium results in samples HC-5S, HC-7S, HC-8S, HC-6S, HC-6I, HC-10I, and HC-10S were qualified as estimated (J) due to low matrix spike recoveries. All reported antimony and thallium results were flagged as estimated based on matrix spike recoveries and RPDs being outside of control limits. Lead was qualified as estimated in sample HC-4S due to RPD exceeding the control limit.

- Surrogate recoveries for acid and base/neutral extractable compounds were outside control limits in six samples. Non-detected acid extractable results were qualified as unusable (R) in samples HC-2S, HC-16S, EPA-7S, and TW-2S. Non-detected base/neutral extractable results were flagged as unusable in samples HC-1S, HC-2S, and HC-13S. Detected values in these samples were qualified as estimated (J).

- Pesticide and PCB results reported for sample HC-5S are qualified as estimated (J) due to low surrogate recoveries.

- Field sampling equipment blank results indicate decontamination procedures were effective.

- Groundwater sample replicate results are presented in Table C-14. RPDs generally indicate the overall precision of the data was adequate.

PHASE II DATA VALIDATION REPORT

Soil Quality Data

Analytical Methods and Reporting Units

A total of 46 soil samples and 11 sediment samples were analyzed for various organic and/or inorganic analyses. A detailed summary of soil analyses performed on Phase II samples is presented in Table 2 located in the main body of the text. Samples were analyzed by Analytical Technologies, Inc. (ATI), Friedman and Bruya, Inc. (FBI), and Laucks Testing Laboratories, Inc. (Laucks).

Results were reported on a dry weight basis. Organic concentrations were generally reported using micrograms per kilogram (μg/kg) or ppb units. Inorganics data were reported using milligrams per kilogram (mg/kg) or ppm units.

Sample Collection and Handling

Samples collection methods are described in Appendix A. Samples were collected in clean glass bottles (with teflon-lined caps) supplied by the analytical laboratories. Samples were collected in a manner to limit headspace in the bottles.

Upon collection of each sample, the sample number, date, time, and sampling personnel initials were recorded on the label of each container. Samples were stored in insulated coolers packed with "blue ice" and maintained in Hart Crowser's custody until samples were delivered to the laboratories.

Holding Times

There are no established holding time requirements for soils and sediment samples. EPA Data Validation Guidelines suggest using water holding time requirements established under 40 CFR 136 (Clean Water Act) when evaluating sediment data. In the quality assurance plan associated with this work (Hart Crowser, 1989c), we established a 14-day holding time criteria for volatile analysis, 14 days for extraction of semivolatiles, 28 days for mercury analysis, and 6 months for other metals. Samples exceeding these holding time criteria were flagged as estimated (J). Exceedences of holding times are summarized below by analyses:

- **Semivolatile Organics (EPA method 8270).** HC-9S/S-3, HC-22S/S-1, ODS-A, ODS-B, ODS-103A, and ODS-103B
- **PCBs (EPA method 8080).** PDS-A, PDS-B, PDS-C, and PDS-104-D
- **Organophosphorus Pesticides (EPA method 8140).** PDS-A, PDS-B, PDS-C, and PDS-104-D
- **Chlorinated Herbicides (EPA method 8150).** PDS-A, PDS-B, PDS-C, and PDS-104-D
- **Total Petroleum Hydrocarbons (EPA method 418.1).** All 10 samples analyzed
- **Total Petroleum Hydrocarbons (modified EPA method 8015).** All samples analyzed
- **TCLP PAHs.** TP-200/S-1, TP-201/S-1, TP-205/S-2, TP-207/S-1, and TP-210/S-1

Blanks

Laboratory Blanks. One laboratory method blank was analyzed with each batch of samples.

Laboratory Blank Contaminants - PAHs. Several PAH compounds including anthracene, acenaphthene, benzo(ghi)perylene, and phenanthrene were detected in at least one method blank sample.

Reported acenaphthene concentrations in samples TP-201/S-1, TP-210/S-1, and PDS-C were less than five times the associated method blank value and were qualified as not detected (U).

Laboratory Blank Contaminants - Semivolatiles. Bis(2-ethylhexyl) phthalate (BEHP) was detected in several method blanks. Reported BEHP concentrations in samples HC-9S/S-3 and HC-22/S-1 were less than five times the associated method blank value and were qualified as not detected (U).

Surrogate Recovery

Surrogate Control. Surrogate compounds were within the laboratory-specified control limit range for all samples analyzed for organics. No samples were qualified based on surrogate recoveries.

Matrix Spikes and Matrix Spike Duplicates

Spike Recoveries. Spike recoveries were within advisory limits for organic analyses. Arsenic spike recoveries in Laucks sample batch 90-10-392 (SS-TCLP-1 through SS-TCLP-5) were below 50 percent and were flagged as estimated (J).

Spike Duplicates. Relative percent differences (RPD) for matrix spike duplicates were acceptable except for arsenic in sample batch 90-10-392. These samples were qualified as estimated.

Groundwater Quality Data Review

Analytical Methods and Reporting Units

Fifty groundwater samples plus additional quality control samples were analyzed by Laucks Testing Laboratory for selected organic and inorganic parameters listed in Table 3 in the main body of the text. Formaldehyde analysis using the draft RCRA method 8315 and hexavalent chromium testing were performed by ATL. Arsenic speciation analysis was performed by Battelle Pacific Northwest Laboratory.

Organic compound and trace metal analytical results were quantitated using micrograms per liter (μg/L) or ppb units. All other parameters were reported using milligrams per liter (mg/L) or ppm units.

Sample Collection and Handling

Samples collection methods are described in Appendix A. Samples were collected in clean containers supplied by the analytical laboratories. Preservatives were added by the laboratory to volatile organic, hardness, hydrogen sulfide, and dissolved metal sample bottles. Bottles filled for volatile organic analysis were filled slowly and were devoid of headspace. Dissolved metal samples were filtered in the field using in-line 0.45 micron filters.

Upon collection of each sample, the sample number, preservative, date, time, and sampling personnel initials were recorded on the label of each container. Samples were stored in insulated coolers packed with "blue ice". Hart Crowser maintained custody of the samples until delivery to the analytical laboratories.

Holding Times

Sample holding times generally met holding time requirements established under 40 CFR 136 (Clean Water Act). Samples exceeding these holding time criteria were flagged as estimated (J). Exceedences of holding times are summarized below by analyses and time of sampling event:

- **Semivolatile Organics (12/90).** HC-2S
- **TDS (10/90).** All samples
- **TDS (12/90).** HC-6S, HC-6I, HC-9S, HC-11S, HC-24S, EPA-9S, EPA-8I, and EPA-10I
- **TSS (10/90).** All samples
- **Chloride (12/90).** HC-4S, HC-5S, HC-11S, and EPA-9S
- **Sulfide (12/90).** HC-4S and HC-5S

- **Sulfate (12/90).** HC-4S, HC-5S, HC-11S, and EPA-9S

Blanks

Laboratory Blanks. At least one laboratory method blank was analyzed for all analytical parameters in each batch of samples.

Laboratory Blank Contaminants. Contaminants detected in laboratory method blanks are summarized below:

- **Metals (10/90).** Nickel, manganese, copper, and zinc were detected in several method blanks associated with PDCA extractions at concentrations ranging from 1 to 8 μg/L. Iron was also detected at concentrations ranging from 14 to 100 μg/L.

- **Metals (12/90).** Chromium and zinc were detected in a method blank at concentrations of 1.0 and 1.2 μg/L, respectively.

- **Semivolatile Organics (12/90).** Bis(2-ethylhexyl)phthalate (BEHP) was detected in six method blanks at concentrations ranging from 1 to 8 μg/L.

We flagged nickel, manganese, copper, zinc, and iron sample concentrations as not detected if they were less than five times the associated method blank value. Because BEHP is a common laboratory contaminant, BEHP sample concentrations less than 10 times the associated method blank value were qualified as not detected.

Field Blanks (10/90). No volatile organic compounds were detected in trip or field blanks.

Field Blanks (12/90). BEHP, manganese, and iron were detected in at least one of the two field blank samples (EPA-101 and HC-100) at concentrations ranging from 1 to 16 μg/L. These compounds were also detected in laboratory method blanks and were qualified based on their method blank concentration values. TDS was also detected in one field blank (EPA-101) at a concentration of 14 mg/L. No action was taken.

Surrogate Recovery

VOA Surrogate Control. Surrogate compound recoveries were within the laboratory-specified control limit range.

Semivolatile Surrogate Control (10/90). Surrogate recoveries were generally within control limits except for samples HC-4S (low recovery) and HC-11S (high recovery). Results from these two samples were flagged as estimated (J). No qualification was necessary for non-detected values reported for HC-11S.

Semivolatile Surrogate Control (12/90). Surrogate recoveries were generally within the laboratory-specified control limit range except for the following samples:

- HC-17S (acid fraction)HC-2S (base/neutral)
- HC-13S (base/neutral)HC-1S (acid fraction)
- HC-3S (acid fraction)HC-16S (acid fraction)
- EPA-7S (acid fraction)

All of these results were qualified as unusable (R) due severe matrix interferences resulting in recoveries of less than 10 percent.

Matrix Spikes and Matrix Spike Duplicates (MS/MSD)

Organic Spike Recoveries/Duplicates. Spike recoveries for organic parameters (including volatile and semivolatile organics, chlorinated herbicides, pesticides and PCBs) were generally within advisory limits. No organic analytical results were qualified based on MS/MSDs.

Trace Metal Spike Recoveries/Duplicates. Recoveries of zinc, silver, and cadmium were low for several batches of samples collected during the December 1990 sampling event indicating a possible negative bias. Results from samples associated with these low matrix spike recoveries were flagged as estimated (J). Iron recoveries were generally high for the December sampling event indicating a possible positive bias. Reported iron concentrations in samples associated with elevated spike recoveries were qualified as estimated.

Hexavalent Chromium Matrix Interferences. Hexavalent chromium results were determined to be unusable due to matrix interferences.

Reported hexavalent results were typically much higher than total chromium results for the same sample. We had the total chromium results reanalyzed by two laboratories and the results were consistent with the original reported values. We suspect that the hexavalent chromium analysis, which uses a colorimetric technique, was positively biased due to the presence of elevated TDS concentrations in the groundwater samples.

Field Duplicates

Field Duplicate Results. A total of seven replicate were analyzed for selected parameters. Results of the split samples were typically consistent and did not indicate the presence of high sampling or analytical variability.

Hart Crowser
J-2350-07

ATTACHMENT B-1
DATA VALIDATION REPORT
SOIL AND SURFACE WATER QUALITY DATA
LAUCKS TESTING LABORATORIES, INC.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Soils, surface water, aqueous QC samples
LTL Nos. 8912073-078, 8912138, 8912139, 8912141, 8912146, 8912151-153, 9002038

Corrections to Report

The following discrepancies were observed during the QC data review and should be corrected in the hardcopy and wherever appropriate.

-page 5 The 3rd line from bottom, 8912075-01C should read 8912075-10C. The client ID for this sample was correct.

-page 6 out of control surrogate recovery table should include

Sample No.	DBC Recovery, %	Isodrin Recovery, %
8912074-01	120	130*

-page 64 Sample 8912153-04 (client ID SS-18) should not be flagged (*) as being outside of holding time

-page 67 GC/FID screens for samples 8912077-2,3,5 and 6 should not be flagged (*) as being outside of holding time

-page 232 The date extracted for 8912139-10B semivolatiles should have been 12/22/89 (not 12/12/89) and results for Bis(2-ethylhexyl)phthalate and Di-n-octyl phthalate should have been "B" flagged, indicating blank contamination.

-page 797 The second nickel MS/MSD analysis should have a matrix spike duplicate recovery of 91% (not 1%) and the RPD should be 1% (not 200%)

Total Solids
(soils, LX SB-3 / SM 209)

Sample Holding Times:

The Project Work Order did not specify a holding time for total solids. All analyses were initiated between 0 and 7 days of sample collection and were considered valid based on holding times.

Duplicate Analyses:

Twelve samples were analyzed for total solids in duplicate throughout the course of the project for 13% replicates, overall. Relative Percent Difference (RPD) values ranged from 0% to 8%, with most values being on the low side of that range. A control limit of 30% RPD was used; no values approached that level. All total solids analyses were considered valid on the basis of duplicate analyses.

Other QC Issues:

No other issues were observed in the analysis of total solids.

Total Suspended and Dissolved Solids
(EPA 160.1 and 160.2)

Sample Holding Times:

The Project Work Order specified a 7-day holding time for the analysis of both total suspended solids (TSS) and total dissolved solids (TDS). Of the 4 samples analyzed, all exceeded holding time by 6 days. It is not known what affect this might have on sample results, but all values should be considered estimates on this basis.

Method Blanks:

Neither analysis demonstrated any detectable method blank. The analyses were considered valid on this basis.

Duplicates:

An action limit of 30% RPD was used for these analyses. The RPD for TSS was 6 and that for TDS was 0, thus validating the analyses on the basis of duplicate results.

Other QC Issues:

No other issues were observed in the analysis of either TSS or TDS.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Soils, surface water, aqueous QC samples
LTL Nos. 8912073-078, 8912138, 8912139, 8912141, 8912146, 8912151-153, 9002038

GC/FID Screen
(LTL methods)

Sample Holding Times:

The Project Work Order specifies a 14-day holding time for the extraction for GC/FID screening with a subsequent 40-day analysis holding time. All samples were extracted within the 14-day time period, although samples extracted in exactly 14 days were inadvertently flagged on the holding time summary as being outside of that timeframe. The longest period of time between extraction and analysis was 35 days. Thus, all GC/FID screens were considered valid on the basis of holding times.

Method Blanks:

Seven blanks were analyzed throughout the course of the project with 69 samples. As noted in the narrative, a solution of AB/N surrogates was inadvertently added to some of the extracts and blanks. The surrogate compounds were observed in all of the method blank chromatograms, as was phthalate contamination in blank B1214GSCSLT. One blank, B1228GSCSLS, contained 18000 ug/kg calculated as phenanthrene. Blank control limits are 20000 ug/kg. Thus all analyses were considered in control and valid on the basis of method blanks.

Duplicates:

As specified in the Project Work Order, a control limit of 30% RPD was used for duplicate comparison. All duplicate analyses met this criterion and were thus considered valid.

Other QC Issues:

No other issues were observed with regards to the GC/FID screens.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Soils, surface water, aqueous QC samples
LTL Nos. 8912073-078, 8912138, 8912139, 8912141, 8912146, 8912151-153, 9002038

Polynuclear Aromatic Hydrocarbons
(SW 846 8100)

Sample Holding Times:

The Project Work Order specifies a 14-day holding time for the extraction of Polynuclear Aromatic Hydrocarbons (PAHs or PNAs), with a subsequent 40-day analysis holding time. The longest time between sampling and extraction was 10 days and the longest time between extraction and analysis was 29 days. All analyses for PAHs were considered valid on the basis of holding times.

Method Blanks:

Four method blanks were analyzed with 11 samples. No target analytes were detected in any of the method blanks, although surrogate recovery was low for one of them, as discussed below. All data were considered acceptable on the basis of method blanks.

Surrogates:

All PNA surrogates were within Project Work Order requirements with the following exception:

Sample No.	Surrogate	Recovery, %	Limits, %
8912078-06 (method blk)	Biphenyl	12	23-126

Since all sample surrogates were within specified bounds, the two other surrogates in this blank were in control, the other extraction blank for that date was in control, and no evidence of contamination was present in any of the method blanks, this event was considered of minor consequence. The data should be considered valid on the basis of surrogate recoveries.

Matrix Spike / Matrix Spike Duplicates:

Three matrix spike / matrix spike duplicates (MS/MSDs) were analyzed with 11 samples. All MS/MSD recoveries and their associated RPDs were within Project Work Order specifications with the following exceptions:

Sample No.	Analyte	MS Recovery, %	MSD Recovery, %	RPD, %
8912076-06	Pyrene	60	25	81*
8912139-09	Naphthalene	7*	49	148*
	1-Methylnaphthalene	47	100	71*
8912153-02	Chrysene	83	57	37*

"*" denotes out-of-control events

No corrective action was required in the Project Work Order for out-of-control MS/MSD QC, although the apparent data quality is addressed here.

Since only one MS or MSD recovery was low and more than enough QC was performed to verify the analyses, analytical values of less than the detection limit were considered adequately validated. This entails almost all of the samples. Since no analyte RPD was out of control in more than one QC sample and since no analyte was detected at greater than 3 times the detection limit, the potential for reduced precision was considered low and the data were considered valid on the basis of MS/MSD analysis.

Other QC Issues:

No other issues were observed in the analysis of PAHs.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Soils, surface water, aqueous QC samples
LTL Nos. 8912073-078, 8912138, 8912139, 8912141, 8912146, 8912151-153, 9002038

Organochlorine (OC) Pesticides / PCBs
(SW 846 8080)

Sample Holding Times:

The Project Work Order specifies a 14-day holding time for the extraction of OC Pesticides/PCBs with a subsequent 40-day analysis holding time. The longest time between sampling and extraction was 10 days and the longest time between extraction and analysis was 21 days with the exception of sample # 8912153-04 (client ID SS-18), which was analyzed in 40 days. This sample was inadvertently flagged in the holding time summary as being out of the specified holding time. All analyses for OC pesticides/PCBs were considered valid on the basis of holding times.

Method Blanks:

Nine method blanks were analyzed with 32 samples. No target analytes were detected in any of the blanks, thus validating the analyses on the basis of method blanks.

Surrogates:

All samples demonstrated recovery of both Isodrin and Dibutylchlorendate (DBC) surrogates with the following exceptions:

Sample No.	DBC Recovery, %	Isodrin Recovery, %
soil limits	(20-156)	(20-112)
8912075-10	0*	0*
8912076-01	110	0*
8912139-10	85	170*
8912074-01	120	130*
8912152-01	170*	100
8912077-01	180*	76
8912139-01	160*	93

"*" denotes out-of-control events

8912074-01 was inadvertently not flagged (*) on the surrogate report nor was it noted in the narrative. For all samples except 8912075-10, one surrogate recovery was in control. The Project Work Order specifies that if either one of these surrogates is in control, the analysis is considered valid. In the case of 8912075-10, the sample had to be diluted 10x due to matrix interference (see other QC issues in this report). This means that the surrogate was diluted too and, as a consequence, was not detected in the sample. No corrective action is required if surrogate recoveries are out of control due to dilution. Of the two other samples which had to be diluted, 8912076-01 is noted above as having only one surrogate out of control and the

other, 8912076-02, had both surrogates in control even with dilution effects.

With the above qualifications, the analysis of OC Pesticides/PCBs was considered valid on the basis of surrogate recoveries.

Matrix Spike / Matrix Spike Duplicates:

Seven matrix spike / matrix spike duplicates (MS/MSDs) were analyzed with 32 samples. All MS/MSD recoveries were within Project Work Order specifications with the following exceptions:

Sample No.	Analyte	MS Recovery, %	MSD Recovery, %	RPD, %
8912074-01	Dieldrin	156*	140*	17
8912076-02	Lindane	141*	110	22
	Heptachlor	148*	113	24
	Dieldrin	190*	178*	6
	Endrin	277*	130	53*
	4,4'-DDT	293*	239*	18
8912138-02	4,4'-DDT	25*	31*	21
8912138-03	Heptachlor	95	131*	32*
	Aldrin	41	31*	29
8912153-04	Dieldrin	177*	124	35
	4,4'-DDT	220*	131	51*
8912153-08	Lindane	50*	59	18*

"*" denotes out-of-control events

The Project Work Order does not require corrective action for out of control MS/MSDs. Recoveries significantly above the control limit, as most of these were, suggest matrix interference. Observation of the chromotograms confirmed this hypothesis. Low DDT recoveries are often due to a degradation of the DDT during chromotography, a fact also confirmed by observation of the chromotograms. Evidence indicates that analytical bias, if any, would generally be high due to positive matrix interference, the exception being some DDT results.

Other QC Issues:

The following samples were reported with detection limits elevated by a factor of 10 because of matrix interference and the necessity of a ten-fold dilution:

LTL No.	Client ID
8912075-10	TP114/S-1
8912076-01	TP115/S-1
8912076-02	TP116/S-2

It was observed during this review that the discussion of this issue in the narrative showed an incorrect LTL number (8912075-01C should have been

8912075-10C), although the client ID was correct.

No other issues were observed in the analysis of OC Pesticides/PCBs.

Organophosphorous (OP) Pesticides
(SW 846 8140)

The analysis was often referred to as "NP pesticides" in the report due to the Nitrogen/Phosphorous detector used in the GC analysis.

Sample Holding Times:

The Project Work Order specifies a 14-day holding time for the extraction of OP pesticides with a subsequent 40-day analysis holding time. The longest time between sampling and extraction was 14 days and the longest time between extraction and analysis was 22 days. All analyses for OP pesticides were considered valid on the basis of holding times.

Method Blanks:

Four blanks were extracted with 13 samples. No target list compounds were detected in any of the blanks, thus validating the analyses on the basis of method blanks.

Surrogates:

All surrogates were within Project Work Order requirements with the following exception:

Sample No.	Nitro-m-xylene Recovery, %
soil limits	(20-150)
8912138-03C	14

As no corrective action was taken for the out-of-control event, OP pesticide results for this sample should be considered estimates and could be biased low due to poor extraction efficiency. No target analytes were observed in this sample and this lack of detection at the levels reported could be erroneous.

Matrix Spike / Matrix Spike Duplicates:

Three Matrix Spike / Matrix Spike Duplicates (MS/MSDs) were analyzed with 13 samples. All recoveries and RPDs were within Project Work Order specifications, thus validating the data on the basis of MS/MSDs.

Other QC Issues:

No other issues were observed in the analysis of OP pesticides.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Soils, surface water, aqueous QC samples
LTL Nos. 8912073-078, 8912138, 8912139, 8912141, 8912146, 8912151-153, 9002038

Herbicides
(SW 846 8150)

Sample Holding Times:

The Project Work Order specifies a 14-day holding time for the extraction of herbicides with a subsequent 40-day analysis holding time. The longest time between sampling and extraction was 11 days. The time between extraction and analysis varied from 20 days to 60 days, with 9 of 13 analyses falling outside of the 40-day analysis holding time.

The 9 violations were due to the late observation that only 2,4-D and 2,4,5-TP, rather than the full target list, had been determined in the initial analysis. All results reported were from the later analytical date. It is not known what effect this would have on the overall analytical results, but all samples associated with LTL work order numbers 8912138, 8912139, 8912152 and 8912153 should be qualified on the basis of holding time violations.

Method Blanks:

No target analytes were detected in any of the method blanks for these samples. However, blank surrogate recovery was below Project Work Order control limits for the blanks associated with 8912074, 8912077, 8912138 and 8912139. Although Picloram has a history of poor recovery in soils, this poor recovery in the blank suggests that extraction efficiency may have been low for the associated samples and the data should be qualified on the basis of uncertain method blanks. Method blank data for 8912152 and 8912153, which encompass client sample IDs SS-1, SS-18, and SW-1, demonstrated adequate surrogate recovery and no target analytes. Data for these 3 samples should be considered valid on the basis of method blanks.

Surrogates:

Six samples demonstrated surrogate recovery which was within the Project Work Order specifications of 20%-150%. Of these, 3 were at the bottom of the range and, since other surrogates were low, cast additional doubt on the overall herbicide data quality. The ACCEPTABLE surrogate recoveries are listed below.

Sample No.	Client ID	Picloram Recovery, %
8912074-01	TP109/S-1	23
8912077-01	TP124/S-1	39
8912138-02	HC-5S/S-1	23
8912139-01	HC-11S/S-1	20
8912153-04	SS-18 SS-1 Dup	110
8912153-05	SW-1 Pennwalt	120

It was observed that the last two of these samples also had acceptable method blank data, as noted above. One sample (client ID SS-1) with acceptable method blank surrogate data did not have adequate surrogate recovery, even though the sample listed as its' duplicate (client ID SS-18 SS-1 Dup) demonstrated excellent recovery. This was considered additional support for the supposition that extraction efficiency was inconsistent.

All other herbicide data should be considered estimates with a distinct probability of low bias. Four samples listed above, though marginally within acceptable limits, may also be biased low when considered in conjunction with the samples and method blanks extracted concurrently and which demonstrated unacceptable surrogate recovery. Two samples demonstrated slightly high recoveries and should be considered valid on the basis of surrogate recoveries in the samples and their associated method blanks.

Matrix Spike / Matrix Spike Duplicates:

Four matrix spike / matrix spike duplicates (MS/MSDs) (3 soil, 1 water) were analyzed with 13 samples. All MS/MSD recoveries were within Project Work Order specifications with the following exceptions:

Sample No.	Analyte	MS Recovery, %	MSD Recovery, %	RPD, %
8912138-04	2,4,5-TP	29	22*	26
8912153-04	2,4-D	6*	67	167*
	2,4,5-TP	18*	58	104*

"*" denotes out-of-control events

Although no corrective action is required in the Project Work Order for out-of-control MS/MSDs, this, in conjunction with previously discussed surrogate data, qualifies analyses associated with these MS/MSDs. It was observed that the surface water sample (8912153-05) demonstrated acceptable surrogate and MS/MSD recovery data. It was further observed that sample 8912074-01, which had low but acceptable surrogate recovery, demonstrated excellent MS/MSD recoveries, thus increasing confidence in data for that and associated samples.

Other QC Issues:

No other issues were observed in the analysis of herbicides.

Every herbicide analysis exhibits one or more factors which diminish reliability. The single surface water sample (8912153-05) was qualified by a holding time violation. Sample 8912074-01 demonstrated good spike recovery, marginally acceptable surrogate recovery, was analyzed within holding time, but had a method blank with a poor surrogate recovery. Data for other samples demonstrate greater unreliability and all data should be considered estimated.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Soils, surface water, aqueous QC samples
LTL Nos. 8912073-078, 8912138, 8912139, 8912141, 8912146, 8912151-153, 9002038

Although the 14-day extraction holding time has been violated, re-extraction and reanalysis was performed on samples with the most questionable data. A review of these reanalyses will follow in an addendum to this report.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Soils, surface water, aqueous QC samples
LTL Nos. 8912073-078, 8912138, 8912139, 8912141, 8912146, 8912151-153, 9002038

Semivolatile Organic Compounds and Chlorinated Phenols
(SW 846 8270, GC/MS)

Sample Holding Times:

The Project Work Order specifies a 14-day holding time for the extraction of semivolatile compounds with a subsequent 40-day analysis holding time. The longest time between sampling and extraction was 10 days and the longest time between extraction and analysis was 20 days, thus making all analyses valid on the basis of holding times.

Method Blanks:

Seven blanks were analyzed throughout the course of the project with 28 samples extracted and 19 analyzed. No target analytes were detected in any of them with the following exceptions:

B1215MSVSLO (LTL # 8912075-11A)	Bis(2-ethylhexyl)phthalate	76 ug/kg
B1222MSVSLO (LTL # 8912138-06A)	Bis(2-ethylhexyl)phthalate	570 ug/kg
	Di-n-octyl phthalate	360 ug/kg
B1221MSVWLI (LTL # 8912141-08A)	Bis(2-ethylhexyl)phthalate	2 ug/L
B1228MSVSLS (LTL # 8912152-11A)	Bis(2-ethylhexyl)phthalate	340 ug/kg
	Di-n-octyl phthalate	250 ug/kg

Closer inspection of the data on samples associated with blank B1222MSVSLO revealed that the date extracted for sample 8912139-10B (client ID HC-8S/S-2) should have been 12/22/89 (still within holding time) and that the results for Bis(2-ethylhexyl)phthalate and Di-n-octyl phthalate should have been "B" flagged, indicating blank contamination, for this sample.

In general, samples associated with these blanks contained approximately the same level of Bis(2-ethylhexyl)phthalate and/or Di-n-octyl phthalate excepting B1228MSVSLS, where significantly higher levels of Bis(2-ethylhexyl)phthalate were found in in the samples. The level of Bis(2-ethylhexyl)phthalate in B1221MSVWLI was at the water detection limit and since none was found in the sample, it was not considered significant. EPA Contract Laboratory Program (CLP) and Laucks internal requirements do not require corrective action for phthalate blank contamination less than 5x the EPA Contract Required Quantitation Limit (330 ug/kg in soil and 10 ug/L in water for these particular analytes).

A number of Tentatively Identified Compounds (TICs) were also observed in most of the blanks. Among these were unknown aldol condensation products, which are routinely detected and are not considered detrimental to the analysis. Some compounds, primarily substituted benzenes, were observed in method blanks B1222MSVSLO and B1228MSVSLS. Many of the same compounds, considered contaminants, were also observed in all of the samples associated with B1222MSVSLO (LTL #s 8912138-01, 8912139-10, 8912146-05, and 8912146-07). As

these were also samples which showed evidence of phthalate blank contamination, it is likely that contamination occurred during the extraction process and the presence of these TICs in the samples should be disregarded. In the case of the two samples associated with the blank B1228MSVSLS (LTL #s 8912152-04 and 8912152-07), none of the TICs observed in the blanks were detected, thus indicating that contamination appears to be limited to the blank only.

With the above qualifications, the data was considered valid with regards to methods blank contamination.

Surrogates:

All surrogate recoveries were within EPA and contract specified limits, thus establishing the analyses as being in control.

Matrix Spike / Matrix Spike Duplicates:

Two matrix spike / matrix spike duplicates (MS/MSDs) were analyzed with nineteen samples for semivolatiles and thirteen samples for chlorinated phenols. All MS/MSDs and their associated RPDs were within EPA and contract required specifications, indicating confidence in both analytical accuracy and precision.

Other QC Issues:

No other issues were observed in the analysis of semivolatile organic compounds and the selected chlorinated phenols.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Soils, surface water, aqueous QC samples
LTL Nos. 8912073-078, 8912138, 8912139, 8912141, 8912146, 8912151-153, 9002038

Volatile Organic Compounds
(SW 846 8240, GC/MS)

Sample Holding Times:

Under Project Work Order requirements, water and soil/sediment samples both were to be analyzed within 14 days. All samples were analyzed within 9 or fewer days, thus validating the analysis based on holding times.

Method Blanks:

Six method blanks were analyzed for Volatile Organic Compounds (VOCs), 20% blanks overall. No target compounds or Tentatively Identified Compounds (TICs) were detected in any of the blanks, thus validating the analyses on the basis of method blanks.

Surrogates:

Surrogate recoveries for sample 8912077-01A (client ID # TP124/S-1) were all outside of contract specified limits. The corrective action taken was reanalysis the sample. Upon reanalysis, similar recoveries were observed, documenting matrix effect. It was also observed that similar native sample levels were detected in both injections. The surrogate recovery data for both injections are summarized below.

	8912077-01A %recovery	8912077-01ARE %recovery	control limits
d4-1.2-Dichloroethane	127	135	70-121
d8-Toluene	138	145	70-121
p-Bromofluorobenzene	63	63	70-121

All other surrogate recoveries were in control, validating the analyses on the basis of surrogate recoveries.

Matrix Spike / Matrix Spike Duplicates:

Three matrix spike / matrix spike duplicates (MS/MSDs) were analyzed (a 10% QC effort), with all recoveries within contract required limits. Relative percent differences (%RPDs) were in control with the exception of benzene in sample 8912138-04, which had an RPD of 21 (with a control limit of 20). As all other recoveries and RPDs for spikes and surrogates were in control, an RPD only 1% outside of the specified range, this was not considered a serious deficit. The current EPA CLP RPD limit for benzene in soils is 21%, which would, in any case, make the RPD in question acceptable.

The data were considered acceptable with regard to both accuracy and precision on the basis of MS/MSD recoveries and RPDs.

Other QC Issues:

No other issues were observed in the analysis of volatile organic compounds.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Soils, surface water, aqueous QC samples
LTL Nos. 8912073-078, 8912138, 8912139, 8912141, 8912146, 8912151-153, 9002038

Metals

This portion of the review covers all metals quality control including EP toxicity metals, ICP and flame AA metals, graphite furnace (antimony and thallium) analyses, and hydride (arsenic and selenium) analyses.

Sample Holding Times:

The Project Work Order holding time specification for all metals was 180 days. Mercury was not observed as a special case in those requirements, but is more typically considered to have a 28-day holding time in water, with no holding time established for soil. All analyses were within Project Work Order guidelines but several mercury analyses were performed within 30 days of sample collection. It is not certain what effect this might have on analytical results, but it is doubtful that the effect would be significant.

There is no known holding time for the EP toxicity extraction, nor was one specified in the Project Work Order. EP toxicity extractions occurred from 50 to 65 days after sampling. Mercury analysis on the extract occurred within 4 days of that time and ICP analyses within 6 days.

All metals data were considered valid on the basis of holding times.

Method Blanks:

A small number of ICP metals demonstrated blank contaminants at the limit of detection. Sample results related to these method blanks are "B" flagged in the report. Laucks' policy for the specific set of metals analyzed in this project does not require corrective action until blank contamination levels exceed twice the limit of detection. If this occurs, corrective action in the form of redigestion and reanalysis is required only for samples which do not exceed the blank by a factor of 10 or more. No blank contamination occurred at a level high enough to require qualification. All metals analyses were considered valid on the basis of method blank considerations.

Matrix Spike / Matrix Spike Duplicates:

All Matrix Spike / Matrix Spike Duplicate (MS/MSD) data were evaluated using EPA control limits of 75%-125% for MS/MSD recoveries and 20% for RPDs, as specified in the Project Work Order.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Soils, surface water, aqueous QC samples
LTL Nos. 8912073-078, 8912138, 8912139, 8912141, 8912146, 8912151-153, 9002038

All total metals recoveries and their associated RPDs met these guidelines with the following exceptions:

Analyte	MS Recovery, %	MSD Recovery, %	RPD, %
Ni	90	1*	200*
As	72*	70*	3
As	68*	58*	3
As	72*	77	6
Tl	31*	60*	62*
Sb	71*	78	10
Tl	48*	68*	35*

"*" denotes out-of-control events

The out-of-control nickel recovery was erroneously reported. The true MSD recovery was 91%, thus reducing the RPD to 1% and bringing Ni values into control.

The Project Work Order corrective action for out-of-control spikes is to perform a post-digestion spike. This, in fact, is done for all graphite furnace work (Sb and Tl) regardless of spike recovery and in this instance confirmed the analytical values. Although contract requirements were met, the persistence of low recoveries for Tl and the somewhat low recovery for Sb suggest a potentially low bias. No detectable Tl was observed in any of the samples and even with this low bias, the reported limit of detection should be valid. Reported Sb results, could be low but, if so, probably by less than a factor of two.

Nine arsenic MS/MSDs were performed with 90 analyses. Three of the MS/MSDs had one or more recoveries which were out of control. Since good precision was demonstrated (low RPD), this occasional low recovery may due to some matrix interference. Since 10% of the samples were subjected to MS/MSD analysis and more than the desired 5% acceptable QC was achieved, no further action was taken. It should be noted, however, that some samples may exhibit a low bias, though other recoveries indicate most values will not be biased. Of those that might be, the bias should be less than a factor of two low.

All EP toxicity metals recoveries and their associated RPDs met the project guidelines with the following exceptions:

Analyte	MS Recovery, %	MSD Recovery, %	RPD, %
Pb	100	130	22*
Cu	120	130*	7
Zn	120	140*	18
Cr	110	130*	11
As	120	130*	6

"*" denotes out-of-control events

Note that the recoveries are reported to 2 significant figures. Rounding after calculation results in some RPDs appearing different than the reported values would suggest. This also was the reason the 130% MSD recovery for Pb was not "*" flagged.

The above MS/MSD recoveries suggest that some EP toxicity values may be biased high. Since all target analytes in the samples, where detected, are well below the maximum contamination level (MCL) for the EP toxicity test, no further action was taken.

With the above qualifications, all metals data were considered valid with respect to MS/MSDs.

Other QC Issues:

No other issues were observed in the analysis of total or EP toxicity metals.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Soils, surface water, aqueous QC samples
LTL Nos. 8912073-078, 8912138, 8912139, 8912141, 8912146, 8912151-153, 9002038

Cyanide
(EPA 335.3, LX-0004)

Sample Holding Times:

The Project Work Order specifies a 14-day holding time for the extraction and analysis of cyanide. The time between sampling and analysis varied from 20 to 35 days. All holding times were violated. It is not certain what effect this would have on sample results. It is likely that if there was an effect, it would tend toward a low bias. Since no cyanide was detected in any of the samples, the data should be regarded as inconclusive.

Method Blanks:

One method blank was analyzed with 11 samples. No cyanide was detected and the analysis was considered valid on the basis of method blanks.

Matrix Spike / Matrix Spike Duplicates:

Three matrix spike / matrix spike duplicates (MS/MSDs) were analyzed with 11 samples. MS/MSD recoveries and their associated RPDs were well within Project Work Order specifications. Thus, the analyses were considered valid on the basis of MS/MSD data.

Other QC Issues:

No other issues were observed in the analysis of cyanide.

Herbicides
(SW 846 8150)

This review pertains to re-extraction and re-analyses of 8 soil samples previously analyzed under laboratory numbers 8912138, 8912139, 8912152, and 8912153.

Sample Holding Times:

The Project Work Order specifies a 14-day holding time for the extraction of herbicides with a subsequent 40-day analysis holding time. These analyses were re-extractions performed between 63 and 71 days after sample collection. Although analysis of the extracts was performed within 5 days of extraction, results should be considered estimates based on the date of the extraction.

Method Blanks:

No target analytes were detected in any of the method blanks for these samples. However, surrogate recovery was out-of-control low (16%) on one of the method blanks and acceptable but low (30%) on the other. The lack of target analyte detection in both blanks, with in-control surrogate recovery in one of them, was sufficient to confirm the analyses on the basis of method blanks, although a potential for low extraction efficiency was demonstrated.

Surrogates:

All Picloram surrogate recoveries were within Project Work Order specified control limits (20%-150%), with the exception of one of the method blanks, which had a surrogate recovery of 16%. All recoveries were toward the low end of the recovery range, however, the highest being 55%. This suggests low extraction efficiency. Since all sample surrogate recoveries were in control, the analyses were considered valid on the basis of surrogate recovery, with the potential for a low bias due to extraction inefficiency.

Matrix Spike / Matrix Spike Duplicates:

One matrix spike / matrix spike duplicate (MS/MSD) was analyzed with the 8 samples. The MS/MSD recoveries and their associated RPDs were within Project Work Order specifications. The fact that recoveries of three actual target analyte spikes (2,4-D, 2,4,5-TP, and 2,4,5-T) were somewhat high on a sample which demonstrated low (28%) surrogate recovery, suggests target analyte extraction may not be as reduced as surrogate recoveries indicate. With only one MS/MSD pair analyzed for only 3 of the target analytes, however, the potential for reduced extraction efficiency suggested by the low surrogate recoveries still exists. Since the MS/MSD recoveries and associated RPDs were within limits specified in the Project Work Order, the analyses were considered valid on this basis.

Other QC Issues:

No other issues were observed in the re-analysis of herbicides.

Conclusions:

Due to holding time violations, data for these 8 samples should be considered estimated. Issues suggested primarily by low surrogate recovery, especially since those recoveries were within specified control limits and MS/MSD recoveries were high, were secondary and should not further detract from overall data quality.

Hart Crowser
J-2350-07

ATTACHMENT B-2
DATA VALIDATION REPORT
GROUNDWATER QUALITY DATA
LAUCKS TESTING LABORATORIES, INC.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Water
LTL Nos. 9001116-118, 9001135, 9001163, 9001190, 9001201-202, 9001204-205, 9001238-239

Corrections to Report

The following discrepancies were observed during the QC data review and should be corrected in the hardcopy and wherever appropriate.

-page 207 Percent recovery for d14-Terphenyl surrogate should be flagged (*) as being outside of the control limits

-page 211 Percent recovery for d14-Terphenyl surrogate should be flagged (*) as being outside of the control limits

-page 600 Matrix spike recovery for Thallium should be flagged (*) as being outside of the control limits

-page 612 Manganese matrix spike and matrix spike duplicate recoveries should both be flagged (*) as being outside of control limits.

-page 623 Pentachlorophenol MS and MSD recoveries should both be flagged (*) as being outside of control limits.

Total Dissolved Solids
(EPA 160.1)

Sample Holding Times:

The Project Work Order specified a 7-day holding time for the analysis of total dissolved solids (TDS). All samples were analyzed within this time period and analyses were thus considered valid on the basis of holding time.

Method Blanks:

Four method blanks were reported with 43 samples. No blank contamination was observed for any of them, thus validating the analyses on the basis of method blanks.

Duplicates:

An action limit of 30% RPD was used for this analysis. Four duplicates were analyzed with 43 samples. The highest RPD was 5%, thus meeting the criterion for validation of the analyses.

Other QC Issues:

No other issues were observed in the analysis of TDS.

Formaldehyde

Sample Holding Times:

The Project Work Order specifies a 7-day holding time for the analysis of water samples for formaldehyde. All samples were analyzed within this time period and were considered valid with regards to holding times with the following exceptions:

Sample No.	Days
9001116-01	8
9001118-02	12
9001135-03	11

It is not known what effect, if any, this failure to meet holding time would have on the analyses. It is likely that if there was an effect, it would be toward a low bias.

Method Blanks:

Three method blanks were analyzed with 43 samples for formaldehyde. No method blank contamination was observed in any of them. The results were considered valid on the basis of method blanks.

Matrix Spike / Matrix Spike Duplicates:

Three matrix spike / matrix spike duplicates (MS/MSDs) were analyzed with 43 samples for formaldehyde. All recoveries and their associated RPDs were within control limits specified in the Project Work Order. All formaldehyde analyses were considered valid on the basis of MS/MSDs.

Other QC Issues:

No other issues were observed in the analysis for formaldehyde.

Metals

This portion of the review covers all metals quality control including ICP and flame AA metals, graphite furnace (antimony and thallium) analyses, and hydride (arsenic and selenium) analyses.

Sample Holding Times:

The Project Work Order holding time specification for all metals was 180 days. Mercury was not observed as a special case in those requirements, but is more typically considered to have a 28-day holding time in water. All analyses were within Project Work Order guidelines. In addition, the longest time between sample collection and preparation for mercury analysis was 14 days. The analyses for metals were all considered valid on the basis of holding times.

Method Blanks:

One blank (B0201ICP_W01) demonstrated nickel contamination at 3 ug/L. Sample results related to this method blank are "B" flagged in the report. Laucks' policy for the specific set of metals analyzed in this project does not require corrective action until blank contamination levels exceed twice the limit of detection. If this occurs, corrective action in the form of redigestion and reanalysis is required only for samples which do not exceed the blank by a factor of 10 or more. No blank contamination occurred at a level high enough to require qualification. All metals analyses were considered valid on the basis of method blank considerations.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Water
LTL Nos. 9001116-118, 9001135, 9001163, 9001190, 9001201-202, 9001204-205, 9001238-239

Matrix Spike / Matrix Spike Duplicates:

All Matrix Spike / Matrix Spike Duplicate (MS/MSD) data were evaluated using EPA control limits of 75%-125% for MS/MSD recoveries and 20% for RPDs, as specified in the Project Work Order.

All total metals recoveries and their associated RPDs met these guidelines with the following exceptions:

Analyte	MS Recovery, %	MSD Recovery, %	RPD, %
Ni	74*	75	2
Cd	70*	70*	0
Cr	73*	75	3
Mo	66*	74*	11
Sb	71*	78	10
Tl	69*	49*	33*
Sb	48*	47*	2
Sb	100	83	20*
Sb	55*	57*	3
Tl	70*	76	7
Pb	83	100	20*
Ag	68*	60*	13
Ag	88	74*	17
Mn	170*	170*	0

"*" denotes out-of-control events

Note that the recoveries are reported to 2 significant figures. Rounding after calculation results in some RPDs appearing different than the reported values would suggest.

The Project Work Order corrective action for out-of-control spikes is to perform a post-digestion spike. This, in fact, is done for all graphite furnace work (Sb, Tl, and Pb) regardless of spike recovery and in this instance confirmed the analytical values. Although all appropriate actions were taken, data for Sb and Tl associated with the out-of-control matrix spikes and RPDs could be biased low and exhibit reduced precision. Likewise, samples associated with the out-of-control Pb RPD could exhibit reduced precision, although the accuracy (recovery) was well within bounds.

The first four out-of-control matrix spike analytes on the above list (Ni, Cd, Cr, and Mo) were from the same spike sample, associated with work order numbers 9001116, 9001117, and 9001118. No corrective action was taken because the analyst was inappropriately using statistically derived, in-house control limits instead of EPA limits as guidelines, as specified in the Project Work Order. Evaluating data based on EPA control limits indicates a potential low bias for these analytes on samples associated with the named work orders.

The same situation was the case for the out-of-control Ag spikes. In the instance where only one Ag spike was out-of-control by just 1%, the MSD was most likely a statistical outlier and overall data quality should not be affected. In the instance where both MS and MSD were out by a more significant degree, a potential low bias for Ag may be the result. Work orders affected by this deviation were 9001202, 9001204, 9001205, 9001238, and 9001239.

Out-of-control Mn recoveries were due to the fact that the normal spiking level was much less than the native analyte level for the spiked sample. Corrective action is required if the native sample level is within 4x the spiking level, which was not the case. No conclusions based on MS/MSD recoveries and RPDs can be drawn for Mn values associated with this sample.

With the above qualifications, all metals data were considered valid on the basis of MS/MSDs and their associated RPDs.

Other QC Issues:

For reasons primarily associated with high solids content of the samples, sample detection limits (SDLs) were elevated because the EPA CLP digestion method (in which the sample is not concentrated) was employed. Most lead analyses were also performed by graphite furnace instead of ICP as had been agreed upon, in order to achieve more suitable detection limits. As these issues did not affect data quality and are thoroughly discussed in the case narrative, further elaboration is not necessary.

No other issues were observed in the analysis of metals.

Blair Backup Data Review
Hart Crowser Job No. 2350-04, Water
LTL Nos. 9001116-118, 9001135, 9001163, 9001190, 9001201-202, 9001204-205, 9001238-239

Semivolatile Organic Compounds and Chlorinated Phenols
(SW 846 8270, GC/MS)

Sample Holding Times:

The Project Work Order specifies a 7-day holding time for the extraction of semivolatile compounds with a subsequent 40-day analysis holding time. The longest time between sampling and extraction was 7 days and the longest time between extraction and analysis was 10 days, thus making all analyses valid on the basis of holding times.

Method Blanks:

Six blanks were analyzed throughout the course of the project with 43 samples, 8 of which were also analyzed for chlorinated phenols. No target analytes were detected in any of them with the following exceptions:

B0117MSVWLO	(LTL # 9001135-05A)	Bis(2-ethylhexyl)phthalate	49 ug/L
B0122MPPWLG	(LTL # 9001190-07A)	Phenol	3 ug/L

B0122MPPWLG also contained an unknown Tentatively Identified Compound (TIC) at an estimated 38 ug/L.

All samples associated with B0117MSVWLO displayed detectable levels of Bis(2-ethylhexyl)phthalate which were below the blank level and are appropriately "B" flagged. This suggests laboratory contamination. Bis(2-ethylhexyl)phthalate results for the associated samples should be considered contaminants. EPA Contract Laboratory Program (CLP) and Laucks' internal requirements do not require corrective action for phthalate blank contamination less than 5x the EPA Contract Required Quantitation Limit (10 ug/L in water).

Of 13 samples associated with B0122MPPWLG, only # 9001202-01B contained any phenol (6 ug/L). This indicates that the phenol contamination was isolated to the blank, though the fact that no other target analytes and very limited TICs were observed in sample 9001202-01B suggests contamination may have occurred in it as well. EPA Contract Laboratory Program (CLP) and Laucks' internal requirements do not require corrective action for phenol blank contamination less than the EPA Contract Required Quantitation Limit (10 ug/L in water).

With the above qualifications, the data was considered valid with regards to methods blank contamination.

Surrogates:

All surrogate recoveries were within EPA and contract specified limits with the following exceptions:

Sample	Surrogate	Recovery, %	Limits
9001118-02B	d14-Terphenyl	24	33-141
9001135-03B	d5-Nitrobenzene	0	35-114
9001205-03B	d5-Nitrobenzene	3	35-114
	d14-Terphenyl	31	33-141
	d6-Phenol	1	10-94
	2-Fluorophenol	1	21-100
	2,4,6-Tribromophenol	2	10-123
9012123-02B	d14-Terphenyl	24	33-141
9001190-03B	2-Fluorophenol	18	21-100
9001204-02B	d14-Terphenyl	26	33-141
9001204-03B	d14-Terphenyl	28	33-141
9001205-01B	d5-Nitrobenzene	3	35-114
	d14-Terphenyl	30	33-141
9001135-02B	d14-Terphenyl	17	33-141
9001163-01B	d14-Terphenyl	23	33-141
9001163-03B	d14-Terphenyl	22	33-141
9001163-04B	d14-Terphenyl	27	33-141
9001163-05B	d14-Terphenyl	28	33-141
9001190-01B	d6-Phenol	2	10-94
	2-Fluorophenol	2	21-100
	2,4,6-Tribromophenol	3	10-123
9001202-02B	d6-Phenol	7	10-94
	2-Fluorophenol	7	21-100
9001238-04B	d14-Terphenyl	16	33-141
9001239-01B	d6-Phenol	1	10-94
	2-Fluorophenol	1	21-100
	2,4,6-Tribromophenol	2	10-123

The Project Work Order, following the EPA Contract Laboratory Program (CLP) protocol, allows for one acid and/or one base/neutral surrogate to fall outside of control limits without requiring corrective action, in the form of re-extraction and re-analysis. Five samples exceeded this specification with two or more like surrogates falling outside of control limits. These samples were 9001190-01, 9001202-02, 9001205-01, 9001205-03, and 9001239-01. Re-extraction and re-analysis was performed with substantially the same results, thus documenting matrix effect. Since re-extraction was performed outside of the contract specified holding time, results from the original analyses, which were performed within holding time limits, were reported.

All data were considered validated either by adequate surrogate recoveries or by appropriate corrective actions.

Matrix Spike / Matrix Spike Duplicates:

Five matrix spike / matrix spike duplicates (MS/MSDs) were analyzed with 43 samples for semivolatiles, 8 of which were also analyzed for chlorinated phenols. Two of these MS/MSDs also contained chlorinated phenol spikes. All MS/MSDs and their associated RPDs were within Project Work Order specifications with the following exceptions:

Sample No.	Analyte	MS Recovery, %	MSD Recovery, %	RPD, %
9001205-02B	Pentachlorophenol	110*	109*	1

"*" denotes out-of-control events

The control limits for Pentachlorophenol are 9%-103% recoveries and 50% RPD. The Project Work Order requires no corrective actions for out-of-control MS/MSD data. As all other recovery and RPD data were in control on this and other spikes and recovery was out-of-control high but near 100%, this was not considered a serious deficit.

All data were considered valid on the basis of MS/MSD recoveries and RPDs.

Other QC Issues:

No other issues were observed in the analysis of semivolatile organic compounds and the selected chlorinated phenols.

Volatile Organic Compounds
(SW 846 8240, GC/MS)

Sample Holding Times:

Under Project Work Order requirements, water samples were to be analyzed within 14 days. All samples were analyzed within 8 or fewer days, thus validating the analyses based on holding times.

Method Blanks:

Ten method blanks were analyzed for Volatile Organic Compounds (VOCs) with 52 samples. No target compounds or Tentatively Identified Compounds (TICs) were detected in any of the blanks with the following exceptions:

Blank Number	Analyte Found	Blank Found, ug/L
9001163-08A	Methylene Chloride	1
9001190-07A	Methylene Chloride	2

Methylene chloride is a solvent common in the laboratory which occasionally results in blank contamination. EPA Contract Laboratory Program (CLP) and Laucks' internal requirements do not require corrective action for methylene chloride blank contamination less than 5x the EPA Contract Required Quantitation Limit (5 ug/L in water). Since no methylene chloride was detected in any of the associated samples and the levels were very near the detection limit (1 ug/L), these were probably isolated phenomena and should not affect sample result validity.

All data were considered valid on the basis of method blanks.

Surrogates:

All surrogate recoveries were within EPA and contract specified limits, thus establishing the analyses as being in control.

Matrix Spike / Matrix Spike Duplicates:

Four matrix spike / matrix spike duplicates (MS/MSDs) were analyzed for Volatile Organic Compounds (VOCs) with 52 samples. All MS/MSD recoveries and their associated RPDs were within EPA and Project Work Order specifications, thus validating data on that basis.

Other QC Issues:

No other issues were observed in the analysis of volatile organic compounds.

Organochlorine (OC) Pesticides / PCBs
(SW 846 8080)

Sample Holding Times:

The Project Work Order specifies a 7-day holding time for the extraction of OC Pesticides/PCBs with a subsequent 40-day analysis holding time. The longest time between sampling and extraction was 6 days and the longest time between extraction and analysis was 22 days. Thus, all analyses for OC Pesticides/PCBs were considered valid on the basis of holding times.

Method Blanks:

Five method blanks were analyzed with 43 samples. No target analytes were detected in any of the blanks, thus validating the analyses on the basis of method blanks.

Surrogates:

All samples demonstrated recovery of both Isodrin and Dibutylchlorendate (DBC) surrogates with the following exceptions:

Sample No.	DBC Recovery, %	Isodrin Recovery, %
water limits	(43-152)	(32-96)
9001116-01	28*	0*
9001135-02	150	13*
9001163-05	190*	56
9001201-04	75	0*

"*" denotes out-of-control events

For all samples except 9001116-01, at least one surrogate was within control limits. The Project Work Order specifies that if either one of these surrogates is in control, the analysis is considered valid. In one instance (sample 9001116-01) both surrogates were out-of-control. Observation of the chromotograms provided with the data indicates significant matrix interference. No further action was taken.

All sample analyses were considered valid with regards to surrogate recoveries as specified in the Project Work Order with the qualification of sample 9001116-01 for which no corrective action was available. Due to low surrogate recoveries and matrix interference, results for this sample should be considered estimated.

Appendix C

APPENDIX C
SUMMARY DATA TABLES

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APPENDIX C
SUMMARY DATA TABLES

This appendix presents summary tables (C-1 through C-12) of analytical results for soil, sediment, surface water, and groundwater samples collected in the defined areas of the Blair Backup property. Data are presented by media type within specific areas. These summary tables were developed from the laboratory analytical results which are presented under separate cover in four accompanying volumes of this report as defined below:

VOLUME III - PHASE I SOIL AND SURFACE WATER LABORATORY REPORTS

VOLUME IV - PHASE I SOIL AND SURFACE WATER QUALITY CONTROL REPORTS

VOLUME V - PHASE I GROUNDWATER LABORATORY AND QUALITY CONTROL REPORTS

VOLUME VI - PHASE II SOIL AND WATER LABORATORY AND QUALITY CONTROL REPORTS

Table C-1 - Summary of General/Fill Area Soil Results

Sample Location:	HC-1S/S-2	HC-1S/S-5	HC-2S/S-1	HC-3S/S-2	HC-13S/S-2	HC-14S/S-1	HC-17S/S-1	HC-17S/S-3	HC-18S/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	5.0 - 6.5	5.0 - 6.5	2.5 - 4.0	5.0 - 6.5	5.0 - 6.5	2.5 - 4.0	2.5 - 4.0	6.5 - 7.0	2.5 - 4.0
		Replicate S-2							
Total Metals									
in mg/kg (ppm)									
Arsenic	3.2	3.2	2.8	3.1	2.6	3.4	NA	NA	NA
Cadmium	0.6	0.6	1.1	1	0.6	0.9	NA	NA	NA
Chromium	14	12	24	12	17	16	NA	NA	NA
Copper	12	9	18	8	16	18	NA	NA	NA
Mercury	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA	NA
Nickel	4	4	26	4	8	10	NA	NA	NA
Lead	12	10 U	19	10 U	10 U	10 U	NA	NA	NA
Zinc	16	16	38	17	23	26	NA	NA	NA
Volatile Organic Compounds									
in mg/kg (ppm)									
Vinyl chloride	0.002 U	0.002 U	NA	0.002 U	NA	NA	NA	NA	NA
Acetone	0.092 U	0.14 U	NA	0.017 U	NA	NA	NA	NA	NA
Carbon disulfide	0.002 U	0.002 U	NA	0.002 U	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	0.002 U	0.002 U	NA	0.002 U	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	0.002 U	0.002 U	NA	0.002 U	NA	NA	NA	NA	NA
Total 1,2-Dichloroethene	0.002 U	0.002 U	NA	0.002 U	NA	NA	NA	NA	NA
2-Butanone (MEK)	0.011	0.021	NA	0.005 U	NA	NA	NA	NA	NA
Trichloroethene	0.002 U	0.002 U	NA	0.002 U	NA	NA	NA	NA	NA
Benzene	0.002 U	0.002 U	NA	0.002 U	NA	NA	NA	NA	NA
Toluene	0.002 U	0.002 U	NA	0.002 U	NA	NA	NA	NA	NA
Ethylbenzene	0.002 U	0.002 U	NA	0.002 U	NA	NA	NA	NA	NA
Total Xylene	0.002 U	0.002 U	NA	0.002 U	NA	NA	NA	NA	NA
Miscellaneous Paramters									
in mg/kg (ppm)									
GC-FID Screen	NA	NA	140	NA	62	27	0.5 UJ	0.5 UJ	0.5 UJ

Sample Location:	HC-1S/S-2	HC-1S/S-5	HC-2S/S-1	HC-3S/S-2	HC-13S/S-2	HC-14S/S-1	HC-17S/S-1	HC-17S/S-3	HC-18S/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	5.0 - 6.5	5.0 - 6.5	2.5 - 4.0	5.0 - 6.5	5.0 - 6.5	2.5 - 4.0	2.5 - 4.0	6.5 - 7.0	2.5 - 4.0
		Replicate S-2							
Semivolatile Organic Compounds in mg/kg (ppm)									
Napthalene	0.086 U	0.084 U	NA	0.079 U	NA	NA	0.069 U	0.078 U	0.061 U
2-Methylnapthalene	0.043 U	0.042 U	NA	0.039 U	NA	NA	0.069 U	0.078 U	0.061 U
Acenapthylene	0.043 U	0.042 U	NA	0.039 U	NA	NA	0.069 U	0.078 U	0.061 U
Acenapthene	0.043 U	0.042 U	NA	0.039 U	NA	NA	0.069 U	0.078 U	0.061 U
Dibenzofuran	0.043 U	0.042 U	NA	0.039 U	NA	NA	NA	NA	NA
Fluorene	0.043 U	0.042 U	NA	0.039 U	NA	NA	0.069 U	0.078 U	0.061 U
Phenanthrene	0.043 U	0.042 U	NA	0.039 U	NA	NA	0.069 U	0.078 U	0.061 U
Anthracene	0.043 U	0.042 U	NA	0.039 U	NA	NA	0.069 U	0.078 U	0.061 U
Fluoranthene	0.043 U	0.042 U	NA	0.039 U	NA	NA	0.069 U	0.078 U	0.061 U
Pyrene	0.043 U	0.042 U	NA	0.039 U	NA	NA	0.069 U	0.078 U	0.061 U
Benzo(a)anthracene	0.043 U	0.042 U	NA	0.039 U	NA	NA	0.069 U	0.078 U	0.061 U
Chrysene	0.043 U	0.042 U	NA	0.039 U	NA	NA	0.069 U	0.078 U	0.061 U
Bis(2-ethylhexyl)phthalate	0.2 UB	0.14 UB	NA	0.59 UB	NA	NA	NA	NA	NA
Di-n-octyl phthalate	0.043 U	0.042 U	NA	0.41 B	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	0.086 U	0.084 U	NA	0.079 U	NA	NA	0.14 U	0.16 U	0.12 U
Benzo(k)fluoranthene	0.086 U	0.084 U	NA	0.079 U	NA	NA	0.14 U	0.16 U	0.12 U
Benzo(a)pyrene	0.086 U	0.084 U	NA	0.079 U	NA	NA	0.14 U	0.16 U	0.12 U
Indeno(1,2,3-cd)pyrene	0.086 U	0.084 U	NA	0.079 U	NA	NA	0.14 U	0.16 U	0.12 U
Dibenzo(a,h)anthracene	0.086 U	0.084 U	NA	0.079 U	NA	NA	0.14 U	0.16 U	0.12 U
Benzo(g,h,i)perylene	0.086 U	0.084 U	NA	0.079 U	NA	NA	0.14 U	0.16 U	0.12

Notes:

U	Indicates compound was analyzed for but not detected at the given detection limit.
J	Indicates an estimated value.
B	Indicates analyte was detected in laboratory method blank.
T	Flagged values represent sum of two co-eluting compounds.
D	Value reported derives from analysis of a diluted sample or sample extract.
NA	Not analyzed.

Sample Location:	SS-9 Fill	SS-10 Fill	TP101/S-1	TP102/S-2	TP103/S-2	TP104/S-1	TP105/S-2	TP106/S-1	TP107/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	0.0 - 0.25	0.0 - 0.5	2.0 - 3.0	7.0 - 8.0	8.0 - 9.0	2.0 - 3.0	6.5 - 7.5	2.0 - 3.0	2.0 - 3.0
Total Metals									
in mg/kg (ppm)									
Arsenic	7.2	3.7	1.8	1	3.7	0.5 U	2.2	2.3	12
Cadmium	6.7	0.98	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chromium	66	19	10 B	13 B	22 B	14 B	21 B	25 B	27 B
Copper	1400	28	17	14	30	9	15	14	60
Mercury	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	24	200	4.3	2.8	12	2 U	18	26	19
Lead	1100	13	10 U	10 U	10 U	10 U	10 U	10 U	43
Zinc	280	47	18 B	14 B	36 B	21 B	31 B	36 B	65 B
Volatile Organic Compounds									
in mg/kg (ppm)									
Vinyl chloride	NA	NA	0.002 U	0.002 U	0.002 U	0.002 U	NA	NA	0.002 U
Acetone	NA	NA	0.12 U	0.13 U	0.1 U	0.048 U	NA	NA	0.009 U
Carbon disulfide	NA	NA	0.002 U	0.002 U	0.004	0.002 U	NA	NA	0.002 U
trans-1,2-Dichloroethene	NA	NA	0.002 U	0.002 U	0.002 U	0.002 U	NA	NA	0.002 U
cis-1,2-Dichloroethene	NA	NA	0.002 U	0.002 U	0.002 U	0.002 U	NA	NA	0.002 U
Total 1,2-Dichloroethene	NA	NA	0.002 U	0.002 U	0.002 U	0.002 U	NA	NA	0.002 U
2-Butanone (MEK)	NA	NA	0.005 U	0.005 U	0.012	0.005 U	NA	NA	0.005 U
Trichloroethene	NA	NA	0.002 U	0.002 U	0.002 U	0.002 U	NA	NA	0.002 U
Benzene	NA	NA	0.002 U	0.002 U	0.002 U	0.002 U	NA	NA	0.002 U
Toluene	NA	NA	0.002 U	0.002 U	0.002 U	0.002 U	NA	NA	0.002 U
Ethylbenzene	NA	NA	0.002 U	0.002 U	0.002 U	0.002 U	NA	NA	0.002 U
Total Xylene	NA	NA	0.002 U	0.002 U	0.002 U	0.002 U	NA	NA	0.002 U
Miscellaneous Paramters									
in mg/kg (ppm)									
GC-FID Screen	110 B	30 UB	NA	NA	NA	NA	10 U	18	590

Sample Location:	SS-9 Fill	SS-10 Fill	TP101/S-1	TP102/S-2	TP103/S-2	TP104/S-1	TP105/S-2	TP106/S-1	TP107/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	0.0 - 0.25	0.0 - 0.5	2.0 - 3.0	7.0 - 8.0	8.0 - 9.0	2.0 - 3.0	6.5 - 7.5	2.0 - 3.0	2.0 - 3.0
Semivolatile Organic Compounds in mg/kg (ppm)									
Napthalene	NA	NA	0.081 U	0.082 U	0.1 U	0.074 U	NA	NA	0.67
2-Methylnapthalene	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	2.1
Acenapthylene	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	0.16 U
Acenapthene	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	0.16 U
Dibenzofuran	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	0.16 U
Fluorene	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	0.16 U
Phenanthrene	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	0.16 U
Anthracene	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	0.16 U
Fluoranthene	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	0.16 U
Pyrene	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	0.16 U
Benzo(a)anthracene	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	0.16 U
Chrysene	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	0.16 U
Bis(2-ethylhexyl)phthalate	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	0.16 U
Di-n-octyl phthalate	NA	NA	0.04 U	0.041 U	0.05 U	0.037 U	NA	NA	0.16 U
Benzo(b)fluoranthene	NA	NA	0.081 U	0.082 U	0.1 U	0.074 U	NA	NA	0.32 U
Benzo(k)fluoranthene	NA	NA	0.081 U	0.082 U	0.1 U	0.074 U	NA	NA	0.32 U
Benzo(a)pyrene	NA	NA	0.081 U	0.082 U	0.17	0.074 U	NA	NA	0.32 U
Indeno(1,2,3-cd)pyrene	NA	NA	0.081 U	0.082 U	0.1 U	0.074 U	NA	NA	0.32 U
Dibenzo(a,h)anthracene	NA	NA	0.081 U	0.082 U	0.1 U	0.074 U	NA	NA	0.32 U
Benzo(g,h,i)perylene	NA	NA	0.081 U	0.082 U	0.1 U	0.074 U	NA	NA	0.32 U

Table C-2 - Summary of North Site Area Soil Results

Sample Location:	HC-7S/S-2	HC-8S/S-2	HC-9S/S-1	HC-9S/S-3	HC-19S/S-2	HC-21S/S-1
Date Sampled:	Dec 1989	Dec 1989	Aug 1990	Aug 1990	Aug 1990	Aug 1990
Sample Depth in feet:	5.0 - 6.5	5.0 - 6.5	2.5 - 4.0	7.5 - 9:0	5.0 - 6.5	2.5 - 4.0
Total Metals						
in mg/kg (ppm)						
Arsenic	3.7	15	21	2.7	3.4	13
Cadmium	0.5 U	0.8	0.50 U	0.50 U	0.50 U	0.50 U
Chromium	15	20	20	19	14	15
Copper	16	23	44	24	14	23
Mercury	0.1 U	0.1 U	1.3	0.1 U	0.1 U	0.1 U
Nickel	10	11	30	9.3	8.8	18
Lead	10 U	12	24	10 U	10 U	14
Zinc	24	40	53 B	33 B	35 B	34 B
EP Toxicity Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds						
in mg/kg (ppm)						
Vinyl chloride	NA	0.002 U	0.002 U	0.007	0.002 U	0.008
Methylene Chloride	NA	0.002 U	0.002	0.002 U	0.002	0.002 U
Acetone	NA	0.086 U	0.12	0.038	0.048	0.098
Carbon disulfide	NA	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
trans-1,2-Dichloroethene	NA	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
cis-1,2-Dichloroethene	NA	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Total 1,2-Dichloroethene	NA	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
2-Butanone (MEK)	NA	0.005 U	0.023	0.006 U	0.006 U	0.006 U
Trichloroethene	NA	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Benzene	NA	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Toluene	NA	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Ethylbenzene	NA	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Total Xylene	NA	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U

Table C-2 - Summary of North Site Area Soil Results

Sample Location:	HC-7S/S-2	HC-8S/S-2	HC-9S/S-1	HC-9S/S-3	HC-19S/S-2	HC-21S/S-1
Date Sampled:	Dec 1989	Dec 1989	Aug 1990	Aug 1990	Aug 1990	Aug 1990
Sample Depth in feet:	5.0 - 6.5	5.0 - 6.5	2.5 - 4.0	7.5 - 9.0	5.0 - 6.5	2.5 - 4.0
Semivolatile Organic Compounds in mg/kg (ppm)						
Napthalene	NA	0.38 U	0.048 U	0.048 UJ	0.045 U	0.092 U
2-Methylnapthalene	NA	0.19 U	0.048 U	0.048 UJ	0.045 U	0.092 U
Acenapthylene	NA	0.19 U	0.048 U	0.048 UJ	0.045 U	0.092 U
Acenapthene	NA	0.19 U	0.048 U	0.048 UJ	0.045 U	0.17
Dibenzofuran	NA	0.19 U	0.048 U	0.048 UJ	0.045 U	0.1
Fluorene	NA	0.19 U	0.048 U	0.048 UJ	0.045 U	0.15
Phenanthrene	NA	0.19 U	0.3	0.048 UJ	0.054	0.42
Anthracene	NA	0.19 U	0.2	0.048 UJ	0.045 U	0.56
Fluoranthene	NA	2.1	3.4	0.048 UJ	0.83	7.4
Pyrene	NA	1.8	6	0.048 UJ	0.91	9.8
Benzo(a)anthracene	NA	0.27	1.6	0.048 UJ	0.15	2.4
Chrysene	NA	0.93	3.6	0.048 UJ	0.42	5.8
Bis(2-ethylhexyl)phthalate	NA	0.76 UB	0.19	0.072 UBJ	0.14	0.17
Di-n-octyl phthalate	NA	0.55	0.048 U	0.048 UJ	0.045 U	0.092 U
Benzo(b)fluoranthene	NA	0.64 T	2.2 T	0.048 UJ	0.25 T	3.5 T
Benzo(k)fluoranthene	NA	0.64 T	2.2 T	0.048 UJ	0.25 T	3.5 T
Benzo(a)pyrene	NA	0.38 U	0.72	0.048 UJ	0.077	1.1
Indeno(1,2,3-cd)pyrene	NA	0.38 U	0.45	0.048 UJ	0.045 U	0.68
Dibenzo(a,h)anthracene	NA	0.38 U	0.12	0.048 UJ	0.045 U	0.25
Benzo(g,h,i)perylene	NA	0.38 U	0.72	0.048 UJ	0.054	1
Miscellaneous Parameters						
GC-FID Screen in mg/kg (ppm)	16	26	NA	NA	NA	NA
Pesticides/PCBs	NA	ND	NA	NA	NA	NA

Notes:

U	Indicates compound was analyzed for but not detected at the given detection limit.
J	Indicates an estimated value.
B	Indicates analyte was detected in laboratory method blank.
T	Flagged values represent sum of two co-eluting compounds.
D	Value reported derives from analysis of a diluted sample or sample extract.
NA	Not analyzed.
ND	Not detected at various detection limits.

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Table C-2 - Summary of North Site Area Soil Results

Sample Location:	HC-22S/S-1	SS-4	SS-5	SS-6	TP113/S-1	TP114/S-1
Date Sampled:	Aug 1990	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	2.5 - 4.0	0.0 - 0.25	0.0 - 0.25	0.0 - 0.25	2.0 - 3.0	2.0 - 3.0
Total Metals						
in mg/kg (ppm)						
Arsenic	4.3	760	12	420	2.7	20
Cadmium	0.50 U	6.3	20	6.2	0.5 U	0.67
Chromium	26	2,100	160	2,700	15 B	18 B
Copper	52	1,200	2,600	660	20	31
Mercury	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.5
Nickel	14	1,100	8	1,000	8.9	22
Lead	10 U	1,200	650	660	14	14
Zinc	40 B	2,500	8,200	1,900	25 B	48 B
EP Toxicity Metals						
in mg/L (ppm)						
Arsenic	NA	0.2 UJ	NA	0.4 J	NA	NA
Barium	NA	0.2	NA	0.4	NA	NA
Cadmium	NA	0.01 U	NA	0.02	NA	NA
Chromium	NA	0.1 UJ	NA	0.1 UJ	NA	NA
Copper	NA	0.4 J	NA	1.8 J	NA	NA
Lead	NA	0.1 UJ	NA	0.1 UJ	NA	NA
Mercury	NA	0.005 U	NA	0.005 U	NA	NA
Nickel	NA	0.6	NA	0.2	NA	NA
Zinc	NA	1.6 J	NA	6.4 J	NA	NA
Volatile Organic Compounds						
in mg/kg (ppm)						
Vinyl chloride	0.002 U	NA	NA	NA	0.002 U	0.002 U
Methylene Chloride	0.002 U	NA	NA	NA	0.002 U	0.002 U
Acetone	0.052	NA	NA	NA	0.31 U	0.26 U
Carbon disulfide	0.002 U	NA	NA	NA	0.002 U	0.002 U
trans-1,2-Dichloroethene	0.002 U	NA	NA	NA	0.002 U	0.002 U
cis-1,2-Dichloroethene	0.002 U	NA	NA	NA	0.002 U	0.002 U
Total 1,2-Dichloroethene	0.002 U	NA	NA	NA	0.002 U	0.002 U
2-Butanone (MEK)	0.007 U	NA	NA	NA	0.005 U	0.036
Trichloroethene	0.002 U	NA	NA	NA	0.002 U	0.002 U
Benzene	0.002 U	NA	NA	NA	0.002 U	0.002 U
Toluene	0.002 U	NA	NA	NA	0.002 U	0.002 U
Ethylbenzene	0.002 U	NA	NA	NA	0.002 U	0.002 U
Total Xylene	0.002 U	NA	NA	NA	0.002 U	0.002 U

Table C-2 - Summary of North Site Area Soil Results

Sample Location:	HC-22S/S-1	SS-4	SS-5	SS-6	TP113/S-1	TP114/S-1
Date Sampled:	Aug 1990	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	2.5 - 4.0	0.0 - 0.25	0.0 - 0.25	0.0 - 0.25	2.0 - 3.0	2.0 - 3.0
Semivolatile Organic Compounds						
in mg/kg (ppm)						
Napthalene	0.055 UJ	4	NA	NA	0.084 U	0.2 U
2-Methylnapthalene	0.055 UJ	0.8	NA	NA	0.042 U	0.1 U
Acenapthylene	0.055 UJ	0.08 U	NA	NA	0.042 U	0.1 U
Acenapthene	0.055 UJ	3	NA	NA	0.042 U	0.1 U
Dibenzofuran	0.055 UJ	0.6	NA	NA	0.042 U	0.1 U
Fluorene	0.055 UJ	3	NA	NA	0.042 U	0.1 U
Phenanthrene	0.055 UJ	9 D	NA	NA	0.042 U	0.35
Anthracene	0.055 UJ	3 D	NA	NA	0.042 U	0.22
Fluoranthene	0.055 UJ	50 D	NA	NA	0.27	5.5
Pyrene	0.055 UJ	40 D	NA	NA	0.23	8.5
Benzo(a)anthracene	0.055 UJ	2 D	NA	NA	0.049	2.2
Chrysene	0.055 UJ	7 D	NA	NA	0.13	4.6
Bis(2-ethylhexyl)phthalate	0.12 UBJ	0.1 UB	NA	NA	0.11 UB	0.13 UB
Di-n-octyl phthalate	0.055 UJ	0.06 B	NA	NA	0.042 U	0.1 U
Benzo(b)fluoranthene	0.055 UJ	70 TD	NA	NA	0.084 U	3.1 T
Benzo(k)fluoranthene	0.055 UJ	70 TD	NA	NA	0.084 U	3.1 T
Benzo(a)pyrene	0.055 UJ	3 D	NA	NA	0.084 U	0.86
Indeno(1,2,3-cd)pyrene	0.055 UJ	4	NA	NA	0.084 U	0.54
Dibenzo(a,h)anthracene	0.055 UJ	2	NA	NA	0.084 U	0.2 U
Benzo(g,h,i)perylene	0.055 UJ	7	NA	NA	0.084 U	0.69
Miscellaneous Parameters						
GC-FID Screen in mg/kg (ppm)	NA	510 B	62 UB	150 B	NA	NA
Pesticides/PCBs	NA	NA	NA	NA	ND	ND J

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Table C-2 - Summary of North Site Area Soil Results

Sample Location:	TP115/S-1	TP116/S-2	TP117/S-1	TP118/S-1	TP119/S-2
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	2.0 - 3.0	5.0 - 6.0	1.0 - 2.0	1.0 - 2.0	3.5 - 4.5
Total Metals					
in mg/kg (ppm)					
Arsenic	26 J	27 J	9.6 J	16 J	11 J
Cadmium	1.3	1.9	0.5 U	2.4	0.5 U
Chromium	25 B	26 B	12 B	31 B	34 B
Copper	54	170	9.9	55	37
Mercury	0.4	2	0.1 U	0.1 U	0.1 U
Nickel	38	160	2.2	27	26
Lead	26	47	10 U	68	17
Zinc	55 B	75 B	37 B	120 B	86 B
EP Toxicity Metals					
in mg/L (ppm)					
Arsenic	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA
Volatile Organic Compounds					
in mg/kg (ppm)					
Vinyl chloride	0.003 U	0.002 U	NA	NA	NA
Methylene Chloride	0.003 U	0.002 U	NA	NA	NA
Acetone	0.085 U	0.18 U	NA	NA	NA
Carbon disulfide	0.003 U	0.002 U	NA	NA	NA
trans-1,2-Dichloroethene	0.003 U	0.002	NA	NA	NA
cis-1,2-Dichloroethene	0.003	0.008	NA	NA	NA
Total 1,2-Dichloroethene	0.003	0.01	NA	NA	NA
2-Butanone (MEK)	0.008 U	0.007	NA	NA	NA
Trichloroethene	0.003 U	0.002 U	NA	NA	NA
Benzene	0.003 U	0.002 U	NA	NA	NA
Toluene	0.003 U	0.002 U	NA	NA	NA
Ethylbenzene	0.003 U	0.002 U	NA	NA	NA
Total Xylene	0.003 U	0.002 U	NA	NA	NA

Table C-2 - Summary of North Site Area Soil Results

Sample Location:	TP115/S-1	TP116/S-2	TP117/S-1	TP118/S-1	TP119/S-2
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	2.0 - 3.0	5.0 - 6.0	1.0 - 2.0	1.0 - 2.0	3.5 - 4.5
Semivolatile Organic Compounds in mg/kg (ppm)					
Napthalene	0.11 U	0.1 U	NA	NA	NA
2-Methylnapthalene	0.057 U	0.052 U	NA	NA	NA
Acenapthylene	0.057 U	0.052 U	NA	NA	NA
Acenapthene	0.083	0.052 U	NA	NA	NA
Dibenzofuran	0.057 U	0.052 U	NA	NA	NA
Fluorene	0.057 U	0.092	NA	NA	NA
Phenanthrene	0.5	1.6	NA	NA	NA
Anthracene	0.58	0.44	NA	NA	NA
Fluoranthene	11 D	3.1	NA	NA	NA
Pyrene	15 D	3.5	NA	NA	NA
Benzo(a)anthracene	3.6 D	1.3	NA	NA	NA
Chrysene	8 D	1.8	NA	NA	NA
Bis(2-ethylhexyl)phthalate	0.22 UB	0.13 UB	NA	NA	NA
Di-n-octyl phthalate	0.057 U	0.052 U	NA	NA	NA
Benzo(b)fluoranthene	4.8 T	1.9 T	NA	NA	NA
Benzo(k)fluoranthene	4.8 T	1.9 T	NA	NA	NA
Benzo(a)pyrene	1.1	0.51	NA	NA	NA
Indeno(1,2,3-cd)pyrene	0.68	0.32	NA	NA	NA
Dibenzo(a,h)anthracene	0.17	0.13	NA	NA	NA
Benzo(g,h,i)perylene	0.94	0.34	NA	NA	NA
Miscellaneous Parameters					
GC-FID Screen in mg/kg (ppm)	NA	NA	10 U	10 U	10 U
Pesticides/PCBs	ND	ND	NA	NA	NA

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Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	HC-4S/S-1	HC-4S/S-2	HC-5S/S-1	HC-5S/S-2	HC-6S/S-1	HC-10S/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	2.5 - 4.0	5.0 - 6.5	2.5 - 4.0	5.0 - 6.5	2.5 - 4.0	2.5 - 4.0
Total Metals						
in mg/kg (ppm)						
Arsenic	0.8	2.1	22	29	100	28
Cadmium	0.5 U	0.5 U	1.1	1.2	0.7	1.5
Chromium	22	14	49	26	14	32
Copper	20	13	66	45	11	51
Lead	10 U	10 U	18	13	10 U	17
Manganese	NA	NA	NA	NA	NA	NA
Mercury	0.1 U	0.1 U	0.2	0.4	0.1 U	1.6
Nickel	13	8.0	49	30	5	24
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	32	22	75	50	18	45
EP Toxicity Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	0.2 UJ	NA
Barium	NA	NA	NA	NA	0.1 U	NA
Cadmium	NA	NA	NA	NA	0.01 U	NA
Chromium	NA	NA	NA	NA	0.1 UJ	NA
Copper	NA	NA	NA	NA	0.1 UJ	NA
Lead	NA	NA	NA	NA	0.1 UJ	NA
Mercury	NA	NA	NA	NA	0.005 U	NA
Nickel	NA	NA	NA	NA	0.1 U	NA
Zinc	NA	NA	NA	NA	0.1 UJ	NA
TCLP Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	HC-4S/S-1	HC-4S/S-2	HC-5S/S-1	HC-5S/S-2	HC-6S/S-1	HC-10S/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	2.5 - 4.0	5.0 - 6.5	2.5 - 4.0	5.0 - 6.5	2.5 - 4.0	2.5 - 4.0
Volatile Organic Compounds						
in mg/kg (ppm)						
Vinyl chloride	NA	0.002 U	NA	0.002 U	0.002 U	NA
Acetone	NA	0.062 U	NA	0.3 U	0.019 U	NA
Carbon disulfide	NA	0.002 U	NA	0.002 U	0.002 U	NA
trans-1,2-Dichloroethene	NA	0.002 U	NA	0.002 U	0.002 U	NA
cis-1,2-Dichloroethene	NA	0.002 U	NA	0.002 U	0.002 U	NA
Total 1,2-Dichloroethene	NA	0.002 U	NA	0.002 U	0.002 U	NA
2-Butanone (MEK)	NA	0.005 U	NA	0.054	0.005 U	NA
1,2-Dichloroethane	NA	0.002 U	NA	0.002 U	0.002 U	NA
Trichloroethene	NA	0.002 U	NA	0.002 U	0.002 U	NA
Benzene	NA	0.002 U	NA	0.002 U	0.002 U	NA
Toluene	NA	0.002 U	NA	0.002 U	0.002 U	NA
Ethylbenzene	NA	0.002 U	NA	0.002 U	0.002 U	NA
Total Xylene	NA	0.005	NA	0.002 U	0.002 U	NA
Semivolatile Organic Compounds						
in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
2-Methylnapthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA
Di-n-octyl phthalate	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	HC-4S/S-1	HC-4S/S-2	HC-5S/S-1	HC-5S/S-2	HC-6S/S-1	HC-10S/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	2.5 - 4.0	5.0 - 6.5	2.5 - 4.0	5.0 - 6.5	2.5 - 4.0	2.5 - 4.0
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Miscellaneous Parameters in mg/kg (ppm)						
GC-FID Screen	44	21	60	36	10	79
GC-FID Screen 8015 Modified	NA	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified (a)	NA	NA	NA	NA	NA	NA
TPH (418.1)	NA	NA	NA	NA	NA	NA
Organophosphorous Pesticides	ND	ND	ND	ND J	NA	NA
Chlorinated Herbicides	ND R	ND R	ND R	ND R	NA	NA
Pesticides/PCBs in mg/kg (ppm)						
4,4'-DDE	0.02 U	0.02 U	0.023 U	0.024 U	NA	NA
4,4'-DDD	0.02 U	0.02 U	0.023 U	0.024 U	NA	NA
4,4'-DDT	0.02 U	0.02 U	0.023 U	0.024 U	NA	NA

Notes:

U	Indicates compound was analyzed for but not detected at the given detection limit.
J	Indicates an estimated value.
B	Indicates analyte was detected in laboratory method blank.
T	Flagged values represent sum of two co-eluting compounds.
D	Value reported derives from analysis of a diluted sample or sample extract.
R	Data was unuseable based on data validation criteria.
(a)	After silica gel cleanup.
(b)	Analyzed using GC-MS (EPA method 8270).
NA	Not analyzed.
ND	Not detected at various detection limits.

OFA-SOIL.WK1

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	HC-10S/S-7	HC-11S/S-1	HC-12S/S-2	HC-15S/S-1	HC-15S/S-3	HC-16/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	2.5 - 4.0	2.5 - 4.0	5.0 - 6.5	2.5 - 4.0	7.5 - 9.0	2.5 - 4.0
	Replicate S-1					
Total Metals						
in mg/kg (ppm)						
Arsenic	33	3	1.9 J	4.2 J	4 J	7 J
Cadmium	1.2	0.5 U	2.2	0.6	1.4	0.8
Chromium	31	3,000	570	17	21	470
Copper	62	11	370	11	35	81
Lead	18	10 U	45	10 U	10 U	23
Manganese	NA	NA	NA	NA	NA	NA
Mercury	0.6	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	30	31	190	6.1	16	42
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	48	13	77	85	42	69
EP Toxicity Metals						
in mg/L (ppm)						
Arsenic	NA	0.2 UJ	NA	NA	NA	NA
Barium	NA	0.2	NA	NA	NA	NA
Cadmium	NA	0.01 U	NA	NA	NA	NA
Chromium	NA	0.1 UJ	NA	NA	NA	NA
Copper	NA	0.1 UJ	NA	NA	NA	NA
Lead	NA	0.1 UJ	NA	NA	NA	NA
Mercury	NA	0.005 U	NA	NA	NA	NA
Nickel	NA	0.2	NA	NA	NA	NA
Zinc	NA	0.1 J	NA	NA	NA	NA
TCLP Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	HC-10S/S-7	HC-11S/S-1	HC-12S/S-2	HC-15S/S-1	HC-15S/S-3	HC-16/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	2.5 - 4.0	2.5 - 4.0	5.0 - 6.5	2.5 - 4.0	7.5 - 9.0	2.5 - 4.0
	Replicate S-1					
Volatile Organic Compounds						
in mg/kg (ppm)						
Vinyl chloride	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	NA
Carbon disulfide	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
Total 1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
2-Butanone (MEK)	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA
Total Xylene	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds						
in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
2-Methylnapthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA
Di-n-octyl phthalate	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	HC-10S/S-7	HC-11S/S-1	HC-12S/S-2	HC-15S/S-1	HC-15S/S-3	HC-16/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	2.5 - 4.0	2.5 - 4.0	5.0 - 6.5	2.5 - 4.0	7.5 - 9.0	2.5 - 4.0
	Replicate S-1					
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Miscellaneous Parameters in mg/kg (ppm)						
GC-FID Screen	110	290	16	10 U	68	47
GC-FID Screen 8015 Modified	NA	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified (a)	NA	NA	NA	NA	NA	NA
TPH (418.1)	NA	NA	NA	NA	NA	NA
Organophosphorous Pesticides	NA	ND	NA	NA	NA	NA
Chlorinated Herbicides	NA	ND R	NA	NA	NA	NA
Pesticides/PCBs in mg/kg (ppm)						
4,4'-DDE	NA	NA	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA

OFA-SOIL.WK1

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	HC-23 S-1	HC-23 S-3	HC-24 S-1	HC-24 S-3	HC-24 S-4	HC-25 S-1
Date Sampled:	Oct 1990	Oct 1990	Oct 1990	Oct 1990	Oct 1990	Oct 1990
Sample Depth in feet:	2.5 - 4.0	7.5 - 9.0	2.5 - 4.0	6.5 - 8.0	2.5 - 4.0	2.5 - 4.0
					Replicate S-1	
Total Metals						
in mg/kg (ppm)						
Arsenic	12	12	3.8	4.1	10	6.3
Cadmium	1.0 U	1.1	1.0 U	1.2	1.0 U	1.0 U
Chromium	12	12	12	17	11	14
Copper	6.7	9.8	5.6	21	27	10
Lead	10 U	10 U	10 U	10 U	10 U	10 U
Manganese	59	72	61	99	88	60
Mercury	0.1	0.1	0.1	0.2	0.1	0.1
Nickel	4.7	11	5.7	13	7.2	5.5
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	20	23	16	35	20	22
EP Toxicity Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA
TCLP Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	HC-23 S-1	HC-23 S-3	HC-24 S-1	HC-24 S-3	HC-24 S-4	HC-25 S-1
Date Sampled:	Oct 1990	Oct 1990	Oct 1990	Oct 1990	Oct 1990	Oct 1990
Sample Depth in feet:	2.5 - 4.0	7.5 - 9.0	2.5 - 4.0	6.5 - 8.0	2.5 - 4.0	2.5 - 4.0
					Replicate S-1	
Volatile Organic Compounds in mg/kg (ppm)						
Vinyl chloride	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	NA
Carbon disulfide	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
Total 1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
2-Butanone (MEK)	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA
Total Xylene	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
2-Methylnapthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA
Di-n-octyl phthalate	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	HC-23 S-1	HC-23 S-3	HC-24 S-1	HC-24 S-3	HC-24 S-4	HC-25 S-1
Date Sampled:	Oct 1990	Oct 1990	Oct 1990	Oct 1990	Oct 1990	Oct 1990
Sample Depth in feet:	2.5 - 4.0	7.5 - 9.0	2.5 - 4.0	6.5 - 8.0	2.5 - 4.0	2.5 - 4.0
					Replicate S-1	
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Miscellaneous Parameters in mg/kg (ppm)						
GC-FID Screen	12 U	13 U	12 U	15 U	12 U	12 U
GC-FID Screen 8015 Modified	NA	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified (a)	NA	NA	NA	NA	NA	NA
TPH (418.1)	NA	NA	NA	NA	NA	NA
Organophosphorous Pesticides	NA	NA	NA	NA	NA	NA
Chlorinated Herbicides	NA	NA	NA	NA	NA	NA
Pesticides/PCBs in mg/kg (ppm)						
4,4'-DDE	NA	NA	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	HC-25 S-3	HC-26 S-1	HC-26 S-2	SS-2	SS-17	SS-3
Date Sampled:	Oct 1990	Oct 1990	Oct 1990	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	6.5 - 8.0	2.5 - 4.0	5.0 - 6.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5
					Duplicate SS-2	
Total Metals						
in mg/kg (ppm)						
Arsenic	8.2	3.5	6.6	130	110	210
Cadmium	1.2	1.0 U	1.3	1.3	1.4	1.3
Chromium	18	14	17	110	95	75
Copper	26	16	21	310	270	320
Lead	16	10 U	10 U	130	10 U	160
Manganese	110	63	110	NA	NA	NA
Mercury	0.1 U	0.1 U	0.1	0.1 U	0.1 U	0.1 U
Nickel	12	8.6	11	270	31	28
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	32	27	30	310	290	420
EP Toxicity Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	0.2 UJ
Barium	NA	NA	NA	NA	NA	0.2
Cadmium	NA	NA	NA	NA	NA	0.01 U
Chromium	NA	NA	NA	NA	NA	0.1 UJ
Copper	NA	NA	NA	NA	NA	0.1 UJ
Lead	NA	NA	NA	NA	NA	0.1 UJ
Mercury	NA	NA	NA	NA	NA	0.005 U
Nickel	NA	NA	NA	NA	NA	0.1 U
Zinc	NA	NA	NA	NA	NA	0.4 J
TCLP Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	HC-25 S-3	HC-26 S-1	HC-26 S-2	SS-2	SS-17	SS-3
Date Sampled:	Oct 1990	Oct 1990	Oct 1990	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	6.5 - 8.0	2.5 - 4.0	5.0 - 6.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5
					Duplicate SS-2	
Volatile Organic Compounds in mg/kg (ppm)						
Vinyl chloride	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	NA
Carbon disulfide	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
Total 1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
2-Butanone (MEK)	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA
Total Xylene	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
2-Methylnapthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA
Di-n-octyl phthalate	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	HC-25 S-3	HC-26 S-1	HC-26 S-2	SS-2	SS-17	SS-3
Date Sampled:	Oct 1990	Oct 1990	Oct 1990	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	6.5 - 8.0	2.5 - 4.0	5.0 - 6.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5
					Duplicate SS-2	
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Miscellaneous Parameters in mg/kg (ppm)						
GC-FID Screen	18 U	13 U	15 U	360 B	270 B	170 B
GC-FID Screen 8015 Modified	NA	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified (a)	NA	NA	NA	NA	NA	NA
TPH (418.1)	NA	NA	NA	NA	NA	NA
Organophosphorous Pesticides	NA	NA	NA	NA	NA	NA
Chlorinated Herbicides	NA	NA	NA	NA	NA	NA
Pesticides/PCBs in mg/kg (ppm)						
4,4'-DDE	NA	NA	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	SS-7	SS-100	SS-200	SS-101	SS-102	SS-103
Date Sampled:	Dec 1989	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	0.0 - 0.25	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5
			Duplicate SS-100			
Total Metals						
in mg/kg (ppm)						
Arsenic	33	NA	NA	NA	NA	NA
Cadmium	8.3	NA	NA	NA	NA	NA
Chromium	44	NA	NA	NA	NA	NA
Copper	150	NA	NA	NA	NA	NA
Lead	140	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA
Mercury	0.1	NA	NA	NA	NA	NA
Nickel	33	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	360	NA	NA	NA	NA	NA
EP Toxicity Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA
TCLP Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	SS-7	SS-100	SS-200	SS-101	SS-102	SS-103
Date Sampled:	Dec 1989	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	0.0 - 0.25	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5
			Duplicate SS-100			
Volatile Organic Compounds in mg/kg (ppm)						
Vinyl chloride	0.013 U	NA	NA	NA	NA	NA
Acetone	1.2	NA	NA	NA	NA	NA
Carbon disulfide	0.013 U	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	0.013 U	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	0.013 U	NA	NA	NA	NA	NA
Total 1,2-Dichloroethene	0.013 U	NA	NA	NA	NA	NA
2-Butanone (MEK)	0.082	NA	NA	NA	NA	NA
1,2-Dichloroethane	0.013 U	NA	NA	NA	NA	NA
Trichloroethene	0.013 U	NA	NA	NA	NA	NA
Benzene	0.013 U	NA	NA	NA	NA	NA
Toluene	0.013 U	NA	NA	NA	NA	NA
Ethylbenzene	0.013 U	NA	NA	NA	NA	NA
Total Xylene	0.013 U	NA	NA	NA	NA	NA
Semivolatile Organic Compounds in mg/kg (ppm)						
Napthalene	0.5 U	NA	NA	NA	0.13 U	NA
2-Methylnapthalene	0.25 U	NA	NA	NA	NA	NA
Acenapthylene	0.25 U	NA	NA	NA	0.26 U	NA
Acenapthene	0.25 U	NA	NA	NA	0.26 U	NA
Dibenzofuran	0.25 U	NA	NA	NA	NA	NA
Fluorene	0.25 U	NA	NA	NA	0.070	NA
Phenanthrene	0.32	NA	NA	NA	0.31	NA
Anthracene	0.25 U	NA	NA	NA	0.061	NA
Fluoranthene	0.53	NA	NA	NA	0.10	NA
Pyrene	0.65	NA	NA	NA	0.64	NA
Benzo(a)anthracene	0.25 U	NA	NA	NA	0.27	NA
Chrysene	0.54	NA	NA	NA	0.41	NA
Bis(2-ethylhexyl)phthalate	4.1 UB	NA	NA	NA	NA	NA
Di-n-octyl phthalate	0.46 B	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	1.3 T	NA	NA	NA	0.27	NA
Benzo(k)fluoranthene	1.3 T	NA	NA	NA	0.12	NA
Benzo(a)pyrene	0.5 U	NA	NA	NA	0.33	NA
Indeno(1,2,3-cd)pyrene	0.5 U	NA	NA	NA	0.24	NA
Dibenzo(a,h)anthracene	0.5 U	NA	NA	NA	0.051 U	NA
Benzo(g,h,i)perylene	0.5 U	NA	NA	NA	0.29	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	SS-7	SS-100	SS-200	SS-101	SS-102	SS-103
Date Sampled:	Dec 1989	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	0.0 - 0.25	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5
			Duplicate SS-100			
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Miscellaneous Parameters in mg/kg (ppm)						
GC-FID Screen	250 B	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified	NA	100 J	300 J	300 J	300 J	300 J
GC-FID Screen 8015 Modified (a)	NA	NA	NA	NA	200 J	NA
TPH (418.1)	NA	NA	NA	NA	620 J	NA
Organophosphorous Pesticides	NA	NA	NA	NA	NA	NA
Chlorinated Herbicides	NA	NA	NA	NA	NA	NA
Pesticides/PCBs in mg/kg (ppm)						
4,4'-DDE	NA	NA	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	SS-104	SS-105	SS-TCLP-1	SS-TCLP-2	SS-TCLP-3	SS-TCLP-4
Date Sampled:	Sept 1990	Sept 1990	Oct 1990	Oct 1990	Oct 1990	Oct 1990
Sample Depth in feet:	0.0 - 0.5	0.0 - 0.5	0.0 - 2.0	0.0 - 2.0	0.0 - 2.0	0.0 - 1.0
Total Metals						
in mg/kg (ppm)						
Arsenic	NA	50	240 J	180 J	150 J	170 J
Cadmium	NA	0.97	2.2	1.9	1.9	1.7
Chromium	NA	120	64	76	150	100
Copper	NA	150	360	260	300	240
Lead	NA	130	190	150	180	120
Manganese	NA	NA	NA	NA	NA	NA
Mercury	NA	0.1 U	0.2	0.1	0.1	0.1 U
Nickel	NA	26	43	26	34	25
Selenium	NA	NA	5.0 U	5.0 U	5.0 U	5.0 U
Silver	NA	NA	1.0 U	1.0 U	1.0 U	1.0 U
Zinc	NA	260	360	320	350	280
EP Toxicity Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA
TCLP Metals						
in mg/L (ppm)						
Arsenic	NA	NA	0.42	0.20 U	0.20 U	0.20 U
Barium	NA	NA	0.39	0.51	0.54	0.54
Cadmium	NA	NA	0.010 U	0.010 U	0.010 U	0.010 U
Chromium	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U
Copper	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U
Lead	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U
Mercury	NA	NA	0.005 U	0.005 U	0.005 U	0.005 U
Nickel	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U
Selenium	NA	NA	0.20 U	0.20 U	0.20 U	0.20 U
Silver	NA	NA	0.10 U	0.10 U	0.10 U	0.10 U
Zinc	NA	NA	0.52	0.44	0.45	0.50

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	SS-104	SS-105	SS-TCLP-1	SS-TCLP-2	SS-TCLP-3	SS-TCLP-4
Date Sampled:	Sept 1990	Sept 1990	Oct 1990	Oct 1990	Oct 1990	Oct 1990
Sample Depth in feet:	0.0 - 0.5	0.0 - 0.5	0.0 - 2.0	0.0 - 2.0	0.0 - 2.0	0.0 - 1.0
Volatile Organic Compounds in mg/kg (ppm)						
Vinyl chloride	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	NA
Carbon disulfide	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
Total 1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
2-Butanone (MEK)	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA
Total Xylene	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds in mg/kg (ppm)						
Napthalene	0.83 U	NA	NA	NA	NA	NA
2-Methylnapthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	1.7 U	NA	NA	NA	NA	NA
Acenapthene	1.7 U	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA
Fluorene	1.5	NA	NA	NA	NA	NA
Phenanthrene	4.5	NA	NA	NA	NA	NA
Anthracene	1.5	NA	NA	NA	NA	NA
Fluoranthene	0.17 U	NA	NA	NA	NA	NA
Pyrene	24	NA	NA	NA	NA	NA
Benzo(a)anthracene	8.2	NA	NA	NA	NA	NA
Chrysene	9.4	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA
Di-n-octyl phthalate	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	5.6	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	3.0	NA	NA	NA	NA	NA
Benzo(a)pyrene	10	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	6.4	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	0.34 U	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	6.0	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	SS-104	SS-105	SS-TCLP-1	SS-TCLP-2	SS-TCLP-3	SS-TCLP-4
Date Sampled:	Sept 1990	Sept 1990	Oct 1990	Oct 1990	Oct 1990	Oct 1990
Sample Depth in feet:	0.0 - 0.5	0.0 - 0.5	0.0 - 2.0	0.0 - 2.0	0.0 - 2.0	0.0 - 1.0
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Miscellaneous Parameters in mg/kg (ppm)						
GC-FID Screen	NA	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified	500 J	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified (a)	300 J	NA	NA	NA	NA	NA
TPH (418.1)	1,500 J	NA	NA	NA	NA	NA
Organophosphorous Pesticides	NA	NA	NA	NA	NA	NA
Chlorinated Herbicides	NA	NA	NA	NA	NA	NA
Pesticides/PCBs in mg/kg (ppm)						
4,4'-DDE	NA	NA	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	SS-TCLP-5	TP108/S-2	TP109/S-1	TP110/S-2	TP111/S-1	TP112/S-1
Date Sampled:	Oct 1990	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	0.0 - 2.0	2.5 - 3.5	2.5 - 3.5	3.0 - 4.0	2.0 - 3.0	2.0 - 3.0
Total Metals						
in mg/kg (ppm)						
Arsenic	63 J	90	4.5	69	23	33
Cadmium	1.4	0.54	0.5 U	1.9	1.1	1
Chromium	57	27 B	13 B	30 B	17 B	17 B
Copper	240	49	9.7	42	34	25
Lead	99	22	10 U	23	220	45
Manganese	NA	NA	NA	NA	NA	NA
Mercury	0.1	1.4	0.1 U	0.2	0.1 U	0.1 U
Nickel	24	22	7.7	290	10	14
Selenium	5.0 U	NA	NA	NA	NA	NA
Silver	1.0 U	NA	NA	NA	NA	NA
Zinc	190	38 B	34 B	56 B	46 B	120 B
EP Toxicity Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	0.2 UJ	NA
Barium	NA	NA	NA	NA	0.1	NA
Cadmium	NA	NA	NA	NA	0.01 U	NA
Chromium	NA	NA	NA	NA	0.1 UJ	NA
Copper	NA	NA	NA	NA	0.1 UJ	NA
Lead	NA	NA	NA	NA	0.1 UJ	NA
Mercury	NA	NA	NA	NA	0.005 U	NA
Nickel	NA	NA	NA	NA	0.1 U	NA
Zinc	NA	NA	NA	NA	0.1 UJ	NA
TCLP Metals						
in mg/L (ppm)						
Arsenic	0.20 U	NA	NA	NA	NA	NA
Barium	0.71	NA	NA	NA	NA	NA
Cadmium	0.010 U	NA	NA	NA	NA	NA
Chromium	0.10 U	NA	NA	NA	NA	NA
Copper	0.10 U	NA	NA	NA	NA	NA
Lead	0.10 U	NA	NA	NA	NA	NA
Mercury	0.005 U	NA	NA	NA	NA	NA
Nickel	0.10 U	NA	NA	NA	NA	NA
Selenium	0.20 U	NA	NA	NA	NA	NA
Silver	0.10 U	NA	NA	NA	NA	NA
Zinc	0.55	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	SS-TCLP-5	TP108/S-2	TP109/S-1	TP110/S-2	TP111/S-1	TP112/S-1
Date Sampled:	Oct 1990	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	0.0 - 2.0	2.5 - 3.5	2.5 - 3.5	3.0 - 4.0	2.0 - 3.0	2.0 - 3.0
Volatile Organic Compounds in mg/kg (ppm)						
Vinyl chloride	NA	NA	NA	NA	NA	0.002 U
Acetone	NA	NA	NA	NA	NA	0.086 U
Carbon disulfide	NA	NA	NA	NA	NA	0.002 U
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	0.002 U
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	0.002 U
Total 1,2-Dichloroethene	NA	NA	NA	NA	NA	0.002 U
2-Butanone (MEK)	NA	NA	NA	NA	NA	0.005 U
1,2-Dichloroethane	NA	NA	NA	NA	NA	0.002 U
Trichloroethene	NA	NA	NA	NA	NA	0.002 U
Benzene	NA	NA	NA	NA	NA	0.002 U
Toluene	NA	NA	NA	NA	NA	0.002 U
Ethylbenzene	NA	NA	NA	NA	NA	0.002 U
Total Xylene	NA	NA	NA	NA	NA	0.002 U
Semivolatile Organic Compounds in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	0.077 U
2-Methylnapthalene	NA	NA	NA	NA	NA	0.039 U
Acenapthylene	NA	NA	NA	NA	NA	0.039 U
Acenapthene	NA	NA	NA	NA	NA	0.039 U
Dibenzofuran	NA	NA	NA	NA	NA	0.039 U
Fluorene	NA	NA	NA	NA	NA	0.039 U
Phenanthrene	NA	NA	NA	NA	NA	0.29
Anthracene	NA	NA	NA	NA	NA	0.057
Fluoranthene	NA	NA	NA	NA	NA	0.18
Pyrene	NA	NA	NA	NA	NA	0.27
Benzo(a)anthracene	NA	NA	NA	NA	NA	0.15
Chrysene	NA	NA	NA	NA	NA	0.14
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	0.053 U
Di-n-octyl phthalate	NA	NA	NA	NA	NA	0.039 U
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	0.2 T
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	0.2 T
Benzo(a)pyrene	NA	NA	NA	NA	NA	0.12
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	0.084
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	0.077 U
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	0.08

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	SS-TCLP-5	TP108/S-2	TP109/S-1	TP110/S-2	TP111/S-1	TP112/S-1
Date Sampled:	Oct 1990	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	0.0 - 2.0	2.5 - 3.5	2.5 - 3.5	3.0 - 4.0	2.0 - 3.0	2.0 - 3.0
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Miscellaneous Parameters in mg/kg (ppm)						
GC-FID Screen	NA	32	10 U	490	25	20
GC-FID Screen 8015 Modified	NA	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified (a)	NA	NA	NA	NA	NA	NA
TPH (418.1)	NA	NA	NA	NA	NA	NA
Organophosphorous Pesticides	NA	NA	ND R	ND	ND	NA
Chlorinated Herbicides	NA	NA	ND R	ND R	ND R	NA
Pesticides/PCBs in mg/kg (ppm)						
4,4'-DDE	NA	NA	0.018 U	0.023 U	0.029	NA
4,4'-DDD	NA	NA	0.018 U	0.023 U	0.17	NA
4,4'-DDT	NA	NA	0.018 U	0.023 U	0.042	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP124/S-1	TP125/S-2	TP126/S-1	TP127/S-1	TP128/S-1	TP129/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	1.5 - 2.5	4.0 - 5.0	1.5 - 2.5	1.5 - 2.5	3.0 - 4.0	2.0 - 3.0
Total Metals						
in mg/kg (ppm)						
Arsenic	26 J	49	58	21	88	15
Cadmium	1.3	2.6	2.8	1.2	4.5	1.1
Chromium	22 B	47 B	1 U	91 B	100 B	440 B
Copper	99	1,500	650	300	240	390
Lead	84	1,100	790	74	130	140
Manganese	NA	NA	NA	NA	NA	NA
Mercury	0.1 U	0.6	0.1	0.1 U	0.1	0.2
Nickel	12	35	2 U	43	20	80
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	97 B	380 B	210 B	140 B	270 B	320 B
EP Toxicity Metals						
in mg/L (ppm)						
Arsenic	NA	0.2 UJ	0.2 UJ	NA	NA	NA
Barium	NA	0.3	0.2	NA	NA	NA
Cadmium	NA	0.01 U	0.01 U	NA	NA	NA
Chromium	NA	0.1 UJ	0.1 UJ	NA	NA	NA
Copper	NA	0.4 J	1.7 J	NA	NA	NA
Lead	NA	0.1 UJ	1.8 J	NA	NA	NA
Mercury	NA	0.005 U	0.005 U	NA	NA	NA
Nickel	NA	0.1 U	0.1 U	NA	NA	NA
Zinc	NA	0.3 J	0.4 J	NA	NA	NA
TCLP Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP124/S-1	TP125/S-2	TP126/S-1	TP127/S-1	TP128/S-1	TP129/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	1.5 - 2.5	4.0 - 5.0	1.5 - 2.5	1.5 - 2.5	3.0 - 4.0	2.0 - 3.0
Volatile Organic Compounds in mg/kg (ppm)						
Vinyl chloride	0.002 UJ	NA	NA	NA	NA	NA
Acetone	0.032 UJ	NA	NA	NA	NA	NA
Carbon disulfide	0.002 UJ	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	0.002 UJ	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	0.002 UJ	NA	NA	NA	NA	NA
Total 1,2-Dichloroethene	0.002 UJ	NA	NA	NA	NA	NA
2-Butanone (MEK)	0.006 UJ	NA	NA	NA	NA	NA
1,2-Dichloroethane	0.002 UJ	NA	NA	NA	NA	NA
Trichloroethene	0.002 UJ	NA	NA	NA	NA	NA
Benzene	0.002 UJ	NA	NA	NA	NA	NA
Toluene	0.002 UJ	NA	NA	NA	NA	NA
Ethylbenzene	0.002 UJ	NA	NA	NA	NA	NA
Total Xylene	0.002 UJ	NA	NA	NA	NA	NA
Semivolatile Organic Compounds in mg/kg (ppm)						
Napthalene	7.6	NA	NA	NA	NA	NA
2-Methylnapthalene	3.9	NA	NA	NA	NA	NA
Acenapthylene	12	NA	NA	NA	NA	NA
Acenapthene	12	NA	NA	NA	NA	NA
Dibenzofuran	1.6	NA	NA	NA	NA	NA
Fluorene	15	NA	NA	NA	NA	NA
Phenanthrene	120 D	NA	NA	NA	NA	NA
Anthracene	32 D	NA	NA	NA	NA	NA
Fluoranthene	120 D	NA	NA	NA	NA	NA
Pyrene	130 D	NA	NA	NA	NA	NA
Benzo(a)anthracene	39 D	NA	NA	NA	NA	NA
Chrysene	43 D	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	0.19 UB	NA	NA	NA	NA	NA
Di-n-octyl phthalate	0.17 U	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	73 TD	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	73 TD	NA	NA	NA	NA	NA
Benzo(a)pyrene	47 D	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	31 D	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	4.9 D	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	37 D	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP124/S-1	TP125/S-2	TP126/S-1	TP127/S-1	TP128/S-1	TP129/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	1.5 - 2.5	4.0 - 5.0	1.5 - 2.5	1.5 - 2.5	3.0 - 4.0	2.0 - 3.0
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Miscellaneous Parameters in mg/kg (ppm)						
GC-FID Screen	1,200	110	12	33	930	470
GC-FID Screen 8015 Modified	NA	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified (a)	NA	NA	NA	NA	NA	NA
TPH (418.1)	NA	NA	NA	NA	NA	NA
Organophosphorous Pesticides	ND	NA	NA	NA	NA	NA
Chlorinated Herbicides	ND R	NA	NA	NA	NA	NA
Pesticides/PCBs in mg/kg (ppm)						
4,4'-DDE	NA	NA	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP130/S-2	TP131/S-1	TP132/S-1	TP133/S-1	TP134/S-1	TP135/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	3.5 - 4.5	3.0 - 4.0	0.5 - 1.5	1.5 - 2.5	2.0 - 3.0	2.0 - 3.0
Total Metals						
in mg/kg (ppm)						
Arsenic	11	33	170	2.7	37	14
Cadmium	2	1.5	11	0.5 U	0.93	0.83
Chromium	65 B	64 B	49 B	22 B	1,100 B	21 B
Copper	25	98	590	18	170	86
Lead	70	71	360	10 U	59	250
Manganese	NA	NA	NA	NA	NA	NA
Mercury	2	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	3.8	19	31	15	77	19
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	96 B	190 B	550 B	41 B	210 B	180 B
EP Toxicity Metals						
in mg/L (ppm)						
Arsenic	NA	NA	0.2 UJ	NA	0.2 UJ	NA
Barium	NA	NA	0.2	NA	0.2	NA
Cadmium	NA	NA	0.01 U	NA	0.01 U	NA
Chromium	NA	NA	0.1 UJ	NA	0.1 UJ	NA
Copper	NA	NA	0.1 UJ	NA	0.1 UJ	NA
Lead	NA	NA	0.1 UJ	NA	0.1 UJ	NA
Mercury	NA	NA	0.005 U	NA	0.005 U	NA
Nickel	NA	NA	0.1 U	NA	0.1 U	NA
Zinc	NA	NA	0.5 J	NA	0.2 J	NA
TCLP Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP130/S-2	TP131/S-1	TP132/S-1	TP133/S-1	TP134/S-1	TP135/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	3.5 - 4.5	3.0 - 4.0	0.5 - 1.5	1.5 - 2.5	2.0 - 3.0	2.0 - 3.0
Volatile Organic Compounds in mg/kg (ppm)						
Vinyl chloride	NA	0.002 U	NA	NA	0.002 U	NA
Acetone	NA	0.11 U	NA	NA	0.024 U	NA
Carbon disulfide	NA	0.002 U	NA	NA	0.002 U	NA
trans-1,2-Dichloroethene	NA	0.002 U	NA	NA	0.002 U	NA
cis-1,2-Dichloroethene	NA	0.002 U	NA	NA	0.002 U	NA
Total 1,2-Dichloroethene	NA	0.002 U	NA	NA	0.002 U	NA
2-Butanone (MEK)	NA	0.006 U	NA	NA	0.006 U	NA
1,2-Dichloroethane	NA	0.002 U	NA	NA	0.002 U	NA
Trichloroethene	NA	0.002 U	NA	NA	0.002 U	NA
Benzene	NA	0.002 U	NA	NA	0.002 U	NA
Toluene	NA	0.004	NA	NA	0.002 U	NA
Ethylbenzene	NA	0.002 U	NA	NA	0.002 U	NA
Total Xylene	NA	0.002 U	NA	NA	0.002 U	NA
Semivolatile Organic Compounds in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
2-Methylnapthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA
Di-n-octyl phthalate	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP130/S-2	TP131/S-1	TP132/S-1	TP133/S-1	TP134/S-1	TP135/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in feet:	3.5 - 4.5	3.0 - 4.0	0.5 - 1.5	1.5 - 2.5	2.0 - 3.0	2.0 - 3.0
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)						
Napthalene	NA	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Miscellaneous Parameters in mg/kg (ppm)						
GC-FID Screen	18	29	260	14	23	20
GC-FID Screen 8015 Modified	NA	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified (a)	NA	NA	NA	NA	NA	NA
TPH (418.1)	NA	NA	NA	NA	NA	NA
Organophosphorous Pesticides	NA	NA	NA	NA	NA	NA
Chlorinated Herbicides	NA	NA	NA	NA	NA	NA
Pesticides/PCBs in mg/kg (ppm)						
4,4'-DDE	NA	NA	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP-200/S-1	TP-201/S-1	TP-202/S-1	TP-203/S-1	TP-204/S-1
Date Sampled:	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	0.5 - 2.0	1.0 - 2.0	2.0 - 3.0	1.5 - 2.5	3.0 - 4.0
Total Metals					
in mg/kg (ppm)					
Arsenic	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA
EP Toxicity Metals					
in mg/L (ppm)					
Arsenic	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA
TCLP Metals					
in mg/L (ppm)					
Arsenic	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP-200/S-1	TP-201/S-1	TP-202/S-1	TP-203/S-1	TP-204/S-1
Date Sampled:	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	0.5 - 2.0	1.0 - 2.0	2.0 - 3.0	1.5 - 2.5	3.0 - 4.0
Volatile Organic Compounds in mg/kg (ppm)					
Vinyl chloride	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA
Carbon disulfide	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA
Total 1,2-Dichloroethene	NA	NA	NA	NA	NA
2-Butanone (MEK)	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA
Total Xylene	NA	NA	NA	NA	NA
Semivolatile Organic Compounds in mg/kg (ppm)					
Napthalene	2.6	0.083 U	NA	NA	NA
2-Methylnapthalene	NA	NA	NA	NA	NA
Acenapthylene	1.7 U	0.17 U	NA	NA	NA
Acenapthene	1.7 U	0.17 U	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA
Fluorene	4.4	0.083	NA	NA	NA
Phenanthrene	16	0.55	NA	NA	NA
Anthracene	3.0 B	0.086 B	NA	NA	NA
Fluoranthene	19	1.6	NA	NA	NA
Pyrene	9.3	0.71	NA	NA	NA
Benzo(a)anthracene	3.7	0.37	NA	NA	NA
Chrysene	0.17 U	0.017 U	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA
Di-n-octyl phthalate	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	2.3	0.31	NA	NA	NA
Benzo(k)fluoranthene	1.4	0.17	NA	NA	NA
Benzo(a)pyrene	3.0	0.32	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.5	0.22	NA	NA	NA
Dibenzo(a,h)anthracene	1.6	0.034 U	NA	NA	NA
Benzo(g,h,i)perylene	1.1	0.17	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP-200/S-1	TP-201/S-1	TP-202/S-1	TP-203/S-1	TP-204/S-1
Date Sampled:	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	0.5 - 2.0	1.0 - 2.0	2.0 - 3.0	1.5 - 2.5	3.0 - 4.0
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)					
Napthalene	0.039 J	0.0005 UJ	NA	NA	NA
Acenapthylene	0.001 UJ	0.001 UJ	NA	NA	NA
Acenapthene	0.019 J	0.001 UJ	NA	NA	NA
Fluorene	0.02 J	0.0001 UJ	NA	NA	NA
Phenanthrene	0.02 J	0.000097 J	NA	NA	NA
Anthracene	0.002 BJ	0.00014 BJ	NA	NA	NA
Fluoranthene	0.0025 J	0.0001 UJ	NA	NA	NA
Pyrene	0.0016 J	0.0001 UJ	NA	NA	NA
Benzo(a)anthracene	0.0001 UJ	0.0001 UJ	NA	NA	NA
Chrysene	0.0001 UJ	0.0001 UJ	NA	NA	NA
Benzo(b)fluoranthene	0.0001 UJ	0.0001 UJ	NA	NA	NA
Benzo(k)fluoranthene	0.0001 UJ	0.0001 UJ	NA	NA	NA
Benzo(a)pyrene	0.0001 UJ	0.0001 UJ	NA	NA	NA
Dibenzo(a,h)anthracene	0.0002 UJ	0.0002 UJ	NA	NA	NA
Benzo(g,h,i)perylene	0.0001 UJ	0.0001 UJ	NA	NA	NA
Indeno(1,2,3-cd)pyrene	0.0001 UJ	0.0001 UJ	NA	NA	NA
Miscellaneous Parameters in mg/kg (ppm)					
GC-FID Screen	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified	300 J	100 J	30 J	30 J	3 J
GC-FID Screen 8015 Modified (a)	400 J	NA	NA	NA	NA
TPH (418.1)	450 J	630 J	NA	NA	NA
Organophosphorous Pesticides	NA	NA	NA	NA	NA
Chlorinated Herbicides	NA	NA	NA	NA	NA
Pesticides/PCBs in mg/kg (ppm)					
4,4'-DDE	NA	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP-205/S-1	TP-205/S-2	TP-206/S-1	TP-207/S-1	TP-207	TP-208/S-1
Date Sampled:	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990 (b)	Sept 1990
Sample Depth in feet:	2.0 - 3.0	4.5 - 5.0	2.0 - 3.0	1.5 - 2.5	1.5 - 2.5	1.0 - 2.0
					EPA Replicate	
Total Metals						
in mg/kg (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA
EP Toxicity Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA
TCLP Metals						
in mg/L (ppm)						
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP-205/S-1	TP-205/S-2	TP-206/S-1	TP-207/S-1	TP-207	TP-208/S-1
Date Sampled:	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990 (b)	Sept 1990
Sample Depth in feet:	2.0 - 3.0	4.5 - 5.0	2.0 - 3.0	1.5 - 2.5	1.5 - 2.5	1.0 - 2.0
					EPA Replicate	
Volatile Organic Compounds in mg/kg (ppm)						
Vinyl chloride	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	NA
Carbon disulfide	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
Total 1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
2-Butanone (MEK)	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA
Total Xylene	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds in mg/kg (ppm)						
Napthalene	NA	0.83 U	0.83 U	89 J	710	NA
2-Methylnapthalene	NA	NA	NA	NA	370	NA
Acenapthylene	NA	1.7 U	1.7 U	280 J	410	NA
Acenapthene	NA	1.7 U	1.7 U	21 UJ	1,300	NA
Dibenzofuran	NA	NA	NA	NA	120 J	NA
Fluorene	NA	1.3	1.5	940 J	970	NA
Phenanthrene	NA	5.6	2.5	3,300 J	3,800	NA
Anthracene	NA	0.92 B	0.66 B	770 J	1,300	NA
Fluoranthene	NA	9.0	0.17 U	2.1 UJ	3,000	NA
Pyrene	NA	5.1	12	2,000 J	3,300	NA
Benzo(a)anthracene	NA	2.7	7.0	570 J	1,600	NA
Chrysene	NA	3.0	7.9	2.1 UJ	1,900	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	240 U	NA
Di-n-octyl phthalate	NA	NA	NA	NA	240 U	NA
Benzo(b)fluoranthene	NA	2.5	6.2	250 J	1,400	NA
Benzo(k)fluoranthene	NA	1.3	4.2	170 J	850	NA
Benzo(a)pyrene	NA	4.7	12	600 J	1,500	NA
Indeno(1,2,3-cd)pyrene	NA	3.6	8.5	260 J	1,400	NA
Dibenzo(a,h)anthracene	NA	0.34 U	0.34 U	4.2 UJ	280	NA
Benzo(g,h,i)perylene	NA	3.8	10	240 J	280	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP-205/S-1	TP-205/S-2	TP-206/S-1	TP-207/S-1	TP-207	TP-208/S-1
Date Sampled:	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990 (b)	Sept 1990
Sample Depth in feet:	2.0 - 3.0	4.5 - 5.0	2.0 - 3.0	1.5 - 2.5	1.5 - 2.5	1.0 - 2.0
					EPA Replicate	
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)						
Napthalene	NA	0.021 J	NA	0.51 J	NA	NA
Acenapthylene	NA	0.0023 J	NA	0.01 UJ	NA	NA
Acenapthene	NA	0.037 J	NA	0.19 J	NA	NA
Fluorene	NA	0.013 J	NA	0.096 J	NA	NA
Phenanthrene	NA	0.036 J	NA	0.16 J	NA	NA
Anthracene	NA	0.0044 BJ	NA	0.019 BJ	NA	NA
Fluoranthene	NA	0.0037 J	NA	0.019 J	NA	NA
Pyrene	NA	0.0038 J	NA	0.019 J	NA	NA
Benzo(a)anthracene	NA	0.0001 UJ	NA	0.001 UJ	NA	NA
Chrysene	NA	0.0001 UJ	NA	0.001 UJ	NA	NA
Benzo(b)fluoranthene	NA	0.0001 UJ	NA	0.001 UJ	NA	NA
Benzo(k)fluoranthene	NA	0.0001 UJ	NA	0.001 UJ	NA	NA
Benzo(a)pyrene	NA	0.0001 UJ	NA	0.001 UJ	NA	NA
Dibenzo(a,h)anthracene	NA	0.0002 UJ	NA	0.002 UJ	NA	NA
Benzo(g,h,i)perylene	NA	0.0001 UJ	NA	0.001 UJ	NA	NA
Indeno(1,2,3-cd)pyrene	NA	0.0001 UJ	NA	0.001 UJ	NA	NA
Miscellaneous Parameters in mg/kg (ppm)						
GC-FID Screen	NA	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified	400 J	100 J	100 J	9,000 J	NA	300 J
GC-FID Screen 8015 Modified (a)	500 J	NA	NA	7,000 J	NA	NA
TPH (418.1)	890 J	NA	240 J	600 J	NA	88 J
Organophosphorous Pesticides	NA	NA	NA	NA	NA	NA
Chlorinated Herbicides	NA	NA	NA	NA	NA	NA
Pesticides/PCBs in mg/kg (ppm)						
4,4'-DDE	NA	NA	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP-208/S-2	TP-209/S-1	TP-210/S-1	TP-211/S-2	Coke/TP-124
Date Sampled:	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	2.0 - 3.0	1.5 - 2.5	0.5 - 2.5	3.5 - 4.5	0.0 - 0.5
Total Metals					
in mg/kg (ppm)					
Arsenic	3.4	NA	NA	NA	NA
Cadmium	0.50 U	NA	NA	NA	NA
Chromium	1,400	NA	NA	NA	NA
Copper	3.4	NA	NA	NA	NA
Lead	10 U	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA
Mercury	0.1 U	NA	NA	NA	NA
Nickel	8.6	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
Zinc	6.6	NA	NA	NA	NA
EP Toxicity Metals					
in mg/L (ppm)					
Arsenic	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA
TCLP Metals					
in mg/L (ppm)					
Arsenic	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP-208/S-2	TP-209/S-1	TP-210/S-1	TP-211/S-2	Coke/TP-124
Date Sampled:	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	2.0 - 3.0	1.5 - 2.5	0.5 - 2.5	3.5 - 4.5	0.0 - 0.5
Volatile Organic Compounds in mg/kg (ppm)					
Vinyl chloride	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA
Carbon disulfide	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA
Total 1,2-Dichloroethene	NA	NA	NA	NA	NA
2-Butanone (MEK)	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA
Total Xylene	NA	NA	NA	NA	NA
Semivolatile Organic Compounds in mg/kg (ppm)					
Napthalene	NA	NA	0.83 U	NA	NA
2-Methylnapthalene	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	1.7 U	NA	NA
Acenapthene	NA	NA	1.7 U	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA
Fluorene	NA	NA	0.17 U	NA	NA
Phenanthrene	NA	NA	6.8	NA	NA
Anthracene	NA	NA	2.5 B	NA	NA
Fluoranthene	NA	NA	0.17 U	NA	NA
Pyrene	NA	NA	38	NA	NA
Benzo(a)anthracene	NA	NA	13	NA	NA
Chrysene	NA	NA	14	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA
Di-n-octyl phthalate	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	8.5	NA	NA
Benzo(k)fluoranthene	NA	NA	4.7	NA	NA
Benzo(a)pyrene	NA	NA	18	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	10	NA	NA
Dibenzo(a,h)anthracene	NA	NA	0.34 U	NA	NA
Benzo(g,h,i)perylene	NA	NA	9.0	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	TP-208/S-2	TP-209/S-1	TP-210/S-1	TP-211/S-2	Coke/TP-124
Date Sampled:	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	2.0 - 3.0	1.5 - 2.5	0.5 - 2.5	3.5 - 4.5	0.0 - 0.5
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)					
Napthalene	NA	NA	0.0005 UJ	NA	NA
Acenapthylene	NA	NA	0.001 UJ	NA	NA
Acenapthene	NA	NA	0.001 UJ	NA	NA
Fluorene	NA	NA	0.0001 UJ	NA	NA
Phenanthrene	NA	NA	0.00016 J	NA	NA
Anthracene	NA	NA	0.00012 BJ	NA	NA
Fluoranthene	NA	NA	0.0001 UJ	NA	NA
Pyrene	NA	NA	0.00018 J	NA	NA
Benzo(a)anthracene	NA	NA	0.0001 UJ	NA	NA
Chrysene	NA	NA	0.0001 UJ	NA	NA
Benzo(b)fluoranthene	NA	NA	0.0001 UJ	NA	NA
Benzo(k)fluoranthene	NA	NA	0.0001 UJ	NA	NA
Benzo(a)pyrene	NA	NA	0.0001 UJ	NA	NA
Dibenzo(a,h)anthracene	NA	NA	0.0002 UJ	NA	NA
Benzo(g,h,i)perylene	NA	NA	0.0001 UJ	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	0.0001 UJ	NA	NA
Miscellaneous Parameters in mg/kg (ppm)					
GC-FID Screen	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified	NA	3 J	100 J	7 J	70 J
GC-FID Screen 8015 Modified (a)	NA	NA	200 J	NA	100 J
TPH (418.1)	NA	NA	190 J	NA	NA
Organophosphorous Pesticides	NA	NA	NA	NA	NA
Chlorinated Herbicides	NA	NA	NA	NA	NA
Pesticides/PCBs in mg/kg (ppm)					
4,4'-DDE	NA	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA

OFA-SOIL.WK1

Table C-3 – Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	Coke/TP-124	Charcoal	Charcoal	Charcoal	Charcoal
Date Sampled:	Sept 1990 (b)	Sept 1990	Sept 1990 (b)	Jan 1991 (b)	Jan 1991
Sample Depth in feet:	0.0 – 0.5	0.0 – 0.5	0.0 – 0.5	0.0 – 0.5	0.0 – 0.5
	EPA Replicate		EPA Replicate		
Total Metals					
in mg/kg (ppm)					
Arsenic	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA
EP Toxicity Metals					
in mg/L (ppm)					
Arsenic	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA
TCLP Metals					
in mg/L (ppm)					
Arsenic	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	Coke/TP-124	Charcoal	Charcoal	Charcoal	Charcoal
Date Sampled:	Sept 1990 (b)	Sept 1990	Sept 1990 (b)	Jan 1991 (b)	Jan 1991
Sample Depth in feet:	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5
	EPA Replicate		EPA Replicate		
Volatile Organic Compounds in mg/kg (ppm)					
Vinyl chloride	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA
Carbon disulfide	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA
Total 1,2-Dichloroethene	NA	NA	NA	NA	NA
2-Butanone (MEK)	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA
Total Xylene	NA	NA	NA	NA	NA
Semivolatile Organic Compounds in mg/kg (ppm)					
Napthalene	20 U	63	1,600	200 J	250 UJ
2-Methylnapthalene	20 U	NA	830	160 J	NA
Acenapthylene	20 U	270	1,700	1,200	680 J
Acenapthene	20 U	50 U	940	260	880 J
Dibenzofuran	20 U	NA	200 J	NA	NA
Fluorene	20 U	150	1,400	860	980 J
Phenanthrene	2.7 J	1,100	5,100	6,700	5,600 J
Anthracene	20 U	220 B	1,700	1,500	1,000 J
Fluoranthene	20 U	1,200	3,200	4,200	4,100 J
Pyrene	1.5 J	760	3,600	4,300	4,100 J
Benzo(a)anthracene	20 U	360	1,600	1,200	850 J
Chrysene	20 U	400	2,100	1,400	900 J
Bis(2-ethylhexyl)phthalate	3.9 J	NA	250 U	NA	NA
Di-n-octyl phthalate	20 U	NA	250 U	NA	NA
Benzo(b)fluoranthene	20 U	210	1,400	1,500	490 J
Benzo(k)fluoranthene	20 U	120	970	540	260 J
Benzo(a)pyrene	20 U	500	1,600	1,700	940 J
Indeno(1,2,3-cd)pyrene	20 U	240	1,500	1,100	490 J
Dibenzo(a,h)anthracene	20 U	10 U	200 J	260 U	100 UJ
Benzo(g,h,i)perylene	20 U	210	310	1,400	460 J

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	Coke/TP-124	Charcoal	Charcoal	Charcoal	Charcoal
Date Sampled:	Sept 1990 (b)	Sept 1990	Sept 1990 (b)	Jan 1991 (b)	Jan 1991
Sample Depth in feet:	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5
	EPA Replicate		EPA Replicate		
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)					
Napthalene	NA	NA	NA	NA	NA
Acenapthylene	NA	NA	NA	NA	NA
Acenapthene	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Miscellaneous Parameters in mg/kg (ppm)					
GC-FID Screen	NA	NA	NA	NA	NA
GC-FID Screen 8015 Modified	NA	18,000 J	NA	NA	8,100
GC-FID Screen 8015 Modified (a)	NA	18,000 J	NA	NA	NA
TPH (418.1)	NA	NA	NA	NA	690
Organophosphorous Pesticides	NA	NA	NA	NA	NA
Chlorinated Herbicides	NA	NA	NA	NA	NA
Pesticides/PCBs in mg/kg (ppm)					
4,4'-DDE	NA	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	Coal	Wood Chips Fresh	Aged Wood Chips
Date Sampled:	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	0.0 - 0.5	0.0 - 0.5	Surface/ Discovery Park
Total Metals			
in mg/kg (ppm)			
Arsenic	NA	NA	NA
Cadmium	NA	NA	NA
Chromium	NA	NA	NA
Copper	NA	NA	NA
Lead	NA	NA	NA
Manganese	NA	NA	NA
Mercury	NA	NA	NA
Nickel	NA	NA	NA
Selenium	NA	NA	NA
Silver	NA	NA	NA
Zinc	NA	NA	NA
EP Toxicity Metals			
in mg/L (ppm)			
Arsenic	NA	NA	NA
Barium	NA	NA	NA
Cadmium	NA	NA	NA
Chromium	NA	NA	NA
Copper	NA	NA	NA
Lead	NA	NA	NA
Mercury	NA	NA	NA
Nickel	NA	NA	NA
Zinc	NA	NA	NA
TCLP Metals			
in mg/L (ppm)			
Arsenic	NA	NA	NA
Barium	NA	NA	NA
Cadmium	NA	NA	NA
Chromium	NA	NA	NA
Copper	NA	NA	NA
Lead	NA	NA	NA
Mercury	NA	NA	NA
Nickel	NA	NA	NA
Selenium	NA	NA	NA
Silver	NA	NA	NA
Zinc	NA	NA	NA

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	Coal	Wood Chips Fresh	Aged Wood Chips
Date Sampled:	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	0.0 - 0.5	0.0 - 0.5	Surface/ Discovery Park
Volatile Organic Compounds in mg/kg (ppm)			
Vinyl chloride	NA	NA	NA
Acetone	NA	NA	NA
Carbon disulfide	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	NA
cis-1,2-Dichloroethene	NA	NA	NA
Total 1,2-Dichloroethene	NA	NA	NA
2-Butanone (MEK)	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA
Trichloroethene	NA	NA	NA
Benzene	NA	NA	NA
Toluene	NA	NA	NA
Ethylbenzene	NA	NA	NA
Total Xylene	NA	NA	NA
Semivolatile Organic Compounds in mg/kg (ppm)			
Napthalene	0.83 U	NA	0.083 U
2-Methylnapthalene	NA	NA	NA
Acenapthylene	1.7 U	NA	0.17 U
Acenapthene	1.7 U	NA	0.17 U
Dibenzofuran	NA	NA	NA
Fluorene	0.62	NA	0.017 U
Phenanthrene	3.0	NA	0.0083 U
Anthracene	1.1 B	NA	0.0083 U
Fluoranthene	0.17 U	NA	0.017 U
Pyrene	5.7	NA	0.017 U
Benzo(a)anthracene	1.0	NA	0.017 U
Chrysene	1.2	NA	0.017 U
Bis(2-ethylhexyl)phthalate	NA	NA	NA
Di-n-octyl phthalate	NA	NA	NA
Benzo(b)fluoranthene	0.64	NA	0.017 U
Benzo(k)fluoranthene	0.33	NA	0.017 U
Benzo(a)pyrene	1.3	NA	0.017 U
Indeno(1,2,3-cd)pyrene	0.72	NA	0.017 U
Dibenzo(a,h)anthracene	0.34 U	NA	0.034 U
Benzo(g,h,i)perylene	0.76	NA	0.017 U

Table C-3 - Summary of Ohio Ferro-Alloy/Pennwalt Area Soil Results

Sample Location:	Coal	Wood Chips Fresh	Aged Wood Chips
Date Sampled:	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	0.0 - 0.5	0.0 - 0.5	Surface/ Discovery Park
TCLP Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)			
Napthalene	NA	NA	NA
Acenapthylene	NA	NA	NA
Acenapthene	NA	NA	NA
Fluorene	NA	NA	NA
Phenanthrene	NA	NA	NA
Anthracene	NA	NA	NA
Fluoranthene	NA	NA	NA
Pyrene	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA
Chrysene	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA
Miscellaneous Parameters in mg/kg (ppm)			
GC-FID Screen	NA	NA	NA
GC-FID Screen 8015 Modified	10 J	400 J	4,000 J
GC-FID Screen 8015 Modified (a)	NA	NA	2,000 J
TPH (418.1)	NA	NA	110 J
Organophosphorous Pesticides	NA	NA	NA
Chlorinated Herbicides	NA	NA	NA
Pesticides/PCBs in mg/kg (ppm)			
4,4'-DDE	NA	NA	NA
4,4'-DDD	NA	NA	NA
4,4'-DDT	NA	NA	NA

OPA-SOIL.WK1

Table C-4 - Summary of Pennwalt Ag-Chem Ditch Sediment Results

Sample Number:	PDS-A	PDS-B	PDS-C	PDS-104-D	PDS-105-D	PDS-106-D	SS-1	SS-18
Sample Location:	Penn Ditch	Penn Ditch	Penn Ditch	Penn Ditch	Penn Ditch	Penn Ditch	Penn Ditch	Penn Ditch
Date Sampled:	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Dec 1989	Dec 1989
Sample Depth in feet:	0.0 - 1.5	1.5 - 3.0	3.0 - 3.5	0.2 - 0.4	0.2 - 0.4	0.2 - 0.4	0.0 - 0.25	0.0 - 0.25
								Replicate SS-1
Total Metals								
in mg/kg (ppm)								
Arsenic	27	19	15	27	NA	NA	46	45
Cadmium	0.50 U	0.50 U	1.2	0.60	NA	NA	1.7	1.5
Chromium	20	17	14	8.4	NA	NA	28	27
Copper	36	18	15	39	NA	NA	78	72
Lead	57	15	13	33	NA	NA	68	10
Mercury	0.1	0.1 U	0.1 U	0.2	NA	NA	0.4	0.4 U
Nickel	490	130	60	36	NA	NA	290	190
Zinc	110	94	70	62	NA	NA	440	360
Chlorinated Pesticides	ND J	ND J	ND J	ND J	NA	NA	ND	ND
PCBs	ND J	ND J	ND J	ND J	NA	NA	ND	ND
Organophosphorous Pesticides	ND J	ND J	ND J	ND J	NA	NA	NA	NA
Chlorinated Herbicides	ND J	ND J	ND J	ND J	NA	NA	ND R	ND R
Volatile Aromatic Compounds								
in mg/kg (ppm)								
Benzene	0.006 UJ	NA	NA	0.01 U	0.008 U	0.008 U	NA	NA
Toluene	0.007 J	NA	NA	0.01 U	0.012	0.039	NA	NA
Ethylbenzene	0.006 UJ	NA	NA	0.01 U	0.008 U	0.008 U	NA	NA
Total Xylene	0.006 UJ	NA	NA	0.01 U	0.008 U	0.008 U	NA	NA
Miscellaneous Parameters								
in mg/kg (ppm)								
GC-FID Screen	NA	NA	NA	NA	NA	NA	120 B	86 B

Table C-4 - Summary of Pennwalt Ag-Chem Ditch Sediment Results

Sample Number:	PDS-A	PDS-B	PDS-C	PDS-104-D	PDS-105-D	PDS-106-D	SS-1	SS-18
Sample Location:	Penn Ditch	Penn Ditch	Penn Ditch	Penn Ditch	Penn Ditch	Penn Ditch	Penn Ditch	Penn Ditch
Date Sampled:	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Sept 1990	Dec 1989	Dec 1989
Sample Depth in feet:	0.0 - 1.5	1.5 - 3.0	3.0 - 3.5	0.2 - 0.4	0.2 - 0.4	0.2 - 0.4	0.0 - 0.25	0.0 - 0.25
								Replicate SS-1
Miscellaneous Parameters in %								
Total Organic Carbon	3.8	2.4	1.2	NA	NA	NA	NA	NA
Polynuclear Aromatic Hydrocarbons in mg/kg (ppm)								
Napthalene	0.036 J	0.025 J	0.0095 J	1.3 U	NA	NA	NA	NA
Acenapthylene	0.024 J	0.026 J	0.008 J	1.7 U	NA	NA	NA	NA
Fluorene	0.027	0.018	0.0037 J	0.15 U	NA	NA	NA	NA
Acenaphthene	0.1 U	0.08 U	0.014 UBJ	1.3 U	NA	NA	NA	NA
Phenanthrene	0.14	0.1	0.025 J	0.06 J	NA	NA	NA	NA
Anthracene	0.012 J	0.0088 J	0.0025 J	0.015 J	NA	NA	NA	NA
Fluoranthene	0.083	0.053	0.026	0.076 J	NA	NA	NA	NA
Pyrene	0.37	0.28	0.11	0.34	NA	NA	NA	NA
Chrysene	0.0085 U	0.0067 U	0.041	0.23	NA	NA	NA	NA
Benzo(a)anthracene	0.053	0.045	0.027	0.18	NA	NA	NA	NA
Benzo(b)fluoranthene	0.058	0.043	0.15	1.2	NA	NA	NA	NA
Benzo(k)fluoranthene	0.067	0.067	0.051	0.012 U	NA	NA	NA	NA
Benzo(a)pyrene	0.0018	0.001 U	0.0031	0.036	NA	NA	NA	NA
Dibenzo(a,h)anthracene	0.52	0.16	0.2	0.81	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	0.017	0.016	0.016	0.031 U	NA	NA	NA	NA
Benzo(g,h,i)perylene	0.22	0.1	0.14	0.82	NA	NA	NA	NA

Notes:

U	Indicates compound was analyzed for but not detected at the given detection limit.
J	Indicates an estimated value.
B	Indicates analyte was detected in laboratory method blank.
T	Flagged values represent sum of two co-eluting compounds.
R	Data not useable based on data validation criteria.
D	Value reported derives from analysis of a diluted sample or sample extract.
ND	Not detected at variable detection limits.
NA	Not analyzed.

Table C-5 - Summary of Ohio Ferro-Alloy Area Ditch Sediment Results

Sample Number:	ODS-A	ODS-B	ODS-103A	ODS-103B
Sample Location:	OFA Ditch	OFA Ditch	OFA Ditch	OFA Ditch
Date Sampled:	Sept 1990	Sept 1990	Sept 1990	Sept 1990
Sample Depth in feet:	0.0 - 1.5	1.5 - 2.5	0.0 - 1.5	1.5 - 2.5
Total Metals				
in mg/kg (ppm)				
Arsenic	120	30	260	260
Cadmium	3.4	2.4	3.2	3.4
Chromium	120	250	61	72
Copper	210	160	300	350
Lead	110	80	180	210
Mercury	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	28	29	24	26
Zinc	260	180	390	500
Miscellaneous Parameters in %				
Total Organic Carbon	6.8	7.0	NA	NA
Semivolatile Organic Compounds				
in mg/kg (ppm)				
Naphthalene	0.24 UJ	0.21 UJ	0.27 UJ	0.26 UJ
Acenapthylene	0.24 UJ	0.21 UJ	0.27 UJ	0.26 UJ
Acenapthene	0.24 UJ	0.21 UJ	0.27 UJ	0.26 UJ
Fluorene	0.24 UJ	0.21 UJ	0.27 UJ	0.26 UJ
4-Methylphenol	3.4 J	2 J	2.8 J	3.3 J
Phenanthrene	1.2 J	1.3 J	1.2 J	1.2 J
Anthracene	0.24 UJ	0.21 UJ	0.27 UJ	0.26 UJ
Fluoranthene	1.3 J	0.21 UJ	1.3 J	1.4 J
Pyrene	1.7 J	1.1 J	1.5 J	1.2 J
Benzo(a)anthracene	0.74 J	0.8 J	-0.68 J	0.44 J
Chrysene	0.82 J	1.1 J	1.4 J	1 J
Bis(2-ethylhexyl)phthalate	0.26 J	0.23 J	0.38 J	0.26 UJ
Benzo(b)fluoranthene	1.2 JT	1.3 JT	2 JT	1.2 JT
Benzo(k)fluoranthene	1.2 JT	1.3 JT	2 JT	1.2 JT
Benzo(a)pyrene	0.34 J	0.44 J	0.49 J	0.65 J
Dibenzo(a,h)anthracene	0.24 UJ	0.21 UJ	0.27 UJ	0.26 UJ
Indeno(1,2,3-cd)pyrene	0.24 UJ	0.27 J	0.27 UJ	0.26 UJ
Benzo(g,h,i)perylene	0.26 J	0.27 J	0.43 J	0.26 UJ

Notes:

U Indicates compound was analyzed for but not detected at the given detection limit.

J Indicates an estimated value.

B Indicates analyte was detected in laboratory method blank.

T Flagged values represent sum of two co-eluting compounds.

D Value reported derives from analysis of a diluted sample or sample extract.

ND Not detected at variable detection limits.

NA Not analyzed.

OFA-SEDM.WK1

Table C-6 - Summary of Pennwalt Ag-Chem Ditch Surface Water Results

Sample Location:	SW-1/Pennwalt
Date Sampled:	Jan 1990

Total Metals		
in μg/L (ppb)		
Antimony	10	UJ
Arsenic	29	
Beryllium	1	U
Cadmium	9	
Chromium	5	
Copper	20	
Lead	10	U
Manganese	3	U
Mercury	1	U
Molybdenum	50	U
Nickel	31	
Selenium	5	U
Silver	1	U
Thallium	5	UJ
Zinc	32	
Miscellaneous Parameters		
GC-FID Screen in μg/L	20	
Chlorinated Herbicides in μg/L	ND	
Total Suspended Solids in mg/L	8	J
Total Dissolved Solids in mg/L	1100	J

Notes:

U Indicates compound was analyzed for but not detected at the given detection limit.

J Indicates an estimated value.

B Indicates analyte was detected in laboratory method blank.

ND Not detected at various detection limits.

PENN-SW.WK1

Table C-7 - Summary of Ohio Ferro-Alloy Ditch Surface Water Results

Sample Location:	SW-2/OFA	SW-3/OFA	SW-1/OFA
Date Sampled:	Jan 1990	Jan 1990	Jan 1991
Total Metals			
in µg/L (ppb)			
Antimony	23 J	16 J	15
Arsenic	68	24	230
Beryllium	1 U	1 U	1 U
Cadmium	21	7	1 U
Chromium	19	8	5
Copper	240	64	61
Lead	46	10 U	14
Manganese	3 U	3 U	320
Mercury	1 U	1 U	1.0 U
Molybdenum	50 U	50 U	12
Nickel	15	7	7
Selenium	5 U	5 U	5 U
Silver	1 U	1 U	1 U
Thallium	5 UJ	5 UJ	2 U
Zinc	150	53	74
Dissolved Metals			
in µg/L (ppb)			
Antimony	NA	NA	15
Arsenic	NA	NA	180
Beryllium	NA	NA	1 U
Cadmium	NA	NA	1 U
Chromium	NA	NA	3
Copper	NA	NA	42
Lead	NA	NA	6.9
Manganese	NA	NA	310
Mercury	NA	NA	1.0 U
Molybdenum	NA	NA	12
Nickel	NA	NA	6
Selenium	NA	NA	5 U
Silver	NA	NA	1 U
Thallium	NA	NA	2 U
Zinc	NA	NA	62
Miscellaneous Parameters			
Hardness as CaCO3 in mg/L	NA	NA	38
Total Suspended Solids in mg/L	87 J	23 J	16
Total Dissolved Solids in mg/L	690 J	250 J	NA

Notes:

U Indicates compound was analyzed for but not detected at the given detection limit.

J Indicates an estimated value.

B Indicates analyte was detected in laboratory method blank.

NA Not analyzed.

OFA-SW.WK1

Table C-8 - Summary of General/Fill Area Groundwater Results

Sample Location:	HC-1S	HC-1S	HC-2I	HC-2I	HC-2S	HC-2S
Date Sampled:	Jan 1990	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
Dissolved Metals						
in µg/L (ppb)						
Antimony	10 UJ	10 U	10 UJ	11	10 UJ	10 U
Arsenic	11	5.0 U	5 U	5.0 U	5 U	6.0
Barium	NA	NA	NA	NA	NA	NA
Beryllium	10 U	NA	10 U	NA	10 U	NA
Cadmium	10 U	11 J	10 U	1.0 UJ	10 U	24 J
Chromium	10 U	4.0	10 U	2.0	10 U	2.0
Copper	10 U	9.0	10 U	1.0 U	10 U	10
Iron	NA	76,000 B	NA	3,700 B	NA	160,000 B
Lead	2 U	3 U	10 U	3 U	2 U	3 U
Manganese	200	7,700 B	760	750 B	15,000	300 B
Mercury	1 U	1.0 U	1 U	1.0 U	1 U	1.0 U
Molybdenum	500 U	NA	NA	NA	NA	NA
Nickel	20 U	76 B	20 U	2.0 UB	590	320 B
Selenium	5 U	NA	5 U	NA	5 U	NA
Silver	10 UJ	1.0 J	10 UJ	1.0 UJ	10 UJ	1.0 UJ
Thallium	5 UJ	NA	5 UJ	NA	5 UJ	NA
Zinc	75	140 J	90	5.0 J	680	230 J
Volatile Organic Compounds						
in µg/L (ppb)						
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U	1 U
Acetone	5 U	57	5 U	5 U	5 U	5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
2-Butanone (MEK)	3 U	3 U	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	3	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U	1 U	1 U
Miscellaneous Parameters						
in µg/L (ppb)						
Formaldehyde	R	10	R	5.0 U	R	47
Miscellaneous Parameters						
in mg/L (ppb)						
Total Dissolved Solids	2,500	1,300	16,000	15,000	3,800	2,700
Total Suspended Solids	NA	78	NA	200	NA	630
Fluoride	NA	1.5	NA	0.4	NA	1.9
Hardness as CaCO3	NA	390	NA	NA	NA	1200

Table C-8 - Summary of General/Fill Area Groundwater Results

Sample Location:	HC-1S	HC-1S	HC-2I	HC-2I	HC-2S	HC-2S
Date Sampled:	Jan 1990	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
Semivolatile Organic Compounds in µg/L (ppb)						
Phenol	3 U	2 UR	2 U	2 U	2 UR	1 UJ
4-Methylphenol	3 U	2 UR	2 U	2 U	2 UR	1 UJ
Benzoic acid	67 U	50 UR	50 U	50 U	50 UR	25 UJ
Napthalene	5 UR	2 U	4 U	2 U	4 UR	1 UR
2-Methylnapthalene	3 UR	2 U	2 U	2 U	2 UR	1 UR
Acenapthylene	3 UR	2 U	2 U	2 U	2 UR	1 UR
Acenapthene	3 UR	2 U	2 U	2 U	2 UR	1 UR
Dibenzofuran	3 UR	2 U	2 U	2 U	2 UR	1 UR
Fluorene	3 UR	2 U	2 U	2 U	2 UR	1 UR
Phenanthrene	3 UR	2 U	2 U	2 U	2 UR	1 UR
Anthracene	3 UR	2 U	2 U	2 U	2 UR	1 UR
Fluoranthene	3 UR	2 U	2 U	2 U	2 UR	1 UR
Pyrene	3 UR	2 U	2 U	2 U	2 UR	1 UR
Benzo(a)anthracene	3 UR	2 U	2 U	2 U	2 UR	1 UR
Chrysene	3 UR	2 U	2 U	2 U	2 UR	1 UR
Bis(2-ethylhexyl)phthalate	4 JR	4 UB	2 U	7 UB	2 UR	36 BR
Di-n-octyl phthalate	3 JR	2 U	2 U	2 U	2 UR	1 UR
Benzo(b)fluoranthene	5 UR	2 U	4 U	2 U	4 UR	1 UR
Benzo(k)fluoranthene	5 UR	2 U	4 U	2 U	4 UR	1 UR
Benzo(a)pyrene	5 UR	2 U	4 U	2 U	4 UR	1 UR
Indeno(1,2,3-cd)pyrene	5 UR	2 U	4 U	2 U	4 UR	1 UR
Dibenzo(a,h)anthracene	5 UR	2 U	4 U	2 U	4 UR	1 UR
Benzo(g,h,i)perylene	5 UR	2 U	4 U	2 U	4 UR	1 UR
Field Parameters						
pH	6.1	6.2	7.1	6.3	5.6	6.7
Temperature in °C	10	12	12	12	10	11
Specific Conductivity in µMhos	1,900	1,650	1,860	19,650	3,600	3,400
Dissolved Oxygen in ppm	2.8	NA	5.2	NA	9.8	NA
Chlorinated Pesticides in µg/L (ppb)	ND	NA	ND	NA	ND	NA
PCBs in µg/L (ppb)	ND	NA	ND	NA	ND	NA

Notes:

U	Indicates compound was not detected at the given detection limit.
J	Indicates an estimated value.
B	Indicates analyte was detected in laboratory method blank.
X	Indicates compound was tentatively identified.
R	Data was unuseable based on data validation criteria.
NA	Not analyzed.
*	Estimate is below EPA contract detection limit and is not a confirmed value.
(a)	Sampled by CH2M Hill as part of Reichhold's Precorrective Action Groundwater Monitoring Program.

ONL-GW.WK1

Table C-8 - Summary of General/Fill Area Groundwater Results

Sample Location:	HC-3I	HC-3R	HC-3I	HC-3S	HC-3S	HC-13I	HC-13I
Date Sampled:	Jan 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
		Rep HC-3I					
Dissolved Metals							
in µg/L (ppb)							
Antimony	10 UJ	10 UJ	10 U	14 J	10 U	10 UJ	10 U
Arsenic	5 U	5 U	5.0 U	5 U	5.0 U	5 U	5.0 U
Barium	NA	NA	NA	NA	NA	NA	NA
Beryllium	10 U	10 U	NA	10 U	NA	10 U	NA
Cadmium	10 U	10 U	1.0 UJ	10 U	1.0 U	10 U	3.0
Chromium	10 U	10 U	10	10 U	1.0 U	10 U	8.0
Copper	10 U	10 U	1.0	10 U	16	10 U	1.0 U
Iron	NA	NA	7,100 B	NA	1,200	NA	24,000 BJ
Lead	10 U	10 U	3 U	2 U	3 U	10 U	3 U
Manganese	770	810	100 B	400	910	2,300	2,300 B
Mercury	1 U	1 U	1.0 U	1 U	1.0 U	1 U	1.0 U
Molybdenum	500 U	500 U	NA	500 U	NA	NA	NA
Nickel	20 U	20 U	4.0 UB	120	100	20 U	2.0 U
Selenium	5 U	5 U	NA	5 U	NA	5 U	NA
Silver	10 UJ	10 UJ	1.0 UJ	10 UJ	1.0 U	10 UJ	1.0 UJ
Thallium	5 UJ	5 UJ	NA	5 UJ	NA	5 UJ	NA
Zinc	35	60	14 J	260	160 J	38	27 UB
Volatile Organic Compounds							
in µg/L (ppb)							
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Acetone	5 U	8 J	5 U	5 U	5 U	14 J	5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2-Butanone (MEK)	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	4	1 U	1 U	1 U	2	2
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Miscellaneous Parameters							
in µg/L (ppb)							
Formaldehyde	R	R	5.0 U	R	5.0 U	R	33
Miscellaneous Parameters							
in mg/L (ppb)							
Total Dissolved Solids	12,000	11,000	11,000	580	530	7,400	NA
Total Suspended Solids	NA	NA	100	NA	94	NA	NA
Fluoride	NA	NA	0.6	NA	1.5	NA	NA
Hardness as CaCO3	NA	NA	NA	NA	190	NA	NA

Table C-8 - Summary of General/Fill Area Groundwater Results

Sample Location:	HC-3I	HC-3R	HC-3I	HC-3S	HC-3S	HC-13I	HC-13I
Date Sampled:	Jan 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
		Rep HC-3I					
Semivolatile Organic Compounds in µg/L (ppb)							
Phenol	2 U	2 U	2 U	2 U	2 UR	2 U	NA
4-Methylphenol	2 U	2 U	2 U	2 U	2 UR	2 U	NA
Benzoic acid	50 U	50 U	50 U	50 U	50 UR	51 U	NA
Napthalene	4 U	4 U	2 U	4 U	2 U	4 U	NA
2-Methylnapthalene	2 U	2 U	2 U	2 U	2 U	2 U	NA
Acenapthylene	2 U	2 U	2 U	2 U	2 U	2 U	NA
Acenapthene	2 U	2 U	2 U	2 U	2 U	2 U	NA
Dibenzofuran	2 U	2 U	2 U	2 U	2 U	2 U	NA
Fluorene	2 U	2 U	2 U	2 U	2 U	2 U	NA
Phenanthrene	2 U	2 U	2 U	2 U	2 U	2 U	NA
Anthracene	2 U	2 U	2 U	2 U	2 U	2 U	NA
Fluoranthene	2 U	2 U	2 U	2 U	2 U	2 U	NA
Pyrene	2 U	2 U	2 U	2 U	2 U	2 U	NA
Benzo(a)anthracene	2 U	2 U	2 U	2 U	2 U	2 U	NA
Chrysene	2 U	2 U	2 U	2 U	2 U	2 U	NA
Bis(2-ethylhexyl)phthalate	2 U	2 U	28 UB	2 U	3 UB	2 U	NA
Di-n-octyl phthalate	2 U	2 U	2 U	2 U	2 U	2 U	NA
Benzo(b)fluoranthene	4 U	4 U	2 U	4 U	2 U	4 U	NA
Benzo(k)fluoranthene	4 U	4 U	2 U	4 U	2 U	4 U	NA
Benzo(a)pyrene	4 U	4 U	2 U	4 U	2 U	4 U	NA
Indeno(1,2,3-cd)pyrene	4 U	4 U	2 U	4 U	2 U	4 U	NA
Dibenzo(a,h)anthracene	4 U	4 U	2 U	4 U	2 U	4 U	NA
Benzo(g,h,i)perylene	4 U	4 U	2 U	4 U	2 U	4 U	NA
Field Parameters							
pH	6.6	NA	6.2	4.7	4.6	7.0	7.0
Temperature in °C	11	NA	11	10	12	9	10
Specific Conductivity in µMhos	14,800	NA	16,100	680	600	10,200	13,700
Dissolved Oxygen in ppm	4.0	NA	NA	3.8	NA	10.5	NA
Chlorinated Pesticides in µg/L (ppb)	ND	ND	NA	ND	NA	ND	NA
PCBs in µg/L (ppb)	ND	ND	NA	ND	NA	ND	NA

ONL-GW.WK1

Table C-8 - Summary of General/Fill Area Groundwater Results

Sample Location:	HC-13S	HC-13S	HC-14I	HC-14I	HC-14S	HC-14S
Date Sampled:	Jan 1990	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
Dissolved Metals						
in µg/L (ppb)						
Antimony	10 UJ	10 U	10 UJ	10 U	17 J	10 U
Arsenic	5 U	5.0 U	5 U	5.0 U	5 U	5.0 U
Barium	NA	NA	NA	NA	NA	NA
Beryllium	10 U	NA	10 U	NA	10 U	NA
Cadmium	10 U	25	10 U	5.4	10 U	1.0 U
Chromium	10 U	8.0	10 U	5.0	10 U	1.0 U
Copper	21	9.0	10 U	1.0 U	10 U	3.0
Iron	NA	170,000 BJ	NA	29,000 BJ	NA	410
Lead	2 U	3 U	10 U	3 U	2 U	3 U
Manganese	16,000	200 B	1,200	720 B	30 U	93
Mercury	1 U	1.0 U	1 U	1.0 U	1 U	1.0 U
Molybdenum	NA	NA	NA	NA	NA	NA
Nickel	340	640	20 U	2.0 U	20 U	6.0
Selenium	5 U	NA	5 U	NA	5 U	NA
Silver	10 U	1.0 UJ	10 UJ	5.0 J	10 UJ	1.0 U
Thallium	5 UJ	NA	5 UJ	NA	5 UJ	NA
Zinc	230	370 B	33	94 B	35	17 J
Volatile Organic Compounds						
in µg/L (ppb)						
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U	1 U
Acetone	5 U	5 U	5 U	5 U	5 U	5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
2-Butanone (MEK)	3 U	3 U	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1	1	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U	1 U	1 U
Miscellaneous Parameters						
in µg/L (ppb)						
Formaldehyde	R	260	R	14	R	5.0 U
Miscellaneous Parameters						
in mg/L (ppb)						
Total Dissolved Solids	4,800	4,700	13,000	14,000	280	230
Total Suspended Solids	NA	300	NA	530	NA	170
Fluoride	NA	0.3	NA	0.7	NA	1.3
Hardness as CaCO3	NA	1400	NA	NA	NA	110

Table C-8 - Summary of General/Fill Area Groundwater Results

Sample Location:	HC-13S	HC-13S	HC-14I	HC-14I	HC-14S	HC-14S
Date Sampled:	Jan 1990	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
Semivolatile Organic Compounds in µg/L (ppb)						
Phenol	2 U	1 U	2 U	1 U	2 U	1 U
4-Methylphenol	2 U	1 U	2 U	1 U	2 U	1 U
Benzoic acid	50 U	25 U	51 U	25 U	50 U	25 U
Napthalene	4 UR	1 UR	4 U	1 U	4 U	1 U
2-Methylnapthalene	2 UR	1 UR	2 U	1 U	2 U	1 U
Acenapthylene	2 UR	1 UR	2 U	1 U	2 U	1 U
Acenapthene	2 UR	1 UR	2 U	1 U	2 U	1 U
Dibenzofuran	2 UR	1 UR	2 U	1 U	2 U	1 U
Fluorene	2 UR	1 UR	2 U	1 U	2 U	1 U
Phenanthrene	2 UR	1 UR	2 U	1 U	2 U	1 U
Anthracene	2 UR	1 UR	2 U	1 U	2 U	1 U
Fluoranthene	2 UR	1 UR	2 U	1 U	2 U	1 U
Pyrene	2 UR	1 UR	2 U	1 U	2 U	1 U
Benzo(a)anthracene	2 UR	1 UR	2 U	1 U	2 U	1 U
Chrysene	2 UR	1 UR	2 U	1 U	2 U	1 U
Bis(2-ethylhexyl)phthalate	3 JBR	11 UB	2 U	5 UB	10 J	4 UB
Di-n-octyl phthalate	2 UR	1 UR	2 U	1 U	2 U	1 U
Benzo(b)fluoranthene	4 UR	1 UR	4 U	1 U	4 U	1 U
Benzo(k)fluoranthene	4 UR	1 UR	4 U	1 U	4 U	1 U
Benzo(a)pyrene	4 UR	1 UR	4 U	1 U	4 U	1 U
Indeno(1,2,3-cd)pyrene	4 UR	1 UR	4 U	1 U	4 U	1 U
Dibenzo(a,h)anthracene	4 UR	1 UR	4 U	1 U	4 U	1 U
Benzo(g,h,i)perylene	4 UR	1 UR	4 U	1 U	4 U	1 U
Field Parameters						
pH	5.8	5.0	6.7	5.8	6.5	6.1
Temperature in °C	11	13	8	11	8	10
Specific Conductivity in µMhos	3,800	4,100	17,300	18,800	520	300
Dissolved Oxygen in ppm	4.1	NA	5.3	NA	5.9	NA
Chlorinated Pesticides in µg/L (ppb)	ND	NA	ND	NA	ND	NA
PCBs in µg/L (ppb)	ND	NA	ND	NA	ND	NA

Table C-8 - Summary of General/Fill Area Groundwater Results

Sample Location:	HC-17I	HC-17I	HC-17S	HC-17S	HC-18S	HC-18S
Date Sampled:	Jan 1990	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
Dissolved Metals						
in µg/L (ppb)						
Antimony	10 UJ	10 U	10 UJ	10 U	10 UJ	10 U
Arsenic	5 U	5.0 U	5 U	5.0 U	5 U	5.0 U
Barium	NA	NA	NA	NA	NA	NA
Beryllium	10 U	NA	10 U	NA	10 U	NA
Cadmium	10 U	1.0 U	10 U	16	10 U	4.0
Chromium	10 U	9.0	10 U	2.0	10 U	1.0 U
Copper	10 U	1.0 U	10 U	6.0	10 U	1.0 U
Iron	NA	4,600 BJ	NA	130,000 BJ	NA	27,000
Lead	6.4	3 U	2 U	3 U	2 U	3 U
Manganese	380	250 B	600	410 B	800	1,900
Mercury	1 U	1.0 U	1 U	1.0 U	1 U	1.0 U
Molybdenum	NA	NA	NA	NA	NA	NA
Nickel	20 U	2.0 U	20 U	25	20 U	6.0
Selenium	5 U	NA	5 U	NA	5 U	NA
Silver	10 U	1.0 UJ	10 U	1.0 UJ	10 U	1.0 U
Thallium	5 UJ	NA	5 UJ	NA	5 UJ	NA
Zinc	35	17 UB	48	210 B	10 U	32
Volatile Organic Compounds						
in µg/L (ppb)						
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U	1 U
Acetone	5 U	5 U	5 U	5 U	5 U	5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
2-Butanone (MEK)	3 U	3 U	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	9	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U	1 U	1 U
Miscellaneous Parameters						
in µg/L (ppb)						
Formaldehyde	R	5.0 U	R	16	R	5.8
Miscellaneous Parameters						
in mg/L (ppb)						
Total Dissolved Solids	8,900	8,400	1,200	1,100	650	620
Total Suspended Solids	NA	680	NA	200	NA	44 B
Fluoride	NA	0.6	NA	6.8	NA	2.6
Hardness as CaCO3	NA	NA	NA	320	NA	270

Table C-8 - Summary of General/Fill Area Groundwater Results

Sample Location:	HC-17I	HC-17I	HC-17S	HC-17S	HC-18S	HC-18S
Date Sampled:	Jan 1990	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
Semivolatile Organic Compounds in µg/L (ppb)						
Phenol	2 U	1 U	2 U	1 UR	2 U	1 U
4-Methylphenol	2 U	1 U	2 U	1 UR	2 U	1 U
Benzoic acid	50 U	25 U	51 U	25 UR	50 U	25 U
Napthalene	4 U	1 U	4 U	1 U	4 U	1 U
2-Methylnapthalene	2 U	1 U	2 U	1 U	2 U	1 U
Acenapthylene	2 U	2	2 U	1 U	2 U	1 U
Acenapthene	2 U	2	2 U	1 U	2 U	1 U
Dibenzofuran	2 U	1	2 U	1 U	2 U	1 U
Fluorene	2 U	1	2 U	1 U	2 U	1 U
Phenanthrene	2 U	1	2 U	1 U	2 U	1 U
Anthracene	2 U	1 U	2 U	1 U	2 U	1 U
Fluoranthene	2 U	1 U	2 U	1 U	2 U	1 U
Pyrene	2 U	1 U	2 U	1 U	2 U	1 U
Benzo(a)anthracene	2 U	1 U	2 U	1 U	2 U	1 U
Chrysene	2 U	1 U	2 U	1 U	2 U	1 U
Bis(2-ethylhexyl)phthalate	2 J	6 UB	2 U	12 UB	3 J	2 UB
Di-n-octyl phthalate	2 U	1 U	2 U	1 U	2 U	1 U
Benzo(b)fluoranthene	4 U	1 U	4 U	1 U	4 U	1 U
Benzo(k)fluoranthene	4 U	1 U	4 U	1 U	4 U	1 U
Benzo(a)pyrene	4 U	1 U	4 U	1 U	4 U	1 U
Indeno(1,2,3-cd)pyrene	4 U	1 U	4 U	1 U	4 U	1 U
Dibenzo(a,h)anthracene	4 U	1 U	4 U	1 U	4 U	1 U
Benzo(g,h,i)perylene	4 U	1 U	4 U	1 U	4 U	1 U
Field Parameters						
pH	6.6	NA	7.0	NA	7.0	8.5
Temperature in °C	11	7.9	9	6.9	10	11.9
Specific Conductivity in µMhos	12,500	12,600	1,200	1,200	700	800
Dissolved Oxygen in ppm	2.5	NA	3.0	NA	2.4	2.0
Chlorinated Pesticides in µg/L (ppb)	ND	NA	ND	NA	ND	NA
PCBs in µg/L (ppb)	ND	NA	ND	NA	ND	NA

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Table C-8 - Summary of General/Fill Area Groundwater Results

Sample Location:	MW-28I (a)	MW-28I (a)	MW-28I (a)	MW-29I (a)	MW-29I (a)	MW-29I (a)
Date Sampled:	Oct 1989	Jan 1990	July 1990	Oct 1989	Jan 1990	July 1990
Dissolved Metals						
in µg/L (ppb)						
Antimony	NA	NA	2.0 UJX	NA	NA	2.0 UJX
Arsenic	2.3 J	NA	1.3 X	3.5 J	NA	1.8 X
Barium	143 J	NA	150 JX	14.3 J	NA	32.0 UJX
Beryllium	NA	NA	4.0 JX	NA	NA	2.0 JX
Cadmium	4.0 U	NA	4.0 JX	4.0 U	NA	4.0 JX
Chromium	2.8 U	NA	7.0 UJX	20.4	NA	17.0 JX
Copper	NA	NA	39.0 JX	NA	NA	19.0 JX
Iron	NA	NA	NA	NA	NA	NA
Lead	1.0 U	NA	3.00 JX	1.0 U	NA	6.50 JX
Manganese	1,150	NA	977 JX	470	NA	468 JX
Mercury	NA	NA	0.03 UX	NA	NA	0.03 UX
Molybdenum	195	5648	247 X	6.0 U	5648	15.0 UX
Nickel	41.6 U	NA	68.0 JX	41.6 U	NA	84.0 JX
Selenium	NA	NA	1.0 URX	NA	NA	1.0 URX
Silver	NA	NA	36.0 RX	NA	NA	19.0 RX
Thallium	NA	NA	3.0 URX	NA	NA	3.0 URX
Zinc	21.4	NA	54.0 JX	9.6 U	NA	43.0 JX
Volatile Organic Compounds						
in µg/L (ppb)						
Vinyl chloride	10 U	10 U	10 U	10 U	10 U	10 U
Methylene chloride	5 U	NA	NA	5 U	NA	NA
Acetone	10 U	NA	10 U	10 U	NA	10 U
trans-1,2-Dichloroethene	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
Total 1,2-Dichloroethene	NA	NA	5 U	NA	NA	5 U
2-Butanone (MEK)	NA	NA	10 U	NA	NA	10 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	5 U	NA	5 U	5 U	NA	5 U
Ethylbenzene	5 U	NA	5 U	5 U	NA	5 U
Total Xylene	NA	NA	5 U	NA	NA	5 U
Miscellaneous Parameters						
in µg/L (ppb)						
Formaldehyde	50 U	60 U	50 U	50 U	60 U	50 U
Miscellaneous Parameters						
in mg/L (ppb)						
Total Dissolved Solids	NA	NA	NA	NA	NA	NA
Total Suspended Solids	NA	NA	NA	NA	NA	NA
Fluoride	NA	NA	NA	NA	NA	NA
Hardness as CaCO3	NA	NA	NA	NA	NA	NA

Table C-8 - Summary of General/Fill Area Groundwater Results

Sample Location:	MW-28I (a)	MW-28I (a)	MW-28I (a)	MW-29I (a)	MW-29I (a)	MW-29I (a)
Date Sampled:	Oct 1989	Jan 1990	July 1990	Oct 1989	Jan 1990	July 1990
Semivolatile Organic Compounds in µg/L (ppb)						
Phenol	NA	NA	10 U	NA	NA	10 U
4-Methylphenol	10 U	10 U	10 U	10 U	10 U	10 U
Benzoic acid	NA	NA	50 U	NA	NA	50 U
Napthalene	10 U	NA	10 U	10 U	NA	10 U
2-Methylnapthalene	NA	NA	10 U	NA	NA	10 U
Acenapthylene	NA	NA	10 U	NA	NA	10 U
Acenapthene	NA	NA	10 U	NA	NA	10 U
Dibenzofuran	NA	NA	10 U	NA	NA	10 U
Fluorene	NA	NA	10 U	NA	NA	10 U
Phenanthrene	NA	NA	10 U	NA	NA	10 U
Anthracene	NA	NA	10 U	NA	NA	10 U
Fluoranthene	NA	NA	10 U	NA	NA	10 U
Pyrene	NA	NA	10 U	NA	NA	10 U
Benzo(a)anthracene	NA	NA	10 U	NA	NA	10 U
Chrysene	NA	NA	10 U	NA	NA	10 U
Bis(2-ethylhexyl)phthalate	10 B	NA	10 U	5 JB*	NA	10 U
Di-n-octyl phthalate	10 U	10 U	10 U	10 U	10 U	10 U
Benzo(b)fluoranthene	NA	NA	10 U	NA	NA	10 U
Benzo(k)fluoranthene	NA	NA	10 U	NA	NA	10 U
Benzo(a)pyrene	NA	NA	10 U	NA	NA	10 U
Indeno(1,2,3-cd)pyrene	NA	NA	10 U	NA	NA	10 U
Dibenzo(a,h)anthracene	NA	NA	10 U	NA	NA	10 U
Benzo(g,h,i)perylene	NA	NA	10 U	NA	NA	10 U
Field Parameters						
pH	NA	NA	NA	NA	NA	NA
Temperature in °C	NA	NA	NA	NA	NA	NA
Specific Conductivity in µMhos	NA	NA	NA	NA	NA	NA
Dissolved Oxygen in ppm	NA	NA	NA	NA	NA	NA
Chlorinated Pesticides in µg/L (ppb)	NA	NA	NA	NA	NA	NA
PCBs in µg/L (ppb)	ND	NA	NA	ND	NA	NA

Table C-9 - Summary of North Site Area Groundwater Results

Sample Location:	HC-7S	HC-7S (a)	HC-7S	HC-8S	HC-8S (a)	HC-8S
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Oct 1990	Dec 1990
Dissolved Metals						
in µg/L (ppb)						
Antimony	10 UJ	5	10 U	10 UJ	4	10 U
Arsenic	47	49	58	5 U	5 U	5.0 U
Beryllium	1 U	1 U	NA	1 U	1 U	NA
Cadmium	1 J	1 U	2.0 J	1 UJ	1 U	1.0 U
Chromium	1 J	2 UB	2.0	1 UJ	1 U	1.0 U
Copper	1 U	1 U	1.0 U	1 U	1 U	1.0 U
Iron	NA	NA	15,000 B	NA	NA	8,200
Lead	3.6	3 U	3 U	2 U	3 U	3 U
Manganese	540	NA	360 B	580	NA	440
Mercury	1 U	1.0 U	1.0 U	1 U	1.0 U	1.0 U
Molybdenum	50 UJ	NA	NA	50 UJ	NA	NA
Nickel	2 UJ	2 U	2.0 U	13 BJ	50	23
Selenium	5 U	5 U	NA	5 U	5 U	NA
Silver	1 U	1 U	1.0 UJ	1 U	1 U	1.0 U
Thallium	5 UJ	2 U	NA	5 UJ	2 U	NA
Zinc	6	3.4 UB	50 UJ	19	3.2 UB	19 J
Volatile Organic Compounds						
in µg/L (ppb)						
Vinyl chloride	85	22	44	10	24	5
Methylene chloride	1 U	1 U	1 U	1 U	1 U	1 U
Acetone	5 U	5 U	5 U	5 U	5 U	5 U
trans-1,2-Dichloroethene	1	1 U	1 U	2	2	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	3	5	1 U
Total 1,2-Dichloroethene	1	1 U	1 U	5	8	1 U
2-Butanone (MEK)	3 U	3 U	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U	1 U	1 U
Miscellaneous Parameters						
in µg/L (ppb)						
Formaldehyde	R	NA	25	R	NA	5.0 U
Miscellaneous Parameters						
in mg/L (ppm)						
Total Dissolved Solids	890	1,000 J	730	410	430 J	330
Total Suspended Solids	NA	1,000 J	96	NA	630 J	76
Fluoride	NA	NA	6	NA	NA	1.4
Hardness as CaCO3	NA	NA	450	NA	NA	160

Table C-9 - Summary of North Site Area Groundwater Results

Sample Location:	HC-7S	HC-7S (a)	HC-7S	HC-8S	HC-8S (a)	HC-8S
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Oct 1990	Dec 1990
Semivolatile Organic Compounds in µg/L (ppb)						
Phenol	2 U	NA	2 U	2 U	NA	2 U
4-Methylphenol	2 U	NA	2 U	2 U	NA	2 U
Benzoic acid	51 U	NA	50 U	51 U	NA	50 U
Napthalene	4 U	9.0 U	2 U	4 U	0.11 J	2 U
2-Methylnapthalene	2 U	NA	2 U	2 U	NA	2 U
Acenapthylene	2 U	1.1 J	2 U	2 U	3.4	2 U
Acenapthene	2 U	9.0 U	2 U	2 U	1.8 U	2 U
Dibenzofuran	2 U	NA	2 U	2 U	NA	2 U
Fluorene	2 U	0.21 J	2 U	2 U	0.20 J	2 U
Phenanthrene	2 U	0.09 J	2 U	2 U	0.27 J	2 U
Anthracene	2 U	0.10 J	2 U	2 U	0.58 J	2 U
Fluoranthene	2 U	0.67 J	2 U	6	7.3	2 U
Pyrene	2 U	1.1 J	2 U	6	11	2 U
Benzo(a)anthracene	2 U	0.08	2 U	2 U	0.01 U	2 U
Chrysene	2 U	0.15 J	2 U	3	7.4	2 U
Bis(2-ethylhexyl)phthalate	2 U	NA	5 UB	2 U	NA	10 UB
Di-n-octyl phthalate	2 U	NA	2 U	2 U	NA	2 U
Benzo(b)fluoranthene	4 U	0.21	2 U	4 U	2.7	2 U
Benzo(k)fluoranthene	4 U	0.16	2 U	4 U	0.38	2 U
Benzo(a)pyrene	4 U	0.10 U	2 U	4 U	0.59	2 U
Indeno(1,2,3-cd)pyrene	4 U	0.06 J	2 U	4 U	0.35	2 U
Dibenzo(a,h)anthracene	4 U	0.15 U	2 U	4 U	0.48	2 U
Benzo(g,h,i)perylene	4 U	0.35 U	2 U	4 U	0.60	2 U
Field Parameters						
pH	7.2	7.1	6.8	7.0	7.3	6.6
Temperature in °C	10	18.4	12	8	17	9.6
Specific Conductivity in µMhos	1,520	1,800	1,300	540	590	490
Dissolved Oxygen in ppm	2.5	3.1	1.4	2.5	3.5	2.2
Chlorinated Pesticides in µg/L (ppb)	ND	NA	NA	ND	NA	NA
PCBs in µg/L (ppb)	ND	NA	NA	ND	NA	NA

Notes:

U	Indicates compound was analyzed for but not detected at the given detection limit.
J	Indicates an estimated value.
B	Indicates analyte was detected in laboratory method blank.
X	Indicates compound was tentatively identified.
R	Data was unuseable based on data validation criteria.
NA	Not analyzed.
(a)	PAHs for these samples were analyzed using EPA method 8310. All other samples were analyzed using method 8270.

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Table C-9 - Summary of North Site Area Groundwater Results

Sample Location:	HC-8SA	HC-9S (a)	HC-9S	HC-21S (a)	HC-21S
Date Sampled:	Dec 1990	Oct 1990	Dec 1990	Oct 1990	Dec 1990
	Replicate				
Dissolved Metals					
in µg/L (ppb)					
Antimony	10 U	3 U	41	NA	10 U
Arsenic	5.0 U	92	32	NA	5.0 U
Beryllium	NA	1 U	NA	NA	NA
Cadmium	1.0 U	1	1.0	NA	1.0 UJ
Chromium	1.0 U	2.6 UB	1.0 U	NA	1.0
Copper	1.0 U	1 U	2.0	NA	2.0
Iron	8,300	NA	1,100	NA	1,400 B
Lead	3 U	3 U	3 U	NA	3 U
Manganese	460	NA	160	NA	510 B
Mercury	1.0 U	1.0 U	1.0 U	NA	1.0 U
Molybdenum	NA	NA	NA	NA	NA
Nickel	23	2 U	4.0	NA	8.0 UB
Selenium	NA	5 U	NA	NA	NA
Silver	1.0 U	1 U	1.0 U	NA	1.0 UJ
Thallium	NA	2 U	NA	NA	NA
Zinc	16 J	8.8 B	110	NA	9.0 J
Volatile Organic Compounds					
in µg/L (ppb)					
Vinyl chloride	6	63	12	64	27
Methylene chloride	1 U	1 U	1 U	1 U	1 U
Acetone	5 U	5 U	5 U	5 U	5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	2	1 U
cis-1,2-Dichloroethene	1	1 U	1 U	2	1
Total 1,2-Dichloroethene	1	1 U	1 U	4	1
2-Butanone (MEK)	3 U	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U
Benzene	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U	1 U
Miscellaneous Parameters					
in µg/L (ppb)					
Formaldehyde	5.0 U	NA	12	NA	5.0 U
Miscellaneous Parameters					
in mg/L (ppm)					
Total Dissolved Solids	330	890 J	240 J	1,100 J	1,200
Total Suspended Solids	81	1,600 J	260 B	1,800 J	630
Fluoride	1.3	NA	3.6	NA	8.6
Hardness as CaCO3	160	NA	120	NA	610

Table C-9 - Summary of North Site Area Groundwater Results

Sample Location:	HC-8SA	HC-9S (a)	HC-9S	HC-21S (a)	HC-21S
Date Sampled:	Dec 1990	Oct 1990	Dec 1990	Oct 1990	Dec 1990
	Replicate				
Semivolatile Organic Compounds in µg/L (ppb)					
Phenol	2 U	NA	1 U	NA	2 U
4-Methylphenol	2 U	NA	1 U	NA	2 U
Benzoic acid	50 U	NA	25 U	NA	50 U
Napthalene	2 U	9.0 U	1 U	9.0 U	2 U
2-Methylnapthalene	2 U	NA	1 U	NA	2 U
Acenapthylene	2 U	0.76 J	1 U	11 J	2 U
Acenapthene	2 U	9.0 U	1 U	7.1 J	2 U
Dibenzofuran	2 U	NA	1 U	NA	2 U
Fluorene	2 U	0.25 J	1 U	0.76 J	2 U
Phenanthrene	2 U	1.3 J	1 U	0.85 J	2 U
Anthracene	2 U	0.03 J	1 U	1.1 J	2 U
Fluoranthene	2 U	2.4	2	25	2 U
Pyrene	2 U	4.3	2	36	2 U
Benzo(a)anthracene	2 U	0.58	1 U	0.05 U	2 U
Chrysene	2 U	1.1	1	NA	2 U
Bis(2-ethylhexyl)phthalate	3 UB	NA	6 UB	NA	4 UB
Di-n-octyl phthalate	2 U	NA	1 U	NA	2 U
Benzo(b)fluoranthene	2 U	0.90	1 U	8.5	2 U
Benzo(k)fluoranthene	2 U	1.6	1 U	3.9	2 U
Benzo(a)pyrene	2 U	0.10 U	1 U	1.4	2 U
Indeno(1,2,3-cd)pyrene	2 U	1.1	1 U	0.97	2 U
Dibenzo(a,h)anthracene	2 U	0.15 U	1 U	1.3	2 U
Benzo(g,h,i)perylene	2 U	0.22 J	1 U	1.8	2 U
Field Parameters					
pH	NA	NA	6.8	NA	6.8
Temperature in °C	NA	18	7.3	14	9.8
Specific Conductivity in µMhos	NA	1,500	340	1,500	1,490
Dissolved Oxygen in ppm	NA	2.4	4.2	4.3	3.6
Chlorinated Pesticides in µg/L (ppb)	NA	NA	NA	NA	NA
PCBs in µg/L (ppb)	NA	NA	NA	NA	NA

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Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-4I	HC-4I (a)	HC-4I	HC-4S	HC-4S (a)
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Oct 1990
Dissolved Metals					
in µg/L (ppb)					
Antimony	10 UJ	3 U	10 U	10 UJ	5
Arsenic	5 U	5 U	5.0 U	33	220
Arsenic (+3)	NA	NA	NA	NA	NA
Arsenic (+5)	NA	NA	NA	NA	NA
Beryllium	10 U	1 U	NA	10 U	10 U
Cadmium	10 U	1 U	1.0 U	10 U	10 U
Chromium	10 U	17 B	12	87	190
Chromium (+6)	NA	NA	NA	NA	NA
Copper	10 U	15	1.0 U	18	70
Iron	NA	NA	1,100 BJ	NA	NA
Lead	50	4.1	3 U	100 J	38
Manganese	490	NA	110 B	330	NA
Mercury	1 U	1.0 U	1.0 U	1 U	1.0 U
Nickel	20 U	5.4	2.0 U	75	120
Selenium	5 U	5 U	NA	5 U	5 U
Silver	10 U	1 U	1.0 UJ	10 U	10 U
Thallium	5 UJ	2 U	NA	5 UJ	2 U
Zinc	40	160 B	48 B	36	79
Volatile Organic Compounds					
in µg/L (ppb)					
Vinyl chloride	1 U	1 U	1 U	5 U	5 U
Methylene chloride	1 U	1 U	1 U	5 U	5 U
Acetone	5 U	5 U	5 U	52 J	74
trans-1,2-Dichloroethene	1 U	1 U	1 U	5 U	5 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	5 U	5 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	5 U	5 U
2-Butanone (MEK)	3 U	3 U	3 U	15 U	15 U
Trichloroethene	1 U	1 U	1 U	5 U	5 U
Benzene	1 U	1 U	1 U	50	42
Tetrachloroethene	1 U	1 U	1 U	5 U	5 U
Toluene	2	1 U	1 U	72	69
Ethylbenzene	1 U	1 U	1 U	13	14
Total Xylene	1 U	1 U	1 U	93	77
Miscellaneous Parameters					
in µg/L (ppb)					
Formaldehyde	R	NA	5.0 U	R	NA

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-4I	HC-4I (a)	HC-4I	HC-4S	HC-4S (a)
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Oct 1990
Miscellaneous Parameters in mg/L (ppm)					
Total Dissolved Solids	10,000	11,000 J	11,000	9,200	13,000 J
Total Suspended Solids	NA	770 J	65	NA	98 J
Fluoride	NA	NA	0.8	NA	NA
Hardness as CaCO3	NA	NA	NA	NA	NA
Calcium	NA	NA	NA	NA	NA
Chloride	NA	NA	NA	NA	NA
Hydrogen Sulfide as S	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA
Sulfate as SO4	NA	NA	NA	NA	NA
Total Alkalinity as CaCO3	NA	NA	NA	NA	NA
Semivolatile Organic Compounds in µg/L (ppb)					
Phenol	2 U	NA	1 U	83	NA
4-Methylphenol	2 U	NA	1 U	34	NA
Benzoic acid	50 U	NA	33 U	100 U	NA
Napthalene	4 U	1.8 U	1 U	13	12 J
2-Methylnapthalene	2 U	NA	1 U	4 U	NA
Acenapthylene	2 U	2.3 U	1 U	4 U	7.9 J
Acenapthene	2 U	1.8 U	1 U	4 U	27 UJ
Dibenzofuran	2 U	NA	1 U	4 U	NA
Fluorene	2 U	0.21 U	1 U	4 U	1.2 J
Phenanthrene	2 U	0.64 U	1 U	4 U	2.3 J
Anthracene	2 U	0.66 U	1 U	4 U	0.30 J
Fluoranthene	2 U	0.21 U	1 U	4 U	0.54 J
Pyrene	2 U	0.27 U	1 U	4 U	2.9 J
Benzo(a)anthracene	2 U	0.01 U	1 U	4 U	0.15 UJ
Chrysene	2 U	0.15 U	1 U	4 U	2.3 UJ
Bis(2-ethylhexyl)phthalate	4 UB	NA	2 UB	9 UB	NA
Di-n-octyl phthalate	2 U	NA	1 U	4 U	NA
Benzo(b)fluoranthene	4 U	0.02	1 U	8 U	0.93 J
Benzo(k)fluoranthene	4 U	0.01 U	1 U	8 U	0.15 UJ
Benzo(a)pyrene	4 U	0.02 U	1 U	8 U	0.30 UJ
Indeno(1,2,3-cd)pyrene	4 U	0.04 U	1 U	8 U	0.60 UJ
Dibenzo(a,h)anthracene	4 U	0.03 U	1 U	8 U	0.45 UJ
Benzo(g,h,i)perylene	4 U	0.07 U	1 U	8 U	1.1 UJ

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-4I	HC-4I (a)	HC-4I	HC-4S	HC-4S (a)
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Oct 1990
Field Parameters					
pH	6.8	6.0	6.5	10.6	10.6
Temperature in °C	12	17	12.8	9	19.9
Specific Conductivity in μMhos	13,900	14,100	14,500	5,900	13,300
Dissolved Oxygen in ppm	2.3	6.2	2.9	0.6	NA
Organophosphorous Pesticides					
in μg/L (ppb)	NA	NA	NA	NA	NA
Chlorinated Pesticides					
in μg/L (ppb)	ND	NA	NA	ND	NA
PCBs in μg/L (ppb)	ND	NA	NA	ND	NA
Chlorinated Herbicides					
in μg/L (ppb)					
2,4-DB	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA

Notes:

U	Indicates compound was analyzed for but not detected at the given detection limit.
J	Indicates an estimated value.
B	Indicates analyte was detected in laboratory method blank.
R	Data was unuseable based on data validation criteria.
T	Flagged values represent sum of two co-eluting compounds.
NA	Not analyzed.
ND	Not detected at various detection limits.
(a)	PAHs for these samples were analyzed using EPA method 8310. All other samples were analyzed using method 8270.

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Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-4S	HC-5S	HC-5S (a)	HC-100	HC-5S
Date Sampled:	Dec 1990	Jan 1990	Oct 1990	Oct 1990	Dec 1990
				Rep HC-5S	
Dissolved Metals					
in μg/L (ppb)					
Antimony	10 U	10 UJ	6	3	10 U
Arsenic	180	200	230	220	150
Arsenic (+3)	57	NA	NA	NA	56
Arsenic (+5)	87	NA	NA	NA	51
Beryllium	NA	1 U	10 U	1.6	NA
Cadmium	1.0 U	1 UJ	10 U	1 U	1.0 U
Chromium	35	88 J	150	150 B	120
Chromium (+6)	570 R	NA	NA	NA	370 R
Copper	1.0 B	6	58	47	3.0 UB
Iron	57 UBJ	NA	NA	NA	90 UBJ
Lead	5	4 U	74	55	15
Manganese	12 B	160	NA	NA	55 B
Mercury	1.0 U	1 U	1.0 U	1.0 U	1.0 U
Nickel	3.0	7 UJ	32	32	5.0
Selenium	NA	5 U	5 U	5 U	NA
Silver	1.0 UJ	4	10 U	1 U	1.0 UJ
Thallium	NA	5 UJ	2 U	2 U	NA
Zinc	4.0 UB	6	90	80 B	7.0 UB
Volatile Organic Compounds					
in μg/L (ppb)					
Vinyl chloride	5 U	1 U	1 U	2 U	5 U
Methylene chloride	5 U	1 U	1 U	2 U	5 U
Acetone	25 U	5 U	5 U	10 U	25 U
trans-1,2-Dichloroethene	5 U	1 U	1 U	2 U	5 U
cis-1,2-Dichloroethene	5 U	1 U	1 U	2 U	5 U
Total 1,2-Dichloroethene	5 U	1 U	1 U	2 U	5 U
2-Butanone (MEK)	15 U	3 U	3 U	6 U	15 U
Trichloroethene	5 U	1 U	1 U	2 U	5 U
Benzene	30	18	17	17	5 U
Tetrachloroethene	5 U	1 U	1 U	2 U	5 U
Toluene	55	1 U	1 U	2 U	5 U
Ethylbenzene	12	1 U	1 U	2 U	5 U
Total Xylene	63	1 U	1 U	2 U	5 U
Miscellaneous Parameters					
in μg/L (ppb)					
Formaldehyde	56	R	NA	NA	140

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-4S	HC-5S	HC-5S (a)	HC-100	HC-5S
Date Sampled:	Dec 1990	Jan 1990	Oct 1990	Oct 1990	Dec 1990
				Rep HC-5S	
Miscellaneous Parameters					
in mg/L (ppm)					
Total Dissolved Solids	7,100	7,500	6,400 J	6,200 J	5,400
Total Suspended Solids	150	NA	550 J	400 J	510
Fluoride	4.1	NA	NA	NA	6.8
Hardness as CaCO3	20	NA	NA	NA	92
Calcium	9.6	NA	NA	NA	23
Chloride	560 J	NA	NA	NA	2,400 J
Hydrogen Sulfide as S	23 J	NA	NA	NA	9.8 J
Magnesium	5.5	NA	NA	NA	8.2
Sodium	2,100	NA	NA	NA	2,300
Sulfate as SO4	38 J	NA	NA	NA	29 J
Total Alkalinity as CaCO3	3,500	NA	NA	NA	1,400
Semivolatile Organic Compounds					
in μg/L (ppb)					
Phenol	77	2 U	NA	NA	10 U
4-Methylphenol	15	2 U	NA	NA	10 U
Benzoic acid	250 U	51 U	NA	NA	250 U
Napthalene	10 U	4 U	27 U	27 U	10 U
2-Methylnapthalene	10 U	2 U	NA	NA	10 U
Acenapthylene	10 U	2 U	5.2 J	6.0 J	10 U
Acenapthene	10 U	2 U	27 U	27 U	10 U
Dibenzofuran	10 U	2 U	NA	NA	10 U
Fluorene	10 U	2 U	0.66 J	0.18 J	10 U
Phenanthrene	10 U	2 U	0.39 J	0.36 J	10 U
Anthracene	10 U	2 U	0.27 J	0.36 J	10 U
Fluoranthene	10 U	17	11	14	10 U
Pyrene	10 U	26	16	20	10 U
Benzo(a)anthracene	10 U	4	2.0	3.0	10 U
Chrysene	10 U	12	2.7	4.1	10 U
Bis(2-ethylhexyl)phthalate	41 UB	8	NA	NA	10 UB
Di-n-octyl phthalate	10 U	2 U	NA	NA	10 U
Benzo(b)fluoranthene	10 U	6 T	1.9	3.1	10 U
Benzo(k)fluoranthene	10 U	6 T	4.1	5.4	10 U
Benzo(a)pyrene	10 U	4 U	0.48	0.69	10 U
Indeno(1,2,3-cd)pyrene	10 U	4 U	0.15 J	0.24 J	10 U
Dibenzo(a,h)anthracene	10 U	4 U	0.45 U	0.45 U	10 U
Benzo(g,h,i)perylene	10 U	4 U	0.30 J	0.54 J	10 U

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-4S	HC-5S	HC-5S (a)	HC-100	HC-5S
Date Sampled:	Dec 1990	Jan 1990	Oct 1990	Oct 1990	Dec 1990
				Rep HC-5S	
Field Parameters					
pH	11.1	8.8	8.1	NA	9.0
Temperature in °C	9.5	9	20.1	NA	11.0
Specific Conductivity in μMhos	7,600	10,800	8,900	NA	8,000
Dissolved Oxygen in ppm	2.1	2.1	2.7	NA	2.2
Organophosphorous Pesticides					
in μg/L (ppb)	ND	NA	NA	NA	ND
Chlorinated Pesticides					
in μg/L (ppb)	ND	ND J	NA	NA	ND
PCBs in μg/L (ppb)	ND	ND J	NA	NA	ND
Chlorinated Herbicides					
in μg/L (ppb)					
2,4-DB	9 U	NA	NA	NA	9 U
Dinoseb	5	NA	NA	NA	2

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Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-6I	HC-6I (a)	HC-6I	HC-6S	HC-6S (a)
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Oct 1990
Dissolved Metals					
in μg/L (ppb)					
Antimony	20 UJ	3 U	10 U	25 J	6.2
Arsenic	5 U	5 U	5.0 U	490	530
Arsenic (+3)	NA	NA	NA	NA	NA
Arsenic (+5)	NA	NA	NA	NA	NA
Beryllium	1 U	1 U	NA	1 U	1 U
Cadmium	1 UJ	1 U	1.0 U	2 J	1 U
Chromium	9 J	9.1 B	17	1 UJ	1 U
Chromium (+6)	NA	NA	NA	NA	NA
Copper	1 U	1 U	1.0 B	110	1 U
Iron	NA	NA	4,200 B	NA	NA
Lead	2 U	3 U	3 U	9.6	3 U
Manganese	220	NA	200 B	230	NA
Mercury	1 U	1.0 U	1.0 U	1 U	1.0 U
Nickel	2 UJ	2 U	2.0 U	18 BJ	5.1
Selenium	5 U	5 U	NA	5 U	5 U
Silver	1 U	1 U	1.0 U	1 U	1 U
Thallium	5 UJ	2 U	NA	5 UJ	2 U
Zinc	6	7.2 B	87 B	68	14 B
Volatile Organic Compounds					
in μg/L (ppb)					
Vinyl chloride	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U
Acetone	5 U	5 U	5 U	5 U	5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
2-Butanone (MEK)	3 U	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U
Benzene	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 J
Toluene	3	2	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U	1 U
Miscellaneous Parameters					
in μg/L (ppb)					
Formaldehyde	R	NA	22	R	NA

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-6I	HC-6I (a)	HC-6I	HC-6S	HC-6S (a)
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Oct 1990
Miscellaneous Parameters in mg/L (ppm)					
Total Dissolved Solids	3,600	5,500 J	4,200 J	260	680 J
Total Suspended Solids	NA	93 J	110 B	NA	1,100 J
Fluoride	NA	NA	0.7	NA	NA
Hardness as CaCO3	NA	NA	NA	NA	NA
Calcium	NA	NA	NA	NA	NA
Chloride	NA	NA	NA	NA	NA
Hydrogen Sulfide as S	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA
Sulfate as SO4	NA	NA	NA	NA	NA
Total Alkalinity as CaCO3	NA	NA	NA	NA	NA
Semivolatile Organic Compounds in μg/L (ppb)					
Phenol	2 U	NA	1 U	2 U	NA
4-Methylphenol	2 U	NA	1 U	2 U	NA
Benzoic acid	51 U	NA	25 U	51 U	NA
Napthalene	4 U	14 U	1 U	4 U	1.8 U
2-Methylnapthalene	2 U	NA	1 U	2 U	NA
Acenapthylene	2 U	17 U	1 U	2 U	2.3 U
Acenapthene	2 U	14 U	1 U	2 U	1.8 U
Dibenzofuran	2 U	NA	1 U	2 U	NA
Fluorene	2 U	1.6 U	1 U	2 U	0.21 U
Phenanthrene	2 U	4.8 U	1 U	2 U	0.64 U
Anthracene	2 U	5.0 U	1 U	2 U	0.66 U
Fluoranthene	2 U	0.18 J	1 U	2 U	0.04 J
Pyrene	2 U	0.20 J	1 U	2 U	0.46
Benzo(a)anthracene	2 U	0.08 U	1 U	2 U	0.05
Chrysene	2 U	1.1 U	1 U	2 U	0.03 J
Bis(2-ethylhexyl)phthalate	3	NA	4 UB	2 U	NA
Di-n-octyl phthalate	2 U	NA	1 U	2 U	NA
Benzo(b)fluoranthene	4 U	0.08 U	1 U	4 U	0.09
Benzo(k)fluoranthene	4 U	0.08 U	1 U	4 U	0.01 U
Benzo(a)pyrene	4 U	0.15 U	1 U	4 U	0.03
Indeno(1,2,3-cd)pyrene	4 U	0.30 U	1 U	4 U	0.03 J
Dibenzo(a,h)anthracene	4 U	0.23 U	1 U	4 U	0.03 U
Benzo(g,h,i)perylene	4 U	0.53 U	1 U	4 U	0.04 J

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-6I	HC-6I (a)	HC-6I	HC-6S	HC-6S (a)
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Oct 1990
Field Parameters					
pH	6.9	7.1	7.0	6.8	7.3
Temperature in °C	12	15	11.5	9	18
Specific Conductivity in μMhos	5,600	5,700	6,600	460	1,200
Dissolved Oxygen in ppm	5.1	6.6	4.0	3.9	4.0
Organophosphorous Pesticides					
in μg/L (ppb)	NA	NA	NA	NA	NA
Chlorinated Pesticides					
in μg/L (ppb)	NA	NA	NA	ND	NA
PCBs in μg/L (ppb)	NA	NA	NA	ND	NA
Chlorinated Herbicides					
in μg/L (ppb)					
2,4-DB	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA

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Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-6S	HC-101	HC-10I	HC-10I	HC-10S
Date Sampled:	Dec 1990	Dec 1990	Jan 1990	Dec 1990	Jan 1990
		Rep HC-6S			
Dissolved Metals					
in μg/L (ppb)					
Antimony	10 U	NA	10 UJ	10 U	10 UJ
Arsenic	640	NA	5 U	5.0 U	37
Arsenic (+3)	380	170	NA	NA	NA
Arsenic (+5)	71	87	NA	NA	NA
Beryllium	NA	NA	1 U	NA	1 U
Cadmium	1.0 U	NA	1 UJ	1.0 U	6 J
Chromium	1.0 U	NA	10 J	16	5 J
Chromium (+6)	NA	NA	NA	NA	NA
Copper	1.0 U	NA	2	1.0 U	6
Iron	7,500	NA	NA	3,400 BJ	NA
Lead	3 U	NA	2 U	3 U	2.2
Manganese	280	NA	300	150 B	1,300
Mercury	1.0 U	NA	1 U	1.0 U	1 U
Nickel	18	NA	2 UJ	2.0 U	2 UJ
Selenium	NA	NA	5 U	NA	5 U
Silver	1.0 U	NA	1 UJ	1.0 U	1 U
Thallium	NA	NA	5 UJ	NA	5 UJ
Zinc	14	NA	7	7.0 UB	19
Volatile Organic Compounds					
in μg/L (ppb)					
Vinyl chloride	1 U	NA	1 U	1 U	1 U
Methylene chloride	1 U	NA	1 U	1 U	1 U
Acetone	5 U	NA	5 U	5 U	5 U
trans-1,2-Dichloroethene	1 U	NA	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	NA	1 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	NA	1 U	1 U	1 U
2-Butanone (MEK)	3 U	NA	3 U	3 U	3 U
Trichloroethene	1 U	NA	1 U	1 U	1 U
Benzene	1 U	NA	1 U	1 U	1 U
Tetrachloroethene	1 U	NA	1 U	1 U	1 U
Toluene	1 U	NA	2	1 U	1 U
Ethylbenzene	1 U	NA	1 U	1 U	1 U
Total Xylene	1 U	NA	1 U	1 U	1 U
Miscellaneous Parameters					
in μg/L (ppb)					
Formaldehyde	25	NA	R	14	R

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-6S	HC-101	HC-10I	HC-10I	HC-10S
Date Sampled:	Dec 1990	Dec 1990	Jan 1990	Dec 1990	Jan 1990
		Rep HC-6S			
Miscellaneous Parameters					
in mg/L (ppm)					
Total Dissolved Solids	.320 J	NA	8,100	8,100 J	1,200
Total Suspended Solids	310 B	NA	NA	700	NA
Fluoride	3.5	NA	NA	1.2	NA
Hardness as CaCO3	130	NA	NA	NA	NA
Calcium	NA	NA	NA	NA	NA
Chloride	NA	NA	NA	NA	NA
Hydrogen Sulfide as S	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA
Sulfate as SO4	NA	NA	NA	NA	NA
Total Alkalinity as CaCO3	NA	NA	NA	NA	NA
Semivolatile Organic Compounds					
in μg/L (ppb)					
Phenol	1 U	NA	2 U	1 U	2 U
4-Methylphenol	1 U	NA	2 U	1 U	2 U
Benzoic acid	25 U	NA	51 U	25 U	51 U
Napthalene	1 U	NA	4 U	1 U	4 U
2-Methylnapthalene	1 U	NA	2 U	1 U	2 U
Acenapthylene	1 U	NA	2 U	1 U	2 U
Acenapthene	1 U	NA	2 U	1 U	2 U
Dibenzofuran	1 U	NA	2 U	1 U	2 U
Fluorene	1 U	NA	2 U	1 U	2 U
Phenanthrene	1 U	NA	2 U	1 U	2 U
Anthracene	1 U	NA	2 U	1 U	2 U
Fluoranthene	1 U	NA	2 U	1 U	2 U
Pyrene	1 U	NA	2 U	1 U	2 U
Benzo(a)anthracene	1 U	NA	2 U	1 U	2 U
Chrysene	1 U	NA	2 U	1 U	2 U
Bis(2-ethylhexyl)phthalate	3 UB	NA	6 J	2 UB	16 J
Di-n-octyl phthalate	1 U	NA	2 U	1 U	2 U
Benzo(b)fluoranthene	1 U	NA	4 U	1 U	4 U
Benzo(k)fluoranthene	1 U	NA	4 U	1 U	4 U
Benzo(a)pyrene	1 U	NA	4 U	1 U	4 U
Indeno(1,2,3-cd)pyrene	1 U	NA	4 U	1 U	4 U
Dibenzo(a,h)anthracene	1 U	NA	4 U	1 U	4 U
Benzo(g,h,i)perylene	1 U	NA	4 U	1 U	4 U

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-6S	HC-101	HC-10I	HC-10I	HC-10S
Date Sampled:	Dec 1990	Dec 1990	Jan 1990	Dec 1990	Jan 1990
		Rep HC-6S			
Field Parameters					
pH	6.6	NA	6.9	6.7	6.8
Temperature in °C	9.0	NA	12	12.5	10
Specific Conductivity in μMhos	560	NA	11,000	1,850	2,000
Dissolved Oxygen in ppm	2.9	NA	3.5	3.5	3.5
Organophosphorous Pesticides					
in μg/L (ppb)	NA	NA	NA	NA	NA
Chlorinated Pesticides					
in μg/L (ppb)	NA	NA	ND	NA	ND
PCBs in μg/L (ppb)	NA	NA	ND	NA	ND
Chlorinated Herbicides					
in μg/L (ppb)					
2,4-DB	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA

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Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-10S	HC-10SA	HC-11S	HC-11S (a)	HC-11S
Date Sampled:	Dec 1990	Dec 1990	Jan 1990	Oct 1990	Dec 1990
		Replicate			
Dissolved Metals					
in μg/L (ppb)					
Antimony	10 U	10 U	10 UJ	NA	10 U
Arsenic	58	54	27	NA	13
Arsenic (+3)	NA	NA	NA	NA	NA
Arsenic (+5)	NA	NA	NA	NA	NA
Beryllium	NA	NA	10 U	NA	NA
Cadmium	5.0	7.0	10 U	NA	1.0 U
Chromium	5.0	6.0	39	NA	16
Chromium (+6)	10 R	10 UR	NA	NA	460 R
Copper	1.0 U	1.0 U	22	NA	5.0
Iron	81,000 BJ	63,000 BJ	NA	NA	1,300
Lead	3 U	3 U	4.8	NA	3 U
Manganese	1,300 B	1,300 B	960	NA	770
Mercury	1.0 U	1.0 U	1 U	NA	1.0 U
Nickel	7.0	8.0	20 U	NA	4.0
Selenium	NA	NA	5 U	NA	NA
Silver	1.0 UJ	1.0 UJ	10 U	NA	1.0 U
Thallium	NA	NA	5 UJ	NA	NA
Zinc	22 UB	30 B	52	NA	4.0
Volatile Organic Compounds					
in μg/L (ppb)					
Vinyl chloride	1 U	1 U	1 U	2 U	1 U
Methylene chloride	1 U	1 U	1 U	2 U	1 U
Acetone	5 U	2 J	24 J	10 U	5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	2 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	2 U	1 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	2 U	1 U
2-Butanone (MEK)	3 U	3 U	3 U	6 U	3 U
Trichloroethene	1 U	1 U	1 U	2 U	1 U
Benzene	1 U	1 U	1 U	2 U	2
Tetrachloroethene	1 U	1 U	1 U	2 U	1 U
Toluene	1 U	1 U	4	5	3
Ethylbenzene	1 U	1 U	1 U	2 U	1 U
Total Xylene	1 U	1 U	1 U	2 U	1 U
Miscellaneous Parameters					
in μg/L (ppb)					
Formaldehyde	57	62	R	NA	47

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-10S	HC-10SA	HC-11S	HC-11S (a)	HC-11S
Date Sampled:	Dec 1990	Dec 1990	Jan 1990	Oct 1990	Dec 1990
		Replicate			
Miscellaneous Parameters					
in mg/L (ppm)					
Total Dissolved Solids	1,200	1,200	860	1,500 J	1,100 J
Total Suspended Solids	510	580	NA	220 J	51 B
Fluoride	2.4	2.5	NA	NA	2.7
Hardness as CaCO3	260	240	NA	NA	510
Calcium	NA	NA	NA	NA	78
Chloride	NA	NA	NA	NA	57 J
Hydrogen Sulfide as S	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	51
Sodium	NA	NA	NA	NA	300
Sulfate as SO4	NA	NA	NA	NA	1 J
Total Alkalinity as CaCO3	NA	NA	NA	NA	960
Semivolatile Organic Compounds					
in μg/L (ppb)					
Phenol	1 U	1 U	2 U	NA	1 U
4-Methylphenol	1 U	1 U	38	NA	1 U
Benzoic acid	25 U	25 U	92	NA	25 U
Napthalene	1 U	1 U	35	20 J	13
2-Methylnapthalene	1 U	1 U	6	NA	3
Acenapthylene	1 U	1 U	12	35 J	3
Acenapthene	1 U	1 U	11	32 J	16
Dibenzofuran	1 U	1 U	2 U	NA	1 U
Fluorene	1 U	1 U	10	15 J	8
Phenanthrene	1 U	1 U	13	43 J	22
Anthracene	1 U	1 U	5	7.7 J	4
Fluoranthene	1 U	1 U	17	23 J	12
Pyrene	1 U	1 U	18	60 J	16
Benzo(a)anthracene	1 U	1 U	4	13 J	4
Chrysene	1 U	1 U	5	13 J	5
Bis(2-ethylhexyl)phthalate	2 UB	2 UB	4 UB	NA	4 UB
Di-n-octyl phthalate	1 U	1 U	2 U	NA	1 U
Benzo(b)fluoranthene	1 U	1 U	6 T	17 J	3 T
Benzo(k)fluoranthene	1 U	1 U	6 T	7.4 J	3 T
Benzo(a)pyrene	1 U	1 U	4	12 J	5
Indeno(1,2,3-cd)pyrene	1 U	1 U	4 U	7.7 J	3
Dibenzo(a,h)anthracene	1 U	1 U	4 U	7.6 J	1 U
Benzo(g,h,i)perylene	1 U	1 U	4	8.4 J	3

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-10S	HC-10SA	HC-11S	HC-11S (a)	HC-11S
Date Sampled:	Dec 1990	Dec 1990	Jan 1990	Oct 1990	Dec 1990
		Replicate			
Field Parameters					
pH	7.8	NA	7.9	8.3	8.1
Temperature in °C	12.0	NA	10	16	11.0
Specific Conductivity in μMhos	13,100	NA	2,600	2,600	1,540
Dissolved Oxygen in ppm	2.9	NA	8.9	8.7	4.8
Organophosphorous Pesticides					
in μg/L (ppb)	NA	NA	NA	NA	NA
Chlorinated Pesticides					
in μg/L (ppb)	NA	NA	ND	NA	NA
PCBs in μg/L (ppb)	NA	NA	ND	NA	NA
Chlorinated Herbicides					
in μg/L (ppb)					
2,4-DB	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA

OFA-GW.WK1

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-12I	HC-12I (a)	HC-12I	HC-12S	HC-12R
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Jan 1990
					Rep HC-12S
Dissolved Metals					
in μg/L (ppb)					
Antimony	10 UJ	3 U	10 U	10 UJ	13 J
Arsenic	5 U	5 U	5.0 U	5	5 U
Arsenic (+3)	NA	NA	NA	NA	NA
Arsenic (+5)	NA	NA	NA	NA	NA
Beryllium	10 U	10 U	NA	10 U	10 U
Cadmium	10 U	10 U	1.0	10 U	10 U
Chromium	10 U	10 U	7.0	10 U	10 U
Chromium (+6)	NA	NA	NA	NA	NA
Copper	10 U	10 U	9.0 B	10 U	10 U
Iron	NA	NA	9,000 B	NA	NA
Lead	100 U	3 U	3 U	2 U	2 U
Manganese	1,400	NA	340 B	520	610
Mercury	1 U	1.0 U	1.0 U	1 U	1 U
Nickel	20 U	20 U	2.0 U	20 U	20 U
Selenium	5 U	5 U	NA	5 U	5 U
Silver	10 U	10 U	1.0 U	10 U	10 U
Thallium	5 UJ	2 U	NA	5 UJ	5 UJ
Zinc	36	21	10 UB	10 U	10 U
Volatile Organic Compounds					
in μg/L (ppb)					
Vinyl chloride	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U
Acetone	9 J	5 U	5 U	5 U	5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
2-Butanone (MEK)	3 U	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U
Benzene	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U
Toluene	2	1 U	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U	1 U
Miscellaneous Parameters					
in μg/L (ppb)					
Formaldehyde	R	NA	27	R	R

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-12I	HC-12I (a)	HC-12I	HC-12S	HC-12R
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Jan 1990
					Rep HC-12S
Miscellaneous Parameters					
in mg/L (ppm)					
Total Dissolved Solids	12,000	13,000 J	12,000	510	500
Total Suspended Solids	NA	150 J	290 B	NA	NA
Fluoride	NA	NA	0.6	NA	NA
Hardness as CaCO3	NA	NA	NA	NA	NA
Calcium	NA	NA	NA	NA	NA
Chloride	NA	NA	NA	NA	NA
Hydrogen Sulfide as S	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA
Sulfate as SO4	NA	NA	NA	NA	NA
Total Alkalinity as CaCO3	NA	NA	NA	NA	NA
Semivolatile Organic Compounds					
in μg/L (ppb)					
Phenol	2 U	NA	1 U	2 U	2 U
4-Methylphenol	2 U	NA	1 U	2 U	2 U
Benzoic acid	50 U	NA	25 U	50 U	50 U
Napthalene	4 U	14 U	1 U	4 U	4 U
2-Methylnapthalene	2 U	NA	1 U	2 U	2 U
Acenapthylene	2 U	17 U	1 U	2 U	2 U
Acenapthene	2 U	14 U	1 U	2 U	2 U
Dibenzofuran	2 U	NA	1 U	2 U	2 U
Fluorene	2 U	1.6 U	1 U	2 U	2 U
Phenanthrene	2 U	0.08 J	1 U	2 U	2 U
Anthracene	2 U	5.0 U	1 U	2 U	2 U
Fluoranthene	2 U	1.6 U	1 U	2 U	2 U
Pyrene	2 U	0.26 J	1 U	2 U	2 U
Benzo(a)anthracene	2 U	0.08 U	1 U	2 U	2 U
Chrysene	2 U	1.1 U	1 U	2 U	2 U
Bis(2-ethylhexyl)phthalate	30 UB	NA	7 UB	13 UB	11 UB
Di-n-octyl phthalate	2 U	NA	1 U	2 U	2 U
Benzo(b)fluoranthene	4 U	0.08 U	1 U	4 U	4 U
Benzo(k)fluoranthene	4 U	0.08 U	1 U	4 U	4 U
Benzo(a)pyrene	4 U	0.15 U	1 U	4 U	4 U
Indeno(1,2,3-cd)pyrene	4 U	0.30 U	1 U	4 U	4 U
Dibenzo(a,h)anthracene	4 U	0.23 U	1 U	4 U	4 U
Benzo(g,h,i)perylene	4 U	0.53 U	1 U	4 U	4 U

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-12I	HC-12I (a)	HC-12I	HC-12S	HC-12R
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Jan 1990
					Rep HC-12S
Field Parameters					
pH	7.0	NA	7.2	7.1	NA
Temperature in °C	11	14	12.5	9	NA
Specific Conductivity in μMhos	14,800	15,500	17,700	800	NA
Dissolved Oxygen in ppm	5.5	5.1	2.4	1.6	NA
Organophosphorous Pesticides					
in μg/L (ppb)	NA	NA	NA	NA	NA
Chlorinated Pesticides					
in μg/L (ppb)	ND	NA	NA	ND	ND
PCBs in μg/L (ppb)	ND	NA	NA	ND	ND
Chlorinated Herbicides					
in μg/L (ppb)					
2,4-DB	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA

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Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-12S	HC-15I	HC-15I	HC-15S	HC-15S
Date Sampled:	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
Dissolved Metals					
in μg/L (ppb)					
Antimony	10 U	10 UJ	10 U	10 UJ	10 U
Arsenic	5.0 U	5 U	5.0 U	5 U	5.0 U
Arsenic (+3)	NA	NA	NA	NA	NA
Arsenic (+5)	NA	NA	NA	NA	NA
Beryllium	NA	10 U	NA	10 U	NA
Cadmium	1.0 U	10 U	1.0 U	10 U	2.0
Chromium	1.0 U	10 U	7.0	10 U	2.0
Chromium (+6)	NA	NA	NA	NA	NA
Copper	1.0 U	10 U	1.0 U	10 U	1.0 U
Iron	6,200	NA	2,500 B	NA	12,000
Lead	3 U	10 U	3 U	2 U	3 U
Manganese	320	370	250 B	3,100	2,300
Mercury	1.0 U	1 U	1.0 U	1 U	1.0 U
Nickel	2.0 U	20 U	2.0 U	20 U	2.0 U
Selenium	NA	5 U	NA	5 U	NA
Silver	1.0 U	10 U	1.0 U	10 U	1.0 U
Thallium	NA	5 UJ	NA	5 UJ	NA
Zinc	31	43	33 B	34	2.0
Volatile Organic Compounds					
in μg/L (ppb)					
Vinyl chloride	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U
Acetone	5 U	5 U	5 U	5 J	5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
2-Butanone (MEK)	3 U	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U
Benzene	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U	1 U
Miscellaneous Parameters					
in μg/L (ppb)					
Formaldehyde	69	R	16	R	19

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-12S	HC-15I	HC-15I	HC-15S	HC-15S
Date Sampled:	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
Miscellaneous Parameters					
in mg/L (ppm)					
Total Dissolved Solids	550	8,600	7,800	1,100	1,000
Total Suspended Solids	550 B	NA	350 B	NA	190 B
Fluoride	7.8	NA	0.7	NA	3.7
Hardness as CaCO3	190	NA	NA	NA	750
Calcium	NA	NA	NA	NA	NA
Chloride	NA	NA	NA	NA	NA
Hydrogen Sulfide as S	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA
Sulfate as SO4	NA	NA	NA	NA	NA
Total Alkalinity as CaCO3	NA	NA	NA	NA	NA
Semivolatile Organic Compounds					
in μg/L (ppb)					
Phenol	1 U	3 U	1 U	2 U	1 U
4-Methylphenol	1 U	3 U	1 U	2 U	1 U
Benzoic acid	33 U	67 U	25 U	50 U	25 U
Napthalene	1 U	5 U	1 U	4 U	1 U
2-Methylnapthalene	1 U	3 U	1 U	2 U	1 U
Acenapthylene	1 U	3 U	1 U	2 U	1 U
Acenapthene	1 U	3 U	1 U	2 U	1 U
Dibenzofuran	1 U	3 U	1 U	2 U	1 U
Fluorene	1 U	3 U	1 U	2 U	1 U
Phenanthrene	3	3 U	1 U	2 U	1 U
Anthracene	1 U	3 U	1 U	2 U	1 U
Fluoranthene	2	3 U	1 U	2 U	1 U
Pyrene	2	3 U	1 U	2 U	1 U
Benzo(a)anthracene	1 U	3 U	1 U	2 U	1 U
Chrysene	1 U	3 U	1 U	2 U	1 U
Bis(2-ethylhexyl)phthalate	8 UB	3 UB	3 UB	3 UB	5 UB
Di-n-octyl phthalate	1 U	3 U	1 U	2 U	1 U
Benzo(b)fluoranthene	1 U	5 U	1 U	4 U	1 U
Benzo(k)fluoranthene	1 U	5 U	1 U	4 U	1 U
Benzo(a)pyrene	1 U	5 U	1 U	4 U	1 U
Indeno(1,2,3-cd)pyrene	1 U	5 U	1 U	4 U	1 U
Dibenzo(a,h)anthracene	1 U	5 U	1 U	4 U	1 U
Benzo(g,h,i)perylene	1 U	5 U	1 U	4 U	1 U

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-12S	HC-15I	HC-15I	HC-15S	HC-15S
Date Sampled:	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
Field Parameters					
pH	8.8	6.9	7.0	7.0	8.2
Temperature in °C	11.2	11	12.4	9	10.2
Specific Conductivity in μMhos	800	11,200	17,100	1,600	1,700
Dissolved Oxygen in ppm	2.0	3.9	1.9	2.9	1.8
Organophosphorous Pesticides					
in μg/L (ppb)	NA	NA	NA	NA	NA
Chlorinated Pesticides					
in μg/L (ppb)	NA	ND	NA	ND	NA
PCBs in μg/L (ppb)	NA	ND	NA	ND	NA
Chlorinated Herbicides					
in μg/L (ppb)					
2,4-DB	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA

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Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-16I	HC-16I	HC-16S	HC-16S	HC-24S
Date Sampled:	Jan 1990	Dec 1990	Jan 1990	Dec 1990	Dec 1990
Dissolved Metals					
in μg/L (ppb)					
Antimony	10 UJ	10 U	10 UJ	10 U	10 U
Arsenic	5 U	5.0 U	11	5.0 U	5.0 U
Arsenic (+3)	NA	NA	NA	NA	2.7
Arsenic (+5)	NA	NA	NA	NA	3.1
Beryllium	10 U	NA	10 U	NA	NA
Cadmium	10 U	1.0 U	10 U	5.0	1.0 U
Chromium	10 U	17	10 U	5.0	1.0
Chromium (+6)	NA	NA	NA	NA	20 R
Copper	10 U	1.0 U	10 U	1.0 U	1.0 U
Iron	NA	4,000 BJ	NA	37,000 BJ	3,200
Lead	2 U	3 U	2 U	3 U	3 U
Manganese	1,100	250 B	7,300	20,000 B	290
Mercury	1 U	1.0 U	1 U	1.0 U	1.0 U
Nickel	20 U	2.0 U	20 U	4.0	2.0 U
Selenium	5 U	NA	5 U	NA	NA
Silver	10 U	1.0 UJ	10 U	3.0 J	1.0 U
Thallium	5 UJ	NA	5 UJ	NA	NA
Zinc	20	16 UB	21	20 UB	92
Volatile Organic Compounds					
in μg/L (ppb)					
Vinyl chloride	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U
Acetone	11 J	5 U	5 U	5 U	5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
2-Butanone (MEK)	3 U	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U
Benzene	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U	1 U
Miscellaneous Parameters					
in μg/L (ppb)					
Formaldehyde	R	5.0 U	R	17	24

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-16I	HC-16I	HC-16S	HC-16S	HC-24S
Date Sampled:	Jan 1990	Dec 1990	Jan 1990	Dec 1990	Dec 1990
Miscellaneous Parameters					
in mg/L (ppm)					
Total Dissolved Solids	7,900	7,200	3,200	3,400	250 J
Total Suspended Solids	NA	1,900	NA	170	890 B
Fluoride	NA	0.9	NA	2.7	1.4
Hardness as CaCO3	NA	NA	NA	600	45
Calcium	NA	NA	NA	NA	NA
Chloride	NA	NA	NA	NA	NA
Hydrogen Sulfide as S	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA
Sulfate as SO4	NA	NA	NA	NA	NA
Total Alkalinity as CaCO3	NA	NA	NA	NA	NA
Semivolatile Organic Compounds					
in μg/L (ppb)					
Phenol	2 U	1 U	2 UR	1 UR	1 U
4-Methylphenol	2 U	1 U	2 UR	1 UR	1 U
Benzoic acid	50 U	25 U	50 UR	25 UR	25 U
Napthalene	4 U	1 U	4 U	1 U	1 U
2-Methylnapthalene	2 U	1 U	2 U	1 U	1 U
Acenapthylene	2 U	1 U	2 U	1 U	1 U
Acenapthene	2 U	1 U	2 U	1 U	1 U
Dibenzofuran	2 U	1 U	2 U	1 U	1 U
Fluorene	2 U	1 U	2 U	1 U	1 U
Phenanthrene	2 U	1 U	2 U	1 U	1 U
Anthracene	2 U	1 U	2 U	1 U	1 U
Fluoranthene	2 U	1 U	2 U	1 U	1 U
Pyrene	2 U	1 U	2 U	1 U	1 U
Benzo(a)anthracene	2 U	1 U	2 U	1 U	1 U
Chrysene	2 U	1 U	2 U	1 U	1 U
Bis(2-ethylhexyl)phthalate	2 U	9 UB	2 U	7 UB	7 UB
Di-n-octyl phthalate	2 U	1 U	2 U	1 U	1 U
Benzo(b)fluoranthene	4 U	1 U	4 U	1 U	1 U
Benzo(k)fluoranthene	4 U	1 U	4 U	1 U	1 U
Benzo(a)pyrene	4 U	1 U	4 U	1 U	1 U
Indeno(1,2,3-cd)pyrene	4 U	1 U	4 U	1 U	1 U
Dibenzo(a,h)anthracene	4 U	1 U	4 U	1 U	1 U
Benzo(g,h,i)perylene	4 U	1 U	4 U	1 U	1 U

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-16I	HC-16I	HC-16S	HC-16S	HC-24S
Date Sampled:	Jan 1990	Dec 1990	Jan 1990	Dec 1990	Dec 1990
Field Parameters					
pH	7.0	NA	7.5	NA	6.9
Temperature in °C	11	7.0	9	9.2	9.0
Specific Conductivity in μMhos	11,000	1,080	5,300	4,800	380
Dissolved Oxygen in ppm	2.3	NA	10.3	NA	2.8
Organophosphorous Pesticides					
in μg/L (ppb)	NA	NA	NA	NA	NA
Chlorinated Pesticides					
in μg/L (ppb)	ND	NA	ND	NA	NA
PCBs in μg/L (ppb)	ND	NA	ND	NA	NA
Chlorinated Herbicides					
in μg/L (ppb)					
2,4-DB	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA

OFA-GW.WK1

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-25S	EPA-6I	EPA-6I	EPA-7S	EPA-7S
Date Sampled:	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
Dissolved Metals					
in μg/L (ppb)					
Antimony	10 U	10 UJ	10 U	10 UJ	10 U
Arsenic	280	5 U	5.0 U	5 U	5.0 U
Arsenic (+3)	NA	NA	NA	NA	NA
Arsenic (+5)	NA	NA	NA	NA	NA
Beryllium	NA	10 U	NA	10 U	NA
Cadmium	1.0 J	10 U	1.0 U	10 U	6.0 J
Chromium	3.0	10 U	17	10 U	8.0
Chromium (+6)	10 R	NA	NA	NA	NA
Copper	8.0	10 U	1.0 U	10 U	2.0
Iron	11,000 B	NA	1,900 BJ	NA	46,000 B
Lead	3 U	10 U	3 U	2 U	3 U
Manganese	490 B	180	110 B	3,200	3,200 B
Mercury	1.0 U	1 U	1.0 U	1 U	1.0 U
Nickel	8.0 UB	20 U	2.0 U	20 U	3.0 UB
Selenium	NA	5 U	NA	5 U	NA
Silver	1.0 UJ	10 UJ	1.0 UJ	10 UJ	2.0 J
Thallium	NA	5 UJ	NA	5 UJ	NA
Zinc	110 J	19	27 UB	16	9.0 J
Volatile Organic Compounds					
in μg/L (ppb)					
Vinyl chloride	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U
Acetone	9	30 J	5 U	5 U	5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
2-Butanone (MEK)	3 U	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U
Benzene	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U	1 U
Miscellaneous Parameters					
in μg/L (ppb)					
Formaldehyde	5.0 U	R	5.0 U	R	21

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-25S	EPA-6I	EPA-6I	EPA-7S	EPA-7S
Date Sampled:	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
Miscellaneous Parameters					
in mg/L (ppm)					
Total Dissolved Solids	330 J	8,900	8,200	420	370
Total Suspended Solids	230	NA	44	NA	63
Fluoride	1	NA	0.5	NA	3.8
Hardness as CaCO3	83	NA	NA	NA	270
Calcium	NA	NA	NA	NA	NA
Chloride	NA	NA	NA	NA	NA
Hydrogen Sulfide as S	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA
Sulfate as SO4	NA	NA	NA	NA	NA
Total Alkalinity as CaCO3	NA	NA	NA	NA	NA
Semivolatile Organic Compounds					
in µg/L (ppb)					
Phenol	2 U	6 UB	1 U	2 UR	1 UR
4-Methylphenol	2 U	3 U	1 U	2 UR	1 UR
Benzoic acid	50 U	67 U	25 U	50 UR	25 UR
Napthalene	2 U	5 U	1 U	4 U	1 U
2-Methylnapthalene	2 U	3 U	1 U	2 U	1 U
Acenapthylene	2 U	3 U	1 U	2 U	1 U
Acenapthene	2 U	3 U	1 U	2 U	1 U
Dibenzofuran	2 U	3 U	1 U	2 U	1 U
Fluorene	2 U	3 U	1 U	2 U	1 U
Phenanthrene	2 U	3 U	1 U	2 U	1 U
Anthracene	2 U	3 U	1 U	2 U	1 U
Fluoranthene	2 U	3 U	1 U	2 U	1 U
Pyrene	2 U	3 U	1 U	2 U	1 U
Benzo(a)anthracene	2 U	3 U	1 U	2 U	1 U
Chrysene	2 U	3 U	1 U	2 U	1 U
Bis(2-ethylhexyl)phthalate	10 UB	3 U	7 UB	2 U	5 UB
Di-n-octyl phthalate	2 U	3 U	1 U	2 U	1 U
Benzo(b)fluoranthene	2 U	5 U	1 U	4 U	1 U
Benzo(k)fluoranthene	2 U	5 U	1 U	4 U	1 U
Benzo(a)pyrene	2 U	5 U	1 U	4 U	1 U
Indeno(1,2,3-cd)pyrene	2 U	5 U	1 U	4 U	1 U
Dibenzo(a,h)anthracene	2 U	5 U	1 U	4 U	1 U
Benzo(g,h,i)perylene	2 U	5 U	1 U	4 U	1 U

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	HC-25S	EPA-6I	EPA-6I	EPA-7S	EPA-7S
Date Sampled:	Dec 1990	Jan 1990	Dec 1990	Jan 1990	Dec 1990
Field Parameters					
pH	6.5	6.6	6.4	7.3	7.1
Temperature in °C	9.8	10	11.5	9	10.8
Specific Conductivity in μMhos	550	12,000	12,800	700	800
Dissolved Oxygen in ppm	1.6	NA	3.9	NA	3.0
Organophosphorous Pesticides					
in μg/L (ppb)	NA	NA	NA	NA	NA
Chlorinated Pesticides					
in μg/L (ppb)	NA	ND	NA	ND	NA
PCBs in μg/L (ppb)	NA	ND	NA	ND	NA
Chlorinated Herbicides					
in μg/L (ppb)					
2,4-DB	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA

OFA-GW.WK1

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	EPA-8I	EPA-8I (a)	EPA-8I	EPA-9S	EPA-9R
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Jan 1990
					Rep EPA-9S
Dissolved Metals					
in μg/L (ppb)					
Antimony	10 UJ	3 U	10 U	13 J	13 J
Arsenic	5 U	5 U	5.0 U	67	45
Arsenic (+3)	NA	NA	NA	NA	NA
Arsenic (+5)	NA	NA	NA	NA	NA
Beryllium	10 U	10 U	NA	10 U	10 U
Cadmium	10 U	10 U	1.0 U	10 U	10 U
Chromium	12	10 U	4.0	87	100
Chromium (+6)	NA	NA	NA	NA	NA
Copper	10 U	10 U	1.0 U	130	64
Iron	NA	NA	1,300 B	NA	NA
Lead	2 U	3 U	3 U	21	4.9
Manganese	310	NA	240 B	58	62
Mercury	1 U	1.0 U	1.0 U	2 U	1 U
Nickel	20 U	20 U	2.0 U	20 U	20 U
Selenium	5 U	5 U	NA	5 U	5 U
Silver	10 U	10 U	1.0 U	10 U	10 U
Thallium	5 UJ	2 U	NA	5 UJ	5 UJ
Zinc	28	10 U	6.0 UB	55	37
Volatile Organic Compounds					
in μg/L (ppb)					
Vinyl chloride	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U
Acetone	5 U	5 U	5 U	7 J	13 J
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U
2-Butanone (MEK)	3 U	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U
Benzene	1 U	1 U	1 U	9	8
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U	1 U
Miscellaneous Parameters					
in μg/L (ppb)					
Formaldehyde	R	NA	6.1	R	R

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	EPA-8I	EPA-8I (a)	EPA-8I	EPA-9S	EPA-9R
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Jan 1990
					Rep EPA-9S
Miscellaneous Parameters					
in mg/L (ppm)					
Total Dissolved Solids	11,000	11,000 J	10,000 J	3,700	3,500
Total Suspended Solids	NA	88 J	11 B	NA	NA
Fluoride	NA	NA	0.7	NA	NA
Hardness as CaCO3	NA	NA	NA	NA	NA
Calcium	NA	NA	NA	NA	NA
Chloride	NA	NA	NA	NA	NA
Hydrogen Sulfide as S	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA
Sulfate as SO4	NA	NA	NA	NA	NA
Total Alkalinity as CaCO3	NA	NA	NA	NA	NA
Semivolatile Organic Compounds					
in µg/L (ppb)					
Phenol	2 U	NA	1 U	8 U	8 U
4-Methylphenol	2 U	NA	1 U	15	14
Benzoic acid	50 U	NA	25 U	200 U	200 U
Napthalene	4 U	2.4 U	1 U	250	240
2-Methylnapthalene	2 U	NA	1 U	19	17
Acenapthylene	2 U	2.7 J	1 U	89	82
Acenapthene	3	2.4 U	2	250	250
Dibenzofuran	2 U	NA	1 U	8	8 U
Fluorene	2 U	0.31	1 U	61	61
Phenanthrene	8	1.6	1 U	200	200
Anthracene	3	1.2	1 U	29	29
Fluoranthene	6	2.0	1	63	66
Pyrene	7	4.3	1	84	84
Benzo(a)anthracene	2 U	0.72	1 U	12	12
Chrysene	2 U	0.92	1 U	13	13
Bis(2-ethylhexyl)phthalate	2 J	NA	2 UB	12 J	8 J
Di-n-octyl phthalate	2 U	NA	1 U	8 U	8 U
Benzo(b)fluoranthene	4 U	0.81	1 U	16 U	16 U
Benzo(k)fluoranthene	4 U	0.19	1 U	16 U	16 U
Benzo(a)pyrene	4 U	0.59	1 U	16 U	16 U
Indeno(1,2,3-cd)pyrene	4 U	0.39	1 U	16 U	16 U
Dibenzo(a,h)anthracene	4 U	2.6	1 U	16 U	16 U
Benzo(g,h,i)perylene	4 U	0.45	1 U	16 U	16 U

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	EPA-8I	EPA-8I (a)	EPA-8I	EPA-9S	EPA-9R
Date Sampled:	Jan 1990	Oct 1990	Dec 1990	Jan 1990	Jan 1990
					Rep EPA-9S
Field Parameters					
pH	6.7	NA	7.0	9.9	NA
Temperature in °C	12	14	12.3	10	NA
Specific Conductivity in μMhos	13,900	13,700	16,100	3,900	NA
Dissolved Oxygen in ppm	NA	5.5	2.2	NA	NA
Organophosphorous Pesticides					
in μg/L (ppb)	NA	NA	NA	NA	NA
Chlorinated Pesticides					
in μg/L (ppb)	ND	NA	NA	ND	ND
PCBs in μg/L (ppb)	ND	NA	NA	ND	ND
Chlorinated Herbicides					
in μg/L (ppb)					
2,4-DB	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA

OFA-OW.WK1

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	EPA-9S (a)	EPA-9S	EPA-10I	EPA-10I
Date Sampled:	Oct 1990	Dec 1990	Jan 1990	Dec 1990
Dissolved Metals				
in µg/L (ppb)				
Antimony	9	11	10 UJ	10 U
Arsenic	77	53	5 U	5.0 U
Arsenic (+3)	NA	31	NA	NA
Arsenic (+5)	NA	22	NA	NA
Beryllium	1 U	NA	10 U	NA
Cadmium	1 U	1.0 U	10 U	1.0 U
Chromium	170 B	88	14	21
Chromium (+6)	NA	690 R	NA	NA
Copper	160	31 B	10 U	1.0 U
Iron	NA	500 B	NA	4,100 BJ
Lead	69	43	2 U	3 U
Manganese	NA	26 B	240	110 B
Mercury	1.0 U	1.0 U	2 U	1.0 U
Nickel	30	8.0	20 U	2.0 U
Selenium	5 U	NA	5 U	NA
Silver	1 U	1.0 U	10 U	1.0 UJ
Thallium	2 U	NA	5 UJ	NA
Zinc	48 B	23 B	16	13 UB
Volatile Organic Compounds				
in µg/L (ppb)				
Vinyl chloride	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U
Acetone	5 U	5 U	8 J	5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U	1 U	1 U
2-Butanone (MEK)	3 U	3 U	3 U	3 U
Trichloroethene	1 U	1 U	1 U	1 U
Benzene	7	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U
Total Xylene	1 U	1 U	1 U	1 U
Miscellaneous Parameters				
in µg/L (ppb)				
Formaldehyde	NA	190	R	5.0 U

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	EPA-9S (a)	EPA-9S	EPA-10I	EPA-10I
Date Sampled:	Oct 1990	Dec 1990	Jan 1990	Dec 1990
Miscellaneous Parameters in mg/L (ppm)				
Total Dissolved Solids	3,700 J	3,500 J	7,800	6,800 J
Total Suspended Solids	50 J	13 B	NA	180
Fluoride	NA	3.2	NA	1
Hardness as CaCO3	NA	54	NA	1000
Calcium	NA	9.7	NA	NA
Chloride	NA	540 J	NA	NA
Hydrogen Sulfide as S	NA	11	NA	NA
Magnesium	NA	1.2	NA	NA
Sodium	NA	1,200	NA	NA
Sulfate as SO4	NA	17 J	NA	NA
Total Alkalinity as CaCO3	NA	1,800	NA	NA
Semivolatile Organic Compounds in µg/L (ppb)				
Phenol	NA	20 U	2 U	1 U
4-Methylphenol	NA	20 U	2 U	1 U
Benzoic acid	NA	500 U	50 U	25 U
Napthalene	72	210	4 U	1 U
2-Methylnapthalene	NA	20 U	2 U	1 U
Acenapthylene	93	79	2 U	1 U
Acenapthene	420	240	2 U	1 U
Dibenzofuran	NA	20 U	2 U	1 U
Fluorene	64	52	2 U	1 U
Phenanthrene	170	180	2 U	1 U
Anthracene	14	20 U	2 U	1 U
Fluoranthene	29	40	2 U	1 U
Pyrene	87	52	2 U	1 U
Benzo(a)anthracene	8.1	20 U	2 U	1 U
Chrysene	6.1	20 U	2 U	1 U
Bis(2-ethylhexyl)phthalate	NA	110 B	2 U	7 UB
Di-n-octyl phthalate	NA	20 U	2 U	1 U
Benzo(b)fluoranthene	6.2	20 U	4 U	1 U
Benzo(k)fluoranthene	1.5	20 U	4 U	1 U
Benzo(a)pyrene	4.5	20 U	4 U	1 U
Indeno(1,2,3-cd)pyrene	2.3	20 U	4 U	1 U
Dibenzo(a,h)anthracene	0.60 U	20 U	4 U	1 U
Benzo(g,h,i)perylene	2.6	20 U	4 U	1 U

Table C-10 - Summary of Ohio Ferro-Alloy/Pennwalt Area Groundwater Results

Sample Location:	EPA-9S (a)	EPA-9S	EPA-10I	EPA-10I
Date Sampled:	Oct 1990	Dec 1990	Jan 1990	Dec 1990
Field Parameters				
pH	NA	9.2	6.9	7.1
Temperature in °C	16	10.4	12	11.2
Specific Conductivity in μMhos	5,100	5,300	10,100	9,600
Dissolved Oxygen in ppm	4.3	1.5	NA	4.6
Organophosphorous Pesticides				
in μg/L (ppb)	NA	ND	NA	NA
Chlorinated Pesticides				
in μg/L (ppb)	NA	ND	ND	NA
PCBs in μg/L (ppb)	NA	ND	ND	NA
Chlorinated Herbicides				
in μg/L (ppb)				
2,4-DB	NA	9	NA	NA
Dinoseb	NA	4	NA	NA

OFA-GW.WK1

Table C-11 - Analytical Results for Phase I Soil Duplicate Samples

Sample Number:	HC-1/S-2	HC-1/S-5	RPD	HC-10S/S-1	HC-10S/S-7	RPD	SS-2	SS-17	RPD
Total Metals									
in mg/kg (ppm)									
Copper	12	9	28.6	51	62	-19.5	310	270	13.8
Nickel	4	4	NV	24	30	-22.2	270	31	158.8
Cadmium	0.6	0.6	NV	1.5	1.2	22.2	1.3	1.4	-7.4
Lead	12	10 U	NV	17	18	-5.7	130	10 U	NV
Chromium	14	12	15.4	32	31	3.2	110	95	14.6
Zinc	16	16	0	45	48	-6.5	310	290	6.7
Arsenic	3.2	3.2	0	28	33	-16.4	130	110	16.7
Mercury	0.1 U	0.1 U	NV	1.6	0.6	90.9	0.1 U	0.1 U	NV
Volatile Organics (EPA 8240)									
in µg/kg (ppb)									
2-Butanone	11	21	NV	NA	NA		NA	NA	
Methylene Chloride	2 U	2	NV	NA	NA		NA	NA	
Semivolatile Organics (EPA 8270)									
in µg/kg (ppb)									
None Detected	ND	ND	NV	NA	NA		NA	NA	
Chlorinated Phenols	ND	ND	NV	NA	NA		NA	NA	
PCBs	ND	ND		NA	NA		NA	NA	
Herbicides/Pesticides	NA	NA		NA	NA		NA	NA	
GC-FID Screen									
in µg/kg (ppb)	NA	NA		79,000	110,000	(33)	360,000 B	270,000 B	29

Notes:

NA Not analyzed.

ND Not detected.

NV Indicates RPD cannot be evaluated because at least one concentration value is below 5 times the detection limit.

SOILDUP.WK1/CLK

Table C-11 - Analytical Results for Phase I Soil Duplicate Samples

Sample Number:	SS-1	SS-18	RPD
Total Metals			
in mg/kg (ppm)			
Copper	78	72	8
Nickel	290	190	41.7
Cadmium	1.7	1.5	12.5
Lead	68	10 U	NV
Chromium	28	27	3.6
Zinc	440	360	20
Arsenic	46	45	2.2
Mercury	0.4	0.4	NV
Volatile Organics (EPA 8240)			
in µg/kg (ppb)			
2-Butanone	NA	NA	
Methylene Chloride	NA	NA	
Semivolatile Organics (EPA 8270)			
in µg/kg (ppb)			
None Detected	NA	NA	
Chlorinated Phenols	NA	NA	
PCBs	ND	ND	NV
Herbicides/Pesticides	ND	ND	NV
GC-FID Screen			
in µg/kg (ppb)	120,000 B	86,000 B	33

SOIL.DUP.WK1/CLK

Table C-12 - Analytical Results for Phase 1 Groundwater Replicate Samples

Sample Number:	HC-12S	HC-12R	RPD	HC-3I	HC-3R	RPD	EPA-9S	EPA-9R	RPD
Dissolved Metals in μg/L (ppb)									
Copper	ND	ND	NV	ND	ND	NV	130	64	68.0
Lead	ND	ND	NV	ND	ND	NV	21	4.9	NV
Chromium	ND	ND	NV	ND	ND	NV	87	100	-13.9
Zinc	ND	ND	NV	35	60	-52.6	55	37	39.1
Manganese	520	610	-15.9	770	810	-5.1	58	62	-6.7
Antimony	10 U	13 J	NV	ND	ND	NV	13 J	13 J	0.0
Arsenic	ND	ND	NV	ND	ND	NV	67	45	39.3
Volatile Organics (EPA 8240) in μg/L (ppb)									
Acetone	ND	ND	NV	5 U	8 J	NV	7 J	13 J	NV
Benzene	ND	ND		ND	ND		9	8	11.8
Toluene	ND	ND	NV	1 U	4	NV	1	1 U	NV
Semivolatile Organics (EPA 8270) in μg/L (ppb)									
4-Methylphenol	ND	ND		ND	ND		15	14	6.9
Napthalene	ND	ND		ND	ND		250	240	4.1
2-Methylnapthalene	ND	ND		ND	ND		19	17	11.1
Acenapthylene	ND	ND		ND	ND		89	82	8.2
Acenapthene	ND	ND		ND	ND		250	250	0.0
Dibenzofuran	ND	ND		ND	ND		8	8 U	NV
Fluorene	ND	ND		ND	ND		61	61	0.0
Phenanthrene	ND	ND		ND	ND		200	200	0.0
Anthracene	ND	ND		ND	ND		29	29	0.0
Fluoranthene	ND	ND		ND	ND		63	66	-4.7
Pyrene	ND	ND		ND	ND		84	84	0.0
Benzo(a)anthracene	ND	ND		ND	ND		12	12	0.0
Chrysene	ND	ND		ND	ND		13	13	0.0
Chlorinated Phenols in μg/L (ppb)	NA	NA		ND	ND		NA	NA	
PCBs in μg/L (ppb)	ND	ND		ND	ND		ND	ND	
Total Dissolved Solids in ppm	510	500	2.0	12000	11000	8.7	3700	3500	5.6

Notes:
NA Not analyzed.
ND Not detected.
NV Indicates RPD cannot be evaluated because at least one concentration value is below 5 times the detection limit.

GWREP.WK1/CLK

Appendix D

APPENDIX D
DETERMINATION OF LOCAL SOIL AND GROUNDWATER REFERENCE CONCENTRATIONS

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APPENDIX D
DETERMINATION OF LOCAL SOIL AND GROUNDWATER REFERENCE CONCENTRATIONS

Determination of Local Soil Reference Concentrations

The purpose of establishing local soil reference concentrations for metals was to provide a comparison of sample metal concentrations to concentrations of metals in "natural" or non-contaminated soils. The concentrations of trace metals in natural soils depend on the composition of the soil's source material, climatic conditions, exposure to biological activity, and many other factors. The natural variability of metal concentrations in soils makes it difficult to determine if industrial or agricultural activities have altered the composition of soils. The establishment of local soil reference concentrations provides a more representative means for comparing natural soil quality found on the site to soils potentially impacted by industrial activity.

The establishment of "natural" soil reference concentrations on the Blair Backup property is complicated by the fact that much of the soils sampled on the property were fill materials dredged from the surrounding waterways. Because of the historical industrial activities conducted along the waterways, the quality of these fill materials may differ from similar soils not exposed to past industrial activity. In addition, soil quality in reference areas not known to have been exposed to on-site activities may have been impacted by off-site activities.

Given these limitations, we selected reference sampling locations on the Blair Backup property based on the following criteria:

- Not known to be impacted by on-site or off-site activities;
- Does not contain fill materials with construction debris, slag, or other man-made materials; and
- Soil type is similar to areas of interest.

Based on this criteria, we selected the northwestern portion of the site excluding samples collected in the Recent Fill Area and the Alexander Avenue Strip Area. Sampling locations are shown on Figure D-1 and

Table D-4 presents analytical results for metals analysis of these samples.

Eight soil samples were used to establish local soil reference concentrations. A variety of statistical methods exist to determine reference concentrations. EPA Region 10 developed a procedure for establishing reference concentrations using the average concentration plus two standard deviations. For inorganic constituents, a log normal distribution is assumed. It is difficult to apply this method to concentrations at or below the detection limit. The simplest statistical approach to establishing reference concentrations is to use the average concentration of the reference samples. However, this method was not considered because using the average concentration as the reference concentration would mean that approximately 25 to 75 percent of the reference soil samples would exceed the reference concentration. The maximum metal concentration in the reference samples could also be used as the reference concentration. This method is the least conservative of the three statistical methods.

We chose to modify EPA's procedure and determine reference concentrations using Land's equation for determining the upper 95 percent confidence limit for a log normal distribution (Gilbert, 1987). For non-detected values, one-half the detection limit was used in the calculations except for metals in which 50 percent or more of the values were not detected (lead, mercury, and cadmium). For lead, cadmium, and mercury, the detection limits were used for non-detected values to determine the mean of the sample population.

Local soil reference values for the Blair Backup property were compared to soil background values determined in other studies (Table D-1). Two of the studies were conducted in the Puget Sound Area (Pevear, 1981 and Harper-Owes, 1985) and the third included data collected in the western United States (Shacklette and Boerngen, 1984). Blair Backup property local reference concentrations were typically lower than the background levels reported in the other three studies.

Determination of Local Groundwater Reference Concentrations

Ten wells were sampled to provide local reference concentrations for formaldehyde and dissolved metals in shallow and intermediate aquifer units located in the Port of Tacoma industrial area. The ten wells were

selected based upon accessibility, location relative to properties of interest, lack of exposure to local industrial activity, and depth of screened interval. Wells in the area between the Puyallup River and the upland bounding Marine View Drive were targeted because they lie within the same regional hydrogeologic system as the properties of interest. For the purposes of this work, the shallow aquifer system is defined as saturated units occurring at depths of less than 10 to 15 feet below ground surface. Saturated units occurring at depths of approximately 25 to 75 feet below ground surface comprise the Intermediate Aquifer system.

Groundwater Sampling Locations

The wells sampled as part of this study are listed below and summarized in Table D-2. Also listed below are the purposes for which these wells were originally installed. The locations of these wells are shown on Figure D-2.

- Wells MW-1, MW-1A, and MW-2 were installed in the Intermediate Aquifer system by the Port of Tacoma to monitor groundwater quality upgradient of the proposed Milwaukee Waterway fill project;

- Wells MP-1 and MP-2 were installed in the Intermediate Aquifer system for the specific purpose of this task, in an undeveloped parcel of land south of East-West Road property;

- Well HC-4 was installed on a Shell Service Station site in Fife to verify that intermediate groundwater quality at this location had not been impacted by hydrocarbon releases;

- Taylor Way wells TW-1, TW-2, and TW-3 were installed in the Intermediate Aquifer system as part of a property transfer investigation of an undeveloped site located near the intersection of Taylor Way and East-West Road; and

- Occidental Chemical Corporation well B-10A was installed in the Shallow Aquifer system south of the Petarcek sludge disposal area - the groundwater quality in the well has not been shown to be impacted by contaminants associated with the sludge materials.

Chemical Analyses of Groundwater Samples

The wells were sampled and analyzed for selected dissolved metals (As, Cd, Cr, Cu, Pb, Mn, Ni, and Zn), formaldehyde, total dissolved solids, and total suspended solids. Groundwater pH, temperature, conductivity, and dissolved oxygen were measured in the field at the time of sampling. These specific sample results are presented in Table D-5. A statistical summary of these data are presented in Table D-3.

Table D-1 - Summary of Port of Tacoma Local Soil Reference and Background Concentrations

	Blair Backup Geometric Mean Soil Reference Concentration	Blair Backup Upper 95th Reference Limit (p)	Puget Sound Mean Soil Background (q)	Western U.S. Mean Soil Background (r)	Pilchuck Farm Median Soil Background (s)
Total Metals in mg/kg (ppm)					
Arsenic	2.0	4.1	100 U	5.5	13.4
Cadmium	0.6	1.1	7 U	---	0.3
Chromium	14.2	17.6	80	41	47
Copper	14.2	22.4	20	21	13.2
Lead	10	10	15	17	25.4
Mercury	0.1 U	0.1 U	---	0.05	0.14
Nickel	4.8	16.2	80	15	42.4
Zinc	22.0	27.3	80	55	56

Note: Data qualifiers and cross references are presented in Table 6.

TBL5-4.WK1

Table D-2 – Reference Well Data

Well Number	Well Location	Water Level Elevation in Feet	Depth of Well in Feet	Screened Interval in Feet
TW-1	Taylor Way	13.05	13	7 – 13
TW-2	Taylor Way	13.59	8.5	3 – 8.5
TW-3	Taylor Way	14.84	11	5 – 11
MP-1	East-West Road Reference Well	11.61	36	25 – 36
MP-2	East-West Road Reference Well	11.19	47.5	41.5 – 47.5
MW-1	Milwaukee Waterway	12.92	30	18 – 30
MW-1A	Milwaukee Waterway	12.24	75	62 – 75
MW-2	Milwaukee Waterway	11.26	46	32 – 46
HC-4	Shell – Fife	1.5 (DTW)	36	28.5 – 36
B-10A	Petarsec Site	94.28	8	2 – 8

Note:
DTW Depth to water below top of casing.

TBLD-2.WK1/CLK

Table D-3 – Summary of Port of Tacoma Local Groundwater Reference Concentrations

	Detection Frequency	Minimum Value	Maximum Detection	Location of Maximum	Upper 95th Confidence Limit of the Mean (a)
Dissolved Metals					
in µg/L (ppb)					
Antimony	4/10	4 U	14	MP-1	7
Arsenic	2/10	5 U	7	TW-10/TW-20	5
Cadmium	1/10	5 U	24	MP-1	10
Chromium	2/10	10 U	25	TW-1	12
Copper	3/10	2.9 U	38	TW-10	19
Lead	0/10	3 U	---		1.5
Manganese	10/10	77	7,900	TW-2	4,570
Nickel	0/10	7.1 U	---		10
Zinc	7/10	10 U	110	TW-1	60
Field Parameters					
pH	9/9	6.7	8	MW-1A	---
Specific Conductivity in µmhos/cm	9/9	390	6,900	MP-1	---
Temperature in °C	9/9	10.9	14	MW-1	---
Dissolved Oxygen in mg/L	9/9	1.9	6	MW-1	---
Miscellaneous Parameters					
in mg/L (ppm)					
Formaldehyde	7/10	0.005 U	0.06	MP-1	0.030
Total Dissolved Solids	10/10	220	4,000	MP-1	---

Note: Data qualifiers and cross references are presented in Table 6.

REFST.WK1

Table D-4 - Port of Tacoma Soil Reference Sample Results

Sample Location:	HC-1S/S-2	HC-3S/S-2	HC-13S/S-2	HC-14S/S-1	TP-101/S-1	TP-102/S-2	TP-103/S-2	TP-104/S-1
Date Sampled:	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989	Dec 1989
Sample Depth in Feet:	5.0 to 6.5	5.0 to 6.5	5.0 to 6.5	2.5 to 4.0	2.0 to 3.0	7.0 to 8.0	8.0 to 9.0	2.0 to 3.0
Total Metals in mg/kg (ppm)								
Arsenic	3.2	3.1	2.6	3.4	1.8	1	3.7	0.5 U
Cadmium	0.6	1	0.6	0.9	0.5 U	0.5 U	0.5 U	0.5 U
Chromium	14	12	17	16	10 B	13 B	22 B	14 B
Copper	12	8	16	18	17	14	30	9
Lead	12	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Mercury	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	4	4	8	10	4.3	2.8	12	2 U
Zinc	16	17	23	26	18 B	14 B	36 B	21 B

Notes:

U Compound was analyzed for but not detected at the given detection limit.

B Analyte was detected in laboratory method blank.

TBLF1.WK1/CLK

Table D-5 - Port of Tacoma Groundwater Reference Sample Results

Sample Number:	MW-1	MW-1A	MW-2	MP-1	MP-2
Well Location:		Milwaukee Waterway		South of East-West Property	
Dissolved Metals in μg/L (ppb)					
Antimony	4 U	4 U	4 U	14	5.6
Arsenic	5 U	5 U	5 U	5.0 U	5.0 U
Cadmium	5 U	5 U	5 U	24	10 U
Chromium	10 U	10 U	10 U	10 U	10 U
Copper	2.9 U	2.9 U	6.5	10 U	10 U
Lead	3 U	3 U	3 U	3 U	3 U
Manganese	440	790	77	2,900	2,100
Nickel	7.1 U	7.1 U	7.1 U	20 U	20 U
Zinc	10 U	10	10 U	43	54
Field Parameters					
pH	7.1	8.1	7.7	6.8	6.7
Specific Conductivity in μmhos/cm	1,160	2,600	520	6,900	5,400
Temperature in °C	14.1	12.5	13.0	12.2	10.9
Dissolved Oxygen in mg/L	6.1	2.7	2.8	4.4	2.8
Miscellaneous Parameters in mg/L (ppm)					
Formaldehyde	0.0058	0.005 U	0.005 U	0.06	0.033
Total Dissolved Solids	650	1,600	340	4,000	3,300

REF-GW.WK1

Table D-5 - Port of Tacoma Groundwater Reference Sample Results

Sample Number:	HC-4	TW-1	TW-2	TW-3	B-10A
Well Location:	Fife Shell Service Station	Taylor Way			Oxychem
Dissolved Metals in µg/L (ppb)					
Antimony	5.0 U	5.4	6.7	5.0 U	5.0 U
Arsenic	5.0 U	7.0	7.0	5.0 U	5.0 U
Cadmium	10 U	10 U	10 U	10 U	10 U
Chromium	10 U	25	10 U	13	10 U
Copper	10 U	38	10 U	32	10 U
Lead	3 U	3 U	3 U	3 U	3 U
Manganese	220	6,500	7,900	5,900	610
Nickel	20 U	20 U	20 U	20 U	20 U
Zinc	10 U	110	23	71	53
Field Parameters					
pH	7.5	6.8	7.1	6.9	NA
Specific Conductivity in µmhos/cm	420	780	610	390	NA
Temperature in °C	13.1	12.3	12.9	12.1	NA
Dissolved Oxygen in mg/L	1.9	2.3	2.5	4.8	NA
Miscellaneous Parameters in mg/L (ppm)					
Formaldehyde	0.0085	0.044	0.014	0.018	0.005 U
Total Dissolved Solids	220	460	450	240	1,900

Notes:

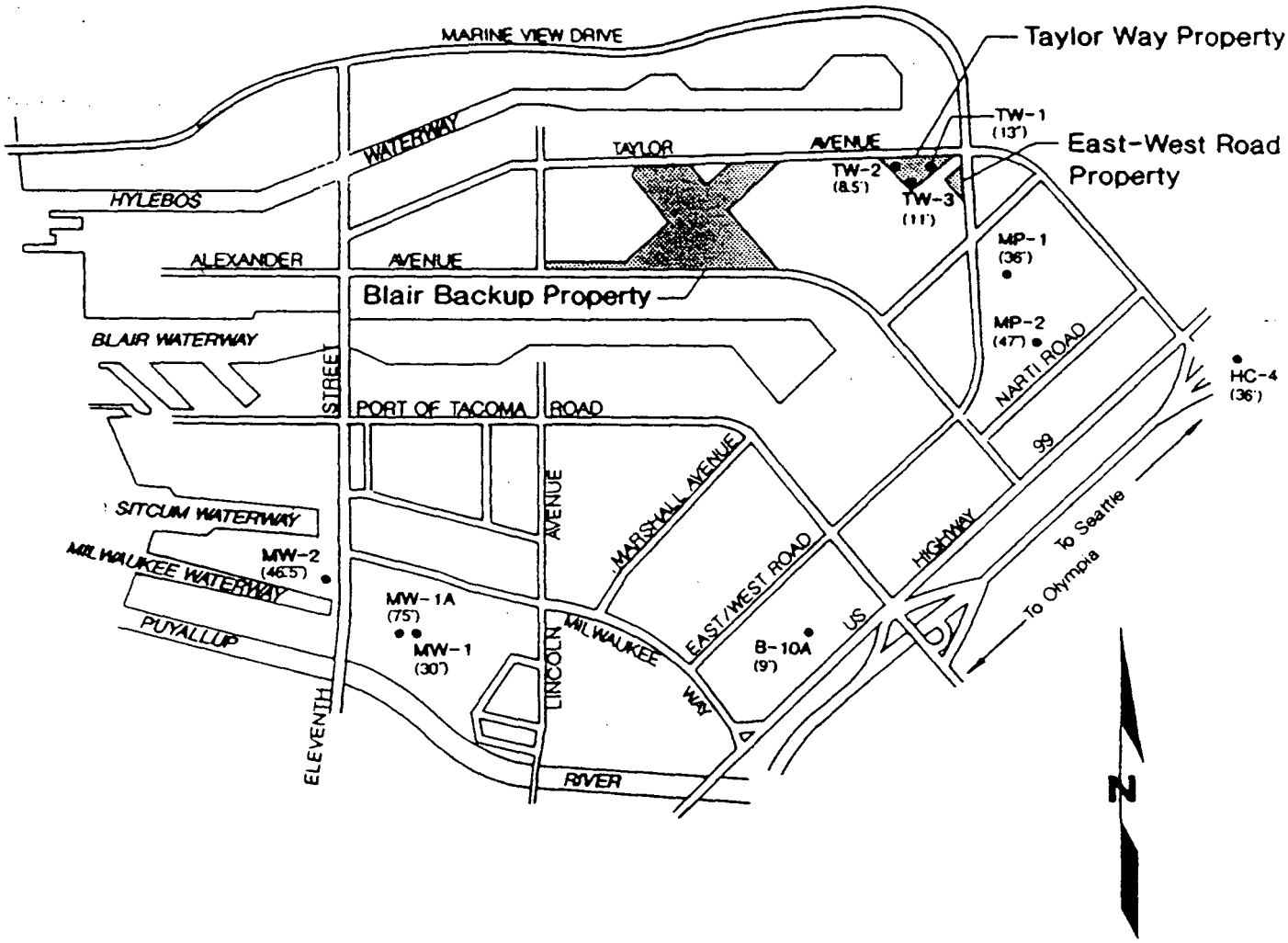
U Indicates compound was analyzed for but not detected at the given detection limit.

NA Not analyzed.

REF-GW.WK1

Location Map

Local Reference Monitoring Wells



NOT TO SCALE

• MW-1 Monitoring Well Location and Number (Location is Approximate)

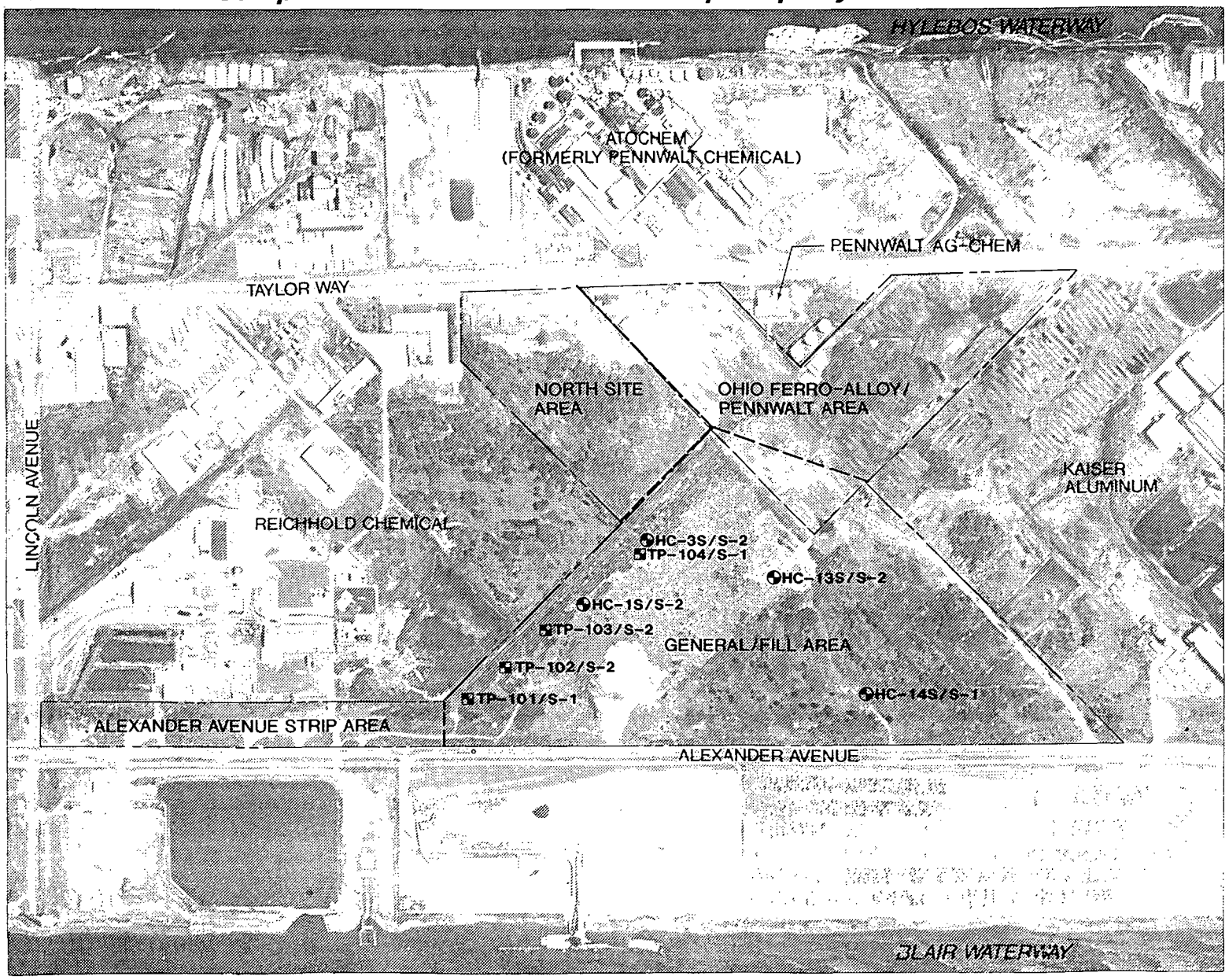
(30') Monitoring Well Depth in Feet

HARTCROWSER

J-2350-07 8/91

Figure D-2

Reference Soil Sample Location Plan – Blair Backup Property



HC-1S/S-2 Monitoring Well Location and Number

TP-101/S-1 Test Pit Location and Number

Note: Base map prepared from aerial photograph of the Port of Tacoma dated June 1, 1989.

N

0 400 800
Scale in Feet

HARTCROWSER
J-2350-07 8/91
Figure D-1

Appendix E

APPENDIX E
ASBESTOS TESTING
BLAIR BACKUP PROPERTY

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FIGURE

E-1 Asbestos Sampling Location Plan

ATTACHMENT E-1
BULK SAMPLE DATA SHEETS
ASBESTOS
PREZANT ASSOCIATES, INC.

APPENDIX E
ASBESTOS TESTING
BLAIR BACKUP PROPERTY

During our site reconnaissance, we discovered and subsequently verified the presence of asbestos on the Blair Backup property. A cement asbestos drainage pipe was discovered adjacent to the wood structure used as an office space on the site and the electrical equipment building is constructed of corrugated cement asbestos board.

The building components are in good condition at this time. The drainage pipe is deteriorated and crushed at several locations. Most of the pipe does not have adequate cover material to protect it from further damage.

We obtained samples of these materials and analyzed them for asbestos content.

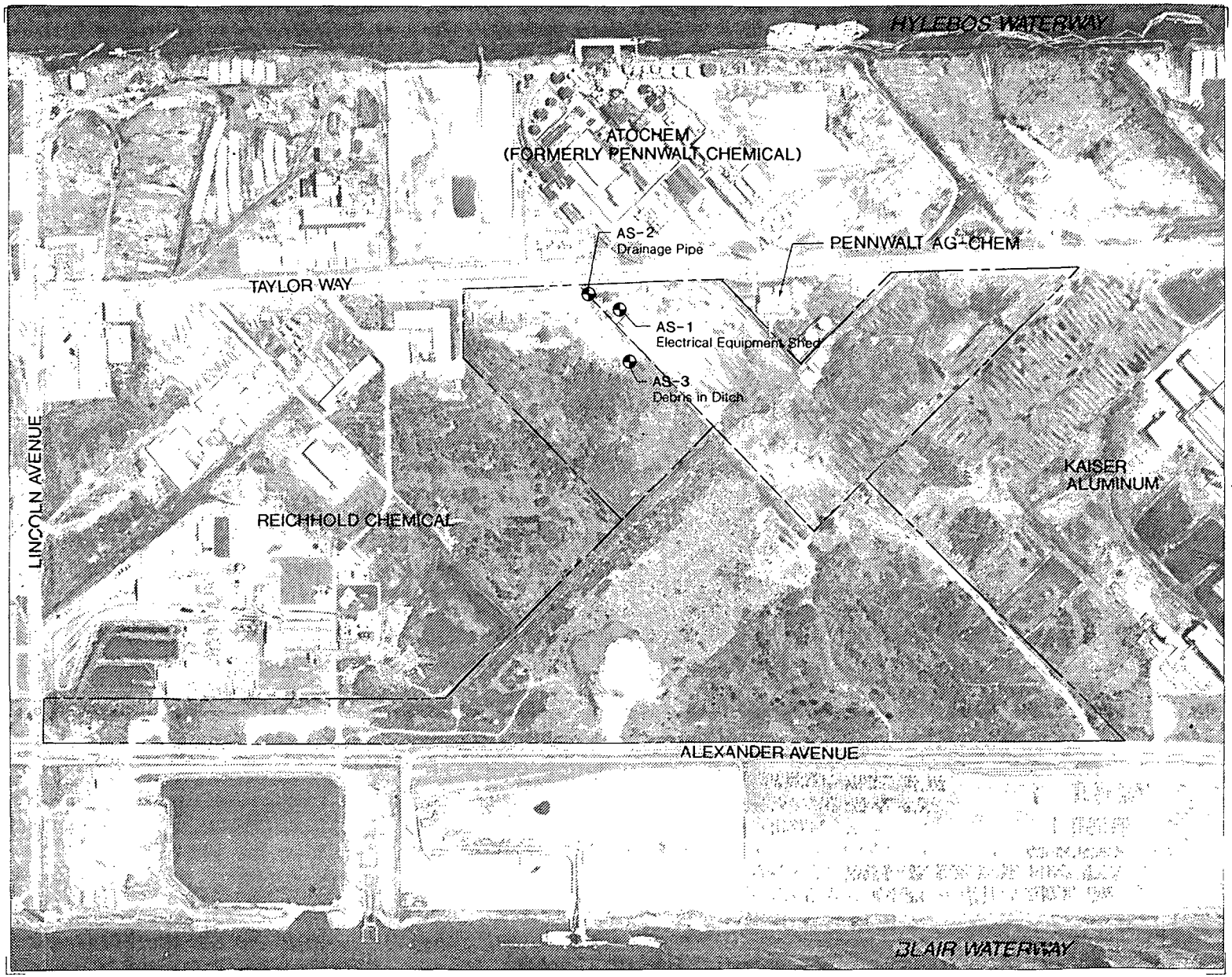
We obtained samples from the building, drainage pipe, and fiber-containing debris nearby (Figure E-1) for asbestos analysis. These analyses confirmed the presence of asbestos in the building materials and drainage pipe. The debris contained no measurable asbestos (see laboratory reports in this appendix).

According to current State of Washington Department of Labor and Industries interpretations, this material is considered friable if broken, drilled, ground, or abraded. Additionally, work which would disturb this material is required to be completed by certified asbestos workers, including demolition. Washington Administrative Code WAC 296-62-07723 Housekeeping, paragraph 8, was a requirement that damaged or deteriorated asbestos containing material be repaired, enclosed, encapsulated, or removed. This section would apply to the CA pipe identified earlier.

During our site reconnaissance, we noted that the abandoned house had suspect asbestos-containing materials incorporated into its structure. Depending upon the ultimate disposition of this building, and the other buildings on the property, a good faith survey as required in the WAC 296-62-07707 Identification should be completed. If demolition of the structure is to occur, the regulated asbestos-containing materials, if any,

must be removed prior to demolition in accordance with the EPA's National Emissions Standards for Hazardous Air Pollutants (NESHAP) and local enforcement by the Puget Sound Air Pollution Control Agency (PSAPCA). There are waiting periods and permit fees associated with PSAPCA permits for asbestos abatement.

Asbestos Sampling Location Plan



AS-1 Asbestos Sample Location and Designation

Note: Base map prepared from aerial photograph of the Port of Tacoma dated June 1, 1989.

N

0 400 800

Approximate Scale in Feet

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J-2350-07 5/91

Figure E-1

ATTACHMENT E-1
BULK SAMPLE DATA SHEETS
ASBESTOS
PREZANT ASSOCIATES, INC.

PREZANT ASSOCIATES INC.

711 6th Ave. North, Suite 200, Seattle, WA 98109
ENVIRONMENTAL HEALTH SCIENCES AND ENGINEERING (206)281-8858

BULK SAMPLE DATA SHEET - ASBESTOS

Invoice number: 90 - 92.00
Number of samples: 3

Client: Hart Crowser
Address: 1910 Fairview Ave East
Seattle, WA

REGULAR

Project: J2350-04

Sample Location:

Sample #: AS-1
Lab #: 9001243

Sample Description: White wavy fiber bundles embedded in gray cement

NON-ASBESTOS NON-FIBROUS COMPONENTS: TOTAL: 40 %

40% Cement

% NON-ASBESTOS FIBROUS COMPONENTS TOTAL: ND %

% ASBESTOS COMPONENTS TOTAL: 60 %

60% Chrysotile

TOTAL ASBESTOS: 60 %

Sampled by:	Client	Date: 1/25/90	Heather Meeds
Analyzed by:	Heather Meeds	Date: 1/26/90	
QC By:	Heather Meeds	Date: 1/26/90	Heather Meeds, Laboratory Director

If samples were inhomogonous, then subsamples of the componants were analyzed.
All bulk samples are analyzed using test method 40 CFR ch. I (1-1-87 edition) Pt 763, Subpt. F App. A, pages 293-299.
This report relates only to the items tested.
If samples were not collected by Prezant Assoc. personnel, then accuracy of the results is limited by the methodology and acuity of the sample collector.
Analyses are cross-checked with other technicians in-house and other laboratories for quality assurance and verification.

PREZANT ASSOCIATES INC.

711 6th Ave. North, Suite 200, Seattle, WA 98109
ENVIRONMENTAL HEALTH SCIENCES AND ENGINEERING (206)281-885

BULK SAMPLE DATA SHEET - ASBESTOS

Invoice number: 90 - 92.00
Number of samples: 3

Client: Hart Crowser
Address: 1910 Fairview Ave East
Seattle, WA

REGULAR

Project: J2350-04

Sample Location:

Sample #: AS-2
Lab #: 9001244

Sample Description: Straight white and blue fiber bundles in a hard brown binder

NON-ASBESTOS NON-FIBROUS COMPONENTS:
40% Binder

TOTAL: 40 %

% NON-ASBESTOS FIBROUS COMPONENTS

TOTAL: ND %

% ASBESTOS COMPONENTS
30% Heated amosite
30% Crocidolite

TOTAL: 60 %

TOTAL ASBESTOS: 60 %

Sampled by:	Client	Date: 1/25/90	
Analyzed by:	Heather Meeds	Date: 1/26/90	Heather Meeds, Laboratory Director
QC By:	Heather Meeds	Date: 1/26/90	

If samples were inhomogonous, then subsamples of the componants were analyzed.
All bulk samples are analyzed using test method 40 CFR ch. I (1-1-87 edition) Pt 763, Subpt. F App. A, pages 293-299.
This report relates only to the items tested.
If samples were not collected by Prezant Assoc. personnel, then accuracy of the results is limited by the methodology and acuity of the sample collector.
Analyses are cross-checked with other technicians in-house and other laboratories for quality assurance and verification.

PREZANT ASSOCIATES INC.

711 6th Ave. North, Suite 200, Seattle, WA 98109
ENVIRONMENTAL HEALTH SCIENCES AND ENGINEERING (206)281-8858

BULK SAMPLE DATA SHEET - ASBESTOS

Invoice number: 90 - 92.00
Number of samples: 3

Client: Hart Crowser
Address: 1910 Fairview Ave East
Seattle, WA

REGULAR

Project: J2350-04

Sample Location:

Sample #: AS-3
Lab #: 9001245

Sample Description: Clear straight fiber bundles embedded in gray glue

NON-ASBESTOS NON-FIBROUS COMPONENTS: TOTAL: 35 %
35% Glue

% NON-ASBESTOS FIBROUS COMPONENTS TOTAL: 65 %
65% Mineral wool

% ASBESTOS COMPONENTS TOTAL: ND %
No detectable asbestos

TOTAL ASBESTOS: ND %

Sampled by:	Client	Date: 1/25/90	Heather Meeds
Analyzed by:	Heather Meeds	Date: 1/26/90	
QC By:	Heather Meeds	Date: 1/26/90	Heather Meeds, Laboratory Director

If samples were inhomogonous, then subsamples of the componants were analyzed.
All bulk samples are analyzed using test method 40 CFR ch. I (1-1-87 edition) Pt 763, Subpt. F App. A, pages 293-299.
This report relates only to the items tested.
. samples were not collected by Prezant Assoc. personnel, then accuracy of the results is limited by the methodology and acuity of the sample collector.
Analyses are cross-checked with other technicians in-house and other laboratories for quality assurance and verification.

Appendix F

APPENDIX F
MISCELLANEOUS SITE ACTIVITY REPORTS

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APPENDIX F
MISCELLANEOUS SITE ACTIVITY REPORTS

This appendix presents the results of miscellaneous site activities conducted by Hart Crowser during our study of the Blair Backup property. The appendix is divided into a series of attachments each presenting separate findings.

Attachment F-1 presents the results of the nuisance material survey conducted on the Blair Backup property and includes a map (Figure F-1-1) depicting the locations of nuisance materials encountered at the property. The Work Plan for removal of these nuisance materials has been prepared (Hart Crowser, 1991b).

Attachment F-2 presents the results of geochemical analyses conducted on samples of slag material collected on the property. Reports prepared by Russell M. Honea and Cone Geochemical Inc. are included as part of the attachment.

Attachment F-3 presents the results of Hart Crowser's investigation of a subsurface structure located in the Ohio Ferro-Alloy Area of the Blair Backup property as depicted on Figure F-3-1. The attached memorandum dated October 12, 1990, presents our findings including a sketch (Figure F-3-2) and photographs of this structure.

Attachment F-4 is a copy of the GeoEngineers, Inc. report dated March 15, 1990, concerning the removal of underground storage tank located adjacent to Taylor Way in the vicinity of the Blair Backup property. This report has been included at the request of the Port of Tacoma. Hart Crowser cannot be responsible for its completeness or accuracy.

ATTACHMENT F-1
NUISANCE MATERIAL SURVEY

ATTACHMENT F-1
NUISANCE MATERIAL SURVEY

Hart Crowser defined the locations of nuisance materials on the Blair Backup property as shown on Figure F-1-1. Tables F-1-1 and F-1-2 present the results of chemical analysis of sandblast waste samples from the General/Fill Area and North Site Area, respectively.

Table F-1-1 Summary of Analytical Results for General/Fill Area Sandblast Waste Sample

Sample Location:	SS-9 Fill	MTCA Method A Soil Cleanup Level - Industrial Compliance (g)	MTCA Method C Soil Cleanup Level - Industrial Direct Contact (g)
Date Sampled:	Dec 1989		
Sample Depth in feet:	0.0 - 0.25		
Total Metals			
in mg/kg (ppm)			
Arsenic	7.2	200	190
Cadmium	6.7	10	1,800
Chromium	66	500	18,000 (h)
Copper	1,400	---	>>
Lead	1,100	1,000	---
Mercury	0.1 U	1	1,000
Nickel	24	---	70,000
Zinc	280	---	>>
Miscellaneous Paramters			
in mg/kg (ppm)			
GC-FID Screen	110 B	---	---

Note: Data qualifiers and cross references are presented in Table 6.

GNLSND.WK1

Table F-1-2 - Statistical Summary and MTCA Exceedences in North Site Area Sandblast Waste Samples

	Detection Frequency	Maximum Detection	Location of Maximum	Average	Upper 95th Confidence Limit of the Mean (a)	MTCA Method A Soil Cleanup Level - Industrial Compliance (g)	Number of Samples Exceeding Levels/ Number Analyzed	MTCA Method C Soil Cleanup Level - Industrial Direct Contact (g)	Number of Samples Exceeding Levels/ Number Analyzed
Total Metals									
in mg/kg (ppm)									
Arsenic	3 / 3	760	SS-4	397.	912.	200	2 / 3	190	2 / 3
Cadmium	3 / 3	20	SS-5	10.8	21.7	10	1 / 3	1,800	0 / 3
Chromium	3 / 3	2,700	SS-6	1653	3480	500	2 / 3	18,000 (h)	0 / 3
Copper	3 / 3	2,600	SS-5	1486	2864	---	---	>>	0 / 3
Lead	3 / 3	1,200	SS-4	836.	1269	1,000	1 / 3	---	---
Mercury	0 / 3	0.1 U				1	0 / 3	1,000	0 / 3
Nickel	3 / 3	1,100	SS-4	702.	1533	---	---	70,000	0 / 3
Zinc	3 / 3	8,200	SS-5	4200	8986	---	---	>>	0 / 3
Semivolatile Organic Compounds									
in mg/kg (ppm)									
Napthalene	1 / 1	4	SS-4			---	---	14,000	0 / 1
2-Methylnapthalene	1 / 1	0.8	SS-4			---	---	>>	0 / 1
Acenapthylene	0 / 1	0.04 U				---	---	>>	0 / 1
Acenapthene	1 / 1	3	SS-4			---	---	210,000	0 / 1
Dibenzofuran	1 / 1	0.6	SS-4			---	---	>>	0 / 1
Fluorene	1 / 1	3	SS-4			---	---	140,000	0 / 1
Phenanthrene	1 / 1	9 D	SS-4			---	---	>>	0 / 1
Anthracene	1 / 1	3 D	SS-4			---	---	>>	0 / 1
Fluoranthene	1 / 1	50 D	SS-4			---	---	140,000	0 / 1
Pyrene	1 / 1	40 D	SS-4			---	---	105,000	0 / 1
Benzo(a)anthracene	1 / 1	2 D	SS-4			---	---	---	---
Chrysene	1 / 1	7 D	SS-4			---	---	---	---
Bis(2-ethylhexyl)phthalate	0 / 1	0.05 UB				---	---	9,400	0 / 1
Di-n-octyl phthalate	1 / 1	0.06 B	SS-4			---	---	---	---
Benzo(b)fluoranthene	1 / 1	70 TD	SS-4			---	---	---	---
Benzo(k)fluoranthene	1 / 1	70 TD	SS-4			---	---	---	---
Benzo(a)pyrene	1 / 1	3 D	SS-4			---	---	---	---
Indeno(1,2,3-cd)pyrene	1 / 1	4	SS-4			---	---	---	---
Dibenzo(a,h)anthracene	1 / 1	2	SS-4			---	---	---	---
Benzo(g,h,i)perylene	1 / 1	7	SS-4			---	---	>>	0 / 1
Carcinogenic PAHs									
in mg/kg (ppm)	1 / 1	88	SS-4			20	1 / 1	10	1 / 1

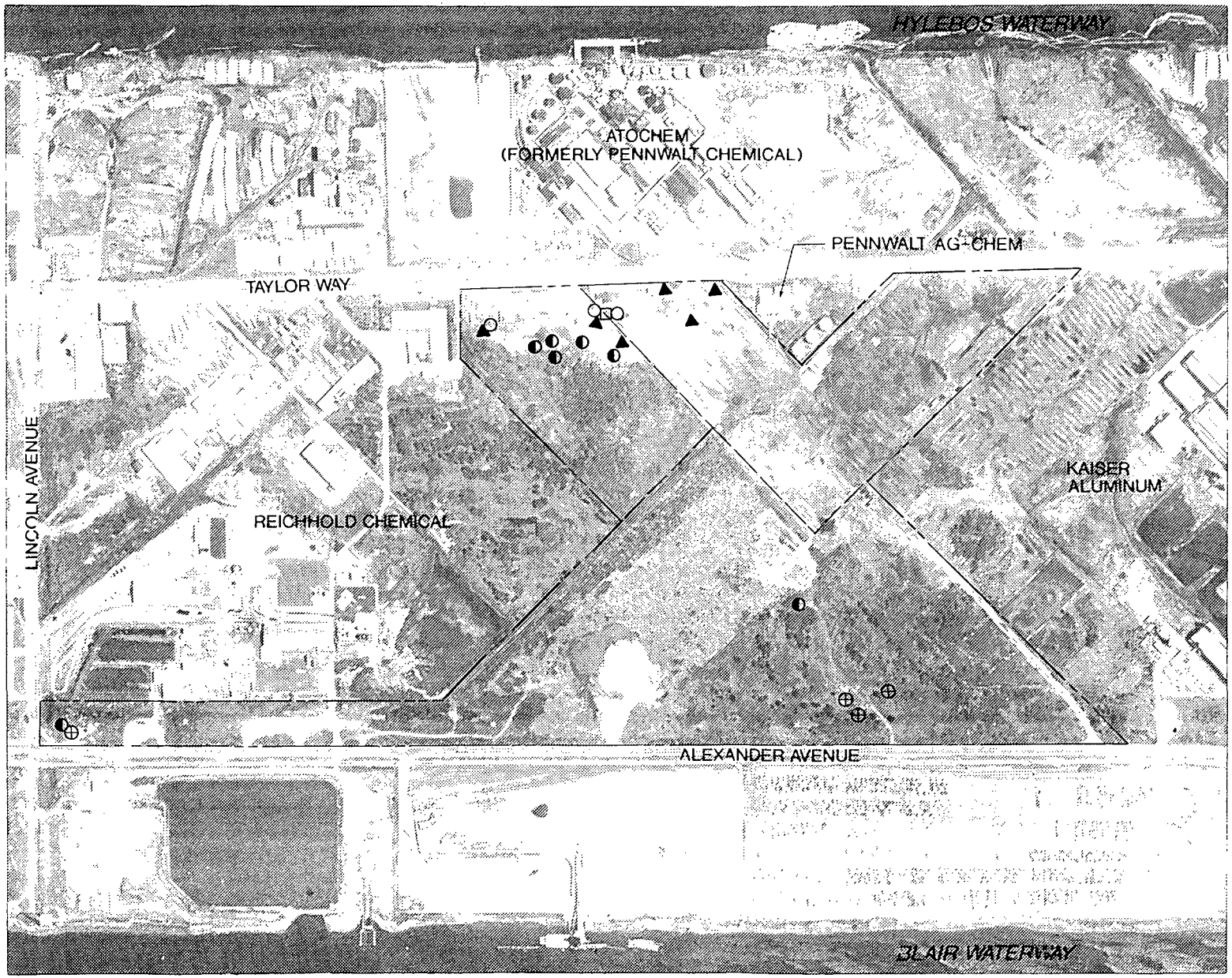
Table F-1-2 - Statistical Summary and MTCA Exceedences in North Site Area Sandblast Waste Samples

	Detection Frequency	Maximum Detection	Location of Maximum	Average	Upper 95th Confidence Limit of the Mean (a)	MTCA Method A Soil Cleanup Level - Industrial Compliance (g)	Number of Samples Exceeding Levels/ Number Analyzed	MTCA Method C Soil Cleanup Level - Industrial Direct Contact (g)	Number of Samples Exceeding Levels/ Number Analyzed
EP Tox Metals						Dangerous			
in mg/L (ppm)						Waste Limites (i)			
Arsenic	1 / 2	0.4 J	SS-6	0.25		5.0	0 / 2	---	---
Barium	2 / 2	0.4	SS-6	0.3	0.74	100.0	0 / 2	---	---
Cadmium	1 / 2	0.02	SS-6	0.01		1.0	0 / 2	---	---
Chromium	0 / 2	0.1 UJ				5.0	0 / 2	---	---
Copper	2 / 2	1.8 J	SS-6	1.1	4.22	---	---	---	---
Lead	0 / 2	0.1 UJ				5.0	0 / 2	---	---
Mercury	0 / 2	0.005 U				0.2	0 / 2	---	---
Nickel	2 / 2	0.6	SS-4	0.4	1.29	---	---	---	---
Zinc	2 / 2	6.4 J	SS-6	4	14.7	---	---	---	---
Miscellaneous Parameters									
in mg/kg (ppm)									
GC-PID Screen	2 / 3	510 B	SS-4	230.	573.	---	---	---	---

Note: Data qualifiers and cross references are presented in Table 6.

NSASND.WK1

Nuisance Material Removal Locations



Nuisance Material Removal
Work Scope Outline

Item	Symbol	Estimated Quantity	Description
1	◐	20 Cubic Yards	Sandblast Grit and Associatec Soil and or Debris
2	▲	10 Units	Drums of 55 Gallon or Smaller Containing Oily Waste Materials
3	○	10 Cubic Yards	Soil Visibly Stained with Oil
4	⊕	30 Cubic Yards	Household Waste and Demolition Debris
5	I	200 Feet	Asbestos Pipe (40% Non-Asbestos, 30% Heated Amosite, 30% Crocidolite) Buried in Soil
6	□	160 Square Feet	Asbestos Board (Corrugated, 40% Cement, 60% Chrysotile and Associated Debris

N

0 400 800
Scale in Feet

HARTCROWSER
J-2350-07 6/91
Figure F-1-1

ATTACHMENT F-2
SLAG GEOCHEMICAL ANALYTICAL ASSESSMENT

ATTACHMENT F-2
SLAG GEOCHEMICAL ANALYTICAL ASSESSMENT

Hart Crowser collected seven discrete slag or ore samples from the OFA/Pennwalt Area and submitted them for geochemical analyses. A mineralogical assessment of the samples using the X-ray powder diffraction technique was performed by Russell M. Honea, a consulting geologist based in Bloomfield, Colorado. Results of his work are presented in the attached letter dated March 1, 1990. Whole-rock geochemical analysis for trace and major elements was performed on the samples by Cone Geochemical, Inc. of Lakewood, Colorado. Analytical results from Cone Geochemical are attached.

Several types of slag and ore were identified. Sample GB-1 was representative of one type of slag/ore observed at the site. It was silver in color and had a low specific gravity (light weight). Sample GB-2 was another commonly observed slag/ore material. It was also silver in color, but had a higher specific gravity. Two of the slag samples (TP-127/G-1 and TP-127/G-2) were obtained based on our field observations of similarity to Asarco slag because of its color, sheen, vesicular nature and specific gravity.

Sample GB-1 appears to be a silicon ore and GB-2 appears to be a ferro-silicon slag/ore. The TP-127 slag samples were the only slag or ore samples with fairly high lead and arsenic concentrations and were similar in composition to copper reverbatory slag produced by Asarco. The other three samples (TP-134/G-1, TP-134/G-2, and TP-131/G-1) were identified as ferro-chromium ore and slag consisting predominantly of chromium and magnesium minerals (spinel and forsterite).

Russell M. Honea
Consulting Geologist

AC 303 466-9719

Office
1105 BELLAIRE
BROOMFIELD, COLORADO 80020

Mailing Address
P.O. BOX 323
BROOMFIELD, COLORADO 80020

March 1, 1990

Mr. Mike Ehlebracht
Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699

Re: X-ray Powder Diffraction Data

Dear Mike:

Enclosed are results of X-ray powder diffraction analysis of the pulp samples forwarded by Cone Geochemical on January 30, 1990. The data were obtained using a Norelco Diffractometer and using filtered copper radiation. In each instance, the more abundant phase is listed first. I believe the identifications include all of the dominant crystalline phases in the samples, but may well omit phases present below the detection limits of the method.

Please let me know if there are questions or problems regarding the data.

Sincerely,

Russell M. Honea, PhD

Encl.

SUMMARY OF X-RAY POWDER DIFFRACTION ANALYSES

METALS REFINING SAMPLES

Sample GB-1

Silicon - Si
Silicon Carbide - SiC

Sample GB-2

Iron Silicide - FeSi
Iron silicide - $FeSi_2$

Sample TP-127, G - 1

Fayalite - Fe_2SiO_4
Hedenbergite - $CaFeSi_2O_6$

Sample TP-127, G - 2

Hedenbergite - $CaFeSi_2O_6$
Clinoferrosilite - $(Fe,Mg)_2Si_2O_6$

Sample TP-131, G - 1

Chromium - Cr
Ferrochrome - FeCr

Sample TP-134, G - 1

Spinel (Chromian) - $Mg(Cr,Al)_2O_4$
Forsterite - Mg_2SiO_4

Sample TP-134, G - 2

Spinel (Chromian) - $Mg(Al,Cr)_2O_4$
Forsterite - Mg_2SiO_4

CONE GEOCHEMICAL INC.
810 Quail Street, Suite 1
Lakewood, Colorado 80215
(303) 232-8371

Job 90-0088
8-Feb-90

ANALYTICAL REPORT

Mike Ehlebracht
Hart Crowser, Inc.
1910 Fairview Ave. East
Seattle, WA 98102

PO # J-2350-04
PROJECT
J-2350-04

SAMPLE NUMBER	PPM CU	PPM MO	PPM PB	PPM ZN	PPM NI	PPM MN
GB-1	64	30	22	164	114	54
GB-2	1179	616	<1	230	1143	3446
TP-127/G-1	3400	980	3800	1.57%	41	630
TP-127/G-2	2900	1500	3500	1.89%	250	650
TP-134/G-1	35	7	3	26	28	420
TP-134/G-2	90	2	<1	7	87	710
TP-131/G-1	50	1	<1	5	2100	3800
METHOD	A.A.	A.A.	A.A.	A.A.	A.A.	A.A.
DIGESTION	4Acid	4Acid	4Acid	4Acid	4Acid	4Acid

CONE GEOCHEMICAL INC.
810 Quail Street, Suite 1
Lakewood, Colorado 80215
(303) 232-8371

ANALYTICAL REPORT

Mike Ehlebracht
Hart Crowser, Inc.
1910 Fairview Ave. East
Seattle, WA 98102

PO # J-2350-04
PROJECT
J-2350-04

SAMPLE NUMBER	PPM CD	PPM V	PPM BE	PPM LI	PPM AS	PPM SB
GB-1	<.2	224	14	26	3	<1
GB-2	<.2	77	<.2	7	29	<1
TP-127/G-1	11.1	27	<.2	6	3411	800
TP-127/G-2	7.3	37	0.4	6	1081	360
TP-134/G-1	<.2	26	<.2	4	15	4
TP-134/G-2	<.2	37	<.2	17	5	<1
TP-131/G-1	<.2	1380	<.2	5	5	<1
METHOD	A.A.	A.A.	A.A.	A.A.	A.A.	A.A.
DIGESTION	4Acid	4Acid	4Acid	4Acid	P/N	Fus'n
PRECISION	9%	10%	10%	8%	6%	10%

CONE GEOCHEMICAL INC.
810 Quail Street, Suite 1
Lakewood, Colorado 80215
(303) 232-8371

ANALYTICAL REPORT

Mike Ehlebracht
Hart Crowser, Inc.
1910 Fairview Ave. East
Seattle, WA 98102

PO # J-2350-04
PROJECT
J-2350-04

SAMPLE NUMBER	PPM HG	PPM TL	PPM W	% SIO2	% AL203	% FE203
GB-1	0.01	<.2	<1	140.9	14.3	9.71
GB-2	<.01	<.2	<1	92.4	1.8	70.2
TP-127/G-1	<.01	9.9	2	37.3	2.8	50.1
TP-127/G-2	<.01	6.4	2	41.7	3.2	43.2
TP-134/G-1	0.01	<.2	<1	8.48	9.0	1.06
TP-134/G-2	<.01	<.2	<1	18.8	9.5	1.49
TP-131/G-1	<.01	0.3	<1	20.1	0.16	20.7

METHOD	A.A.	A.A.	Color	A.A.	A.A.	A.A.
DIGESTION	P/N	4Acid	Fus'n	LMB	4Acid	LMB
PRECISION	20%	10%	10%	5%	10%	8%

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ANALYTICAL REPORT

Mike Ehlebracht
Hart Crowser, Inc.
1910 Fairview Ave. East
Seattle, WA 98102

PO # J-2350-04
PROJECT
J-2350-04

SAMPLE NUMBER	% MGO	% CAO	% NA2O	% K2O	PPM BAO
GB-1	0.02	3.31	0.04	0.01	1568
GB-2	0.01	0.27	0.02	<.005	90
TP-127/G-1	0.58	3.56	0.99	0.35	224
TP-127/G-2	1.15	7.22	0.46	0.36	224
TP-134/G-1	33.2	0.77	0.03	0.01	90
TP-134/G-2	32.7	1.64	0.10	0.01	179
TP-131/G-1	0.02	0.02	0.01	<.005	<50
METHOD	A.A.	A.A.	A.A.	A.A.	A.A.
DIGESTION	LMB	LMB	LMB	LMB	LMB

CONE GEOCHEMICAL INC.
810 Quail Street, Suite 1
Lakewood, Colorado 80215
(303) 232-8371

Job 90-0182
28-Feb-90
Page 1

ANALYTICAL REPORT

Mike Ehlebracht
Hart Crowser, Inc.
1910 Fairview Ave. East
Seattle, WA 98102

PO # J-2350-04
PROJECT
J-2350-04

SAMPLE NUMBER	PPM CR
GB-1	6200
GB-2	4600
TP-127/G-1	2400
TP-127/G-2	2400
TP-134/G-1	6000
TP-134/G-2	9500
TP-131/G-1	74%

METHOD	A.A.
DIGESTION	4Acid

ATTACHMENT F-3
OHIO FERRO-ALLOY SUBSURFACE STRUCTURE MEMO

ATTACHMENT F-3
OHIO FERRO-ALLOY SUBSURFACE STRUCTURE MEMO

MEMORANDUM

DATE: October 12, 1990

TO: Leslie Sacha
Port of Tacoma

FROM: Anne Fitzpatrick
Hart Crowser

RE: Identification of Subsurface Structure
Port of Tacoma - Blair Backup Property
J-2350-07

This memo briefly describes our field activities on September 6, 1990, related to the subsurface structure recently identified on the Ohio Ferro-Alloy portion of the Blair Backup property.

Using a backhoe, we exposed a 6-foot by 28-foot rectangular concrete structure. Because of the shallow water table present in the Ohio Ferro-Alloy Area, we were unable to excavate to the base of the structure. We assume the structure extends approximately 7.5 feet below ground surface based on depth measurements collected inside the structure. We have interpreted the subsurface structure to be an old septic tank based on the following observations:

- Top of structure is capped with a concrete slab. Two open manholes are positioned at either end of the tank to allow access.
- 3-inch to 5-inch steel pipes lead into the structure.
- Broken piping found near structure, apparently at one time part of a line leading from the tank to the nearby buildings.
- Water levels inside the tank, as observed through manholes, were the same as outside the tank. As we excavated deeper, water flowed out of pipes and exit holes located on the side walls of structure.

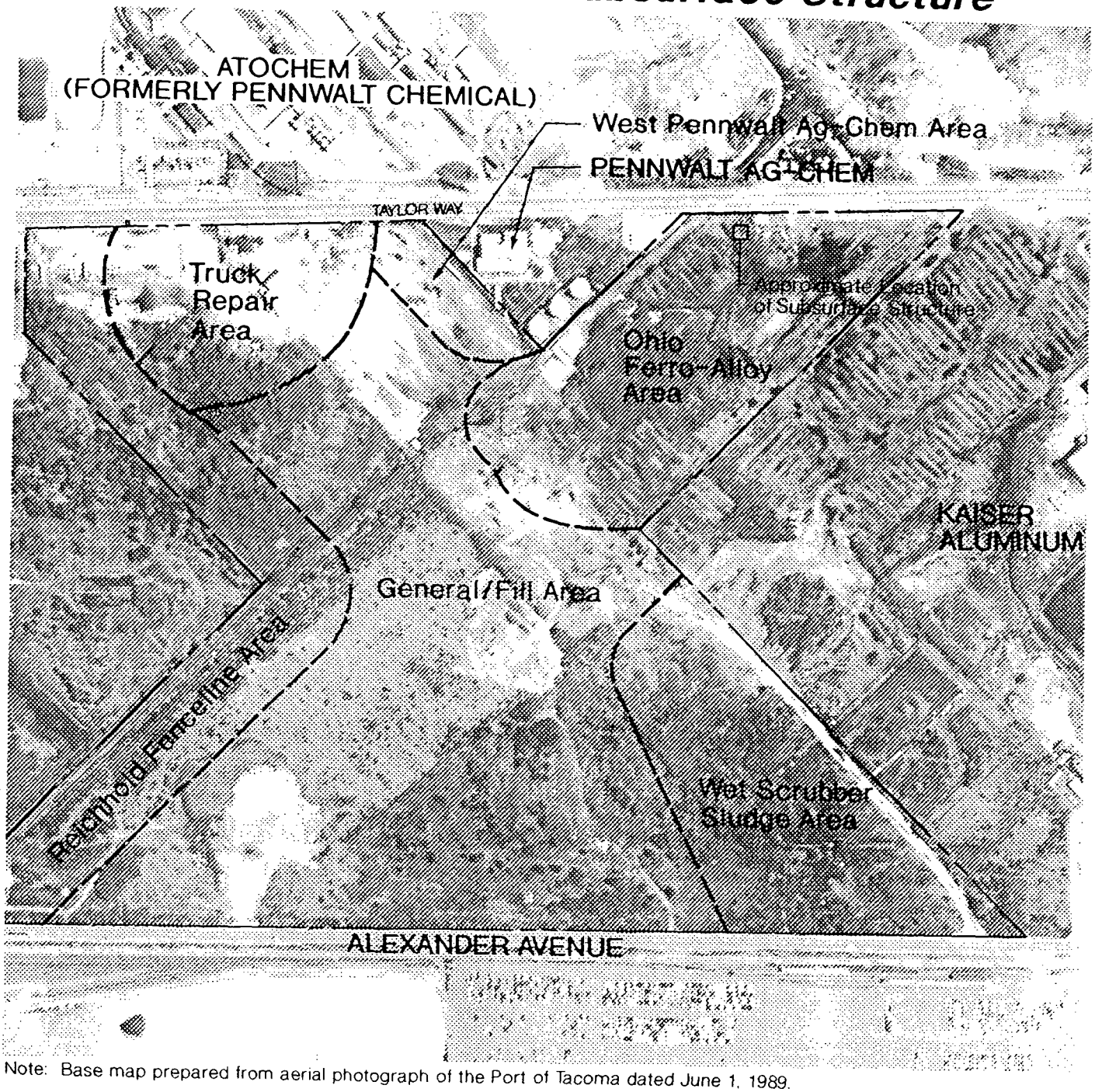
Soil Excavation Observations

Soil surrounding the structure was primarily black dredge fill sand. We did not observe any obvious contamination in soil or water adjacent to the tank. We encountered the water table at a depth of 2 to 4 feet below ground surface. We recommend that this structure be demolished as part of general site remediation or improvement.

Attachments:

Figure F-3-1 - Approximate Location of Subsurface Structure
Figure F-3-2 - Sketch of Structure
Photographs of Structure

Approximate Location of Subsurface Structure



Note: Base map prepared from aerial photograph of the Port of Tacoma dated June 1, 1989.

0 400 800

Scale in Feet

N

HARTCROWSER

J-2350-07 6/91

Figure F-3-1

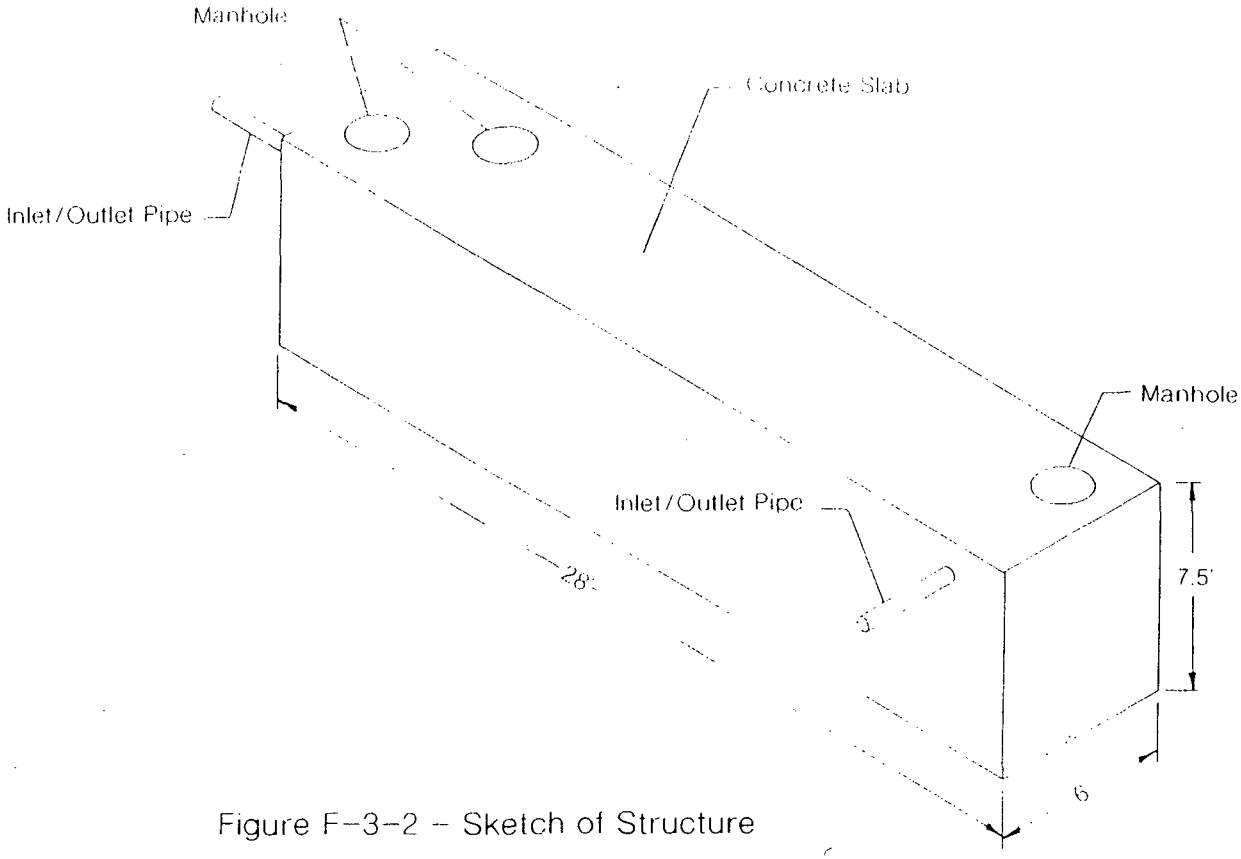
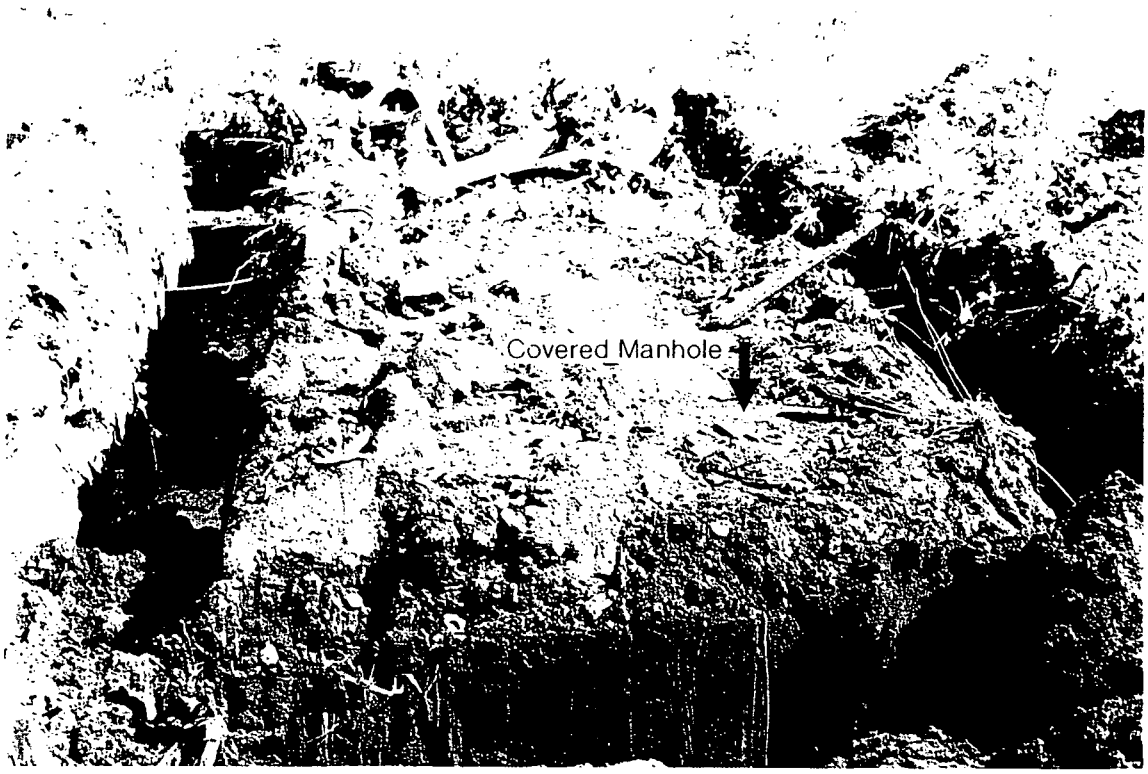
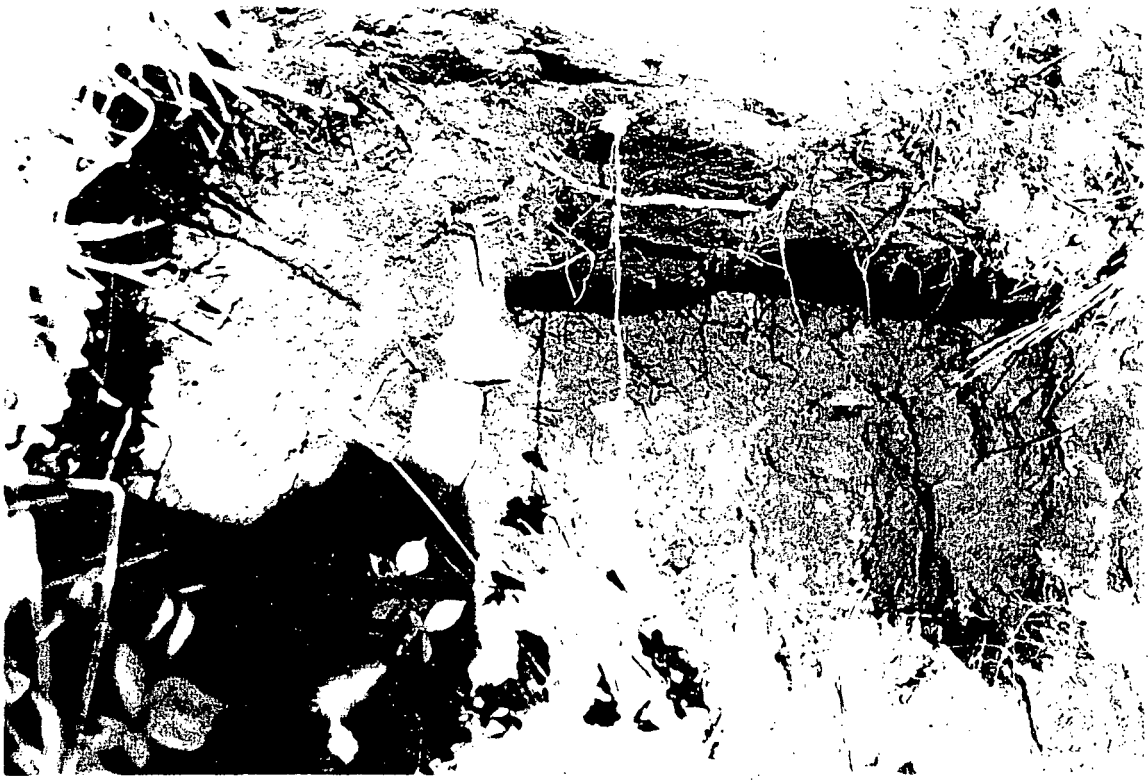


Figure F-3-2 - Sketch of Structure



Photograph 1 - Exposed subsurface structure near Taylor Way.

Photograph 2 – Open manhole



Photograph 3 – Likely inlet pipe from nearby red building.

Hart Crowser
J-2350-07

ATTACHMENT F-4
UNDERGROUND STORAGE TANK REMOVAL REPORT
GEOENGINEERS, INC.

GeoEngineers

March 15, 1990

Consulting Geotechnical
Engineers and Geologists

Port of Tacoma
P.O. Box 1837
Tacoma, Washington 98401

Attention: Ms. Laura Cooper

We are submitting two copies of our Report of Underground Storage Tank Removal at the Taylor Way site in Tacoma, Washington. Our services were authorized on December 28, 1989. Contractual terms for our services are listed in professional services agreement number E1234. The scope of our services is described in our proposal dated December 21, 1989, which is appended to the professional services agreement.

We appreciate the opportunity to be of continued service to the Port of Tacoma. Please call if you have any questions regarding this report.

Yours very truly,

GeoEngineers, Inc.

Stephen C. Perrigo
Associate

CLH:SCP:cs

File No. 0454-007-B04

GeoEngineers, Inc.
2405 140th Ave. NE, Suite 105
Bellevue, WA 98005
Telephone (206) 746-5200
Fax. (206) 746-5068

Geo Engineers

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SOIL DISPOSAL	4
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	Page No.
CHEMICAL ANALYTICAL DATA	B-1 thru B-13

GeoEngineers

REPORT OF UNDERGROUND STORAGE TANK REMOVAL
TAYLOR WAY
TACOMA, WASHINGTON
FOR
PORT OF TACOMA

INTRODUCTION

This report summarizes the results of our observations during the removal of an underground fuel storage tank located on Port of Tacoma property northwest of Taylor Way in Tacoma, Washington. The site location relative to surrounding features is shown on the Vicinity Map, Figure 1. The general layout of the site is shown on the Site Plan, Figure 2. One 2000-gallon underground fuel storage tank was removed from the site on January 10, 1990. The steel tank was removed but not replaced. We understand that the tank had been used to store gasoline. Subsequent information provided to us indicated that the tank may have been used only to store and distribute diesel.

The purpose of our services was to observe and evaluate subsurface soil conditions during the removal of the underground storage tank and to develop remediation plans, as necessary. GeoEngineers' scope of services completed for this project is listed below.

1. Observe and document the excavation and removal of the underground storage tank at the site.
2. Obtain soil samples from the limits of the excavation for chemical analysis of petroleum-related contaminants. Field screening was conducted on each soil sample for evidence of contamination using visual, water sheen and headspace vapor screening methods. These methods are described in Appendix A.
3. Analyze soil samples for benzene, ethylbenzene, toluene, and xylenes (BETX) by EPA Method 8020, total petroleum hydrocarbons (TPH) by EPA Method 418.1 and/or fuel hydrocarbons by EPA Method 8015 (modified). Analytical results are presented in Appendix B.
4. Excavate two test pits adjacent to the limits of the excavation to evaluate the extent of contamination.

5. Analyze soil samples from the test pits for BETX by EPA Method 8020 and TPH by EPA Method 418.1. Analytical results are presented in Appendix B.
6. Excavate additional contaminated soil from the excavation. Field screening was conducted on soil samples to assist in determining the limits of contamination.
7. Collect and analyze soil samples from the enlarged excavation for TPH by EPA Method 418.1.
8. Obtain a composite soil sample of the soil stockpile for analysis of TPH by EPA Method 418.1 in order to secure clearance for disposal of the soil at the Kitsap County Sanitary Landfill.
9. Evaluate the field and laboratory data with regard to existing regulatory concerns.

SOIL EXCAVATION AND SAMPLING

CECON Corporation removed the diesel storage tank from the location shown in Figure 2 on January 10, 1990. The product pump, distribution lines and service island had been removed prior to our initial site visit. A representative of our staff was present to observe tank removal operations and to obtain soil samples. A representative of the Tacoma-Pierce County Health Department (TPCHD) was also present to observe the removal of the diesel tank. The TPCHD representative did not obtain soil samples.

The tank removal excavation extended to a depth of approximately 6.5 feet below the ground surface. Backfill surrounding the tank consisted of silty fine to medium sand with occasional gravel. Fill soils consisting of silty fine to medium sand with occasional gravel was encountered in the walls and floor of the excavation. Rapid ground water seepage perched approximately 2 to 3 feet below the ground surface was observed flowing in the excavation. The perched ground water appeared to be related to the heavy precipitation event which occurred on January 9, 1990. No pitting, holes or corrosion was observed on the surface of the tank. Field screening methods detected the presence of petroleum-related soil contamination in the walls or base of the excavation.

Soils removed during the excavation of the tank were stockpiled on plastic sheeting adjacent to the excavation and covered with plastic

sheeting until analytical results were obtained. The limit of the tank removal excavation is shown in Figure 2. Five soil samples (900110-1 through 900110-5) were obtained from the limits of the initial excavation at the locations shown in figure 2. These samples were analyzed for BETX by EPA Method 8020 and for TPH by EPA Method 418.1. Soil sample 900110-2 was also analyzed for fuel hydrocarbons (gasoline and diesel) by modified EPA Method 8015. Analytical results indicated that the soil contamination was attributable to diesel fuel.

Current Washington Department of Ecology (Ecology) cleanup guidelines for petroleum-contaminated soil are 200 ppm for TPH, 660 ppb for benzene, 143 ppm for toluene, and 14 ppm for ethylbenzene. The concentrations of BETX in the soil samples analyzed from the limits of the tank excavation were either nondetected or were less than Ecology cleanup guidelines. The concentration of TPH in the soil samples 900110-2 through 900110-5 all exceeded Ecology's cleanup guidelines for TPH. Field screening and analytical results are summarized in Table 1.

On January 12, 1990, two exploratory test pits were excavated outside the limits of the initial excavation to assist in evaluating the extent of soil contamination. Soil samples were obtained from the test pits and submitted for analysis of TPH and BETX. Analytical results indicated that the soil samples (900110-6 and 900110-7) obtained from the test pits were below cleanup guidelines. Field screening and analytical results are summarized in Table 1. Test pit locations are shown in Figure 2.

The limits of the excavation were enlarged on January 24, 1990. Five soil samples (900124-2, 900124-3 and 900124-5, 900124-6 and 900124-7) were obtained from the limits of the enlarged excavation and analyzed for TPH. Analytical results indicated that limits of the enlarged excavation were below cleanup guidelines with the exception of the soil sample obtained from the northeastern wall. Additional soil was excavated from the northeastern wall on January 29, 1990. Soil sample 900110-9 was obtained from the northeastern wall after additional soil was excavated. Testing of this additional sample indicated TPH concentrations below cleanup guidelines for TPH. Field screening and analytical results are summarized in Table 1. Sample locations are shown in Figure 2. Laboratory reports are included in Appendix B.

SOIL DISPOSAL

Two soil samples were obtained from the stockpiled soil on January 24, 1990. These soil samples were composited into one sample (900124-4 and -8) by the laboratory and analyzed for TPH as requested by the consultant (Parametrix, Inc.) for the Kitsap County Sanitary Landfill. GeoEngineers sent a letter on behalf of the Port to Parametrix on February 7, 1990 requesting clearance for disposal of the contaminated soil at the landfill. A copy of this letter is included in Appendix C.

Approximately 80 cubic yards of contaminated soil was transported to Kitsap County Sanitary Landfill on February 7, 1990. Ground water in the excavation was pumped on January 29, 1990 prior to partially backfilling the excavation with imported backfill. Field screening methods indicated that the imported backfill was clean. We understand that the part of the excavation which was left open on January 29, 1990 was subsequently backfilled with imported backfill on January 30, 1990.

CONCLUSIONS

Based on the results of our field observations and analytical testing, it is in our opinion that no further action related to potential subsurface petroleum-related soil contamination is required at this site. Laboratory testing of soil samples obtained from the limits of the enlarged excavation indicate that the concentrations of petroleum-related soil contamination are significantly less than Ecology's current cleanup goals.

LIMITATIONS

We have prepared this report for use by the Port of Tacoma. This report may be made available to regulatory agencies. This report is not intended for use by others and the information contained herein is not applicable to other sites.

Our interpretation of soil conditions during remediation is based on field observations and chemical analytical data. It is possible that areas with undetected contamination may exist in portions of the site which were not excavated or analyzed.

GeoEngineers

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No other conditions, express or implied, should be understood.

Respectfully submitted,

GeoEngineers, Inc.

Cheryl L. Haines

Cheryl L. Haines
Hydrogeologist

Stephen C. Perrigo
Associate

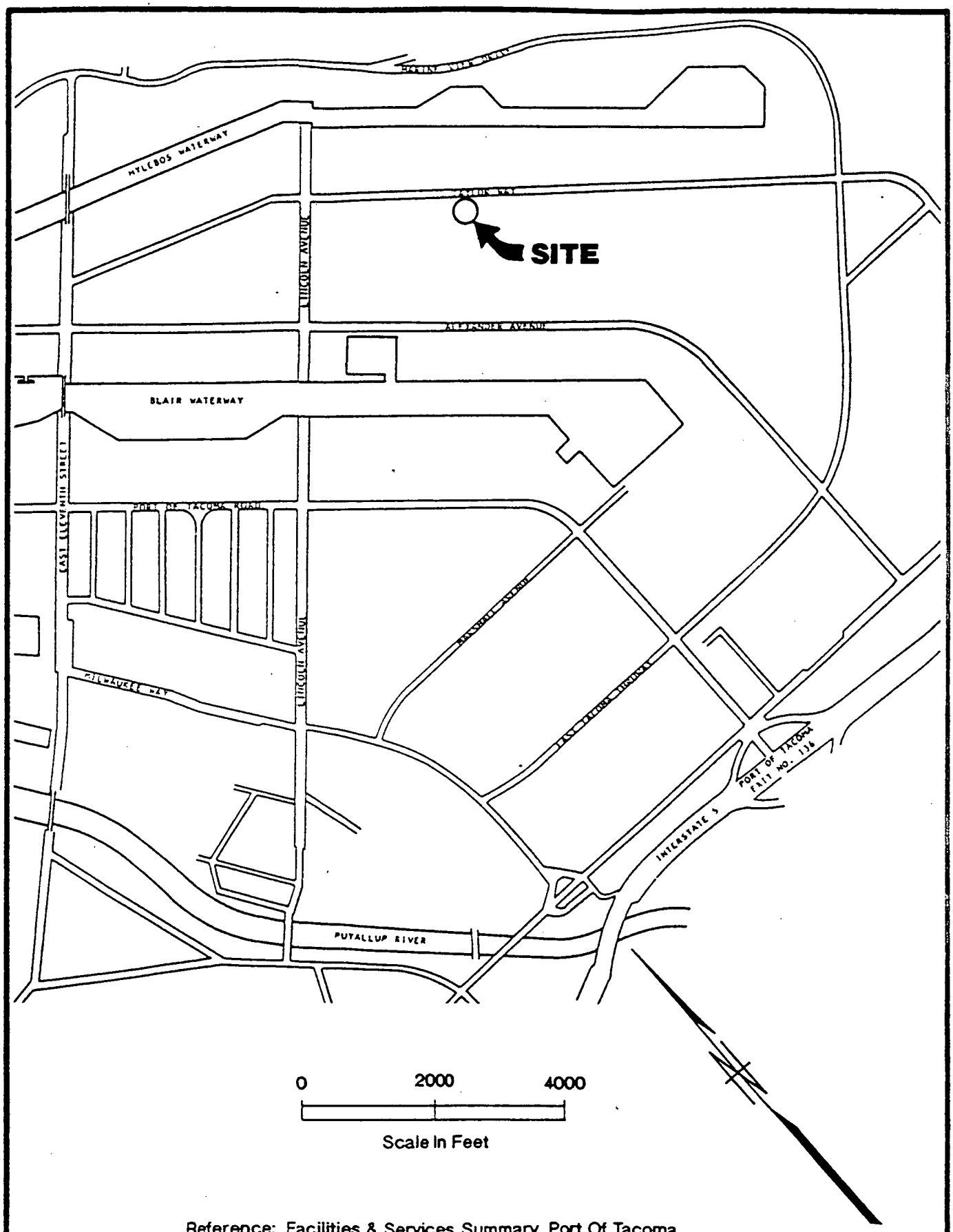
CLH:SCP:cs

Geo Engineers

TABLE 1
SUMMARY OF SOIL CONTAMINATION DATA

Sample Number	Sample Depth(ft)	BETX (ppm)(1)				TPH(2) (ppm)	Sample Location
		B	E	T	X		
Initial Sampling							
900110-1	6.5	<0.05	<0.05	<0.05	0.09	89.9	Northwest Wall
900110-2*	5.0	<0.05	<0.05	<0.05	0.45	986	Northeast Wall
900110-3	3.5	<0.05	<0.05	<0.05	0.33	257	Southwest Wall
900110-4	4.0	<0.05	<0.05	<0.05	0.10	253	Northeast Wall
900110-5	3.0	<0.05	<0.05	<0.05	0.17	296	Southeast Wall
Test Pits							
900112-6	3.0	<0.05	<0.05	<0.05	<0.05	11.8	Composite Stockpile
900112-7	2.5	<0.05	<0.05	<0.05	<0.05	<0.05	Northeast Wall
Follow-up Samples							
900124-2	4.5	NT	NT	NT	NT	40.8	Northwest Wall
900124-3	4.5	NT	NT	NT	NT	5.3	Northeast Wall
900124-5	4.5	NT	NT	NT	NT	8.9	Southwest Wall
900124-6	5.0	NT	NT	NT	NT	303	Northeast Wall
900124-7	4.5	NT	NT	NT	NT	9.7	Southeast Wall
900124-4&8	--	NT	NT	NT	NT	1,171	Composite of Stockpile
900110-9	5.0	NT	NT	NT	NT	47.9	Northeast Wall

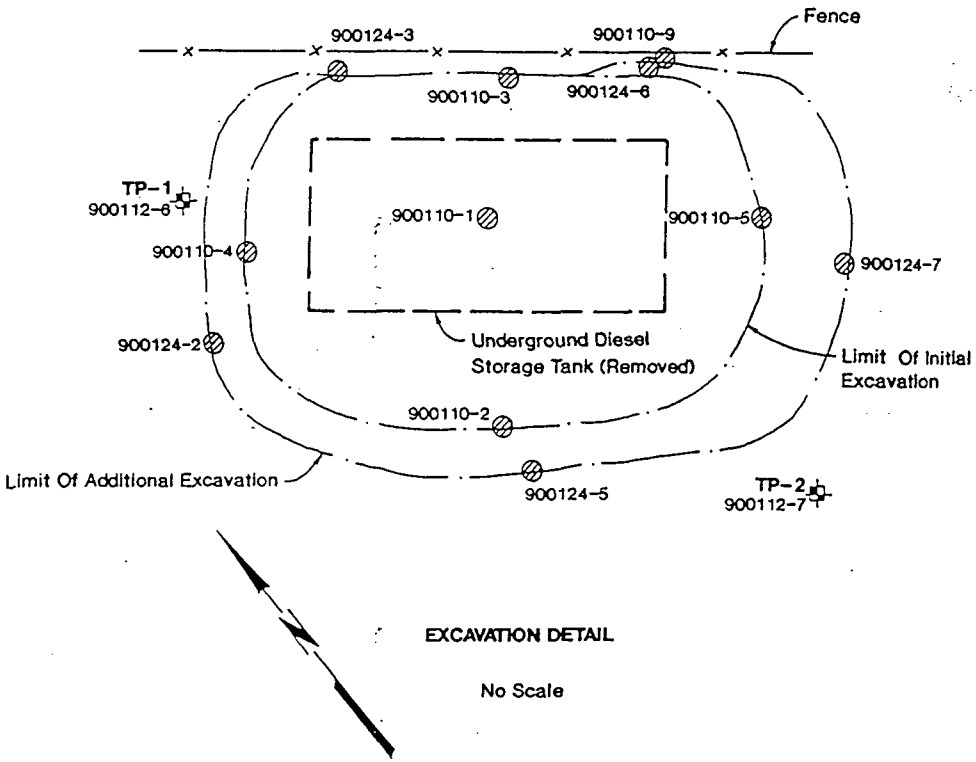
Notes:
(1) Analyzed by EPA Method 8020. BETX = benzene, ethylbenzene, toluene and total xylenes.
(2) Analyzed by EPA Method 418.1. TPH = total petroleum hydrocarbons.
*Analyzed by modified EPA Method 8015 for gasoline and diesel. Results indicated diesel at 127 ppm.
"ppm" signifies "parts per million"
"<" signifies "less than"
"ft" signifies "feet"
"--" signifies "not applicable"



Reference: Facilities & Services Summary, Port Of Tacoma.

GeoEngineers	VICINITY MAP
	FIGURE 1

0454-007-804 CL4:KKT 1-24-91



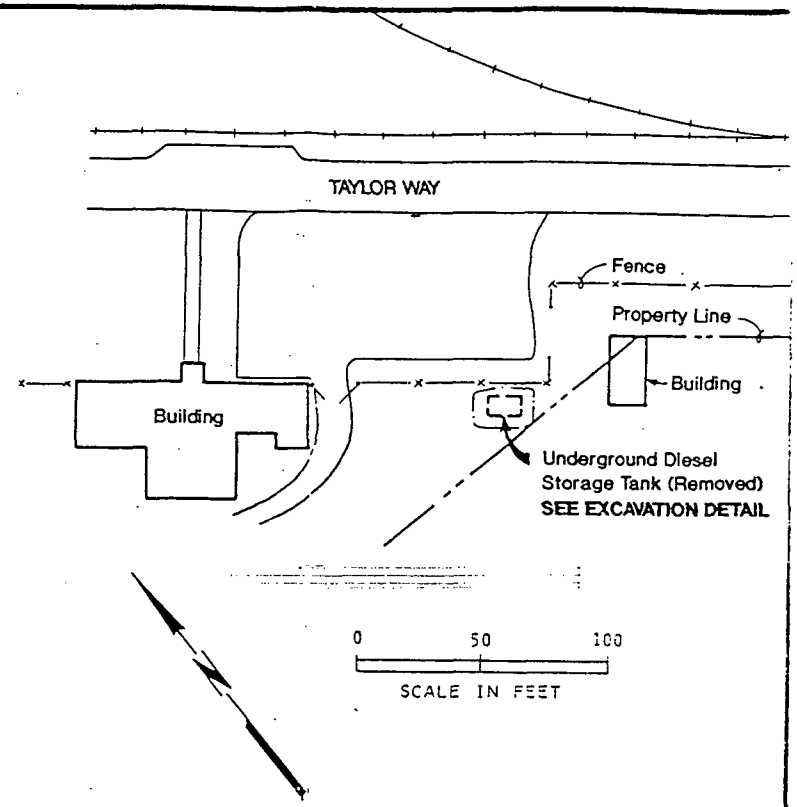
EXCAVATION DETAIL

No Scale

EXPLANATION:

TP-1 / 900112-6 — TEST PIT LOCATION AND NUMBER AND SOIL SAMPLE NUMBER

900110-1 — SOIL SAMPLE LOCATION AND NUMBER



LOCATION MAP

REFERENCE: DRAWING ENTITLED "SHOP BUILDING, FOR L. B. FOSTER CO., TAYLOR WAY" REVISION DATED 10/2/75, BY PORT OF TACOMA.

Geo Engineers	SITE PLAN
	FIGURE 2

0454-007-804 CLH/KKT 2/12/90

APPENDIX A

APPENDIX A

FIELD SCREENING OF SOIL SAMPLES

Soil samples obtained from the excavations were split into two portions. One portion of the sample was retained for soil classification and laboratory analysis. The second portion was tested in the field for fuel-related contamination using (1) visual examination, (2) sheen testing, and/or (3) headspace vapor testing using the Bacharach TLV Sniffer. The results of headspace and/or sheen screening are included in Table 1.

Visual screening consisted of inspecting the soil for the presence of stains indicative of fuel-related contamination. Visual screening is generally more effective when contamination is related to heavier petroleum hydrocarbons, such as motor oil, or when hydrocarbon concentrations are high. Sheen testing and measurement of headspace vapors are more sensitive screening methods which have been effective in detecting contamination at levels below regulatory cleanup guidelines.

Sheen testing involves immersion of the soil sample in water and observing the water surface for signs of a sheen. Sheen classifications follow:

No Sheen (NS)	
Slight Sheen (SS)	Light colorless sheen, spread is irregular, not rapid; film dissipates rapidly.
Moderate Sheen (MS)	Light to heavy film, may have some color or iridescence; spread is irregular to flowing, may be rapid; few remaining areas of no sheen on water surface.
Heavy Sheen (HS)	Heavy colorful film with iridescence; spread is rapid, and sheen flows off the sample; entire water surface may be covered with sheen.

Headspace vapor screening involves placing a soil sample in a plastic sample bag. The sample bag is sealed and shaken slightly to expose the soil to the air trapped in the bag. The probe of a Bacharach TLV Sniffer is then

inserted into the bag and the TLV Sniffer measures the concentration of combustible vapors present within the sample bag headspace. The TLV Sniffer records combustible vapor concentrations in part per million (ppm) and is calibrated to hexane. The instrument is designed to detect combustible hydrocarbon vapors at concentrations between 100 and 10,000 ppm.

Field screening results are site specific. The results vary with temperature, moisture content, soil lithology, organic content, and type of contaminant(s).

CHEMICAL ANALYTICAL PROGRAM

All soil samples obtained from the excavation were submitted to Sound Analytical Services, Inc. for laboratory analysis. Soil samples were analyzed for TPH using infrared spectrophotometry methods (EPA Method 418.1). Seven soil samples were analyzed for BETX (EPA Method 8020) by gas chromatograph/photoionization procedures. One soil sample was analyzed for gasoline and diesel (EPA Method 8015, modified) by gas chromatograph/flame ionization procedures.

Chain-of-custody procedures were observed in transporting the soil samples to the analytical laboratory. The laboratory reports are presented in Appendix B.

APPENDIX B

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS
4630 PACIFIC HIGHWAY EAST, SUITE B-14, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: GeoEngineers, Inc

Date: January 11, 1990

Report On: Analysis of Soil

Lab No.: 9298
Page 1 of 2

IDENTIFICATION:
Samples Received on 1-10-90
Project: 454-007-B04 POT, Tacoma

ANALYSIS:

Lab Sample No.	RUSH 1	RUSH 2	RUSH 3
Client ID:	900110-1	900110-2	900110-3
Matrix/units	Soil mg/kg	Soil mg/kg	Soil mg/kg
Total Petroleum Hydrocarbons by EPA Method 418.1	89.9	986	257
Total Petroleum Fuel Hydrocarbons, as by EPA SW-846 Modified Method 8020	NT	127 Diesel	NT
Benzene	< 0.05	< 0.05	< 0.05
Toluene	< 0.05	< 0.05	0.05
Ethyl Benzene	< 0.05	< 0.05	< 0.05
Xylenes	0.09	0.45	0.33
BTEX by EPA SW-846 Method 8020			

NT = Not Tested.

Continued . . . .

SOUND ANALYTICAL SERVICES, INC.

GeoEngineers, Inc
Page 2 of 2
Lab Report No: 9298
January 11, 1990

Lab Sample No.	RUSH 4	RUSH 5
Client ID:	900110-4	900110-5
Matrix/units	Soil mg/kg	Soil mg/kg
Total Petroleum Hydrocarbons by EPA Method 418.1	253	296
Benzene	< 0.05	< 0.05
Toluene	< 0.05	< 0.05
Ethyl Benzene	< 0.05	< 0.05
Xylenes	0.10	0.17
BTEX by EPA SW-846 Method 8020		

SOUND ANALYTICAL SERVICES

STAN P. PALMQUIST

This report is issued solely for the use of the person or company to whom it is addressed. This laboratory accepts responsibility only for the due performance of analysis in accordance with

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4630 PACIFIC HIGHWAY EAST, SUITE B-14, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

QUALITY CONTROL REPORT

DUPLICATES

Lab No: 9298
Date: January 11, 1990
Client: GeoEngineers, Inc
Client ID: 900110-5
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD*
Total Petroleum Hydrocarbons	296	272	8.5

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

454-007-B04

GEOENGINEERS INC.
2405 - 140th AVE. N.E., SUITE 105
BELLEVUE, WASHINGTON 98005
206-746-5200

PROJECT LOC. Tacoma
PROJECT NAME POT
GEI FILE NO. 454-007-B04

CHAIN OF CUSTODY RECORD

SAMPLED BY Cheryl Haines DATE 1/10/90

SAMPLE No.	DATE SAMPLED	TIME SAMPLED	DEPTH OF SAMPLE	TYPE OF SAMPLE	FIELD FILTERED	PRESERVATIVE ADDED TO SAMPLE	ANALYSES TO BE CONDUCTED	NO. OF SAMPLE CONTAINERS	COMMENTS
900110-1				Soil	NO	ice	418.1, 8020	1	RUSH !!!
900110-2				"	"	"	418.1, 8020	1	"
900110-3				"	"	"	418.1, 8020	1	"
900110-4				"	"	"	418.1, 8020	1	"
900110-5				"	"	"	418.1, 8020	1	"

RELINQUISHED BY (SIGNATURE) NAME / FIRM	DATE	TIME	RECEIVED BY (SIGNATURE) NAME / FIRM	DATE	TIME
Cheryl Haines / GeoEngineers	1/10/90	1420	Patty Velasquez	1-10-90	2:20 pm
RELINQUISHED BY (SIGNATURE) NAME / FIRM	DATE	TIME	RECEIVED BY (SIGNATURE) NAME / FIRM	DATE	TIME

ADDITIONAL COMMENTS:

Rush Please !!! 24 hour turnaround
Thanks

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4630 PACIFIC HIGHWAY EAST, SUITE B-14, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: GeoEngineers, Inc. Date: January 15, 1990

Report On: Analysis of Soil Lab No.: 9351

IDENTIFICATION:
Samples Received on 01-12-90
Project: 0454-007-B04 POT, Tacoma

ANALYSIS:

Lab Sample No.	RUSH 1	RUSH 2
Client ID	900112-6	900112-7
Benzene, mg/kg	<0.5	<0.5
Toluene, mg/kg	<0.5	<0.5
Ethyl Benzene, mg/kg	<0.5	<0.5
Xylenes, mg/kg	<0.5	<0.5
(BTEX by EPA SW-846 Method 8020)		
Total Petroleum Hydrocarbons, mg/kg by EPA Method 418.1	11.8	<5.0

SOUND ANALYTICAL SERVICES

C. LARRY ZURAW

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QUALITY CONTROL REPORT

DUPLICATES

Lab No: 9351
Date: January 15, 1990
Client: GeoEngineers, Inc.
Client ID: 900112-7
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD*
Total Petroleum Hydrocarbons	<5.0	<5.0	----

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

GEOENGINEERS INC.
2405 - 140th AVE. N.E., SUITE 105
BELLEVUE, WASHINGTON 98005
206-746-5200

PROJECT LOC. Tacoma

PROJECT NAME P OT

GEI FILE NO. 0454-007-00

CHAIN OF CUSTODY RECORD

SAMPLED BY Cheryl Hanes DATE 1/12/90

SAMPLE No.	DATE SAMPLED	TIME SAMPLED	DEPTH OF SAMPLE	TYPE OF SAMPLE	FIELD FILTERED	PRESERVATIVE ADDED TO SAMPLE	ANALYSES TO BE CONDUCTED	NO. OF SAMPLE CONTAINERS	COMMENTS
900112-6	1/12/90	0145	3'	SOIL	NO	ICE	BTEX ~~8020~~ 418.1	1	
900112-7	1/12/90	1515	2½	"	"	"	"	1	

RELINQUISHED BY (SIGNATURE) NAME Cheryl Hanes FIRM GeoEngineers	DATE 1/12/90	TIME 1443	RECEIVED BY (SIGNATURE) NAME [illegible] FIRM Central Analytical	DATE 1/12/90	TIME 3:43 pm
RELINQUISHED BY (SIGNATURE) NAME FIRM	DATE	TIME	RECEIVED BY (SIGNATURE) NAME FIRM	DATE	TIME

ADDITIONAL COMMENTS:

B-1

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Report To: GeoEngineers Date:

Report On: Analysis of Soil Lab No.: 9551

IDENTIFICATION:
Samples Received on 1-24-90
Project: 454-007-B04 Port of Tacoma

ANALYSIS:

Lab Sample No.	RUSH 1	RUSH 2	RUSH 3
Client ID:	900124-2	900124-3	900124-5
Matrix/Units	Soil mg/kg	Soil mg/kg	Soil mg/kg
Total Petroleum Hydrocarbons by EPA Method 418.1	40.8	5.3	8.9

Lab Sample No.	RUSH 4	RUSH 5	RUSH 6
Client ID	900124-6	900124-7	900124-4 900124-8 COMPOSITE
Matrix/Units	Soil mg/kg	Soil mg/kg	Soil mg/kg
Total Petroleum Hydrocarbons by EPA Method 418.1	303	9.7	1,171
Total Petroleum Fuel Hydrocarbons by EPA SW-846 Modified Method 8015 TPH as	< 10	< 10	NT

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QUALITY CONTROL REPORT

DUPLICATES

Lab No: 9551
Date: January 26, 1990
Client: GeoEngineers

Client ID: 900124-6
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD*	
Total Petroleum Hydrocarbons	303	353	15.2	
Total Petroleum Hydrocarbons with 3 Silica Gel Clean-ups	303	362	17.7	

Lab No: 9551
Date: January 26, 1990
Client: GeoEngineers

Client ID: Composite
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD*	
Total Petroleum Fuel Hydrocarbons	< 10	< 10	---	

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

CHAIN OF CUSTODY RECORD

Page ___ of ___

CUSTOMER: Geo Engineers 454-007-B04

PROJECT: Port of Tacoma P.O./JOB NO.: 454-007-B04

SAMPLER: WSL

Lab No.	Sample No.	Date	Time	Cont.	Analysis Required
	900124 - 2				418.1 Rush
	900124 - 3				418.1 Rush
	900124 - 4				Stockpile - 418.1 Hold, ~~8015~~
	900124 - 5				418.1 Rush
	900124 - 6				418.1 + 8015 Rush
	900124 - 7				418.1 + 8015 Rush
	900124 - 8				Stockpile 418.1 hold, ~~8015~~
					1/25/90 Composite #4 & 8 mm 418.1

Rush

Hold Samples for possible other testing

Relinquished by:	Date	Time	Received by:	Date	Time
W. Stephen Lewis	1/24/90	5:00	Gary Brown	1/24/90	5:00 pm
Relinquished by:	Date	Time	Received by:	Date	Time

Dispatched by:	Date	Time	Received at lab by:	Date	Time

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Report To: GeoEngineers, Inc. Date: January 29, 1990

Report On: Analysis of Soil Lab No.: 9613

IDENTIFICATION:
Samples Received on 1-29-90
Project: 454-07-B4 Port of Tacoma
Client ID: RUSH 900110-9

ANALYSIS:

Total Petroleum Hydrocarbons, mg/kg 47.9
by EPA Method 418.1

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QUALITY CONTROL REPORT

DUPLICATES

Lab No: 9613
Date: January 29, 1990
Client: GeoEngineers, Inc.
Client ID: 900110-9
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD*
Total Petroleum Hydrocarbons	47.9	44.8	6.7

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

CHAIN OF CUSTODY RECORD

Page 1 of 1

CUSTOMER: GEO ENGINEERS

PROJECT: Port of Tacoma PO./JOB NO.: 454-07-84

SAMPLER: J. Roth

Lab No.	Sample No.	Date	Time	Cont.	Analysis Required
	900[illegible]-9	1/29	1115		418.1 (Rush)

Relinquished by:	Date	Time	Received by:	Date	Time
James [illegible]	1/29	1115	Cathy Waldman	1/29/90	11:15
Relinquished by:	Date	Time	Received by:	Date	Time

Dispatched by:	Date	Time	Received at lab by:	Date	Time

SOUND ANALYTICAL SERVICES, INC.
4630 Pacific Hwy East Suite B-14
Tacoma, WA 98424 (206) 922-2310

APPENDIX C

February 7, 1990

Parametrix
13020 Northup Way
Bellevue, Washington 98005

Attention: Mr. Rich Mullan

GeoEngineers is assisting the Port of Tacoma with the cleanup of contaminated soil related to an underground storage tank located along Taylor Way in Tacoma, Washington. We understand that the underground storage tank had been used for the storage of diesel fuel. Soil removed from the excavation has been temporarily stockpiled on site. We estimate the volume at approximately 140 cubic yards.

The stockpiled soil was sampled on January 10 and 24, 1990. Two samples (designated as 900124-4 and -8: composite and 900110-2) were analyzed for total petroleum hydrocarbons (TPH) by EPA Method 418.1 at your request. The concentrations of TPH in those samples was 1171 and 986 ppm as shown on the attached laboratory reports. The latter sample was also analyzed for BETX by EPA Method 8020. In that sample, benzene, ethylbenzene and toluene were not detected (<0.05 ppm) and total xylenes were detected at 0.45 ppm.

On behalf of the Port of Tacoma, we are requesting permission for disposal of this soil at the Kitsap County Sanitary Landfill.

Thank you for your assistance in this matter. If you have any questions regarding these waste soils, please call.

Yours very truly,
GeoEngineers, Inc.

Cheryl L. Haines

Cheryl L. Haines
Staff Geologist

WSL:cs

Attachments

File No. 0454-007-B04

cc: Port of Tacoma
Attn: Ms. Laura Cooper

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Report To: GeoEngineers

Date: January 26, 1990
Revised: January 29, 1990

Report On: Analysis of Soil

Lab No.: 9551

IDENTIFICATION:
Samples Received on 1-24-90
Project: 454-007-B04 Port of Tacoma

ANALYSIS:

Lab Sample No.	RUSH 1	RUSH 2	RUSH 3
Client ID:	900124-2	900124-3	900124-5
Matrix/Units	Soil mg/kg	Soil mg/kg	Soil mg/kg
Total Petroleum Hydrocarbons by EPA Method 418.1	40.8	5.3	8.9

Lab Sample No.	RUSH 4	RUSH 5	RUSH 6
Client ID	900124-6	900124-7	900124-4 900124-8 COMPOSITE
Matrix/Units	Soil mg/kg	Soil mg/kg	Soil mg/kg
Total Petroleum Hydrocarbons by EPA Method 418.1	303	9.7	1,171
Total Petroleum Fuel Hydrocarbons by EPA SW-846 Modified Method 8015 TPH as	< 10	< 10	NT

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QUALITY CONTROL REPORT

DUPLICATES

Lab No: 9551
Date: January 26, 1990
Client: GeoEngineers

Client ID: 900124-6
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD*	
Total Petroleum Hydrocarbons	303	353	15.2	
Total Petroleum Hydrocarbons with 3 Silica Gel Clean-ups	303	362	17.7	

Lab No: 9551
Date: January 26, 1990
Client: GeoEngineers

Client ID: Composite
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD*	
Total Petroleum Fuel Hydrocarbons	< 10	< 10	---	

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

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Report To: GeoEngineers, Inc

Report On: Analysis of Soil

Date: January 11, 1990
Revised: January 17, 1990
Lab No.: 9298

IDENTIFICATION:
Samples Received on 1-10-90
Project: 454-007-B04 POT, Tacoma

ANALYSIS:

Lab Sample No.	RUSH 1	RUSH 2	RUSH 3
Client ID:	900110-1	900110-2	900110-3
Matrix/units	Soil mg/kg	Soil mg/kg	Soil mg/kg
Total Petroleum Hydrocarbons by EPA Method 418.1	89.9	986	257
Total Petroleum Fuel Hydrocarbons, as by EPA SW-846 Modified Method 8015	NT	127 Diesel	NT
Benzene	< 0.05	< 0.05	< 0.05
Toluene	< 0.05	< 0.05	0.05
Ethyl Benzene	< 0.05	< 0.05	< 0.05
Xylenes	0.09	0.45	0.33
BTEX by EPA SW-846 Method 8020			

NT = Not Tested.

Continued . . . .

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GeoEngineers, Inc
Page 2 of 2
Lab Report No: 9298
January 11, 1990
Revised: January 17, 1990

Lab Sample No.	RUSH 4	RUSH 5
Client ID:	900110-4	900110-5
Matrix/units	Soil mg/kg	Soil mg/kg
Total Petroleum Hydrocarbons by EPA Method 418.1	253	296
Benzene	< 0.05	< 0.05
Toluene	< 0.05	< 0.05
Ethyl Benzene	< 0.05	< 0.05
Xylenes	0.10	0.17
BTEX by EPA SW-846 Method 8020		

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Appendix G

APPENDIX G
QUANTITATION OF HUMAN EXPOSURE AND RISK; UNCERTAINTY ANALYSIS; RISK TRANSPORT PATHWAYS AND MODELING BLAIR BACKUP PROPERTY

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APPENDIX G
QUANTITATION OF HUMAN EXPOSURE AND RISK; UNCERTAINTY ANALYSIS; RISK TRANSPORT PATHWAYS AND MODELING
BLAIR BACKUP PROPERTY

Quantification of Human Exposures

This section presents the approach used to estimate human exposures via each of the identified exposure pathways. The general equation used to calculate exposure is as follows:

$$D = \frac{C \times CR \times EFD}{BW \times AT}$$

Where

D	Chemical Dose (also called the Chronic Daily Intake (CDI); the amount of a chemical penetrating the exchange boundaries of an organism (e.g., skin or gastrointestinal tract) in mg/kg body weight-day (mg/kg-day)
C	Chemical Concentration; the concentration contacted over the exposure period in ppm
CR	Contact Rate; amount of contaminated medium contacted per unit time in gm/hour
EFD	Exposure Frequency and Duration; the combined frequency in hours/day and duration in years of exposure
BW	Body Weight; the average body weight of an individual over the exposure period in kg
AT	Averaging Time; period over which exposure is averaged to compare with toxicity criteria in years. The averaging time for carcinogens, AT equals the average lifetime (75 years); for non-carcinogens, AT equals the number of years over which the exposure occurs.

For each exposure pathway, an average case and reasonable maximum exposure scenario were developed. The average case is based on the arithmetic mean exposure point concentration in the appropriate environmental medium. The reasonable maximum exposure (RME) case uses the 95th percentile confidence limit (95% CL) of the arithmetic mean. The maximum concentration was used in place of the 95% CL if a chemical was detected fewer than three times in a set of data, or if the 95% CL exceeded the maximum. In calculating the average and 95% CL concentrations, nondetected chemicals were assumed to be present at one half of the method detection limit for the chemical.

By providing both an average case and a RME scenario a measure of the uncertainty in the final risk estimates, as a result of using a range of potential exposures in the exposure estimate, is provided.

Exposure parameter values used in each of the scenarios evaluated in this assessment are summarized in Table G-1 and are described below. In general, values used are those recommended by EPA Region 10 for industrial exposures. In selected cases, Region 10 recommended values were not used or were not available and the derivation of the values used are discussed in the following text.

Methods used to estimate concentrations of chemicals of potential concern at the point of human contact (exposure point concentrations) in air and off-site surface water, and the values and assumptions used in those models, are presented below.

Soil and Sediment Exposures. Exposure point concentrations for direct contact with soils were estimated using the average and 95% CL of soil sampling results from surface to 15 feet in depth consistent with MTCA guidelines. Although exposure concentrations could be somewhat higher in surficial soils, our sampling design did not address overall site surficial soil quality in the North Site, General/Fill, and Ohio Ferro-Alloy/Pennwalt Areas. Surficial soil samples collected from discrete waste piles (e.g., the sandblast waste samples shown in Tables F-1-1 and F-1-2) were not used to calculate exposure point concentrations, because removal of these piles will be included in the land transfer agreement. Assumptions on body weight, soil intake, exposed skin surface area, and frequency and duration of exposure to soils are presented in Table G-1. These values were obtained from EPA Region 10 (1990) guidelines for evaluation of industrial exposures (for the

average case) or from the EPA Region 10 1991 guidelines (for the RME case). Because EPA is no longer requiring or updating the average case scenario, some of the average exposure assumptions exceed the new RME assumptions. Exposures to sediments were assumed to occur at the same contact rate as for soils, but the frequency of exposure was assumed to be one 8-hour exposure per week (5 percent) for the average case and two 8-hour exposures per week (10 percent) for the RME case.

In general, absorption of chemicals into the body from ingested soil or sediment was conservatively assumed to be equal to the absorption efficiency from the study on which the toxicity factor was based (relative bioavailability 100 percent). However, some chemicals are known to have lower bioavailability from soils than from water or dietary media. In this case, EPA (1989) guidelines indicate that it is appropriate to make a correction to the dose to reflect the lower absorption rate. Chemicals for which less than 100 percent relative bioavailability was assumed were as follows:

- **Polycyclic Aromatic Hydrocarbons.** Relative bioavailability of PAHs from ingested soils, compared to intake in water or diet, can be estimated by analogy to dioxins, a group of compounds of similar hydrophobicity. Compounds with a higher octanol-water partition coefficient (K_{ow}) tend to be strongly adsorbed to soils and to have lower bioavailability. The log K_{ow}s of dioxins range from 4.0 to about 8.6 (EPA, 1988d), while those of the carcinogenic PAHs range from about 4.5 to 6.5 (HSDB, 1991). In a review of the literature, EPA (1988d) determined that the gut absorption of tetrachloro-dibenzodioxins (TCDDs) from soil ranges from 20 to 40 percent, and that the bioavailability relative to administration in corn oil ranges from 25 to 50 percent. The latter range of values will be used for the average and RME absorption factors for PAHs. The uncertainty associated with this assumption and the effect of the assumption on the risk estimate are discussed later in this section.

Dermal absorption of chemicals applied directly to the surface of human skin spans a tremendous range. Absorption rates of 21 pure organic compounds were shown to range over one thousand fold (Feldman and Maibach, 1970). Dermal absorption of chemicals from soil and dust adhering to the surface of the skin spans an even greater range than direct absorption. For this risk assessment, inorganic chemicals were assumed to be absorbed at a rate of 0.1 percent for the

average case and 1 percent for the RME case, as recommended by EPA Region 10 (1990).

- **Polycyclic Aromatic Hydrocarbons.** Dermal absorption of PAHs was estimated from a study by Wester et al. (1990) in which dermal absorption of benzo[a]pyrene from acetone solution and from soil was measured with *in vitro* and *in vivo* preparations. The *in vivo* percutaneous absorption in rhesus monkeys of 13.2 +/- 3.4 percent was significantly less than the absorption from acetone of 51 +/- 13.2 percent. For this assessment, the average dermal absorption of 13 percent was used for the average exposure and the average plus two standard deviations (20 percent) was used for the RME exposure.

- **Phthalates.** The dermal absorption of bis(2-ethylhexyl)phthalate was assumed to be 50 percent, a conservative assumption since most studies of absorption of hydrophobic organic chemicals have shown absorption of less than 50 percent (Wester et al. 1990, Feldman and Maibach, 1970).

Inhalation Exposures. Concentrations of fugitive dusts in on-site and off-site ambient air, of vapors in off-site ambient air, and of vapors in air inside a future industrial or commercial facility built on the property were estimated using emissions and air transport models. Details of these models are presented below.

The estimated intakes of contaminants absorbed via inhalation exposure were calculated using the following equation:

$$CDI_a = \frac{(C_a)(IR)(EF)(D)(A)}{BW \times AT}$$

where,

CDI_a =	average chemical dose from inhalation (Chronic Daily Intake) in mg/day;
C_a =	chemical concentration in air in mg/m^3;
IR =	inhalation rate in m^3/hr;
EF =	exposure frequency factor in hrs/year;
D =	duration of exposure in years;
A =	inhalation absorption factor (unitless);
BW =	body weight in kg;

AT = averaging time; for carcinogens, equal to the average lifetime, for non-carcinogens, AT equals the duration of exposure (D).

Inhalation exposure factors used in the risk assessment, including ventilation rate, duration and frequency of exposure, and body weight, were taken from EPA Region 10 (1990 and 1991) guidelines for evaluation of industrial exposures. The bioavailability of inhaled chemicals was assumed to be equal to that in the study on which the toxicity factor for the chemical was based (relative bioavailability = 100 percent), with the following exceptions:

- **PAHs.** Average and RME relative bioavailability of 25 and 50 percent was assumed for inhaled dusts, as explained above for ingested soils.

If an absorption factor for inhalation of 100 percent was used, it would result in a risk estimate twice as high (refer to uncertainty discussion on page G-21).

Exposures from Ingestion of Fish. Concentrations of chemicals of concern in fish in Blair and Hylebos waterways due to groundwater discharge into these water bodies were estimated from the average and 95% CL concentrations in on-site groundwater. Transport models used to calculate the discharge rate of contaminants into the waterways and the equilibrium concentrations in fish tissue are described below. All exposure factors used to calculate doses from ingestion of fish, including quantity of fish consumed, body weight, and frequency and duration of exposure, were consistent with EPA Region 10 (1990) guidance. The estimated chronic daily intakes (CDIs) of contaminants due to ingestion of contaminated fish from Fife Ditch were calculated using the following equation:

$$CDI_f = \frac{(C_f)(IR)(EF)(D)}{BW \times AT}$$

where,

CDI_f = average chemical dose from ingestion of fish (Chronic Daily Intake) in mg/day;
C_f = chemical concentration in fish edible tissue in mg/kg;
IR = fish consumption rate in kg/day;
EF = exposure frequency (dietary fraction) in percent;
D = duration of exposure in years;

BW = body weight in kg;
AT = averaging time; for carcinogens, equal to the average lifetime, for non-carcinogens, AT equals the duration of exposure (D).

Toxicity Assessment

This section describes the methodology developed by EPA to evaluate human health effects of chemicals and summarizes the toxicity values which have been developed by EPA for evaluation of exposure to these chemicals. Toxicity profiles for the chemicals of concern are presented in Appendix H. Regulatory criteria that have been developed for protection of human health and for protection of aquatic organisms are also described in those profiles.

The procedure used to evaluate health risk depends upon whether non-carcinogenic or carcinogenic responses (toxicological endpoints) are used to assess potential risks. These criteria, in turn, are based on the toxic effect observed in laboratory or epidemiological studies with the chemicals. Some chemicals of concern may exhibit both non-carcinogenic and carcinogenic effects; however, in most cases the EPA developed toxicity criteria only for the effect occurring at the lowest dose, i.e., the most sensitive endpoint.

Health Effects Criteria for Non-Carcinogenic Chemicals. Reference doses (RfDs) developed by the EPA RfD Work Group, obtained from Health Effects Assessments (HEAs) are generally used as health criteria for chemicals exhibiting non-carcinogenic effects. The RfD, expressed in units of mg/kg-day, is an estimate of the maximum human chronic daily exposure level that is likely to be without an appreciable risk of deleterious effects during a lifetime. RfDs are usually derived either from human studies involving work place exposures or from animal studies, and are adjusted using uncertainty and modifying factors, as described in Barnes et al. (1987). The RfD provides a benchmark against which human intakes of chemicals estimated for exposures to contaminated environmental media may be compared.

Certain inhalation toxicity factors are presented by EPA as a reference concentration (RfC) in mg/m^3 rather than as an RfD in mg/kg-day. In this report, RfCs were converted to RfDs by assuming inhalation of 20 m^3/day of air by a 70-kg individual.

Health Effects Criteria for Potentially Carcinogenic Chemicals. The risk associated with a chemical classified by EPA as a potential human carcinogen is evaluated differently from a non-carcinogen. The upper-bound cancer risk associated with a given dose is calculated by multiplying the dose from a given route of exposure by a cancer potency factor or cancer slope factor (q_1*). These factors are derived from the results of chronic animal bioassays or human epidemiological studies and are expressed in units of $(mg/kg\text{-}day)^{-1}$. Certain cancer potency factors are expressed by EPA as a unit risk in $(\mu g/m^3)^{-1}$. For use in this assessment, unit risks were converted to a cancer slope factor by assuming inhalation of 20 m^3/day by a 70-kg individual.

Animal bioassays are usually conducted at dose levels that are much higher than those likely to be encountered by human exposure to environmental media, in order to detect possible adverse effects in the small test populations used in these studies. Since humans are generally exposed at lower doses, the data are adjusted using mathematical models of the dose-response curve. A linearized multistage model is typically fitted to data from animal studies to obtain a dose-response curve. The 95th percentile upper confidence limit of the slope of the dose-response curve is subjected to various adjustments and an interspecies scaling factor is usually applied to derive a cancer potency factor for humans. Dose-response data derived from human epidemiological studies are fitted to dose-time-response curves to derive a cancer slope factor. In both types of analysis, health conservative assumptions are applied and the models provide estimates of the upper limits on lifetime risk. The actual risks associated with exposure to a potential carcinogen are not likely to exceed the risks estimated using slope factors, but may be much lower and may even be zero.

EPA assigns weight-of-evidence classifications to potential carcinogens. Under this system, chemicals are classified as either Group A, Group B1, Group B2, Group C, Group D, or Group E. Group A chemicals (known human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer. Groups B1 and B2 chemicals (probable human carcinogens) are agents for which there is limited (B1), or inadequate (B2) evidence of carcinogenicity from human studies, but for which there is sufficient evidence of carcinogenicity from animal studies. Group C chemicals (possible human carcinogens) are agents for which there is limited evidence of carcinogenicity in animals, and Group D chemicals (not classified as to human carcinogenicity) are agents with

inadequate human and animal evidence of carcinogenicity or for which no data are available. Group E chemicals (evidence of non-carcinogenicity in humans) are agents for which there is no evidence of carcinogenicity in adequate human or animal studies.

Use of Chronic Toxicity Values. For the purposes of the present assessment, the toxicological characterization of indicator chemicals was generally confined to chronic (i.e., lifetime) exposures. It is recognized, however, that shorter term exposures to contaminants, such as those resulting from episodic releases of high concentrations, could also occur. While shorter term toxicity criteria (e.g., subchronic RfD values) are not discussed or presented in this risk assessment, it is assumed that use of a chronic toxicity value will be adequately conservative to address less than chronic exposures (EPA, 1989). The types of exposures likely at the Blair Backup property (e.g., contact with soils by workers, inhalation of vapors) are also more appropriately addressed in the context of long-term cumulative (i.e., chronic) doses.

Oral and Inhalation Toxicity Values. Important differences exist in the disposition of chemical compounds in the body following different routes of exposure, due in part to physiologic and pharmacokinetic factors. However, when toxicologic information for a particular exposure route is unavailable (usually for dermal or inhalation exposures) it may be appropriate to assume similar physiological processes (e.g., absorptivity and metabolism) for both exposure pathways and to utilize the existing value (usually for oral exposure) to represent the other exposure pathways. In this assessment, risks associated with dermal exposures were evaluated using oral toxicity factors, since EPA has not developed dermal toxicity criteria. Oral toxicity values were not used to evaluate inhalation exposures due to the increased uncertainty added to the risk assessment by this extrapolation step.

Selection of Toxicity Values for Chemicals of Potential Concern. The RfD and q_1* values used in this risk assessment are summarized in Tables G-2 and G-3, respectively. Toxicological profiles describing the bases of these values are presented in Appendix H.

Toxicity criteria listed in the EPA Integrated Risk Information System (IRIS; EPA, 1991a) are regarded as "verified", in as much as they represent a consensus of the major scientific entities within EPA. For those chemicals of potential concern for which no value has been

published in IRIS, toxicity criteria were obtained from EPA Health Effects Assessment (HEA) documents or summary tables or from the EPA Office of Drinking Water (ODW) health advisories. These criteria do not represent as broad a consensus within the EPA and are not regarded as verified.

It should be noted that chromium detected at the property was assumed to be present in a 50:50 ratio of trivalent to hexavalent forms for calculation of cancer risk from inhalation based on slag mineralogy data as presented in Attachment F-2 of Appendix F. For calculating non-carcinogenic toxicity via inhalation, the form of the Cr is not important, since the inhalation RfDs for Cr(VI) and Cr(III) are equal. For the fish ingestion pathway, the RfD for Cr(III) was used to evaluate non-carcinogenic risk, because Cr(VI) would be converted to Cr(III) in fish tissue.

Dermal exposure to PAHs was not evaluated quantitatively in this last assessment, because PAHs are direct-acting carcinogens (i.e., the effect of concern is skin cancer), and it is not appropriate to use an oral toxicity factor to evaluate dermal exposures to such chemicals.

Adjustments were made in carcinogenic and non-carcinogenic toxicity factors to assure that the site exposure estimate and the toxicity value were both expressed as intakes (also called administered doses) or both expressed as absorbed doses (EPA, 1989). The following adjustments were made for this purpose:

- **Arsenic.** The oral RfD and cancer slope factors for arsenic are based on absorbed doses from epidemiological studies (EPA, 1991a). Thus, estimated exposures to ingested arsenic in soil and sediments were multiplied by a factor of 0.4 for both the average and RME cases, based on a recommended value for arsenic absorption of 40 percent from Ecology (1991b).

  The inhalation cancer slope factor for arsenic was derived from epidemiological studies in humans and is based on an absorbed rather than administered dose. A pulmonary absorption rate of 30 percent was assumed in deriving the cancer slope factor (EPA, 1984a). According to EPA (1989) guidance, the inhalation intake should be adjusted to reflect this factor.

- **Dermal Exposure: All Chemicals.** Since an absorbed dose is calculated for dermal exposure, toxicity factors that are based on administered doses were adjusted to an absorbed dose factor by multiplying the oral RfD by the oral absorption rate, or by dividing the oral cancer slope factor by the oral absorption rate (EPA, 1989). The oral absorption rates assumed in this assessment, and the bases for these assumptions, are as follows:

PAHs	100%	NAS, 1981
bis(2-ethylhexyl)phthalate	5%	Default assumption (EPA, 1989)
cadmium	5%	EPA, 1991a
chromium	20%	Gregus and Klaassen, 1986
copper	20%	Gregus and Klaassen, 1986
manganese	5%	Default assumption (EPA, 1991a)
mercury	5%	Default assumption (EPA, 1991a)
nickel	5%	Default assumption (EPA, 1991a)
zinc	20%	Gregus and Klaassen, 1986

Oral absorption rates for chromium, copper, and zinc ranging from 20 to 50 percent were measured by Gregus and Klaassen (1986). The 20 percent value used in this report will thus provide a conservative assessment of risk. Toxicity factors for arsenic were not adjusted for comparison with dermal exposure since these are already expressed as absorbed dose factors.

Human Health Risk Assessment

In this section, the methodology used to estimate intakes of the chemicals of potential concern is discussed, potential carcinogenic and non-carcinogenic risks are estimated, and multipathway exposures to potentially exposed human populations are evaluated.

Carcinogenic Risk Assessment Methodology

For carcinogens, baseline risk is presented as the increase in the probability of contracting some form of cancer over a lifetime, above and beyond the national average cancer rate found in the general population. These excess lifetime cancer risks are obtained by

multiplying the daily dose (D) or chronic daily intake (CDI) of the contaminant under consideration by its cancer slope factor (q_1^*).

$$Risk = D * q_1^*$$

Where:

Risk — Lifetime Excess Cancer Risk; the probability of contracting cancer over a lifetime of exposure to a contaminant which is in excess of the national average cancer rate, unitless.

D — Chemical Dose; the amount of a chemical penetrating the exchange boundaries of an organism over a lifetime (e.g., skin or gastrointestinal tract) in mg/kg-day. Also referred to as the Chronic Daily Intake (CDI).

q_1^* — Slope Factor; the upper-bound estimate of the probability of a cancer response per unit of intake of a chemical over a lifetime in $(mg/kg\text{-}day)^{-1}$

According to EPA guidance (EPA, 1989), the risk equation shown above is appropriate for excess cancer risks of less than 10^{-2} (i.e., 1 excess cancer in every 100 individuals exposed throughout their lifetime). When the daily intakes are large, the linear approach described above is not valid. For excess lifetime cancer risks greater than 10^{-2}, individual cancer risks are calculated by the following equation:

$$\text{Excess Lifetime Cancer Risk} = 1 - \exp(-D \times q_1^*)$$

Since more than one potentially carcinogenic chemical is present at the Blair Backup property, the total potential risk will be estimated by summing the potential risks for the individual chemicals, as suggested in EPA's guidance document for chemical mixtures (EPA, 1986b). All chemicals with known or potential carcinogenic effects are summed regardless of their weight of evidence factors, (e.g., Group A, B2, C).

Regulatory guidelines of "acceptable" upper-bound cancer risks to protect the health of the public, including sensitive individuals, normally range from approximately 10^{-4} to 10^{-6}, or a probability of 1 in 10,000 to 1 in 1,000,000 of developing cancer due to lifetime exposure to a

carcinogen (EPA, 1988c). The general target for lifetime cancer risks under the RME scenario is 10^{-6}, or 1 in 1,000,000.

Non-carcinogenic Risk Assessment Methodology

Potential risks are assessed for non-carcinogens by calculating the ratio of the CDI to the reference dose (CDI:RfD). In general, if the CDI:RfD ratio is less than one (i.e., if the daily intake is below the designated EPA health criterion), the contaminant is considered unlikely to be associated with any significant health risks. It is, therefore, projected to be less likely to be of regulatory concern than a chemical with a CDI:RfD ratio greater than one.

Toxic effects of non-carcinogenic chemicals are initially assumed to be additive, in accordance with EPA guidance on health risk assessment of complex mixtures (EPA, 1986b). For each scenario, the CDI:RfD ratios for each individual chemical are summed to produce a Hazard Index for total toxic risks. If the Hazard Index is less than one, the combined intake of chemicals by the exposure route under consideration is unlikely to pose a health risk. If the Hazard Index exceeds one, the chemicals are generally subdivided according to their toxicological endpoints (e.g., kidney effects), and the risk for each endpoint is considered separately (EPA, 1989).

Chronic daily intakes (CDIs), excess lifetime cancer risks, and CDI:RfD ratios for the chemicals of potential concern considered in this assessment are discussed below for each scenario that was quantitatively evaluated.

Quantification of Human Health Risks

Potential human health risks were evaluated for each of the pathways identified in Section 7.3. Chronic daily intakes and risks for these exposure scenarios are presented in tables in this appendix. The results of the human health risk assessment are summarized below.

Potential Current-Use Risks

Inhalation by Off-site Workers of Airborne Vapors. Average and RME chronic daily intakes and risk estimates for inhalation of volatile organic chemicals and fugitive dust by off-site workers are presented in Tables G-6 and G-7, for the North Site and OFA/Pennwalt Areas, respectively.

Risks were estimated for a receptor located at the Pennwalt Ag-Chem facility northeast of the property. Combined potential lifetime excess cancer risks from vapors generated from the two areas were 5×10^{-9} for the average exposure and 3×10^{-8} for the RME exposure. The risk was due to vinyl chloride at the North Site Area and benzene at the OFA/Pennwalt Area. Both of these chemicals are known (Group A) human carcinogens. The Hazard Index for total non-carcinogenic effects did not exceed unity for the combined exposure to the two sources; thus, no adverse non-carcinogenic health effects are expected for this pathway.

The estimated risks for exposure to VOCs in air may be put into perspective by comparing the estimated air concentrations with typical ambient air concentrations. For example, Shah and Singh (1988) reported average U.S. outdoor air concentrations of 3.2 ppbv (8.9 $\mu g/m^3$) vinyl chloride and 2.8 ppbv (9.8 $\mu g/m^3$) benzene. These measurements represented a combination of rural, urban, and industrial environments. The ambient levels may be compared to the RME outdoor air concentrations estimated in this report for off-site workers: 0.001 $\mu g/m^3$ vinyl chloride and 0.005 $\mu g/m^3$ benzene. Thus, the estimated exposure point concentrations for the site are three orders of magnitude lower than average concentrations in ambient air.

Inhalation by Off-site Workers of Airborne Dusts. Average and RME chronic daily intakes and risk estimates for off-site workers inhaling particulates emitted from on-site soils are presented in Tables G-8, G-9, and G-10 for the General/Fill, North Site, and OFA/Pennwalt Areas, respectively. Risks were estimated for a receptor located at the Pennwalt Ag-Chem facility northeast of the property. Combined potential lifetime excess cancer risks from inhalation of particulates generated from all three areas were 1×10^{-7} for the average exposure and 7×10^{-7} for the RME exposure. Most of the carcinogenic risk was associated with hexavalent chromium. The chromium detected in site soils was assumed to exist in a 50:50 ratio of trivalent to the hexavalent form based on slag mineralogy data (as presented in Attachment F-2 of Appendix F). Chromium (VI) is a known (Group A) human carcinogen, while chromium (III) is not considered to be carcinogenic. Arsenic and carcinogenic PAHs from the OFA/Pennwalt Area also contributed to the total potential cancer risk.

The Hazard Indices for average and RME non-carcinogenics were less than one for inhalation of combined fugitive dusts from the three areas of the site.

The fugitive dust emissions models and the SCREEN model used to estimate emissions and dispersion of dusts from on-site soils are screening-level models which use simplifying assumptions to estimate the generation and transport of particulates. These models produce conservative estimates of dust generation and annual average air concentrations, respectively, and are likely to overestimate the true risk from this exposure pathway.

Potential Future Commercial/Industrial Use Risks

Inhalation of Airborne Vapors by Future On-Site Workers. Average and RME chronic daily intakes and risk estimates for inhalation of vapors in indoor air by future on-site workers are presented in Tables G-11 and G-12 for the North Site and OFA/Pennwalt Areas, respectively. For workers in the North Site Area, potential upper-bound lifetime excess cancer risks were 1×10^{-5} for the average case and 2×10^{-5} for the RME case. The majority of the potential risk in both cases was from vinyl chloride, a known (Group A) human carcinogen. For future workers at a building in the OFA/Pennwalt Area, the cancer risks were 7×10^{-7} for the average case and 1×10^{-6} for the RME case. The non-carcinogenic Hazard Index did not exceed unity for the OFA/Pennwalt Area; thus, adverse non-carcinogenic health effects are not expected for this exposure. Non-carcinogenic risks were not evaluated for the North Site Area, since no volatile chemicals of potential concern with inhalation toxicity factors were detected in groundwater in this area.

Inhalation of Airborne Dusts by Future On-Site Workers. Average and RME chronic daily intakes and risk estimates for inhalation of dusts by future on-site workers are presented in Tables G-13, G-14, and G-15 for the General/Fill, North Site, and OFA/Pennwalt Areas, respectively. Risks were calculated separately for each of the three on-site areas, although actual exposures would be a combination of risks from the three areas due to dust dispersion across the site. Potential average and RME lifetime excess cancer risks for the General/Fill Area were 3×10^{-7} and 1×10^{-6}. At the North Site Area, corresponding excess cancer risks were 4×10^{-7} and 2×10^{-6}.

For the OFA/Pennwalt area, potential risks were estimated using an unlimited dust emission model. In addition, risks were evaluated using two data sets: one which contained the samples taken from surficial charcoal materials on the site and one omitting samples from a proposed interim source removal action area. The purpose of this comparison is to determine the potential future risks if the discrete areas of charcoal are remediated. The carcinogenic risks in this area are due primarily to chromium, arsenic, and carcinogenic PAHs. Average and RME risks from the four sets of calculations are as follows:

- Unlimited reservoir model - with charcoal: 5×10^{-6} and 3×10^{-5}
- Unlimited reservoir model - without charcoal: 5×10^{-6} and 2×10^{-5}

The Hazard Index for total non-carcinogenic health effects exceeded unity only for the OFA/Pennwalt area. Average and RME Hazard Indices exceeded unity in all cases. The exceedences were due primarily to chromium.

The risk was associated primarily with chromium. The other two non-carcinogenic indicator chemicals evaluated for airborne dust exposures (manganese and mercury) do not have the same toxicological endpoint as chromium and thus would not have a cumulative effect on the risk from inhalation of chromium. The critical effects of chromium are damage to the nasal mucosa (EPA, 1991c), while manganese and mercury have systemic effects on the respiratory system and nervous system, respectively (EPA, 1991a).

As noted above, the screening-level empirical models used to estimate dust generation produce conservative estimates that are likely to overestimate dust emissions and therefore risk, at the property.

Direct Contact with Soils by Future On-Site Workers. Average and RME chronic daily intakes and risk estimates for direct contact by future workers with soils are presented in Tables G-16, G-17, and G-18 for the General/Fill, North Site, and OFA/Pennwalt Areas, respectively. Average and RME excess cancer risks for the General/Fill Area were 1×10^{-7} and 2×10^{-6}, associated with carcinogenic PAHs and arsenic. The Hazard Index was less than unity for both the average and RME cases. At the North Site Area, potential excess lifetime cancer risks of 7×10^{-7} and 6×10^{-6} were primarily due to arsenic and PAHs. The Hazard Index did not exceed unity for either case. At the

OFA/Pennwalt Area, potential cancer risks of 3×10^{-5} and 6×10^{-4} were primarily associated with PAHs. If PAH-containing charcoal is removed from the site, the risks would fall to 3×10^{-6} and 3×10^{-5} for the average and RME cases, respectively. The Hazard Index did not exceed unity for either case.

Direct Contact with Contaminated Sediments by Future On-Site Workers. Average and RME chronic daily intakes and risk estimates for dermal contact and incidental ingestion of sediments in the Pennwalt Ag-Chem Ditch and OFA Ditch are presented in Tables G-19 and G-20. Potential excess lifetime cancer risks from exposure to Pennwalt Ag-Chem Ditch sediments were 2×10^{-7} and 2×10^{-6} for the average and RME cases, due primarily to arsenic, a known (Group A) human carcinogen and to carcinogenic PAHs, which are possible (Group B2) carcinogens. The Hazard Index for this scenario did not exceed unity in either case. Potential excess cancer risks from exposure to OFA Ditch sediments were 1×10^{-6} and 1×10^{-5} for the average and RME cases, respectively, also due primarily to arsenic. The Hazard Index for this scenario did not exceed unity in either case.

Potential Risks from Off-Site Groundwater and Surface Water Transport

Ingestion of Fish from Blair and Hylebos Waterways. Average and RME chronic daily intakes and risk estimates for persons potentially consuming fish from Hylebos and Blair waterways on a regular basis are presented in Tables G-21 and G-22. Potential lifetime excess cancer risks for ingestion of fish from the Hylebos Waterway were 1×10^{-9} for the average case scenario and 1×10^{-7} for the RME scenario. The majority of risk in both cases was due primarily to arsenic. Potential excess lifetime cancer risks for ingestion of fish from the Blair Waterway were 7×10^{-10} and 8×10^{-8} for the average and RME cases, respectively. As in the case of the Hylebos Waterway, the majority of the cancer risk was due to arsenic.

The Hazard Index for total non-carcinogenic health effects did not exceed one for the average or the RME case in either waterway, indicating that adverse non-carcinogenic health effects are not likely to be associated with this route of exposure.

It should be noted that the model used to predict surface water concentrations did not incorporate losses from the water column due to

precipitation, sedimentation, volatilization, or biological decay, and is therefore likely to overestimate steady-state concentrations of these chemicals both in the surface water and in the fish.

Qualitative Evaluation of Potential Risks to Trespassers

Risks to individuals trespassing on the property will vary depending on the frequency of entry and the extent of contact with site media. Based on the risks from inhalation of dusts and direct contact with soils for a future on-site worker, a trespasser entering the site a few days per year would not be exposed to unacceptable cancer risks from dust inhalation. However, a trespasser frequenting the site on a regular basis (e.g., once a week) could have some risk under the RME exposure.

Evaluation of Multipathway Risks for the Blair Backup Property

Total potential upper-bound lifetime excess cancer risks for a current worker at an adjacent industrial facility from inhalation of vapors and particulates from the Blair Backup property are 1×10^{-7} and 7×10^{-7} for the average and RME cases, respectively. The majority of the risk is associated with inhalation of chromium, arsenic, and PAHs in fugitive dust from the OFA/Pennwalt Area. Hazard Indices for total non-carcinogenic effects do not exceed unity for total exposure via inhalation. Exposures from inhalation of vapors and from ingestion of fish from the Hylebos or Blair waterways (assuming that these are consumed by industrial workers) do not contribute substantially to the total carcinogenic or non-carcinogenic risk.

Average and RME total potential lifetime excess cancer risks to workers in a future commercial or industrial facility in the OFA/Pennwalt area are 3×10^{-5} and 6×10^{-4}, assuming that charcoal materials are not removed from the site. If charcoal materials are removed, the total potential average and RME risks would be 9×10^{-6} and 5×10^{-5}. These risks are due primarily to direct contact with carcinogenic PAHs and arsenic in surface soils. The Hazard Index for total non-carcinogenic effects exceeds unity for both the average and RME cases. The majority of the non-carcinogenic hazard is due to inhalation of total chromium in dust. Direct contact with sediments and inhalation of vapors in indoor air did not contribute significantly to the carcinogenic or non-carcinogenic risk.

Average and RME total potential lifetime excess cancer risks to workers in a future commercial or industrial facility in the General/Fill Area are 4×10^{-7} and 3×10^{-6}. These risks are due primarily to inhalation of hexavalent chromium in dust and direct contact with carcinogenic PAHs in soil. The Hazard Index for total non-carcinogenic effects did not exceed unity for either case.

Average and RME total potential lifetime excess cancer risks to workers in a future commercial or industrial facility in the North Site Area are 1×10^{-5} and 3×10^{-5}. These risks are due primarily to inhalation of vinyl chloride emitted from groundwater. The Hazard Index for total non-carcinogenic effects did not exceed unity for either case.

Total potential lifetime excess cancer risks to off-site residents from ingestion of fish are estimated to be approximately 1×10^{-9} for the average case and 1×10^{-7} for the RME case. No other exposure pathways were identified for residents that would result in an increase in the multipathway risk.

Uncertainties in the Human Health Risk Assessment

The procedures and inputs used to assess potential human health risks in this evaluation are subject to a number of uncertainties. General areas in which uncertainties are introduced into the risk estimates include:

- Environmental chemistry sampling and analysis;
- Environmental parameter measurements;
- Fate and transport modeling;
- Exposure parameter assumptions; and
- Toxicological data and dose-response extrapolations.

Uncertainty in environmental chemistry sampling and analysis can stem from the procedural error collection of an inadequate number of samples to arrive at sufficient areal resolution, or from the heterogeneity of the matrix being sampled. Data validation procedures were applied to the Blair Backup property data to demonstrate that the precision and accuracy of the data are within acceptable limits. In general, the measurement variability of the chemical analyses is a minor contributor to the total uncertainty of the risk assessment, since quality control measures assure that the reported value is within a factor of two or less of the true value. Heterogeneity of the medium is generally a

larger contributor to the total uncertainty, particularly for soils. The 95 percent confidence limit of the mean was used in this assessment in order to assure that concentrations are not underestimated. The comparatively few samples collected from each area of the Blair Backup property produced high standard deviations and therefore a high 95% CL. This value is likely to overestimate the true 95% CL of the concentration distribution and to therefore overestimate risks at the site.

All chemicals of potential concern were not analyzed in all media. For example, soil samples were not analyzed for formaldehyde, and certain inorganics (e.g., molybdenum) were only analyzed in a small number of groundwater samples. Selected data analysis could result in some underestimation of risk from the soil contact, dust inhalation, and fish ingestion exposure routes.

A moderate degree of uncertainty is associated with the characterization of soil contamination at the Blair Backup property. Samples which were collected from discrete waste piles in the General/Fill and OFA Pennwalt Areas were not included in the estimate of exposure point concentrations, because removal of these piles will be included in the land transfer agreement. Therefore, current risks from dust inhalation may be underestimated since higher concentrations of metals from sand-blast grit material is not reflected in the risk estimates. However, these piles are limited in extent and the impact of releases from these piles is expected to be minor.

Some of the soil samples which were used to calculate exposure point concentrations may have been impacted by waste materials dispersed by wind from the sandblast grit piles. Thus, the average and 95% CL may not be representative of site soils and may overestimate risks from soil contact and fugitive dust inhalation.

Chemicals of potential concern were selected based on concentration, comparison to background levels, and available toxicological information. Chemicals that were not selected may contribute to the overall toxicity at the site, and as a result total site risk may be underestimated. However, the impact on the risk estimates is expected to be low, since the majority of chemicals detected at the site, and all known (Group A) human carcinogens, were selected for consideration. A toxicity/concentration screening procedure was used to ensure that the chemicals selected represent at least 95 percent of the nominal hazard associated with each contaminated medium.

Absence of environmental parameter measurements contributes to uncertainty. Estimates must therefore be made based on literature values, regression equations, extrapolations, mathematical models, and best professional judgment. In estimating the mass of VOCs present in soils that could volatilize to ambient air, a soil organic carbon content of 3 percent was assumed as a very conservative value in the absence of site-specific information. This assumption may lead to overestimation of exposures to VOCs.

Environmental modeling contributes to the uncertainty in the risk assessment by incorporating simplifying assumptions as to the behavior of contaminants in the environment. An attempt was made in this risk assessment to use assumptions that would lead to conservative estimation exposure point concentrations.

In modeling emissions of VOCs from shallow groundwater to air, it was assumed that all VOCs present in groundwater will volatilize within a ten-year period. This assumption is likely to underestimate short-term exposures (i.e., those occurring in the first few years of exposure) but is expected to provide a conservatively high estimate of chronic exposures averaged over the exposure period.

The assumption that a future building constructed on the Blair Backup property will have a gas-permeable floor is a highly conservative assumption. Use of common construction techniques which would be reasonably expected to be used on site, such as a vapor barrier, would reduce risks from this pathway substantially.

Assumptions incorporated into the fugitive dust emissions model are likely to overestimate exposures from this pathway. Use of SCREEN to model off-site air concentrations of dusts and vapors is expected to provide a high degree of overestimation of risks. This model assumes worst-case meteorological conditions.

In modeling potential exposures from chemicals transported to the Blair and Hylebos waterways, the assumption was made that concentrations in groundwater will remain constant over a lifetime of exposure. In actuality, depletion of the source via leaching, volatilization, and biological transformation may decrease concentrations of contaminants in the groundwater within a shorter time period. In addition, the model used to calculate surface water concentrations is conservative, since it

assumes that chemicals will not be removed from the water column by volatilization, biological decay, sedimentation, or other processes.

There are inherent uncertainties in determining exposure parameters. For example, there are uncertainties in estimating the likelihood of an individual contacting contaminants at the site, the frequency of contact, and the period of time over which such exposures would occur. All exposure estimates made in this assessment are based on conservative assumptions about human activity patterns in the site area, not on direct observations of the behavior of specific individuals or populations. Exposure is expected to vary widely among individuals.

Assumptions that were made regarding the oral and dermal absorption of chemicals from soil may overestimate or underestimate risks. In general, conservative assumptions were made for those chemicals where experimental data were not available from the literature to estimate absorption. However, the oral absorption of PAHs from soil was estimated based on analogy to TCDD, due to the similar physico-chemical properties of the two groups of compounds. This assumption could possibly underestimate risk if the extent of absorption in the study used to establish the toxicity of PAHs (chemical applied in a food medium) is different from that in the TCDD study (chemical applied in corn oil). If an absorption for PAHs of 100 percent from soil were assumed rather than 50 percent, risks for some scenarios would increase by a factor of 2 or less.

Assumptions were also made regarding the inhalation absorption of PAHs which may underestimate risk. A 50 percent absorption factor for inhalation of PAHs adhered to soil particles was assumed. Use of a higher absorption estimate such as 100 percent, would result in a risk estimate twice as high.

Carcinogenic risk from dermal absorption of PAHs was not evaluated quantitatively in the assessment because these compounds are known to exhibit their carcinogenic effect at the point of contact. Use of an oral toxicity factor is not appropriate for such chemicals and EPA has not developed dermal toxicity factors. Therefore, the total carcinogenic risk from dermal contact with soils and sediments may be underestimated in this assessment.

Toxicological data are a large source of uncertainty in this risk assessment. The results of animal studies are often used to predict the

potential health effects of a chemical in humans. Extrapolation of toxicological data from animal tests is one of the largest sources of uncertainty in a risk assessment. There may be important, but unidentified, differences in uptake, metabolism, and distribution of chemicals in the body between the test species and humans. Typically, animals are administered high doses of a chemical in a standard diet. Humans, on the other hand, may be exposed to much lower doses in a highly variable diet. In these studies, animals, usually laboratory rodents, are exposed daily to the chemical agent for various periods of time up to their 2-year lifetime. Humans have a 75-year lifetime and may be exposed either intermittently or regularly for an exposure period ranging from months to a full lifetime. Even if studies in humans are available, uncertainties can be large because the diet, activity patterns, exposure duration and frequency, and individual susceptibility may not be the same in the study populations as in the individuals exposed to environmental concentrations.

Cancer potency factors used in this assessment are generally upper-bound estimates of risk. Actual risks are not likely to be higher than these estimates, but could be considerably lower, and could even be zero. This is an important factor contributing to the conservative nature of the risk assessment procedures used in this report.

Summation of cancer risks for chemicals with different weight of evidence classifications increases the uncertainty in the risk analysis. For this assessment, potential cancer risk from inhalation of chemicals volatilizing from shallow groundwater and particulates in fugitive dust were due primarily to vinyl chloride, benzene, arsenic, and chromium (VI), which are known (Group A) human carcinogens. Thus, little uncertainty was contributed to the risk assessment by these toxicity factors. However, carcinogenic PAHs, which also contributed significantly to the overall risk, are in Group B2, and a higher degree of uncertainty is associated with these toxicity factors.

Non-carcinogenic toxicity factors (RfDs or RfCs) are derived by EPA by multiplying a lowest observed adverse effect level (LOAEL) or no observed adverse effect level (NOAEL) by uncertainty and modifying factors. The RfCs for inhaled trivalent and hexavalent chromium have an associated uncertainty factor of 300 (EPA, 1990), meaning that the RfC is set at a level 300 times lower than the LOAEL from the epidemiological study on which the RfC was based. Therefore, the RfC may overestimate the toxic effects of exposure to chromium by as much

as 300 times. Uncertainty factors for other indicator chemicals range from 1 to 10,000.

Inhalation toxicity factors have not been developed by EPA for most of the chemicals of potential concern at the site, and the risks associated with inhalation of these chemicals were not evaluated in this assessment. Therefore, risks from inhalation exposures may have been underestimated. No inhalation RfD was available for non-carcinogenic PAHs; thus, risks from inhalation of fugitive dusts from the OFA/Pennwalt Area may have been underestimated.

Emissions of Volatile Organic Chemicals from Groundwater

Emissions of volatile organic chemicals (VOCs) from shallow groundwater into the ambient air were estimated by using the conservative assumption that the entire mass of each chemical currently present in the shallow aquifer will volatilize to the air during the shortest exposure period considered for the scenario (10 years for industrial exposures). The estimated total mass of each volatile chemical was divided by the number of seconds in a 10-year period, to obtain a chemical-specific emission factor, in mg/sec.

The mass of each VOC of potential concern present in the shallow aquifer was estimated by assuming that the groundwater within each site area is uniformly contaminated with the average or 95% CL concentration of the chemical. The masses of VOCs present in water (M_w) and adsorbed to soil (M_s) were calculated using the following equations:

$$M_w = C_w * A * b * p_T * CONV_1$$

Where

M_w = mass of chemical in water phase in mg,
C_w = average or 95% CL concentration in groundwater in mg/L,
A = surface area of site in m^2,
b = average saturated thickness of aquifer in m,
p_T = total porosity, unitless, and
$CONV_1$ = conversion factor - 1,000 L/m^3.

and

$$M_s = C_w * A * b * B* (1-p_T) * K_D * CONV_2 * CONV_3$$

Where

M_s = mass of chemical in soil phase in mg,

C_w	=	average or 95% CL concentration in groundwater in mg/L,
A	=	surface area of site in m^2,
b	=	average saturated thickness of aquifer in m,
B	=	bulk density of aquifer material in g/cm^3,
p_T	=	total porosity, unitless,
K_d	=	soil/water distribution coefficient in L/kg,
$CONV_2$	=	conversion factor - 0.001 kg/g, and
$CONV_3$	=	conversion factor - 10^6 cm^3/m^3.

Distribution coefficients (K_ds) for the chemicals of potential concern were estimated from literature values of the soil organic carbon coefficient (K_{oc}) using the formula:

$$K_d = K_{oc} * f_{oc}$$

where f_{oc} is the fraction of organic matter in the soil. Soil organic carbon contents have not been measured at the site and are expected to be highly variable, due to the wood debris and other organic materials incorporated into the surface soils. A f_{oc} of 0.03 (3 percent) was used in the assessment as a conservative estimate of the mean f_{oc} in shallow aquifer soils.

Masses of each chemical present in groundwater in the North Site and Ohio Ferro-Alloy/Pennwalt Areas are shown in Table G-23. Volatilization was not estimated for the General/Fill Area since the only volatile chemical of potential concern detected was toluene, which was detected at a low level (9 μg/L) in only one of 14 monitoring wells in this area. Based on this fact, it was concluded that groundwater within the General/Fill Area generally is not contaminated by volatile organic compounds.

Emissions of Fugitive Dusts from Surface Soils via Wind Erosion

Emissions of fugitive dusts from surface soils were estimated using a conservative empirical model developed by Cowherd et al. (1985) to predict wind erosion of respirable particulates of less than 10 μm diameter (PM_{10}) from surface soils. The first step in estimating PM_{10} emissions is the classification of the soil surface as having either a "limited reservoir" or and "unlimited reservoir" of erodible particles. Different equations are used to determine the wind erosion from these two classes of soil surfaces. Based on the particle size distribution tests

presented in Appendix A, more than 60 percent of surface soils fell into the <1 mm size range. By this criterion, soils at the Blair Backup property should be analyzed by the "unlimited reservoir" model (Cowherd et al., 1985). The equation for this model is as follows:

$$E_{10} = 0.036 * (1-v) * ([u]/u_t)^3 * F(x) * CONV * \frac{(365-P)}{365}$$

Where

E_{10}	=	PM_{10} emission factor, i.e., annual average PM_{10} emission rate per unit area of contaminated surface in gm/m^2-sec,
v	=	fraction of surface covered by a combination of vegetation, ponded water, buildings, and pavement (equals 0 for bare soil),
[u]	=	mean annual wind speed in m/sec,
u_t	=	threshold value of wind speed at 7 m in m/sec,
x	=	0.886 u_t /[u], dimensionless ratio,
F(x)	=	function plotted on Figure 4-3 of Cowherd et al., (1985),
P	=	number of days per year with precipitation exceeding 0.01 inch, and
CONV	=	conversion factor, 3600 sec/hr.

Entrainment of particles into air is dependent on wind speed. For a given soil type there is a threshold wind velocity which must be attained to initiate entrainment. This threshold velocity can be estimated from the mode of the particle size distribution of the surface materials. The mode of the distribution was estimated by averaging the D_{50} values from four surface soil samples from the North Site, Ohio Ferro-Alloy/Pennwalt and General/Fill Areas, which are presented in Appendix B. These D_{50} values ranged from 0.33 to 0.39 mm and had an arithmetic mean of 0.36 mm. A fifth sample taken in the North Site Area had a D_{50} of 0.06 mm - this fine-grained material does not appear to be representative of site soils and was not included in the average. Other values and assumptions used in the Cowherd model are summarized in Table G-4.

To obtain the chemical-specific PM_{10} emission rate due to wind erosion, Q_e, the PM_{10} emission factor is multiplied by the weight fraction of the chemical measured in soil:

$$Q_c = WF * E_{10}$$

Where

Q_c	=	emission flux of contaminant in mg/m^2-sec,
WF	=	weight fraction of chemical in soil in mg/mg, and
E_{10}	=	PM_{10} emission rate due to wind erosion in mg/m^2-sec.

Wind Dispersion of Dusts and Vapors to On-Site and Off-Site Receptors

The EPA-approved SCREEN computer dispersion model was used to estimate the downwind concentrations of contaminants emitted from the affected area. SCREEN is by definition a worst-case screening tool. Its algorithm automatically selects the worst-case dispersion conditions related to the distance from the emission source. The agencies have accepted that SCREEN will always predict higher downwind impacts than would actually occur.

The following assumptions were used to estimate the downwind concentrations:

- The area sources are modeled as square areas;
- The emission release height is zero (ground surface);
- Receptor height is 1.5 meters; and
- Worst-case receptors are placed at the downwind edge of the emission area.

SCREEN predicts the worst-case one-hour impact. The calculated 1-hour ambient concentration produced by SCREEN is adjusted for the worst-case annual average by multiplying by a 0.15 scaling factor. That factor is mandated by Puget Sound Air Pollution Control Agency for use in modeling the impacts of toxic air pollutants.

Indoor Vapor Concentrations - Future Commercial/Industrial Facility

Emissions of VOCs from on-site groundwater were estimated using the procedure described above. A one-compartment model of soil gas infiltration was used to estimate indoor air concentrations of VOCs

within a future industrial or commercial building located on the Blair Backup property. This model assumes that the infiltrating gas is uniformly and instantaneously mixed within the entire air space of the building. The indoor air concentration is the ratio of the infiltration rate and the rate at which indoor air is exchanged with outdoor air.

The concentrations of VOCs in indoor air due to entry of soil gas into a building depend on the flux of VOCs from the soil, the floor area and volume of the building, and the rate of air exchange between indoor and outdoor air. Much of the information on soil gas infiltration is derived from research on radon migration into residences. Models developed for predicting radon migration may be adopted to estimate transport of volatile organics, by omitting terms related to radioactive decay. Indoor air concentrations may be estimated using the following model:

$$IAC = \frac{(Qc * A * F)}{(ACH/3600)} * V$$

Where

IAC	=	indoor air concentration in mg/m^3,
Q_c	=	chemical flux from soil gas in gm/m^2-sec,
A	=	area of crawlspace in m^2,
F	=	fraction of soil gas flux entering building,
ACH	=	air changes per hour in hr^{-1},
3600	=	seconds/hour, and
V	=	volume of air in building in m^3.

The rate of soil gas infiltration into a hypothetical industrial or commercial structure built on the site would depend on the type of structure, the construction materials and methods, and on factors relating to building usage (e.g., heating, ventilation). Buildings with basements and crawlspaces tend to exhibit the highest infiltration rates (Mueller et al., 1988); however, these types of construction are currently not likely to be used in new construction, given the shallow water table in the area. However, risks associated with a permeable floor building will be evaluated in order to provide a conservative estimate of potential maximum risks.

The structure was assumed to be a building constructed over a perimeter foundation with a gas-permeable floor. The area of infiltration of this building was assumed to be the total floor area minus a 1-meter-wide perimeter wall, which equals 2,300 m^2. The air exchange rate, expressed as the number of air changes per hour (ACH), is a function of temperature and pressure differences between the indoor and outdoor air and the tightness of the structure. ACHs for retrofitted energy-efficient structures generally have ACHs between 0.5 and 0.8, and may be as low as 0.2 for new construction (Mueller, 1988). An ACH of 0.2 was used to provide a conservative estimate of indoor air concentrations. Values used in the indoor air model are summarized in Table G-4.

Surface Water Concentrations: Blair and Hylebos Waterways

Concentrations of the chemicals of concern in Hylebos and Blair waterways were estimated based on measured concentrations in on-site groundwater within the General Fill, Ohio Ferro-Alloy/Pennwalt, and North Site Areas, the hydrologic properties of the Shallow Aquifer, and the directions and rates of flow from each of the three areas into the ditches bordering the property.

The arithmetic mean and 95% CL of on-site groundwater concentrations were used for the average and RME scenarios, respectively. Maximum concentrations were used in place of the 95% CL for those chemicals detected in two or fewer samples.

Aquifer hydrologic properties and flow directions were estimated from slug tests of the Shallow Aquifer at the Blair Backup property and from water level measurements made in September 1990 and in January and February 1991. Based on these data, the following flow paths were identified by which groundwater could discharge into the Blair or Hylebos waterways:

Blair Waterway:	North Site Area to wetland to Reichhold S Ditch General/Fill Area to Reichhold S Ditch OFA/Pennwalt Area to Reichhold S Ditch Intermediate Aquifer to Blair Waterway

Hylebos Waterway: North Site Area to Taylor Way drain
OFA/Pennwalt Area to Taylor Way drain
Intermediate Aquifer to Hylebos Waterway

Contributions to surface water concentrations from the Intermediate Aquifer were not evaluated because the flat gradients observed in this aquifer make evaluating flows highly uncertain. With the exception of a few inorganics, concentrations of indicator chemicals are generally low or nondetected in this aquifer and this source is not likely to contributed significantly to exposures from fish consumption.

Flow rates for the flow paths were calculated using Darcy's Law:

$$Q = K * i * A$$

Where

Q	=	flow rate into ditch in m/sec,
K	=	hydraulic conductivity in m/sec,
i	=	hydraulic gradient in m/m, and
A	=	cross sectional area of aquifer (width x thickness) in m^2,

Values of hydraulic gradient, aquifer width and thickness, and hydraulic conductivity for each of the flow paths are summarized in Tables 4 and 5 of the main report text. The flow rate for each flow path (in liters/sec) was multiplied by the average or 95% CL concentration in the groundwater (in mg/L) to obtain the amount of chemical (in mg/sec) entering the ditch from that area of the site. Chemical masses from all surface water sources discharging to a particular waterway from the site were summed to obtain the total chemical loading (in mg/sec) entering that waterway.

Concentrations of chemicals in the Blair and Hylebos waterways near the ditch discharge points were estimated by modeling the dilution of contaminants within a longitudinal cross section of the waterway. The length of the two cross sections were assumed to equal the length of the property boundary parallel to the waterway, 740 m. The estuary widths were approximately 110 m for the Blair and 120 m for the Hylebos.

Mixing factors for the two waterways were calculated using the tidal exchange analysis procedure described by Fischer et al. (1979). This procedure estimates the extent of dilution from tidal flow, river flow,

and waste effluent flow as a function of the flow rates and dimensions of the waterway. The total flow available for diluting the effluent is:

$$Q_d = Q_o + Q_e + Q_f$$

Where

Q_d	=	total flow entering the cross section in m^3/hr,
Q_o	=	circulating flow of ocean water in m^3/hr,
Q_e	=	effluent flow into waterway in m^3/hr, and
Q_f	=	tributary discharge from upstream in m^3/hr.

The tributary discharge, Q_f, was assumed to be negligible compared with the ocean flow. This is a conservative assumption and will result in a higher estimate of surface water concentrations than if creek flows were considered. The effluent discharge, Q_e, was calculated by summing the average groundwater discharge rates for the flow paths listed above. The ocean flow, Q_o, was computed using the following relationship (Fischer et al., 1979):

$$Q_o = R * P/T$$

Where

R	=	tidal exchange ratio of waterway, unitless,
P	=	volume of the tidal prism in m^3 per diurnal cycle, and
T	=	duration of diurnal tidal cycle in hours.

The tidal exchange ratio is the fraction of water entering an estuary during a tidal cycle that is "new" ocean water, compared to the total volume of water entering from all sources, including water that had left the estuary on the previous tidal cycle. The tidal exchange ratio has not been measured for the Blair or Hylebos waterways; however, a ratio of 0.5 is characteristic of small estuaries in the Puget Sound area (Nece et al., 1975) and will be used in this evaluation.

The tidal prism (P) is the difference in the volumes of water contained within the estuary between the mean high water elevation and the mean lower low water elevation, and is calculated by multiplying the diurnal tidal range (in m) by the estuary surface area in m^2. The diurnal tidal range in Commencement Bay is approximately 4 m (Ebbesmayer, 1986). Mean surface areas of the Blair and Hylebos estuaries within the

longitudinal cross sections defined by the property boundaries were estimated from topographic maps. The duration of the diurnal tidal cycle (T) in Commencement Bay is 24.84 hours (Ebbesmayer, 1986).

The mean concentration of effluent near the point of discharge was estimated from:

$$C_d = M/Q_d$$

Where

M = discharge rate of contaminant in mg/hr.

This procedure estimates the average concentration within the cross section; levels would be higher in the immediate vicinity of the ditch outflow. However, fish are not likely to spend a significant fraction of their lives adjacent to the outfall; therefore, average surface water concentrations are sufficiently conservative for the risk assessment. In addition, processes that would lead to removal of the contaminants from the water column, such as precipitation, sedimentation, volatilization, and biological decay, are not considered in this approach. Therefore, this approach is likely to overestimate risks from the fish consumption pathway.

Concentrations in Fish

Concentrations of chemicals of potential concern in fish from the Blair and Hylebos waterways were estimated by assuming that an equilibrium will be reached between the surface water concentrations calculated above and the edible tissues of the fish. Equilibrium concentrations in the fish were calculated with the equation:

$$C_f = C_L * BCF$$

Where

C_f	=	Concentration in fish edible tissue in mg/kg,
C_L	=	Concentration in waterway in mg/L, and
BCF	=	Bioconcentration factor in L/kg.

Bioconcentration factors recommended by Ecology (PTI, 1989) were used in this report if available. For those chemicals for which Ecology

has not provided a value, a factor was obtained from the literature for a marine species appropriate to the ecosystem under consideration, if available. Otherwise BCFs were estimated based on the octanol/water partition coefficients of the chemical (for organics). BCFs used in this scenario, and the sources of these values, are shown in Table G-5.

Table G-1 - Summary of Blair Backup Property Exposure Factors

Exposure Factor	Units	Average Condition	RME Condition
1. Dermal contact and incidental ingestion of soil and sediment (future on-site worker)			
a) Exposed skin surface area	cm^2	3000	1900
b) Dermal absorption	percent		
- metals		0.1	1
- CPAHs/		*	*
- other organics		50	50
- NCPAHs		13	20
c) Skin contact rate	mg/cm^2	0.6	0.9
d) Ingestion rate	mg/day	100	50
e) Oral absorption from soil (relative to intake in water or diet)	percent		
- PAHs		25	50
- other chemicals		100	100
f) Exposure duration	years	10	25
g) Exposure frequency	percent		
- soils		24	68[a]
- sediments		5	10
h) Body weight	kg	70	70
2. Inhalation of vapors and particulates (off-site and future on-site workers)			
a) Inhalation rate	m^3/day	43	20
b) Absorption rate	by wt.		
- vapors		100%	100%
- particulates		(see ingestion of soils)	(see ingestion of soils)
3. Ingestion of Fish (residents)			
a) Ingestion rate	gm/day	30	140
b) Exposure duration	years	9	30
c) Exposure frequency	diet fraction	20%	100%
d) Body weight (0 - 6 yrs)	kg	15	15
(6 - 18 yrs)		none	none
(18 - 75 yrs)		70	70

Note: [a]250/365 days per year
*Risks associated with dermal absorption of CPAHs were not evaluated quantitatively.
Source: average industrial exposure factors - EPA Region 10 (1990), RME industrial exposure factors - EPA Region 10 (1991).

Table G-2 - Summary of Non-Carcinogenic Toxicity Factors for Blair Backup Property Indicator Chemicals

CHEMICAL	ORAL EXPOSURE				INHALATION EXPOSURE			
	Chronic Oral RfD in mg/kg-day	Uncertainty/ Modifying Factors	Critical Effect/Organ System	Ref.	Chronic Inhalation RfD in mg/kg-day	Uncertainty/ Modifying Factors	Critical Effect/Organ System	Ref.
ORGANIC CHEMICALS								
Benzene	ND				ND			
Bis(2-ethylhexyl)phthalate	0.02	1000/1	liver	(a)	ND			
PAHs - non-carcinogenic(d)	0.004	10,000/--	decreased body weight gain	(b)	ND			
Toluene	0.2	1000/1	liver, kidney	(a)	0.6(c)	100/--	CNS	(b)
Vinyl chloride	ND				ND			
Xylenes	2.0	100/1	body wt., mortality	(a)	0.9(c)	100/--	CNS	(b)
INORGANIC CHEMICALS								
Antimony	4×10^{-4}	1000/1	reduced longevity, blood	(a)	ND			
Arsenic	3×10^{-4}	3/1	keratosis/hyper-pigmentation	(a)	ND			
Beryllium	5×10^{-3}	100/1	none	(a)	ND			
Cadmium (water)	5×10^{-4}	10/1	renal	(a)	ND			
(food)	1×10^{-3}	10/1	renal	(a)				
Chromium (III)	1.0	100/10	no effects	(a)	6×10^{-7}(c)	300	nasal mucosa atrophy	(b)
Chromium (VI)	5×10^{-3}	500/1	no effects	(a)	6×10^{-7}(c)	300	nasal mucosa atrophy	(b)
Copper	0.037(e)	--/--	local GI irritation	(b)	ND			
Lead	ND		CNS	(b)	ND		CNS	(b)

Table G-2 - (Continued)

CHEMICAL	ORAL EXPOSURE				INHALATION EXPOSURE			
	Chronic Oral RfD in mg/kg-day	Uncertainty/ Modifying Factors	Critical Effect/Organ System	Ref.	Chronic Inhalation RfD in mg/kg-day	Uncertainty/ Modifying Factors	Critical Effect/Organ System	Ref.
Manganese	0.1	1/1	no effect	(a)	1×10^{-4}(c)	300/3	Respiratory/ psychomotor effects	(a)
Mercury - inorganic	3×10^{-4}	1000/--	kidney	(b)	9×10^{-5}(c)	30	neurotoxicity	(b)
Molybdenum	4×10^{-3}	1/--	biochemical changes	(b)	ND			
Nickel	0.02	100/3	decreased body/ organ weight	(a)	ND			
Zinc	0.2	10/--	blood	(b)	ND			

FOOTNOTES:

(a) Verified Reference Dose - IRIS; EPA Integrated Risk Information System (EPA, 1991a).
(b) EPA Health Effects Assessment Summary Tables, 1991 (EPA, 1991b).
(c) Derived from an Inhalation RfC in mg/m^3 by assuming exposure to 20 m^3/day by a 70-kg individual.
(d) Non-carcinogenic effects of PAHs were evaluated by assuming that toxicity of all non-carcinogenic PAHs is equivalent to most toxic chemical in group - naphthalene.
(e) Calculated from the EPA drinking water standard of 1.3 mg/liter (EPA, 1991b) assuming ingestion of 2 liters of water/day by a 70-kg individual. The Drinking Water Criteria document concluded that toxicity data for copper were inadequate for calculation of an RfD.

ND No toxicity factor available at this time from EPA-verified sources.
CNS Central nervous system effects.

Table G-3 - Carcinogenic Toxicity Factors for Blair Backup Property Indicator Chemicals

CHEMICAL	ORAL CARCINOGENESIS				INHALATION CARCINOGENESIS			
	Oral Slope Factor in $(mg/kg\text{-}day)^{-1}$	CAG Group (a)	Type of Cancer/ Basis	Ref.	Inhalation Slope Factor in $(mg/kg\text{-}day)^{-1}$	CAG Group (a)	Type of Cancer/ Basis	Ref.
ORGANIC CHEMICALS								
Benzene	0.029	A	leukemia	(b)	0.029 (g)	A	leukemia	(b)
Bis(2-ethylhexyl)phthalate	0.014	B2	liver	(b)	ND	B2		(c)
PAHs - carcinogenic (d) - Benzo[a]pyrene	11.5	B2	stomach	(c)	6.1	B2	respiratory tract	(c)
Toluene	ND	D			ND	D		
Vinyl chloride	1.9	A	lung	(c)	0.295 (g)	A	liver	(c)
Xylenes	ND	D		(c)	ND	D		(c)
INORGANIC CHEMICALS								
Antimony	ND				ND			
Arsenic	2 (e)	A	skin	(b)	50 (f)	A	lung/skin	(b)
Beryllium	4.3	B2	total tumors	(b)	8.4	B2	lung	(c)
Cadmium	ND				6.1 (g)	B1	respiratory tract	(b)
Chromium (III)	ND				ND			
Chromium (VI)	ND				41(g)	A	lung	(b)
Copper	ND	D		(b)	ND	D		(b)
Lead	ND	B2		(c)	ND	B2		(c)
Manganese	ND	D		(b)	ND	D		(b)
Mercury	ND	D		(b)	ND	D		(b)
Molybdenum	ND				ND			

Table G-3 - (Continued)

CHEMICAL	ORAL CARCINOGENESIS				INHALATION CARCINOGENESIS			
	Oral Slope Factor in $(mg/kg\text{-}day)^{-1}$	CAG Group (a)	Type of Cancer/ Basis	Ref.	Inhalation Slope Factor in $(mg/kg\text{-}day)^{-1}$	CAG Group (a)	Type of Cancer/ Basis	Ref.
Nickel - soluble salts	ND				ND			
Nickel - refinery dusts	ND				0.84	A	respiratory tract	(c)
Zinc	ND	D		(b)	ND	D		(b)

FOOTNOTES

(a) Cancer Assessment Group (CAG) Weight of Evidence groups for carcinogens: A - Human Carcinogen, sufficient evidence from human epidemiological studies; B1 - Probable Human Carcinogen, limited evidence from epidemiological studies and adequate evidence from animal studies; B1 - Probable Human Carcinogen, limited evidence of carcinogenicity in humans; B2 - Probable Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; C - Possible Human Carcinogen, limited evidence in animals with inadequate or no human data; D - Not Classified as to human carcinogenicity; and E - Evidence of Noncarcinogenicity in humans.

(b) Verified Reference Dose - EPA Integrated Risk Information System (IRIS), EPA, 1991a.

(c) EPA Health Effects Assessment Summary Tables, 1991 (EPA, 1991b).

(d) Carcinogenic effects of PAHs were evaluated by assuming that all PAHs with known or potential carcinogenic effects are equal in potency to benzo[a]pyrene.

(e) Arsenic oral slope factor of 2 (rounded off from 1.75) was calculated from a unit risk of 5×10^{-5} $\mu g/L$ (EPA, 1991b) assuming ingestion of 2 L/day by a 70-kg individual. This unit risk has been proposed by the Risk Assessment Forum but has not yet been accepted by the Science Advisory Board or entered into HEAST or IRIS (EPA, 1991a).

(f) Arsenic inhalation slope factor of 50 was calculated from an inhalation unit risk of 4.3×10^{-3} $\mu g/m^3$ (EPA, 1991) using an inhalation unit risk (EPA, 1991a) by assuming inhalation of 20 m^3/day by a 70-kg individual and an absorption rate of 30%.

(g) Inhalation slope factors for these chemicals were calculated from unit risk using an inhalation unit risk (EPA, 1991a) by assuming inhalation of 20 m^3/day by a 70-kg individual.

ND No toxicity factor available at this time from EPA-verified sources.

Table G-4 - Values and Assumptions Used to Estimate Air Concentrations

Symbol	Parameter	Value	Source
COWHERD et al. (1985) UNLIMITED RESERVOIR FUGITIVE DUST EMISSIONS MODEL			
v	Fraction vegetated soil (current conditions)	0.25 - OFA/Pennwalt Area 0.5 - General/Fill Area 0.75 - North Site Area	observations at property
	(future conditions)	0 - all areas	conservative assumption
D_{50}	Mode of particle size distribution	0.36 mm	Appendix - Figure B-93
[u]	mean annual wind speed	2.8 m/sec	Annual average wind speed - Tacoma Tideflats
u_t	threshold wind speed at 7m (current conditions) (future conditions)	 2.39 m/sec 5.46 m/sec	calculated using procedures in Cowherd et al. (1985)
Z_0	surface roughness height (current conditions) (future conditions)	 5 cm 70 cm	Cowherd et al. (1985) value for: medium brush (wheat field) suburban institutional buildings
E_{10}	PM_{10} emissions factor (current conditions)	8.0×10^{-7} gm/m^2-sec - North Site and General/Fill Areas 8.3×10^{-7} gm/m^2-sec - OFA/Pennwalt Area	calculated using procedures in Cowherd et al. (1985)
	(future conditions)	2.9×10^{-5} gm/m^2-sec - North Site and General/Fill Areas 5.4×10^{-5} gm/m^2-sec - OFA/Pennwalt Area	
P	Days of precipitation	180 days/year	Cowherd et al. (1985)
INDOOR AIR MODEL			
	building dimensions	50 m x 50 m x 3 m	assumed
A	area of infiltration	2300 m^2	floor area minus area of 1-m perimeter wall
V	indoor air volume	7500 m^3	calculated
ACH	air exchange rate	0.2 (hr^{-1})	conservative assumption
F	infiltration fraction	100%	conservative assumption

Table G-5 - Fish Bioconcentration Factors for Chemicals of Potential Concern

Chemical	BCF	Organism	Source
INORGANIC CHEMICALS			
Antimony	1	na	EPA Region IV, 1991
Arsenic	44	na	PTI, 1989
Beryllium	19	na	EPA Region IV, 1991
Cadmium	81	na	PTI, 1989
Chromium	16	na	PTI, 1989
Copper	200	na	PTI, 1989
Lead	49	na	PTI, 1989
Manganese	0	na	EPA, 1986
Mercury	3,760	estuarine organisms	EPA Region IV, 1991
Molybdenum	na	na	
Nickel	47	na	EPA Region IV, 1991
Zinc	47	na	PTI, 1989
ORGANIC CHEMICALS			
Benzene	5.2	na	PTI, 1989
Bis(2-ethylhexyl)phthalate	2,680	Gammarus Pseudolimnaeus (scud)	EPA, 1980a
Formaldehyde	0	na	HSDB, 1991
PAHs - noncarcinogenic (a)	10.5	na	EPA Region IV, 1991
- carcinogenic (b)	30	na	EPA Region IV, 1991
Toluene	10.7	na	PTI, 1989
Vinyl Chloride	1.17	na	PTI, 1989
Xylenes	160	na	(c)

na Information not available.
(a) Bioconcentration factor for anthracene was used to represent all non-carcinogenic PAHs.
(b) Bioconcentration factor for benzo(a)pyrene was used to represent all non-carcinogenic PAHs.
(c) Estimated from octanol-water partition coefficient using regression equation recommended by Lyman et al, 1982

Table G-6 - Estimated Doses and Potential Risks to Current Off-site Workers from Inhalation of Chemicals Volatilized from On-Site Groundwater: North Site Area

Chemical (a)	Groundwater Concentration in µg/L		Total Mass in Shallow Aquifer in kg		Estimated Ambient Air Concentration in mg/m3		Chronic Daily Intake in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals	Average	95% CL	Average	RME	Average	RME	Average	RME		Average	RME
Vinyl chloride	36	50	5.4	7.7	5.9E-07	8.5E-07	1.2E-08	5.5E-08		3E-09	2E-08
									TOTAL RISK	3E-09	2E-08
										CDI:RfD Ratio	
B. Non-carcinogenic chemicals										Average	RME
(b)											
									HAZARD INDEX	0E+00	0E+00

(a) - Air concentrations were estimated only for chemicals with inhalation toxicity criteria.
(b) - No volatile chemicals of potential concern with non-carcinogenic inhalation toxicity factors were detected in this area.

G-4.WK1/CLK

Table G-7 - Estimated Doses and Potential Human Health Risks to Current Off-site Workers from Inhalation of Chemicals Volatilized from On-Site Groundwater - Ohio Ferro Alloy/Pennwalt Area

Chemical (a)	Groundwater Concentration in μg/L		Total Mass in Shallow Aquifer in kg		Estimated Ambient Air Concentration in mg/m3		Chronic Daily Intake in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals	Average	95% CL	Average	RME	Average	RME	Average	RME		Average	RME
Benzene	6.9	11	5.3	8.5	3.0E-06	4.8E-06	5.8E-08	3.1E-07		2E-09	9E-09
									TOTAL RISK	2E-09	9E-09
										CDI:RfD Ratio	
B. Non-carcinogenic chemicals										Average	RME
Toluene	8.2	15	20	36	1.1E-05	2.0E-05	1.7E-06	1.2E-06		3E-06	2E-06
Xylenes	9.2	17	18	33	1.0E-05	1.9E-05	1.5E-06	1.1E-06		2E-06	1E-06
									HAZARD INDEX	4E-06	3E-06

(a) - Air concentrations were estimated only for chemicals with inhalation toxicity criteria.

G-5.WK1/CLK

Table G-8 - Estimated Doses and Potential Health Risks to Current Off-site Workers from Inhalation of Airborne Dusts
General/Fill Area

Chemical (a)	Soil Concentration in mg/kg		Annual Average Air Concentration in mg/m3		Absorption Factor	Chronic Daily Intake in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals	Average	95% CL	Average	RME	Average	Average	RME		Average	RME
Arsenic	3.2	4.6	2.0E-09	2.9E-09	0.3	1.2E-11	5.7E-11		6E-10	3E-09
Cadmium	0.53	0.70	3.3E-10	4.4E-10	1	6.6E-12	2.9E-11		4E-11	2E-10
Chromium (hexavalent) (b)	9	10.5	5.7E-09	6.6E-09	1	1.1E-10	4.3E-10		5E-09	2E-08
Nickel	26	51	1.6E-08	3.2E-08	1	3.2E-10	2.1E-09		3E-10	2E-09
PAHs - carcinogenic	0.16	0.42	1.0E-10	2.6E-10	0.25	4.9E-13	8.6E-12		3E-12	5E-11
								TOTAL RISK	5E-09	2E-08
									CDI:RfD Ratio	
B. Non-carcinogenic Chemicals									Average	RME
Chromium (total)	18	21	1.1E-08	1.3E-08	1	1.7E-09	2.6E-09		3E-03	4E-03
								HAZARD INDEX	3E-03	4E-03

(a) - Air concentrations were estimated only for chemicals with inhalation toxicity criteria.
(b) - Chromium was assumed to be present in a 50:50 ratio of trivalent to hexavalent forms.

G-6.WK1/CLK

Table G-9 - Estimated Doses and Potential Health Risks to Current Off-site Workers from Inhalation of Airborne Dusts
North Site Area

Chemical (a)	Soil Concentration in mg/kg		Annual Average Air Concentration in mg/m3		Chronic Daily Intake in mg/kg-day			Upper-bound Excess Lifetime Cancer Risk	
A. Potentially carcinogenic chemicals	Average	95% CL	Average	RME	Average	RME		Average	RME
Arsenic	13	16	2.3E-09	2.8E-09	1.3E-11	5.5E-11		7E-10	3E-09
Cadmium	0.67	0.99	1.2E-10	1.7E-10	2.3E-12	1.1E-11		1E-11	7E-11
Chromium - hexavalent (b)	11	12	1.8E-09	2.1E-09	3.6E-11	1.4E-10		1E-09	6E-09
Nickel	28	45	4.9E-09	7.9E-09	9.6E-11	5.1E-10		8E-11	4E-10
PAHs - carcinogenic	1.1	1.6	1.9E-10	2.8E-10	9.5E-13	9.1E-12		6E-12	6E-11
							TOTAL RISK	2E-09	9E-09
B. Non-carcinogenic chemicals								CDI/RfD Ratio	
								Average	RME
Chromium (total)	21	24	3.7E-09	4.2E-09	5.4E-10	8.2E-10		9E-04	1E-03
Mercury	0.34	0.61	6.0E-11	1.1E-10	8.8E-12	2.1E-11		1E-07	2E-07
							HAZARD INDEX	9E-04	1E-03

(a) - Air concentrations were estimated only for chemicals with inhalation toxicity criteria.
(b) - Chromium was assumed to be present in a 50:50 ratio of trivalent to hexavalent forms.

G-7.WK1/CLK

Table G-10 - Estimated Doses and Potential Health Risks to Current Off-site Workers from Inhalation of Airborne Dusts
Ohio Ferro-Alloy/Pennwalt Area

Chemical (a)	Soil Concentration in mg/kg		Annual Average Air Concentration in mg/m3		Chronic Daily Intake in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals	Average	95% CL	Average	RME	Average	RME		Average	RME
Arsenic	49	64	5.7E-08	7.5E-08	3.4E-10	1.5E-09		2E-08	7E-08
Cadmium	1.4	1.9	1.6E-09	2.2E-09	3.2E-11	1.4E-10		2E-10	9E-10
Chromium - hexavalent (b)	96	159	1.1E-07	1.9E-07	2.2E-09	1.2E-08		9E-08	5E-07
Nickel	35	48	4.1E-08	5.6E-08	8.0E-10	3.6E-09		7E-10	3E-09
PAHs - carcinogenic	250	659	2.9E-07	7.7E-07	1.4E-09	2.5E-08		9E-09	2E-07
							TOTAL RISK	1E-07	7E-07
B. Non-carcinogenic chemicals								CDI/RfD Ratio	
								Average	RME
Chromium - total	192	318	2.2E-07	3.7E-07	3.3E-08	7.2E-08		5E-02	1E-01
Manganese	81	95	9.4E-08	1.1E-07	1.4E-08	2.2E-08		1E-07	2E-07
Mercury	0.19	0.29	2.2E-10	3.4E-10	3.3E-11	6.6E-11		1E-07	2E-07
							HAZARD INDEX	5E-02	1E-01

(a) - Air concentrations were estimated only for chemicals with inhalation toxicity criteria.
(b) - Chromium was assumed to be present in a 50:50 ratio of trivalent to hexavalent forms.

G-8.WK1/CLK

Table G-11 - Estimated Doses and Potential Risks to Future On-site Workers from Inhalation of Chemicals Volatilized from On-site Groundwater: North Site Area

Chemical (a)	Groundwater Concentration in μg/L		Total Mass in Shallow Aquifer in kg		Estimated Indoor Air Concentration in mg/m3		Chronic Daily Intake in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals	Average	95% CL	Average	RME	Average	RME	Average	RME		Average	RME
Vinyl chloride	36	50	5.4	7.7	1.9E-03	2.7E-03	3.8E-05	5.4E-05		1E-05	2E-05
									TOTAL RISK	1E-05	2E-05
										CDI:RfD Ratio	
B. Non-carcinogenic chemicals										Average	RME
(b)											
									HAZARD INDEX	0E+00	0E+00

(a) - Air concentrations were estimated only for chemicals with inhalation toxicity criteria.
(b) - No chemicals of potential concern with non-carcinogenic inhalation toxicity factors were detected in this area.

G-9.WK1/CLK

Table G-12 - Estimated Doses and Potential Health Risks to Future On-site Workers from Inhalation of Chemicals Volatilized from On-site Groundwater: Ohio Ferro-Alloy/Pennwalt Area

Chemical (a)	Groundwater Concentration in µg/L		Total Mass in Shallow Aquifer in kg		Estimated Indoor Air Concentration in mg/m3		Chronic Daily Intake in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals	Average	95% CL	Average	RME	Average	RME	Average	RME		Average	RME
Benzene	6.9	11	5.3	8.5	1.2E-03	1.9E-03	2.3E-05	3.6E-05		7E-07	1E-06
									TOTAL RISK	7E-07	1E-06
										CDI:RfD Ratio	
B. Non-carcinogenic chemicals										Average	RME
Toluene	8.2	15	20	36	4.4E-03	7.8E-03	6.4E-04	4.6E-04		1E-03	8E-04
Xylenes	9.2	17	18	33	3.9E-03	7.2E-03	5.8E-04	4.2E-04		6E-04	5E-04
									HAZARD INDEX	1E-03	8E-04

(a) - Air concentrations were estimated only for chemicals with inhalation toxicity criteria.

G-10.WK1/CLK

Table G-13 - Estimated Doses and Potential Health Risks to Future Off-site Workers from Inhalation of Airborne Dusts
General/Fill Area

Chemical (a)	Soil Concentration in mg/kg		Annual Average Air Concentration in mg/m3		Chronic Daily Intake in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals	Average	95% CL	Average	RME	Average	RME		Average	RME
Arsenic	3.2	4.6	1.2E-07	1.7E-07	7.0E-10	3.4E-09		4E-08	2E-07
Cadmium	0.53	0.70	2.0E-08	2.6E-08	3.9E-10	1.7E-09		2E-09	1E-08
Chromium (hexavalent) (b)	9	10.5	3.4E-07	3.9E-07	6.6E-09	2.6E-08		3E-07	1E-06
Nickel	26	51	9.7E-07	1.9E-06	1.9E-08	1.2E-07		2E-08	1E-07
PAHs - carcinogenic	0.16	0.42	6.0E-09	1.6E-08	2.9E-11	5.1E-10		2E-10	3E-09
							TOTAL RISK	3E-07	1E-06
								CDI:RfD Ratio	
B. Non-carcinogenic chemicals								Average	RME
Chromium (total)	18	21	6.7E-07	7.8E-07	9.9E-08	1.5E-07		2E-01	3E-01
							HAZARD INDEX	2E-01	3E-01

(a) - Air concentrations were estimated only for chemicals with inhalation toxicity criteria.
(b) - Chromium was assumed to be present in a 50:50 ratio of trivalent to hexavalent forms.

G-11.WK1/CLK

Table G-14 - Estimated Doses and Potential Health Risks to Future Off-site Workers from Inhalation of Airborne Dusts
North Site Area

Chemical (a)	Soil Concentration in mg/kg		Annual Average Air Concentration in mg/m3		Chronic Daily Intake in mg/kg-day			Upper-bound Excess Lifetime Cancer Risk	
A. Potentially carcinogenic chemicals	Average	95% CL	Average	RME	Average	RME		Average	RME
Arsenic	13	16	4.3E-07	5.4E-07	2.6E-09	1.0E-08		1E-07	5E-07
Cadmium	0.67	0.99	2.2E-08	3.3E-08	4.4E-10	2.2E-09		3E-09	1E-08
Chromium - hexavalent (b)	10.5	12	3.5E-07	4.0E-07	6.9E-09	2.6E-08		3E-07	1E-06
Nickel	28	45	9.4E-07	1.5E-06	1.8E-08	9.8E-08		2E-08	8E-08
PAHs - carcinogenic	1.1	1.6	3.7E-08	5.4E-08	1.8E-10	1.7E-09		1E-09	1E-08
							TOTAL RISK	4E-07	2E-06
								CDI/RfD Ratio	
B. Non-carcinogenic chemicals								Average	RME
Chromium (total)	21	24	7.0E-07	8.0E-07	1.0E-07	1.6E-07		2E-01	3E-01
Mercury	0.34	0.61	1.1E-08	2.0E-08	1.7E-09	4.0E-09		2E-05	4E-05
							HAZARD INDEX	2E-01	3E-01

(a) - Air concentrations were estimated only for chemicals with inhalation toxicity criteria.
(b) - Chromium was assumed to be present in a 50:50 ratio of trivalent to hexavalent forms.

G-12.WK1/CLK

Table G-15A - Estimated Doses and Potential Health Risks to Future Off-site Workers from Inhalation of Airborne Dusts
Ohio Ferro-Alloy/Pennwalt Area (Charcoal Samples Included)

Chemical (a)	Soil Concentration in mg/kg		Annual Average Air Concentration in mg/m3		Chronic Daily Intake in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals	Average	95% CL	Average	RME	Average	RME		Average	RME
Arsenic	49	64	2.4E-06	3.2E-06	1.4E-08	6.2E-08		7E-07	3E-06
Cadmium	1.4	1.9	7.0E-08	9.5E-08	1.4E-09	6.2E-09		8E-09	4E-08
Chromium - hexavalent (b)	96	159	4.8E-06	7.9E-06	9.4E-08	5.2E-07		4E-06	2E-05
Nickel	35	48	1.7E-06	2.4E-06	3.4E-08	1.6E-07		3E-08	1E-07
PAHs - carcinogenic	250	659	1.2E-05	3.3E-05	6.1E-08	1.1E-06		4E-07	7E-06
							TOTAL RISK	5E-06	3E-05
B. Non-carcinogenic chemicals								CDI/RfD Ratio	
								Average	RME
Chromium - total	192	318	9.6E-06	1.6E-05	1.4E-06	3.1E-06		2E+00	5E+00
Manganese	81	95	4.0E-06	4.7E-06	5.9E-07	9.3E-07		6E-06	9E-06
Mercury	0.19	0.29	9.5E-09	1.4E-08	1.4E-09	2.[illegible]E-09		5E-06	9E-06
							HAZARD INDEX	2E+00	5E+00

(a) - Air concentrations were estimated only for chemicals with inhalation toxicity criteria.
(b) - Chromium was assumed to be present in a 50:50 ratio of trivalent to hexavalent forms.

G-15D1.WK1/CLK

Table G-15B - Estimated Doses and Potential Health Risks to Future Off-site Workers from Inhalation of Airborne Dusts
Ohio Ferro-Alloy/Pennwalt Area (Charcoal Samples Omitted)

Chemical (a)	Soil Concentration in mg/kg		Annual Average Air Concentration in mg/m3		Chronic Daily Intake in mg/kg-day			Upperbound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals	Average	95% CL	Average	RME	Average	RME		Average	RME
Arsenic	49	64	2.4E-06	3.2E-06	1.4E-08	6.2E-08		7E-07	3E-06
Cadmium	1.4	1.9	7.0E-08	9.5E-08	1.4E-09	6.2E-09		8E-09	4E-08
Chromium - hexavalent (b)	96	159	4.8E-06	7.9E-06	9.4E-08	5.2E-07		4E-06	2E-05
Nickel	35	48	1.7E-06	2.4E-06	3.4E-08	1.6E-07		3E-08	1E-07
PAHs - carcinogenic	5.8	9.9	2.9E-07	4.9E-07	1.4E-09	1.6E-08		9E-09	1E-07
							TOTAL RISK	5E-06	2E-05
B. Noncarcinogenic Chemicals								CDI/RfD Ratio	
								Average	RME
Chromium - total	192	318	9.6E-06	1.6E-05	1.4E-06	3.1E-06		2E+00	5E+00
Manganese	81	95	4.0E-06	4.7E-06	5.9E-07	9.3E-07		6E-06	9E-06
Mercury	0.19	0.29	9.5E-09	1.4E-08	1.4E-09	2.8E-09		5E-06	9E-06
							HAZARD INDEX	2E+00	5E+00

(a) - Air concentrations were estimated only for chemicals with inhalation toxicity criteria.
(b) - Chromium was assumed to be present in a 50:50 ratio of trivalent to hexavalent forms.

G-13B.WK1/CLK

Table G-16 - Estimated Doses and Potential Health Risks to Future On-site Workers from Direct Contact with Soil
General Fill Area

Chemical	Soil Concentration in mg/kg		Oral Intake in mg/day		Dermal Intake in mg/day		Chronic Daily Intake (Dermal and Oral) in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals (a)	Average	95% CL	Average	RME	Average	RME	Average	RME		Average	RME
PAHs - carcinogenic	0.16	0.42	4.0E-06	1.1E-05	(b)	(b)	1.8E-09	3.4E-08		2E-08	4E-07
Arsenic	3.2	4.6	1.3E-04	9.2E-05	5.8E-06	8.7E-05	6.1E-08	5.9E-07		1E-07	1E-06
									TOTAL RISK	1E-07	2E-06
B. Non-carcinogenic chemicals										CDI:RfD Ratio Average	CDI:RfD Ratio RME
PAHs - non-carcinogenic	0.62	3.5	1.6E-05	8.8E-05	1.5E-04	1.3E-03	5.5E-07	1.4E-05		1E-04	3E-03
Arsenic	3.2	4.6	1.3E-04	9.2E-05	5.8E-06	8.7E-05	4.6E-07	1.8E-06		2E-03	6E-03
Cadmium (a)	0.54	0.70	5.4E-05	3.5E-05	9.7E-07	1.3E-05	1.9E-07	4.7E-07		3E-04	3E-03
Chromium (a)	18	21	1.8E-03	1.1E-03	3.2E-05	4.0E-04	6.3E-06	1.4E-05		1E-03	6E-03
Copper	20	26	2.0E-03	1.3E-03	3.6E-05	4.9E-04	7.0E-06	1.8E-05		2E-04	1E-03
Nickel (a)	26	51	2.6E-03	2.6E-03	4.7E-05	9.7E-04	9.1E-06	3.4E-05		6E-04	1E-02
Zinc	30	37	3.0E-03	1.9E-03	5.4E-05	7.0E-04	1.0E-05	2.5E-05		6E-05	3E-04
									HAZARD INDEX	4E-03	3E-02

(a) - Cadmium, chromium, and nickel are considered carcinogens only for inhalation exposures.
(b) - Dermal intake of PAHs was not evaluated quantitatively in this risk assessment.

G-14.WK1/CLK

Table G-17 - Estimated Doses and Potential Health Risks to Future On-site Workers from Direct Contact with Soil
North Site Area

Chemical	Soil Concentration in mg/kg		Oral Intake in mg/day		Dermal Intake in mg/day		Chronic Daily Intake (Dermal and Oral) in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals (a)	Average	95% CL	Average	RME	Average	RME	AVERAGE	RME		Average	RME
Bis(2-ethylhexyl)phthalate	0.13	0.18	1.3E-05	9.0E-06	1.2E-04	1.7E-04	5.9E-08	5.9E-07		2E-08	2E-07
PAHs - carcinogenic	1.1	1.6	2.8E-05	4.0E-05	(b)	(b)	1.3E-08	1.3E-07		1E-07	2E-06
Arsenic	13	16	5.2E-04	3.2E-04	2.3E-05	3.0E-04	2.5E-07	2.0E-06		5E-07	4E-06
									TOTAL RISK	7E-07	6E-06

B. Non-carcinogenic chemicals										CDI:RfD Ratio Average	CDI:RfD Ratio RME
Bis(2-ethylhexyl)phthalate	0.13	0.18	1.3E-05	9.0E-06	1.2E-04	1.7E-04	4.5E-07	1.8E-06		4E-04	2E-03
PAHs - non-carcinogenic	9.1	14	2.3E-04	3.5E-04	2.1E-03	5.3E-03	8.1E-06	5.5E-05		2E-03	1E-02
Arsenic	13	16	5.2E-04	3.2E-04	2.3E-05	3.0E-04	1.9E-06	6.1E-06		6E-03	2E-02
Cadmium (a)	0.67	0.99	6.7E-05	5.0E-05	1.2E-06	1.9E-05	2.3E-07	6.7E-07		3E-04	4E-03
Chromium (a)	21	24	2.1E-03	1.2E-03	3.8E-05	4.6E-04	7.3E-06	1.6E-05		2E-03	7E-03
Copper	41	59	4.1E-03	3.0E-03	7.4E-05	1.1E-03	1.4E-05	4.0E-05		4E-04	2E-03
Mercury	0.34	0.6	3.4E-05	3.0E-05	6.1E-07	1.1E-05	1.2E-07	4.1E-07		5E-04	8E-03
Nickel (a)	27	45	2.7E-03	2.3E-03	4.9E-05	8.6E-04	9.4E-06	3.0E-05		6E-04	9E-03
Zinc	50	62	5.0E-03	3.1E-03	9.0E-05	1.2E-03	1.7E-05	4.2E-05		9E-05	4E-04
									HAZARD INDEX	1E-02	7E-02

(a) - Cadmium, chromium, and nickel are considered carcinogens only for inhalation exposures.
(b) - Dermal intake of PAHs was not evaluated quantitatively in this risk assessment.

G-15.WK1/CLK

Table G-18A - Estimated Doses and Potential Health Risks to Future On-site Workers from Direct Contact with Soil
Ohio Ferro-Alloy/Pennwalt Area (Charcoal Samples Included)

Chemical	Soil Concentration in mg/kg		Oral Intake in mg/day		Dermal Intake in mg/day		Chronic Daily Intake (Dermal and Oral) in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals (a)	Average	95% CL	Average	RME	Average	RME	Average	RME		Average	RME
PAHs - carcinogenic	250	659	6.3E-03	1.6E-02	(b)	(b)	2.9E-06	5.4E-05		3E-05	6E-04
Arsenic	49	64	2.0E-03	1.3E-03	8.8E-05	1.2E-03	9.4E-07	8.1E-06		2E-06	2E-05
									TOTAL RISK	3E-05	6E-04

B. Non-carcinogenic chemicals										CDI:RfD Ratio Average	CDI:RfD Ratio RME
PAHs - non-carcinogenic	1,614	4,287	4.0E-02	1.1E-01	3.8E-01	1.6E+00	1.4E-03	1.7E-02		4E-01	4E+00
Arsenic	49	64	2.0E-03	1.3E-03	8.8E-05	1.2E-03	7.0E-06	2.4E-05		2E-02	8E-02
Cadmium (a)	1.4	1.90	1.4E-04	9.5E-05	2.5E-06	3.6E-05	4.9E-07	1.3E-06		7E-04	8E-03
Chromium (a)	192	318	1.9E-02	1.6E-02	3.5E-04	6.0E-03	6.7E-05	2.1E-04		1E-02	9E-02
Copper	163	227	1.6E-02	1.1E-02	2.9E-04	4.3E-03	5.7E-05	1.5E-04		2E-03	9E-03
Manganese	81	95	8.1E-03	4.8E-03	1.5E-04	1.8E-03	2.8E-05	6.4E-05		4E-04	4E-03
Mercury	0.19	0.29	1.9E-05	1.5E-05	3.4E-07	5.5E-06	6.6E-08	2.0E-07		3E-04	4E-03
Nickel (a)	34	48	3.4E-03	2.4E-03	6.1E-05	9.1E-04	1.2E-05	3.2E-05		8E-04	1E-02
Zinc	138	172	1.4E-02	8.6E-03	2.5E-04	3.3E-03	4.8E-05	1.2E-04		3E-04	1E-03
									HAZARD INDEX	4E-01	4E+00

(a) - Cadmium, chromium, and nickel are considered carcinogens only for inhalation exposures.
(b) - Dermal intake of carcinogenic PAHs was not evaluated quantitatively in this risk assessment.

G-16A.WK1/CLK

Table G-18B - Estimated Doses and Potential Health Risks to Future On-site Workers from Direct Contact with Soil
Ohio Ferro-Alloy/Pennwalt Area (Charcoal Samples Omitted)

Chemical	Soil Concentration in mg/kg		Oral Intake in mg/day		Dermal Intake in mg/day		Chronic Daily Intake (Dermal and Oral) in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals (a)	Average	95% CL	Average	RME	Average	RME	AVERAGE	RME		Average	RME
PAHs - carcinogenic	5.8	9.9	1.5E-04	2.5E-04	(b)	(b)	6.6E-08	8.1E-07		8E-07	9E-06
Arsenic	49	64	2.0E-03	1.3E-03	8.8E-05	1.2E-03	9.4E-07	8.1E-06		2E-06	2E-05
									TOTAL RISK	3E-06	3E-05
										CDI:RfD Ratio	
B. Non-carcinogenic chemicals										Average	RME
PAHs - non-carcinogenic	23	38	5.7E-04	9.4E-04	5.3E-03	1.4E-02	2.0E-05	1.5E-04		5E-03	4E-02
Arsenic	49	64	2.0E-03	1.3E-03	8.8E-05	1.2E-03	7.0E-06	2.4E-05		2E-02	8E-02
Cadmium (a)	1.4	1.90	1.4E-04	9.5E-05	2.5E-06	3.6E-05	4.9E-07	1.3E-06		7E-04	8E-03
Chromium (a)	192	318	1.9E-02	1.6E-02	3.5E-04	6.0E-03	6.7E-05	2.1E-04		1E-02	9E-02
Copper	163	227	1.6E-02	1.1E-02	2.9E-04	4.3E-03	5.7E-05	1.5E-04		2E-03	9E-03
Manganese	81	95	8.1E-03	4.8E-03	1.5E-04	1.8E-03	2.8E-05	6.4E-05		4E-04	4E-03
Mercury	0.19	0.29	1.9E-05	1.5E-05	3.4E-07	5.5E-06	6.6E-08	2.0E-07		3E-04	4E-03
Nickel (a)	34	48	3.4E-03	2.4E-03	6.1E-05	9.1E-04	1.2E-05	3.2E-05		8E-04	1E-02
Zinc	138	172	1.4E-02	8.6E-03	2.5E-04	3.3E-03	4.8E-05	1.2E-04		3E-04	1E-03
									HAZARD INDEX	5E-02	2E-01

(a) - Cadmium, chromium, and nickel are considered carcinogens only for inhalation exposures.
(b) - Dermal intake of carcinogenic PAHs was not evaluated quantitatively in this risk assessment.

G-16B.WK1/CLK

Table G-19 - Estimated Doses and Potential Health Risks to Future On-site Workers from Direct Contact with On-Site Sediments
Pennwalt Ag-Chem Ditch

Chemical	Sediment Concentration in mg/kg		Oral Intake in mg/day		Dermal Intake in mg/day		Chronic Daily Intake (Dermal and Oral) in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals (a)	Average	95% CL	Average	RME	Average	RME	AVERAGE	RME		Average	RME
PAHs - carcinogenic	0.53	0.92	1.3E-05	2.3E-05	(b)	(b)	1.3E-09	1.1E-08		1E-08	1E-07
Arsenic	27	37	1.1E-03	7.4E-04	4.9E-05	7.0E-04	1.1E-07	6.9E-07		2E-07	1E-06
									TOTAL RISK	2E-07	2E-06
										CDI:RfD Ratio	
B. Non-carcinogenic chemicals										Average	RME
PAHs - non-carcinogenic	1.4	2.7	3.5E-05	6.8E-05	3.3E-04	1.0E-03	2.6E-07	1.6E-06		6E-05	4E-04
Arsenic	27	37	1.1E-03	7.4E-04	4.9E-05	7.0E-04	8.1E-07	2.1E-06		3E-03	7E-03
Cadmium (a)	0.78	1.3	7.8E-05	6.5E-05	1.4E-06	2.5E-05	5.7E-08	1.3E-07		8E-05	8E-04
Chromium (a)	17	23	1.7E-03	1.2E-03	3.1E-05	4.4E-04	1.2E-06	2.3E-06		3E-04	1E-03
Copper	37	57	3.7E-03	2.9E-03	6.7E-05	1.1E-03	2.7E-06	5.6E-06		8E-05	3E-04
Mercury	7.9	23	7.9E-04	1.2E-03	1.4E-05	4.4E-04	5.7E-07	2.3E-06		3E-03	5E-02
Nickel (a)	143	313	1.4E-02	1.6E-02	2.6E-04	5.9E-03	1.0E-05	3.1E-05		7E-04	1E-02
Zinc	147	268	1.5E-02	1.3E-02	2.6E-04	5.1E-03	1.1E-05	2.6E-05		6E-05	3E-04
									HAZARD INDEX	6E-03	7E-02

(a) - Cadmium, chromium, and nickel are considered carcinogens only for inhalation exposures.
(b) - Dermal intake of carcinogenic PAHs was not evaluated quantitatively in this risk assessment.

G-17.WK1/CLK

Table G-20 - Estimated Doses and Potential Health Risks to Future On-site Workers from Direct Contact with On-Site Sediments
Ohio Ferro-Alloy Ditch

Chemical	Sediment Concentration in mg/kg		Oral Intake in mg/day		Dermal Intake in mg/day		Chronic Daily Intake (Dermal and Oral) in mg/kg-day			Upper-bound Lifetime Excess Cancer Risk	
A. Potentially carcinogenic chemicals (a)	Average	95% CL	Average	RME	Average	RME	Average	RME		Average	RME
Bis(2-ethylhexyl)phthalate	0.25	0.35	2.5E-05	1.8E-05	2.3E-04	3.3E-04	2.4E-08	1.7E-07		6E-09	4E-08
PAHs - carcinogenic	0.96	1.1	2.4E-05	2.8E-05	(b)	(b)	2.3E-09	1.3E-08		3E-08	2E-07
Arsenic	167	282	6.7E-03	5.6E-03	3.0E-04	5.4E-03	6.6E-07	5.2E-06		1E-06	1E-05
									TOTAL RISK	1E-06	1E-05

B. Non-carcinogenic chemicals										CDI:RfD Ratio Average	CDI:RfD Ratio RME
Bis(2-ethylhexyl)phthalate	0.25	0.35	2.5E-05	1.8E-05	2.3E-04	3.3E-04	1.8E-07	5.0E-07		2E-04	5E-04
PAHs - non-carcinogenic	4.5	5.4	1.1E-04	1.4E-04	1.1E-03	2.1E-03	8.3E-07	3.1E-06		2E-04	8E-04
Arsenic	167	282	6.7E-03	5.6E-03	3.0E-04	5.4E-03	5.0E-06	1.6E-05		2E-02	5E-02
Cadmium (a)	3.1	3.6	3.1E-04	1.8E-04	5.6E-06	6.8E-05	2.3E-07	3.5E-07		3E-04	2E-03
Chromium (a)	125	214	1.3E-02	1.1E-02	2.3E-04	4.1E-03	9.1E-06	2.1E-05		2E-03	9E-03
Copper	255	342	2.6E-02	1.7E-02	4.6E-04	6.5E-03	1.9E-05	3.4E-05		5E-04	2E-03
Nickel (a)	27	29	2.7E-03	1.5E-03	4.9E-05	5.5E-04	2.0E-06	2.9E-06		1E-04	9E-04
Zinc	332	476	3.3E-02	2.4E-02	6.0E-04	9.0E-03	2.4E-05	4.7E-05		1E-04	5E-04
									HAZARD INDEX	2E-02	7E-02

(a) - Cadmium, chromium, and nickel are considered carcinogens only for inhalation exposures.
(b) - Dermal intake of carcinogenic PAHs was not evaluated quantitatively in this risk assessment.

G-18.WK1/CLK

Table G-21 - Estimated Doses and Potential Human Health Risks from Ingestion of Fish from Hylebos Waterway

A. Potentially carcinogenic chemicals	Estimated Surface Water Concentration in μg/L		Fish Tissue Concentration in mg/kg		Chronic Daily Intake For Ingestion of Fish in mg/kg-day		Upperbound Lifetime Excess Cancer Risk	
	Average	RME	Average	RME	Average	RME	Average	RME
ORGANICS								
Benzene	4.1E-05	6.6E-05	2.1E-07	3.4E-07	2.5E-12	3.1E-10	7E-14	9E-12
Bis(2-ethylhexyl)phthalate	5.7E-05	1.1E-04	1.5E-04	2.9E-04	1.8E-09	2.6E-07	3E-11	4E-09
PAHs - carcinogenic	5.1E-05	6.9E-05	1.5E-06	2.1E-06	1.8E-11	1.9E-09	2E-10	2E-08
Vinyl chloride	1.8E-04	2.5E-04	2.0E-07	2.9E-07	2.4E-12	2.6E-10	6E-12	6E-10
INORGANICS								
Arsenic	9.1E-04	1.4E-03	4.0E-05	6.0E-05	4.7E-10	5.4E-08	9E-10	1E-07
Beryllium	2.0E-05	2.0E-05	3.7E-07	3.7E-07	4.4E-12	3.4E-10	2E-11	1E-09
						TOTAL RISK	1E-09	1E-07

B. Non-carcinogenic chemicals	CDI:RfD RATIO	
	Average	RME
ORGANICS		
Bis(2-ethylhexyl)phthalate	3E-08	1E-06
Formaldehyde	0E+00	0E+00
PAHs - non-carcinogenic	2E-07	9E-06
Toluene	3E-10	1E-08
Xylenes	4E-10	2E-08
INORGANICS		
Antimony	2E-08	7E-07
Arsenic	1E-05	5E-04
Beryllium	7E-09	2E-07
Cadmium (in food)	2E-07	5E-06
Chromium (III)	4E-10	1E-08
Copper	8E-08	3E-06
Manganese	0E+00	0E+00
Nickel	3E-08	1E-06
Zinc	7E-09	2E-07
HAZARD INDEX	1E-05	5E-04

G-19.WK1/CLK

Table G-22 - Estimated Doses and Potential Human Health Risks from Ingestion of Fish from Blair Waterway

A. Potentially carcinogenic chemicals	Estimated Surface Water Concentration in µg/L		Fish Tissue Concentration in mg/kg		Chronic Daily Intake For Ingestion of Fish in mg/kg-day		Upper-bound Lifetime Excess Cancer Risk	
	Average	RME	Average	RME	Average	RME	Average	RME
ORGANICS								
Benzene	4.4E-05	7.0E-05	2.3E-07	3.6E-07	2.7E-12	3.3E-10	8E-14	1E-11
Bis(2-ethylhexyl)phthalate	1.1E-04	2.6E-04	2.8E-04	6.9E-04	3.3E-09	6.3E-07	5E-11	9E-09
PAHs - carcinogenic	5.4E-05	7.3E-05	1.6E-06	2.2E-06	1.9E-11	2.0E-09	2E-10	2E-08
Vinyl chloride	1.8E-04	2.6E-04	2.1E-07	3.0E-07	2.5E-12	2.8E-10	6E-12	6E-10
INORGANICS								
Arsenic	1.0E-03	1.6E-03	4.5E-05	7.0E-05	2.1E-10	2.6E-08	4E-10	5E-08
Beryllium	2.1E-05	2.1E-05	4.0E-07	4.0E-07	4.6E-12	3.6E-10	2E-11	2E-09
						TOTAL RISK	7E-10	8E-08

B. Non-carcinogenic chemicals	CDI:RfD Ratio	
	Average	RME
ORGANICS		
Bis(2-ethylhexyl)phthalate	6E-08	3E-06
Formaldehyde	0E+00	0E+00
PAHs - non-carcinogenic	3E-07	1E-05
Toluene	3E-10	1E-08
Xylenes	5E-10	2E-08
INORGANICS		
Antimony	4E-08	2E-06
Arsenic	6E-06	2E-04
Beryllium	8E-09	2E-07
Cadmium (in food)	1E-06	4E-05
Chromium (III)	5E-10	2E-08
Copper	1E-07	5E-06
Manganese	0E+00	0E+00
Nickel	6E-07	2E-05
Zinc	7E-08	2E-06
HAZARD INDEX	8E-06	3E-04

G-20.WK1/CLK

Table G-23 Estimation of Quantities of Volatile Organic Indicator Chemicals in the Shallow Aquifer

North Site Area

Chemical	Cw in mg/L Average	Cw in mg/L 95%CL	Koc in L/kg	Kd in L/kg	Cs in mg/kg Average	Cs in mg/kg 95%CL	Mw in mg Average	Mw in mg 95%CL	Ms in mg Average	Ms in mg 95%CL	Mtotal in kg Average	Mtotal in kg 95%CL
Vinyl chloride	0.036	0.051	8	0.246	0.0089	0.013	3.2E+06	4.6E+06	2.2E+06	3.1E+06	5.4	7.7

Ohio Ferro-Alloy/Pennwalt Area

Chemical	Cw in mg/L Average	Cw in mg/L 95%CL	Koc in L/kg	Kd in L/kg	Cs in mg/kg Average	Cs in mg/kg 95%CL	Mw in mg Average	Mw in mg 95%CL	Ms in mg Average	Ms in mg 95%CL	Mtotal in kg Average	Mtotal in kg 95%CL
Benzene	0.0069	0.011	83	2.49	0.017	0.027	1.0E+06	1.6E+06	4.3E+06	6.8E+06	5.3	8.5
Toluene	0.0082	0.015	300	9.00	0.074	0.14	1.2E+06	2.2E+06	1.8E+07	3.4E+07	20	36
Xylene	0.0092	0.017	238	7.14	0.066	0.12	1.3E+06	2.5E+06	1.6E+07	3.0E+07	18	33

Input Parameters for Source Term Calculation

Parameter	Symbol	North Site Area		OFA/Pennwalt Area	
Site Area	A	49,300	m2	80,300	m2
Saturated thickness	b	5.2	m	7	m
Total porosity	pT	0.35		0.35	
Bulk density	BD	1.5	gm/cm3	1.5	gm/cm3
Soil organic carbon	foc	0.03		0.03	

G-23.WK1/CLK

Appendix H

APPENDIX H
BLAIR BACKUP TOXICITY PROFILES

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APPENDIX H
BLAIR BACKUP TOXICITY PROFILES

Toxicity Profiles for the Chemicals of Potential Concern

Antimony

Mammalian Toxicology and Regulatory Criteria. Humans and animals exposed orally or through inhalation to either trivalent or pentavalent forms of antimony displayed electrocardiogram (ECG) changes and myocardial lesions (EPA, 1980b). Pulmonary effects including pneumoconiosis have been observed in humans exposed by inhalation, and dermatitis has occurred in individuals exposed either orally or dermally. Oral administration of therapeutic doses in humans has been associated with nausea, vomiting, and hepatic necrosis (EPA, 1980b). A single report (Balyaeva, 1967) noted an increase in spontaneous abortions, premature births, and gynecological problems in 318 female workers exposed to a mixture of antimony metal, antimony trioxide, and antimony pentasulfide dusts. Absorption of antimony via oral and inhalation exposure is low (EPA, 1980b). The carcinogenicity of antimony has not been reviewed by the EPA.

EPA (1991a) derived an oral RfD of 4×10^{-4} mg/kg-day for antimony based on a chronic oral study in which rats given the metal in drinking water had altered blood glucose, altered blood cholesterol levels, and decreased lifespans. An uncertainty factor of 1,000 was used to derive the oral RfD. EPA has not developed an inhalation RfD for antimony.

EPA has proposed maximum contaminant levels (MCL) of 0.01 and 0.005 mg/L (two options proposed) for antimony.

Aquatic Toxicology and Regulatory Criteria. The available data for antimony indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 9.0 and 1.6 mg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Toxicity to algae occurs at concentrations as low as 0.61 mg/L (EPA, 1991b).

Arsenic

Mammalian Toxicology and Regulatory Criteria. Trivalent arsenic compounds can be corrosive to the skin with prolonged contact. Acute and chronic exposure to inorganic arsenic via ingestion and inhalation can result in a variety of toxic effects, especially to moist tissues such as the

eyes and respiratory system. Arsenic is classified by the EPA as a group A carcinogen, meaning that sufficient evidence of carcinogenicity in exposed humans exists. Cancers have been observed in both the lung and skin. Reproductive and teratogenic effects have been observed in experimental animals given high doses of inorganic arsenic; however, such effects have not been observed in people with excessive occupational exposure to arsenic compounds. Little evidence of mutagenic effects of arsenic compounds have been observed (Sittig, 1985).

Arsenic is classed as a group A carcinogen. EPA (1991a) has developed an inhalation unit risk of 4.3 $(mg/m^3)^{-1}$ based on the occurrence of lung cancers in humans. An inhalation slope factor of 50 $(mg/kg\text{-}day)^{-1}$ was calculated from this unit risk by assuming inhalation of 20 m^3/day by a 70-kg individual and an absorption rate of 30 percent. For oral exposures a unit risk of 5×10^{-5} $(mg/L)^{-1}$ has been proposed by the EPA Risk Assessment Forum based on the occurrence of skin cancer in humans. An oral cancer slope factor of 1.75 $(mg/kg\text{-}day)^{-1}$ was calculated from this unit risk, assuming ingestion of 2 L/day by a 70-kg individual. This value was rounded to 2 for this assessment.

For non-carcinogenic effects, an oral reference dose of 0.003 mg/kg-day has been established for both subchronic and chronic exposures (EPA, 1990). This reference dose is based on keratosis and hyperpigmentation observed in humans exposed to 0.001 mg/kg-day. There is no uncertainty factor incorporated into the reference dose.

EPA has established ambient water quality criteria for the protection of human health as follows: for the consumption of drinking water only the criterion is 2.5×10^{-6} mg/L; for contaminated drinking water and fish the criterion is 2.2×10^{-6} mg/L; and for contaminated fish consumption only the criterion is 1.75×10^{-5} mg/L (EPA, 1991b). The existing maximum contaminant level (MCL) for total arsenic in drinking water is 0.05 mg/L.

Aquatic Toxicology and Regulatory Criteria. Arsenic (III) and (IV) acute toxicity to various species of freshwater fish range from 0.812 to 97 mg/L. Acute toxicities of arsenic to freshwater plants fall into a similar range. Low to moderate bioconcentration factors and a short half-life of arsenic in fish tissue suggest that arsenic residues should not be a problem to predators of aquatic life (EPA, 1991b).

Freshwater organisms should not be adversely effected if the four-day average concentration of arsenic (III) does not exceed 0.19 mg/L and the 1-hour average concentration does not exceed 0.36 mg/L more than once every three years on average. Insufficient information is available to derive numerical national water quality criteria for arsenic (V) or any

organic forms of arsenic. Inorganic arsenic (V) is acutely toxic to freshwater fish at 850 μg/L, and an acute-chronic ratio of 28 has been measured for the fathead minnow (EPA, 1991b).

Beryllium

Mammalian Toxicology and Regulatory Criteria. Beryllium is classified in group B2 — probable human carcinogen based on sufficient evidence of carcinogenicity in animals and limited evidence of carcinogenicity in humans (EPA, 1990). Inhalation of beryllium has been shown to induce cancer in rats and monkeys. Subchronic exposure of animals to beryllium sulfate at a concentration of 40 ug/m^3 resulted in pneumonitis, as did exposure to beryllium oxide powder at a concentration of 30 mg/m^3.

For carcinogenic effects, an oral slope factor of 4.3 (mg/kg-day)$^{-1}$ has been established by the EPA (1991a) based on tumors in rats exposed to 5 mg/L in drinking water for a lifetime. An inhalation slope factor of 8.4 (mg/kg-day)$^{-1}$ has been established by EPA (1990) based on lung tumors in humans exposed occupationally.

An oral RfD of 5 x 10^{-3} mg/kg-day was developed by EPA (1991a) based on a no observed adverse effect level (NOAEL). Thus, no critical endpoint was identified for this chemical. An uncertainty factor of 100 was used to develop the RfD. No inhalation Rfd has been developed by EPA.

A maximum contaminant limit goal and a maximum contaminant limit of 0 and 0.001 mg/L, respectively, have been proposed.

Aquatic Toxicology and Regulatory Criteria. The available data for beryllium indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 0.130 and 0.053 mg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Hardness has a substantial effect on toxicity. For the above criteria a hardness value of 100 mg/L was used (EPA, 1991b).

Cadmium

Mammalian Toxicology and Regulatory Criteria. Cadmium is poorly absorbed by the skin or upon ingestion, but is well absorbed upon inhalation. Once absorbed cadmium is retained in the kidneys and liver and may result in kidney damage. Cadmium is a respiratory tract irritant. Acute inhalation exposures can cause severe respiratory irritation, while chronic exposures can lead to a form of emphysema. Several effects have been observed in experimental animals exposed to cadmium including liver

and central nervous system damage, testicular atrophy, testicular neoplasms, teratogenic effects and hypertension.

The EPA (1991a) has classified cadmium as a probable human carcinogen (Group B1) via the inhalation route, and has identified a 10^{-6} risk at an air concentration of 6×10^{-1} mg/m^3. This was converted to a carcinogenic slope factor of 6.1 (mg/kg-day)$^{-1}$ by assuming inhalation of 20 m^3/day for a 70-kg individual. This value is based on an increased incidence of respiratory tract tumors observed in occupationally exposed workers.

EPA (1991a) has developed oral reference doses for cadmium in water and in food. An oral RfD for water of 5×10^{-4} mg/kg-day has been established based on observed renal damage in humans. EPA (1991a) also derived an oral RfD for cadmium in food of 1×10^{-3} mg/kg-day. An uncertainty factor of 10 was used to derive both values (EPA, 1991a). EPA has not developed an inhalation RfD for cadmium.

The current MCL for cadmium is 0.01 mg/L, with a reduction to 0.005 mg/L effective July 30, 1992.

The water quality criterion for cadmium associated with consumption of both contaminated water and aquatic organisms is 0.01 mg/L. No water quality criterion has been established for consumption of aquatic organisms only.

Aquatic Toxicology and Regulatory Criteria. Due to the chemical similarity of cadmium to zinc, Callahan et al. (1979) reports that following uptake in aquatic organisms cadmium may disrupt normal metabolic functions. Freshwater acute values for 44 genera range from 0.001 mg/L for rainbow trout to 28.0 mg/L for the mayfly. Freshwater aquatic plants are affected by cadmium at concentrations ranging from 0.002 to 7.40 mg/L (EPA, 1991b).

EPA criteria (1991b) stipulate that, except where a locally important species is very sensitive, freshwater aquatic organisms and their uses should not be affected unacceptably if the 4-day average concentration of cadmium does not exceed the numerical value given by $e^{(0.7852[\ln(\text{hardness})]-3.490)}$ more than once every three years on average and if the one-hour concentration does not exceed the numerical value given by $e^{(1.123[\ln(\text{hardness})]-3.828)}$ more than once every three years on average. At a hardness of 100 mg/L the 4-day average criterion is 0.0011 mg/L, and the 1-hour average criterion is 0.0039 mg/L (EPA, 1991b).

Chromium

Mammalian Toxicology and Regulatory Criteria. Trivalent chromium is found in biological tissues and is essential in trace concentrations for carbohydrate metabolism. Trivalent chromium is not known to be converted to the hexavalent form in biological tissues. However, the hexavalent form readily crosses cell membranes and is reduced intracellularly to trivalent chromium. The harmful effects of chromium have been attributed to the hexavalent form, however, the mechanism by which toxic effects are manifest are not fully known.

In some individuals chromium acts as an allergen resulting in dermatitis. Hexavalent chromium can enter the body by ingestion, inhalation, and through the skin. Irritation of the respiratory system can result from acute inhalation exposures.

Hexavalent chromium is classed as a known human carcinogen (Group A) due to increased incidence of lung cancer associated with occupational inhalation exposure. Using a multistage model, EPA (1991a) identified a 10^{-6} at a concentration of 8×10^{-5} mg/m^3 in air. This was converted to an inhalation slope factor of 41 (mg/kg-day)$^{-1}$ assuming inhalation of 20 m^3/day by a 70-kg individual. Ingested hexavalent chromium is not considered carcinogenic.

Based on a study using rats, the EPA has established an oral RfD for chronic exposure to hexavalent chromium of 5×10^{-3} mg/kg-day. This value was established based on an uncertainty factor of 500. This RfD is limited to soluble salts of hexavalent chromium. The EPA states that confidence in the RfD is low due to several shortcomings in the rat bioassay. The foremost shortcoming is the lack of an observed effect in the highest dose used in the study (EPA, 1991a).

An oral RfD of 1 mg/kg-day has been established for acute exposure to trivalent chromium. The standard is based on hepatotoxicity to rats. Like the study on hexavalent chromium, confidence in this oral RfD has been listed as low largely due to the absence of any effect at the highest dose used in the study. An uncertainty factor of 100 is applied in establishing a subchronic value to account for expected interhuman and interspecies variability in the toxicity of the chemical. An additional modifying factor of 10 is used to establish the chronic value. The RfD only applies to insoluble salts of metallic trivalent chromium (EPA, 1991a).

Inhalation RfCs of 2×10^{-6} mg/m^3 were listed by EPA (1990) for both trivalent and hexavalent chromium. Both RfCs were based on occurrence of nasal mucous atrophy in humans. An effect was noted at a

concentration of 0.714 $\mu g/m^3$ Cr(VI) in air. The basis for applying this value to trivalent chromium was not stated.

An MCL of 0.05 mg/L (total chromium) has been established and an MCL of 0.10 mg/L has been proposed by the EPA.

For consumption of contaminated aquatic organisms, the water quality criterion for trivalent chromium is 3,433 mg/L. For water and fish consumption, ambient water quality criteria for protection of human health have been established at 170 mg/L. Ambient water quality criteria for hexavalent chromium has been established at 0.05 mg/L for water and fish consumption (EPA, 1991a).

Aquatic Toxicology and Regulatory Criteria. Acute values for trivalent chromium are available for 20 freshwater species in 18 genera and range from 2.22 mg/L for the mayfly to 71.06 mg/L for the caddisfly.

Acute toxicity values for hexavalent chromium are available for 27 freshwater genera and range from 0.023 mg/L for a cladoceran to 1,870 mg/L for a stonefly. Reduced growth in chinook salmon was observed at 0.016 mg/L. The bioconcentration factor for rainbow trout was less than 3 (EPA, 1991b).

For hexavalent chromium, freshwater organisms should not be adversely effected if the four-day average concentration does not exceed 0.05 mg/L more than once every three years.

Hardness has a significant influence on trivalent chromium toxicity, with soft water producing greater toxic effects. The trivalent chromium 4-day average concentration not to be exceeded more than once every three years for a hardness of 100 mg/L is 0.210 mg/L (EPA, 1991b) for freshwater organisms. Given a hardness value, the criterion is calculated by:

$$e^{(0.8190[\ln(\text{hardness})]+1.561)}.$$

Copper

Mammalian Toxicology and Regulatory Criteria. Copper is a necessary micronutrient for humans, and potential toxic effects only occur at relatively high exposure levels (EPA, 1991b; Callahan et al., 1979). Due to inadequate toxicity data, no confirmed toxicity criteria for use in risk assessment have been developed by the EPA for copper. However, EPA cites an oral RfD of 3.7×10^{-2} mg/kg-day based on the drinking water standard of 1.3 mg/L.

Regarding carcinogenicity potential, EPA has classified copper as a Group D (not classifiable) compound, due to inadequate data (EPA, 1991a).

Neither an MCL nor a water quality criterion for protection of human health has been established for copper. The secondary (aesthetic) drinking water standard for copper is 1.0 mg/L.

Aquatic Toxicology and Regulatory Criteria. Ionic forms of copper present in water can be toxic to aquatic life at low concentrations. The aqueous toxicity of copper is dependent upon a variety of physical and chemical factors influencing copper ion activity, including water hardness, pH, suspended particulate matter, and dissolved colloidal materials. Only a fraction of the total copper present in most ambient waters is typically bioavailable and thereby toxic.

Based on existing aquatic toxicity information, EPA (1991b) has established a hardness-dependent freshwater criterion for copper of 0.012 mg/L (at 100 mg/L as $CaCO_3$) as a 4-day average not to be exceeded more than once every three years on average. Given a hardness value, the criterion is determined by $e^{(0.8545[\ln(\text{hardness})]-1.465)}$.

Lead

Mammalian Toxicology and Regulatory Criteria. Of greatest concern regarding chronic exposure to lead is the effect on the central nervous system. Changes in EEG brain wave patterns and CNS evoked neurophysiologic deficits in children have been observed at blood lead levels of 30 to 50 μg/L (Burchfiel et al., 1980). The EPA office of Health and Environmental Assessment has stated that "levels in certain blood enzymes and in aspects of children's neurobehavioral development may occur at blood lead levels so low as to be essentially without a threshold." Therefore it was "considered inappropriate to develop a reference dose for inorganic lead" (EPA, 1991a).

Blood lead levels of children have been shown to be correlated with environmental lead levels and the magnitude of adverse health effects. EPA has recently changed the "maximum safe blood lead level" for pediatric exposures from 30 micrograms lead per deciliter (μg/dl) of blood to 10 to 15 μg/dl. Since children in urban areas often exhibit blood lead levels in excess of this new pediatric exposure guideline (Glass, 1984), all sources of ambient lead exposure are of concern.

Teratogenic and reproductive effects have been observed in studies conducted with mice and rats. In addition reproductive effects including increases in spontaneous abortions, premature delivery, and early

membrane rupture have been observed in epidemiological studies (EPA, 1984b).

The EPA has classified lead as a probable human carcinogen (Group B2) based on sufficient animal evidence but insufficient human evidence. The most characteristic cancer response was a renal carcinoma. Most investigations observed a carcinogenic response at only the highest doses indicating that lead is not a particularly potent carcinogen. Due to the uncertainties and individual variability in evaluating the uptake and distribution of lead in the body, the effect of different nutritional states, and the effect of previous body burdens, EPA's Carcinogen Assessment Group recommends that a quantitative risk assessment not be used to evaluate the carcinogenic effect of lead (EPA, 1991a).

The ambient water quality criteria established for the protection of human health is identical to the MCL in drinking water of 0.05 mg/L.

Aquatic Toxicology and Regulatory Criteria. The toxicity of lead in freshwater has been shown to be dependent on water hardness. Increasing toxicity is associated with decreasing $CaCO_3$ concentrations.

At a hardness of 50 mg/L the acute sensitivity of 10 species of fish range from 0.142 mg/L for an amphipod to 235.9 mg/L for a midge. Chronic toxicity values range from 0.012.3 to 0.128.1 mg/L for the cladoceran. Four species of freshwater algae are effected by lead concentrations greater than 0.500 mg/L. Spinal deformities have been observed in rainbow trout at 0.013 to 0.027 mg/L (28 mg/L $CaCO_3$). Available bioconcentrations factors range from 42 to 1,700 (EPA, 1991b).

Water hardness-dependent criteria have been developed for lead. At 50 mg/L $CaCO_3$ the chronic concentration would be 0.0032 mg/L, and the acute concentration would be 0.082 mg/L (EPA, 1991b). The numerical values are given by $e^{(1.273[\ln(\text{hardness})]-1.460)}$.

Manganese

Mammalian Toxicology and Regulatory Criteria. Manganese is an essential trace element considered necessary for human health. Daily manganese intake in the diet ranges from 2 to 9 mg (WHO, 1973). Manganese dust and fumes are minor irritants to the eyes and mucous membranes of the respiratory tract. Chronic exposures to manganese dust or fumes may result in a wide array of nervous system symptoms which can progress into a Parkinson-like syndrome. Wide variation in susceptibility among exposed workers to such effects has been observed (Sittig, 1985). Neurological effects from oral exposure to manganese have

been observed in humans consuming drinking water contaminated with high levels of manganese from battery acids (EPA, 1991a).

EPA (1991a) has developed a chronic oral RfD of 0.1 mg/kg-day, based on epidemiological studies in humans that show no adverse effects at a dose of 0.14 mg/kg-day. No uncertainty factors were used to derive this RfD. EPA (1991a) has also developed a chronic inhalation RfD of 1.1×10^{-4} mg/kg-day for manganese, based on increased prevalence of respiratory symptoms and psychomotor disturbances in workers exposed to inorganic manganese. Uncertainty and modifying factors of 300 and 3, respectively, were used to derive the inhalation RfD.

No indication of carcinogenicity or teratogenicity of manganese was located in the literature (EPA, 1991a). Manganese has been classified as a Group D carcinogen - not classifiable as to human carcinogenicity.

A secondary MCL of 0.05 mg/L has been set by the EPA.

Aquatic Toxicology and Regulatory Criteria. Freshwater tolerance values for manganese range from 1.5 to over 1,000 mg/L. Because manganese ions are rarely found at concentrations exceeding 1 mg/L, manganese is not normally a problem in fresh water (EPA, 1991b). EPA has not proposed a numerical ambient water quality criterion for manganese.

Mercury

Elemental, inorganic, and organic forms of mercury exists, with each form displaying different toxicological effects.

Mammalian Toxicology and Regulatory Criteria. Elemental mercury exposure can result in respiratory effects such as coughing, pain and bronchitis, and central nervous system effects such as tremors, irritability, and insomnia. Inorganic mercury is a skin and mucous membrane irritant. Acute inhalation exposures to inorganic mercury can result in respiratory effects such as bronchitis. Chronic exposure to inorganic forms of mercury may result in gingivitis, sialorrhea, increased irritability, and muscular tremors.

Organic forms of mercury are of greater toxicological importance than inorganic forms. Alkyl compounds are primary skin irritants which may result in second-degree burns. The principal systemic effect resulting from organic mercury exposure relate to the central nervous system. The effects progress from tremors and convulsions to sensory disturbances and finally irreversible brain damage (Sittig, 1985).

Although inorganic mercury may be converted to organic forms by microbial action in certain environments, there is no reason to assume that these processes are occurring in site soils. Thus, toxicity factors for inorganic mercury will be used in this assessment.

EPA (1990) developed oral and inhalation RfDs for inorganic mercury of 3×10^{-4} and 9×10^{-5} mg/kg-day, respectively. An uncertainty factor of 1,000 was applied to derive the oral reference dose, while an uncertainty factor of 30 was applied to derive the inhalation reference dose. The oral criterion is based on oral and parenteral studies which observed kidney effects in rats. The inhalation criterion is based on neurotoxicity observed in humans exposed occupationally to 0.009 mg/m^3 (EPA, 1990).

To protect human health the EPA has established a federal water quality criteria of 1.44×10^{-4} mg/L for protection from water and fish consumption and 1.46×10^{-4} mg/L for fish consumption only. The maximum contaminant level for mercury is 0.002 mg/L.

Aquatic Toxicology and Regulatory Criteria. Acute toxicity values for 28 genera of freshwater animals to mercury (II) range from 0.0022 mg/L for Daphnia pulex to 2 mg/L for three insects. Limited available data for various organomercury compounds and mercurous nitrate indicate that these compounds are 4 to 31 times more toxic than mercury (II). Methylmercury is the most chronically toxic mercury compound with 7.0×10^{-5} mg/L being toxic to brook trout. Freshwater plants appear to be less sensitive to mercury (II) than are freshwater animals. A bioconcentration factor of 4,994 has been reported for mercury (II). For methylmercury bioconcentration factors of 4,000 to 85,000 have been reported (EPA, 1991a).

The available data for mercury (total) indicate that, except where a locally important species is very sensitive, acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 1.2×10^{-5} and 2.4×10^{-3} mg/L, respectively (EPA, 1991b).

Molybdenum

Mammalian Toxicology and Regulatory Criteria. Molybdenum is considered to be an essential trace element in many species, including man. Insoluble molybdenum compounds (e.g., disulfides, oxides, and halides) have low toxicity, while soluble molybdenum compounds (e.g., sodium molybdate) and freshly generated molybdenum fumes are more toxic. High concentrations of molybdenum trioxide dust have caused weight loss, diarrhea, loss of muscular coordination, and a high mortality rate in animals. Excessive intake of molybdenum may produce signs of copper

deficiency. Molybdenum trioxide may produce irritation of the eyes and mucous membranes of the nose and throat (Sittig, 1985).

An oral RfD for molybdenum has been set at 0.004 mg/kg-day based on changes in biochemical indices observed in humans exposed to 0.050 mg/day in drinking water (EPA, 1990). No uncertainty factor was applied in deriving the criterion.

Aquatic Toxicology and Regulatory Criteria. No aquatic toxicological data or regulatory criteria were found in the literature.

Nickel

Mammalian Toxicology and Regulatory Criteria. Nickel refinery dust is considered by EPA to be potentially carcinogenic, and has been accorded a Group A (known human carcinogen) status for inhalation exposures. The slope factor for inhalation exposures established by EPA is 0.84 $(mg/kg\text{-}day)^{-1}$ (EPA, 1990). Inadequate toxicologic evidence exists to support carcinogenicity of this compound by the oral route.

A chronic oral RfD of 0.02 mg/kg-day was derived for soluble salts of nickel by EPA (1991a) based on decreased body weight in a feeding study of rats and dogs. Uncertainty and modifying factors of 100 and 3 were applied to derive this factor. No inhalation RfD has been developed for nickel.

No MCL currently exists for nickel; however, an MCL and MCLG of 0.1 mg/L have been proposed. The water quality criterion for nickel associated with consumption of contaminated aquatic organisms is 0.1 mg/L. For consumption of water and fish the EPA criteria for protection of human health is 0.0134 mg/L.

Aquatic Toxicology and Regulatory Criteria. Nickel has an affinity for both inorganic and organic complexes, with the latter forming perhaps the dominant environmental fate in aquatic systems. Bioaccumulation of this compound is considerably less than with other metals (measured BCF in freshwater fish of 47:1).

To protect freshwater aquatic life hardness-dependent criteria have been developed. At 100 mg/L $CaCO_3$, the 24-hour average concentration should not exceed 0.096 mg/L, and the concentration should not exceed 1.8 mg/L at any time. Given a hardness value, the 24-hour average concentration value is given by $e^{(0.76[\ln(hardness)]+4.02)}$, and the concentration not to be exceeded at any time is given by $e^{(0.76[\ln(hardness)+4.02)}$ (EPA, 1991b).

Zinc

An essential trace element in all organisms, zinc in bioaccumulated in all organisms (measure BCF for freshwater fish of 1,000:1). Zinc is one of the most important trace nutrients in living organisms, with over 25 zinc-containing enzymes identified.

Mammalian Toxicology and Regulatory Criteria. Similar to copper, zinc is a necessary micronutrient for humans, and potential toxic effects appear to occur only at relatively high exposure levels. Due to inadequate toxicological data the EPA (1991a) has classified zinc as a Group D carcinogen.

A chronic oral RfD for zinc has been established at 0.2 mg/kg-day based on anemia in humans exposed to therapeutic doses of 2.14 mg/kg-day. An uncertainty factor of 10 was applied in deriving the criterion (EPA, 1990). No inhalation RfD is available for zinc.

No MCL currently exists for zinc, although a secondary water quality criterion of 5.0 mg/L has been established by EPA.

Aquatic Toxicology and Regulatory Criteria. Ionic forms of zinc present in water can be toxic to aquatic life at low concentrations, and toxicity is dependent upon a variety of physical and chemical factors which influence the ion activity, including water hardness, pH, suspended particulate matter, and dissolved colloidal materials.

EPA (1991b) has established a hardness-dependent criterion for zinc of 0.12 mg/L (at 100 mg/L as $CaCo_3$) which should not be exceeded more than once every three years on average. Given a hardness value the criterion is calculated by $e^{(0.8473[\ln(hardness)]+0.7614)}$.

Benzene

Mammalian Toxicology and Regulatory Criteria. While benzene liquid is a skin, eye, and upper respiratory irritant, and acute exposure to benzene may result in central nervous system depression, carcinogenicity is the primary health concern. The primary toxicologic endpoint which forms the basis for human toxicology criteria from both oral and inhalation exposures to benzene is leukemia. The verified potency slope for both pathways is 2.9×10^{-2} $(mg/kg\text{-}day)^{-1}$ (EPA, 1991a).

EPA has not developed oral or inhalation RfDs for benzene.

EPA has determined a drinking water MCL of 0.005 mg/L for benzene and proposed an MCLG of zero to reflect its status as a human carcinogen. The groundwater cleanup standard under the Washington State Model Toxics Control Act (MTCA) Method A is also set at 0.005 mg/L.

EPA has estimated water quality criteria for the protection of human health (corresponding to a one-in-a-million lifetime cancer risk) of 0.04 mg/L for consumption of fish/shellfish alone and 6.6×10^{-4} mg/L for the consumption of both contaminated fish/shell fish and contaminated drinking water (EPA, 1991b).

Aquatic Toxicology and Regulatory Criteria. Aquatic life criteria for benzene (approximately 5,300 μg/L for freshwater acute toxicity) are much less restrictive than those based on human health considerations. No data are available with which chronic toxicity to benzene can be evaluated (EPA, 1991b).

Bis(2-ethylhexyl)phthalate

Mammalian Toxicity and Regulatory Criteria. Bis(2-ethylhexyl) phthalate is also classified in Group B2, probable human carcinogen, based on sufficient evidence of carcinogenicity in animals and inadequate evidence in humans. The oral slope factor is 0.014 $(mg/kg\text{-}day)^{-1}$, based on liver tumors observed in mice exposed by ingestion (EPA, 1991a). This chemical is also considered a Group B2 carcinogen by inhalation; however, no inhalation slope factor is available.

The oral RfD for bis(2-ethylhexyl)phthalate is 0.02 mg/kg-day, based on increased relative liver weight in guinea pigs exposed by ingestion (EPA, 1991a). An uncertainty factor of 100 was used to protect against interspecies variation (from guinea pig to man), and for protection of sensitive human subpopulations. An additional uncertainty factor of 10 was applied because the guinea pigs were not exposed for a full lifetime and the effect observed was considered minimally adverse.

Under the Clean Water Act, the EPA (1991a) has established criteria for the protection of human health from water and fish consumption at 15 mg/L, and for consumption only at 50 mg/L.

Aquatic Toxicity and Regulatory Criteria. Lowest observed effect levels for acute exposures are 0.94 mg/L, and for chronic exposures are 0.003 mg/L (EPA, 1991a). Toxic effects are expected to occur for species which are more sensitive than those tested.

Formaldehyde

Mammalian Toxicity and Regulatory Criteria. Formaldehyde gas may cause severe irritation of the mucous membranes of the respiratory tract and eyes. An oral reference dose has been established at 0.2 mg/kg-day based on reduced weight gain and histopathology observed in rats given formaldehyde in drinking water (EPA, 1991a). An uncertainty factor of 100 was applied to account for inter- and intraspecies variations in toxicity.

Formaldehyde has also been classified in group B1, probable human carcinogen based on limited evidence of carcinogenicity in humans by both the oral and inhalation exposure routes. An oral slope factor of 0.03 $(mg/kg\text{-}day)^{-1}$ has been set based on nasal cavity tumors observed in rodents (EPA, 1990). The inhalation slope factor has been set at 0.045 $(mg/kg\text{-}day)^{-1}$ based on squamous cell carcinomas observed in rats (EPA, 1991a).

Aquatic Toxicity and Regulatory Criteria. No toxicological data or criteria for protection of aquatic life were found in the literature.

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are large group of structurally related organic compounds consisting of annealed aromatic (benzene) rings. The toxicity of different PAH compounds has been shown to be related to the chemical structure of the compound. Of the PAHs listed as priority pollutants, sufficient data exist to allow classification by the EPA of seven high molecular weight PAH compounds (HPAHs) as probable (Group B2) carcinogens: benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene. An additional nine PAHs are classified as non-carcinogens: naphthalene, acenaphthalene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, and benzo(g,h,i)perylene.

Because benzo(a)pyrene (B(a)P) is considered to be the most potent and most common occurring of the carcinogenic PAHs, a conservative method for evaluating the effects of carcinogenic PAHs is to use benzo(a)pyrene as a surrogate and assume that all other carcinogenic PAHs are equally toxic. This approach is necessary because there is not information of sufficient quality for all carcinogenic PAHs to allow a quantitative evaluation of each compound.

For the non-carcinogens, naphthalene is considered to be the most toxic PAH. It is therefore commonly used to evaluate risks from all non-carcinogenic PAHs in a conservative manner.

Mammalian Toxicology and Regulatory Criteria for Benzo(a)pyrene. The EPA classifies benzo(a)pyrene in Group B2, probable human carcinogen based on sufficient evidence of carcinogenicity in all nine species of experimental animals for which data are reported. Slope factors of 11.5 $(mg/kg\text{-}day)^{-1}$ for oral exposures and 6.1 $(mg/kg\text{-}day)^{-1}$ for inhalation exposure, have been proposed by the EPA based on respiratory tract tumors in exposed hamsters and stomach cancers in exposed mice. These values are currently being reviewed by the EPA, are not presently reported in IRIS (EPA, 1991a) or HEAST (EPA, 1990), and are not regarded as verified for use in quantitative risk assessments.

Use of Toxicity Equivalence Factors (TEFs) in Risk Assessment of CPAHs. Although use of TEFs in the evaluation of CPAH risk is currently under EPA review, EPA has used a similar TEF approach of estimating risk associated with exposures to other constituents such as PCBs and dioxins therefore justifying use of the TEF approach. Assessment of human health risk of mixtures, using the TEF approach, involves the following steps:

- Analytical determination of PAHs;
- Multiplication of sample concentrations by the TEFs listed in Table H-1 to express concentration in terms of Benzo(a)pyrene (BaP) equivalents;
- Summation of the above to obtain total BaP equivalents in the sample;
- Determination of human exposure (expressed in terms of BaP equivalents); and
- Combining exposure with toxicity information on BaP (usually expressed as carcinogenicity) to estimate risk associated with the PAH mixture.

However, since the applicability of the TEF approach to PAH is currently under EPA review, for the purposes of completeness, we also conducted the risk assessment using total CPAHs. The differences in risks calculated using both approaches for each area are summarized in Table H-2.

Mammalian Toxicology and Regulatory Criteria for Naphthalene. Acute exposure to naphthalene can result in headaches, dizziness, and related effects. Systemic effects from chronic exposures include cataracts and internal lesions; however, such systemic effects have only been observed in laboratory animals.

An oral RfD of 4 x 10^{-3} mg/kg-day for chronic exposure to naphthalene has been established based on ocular and internal lesions observed in exposed rats (EPA, 1990). An uncertainty factor of 10,000 was used to derive the criterion. Such a large uncertainty factor indicates extremely low confidence in the available toxicological data, and the need to apply this criterion with caution.

Aquatic Toxicology and Regulatory Criteria. For total PAHs acute toxicity to salt water aquatic life occurs at concentrations as low as 0.3 mg/L (EPA, 1991b). Effects are expected to occur at lower concentrations for some sensitive species and for chronic exposures.

Insufficient toxicologic data are available to evaluate freshwater toxicity for total PAHs. Limited toxicologic data for naphthalene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 2.3 mg/L, and chronic toxicity would occur at concentrations as low as 0.62 mg/L (EPA, 1991b). Effects are expected to occur at lower concentrations for some sensitive species.

Toluene

Mammalian Toxicity and Regulatory Criteria. The oral RfD for toluene is 0.2 mg/kg-day (EPA, 1991a). This value is based on a subchronic gavage assay in rats from which a no observed adverse effect level (NOAEL) of 223 mg/kg-day and a lowest observed adverse effect level (LOAEL) of 446 mg/kg-day were established. The critical effects in this study were changes in liver and kidney weights. Confidence in the RfD is classified as medium, and an uncertainty factor of 1,000 was incorporated into the RfD to account for species differences, subchronic to chronic extrapolation, and because limited reproductive and developmental toxicity observations were performed.

EPA (1990) reported an inhalation RfC of 2 mg/m^3 based on central nervous system effects and eye irritation in humans. An uncertainty factor of 100 was used to derive this value. This RfC was converted to an RfD of 0.6 mg/kg-day by assuming inhalation of 20 m^3/day by a 70-kg individual.

Toluene is classified as a Group D (not classified) carcinogen, based on the lack of human data and inadequate animal data (EPA, 1990). Toluene has not produced positive results in the majority of genotoxic assays reported.

Health advisories have been established by the EPA Office of Drinking Water for toluene. The 1-day health advisory for a child is 20 mg/L. The drinking water equivalent level for toluene is 7 mg/L. A proposed

maximum contaminant level of 1.0 mg/L has been established for toluene (effective July 30, 1992) under the Safe Drinking Water Act. Under the Clean Water Act, ambient water quality criteria for protection from freshwater and fish consumption is 14.3 mg/L, while for fish consumption only the criteria is 424 mg/L (EPA, 1991b).

Aquatic Toxicity and Regulatory Criteria. The available toxicologic data for toluene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 17.5 mg/L and would occur at lower concentrations for some sensitive species. A chronic value has not been established for freshwater (EPA, 1991b).

Vinyl Chloride

Mammalian Toxicology and Regulatory Criteria. In experimental animals, inhalation exposure to high levels of vinyl chloride can induce narcosis and death. Lower doses result in ataxia, narcosis, congestion, edema of the lungs, and hyperemia of the liver. Chronic inhalation exposure of workers to vinyl chloride is associated with hepatotoxicity, central nervous system disturbances, pulmonary insufficiency, cardiovascular toxicity, gastrointestinal toxicity, and acro-osteolysis.

EPA has classified vinyl chloride in Group A — known human carcinogen based on adequate evidence of carcinogenicity from epidemiological studies. EPA (1990) reported an oral cancer potency factor of 1.9 $(mg/kg\text{-}day)^{-1}$ based on liver tumors observed in rats fed 10 to 50 mg/kg vinyl chloride. EPA (1990) has also calculated an inhalation unit risk of 8.4×10^{-5} $(mg/m^3)^{-1}$ based on lung tumors in rats exposed via inhalation for 1 year. This was converted to a cancer slope factor of 0.295 $(mg/kg\text{-}day)^{-1}$ by assuming inhalation of 20 m^3 by a 70-kg individual. EPA has not established oral or inhalation RfDs for vinyl chloride.

EPA has established a MCL of 0.002 mg/L for vinyl chloride and an MCLG of zero, based on its known carcinogenicity in humans. The EPA (1991b) standard for the protection of human health from drinking water and ingestion of aquatic organisms is 0.002 mg/L.

Aquatic Toxicity and Regulatory Criteria. EPA has not established an aquatic protection criterion for vinyl chloride.

Xylenes

Mammalian Toxicology and Regulatory Criteria. Xylene vapor may cause irritation of the eyes, nose, and throat. Acute exposure to xylene vapor may cause central nervous system depression. EPA (1990) reports a

chronic inhalation RfC for mixed xylenes of 0.3 mg/m^3 based on central nervous system effects and nose and throat irritation in humans. This was converted to an RfD of 0.9 mg/kg-day by assuming inhalation of 20 m^3/day by a 70-kg individual. The chronic oral reference dose established by the EPA is 2.0 mg/kg-day, based on hyperactivity, decreased body weight, and increased mortality in exposed rats (EPA, 1991a). Uncertainty factors of 100 were used to derive both criteria.

Marine Toxicology and Regulatory Criteria. No criteria for xylenes are available.

Table H-1 - Summary of Relative Carcinogenic Potencies of PAH Compounds

	Carcinogenic Status		Carcinogenic Potency Factor (mg/kg-day)-1		Relative (c) Potency	
	EPA (a)	IARC (b)	Multi-Stage	Two-Stage	Estimates	Reference
Oral Exposures						
Acenapthene	—	3				
Acenapthylene	D	3				
Anthracene	D	4				
Benzo(a)anthracene	B2	1			0.145	Bingham and Falk (1969)
Benzo(a)pyrene	B2	1	6.10E+00 (a)	4.53E-01 (d)	1.000	
Benzo(b)fluoranthene	B2	1			0.115	Deutsch-Wenzel et al. (1983)
Benzo(g,h,i)perylene	D	—			0.018	Deutsch-Wenzel et al. (1983)
Benzo(k)fluoranthene	B2	1			0.053	Deutsch-Wenzel et al. (1983)
Chrysene	B2	2			0.004	Wynder and Hoffman (1959)
Dibenzo(a,h)anthracene	B2	1			1.110	Wynder and Hoffman (1959)
Fluoranthene	D	4				
Fluorene	D	3				
Indeno(1,2,3-cd)pyrene	B2	1			0.078	Deutsch-Wenzel et al. (1983)
Napthalene	D	4				
Phenanthrene	D	3				
Pyrene	D	4				
Inhalation Exposures						
Acenapthene	—	3				
Acenapthylene	D	3				
Anthracene	D	4				
Benzo(a)anthracene	B2	1			0.145	Bingham and Falk (1969)
Benzo(a)pyrene	B2	1	1.15E+01 (a)	3.20E+00 (d)	1.000	
Benzo(b)fluoranthene	B2	1			0.115	Deutsch-Wenzel et al. (1983)
Benzo(g,h,i)perylene	D	—			0.018	Deutsch-Wenzel et al. (1983)
Benzo(k)fluoranthene	B2	1			0.053	Deutsch-Wenzel et al. (1983)
Chrysene	B2	2			0.004	Wynder and Hoffman (1959)
Dibenzo(a,h)anthracene	B2	1			1.110	Wynder and Hoffman (1959)
Fluoranthene	D	4				
Fluorene	D	3				
Indeno(1,2,3-cd)pyrene	B2	1			0.078	Deutsch-Wenzel et al. (1983)
Napthalene	D	4				
Phenanthrene	D	3				
Pyrene	D	4				

Notes:

(a) As reported by EPA (1986a) (Superfund Public Health Evaluation Manual), and EPA 1986d (Health Effects Assessment for PAHs and EPA personal communication 1990).

(b) Based on the classification used by the International Agency for Research on Cancer (IARC), where:

1 = sufficient animal evidence of carcinogenicity;

2 = limited animal evidence of carcinogenicity;

3 = Inadequate evidence to permit evaluation of carcinogenicity;

4 = no evidence of carcinogenicity.

(c) Thorslund, personal communication (1989).

PAH.WK1/CLK

Table H-2 - Difference in Upper-bound Lifetime Cancer Risk Using TEFs Versus Total CPAHs

Land Use Scenario/ Exposure Pathway	Blair Property Area	Average or RME	Upper-bound Lifetime Cancer Risk TEFs CPAHs	Upper-bound Lifetime Cancer Risk Total CPAHs
Current Use				
-Dust Inhalation	OFA/Pennwalt	RME	7 x 10-7	1 x 10-6
Future Use				
-Dust Inhalation	OFA/Pennwalt	Average(a)	5 x 10-6	6 x 10-6
		RME(a)	3 x 10-5	5 x 10-5
-Direct Contact - Soils	North Site	Average	6 x 10-7	1 x 10-6
		RME	6 x 10-6	1 x 10-5
	General Fill	Average	1 x 10-7	2 x 10-7
		RME	2 x 10-6	2 x 10-6
	OFA/Pennwalt	Average(a)	3 x 10-5	1 x 10-4
		RME(a)	6 x 10-4	2 x 10-3
		Average(b)	3 x 10-6	4 x 10-6
		RME(b)	3 x 10-5	5 x 10-5
-Direct Contact - Sediment	Pennwalt/Ag-Chem Ditch	Average	2 x 10-7	2 x 10-7
		RME	2 x 10-6	2 x 10-6
	OFA Ditch	RME	1 x 10-5	1 x 10-5

Notes:
(a) With charcoal samples.
(b) Without charcoal samples.

2350TH3.wk1

Appendix I

APPENDIX I
HISTORICAL SITE DEVELOPMENT
OHIO FERRO-ALLOY FACILITY
BLAIR BACKUP PROPERTY

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Ohio Ferro-Alloys Corporation Area

APPENDIX I
HISTORICAL SITE DEVELOPMENT
OHIO FERRO-ALLOY FACILITY
BLAIR BACKUP PROPERTY

Historical Outline

Prior to development of the Ohio Ferro-Alloy (OFA) plant in 1941, the property was owned by Pierce County and, for less than a year, by the Port of Tacoma. The Port purchased the property in October 1940. OFA announced contracts for electrical power and the factory site in February 1941 with construction slated for April (Tacoma Times, 1941). The originally proposed plant location was between the Wapato (Blair) Waterway and Alexander Street immediately south of 11th Street. No records were found regarding the subsequent selection of the Taylor Way property, but the plant produced its first batch of ferro-chrome alloy in July 1941 (Tacoma Times, 1949) at the latter site.

The focus of the plant for its first 8 years of operation was production of ferro-chrome, although ferro-silicates also appear to have been made. During World War II, the ferro-chrome alloys were used for manufacturing armor plating for tanks and weapons (Tacoma Ledger, 1953). By 1949, the operation focused on silicon metals and ferro-silicon alloy, although some ferro-chrome apparently was still produced. Two furnaces operated continuously and produced between 1,000 and 1,200 tons of alloys each month. Both the ferro-chrome and the ferro-silicon were poured into conical molds. The chrome ingots weighed 6 tons each, while silicon was formed at 1.5 tons each. A smaller briquet product casting was added in late 1948.

A new raw-materials mixing building was constructed sometime shortly after 1950 to the east of the furnace building. Offloading and storage of raw materials as well as mixing previously occurred along the north side of the furnace building.

Very few details on the operation of the plant were found relating to the 1950s and 1960s. Discussions with local historians indicate that a multiple-alarm fire occurred on the property in January 1963. We were unable to establish details of the extent of damage suffered. OFA threatened to close the plant in 1966 due to increasing electrical rates,

the cost of transporting raw materials, and the effects of foreign competition.

The plant continued to operate until at least 1971 when their permit to discharge wastes to the Hylebos Waterway was renewed. By July of 1973, however, OFA was seeking offers for purchase of the plant and had contacted the Port of Tacoma as a prospective buyer. A letter in Port files suggest that OFA was dismantling portions of the facility by August 1973 as the "baghouse" (air emission filtration system) was reportedly removed and possibly sold to a foundry in Oregon. The Port acquired the property in September 1974 contingent on completion of demolition by OFA, and the parcel was subsequently accepted in February 1975.

Plant Facilities

The original plant consisted of the electric furnace house containing two furnaces, ore storage areas serviced by two rail spurs on the north margin of the property, batching bins and conveyer chutes north of the furnace house. A small, possibly oil-fired, furnace was located west of the main building. Other structures included a compressor house and transformer switch yard (4 circuits switching 25,000KVA at 13,800 volts), a water tank, two water coolers, a laboratory for quality control testing, an office, and ancillary product storage buildings (Figures I-1 and I-2). Two main furnace transformers were located in vaults adjacent to the north side of the furnace house. Raw materials were delivered by rail on the north side, processed through the furnaces, and stored on the south side near a second shipment rail spur.

The raw materials spur extended west along a retaining wall embankment that curved south about 600 feet west of the furnace building (Walker & Associates, 1946). It appears that the area between the retaining wall and the furnace was designated for disposal of waste slags and unsuitable materials. The slag materials periodically were leveled and formed a base for storage of the coal and scrap iron used in the manufacturing process.

Additional slag fill appears to have been placed south of the furnace building and subsequently formed suitable land for plant improvements. The majority of buildings on the facility remained intact throughout the plant's operation. The small furnace, however, was demolished in the 1940s and a briquet molding furnace added southwest of the main plant.

Sometime in the 1950s a new batcher (mixing) house was added near the south side of the furnace building, replacing the smaller open-air batching facilities to the north. It included new conveyor systems connected to the roof of the furnace house. Another rail spur was constructed to service the new batcher. Aerial photos provided by the Port suggest that the 60,000-gallon water tower servicing the plant was demolished about the same time that the new batch house was constructed.

Ferro-Alloy Operations

The specifics associated with the ferro-alloy processing at the Tacoma plant are not well known. According to the Tacoma Times (1949) the company was using "an exclusive patented process...(for) making of a highly popular silicon mold cast metal." Nevertheless, the general process associated with ferro-alloy smelting is similar throughout the industry and is also similar regardless of whether ferro-chrome or ferro-silicons are desired.

Manufacturing. These alloys are made by the endothermic reduction of an oxide ore with carbon in an electric furnace. The standard furnaces use a submerged-arc electrode process to melt the prepared mix. In addition to the oxide materials (either chromium ore or silica in the form of quartzite), the major manufacturing ingredients are coke or coal (as a reducing agent) and iron scrap. In some cases, wood chips may be added to the mix.

The 1971 discharge permit application for OFA indicated that they were using coal, silica rock, petroleum coke, and refuse wood in their process. Earlier publications (Tacoma Times, 1949) indicate raw chromium imports from the Philipines, New Caledonia, the Union of South Africa, Turkey, and the Soviet Union. Quartzite was quarried in Chewelah, Washington and Dennison, Colorado. Coke was imported from Utah. Another reported source for quartzite was Rockport, Washington (Tacoma Ledger, 1953).

The batch mixes typically are melted in an open-top electrical arc smelting furnace and, when thoroughly melted, poured to molds. According to a note contained in the Port of Tacoma files, the OFA plant had two furnaces, one rated at 12,000 kilowatt capacity, the other at 9,000 kilowatt. Specifics on these furnaces could not be established, but furnaces generally were constructed with steel outer shell lined with

firebrick. A thin layer of sand and asbestos separated the lining from the shell. The bottom furnace lining consisted of a layer of firebrick overlain by courses of carbon blocks. The carbon material, cemented by packed paste, extended up the lower side walls to a point above the expected area of melt. A well-maintained lining could last 5 to 6 years at which time the bricks would be removed and scrapped (Robiette, 1973). A former Port employee remembers stacks of whitish fire brick at the plant and indicated that they were available free for reuse by locals.

Carbon pack electrodes averaging around 3 feet in diameter extended into the mix. The electrodes generally were manufactured on site, and there is no reason to believe that OFA operated differently. The electrodes, operating on a three phase system, provided the arc heat to melt the raw materials. Some furnaces were water cooled to increase electrode durability. It appears that the OFA plant used a recirculating cooling system. Overflow discharge from this system, however, occurred at least in the later years of operation. Their discharge permit application indicates approximately 60,000 gallons per day were fed into a ditch on the south side of the property. The ditch connected with the Hylebos Waterway.

Air emission concerns in the 1960 resulted in installation of a cloth filter dust collection system. In addition, the discharge permit indicates that fines recovery was occurring using water and settling ponds in the 1960s, with a discharge also about 60,000 gallons per day. One aerial photo taken during this period shows a contained pond immediately west of the spoils pile retaining wall area. A note on the application indicates that the company intended to pelletize and reprocess this material from the settling ponds.

Products. Ferro-alloys serve as a deoxidizing and degasification agent and as an alloying material in a metal smelting process. As used in the industry for either furnace or ladel charges, "chunks" of varying sizes of ferro-alloy are introduced to the molten metal. At the OFA plant, products were cast into large ingots, as noted above, or into smaller briquets. Thinner pan-molded slabs also may have been produced in later years. Although when used in the steel industry, ferro-alloys may be introduced in a crushed form, there was no indication that this operation occurred at the OFA plant.

The ferro-silicon alloys are manufactured in a variety of grades

based on silicon content ranging from 15 to 90 percent. Silicon metal achieves a 96 to 98 percent silicon content by definition. The remainder of the product is chiefly iron with small amounts of other elements that depend on the nature of the raw materials. Other elements include aluminum, calcium, titanium, carbon, phosphorous, and trace metals such as chromium, manganese, nickel, and copper.

Waste Materials. Waste materials depend on the specific ferro-alloy under production. Most residuals are a result of impurities that are skimmed as slags. Silicon alloys are noted as being relatively slag-free due to the high purity of the quartzite ore (Gate, 1981). Manganese and chromium ores, however, contain impurities that are separated through a flux process into a slag. Burnt lime and alumina are sometimes used as fluxing agents.

Other waste materials are associated with the casting process and plant maintenance. These include sands, fireclay and graphite patch materials, carbon, and firebrick from the furnace linings.

OFA Demolition

We reviewed Port of Tacoma records and interviewed Mr. William Kittrel and Mr. George Yaconetti regarding demolition of the plant and subsequent site preparation.

Demolition of the facility was handled through OFA as part of the purchase agreement stipulations. Port estimated demolition costs were about $100,000. Two firms, Lige Dickson Co. and Rhine Co. were reviewing the property in November 1973 preparatory to submitting bids. Estimates were to assume a salvage value for above-ground improvements.

No specific records were found covering the actual demolition. This apparently occurred prior to mid-January 1975 when Port correspondence with OFA noted that there was much remaining debris on site and that pictures of the unsuitable condition were being forwarded. The situation apparently was rectified by the end of February, as the property was deemed satisfactory for Port use. Mr. Yaconetti indicated that, to the best of his knowledge, demolition materials were sent to either the General Metals or the Simon recycling operation. Only the former office building along Taylor Way was left standing.

Those interviewed had limited recollections of site regrading or filling subsequent to demolition. Mr. Kittrel remembered discussions about grading the materials/slag piles along the northern edge of the property toward the south.

Port files dated July 1976 include an estimate for using about 144,000 cubic yards of fill on the site from the Manke property northeast of the Hylebos Waterway. The material from this area was considered good clean fill, but Mr. Yaconetti indicated that, to the best of his knowledge, Manke fill was not used. One undated aerial photo in the Port collection, however, suggest filling and grading did occur. The photo depicts site preparation for a log storage yard south and east of the OFA plant area, which currently is outside property boundaries. This area formerly had wetland channels, and appears from the photograph to have received some gravel materials. In addition, the photograph shows a series of linear pile dumps on the southern edge of the former slag pile and west of the then demolished furnace building. Trucking roads pass over the former furnace house location to the area of the dumped material. The nature of the piles could not be determined, and the area has since been graded. No indications of building debris were noted in any of the post-demolition photographs.

Asbestos Issues

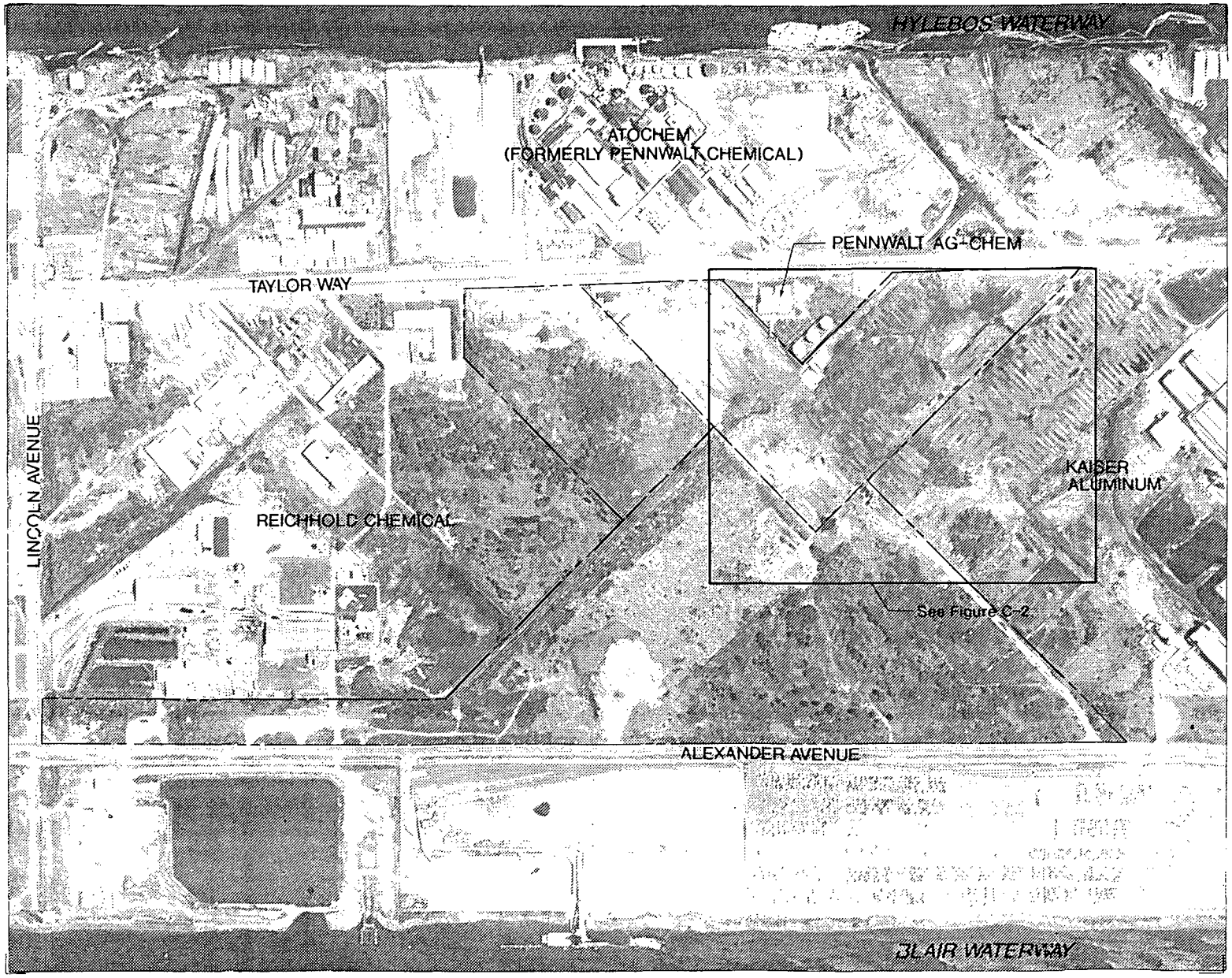
We were unable to find pictures or records showing the detailed construction of the OFA plant and particularly the interior of the furnace building. None of the interviewees had experience with or recollections of the interior of buildings. Use of asbestos-containing materials (ACM) at the facility is possible if not probable, although amounts may have been limited. The furnaces themselves may have included some asbestos lining; in the 1960s, the company introduced an improved protective glove as a worker safety measure, and these may have included ACM. Additional material might have been included in venting structures and cooling water return pipes.

A review of the literature shows pictures of possibly similar plant facilities. The furnace buildings are universally unprotected bare steel and iron structures with no extensive amounts of insulating materials visible.

The interview process, photo review, and the demolition by the owner under terms of the purchase agreement suggest that most if not all

improvement rubble was removed from the property. Consequently, we would not expect extensive ACM materials to remain on the property, although limited amounts associated primarily with piping might occur.

Vicinity Map



Note: Base map prepared from aerial photograph of the Port of Tacoma dated June 1, 1989.

N

0 400 800

Approximate Scale in Feet

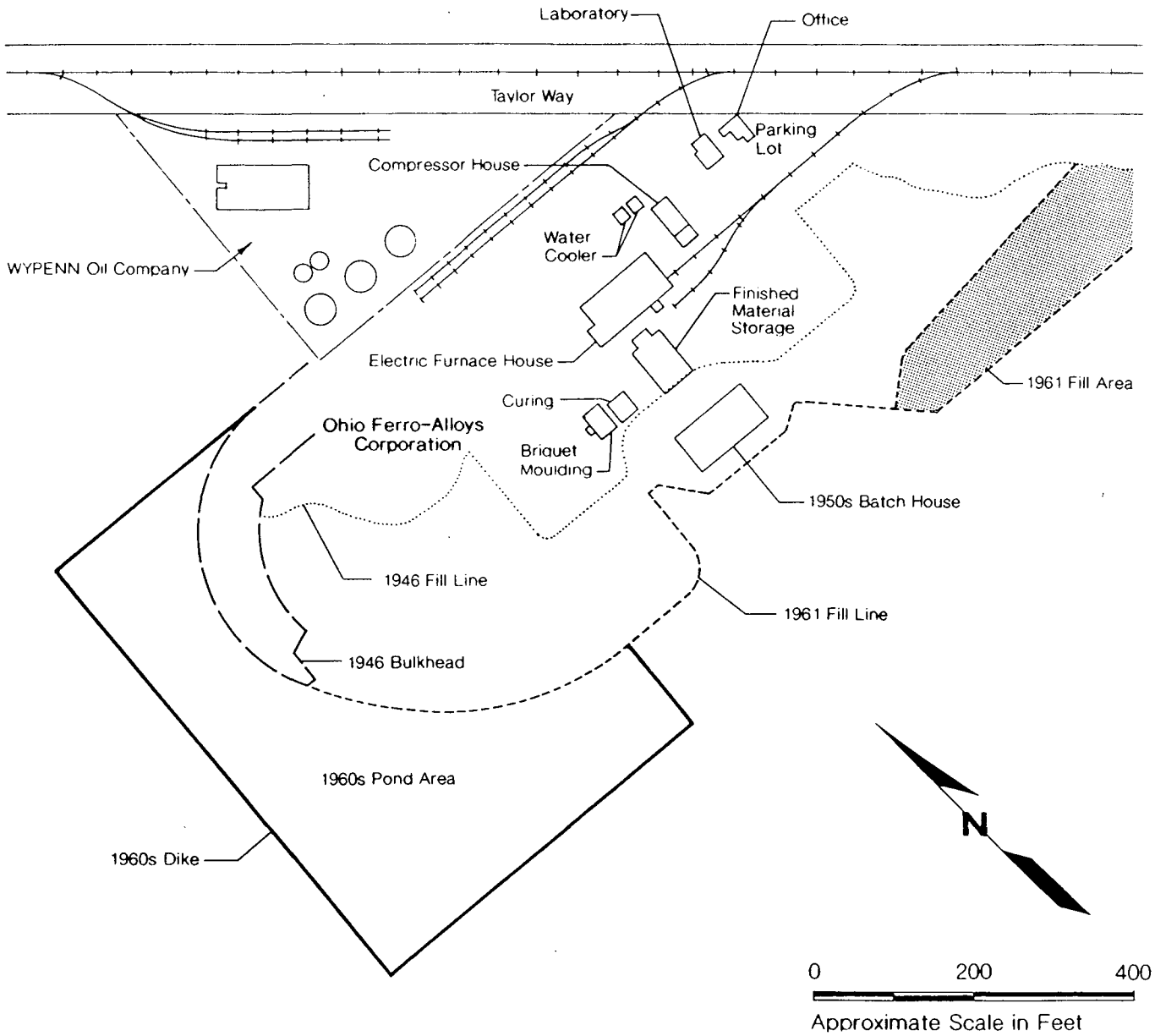
HARTCROWSER

J-2350-07 5/91

Figure I-1

Historical Features Map

Ohio Ferro-Alloys Corporation Area



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Appendix J

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FORMALDEHYDE ANALYSIS ASSESSMENT

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FORMALDEHYDE METHOD COMPARISON
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ATTACHMENT J-2
FORMALDEHYDE DATA REVIEW AND REPLY
EPA AND LAUCKS CORRESPONDENCE

APPENDIX J
FORMALDEHYDE ANALYSIS ASSESSMENT

MEMORANDUM

DATE: August 12, 1991

TO: Ms. Leslie Sacha, Port of Tacoma

FROM: Cathy Kiley and Mike Ehlebracht, Hart Crowser, Inc.

RE: Formaldehyde Analytical Method Comparison Study and Occurrence of Formaldehyde in Port of Tacoma Shallow Groundwater
J-2350-07

INTRODUCTION

The purpose of this technical memorandum is to discuss the formaldehyde analytical method evaluation study conducted by Hart Crowser and to summarize our understanding of the occurrence of formaldehyde in Port of Tacoma shallow groundwater systems. As part of the Phase 1 (Hart Crowser, 1989a and 1989b) Port of Tacoma Tribal Property Transfer Project, we identified formaldehyde as being of potential concern on the Blair Backup property due to its usage on the adjacent Reichhold facility. During subsequent investigations, we analyzed groundwater samples collected from the Blair Backup property for formaldehyde. We also analyzed groundwater samples collected from the East-West Road and Taylor Way properties for formaldehyde to provide data on "local reference" conditions. No major anthropogenic sources of formaldehyde are known to exist on or adjacent to these properties.

Formaldehyde concentrations in groundwater samples collected as part of our initial investigations, including samples collected from the East-West Road and Taylor Way properties, were often much higher than the levels detected on the Reichhold facility and exceeded MTCA groundwater cleanup levels. We investigated possible sources for these elevated concentrations and found that the methods used to detect and quantify formaldehyde (including the Hantzsch Reaction method used in the initial investigations) are subject to matrix interferences and misidentification. We then conducted a study comparing the three most commonly used formaldehyde analytical

methods (Hantzsch Reaction, NIOSH Method 3500, and RCRA Draft Method 8315) to assess which is more accurate and less prone to matrix interferences.

Results of this study indicated that the RCRA method was the most defensible and least prone to interferences. Groundwater from the Blair Backup property was resampled and analyzed for formaldehyde using the RCRA method. Results were compared to formaldehyde concentrations observed in Port of Tacoma (Port) groundwater local reference samples. Although formaldehyde levels observed in Blair Backup groundwater were generally within the range of concentrations measured in the Port local reference samples, they often exceed MTCA groundwater or surface water cleanup levels. We believe that these elevated concentrations of formaldehyde are derived primarily from global or natural sources or are a result of analytical matrix interferences and misidentification of formaldehyde.

Data supporting these conclusions are presented in the following sections. We have divided this technical memo into seven sections. Following this introduction, we present a brief description of the three common formaldehyde methods followed by a summary of our method evaluation study scope of work and results. The next two sections discuss the results of our formaldehyde local reference study and the occurrence of formaldehyde in the Port of Tacoma area. We conclude this technical memo with a discussion of factors which affect formaldehyde concentrations in groundwater and a summary of our conclusions. Details of our Port of Tacoma groundwater background sampling study are presented in Appendix D to the Blair Backup property report. Data validation results are presented in Attachment J-1.

FORMALDEHYDE ANALYTICAL METHODS

Hantzsch Reaction. This test method, developed by an American Standards Testing Methods (ASTM) committee for determining formaldehyde concentrations in water, uses the Hantzsch Reaction to extract samples. Acetylacetone reagent is added to the water sample and the mixture is agitated and heated. After cooling, the absorbance of ultraviolet (UV) light at a particular wavelength by the sample solution

is measured using a spectrophotometer. Additional extraction procedures may be used for turbid or colored samples.

Matrix interferences can occur if the samples are turbid and/or colored. Color and turbidity in the water increases the scattering of light and decreases the amount of light reaching the detector. Normally, a decrease in the light measured at the detector indicates an increase in absorbance by the compound. However, when the sample is turbid or colored, this decrease in absorbance may incorrectly be attributed to high concentrations of formaldehyde. Thus, measured formaldehyde concentrations may be higher than actual sample concentrations.

Negative interferences occur when the formaldehyde in solution reacts with phenols, sulfites, alcohols, and aromatic hydrocarbons also in solution to form compounds not measured by this method. Thus, in the presence of these compounds, the calculated concentration of formaldehyde may be much less than the actual concentration.

NIOSH Method 3500. This method involves an extraction of samples using a chromotropic acid reagent mixture. Originally, this method was developed for air sample analysis, but it has also been used for aqueous samples. A spectrophotometer is used to measure the absorbance of UV light at a particular wavelength.

Matrix interferences may result in incorrect measurements of formaldehyde. Suspended particulate matter scatters light, reduces the amount of light reaching the detector, and causes a false positive measurement of formaldehyde. Color in solution causes light to be absorbed at the wavelength used in calibration and quantification, leading to inaccurate quantification of formaldehyde. Formaldehyde may actually form in samples that have a high organic content (lignins), thus increasing the amount of formaldehyde in solution. Interference by lignins is not eliminated by distillation. Formaldehyde and formaldehyde polymers also form under acidic condition ($pH<5.5$) as well as during distillation process when heat is generated. In these instances, the measurements of formaldehyde may be greater than the actual levels found in the sample.

Negative interference will occur when reactive compounds including alcohols, phenols, and aromatic hydrocarbons combine with formaldehyde in solution to produce compounds that are not measured by this method. The measured concentration may actually be less than the actual sample formaldehyde concentration.

RCRA Draft Method 8315. Formaldehyde concentrations are determined using High Performance Liquid Chromatography (HPLC) to separate the analyte from other matrix compounds. Derivatization of formaldehyde in the sample is accomplished by reacting the sample solution with 2,4-Dinitrophenylhydrazine (DNPH). Liquid-liquid or solid sorbent extractions are performed to isolate the formaldehyde fraction.

The predominant matrix interference occurs during the extraction process. Emulsions may form during the liquid-liquid extractions causing incomplete separation of the formaldehyde from the solution. The solid sorbent extraction does not form emulsions.

Interferences in the quantification of formaldehyde also result from the incomplete or degraded derivatization of the samples and standards. This causes the detected concentration of formaldehyde to be lower than the actual amount.

FORMALDEHYDE ANALYTICAL METHOD EVALUATION STUDY

Selection of Sampling Locations. As part of the method evaluation study, Hart Crowser sampled groundwater from 10 wells and analyzed the samples for formaldehyde using the three different testing methods to determine which is more accurate and less prone to matrix interferences. The following ten wells were selected for formaldehyde sampling:

- Blair Backup Property - Shallow Wells HC-7S, HC-10S, HC-13S, HC-17S, and EPA-7S;

- Blair Backup Property - Intermediate Wells HC-3I, HC-14I, and EPA-10I;

- East-West Road Property - Well TW-5; and
- Taylor Way Property - Well TW-1.

These wells were selected for sampling based on four major considerations: Phase II formaldehyde results; spatial distribution; aquifer type; and sample recovery. We collected samples exhibiting a wide range of reported formaldehyde concentrations with an emphasis on samples identified as containing high levels of formaldehyde. Selected wells from the East-West Road and Taylor Way properties and from different areas of the Blair Backup property were sampled to evaluate groundwater samples with varying geochemical characteristics and potential matrix interferences. Both shallow and intermediate aquifers were sampled on the Blair Backup property. Several of the shallow wells on the Blair Backup property (including wells HC-1S and HC-2S) did not contain an adequate volume of water for sampling during the dry season.

Chemical Analyses. Samples were analyzed for formaldehyde and total suspended solids. Groundwater pH, temperature, specific conductivity, and dissolved oxygen were measured in the field. One duplicate sample and one field blank were also submitted for formaldehyde analysis.

Formaldehyde Analytical Testing. Laucks Testing Laboratories (Laucks) analyzed 12 samples for formaldehyde using the Hantzsch Reaction and NIOSH Method 3500 techniques. Splits of these samples were also analyzed for formaldehyde by Analytical Technologies, Inc. (ATI) using RCRA Draft Method 8315. The ATI-Fort Collins laboratory modified the RCRA 8315 method slightly by substituting acetonitrile for ethanol as the solvent in the DNPH reaction solution. Ethanol used by ATI was found to contain low levels of acetaldehyde which caused method blank problems. Acetonitrile did not contain acetaldehyde and produced cleaner method blanks.

Quality Control Data Review. We reviewed the quality of the data relative to control limits specified in the methods or by the laboratories. A detailed discussion of the data review is presented in Attachment J-1. EPA's review of the formaldehyde data and Lauck's reply to EPA comments are also presented in Attachment J-2. We

determined that the laboratory data generated from analysis of groundwater samples were valid for purposes of formaldehyde method comparison study. However, matrix interference problems were encountered using the Hantzsch reaction and NIOSH Method 3500 methods. Since spike recoveries for the NIOSH method were below 50%, all formaldehyde concentration results generated using this method were qualified as estimated (J). The validity of the NIOSH method data should be considered suspect.

Discussion of Results. Results indicate that the Hantzsch Reaction Method overestimated the formaldehyde concentrations by 30 to 270 times compared with the NIOSH 3500 and RCRA Draft methods (Table J-1). For example, reported formaldehyde concentrations in TW-1 were 55 μg/L (RCRA method), 175 μg/L (NIOSH method) and 9,600 μg/L (Hantzsch Reaction). The RCRA Draft method generally reported the lowest concentrations of formaldehyde.

All three methods are susceptible to matrix interferences. Turbidity and/or color was noted in most samples. Cleanup procedures which may diminish the interferences were not performed for the Hantzsch Reaction and NIOSH methods. Because these methods use colorimetric techniques, they are probably affected by turbidity and natural color in the sample. Severe matrix interferences were observed by the laboratory using the NIOSH method. However, we did not find a statistically significant correlation ($r^2 < 0.5$ using linear correlation) between sample turbidity measured as total suspended solids (TSS) and reported formaldehyde concentrations using the three methods.

Differences observed in the formaldehyde results produced by the three methods are probably due to matrix interferences. As discussed previously, the Hantzsch Reaction and NIOSH methods are much more susceptible to matrix interferences and misidentification of formaldehyde than the RCRA method. Because shallow groundwater sampled during this investigation was typically turbid and appeared to contain high levels of organics derived from decaying plant materials, we believe that quantifying formaldehyde using colorimetric techniques under these conditions is inappropriate. The RCRA Draft method is a more selective method for analyzing formaldehyde and is least affected by these conditions. Therefore, the RCRA Draft

method 8315 was selected as the method of choice and was used for all formaldehyde determinations in subsequent investigations.

SUMMARY OF PORT OF TACOMA FORMALDEHYDE LOCAL REFERENCE STUDY

Hart Crowser sampled 10 wells to provide general background reference levels for dissolved metals and formaldehyde in shallow groundwater located in the Port of Tacoma industrial area. The 10 wells were selected based upon accessibility, location relative to properties of interest, lack of exposure to local industrial activity, and depth of screened interval. Wells in the area between the Puyallup River and the upland bounding Marine View Drive were targeted because they lie within the same regional hydrogeologic system as the properties of interest. A detailed description of the study including a map of sample locations and analytical results are presented in Appendix D in the Blair Backup property report.

Formaldehyde was detected in seven of the ten reference wells with concentrations ranging from 5.8 to 60 μg/L, using the RCRA method (Table J-2). The highest concentration was detected in well MP-1 located in an undeveloped parcel of land south of the East-West Road property.

OCCURRENCE OF FORMALDEHYDE IN THE PORT OF TACOMA AREA

Detected formaldehyde concentrations in groundwater samples collected from Taylor Way and East-West Road properties are within the range of formaldehyde concentrations (<5 to 60 μg/L) encountered in the Port of Tacoma reference study. There are no known major anthropogenic sources of formaldehyde on or adjacent to these properties (Hart Crowser, 1991b and 1991c).

On the Blair Backup property, formaldehyde was detected in 20 of 23 groundwater samples collected in the shallow aquifer, and in 7 of 20 samples in the intermediate aquifer. Only four of the groundwater samples (HC-5S, HC-12S, HC-13S, and

EPA-9S) collected from the Blair Backup property exceeded the range of formaldehyde concentrations reported in the Port reference study. The highest detected concentration of formaldehyde (260 μg/L) was observed in well MW-13S located in the central portion of the site. No known major anthropogenic sources of formaldehyde exist on the Blair Backup property. Formaldehyde is handled at the Reichhold facility and has been detected in groundwater samples collected from this site at concentrations ranging from 60 to 440 μg/L. However, it is unlikely that formaldehyde has migrated from the Reichhold site to the Blair Backup shallow aquifer because:

- The Reichhold Ditch intercepts most of the shallow groundwater flowing from the Reichhold facility; and

- The highest formaldehyde concentrations were detected in the central and northern portions of the site and not in the area adjacent to Reichhold.

No samples collected in the Blair Backup property Intermediate Aquifer exceeded the range of formaldehyde concentrations reported in the Port reference study.

The source of formaldehyde (if actually present) to the Blair Backup property and Port of Tacoma shallow groundwater sampled during our investigations is unknown. It is possible that there is a natural or global source of formaldehyde to the area or that the analytical method is actually quantifying some other material as formaldehyde. Potential natural or global sources of formaldehyde are discussed in the following section.

FACTORS AFFECTING FORMALDEHYDE CONCENTRATION IN GROUNDWATER

Global Sources of Formaldehyde. The presence of formaldehyde is ubiquitous in the environment particularly in the atmosphere. Natural sources of formaldehyde include forest fires, animal wastes, microbial products, and plant remains. The major source of formaldehyde to the atmosphere is automobile emissions. Combustion processes

emit formaldehyde as well as hydrocarbons which are then converted to formaldehyde through photooxidization in the atmosphere (Howard et al., 1989; Kitchens et al., 1976). Because formaldehyde is highly soluble in water, it will be washed out of the atmosphere with rainfall and may eventually be incorporated into groundwater.

Environmental Fate of Formaldehyde. Formaldehyde in aqueous solutions generally biodegrades to low levels within a few days (Howard et al., 1989). At this time, the rate of biodegradation of formaldehyde in soils is unknown. However, there is some evidence of formaldehyde degradation by bacteria in soils (Atlas and Bartha, 1987). Because degradation of formaldehyde is so rapid, it is unlikely that formaldehyde found in remote areas away from continuous atmospheric or other sources has been transported as formaldehyde. However, formaldehyde may occur in these areas due to the degradation of more stable formaldehyde-forming compounds (Howard et al., 1989; Kitchens et al, 1976).

Formaldehyde is very unstable in aquatic environments. Chemical processes such as oxidation-reduction, depolymerization, and addition reactions, occur in the groundwater as it contacts geologic units. Formaldehyde is a reducing agent that can be oxidized to formic acid. Oxidation-reduction reactions also occur between formaldehyde and metal ions and other easily reduced compounds. Polymers of formaldehyde and formaldehyde can undergo polymerization and depolymerization reactions that alter the amount of formaldehyde in solution. In addition, formaldehyde and its polymers can readily react with other aqueous compounds such as alcohols, phenols, ammonia, urea, and aromatic hydrocarbons, to form other compounds. Because formaldehyde is so unstable, its concentration in solution is extremely variable.

Formaldehyde and related compounds are utilized and produced in a number of metabolic pathways by certain microorganisms. Methanogens, in particular, assimilate formaldehyde and formic acid as nutrient sources. During periods of increased anaerobic activity, marked changes in the concentration of formaldehyde in solution can occur (Atlas and Bartha, 1987).

Sources of Formaldehyde in the Port of Tacoma Area. There are no known historical or current anthropogenic sources of formaldehyde on any of the properties of interest. As discussed previously, it does not appear that formaldehyde detected on the Tribal Land Transfer properties are derived from Reichhold. While it is possible that Reichhold operations could have released some formaldehyde to the Blair Backup property via groundwater transport or potential dumping of formaldehyde-containing materials (we have no evidence that this has ever occurred), it is extremely unlikely that Reichhold operations could be responsible for formaldehyde concentrations detected in the East-West Road and Taylor Way properties as well as the Port of Tacoma background areas.

The apparent wide-spread distribution of formaldehyde in the Port of Tacoma area suggests that the global processes discussed previously such as atmospheric deposition may act as sources. Degradation of organic matter associated with the tideflats and the log sorting operations may also act as a widespread source of formaldehyde to the Port area. The presence of high levels of organic materials in groundwater also increases the likelihood for analytical matrix interferences resulting in the quantitation of other materials as formaldehyde.

SUMMARY

The range of formaldehyde concentrations detected in the properties associated with the Port of Tacoma Tribal Property Transfer projects are consistent with local reference concentrations reported by Hart Crowser as part of the Port of Tacoma reference study. It is believed that these background concentrations are either derived from natural or global sources or are due to analytical interferences which result in quantifying other compounds as formaldehyde. In either case, we do not believe that remedial action based on the presence of formaldehyde is feasible or appropriate for the East-West Road, Taylor Way, and Blair Backup properties.

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Table J-1 - Formaldehyde Analytical Method Comparison Results

Sample ID:	HC-13S	HC-3I	HC-14I	HC-10D Field Blank	HC-10S	HC-7S	HC-17S
Formaldehyde in μg/L							
Hantzsch Reaction	8,300	560	4,600	200 U	10,000	1,200	9,400
NIOSH Method 3500	100 J	180 J	180 J	20 UJ	130 J	70 J	40 J
RCRA Draft Method 8315	130	17	30	5 U	79	40	35
Total Suspended Solids in mg/L	960	210	1,100	2 U	3,100	190	160
Field Parameters							
pH	4.4	6.7	6.6	NA	6.9	6.6	6.0
Specific Conductivity in μmhos/cm	4,000	14,800	16,900	NA	2,100	900	1,200
Temperature in °C	13	11	12.3	NA	12.0	12.6	11.6
Dissolved Oxygen in mg/L	4.5	4.7	3.5	NA	5.7	5.2	3.8

Notes:

U	Not detected at indicated detection limit.
J	Indicates an estimated value.
NA	Not analyzed.

FORMLD.WK1

Table J-1 - Formaldehyde Analytical Method Comparison Results

Sample ID:	EPA-7S	EPA-10I	EPA-11I Duplicate of EPA-10I	TW-5S	TW-1S
Formaldehyde in μg/L					
Hantzsch Reaction	5,100	970	670	4,000	9,600
NIOSH Method 3500	50 J	150 J	180 J	100 J	170 J
RCRA Draft Method 8315	25	11	9	17	55
Total Suspended Solids in mg/L	370	250	420	1,300	4,300
Field Parameters					
pH	6.5	6.7	NA	6.7	6.6
Specific Conductivity in μmhos/cm	740	10,400	NA	750	710
Temperature in °C	11.6	10.7	NA	12.6	13.7
Dissolved Oxygen in mg/L	3.6	3.4	NA	2.2	1.7

FORMLD.WK1

Table J-2 - Summary of Formaldehyde Concentrations in the Port of Tacoma Area

Source	Formaldehyde in $\mu g/L$
Port of Tacoma Reference Study (a.)	5.8 to 60
East-West Road Property (a.)	17
Blair Backup Property (b.)	5.8 to 260
Taylor Way Property (c.)	14 to 55
Reichhold (d.)	60 to 440

a. Hart Crowser, 1991b.
b. Hart Crowser, 1991a.
c. Hart Crowser, 1991c.
d. CH2M HILL, 1991.

ATTACHMENT J-1
FORMALDEHYDE METHOD COMPARISON STUDY DATA VALIDATION REPORT

ATTACHMENT J-1
FORMALDEHYDE METHOD COMPARISON STUDY DATA VALIDATION REPORT

Purpose of This Report

This report presents our validation of the Laboratory Data Reports for chemical analysis of groundwater samples collected as part of the formaldehyde method comparison study. The laboratory work reviewed herein was conducted for samples collected in November 1990 as part of the Draft Final Investigation reports compiled for the Taylor Way, East-West Road, and Blair Backup properties located in the Port of Tacoma, Washington. Our review of the Laboratory Data Reports was performed in general accordance with Laboratory Data Validation Functional Guidelines (EPA, 1988a and 1988b), as appropriate. Laboratory in-house control limits and control limits specified in the methods were used to evaluate duplicate results as well as surrogate and matrix spike recoveries.

Summary of Findings

We have determined that the laboratory data generated from analysis of groundwater samples collected during this work are valid for the purposes of the formaldehyde method comparison study. Summaries of the formaldehyde method results are presented in Tables J-1 and J-2, respectively. Some of the data required qualification. Qualified data are listed below.

NIOSH Method 3500 formaldehyde spike recoveries and relative percent differences were outside of control limits. The laboratory reported severe matrix interferences using the NIOSH method. All formaldehyde concentration results generated using the NIOSH method were qualified as estimated (J). The validity of the NIOSH method data should be considered suspect.

FORMALDEHYDE METHOD COMPARISON DATA REVIEW

Analytical Methods

Appropriateness of Testing. Laucks Testing Laboratories, Inc. (Laucks) analyzed 12 samples for formaldehyde using the Hantzsch Reaction and NIOSH Method 3500 techniques. Splits of these samples were also analyzed for formaldehyde by Analytical Technologies, Inc. (ATI) using RCRA Draft Method 8315. The ATI-Fort Collins laboratory modified the RCRA 8315 method slightly by substituting acetonitrile for ethanol as the solvent in the DNPH reaction solution. Ethanol used by ATI was found to contain low levels of acetaldehyde which caused method blank problems. Acetonitrile did not contain acetaldehyde and produced cleaner method blanks.

Reporting of Data. Results reported by Laucks were quantitated using milligrams per liter (mg/L) or ppm units. ATI reported the RCRA formaldehyde method results in micrograms per liter (μg/L) or ppb units.

Sample Handling

Sample Collection. Samples were collected in clean 1-liter amber bottles (with teflon-lined caps) supplied by Laucks and ATI. Samples were collected in a manner to limit agitation and headspace in the bottles.

Sample Handling. Upon collection of each sample, the sample number, date, time, and sampling personnel initials were recorded on the label of each container. Samples were stored in insulated coolers packed with "blue ice" and maintained in Hart Crowser's custody until samples were hand-delivered to Laucks and ATI.

Holding Times

Holding Times. There are no established holding time requirements under 40 CFR 136 (Clean Water Act) for formaldehyde in groundwater. The EPA Environmental Monitoring Systems Laboratory (EMSL) in Las Vegas, Nevada has established a five-day holding time from the verified time of sample receipt (VTSR) for contract laboratories. A five-day VTSR criteria generally corresponds to a seven-day holding

time limit from the date of sample collection. All samples were analyzed within the seven day holding time requirement.

Blanks

Laboratory Blanks. The appropriate number of laboratory blanks were analyzed. At least one blank sample was analyzed for each set of extracted samples.

Laboratory Blank Contaminants. Formaldehyde was not detected any of the laboratory method blanks.

Field Blanks. One field blank (HC-100) consisting of carbon-free deionized water was analyzed for formaldehyde using all three methods. No formaldehyde was detected in any of the analyses.

Calibration

Frequency. The appropriate number of external calibration standards were run for each analysis. Initial and continuing calibration standards were analyzed as part of the RCRA method.

Acceptability. Correlation coefficients were acceptable for all three analyses (>0.990). Percent differences for RCRA method continuing calibration were less than or equal to 15%.

Matrix Spikes and Matrix Spike Duplicates

Spike Recoveries. Spike recoveries were within laboratory control limits for the Hantzsch Reaction (50 to 150%) and RCRA 8315 analyses (50 to 125%). NIOSH Method 3500 spike recoveries were below 50%. The laboratory reported severe matrix interferences using the NIOSH method. All formaldehyde concentration results generated using the NIOSH method were qualified as estimated (J). The validity of the NIOSH method data should be considered suspect.

Spike Duplicates. Relative percent differences (RPDs) for MSD were acceptable for the Hantzsch Reaction (±20%) and RCRA 8315 analyses (±25%). RPDs were outside of control limits for the NIOSH method analysis.

Field Duplicates

Field Duplicate Results. One field duplicate of EPA-10I (EPA-11I) was analyzed using all three of the formaldehyde methods. RPDs for the Hantzsch Reaction and NIOSH method analyses were 37% and 18%, respectively. Duplicate results for the RCRA method were within plus or minus the sample detection limit.

ATTACHMENT J-2
FORMALDEHYDE DATA REVIEW AND REPLY
EPA AND LAUCKS CORRESPONDENCE

United States
Environmental Protection
Agency

Region 10
1200 Sixth Avenue
Seattle WA 98101

Alaska
Idaho
Oregon
Washington

EPA

April 3, 1991

REPLY TO
ATTN OF: ES-095

APR 3 1991

MEMORANDUM

SUBJECT: Review of Data Validation Reports for Commencement Bay Nearshore/Tideflats Taylor Way Property, Hart Crowser, Inc. (2/8/91, Letter of Transmittal)

FROM: Donald Matheny, Chemist
Regional Quality Assurance Management Office

TO: Karen Keeley, Site Manger
Superfund Branch, HWD, Region 10

The Quality Assurance Management Office has received and is transmitting the above review submitted by ESAT.

Environmental Service Assistance Team – Zone II

ICF Technology, Inc.

NSI Technology Corp.

The Bionetics Corp.

Esat Region X
ICF Technology, Inc.
1200 6th Avenue
Seattle, WA 98101
(206) 553-1849

MEMORANDUM

DATE: March 29, 1991

TO: Donald Matheny, Task Monitor
USEPA Region 10

FROM: Michael W. Letourneau, ESAT Data Reviewer

SUBJECT: Data Validation Report Review
Commencement Bay Nearshore/Tideflats Taylor Way Property
Hart Crowser, Inc.

TID NO: 10-9101-520

DOCUMENT NO: ESAT-10-B-1019

The Data Validation Report for Formaldehyde and Groundwater Background Studies (February 8, 1991) from the Draft Final Investigation Report for the Commencement Bay Nearshore/Tideflats Taylor Way Property has been completed. The following conclusions are based on the information provided for the review.

Three methods of analysis for Formaldehyde in groundwater were utilized in the investigation. The results from the three methods of analysis varied substantially. The following is a discussion of the results from the three different methods, possible sources of variation between the results and the validity of the results.

The Formaldehyde results from the analysis of the samples via the ASTM Hantzsch reaction method were the highest of the three methods utilized. Results from the Hantzsch reaction method were 30 to 270 times greater than those of the NIOSH 3500 and RCRA 8315 Methods.

The results for the NIOSH method of analysis were qualified "J" (estimated value) by the reviewer due to poor Matrix Spike/Matrix Spike Duplicate recoveries (19% - 32% recovery) and poor duplicate analysis results (RPD 36).

RCRA method 8315 results were the lowest of the three methods of analysis. The laboratory performing the analysis noted an error in the January 1990 version of Method 8315 in section 5.14.1.1 where the formula provided for the determination of Formaldehyde in the standards was incorrect. The error was <u>not</u> incorporated into the results provided by the laboratory.

The three methods of analysis are susceptible to interferences such as turbidity, color, phenols, alcohols and sulfites. The laboratory notes for the Hantzsch reaction analysis did not indicate if the samples were turbid or colored. However, the laboratory notes for the NIOSH method of analysis noted "most sample[s] developed a yellow color, could be matrix interference (false hits)." In addition, the laboratory performing the RCRA 8315 analysis noted that one sample was "dark and viscous" and that "many of the samples were somewhat turbid." In a conversation with the analyst performing the Hantzsch reaction and NIOSH analyses, I was informed that the cleanup procedures for these methods were <u>not</u> performed on the samples. Therefore, there is a possibility that interferences affected the results in these analyses. The NIOSH method and the Hantzsch reaction method are tests that measure the absorbance of UV light at particular wavelengths. Turbidity in the samples would increase scattering which would decrease the light reaching the detector. This decrease in power at the detector would be incorrectly interpreted as increased absorbance. Therefore, an interference such as turbidity would give false high readings for Formaldehyde in the NIOSH and Hantzsch methods. While the Quality Control results for the NIOSH indicate a negative matrix interference (recoveries of Formaldehyde spiked into the samples were low), it is believed that the interference masked the response of the Formaldehyde spiked into the sample. It is the masking of the Formaldehyde by the interference that lead to the low recoveries.

The RCRA 8315 method is also susceptible to interferences. It was learned, through a conversation with the laboratory, that the samples were extracted via the liquid-liquid technique, and that none of the extracts underwent any cleanup procedures. The RCRA sample results would be least affect by the interference. The use of liquid chromatography in the RCRA method allows for the resolution of the analyte (Formaldehyde) from other matrix components, providing a more accurate assessment of the amount of analyte present in the sample.

The derivatization of the samples and standards is a critical step in the RCRA 8315 method. Incomplete derivatization of the samples or degraded derivatization agents would result in Formaldehyde values that were incorrect, a possible justification for the lower RCRA 8315 Formaldehyde results. However, in speaking with the analyst, it was learned that the derivatization agent (DNPH) was prepared fresh with each days analysis and that experimentation prior to sample analysis insured that all samples and standards were derivatized completely.

Standard preparation is a major component of all three methods. In the RCRA 8315 method the Formaldehyde standards are prepared from Formalin (approximately 37.6% w/w Formaldehyde), and a standardization procedure must be performed to determine the exact concentration of Formaldehyde in the standards. A review of the raw data for this standardization procedure indicated that the procedure was performed correctly. While the NIOSH and Hantzsch reaction methods also call for the preparation of Formaldehyde standards from Formalin, the laboratory utilized Sodium Formaldehydebisulfite for standard preparation. No information was available from the laboratory regarding the preparation of the Formaldehyde standards from the Sodium Formaldehydebisulfite. If the standards were prepared incorrectly, the reported sample results for the NIOSH and Hantzsch reaction methods would also be incorrect. Therefore, the standards utilized in these analyses could account for the difference between the NIOSH and Hantzsch reaction method results and the RCRA method results. However, because the there are substantial differences between the NIOSH and the Hantzsch reaction results, errors in the Formaldehyde standard preparation from Sodium Formaldehydebisulfite could not be the sole source of error

between the three methods' results.

As the Field Blanks and the Method Blanks do not contain detectable concentrations of Formaldehyde, contamination of the samples prior to their arrival at the laboratory or during the analytical procedure is not possible cause for the differences in the analytical results.

Each sample submitted for analysis was in a full 1 liter amber bottle. Thus eliminating the chance that head-space in the bottles would allow for the Formaldehyde to escape from the water samples, accounting for the lower Formaldehyde values detected by the RCRA method.

While each of the methods of analysis resulted in some samples that contained greater concentrations of Formaldehyde than the background samples, the results were inconsistent between the three methods of analysis. For example one sample (HC-13S) analyzed by the RCRA method resulted in a Formaldehyde concentration greater than the highest background sample (TW-1). The field sample (HC-13S) was less than the background sample (TW-1) when analyzed by the NIOSH and the Hantzsch reaction methods. What is made evident by these Formaldehyde analyses is that background results can only be compared with field samples analyzed by the same method. The comparison of background samples analyzed by one method of analysis with field samples analyzed by another method of analysis would be erroneous and misleading.

The presence of natural and artificial sources of Formaldehyde in the environment have been documented. While there is a limited amount of literature available on Formaldehyde concentrations in groundwater, what is evident is that background concentrations of Formaldehyde vary from location to location. Therefore, it is recommended that additional sampling and analysis be performed in order to make an accurate determination of th background levels of Formaldehyde at the Taylor Way Property site. Only after an accurate determination of the background levels at the site are made can conclusions regarding the Formaldehyde concentrations in the groundwater at the site be made.

Summary

The QC requirements of the QAPP for the Formaldehyde analysis were met for the RCRA Method 8315 and ASTM Hantzsch reaction method. Due to the poor Matrix Spike/Matrix Spike Duplicate and Duplicate sample analysis results in the NIOSH Method 3500 analysis, the estimated value "J" qualification was applied to all sample results. The RCRA 8315 method results for the Formaldehyde analyses conducted on samples from the Commencement Bay Nearshore/Tideflats Taylor Way Property are the most accurate of the three methods utilized for analysis. The NIOSH 3500 method and ASTM Hantzsch reaction method results are greatly influenced by the presence of matrix interferences that bias the data. It is recommended that future analyses of the groundwater samples utilize the RCRA 8315 method. It is also recommended that the solid sorbent (C18) cartridge extraction option of Method 8315 be employed to assure that results are not influenced by interferences.

The Quality Control requirements for these analyses could be improved. In addition to the Matrix Spike/Matrix Spike Duplicate analysis, it is recommended that the analysis include some kind of Laboratory Control Sampl (LCS). As there are no known NBS Formaldehyde water standards, it is recommended that a reagent water sample be spiked with a known concentration of Formaldehyde and processed in the same manner as all other samples. The

LCS would be an indicator for any sample processing problems. It is also recommended that Continuing Calibration Verification (CCV) standards and Continuing Calibration Blanks (CCB) be analyzed after every five samples and at the end of each analysis run. This would insure that the calibration of the instrument remains acceptable throughout the analysis of samples, and that "carry-over" does not influence the sample results.

In comparing the background sample results with those of the field samples, no definite conclusions can be made. While further statistical analysis of the background/field sample comparisons may prove that some sampling sites have "significantly" higher concentrations of Formaldehyde than the background samples, it is recommended that a more accurate determination of the background levels at the site be made. When making background/field sample comparisons, it is important that the comparisons be made on results from the same method of analysis.

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(702/798-2100 - FTS 545-2100)

APR 19 1991

April 16, 1991

SUBJECT: Formaldehyde Analysis in Groundwater Samples at CB/NT Site

FROM: Kenneth W. Brown
Manager, Technology Support Center

TO; Karen Keeley
Site Manager, EPA Superfund Branch
Region 10

Karen, please find attached comments by Dr. Richard Flotard, addressing the analytical methods used to determine formaldehyde levels in groundwater at the CB/NT Site. After you have read the comments, Richard, Phil Malley, and I, would like to discuss these comments and other issues you mentioned in your memorandum dated March 28, 1991.

Please give me a call at FTS 545-2270 as soon as it is convenient.

Attachment

cc:
Richard Flotard, QAD
Phil Malley. AMD

FINDINGS FOR THE FORMALDEHYDE ANALYSIS

1. The ASTM (Hanszsch Reaction) method results are absolutely unusable due to the failure of Laucks laboratory analyst to perform extractions on the standards and the samples before measuring the absorbance. If one compares the amount of formaldehyde in a sample analyzed by this method with the Total Suspended Solids (TSS) result, they correlate quite well. These samples contained up to 0.4% TSS by weight. The analyst reported that the turbidity of some samples was great enough to be visible to the naked eye. This would certainly result in considerable absorbance as compared to the standards made with distilled water. The effect would also be expected to be somewhat variable as the larger particles would settle out as the derivatized sample was allowed to remain undisturbed. The color is stable for several hours and the samples may have sat for some time before being analyzed. To test this hypothesis, the Region should ask Laucks to mix up a suspension of fine clay mineral particles (0.4% by weight) and to compare the absorbence to this mixture to distilled water. My judgement is that the data are totally unusable and should not be relied upon for any site cleanup judgements.

2. There are also some serious problems with the way in which Laucks Laboratory chose to conduct the NIOSH method based test. The stated range of this method is 2 ug-40 ug in a 2 mL water sample. This is equivalent to a concentration of 1 mg/L to 20 mg/L in an undiluted water sample, using the same 2 mL aliquot as is used for the NIOSH impinger solution. The method specifies a calibration range which is equivalent to 0.25 mg/L to 5 mg/L in six increasing concentrations. The calibration range chosen by Laucks began with 0.125 mg/L and increased only to 1.0 mg/L. The matrix spikes were added at 0.125 mg/L. Thus all of the calibrations and dilutions on the samples resulted in analysis of samples far below the minimum recommended range for this method. It is not surprising that Laucks had difficulty with matrix spike recoveries since they were working far below the normal range for the method. Since all of the results obtained by Laucks were less than 0.2 mg/L, I would also consider this data to be estimated values at best, and probably unusable as well.

3. The reviewers concern about the use of a titration for standardization of the formaldehyde solutions is unfounded. This calibration method uses a pH meter to measure the endpoint of the titration. Since it is not a colorimetric method in which there is subjective judgement of a color change, I have no doubt that any reasonably well trained chemist could perform it.

Laucks 83 years
Testing Laboratories, Inc.
940 South Harney St., Seattle, WA 98108 (206) 767-5060 FAX 767-5063

Chemistry, Microbiology and Technical Services

TO: Philip Spadaro
Hart Crowser, Inc.

FROM: B. Gleason
Laucks Testing Laboratories

Date: May 14, 1991

Re: Job No. 2350-07
EPA Memo of 4/16/91

I appreciate your sending this memo along to us. I did indeed share it with Mike Nelson, as well as Harry Romberg, QC Officer, and Mark Babich, the analyst who performed both formaldehyde methods.

While I realize this review is now written in stone and that there is no opportunity for give-and-take on the issues raised, we at Laucks feel it is very important that Hart Crowser understand we did not take a careless approach to these samples, nor do we agree with all of the reviewer's conclusions.

Calibration (NIOSH) The reviewer states the calibration range was too low. In fact, the calibration range bracketed the absorbances from the samples. In addition, using the recommended calibration range would have resulted in standard absorbances greater than 2.0 AU, while the spectrophotometer can only measure up to 2.0 AU.

Calibration seems to be the reviewer's main concern as regards the NIOSH data and in our opinion, since calibrating as the reviewer suggested would have put the analysis off-scale, it is a non-issue.

It is probably appropriate to note here that Laucks' analyst did observe interference with the color development when performing this method, knew that spike recoveries were poor, and suggested that the samples should be distilled to remove interferences (turbidity) and re-analyzed. Mike Ehlebracht was contacted with that suggestion and declined to have the distillation performed, since the procedure is not part of the NIOSH method and one of Hart Crowser's explicitly stated goals was to demonstrate that the method is ineffective. The tone that suggests Laucks was incompetent not to notice the interferences seems unjustified.

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May 6, 1991

SUBJECT: Technical Support for Commencement Bay Nearshore/Tideflats NPL Site

FROM: Kenneth W. Brown
Manager, Technology Support Center

TO: Karen Keeley
Site Manager, EPA Superfund Branch
Region 10

Karen, please find an attachment titled "Technical Support for Commencement Bay". This attachment addresses questions concerning "formaldehyde in groundwater" that were identified in your memorandum dated March 28, 1991. Dr. Richard Flotard and Dr. Gary Robertson have provided this information.

Karen, if you have additional questions or require more information, please give me a call at FTS 545-2270.

Attachment

cc:
Phil Malley, LESC

Attachment
Technical Support for Commencement Bay

1. **Are the data for real?**

Data from the ASTM (Hantzsch) Method are flawed due to the fact that the laboratory failed to extract turbid samples with n-butanol as required by the method before performing absorption spectroscopy on the samples. The "formaldehyde content" of these samples correlates well with the total suspended solid (TSS) content. The results are unusable. The method, as performed, specifies a lower limit of 200ug/L (ppb) which is well above the 2 to 15 ppb needed for decision making at the site. There is an alternate procedure in which a 10 cm cell is used along with a fluorescence spectroscopy detector in which the lower limit is 10ug/L. The laboratory did not use this modification and listed the LOD as 200 ppb.

The NIOSH Method was designed to cover a range of from 20 to 400ppb. The laboratory chose to calibrate the method at 1/10 of the calibration range specified in the method and to spike the matrix spike samples well below the lower end of the published range for the method, while still keeping the same limit of detection (LOD). It is unclear as to whether the method works well within this range. As such, the data are suspect at best.

The remaining method, RCRA Method 8315, appears to be the best one to rely upon. The method has been tested down to 15ppb in a single laboratory test. Since it involves two separation and concentration steps (C-18 cartridges and HPLC) it would expected to be more selective and less subjected to interferences. The laboratory used a 5ppb quantitation limit which may be a bit optimistic. The analyst met all method QA requirements. I would accept the data from this method with the understanding that values less than 15ppb are estimated since they lie below the test range for the method.

2. **Which method most accurately measures formaldehyde in the site conditions ?**

It appears that the RCRA method is the method of choice since it measures free formaldehyde which is the chemical of concern. The ASTM method can be made to operate in the range desired but requires the use of acidic conditions in which the polymeric formaldehyde can be reconverted to free formaldehyde.

3. **What groundwater conditions affect the tests?**

The biggest one is the presence of particulates in the samples. Even the RCRA method has problems with particulates. The C-18 cartridges plug up when particulates are present. Samples should be filtered through a glass fiber filter or extracted as per the recommendations in the ASTM Method. Certainly any chemical in the groundwater which competes with formaldehyde by reacting with the chromophoric reagent (the reagent causing the color change) would have an effect on the results. Matrix spike sample results may help to confirm or to discount this effect.

4. Is the background concentration due to laboratory contamination?

This is unlikely since there was no contamination in the trip blank.

5. What is background concentration in the groundwater?

This requires knowledge of results from other waste sites. These data are not available to my knowledge. It is really outside my area of expertise. My gut feeling is that background for formaldehyde in groundwater should be low. We will contact the experts at R.S. Kerr Laboratory for assistance in this area.

6. How is the NIOSH method modified for aqueous media? What are the reaction conditions? How is the method modified and what are the effects of modification?

No modifications are needed. In air sampling, the formaldehyde is collected in impingers containing an aqueous sodium bisulfite solution. There is no difference except that the laboratory may not have added 1% sodium bisulfite to the samples. (I have no way of knowing that.) The reaction conditions are quite harsh. Of the 10mL final sample volume, 6mL are concentrated sulfuric acid. If depolymerization were to occur, these conditions would probably accelerate it. Technically, there is no difference between analyzing the impinger contents and analyzing a groundwater sample.

7. Are other options available for calibration other than using formaldehyde and titration methods?

In conversations with Mark Roby of Lockheed, who regularly used the RCRA method while working at S-Cubed, I was informed that he had tested some modifications to the RCRA method. One of these was to independently produce the DNPH-Formaldehyde reaction product and to purify this material. It is a crystalline material which can be weighed out to make standards in a much more precise manner than to measure out formaldehyde and react it with DNPH in solution. This option is a modification of the method and would have to be tested before it could be accepted.

8. What kinetics information is available for depolymerization of formaldehyde polymers? Are any of the methods good for "total formaldehyde"?

There was no hard numbers mentioned in the methods except to say that it is slow for the ASTM Method. Since this method has the harshest conditions, it appears that depolymerization is not a significant problem. If the RCRA Method is to be used for future work, this question is moot. I think we already know the reason for the extreme variability in results obtained using the ASTM method due to particulates in the sample. None of the methods works well for "total formaldehyde." This would only be of concern if the state determines that their regulations require measuring total formaldehyde.

9. **What information is available on interferences?**

Some information is available in the method description. Without doing a research project, this question can not be answered. Mr. Roby indicated that the RCRA method has proven to be very rugged in actual use on difficult-to-analyze environmental samples. That would suggest few interferences.

10. **Environmental sources?**

These questions lie outside of my area of expertise. In our conversations it became very obvious that not much data are available for formaldehyde in groundwater. We will attempt to find out additional information and relay it to you.

11. **What contributes to error in sampling and analysis of formaldehyde?**

I posed this question to Mark Roby since he has quite some experience with the RCRA method which appears to be most suitable for formaldehyde in groundwater. While working at S-Cubed Laboratory in San Diego, Mark investigated problems with the method, particularly limit of detection and blank contamination. He traced down contamination problems to the use of glacial acetic acid to adjust the Ph of the sample. All chemically pure grade acetic acid contains some residual formaldehyde. By switching to a phosphate buffer, Mark was able to eliminate the background formaldehyde in the method blank and to lower the limit of detection by a factor of 5. Under the current protocol, sample results are adjusted by the amount found in the blank. It was the amount in the acetic acid buffer which probably controlled the LOD.

Since it appears that formaldehyde may become an analyte of concern at future Superfund and RCRA sites, it may be worthwhile to consider funding a laboratory study on ways to decrease the PQL of this method. Obviously changing the buffer is one possibility. Reducing the elution volume or concentrating the eluate from the C-18 cartridges is another possibility. These would be minor modifications to the method and could be easily tested in a single laboratory study. Mr. Roby indicated that he would be happy to work with the region to help design a study for this purpose. The method already contains QA requirements which appear to be sufficient to monitor laboratory performance (check samples, matrix spike samples, replicate analysis and method blanks). , The laboratory should be required to report the results of QA to the EPA as well as sample results.

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Chemistry Microbiology and Technical Services

Extraction (Hantzsch) The reviewer states that Laucks failed to extract the standards and samples and that, therefore, the data are unusable. The method suggests that samples showing color or turbidity be extracted to remove color absorbed at 412 nm that might interfere with color development at the same absorbance. As it happens, we still have these samples, so Mike took a look at them today. His judgment is that samples -01, -04, -06, -07, and -08 have no visible color; samples -05 and -11 show very slight color; samples -02, -03, -09, and -10 show a discernible but not dark color; and sample -12 is (relative to the other samples) heavily colored.

If you look at the test results, you will see that there is no correlation between the formaldehyde concentration reported and the color. Sample -01, for instance, which is color-free, demonstrated a formaldehyde concentration similar to that in sample -12, which was dark in color. It therefore appears likely that color in the samples did not interfere with the analysis.

The samples do have some turbidity and Mike agrees that, all in all, it would have been good to extract them to be sure of removing that potential interferent. The analyst did not do this because he achieved acceptable spike recoveries (although in an uncolored sample, -04) and concluded that interference was not an issue. The conclusion may have been erroneous.

We disagree that the data are unusable. Qualifying them as estimated is probably reasonable.

Conclusion

In conclusion, we would like to add that there is one standard of care to be followed when we are told an analysis is being performed to demonstrate its ineffectiveness (and we believe we met that standard of care by calibrating within the range of our instrument, by suggesting an alternative sample preparation when interference was noted, and by generating 3 QC data points - 1 dup and 1 MS/MSD - for the apparently "successful" method and 5 QC data points - 1 dup and 2 MS/MSD - for the apparently "unsuccessful" method) and there is a second standard of care to be observed had we known the data were for making site clean-up judgments. If nothing else, this experience demonstrates to all of us the futility of attempting to use data for a purpose never intended.

We appreciate the opportunity to look at this review, we appreciate the time you have given to our response, and we want to assure you that Laucks does not wantonly disregard methodology or appropriate corrective actions, as one might conclude from this review.

Appendix K

APPENDIX K
OCCURRENCE OF IRON AND MANGANESE

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LOWER PUYALLUP RIVER BASIN
IRON AND MANGANESE DATA
EBERT ET AL., 1986

APPENDIX K
OCCURRENCE OF IRON AND MANGANESE

TECHNICAL MEMORANDUM

DATE: November 12, 1991

TO: Ms. Leslie Sacha, Port of Tacoma

FROM: Cathy Kiley and Mike Ehlebracht, Hart Crowser, Inc.

RE: Occurrence of Iron and Manganese in Shallow Groundwater in the Port of Tacoma Area
J-2350-07

INTRODUCTION

The purpose of this technical memorandum is to summarize our understanding of the occurrence of iron and manganese in shallow groundwater in the Port of Tacoma area. Concentrations of iron and manganese detected in shallow groundwater samples collected in the Port of Tacoma area typically exceed Model Toxics Control Act (MTCA) groundwater cleanup and secondary drinking water levels. We believe that elevated iron and manganese concentrations detected in groundwater samples collected as part of our Port of Tacoma Tribal Property Transfer investigations (Hart Crowser, 1991a, 1991b, and 1991c) are primarily derived from natural sources and that their presence does not require remedial actions. Data supporting these conclusions are presented in the following sections.

SUMMARY OF EXISTING REGIONAL REFERENCE STUDIES

Hart Crowser sampled 10 wells to provide general local reference concentrations for dissolved metals in shallow groundwater located in the Port of Tacoma industrial area. The 10 wells were selected based upon accessibility, location relative to properties of interest, lack of exposure to local industrial activity, and depth of screened interval. Wells in the area between the Puyallup River and the upland bounding Marine View Drive were targeted because they lie within the same regional hydrogeologic system as the properties of interest. Manganese concentrations

detected in the Port of Tacoma reference samples ranged from 77 to 7,900 ug/L (Table K-1). Iron was not analyzed. A detailed description of the study including a map of sample locations and analytical results are presented in Appendix D of the Blair Backup property report.

Ebbert et al. (1986) collected groundwater samples from 15 wells in the lower Puyallup River basin as part of a study to assess the quality of the groundwater for usage in fish hatcheries. This study was conducted by the United States Geological Survey in conjunction with the Puyallup Indian Tribe. Dissolved iron and manganese concentrations ranged from 3 to 210,000 ug/L and <1 to 4,300 ug/L, respectively. Maps showing sampling locations and analytical results are included in Attachment K-1.

OCCURRENCE OF IRON AND MANGANESE

Iron and manganese have been detected in shallow groundwater throughout the Port of Tacoma area (Table K-1). Detected concentrations of iron at the Blair Backup property range from 57 to 170,000 ug/L. Comparable levels of iron are reported by CH2M Hill in samples taken on or near the Reichhold Chemical facility located next to the Blair Backup site (268 to 110,000 ug/L). These levels are well within the range of concentrations observed by the Ebbert study (<3 to 210,000 ug/L).

Concentrations of manganese detected on the East-West Road property range from 1,100 to 2,800 ug/L, and are within the ranges detected in the lower Puyallup River basin (Ebbert et al., 1986) and by Hart Crowser in the Port of Tacoma local reference study. Manganese concentrations detected at the Taylor Way property are slightly higher than those reported by the CH2M Hill and Ebbert studies. However, most of the wells sampled as part of the CH2M Hill and Ebbert studies were screened in deeper aquifers than the Taylor Way wells. The highest iron and manganese concentrations encountered in the Port area were generally found in shallow aquifers. The East-West Road and Taylor Way properties are currently undeveloped and have no identified anthropogenic sources of metals other than a few scattered pieces of slag found on the surface of Taylor Way property. The Blair Backup property has the highest detected concentrations of manganese, ranging from 12 to 20,000 ug/L. However, only three samples have manganese levels above those reported by the Ebbert study or by Hart Crowser in the local reference study. Asarco slag and Ohio-Ferro Alloy slag have been used as fill material on the Blair Backup property and may act as a potential source for some iron and manganese. However, the highest iron and manganese concentrations are not found in the area containing the slag. Since the range of concentrations of iron and manganese are generally

within the ranges found throughout the Port of Tacoma area, it is believed that the levels of metals are primarily derived from natural sources.

FACTORS AFFECTING CONCENTRATIONS OF IRON AND MANGANESE IN GROUNDWATER

General

Factors which affect the concentrations of the trace metals in groundwater include:

- Mineral composition;
- Hydrogeology;
- Redox conditions; and
- Microbial activity.

The source for the majority of dissolved ions in groundwater is the mineral constituents found in soils or bedrock. Igneous rock minerals including pyroxene, amphibole, magnetite, and olivine have relatively high iron contents. Igneous and metamorphic rock minerals including pyroxene, amphibole, basalt, and olivine have high contents of manganese. In addition, iron and manganese oxides are often present as coatings on soils (Bodek et al., 1988; Hem, 1986).

The hydrogeology of the area determines the flow path that the water will take, and thus which geologic unit the groundwater will contact. Elements found in rock or soil minerals contacted by the groundwater may leach into groundwater (Freeze and Cherry, 1979; Hem, 1986).

When groundwater is in contact with geologic units, chemical processes such as oxidation-reduction occur and alter the chemistry of the groundwater. Iron and manganese oxides are stable and not readily leachable under oxidizing conditions. Under reducing or oxygen deficient conditions, ferric (III) iron and manganese oxides will be reduced to soluble ferrous (II) and manganese (II) forms. This increases the solubility and mobility of iron and manganese (Atlas and Bartha, 1987; Hem, 1986). High concentrations of dissolved ferrous iron and manganese often occur at locations exhibiting these reducing conditions. Oxidation of organic matter may cause oxygen to be depleted in shallow groundwater, resulting in these reducing conditions.

Microbial activity may further increase the concentration of manganese and iron in solution. Soluble iron and manganese are available for microbial transformation. Increased anaerobic microbial activity reduces the stable manganese oxide, and causes

the manganese (II) ions to be mobilized. Iron is reduced under similar anaerobic conditions (Atlas and Bartha, 1987).

Site-Specific

The Port of Tacoma area serves as the mouth of the Puyallup River drainage basin that encompasses Mount Rainier and adjacent uplands. The Bedrock geology of the area is predominantly of igneous origin. The Tacoma tideflats area includes the lowermost part of the Puyallup River drainage basin. Seafloor sediments from Commencement Bay have been dredged and used as fill in this area since the 1920s. Iron and manganese occur naturally in Port of Tacoma soils and sediments incorporated within mineral and coating phases. Iron and manganese concentrations in the lower Puyallup River sediment samples collected as part of the Ebbert study ranged from 24,000 to 140,000 mg/kg and from 390 to 4,100 mg/kg, respectively.

Shallow soils present in the Port of Tacoma area often have high organic content resulting from natural sources associated with tideflats (marshes, swamps) as well as industrial activities including log sorting and pulp manufacturing (Ebbert et al., 1986). Oxidation of organic matter in Port of Tacoma shallow aquifer units may produce reducing conditions thus enhancing iron and manganese solubility.

SUMMARY

The range of concentrations of iron and manganese detected in the properties associated with the Port of Tacoma Tribal Property Transfer investigations are consistent with the background concentrations reported by Ebbert et al., (1986) and by Hart Crowser as part of the Port of Tacoma local reference study. We believe iron and manganese detected in shallow groundwater in the Port of Tacoma area are primarily derived from natural sources. As such, their presence does not require remedial action.

Attachments:

Table K-1	Summary of Iron and Manganese Concentrations in Groundwater in the Port of Tacoma Area
References	
Attachment K-1	Lower Puyallup River Basin Iron and Manganese Data Ebbert et al., 1986
Figure K-1-1	Dissolved Manganese Concentrations in Ground Water
Figure K-1-2	Dissolved Iron Concentrations in Ground Water

Table K-1 - Summary of Iron and Manganese Concentrations in Groundwater in the Port of Tacoma Area

Source	Concentration in ug/L	
	Iron	Manganese
POT Local Reference (a)	NA	77 to 7,900
Puyallup River Basin (b)	<3 to 210,000	<1 to 4,300
East-West Property (a)	NA	1,100 to 2,800
Blair Backup Property (c)	57 to 170,000	12 to 20,000
Taylor Way Property (d)	NA	3,900 to 7,900
Reichhold (e)	268 to 110,000	117 to 1,270

(a) Hart Crowser, 1991b.
(b) Ebbert, et al., 1986.
(c) Hart Crowser, 1991a.
(d) Hart Crowser, 1991c.
(e) CH2M HILL, 1991.
NA - Not analyzed

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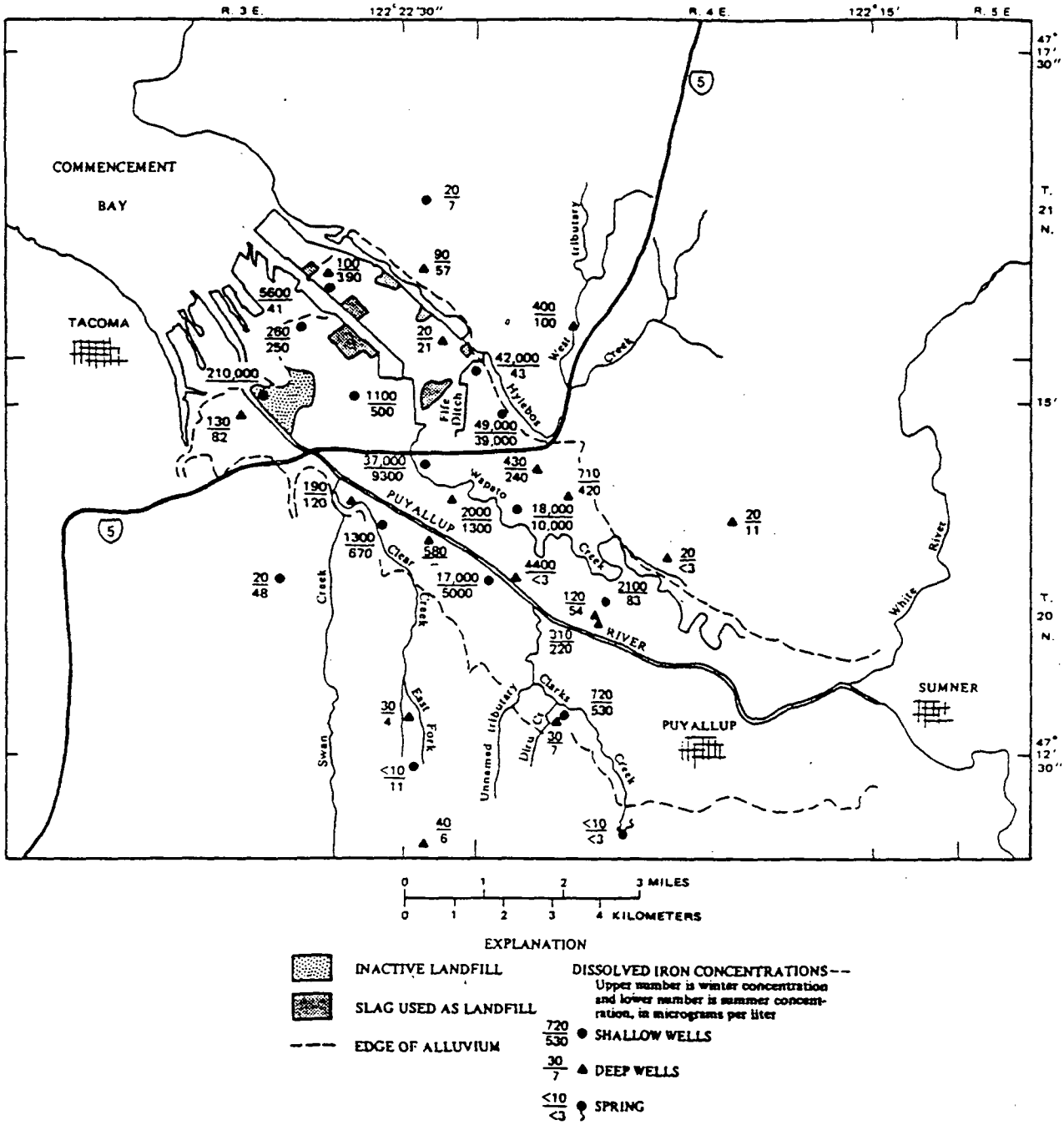
Hart Crowser
J-2350-07

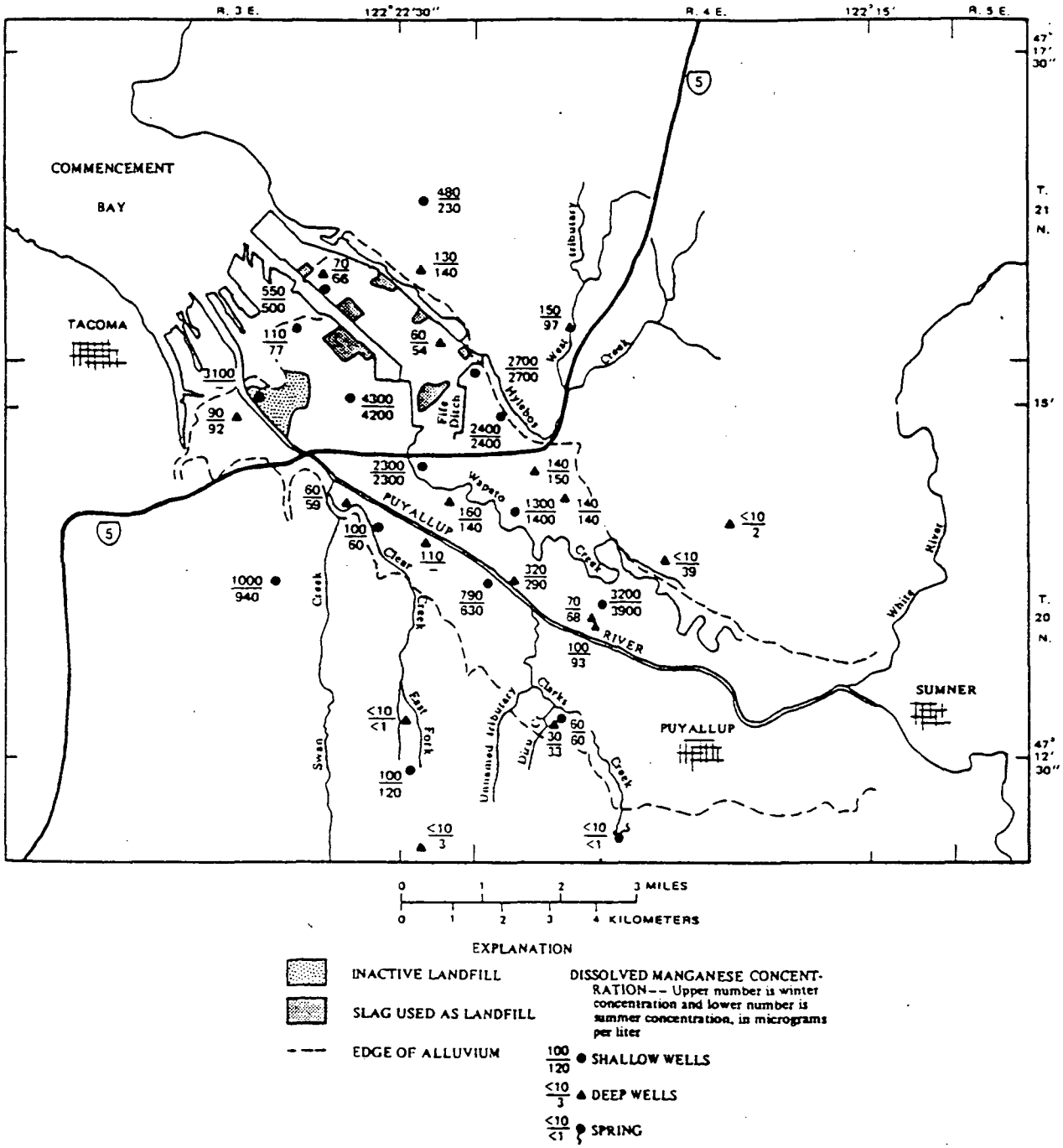
ATTACHMENT K-1
LOWER PUYALLUP RIVER BASIN
IRON AND MANGANESE DATA
EBBERT ET AL., 1986

Figure K-1-1 Dissolved Iron Concentrations in Ground Waters in Winter and Summer, 1984.



This Figure was taken from Ebbert, et al, 1986, pg.30.

Figure K-1-2 Dissolved Manganese Concentrations in Ground Waters in Winter and Summer, 1984.



This Figure was taken from Ebbert, et al, 1986, pg.31.

Appendix L

APPENDIX L
COMPARISON OF SOIL QUALITY DATA WITH MTCA RESIDENTIAL CLEANUP LEVELS

Table L-6 - Continued

(m) Samples were collected in Bellevue, Washington, as part of Metro's Toxicants in Urban Runoff Study (December 1982).

(n) Samples were collected from the Puyallup River during January and May 1984 as part of a Puyallup River Valley water quality investigation conducted by the U.S. Geological Survey (Ebbert et al., 1986).

(o) Data obtained from Reichhold Chemical report "Sediment and Surface Water Report: Offsite Drainageways" (CH2M Hill, 1989c).

(p) Upper 95th Background Limit was calculated using Lands (Gilbert, 1987) equation for determining confidence limits of lognormal distributions.

(q) Pevear, D., Geology Department, Western Washington University, unpublished data cited in Dexter et al., 1981.

(r) Shacklette and Boerngen, 1984.

(s) Harper-Owes, 1985.

(t) EPA criteria provided for trivalent chromium only.

(u) Ecology, February 1991 MTCA Cleanup Levels (Chapter 173-340-730(3)(a)(III)(A). Values calculated using oral reference doses provided in HEAST, EPA 1991, and Bioconcentration Factors provided in EPA Criteria Chart, January 1991.

(v) Ecology, February 1991 MTCA Cleanup Levels (Chapter 173-340-730(3)(a)(III)(B). Values calculated using oral reference doses provided in HEAST, EPA 1991, and Bioconcentration Factors provided in EPA Criteria Chart, January 1991.

(w) Lowest Observed Effect Level (LOEL) Goldbook, EPA, 1986.

(x) Based on the oral reference dose for food, HEAST 1991.

(y) Based on the more toxic form (hexavalent) chromium.

(z) The estaurine/coast organisms bioconcentration factors provided in the EPA Criteria Chart, January 1991.

(aa) Based on oral reference dose for water.

(ab) Ecology, April 1991, Sediment Management Standards, Table 1 Marine Sediment Quality Standards - Chemical Criteria (for designation of sediments).

(ac) Clean Water Act, Marine Chronic Criteria, obtained from EPA Region IV Criteria Chart, January 1991.

(ad) Clean Water Act, Criteria for Protection of Human Health from Consumption of Aquatic Organisms Only, EPA Region IV Criteria Chart, January 1991.

(ae) Clean Water Act, Marine Acute Criteria, obtained from EPA Region IV Criteria Chart, January 1991.

(af) For non-carcinogenic PAHs based on oral reference dose for naphthalene.

>> Greater than 75,000 μg/L for groundwater; greater than 300,000 ppm for soil.

>>> Greater than 200,000 μg/L for groundwater.

Table L-6 - Data Qualifiers and Cross Reference Notes for Tables L-1 through L-5

Averages and upper 95th confidence limit of the mean for carcinogenic PAHs were adjusted using relative potency estimates (Thorslund, personal communication 1990), currently under Science Advisory Board review.

All soil sample and ditch sediment data are reported on dry weight basis.

MTCA tables for Industrial Soil and Surface Water/Groundwater cleanup levels (Tables 6 and 7) were generated in April 1991. MTCA tables for residential use (Appendix C) were generated in July 1991.

Surface water standards do not address risk due to multiple exposure pathways or multiple contaminants.

A	Ecology, February 1991 MTCA Method A residential soil cleanup levels. (Chapter 173-340-740, Table 2).
B	Indicates analyte was detected in laboratory method blank.
D	Value reported derives from analysis of a diluted sample or sample extract.
J	Indicates an estimated value.
ND	Not detected at various detection limits.
T	Flagged values represent sum of two coeluting compounds.
U	Indicates compound was analyzed for but not detected at the given detection limit.
(a)	Calculated using one-half of the detection limit for non-detected compounds.
(b)	Practical quantitation limit using EPA method 206.3.
(c)	Practical quantitation limit using EPA method 210.2.
(d)	Marine criteria for hexavalent chromium.
(e)	Practical quantitation limit using EPA method 245.2.
(f)	Cleanup standard based on 10^{-6} cancer risk for benzo(a)pyrene.
(g)	Ecology, February 1991 MTCA Cleanup Levels (Chapter 173-340 WAC). Oral references doses and oral slope factors obtained from Health Effects Assessment Summary Tables (HEAST) EPA, January 1991.
(h)	For hexavalent chromium only; cleanup levels for trivalent chromium and total chromium are greater than 65,000 ppm.
(i)	Resource Conservation and Recovery Act criteria (Chapter 173-303 WAC and 40 CFR Part 26).
(j)	Toxicity Characteristics Revisions (40 CFR Part 261).
(k)	July 1990 metals data for wells MW-28I and MW-29I were not included due to quality control problems.
(l)	After silica gel cleanup.

Table L-5 - Statistical Summary and MTCA Residential Exceedences in Ohio Ferro-Alloy Ditch Sediment Samples

	Detection Frequency	Maximum Detection	Location of Maximum	Average	Upper 95th Confidence Limit of the Mean (a)	MTCA Method B Soil Cleanup Level - Residential	Number of Samples Exceeding Levels/ Number Analyzed	MTCA Method C Soil Cleanup Level - Commercial	Number of Samples Exceeding Levels/ Number Analyzed
Total Metals									
in mg/kg (ppm)									
Arsenic	4 / 4	260	ODS-103B	167.	282.	20 A	4 / 4	23	4 / 4
Cadmium	4 / 4	3.4	ODS-A & 103B	3.1	3.58	40	0 / 4	160	0 / 4
Chromium	4 / 4	250	ODS-B	125.	214.	400 (h)	0 / 4	1,600 (h)	0 / 4
Copper	4 / 4	350	ODS-103B	255	342.	2,970	0 / 4	11,890	0 / 4
Lead	4 / 4	210	ODS-103B	145	206.	250 A	0 / 4	---	---
Mercury	0 / 4	0.1 U				24	0 / 4	96	0 / 4
Nickel	4 / 4	29	ODS-B	26.7	29.0	1,600	0 / 4	6,400	0 / 4
Zinc	4 / 4	500	ODS-103B	332.	476.	16,000	0 / 4	64,000	0 / 4
Miscellaneous Parameters in %									
Total Organic Carbon	2 / 2	7	ODS-B	6.9	7.34	---	---	---	---
Semivolatile Organic Compounds									
in mg/kg (ppm)									
4-Methylphenol	4 / 4	3.4 J	ODS-A	2.87	3.52	---	---	---	---
Bis(2-ethylhexyl)phthalate	3 / 4	0.38 J	ODS-103A	0.25	0.35	71	0 / 4	2,860	0 / 4
Carcinogenic PAHs									
in mg/kg (ppm)	4 / 4	4.84 J	ODS-103A	0.84	0.97	1.0 A	4 / 4	3.5	2 / 4
Non-carcinogenic PAHs									
in mg/kg (ppm)									
Acenaphthene						4,800	0 / 4	19,200	0 / 4
Acenapthylene						---	---	---	---
Anthracene						24,000	0 / 4	96,000	0 / 4
Benzo(g,h,i)perylene						---	---	---	---
Fluoranthene						3,200	0 / 4	12,800	0 / 4
Fluorene						3,200	0 / 4	12,800	0 / 4
2-Methylnaphthalene						---	---	---	---
Naphthalene						320	0 / 4	1,280	0 / 4
Phenanthrene						---	---	---	---
Pyrene						2,400	0 / 4	9,600	0 / 4
Total Non-carcinogenic PAHs	4 / 4	5.105 J	ODS-103A	4.51	5.36	14,000	0 / 4	---	---

Note: Data qualifiers and cross references are presented in Table L-6.

OFAD-BC.WK1/CLK

Table L-4 - Statistical Summary and MTCA Residential Exceedences in Pennwalt Ag-Chem Ditch Sediment Samples

	Detection Frequency	Maximum Detection	Location of Maximum	Average	Upper 95th Confidence Limit of the Mean (a)	MTCA Method B Soil Cleanup Level - Residential	Number of Samples Exceeding Levels/ Number Analyzed	MTCA Method C Soil Cleanup Level - Commercial	Number of Samples Exceeding Levels/ Number Analyzed
Miscellaneous Parameters in %									
Total Organic Carbon	3 / 3	3.8	PDS-A	2.466	3.77	---	---	---	---
Volatile Aromatic Compounds in mg/kg (ppm)									
Benzene	0 / 4	0.01 U				34	0 / 4	1,380	0 / 4
Toluene	3 / 4	0.039	PDS-106-D	0.015	0.03	16,000	0 / 4	64,000	0 / 4
Ethylbenzene	0 / 4	0.01 U				8,000	0 / 4	32,000	0 / 4
Total Xylene	0 / 4	0.01 U				160,000	0 / 4	640,000	0 / 4
Miscellaneous Parameters in mg/kg (ppm)									
GC-FID Screen	1 / 1	103	SS-1			---	---	---	---

Note: Data qualifiers and cross references are presented in Table L-6.

PEN-BC.WK1/CLK

Table L-4 - Statistical Summary and MTCA Residential Exceedences in Pennwalt Ag-Chem Ditch Sediment Samples

	Detection Frequency	Maximum Detection	Location of Maximum	Average	Upper 95th Confidence Limit of the Mean (a)	MTCA Method B Soil Cleanup Level - Residential	Number of Samples Exceeding Levels/ Number Analyzed	MTCA Method C Soil Cleanup Level - Commercial	Number of Samples Exceeding Levels/ Number Analyzed
Total Metals									
in mg/kg (ppm)									
Arsenic	5 / 5	46	SS-1	26.7	36.6	20 A	3 / 5	23	3 / 5
Cadmium	3 / 5	1.6	SS-1	0.78	1.29	40	0 / 5	160	0 / 5
Chromium	5 / 5	28	SS-1	17.38	23.4	400 (h)	0 / 5	1,600 (h)	0 / 5
Copper	5 / 5	75	SS-1	36.6	57.0	2,970	0 / 5	11,890	0 / 5
Lead	5 / 5	57	PDS-A	31.4	46.9	250 A	0 / 5	---	---
Mercury	3 / 5	0.4	SS-1	0.14	0.23	24	0 / 5	96	0 / 5
Nickel	5 / 5	490	PDS-A	191.2	348.	1,600	0 / 5	6,400	0 / 5
Zinc	5 / 5	400	SS-1	147.2	268.	16,000	0 / 5	64,000	0 / 5
Chlorinated Pesticides									
in mg/kg (ppm)	0 / 6	ND				---	---	---	---
PCBs in mg/kg (ppm)	0 / 5	ND							
Organophosphorous Pesticides									
in mg/kg (ppm)	0 / 4	ND J				---	---	---	---
Chlorinated Herbicides									
in mg/kg (ppm)	0 / 4	ND J				---	---	---	---
Carcinogenic PAHs									
in mg/kg (ppm)	4 / 4	2.477	PDS-104-D	0.536	0.92	1.0 A	1 / 4	3.5	0 / 4
Non-carcinogenic PAHs									
in mg/kg (ppm)									
Acenaphthene						4,800	0 / 4	19,200	0 / 4
Acenapthylene						---	---	---	---
Anthracene						24,000	0 / 4	96,000	0 / 4
Benzo(g,h,i)perylene						---	---	---	---
Fluoranthene						3,200	0 / 4	12,800	0 / 4
Fluorene						3,200	0 / 4	12,800	0 / 4
2-Methylnaphthalene						---	---	---	---
Naphthalene						320	0 / 4	1,280	0 / 4
Phenanthrene						---	---	---	---
Pyrene						2,400	0 / 4	9,600	0 / 4
Total Non-carcinogenic PAHs	4 / 4	3.536	PDS-104-D	1.370	2.72	14,000	0 / 4	---	---

Table L-3 - Statistical Summary and MTCA Residential Exceedences in Ohio Ferro-Alloy/Pennwalt Area Soil Samples

Excluding Waste Material Samples	Detection Frequency	Maximum Detection	Location of Maximum	Average	Upper 95th Confidence Limit of the Mean (a)	MTCA Method B Soil Cleanup Level - Residential	Number of Samples Exceeding Levels/ Number Analyzed	MTCA Method C Soil Cleanup Level - Commercial	Number of Samples Exceeding Levels/ Number Analyzed
Pesticides/PCBs in mg/kg (ppm)									
4,4'-DDE	1 / 7	0.029	TP111/S-1	0.013		3.0	0 / 7	118	0 / 7
4,4'-DDD	1 / 7	0.17	TP111/S-1	0.033		4.2	0 / 7	167	0 / 7
4,4'-DDT	1 / 7	0.042	TP111/S-1	0.015		3.0	0 / 7	118	0 / 7
TCLP Polynuclear Aromatic Hydrocarbons in mg/L (ppm)									
Napthalene	3 / 5	0.51 J	TP-207/S-1	0.114	0.303	---	---	---	---
Acenapthylene	1 / 5	0.0023 J	TP-205/S-2	0.001		---	---	---	---
Acenapthene	3 / 5	0.19 J	TP-207/S-1	0.049	0.117	---	---	---	---
Fluorene	3 / 5	0.096 J	TP-207/S-1	0.025	0.060	---	---	---	---
Phenanthrene	5 / 5	0.16 J	TP-207/S-1	0.043	0.100	---	---	---	---
Anthracene	5 / 5	0.019 BJ	TP-207/S-1	0.005	0.011	---	---	---	---
Fluoranthene	3 / 5	0.019 J	TP-207/S-1	0.005	0.011	---	---	---	---
Pyrene	4 / 5	0.019 J	TP-207/S-1	0.004	0.011	---	---	---	---
Benzo(a)anthracene	0 / 5	0.001 U	----			---	---	---	---
Chrysene	0 / 5	0.001 U	----			---	---	---	---
Benzo(b)fluoranthene	0 / 5	0.001 U	----			---	---	---	---
Benzo(k)fluoranthene	0 / 5	0.001 U	----			---	---	---	---
Benzo(a)pyrene	0 / 5	0.001 U	----			---	---	---	---
Dibenzo(a,h)anthracene	0 / 5	0.002 U	----			---	---	---	---
Benzo(g,h,i)perylene	0 / 5	0.001 U	----			---	---	---	---
Indeno(1,2,3-cd)pyrene	0 / 5	0.001 U	----			---	---	---	---
Miscellaneous Parameters in mg/kg (ppm)									
GC-FID Screen	28 / 38	1,200	TP-124/S-1	129.5	198.8	---	---	---	---
GC-FID Screen 8015 Modified	18 / 18	9,000 J	TP-207/S-1	670.7	1501.	---	---	---	---
GC-FID Screen 8015 Modified (l)	6 / 6	7,000 J	TP-207/S-1	1433.	3483.	---	---	---	---
TPH (418.1)	9 / 9	1,500 J	SS-104	578.6	829.5	---	---	---	---
Organophosphorous Pesticides	0 / 8	ND				---	---	---	---
Chlorinated Herbicides	0 / 0					---	---	---	---

Note: Data qualifiers and cross references are presented in Table L-6.

OFA-BC.WK1/CLK

Table L-3 - Statistical Summary and MTCA Residential Exceedences in Ohio Ferro-Alloy/Pennwalt Area Soil Samples

Excluding Waste Material Samples	Detection Frequency	Maximum Detection	Location of Maximum	Average	Upper 95th Confidence Limit of the Mean (a)	MTCA Method B Soil Cleanup Level - Residential	Number of Samples Exceeding Levels/ Number Analyzed	MTCA Method C Soil Cleanup Level - Commercial	Number of Samples Exceeding Levels/ Number Analyzed
Volatile Organic Compounds in mg/kg (ppm)									
Vinyl chloride	0 / 7	0.002 U	----			0.53	0 / 7	21	0. / 7
Acetone	0 / 7	0.3 U	----			8,000	0 / 7	32,000	0 / 7
Carbon disulfide	0 / 7	0.002 U	----			8,000	0 / 7	32,000	0 / 7
trans-1,2-Dichloroethene	0 / 7	0.002 U	----			1,600	0 / 7	32,000	0 / 7
cis-1,2-Dichloroethene	0 / 7	0.002 U	----			800	0 / 7	3,200	0 / 7
Total 1,2-Dichloroethene	0 / 7	0.002 U	----			800	0 / 7	3,200	0 / 7
2-Butanone (MEK)	1 / 7	0.054	HC-5S/S-2	0.010		4,000	0 / 7	16,000	0 / 7
1,2-Dichloroethane	0 / 7	0.002 U	----			11	0 / 7	440	0 / 7
Trichloroethene	0 / 7	0.002 U	----			91	0 / 7	3,636	0 / 7
Benzene	0 / 7	0.002 U	----			34	0 / 7	1,380	0 / 7
Toluene	1 / 7	0.004	TP131/S-1	0.001		16,000	0 / 7	64,000	0 / 7
Ethylbenzene	0 / 7	0.002 U	----			8,000	0 / 7	32,000	0 / 7
Total Xylene	1 / 7	0.005	HC-4S/S-2	0.001		160,000	0 / 7	640,000	0 / 7
Semivolatile Organic Compounds in mg/kg (ppm)									
Dibenzofuran	2 / 3	120 J	TP-207 Rep.	40.53	135.2	---	---	---	---
Bis(2-ethylhexyl)phthalate	0 / 3	240 U	----			71	0 / 3	2,860	0 / 3
Di-n-octyl phthalate	0 / 3	240 U	----			1,600	0 / 3	6,400	0 / 3
Carcinogenic PAHs in mg/kg (ppm)	10 / 10	8,930	TP-207 Rep.	249.4	658.5	1.0 A	9 / 10	3.5	7 / 10
Non-carcinogenic PAHs in mg/kg (ppm)									
Acenaphthene						4,800	0 / 10	19,200	0 / 10
Acenapthylene						---	---	---	---
Anthracene						24,000	0 / 10	96,000	0 / 10
Benzo(g,h,i)perylene						---	---	---	---
Fluoranthene						3,200	0 / 10	12,800	0 / 10
Fluorene						3,200	0 / 10	12,800	0 / 10
2-Methylnaphthalene						---	---	---	---
Naphthalene						320	1 / 10	1,280	0 / 10
Phenanthrene						---	---	---	---
Pyrene						2,400	1 / 10	9,600	0 / 10
Total Non-carcinogenic PAHs	10 / 10	15,440	TP-207 Rep.	1614.	4287.	14,000	1 / 10	---	---

Table L-3 - Statistical Summary and MTCA Residential Exceedences in Ohio Ferro-Alloy/Pennwalt Area Soil Samples

Excluding Waste Material Samples	Detection Frequency	Maximum Detection	Location of Maximum	Average	Upper 95th Confidence Limit of the Mean (a)	MTCA Method B Soil Cleanup Level - Residential	Number of Samples Exceeding Levels/ Number Analyzed	MTCA Method C Soil Cleanup Level - Commercial	Number of Samples Exceeding Levels/ Number Analyzed
Total Metals									
in mg/kg (ppm)									
Arsenic	45 / 45	240 J	SS-TCLP-1	48.77	64.34	20 A	25 / 45	23	22 / 45
Cadmium	35 / 45	11	TP132/S-1	1.453	1.868	40	0 / 45	160	0 / 45
Chromium	44 / 45	3,000	HC-11S/S-1	191.5	317.7	400 (h)	5 / 45	1,600 (h)	1 / 45
Copper	45 / 45	1,500	TP125/S-2	163.0	227.3	2,970	0 / 45	11,890	0 / 45
Lead	29 / 45	1,100	TP125/S-2	105.5	155.8	250 A	4 / 45	---	---
Manganese	8 / 8	110	HC-25 S-3 / HC-26 S-2	80.93	94.70	8,000	0 / 8	32,000	0 / 8
Mercury	21 / 45	2	TP130/S-2	0.195	0.289	24	0 / 45	96	0 / 45
Nickel	44 / 45	290	TP110/S-2	34.53	47.62	1,600	0 / 45	6,400	0 / 45
Selenium	0 / 5	5 U	----			---	---	---	---
Silver	0 / 5	1 U	----			240	0 / 5	960	0 / 5
Zinc	45 / 45	550 B	TP132/S-1	137.8	171.8	16,000	0 / 45	64,000	0 / 45
EP Tox Metals									
in mg/L (ppm)									
Arsenic	0 / 8	0.2 U	----			---	---	---	---
Barium	7 / 8	0.3	TP125/S-2	0.181	0.228	---	---	---	---
Cadmium	0 / 8	0.01 U	----			---	---	---	---
Chromium	0 / 8	0.1 U	----			---	---	---	---
Copper	2 / 8	1.7 J	TP126/S-1	0.3	0.662	---	---	---	---
Lead	1 / 8	1.8 J	TP126/S-1	0.268		---	---	---	---
Mercury	0 / 8	0.005 U	----			---	---	---	---
Nickel	1 / 8	0.2	HC-11S/S-1	0.068		---	---	---	---
Zinc	6 / 8	0.5 J	TP132/S-1	0.25	0.359	---	---	---	---
TCLP Metals									
in mg/L (ppm)									
Arsenic	1 / 5	0.42	SS-TCLP-1	0.164		---	---	---	---
Barium	5 / 5	0.71	SS-TCLP-1	0.538	0.635	---	---	---	---
Cadmium	0 / 5	0.01 U	----			---	---	---	---
Chromium	0 / 5	0.1 U	----			---	---	---	---
Copper	0 / 5	0.1 U	----			---	---	---	---
Lead	0 / 5	0.1 U	----			---	---	---	---
Mercury	0 / 5	0.005 U	----			---	---	---	---
Nickel	0 / 5	0.1 U	----			---	---	---	---
Selenium	0 / 5	0.2 U	----			---	---	---	---
Silver	0 / 5	0.1 U	----			---	---	---	---
Zinc	5 / 5	0.55	SS-TCLP-5	0.492	0.531	---	---	---	---

Table L-2 - Statistical Summary and MTCA Residential Exceedences in North Site Area Soil Samples

Excluding Waste Material Samples	Detection Frequency	Maximum Detection	Location of Maximum	Average	Upper 95th Confidence Limit of the Mean (a)	MTCA Method B Soil Cleanup Level - Residential	Number of Samples Exceeding Levels/ Number Analyzed	MTCA Method C Soil Cleanup Level - Commercial	Number of Samples Exceeding Levels/ Number Analyzed
Non-carcinogenic PAHs in mg/kg (ppm)									
Acenaphthene						4,800	0 / 10	19,200	0 / 10
Acenapthylene						---	---	---	---
Anthracene						24,000	0 / 10	96,000	0 / 10
Benzo(g,h,i)perylene						---	---	---	---
Fluoranthene						3,200	0 / 10	12,800	0 / 10
Fluorene						3,200	0 / 10	12,800	0 / 10
2-Methylnaphthalene						---	---	---	---
Naphthalene						320	0 / 10	1,280	0 / 10
Phenanthrene						---	---	---	---
Pyrene						2,400	0 / 10	9,600	0 / 10
Total Non-carcinogenic PAHs	8 / 10	28.31	TP-115/S-1	9.143	14.38	14,000	0 / 10	---	---
Miscellaneous Parameters in mg/kg (ppm)									
GC-FID Screen	2 / 5	26	HC-8S/S-2	11.4	19.45	---	---	---	---
Pesticides/PCBs in mg/kg (ppm)	0 / 5	ND	----			---	---	---	---

Note: Data qualifiers and cross references are presented in Table L-6.

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Table L-2 - Statistical Summary and MTCA Residential Exceedences in North Site Area Soil Samples

Excluding Waste Material Samples	Detection Frequency	Maximum Detection	Location of Maximum	Average	Upper 95th Confidence Limit of the Mean (a)	MTCA Method B Soil Cleanup Level - Residential	Number of Samples Exceeding Levels/ Number Analyzed	MTCA Method C Soil Cleanup Level - Commercial	Number of Samples Exceeding Levels/ Number Analyzed
Total Metals									
in mg/kg (ppm)									
Arsenic	14 / 14	27 J	TP116/S-2	12.52	16.46	20 A	6 / 14	23	2 / 14
Cadmium	5 / 14	2.4	TP118/S-1	0.665	0.988	40	0 / 14	160	0 / 14
Chromium	14 / 14	34 B	TP119/S-2	20.71	23.77	400 (h)	0 / 14	1,600 (h)	0 / 14
Copper	14 / 14	170	TP116/S-2	40.92	59.23	2,970	0 / 14	11,890	0 / 14
Lead	9 / 14	68	TP118/S-1	18.64	27.00	250 A	0 / 14	---	---
Mercury	4 / 14	2	TP116/S-2	0.335	0.605	24	0 / 14	96	0 / 14
Nickel	14 / 14	160	TP116/S-2	27.51	45.50	1,600	0 / 14	6,400	0 / 14
Zinc	14 / 14	120 B	TP118/S-1	50.35	62.55	16,000	0 / 14	64,000	0 / 14
Volatile Organic Compounds									
in mg/kg (ppm)									
Vinyl chloride	2 / 10	0.008	HC-21/S-1	0.002	0.003	0.53	0 / 10	21	0 / 10
Methylene Chloride	2 / 10	0.002	HC-9S/S-1, 19S/S-2	0.001	0.001	133	0 / 10	5,333	0 / 10
Acetone	5 / 10	0.12	HC-9S/S-1	0.081	0.105	8,000	0 / 10	32,000	0 / 10
Carbon disulfide	0 / 10	0.003 U	----			8,000	0 / 10	32,000	0 / 10
trans-1,2-Dichloroethene	1 / 10	0.002	TP116/S-2	0.001		1,600	0 / 10	32,000	0 / 10
cis-1,2-Dichloroethene	2 / 10	0.008	TP116/S-2	0.001	0.003	800	0 / 10	3,200	0 / 10
Total 1,2-Dichloroethene	2 / 10	0.01	TP116/S-2	0.002	0.003	800	0 / 10	3,200	0 / 10
2-Butanone (MEK)	3 / 10	0.036	TP114/S-1	0.008	0.015	4,000	0 / 10	16,000	0 / 10
Trichloroethene	0 / 10	0.003 U	----			91	0 / 10	3,636	0 / 10
Benzene	0 / 10	0.003 U	----			34	0 / 10	1,380	0 / 10
Toluene	0 / 10	0.003 U	----			16,000	0 / 10	64,000	0 / 10
Ethylbenzene	0 / 10	0.003 U	----			8,000	0 / 10	32,000	0 / 10
Total Xylene	0 / 10	0.003 U	----			160,000	0 / 10	640,000	0 / 10
Semivolatile Organic Compounds									
in mg/kg (ppm)									
Dibenzofuran	1 / 10	0.1	HC-21S/S-1	0.041		---	---	---	---
Bis(2-ethylhexyl)phthalate	3 / 10	0.19	HC-9S/S-1	0.127	0.183	71	0 / 10	2,860	0 / 10
Di-n-octyl phthalate	1 / 10	0.55	HC-8S/S-2	0.081		1,600	0 / 10	6,400	0 / 10
Carcinogenic PAHs									
in mg/kg (ppm)	8 / 10	18.35	TP-115/S-1	0.925	1.403	1.0 A	6 / 10	3.5	5 / 10

Table L-1 - Statistical Summary and MTCA Residential Exceedences in General/Fill Area Soil Samples

Excluding Waste Material Samples	Detection Frequency	Maximum Detection	Location of Maximum	Average	Upper 95th Confidence Limit of the Mean (a)	MTCA Method B Soil Cleanup Level - Residential	Number of Samples Exceeding Levels/ Number Analyzed	MTCA Method C Soil Cleanup Level - Commercial	Number of Samples Exceeding Levels/ Number Analyzed
Non-carcinogenic PAHs in mg/kg (ppm)									
Acenaphthene						4,800	0 / 10	19,200	0 / 10
Acenapthylene						---	---	---	---
Anthracene						24,000	0 / 10	96,000	0 / 10
Benzo(g,h,i)perylene						---	---	---	---
Fluoranthene						3,200	0 / 10	12,800	0 / 10
Fluorene						3,200	0 / 10	12,800	0 / 10
2-Methylnaphthalene						---	---	---	---
Naphthalene						320	0 / 10	1,280	0 / 10
Phenanthrene						---	---	---	---
Pyrene						2,400	0 / 10	9,600	0 / 10
Total Non-carcinogenic PAHs	2 / 10	5.59	TP107/S-1	0.852	1.768	14,000	0 / 10	---	---

Note: Data qualifiers and cross references are presented in Table L-6.

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Table L-1 - Statistical Summary and MTCA Residential Exceedences in General/Fill Area Soil Samples

Excluding Waste Material Samples	Detection Frequency	Maximum Detection	Location of Maximum	Average	Upper 95th Confidence Limit of the Mean (a)	MTCA Method B Soil Cleanup Level - Residential	Number of Samples Exceeding Levels/ Number Analyzed	MTCA Method C Soil Cleanup Level - Commercial	Number of Samples Exceeding Levels/ Number Analyzed
Total Metals									
in mg/kg (ppm)									
Arsenic	12 / 13	12	TP107/S-1	3.234	4.576	20 A	0 / 13	23	0 / 13
Cadmium	6 / 13	1.1	HC-2S/S-1	0.533	0.697	40	0 / 13	160	0 / 13
Chromium	13 / 13	27 B	TP107/S-1	17.92	20.53	400 (h)	0 / 13	1,600 (h)	0 / 13
Copper	13 / 13	60	TP107/S-1	19.80	26.30	2,970	0 / 13	11,890	0 / 13
Lead	4 / 13	43	TP107/S-1	9.884	15.02	250 A	0 / 13	---	---
Mercury	0 / 13	0.1 U	----			24	0 / 13	96	0 / 13
Nickel	12 / 13	200	SS-10 Fill	25.77	50.96	1,600	0 / 13	6,400	0 / 13
Zinc	13 / 13	65 B	TP107/S-1	29.84	36.78	16,000	0 / 13	64,000	0 / 13
Volatile Organic Compounds									
in mg/kg (ppm)									
Vinyl chloride	0 / 7	0.002 U	----			0.53	0 / 7	21	0 / 7
Acetone	0 / 7	0.14 U	----			8,000	0 / 7	32,000	0 / 7
Carbon disulfide	1 / 7	0.004	TP103/S-2	0.001		8,000	0 / 7	32,000	0 / 7
trans-1,2-Dichloroethene	0 / 7	0.002 U	----			1,600	0 / 7	32,000	0 / 7
cis-1,2-Dichloroethene	0 / 7	0.002 U	----			800	0 / 7	3,200	0 / 7
Total 1,2-Dichloroethene	0 / 7	0.002 U	----			800	0 / 7	3,200	0 / 7
2-Butanone (MEK)	2 / 7	0.016	HC-1S/S-2	0.005	0.009	4,000	0 / 7	16,000	0 / 7
Trichloroethene	0 / 7	0.002 U	----			91	0 / 7	3,636	0 / 7
Benzene	0 / 7	0.002 U	----			34	0 / 7	1,380	0 / 7
Toluene	0 / 7	0.002 U	----			16,000	0 / 7	64,000	0 / 7
Ethylbenzene	0 / 7	0.002 U	----			8,000	0 / 7	32,000	0 / 7
Total Xylene	0 / 7	0.002 U	----			160,000	0 / 7	640,000	0 / 7
Miscellaneous Paramters									
in mg/kg (ppm)									
GC-FID Screen	5 / 10	590	TP107/S-1	85.77	186.0	---	---	---	
Semivolatile Organic Compounds									
in mg/kg (ppm)									
Dibenzofuran	0 / 7	0.16 U	----			---	---	---	---
Bis(2-ethylhexyl)phthalate	0 / 7	0.59 U	----			71	0 / 7	2,860	0 / 7
Di-n-octyl phthalate	1 / 7	0.41 B	HC-3S/S-2	0.085		1,600	0 / 7	6,400	0 / 7
Carcinogenic PAHs									
in mg/kg (ppm)	1 / 10	0.42	TP103/S-2	0.162		1.0 A	0 / 10	3.5	0 / 10

APPENDIX L
COMPARISON OF SOIL AND DITCH SEDIMENT QUALITY DATA WITH MTCA RESIDENTIAL CLEANUP LEVELS

Tables L-1 through L-5 presented in this appendix compare the soil and ditch sediment quality data collected during this study with the most stringent MTCA soil cleanup levels for residential use. Table L-6 presents the qualifiers and cross reference notes used in Tables L-1 through L-5. These comparisons are provided for informational purposes only and have not been used in the discussions of this report. It is understood that these values would not be applicable at this site due to preclusion of site use for residential purposes as defined by Tribal Settlement Agreement. The Tribe is determined to use the property for industrial purposes only as defined in the Tribal Council Resolution and the proposed Draft Port/Tribe Implementing Agreement.

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