816

EVALUATION OF POTENTIAL
SOIL AND GROUND WATER CONTAMINATION
AT THE ISAACSON CORPORATION PROPERTY
SEATTLE, WASHINGTON

December 21, 1983

Submitted to:

Isaacson Corporation
8620 East Marginal Way South
Seattle, WA 98108

and

Graham & Dunn
Attorneys-at-Law
1301 Fifth Avenue
Seattle, WA 98101

Submitted by:

Patrick H. Wicks, P.E.
Consultant in Hazardous Waste Management
2535 - 152nd N.E., Suite A
Redmond, WA 98052

In association with

Sweet, Edwards & Associates, Inc.
P.O. Box 328
Kelso, WA 98626

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

FIGURES Page

TABLES

APPENDICES

INTRODUCTION

Patrick H. Wicks, Consultant in Hazardous Waste Management, was initially retained by Graham & Dunn, Attorneys-at-Law, on the behalf of their client, The Isaacson Corporation, to evaluate a previous study (Dames & Moore, 1983). The previous study consisted of evaluation of soils, fills, ground water, and surface water on and surrounding The Isaacson Corporation property at 8620 East Marginal Way South, Seattle, Washington, see Figure 1, Location Map.

The Isaacson operation at this site consisted primarily of structural steel fabrication and supply, see Figure 2, Site Plan. Until its sale in 1965 to the Earle M. Jorgensen Company, the Isaacson Corporation also operated the steel manufacturing facilities on the adjacent parcel to the north. A zinc galvanizing operation was also conducted by the Isaacson Corporation near the northeast corner of the current Isaacson site from about 1943 through 1967. This description is purposely brief, since site history has been reported in the previous evaluation. No attempt is made here to correct inaccuracies in the previous evaluation (section on site history); those which are relevant are discussed later in the report.

The previous study and the resulting reports are referred to on several occasions herein. It is not the purpose of this report to comment on the results of that previous study, although certain aspects of that study apparently lack the documentation and quality assurance/quality control (QA/QC) measures warranted in a project of this type, and consequently bring into question the conclusions of that evaluation. Following Patrick H. Wicks' review of the previous study, it was determined that a more extensive evaluation of existing conditions on the property would be required. Accordingly, a more detailed, documented study of the Isaacson property incorporating appropriate

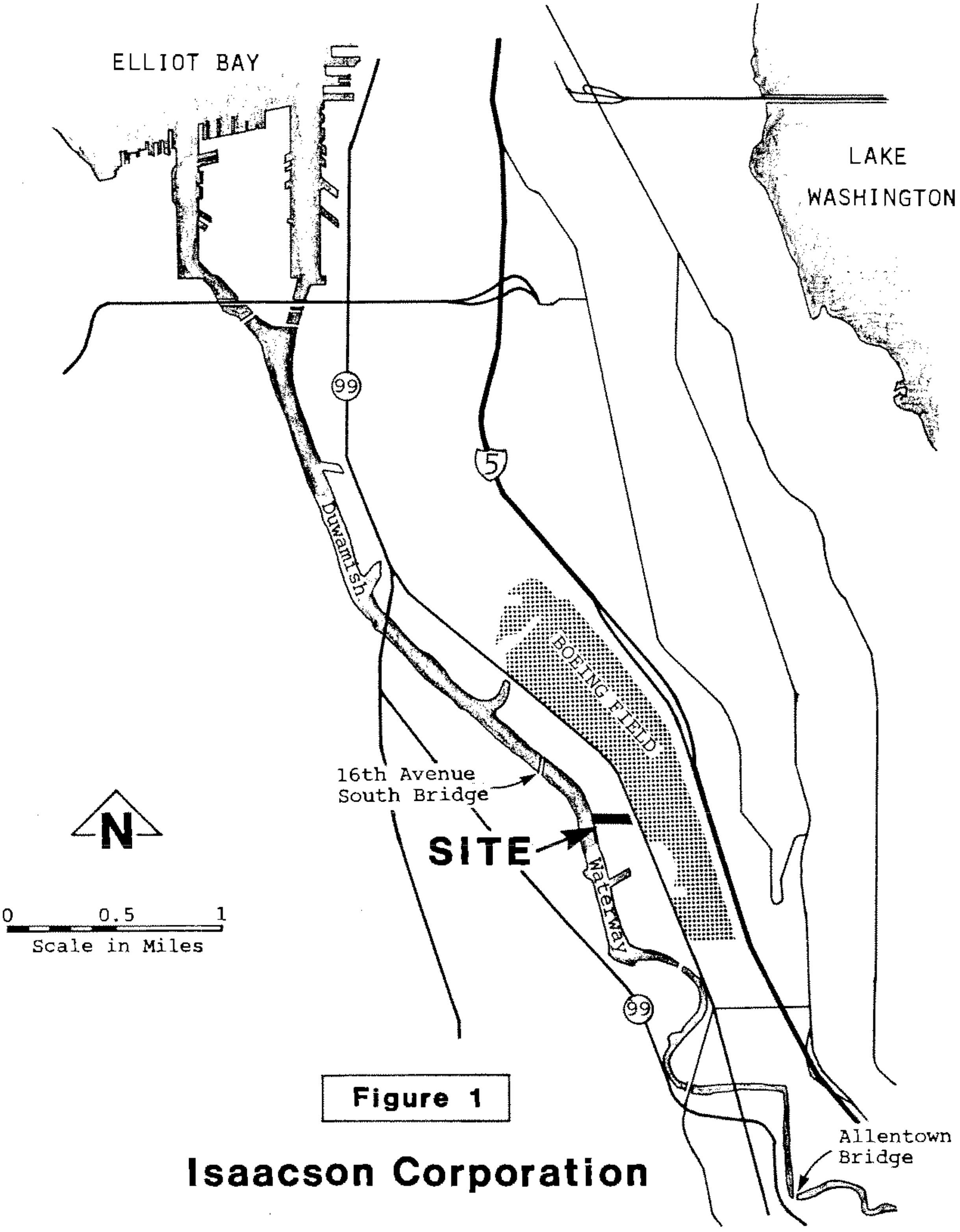
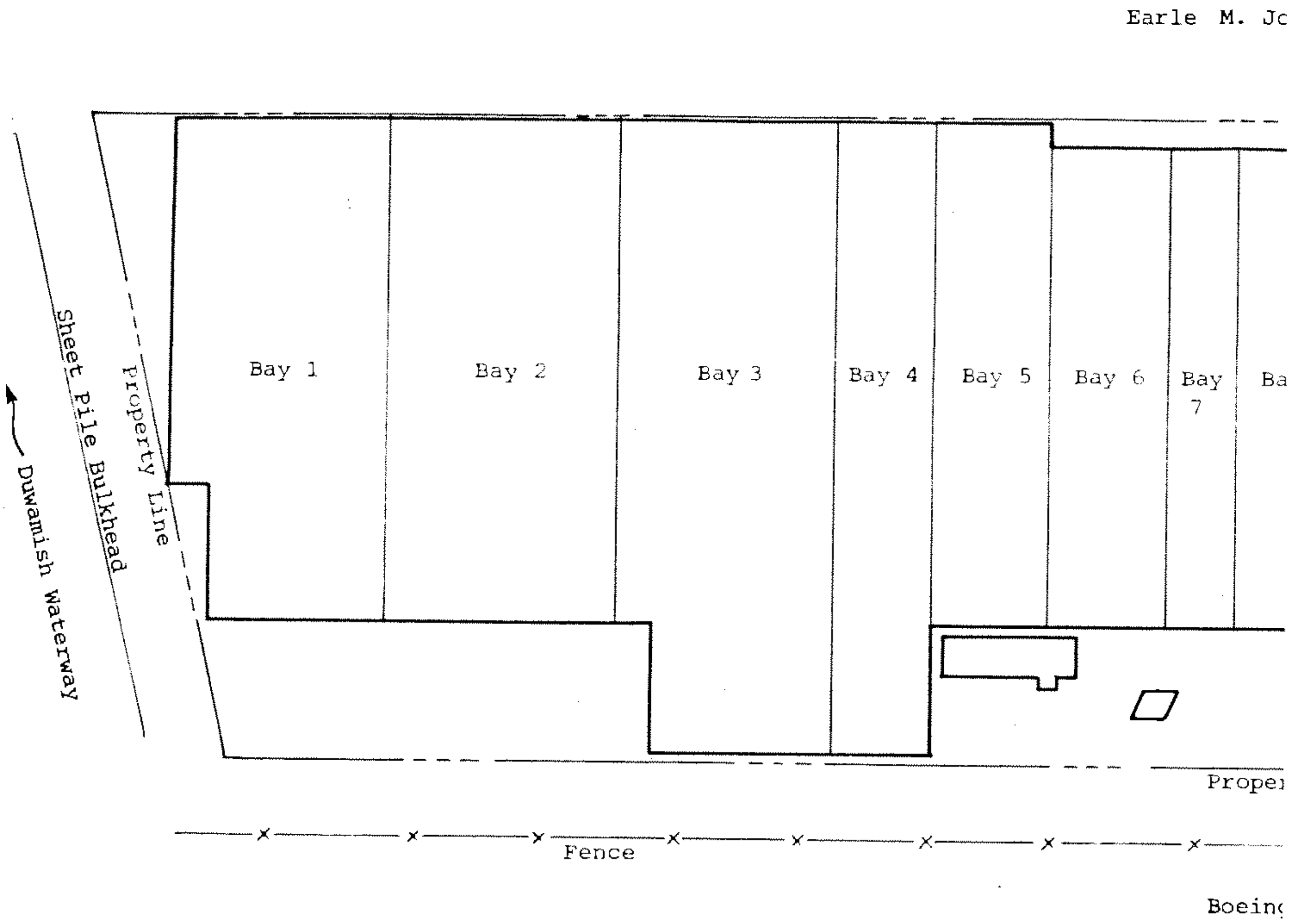


Figure 1

Isaacson Corporation

LOCATION MAP

Patrick H. Wicks
CONSULTANT IN HAZARDOUS WASTE MANAGEMENT
In association with:
Sweet, Edwards & Associates, Inc. • P.O. Box 328 • Kelso, WA 98626


Earle M. Jc
Bay 1
Bay 2
Bay 3
Bay 4
Bay 5
Bay 6
Bay 7
Ba
Property Line
Sheet Pile Bulkhead
Duwamish Waterway
Prope
Fence
Boein

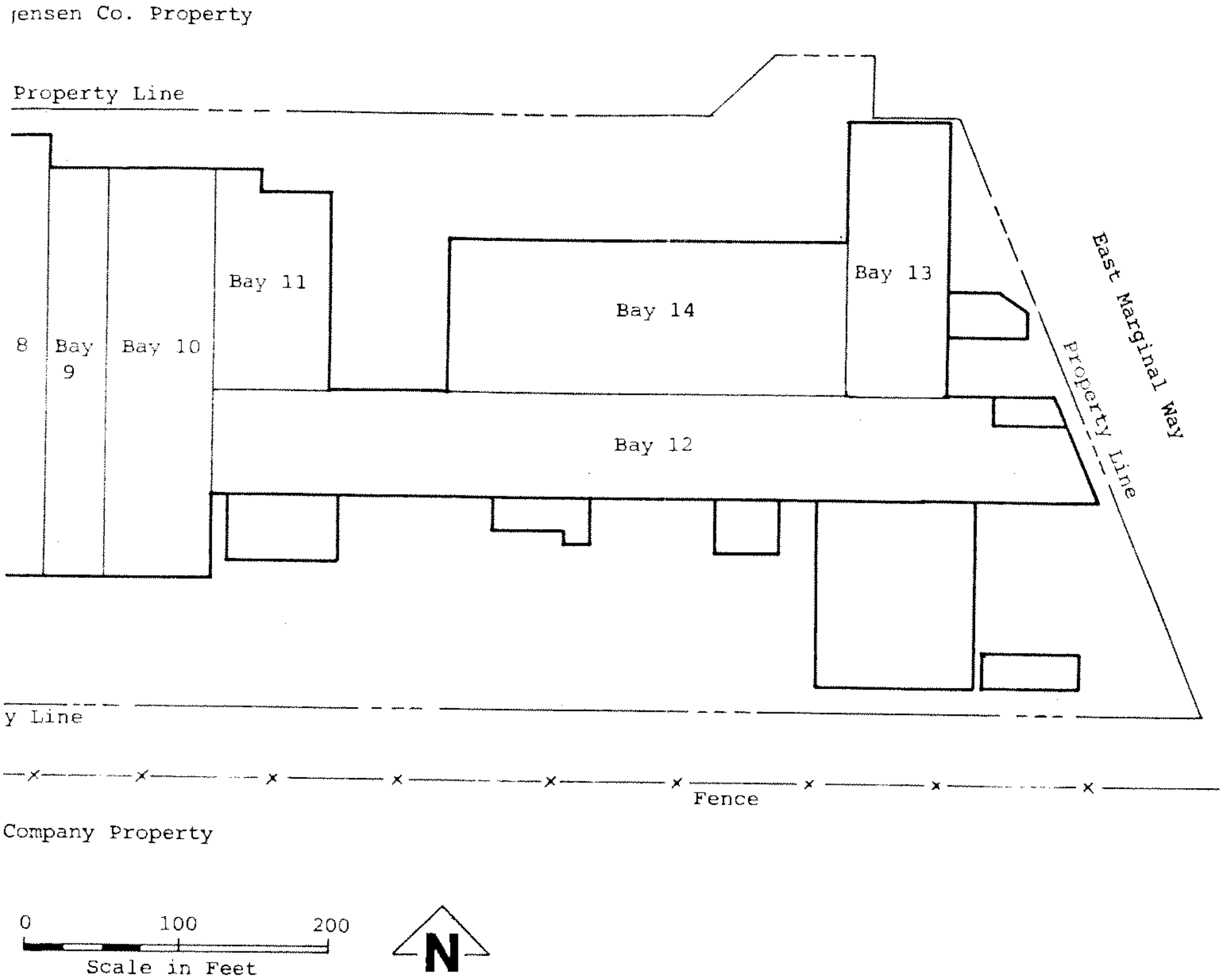


Figure 2

Isaacson Corporation

SITE PLAN

Patrick H. Wicks
CONSULTANT IN HAZARDOUS WASTE MANAGEMENT
In association with:
Sweet, Edwards & Associates, Inc. • P.O. Box 328 • Kelso, WA 98626

QA/QC measures, was undertaken with respect to soils, fill material, ground water, and surface water. The objectives of this evaluation have been as follows:

1. Determine whether and to what extent there is contamination of soil and fills on the site, and if so, does it have a magnitude to require remedial measures.

2. Ascertain whether ground water movement from the site is causing contamination at adjacent properties and/or the Duwamish River.

3. Define the potential source(s) or origin(s) of contamination if it is found in the soils, fills, and/or ground water.

All work performed during this project was directed toward the objectives above, to the level that appropriate decisions could be made to determine whether there is a problem and if so, what is its magnitude and significance in terms of background data, regulatory requirements, and effect(s) on the environment.

It would be unreasonable to expect pristine conditions in a highly industrialized area such as the one which is the subject of this report. It has been commonly found in the Seattle and Tacoma area of Washington, as well as in many other parts of the United States, that industrial areas were filled (or spills and leaks have occurred, with similar effects) in years past with a variety of industrial wastes. Today many of these wastes are considered to be hazardous waste under U.S. Environmental Protection Agency (EPA) regulations, or extremely hazardous waste or dangerous waste under the Washington Department of Ecology (DOE) regulations. In many cases, wastes were filled in such areas in ignorance of contaminants that were present or of the fact that such contaminants were toxic in any way to fish, wildlife, humans, or the environment. As a result, there are numerous areas in the United States and within the State of Washington which are contaminated far beyond "current regulatory limits." A prime example is the Tacoma (Near Shore) Tideflats area, a Federal Superfund site, where extensive studies are now underway to determine contamination levels from previous industrial waste disposal. Over the next several years additional studies will define remedial actions that will be needed to resolve Tacoma Tideflats contamination.

It should be further stated that "current regulatory limits" as used above is really a misnomer as to requirements for remedial actions in a contamination situation of this type since actual regulatory standards have not been clearly established by the EPA nor DOE with respect to degree of degradation of soil and ground water quality. Resolution of potential ground water and soil contamination situations such as this therefore often involves extensive negotiation between the state/federal agencies and the property owner without the benefit of accepted and established standards. In essence, "current regulatory limits" do not answer the questions: "What are acceptable levels of contaminants beyond which there are no unacceptable environmental effects?"; "How clean is clean?"; and "What beneficial uses are we protecting at this facility?".

The work performed during this evaluation is described further in the next section, PROJECT SCOPE, followed by RESULTS, and finally, a SUMMARY AND CONCLUSION section. All other relevant information collected during this evaluation is presented in APPENDIX A, References, APPENDIX B, Geotechnical Procedures and Data, and APPENDIX C, Laboratory Reports.

PROJECT SCOPE

General

In the previous study, soil and water sampling and testing were conducted for arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, zinc, oil and grease, total organic carbon, PCB, and total cyanide. In addition, a limited number of soil samples were tested for priority pollutants. Based on that study and other factors, it was apparent that there should be no concern on this property for the contaminants barium, cadmium, mercury, cyanide, and organic pollutants (including oil and grease, total organic carbon, PCB's, and organic priority pollutants). Accordingly, evaluations undertaken in the current project were limited to the following contaminants of possible concern: arsenic, chromium, copper, lead, zinc, and nickel. Copper had not been evaluated in soil and water in the previous study. Copper was added as a potential contaminant of concern due to the possibility that wood-treating wastes, waste pesticides, or paint residues containing both arsenic and copper may have been deposited on the property.

In addition, to assist in eliminating any other potential problems, spectrographic analyses were performed on most of the soil samples during this evaluation. As part of the laboratory analysis program, arsenic speciation tests were also performed. Further, due to the possibility that potentially contaminated soils might be classified as a hazardous waste under EPA regulations or as extremely hazardous or dangerous waste under DOE regulations, EP toxicity tests for toxic metals were also performed on selected soil samples and slag. Personal communications with EPA laboratory personnel and Washington Department of Ecology personnel confirmed a difference in the EP toxicity tests for classification of waste material as a hazardous waste under DOE and EPA regulations. This difference is for chromium: under the EPA procedure, total chromium is analyzed, whereas under the DOE procedure, hexavalent chromium (CrVI) is analyzed and total chromium ignored. All EP toxicity tests were performed for both total chromium and hexavalent chromium to eliminate possible undetected test failures for Cr(VI) and total chromium.

No further priority pollutant scans were performed under this project in view of the results of the previous study.

Two sets of samples were taken of the Duwamish River, upstream of the property (at the Allentown Bridge) and downstream from the property (at the 16th Avenue South Bridge), to determine arsenic levels. These samples were taken using the same procedures as does Metro, i.e., surface samples without regard to tidal stage or river flow. The analytical results from these river samples could then be compared with the extensive data available from Metro on Duwamish River water quality with respect to most metal contaminants of concern in this evaluation. However, for arsenic, it should be noted that current and historical analyses of Duwamish River water by Metro does not include arsenic. A Seattle consulting firm was requested to gather and compile the limited available arsenic data in the Duwamish River area and also provide information on the known or expected sources of arsenic to the river.

In addition, there are two sewer outfalls into the Duwamish within several hundred feet upstream of the Isaacson property. During this evaluation, several observations were made of these outfalls. The one immediately upstream from the 48" storm sewer was discharging water on only one of the four observations. The second outfall, about 100 feet further upstream, seemed to be discharging at the time of all observations. It is not known what effect on Duwamish River water quality these outfalls have, nor were they sampled during this project. why not?

Portions of the background and historical information and other data for use in this evaluation were obtained through personal communications with current or former representatives or employees of the Isaacson Corporation, Oregon State University (Department of Agricultural Chemistry), Pace National Corporation, Lilyblad Petroleum, Inc., Seattle Steel, Harper Owes, Earle M. Jorgensen Company, University of Washington (Department of Chemistry), Laucks Testing Laboratories, Inc., Dames & Moore, EPA, and DOE, as listed in the references.

Sweet, Edwards and Associates, Inc., (Sweet-Edwards) provided major assistance on this project in performing the geotechnical portion of the evaluation, and accordingly is an associate author of this report. All other subcontractors involved in the project are not specifically identified, except in the APPENDICES, when appropriate.

Geotechnical Field Work

A. History

The field investigative tasks completed by Sweet-Edwards from October 10 through November 2, 1983, at the Isaacson site are listed below.

Task Description	Date - 1983
1. Site reconnaissance and monitoring well siting	October 10
2. Soil sampling and installation of monitoring wells I-1 and I-2	October 12-14

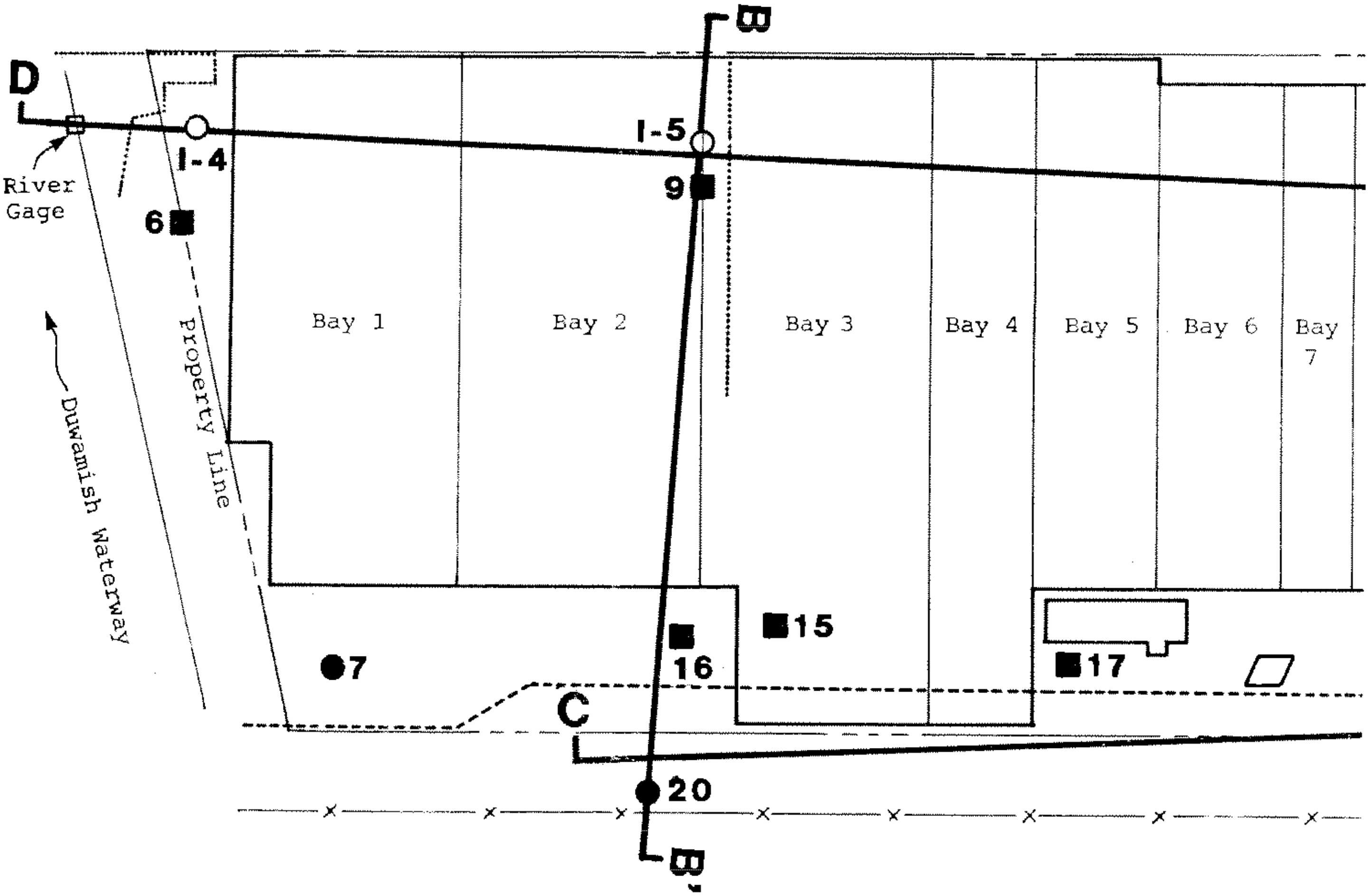
3. Radar survey and test pit exploration	October 17
4. Soil sampling and installation of monitoring wells I-3 through I-7	October 18-21
5. Well development and purging	October 12-25
6. Ground water sampling	October 24-25 December 9-10
7. Hydrology monitoring	October 24-26 November 1, 2

B. Description

A general description of the above field tasks is provided in the following paragraphs.

Task 1 - The locations of monitoring wells I-1 through I-7 were influenced by the factors of site configuration, locations of potential contaminant sources and buried utilities, hydrology in the site vicinity, and the existing monitoring wells installed by others. These factors were evaluated during the site reconnaissance, and seven monitoring wells were sited as shown on Figure 3.

Task 2 - Because the previous report indicated contaminated surface soils at the site, a soil sampling and monitoring well installation methodology was used which minimized the introduction of contaminants into the intake or screened zone of the monitoring well. For wells I-1 and I-2, this was accomplished by drilling an exploratory borehole to obtain soil samples, determine the



EXPLANATION

1 ■ Boring: Previous study

7 ● Monitoring well: Previous study

I-1 ○ Monitoring well: Present study

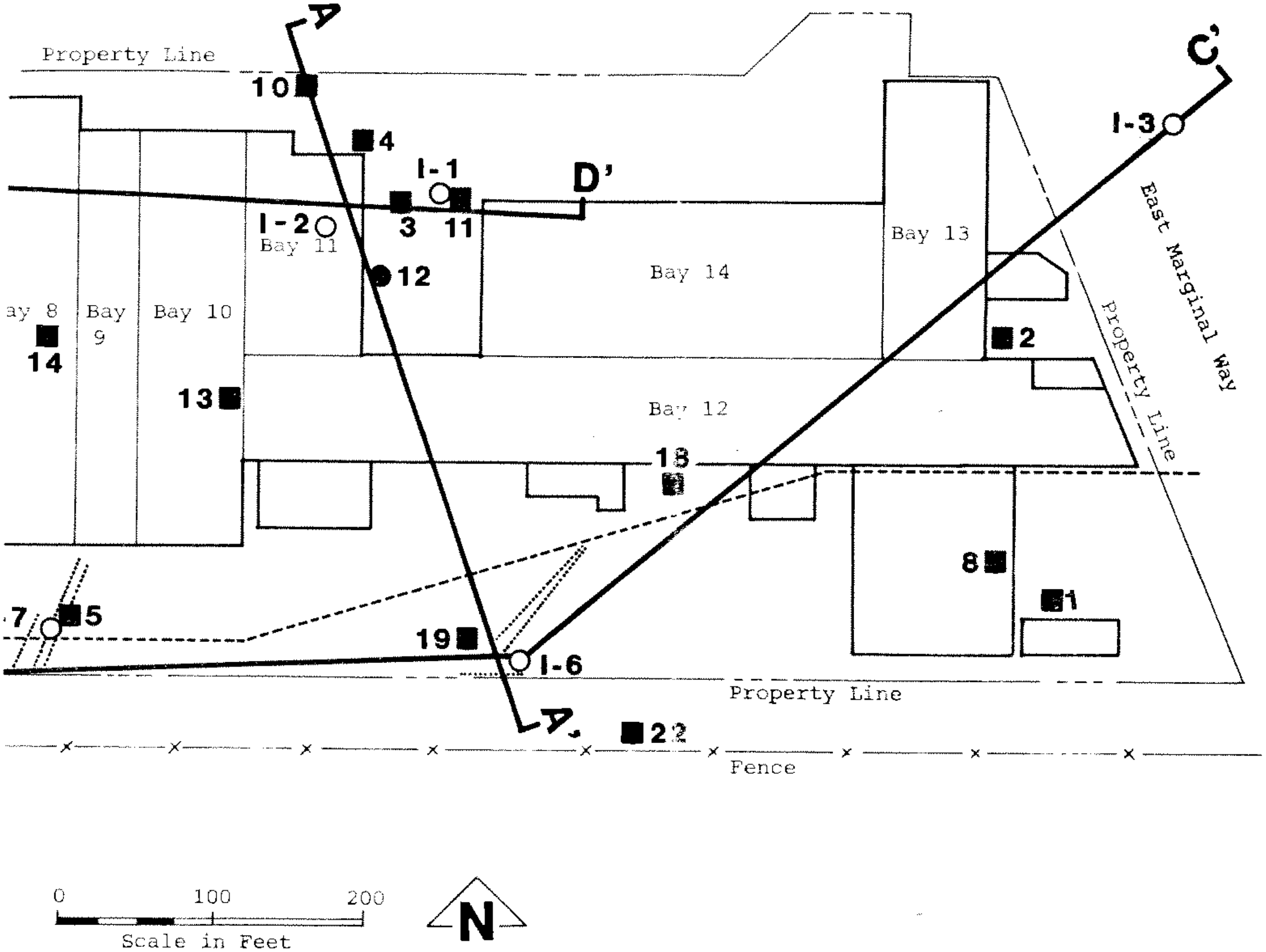
.... Radar traverse

------ 48" Storm sewer

A A' Schematic section location

Notes:

1. The loc
wells a
from bu
points.
2. Test pi
I-4,I-5



ions of the I-series monitoring based on measured distances dings and other site reference

are located at monitoring wells -6 and I-7.

Figure 3

Isaacson Corporation

FIELD INVESTIGATIONS MAP

Patrick H. Wicks
CONSULTANT IN HAZARDOUS WASTE MANAGEMENT
In association with:
Sweet, Edwards & Associates, Inc. • P.O. Box 328 • Kelso, WA 98626

subsurface profile, and design the monitoring well. The monitoring well was then installed by drilling an adjacent borehole using a plugged hollow stem auger, thus minimizing the introduction of contaminated soil and water into the screened zone of the monitoring well.

Monitoring wells I-1 and I-2 were completed at depths of 22.0 and 23.5 feet below ground, respectively. More detail on monitoring well installation field procedures is provided in APPENDIX B. Screen depths and other monitoring well details are provided on the boring logs in the APPENDIX.

Task 3 - Later sections of this report include a description of the surface fill existing below ground at the Isaacson site. The nature and unknown distribution of the fill makes conventional drilling difficult over most of the site and impossible in areas with buried slag, concrete and other demolition waste.

To complete the monitoring well installations in the general locations initially planned, it was decided to conduct predrilling shallow subsurface exploration using ground penetrating radar (GPR) and backhoe test pit exploration. Details of the GPR survey and test pit work are provided in APPENDIX B. The GPR survey traverse locations are shown on Figure 3.

Test pits I-4 through I-7 were excavated in the areas considered to be free of large slag fragments, based on the GPR survey. These test pits were excavated in the locations shown for monitoring wells I-4 through I-7 on Figure 3.

Task 4 - Following the excavation of test pits I-4 through I-7 the monitoring wells were installed. Monitoring wells I-4, I-6, and I-

7 were installed by drilling with hollow stem auger through the open test pit excavation. Monitoring well I-5 was installed through a borehole drilled adjacent to test pit 5. Monitoring well I-3, the upgradient monitoring well east of Marginal Way, was installed employing standard hollow stem auger procedures. Details of the field drilling and monitoring well installation procedures are provided in APPENDIX B. As-built drawings of the installed monitoring wells are provided in APPENDIX B.

During installation of the monitoring wells, soil samples were obtained from the walls of test pits I-4 through I-7. Samples of random fill and slag were also obtained for laboratory testing. Details of the field sampling procedures are shown in APPENDIX B.

Task 5 - Following installation the site monitoring wells were surged, developed and pumped to clear the screen and establish a sand-free discharge from the well. This also helped to remove potential contaminants introduced during the drilling and well installation process. The well development and pumping was done by Isaacson personnel under the supervision of Sweet-Edwards. The total volume of water estimated to have been pumped from each of the wells is shown on Table 1 of APPENDIX B. The well development and surging field techniques are described in more detail in APPENDIX B.

Task 6 - Following completion of the well development and pumping, Sweet-Edwards obtained ground water samples from all of the I-series monitoring wells and the three previously installed monitoring wells. Two sampling runs were performed: the first on

October 25 and 26, 1983 and a second on December 9 and 10, 1983. Field sampling procedures, sample storage, chain-of-custody, and transport to the laboratory are outlined in detail in APPENDIX B. Laboratory testing data are shown on Table 2 and discussed in the RESULTS section.

Task 7 - Measurement of ground water and surface water levels at the site began during the ground water sampling. In order to establish the effects of tidal influence from the Duwamish River on the local ground water table, hydrology measurements in the well and river were continued for several days following ground water sampling. The hydrology data, including water table and Duwamish River elevations, are listed in Table 2 in APPENDIX B.

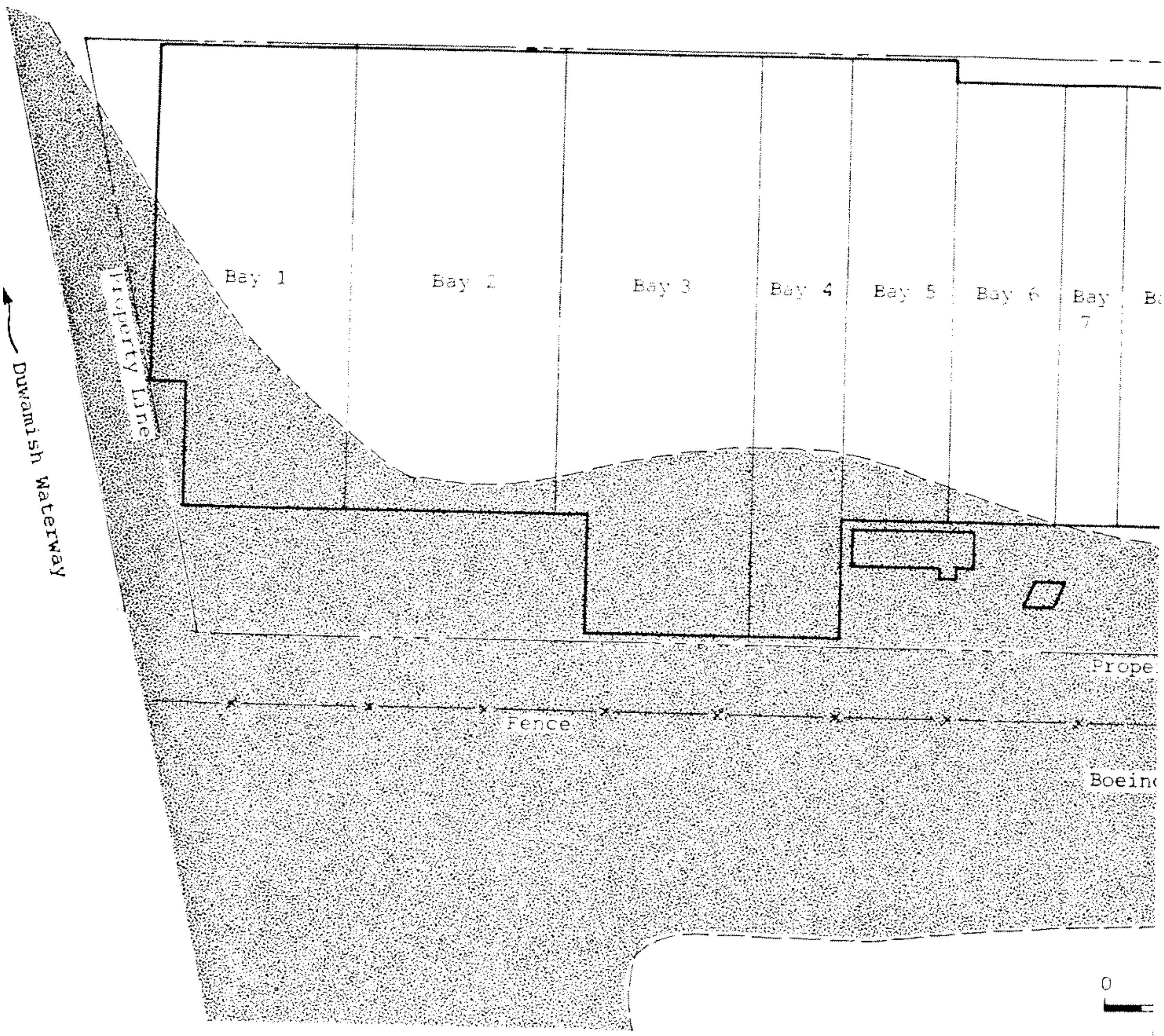
RESULTS

Geology

The Isaacson site is located on the east bank of the Duwamish River. The topography of the Duwamish floodplain in this area is relatively flat as it is at Boeing Field and the surrounding industrial area. Subsurface investigations during this and the previous study have shown that the site is underlain by two primary shallow subsurface units. These are a surface unit of random fill with an underlying unit composed of native alluvial soils and dredge spoils.

The surface unit of random fill apparently covers the entire Isaacson site, and, where observed, varies in thickness from less than 5 feet to greater than 12 feet. The greatest observed thickness of random fill as shown on Figure 5, sheets 1 and 2, is in the south and western portions of the site where Slip 5 was filled. As shown on Figures 4 and 5, the random fill is generally greater than 10 feet in thickness in the southern and western portions of the site and less than 10 feet in thickness in the northern and eastern portions of the site. The composition of the random fill and underlying soils are described in detail in the appended site boring logs.

Earle M. J



EXPLANATION

☐	Random fill (generally less than ten feet thick)
▨	Random fill (generally greater than ten feet thick)
▩	Basin sludge disposal area

All areas dashed where approximate.

Notes:

1. The location an
potential conta
estimated from
personal commun
Isaacson person
2. For more detail
fill thicknesse

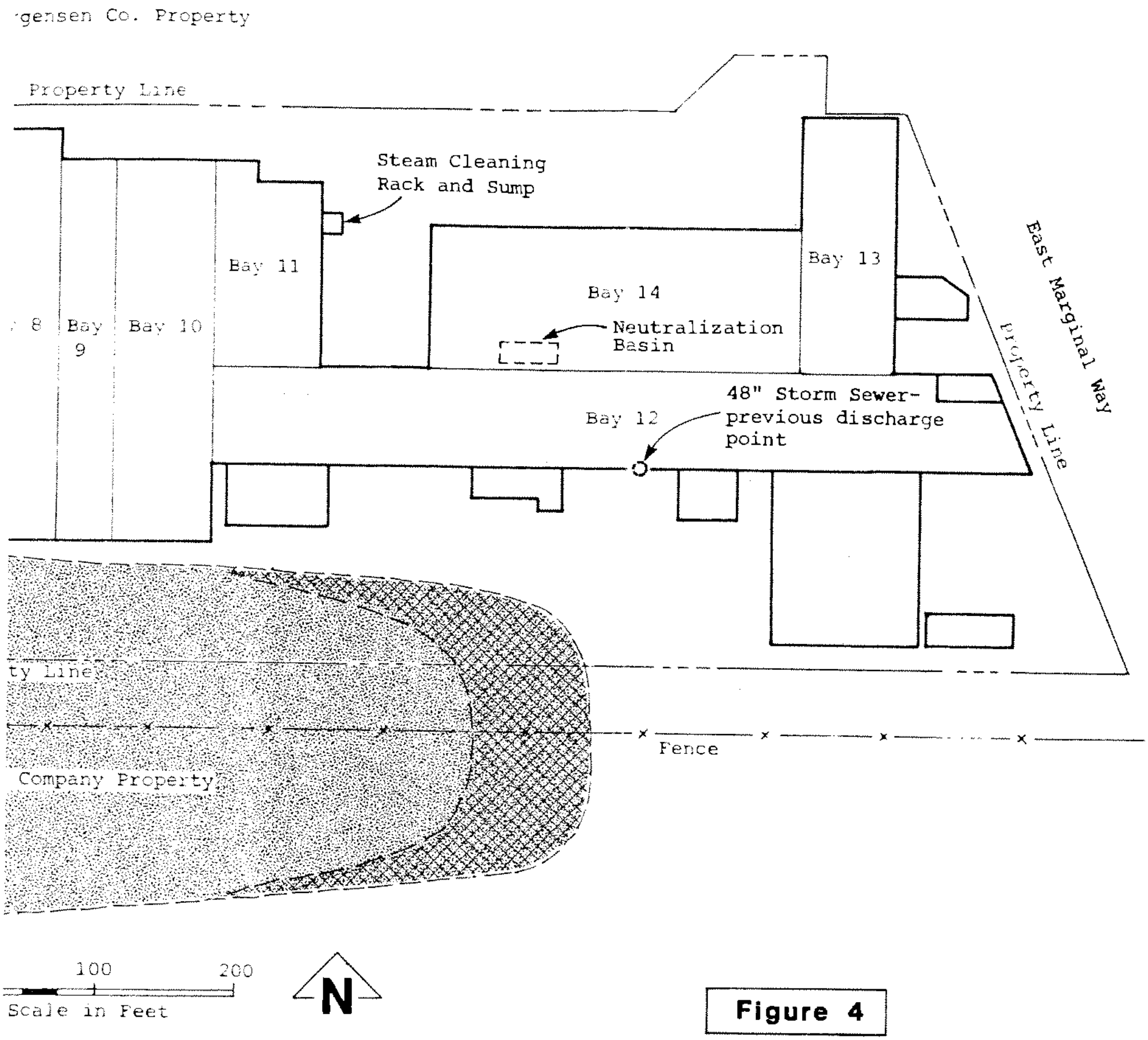


Figure 4

Isaacson Corporation

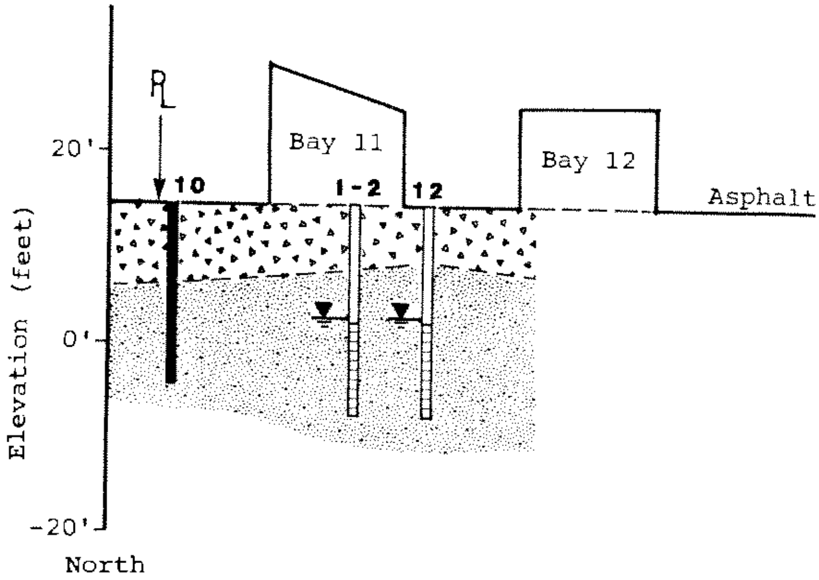
**POTENTIAL ON-SITE
CONTAMINANT SOURCES**

boundaries of the
inant sources are
erial photos and
cation with
el.

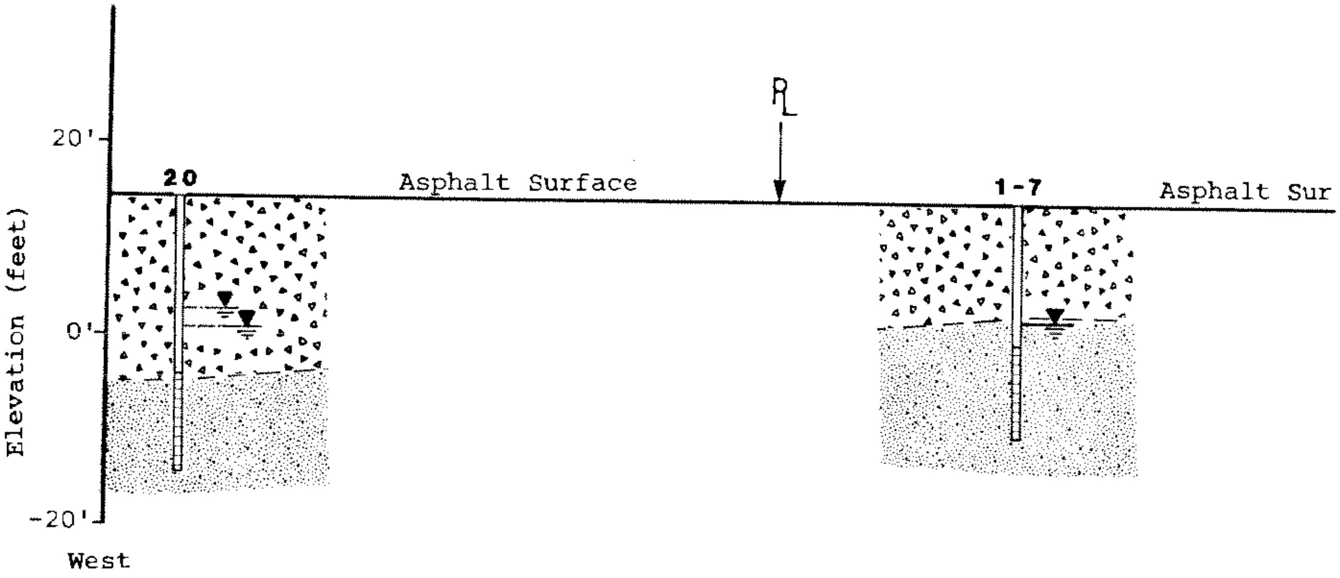
regarding random
, see Figure 5.

Patrick H. Wicks
CONSULTANT IN HAZARDOUS WASTE MANAGEMENT
In association with:
Sweet, Edwards & Associates, Inc. • P.O. Box 328 • Kelso, WA 98626

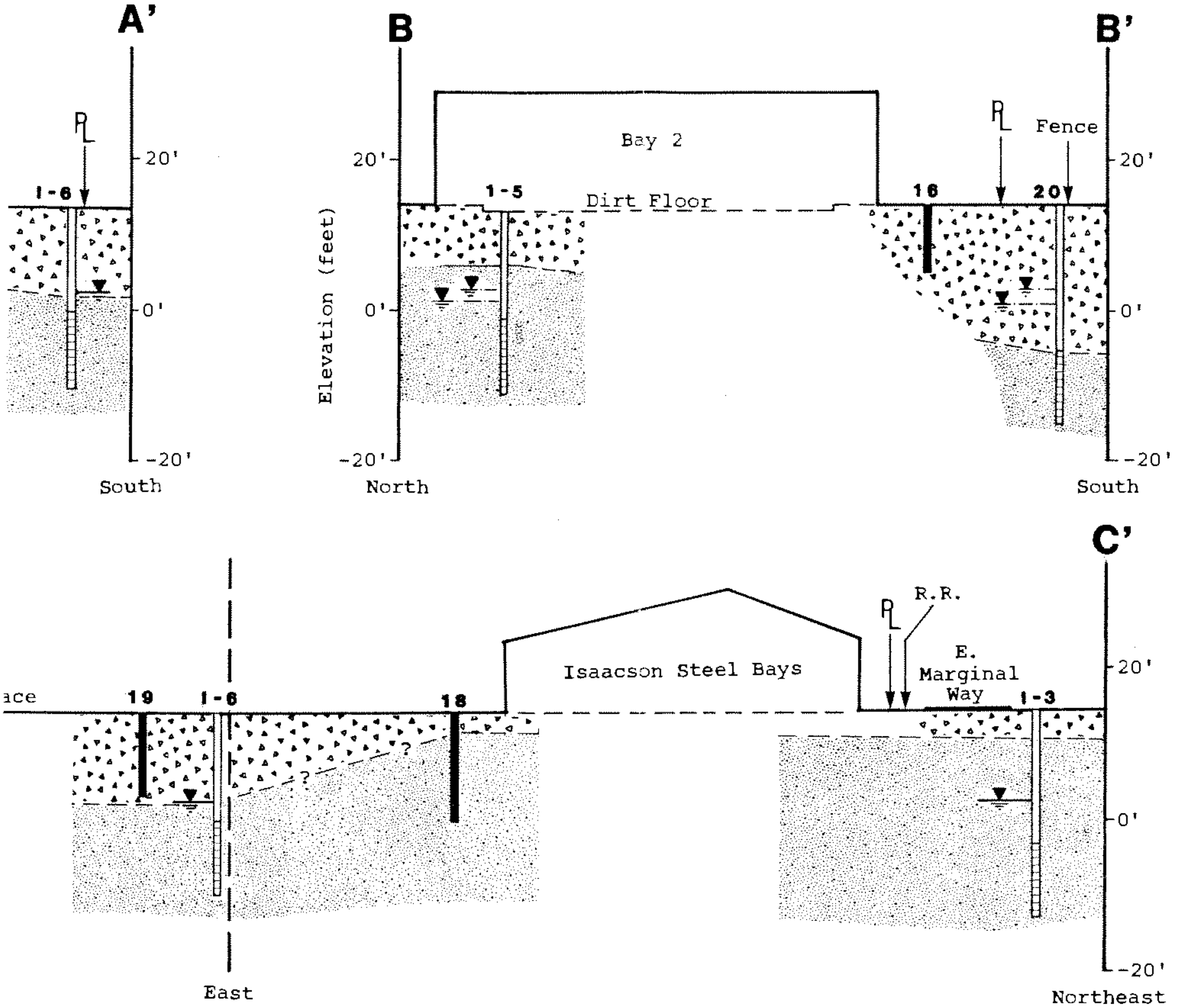
A


PL
20'
0'
-20'
Elevation (feet)
North
10
Bay 11
1-2
12
Bay 12
Asphalt

C


20'
0'
-20'
Elevation (feet)
West
20
Asphalt Surface
PL
1-7
Asphalt Sur

See Sheet



for Explanation.

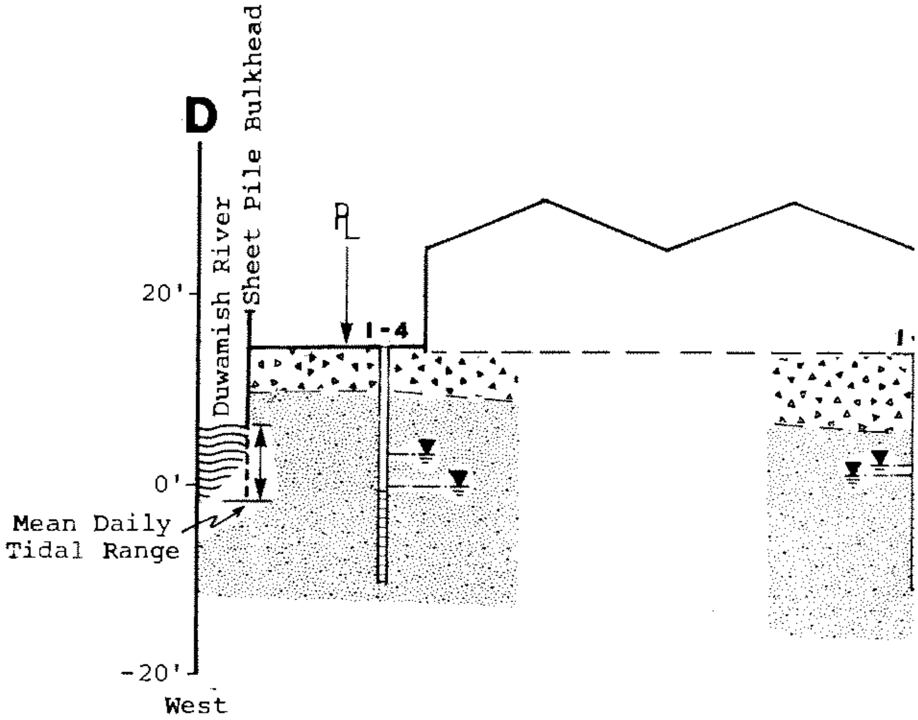
Figure 5

Sheet 1

Isaacson Corporation

SCHEMATIC SITE PROFILES

Patrick H. Wicks
CONSULTANT IN HAZARDOUS WASTE MANAGEMENT
In association with:
Sweet, Edwards & Associates, Inc. • P.O. Box 328 • Kelso, WA 98626



EXP

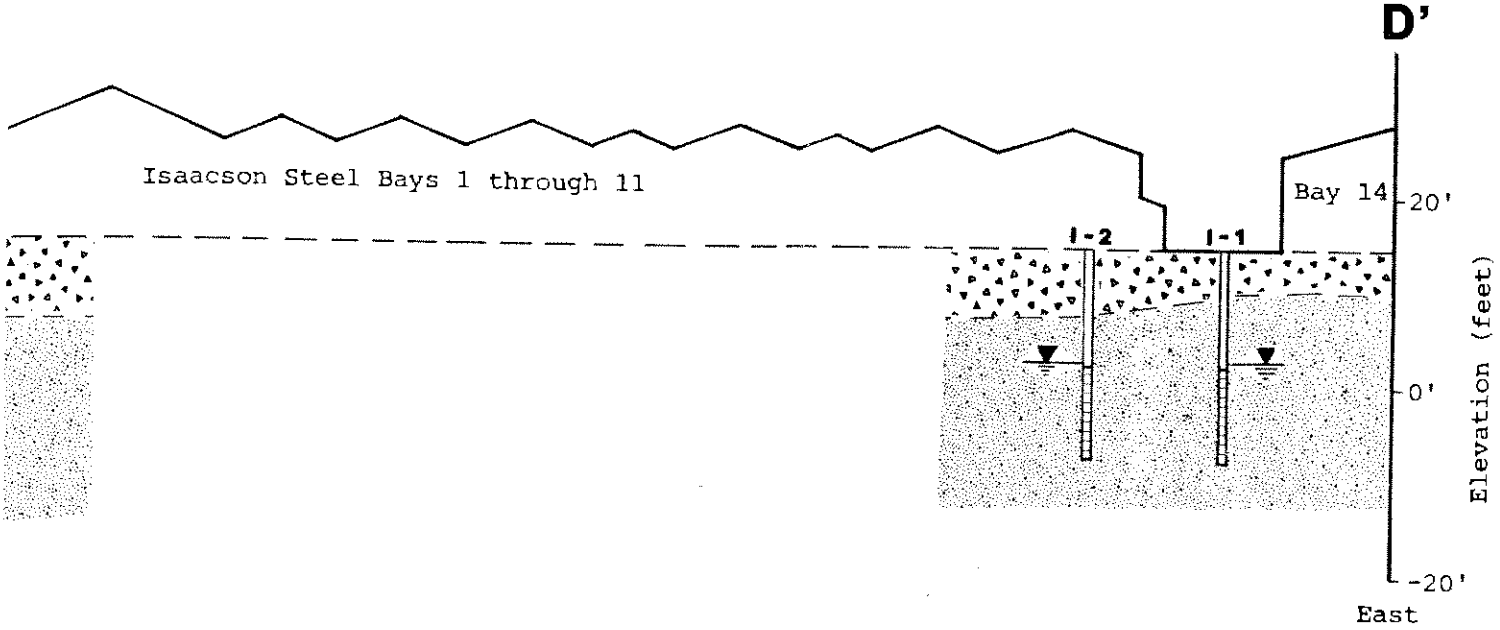
▨ RANDOM FILL
Gravel, sand, silt, slag, demolit
waste, crushed rock and brick.

▒ ALLUVIUM
Sand with occasional small amount
silt and sand-silt interbeds, inc
dredge spoils.

▼ Potentiometric Surface

▼ Potentiometric Surface
(influenced by tidal fluctuation)

Horizonta
Vertical



ANATION

ı

Boring: Previous study-
no monitoring well installed

of
ies

Monitoring Well

Screened Interval

Scale: 1" = 100'
aggeration = 5X

Figure 5

Sheet 2

Isaacson Corporation

SCHEMATIC SITE PROFILES

Patrick H. Wicks
CONSULTANT IN HAZARDOUS WASTE MANAGEMENT
In association with:
Sweet, Edwards & Associates, Inc. • P.O. Box 328 • Kelso, WA 98626

Fill and Soil Quality

A. Introduction

Selected random fill and soil samples obtained from borings and test pits in the current study were laboratory tested for heavy metal elements and EP toxicity. Table 1 lists the results of these analyses plus selected results from the previous study. Subsurface profiles of the random fill and soil lab test results are shown graphically on Figure 6.

Figure 3 shows that many of the monitoring wells installed during this study are adjacent to borings completed during the previous study. For comparison purposes, random fill and soil samples selected for lab testing in the current study are from depths similar to the random fill and soil samples tested in the previous study. The profiles shown on Figure 6 should be used to compare the contaminant concentrations in random fill and soil samples collected from borings drilled in similar site areas during the current and previous evaluations. Spectrographic analyses of random fill and soil samples were also completed, and these results are in APPENDIX C. The spectrographic lab results are semiquantitive scans for elemental concentrations, and therefore were not shown on Table 1.

Review of the profiles on Figure 6 (14 sheets) shows that the heavy metal concentration in the random fill and soil resulting from the current study are similar to those found in the previous study. The metals concentrations shown on Figure 6, sheet 3, Borings 2 and I-3 can be considered uncontaminated or background levels for the Isaacson site. These background concentrations are less than 100

TABLE 1. SUMMARY OF SOIL

BORING NUMBER	SAMPLE DEPTH FT	SAMPLE$^{(2)}$ NUMBER		TOTAL METALS ANALYSES,$^{(3)}$ ppm					
		S-E	LAB	Arsenic As	Barium Ba	Cadmium Cd	Total Chromium Cr	Copper Cu	Lea Pt
I-1	2.5- 3.5	S-2	12	8	--	--	39	21	9.
	5.0- 8.0	S-4	1	1300	--	--	25	1400	97
	10.0-11.5	S-7	2	1000	--	--	25	2400	23
	13.0-14.5	S-9	13	9	--	--	9.5	520	6.
I-2	4.0- 7.0	S-3	3	290	--	--	70	390	39
	7.0- 8.5	S-4	14	1100	--	--	23	450	440
	8.5-10.0	S-5	4	3800	--	--	26	450	32
	13.5-15.0	S-6	15	1200	--	--	9.3	420	4.
I-3	9.5-11.0	S-2	10	11	--	--	47	45	36
I-4	3.0	TP-2	5	510	--	--	16	280	150
I-5	3.0	TP-2	6	130	--	--	29	90	21
I-6	9.0-11.0	TP-5	7	79	--	--	540	390	150
I-7	2.0- 4.0	TP-1	8	30	89	2	580	360	3900
	4.0- 6.0	TP-2	11	23	--	--	740	340	630
I-4 & I-6	Slag Composite		9	18	440	2.2	1300	430	240
I-4	Slag		16	120	--	--	920	370	630
I-6	Slag		17	33			2200	1200	1400
I-7	Slag		18	26			1700	160	120

DATA FROM PREVIOUS EVALUATION

BORING$^{(5)}$ NUMBER	BORING NUMBER	SAMPLE DEPTH ft	TOTAL METALS ANALYSES, ppm					
			Arsenic As	Barium Ba	Cadmium Cd	Total Chromium Cr	Copper Cu	Lea Pb
I-1	11	6.5	2880	--	--	--	--	--
I-1	11	11.5	1210	--	--	--	--	--
I-2	3	6.5	932	43	0.4	12	--	3.
	12	6.5	44	--	--	--	--	--
I-2	3	10.5	200	60	0.2	16	--	4.
	4	10.5	15	--	--	--	--	--
	12	9.0	31-13	--	--	--	--	--
I-4	6	2.0	18	520	8	466	--	580
I-5	9	3.0	47	63	1	31	--	16
I-6	19	9.0	36	63	3	835	--	220
I-7	5	2.5	33	650	16	1130	--	1170
Slag			ND	1350	ND	4330	62	105

D FILL ANALYSES DATA(1)

Zinc Zn	EP TOXICITY ANALYSES,(4) mg/l Arsenic As	Barium Ba	Cadmium Cd	Total Chromium Cr	Hexaval. Chromium Cr(VI)	Lead Pb	Mercury Hg	Selenium Se	Silver Ag
37	ND	ND	ND	ND	ND	ND	ND	ND	ND
280	7.8	ND	ND	ND	ND	ND	ND	ND	ND
240	7.3	ND	ND	ND	ND	ND	ND	ND	ND
380	ND	ND	ND	ND	ND	ND	ND	ND	ND
89	--	--	--	--	--	--	--	--	--
180	ND	ND	ND	ND	ND	ND	ND	ND	ND
140	--	--	--	--	--	--	--	--	--
220	ND	ND	ND	ND	ND	ND	ND	ND	ND
50	--	--	--	--	--	--	--	--	--
430	--	--	--	--	--	--	--	--	--
68	--	--	--	--	--	--	--	--	--
390	--	--	--	--	--	--	--	--	--
1500	ND	ND	.02	0.1	ND	6.1	ND	ND	ND
310	ND	ND	ND	ND	ND	ND	ND	ND	ND
790	ND	ND	ND	ND	ND	ND	ND	ND	ND
580	ND	ND	ND	ND	ND	ND	ND	ND	ND
700	ND	ND	ND	ND	ND	ND	ND	ND	ND
170	ND	ND	ND	ND	ND	ND	ND	ND	ND

EP TOXICITY ANALYSES, MAXIMUM CONCENTRATION LIMIT,(6) mg/l

5	100	1	5(EPA)	5(DOE)	5	0.2	1	5

Zinc Zn
301
261
2030
18
416
132
28.5-33
2320
80
300
2270
280

(1) -- denotes analysis not performed.

(2) S-E column lists sample numbers assigned by Sweet, Edwards and Associates as samples were taken in the field. LAB column lists sample numbers assigned by the laboratory.

(3) Dry weight basis.

(4) ND denotes non-detectible above detection limit; for laboratory sample numbers 1, 2, 8, and 9, EP toxicity analyses lower detection limits are: As, 0.5; Ba, 0.5; Cd, 0.01; Cr. 0.1; Cr(VI), 0.1; Pb, 0.2; Hg, 0.005; Se, 0.5; Ag, 0.1. For laboratory sample numbers 11 through 18, EP toxicity analyses lower detection limits of detection are: As, 0.2; Ba, Cd, CrVI, Pb, and Hg are same as above; Se, 0.1; Ag, 0.2.

(5) Borings in this evaluation which are nearest to borings in previous evaluation.

(6) Soil/fill analyses results exceeding any one of these maximum concentration limits classifies that soil/fill as a hazardous waste under EPA regulations and/or as dangerous waste under DOE regulations.

parts per million (ppm) of the selected metals. Borings 1 and 2 are located at the east end of the site and I-3 is east of Marginal Way.

Figure 6. Fill and Soil Chemical Analysis Profiles

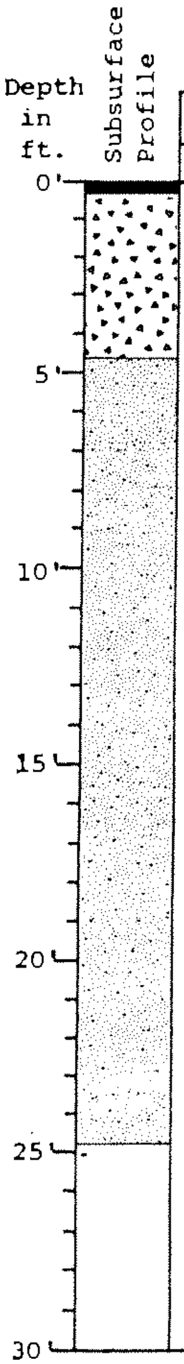
EXPLANATION

■	Asphalt
░	Concrete
▨	Random Fill- Gravel, sand, silt, slag, demolition waste and crushed rock.
▒	Alluvium- Sand with occasional small amounts of silt and sand-silt interbeds, includes dredge spoils.

All elemental constituents are reported in parts per million (dry weight).

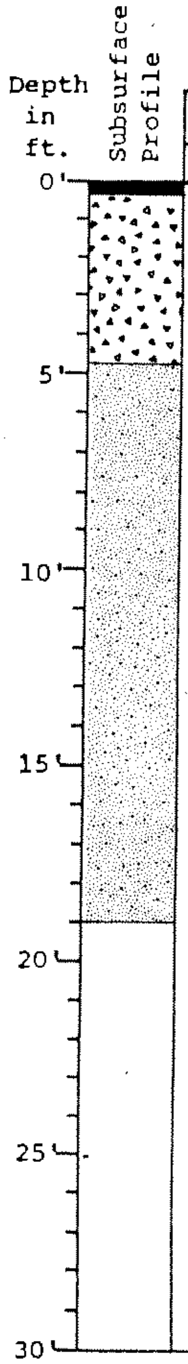
Figure 6. Fill and Soil Chemical Analysis Profiles - Sheet 1

BORING I-1



Sample		Constituents					EP Tox.
no.	type	As	Pb	Zn	Cr	Cu	
S-2	Spoon	0.8	9.7	37	39	21	Pass
S-4	Spoon	1300	97	280	25	1400	Failed As
S-7	Spoon	1000	23	240	25	24	Failed As
S-9	Spoon	0.9	6.0	380	9.5	520	Pass

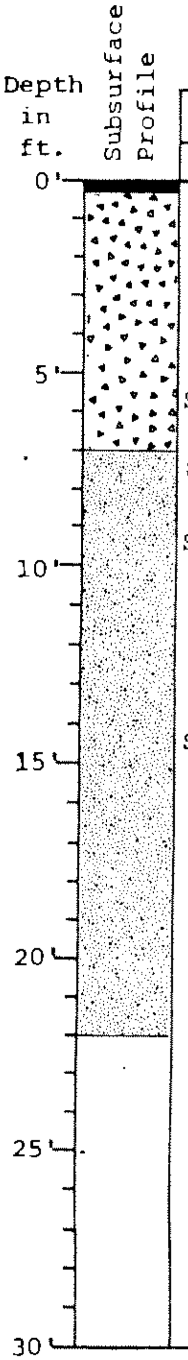
BORING 11



Sample		Constituents					EP Tox.
no.	type	As	Pb	Zn	Cr	Cu	
2		2880	---	301	---	---	---
4		1210	---	261	---	---	---

Figure 6. Fill and Soil Chemical Analysis Profiles - Sheet 2

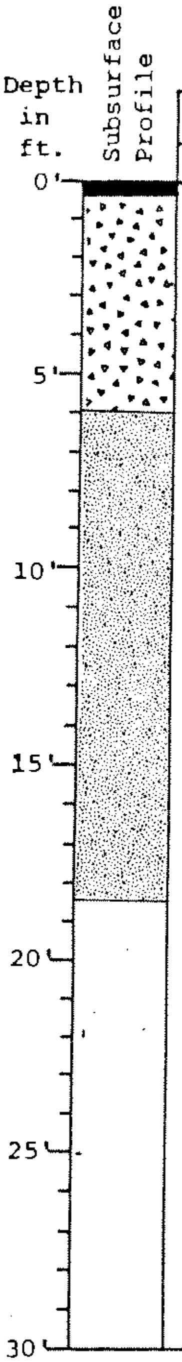
BORING I-2



Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
S-3	Auger	290	39	89	70	390	---
S-4	Split Spoon	1100	440	180	23	450	Pass
S-5	Split Spoon	3800	32	140	26	450	---
S-6	Split Spoon	1200	4.5	220	9.3	420	Pass

Should have been run

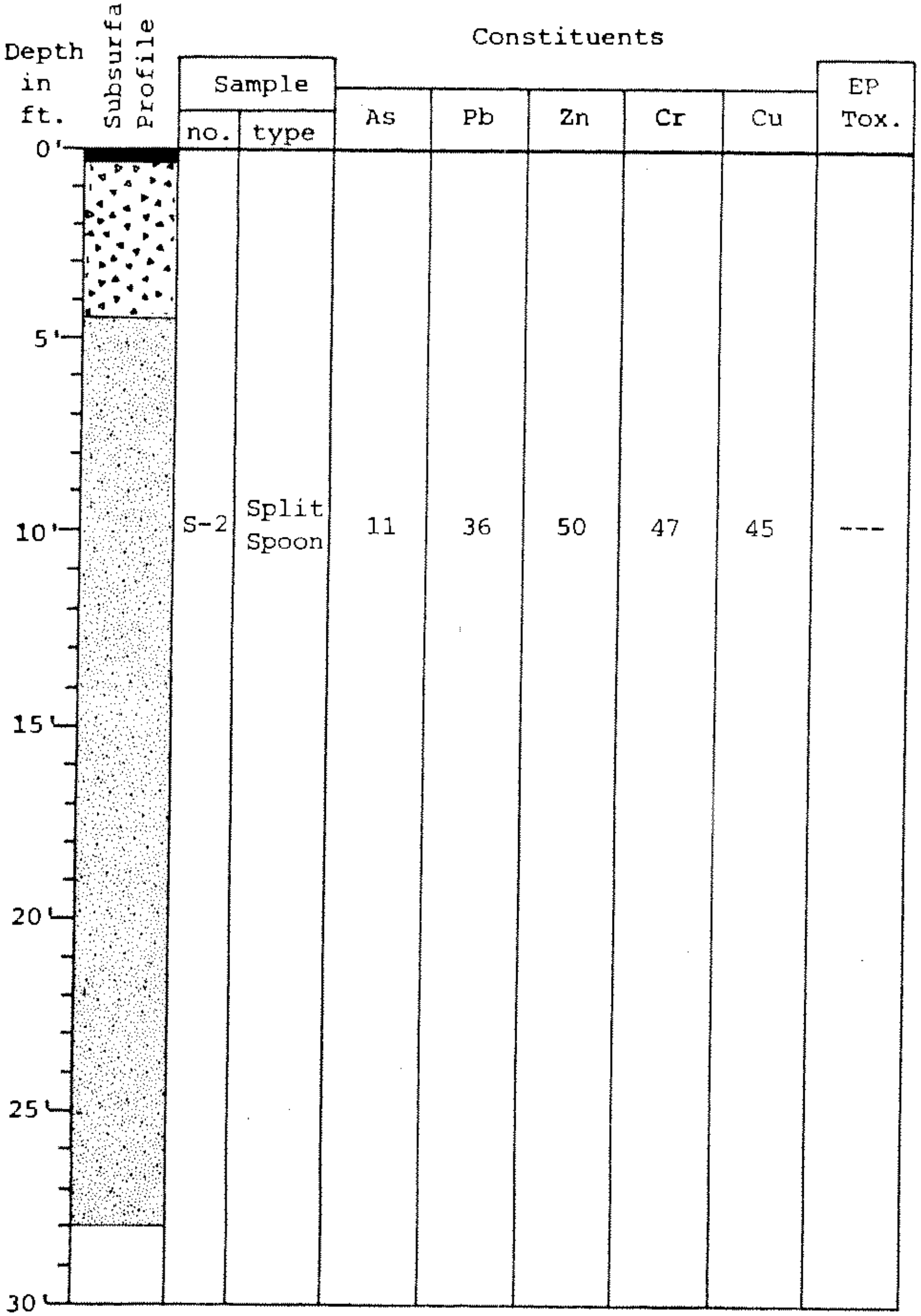
BORING 12



Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
2		44	---	18.2	---	---	---
3		13	---	28.5	---	---	---

Figure 6. Fill and Soil Chemical Anlaysis Profiles - Sheet 3

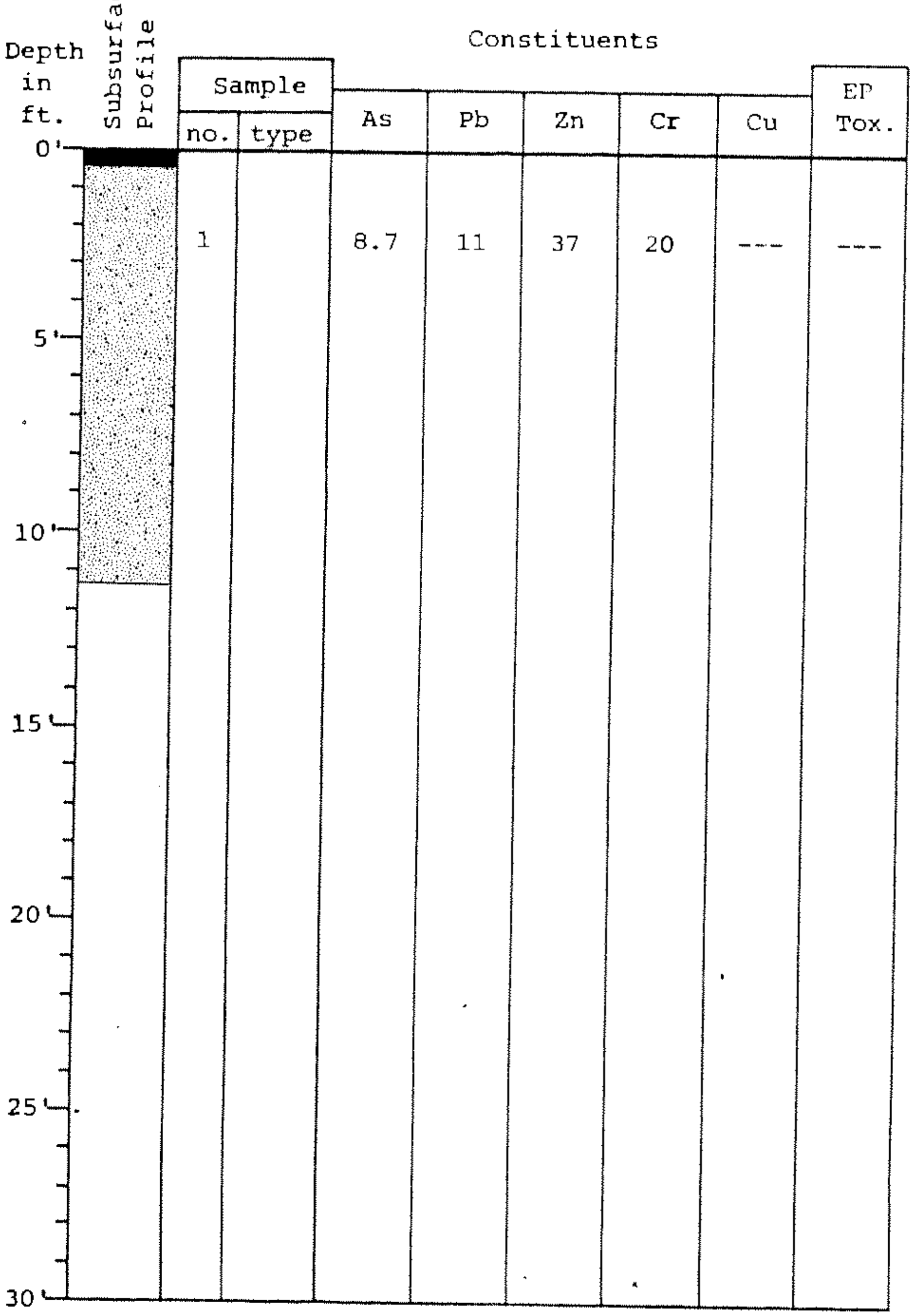
BORING I-3



Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
S-2	Split Spoon	11	36	50	47	45	---

Constituents

BORING 2

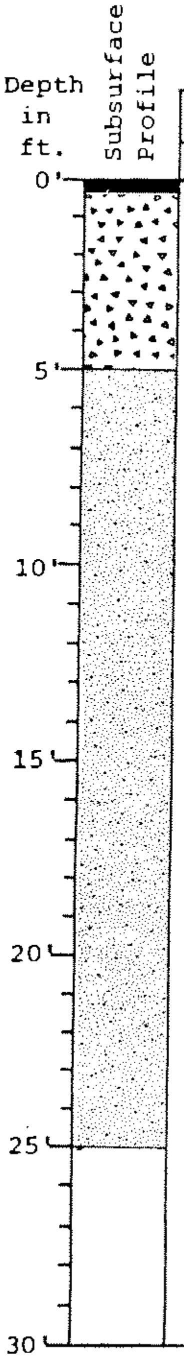


Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
1		8.7	11	37	20	---	---

Constituents

Figure 6. Fill and Soil Chemical Analysis Profiles - Sheet 4

BORING I-4

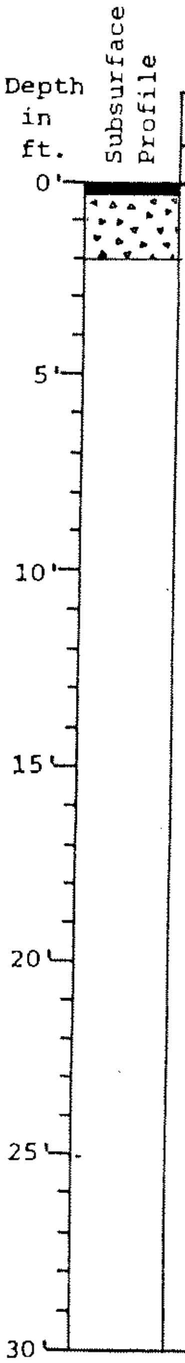


Constituents

Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
	Slag	12	630	580	920	370	Pass
TP-2	Composite Test Pit	510	150	430	16	280	---

Should have been run

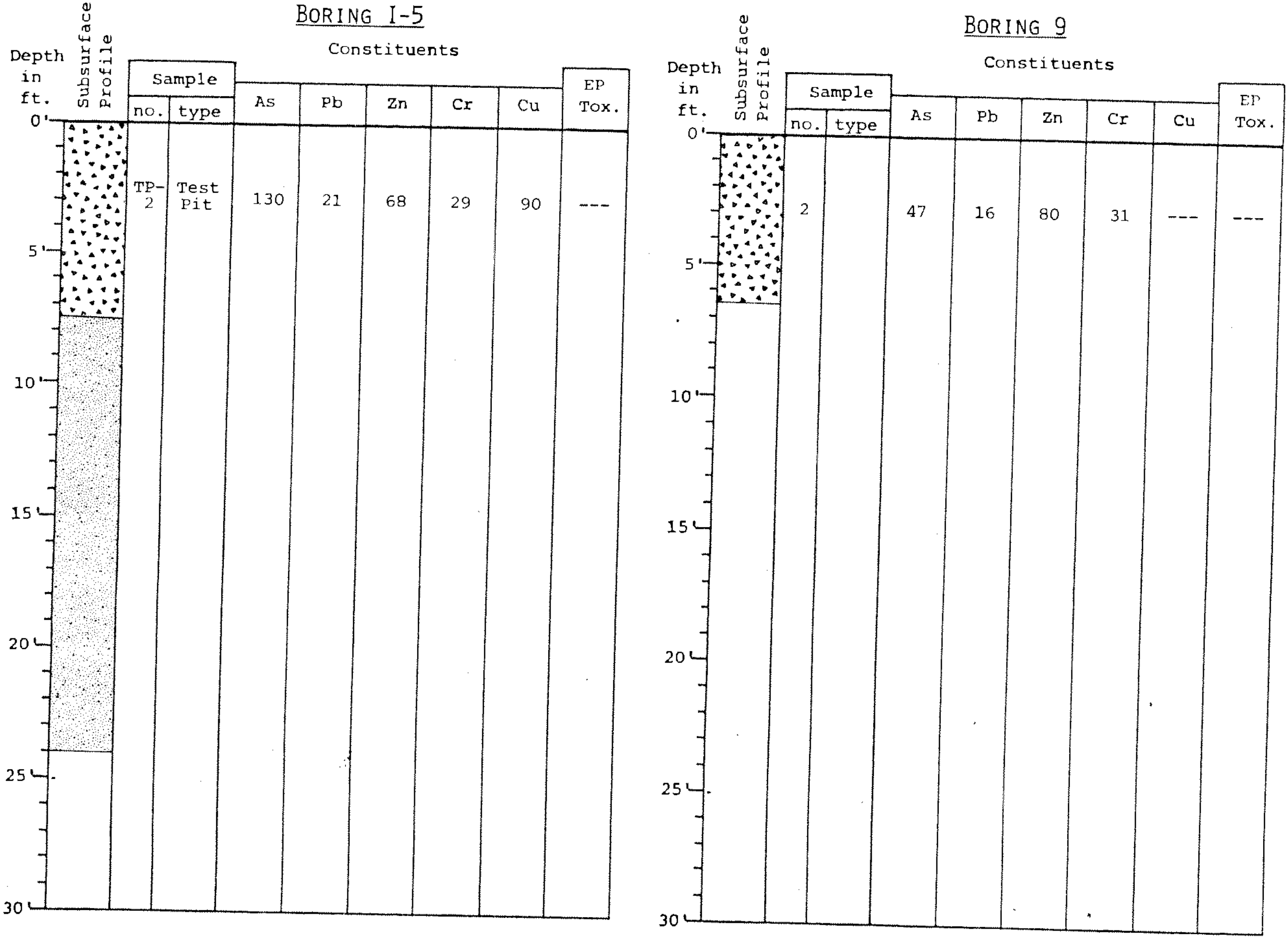
BORING 6



Constituents

Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
1		18	580	2320	466	---	---

Figure 6. Fill and Soil Chemical Analysis Profiles - Sheet 5

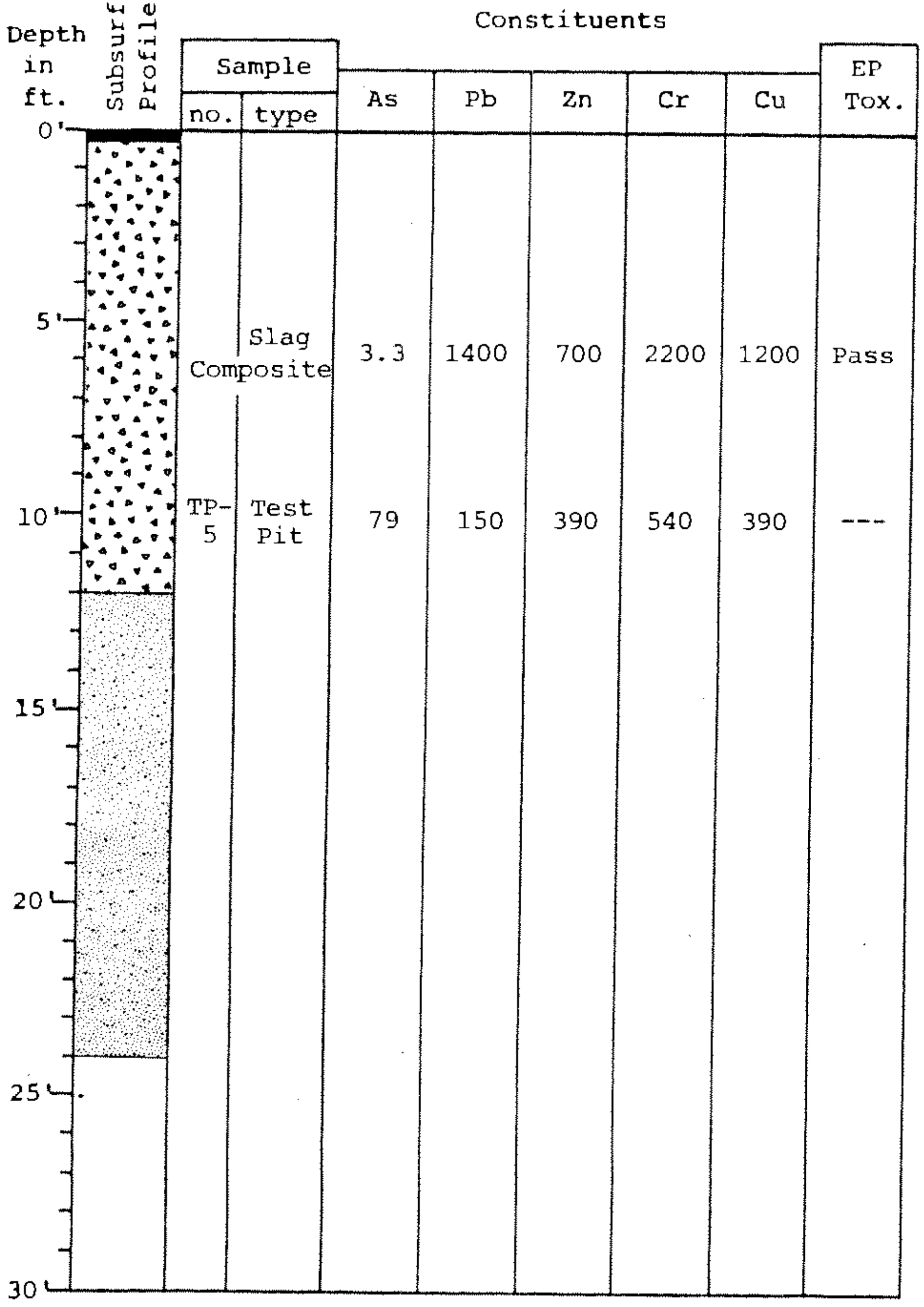


BORING I-5

BORING 9

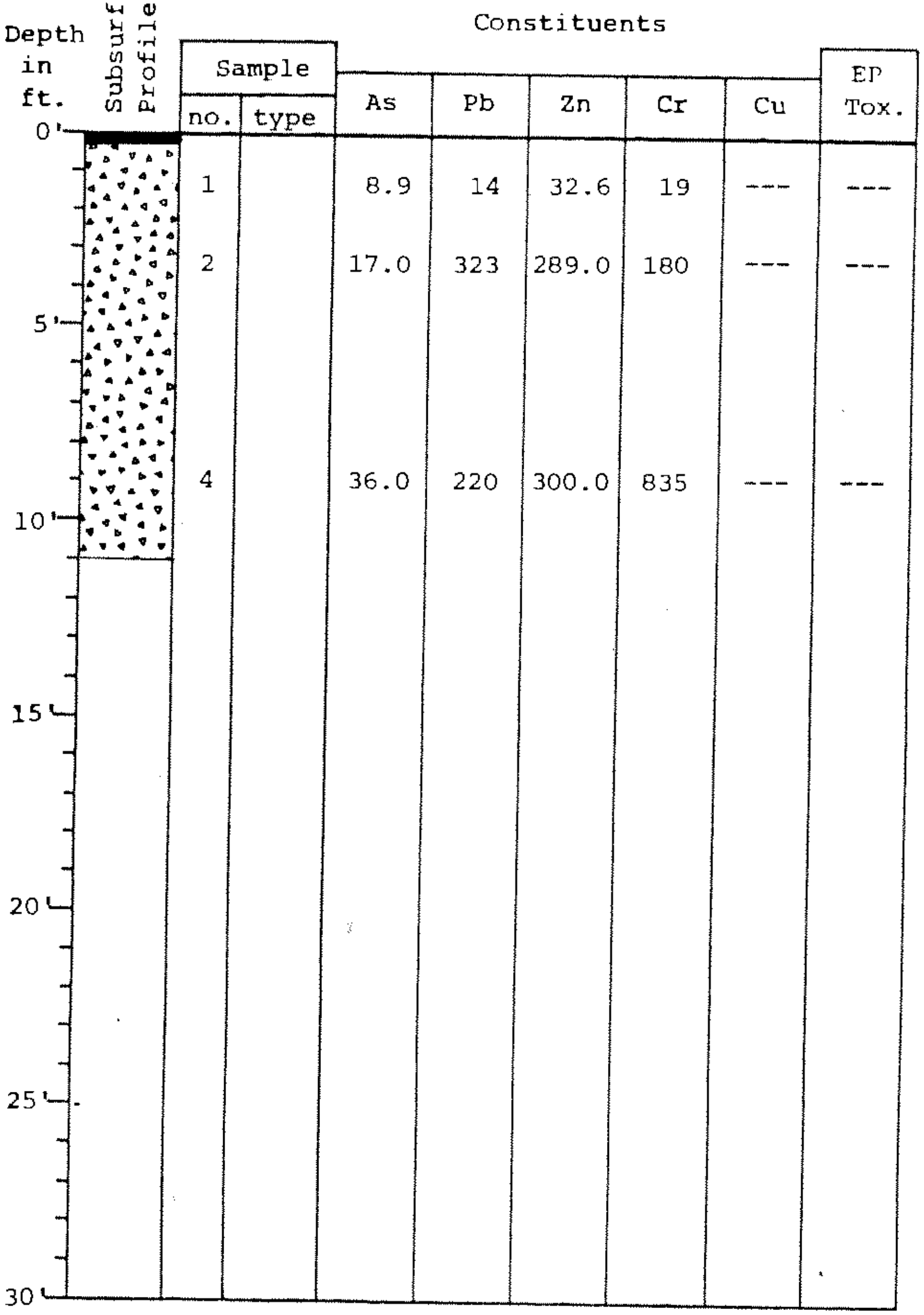
Figure 6. Fill and Soil Chemical Analysis Profiles - Sheet 6

BORING I-6



Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
	Slag Composite	3.3	1400	700	2200	1200	Pass
TP-5	Test Pit	79	150	390	540	390	---

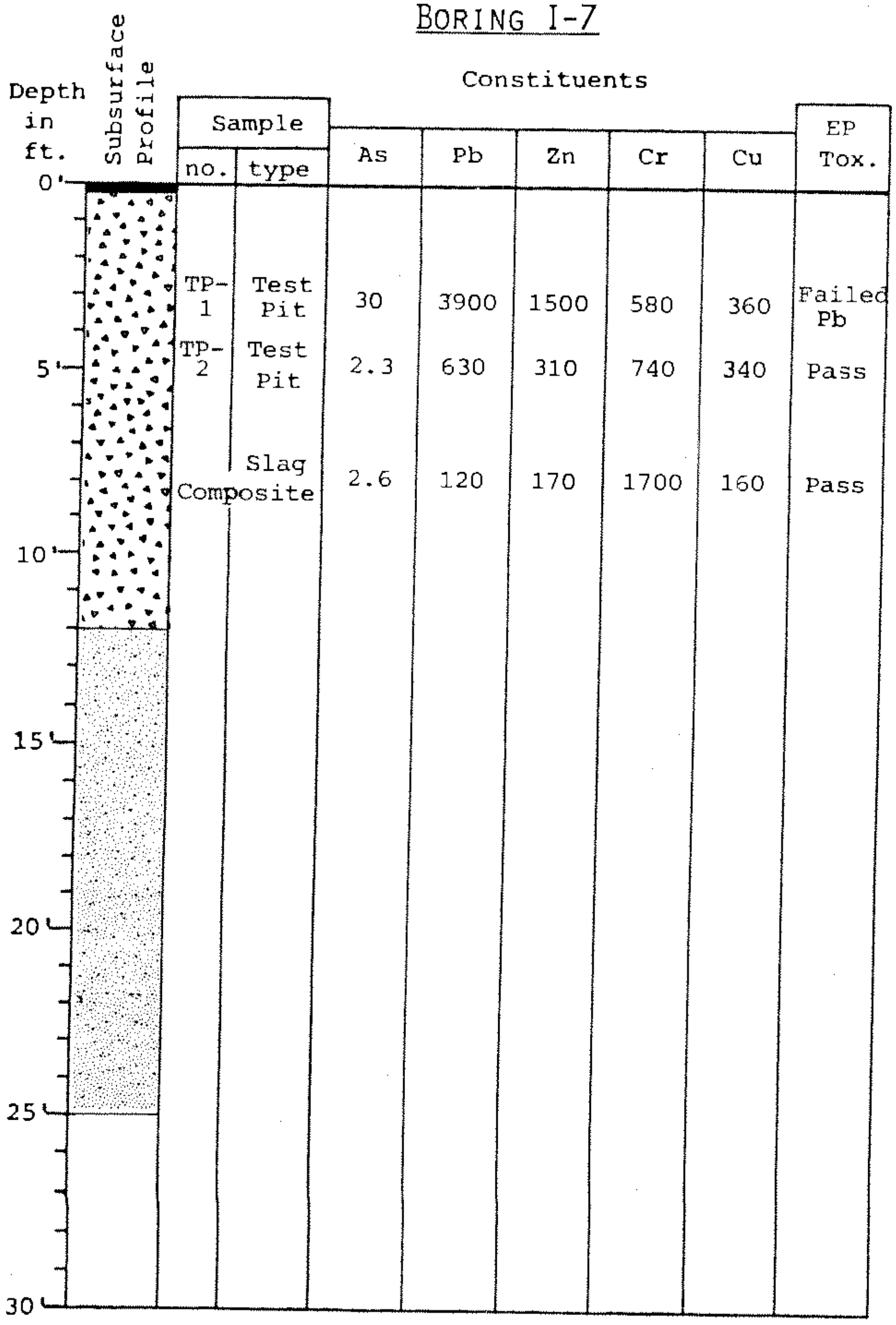
BORING 19



Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
1		8.9	14	32.6	19	---	---
2		17.0	323	289.0	180	---	---
4		36.0	220	300.0	835	---	---

Figure 6. Fill and Soil Chemical Anaysis Profiles - Sheet 7

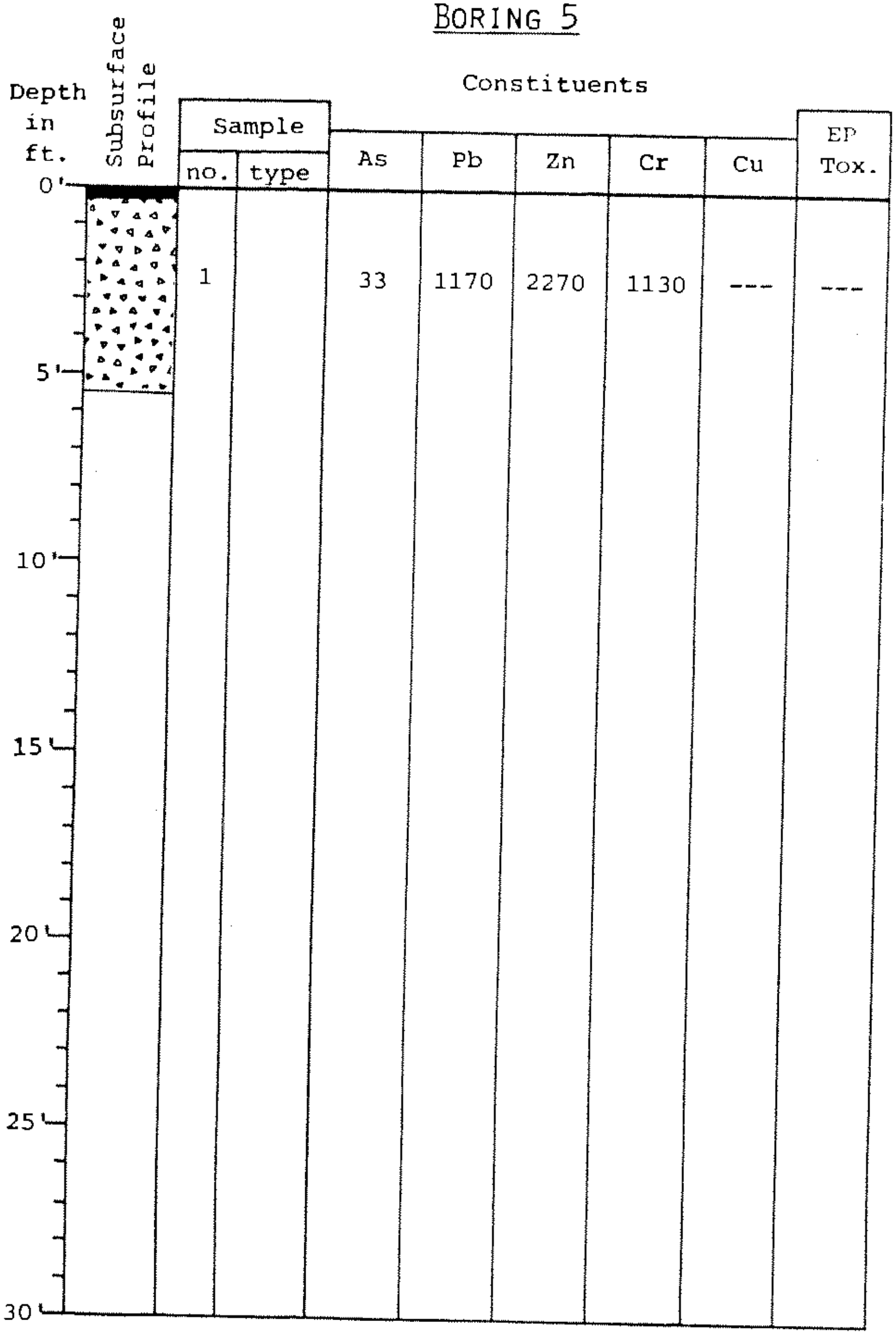
BORING I-7



Constituents

Depth in ft.	Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
	TP-1	Test Pit	30	3900	1500	580	360	Failed Pb
	TP-2	Test Pit	2.3	630	310	740	340	Pass
	Composite	Slag	2.6	120	170	1700	160	Pass

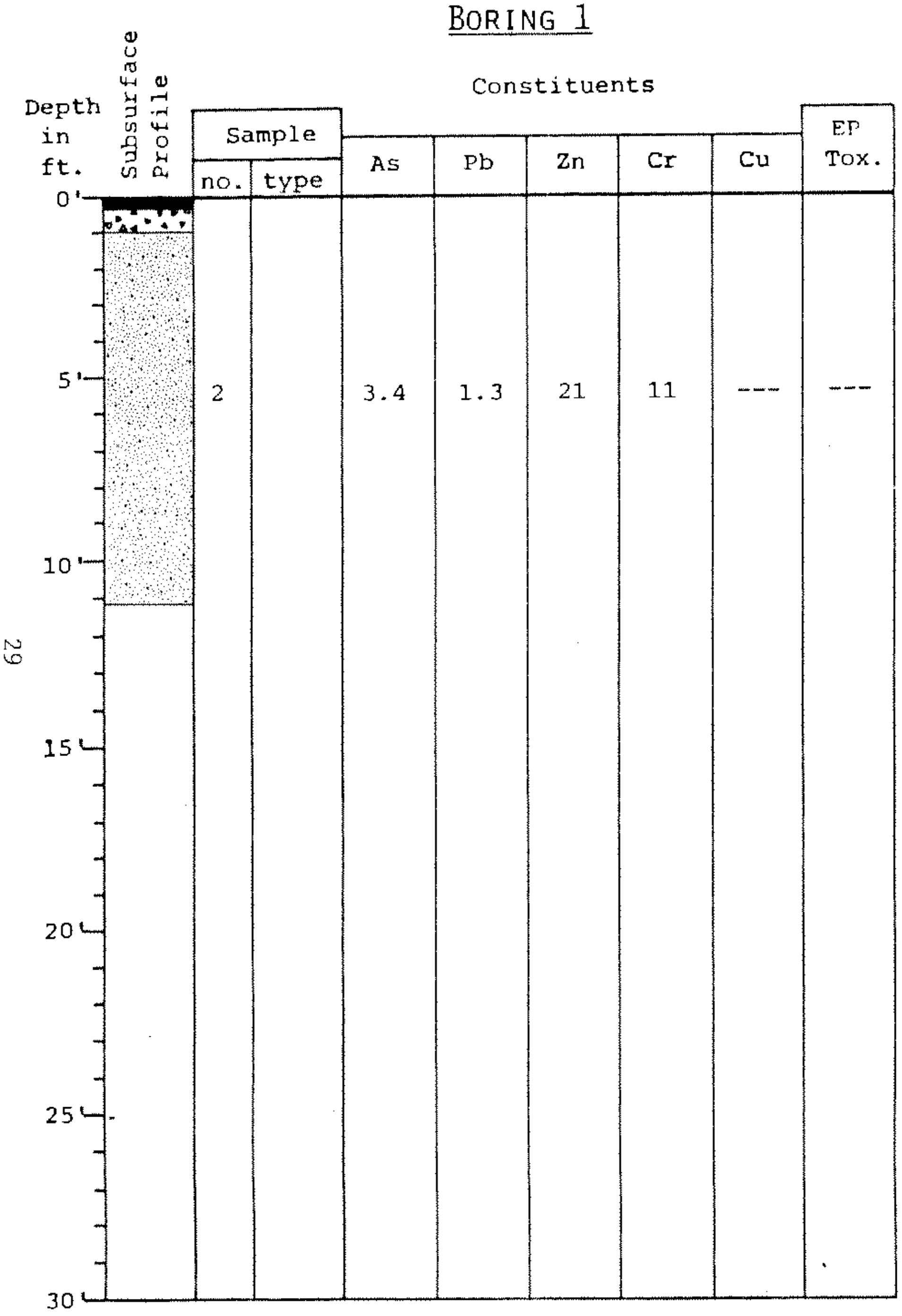
BORING 5



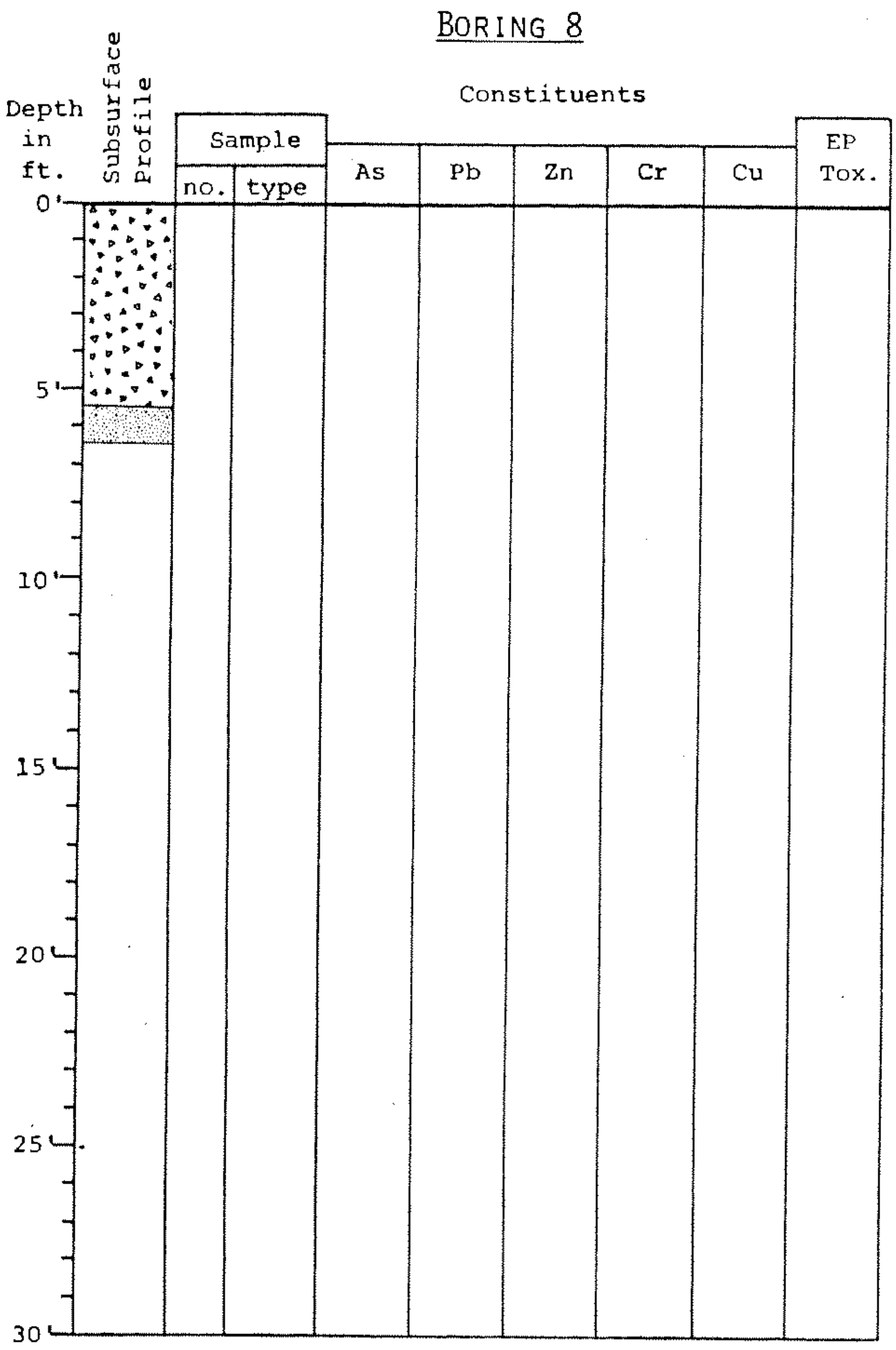
Constituents

Depth in ft.	Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
	1		33	1170	2270	1130	---	---

Figure 6. Fill and Soil Chemical Analysis Profiles - Sheet 8



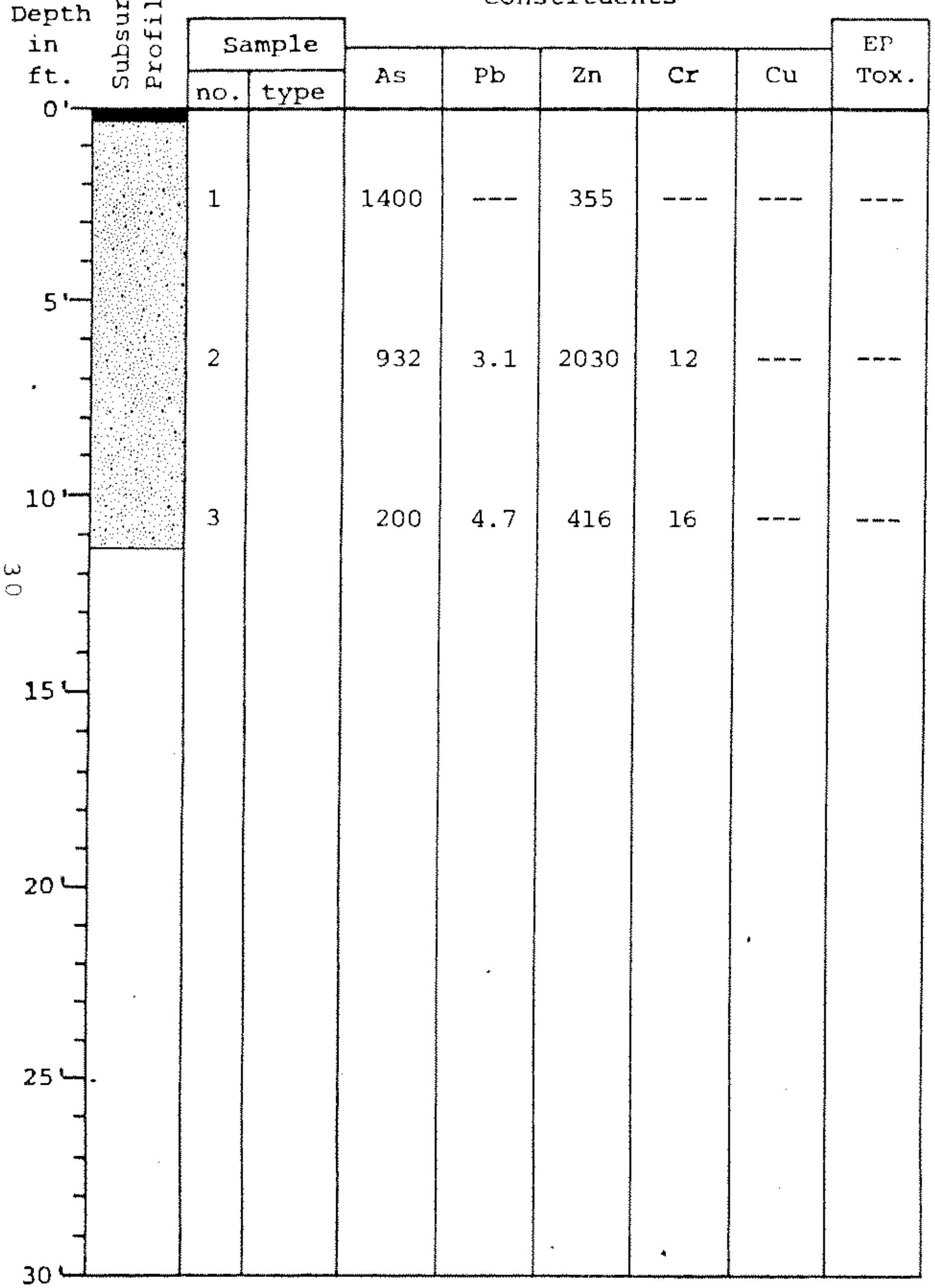
BORING 1



BORING 8

Figure 6. Fill and Soil Chemical Analysis Profiles - Sheet 9

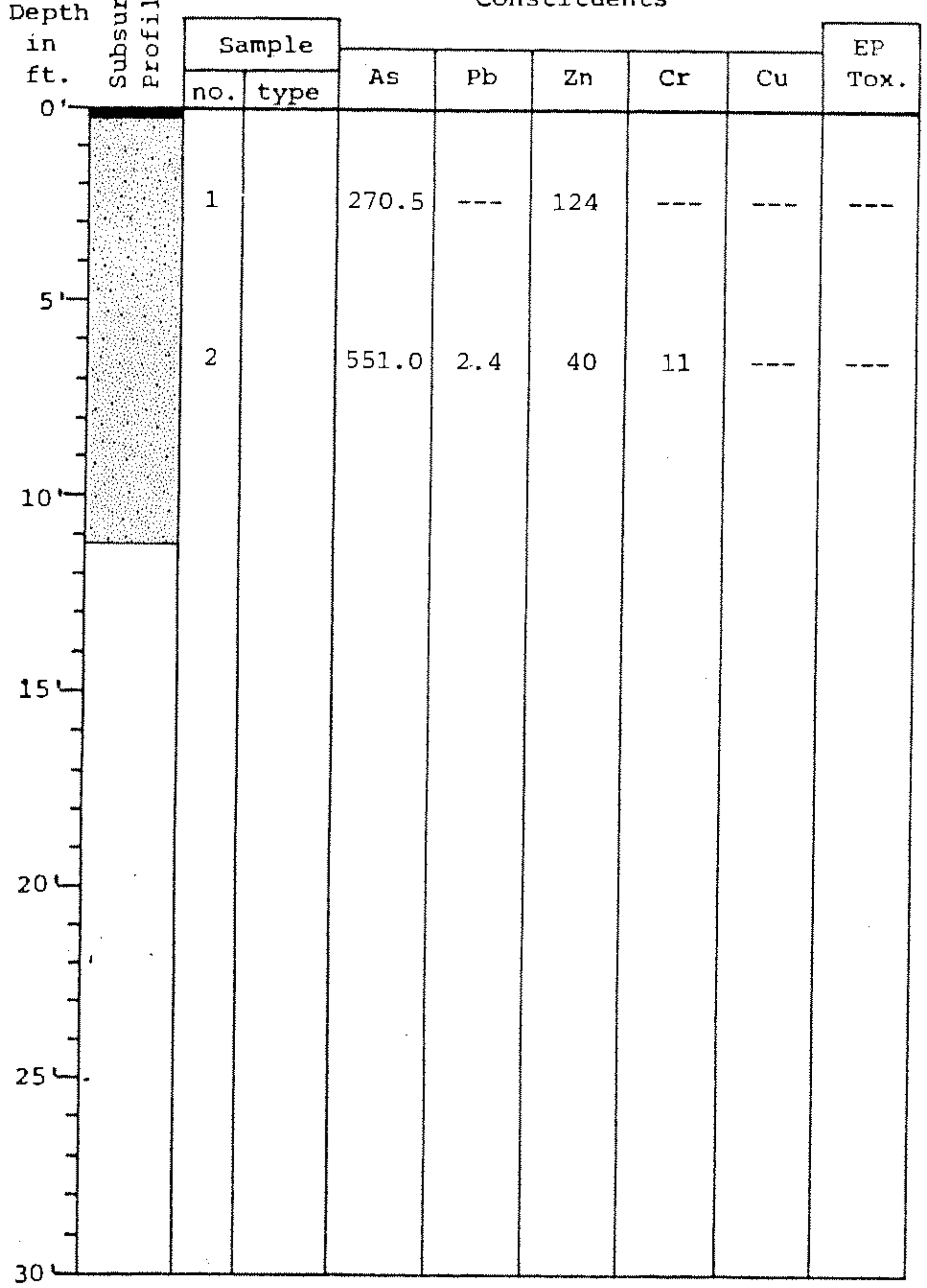
BORING 3



Constituents

Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
1		1400	---	355	---	---	---
2		932	3.1	2030	12	---	---
3		200	4.7	416	16	---	---

BORING 4

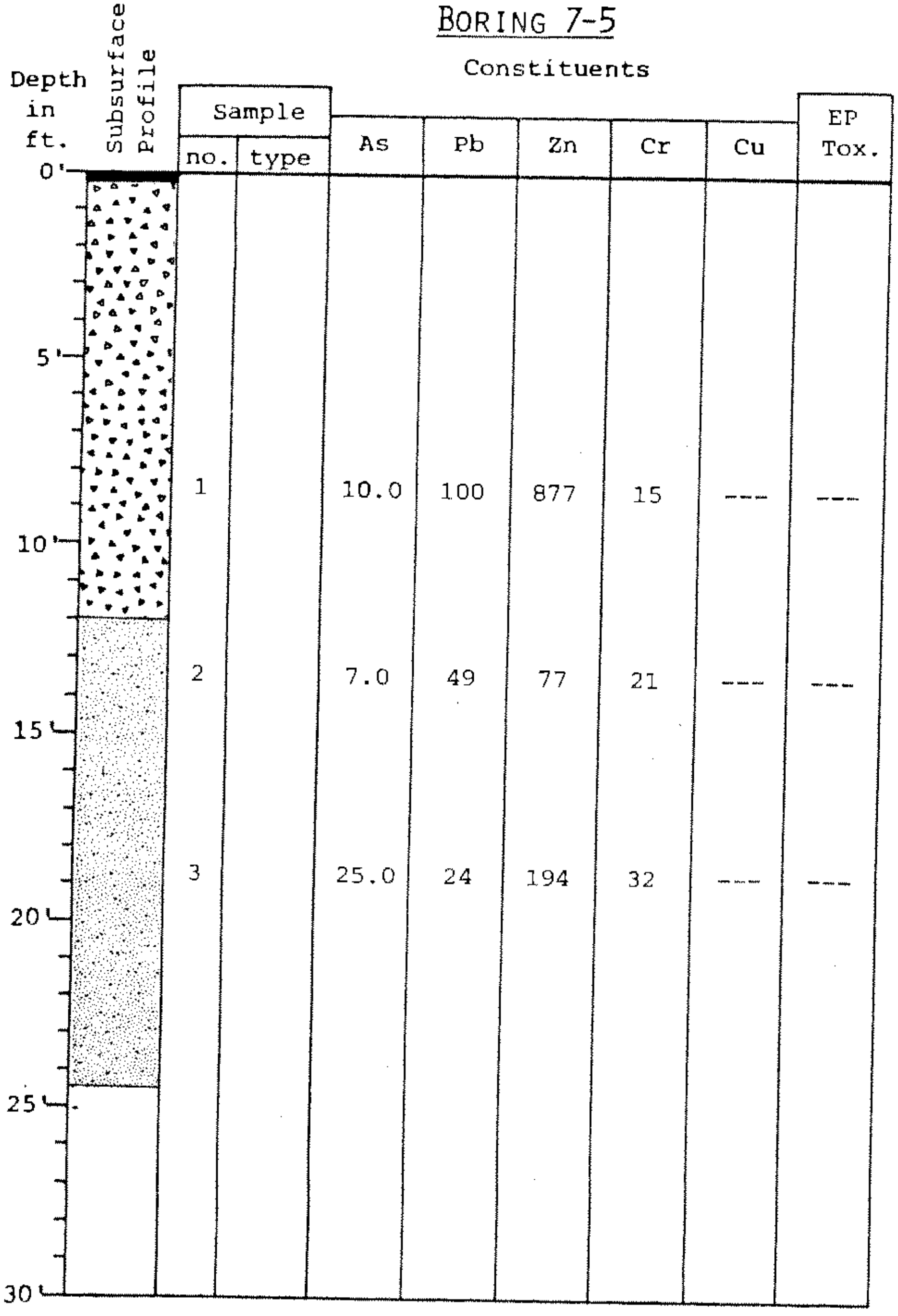


Constituents

Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
1		270.5	---	124	---	---	---
2		551.0	2.4	40	11	---	---

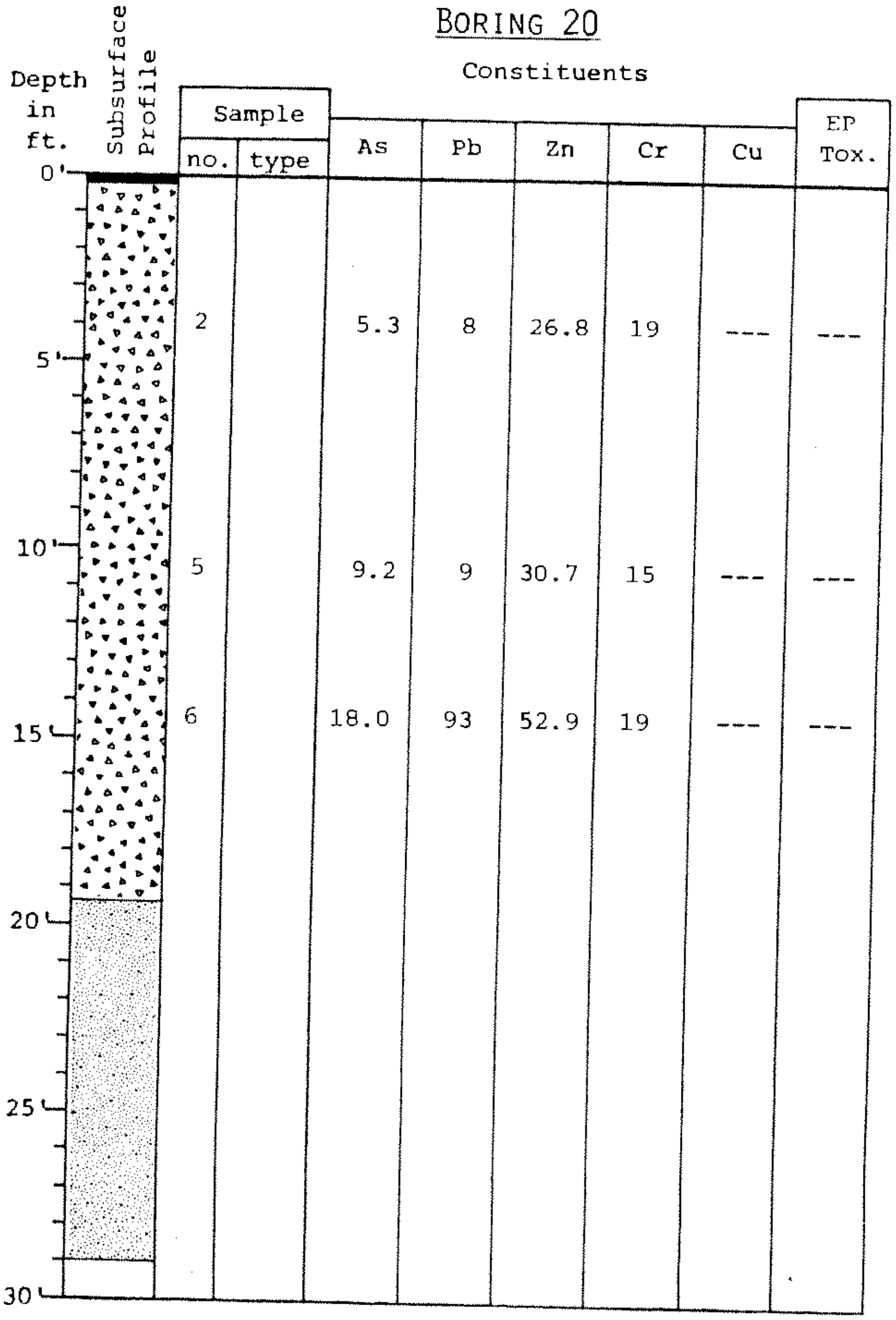
Figure 6. Fill and Soil Chemical Analysis Profiles - Sheet 10

BORING 7-5



Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
1		10.0	100	877	15	---	---
2		7.0	49	77	21	---	---
3		25.0	24	194	32	---	---

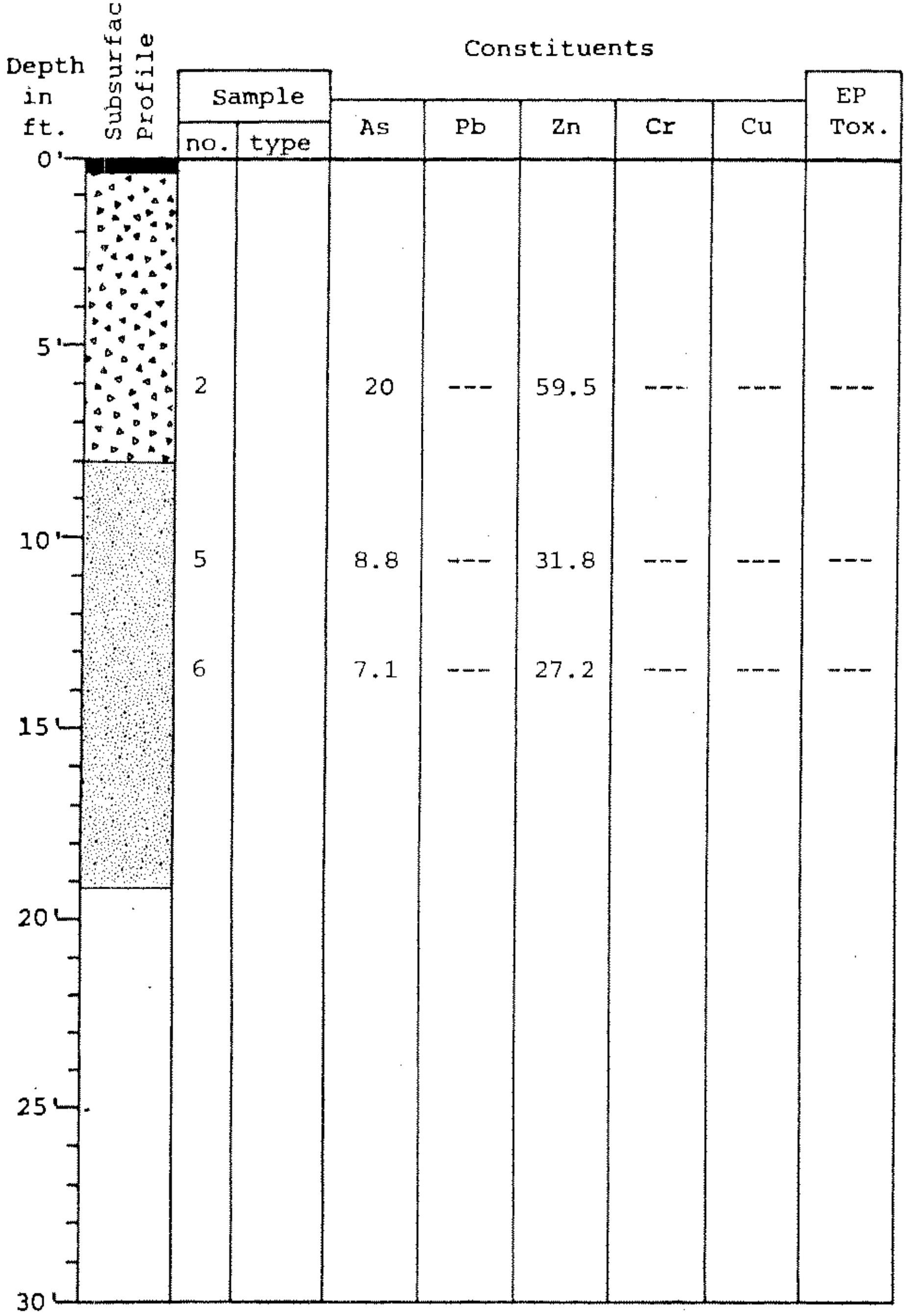
BORING 20



Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
2		5.3	8	26.8	19	---	---
5		9.2	9	30.7	15	---	---
6		18.0	93	52.9	19	---	---

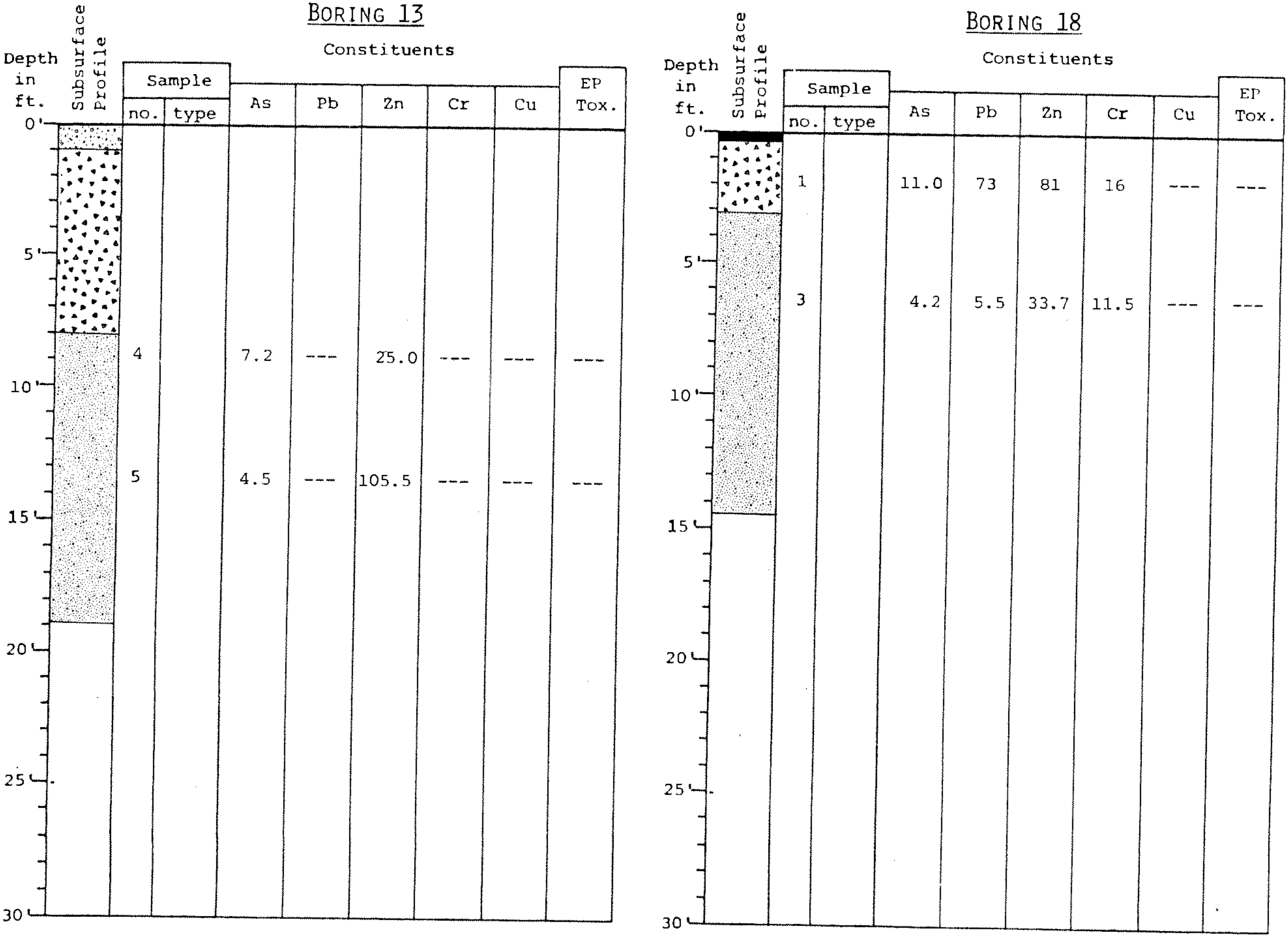
Figure 6. Fill and Soil Chemical Analysis Profiles - Sheet 11

BORING 10



Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
2		20	---	59.5	---	---	---
5		8.8	---	31.8	---	---	---
6		7.1	---	27.2	---	---	---

Figure 6. Fill and Soil Chemical Analysis Profiles - Sheet 12



BORING 13

Constituents

Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
4		7.2	---	25.0	---	---	---
5		4.5	---	105.5	---	---	---

BORING 18

Constituents

Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
1		11.0	73	81	16	---	---
3		4.2	5.5	33.7	11.5	---	---

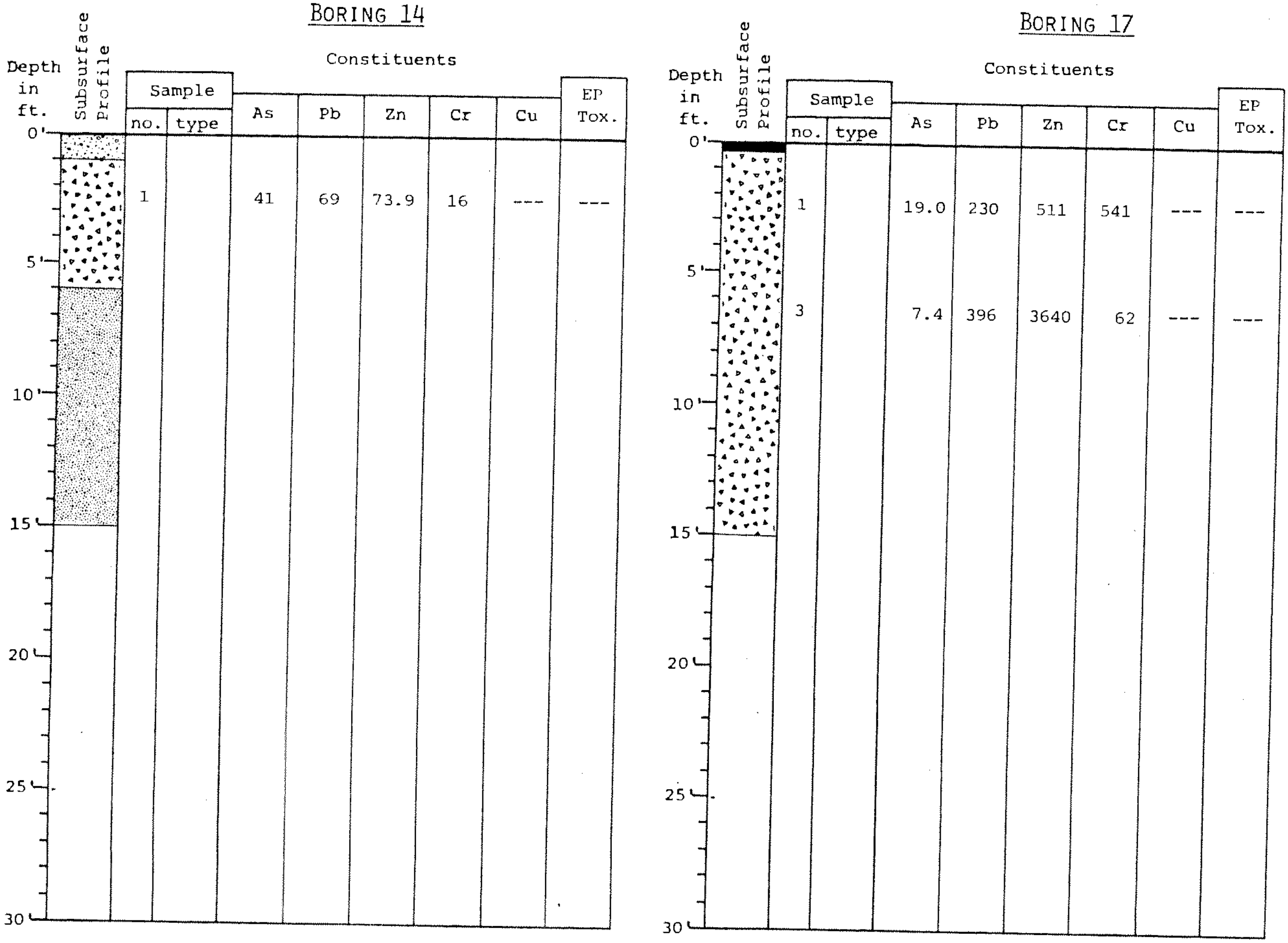
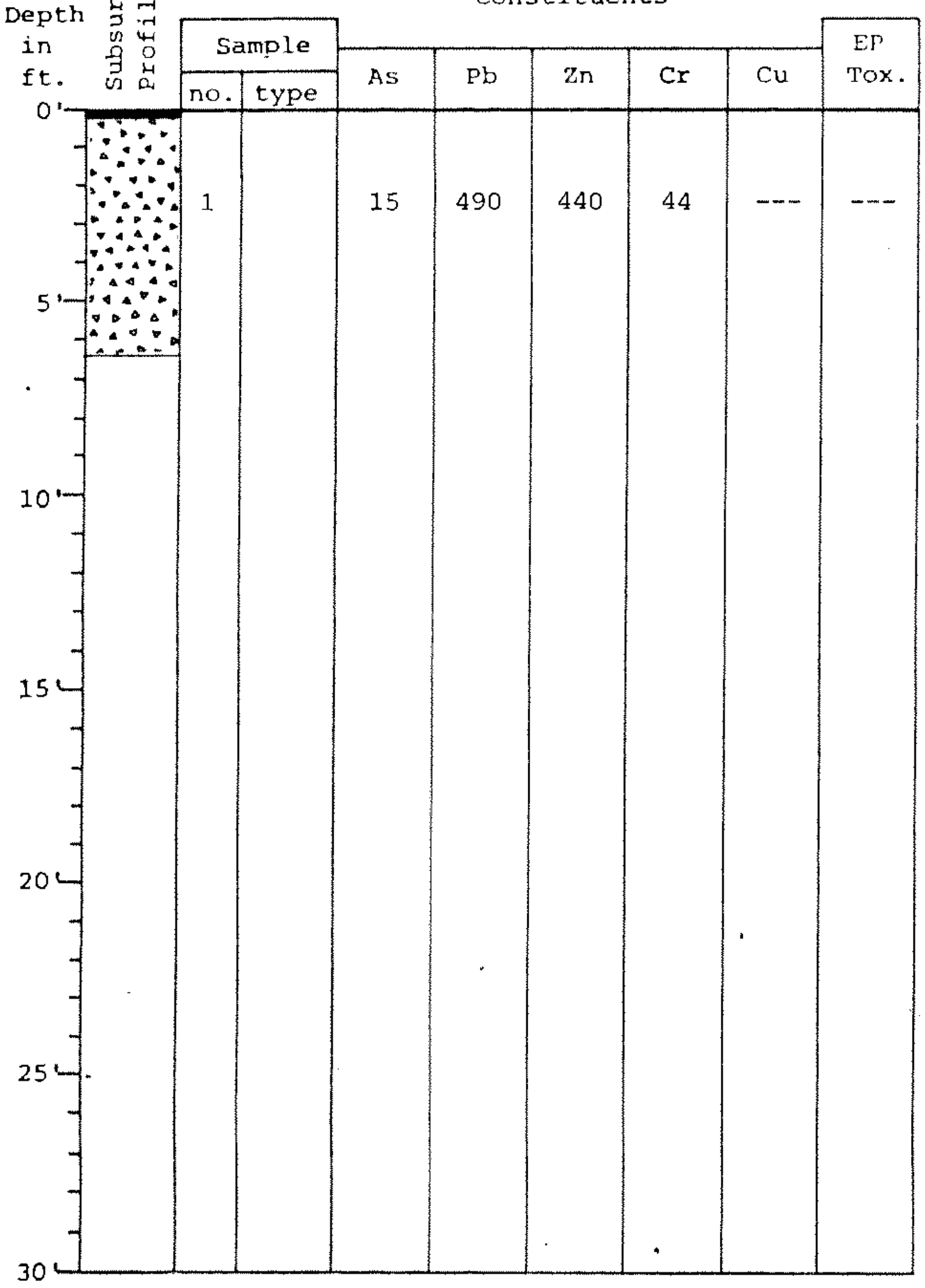


Figure 6. Fill and Soil Chemical Analysis Profiles - Sheet 13

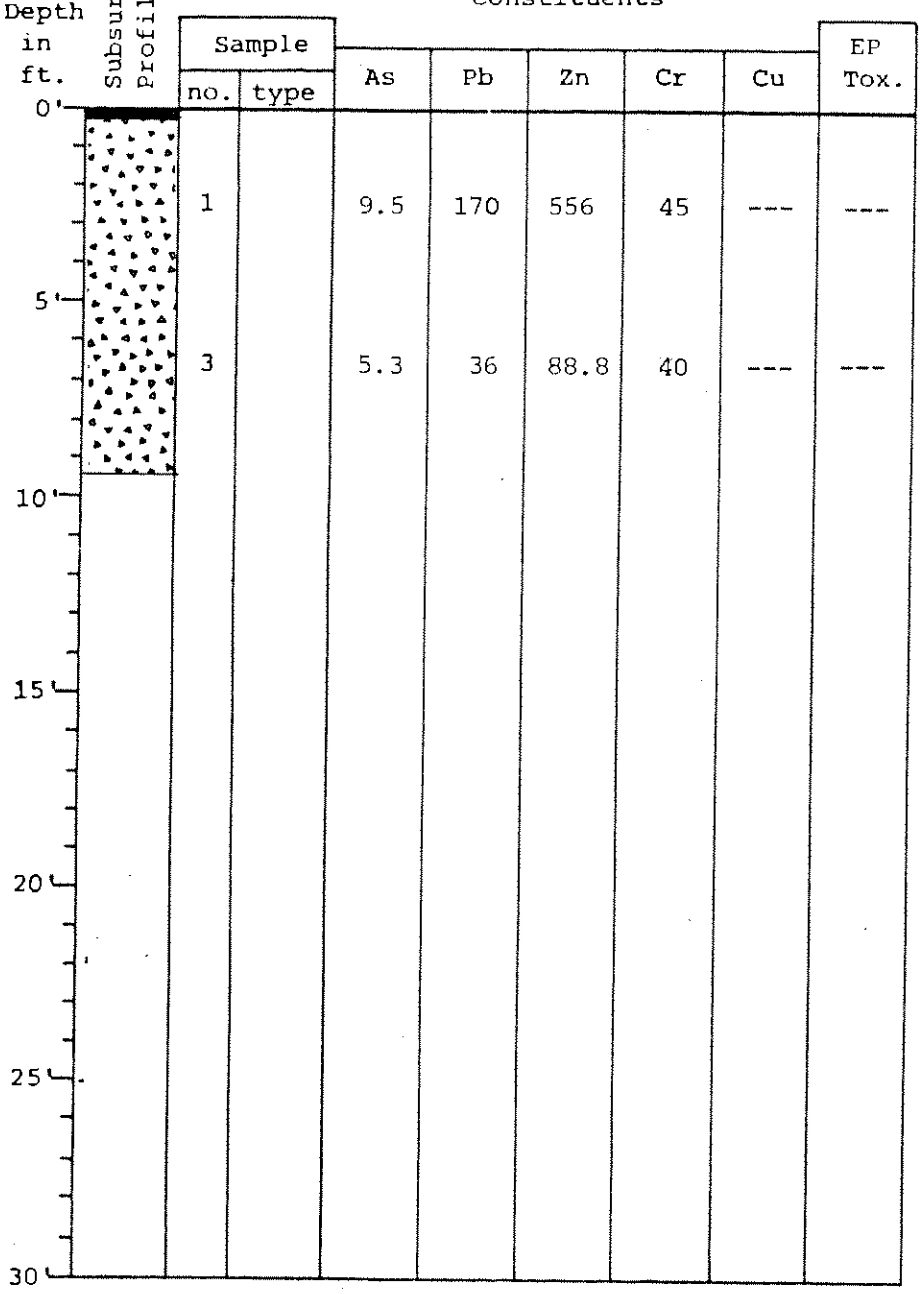
Figure 6. Fill and Soil Chemical Analysis Profiles - Sheet 14

BORING 15



Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
1		15	490	440	44	---	---

BORING 16



Sample no.	Sample type	As	Pb	Zn	Cr	Cu	EP Tox.
1		9.5	170	556	45	---	---
3		5.3	36	88.8	40	---	---

B. Random Fill Contaminants

Descriptions and subsurface profiles of the random fill are shown on Figures 4, 5, 6, and the boring logs in APPENDIX B. Table 1 and Figure 6 show metals concentrations in both slag and soil samples from the random fill.

As shown on the appended boring logs and Figures 5 and 6, the surface layer of random fill consists primarily of soil, demolition waste, fire bricks, and slag. In all discussion, the random fill is divided into fill soil and slag because these were lab tested separately as shown on Table 1. The firebrick and demolition waste components of the random fill were not specifically lab tested in this study.

The arsenic concentrations in the fill soil samples are generally less than 100 ppm. The lead, zinc, total chromium, and copper concentrations in the fill soil range from less than 100 to greater than 1,000 ppm in the following borings.

- Boring I-2, in Bay 11
- Borings I-4 and 6, in the northwest corner of site
- Borings I-6, I-7, 5, 7, 15, 16, 17, and 19 along southern edge of site

In contrast, the results from lab testing of fill soil from Borings I-5, 9, 10, 14, and 18 show concentrations of these four metals generally less than 100 ppm.

Fill slag samples from Borings I-4, I-6, and I-7 had arsenic concentrations from 18 to 120 ppm. Lab test results from these borings show chromium, copper, lead, and zinc concentrations from several hundred to greater than 2,000 ppm.

EP toxicity tests of fill soil samples from Borings I-1 and I-7 were conducted. Of the three soil samples tested, sample TP-1 in Boring I-7 failed the EP toxicity test because of high lead concentration, and the other two samples passed.

EP toxicity tests were run on four slag samples from Borings I-4, I-6, and I-7. All four slag samples passed the EP toxicity test.

C. Soil Contaminants

Most of the samples lab tested from soil underlying the random fill were obtained from borings drilled in the area of the steam clean sump, west of Bay 14. These samples generally show arsenic concentrations from less than 100 to greater than 3,000 ppm, generally higher than the arsenic concentrations in the overlying random fill. Concentrations of zinc and copper ranging from 100 to 500 ppm were also detected in soils from this area. Heavy metal concentrations in soil samples from Borings I-3, 1, 7, 10, and 13 were generally less than 100 ppm.

EP toxicity tests were conducted on five soil samples from Borings I-1 and I-2. Two of the samples tested from Boring I-1 failed EP toxicity because of high arsenic, and the third Boring I-1 sample passed. The two soil samples from Boring I-2 passed the EP toxicity test.

D. Spectrographic Analyses

Results from spectrographic analyses of nine soil samples and one slag composite sample are reported in APPENDIX C (October 28, 1983 laboratory report, Laboratory No. 82511-a). Although some anomalies (i.e., the highest value being 5-10 times greater than the lowest value) appeared in these results for silicon, aluminum, iron, sodium, titanium, manganese, molybdenum, zirconium, cobalt, strontium, potassium, and tin, these are not elements of concern from a contamination standpoint. No such anomalies were found for calcium, magnesium, gallium, and vanadium, which are also not elements of concern regarding contamination. Spectrographic results were consistently low for barium, boron, and silver, thus essentially eliminating them as contaminants of concern in the samples analyzed. For copper, arsenic, lead, chromium, and nickel, there was reasonable agreement of these semiquantitive spectrographic results with the total metals analyses reported in Table 1. In several cases, the results from the two types of analytic procedures did not correspond well, but this was not unexpected, and does not raise any significant question on the analytic results.

Of the samples tested by a semiquantitative spectrographic analysis, no concentrations of metallic elements of concern from a contamination standpoint were detected, other than the six contaminants discussed above.

E. Arsenic Speciation

Arsenic speciation tests were performed to attempt to determine the specific arsenic compounds present in the soils and fill, which could indicate the origin or source of arsenic. However, the results of these tests were inconclusive.

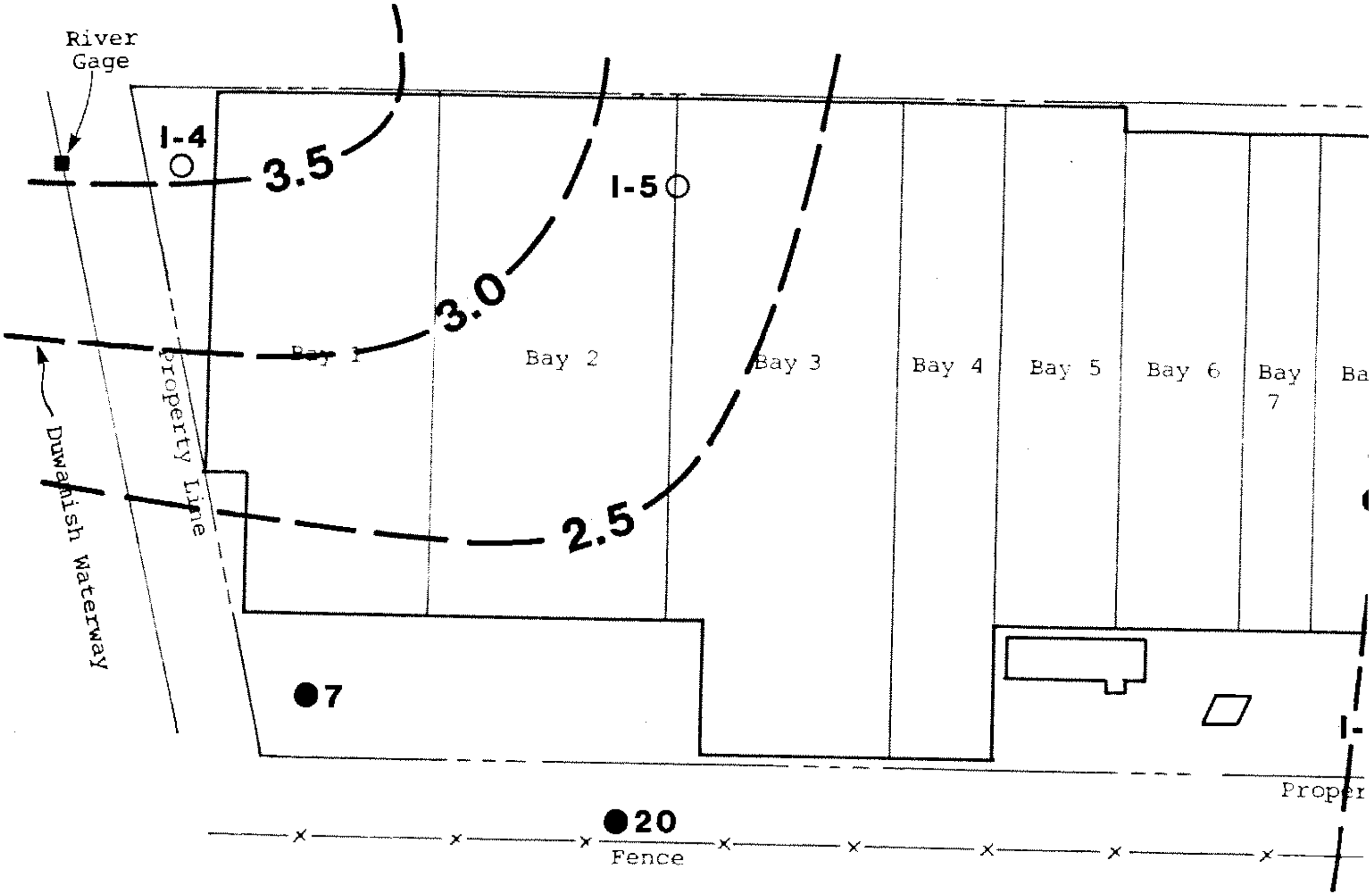
Hydrology

This evaluation has shown that shallow ground water at the site occurs generally under water table (non-artesian) or unconfined conditions. The depth to the water table as measured during this study is generally less than 15 feet below ground surface. The water table elevations and river elevations measured during this study are shown on Table 3 in APPENDIX B.

Early in this project it was determined that tidal fluctuations in the Duwamish River cause moderately large water table fluctuations in the near shore alluvial sediments and fill. Water table elevation contours measured at high and low tide are shown on Figures 7 and 8, respectively. These water table contour maps indicate that ground water flow at the site is generally from east to west.

Hydrology measurements made during this study indicate that ground water gradients and an east-to-west flow direction is relatively constant in the eastern portion of the site. In the western portion of the site, however, the ground water flow directions in the shallow aquifer near the Duwamish River appear to fluctuate with the tide. The low tide water table map shown on Figure 8 shows a ground water flow direction toward the northwest, i.e., toward the river, and in a downriver direction, along the western portion of the site. The high tide water table map shown on Figure 7 indicates a general reversal of ground water flow toward the south-southeast, i.e., away from the river, on the western portion of the site.

Figures 7 and 8 show that the water table surface in the eastern portion of the site is fairly constant, and slopes from east to west at a rate of approximately 0.0009 feet per foot. This relatively flat gradient is typical of large alluvial valleys similar to the Duwamish.



EXPLANATION

7●	Monitoring well: Previous study
I-1○	Monitoring well: Present study
—2.5—	Water table elevation contour (feet, msl) (dashed where approximate)

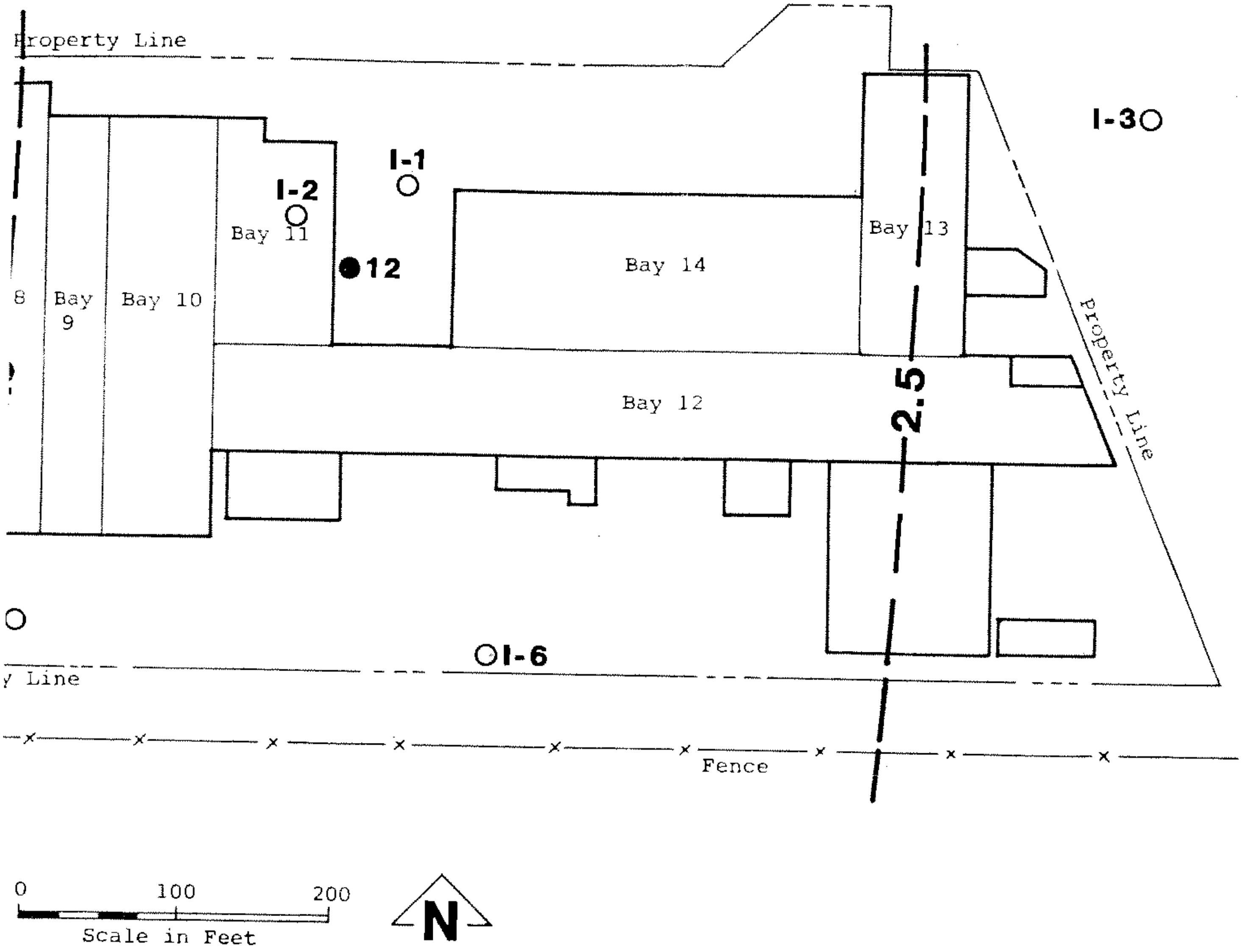
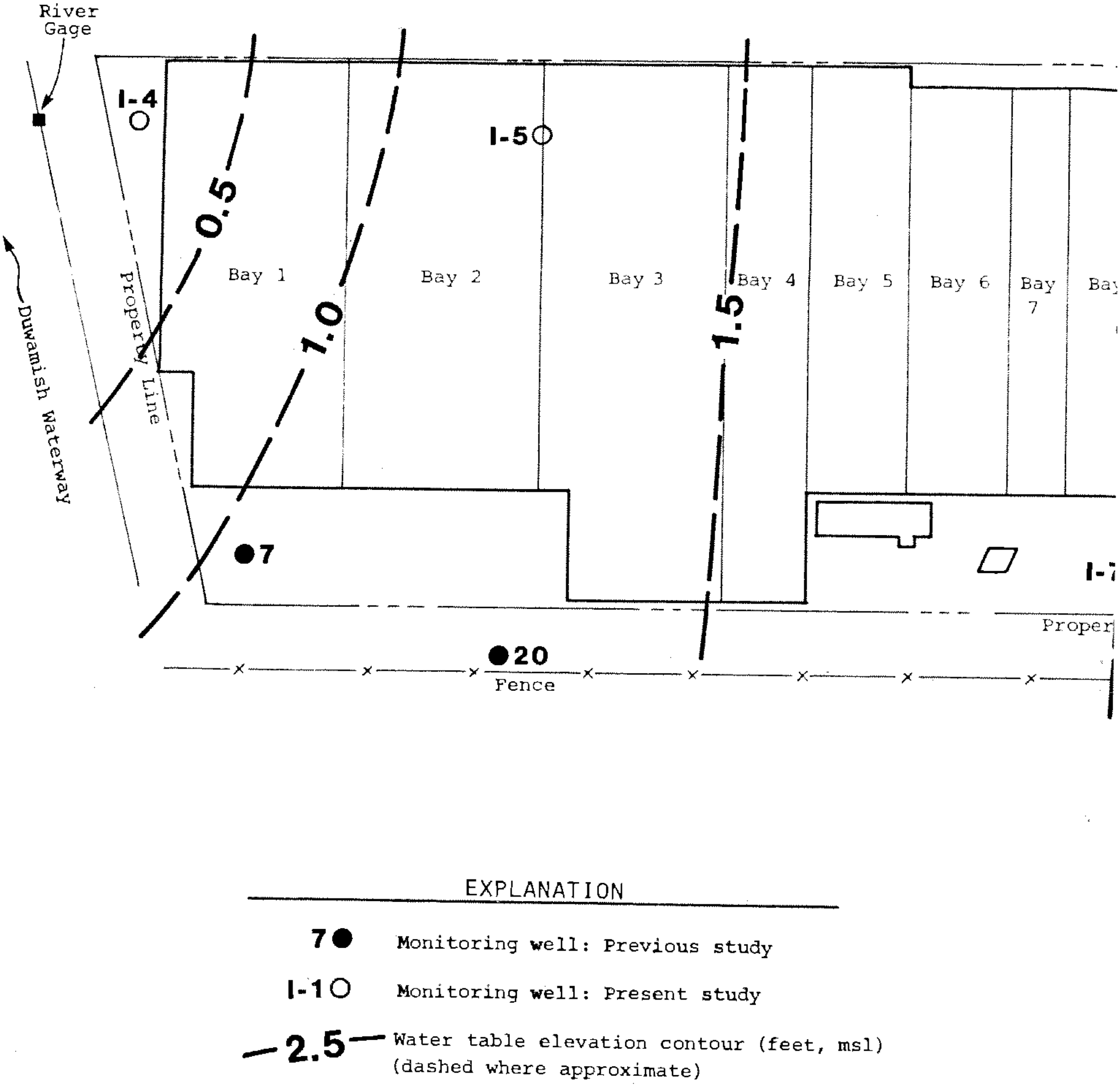


Figure 7

Isaacson Corporation

WATER TABLE MAP (High Tide)

Patrick H. Wicks
CONSULTANT IN HAZARDOUS WASTE MANAGEMENT
In association with:
Sweet, Edwards & Associates, Inc. • P.O. Box 328 • Kelso, WA 98626


River Gage
Duwamish Waterway
Property Line
I-4
I-5
I-7
7
20
0.5
1.0
1.5
Bay 1
Bay 2
Bay 3
Bay 4
Bay 5
Bay 6
Bay 7
Fence
EXPLANATION
7● Monitoring well: Previous study
I-1○ Monitoring well: Present study
—2.5— Water table elevation contour (feet, msl) (dashed where approximate)

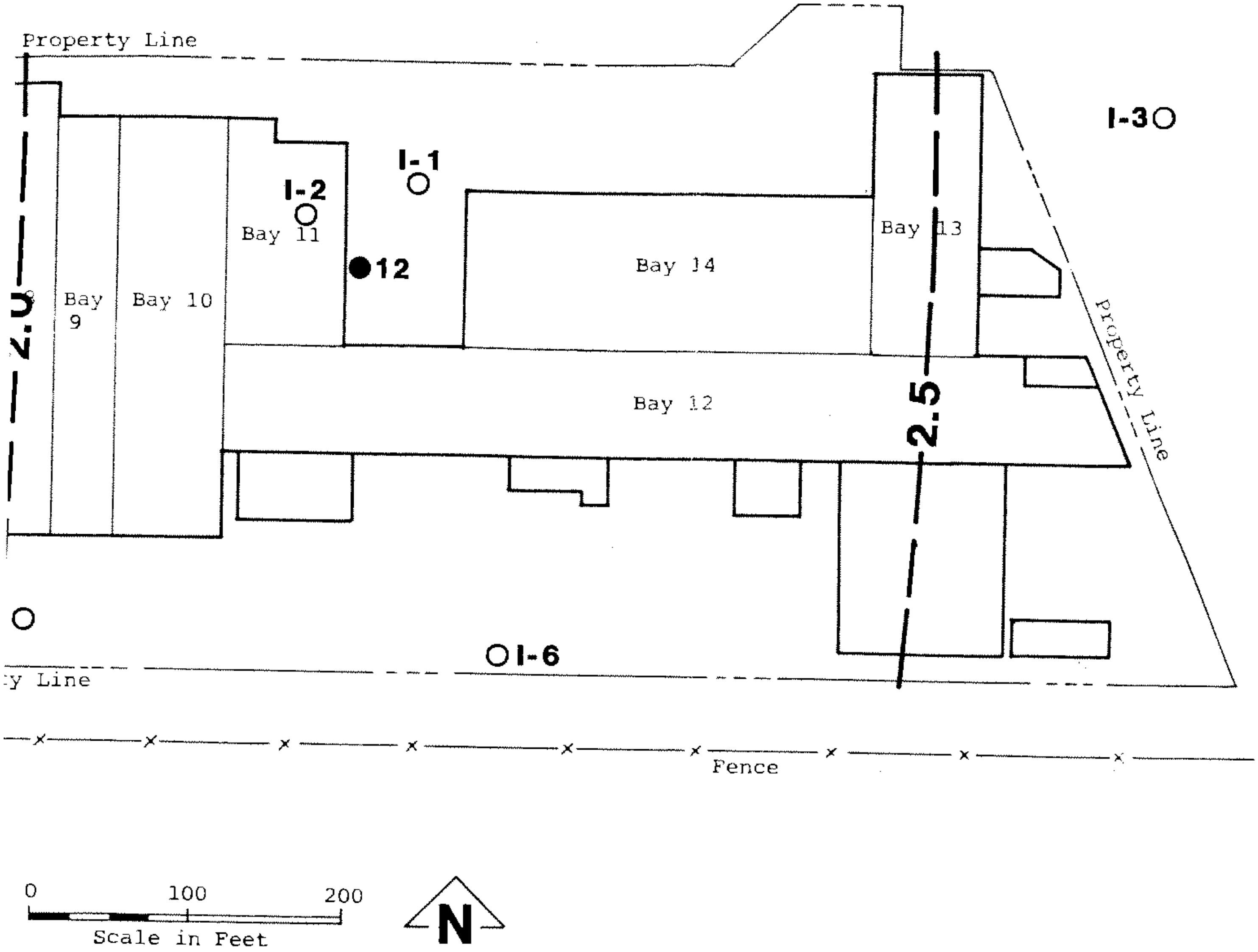


Figure 8

Isaacson Corporation

WATER TABLE MAP
(Low Tide)

Patrick H. Wicks
CONSULTANT IN HAZARDOUS WASTE MANAGEMENT
In association with:
Sweet, Edwards & Associates, Inc. • P.O. Box 328 • Kelso, WA 98626

The water table gradients on the western portion of the site are strongly influenced by tidal fluctuations in the Duwamish River, and ranged from approximately .001 to .004 feet per foot, more than four times higher than those found on the eastern portion of the site. Note this gradient reverses with the tidal extremes.

Thus, the field hydrology data gathered during this study indicates that the ground water flow direction is reversed from toward the northwest at low tide to toward the southeast at high tide on the western portion of the site. This ground water flow reversal apparently occurs only in those areas immediately adjacent to the Duwamish River. The lateral extent of flow reversal depends upon the magnitude of river stage and tidal fluctuations. With the existing data, it is not possible to determine what the predominant ground water flow direction near the river is, that is, what direction does ground water flow during most of the year. To obtain this information, a long-term, i.e., one water year, monitoring effort would be required in order to take into account seasonal precipitation, recharge, river stage, and annual/diurnal tidal extremes.

Because the Isaacson site is predominantly covered with impervious surfaces, e.g., asphalt and/or roofs, there is probably very little direct recharge to ground water from the site. Within the limited time frame of this study it was not possible to locate and/or quantify existing ground water recharge sources at the Isaacson site. Potential ground water recharge sources at the site include the steam cleaning sump, leaking subsurface utilities (such as storm drains), some roof drains, and areas where the surface asphalt is cracked, thin, or absent.

Water Quality

A. Ground Water

1. Introduction

As discussed under Task 6 of the Geotechnical Field Work section, the ten site monitoring wells were sampled a first time October 24 and 25, 1983. A second sampling was performed December 9 and 10, 1983. The sampling procedures and equipment used are described in detail in APPENDIX B.

The lab results from testing of the ground water samples are shown in the Summary of Water Quality Data, Table 2, and in the appended laboratory test reports. The elements tested in the ground water samples were arsenic (As), total chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), and zinc (Zn). This list is based upon review of the soil/fill and limited ground water quality data in the previous report. As explained in the PROJECT SCOPE, trace organics were not tested in the ground water samples because there were no significant levels of trace organics in the soil/fill or ground water samples collected during the previous study. Split samples from monitoring wells I-1, I-2, I-4, I-7 and 20 were sent to a separate laboratory.

Table 2 lists the laboratory detection limits for all of the tested elements. The table also shows the data from the previous testing of ground water from monitoring wells 7, 12, and 20. The EPA Primary and Secondary Drinking Water Standards for each of the tested elements are also shown.

TABLE 2. SUMMARY OF WATER QUALITY DA

DATA SOURCE	LOCATION	Arsenic As 10/83	Arsenic As 12/83	Tota Chrom Cr 10/83
(1)	Background	<0.005		<0.(
This evaluation (October through December 1983)	I-3 (background)	ND	0.010	ND
	SITE WELLS			
This evaluation (October through December 1983)	[I-1	0.27	0.31	ND
	[I-1 (S)	0.235	--	0.0043
	[I-2	9.2	4.4	0.01
	[I-2 (S)	--	3.0	--
	[12	0.36	0.34	ND
	[I-6	0.014	0.034	ND
	[I-7	0.096	0.11	ND
	[I-7 (S)	--	0.0085	--
This evaluation (October through December 1983)	[I-5	0.36	0.59	ND
	[I-4	0.041	0.042	ND
	[I-4 (S)	0.049	--	0.0041
	[20	0.056	0.14	ND
	[20 (S)	0.081	--	0.0416
	[7	0.053	0.020	ND
Previous Evaluation (August to October 1983)	[12	0.26		0.0
	[20	0.30(5)		0.1
	[20 (S)	0.31(5)		0.0
	[7	0.028		0.0
STANDARDS(2)				
Primary Drinking Water Standard		0.05		0.0
Secondary Drinking Water Standard		--		--
	DUWAMISH RIVER			
This evaluation (October 1983)	[Allentown - 10/14	ND	--	0.005
	[Bridge - 10/25	ND	--	ND
	[16th Ave. S. - 10/14	ND	--	0.016
	[Bridge - 10/25	ND	--	0.11
(3)	[Allentown - Mean	0.0035		0.0
	[- Max	0.009		0.0
	[16th Ave. S. - Mean	0.004		0.0
	[- Max	0.012		0.0.

mg/1(4)

um	Copper Cu		Nickel Ni		Lead Pb		Zinc Zn	
12/83	10/83	12/83	10/83	12/83	10/83	12/83	10/83	12/83
)2	≤0.016		≤0.052		<0.005		≤0.032	
0.010	0.004	ND	ND	0.01	ND	--	0.05	0.010
ND	0.049	0.027	ND	0.01	ND	ND	0.27	0.52
--	0.062	--	0.005	--	0.003	--	0.333	--
ND	0.016	0.008	0.03	0.02	ND	ND	0.8	0.18
0.0109	--	0.008	--	0.044	--	0.004	--	0.505
ND	0.7	0.47	0.06	0.04	ND	ND	14.0	8.0
ND	ND	ND	ND	0.01	ND	ND	0.036	0.018
ND	0.026	ND	ND	ND	ND	ND	0.38	0.10
0.0081	--	0.004	--	ND	--	0.003	--	0.058
ND	0.004	ND	ND	ND	ND	ND	0.048	0.22
ND	ND	ND	ND	ND	ND	ND	0.041	0.018
--	0.003	--	0.003	--	0.004	--	0.048	--
0.030	0.06	0.013	ND	0.04	0.03	ND	ND	0.025
--	0.034	--	0.005	--	0.002	--	0.027	--
0.029	0.005	0.011	ND	0.04	0.002	ND	0.027	0.026
(5)	--		--		0.001		--	
1	--		--		0.017		--	
	--		--		0.038		--	
	--		0.01		0.095(5)		0.11	
	--		--		0.05		--	
	1.0		--		--		5.0	
--	--	--	--	--	ND	--	0.023	--
--	0.049	--	--	--	ND	--	0.007	--
--	--	--	--	--	ND	--	0.028	--
--	--	--	--	--	0.003	--	0.017	--
6	0.0126		0.02		0.034		0.0106	
	0.023		0.02		0.06		0.02	
	0.0125		0.058		0.052		0.0134	
	0.02		0.14		0.1		0.026	

FOOTNOTES

1. These data are from a ground water evaluation performed at a location approximately 2.2 miles north in 1982 and 1983. Accordingly, they do not represent background, but do give a measure of ground water in the vicinity that may be uncontaminated."
2. Primary drinking water standards are based on human health considerations, as adopted through 1983. Secondary drinking water standards are based on aesthetics not health considerations; accordingly, values at or somewhat above these standards are considered safe to humans in drinking water, but may be displeasing to the taste/odor.
3. Metro has collected water quality data on the Duwamish River for 10 years. The values shown in this table are for the October data over the 10-year period of record, except for Arsenic. Arsenic analyses have not been performed by Metro. Accordingly, the values shown for Arsenic are from limited data available from other sources and as collected as part of this evaluation. The Arsenic data reported here for the 16th Avenue South Bridge are actually for 2-6 km from the river mouth, and the Arsenic data reported here for the Allentown Bridge are for 7-10 km from the river mouth.
4. Detection limits used for water analysis reported in this table which were performed during this evaluation are as follows:

	mg/l		
	Non-Split Samples		Split Samples(S)
	10/83	12/83	
Arsenic	0.005	0.005	0.001
Barium	0.02	---	---
Cadmium	0.001	---	---
Chromium	0.005	0.008	0.0005
Copper	0.004	0.004	0.001
Nickel	0.01*	0.01	0.001
Lead	0.001	0.005	0.001
Zinc	0.03	0.005	0.01

*Except for B-20 and field blank, where detection limit was 0.03 mg/l.

-- Denotes analysis not performed.

5. These heavy metal concentrations are not considered to be representative of in-situ ground water quality because the samples were reportedly not field filtered prior to being placed in the acide fixed sample bottle. See report RESULTS, Ground Water Quality section for detailed discussion.

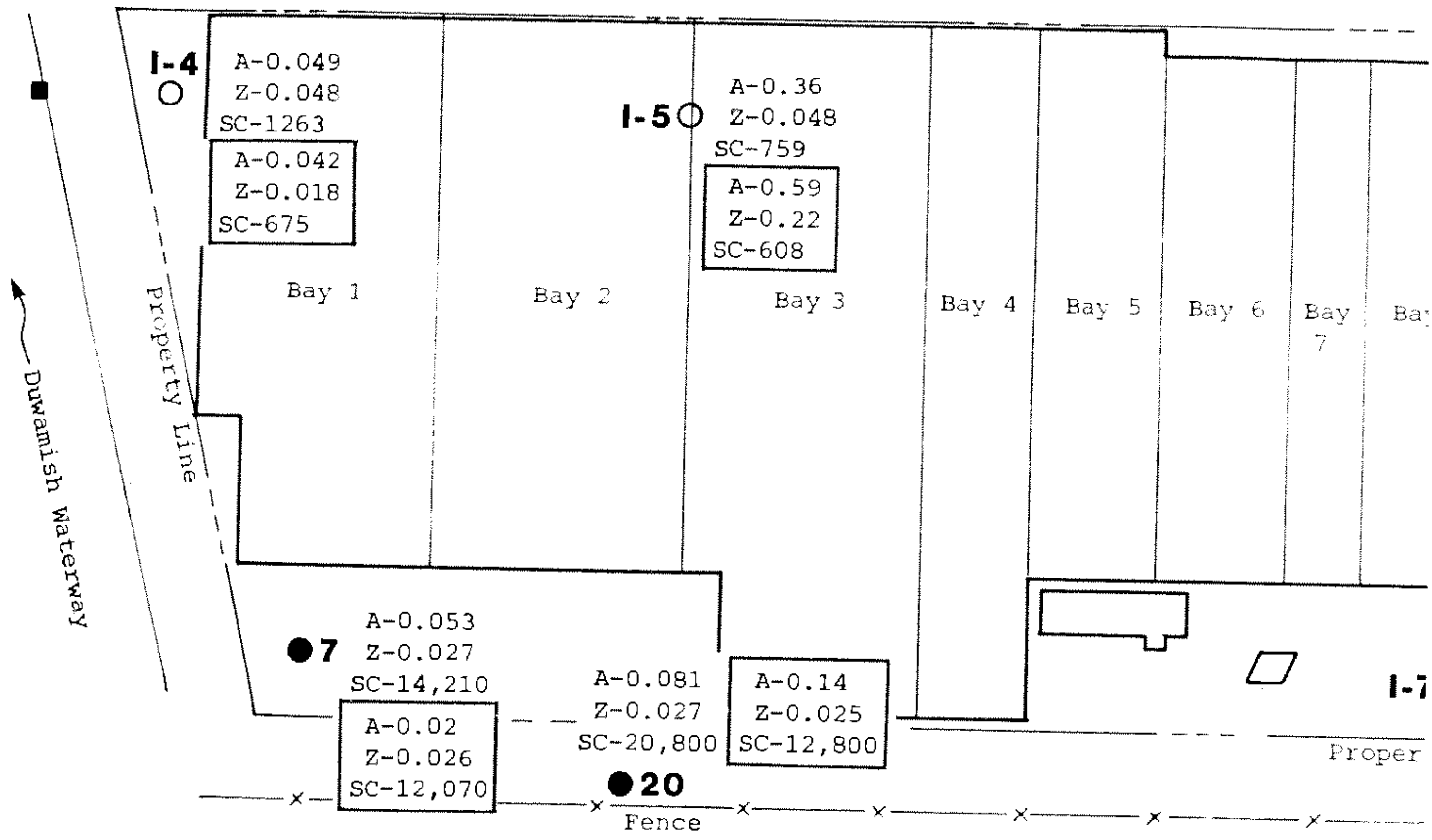
The ground water data in this report refers only to the upper 10 to 15 feet of the water table aquifer. There are no available data regarding ground water quality below the screen depths of the existing site monitoring wells.

2. Heavy Metal Concentrations

Lab results from the current study show that arsenic concentrations in ground water exceed the EPA Primary Drinking Water Standard maximum contaminant level (MCL) of 0.05 mg/l in all monitoring wells except I-3, I-4, and I-6. Arsenic was detected in all wells except well I-3 on the first sampling run (see Figure 9). The arsenic concentrations ranged from 0.010 to 9.2 mg/l in wells I-3 and I-2, respectively. Excluding wells I-3 and I-2, the average arsenic concentration for the remaining eight wells was 0.17 mg/l. Review of Table 1 shows generally good agreement between laboratories for the split samples.

Lab results from the current study show that chromium was not detected in ground water at wells I-5, I-6 and 12. Chromium was also not detected in two of three samples at wells I-1, I-4 and I-7. In the other wells, concentrations range from 0.01 to 0.0416 mg/l in wells I-2/I-3 and 20, respectively. Chromium concentrations in lab test results from the current study do not exceed the Primary Drinking Water Standard MCL of 0.05 mg/l.

Copper was detected in all monitoring wells sampled during the current study except well I-6. Copper concentrations ranged from 0.003 to 0.70 mg/l in wells I-4 and 12, respectively.

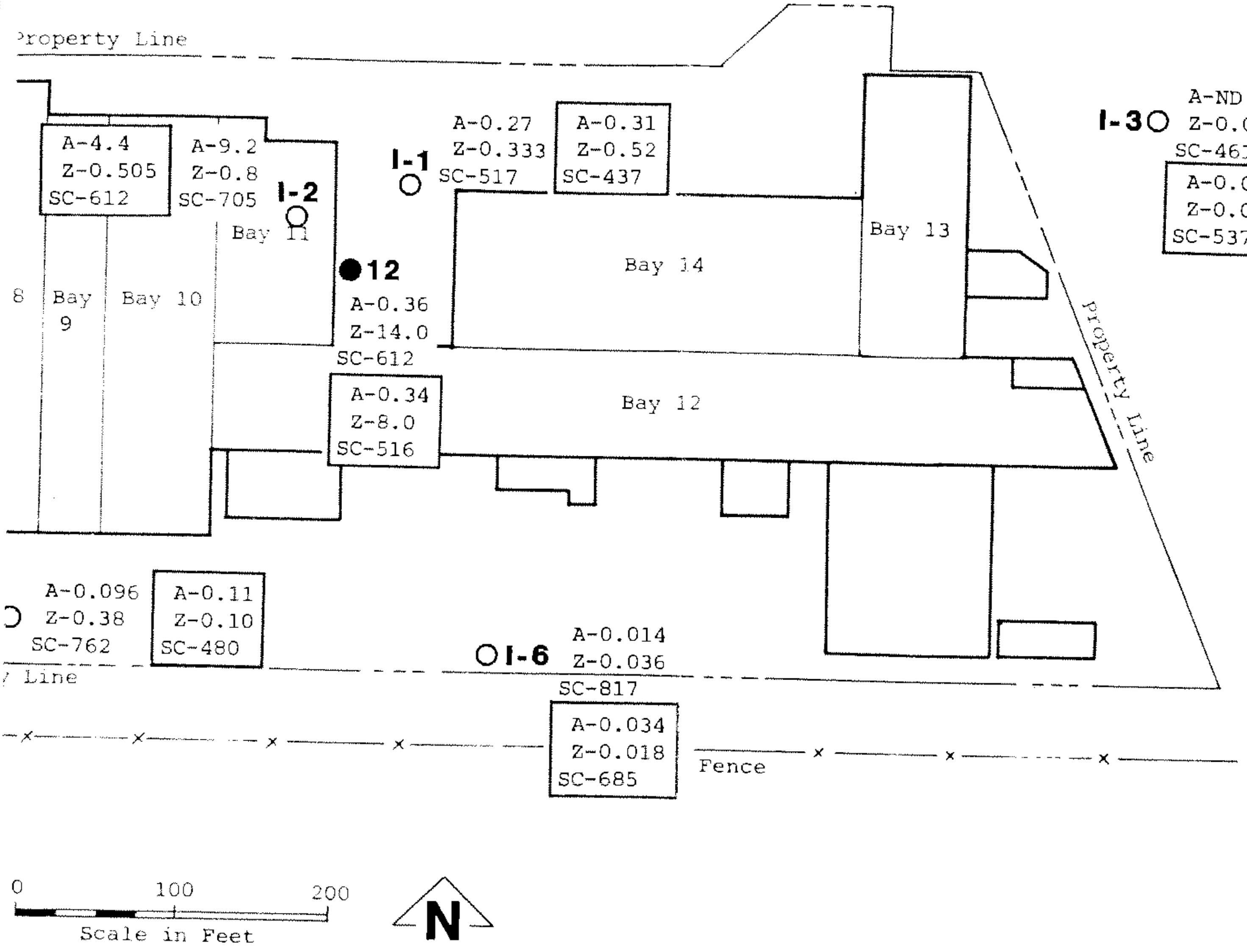


EXPLANATION

A-	Arsenic concentration (mg/1)
Z-	Zinc concentration (mg/1)
SC-	Specific Conductivity (µmho/cm)
7●	Monitoring well: Previous study
I-1○	Monitoring well: Present study

Notes:

1. First wate
on lab resu
10/26/83 s
2. Second sam
12/9/83 an
enclosed b



quality data is based
ts from 10/25/83 and
pling run.

ing run is from
12/10/83 (results
box in this figure).

Figure 9

Isaacson Corporation

ARSENIC, ZINC and SPECIFIC CONDUCTIVITY
Ground Water Data

Patrick H. Wicks
CONSULTANT IN HAZARDOUS WASTE MANAGEMENT
In association with:
Sweet, Edwards & Associates, Inc. • P.O Box 328 • Kelso, WA 98626

Current data indicate that copper concentrations do not exceed the Secondary Drinking Water Standard aesthetics limit of 1.0 mg/l in any of the on-site wells.

Nickel was not detected in wells I-5 and I-7 and in two of three samples from I-4. In the other wells, concentrations ranged from 0.01 mg/l in I-1, I-3 and I-6 to 0.06 mg/l in well 12. There are no drinking water standards for nickel.

Lead was not detected in wells I-3, I-5, I-6 and 12 in the current study. It was also not detected in two of three samples from wells I-1, I-2, I-4 and I-7. In the other wells, 7 and 20, lead concentrations ranged from 0.002 to 0.03 mg/l. Results from this evaluation for lead in ground water do not exceed the Primary Drinking Water Standard MCL of 0.05 mg/l.

Zinc was detected in all monitoring wells sampled during the current study, and the Zn concentrations ranged from 0.027 to 14.0 mg/l in wells 20 and 12, respectively. Excluding wells 12 and 20, the average Zn concentration in ground water indicated by the current data is 0.22 mg/l. The Secondary Drinking Water Standard aesthetics limit of 5.0 mg/l Zn is exceeded only at well 12.

3. Comparison with Previous Study

Comparison of the ground water quality data from the current study and from the previous evaluation shows that the contaminant concentrations from this study are lower for several wells. Two sampling runs were completed in the current study, and only one was completed for the previous study. Comparison of data gathered during the two studies may be questionable, given varying field sampling techniques and possible laboratory error. Nonetheless, there are several significant differences between results of the two studies, as discussed below.

A review of the data on Table 2 shows that the arsenic concentration in well 20 was higher in the previous study lab test results. Similarly, the chromium concentration in well 20 was higher in the previous lab test results. This chromium data is important because the 0.13 mg/l Cr concentration shown for well 20 in the previous report is the only case where chromium exceeds the Primary Drinking Water Standard MCL of 0.05 mg/l. Similarly, the lead concentration in well 7 is approximately 50 times higher in the previous study sampling and test results and again is the only lead concentration to date which exceeds the Primary Drinking Water Standard of 0.05 mg/l, Pb.

The variations in lab test results from wells 7 and 20 are probably due in part to varying sampling techniques. Wells 7 and 20 are low-yield wells, i.e., less than one gallon per minute, and the ground water from these wells contains a significant amount of fine-grained silt and clay which passes through the well intake screen when the wells are pumped.

According to the previous study (Dames & Moore, 1983) three pore volumes of well water were removed from these wells prior to sampling. For the current study, Sweet-Edwards developed these wells through continuous pumping for 30 hours prior to sampling, yielding more than 50 pore volumes of ground water. In addition, Sweet-Edwards removed most of the silt and clay from the ground water samples by field filtering the ground water with a 0.45 micron filter prior to placing the water in the lab sample bottle. The previous investigators reportedly did not field filter the water samples, but pumped the ground water directly into the sample bottle. The lab sample bottles generally are fixed with approximately 2 milliliters of nitric acid prior to shipment to the field. Although the bottles reportedly were acid fixed, this has not been confirmed with the laboratory. The nitric acid commonly results in a total sample pH of < 2 in the sample bottle according to the lab (Laucks Testing Laboratories, Inc., 1983). The nitric acid in the lab bottle creates an artificial reducing condition which will chemically elute or remove metal elements such as arsenic, chromium and lead from the fine-grained silts and clays. For this reason, the lab results from the previous study may have resulted in higher heavy metals concentrations than were actually present in solution in ground water at wells 7 and 20.

Given the above discussion, ground water quality data from the current study indicates that shallow ground water beneath the site meets EPA Primary Drinking Water Standard in all heavy metals tested except arsenic. Additionally, the EPA Secondary Drinking Water Standard aesthetic limit of 5.0 mg/1 zinc is exceeded only in well 12.

4. Extent of Contamination

The predominant east-to-west site ground water flow direction is generally reflected in the site ground water quality. The heavy metal concentrations in well I-3 are at trace levels or below laboratory detection limits. These data from well I-3 preliminarily indicate that the heavy metal contaminants detected in site ground water are not present in shallow ground water immediately upgradient of the site.

Ground water quality data from additional sampling runs would be needed to statistically refine the contaminant distribution and concentrations shown on Table 2, and Figure 9. However, the current data are sufficient to allow some generalizations regarding areal variations in ground water quality.

The arsenic and zinc concentrations measured in ground water during the current study are shown on Figure 9. The highest concentrations are in monitoring wells around the steam clean pit and west of the previous location of the galvanizing plant (now Bay 14). These monitoring wells include I-1, I-2, and 12. Potential sources of ground water contamination are shown on Figure 4, including random fill, steam clean sump, abandoned neutralization basin, and the sludge disposal area at the east end of Slip 5.

Existing data are not sufficient to define the plume(s) of contaminated ground water. Definition of the the lateral and vertical extent of ground water contamination is complicated by tidal fluctuations in the western portion of the site, and by saline ground water in the western area of the site.

5. Saline Water

The Hydrology dicussion described the tidal effect on ground water flow direction in the western area of the site. Lab analysis of the ground water from wells 7 and 20 indicate that the ground water is contaminated by salt water of marine origin, see APPENDIX C lab test reports.

The presence of salt water in wells 7 and 20 is due to one or both of the following occurrences. The Puget Sound (Elliot

Bay) salt water wedge commonly extends from the mouth of the Duwamish River/Waterway eight miles upriver (Fisher, et al., 1975). The extent of salt water upriver depends upon river stage and tidal fluctuations. Depending upon daily ground water and surface water fluctuations, the salt water may intrude laterally from the river into the fresh water aquifer at the site. The lateral extent of salt water intrusion into the aquifer is not known. Additionally, salt water was undoubtedly present in Slip 5 prior to being filled. During filling, salt water was probably trapped in the fill and may not be completely flushed out of the fill and underlying sediments.

The presence of salt water elevated the specific conductivities of ground water at wells 7 and 20 to 14,210 and 20,800 umho/cm, respectively, during the first sampling and to 12,070 and 12,800 umho/cm, respectively, during the second sampling, as measured in the field and shown on Figure 9. The specific conductivities of ground water from the other wells were less than 1.000 umho/cm except well I-4, which was 1263 umho/cm on the first sampling run.

The ground water data in this report refer only to the upper 10 to 15 feet of the water table aquifer. There are no available data regarding ground water quality below the screen depths of the existing site monitoring wells.

6. Heavy Metal Loading

There are not sufficient data available at the current stage of this evaluation to predict the fate of heavy metal contaminants in site ground water. The water quality data indicate average concentrations of arsenic and zinc as previously described.

These heavy metals are assumed to be in aqueous solution in the shallow site ground water.

Of the metal contaminants of concern analyzed in site ground water existing data indicate that arsenic and zinc have the highest concentrations. Research on the mobility of selected metal elements in ground water has recently been published (Gibb, 1982). That study concluded that zinc has the greatest subsurface mobility, followed in descending order by cadmium, copper, and lead. The same study also concluded that the principal attenuating mechanisms which reduce mobility are cation exchange on the sediments and the precipitation of insoluble metals as a result of pH changes in the ground water.

Elemental arsenic is insoluble in water (McKee, 1963), but arsenic compounds such as arsenic oxides and arsenates have moderate to very high solubility in ground water. Research has also shown that the arsenic oxide compounds created during the smelting of zinc, copper, and lead ores are highly soluble, and therefore highly mobile in ground water.

These data from other studies help explain the comparatively high concentrations of arsenic and zinc in the site ground water compared to the concentrations of lead and copper which are also present in the random fill and soil.

There are no existing data on what occurs chemically in the subsurface zone where contaminated ground water interfaces with the saline ground and/or river water. The pH and reduction/oxidation states of the fresh ground water and saline ground water are different, which may cause precipitation of the heavy metals from solution. This possibility deserves further study, as it may constitute a natural treatment system, which under existing hydrologic conditions prevents or minimizes contamination of the Duwamish River.

To calculate cumulative heavy metal loading from the aquifer to the river, an accurate moisture balance and analysis of daily and seasonal ground water fluctuations would be needed. These data are necessary to calculate the total volume of ground water entering the river, given the observed reversals in near-shore ground water flow direction.

7. Other Ground Water Evaluations in Boeing Field/Duwamish Area

Personal communications with the DOE and EPA were conducted regarding any other ground water evaluations in the Boeing Field area during the last several years. Agency personnel contacted confirmed only two such studies. The first was related to a spill in 1982 involving chromic acid and trichloroethelene at the Boeing EMF facility. The second was a ground water contamination study at a solvent recovery and waste treatment plant just north of Boeing Field. To the extent they were available, data from this second evaluation was included in this report (Harper Owes, 1983). No other such studies were known to have been conducted according to the agency personnel. In addition, a consulting firm confirmed that no such studies other than the two noted above had been conducted to their knowledge. This firm indicated further that Metro had intended to install ground water monitoring wells along the Duwamish, but has not done so.

B. Effects on Duwamish River

Despite the Duwamish River sample analyses that were performed, and other data gathered relative to water quality of the river, no conclusions can be drawn as to effects of this site on the water quality of the Duwamish at this point in the evaluation. Certain inferences might be made as to the lack of any adverse environmental effects on the Duwamish from this property, based on data collected during this study as well as a review of other existing data on water quality of the Duwamish (Harper Owes, 1983). Definitive conclusions on such effects or the lack thereof would, however, be premature due to the limited time and data available for preparing this report.

Possible Sources of Contamination

A. Storm Sewer Discharges

Based on personal communications with Isaacson personnel, only surface drainage from the plant is discharged to the 48" storm drain that runs beneath the Isaacson property as shown in Figure 3. This storm drain also apparently drains most of the Boeing Field area to the east of East Marginal Way South. In the last several years there have been no process discharges from the Isaacson plant to the storm sewer. However, previous to the last several years, process effluents were discharged to this storm sewer as discussed below. The 48" storm drain, prior to its being extended to the river, emptied into Slip 5 at the approximate location as shown on Figure 4.

B. Metro Discharges

Discharge from the Isaacson plant was originally via the Jorgensen Metro sewer discharge line. In 1970 Isaacson installed its own sewer discharge line from the plant. The only discharges to the Metro line were from sanitary uses in the plant.

C. Water/Air Wash System

The water/air wash system in the east end of Bay 12 was installed in the late 1950's or early 1960's, about the time Bay 13 was constructed. The primary purpose of this system was to reduce exposure of employees to airborne paint for health and safety reasons. The system is comprised of a fan, scrubber, sump, several grates and underground tunnels through which airborne paint solvents and solids were drawn for scrubbing before discharge to the atmosphere.

After its installation, water overflowing from the sump of this system discharged along the ground surface to an area south of the original end of the 48" storm drain, i.e., the eastern end of Slip 5. After the 48" storm drain was extended to the river, in about 1967, sump overflow discharged into the storm drain until it was disconnected from the storm drain in 1971. After that time there was no discharge to the storm sewer from this source, nor to the Metro sewer. Sludge from the water/air wash system had been disposed via commercial disposal companies since its installation. The walls and bottom of the sump were constructed of concrete. While there is some possibility of leakage from the sump, this could only be determined by a detailed inspection and monitoring beneath the sump. This was not deemed to be necessary in this case. The system had been shut down prior to this evaluation.

D. Steam Cleaning Operations

The steam cleaning rack and sump are located as shown on Figure 4. They consist of a metal grate supported over a concrete walled sump. One to two feet below the grate is a metal pan up to 12 inches deep, which is intended to capture sediment and large objects from steam cleaning operations. The pan rests on a one-foot layer of sand beneath which is a one-foot layer of gravel. There is no seal beneath the gravel. The accumulated sediment (sludge) which collected in and around the pan, and in the sand and gravel, was removed along with the sand and gravel every several years when drainage became restricted from the sump. Disposition of the sludge, gravel, and sand has been through commercial disposal companies.

The steam cleaning rack and sump were installed in 1970 or 1971 to eliminate drainage discharging from this area to the storm sewer. This steam cleaning area was used to clean cranes, forklifts, and other machinery used in the Isaacson operation. It was not, however, used for any process cleaning of steel products prior to, during, or after fabrication. A detergent supplied by Pace National Corporation, "Fist," was used in the steam cleaning operation for the past 10 years or more. A representative of Pace National indicated the only significant hazardous property of this detergent is its high alkalinity (pH). The Pace representative had no readily available data on any heavy metal concentration in this product, but did indicate that the product is authorized by USDA for cleaning in meat and poultry plants, leading to the belief that it should be essentially free of heavy metal contaminants. The Pace representative also recalled arsenic being present in other cleaners used in the past but not in this product. He believed that the arsenic was present intentionally as a corrosion inhibitor in those other cleaners.

A representative of Lilyblad Petroleum, Inc. indicated that zinc dithiophosphate is used as an anti-wear additive in lubricating oils and hydraulic oils at a concentration of 0.12-0.15 percent by weight. He also indicated that in heavy lubricants (greases), zinc compounds of the same type are present, at slightly lower concentrations. This and related zinc compounds are believed to be the source of relatively high zinc levels, i.e., about 9-10 percent in the sludge at the steam cleaning sump, from the analysis in the previous report. Another possible source is zinc from galvanized parts on equipment cleaned at the steam cleaning sump/rack.

E. Possible Arsenic Contamination in Similar Steel Operations

Personal communication with Seattle Steel (formerly Bethlehem Steel) indicated that a detergent cleaner was used up until 1971 at that facility in the plating line. This had resulted in arsenic contamination. The cleaner involved is believed to be an Oakite product, but the level of arsenic was not determined.

F. Steel Cleaning

Cleaning of steel before, during, or after fabrication at the Isaacson plant was also a possible source of contamination. Isaacson personnel indicated that no ASARCO slag (which does contain arsenic) was used for blasting steel during the fabrication process. Instead, Isaacson used a steel shot-blasting system for this purpose.

G. Agricultural Activities

Agricultural pesticides were also evaluated as a possible source of elevated arsenic levels in soil and fill on the Isaacson property. A representative of Oregon State University (OSU), Department of Agricultural Chemistry was contacted in this regard, see References. The OSU representative indicated that numerous arsenic-containing pesticides had been used in years past, e.g:

lead arsenate on apple and pear orchards from the late 1800's through about 1945 as an insecticide; arsenic trioxide as an herbicide from about 1920 to about 1950; calcium arsenate as an insecticide also in fruit crops from about 1900 through 1945; paris green, with the approximate formula of $(CH3COO)2\text{-}Cu.3(CuAsO2)2$; and basic copper arsenate, with the approximate formula of $(Cu)(CuOH)\text{-}AsO4$. Of these arsenic compounds used as pesticides, those which were soluble in water were used as herbicides, and those which were insoluble in water were used as insecticides. None of these compounds are used today as pesticides. Two organic arsenicals have been used over the last 15 years. These are mono- and disodium methyl arsenate.

The OSU representative also indicated that in the late 1800's and early 1900's some of the major manufacturers of pesticides were paint companies. This was because many of the paint pigments used in those years were also excellent pesticides from the standpoint of their toxicity. Many of these pigments and pesticides were very similar in composition and formula to paris green, which contains both arsenic and copper.

Based on the review of aerial photographs from 1936 through the present in the vicinity of the Isaacson property, as well as interviews with Isaacson personnel, it is known that agricultural activities existed in the area, consisting of several truck farms, and perhaps the production of grain or hay crops during that period of time. As a result, it is possible that excess or unwanted pesticides from these farming operations were disposed or deposited intentionally on the Isaacson property prior to it being developed for industrial use. However, it does not appear that lead arsenate and calcium arsenate, in particular, would likely have been disposed on the Isaacson property since these arsenates were used primarily in fruit orchards, none of which are believed to have existed in the Duwamish area.

H. Disposal of Fill From Isaacson Operations

In Figure 4, the large area shaded as a potential source of contamination is the former Slip 5, based on a 1936 aerial photo. Slip 5 received various materials from the Isaacson operation as well as from other outside sources, based on written and verbal information provided by Isaacson personnel. Waste materials from the prior Isaacson operation (currently Earle M. Jorgensen Company, steel manufacturing facility), which were placed in Slip 5, include: spent firebrick from heat treating furnaces; brick from forging reheat furnaces; brick from the melt shop; steel scale generated from forging operations; and excavation material (much of which was probably clean) generated from the excavation of foundations for new buildings on the Isaacson property. In addition, Slip 5 received slag from the manufacture of stainless and other steels. Note that generally all stainless steels are iron-based, with 12-30 percent chromium, 0-22 percent nickel, and minor amounts of carbon, columbium, copper, molybdenum, selenium, tantalum, and titanium (Perry, 1963).

These fill materials were placed in Slip 5 until 1967. In addition, at that time, the soil and other material excavated for the construction of the Seattle-First National Bank Building in downtown Seattle and perhaps associated demolition debris was the final fill material placed in the Slip 5 area to bring it approximately to the current grade. The filling described above extended Slip 5 fill to close to its current location along the edge of the Duwamish River.

In addition, aerial photos dating as far back as 1936 reveal at least three nearby industrial or commercial facilities, beyond those noted previously, that may have contributed wastes to the Isaacson property. One of these was located at the east end of Slip 5, but east of East Marginal Way. Two others were located across East Marginal Way from Slip 5.

In addition it is probable that wastes (containing contaminants of concern) were filled on the property prior to its purchase by the Isaacson Corporation. Part of the site apparently occupies a previous Duwamish River channel and was formed by filling the channel during or after the river was channelized in the early 1900's. It is suspected that dredge spoils below the random fill were not contaminated when placed there. However, it is likely that contaminants were present in fill or wastes placed on the site prior to 1937 or 1938 when the property was purchased by Isaacson Iron Works (predecessor to the Isaacson Corporation) from King County. This possibility is given further weight because when buildings (galvanizing plant and Bays 10, 11, 12 and 14) were constructed on the northern one-half of the property, no significant fill was placed there during construction.

SUMMARY AND CONCLUSIONS

Contamination in Fill and Soil

1. The two primary shallow subsurface units at the site are the surface layer of random fill and the underlying soils (including dredge spoils). Soil and slag samples from the random fill were laboratory tested as were selected soil samples collected beneath the random fill.

2. The lowest arsenic concentrations detected on site were in the soil samples collected from the random fill, i.e., less than 100 ppm. The lead, zinc, chromium and copper concentration in these samples are higher and range from less than 100 to greater than 1,000 ppm.

3. Fill slag samples from three borings were tested and have concentrations of arsenic from 18 to 120 ppm with chromium, copper, lead, and zinc concentrations from several hundred to greater than 2,000 ppm.

4. EP toxicity tests of fill soil samples resulted in one failure due to high lead concentration, and two samples which passed.

5. The four samples of slag which were tested for EP toxicity all passed.

6. Most of the samples of soil obtained from below the random fill are from borings drilled in the area of the steam clean sump west of Bay 14. These samples generally show concentrations of arsenic from less than 100 to greater than 3,000 ppm. Zinc and copper concentrations from approximately 100 to 500 ppm were also detected in these soil samples.

7. EP toxicity tests were conducted on five soil samples collected from below the random fill. Two of the samples failed the EP toxicity test because of high arsenic concentration and the remaining three samples passed.

8. Spectrographic analyses were conducted on nine soil samples and one composite sample of slag. The spectrographic analyses generally confirmed the concentrations of copper, arsenic, lead, chromium, and nickel from the previously described quantitative lab analyses. Other elements shown in the spectrographic analyses are not elements of concern with respect to contamination.

9. Current data on distribution and concentrations of contaminants in the site random fill and underlying soils are not sufficient for a complete evaluation of remedial measures.

Hydrology and Water Quality

1. Ground water at the site occurs under water table or unconfined conditions and the water table surface is generally less than 15 feet below ground.

2. Ground water in the eastern portion of the site flows from east to west toward the Duwamish River. In the western portion of the site flow is northwest and in a downriver direction at low tide and southeast away from the river at high tide.

3. Water table gradients vary greatly from east to west because of tide influenced water table fluctuations.

4. The existing data indicate that tide induced water table fluctuations in the western portion of the site cause reversals in

ground water flow direction across the southern and northern Isaacson property lines.

5. Adequate definition of site vicinity ground water flow patterns will require additional monitoring wells and continued water table/river measurements.

6. Semi-impervious surfaces at the site, including roofs, asphalt, and concrete probably result in very little direct recharge to ground water at the site.

7. Arsenic concentrations measured in ground water during the current study exceed the EPA Primary Drinking Water Standard maximum contaminant level (MCL) of 0.05 mg/l in seven of the ten site monitoring wells.

8. Excluding the highest and lowest levels detected, the average arsenic concentration in shallow ground water at the site was 0.17 mg/l.

9. Chromium was detected in ground water during the current study from seven site monitoring wells and the concentrations did not exceed the EPA Primary Drinking Water Standard MCL of 0.05 mg/l.

10. Copper was detected in ground water in nine of the site monitoring wells during the current study but the concentrations did not exceed the EPA Secondary Drinking Water Standard MCL at 1.0 mg/l.

11. Lead was detected during the current study in six site monitoring wells but concentrations did not exceed the EPA Primary Drinking Water Standard MCL of 0.05 mg/l.

12. Zinc was detected in all ten monitoring wells during the current study and the EPA Secondary Drinking Water Standard aesthetics limit of 5 mg/l was exceeded only at monitoring well 12.

13. Excluding the highest and lowest concentrations measured, the average zinc concentration in ground water was 0.17 mg/l.

14. Arsenic, chromium and lead concentrations found were significantly lower in monitoring wells 7 and 20 than were reported in the previous study. This is important because chromium and lead concentrations previously reported were higher than the EPA Primary Drinking Water Standard maximum contaminant levels. A probable cause of this difference is that the previous workers reportedly did not field filter the ground water prior to fixing the samples with nitric acid.

15. Given conclusions 7 through 14 above, the current study results indicate that shallow ground water beneath the site meets EPA Primary Drinking Water Standards on heavy metals tested except arsenic.

16. Ground water quality data from upgradient monitoring well I-3 preliminarily indicate that the heavy metal contaminants in site ground water are not present in upgradient shallow ground water.

17. Data from the current study indicate that the highest concentrations of arsenic and zinc in shallow ground water are from the monitoring wells around the steam clean pit and west of Bay 14.

18. Water quality data from monitoring wells 7 and 20 indicate that a limited area of the western portion of the site contains saline ground water of marine origin.

19. Existing data are insufficient to define the plume(s) of contaminated ground water.

20. Definition of the lateral and vertical extent of contaminated ground water are complicated by tidal fluctuations and saline ground water in the western portion of the site.

21. There are not sufficient data available at this stage of the study to predict the fate of heavy metal contaminants in site ground water.

22. Natural attenuative mechanisms for metals may exist on-site. Sediments in the soil/alluvium unit may absorb metals from ground water via cation exchange. Metals may also be removed from ground water by precipitation at the fresh/saline ground water interface.

23. Certain inferences might be made as to the lack of adverse environmental effects on the Duwamish River from this site. However, it may be premature to state any definitive conclusions other than the likelihood that there is no imminent hazard with respect to effects on the Duwamish.

Origin and Sources of Contaminants

In this subsection are described the probable and possible origin and sources of contaminants found during this evaluation. "Probable" sources of contaminants are the most likely sources based on information gathered during this study. "Possible" sources are simply judged to be less likely sources than the "Probable" sources, but it cannot be concluded definitively that any source in either category is the cause of contamination without additional research. Further, there may be other sources which have not been listed here.

A. Probable Sources - Steam Cleaning Sump/Rack

The probable origin of elevated zinc concentrations in sludge at the sump and immediately adjacent soil and ground water is zinc additives present in lubricating oil and greases used in equipment (forklifts, cranes, and other machinery) which have been steam cleaned at the sump. No other more likely sources are believed to exist.

B. Probable Sources - Slip 5 Area and Steam Cleaning Sump Area (excluding the sump itself) and Other Plant Areas

Materials deposited in these areas from the former Isaacson operation are believed to be the most probable sources of contaminants, as follows:

1. Slag and related waste from manufacture of stainless steels and other steels.
2. Emissions from steel manufacturing facilities prior to installation of air-pollution control devices (i.e., prior to 1970's.
3. Paint wastes containing copper, arsenic, lead, and/or chromium pigments.
4. Disposal and/or emissions of zinc-contaminated material from the galvanizing plant.

Another probable source of contaminants is fills and wastes that were placed on the property prior to its purchase by Isaacson. If this is true, the types of materials placed there likely include one or more of those listed in item C below.

C. Possible Sources - Slip 5 Area and Steam Cleaning Sump Area (excluding the sump itself) and Other Plant Areas

   1. Emissions/disposal from several industrial or commercial facilities located east of Slip 5.

   2. Pesticides from farming on the Isaacson plant site (circa 1930-40).

   3. Disposal of material from off-site sources of the following types:

      a. Wood-treating (copper, chromium, and arsenic).

      b. Pesticides from agricultural operations in the vicinity, e.g., truck farm east of Marginal Way, circa 1940, (materials containing arsenic and copper and perhaps lead).

      c. Slag wastes from the ASARCO smelter in Tacoma, which contains arsenic (exclusive of atmospheric emissions).

      d. Waste from glass manufacturing where arsenic may be used (such a plant is located in the immediate vicinity).

      e. Waste from paint manufacturing.

      f. The use of paint in various industrial applications.

g. Paint removal as in drum reconditioning, shipyards, and other industrial applications.

h. Waste from lead and/or copper alloy manufacturing in which arsenic is also a component.

Considering the data generated during this evaluation and the history of Isaacson's activities on the site it appears most likely that elevated arsenic concentrations in the soil/alluvium unit in the vicinity of wells I-1 and I-2 resulted from wastes or fills placed there prior to Isaacson's purchase of the property in 1937 or 1938.

REFERENCES

Isaacson Corporation, 1983. Personal communications (verbal and written) between P. Wicks and current or former employees of Isaacson Corporation (H. Isaacson, D. Hegland, S. King, E. Stougard).

Oregon State University, 1983. Personal communications between P. Wicks and Oregon State University, Department of Agricultural Chemistry (Dr. James Witt).

Pace National Corporation, 1983. Personal communication between P. Wicks and Pace National Corporation (D. Baker).

Lilyblad Petroleum, Inc., 1983. Personal communication between P. Wicks and Lilyblad Petroleum Inc. (G. Allen).

Seattle Steel, 1983. Personal communications between P. Wicks and Seattle Steel (L. Mork).

Harper Owes, 1983. Personal communications between P. Wicks and Harper Owes (R. Owes, C. Patmont).

Earle M. Jorgensen Company, 1983. Personal communications between P. Wicks and Earle M. Jorgensen Company (L. Dillinger, J. LaVillett).

EPA, 1983. Personal communications between P. Wicks and EPA Region X (J. Barich, C. Rice, J. O'Patz, H. Scott).

Washington Department of Ecology, 1983. Personal communications between P. Wicks and Washington Department of Ecology (J. Selic, J. Knudsen, G. Gregory, T. Cook).

Dames & Moore, 1983, Report of Evaluation of Site Contamination, Isaacson Steel Property.

University of Washington, 1983. Personal communication between P. Wicks and University of Washington, Department of Chemistry (G. Christian).

Perry, John H., et al., 1963. Chemical Engineers' Handbook.

Dames & Moore, 1983. Personal communication between P. Wicks, J. Edwards and Dames & Moore (H. Chabra, and G. Glass).

Fisher, H. B., et al., 1975. Numerical Model of Material Transport in Salt Wedge Estuaries., U.S. Geological Survey Professional Paper 917.

Gibb, J. P., and Cartwright, K., 1982. Retention of Zinc, Cadmium, Copper Lead, by Geologic Materials., Cooperative Ground Water Report 9, Illinois State Water Survey and Illinois State Geological Survey.

McKee & Wolfe, 1963. Water Quality Criteria.

Laucks Testing Laboratories, Inc., 1983. Personal communications between P. Wicks, J. Edwards and Laucks Testing Laboratories, Inc. (M. Nelson).

Harper Owes, 1983. Water Quality Assessment of the Duwamish Estuary, Washington, for Metro.