TECHNICAL MEMORANDUMS FOR REMEDIAL INVESTIGATION

MOSS-AMERICAN SITE
Milwaukee, Wisconsin

WA 15-5LM7.0
Contract No. 68-W8-0040

October 25, 1988

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GLT595/61

CONTENTS

TECHNICAL MEMORANDUM

TO: Angela Porter/U.S. EPA Region V

FROM: Don Johnson/CH2M HILL
Solveig Christenson/CH2M HILL

DATE: October 25, 1988

RE: Task FM--Field Mapping and Surveying of
the Little Menomonee River
Moss-American Site

PROJECT: GL063341.FM

INTRODUCTION

This memorandum describes conditions observed during the field mapping of sediment along the Little Menomonee River at and downstream of the Moss-American site (Figure 1). Data gathered during this field effort were evaluated along with previous information to determine locations suitable for sampling.

OBJECTIVES

The field mapping and surveying task consisted of both river mapping and site mapping. River mapping and surveying were performed before actual sampling so that current information could be used to determine sediment sample locations and also to refine data quality objectives for remaining Remedial Investigation (RI) activities.

PROCEDURES

RECONNAISSANCE

Preliminary reconnaissance of the Little Menomonee River was performed from 500 feet upstream of the site to the confluence with the Menomonee River on November 30 through December 2, 1987. The length of the river was measured with a 100-foot tape; flags were used to mark 300-foot intervals. Downstream lengths were measured from a zero point set halfway between the two railroad bridges that cross the Little Menomonee River north of the site and south of Brown Deer Road. The zero point corresponds to river mile 5.84 (SEWRPC 1986). Soils and bank sediments were uncovered or stirred with a shovel for visual inspection. An HNu was used for preliminary analysis of volatile organic compounds in soils and sediments. All observations were logged and plotted on 1 inch = 400 feet aerial photos taken in 1985 obtained from the Southeastern Wisconsin Regional Planning Commission. These observations are summarized and included in Attachment 1.

General features of channel width and depth, channel and bank alignment, areas of deposition and erosion, vegetation, log jams, and evidence of dredging were noted as the distance downstream was measured. Discharge points to the river were noted (Table 1). The information collected was used to describe variations in stream channel configuration and to delineate stream segments.

CHANNEL PROFILES

Based on the results of the stream characterization, 28 typical sections were profiled on December 3 and 4, 1987. The profiles were taken at 1,200-foot intervals using a boat, a 100-foot measuring tape, and a wooden pole marked with 1/4-foot increments. Depth of water was measured at five locations along each profile: 1 to 3 feet from the west bank, at the 1/4, 1/2, and 3/4 points, and 1 to 3 feet from the east bank. Side banks higher than 1 foot above the water surface were noted in the field book. General characteristics of bottom sediments were also recorded.

DATA LIMITATIONS

HNu readings were unstable because of high humidity on the days of river reconnaissance and surveying. On the first day, approximately 8,500 feet downstream of the zero point, use of the HNu was abandoned because of the heavy snowfall. From that point to the confluence with the Menomonee River, no HNu readings were taken.

Dredgings and sediment were sampled at 300-foot intervals on the west bank of the Little Menomonee River. The samples examined were shallow because of the method of excavation.

A surveying error was made between West Silver Spring Drive and State Highway 100 while measuring the length of the Little Menomonee River. A 200-foot length was recorded as being 300 feet.

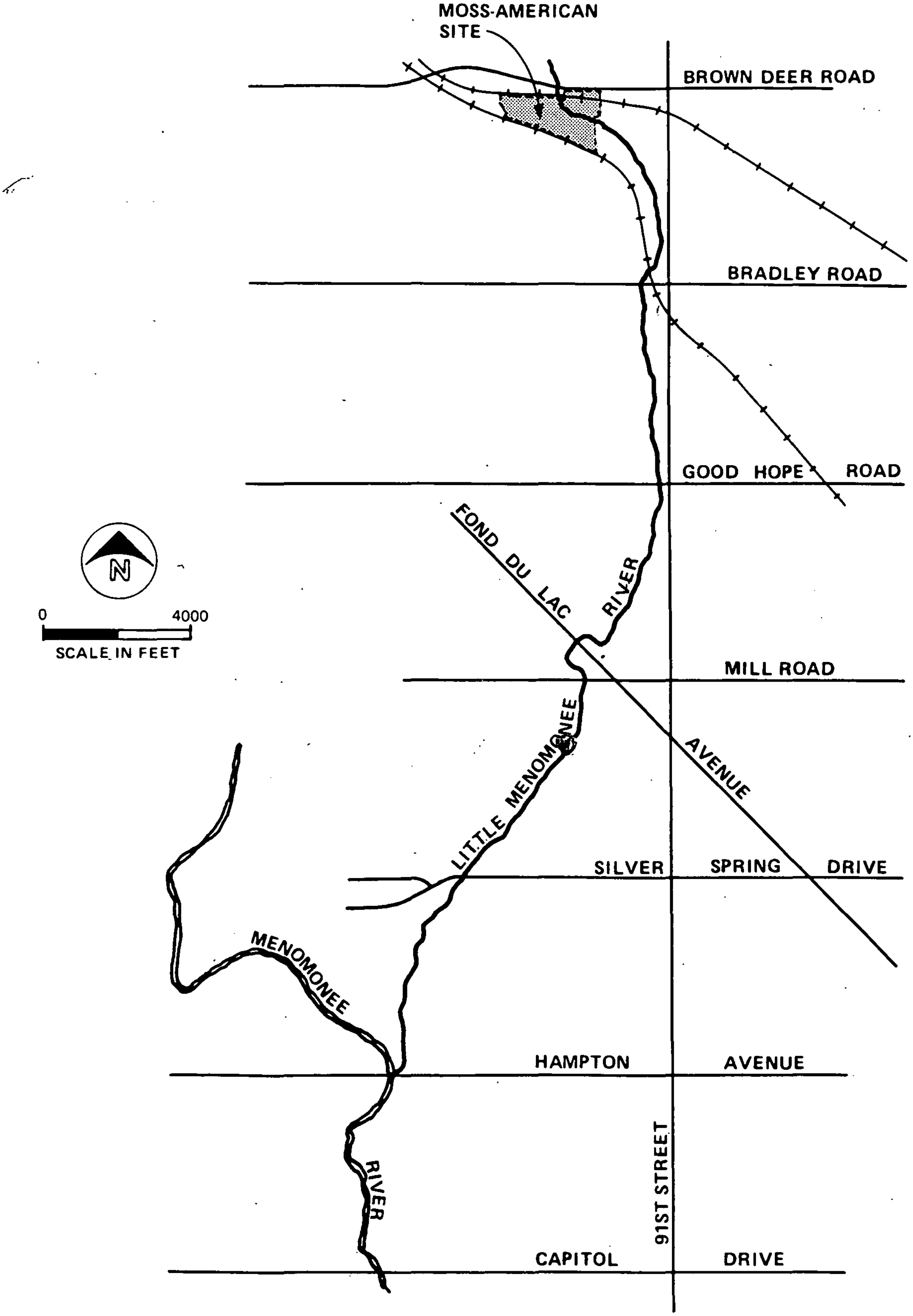


FIGURE 1
LOCATION MAP
MOSS-AMERICAN RI

Table 1
INLETS INTO THE LITTLE MENOMONEE RIVER
(12/3/87 and 12/4/87)

Inlet	Width	Depth	Comments
A	4	2	Oil found in inlet sediments.
B	2	0.3	
C	5	2	
D	7	2	
E	13	2	
F	10	1	
G	5	1	
H	4	1	
I	4	0.5	
J	7	0.5	Manmade channel, only shallow flow about 1/2 inch deep in the concrete channel.
K	4	2	
L	4	2	
M	4	1	
N	4	1	
O	15	2	Oil found in inlet sediments.
P	4	1	Only 1/4 inch of flow in culvert itself.
Q	15	1	Backwater.
R	0.3	0.04	
S	3	0.08	
T	2	1	
U	15	2	
V	3	0.25	
W	2	2	
X	4	2	
Y	3	0.2	
Z	2	0.2	
AA	3	1	Oil found in inlet sediments.
AB	10	2	Bluish green water in inlet.
AC	1	1	
AD	0.3	0.02	From culvert 6 to 8 inches in diameter.
AE	wet	wet	From culvert 6 to 8 inches in diameter.
AF	3	0.75	
AG	2	0.2	
AH	3	1	Oil found in inlet sediments.
AI	5	2	From box culvert 8 feet wide, 20 feet from Little Menomonee River.
AJ	2	0.25	Oil found in inlet sediments.
AK	3	1	
AL	7	2	Oil found in inlet sediments. Well developed channel (old bed?).
AM	25	2	Flooded area.
AN	3	1	
AO	4	0.75	Joining of stream west of dredgings.
AP	0.5	1	
AQ	1	0.2	
AR	5	2	
AS	3	2	Culvert about 3/4 submerged.
AT	3	3	Culvert submerged.
AU	1	0.2	
AV	10	3	Coming from 8-foot box culvert.
AW	8	2	
AX	1	0.5	
AY	5	3	Oil found in inlet sediments.
AZ	4	1	
BA	1	0.04	
BB	5	2	
BC	5	0.25	Oily sheen on water.
BD	0.4	0.04	Culvert about 15 inches in diameter.
BE	5	1	
BF	2	0.08	Oily sheen on water.
BG	6	1	

Channel and inlet depths and widths apply only to the dates and times for which the field data were collected. Variations in volume and depth of flow were clearly visible during the 2 days that channel sections were profiled. Grates draining road runoff directly into the river through bridge structures were not recorded in the field notes.

The release of oily residues from west bank sediments during reconnaissance was erratic. Therefore, a sampler walking to the same locations may not immediately find the same condition, even in areas where significant oily residue was recorded by the survey team.

RESULTS

The results of the river reconnaissance and surveying are shown on the maps in Attachment 1.

The average width of the Little Menomonee River in the sections profiled is approximately 20 feet; the average depth is 2 feet. The Little Menomonee River flows predominantly through a trapezoidal channel of silty clay. The channel runs through both woods and marsh with few variations in channel alignment.

Intermittent meanders are seen south of the Mill Road Bridge to the Lovers Lane bridge. Erosion occurs on the outside of the river curves and deposition occurs on the inside. In the wooded areas of the same stretch, the Little Menomonee River has undercut and toppled large trees rooted in the riverbanks. The river width tends to narrow as it cuts through the sod of the marshy land and as it passes through low wet areas where bushy willows grow into the channel. Slumps occur where the channel banks are steep and composed of clay.

The entire length of the Little Menomonee River has undergone minor channelization for agricultural or other purposes. The dates of those alterations are not known precisely. Major channelization at West Fond du Lac Avenue routes the river through a bridge that passes over both the river and a local road. Dredgings have been deposited over much of the surveyed length of the Little Menomonee River (Attachment 1). Downstream of the first 3,900 feet, very large trees stand in the dredging piles.

The river occasionally conveys large volumes of water, as indicated by brush and debris caught high on flood plain deposit areas and in trees and bushes adjacent to the channel. No vegetation or wildlife were seen in the channel, although deer, rabbits, mice and birds seem abundant around the river. A muskrat was seen on a flooded part of the flood plain deposit area immediately upstream of the Appleton Avenue bridge, and farther upstream in the woods along the east bank a mink was seen.

At this time, the oily sheens and residues seen during river mapping and surveying are assumed to indicate the presence of creosote. Oily releases from disturbed sediments came almost exclusively from areas of softer sediments. Portions of the stream with a coarse sand and gravel bed yielded no oil when they were stirred.

✓ Oil was released from bottom sediments along the Little Menomonee River from approximately 3,900 feet downstream of the railroad bridge zero point to the confluence with the Menomonee River. Locations where the oily sheens and residue were seen are mapped in Attachment 1.

CONCLUSIONS

Information gathered during initial river survey activities suggests intermittent creosote contamination in the Little Menomonee River from 3,900 feet downstream of the river mapping zero point to the confluence with the Menomonee River. No contamination was detected either visually or with an HNu for the first 3,900 feet of the river survey, corresponding closely to the 4,000 feet dredged in 1973 by the U.S. EPA. The data are insufficient, however, to state that no contamination exists in that reach.

Contamination was seen predominantly in softer silty sediments. Only a few locations of harder packed clays had signs of creosote contamination; sand, gravel, and rock exhibited no signs of contamination.

Surface runoff is a potential contamination hazard for the Moss-American site. Exposing soils containing creosote to erosion facilitates their transport to the sediments of the Little Menomonee River. River flooding is a concern in that soils inundated with flood water may potentially carry creosote residues and compounds with them as they recede. Site investigation and remedial activities should minimize transport and erosion of sediment materials.

RECOMMENDATIONS

SAMPLE SELECTION

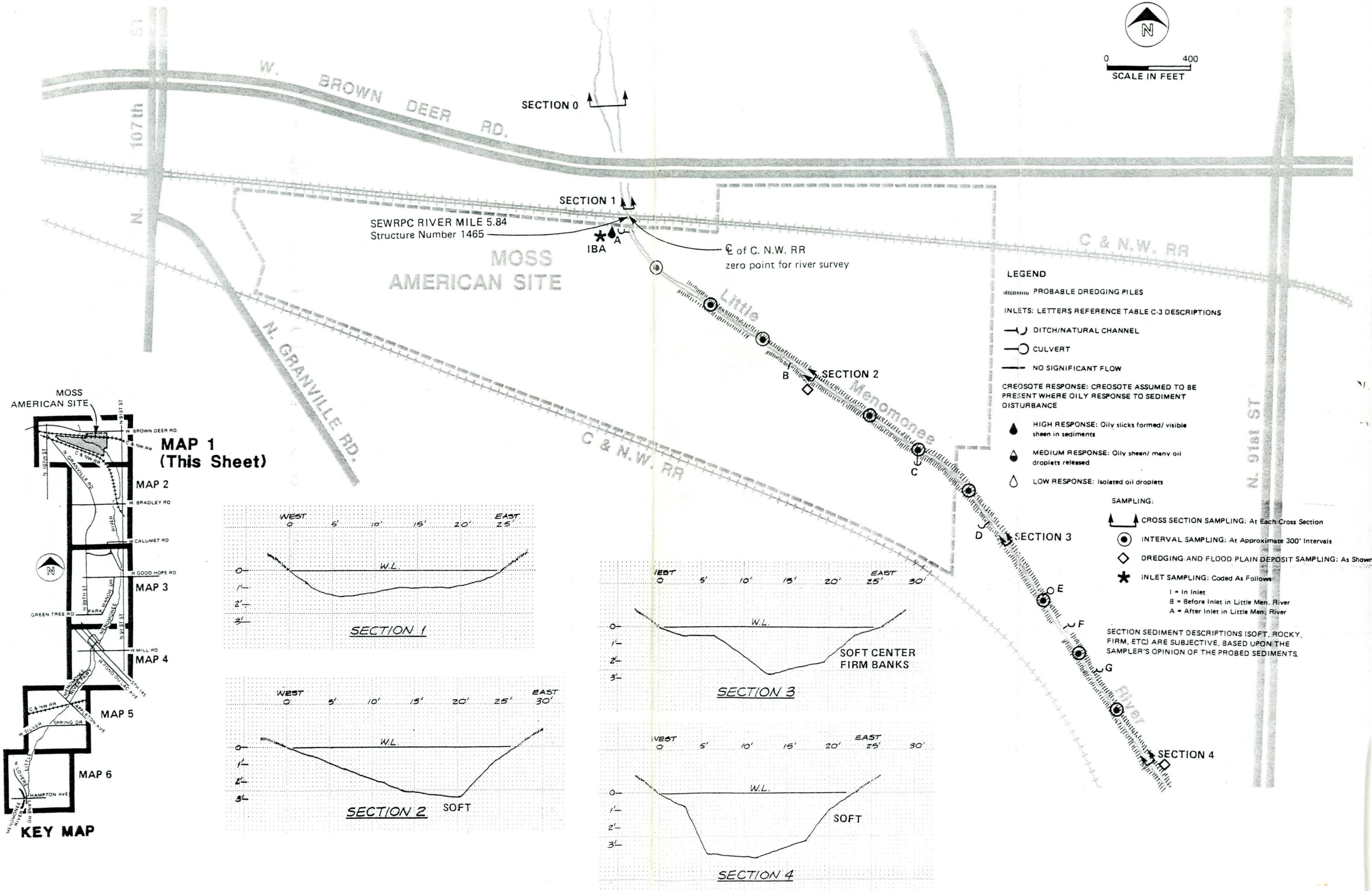
As part of the sediment sampling program, samples will be taken at intervals of approximately 300 feet (see Attachment 1). At each surveyed cross section, about every 1,200 feet, samples should be taken at several depths and locations across the section. Dredging piles, flood plain deposit areas, and certain inlets will also be sampled. Extractable organics (EO) concentrations will be measured on approximately 265 samples; approximately 60 samples will be sent for GC/FID analysis.

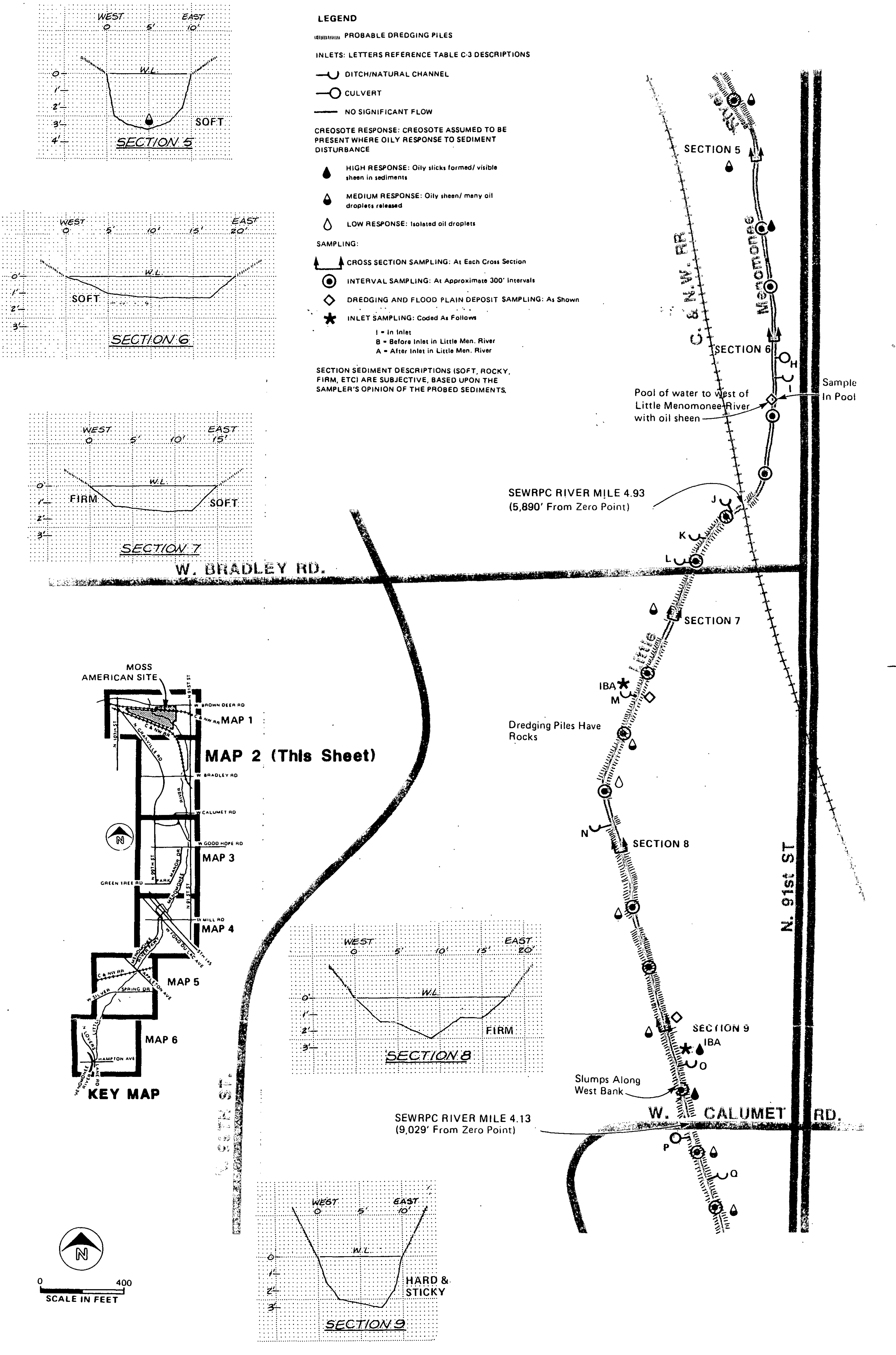
Specific sampling locations will be tailored in the field to best determine the extent of creosote contamination of the Little Menomonee River. The sampling guidelines described here are an outline that will be refined in the field. Visual inspection of samples and initial EO results can help direct subsequent sampling.

Most river sampling will focus on sediment depositional areas; that is, at pools and inside curves. Samples will be taken from portions of the river where the deepest sediment deposits can be determined with a probe, particularly for sections where only one sample will be taken. Natural processes of sedimentation are expected to have provided a shallow covering of clean deposits over the sediments of interest.

Sediments will be sampled at either of two intervals. A shallow sample will be taken from a sediment depth of 0 to 1 foot and a deep sample will be taken from a depth of 1 to 2 feet. If sediments appear visually to be contaminated at 2 feet, sampling should extend deeper. If EO screening shows that contamination consistently exists in only the top 4 to 6 inches of sediment, the usefulness of deeper samples should be re-evaluated. Deep samples that consistently show no contamination through EO screening, should be reassigned to a shallower depth interval or extended horizontally to sample a wider area.

Attachment 1
LITTLE MENOMONEE RIVER MAPS


W. BROWN DEER RD.
N. 107th ST
N. 91st ST
N. GRANVILLE RD.
C & N.W. RR
C & N.W. RR
MOSS AMERICAN SITE
SECTION 0
SECTION 1
SEWRPC RIVER MILE 5.84
Structure Number 1465
IBA
A
℄ of C. N.W. RR
zero point for river survey
Little Menomonee River
B
SECTION 2
C
D
SECTION 3
E
F
G
SECTION 4
N
0
400
SCALE IN FEET
LEGEND
PROBABLE DREDGING PILES
INLETS: LETTERS REFERENCE TABLE C-3 DESCRIPTIONS
DITCH/NATURAL CHANNEL
CULVERT
NO SIGNIFICANT FLOW
CREOSOTE RESPONSE: CREOSOTE ASSUMED TO BE PRESENT WHERE OILY RESPONSE TO SEDIMENT DISTURBANCE
HIGH RESPONSE: Oily slicks formed/ visible sheen in sediments
MEDIUM RESPONSE: Oily sheen/ many oil droplets released
LOW RESPONSE: Isolated oil droplets
SAMPLING:
CROSS SECTION SAMPLING: At Each Cross Section
INTERVAL SAMPLING: At Approximate 300' Intervals
DREDGING AND FLOOD PLAIN DEPOSIT SAMPLING: As Shown
INLET SAMPLING: Coded As Follows
I = In Inlet
B = Before Inlet in Little Men. River
A = After Inlet in Little Men. River
SECTION SEDIMENT DESCRIPTIONS (SOFT, ROCKY, FIRM, ETC) ARE SUBJECTIVE, BASED UPON THE SAMPLER'S OPINION OF THE PROBED SEDIMENTS.
MOSS AMERICAN SITE
MAP 1 (This Sheet)
MAP 2
MAP 3
MAP 4
MAP 5
MAP 6
N 91ST ST
W. BROWN DEER RD
C & NW RR
C & NW RR
N 107th ST
N. GRANVILLE RD
W. BRADLEY RD
RIVER
W CALUMET RD
W GOOD HOPE RD
N 99TH ST
PARK MANOR DR
MENOMONEE
GREEN TREE RD
N 91 ST ST
W MILL RD
W FOND DU LAC AVE
STH 145
MENOMONEE RIVER PKWY
C & NW RR
APPLETON AVE
W SILVER SPRING DR
LITTLE
N LOVERS LANE RD
HAMPTON AVE
MENOMONEE RIVER
KEY MAP
WEST
EAST
0
5'
10'
15'
20'
25'
30'
W.L.
0
1'
2'
3'
SECTION 1
SECTION 2
SOFT
SECTION 3
SOFT CENTER
FIRM BANKS
SECTION 4
SOFT



LEGEND

PROBABLE DREDGING PILES

INLETS: LETTERS REFERENCE TABLE C-3 DESCRIPTIONS

DITCH/NATURAL CHANNEL

CULVERT

NO SIGNIFICANT FLOW

CREOSOTE RESPONSE: CREOSOTE ASSUMED TO BE PRESENT WHERE OILY RESPONSE TO SEDIMENT DISTURBANCE

HIGH RESPONSE: Oily slicks formed/ visible sheen in sediments

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LOW RESPONSE: Isolated oil droplets

SAMPLING:

CROSS SECTION SAMPLING: At Each Cross Section

INTERVAL SAMPLING: At Approximate 300' Intervals

◇ DREDGING AND FLOOD PLAIN DEPOSIT SAMPLING: As Shown

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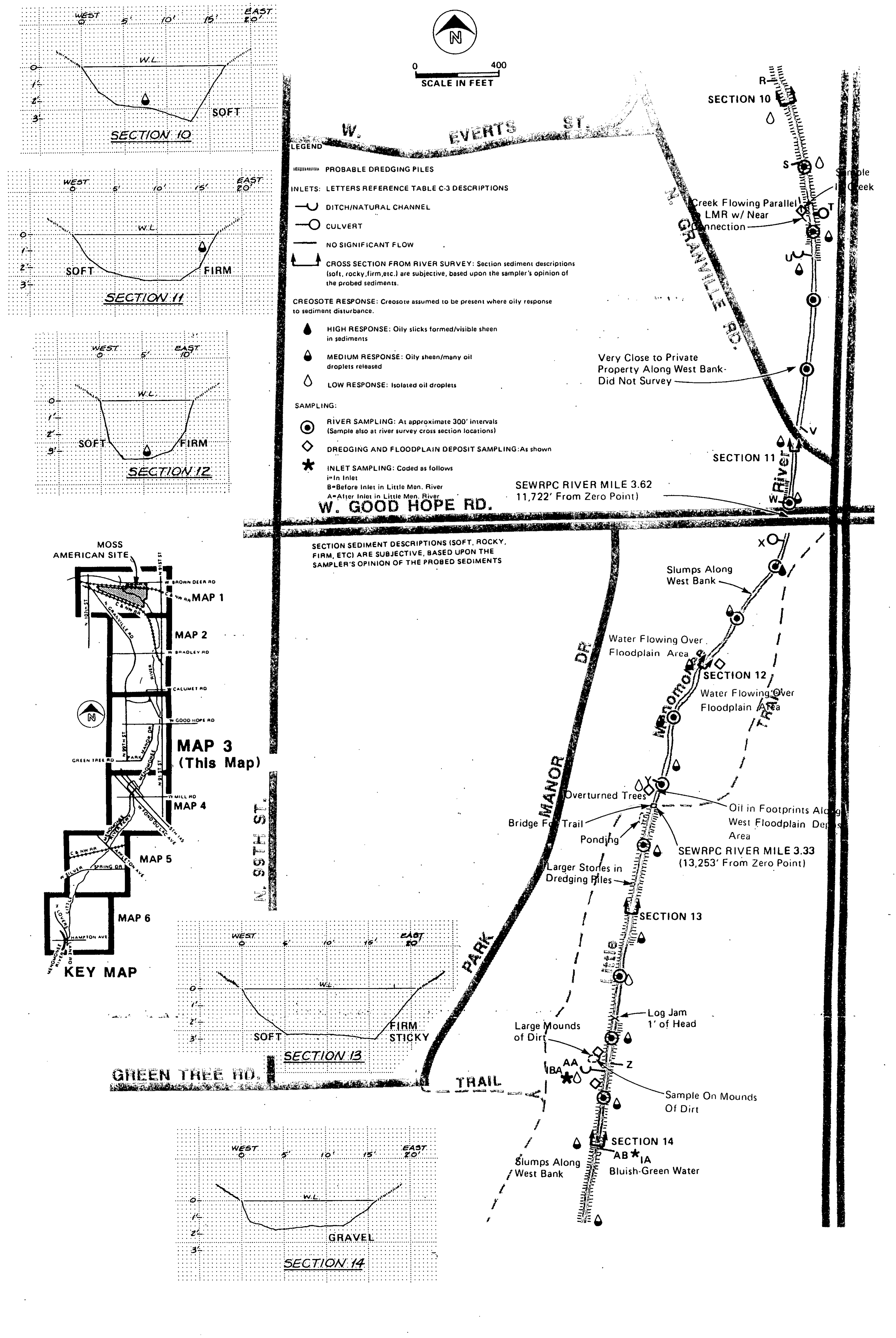

LEGEND

PROBABLE DREDGING PILES

INLETS: LETTERS REFERENCE TABLE C-3 DESCRIPTIONS

DITCH/NATURAL CHANNEL

CULVERT

NO SIGNIFICANT FLOW

CROSS SECTION FROM RIVER SURVEY: Section sediment descriptions (soft, rocky, firm, etc.) are subjective, based upon the sampler's opinion of the probed sediments.

CREOSOTE RESPONSE: Creosote assumed to be present where oily response to sediment disturbance.

HIGH RESPONSE: Oily slicks formed/visible sheen in sediments

MEDIUM RESPONSE: Oily sheen/many oil droplets released

LOW RESPONSE: Isolated oil droplets

SAMPLING:

RIVER SAMPLING: At approximate 300' intervals (Sample also at river survey cross section locations)

DREDGING AND FLOODPLAIN DEPOSIT SAMPLING: As shown

INLET SAMPLING: Coded as follows
I=In Inlet
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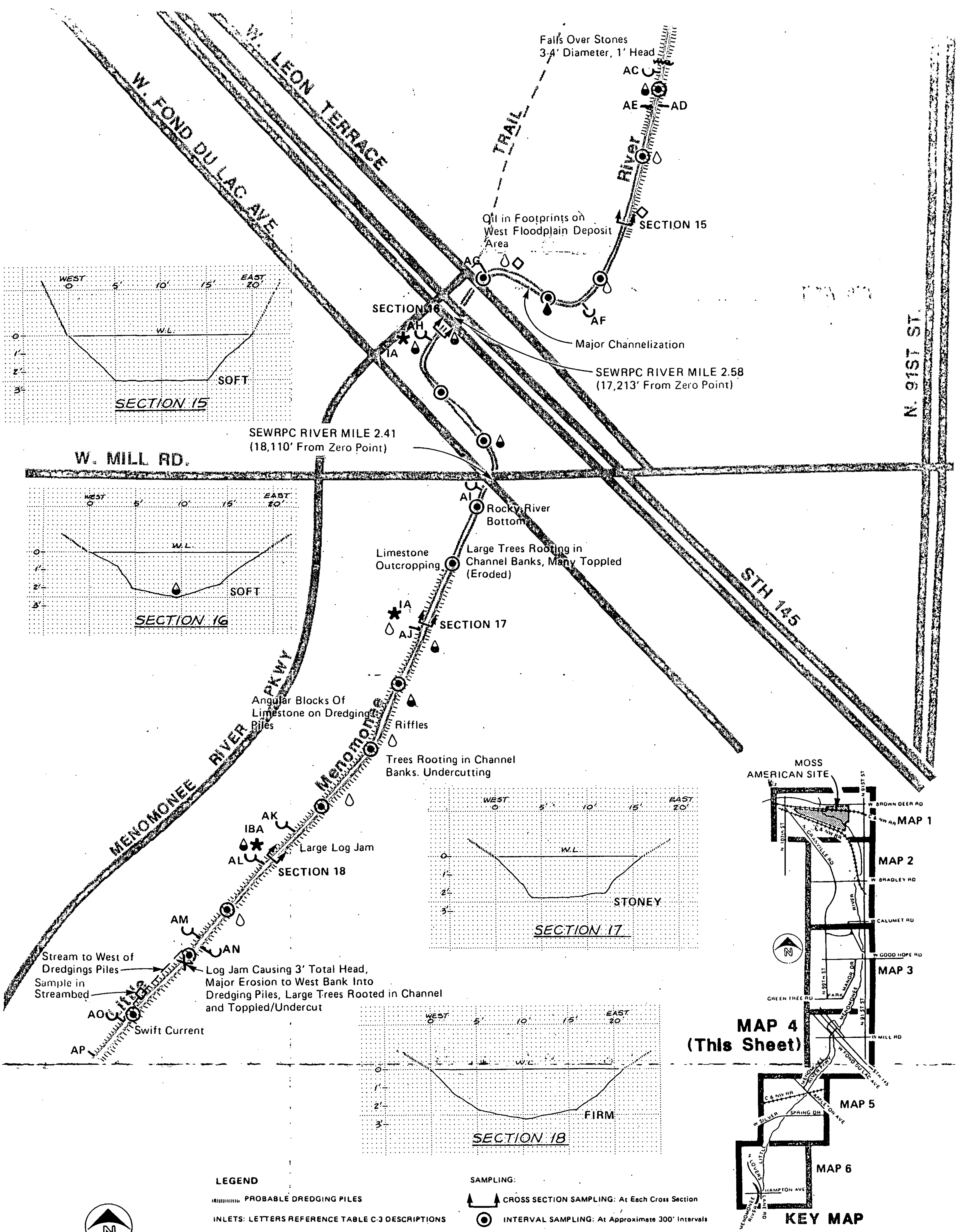
A=After Inlet in Little Men. River

SECTION SEDIMENT DESCRIPTIONS (SOFT, ROCKY, FIRM, ETC) ARE SUBJECTIVE, BASED UPON THE SAMPLER'S OPINION OF THE PROBED SEDIMENTS



0 400
SCALE IN FEET

LEGEND

PROBABLE DREDGING PILES

INLETS: LETTERS REFERENCE TABLE C-3 DESCRIPTIONS

DITCH/NATURAL CHANNEL

CULVERT

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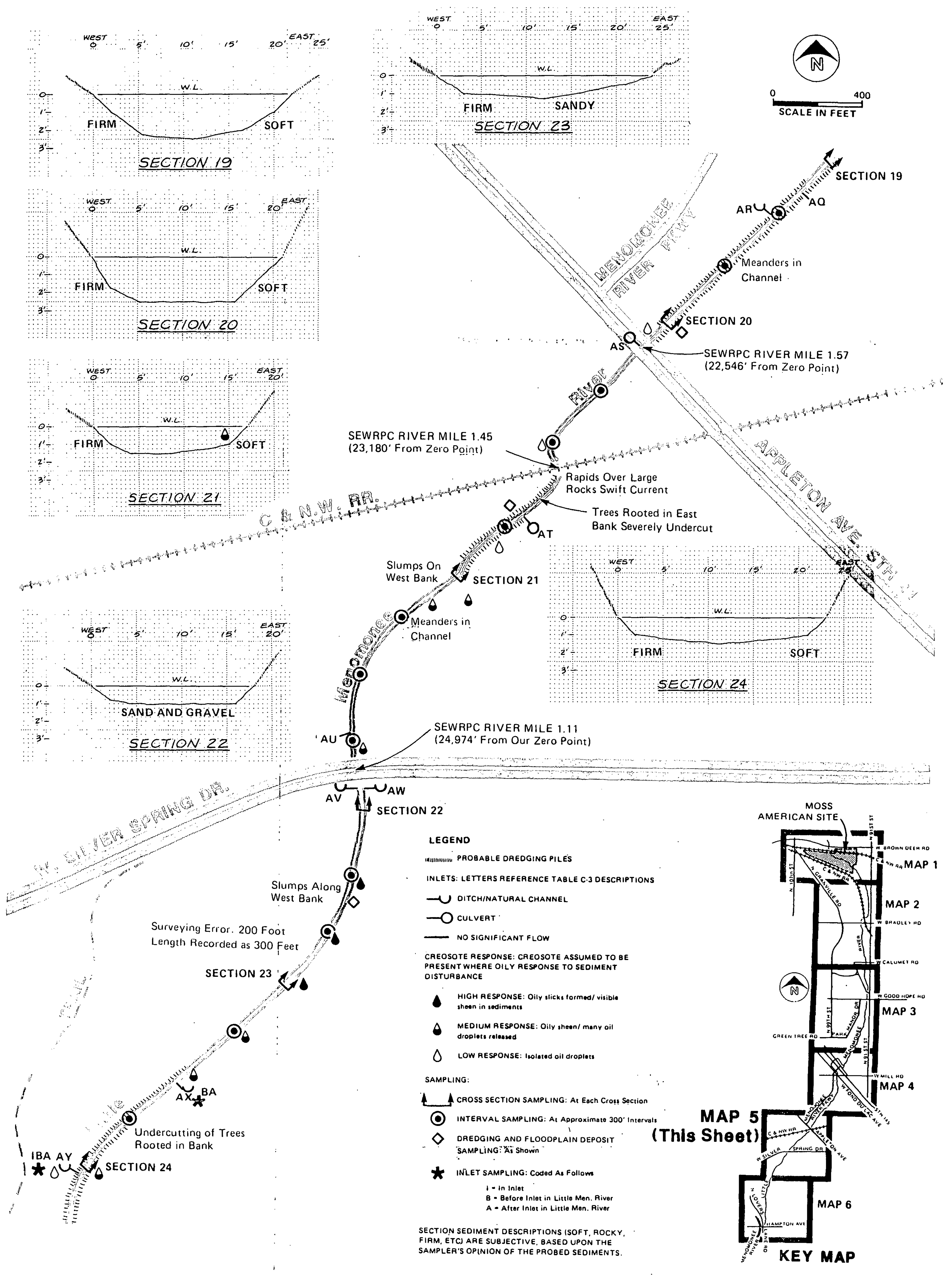
WEST 0 5' 10' 15' 20' EAST 25'
0 1' 2' 3'
W.L.
FIRM
SOFT
SECTION 19
WEST 0 5' 10' 15' 20' EAST
W.L.
FIRM
SOFT
SECTION 20
WEST 0 5' 10' 15' EAST 20'
W.L.
FIRM
SOFT
SECTION 21
WEST 0 5' 10' 15' EAST 20'
W.L.
SAND AND GRAVEL
SECTION 22
WEST 0 5' 10' 15' 20' EAST 25'
W.L.
FIRM
SANDY
SECTION 23
WEST 0 5' 10' 15' 20' EAST 25'
W.L.
FIRM
SOFT
SECTION 24
N
0 400
SCALE IN FEET
SECTION 19
AR
AQ
Meanders in Channel
SECTION 20
AS
SEWRPC RIVER MILE 1.57 (22,546' From Zero Point)
MENOMONEE RIVER PKWY
River
SEWRPC RIVER MILE 1.45 (23,180' From Zero Point)
Rapids Over Large Rocks Swift Current
Trees Rooted in East Bank Severely Undercut
APPLETON AVE. STH. 145
C. & N.W. RR.
AT
Slumps On West Bank
SECTION 21
Meanders in Channel
Menomonee
AU
SEWRPC RIVER MILE 1.11 (24,974' From Our Zero Point)
W. SILVER SPRING DR.
AV
AW
SECTION 22
Slumps Along West Bank
Surveying Error. 200 Foot Length Recorded as 300 Feet
SECTION 23
AX
BA
Undercutting of Trees Rooted in Bank
IBA
AY
SECTION 24
LEGEND
PROBABLE DREDGING PILES
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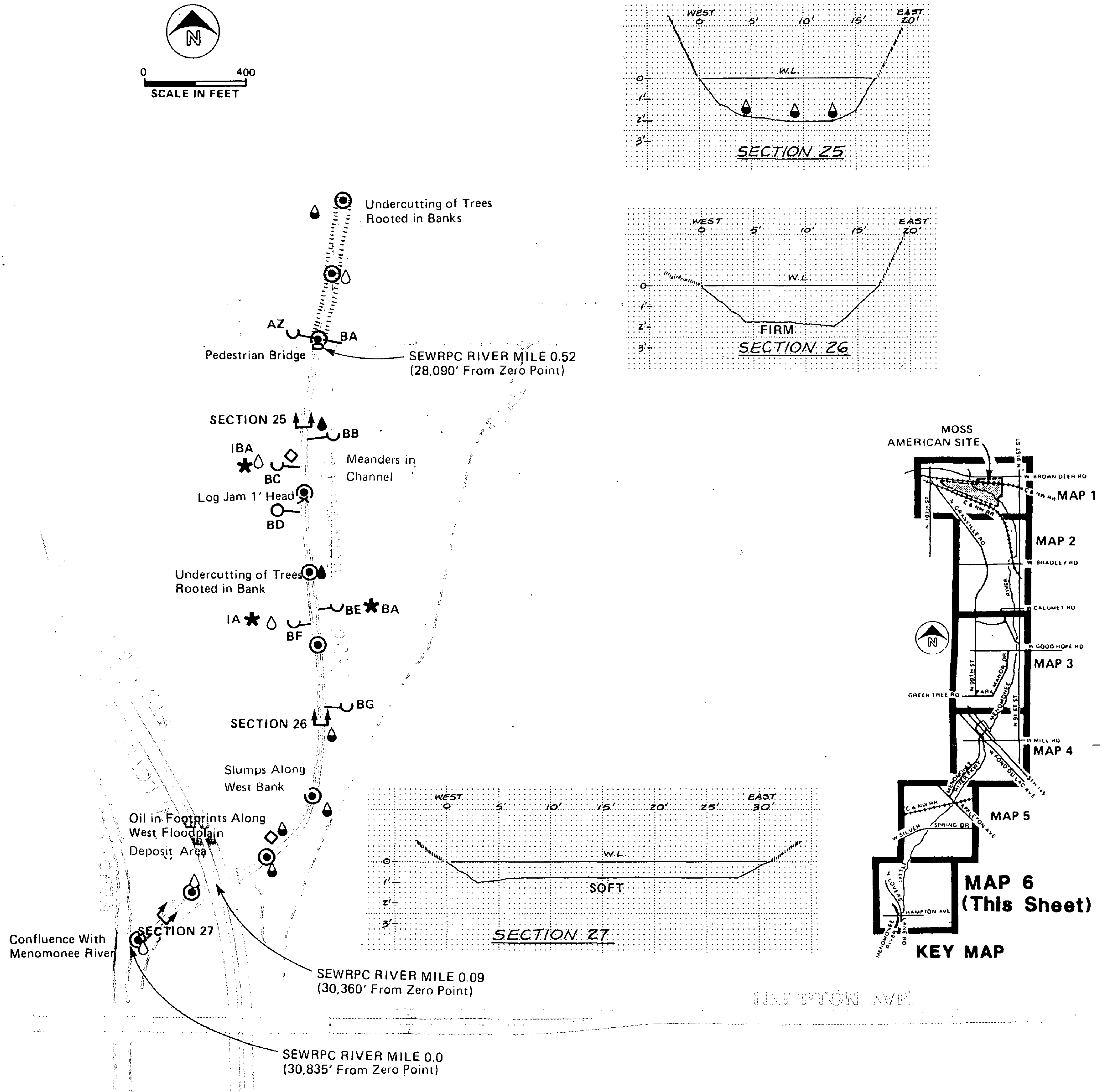
N 91st ST
W BROWN DEER RD
C & NW RR
MAP 1
N 107th ST
N GRANVILLE RD
MAP 2
W BRADLEY RD
RIVER
W CALUMET RD
N
W GOOD HOPE RD
MAP 3
N 99th ST
MANOR DR
GREEN TREE RD
PARK
MENOMONEE
N 91 ST
W MILL RD
MAP 4
W FOND DU LAC AVE
STH 145
MAP 5
(This Sheet)
C & NW RR
APPLETON AVE
W SILVER SPRING DR
MAP 6
LITTLE
LOVERS LANE RD
HAMPTON AVE
MENOMONEE RIVER
KEY MAP



LEGEND

ıııııııı PROBABLE DREDGING PILES

INLETS: LETTERS REFERENCE TABLE C-3 DESCRIPTIONS

—◡ DITCH/NATURAL CHANNEL

—○ CULVERT

—— NO SIGNIFICANT FLOW

CREOSOTE RESPONSE: CREOSOTE ASSUMED TO BE PRESENT WHERE OILY RESPONSE TO SEDIMENT DISTURBANCE

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TECHNICAL MEMORANDUM

TO: Angela Porter/U.S EPA Region V

FROM: Don Johnson/CH2M HILL
Solveig Christenson/CH2M HILL

DATE: October 25, 1988

RE: Tasks S1 and S2--Sediment Sampling
Moss-American Site

PROJECT: GLO63341.S1
GLO63341.S2

INTRODUCTION

This memorandum describes the sediment screening and sampling performed at the Moss-American site. Objectives, tasks, results, and observations are presented for:

Task S1 - Initial Sediment Screening
Task S2 - Confirmatory Sediment Sampling

Sediment sampling proceeded as described in the Quality Assurance Project Plan (September 14, 1987) and the Work Plan (July 23, 1987). Field modifications to the Sampling Plan described in the QAPP are noted in the section following each task description.

INITIAL SEDIMENT SCREENING

The data collected during initial sediment screening will be used to define the volume and extent of contamination in the sediments of the Little Menomonee River adjacent to and downstream of the Moss-American site. A total of 261 sediment samples and 30 bank and flood plain samples were collected.

The Little Menomonee River was sampled in three stages from downstream to upstream. Sampling was performed by Solveig Christenson, Stuart Grubb, and Kevin Olson of CH2M HILL from May 4 to May 19. The first stage of sampling consisted of the collection of samples at 300-foot intervals for the length of the river from the confluence with the Menomonee River to the Chicago and Northwestern (C&NW) Railroad bridge from May 4 to 10, 1988 (samples SD001 to SD104). Samples were analyzed throughout the task in the onsite close support laboratory (CSL) to determine the concentration of extractable organic (EO) compounds. Cross-section sampling and inlet sampling were completed in the second stage from May 11 to 18 (samples SD105 to SD261). Flood plain and bank sampling were performed in the final stage of sampling on May 18 and 19 (samples SS1001 to SS1029). Sample locations are shown in the maps in Attachment 1.

Representative samples were selected and sent to CH2M HILL's Montgomery laboratory for analysis of polynuclear aromatic hydrocarbons (PAHs) and phenolic compounds using capillary gas chromatography with flame ionization detection (GC/FID). This analysis is used to achieve U.S. EPA Level III data quality objectives. The CSL and GC/FID analytical methods are described in the Sampling Plan.

METHODOLOGY

Environmental Protection

Before sampling began, an oil boom was placed across the Little Menomonee River directly upstream of the confluence with the Menomonee River. During reconnaissance, floating oil frequently appeared when sediments were disturbed. The oil boom was used to catch oil that could float into the Menomonee River beyond the study area. It remained in place until sediment screening was completed. Upon completion of Task S1, the boom was removed and placed onsite for reuse during Task S2.

Sampling

Samples were initially gathered with a 2-inch-diameter, 20-inch-long corer lined with a plastic sleeve and stainless steel, bronze, or plastic sediment catcher. After the sample was collected, the plastic tube was removed from the corer, capped, labelled, and transported to the field trailer. The corer was decontaminated and refilled with another decontaminated plastic sleeve and sediment catcher.

Sediment cores were visually inspected and described in the log; samples were stored in 4-ounce jars. The plastic sleeves, caps, and sediment catchers were decontaminated by washing in a detergent solution, washing in potable water, rinsing with a methanol solution, and rinsing with distilled water.

The softer sediments were not always retained by the corer and the corer was not capable of penetrating to depths sufficient for cross-section sampling. Therefore, a 1-inch auger was substituted for the corer at cross section No. 4 and used for all subsequent sediment sampling. Sediment samples collected with the auger were described and bottled at each sample location. The auger was decontaminated between sample locations using the procedure described above.

Sampling at 300-foot Intervals

Sediment samples were taken along the Little Menomonee River from downstream to upstream at approximately 300-foot intervals from the confluence with the Menomonee River to the north edge of the Moss-American site at the C&NW Railroad bridge. The intervals were adjusted for river characteristics as necessary.

Samples were taken from the portion of the river cross section where sediments were the deepest. If water depth or apparent severity of contamination made wading across the section unadvisable, samples were collected from the bank. When the quantity of sediment remaining in the corer after extraction from the riverbed was insufficient for analysis, more sediment was collected from a series of adjacent cuts until sufficient sediment was collected.

Cross Section and Inlet Sampling

Cross Section Sampling. Cross section locations were chosen from 300-foot interval locations having higher concentrations of EO compounds than neighboring intervals. The average distance between cross sections was about 1,400 feet. Cross section locations are shown on the location map in Attachment 3.

The width of the channel was measured and water depth at the sampling locations was estimated. Samples were taken from the 1/4, 1/2, and 3/4 points across the cross section. Sediment depth was based on the depth to which the auger could penetrate. Samples were collected at 1-foot intervals to a maximum depth of about 3 feet, depending on auger penetration.

Inlet Sampling. All inlets that potentially carry residential, industrial, and roadway drainage were sampled to investigate other possible sources of contamination. Inlets were defined as flows tributary to the Little Menomonee River (culverts, outfalls, streams, and other drainageways). Ideally, all inlet samples were to be taken from outside (above) the Little Menomonee River flood plain; however, that was usually not possible.

Flood Plain and Bank Sampling

Flood plain and bank sample locations were chosen to provide a representative sampling of river banks, the flood plain, and dredging piles. Samples were collected with a shovel or post hole digger. A hole was dug to a depth of 18 to 24 inches, and a sample of the bottom material was collected from the shovel or post hole digger and put into a sample jar. The shovel or post hole digger was decontaminated between each sample.

LABORATORY SCREENING AND ANALYSIS

Sediment samples were analyzed at the CSL to determine the concentration of EO compounds. Sixty samples were selected to represent ranges of EO concentration and to provide an even distribution of samples along the Little Menomonee River for PAHs and phenolic compounds. The selection process was intentionally biased to include a greater number of samples from contaminated areas. The results of the GC/FID analysis (Attachment 4) were used to validate the EO screening results, to provide concentrations of specific compounds found in creosote, and to provide a further basis for selection of samples for RAS and SAS analysis by CLP laboratories.

FIELD MODIFICATIONS TO THE SAMPLING PLAN

The three sampling subtasks were not performed in the sequence presented in the Sampling Plan. The cross sections were to be sampled first; then 300-foot intervals were to be sampled between cross sections. It was determined upon completion of Task FM, however, that sampling the river at 300-foot intervals from the confluence to the site would more effectively place cross sections. Therefore, the 300-foot interval sampling was performed before cross section sampling.

Was the Hnu fully charged?.

The decision was made not to collect HNu headspace readings from the sediment samples because initial sampling indicated no HNu headspace readings even from visually contaminated sediments. No readings above background were obtained at any time during the sediment sampling or from the sample headspace. Headspace measurements using the OVA were misleading due to methane in the samples, so further OVA headspace readings were not taken.

Only one sample was collected in each inlet, eliminating the samples to be taken immediately above and below each inlet and allowing more inlets to be sampled.

RESULTS AND OBSERVATIONS

Locations and Results

A total of 291 samples were collected. Of these, 210 were collected from the Little Menomonee River sediments, 51 from inlets to the river, and 30 from flood plain and bank areas. Twenty-two cross sections were sampled. Sample locations are shown in Attachment 1. Results of analysis for EO compounds are tabulated in Attachment 2, and the distribution of EO concentrations at each cross section is shown in Attachment 3. Attachment 4 contains the results of the GC/FID Analyses. Figure 1 shows the concentration of extractable organics and total PAHs plotted against the distance downstream in the Little Menomonee River. Results from locations with more than one sample, such as cross sections, were averaged for the graph.

Observations

The Little Menomonee River sediment contamination is best characterized by its erratic distribution along the length of the channel and within the sediments. Pockets of highly contaminated sediment appear to exist side by side with visibly clean sediments. For example, disturbing sediments during sampling may have caused a surface sheen; however, within a few feet there may have been no response from the disturbed sediments.

The data indicate that contaminated sediments are present from the site to the confluence of the Little Menomonee River at the Menomonee River. EO concentrations apparently do not decrease with distance from the site although concentrations are higher in some areas ~~than in others.~~

For most of the inlet samples, it was not possible to sample outside the Little Menomonee River flood plain, particularly

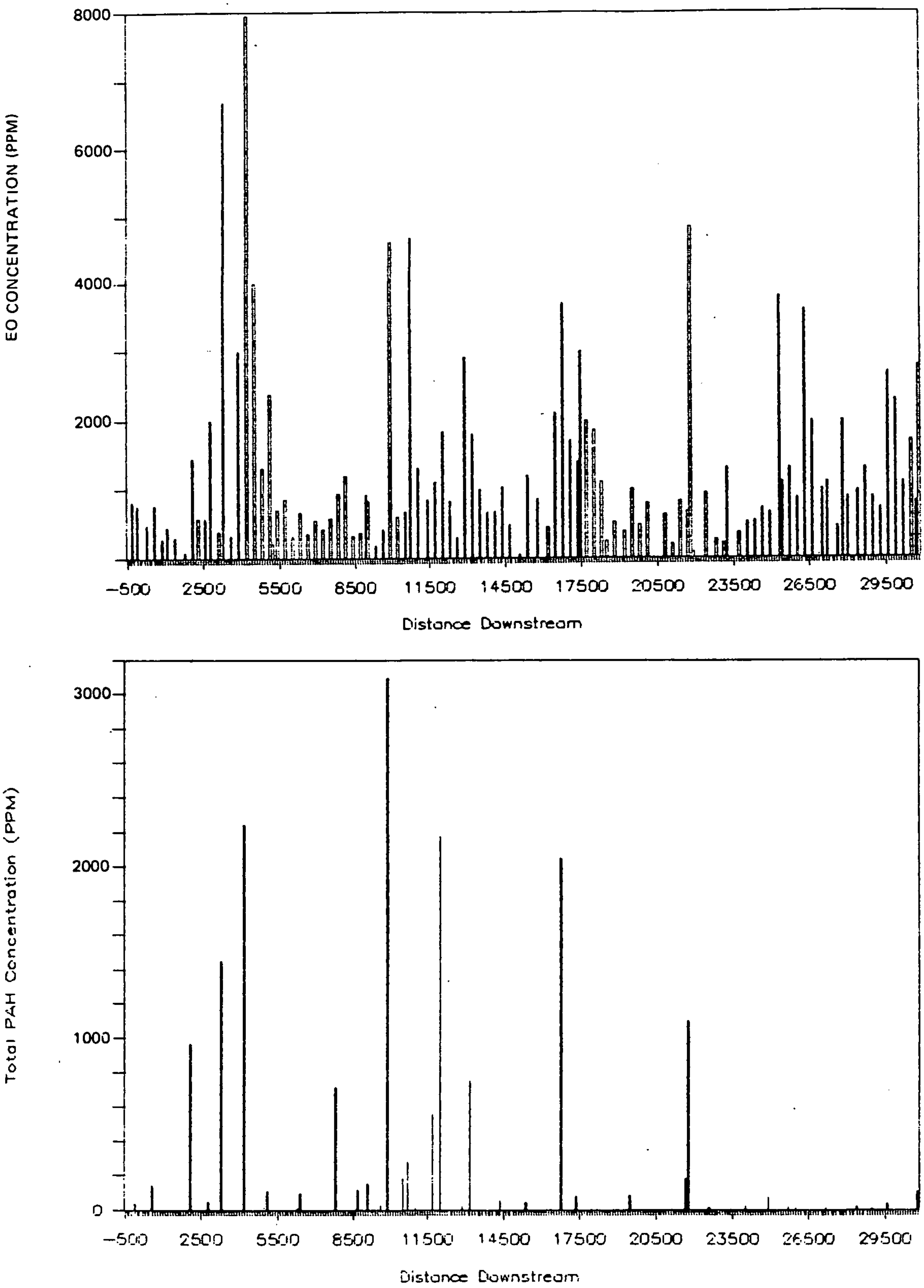


FIGURE 1
DISTRIBUTION OF EXTRACTABLE ORGANIC (EO) AND TOTAL PAH CONCENTRATIONS ALONG THE LITTLE MENOMONEE RIVER
MOSS-AMERICAN RI

when the inlet was a culvert. Therefore, the data obtained for the inlets cannot be attributed to the inlet alone. Most of the inlet samples can be expected to contain sediments deposited there by the Little Menomonee River.

Contaminated sediment can be buried below substantial amounts of clean sediment. For example, north of Bradley Road a large quantity of light brown silt was entering the river. Three inlets in particular, located 600 to 1,100 feet downstream of the site, appeared to be filled with the silt from a new development area. About 680 feet downstream of the site, a culvert had approximately 70 percent of its area clogged with the silt. Downstream cross section samples showed the same silt in layers up to 14 inches over potentially contaminated silty sand and sandy silt sediments.

The qualitative correlation between visual observations and concentrations of EO compounds was very good. Generally, sediments with more than 1,000 ppm (0.1 percent) of EO compounds showed visible signs of contamination. The statistical correlation between EO compounds and total PAHs was also significant (see Figure 2). The value of the correlation coefficient (R) for a log-log comparison of these data is 0.7. At a significance level of 0.05, the EO and total PAH concentrations are linearly dependant; higher EO concentration correspond to higher PAH concentration.

CONFIRMATORY SEDIMENT SAMPLING

Following the review of data from Task S1, confirmatory samples were collected at 16 sites (see Figure 3) on June 16 and 17 by Solveig Christenson and John Gannon. Samples were sent to CLP laboratories for detailed analysis. A list cross-referencing the sample numbers for these samples and earlier samples is given in Table 1.

The sediment sampling results will be used to confirm the results of the GC/FID analyses with legally defensible analytical results that will be used in the endangerment assessment. In addition, an analysis of Target Compound List substances will be done to determine whether other contaminants are present, and treatment parameters will be analyzed to support the feasibility study.

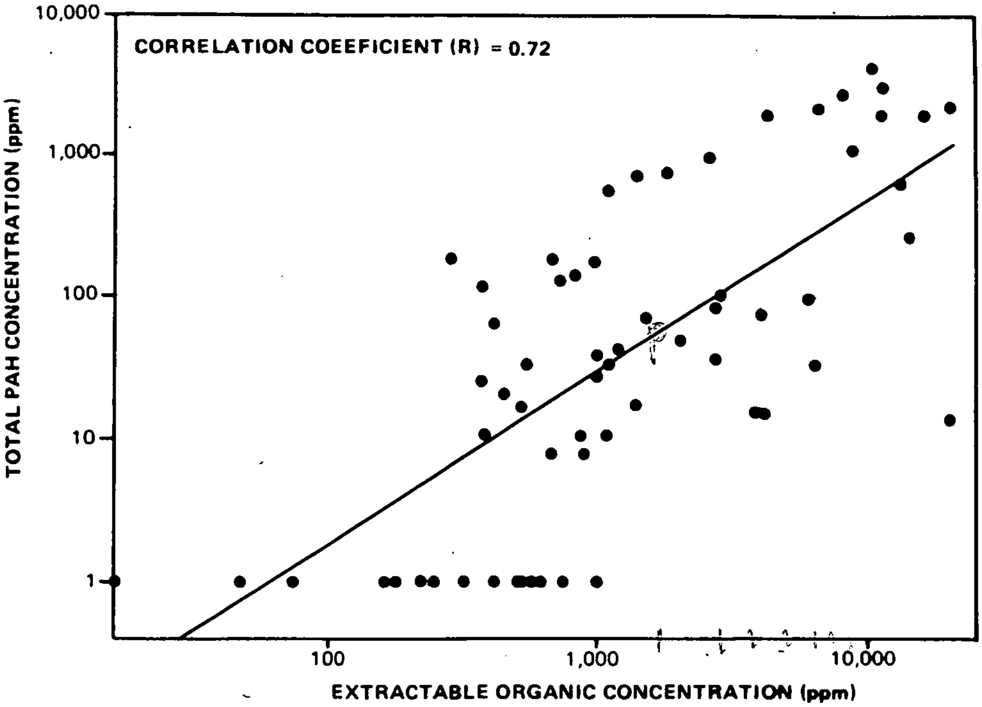


FIGURE 2
RELATIONSHIP BETWEEN EO
AND PAH CONCENTRATIONS
MOSS-AMERICAN RI

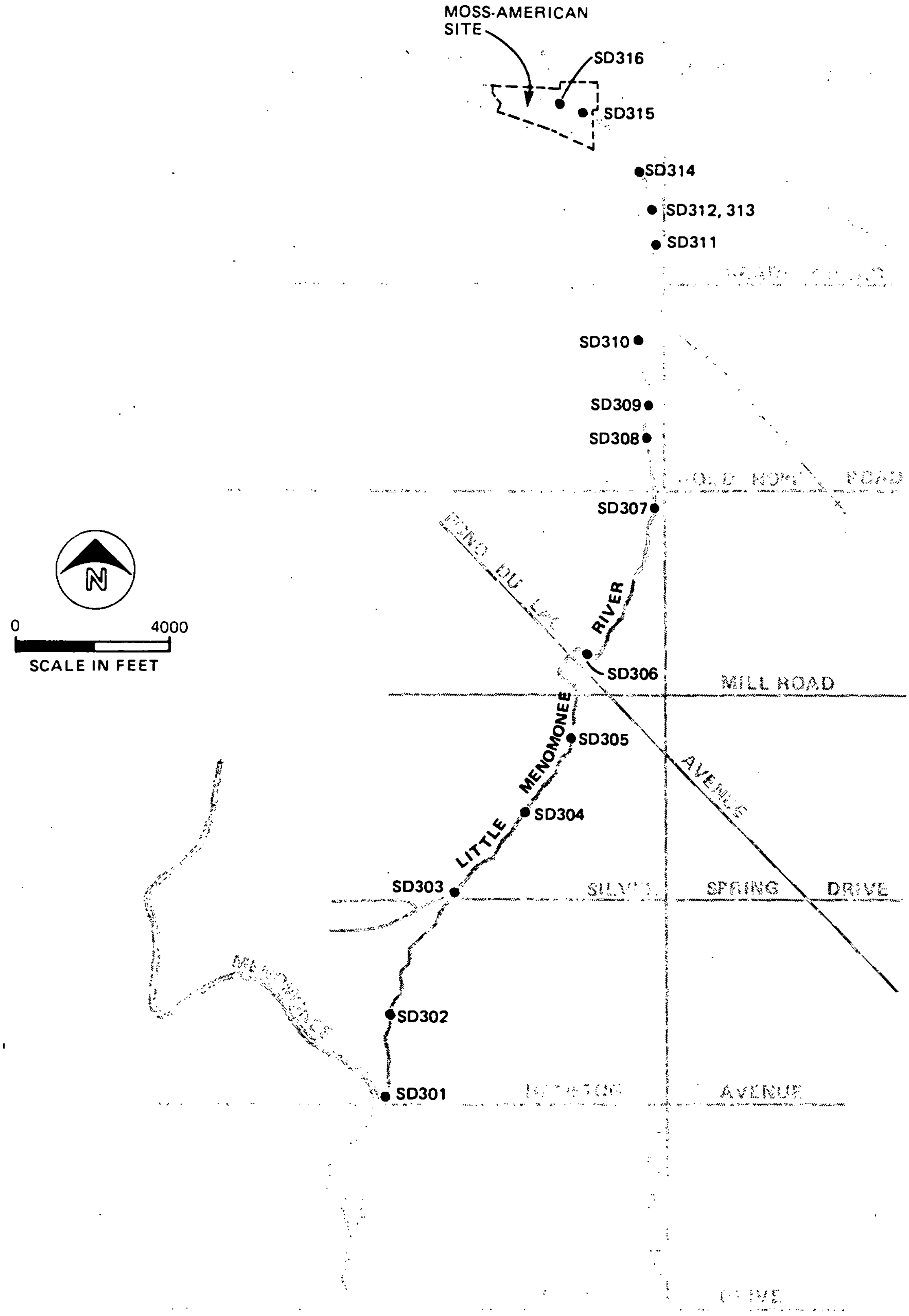


FIGURE 3
CONFIRMATORY SEDIMENT SAMPLING LOCATIONS (TASK S2)
MOSS-AMERICAN RI

Table 1
SAMPLES COLLECTED FOR CLP ANALYSES

CLP Sample Number	Previous Sample at Same Location
SD301-01	SD110-01
SD302-01	SD116-01
SD303-01	SD131-01
SD304-01	SD031-01
SD305-01	SD154-01
SD306-01	SD164-01
SD307-01	SD062-01
SD308-01	SD197-01
SD309-01	SD204-01
SD310-01	SD076-01
SD311-01	SD227-01
SD312-01	SD231-01
SD313-01	SD234-01
SD314-01	SD236-01
SD315-01	SD244-01
SD316-01	SD255-01

GLT779/34-1

TASK DESCRIPTION

Environmental Protection

Before confirmatory sediment sampling began, the oil boom was again placed across the Little Menomonee River directly upstream of its confluence with the Menomonee River. Upon completion of the task, the boom was placed in a 55-gallon drum and stored onsite.

Sample Locations

Ten samples were collected from areas representative of the most contaminated soils based on GC/FID and EO results. Six background or noncontaminated samples were also collected from along the length of the Little Menomonee River (see Figure 3).

Sample Collection

Samples for this task were taken from the same location as the corresponding EO screening samples taken previously. The sample location within the cross section was measured from the west bank and the sample depth was measured along the auger. For each sample, four 8-ounce jars, one 32-ounce jar, and two 4-ounce VOA vials were filled. Enough sediment was collected by making several adjacent cuts at the specified depth. The sediment was extruded from the auger onto a stainless steel tray and mixed. The jars were then filled using a stainless steel spoon. Implements were decontaminated before the next sample with a detergent wash and freshwater rinse followed by spray rinses of methanol and distilled water.

LABORATORY ANALYSIS

The samples were sent to CLP laboratories for detailed analysis of target compounds and analytes. Additional parameters analyzed to support the feasibility study consisted of carbon, hydrogen, sulfur, oxygen, nitrogen, moisture content, ash content, volatile content, fixed carbon, total organic carbon, water soluble chlorides, heating value, flash point, and pH.

RESULTS AND OBSERVATIONS

Analytical results are not available at this time.

Because of the dry weather during the period between sampling tasks, the Little Menomonee River stage was significantly lower during Task S2 sampling than during previous sampling. Since sample location was keyed to the location of the west bank, the change in water surface elevation may have affected the ability to locate precisely the sampling point to have been replicated from Task S1. Variations in the degree of contamination from S2 and S1 samples may occur because of difficulties in locating the sampling point.

CONCLUSIONS

Based on the observations and results obtained to date, the following conclusions have been reached regarding the sediments in the Little Menomonee River:

- Contaminated sediments are present over the entire length of the river below the Moss-American site.
- Contamination is not evenly distributed along the length of the river, across its width, or with depth.
- No significant decrease in contaminant concentrations was observed at increasing distances from the site.
- Contamination is assumed to have been deposited in the Menomonee River downstream of its confluence with the Little Menomonee River.

Oily sediment is present in varying degrees over the entire length of the Little Menomonee River. At several locations, when sediments were disturbed during sampling, iridescent or silver sheens were produced across the entire width of the river. Visual observations were verified by analytical results. EO concentrations up to approximately 1 percent (by dry weight) were measured in the sediment.

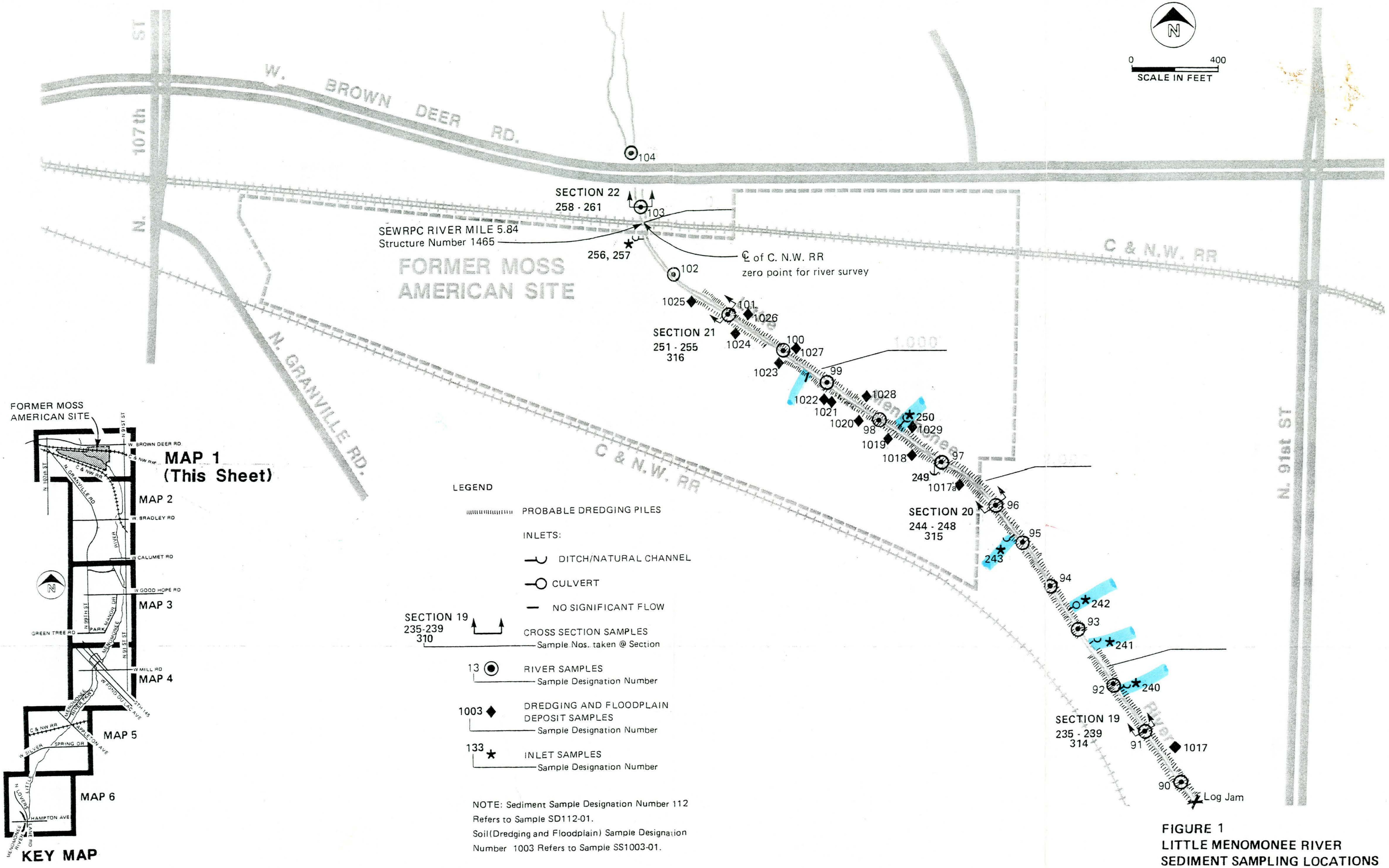
The distribution of contamination varies over the length, width, and depth of the river. Several areas of oily sediments are buried under approximately 1 foot of clean

Non-Point Source Erosion

sediment between the site and Bradley Road. Samples with low EO concentrations are interspersed between higher values throughout the river. Contaminated sediments are generally present along the banks and other depositional areas. Where the channel has been scoured, the sediments consist primarily of uncontaminated sands and gravels.

Based on the analytical data, no significant decrease in the level and extent of contamination was observed with distance from the site. Two areas between the site and Bradley Road and in the vicinity of Leon Terrace have higher levels of contamination. A trend in the EO data indicated that a slight decrease in contaminant concentration may occur below Leon Terrace. It should be noted, however, that samples were collected at 300-foot intervals. If samples had been collected at more frequent intervals, these trends may or may not have been substantiated. * On the basis of the extent of contamination in the Little Menomonee River, it is reasonable to expect that contamination has been deposited in the Menomonee River.

Attachment 1
SAMPLING LOCATIONS



NOTE: Sediment Sample Designation Number 112 Refers to Sample SD112-01.
Soil (Dredging and Floodplain) Sample Designation Number 1003 Refers to Sample SS1003-01.

FIGURE 1
LITTLE MENOMONEE RIVER
SEDIMENT SAMPLING LOCATIONS
MAY 4 - 19 AND JUNE 16 - 17, 1988
MOSS-AMERICAN RI

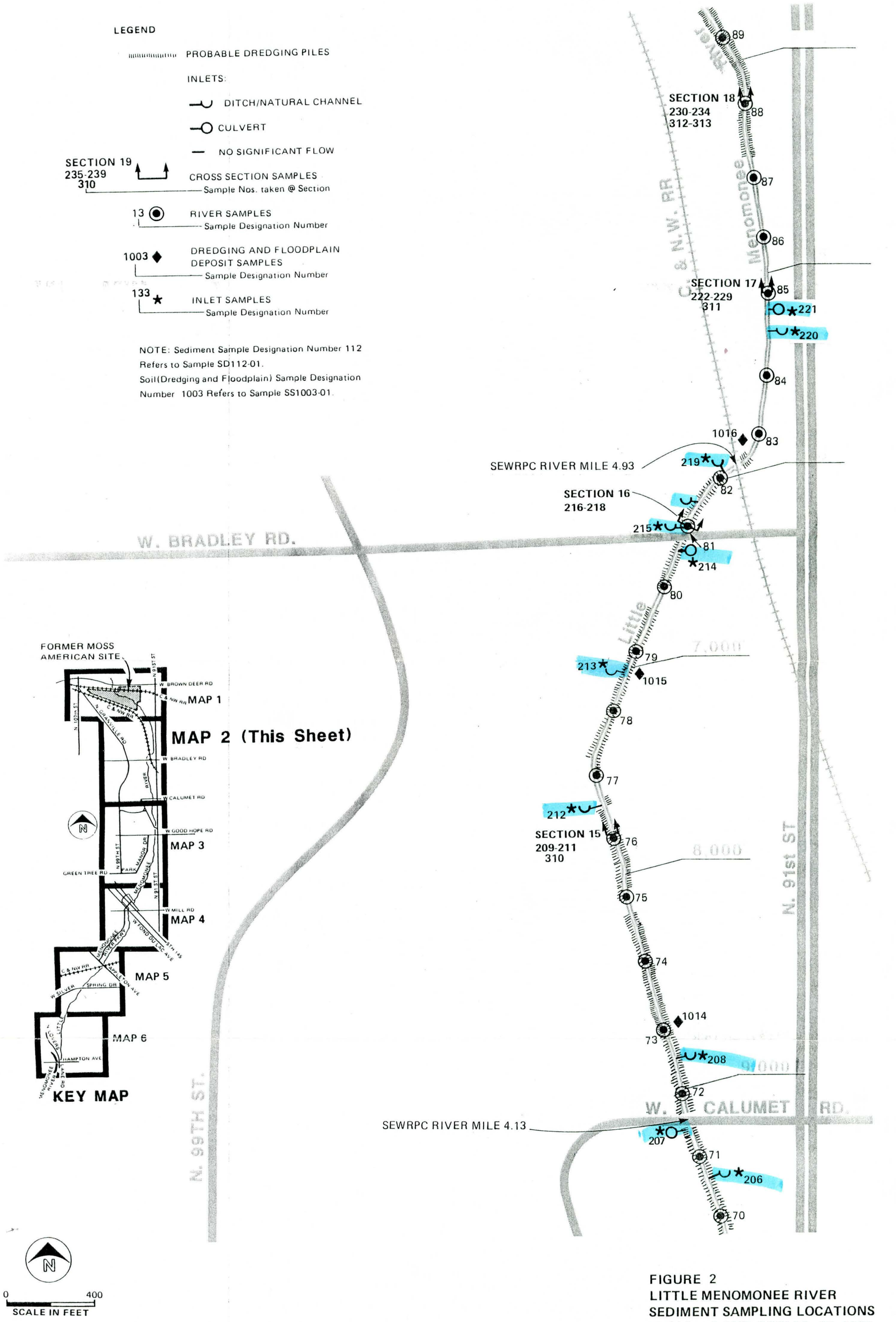
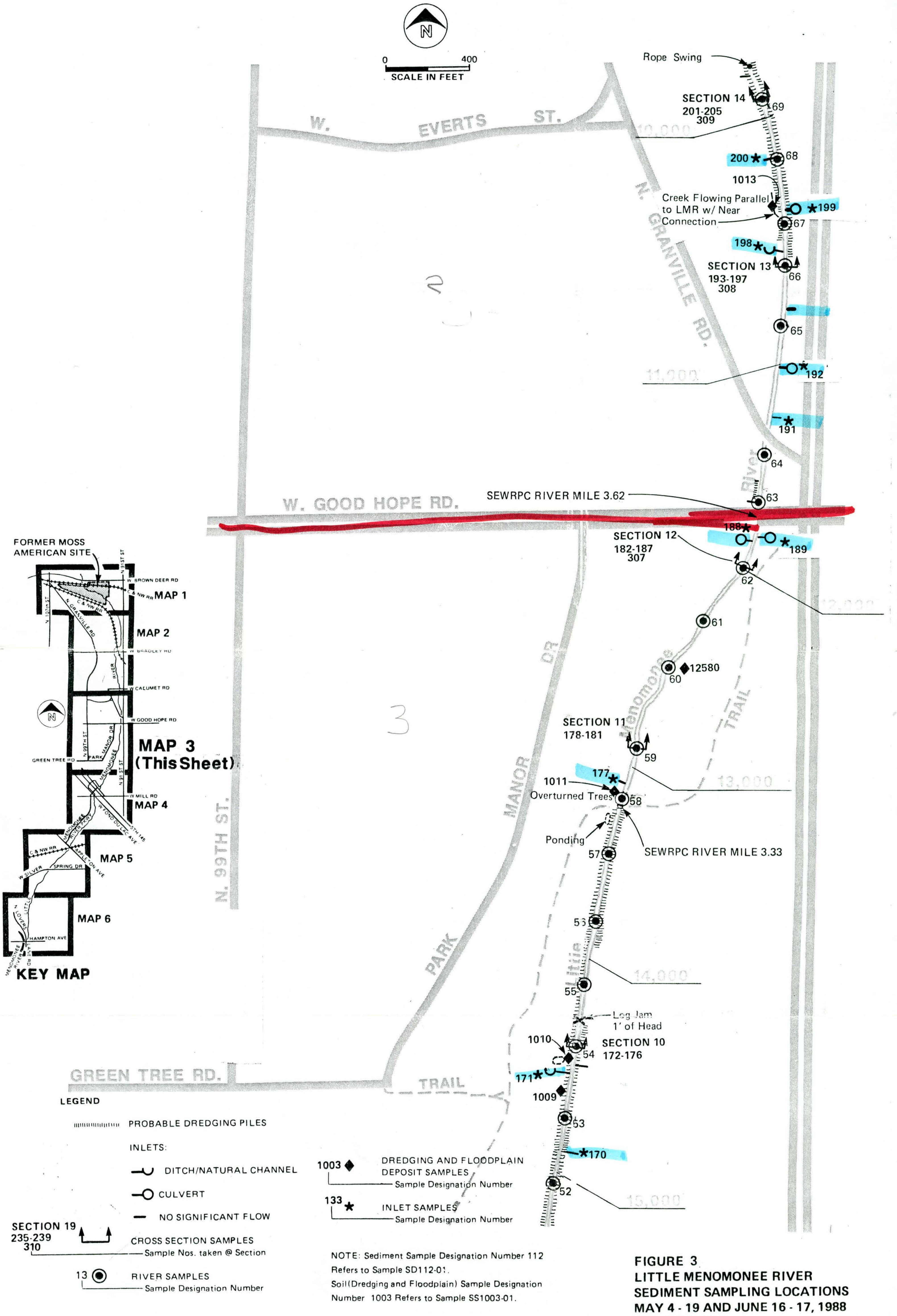
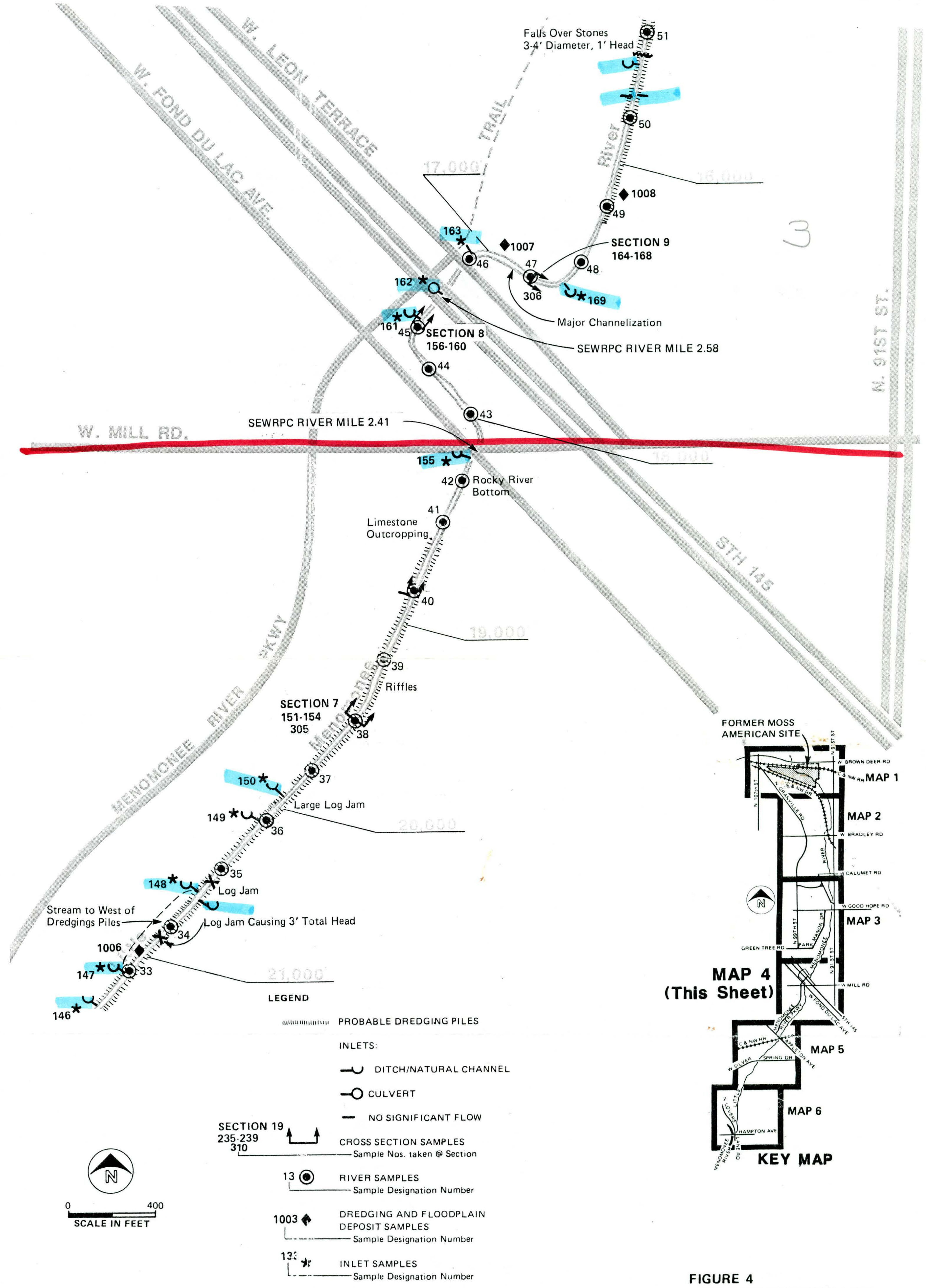


FIGURE 2
LITTLE MENOMONEE RIVER
SEDIMENT SAMPLING LOCATIONS
MAY 4 - 19 AND JUNE 16 - 17, 1988
MOSS-AMERICAN RI



NOTE: Sediment Sample Designation Number 112 Refers to Sample SD112-01. Soil (Dredging and Floodplain) Sample Designation Number 1003 Refers to Sample SS1003-01.

FIGURE 3
LITTLE MENOMONEE RIVER
SEDIMENT SAMPLING LOCATIONS
MAY 4 - 19 AND JUNE 16 - 17, 1988
MOSS-AMERICAN RI



NOTE: Sediment Sample Designation Number 112 Refers to Sample SD112-01.
Soil (Dredging and Floodplain) Sample Designation Number 1003 Refers to Sample SS1003-01.

FIGURE 4
LITTLE MENOMONEE RIVER
SEDIMENT SAMPLING LOCATIONS
MAY 4 - 19 AND JUNE 16 - 17, 1988
MOSS-AMERICAN RI

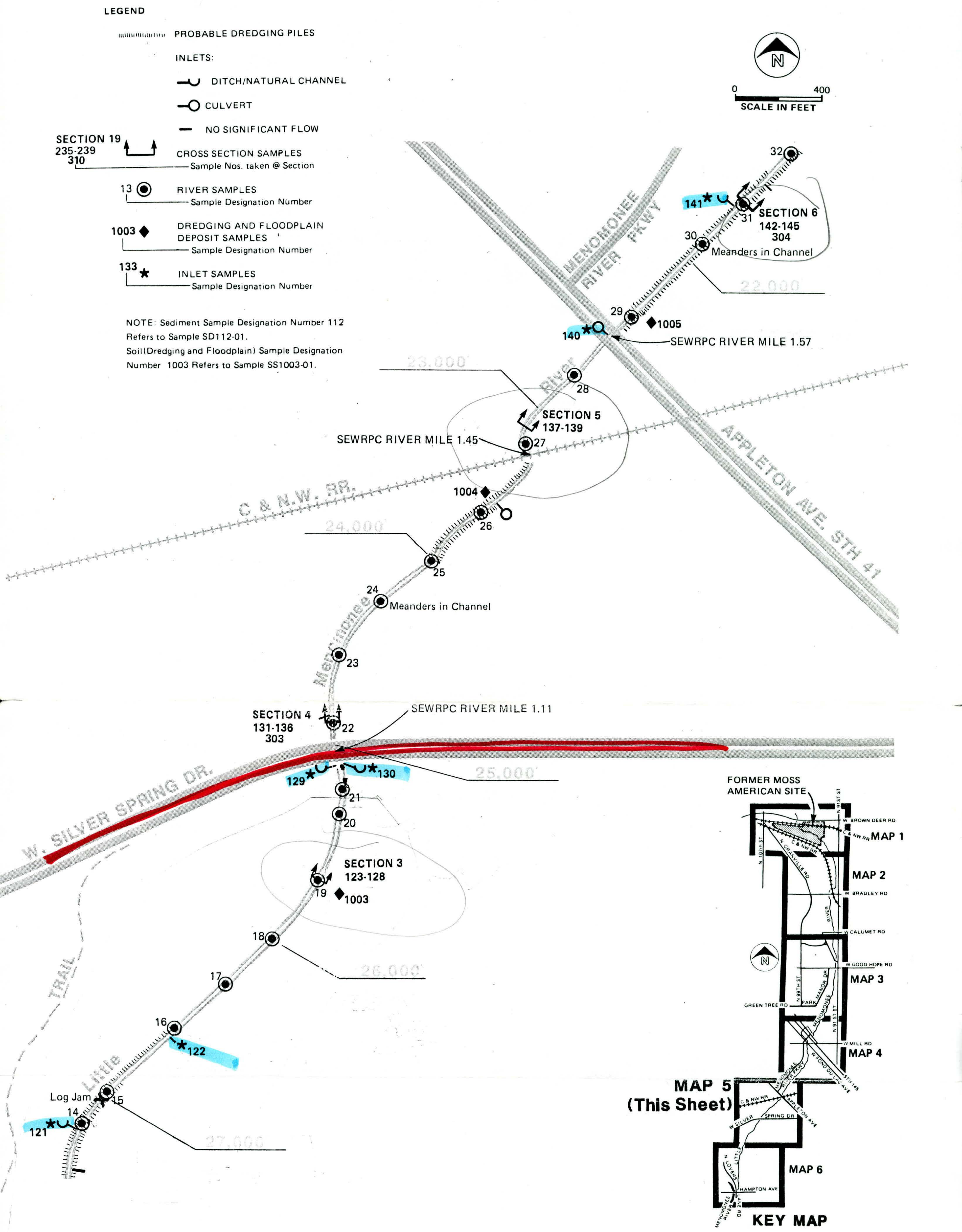
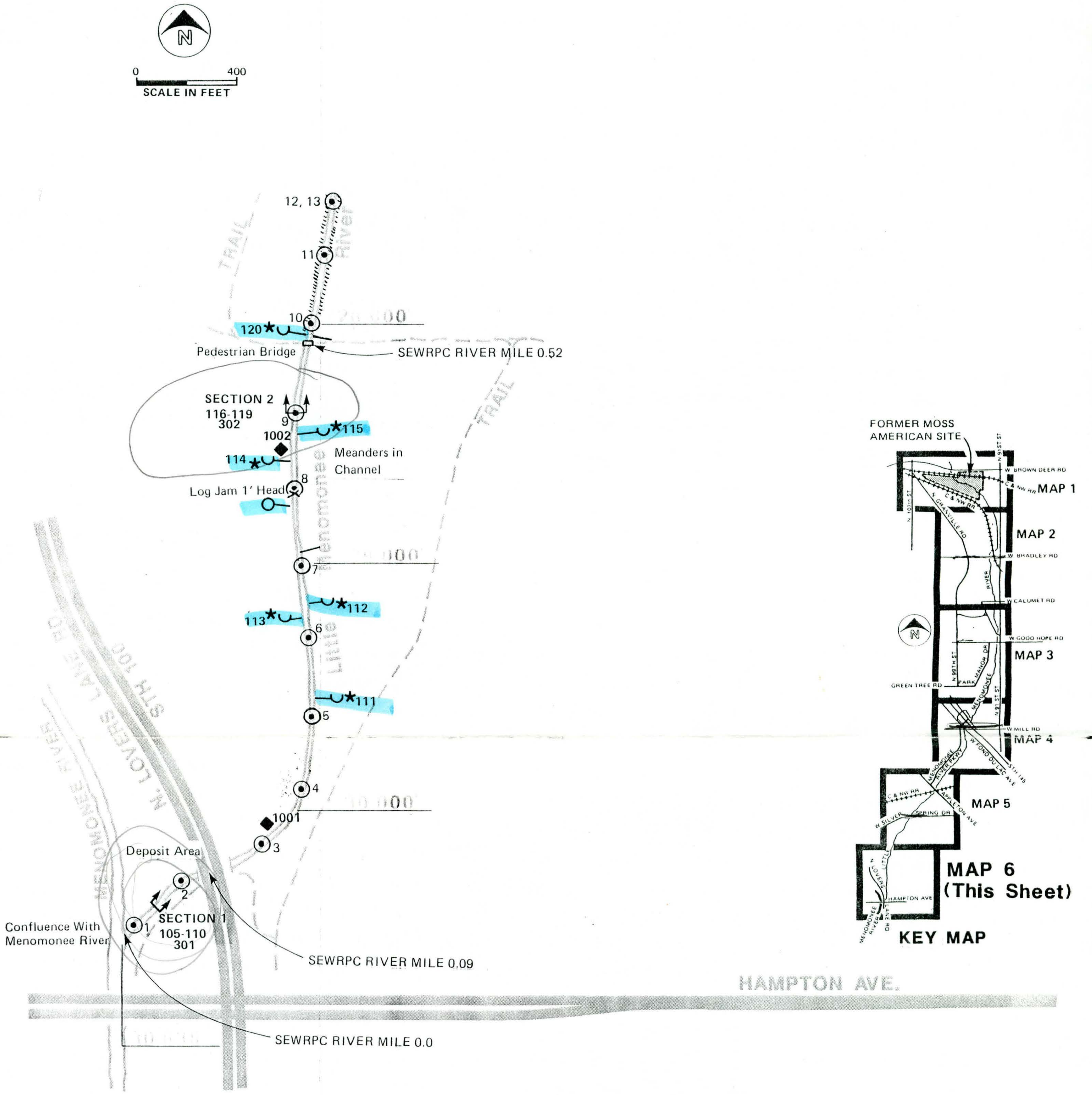


FIGURE 5
LITTLE MENOMONEE RIVER
SEDIMENT SAMPLING LOCATIONS
MAY 4 - 19 AND JUNE 16 - 17, 1988
MOSS-AMERICAN RI



LEGEND

ıııııııııııııı PROBABLE DREDGING PILES

INLETS:

—∪ DITCH/NATURAL CHANNEL

—○ CULVERT

— NO SIGNIFICANT FLOW

SECTION 19
235-239
310
↑_↑ CROSS SECTION SAMPLES
Sample Nos. taken @ Section

13 ⊙ RIVER SAMPLES
Sample Designation Number

1003 ◆ DREDGING AND FLOODPLAIN DEPOSIT SAMPLES
Sample Designation Number

133 ★ INLET SAMPLES
Sample Designation Number

NOTE: Sediment Sample Designation Number 112 Refers to Sample SD112-01.
Soil(Dredging and Floodplain) Sample Designation Number 1003 Refers to Sample SS1003-01.

FIGURE 6
LITTLE MENOMONEE RIVER
SEDIMENT SAMPLING LOCATIONS
MAY 4 - 19 AND JUNE 16 - 17, 1988
MOSS-AMERICAN RI

Attachment 2
FIELD DATA BY SAMPLE NUMBER
AND
EXTRACTABLE ORGANIC CONCENTRATIONS

ATTACHMENT NUMBER 2
MOSS-AMERICAN SEDIMENT SCREENING AND EXTRACTABLE ORGANIC CONCENTRATIONS

SAMPLE	X	Y	Z	W	S	DEPTH	EO	COMMENTS
SD001-01	30780	4	1.5	24	0.7	1	2800	Oil sheen during sample
SD002-01	30500	15	0.0	30	1.0	1	1700	Slight sheen on water
SD003-01	30200	5	0.5	25	2.0	1	1100	Sheen on water
SD004-01	29900	5	0.8	20	0.5	1	2300	Sheen on water
SD005-01	29600	-1	0.0	20	0.5	1	2700	Sheen on water
SD006-01	29300	14	1.5	18	0.8	1	730	No sheen
SD007-01	29000	12	1.5	15	0.5	1	890	Sheen on water
SD008-01	28650	14	0.5	15	1.0	1	1300	Sheen on water
SD009-01	28400	-3	0.0	10	0.5	1	3800	Sheen on water
SD010-01	28010	1	1.5	20	0.5	1	890	No sheen
SD011-01	27750	3	1.5	25	0.8	1	2000	Sheen on water
SD012-01	27600	1	1.5	15	0.8	1	210	Slight sheen on water
SD013-01	27600	-1	0.0	15	0.5	1	710	No visible sheen
SD014-01	27200	3	1.0	20	1.3	1	1100	Large sheen on water
SD015-01	27000	12	3.0	25	1.5	1	1000	Large oil sheen on water
SD016-01	26600	3	2.0	12	2.5	1	2000	Sheen on water
SD017-01	26300	18	0.0	17	2.5	1	3600	Sheen on water
SD018-01	26000	15	1.0	15	0.7	1	880	Slight sheen on water
SD019-01	25670	12	1.0	17	40.0	1	4200	Oil sheen on water and sample
SD020-01	25370	1	0.7	11	0.8	1	1100	No sheen
SD021-01	25270	0	0.0	25	1.5	1	3800	Sheen on water
SD022-01	24900	1	0.3	22	2.5	1	640	Slight sheen on water
SD023-01	24610	1	1.0	16	2.0	1	720	No sheen
SD024-01	24300	1.5	2.0	12	1.0	1	540	No sheen
SD025-01	24000	12	0.0	12	0.5	1	520	No sheen
SD026-01	23700	14	0.5	14	0.5	1	370	No sheen
SD027-01	23190	23	0.0	25	2.5	1	1300	No sheen
SD028-01	22800	17	2.5	18	0.3	1	270	No sheen
SD029-01	22410	1	1.0	20	2.0	1	940	Slighy sheen on water
SD030-01	21920	1	1.0	15	0.3	1	75	Sheen on water
SD031-01	21750	16	1.5	17	2.5	1	8600	Sheen on water and sample
SD031-01R	21750	16	1.5	17	0.5	1	1100	Field id RPSD001
SD032-01	21400	14.5	1.0	16	1.5	1	830	No sheen
SD033-01	21100	1	0.7	16	0.5	1	200	No sheen
SD034-01	20760	1.5	0.5	18	1.5	1	630	No sheen
SD035-01	20100	-0.5	0.0	16	0.8	1	1000	No sheen
SD036-01	20100	1	0.5	17	0.8	1	590	Sheen on water
SD037-01	19800	2	1.0	16	2.0	1	480	Sheen on water
SD038-01	19500	1.5	1.0	12	1.0	1	2700	Sheen on water and sample
SD039-01	19200	0	1.0	15	0.8	1	380	Slight sheen on water
SD040-01	18800	1	1.0	20	1.5	1	520	Sheen on water
SD041-01	18500	15	1.0	20	0.7	1	250	Slight sheen on water
SD042-01	18300	-1	0.0	9	2.5	1	1100	No sheen
SD043-01	18000	1	1.0	20	2.5	1	1400	Sheen on water and sample
SD043-01R	18000	1	1.0	20	2.5	1	2300	Field id RPSD002
SD044-01	17700	3	2.0	20	2.5	1	2000	Sheen on water and sample
SD045-01	17450	3	2.5	20	2.5	1	3000	Sheen on water
SD046-01	17100	4	2.5	12	0.5	1	1700	Sheen on water and sample
SD047-01	16800	3	2.0	12	2.5	1	4700	Heavy sheen on water & sample
SD048-01	16500	2	1.0	15	2.5	1	2100	Sheen on water and sample
SD049-01	16200	2	1.0	15	2.0	1	450	Sheen on water
SD050-01	15800	4	1.5	15	0.7	1	860	No sheen
SD051-01	15400	2	2.5	17	1.0	1	1200	Sheen on water
SD052-01	15050	2	2.0	15	2.5	1	46	Sheen on sample
SD053-01	14700	1	2.0	15	2.5	1	480	No sheen
SD054-01	14400	2	1.0	15	0.5	1	1500	Slight sheen on sample
SD055-01	14100	1	2.0	15	0.5	1	680	Sheen on water and sample
SD056-01	13800	8	2.5	16	0.5	1	660	Sheen on water and sample
SD057-01	13450	7	2.5	14	1.0	1	1000	Sheen on water
SD058-01	13200	3	2.0	17	1.0	1	1800	Slight sheen on water & sample
SD059-01	12920	1	3.0	8	2.5	1	5100	Heavy sheen, water and sample
SD060-01	12580	1	2.5	8	2.5	1	290	Sheen on water
SD061-01	12300	2	2.0	12	1.0	1	830	Sheen on water and sample
SD062-01	12000	2	2.0	10	1.5	1	10000	Heavy sheen, water and sample
SD063-01	11700	2	2.5	12	1.0	1	1100	Sheen on water and sample
SD064-01	11400	13	2.5	18	0.7	1	840	Sheen on water and sample
SD065-01	10950	5	2.0	18	1.5	1	1300	Sheen on water and sample
SD066-01	10670	3	2.0	14	1.5	1	3900	Heavy sheen, water and sample

ATTACHMENT NUMBER 2
MOSS-AMERICAN SEDIMENT SCREENING AND EXTRACTABLE ORGANIC CONCENTRATIONS

SAMPLE	X	Y	Z	W	S	DEPTH	EO	COMMENTS
SD067-01	10500	4	2.0	15	2.0	1	670	Sheen on water
SD068-01	10200	6	2.0	16	2.0	1	600	Sheen on water
SD069-01	9900	4	2.0	16	2.5	1	1600	Heavy sheen, water and sample
SD070-01	9600	-1	0.0	14	2.5	1	370	Sheen on water
SD070-01R	9600	-1	0.0	14	2.5	1	450	Field id RPSD003
SD071-01	9300	1	1.5	15	1.0	1	190	Slight sheen on water
SD072-01	9000	3	2.0	10	1.0	1	830	Sheen on water
SD073-01	8700	6	3.0	8	1.0	1	370	Slight sheen on water
SD074-01	8400	15	0.0	15	0.8	1	330	Slight sheen on water
SD075-01	8100	4	2.0	15	2.5	1	1200	Sheen on water and sample
SD076-01	7800	5	2.0	18	2.0	1	1400	Sheen on water and sample
SD077-01	7500	6	2.0	10	2.0	1	590	Sheen on sample and water
SD078-01	7200	2	2.0	10	0.7	1	410	No sheen, OVA methane perhaps
SD079-01	6900	2	1.5	12	0.7	1	550	No sheen
SD080-01	6600	2	1.5	11	0.7	1	350	Sheen on water
SD081-01	6300	1	1.5	10	0.3	1	1000	Sheen on water and sample
SD082-01	6000	1	1.0	14	1.5	1	330	Slight sheen on water
SD083-01	5700	1	2.0	12	2.0	1	860	Sheen on water and sample
SD084-01	5400	0	1.0	10	2.5	1	700	Sheen on water
SD085-01	5100	0.5	1.0	14	2.5	1	2500	Sheen on water and sample
SD086-01	4800	1	2.0	10	2.5	1	1300	Sheen on water and sample
SD087-01	4500	1	2.0	12	1.0	1	4500	Sheen on water and sample
SD087-01R	4500	1	2.0	12	1.0	1	3500	Field id RPSD004
SD088-01	4200	1	1.0	10	3.5	2	6100	Heavy sheen, water and sample
SD089-01	3900	2	3.0	10	3.0	1	3000	Very oily sample, water sheen
SD090-01	3600	2	1.0	15	2.5	1	330	No sheen, soil structure
SD091-01	3300	2	1.0	0	2.5	1	13000	No sheen, soil structure
SD092-01	3070	5	0.5	22	0.5	1	390	No sheen, soil structure
SD093-01	2770	6	0.5	25	1.5	1	2000	No sheen, soil structure
SD094-01	2550	1	2.0	15	0.5	1	560	No sheen, soil structure
SD095-01	2310	2	0.5	12	1.0	1	570	Slight sheen on water
SD096-01	2100	0.5	1.0	12	0.5	1	1200	Slight sheen on water
SD097-01	1800	0	0.5	13	0.3	1	73	Slight sheen on water
SD098-01	1400	1	0.5	20	0.7	1	290	Sheen on water
SD099-01	1050	3	0.5	20	2.5	1	450	Slight sheen in water
SD100-01	900	3	0.5	20	1.5	1	320	Sheen on water
SD100-01R	900	3	0.5	20	1.5	1	250	Field id RPSD005
SD101-01	600	2	0.5	20	2.0	1	270	Sheen on water
SD102-01	300	2	0.5	15	2.0	1	480	Sheen on water
SD103-01	-70	1	1.0	17	1.0	1	470	No sheen
SD104-01	-300	2	2.0	35	2.0	1	820	No sheen
SD105-01	30650	7	0.7	30	1.0	1	150	Section 1, no sheen
SD106-01	30650	15	0.7	30	1.7	2	420	Section 1, no sheen
SD107-01	30650	15	0.7	30	1.7	1	560	Section 1, no sheen
SD108-01	30650	23	0.7	30	2.0	2	1900	Section 1, no sheen
SD109-01	30650	23	0.7	30	2.0	1	1100	Section 1, no sheen
SD110-01	30650	0	0.0	30	1.2	1	750	Section 1, no sheen
SD111-01	29530	20	0.3	3	0.3	1	530	East inlet BG, some sheen
SD112-01	29160	20	0.3	3	0.3	1	230	East inlet BE, sheen on water
SD113-01	29170	-15	0.0	-0	0.7	1	1000	West inlet BF, no sheens
SD114-01	28570	-20	0.1	0	2.5	1	570	West inlet BC, sheen on water
SD115-01	28460	30	0.1	3	0.5	1	340	East inlet BB, no sheen
SD116-01	28400	-0.5	0.0	15.5	3.0	1	570	Section 2, sheen on water
SD117-01	28400	4.5	0.8	15.5	0.5	1	250	Section 2, no sheen
SD118-01	28400	4.5	0.8	15	0.5	2	230	Section 2, no sheen
SD119-01	28400	10.5	1.5	15.5	0.1	1	62	Section 2, no sheen
SD120-01	28060	-30	0.1	2	0.2	1	650	West inlet AZ, sheen on water
SD121-01	27240	-40	0.5	4	0.3	1	390	West inlet AY, sheen on water
SD122-01	26630	20	0.1	1	0.1	1	380	East inlet AX, no sheen
SD123-01	25670	4	0.7	22	1.7	1	1000	Section 3, sheen on water
SD124-01	25670	4	0.7	22	1.7	2	640	Section 3, sheen on water
SD125-01	25670	13	0.7	22	1.7	1	1100	Section 3, sheen on water
SD126-01	25670	13	0.7	22	1.7	2	420	Section 3, sheen on water
SD127-01	25670	18	0.7	22	1.7	1	1600	Section 3, sheen on water
SD128-01	25670	18	0.7	22	1.7	2	230	Section 3, sheen on water
SD129-01	25050	-10	0.5	9	0.3	1	280	West inlet AV, sheen on water
SD130-01	25050	20	2.0	5	0.3	1	2800	East inlet AW, sheen on water
SD131-01	24900	9	0.5	37	2.5	1	730	Section 4, no sheen

ATTACHMENT NUMBER 2
MOSS-AMERICAN SEDIMENT SCREENING AND
EXTRACTABLE ORGANIC CONCENTRATIONS

SAMPLE	X	Y	Z	W	S	DEPTH	EO	COMMENTS
SD132-01	24900	9	0.5	37	2.5	2	410	Section 4, no sheen
SD133-01	24900	18	2.0	37	1.2	1	590	Section 4, no sheen
SD134-01	24900	18	2.0	37	1.2	2	1000	Section 4, no sheen
SD135-01	24900	28	0.5	37	2.2	1	590	Section 4, no sheen
SD136-01	24900	28	0.5	37	2.2	2	660	Section 4, no sheen
SD137-01	23100	4	2.5	16	0.5	0	160	Section 5, some sheen
SD138-01	23100	8	2.5	16	0.7	1	140	Section 5, some sheen
SD139-01	23100	12	2.5	16	0.5	0	350	Section 5, some sheen
SD140-01	22550	-5	0.1	2	0.4	1	20000	West inlet AS, no sheen
SD141-01	21750	-60	0.3	4	0.4	1	87	West inlet AR, no sheen
SD142-01	21745	6	1.5	22	0.5	0	490	Section 6, no sheen
SD143-01	21745	10.5	2.0	22	1.0	1	510	Section 6, no sheen
SD144-01	21745	16	2.0	22	1.5	0	1000	Section 6, oily
SD145-01	21745	16	2.0	22	1.5	1	720	Section 6, oily
SD146-01	21350	-40	0.2	1	0.8	1	380	West inlet AP, no sheen
SD147-01	21150	-30	0.0	4	0.3	1	16	West inlet AO, no sheen
SD148-01	20600	-120	0.5	7	0.7	1	630	West inlet AM, no sheen
SD149-01	20140	-25	0.2	3	0.3	1	80	West inlet AL, no sheen
SD150-01	19970	-70	0.2	5	0.5	1	180	West inlet AK, no sheen
SD151-01	19500	9	2.0	25	1.2	0	470	Section 7, some sheen
SD152-01	19500	9	2.0	25	1.2	1	1100	Section 7, some sheen
SD153-01	19500	15	2.0	25	0.5	0	490	Section 7, very oily
SD154-01	19500	20	1.5	25	0.3	0	250	Section 7, no sheen
SD155-01	18115	-70	0.0	5	0.5	1	530	West inlet AI, no sheen
SD156-01	17400	4	1.5	19	2.0	1	940	Section 8, some oil
SD157-01	17400	4	1.5	19	2.0	2	1800	Section 8, very oily
SD158-01	17400	9	1.0	19	1.5	0	4000	Section 8, some oil
SD159-01	17400	9	1.0	19	1.5	1	130	Section 8, some oil
SD160-01	17400	14	2.0	19	0.7	1	120	Section 8, no sheen
SD161-01	17440	-200	0.5	3	0.5	1	440	West inlet AH, no sheen
SD162-01	17210	-6	0.2	2	0.3	1	1200	West inlet ACA, no sheen
SD163-01	17995	-40	0.1	1	0.4	1	370	West inlet AC, no sheen
SD164-01	16800	5	1.0	18	1.0	1	6400	Section 9, oily
SD165-01	16800	5	1.0	18	2.0	2	4200	Section 9, oily
SD166-01	16800	9	1.8	18	1.5	1	2600	Section 9, no sheen
SD167-01	16800	9	1.8	18	1.5	2	2500	Section 9, some oil
SD168-01	16800	14	2.0	18	1.0	1	1800	Section 9, no sheen
SD169-01	16630	30	0.2	1.5	0.3	1	290	East inlet AF, sheen on water
SD170-01	14900	50	0.3	10	0.3	1	390	East inlet AB, no sheen
SD171-01	14560	-30	0.1	1	0.3	1	590	West inlet AA, no sheen
SD172-01	14400	6	2.0	18	2.0	1	780	Section 10, no sheen
SD173-01	14400	6	2.0	18	2.0	2	180	Section 10, no sheen
SD174-01	14400	9	2.3	18	2.5	1	2400	Section 10, no sheen
SD175-01	14400	9	2.3	18	2.5	2	540	Section 10, some sheen
SD176-01	14400	14	2.0	18	1.0	1	790	Section 10, no sheen
SD177-01	13200	-45	0.0	3	0.3	1	140	West inley Y, no sheen
SD178-01	12920	3	2.5	12	0.8	1	500	Section 11, very oily
SD179-01	12920	5	2.8	12	0.7	1	1400	Section 11, some sheen
SD180-01	12920	9	2.5	12	1.5	1	5700	Section 11, oily
SD181-01	12920	9	2.5	12	1.5	2	1900	Section 11, oily
SD182-01	12000	3	1.5	11	1.0	0	1800	Section 12, oily
SD182-01R	12000	3	1.5	11	1.0	0	280	Field id RPSD006
SD183-01	12000	3	1.5	11	1.0	1	850	Section 12, oily
SD184-01	12000	5	2.0	11	0.8	0	230	Section 12, no sheen
SD185-01	12000	5	2.0	11	0.8	1	850	Section 12, no sheen
SD186-01	12000	9	2.0	11	1.0	0	200	Section 12, no sheen
SD187-01	12000	9	2.0	11	1.0	1	410	Section 12, no sheen
SD188-01	11880	-30	1.0	12	0.5	1	300	West inlet X, no sheen
SD189-01	11870	40	0.4	5	0.4	1	1200	East inlet WA, no sheen
SD190-01	11705	-30	0.3	1	0.5	1	560	West inlet W, no sheen
SD191-01	11220	40	0.0	4	0.4	1	420	East inlet V, sheen on water
SD192-01	11000	5	0.3	3	0.2	0	380	East inlet UB, no sheen
SD193-01	10670	3	1.0	17	0.7	1	1300	Section 13, oily
SD194-01	10670	9	2.0	17	2.2	0	5000	Section 13, very oily
SD195-01	10670	9	2.0	17	2.2	1	6100	Section 13, very oily
SD196-01	10670	9	2.0	17	2.2	2	1900	Section 13, very oily
SD197-01	10670	13	0.7	17	0.7	1	14000	Section 13, very oily
SD198-01	10610	-100	0.3	2	0.5	1	390	West inlet U, no sheen

ATTACHMENT NUMBER 2
MOSS-AMERICAN SEDIMENT SCREENING AND
EXTRACTABLE ORGANIC CONCENTRATIONS

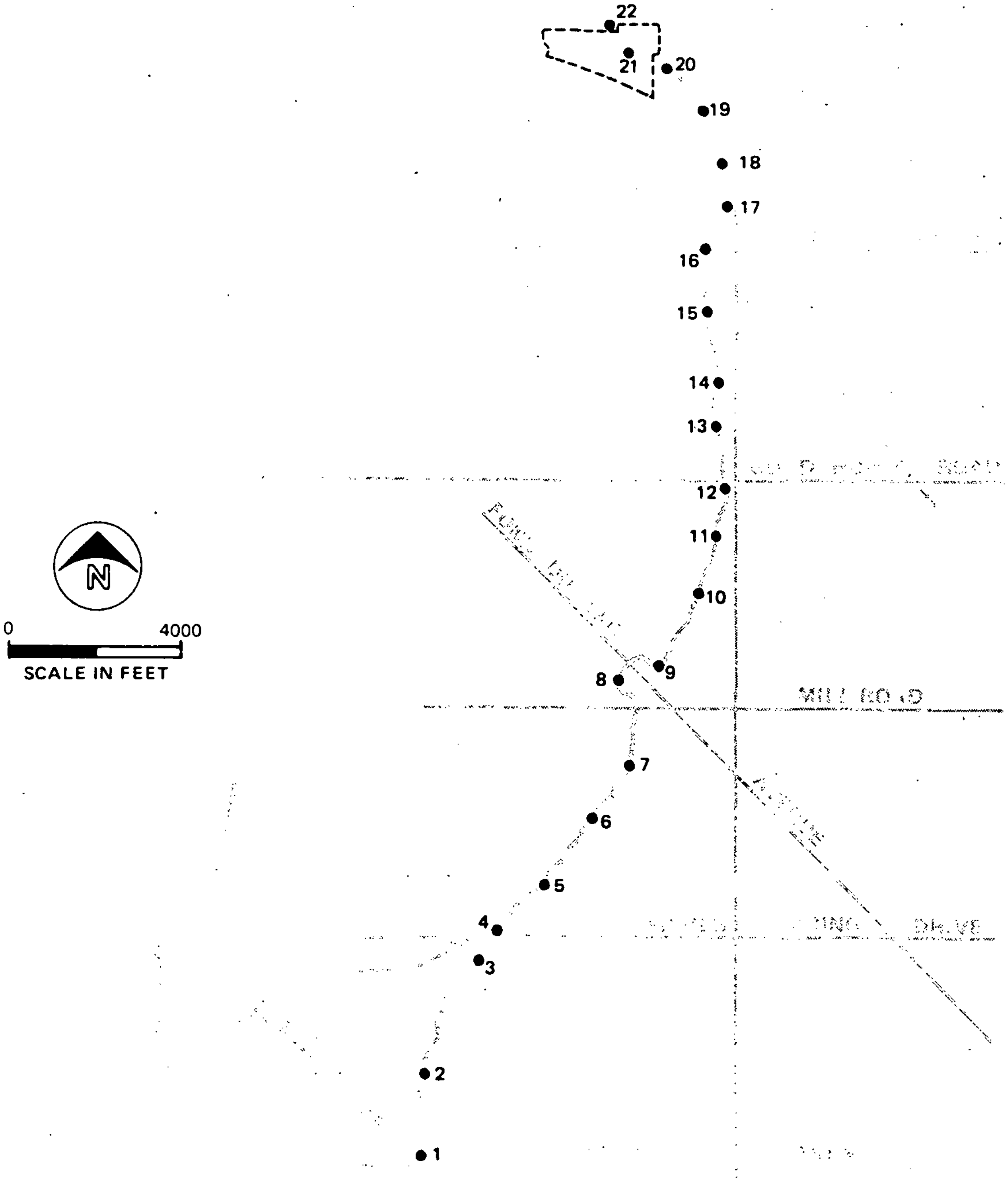
SAMPLE	X	Y	Z	W	S	DEPTH	EO	COMMENTS
SD199-01	10430	5	0.0	3	0.1	1	1000	West inlet T, no sheen
SD200-01	10180	-40	0.0	3	0.5	1	380	West inlet S, no sheen
SD201-01	9900	3	1.5	15	3.0	1	4800	Section 14, some oil
SD202-01	9900	3	1.5	15	3.0	2	4900	Section 14, oily
SD203-01	9900	3	1.5	15	3.0	3	3900	Section 14, oily
SD204-01	9900	8	2.0	15	0.5	0	11000	Section 14, some sheen
SD205-01	9900	12	2.0	15	0.7	1	1600	Section 14, oily
SD206-01	9450	40	0.2	4	0.5	1	670	East inlet Q, sheen on water
SD207-01	9080	-10	0.0	3	0.2	0	1000	West inlet P, no sheen
SD208-01	8880	100	1.0	14	0.7	1	490	East inlet O, sheen on water
SD208-01R	8880	100	1.0	14	0.7	1	920	Field id RPSD007
SD209-01	7800	4	1.0	16.5	0.8	1	760	Section 15, some oil
SD210-01	7800	8	1.0	16.5	0.7	1	790	Section 15, no sheen
SD211-01	7800	13	1.0	16.5	0.5	0	790	Section 15, no sheen
SD212-01	7660	-45	0.0	4	0.3	0	120	West inlet N, no sheen
SD213-01	7020	-70	0.3	3	0.3	0	140	West inlet M, no sheen
SD214-01	6380	20	0.0	1.5	0.2	0	5900	East inlet LA, no sheen
SD215-01	6320	-30	0.7	3	0.3	0	650	West inlet L, some sheen
SD216-01	6300	3	1.0	12	0.3	0	240	Section 16, no sheen
SD217-01	6300	6	1.0	12	0.3	0	680	Section 16, no sheen
SD218-01	6300	9	1.0	12	0.3	0	740	Section 16, oily below surface
SD219-01	5960	-4	2.0	7	0.5	0	150	West inlet J, no sheen
SD220-01	5260	35	0.0	3	0.8	1	100	East inlet I, no sheen
SD221-01	5160	4	0.0	4	0.7	1	47	East culvert H, no sheen
SD221-01R	5160	4	0.0	4	0.7	1	220	Field id RPSD008
SD222-01	5100	5	0.0	20	3.0	1	280	Section 17, no sheen
SD223-01	5100	5	0.0	20	3.0	2	390	Section 17, some oil
SD224-01	5100	5	0.0	20	3.0	3	440	Section 17, no sheen
SD225-01	5100	11	1.0	20	3.2	1	230	Section 17, no sheen
SD226-01	5100	11	1.0	20	3.2	2	4900	Section 17, very very oily
SD227-01	5100	11	1.0	20	3.2	3	6300	Section 17, oily
SD228-01	5100	15	1.8	20	1.8	1	2000	Section 17, no sheen
SD229-01	5100	15	1.8	20	1.8	2	4700	Section 17, some oil
SD229-01R	5100	15	1.8	20	1.8	2	2000	Field id RPSD009
SD230-01	4200	3	1.0	12	2.0	1	1100	Section 18, oily underneath
SD231-01	4200	3	1.0	12	2.0	2	16000	Section 18, very oily
SD232-01	4200	6	2.5	12	2.0	1	2600	Section 18, oily underneath
SD233-01	4200	6	2.5	12	2.0	2	7900	Section 18, very very oily
SD234-01	4200	9	2.0	12	1.0	1	11000	Section 18, oily underneath
SD235-01	3300	5	1.0	20	2.5	1	4100	Section 19, oily underneath
SD236-01	3300	5	1.0	20	2.5	2	20000	Section 19, very oily
SD237-01	3300	10	1.5	20	2.0	1	940	Section 19, no sheen
SD238-01	3300	10	1.5	20	2.0	2	5800	Section 19, very oily
SD239-01	3300	15	1.3	20	1.0	1	1000	Section 19, very oily
SD239-01R	3300	15	1.3	20	1.0	1	2000	Field id RPSD010
SD240-01	3110	40	0.2	3	0.5	0	270	East inlet G, no sheen
SD241-01	2860	40	0.0	20	0.2	0	150	East inlet F, no sheen
SD242-01	2680	70	0.2	4	2.5	1	100	East culvert E, no sheen
SD243-01	2250	-20	0.1	2	0.5	0	29	West inlet D, no sheen
SD244-01	2100	3	2.0	13	1.0	1	2600	Section 20, oily
SD245-01	2100	6	2.5	13	3.0	1	680	Section 20, no sheen
SD246-01	2100	6	2.5	13	3.0	2	2100	Section 20, oily
SD247-01	2100	6	2.5	13	3.0	3	290	Section 20, oil sheen
SD248-01	2100	9	2.0	13	1.0	1	2300	Section 20, oil underneath
SD248-01R	2100	9	2.0	13	1.0	1	940	Field id RPSD011
SD249-01	1780	-25	0.1	2	0.3	0	400	West inlet C, no sheen
SD250-01	1500	20	0.0	2	0.4	0	220	East inlet BAA, no sheen
SD251-01	600	5	1.0	21	0.8	1	890	Section 21, no sheen
SD252-01	600	11	1.0	21	3.0	1	760	Section 21, very oily
SD253-01	600	11	1.0	21	3.0	2	1000	Section 21, very oily
SD254-01	600	11	1.0	21	3.0	3	880	Section 21, some oil
SD255-01	600	16	0.8	21	0.8	1	830	Section 21, oily
SD256-01	50	-30	0.7	4	0.5	1	270	West inlet A, no sheen
SD257-01	50	-150	0.5	4	0.3	0	620	West inlet A, no sheen
SD258-01	-70	7	1.5	26	0.5	0	510	Section 22, no sheen
SD259-01	-70	12	1.5	26	0.8	1	740	Section 22, no sheen
SD259-01R	-70	12	1.5	26	0.8	1	1000	Field id RPSD012
SD260-01	-70	19	1.0	26	1.5	0	1000	Section 22, no sheen

ATTACHMENT NUMBER 2
MOSS-AMERICAN SEDIMENT SCREENING AND
EXTRACTABLE ORGANIC CONCENTRATIONS

SAMPLE	X	Y	Z	W	S	DEPTH	EO	COMMENTS
SD261-01	-70	19	1.0	26	1.5	1	840	Section 22, no sheen
SS1001-01	30130	-20	--	--	--	2	640	Floodplain
SS1002-01	28500	-15	--	--	--	2	190	Floodplain
SS1003-01	25580	15	--	--	--	2	180	Grassy slope
SS1004-01	23550	-30	--	--	--	2	20	Circular mound in woods
SS1005-01	22370	15	--	--	--	2	20	Tall dredging piles
SS1005-01	22370	15	--	--	--	2	110	Field id RPSS1001
SS1006-01	21030	-20	--	--	--	2	170	Dredging piles
SS1007-01	16950	-10	--	--	--	2	3600	Wide floodplain, oily
SS1008-01	16190	20	--	--	--	2	120	Small dredging piles
SS1009-01	14630	-20	--	--	--	1	90	Small dredging piles
SS1010-01	14470	-100	--	--	--	2	60	Large mounds of dirt
SS1011-01	13180	-15	--	--	--	2	8400	Floodplain, oily
SS1012-01	12580	20	--	--	--	1	450	Floodplain
SS1013-01	10400	-50	--	--	--	2	50	In ponded area
SS1014-01	8700	20	--	--	--	2	30	Dredging piles
SS1015-01	7010	30	--	--	--	0	50	Dredging piles, many rocks
SS1016-01	5840	-10	--	--	--	2	6500	Floodplain
SS1017-01	3430	40	--	--	--	2	130	In piles of dirt
SS1017A-0	1910	-40	--	--	--	2	0	Dredging pile, G1 task sample
SS1018-01	1670	-40	--	--	--	1	0	Dredging pile, G1 task sample
SS1019-01	1500	-40	--	--	--	1	450	G1 task sample
SS1020-01	1295	-40	--	--	--	2	10	G1 task sample
SS1021-01	1105	-40	--	--	--	2	790	G1 task sample
SS1022-01	1095	-45	--	--	--	2	300	Dirt mound, G1 task sample
SS1023-01	915	-50	--	--	--	2	720	Dirt pile, G1 task sample
SS1023-01	905	-50	--	--	--	2	890	Replicate, G1 task sample
SS1024-01	700	-40	--	--	--	1	20	Grassy area, G1 task sample
SS1025-01	455	-40	--	--	--	2	2400	G1 task sample
SS1026-01	700	40	--	--	--	2	0	Dredging pile, G1 task sample
SS1027-01	925	40	--	--	--	1	0	High organics, G1 task sample
SS1028-01	1240	20	--	--	--	2	30	G1 task sample
SS1029-01	1570	40	--	--	--	1	20	G1 task sample
SS1029-01	1570	40	--	--	--	1	0	Replicate, G1 task sample

NOTES: SAMPLE = SD, SEDIMENT SAMPLES, OR SS, BANK OR FLOODPLAIN SAMPLES, R, FIELD REPLICATE
X = DISTANCE DOWNSTREAM OF LITTLE MENOMINEE RIVER ZERO POINT, IN FEET
X = 0 AT CENTERLINE OF C & NW RAILROAD NORTH OF MOSS AMERICAN SITE.
Y = DISTANCE FROM WEST BANK, IN FEET.
FOR INLETS, DISTANCE FROM LITTLE MENOMINEE RIVER EITHER EAST(+) OR WEST(-)
Z = DEPTH OF WATER, IN FEET
W = WIDTH OF RIVER OR INLETS, IN FEET
S = TOTAL SEDIMENT DEPTH, IN FEET
DEPTH = DEPTH INTERVAL FROM WHICH SAMPLE WAS TAKEN.
EO = EXTRACTABLE ORGANICS IN SAMPLE.

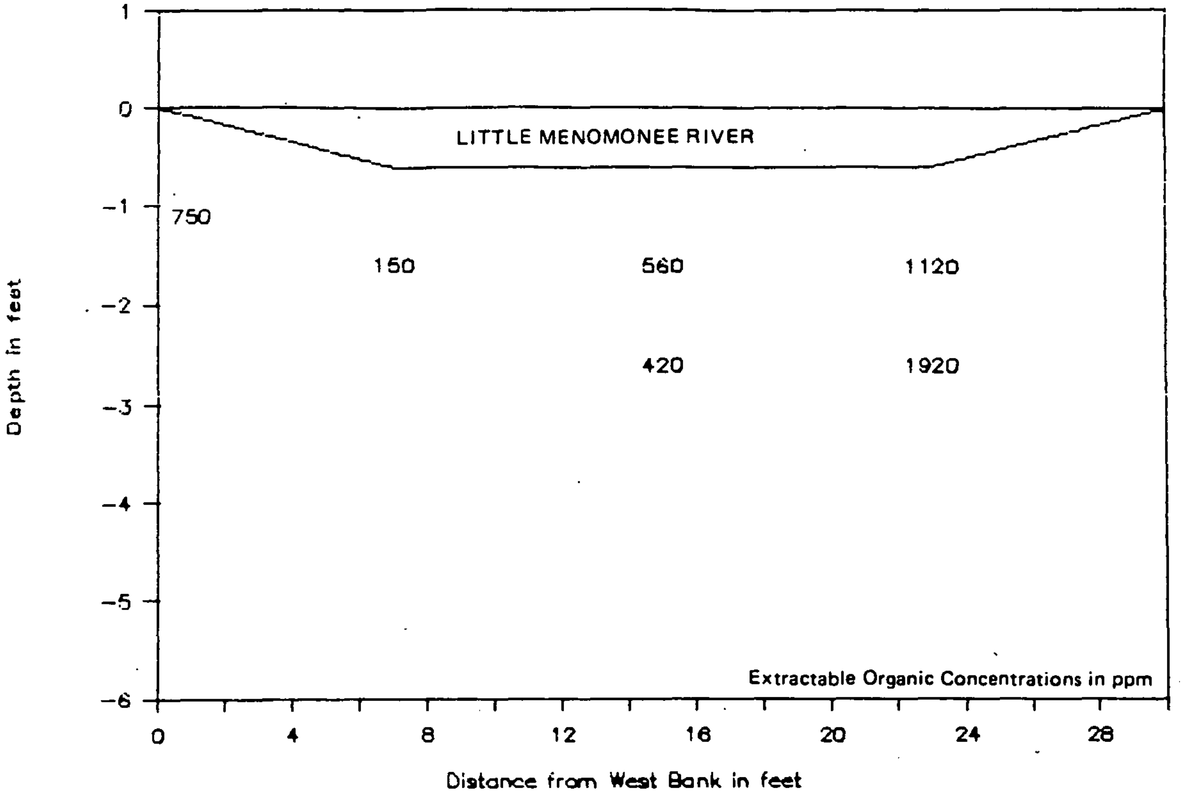
Attachment 3
RIVER CROSS SECTION EO DATA



RIVER CROSS SECTION LOCATION MAP
MOSS-AMERICAN RI

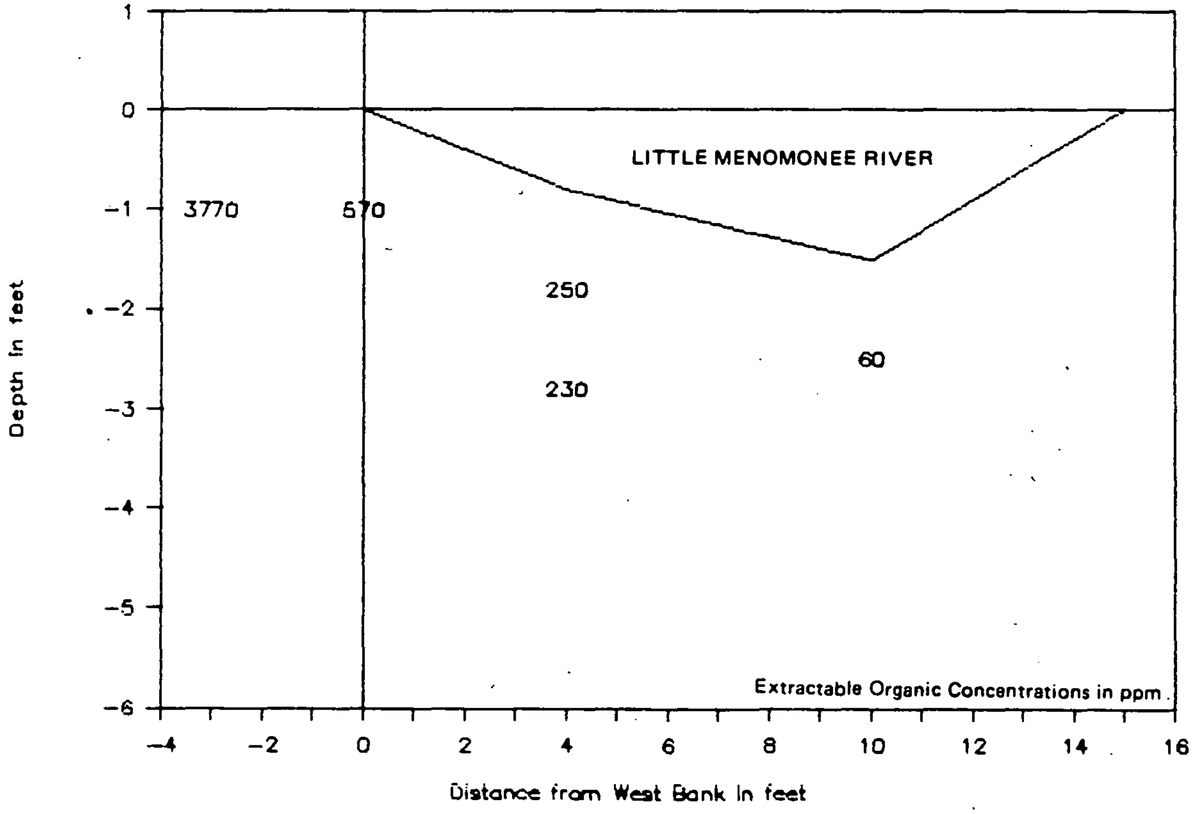
CROSS SECTION 1

Samples SD105–SD110



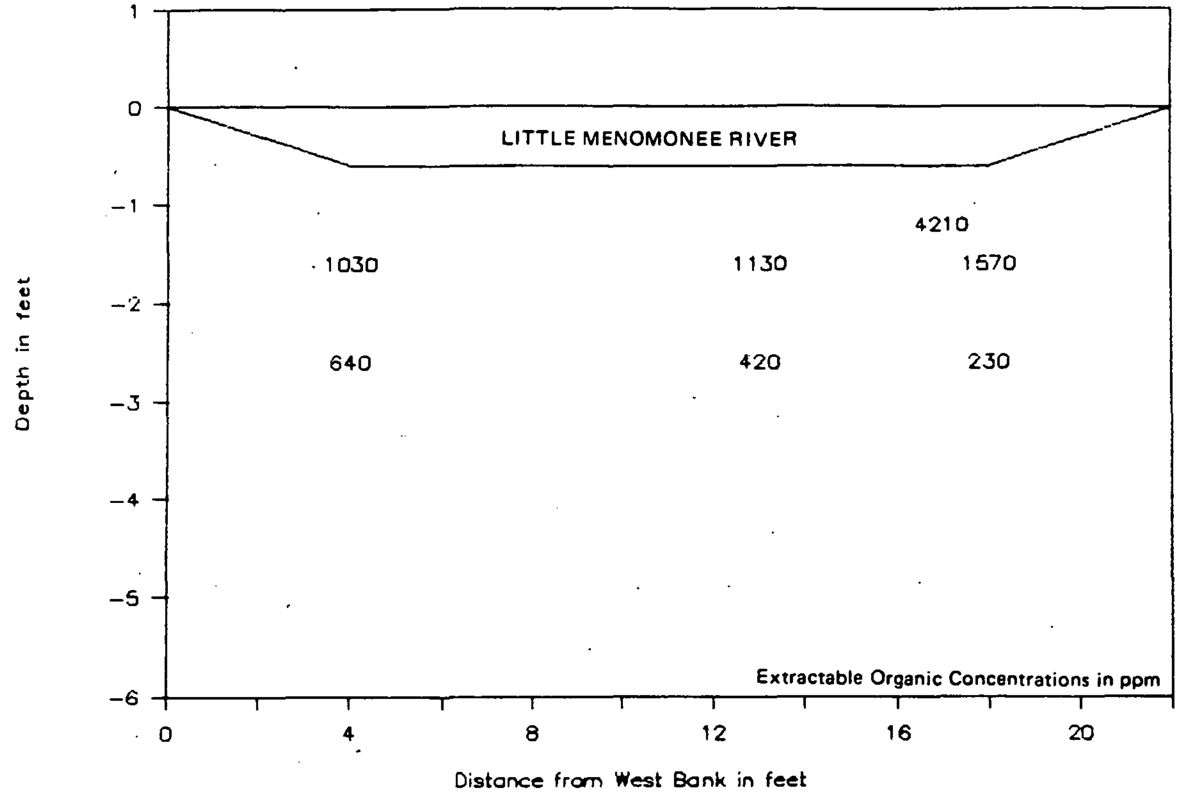
CROSS SECTION 2

Samples SD109, SD116–119



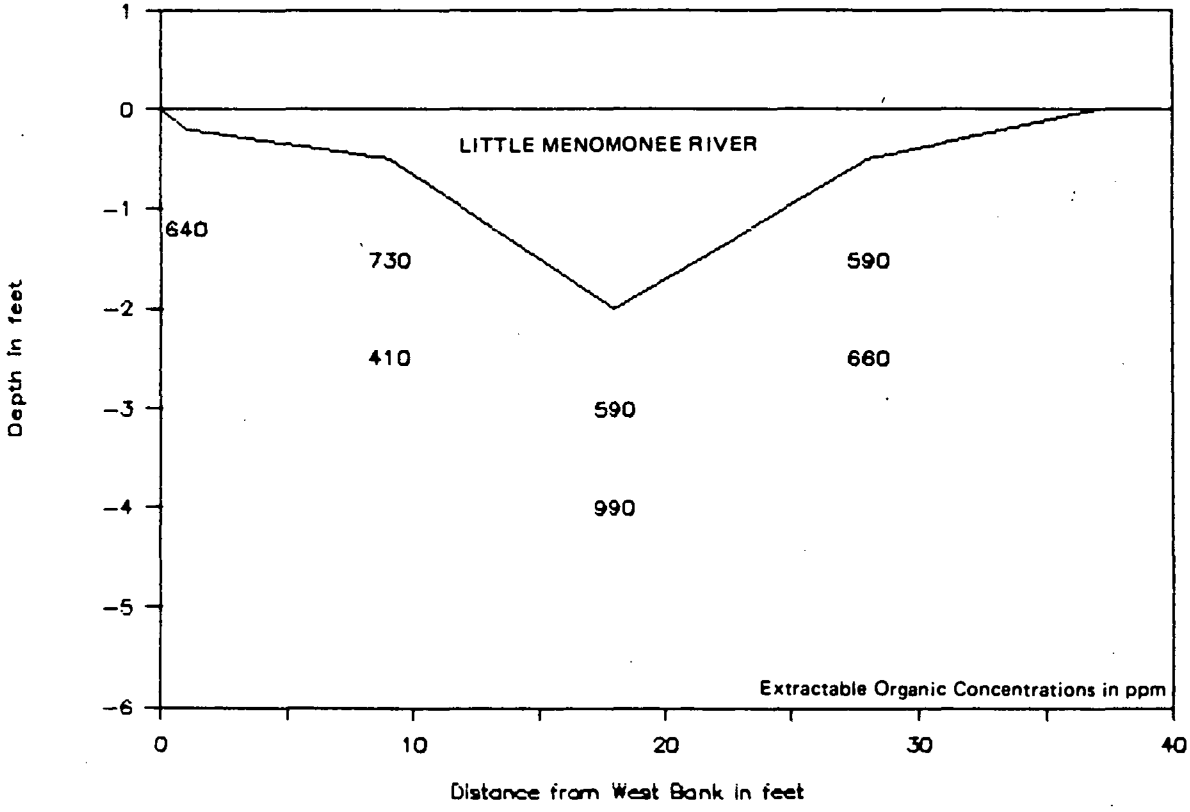
CROSS SECTION 3

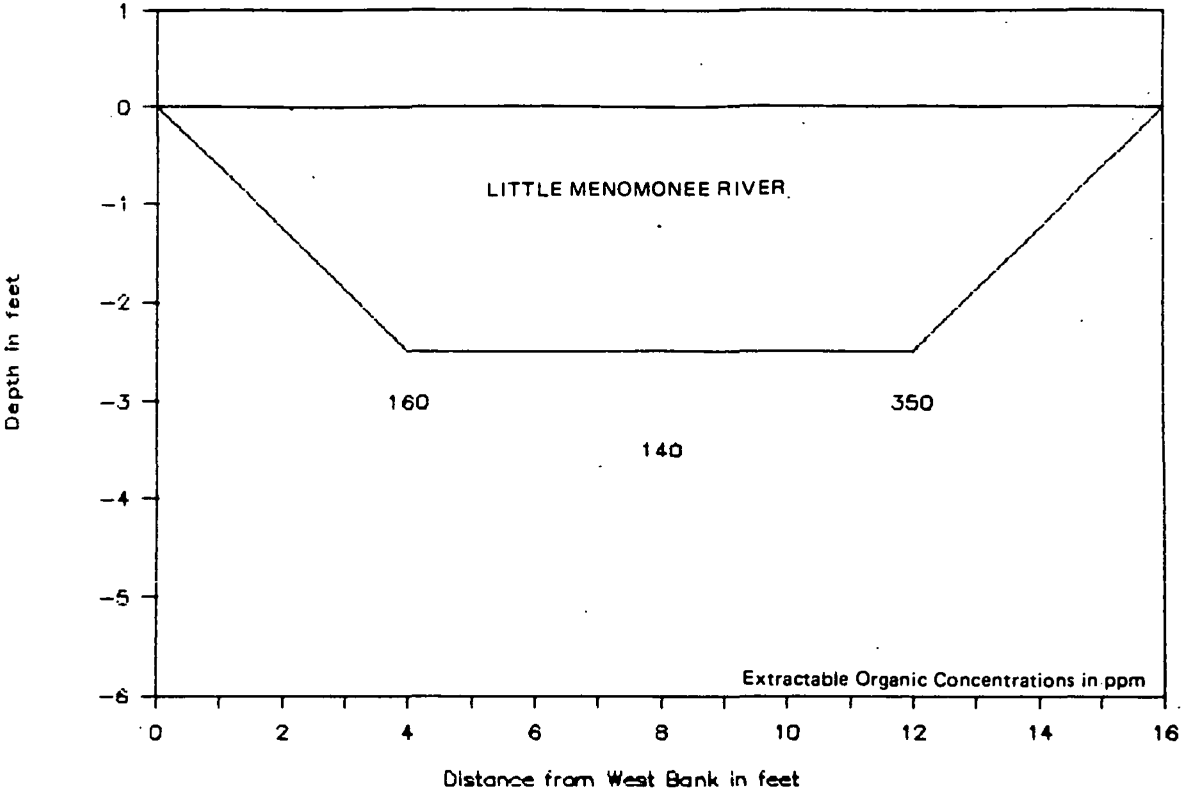
Samples SD019, SD123-127



CROSS SECTION 4

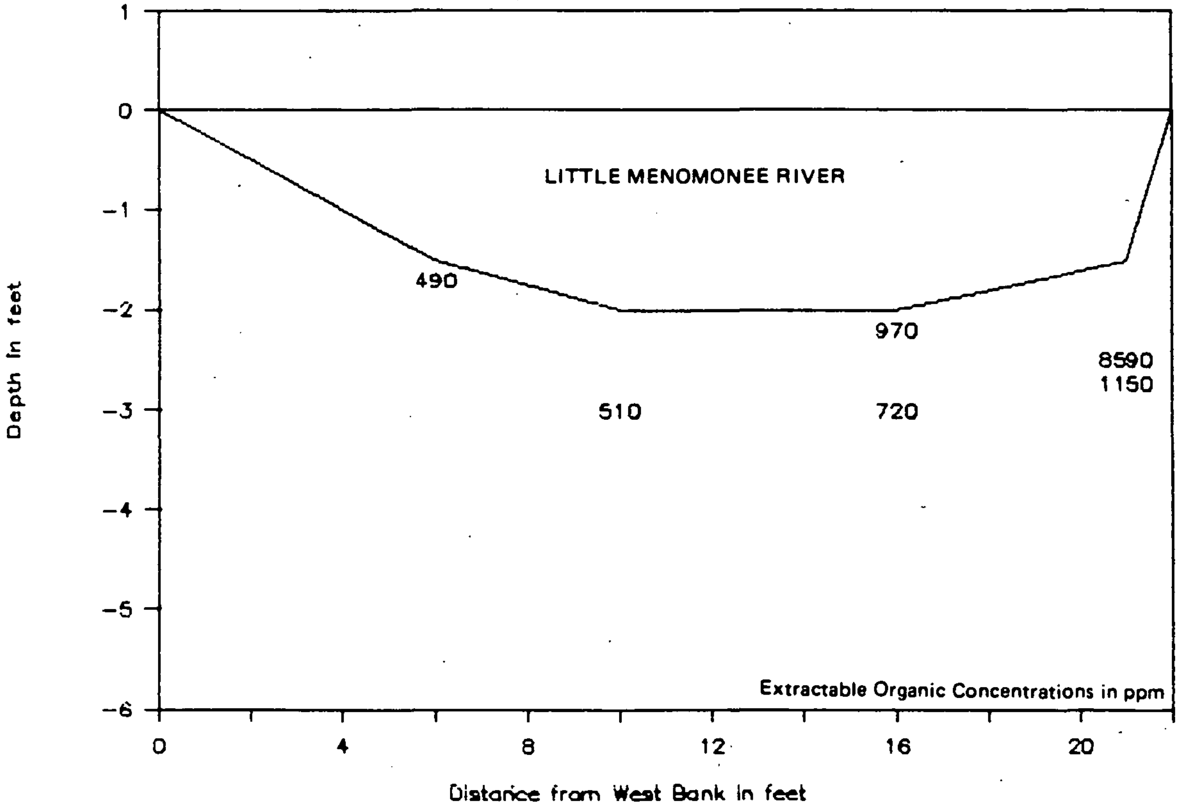
Samples SD022, SD131-136





CROSS SECTION 5

Samples SD137–139

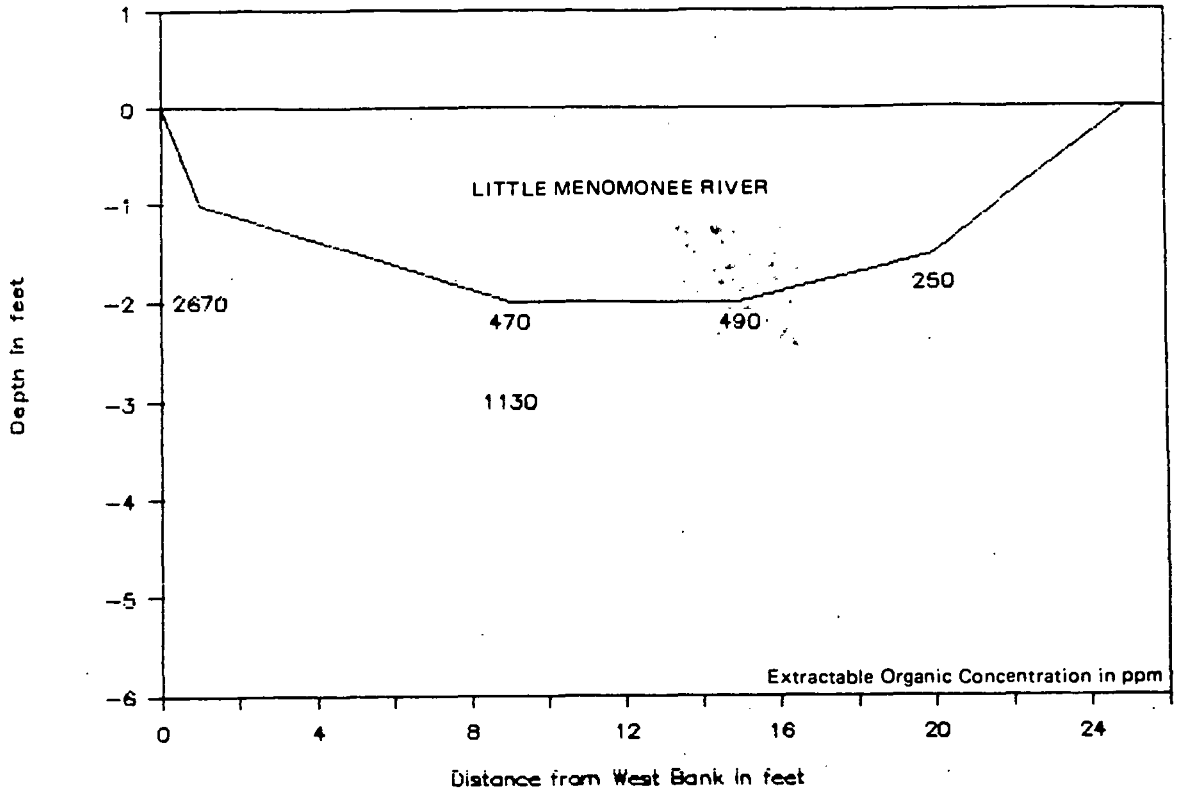


CROSS SECTION 6

Samples SD031, SD142–145

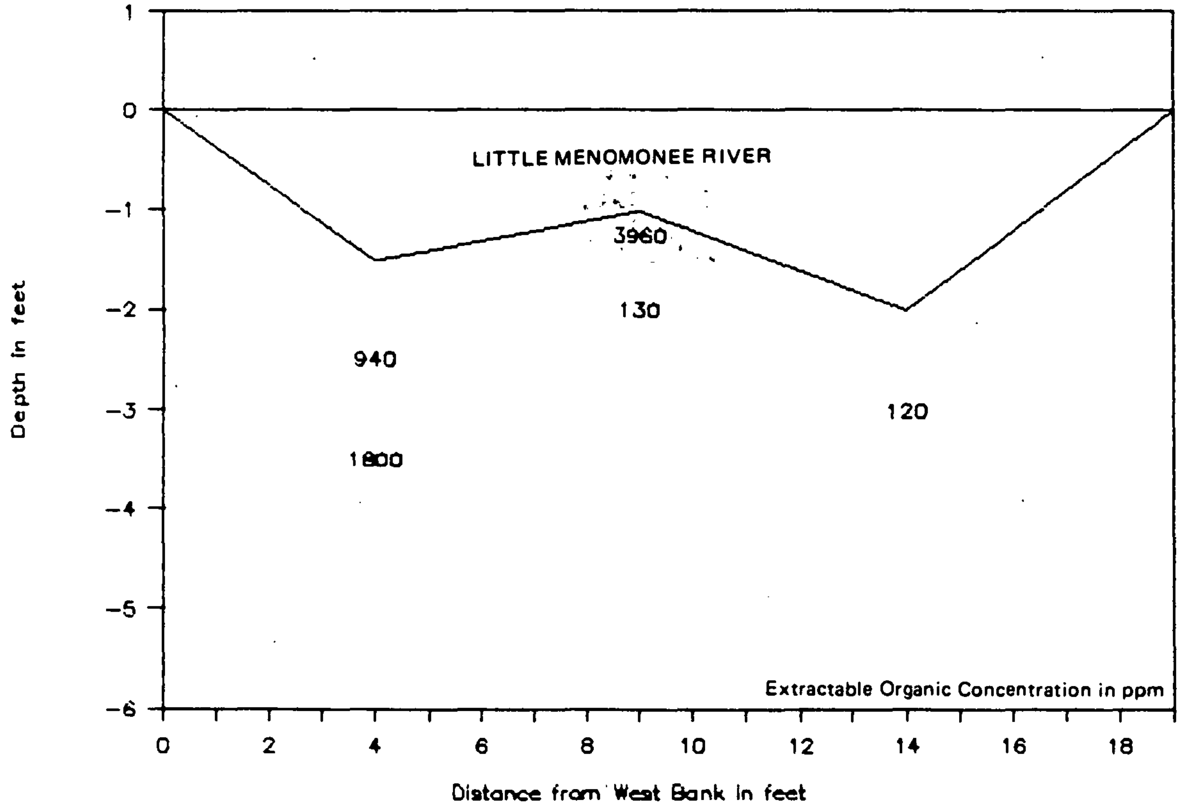
CROSS SECTION 7

Samples SD038, SD151-154



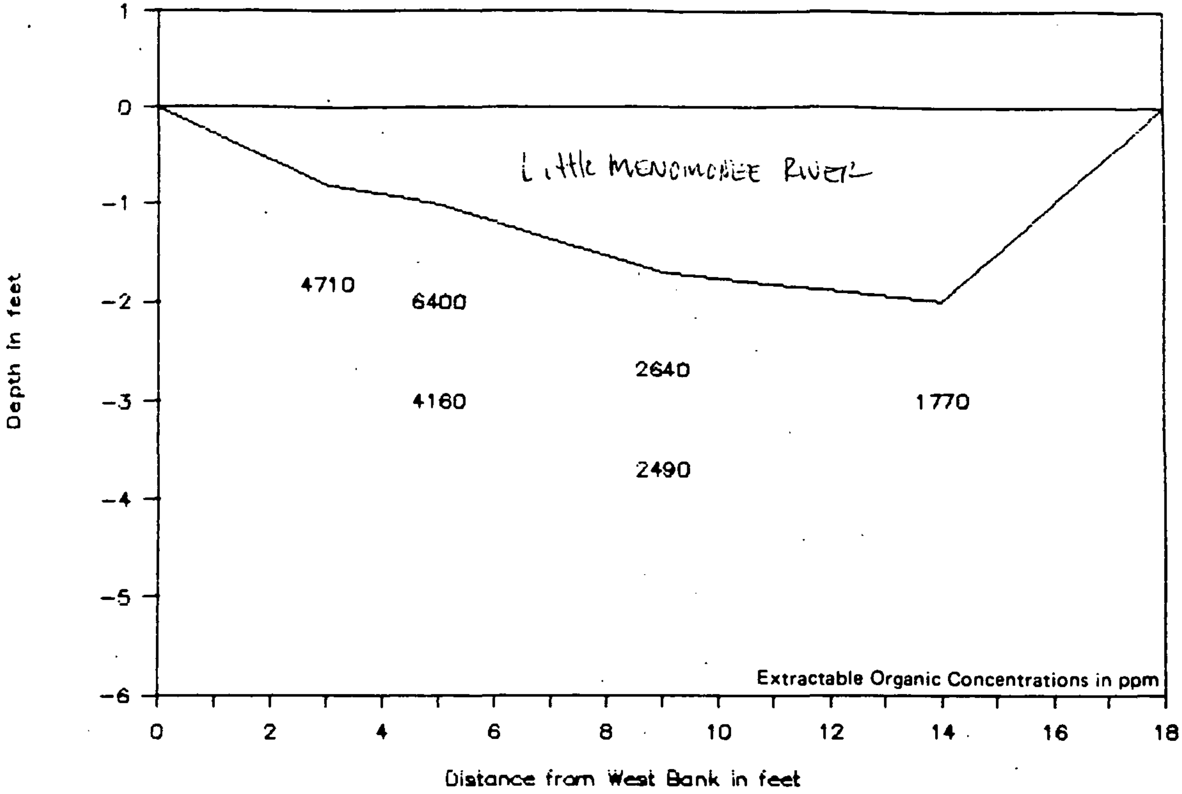
CROSS SECTION 8

Samples SD156-160



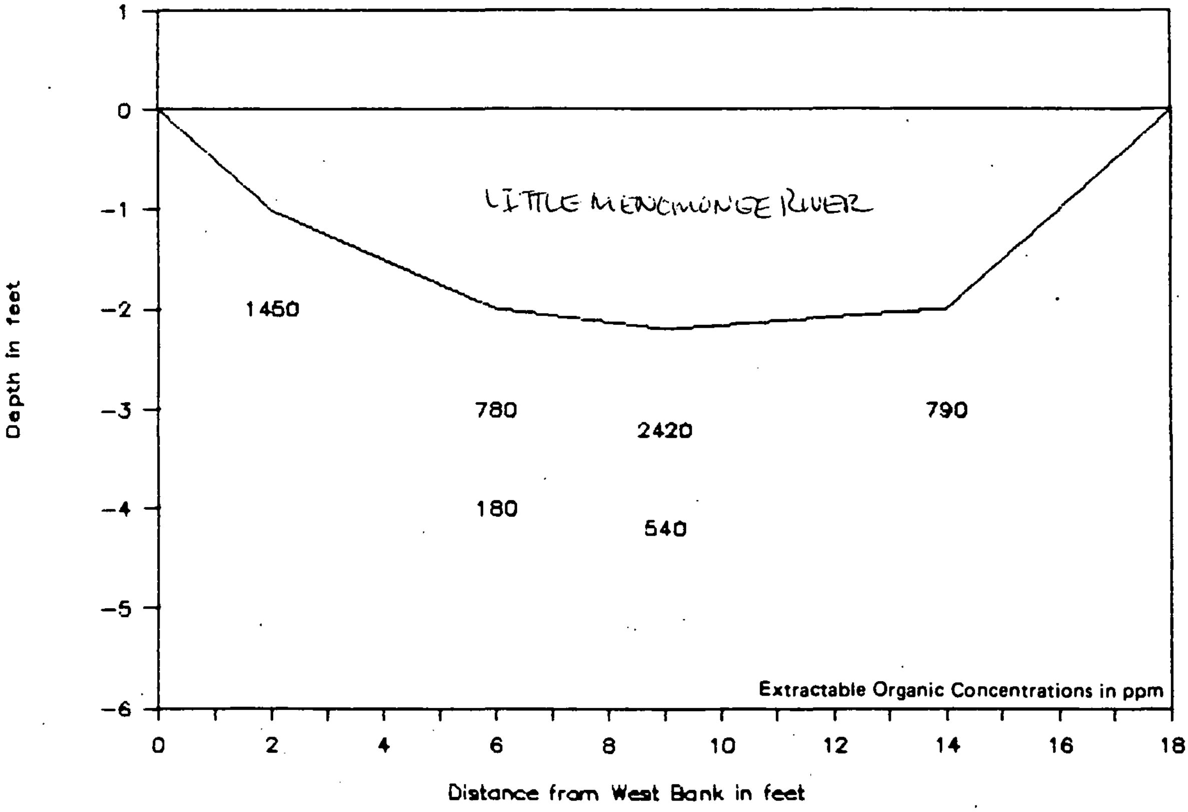
CROSS SECTION 9

Samples SD047, SD164–168



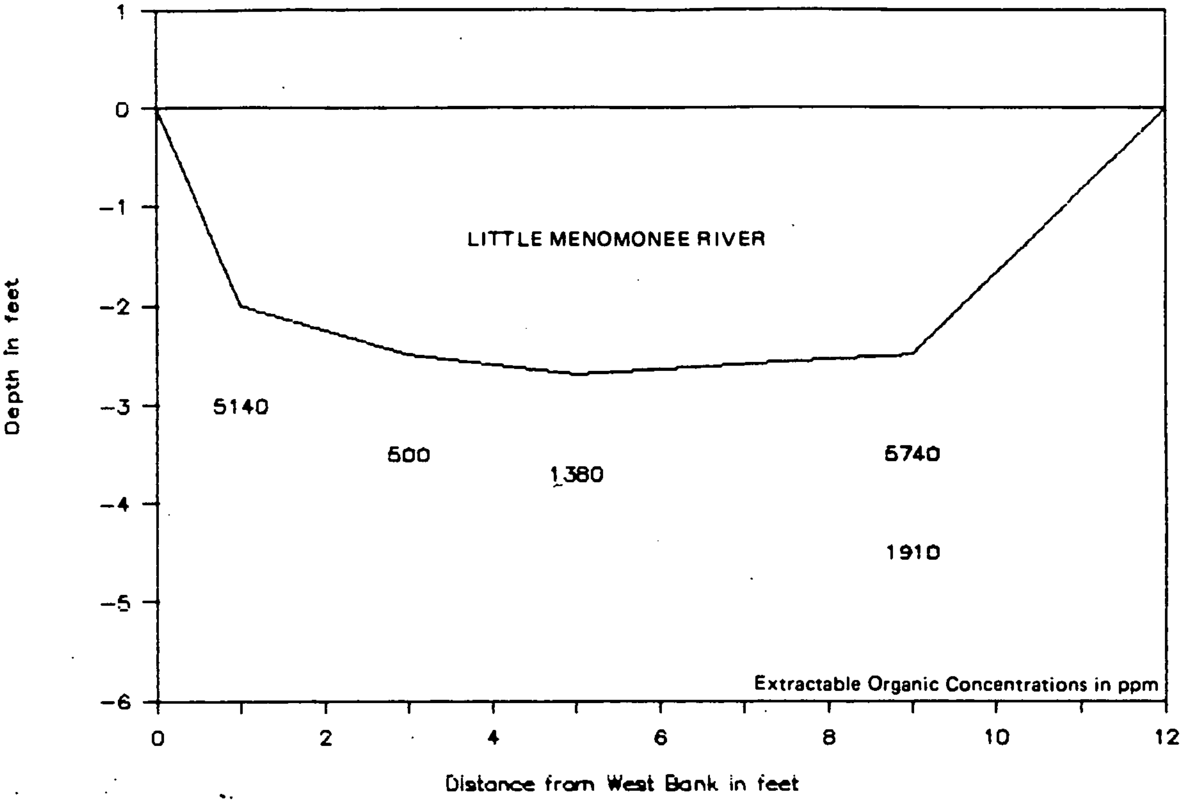
CROSS SECTION 10

Samples SD054, SD172–176



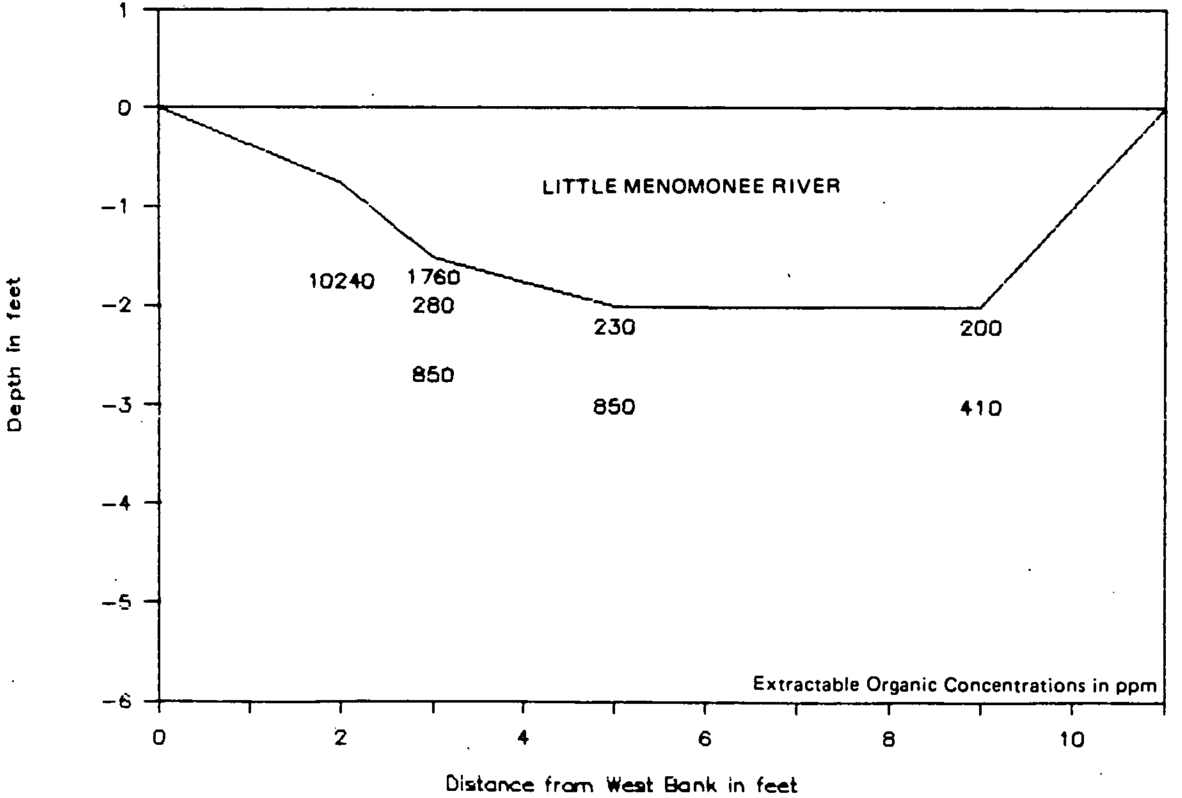
CROSS SECTION 11

Samples SD059, SD178–181



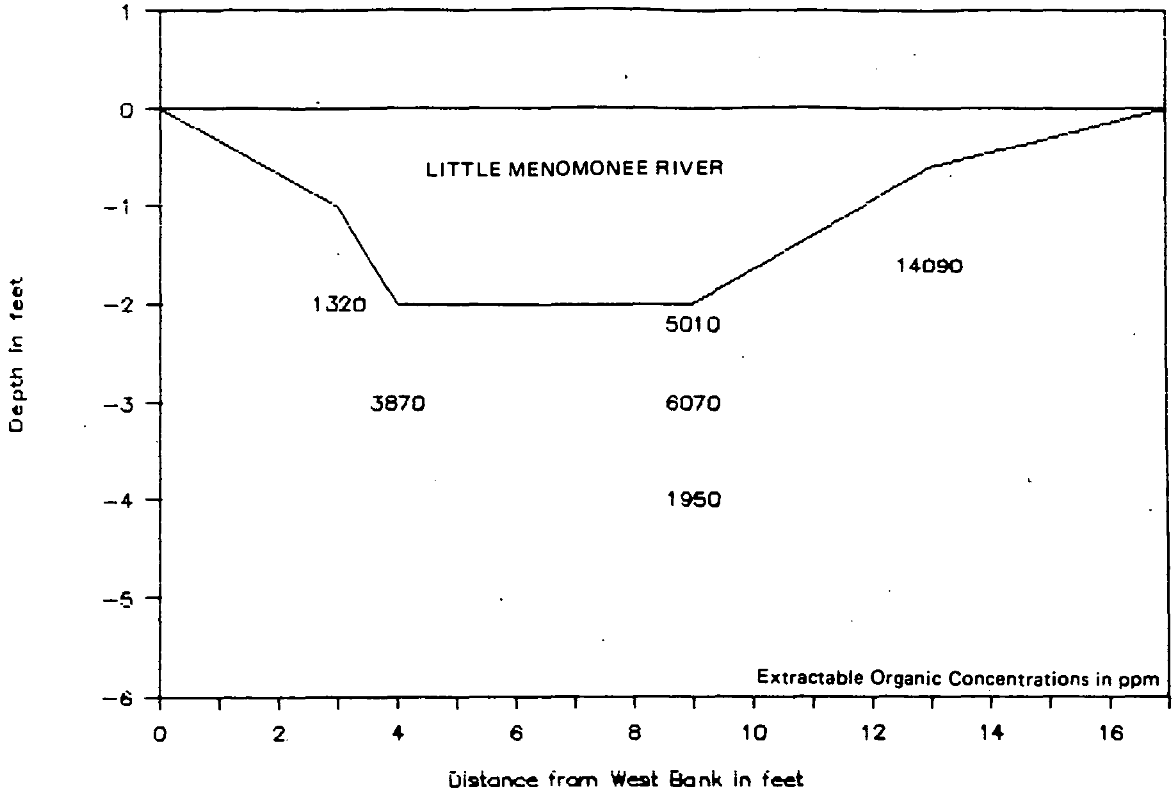
CROSS SECTION 12

Samples SD062, SD182–187



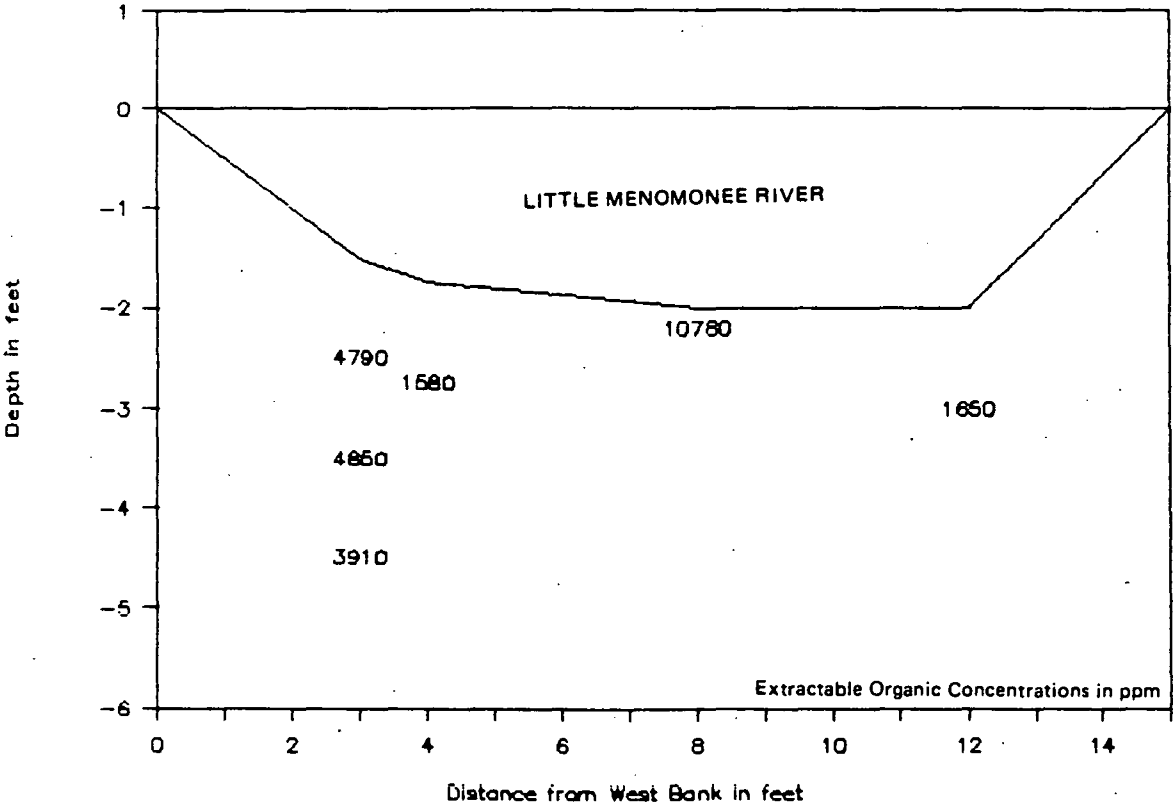
CROSS SECTION 13

Samples SD066, SD193-197



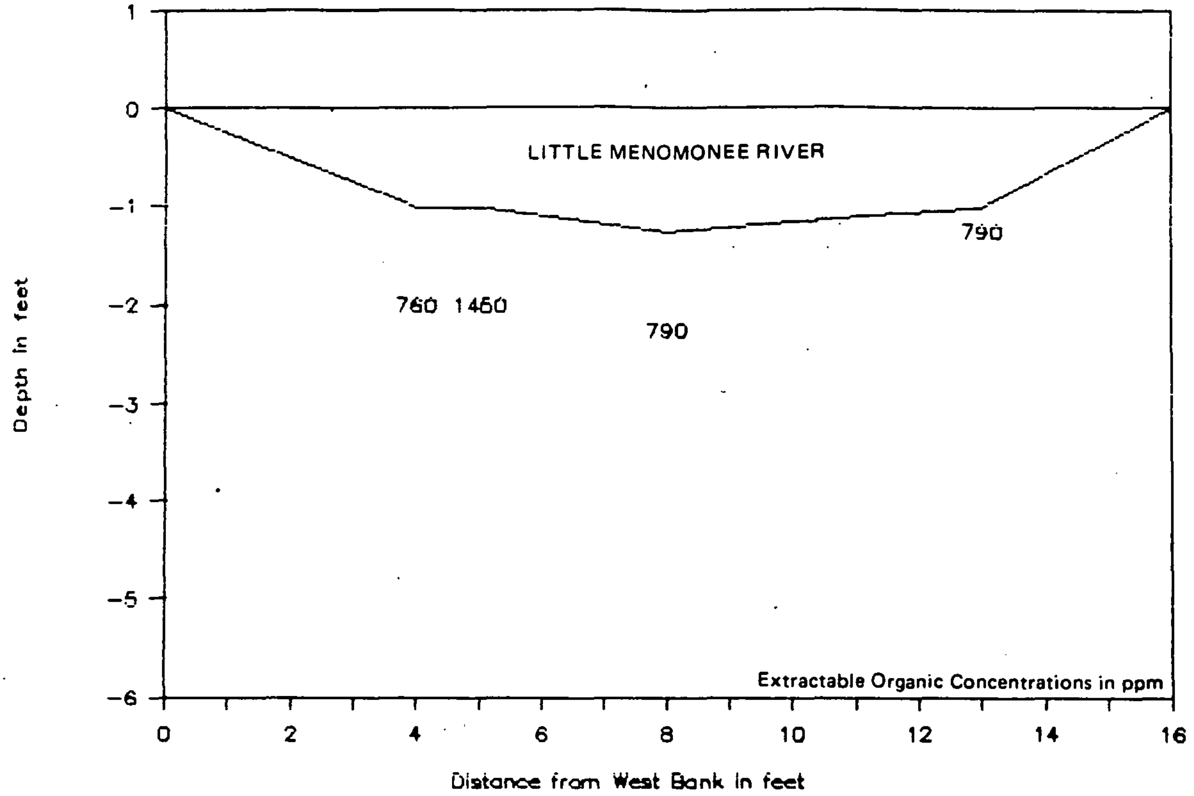
CROSS SECTION 14

Samples SD069, SD201-205



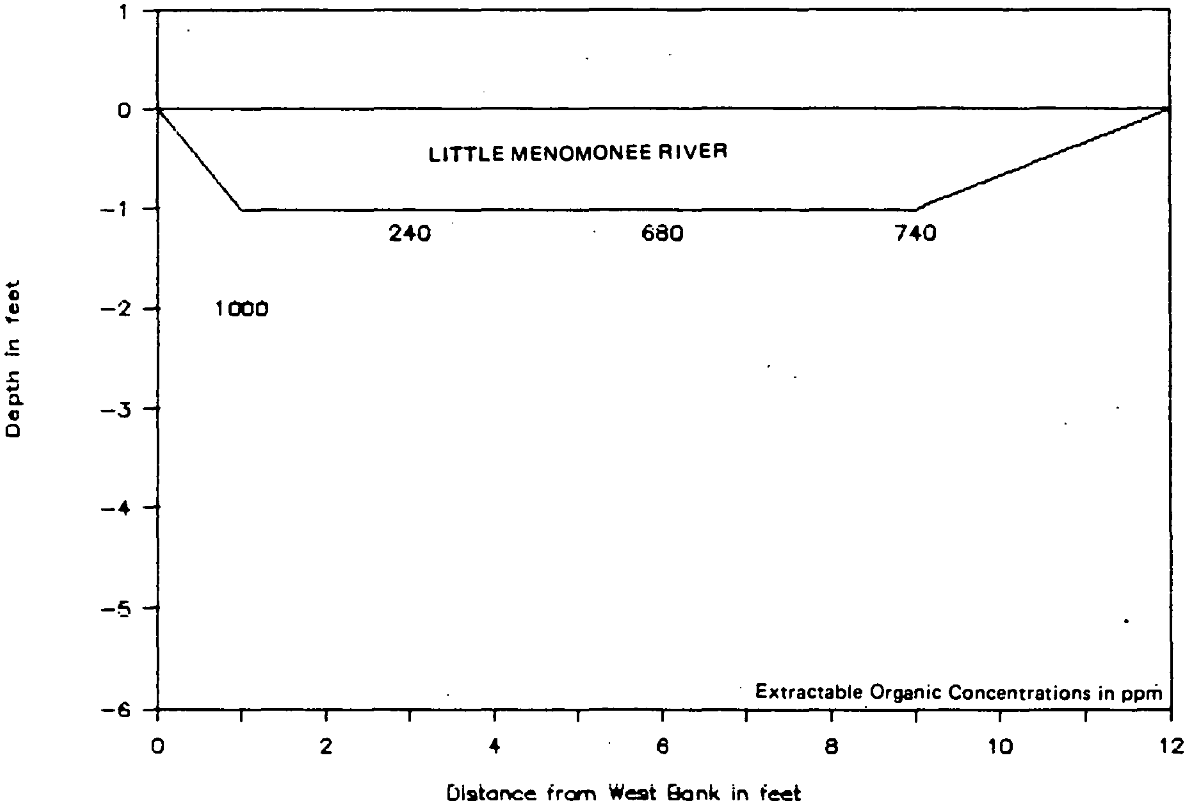
CROSS SECTION 15

Samples SD076, SD209–211



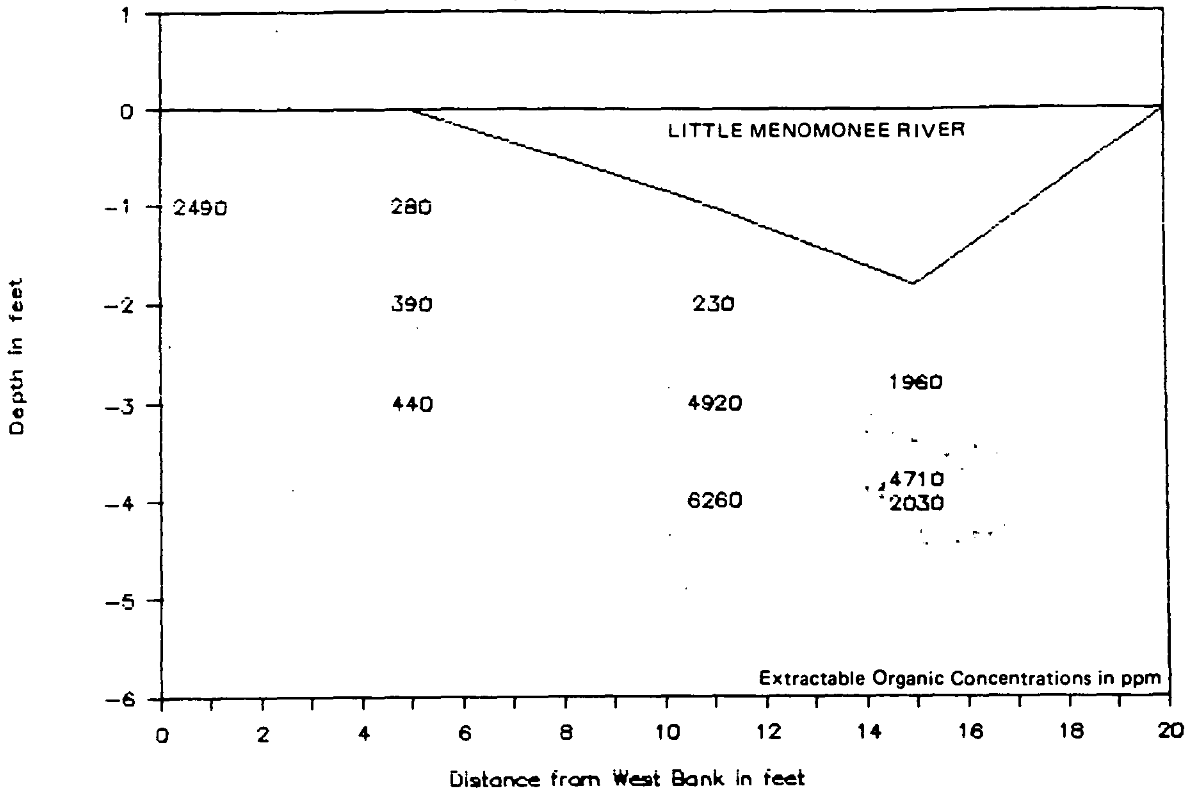
CROSS SECTION 16

Samples SD081, SD216–218



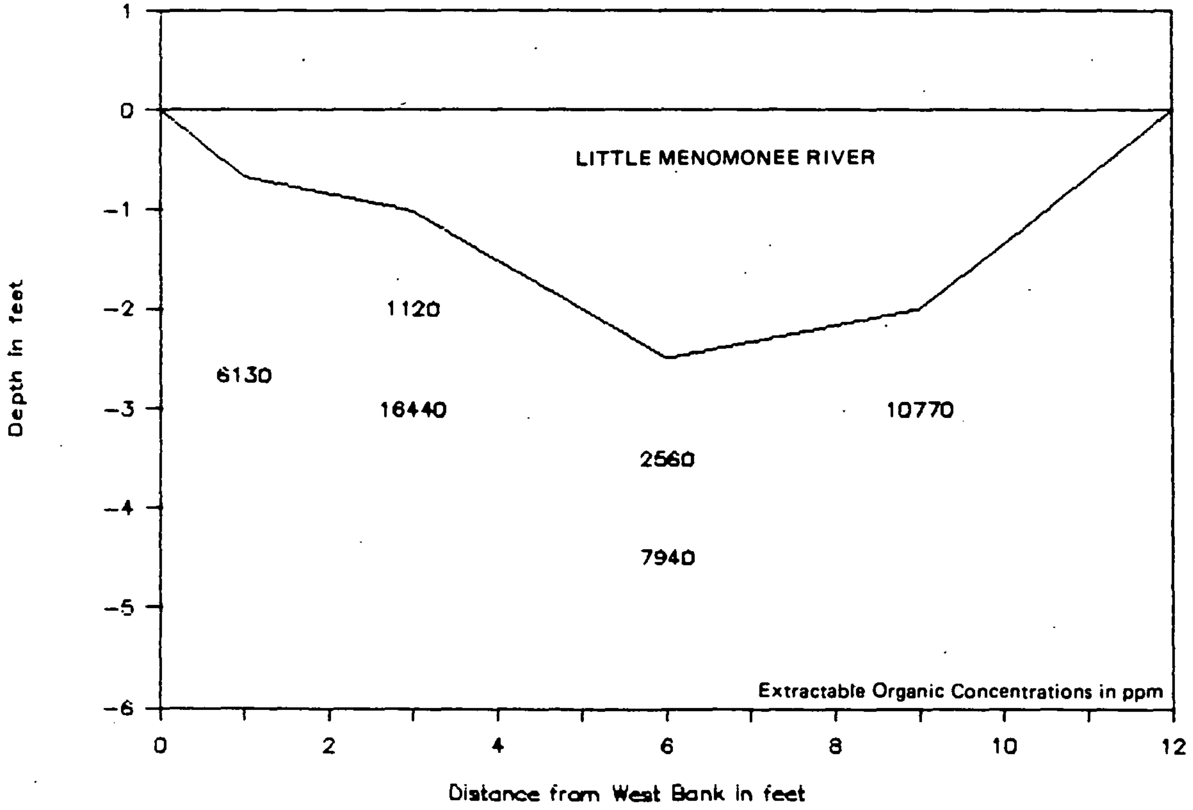
CROSS SECTION 17

Samples SD085, SD222–229



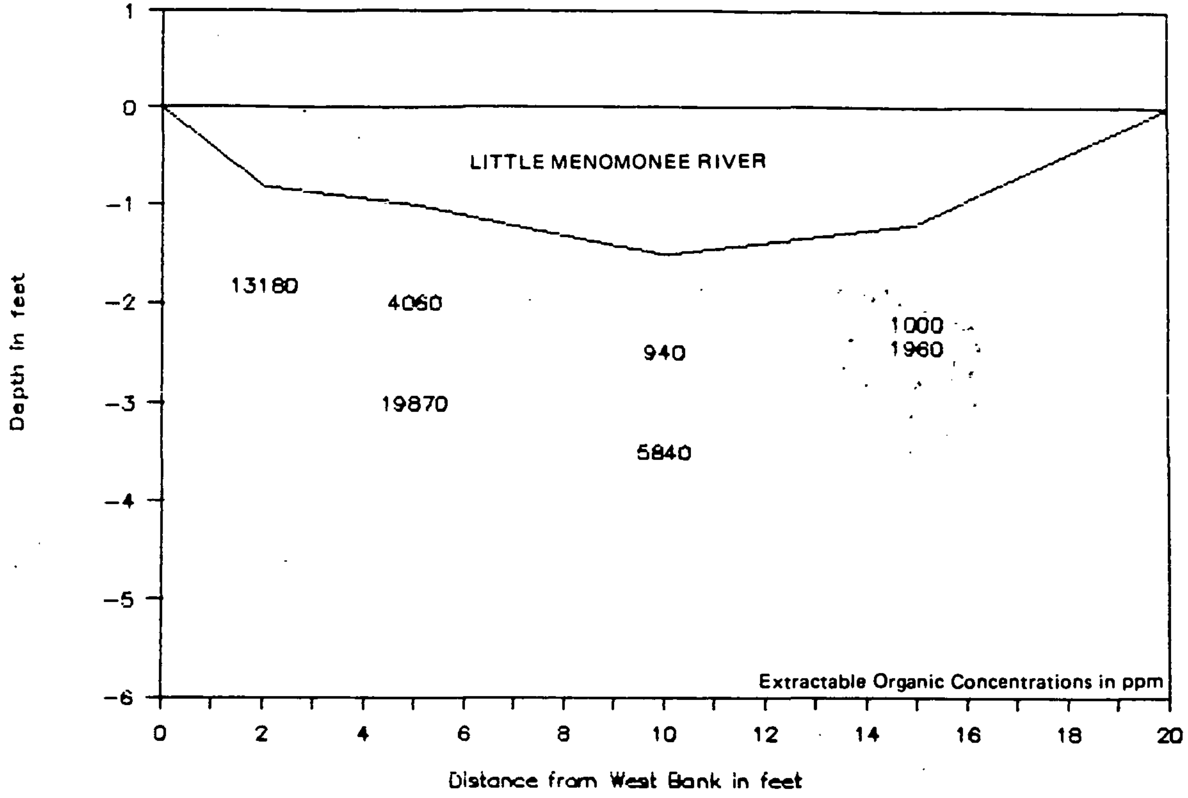
CROSS SECTION 18

Samples SD088, SD230–234



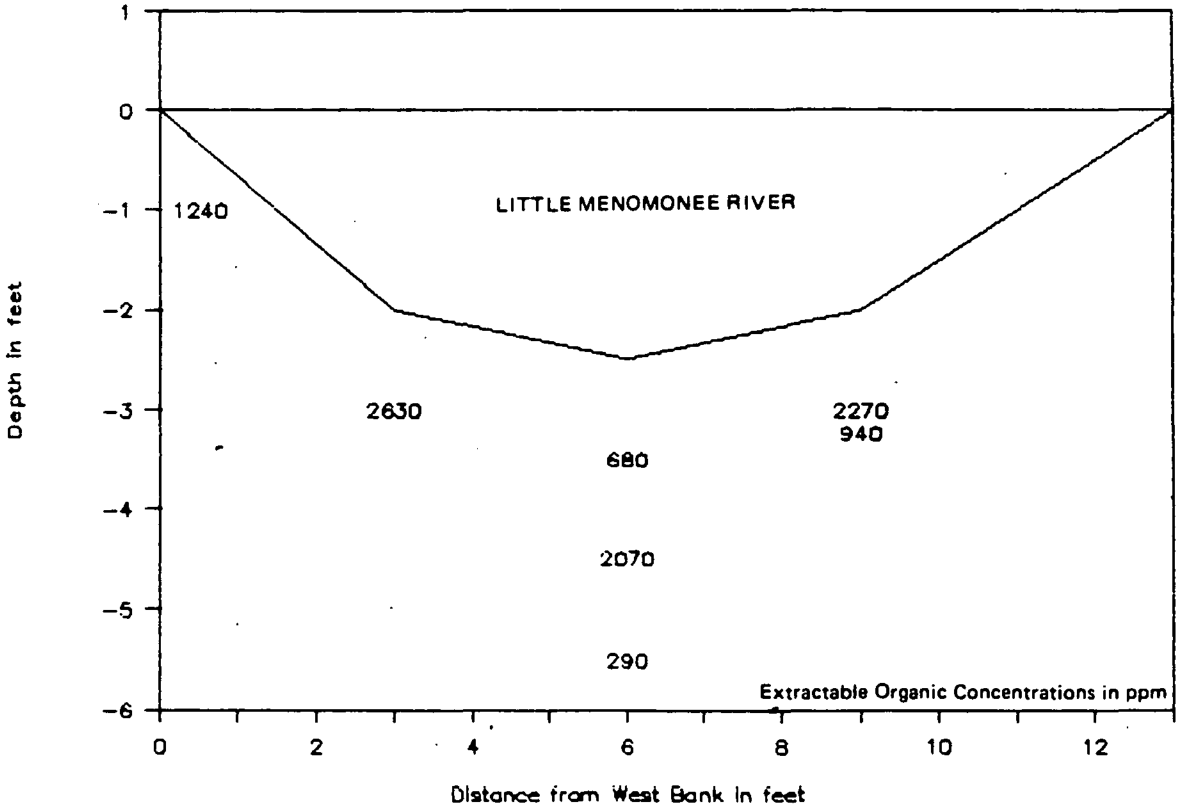
CROSS SECTION 19

Samples SD091, SD235-239



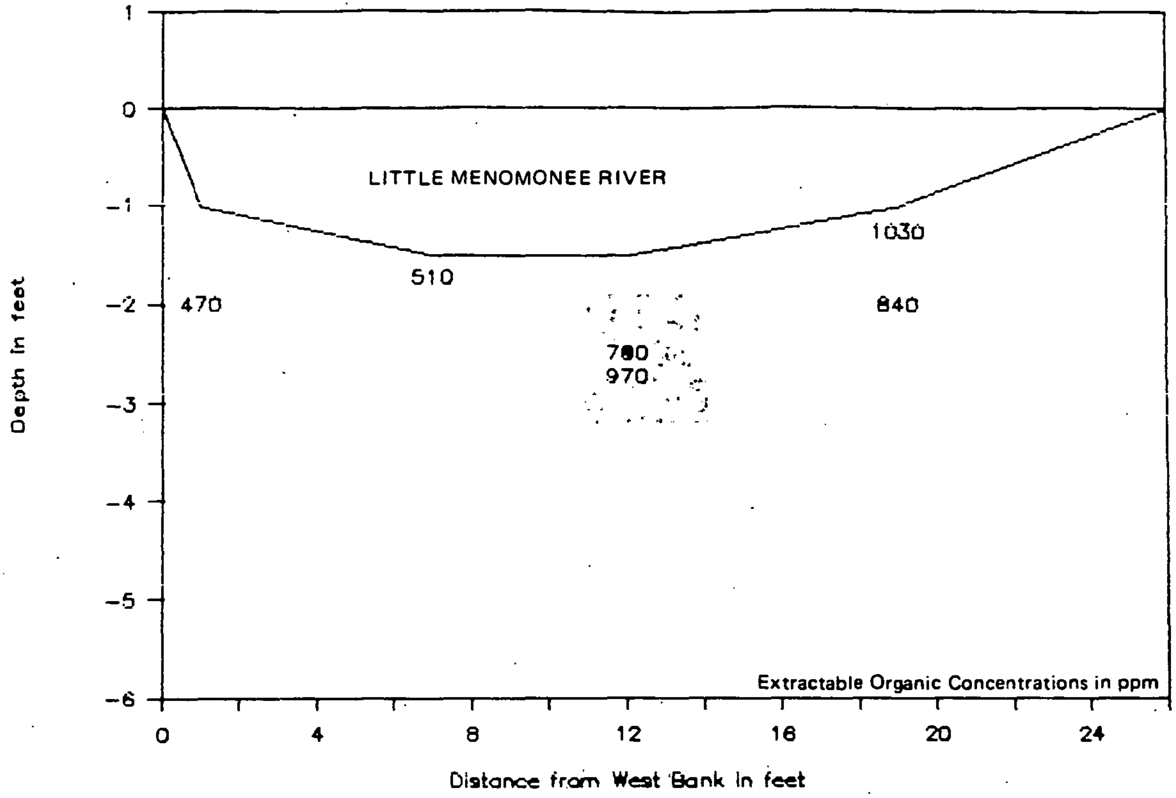
CROSS SECTION 20

Samples SD096, SD244-248



CROSS SECTION 22

Samples SD103, SD258–261



Attachment 4
GC/FID DATA

Polyaromatic Hydrocarbons (PAH) Concentrations in Sediments
Units: parts per million (ppm) dry weight

River

x-sec inlet

SAMPLE	%SOLIDS	NAP	ACY	ACE	FLR	PHEN	ANT	FLN	PYR	BAA	CHR	BBF	BKF	BAP	IDP	DBA	BGHIP	TOTAL PAH	EO
SD001-01	50	2 U	2 U	2 U	2 U	2 U	2 U	4	6	4	2	26	36	28	2 U	2 U	2 U	106	2800
SD005-01	59	2 U	2 U	2 U	2 U	5	2 U	7	5	3	3	3	3	3	3	2 U	3	38	2700
SD007-01	71	1 U	1 U	1 U	1 U	1 U	1 U	1	3	1	3	1 U	1 U	1 U	1 U	1 U	1 U	8	890
SD009-01	65	2 U	2 U	2 U	2 U	2 U	2 U	3	5	3	3	2 U	2 U	2	2 U	2 U	2 U	16	3800
SD014-01	60	2 U	2 U	2 U	2 U	2 U	2 U	3	3	2	3	2 U	2 U	2 U	2 U	2 U	2 U	11	1100
SD018-01	64	2 U	2 U	2 U	2 U	2 U	2 U	3	3	2	3	2 U	2 U	2 U	2 U	2 U	2 U	11	880
SD019-01	69	1 U	1 U	1 U	1 U	3	1 U	4	3	1	3	1	1	1 U	1 U	1 U	1 U	16	4200
SD025-01 4	78	1 U	1 U	1 U	1 U	1 U	1 U	4	4	3	3	1 U	1 U	3	1 U	1 U	1 U	17	520
SD031-01 4	58	9 U	9 U	126	97	310	36	241	150	50	38	19	17	17	9 U	9 U	9 U	1101	8600
SD035-01 4	74	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	1000
SD038-01 4	68	1 U	1 U	6	4	13	3	24	15	7	6	3	3	3	1 U	1 U	1 U	87	2700
SD051-01	69	1 U	1 U	4	1	4	1	9	9	4	3	3	3	3	1 U	1 U	1 U	44	1200
SD054-01	63	2 U	2 U	3	3	3	2 U	17	13	8	6	5	5	5	3	2 U	2	73	1500
SD058-01	55	2 U	2 U	84	85	56	62	200	127	42	35	16	15	15	9	2 U	4	750	1800
SD062-01	59	186	8 U	661	475	1153	125	712	458	188	146	58	58	54	8 U	8 U	8 U	4274	10000
SD063-01	60	2 U	2 U	45	40	132	18	135	87	32	25	13	12	10	5	2 U	3	557	1100
SD067-01	69	3	1 U	23	17	49	7	39	23	9	7	4	3	3	1 U	1 U	1 U	187	670
SD070-01	73	1 U	1 U	1 U	1 U	1 U	1 U	3	3	7	1 U	3	1	3	3	1 U	3	26	370
SD070-01R	71	1 U	1 U	1 U	1 U	1 U	1 U	1 U	3	4	1	3	1	3	3	1 U	3	21	450
SD073-01	71	1 U	1 U	6	4	6	6	30	21	10	10	7	6	6	4	1 U	3	119	370
SD076-01	72	4	1 U	49	57	167	36	153	100	39	38	18	17	15	11	1 U	6	710	1400
SD078-01	68	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	410
SD091-01	54	9 U	9 U	9 U	9 U	57	17	204	152	70	52	30	30	30	9 U	9 U	9 U	642	13000
SD093-01	64	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	27	8 U	8 U	8 U	8	8 U	8 U	16	51	2000
SD097-01	78	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	73
~~SD100-01~~	56	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	0	320
SD110-01	68	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	750
SD116-01	77	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	570
SD131-01	68	1 U	1 U	1 U	1 U	3	1 U	7	15	4	6	44	6	37	3	1 U	3	128	730
SD134-01	66	2 U	2 U	2 U	2 U	5	2 U	6	5	3	3	3	3	2 U	2 U	2 U	2 U	28	1000
SD137-01	82	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	160
SD140-01	63	2 U	2 U	2 U	2 U	2 U	2 U	3	3	2	2	2	2	2 U	2 U	2 U	2 U	14	20000
SD144-01	69	1 U	1 U	20	13	38	4	36	14	9	9	12	7	9	4	1 U	3	178	1000
SD147-01	76	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	16
SD154-01	87	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	250
SD155-01	59	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	0	530
SD158-01	67	4	1 U	9	7	15	9	10	7	4	4	3	1	3	3	1 U	1 U	79	4000
SD164-01	65	58	8 U	323	231	554	68	369	262	114	95	35	35	34	8 U	8 U	8 U	2178	6400
SD165-01	65	28	8 U	277	200	523	60	323	231	95	77	31	31	31	8 U	8 U	8 U	1907	4200
SD175-01	67	1 U	1 U	1 U	1 U	4	1	12	7	4	4	1	1	1 U	1 U	1 U	1 U	34	540
SD179-01	67	1 U	1 U	1 U	1 U	1	1 U	6	4	4	1	1	1 U	1	1 U	1 U	1 U	18	1400
SD187-01	66	2 U	2 U	2 U	2 U	6	2	15	11	5	5	5	3	8	3	2 U	2	65	410
SD192-01	76	1 U	1 U	1 U	1 U	3	1 U	3	4	1 U	1 U	1	1 U	1 U	1 U	1 U	1 U	11	380
SD197-01	64	2 U	2 U	5	3	13	2	8	8	73	2 U	38	53	67	5	2 U	2 U	275	14000
SD204-01	65	3	2 U	431	308	892	106	631	385	97	82	49	29	37	26	2 U	14	3090	11000
SD207-01	71	1 U	1 U	1 U	1 U	3	1 U	4	6	3	3	3	3	3	3	1 U	4	35	1000
SD207-01R	65	38	2 U	400	323	862	95	477	292	83	66	38	25	29	14	2 U	8	275	--
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SD217-01	67	1 U	1 U	1 U	1 U	1 U	1 U	1	3	4	1 U	1 U	1 U	1 U	1 U	1 U	1 U	8	680
SD221-01	82	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	47
SD221-01R	86	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	220
SD222-01	86	1 U	1 U	10	5	16	7	35	27	8	7	1 U	40	29	2	1 U	1	187	280
SD227-01	93	1 U	1 U	2	2	5	4	9	5	2	1	3	2	1 U	1 U	1 U	1 U	35	6300
SD231-01	57	135	2 U	263	193	456	75	351	228	74	56	40	35	37	23	2 U	12	1978	16000
SD233-01	58	59	2 U	328	293	655	328	448	328	97	81	43	41	41	21	5	14	2782	7900
SD234-01	56	9	2 U	268	214	500	179	339	214	73	63	25	25	30	11	4	7	1961	11000
SD236-01	55	105	2 U	345	258	618	120	345	236	67	58	29	27	27	11	4	7	2257	20000
SD244-01	55	2 U	4	91	69	165	49	218	145	49	42	35	35	33	15	2 U	13	963	2600
SD255-01	58	2	2 U	12	10	33	5	29	21	9	7	5	5	3	2 U	2 U	2 U	141	830
SD257-01	52	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	0	620
SD258-01	76	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	510
SD260-01	66	2 U	2 U	2 U	2 U	2 U	2 U	11	9	5	5	5	3	2	2 U	2 U	2 U	40	1000
SS1003-01	90	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	180
SD001-01FB	98	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	--
SD002-01FB	99	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	--
SD003-01FB	99	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0	--

NOTES:

U = Not detected (detection limit listed)

ABBREVIATIONS:

NAP = Naphthalene	CHR = Chrysene
ACY = Acenaphthylene	BBF = Benzo(b)fluoranthene
ACE = Acenaphthene	BKF = Benzo(k)fluoranthene
FLR = Fluorene	BAP = Benzo(a)pyrene
PHEN = Phenanthrene	IDP = Indeno(1,2,3-cd)pyrene
ANT = Anthracene	DBA = Dibenzo(a,h)anthracene
FLN = Fluoranthene	BGHIP = Benzo(g,h,i)perylene
PYR = Pyrene	EO = Extractable Organics
BAA = Benzo(a)anthracene	

PHENOLIC COMPOUNDS ANALYZED BY GC/FID AND MINIMUM DETECTABLE CONCENTRATIONS

Phenol	2
2-Chlorophenol	2
2-Nitrophenol	2
2,4-Dimethylphenol	2
2,4-Dichlorophenol	2
4-Chloro-3-methylphenol	2
2,4,6-Trichlorophenol	2
2,4-Dinitrophenol	5
4-Nitrophenol	5
4,6-Dinitro-2-methylphenol	5
Pentachlorophenol	5

Sample locations are the same as those listed for the PAH results. No phenolic compounds were detected.

TECHNICAL MEMORANDUM

TO: Angela Porter/U.S. EPA Region V

FROM: Solveig Christenson/CH2M HILL
Don Johnson/CH2M HILL

DATE: October 25, 1988

RE: Task FW--Surface Water Sampling
Moss-American Site

PROJECT: GLO63341.FW

INTRODUCTION

This technical memorandum describes the surface water sampling performed in the Little Menomonee River (Task FW) as part of the Moss-American Remedial Investigation (RI). The data collected will be used to assess the nature and extent of surface water contamination and to evaluate the potential for endangerment of public health and the environment. These analyses and an examination of contaminant loading to the Little Menomonee River from surface water routes or groundwater recharge will be presented in the RI report. Surface water sampling proceeded as described in the Quality Assurance Project Plan (September 14, 1987) and the Work Plan (July 23, 1987). Changes to the Site Sampling Plan are noted after the task description.

SURFACE WATER SAMPLING COLLECTION

Eight surface water samples were taken on the Little Menomonee River. Sampling was performed by Solveig Christenson and Gerald Bills of CH2M HILL on May 2, 1988. At each sampling location, seven 1-liter polyethelene bottles, two 1/2-gallon amber glass bottles, and two 40-milliliter VOA vials were filled. Each was labeled with the sample number and stored in a cooler. Two sets of bottles were filled at SW003-01 for matrix spike analysis, a field replicate was taken at SW005-01, and a field blank was prepared using distilled water.

Sample bottles were filled directly from the Little Menomonee River and the drainage ditches. Samples were taken at the approximate midpoint of the river or ditches at mid-depth. Water temperature and conductivity were measured in the field with a conductivity meter (Table 1). Filtering and sample preservation were performed at the site trailer. Samples were labeled and shipped the same day to designated EPA Contract Laboratory Program (CLP) laboratories.

Sample locations (Figures 1 and 2) were chosen as outlined in the Sampling Plan. Distances were measured downstream from the Chicago and Northwestern (C&NW) Railroad Bridge that crosses the Little Menomonee River at the northern edge of the site.

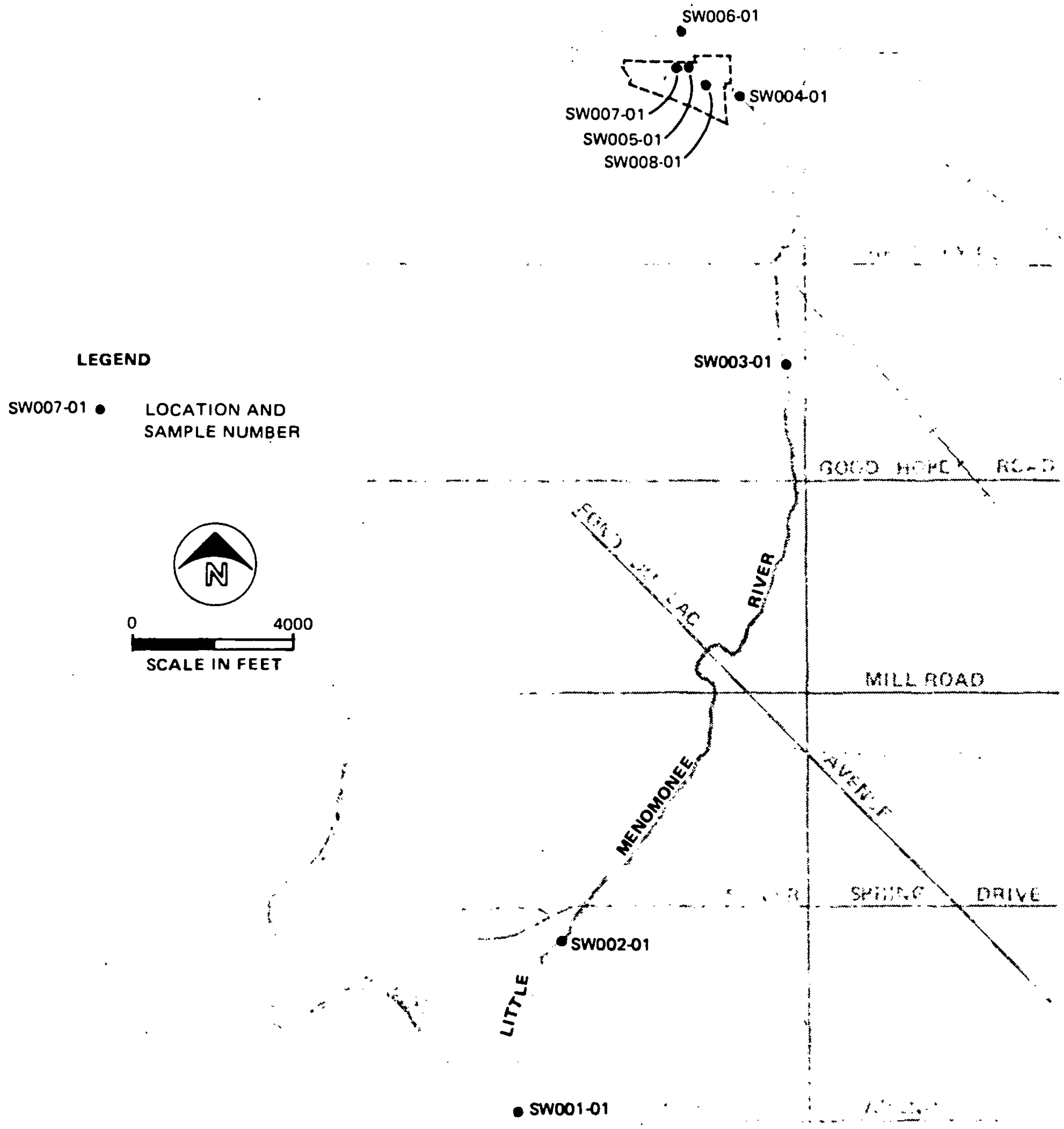
- SW001 was taken about 40 feet upstream of the confluence of the Little Menomonee River with the Menomonee River (30,800 feet) to determine the quality of the water leaving the Little Menomonee River.
- SW002 and SW003 were collected to represent general water quality conditions in the Little Menomonee River downstream of the site and upstream of the confluence with the Menomonee River. They were collected about 750 feet south of Silver Spring Drive (25,720 feet) and 250 feet north of West Calumet Road (8,780 feet).
- SW004 was taken to evaluate water quality where the Little Menomonee River exited the Moss-American site (2,100 feet).
- SW005 was taken where the Little Menomonee River enters the site (40 feet), just north of an unnamed drainage ditch.
- SW006 was taken upstream of the site (350 feet) about 100 feet north Brown Deer Road as a background sample.
- SW007 was taken in the drainage ditch that flows from the northern boundary of the site to the Little Menomonee River. It was collected about 60 feet from the Little Menomonee River (50 feet) to evaluate the quality of water flowing to the northern boundary of the site.

Table 1
FIELD MEASUREMENTS OF SURFACE WATER SAMPLES

Sample Number	Conductivity (umhos)	Temperature (°C)
SW001	780	14.0
SW002	780	14.5
SW003	700	15.0
SW004	730	17.0
SW005	720	17.0
SW006	710	17.5
SW007	930	14.0
SW008	NR	NR

NR--No reading taken; inlet too shallow.

GLT779/32



NOTE: SW004 THROUGH SW008 LOCATIONS ARE
SHOWN IN GREATER DETAIL ON FIGURE 2.

FIGURE 1
SURFACE WATER SAMPLE LOCATIONS
MOSS-AMERICAN RI

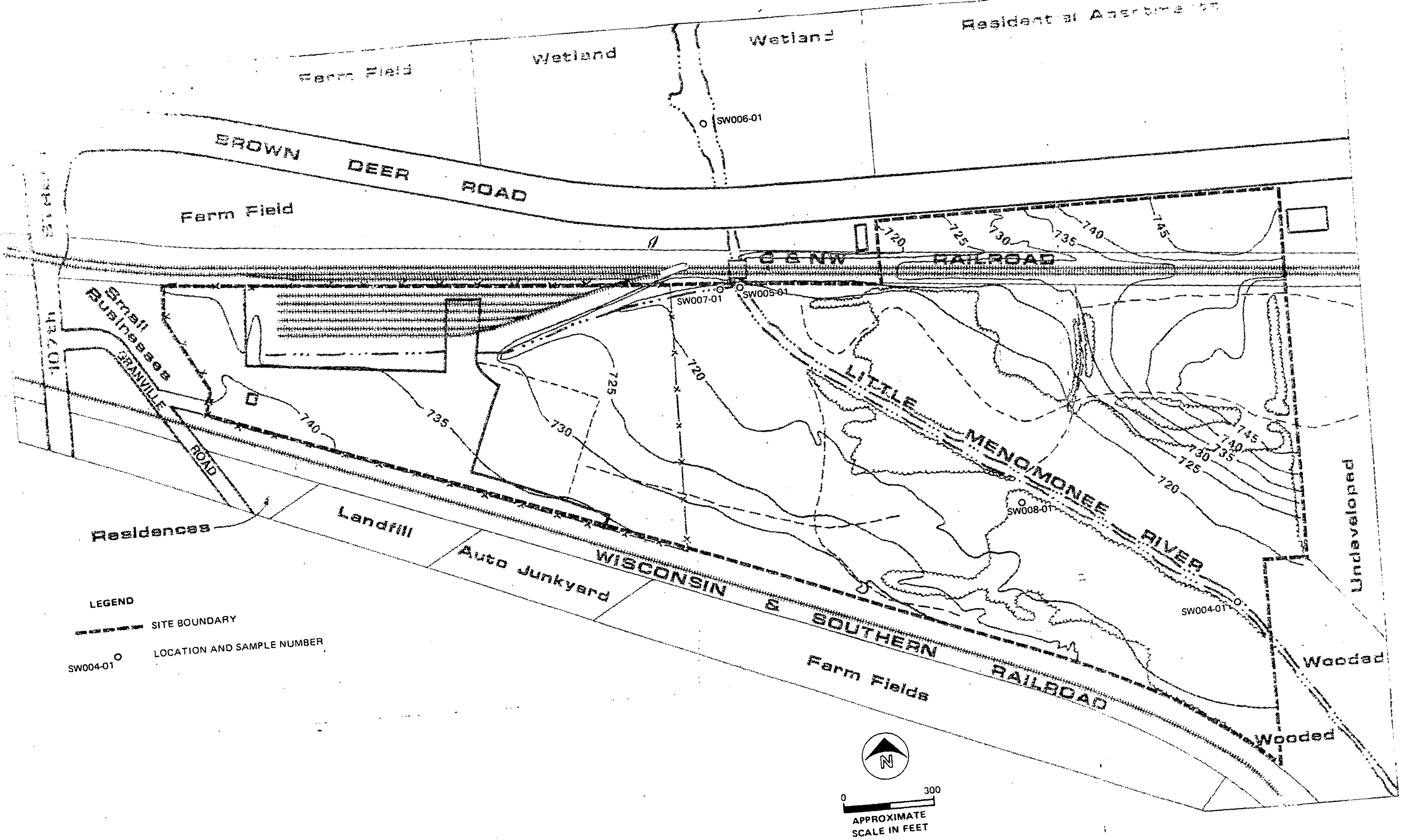


FIGURE 2
SURFACE WATER SAMPLE LOCATIONS
MOSS-AMERICAN RI

- SW008 was taken at a drainage ditch that drains a wet area on the south end of the site into the Little Menomonee River. It taken about 40 feet from the river (1,800 feet) to determine the quality of the water from the ditch.

FIELD MODIFICATIONS TO THE SAMPLING PLAN

Samples SW008 and SW005 were collected from locations different from those presented in the Sampling Plan. The planned location for SW008 was dry, so the sample was collected in a ditch that drains a wet area on the south side of the site. Sample SW005 was taken upstream of a drainage ditch instead of downstream to provide a water quality sample where the river entered the site.

According to the Sampling Plan, surface water samples were to have been collected using a stainless steel laboratory beaker. Instead, sample bottles were filled directly from the river. The pH of the water not measured in the field, but was measured as part of the CLP laboratory's analysis.

OBSERVATIONS

No visible evidence of surface water contamination was noted during the sampling effort, except that oil sheens were produced in several areas when sediments were disturbed during the collection process.

Later in the summer, however, a continuous streamer of oil was observed on the surface of the Little Memononee River adjacent to the Moss-American site where the outfall of the settling ponds had previously existed. The discharge was most notable during the low flow condition that resulted from the summer drought. The discharge was not noted during the original surface water sampling or during a site visit on October 18, 1988. At both times flow in the river appeared to be near normal, based on observations of the banks and channel width.

CONCLUSION

Oil from the site is being discharged to the river and transported downstream. The discharge is visible during low flow conditions. During normal flow conditions, the discharge is either not noticeable (possibly, because of dilution) or it does not occur. This conclusion is based upon observations during the field investigation. Final conclusion will, of course, include the analytical results from the samples and will be reported in the Remedial Investigation reports.

GLT779/29

TECHNICAL MEMORANDUM

TO: Angela Porter/U.S. EPA Region V

FROM: Kevin Olson/CH2M HILL
Don Johnson/CH2M HILL

DATE: October 25, 1988

RE: Task FM--Mapping and Surveying
Moss-American Site

PROJECT: GLO63341.FM

INTRODUCTION

This memorandum describes the fieldwork and related investigation associated with mapping and surveying for the remedial investigation of the Moss-American Superfund site. This memorandum describes the methods and field procedures that were employed and recommendations made for the next phase of the investigation, initial soil screening. A separate memorandum describes the mapping and surveying along the Little Menomonee River from the southern boundary of the site to its confluence with the Menomonee River.

OBJECTIVES

The objectives of the surveying and mapping task (Task FM) were to inspect existing conditions at the site and to establish sample locations in preparation for the initial soil sampling program.

METHODOLOGY

SITE RECONNAISSANCE

The site was inspected by Don Johnson, Kevin Olson, and Solveig Christenson of CH2M HILL on November 19, 1987. The purpose of the inspection was to gain familiarity with the site and develop a strategy for completing Task FM.

Recent aerial photographs were compared to existing conditions to identify and correlate landforms and other surface features. Reference points found both in the field and on the photographs were identified for subsequent use in laying out a grid for field mapping. The general locations of potential sources of contaminants and other features that existed before the creosoting facility was closed were established in the field. Visible evidence of contamination at these and other locations was noted. The presence and general location of dredgings along the river were noted and an attempt was made to identify the general location of the dredgings landfill in the northeast corner of the site.

SITE SURVEY AND MAPPING

Onsite fieldwork was conducted from November 20 to 24, 1987, by Don Johnson, Kevin Olson and Solveig Christenson, and on December 10 by Don Johnson and Solveig Christenson.

A rectangular grid (200 by 100 feet) was established and existing surface features were observed and mapped. Surface soils were evaluated at intersecting grid lines by digging test holes approximately 2 feet deep with a hand shovel (Figure 1). The freshly disturbed soil was screened for organic vapor using an HNu photoionization detector. The type of soil or fill material was then described and visually evaluated for evidence of contamination.

The reference line for the grid west of the Little Menomonee River is a north-south fence that is the eastern boundary of an automobile storage lot on the site. Starting at the northeast corner of the fence, 200-foot intervals were marked in a southerly direction along the fence line. Transects perpendicular to the fence line (roughly east-west) were flagged at 100-foot intervals both east and west of the fence line. The grid included the open area between the paved portion of the automobile storage area on the west and either the Little Menomonee River or a wooded area on the east. The area includes potentially contaminated areas previously used for processing and storage of lumber treated with creosote. Test holes were dug along extensions of the grid within the wooded areas to evaluate dredging piles along the river.

Two areas east of the Little Menomonee River were evaluated. Test holes were dug in a small open area immediately southeast of the railroad bridges crossing the river, which may have contained standing liquid according to previous interpretations of aerial photographs. The other area was the field in the northeast corner of the site. Dredgings from the settling ponds and river are reportedly buried in a landfill within the field. The reference point for the grid east of the river is the intersection of two one-lane dirt roads in the northwest corner of the field. One hundred-foot intervals were flagged along three north-south transects, starting at 100, 300, and 500 feet east of the reference point.

COMPARISON OF CURRENT AND HISTORICAL CONDITIONS

Information obtained during the site survey, recent topographic maps, and aerial photographs of the site were compared to older maps and aerial photographs to identify changes to the site. In particular, changes that would affect the sampling strategy were identified, such as the addition of fill or pavement. Cross sections were constructed of the landfill area using current and historical maps to delineate potential areas of deposition or fill and to identify the general location of the landfill. Cross sections of the settling ponds and the automobile storage area were constructed to estimate the depth and lateral extent of the fill covering those areas.

DATA LIMITATIONS

Organic vapor concentrations in the disturbed soil measured with the HNu photoionization detector were erratic and unreliable, presumably because of high humidity and cold temperatures. HNu readings ranging from background to as high as 190 ppm were recorded; however, it was also noted that the standby meter reading increased along with the normal meter reading, indicating considerable drift in background levels during sample measurement. In addition, the response time for these measurements was on the order of 1 to 2 minutes. During measurement at test holes in which visible evidence of contamination was present, the response time was less than 5 seconds. Remeasurement at several test holes resulted in significant variation in the meter readings. Therefore, the HNu readings are suspect and will not be used for analytical purposes.

Crushed limestone fill prevented digging test holes to the desired depth in several areas (see Figure 2). If the limestone fill was not laterally extensive, such as at the abandoned railroad bed, then the test hole was offset to the edge of the fill. In laterally extensive limestone fill areas, an attempt was made to dig through the bed to determine its thickness and observe the underlying soil for evidence of contamination. This was particularly important for one large gravelly area that, according to previous interpretations, was used as a sludge disposal area. In all cases, however, it was not possible to penetrate the gravel with a shovel. Test holes in those areas ranged from approximately 6 inches to 1 foot.

RESULTS

The results of the site and soil survey are presented in Figure 2. Figure 3 is a map of the Moss-American facility as it appeared in 1962. The delineations shown on Figure 3 divide the site according to the different land uses occurring during site operation. Most of the changes to the site occurred between 1976 and 1978 after Moss-American ceased the creosoting operations. All buildings, storage tanks, and process vessels were demolished and contaminated residue was shipped offsite. The surface of the process area was reportedly backfilled and leveled. The western part of the site was graded with new fill and paved sometime after March 1980, when Kerr-McGee sold this portion of the site to the Chicago and Northwestern (C&NW) Railroad Company.

PROCESSING AREA, DRIP TRACKS, AND UNTREATED STORAGE AREA

The processing area, drip tracks, and untreated storage area are roughly coincident with the portion of the site currently owned by the C&NW railroad and used for automobile storage. The location of three cross sections in those areas are shown in Figure 4. Figure 5 illustrates the extent of the fill material in those areas. The previous topography is superimposed on the present topography to show the minimum depth of fill and the location of borrow (cut) areas.

Cross section A-A' (Figure 5) shows a small cut and fill area, presumably for leveling the area currently used for parking rail cars. In addition, a drainage ditch that previously paralleled the tracks on the northern edge of the site has been filled with at least 4 feet of material.

At cross section B-B', it appears that a wedge of fill ranges in thickness from 2 feet on the south side to approximately 8 feet on the north. At least 3 or 4 feet of material covers what used to be the foundation of a building. However, according to documents in EPA files, buildings demolished during closure were excavated to a depth of 18 inches, backfilled with clean fill and leveled. Inasmuch as episodes of cut and fill occurring between 1962 and 1987

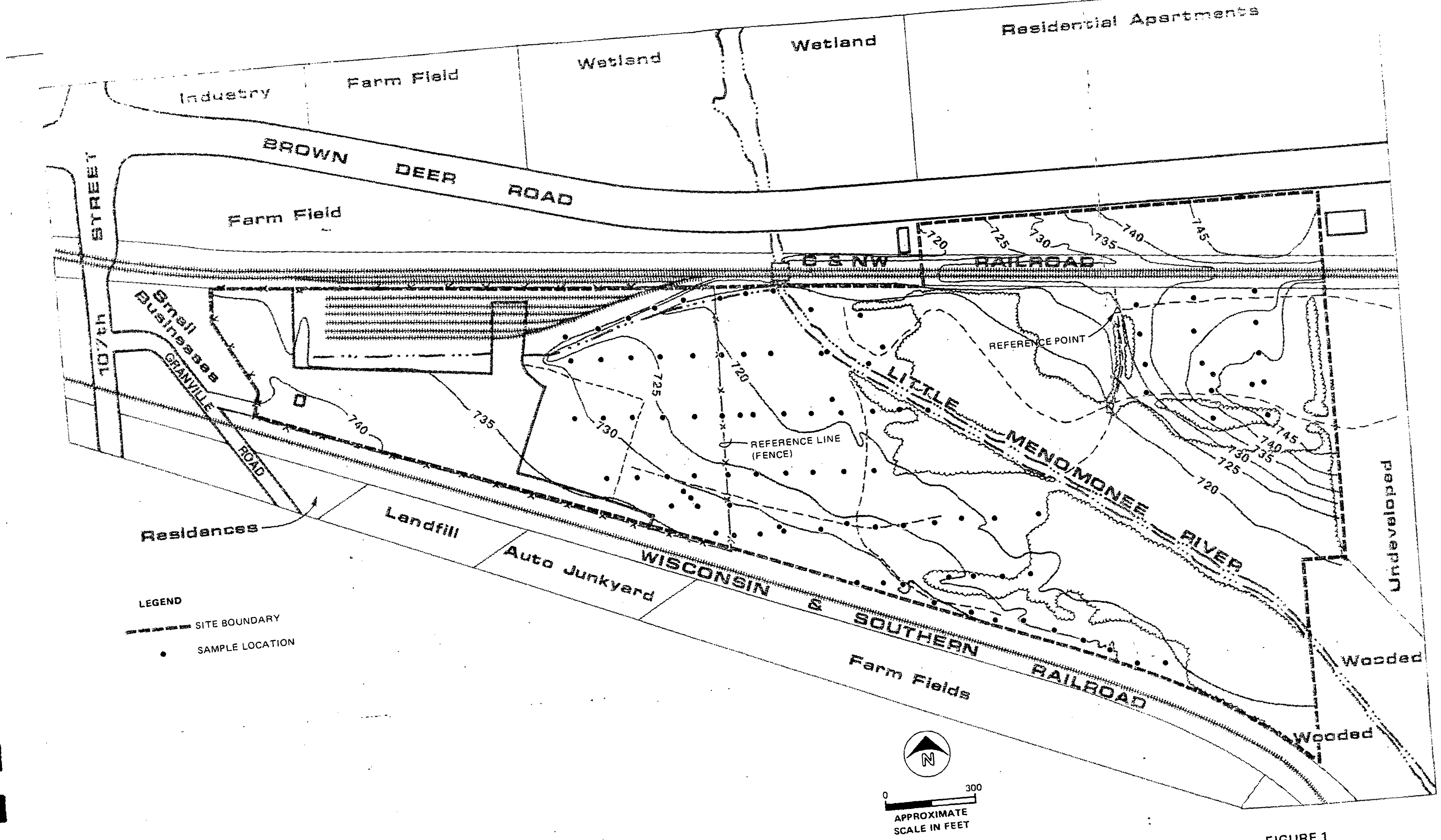


FIGURE 1
SAMPLING POINTS USED
DURING TASK FM, MAPPING AND
SURVEYING
MOSS-AMERICAN RI

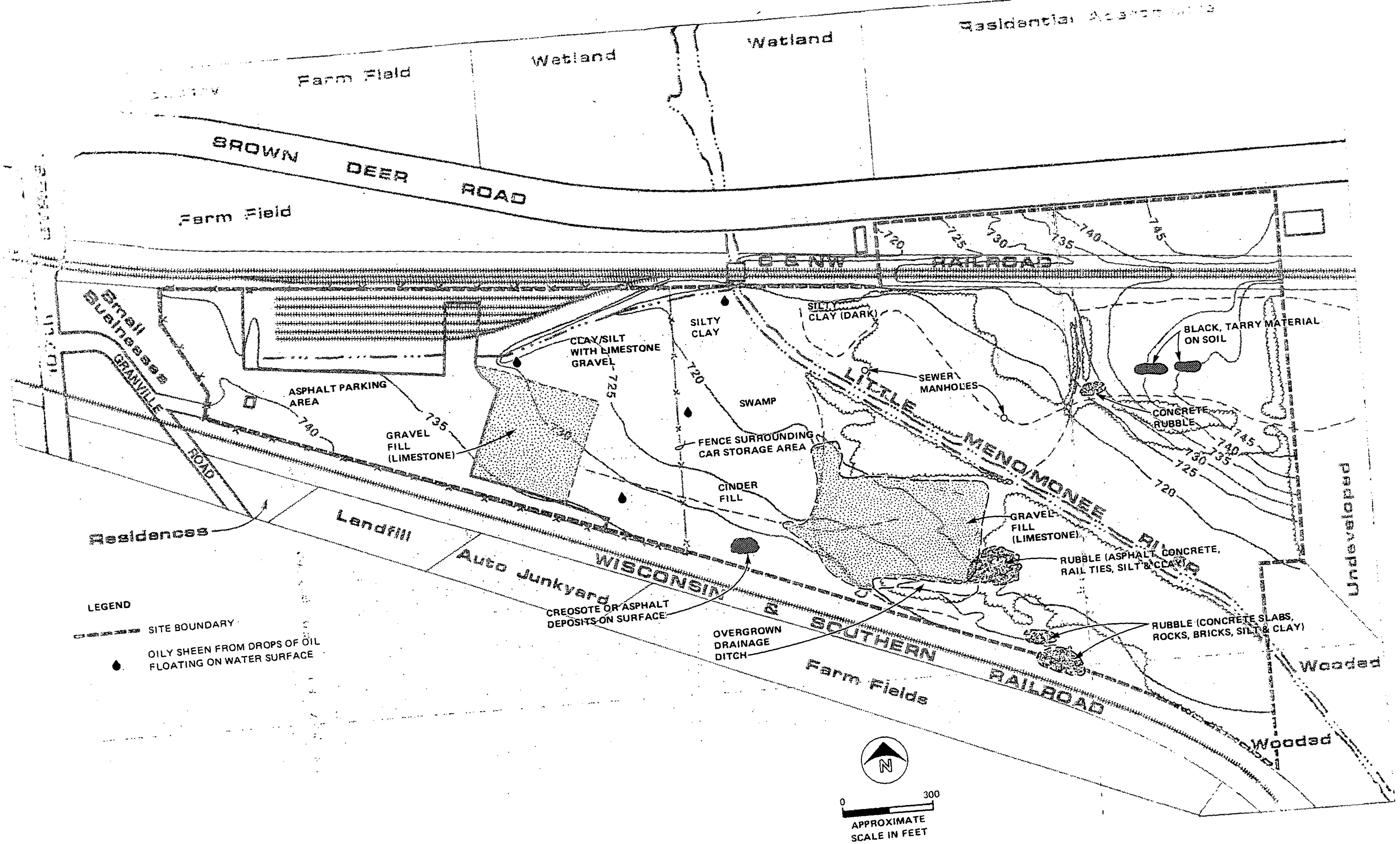
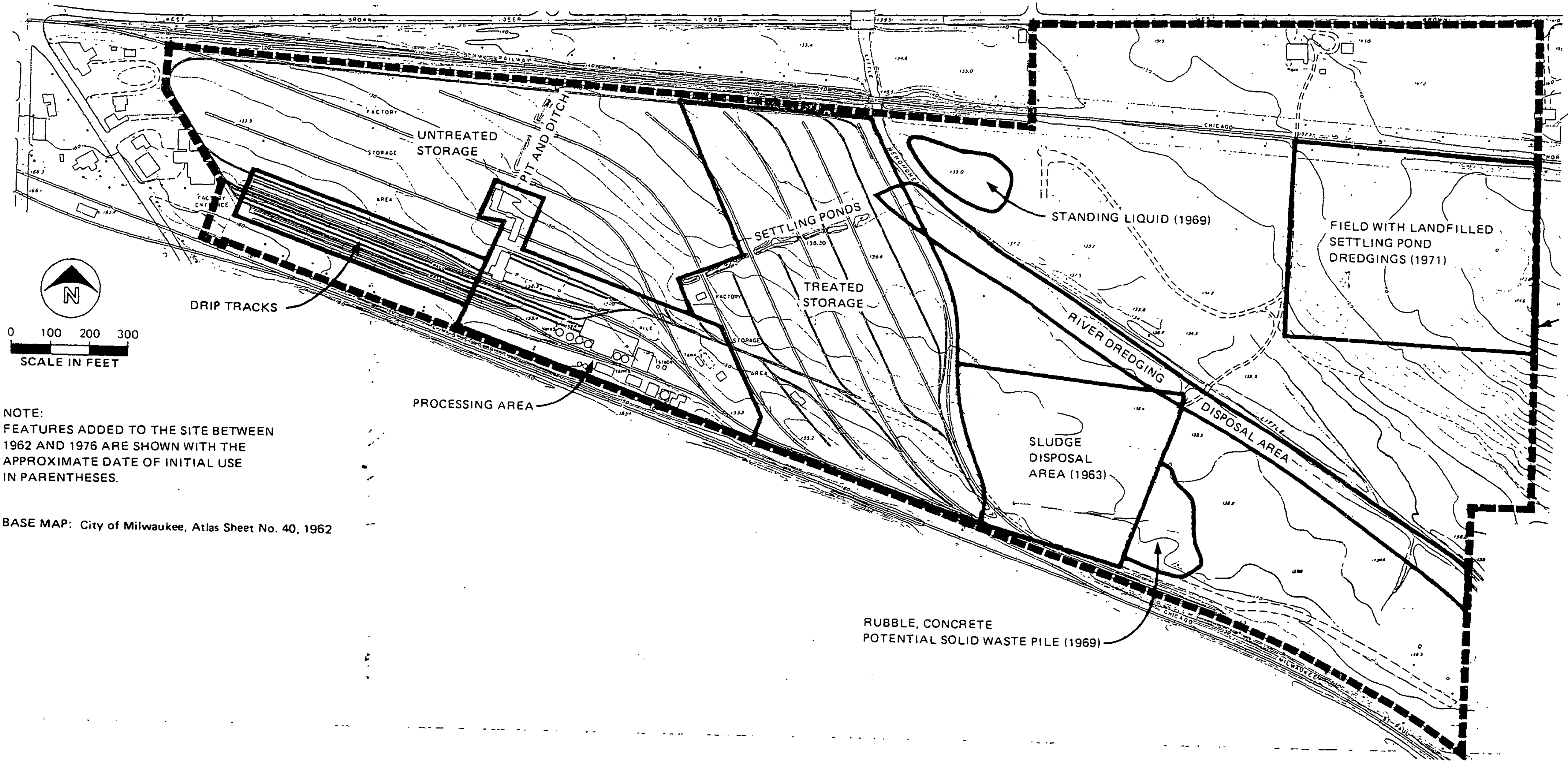


FIGURE 2
EXISTING CONDITIONS: 1987
MOSS-AMERICAN RI



NOTE:
FEATURES ADDED TO THE SITE BETWEEN 1962 AND 1976 ARE SHOWN WITH THE APPROXIMATE DATE OF INITIAL USE IN PARENTHESES.

BASE MAP: City of Milwaukee, Atlas Sheet No. 40, 1962

FIGURE 3
AREAS OF
POTENTIAL CONCERN
MOSS-AMERICAN RI

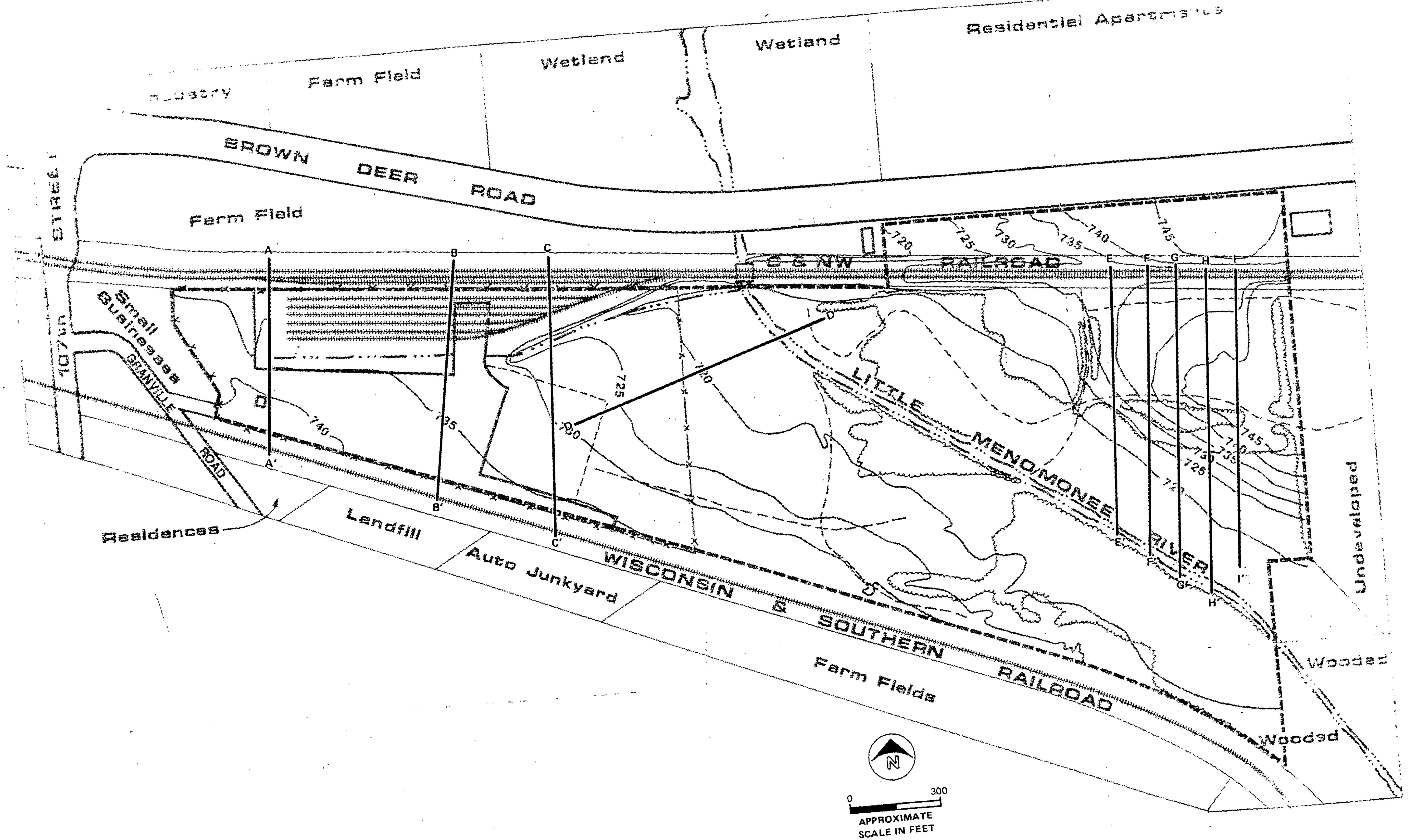


FIGURE 4
CROSS SECTION LOCATIONS
MOSS-AMERICAN RI

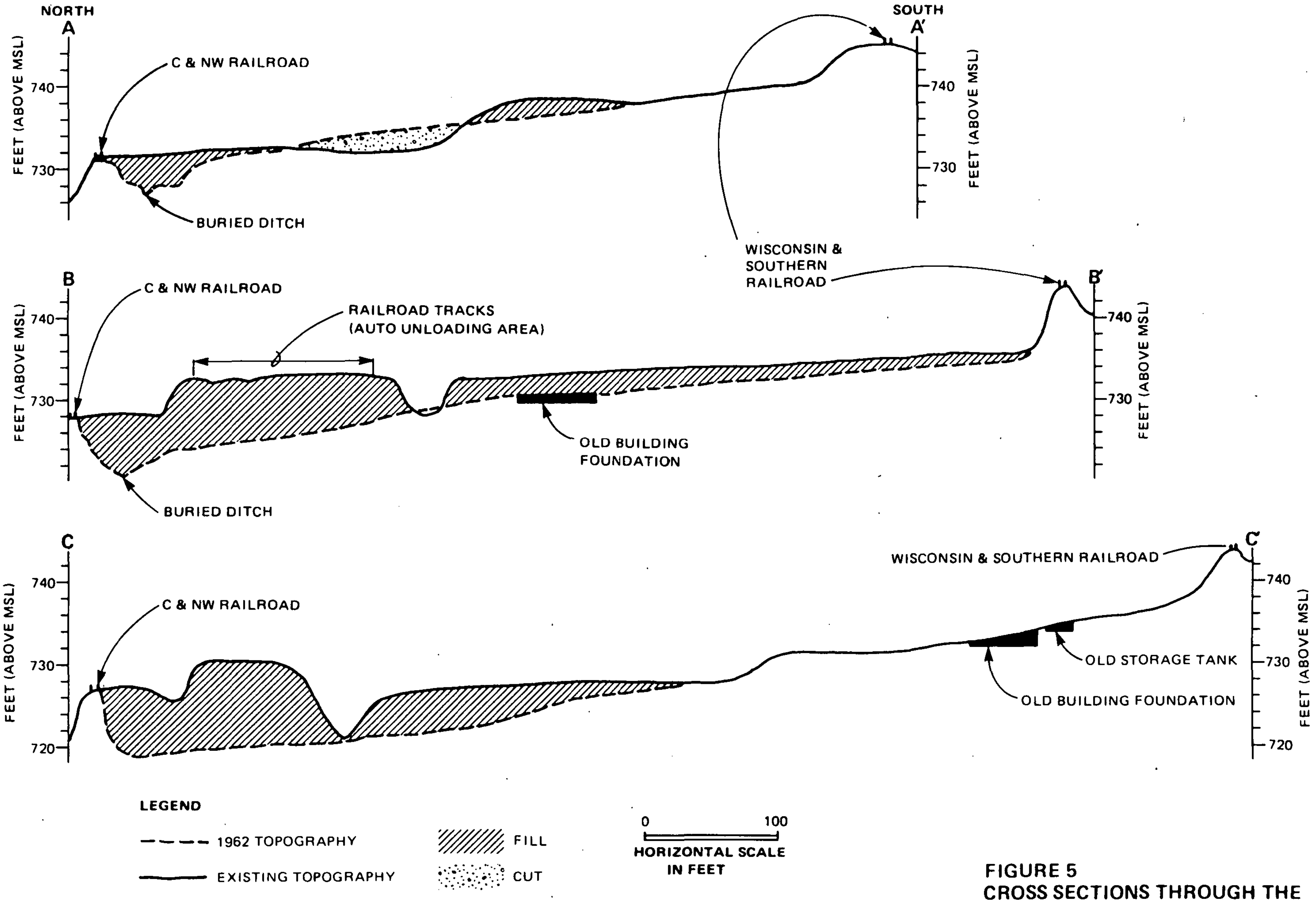


FIGURE 5
CROSS SECTIONS THROUGH THE EXISTING AUTO STORAGE LOT
MOSS-AMERICAN SITE RI

may not be shown in the cross sections, it is possible that more than 5 feet of fill (18 inches from site closure and 3 to 4 feet from redevelopment) covers the old building along cross section B-B'. At the northern end of the cross section, the old drainage on the northern edge of the site is covered with approximately 7 feet of fill.

Cross section C-C' shows little if any change in topography along the southern half of the area. The existing land surface in the vicinity of what was previously a building and storage tank along C-C' is fairly close to the elevation of the land surface in 1962. However, according to Kerr-McGee documents in EPA files approximately 18 inches of backfill may exist there. Part of one building foundation was observed along the paved road near the eastern part of the processing area. Therefore, the fill added near the foundation during and after site closure appears to be minimal.

During the site survey an oily sheen was observed on ponded surfaces in the area previously used for storing untreated railroad ties. The oil appeared to emanate from the fill material below the asphalt surface. It was not possible to determine if the oil was a remnant of past creosoting activity or the result of current activity at the site.

Three patches of black, dried, tarry deposits were noted in the eastern part of the processing area. The area is littered with railroad ties that appear to be remnants of abandoned railroad beds.

TREATED STORAGE AREA

No significant changes are evident in the treated storage area. The surface materials consist of either cinder fill mixed with varying amounts of silt, sand, and wood chips, or an organic rich silty sandy material. The variability in the silty sandy material indicates that it is probably fill material or reworked soil. Remnants of abandoned railroad beds are present throughout the area.

The settling ponds that previously drained this area (see Figure 3) were reportedly dredged and backfilled with clean fill in 1971. Figure 6 shows a cross section through the ponds (from 1962) superimposed on the existing topography. The thickness of fill in that area is shown as 2 to 6 feet in Figure 6, but the actual depth of fill includes the depth

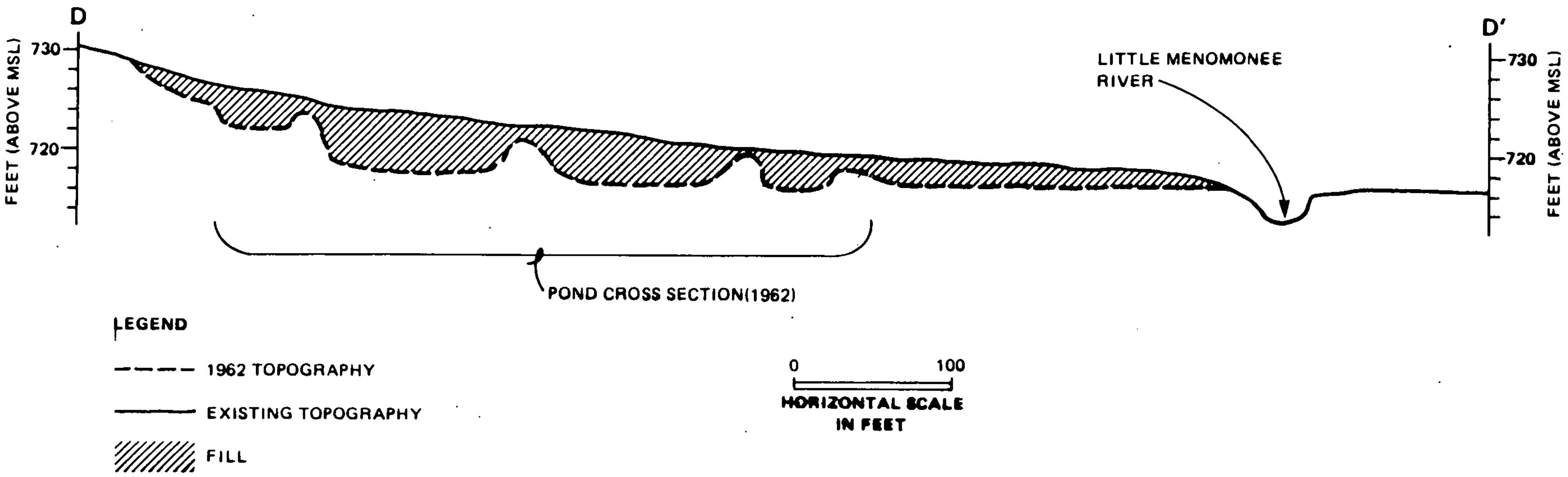


FIGURE 6
CROSS SECTION THROUGH
SETTLING PONDS
MOSS-AMERICAN RI

to which the ponds were dredged before backfilling, which is not known.

A clay wall 75 feet long and 12 feet deep was reportedly constructed between the settling ponds and Little Menomonee River in 1971. Its exact location was not determined during the field investigation.

SLUDGE DISPOSAL AREA

The sludge disposal area consists of coarse limestone or dolomite gravel. No evidence of contamination was observed; however, it was not possible to dig to the base of the gravel to evaluate the interface between the gravel and underlying soil.

why not? X

SOLID WASTE PILES

A mound of rubble was observed in the area of the solid waste piles. The mound consisted of concrete and asphalt slabs, rocks, bricks, and dirt. No other evidence of solid waste disposal was observed near the areas delineated as solid waste piles, but trash disposal areas were observed in low-lying wooded areas along the river. Trash consisting of old bottles, cans, and automobile parts appeared to have been dumped on the surface. No signs of industrial or hazardous waste were observed in the trash disposal areas. One area, interpreted from an aerial photograph as a solid waste pile, was an overgrown drainage ditch.

DREDGINGS PILES

Piles of dredgings were observed along both banks of the river. River dredging was performed at least twice in this area. Although not documented, it appears from observing old river channels meandering through the woods onsite and from the straightness of the existing river channel that the channel was dredged and straightened prior to 1950, the date of the earliest aerial photograph. In 1971, Moss-American dredged parts of the river to remove creosote deposits. According to Kerr-McGee's "Notification of Hazardous Waste Site" (June 4, 1985), 6 inches of creosote contaminated dredgings, 50 feet wide and 1,700 feet long, are deposited on the south bank of the river. During the field investigation it was not possible to distinguish the source or age of the dredging piles.

STANDING LIQUID AREA

The standing liquid area was identified in an aerial photograph taken in 1969. Dredging piles along the river have created a dike that traps water and possibly other fluids in the area behind the dredgings. The aerial photograph showed a new road connecting the sludge disposal area and the standing liquid area that may have been used to transport liquids to the standing liquid area. During the field investigation, however, it was noted that the road connects two manholes on a sewer in the Metropolitan Interceptor Sewer System.

DREDGINGS LANDFILL

Kerr-McGee's "Notification of Hazardous Waste Site" describes a landfill in the northeast corner of the site

> that was created around 1971 to dispose of creosote contaminated soil (K001) generated by the closure of the impoundment area. Land-fill construction included four trenches measuring 8 feet wide, 8 feet deep and 100 feet long each. Approximately 8,100 cubic feet of residue was mixed with clean clay soil in a ratio of approximately 2:1 clean clay soil to residue. The trenches were filled to a depth of approximately 6 feet and then covered with a 2-foot clean clay soil cap.

The "impoundment area" is a series of settling ponds west of the river. Other reports have suggested that river dredgings may also be landfilled. The exact locations of the trenches and trench arrangement were not given.

During the site survey black dried, tarry deposits were observed on the land surface along the 2-track road on the south side of the field (see Figure 2). Two deposits were observed. The combined surface dimensions of the deposits (including a middle area with no visual evidence of contamination) are approximately 200 by 50 feet. Four trenches with the dimensions given in the hazardous waste site notification could easily fit within that area.

Figure 7 shows a comparison of the existing topography in the vicinity of the landfill and the topography as of 1962.

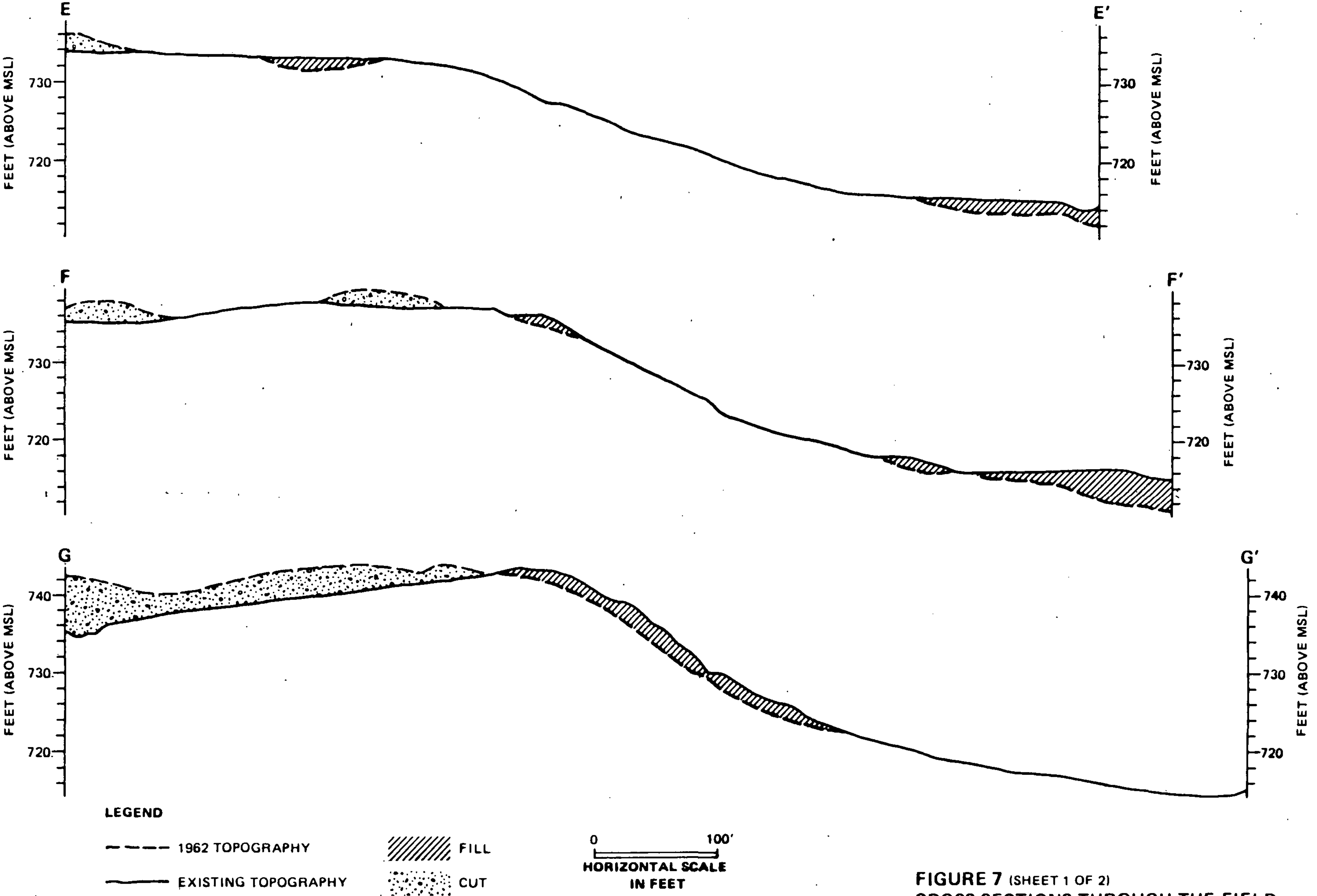


FIGURE 7 (SHEET 1 OF 2)
CROSS SECTIONS THROUGH THE FIELD IN THE NORTHEAST CORNER
MOSS-AMERICAN RI

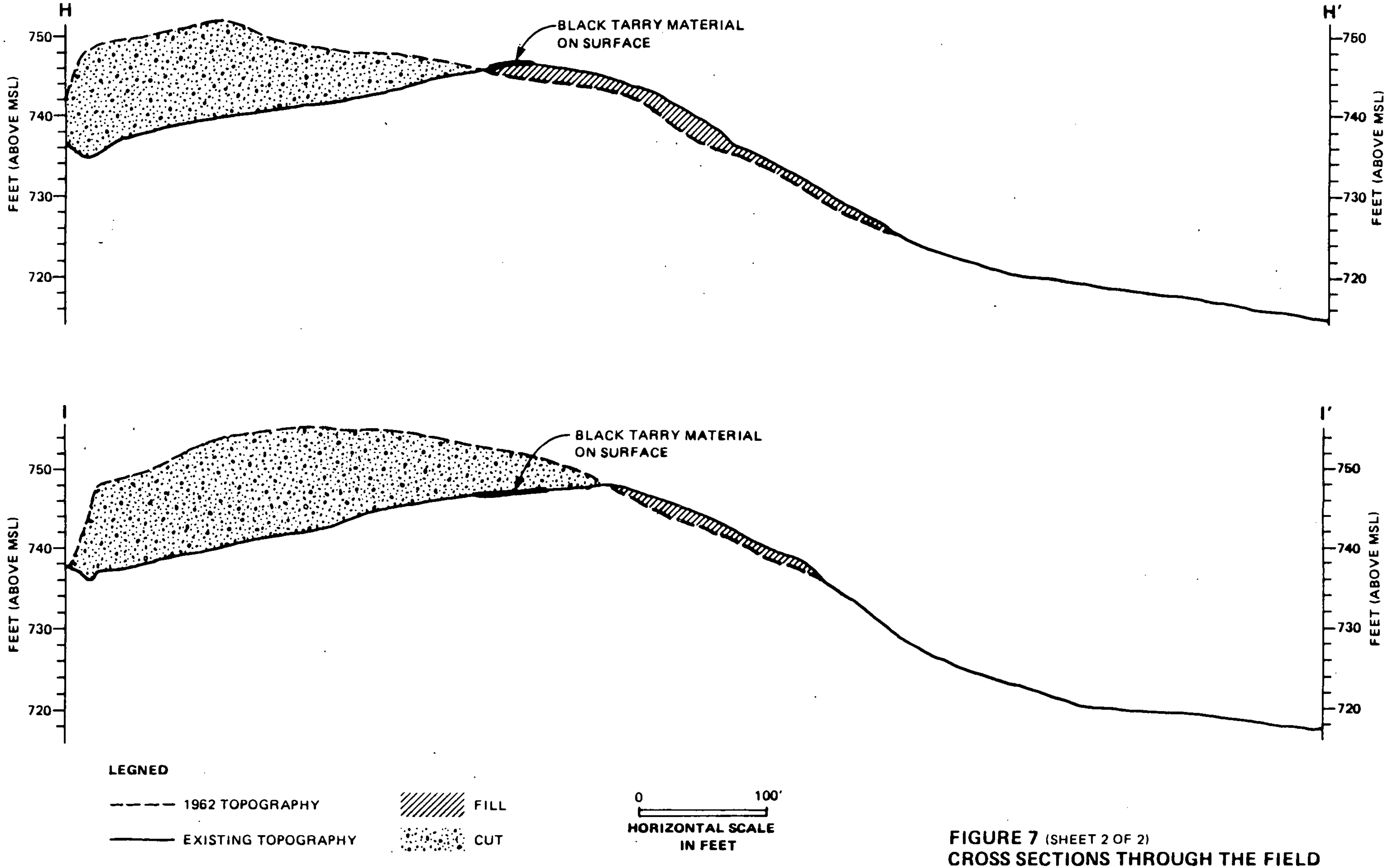


FIGURE 7 (SHEET 2 OF 2)
CROSS SECTIONS THROUGH THE FIELD IN THE NORTHEAST CORNER
MOSS-AMERICAN RI

Borrow areas are clearly shown on the cross sections as large cuts from the eastern part of the field. Areas of potential fill, which could indicate the location of the landfill or other material spread on the surface, are shown on the three easternmost cross sections in Figure 7 (G-G', H-H', and I-I').

RECOMMENDATIONS

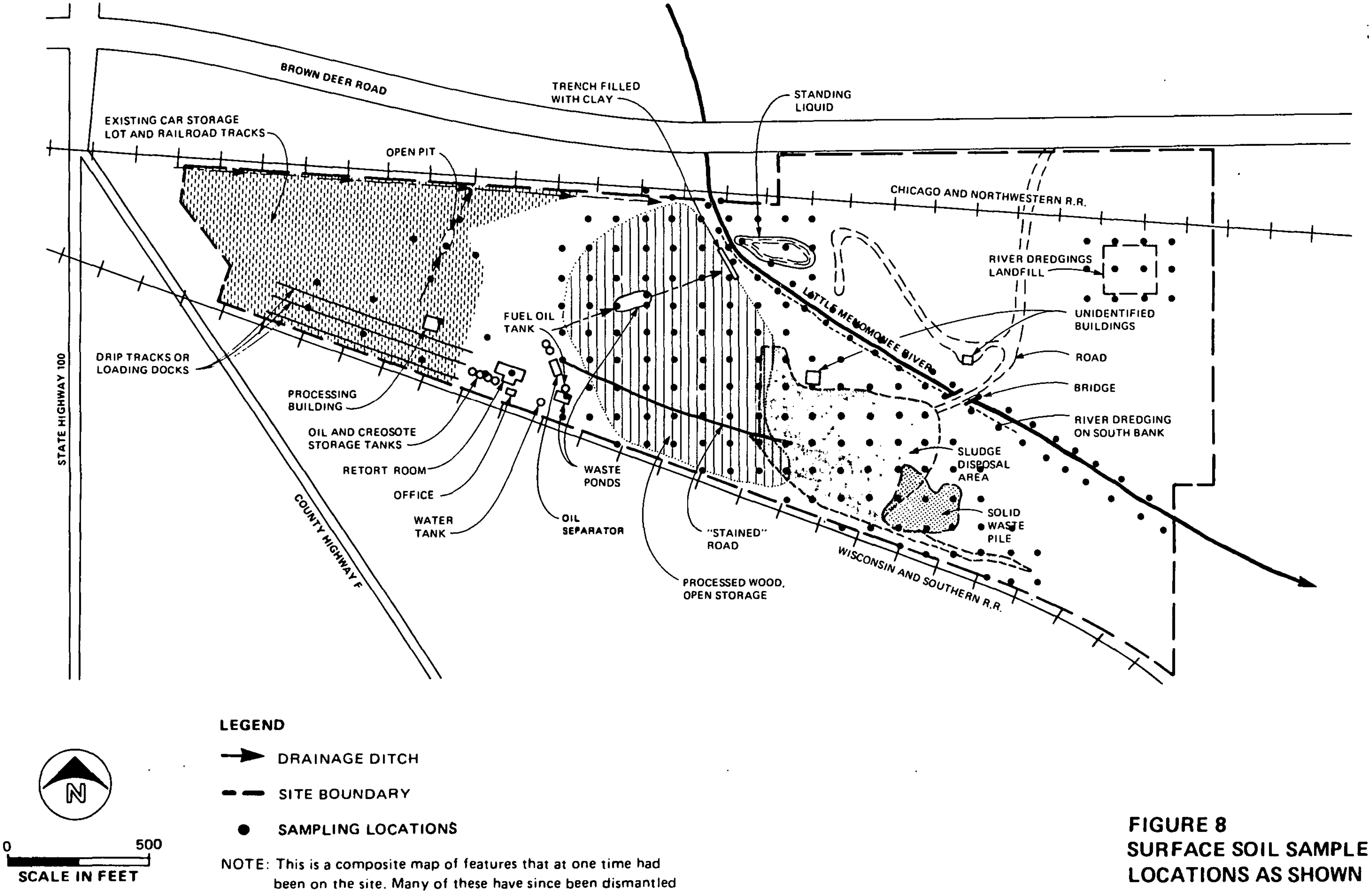
This section summarizes the recommendations made regarding sample locations and sampling methodology for initial soil screening. The use of a backhoe in place of a hollow-stem auger was recommended for most samples, as were location refinements to the sampling plan described in the work plan and QAPP (Figure 8). Proposed sample locations for the initial soil sampling based on these recommendations are shown in Figure 9.

BACKHOE VERSUS AUGER

A backhoe, rather than a trailer-mounted auger, was recommended for digging test holes in all areas except the paved automobile storage area for the following reasons:

- Augering in coarse gravel areas could be difficult.
- Abandoned railroad beds and the sludge disposal area, which are composed of coarse gravel, should be visually evaluated because of their potential significance as conduits for contaminant transport.
- Test holes dug by backhoe would allow visual inspection of the subsurface, improving the quality and accuracy of observation and interpretations.
- Subsurface samples obtained from discrete layers would provide more meaningful data than compositing samples over a particular depth, which is often necessary to obtain sufficient sample volume from split spoons.

Test holes dug by backhoe would follow the same general sampling plan prepared for augering except the hole would be dug rather than augered. The number of test holes and samples would remain unchanged. Auger samples are still



NOTE: This is a composite map of features that at one time had been on the site. Many of these have since been dismantled or covered.

FIGURE 8
SURFACE SOIL SAMPLE LOCATIONS AS SHOWN IN THE WORK PLAN
MOSS-AMERICAN RI

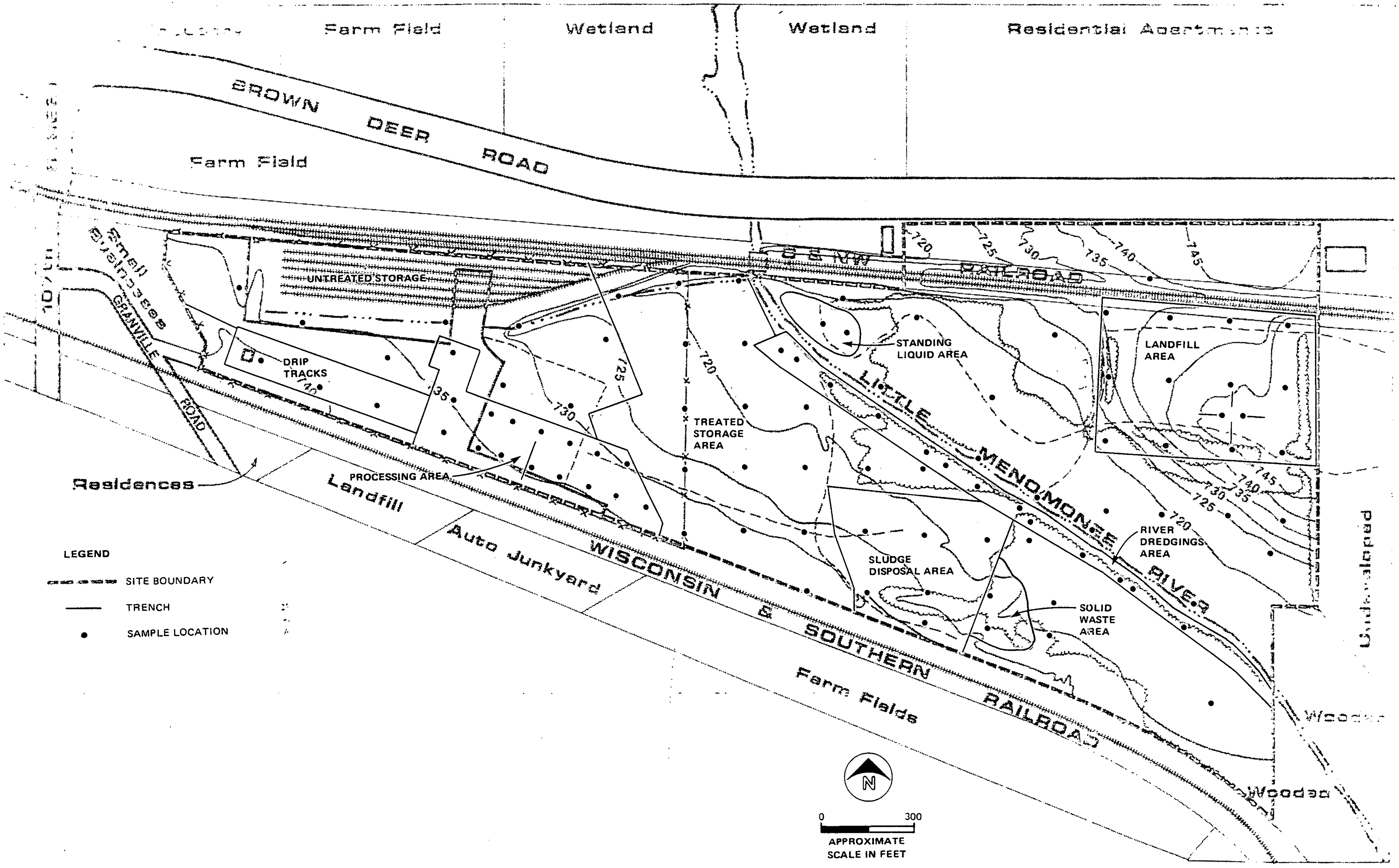


FIGURE 9
PROPOSED SAMPLE LOCATIONS
FOR INITIAL SOIL SCREENING
MOSS-AMERICAN RI

recommended for the paved area to minimize damage and interference to the facility and operations at the auto storage lot.

UNTREATED STORAGE AREA

Contamination is not expected in the untreated storage area. Figure 8 shows five sample locations in that area, in addition to four samples along a trench and pit that previously drained the area.

Because of extensive redevelopment and the addition of significant amounts of fill over the northern half of the area, the following recommendations were made:

- Arrange the five spot samples at regular intervals along the southern and eastern boundaries of the untreated storage area, approximately 50 feet inside the area boundary. This would avoid areas of new fill and should help delineate the actual boundary between contaminated and uncontaminated areas.
- Due to the thickness of the fill, samples near the pit and trench should be limited to the existing drainageway. The drainageway is perpendicular to the previous drainage. The intersection of the two ditches is near the culvert that passes under the paved area. Surface samples should be taken at each end of the culvert of the existing drainageway.
- If additional sampling in the pit and ditch area is warranted, precise surveying techniques should be used to locate the buried pit and trench before sampling. Sampling should be done to the necessary depth with soil borings using a hollow-stem auger.
- Samples in the pit and ditch area should be carefully screened so the clean new fill is properly logged but not sampled. Sampling depth should be adjusted from 0 to 4 feet (the current plan) to 0 to 12 feet to identify the top of the original land surface and then to evaluate the next 4 feet.

DRIP TRACK AREA

Six samples were proposed for the drip track area on a grid of approximately 100 by 200 feet. The following clarification was recommended:

- The samples down the center of the drip track area from the first round of sampling should be adequate to determine the degree of contamination.
- Four samples should be considered for the second round--two on each side of the centerline, staggered, and at different distances from the centerline. These, in conjunction with the samples taken in the untreated storage area along the boundary, should focus on determining the lateral extent of contamination.

PROCESSING AREA

The processing area was considered the most difficult to characterize. Unlike most of the other areas, which should be fairly uniform, the processing area contained buildings, railroad beds, aboveground storage tanks, waste piles, and an oil separator. The area around the retort room was probably one of the most contaminated areas during site operation. Although the processing area was reportedly excavated and backfilled during site closure, thorough investigation of the area was still warranted. The following recommendations were made:

- A trench should be excavated through the retort area using a backhoe. Visual observations of the trench wall should provide information about the extent of removal operations occurring during site closure. The observations on the trench should also improve the interpretations of subsequent split-spoon samples from the paved part of the processing area west of the retort building.
- Instead of collecting samples on a 200-foot grid, samples should be collected on a 100-foot grid during the first round of sampling. Additional locations should be for a selected the second round of sampling on the basis of the initial results.

- The sampling depth should be adjusted to a maximum of 5 feet in areas where clean fill is obviously present.

TREATED STORAGE AREA

The treated storage area should be fairly uniform except for the area previously containing settling ponds. No changes or refinements, other than the use of a backhoe, were recommended for that area.

SLUDGE DISPOSAL AREA

No changes or refinements to the sampling plan were recommended for the sludge disposal area.

SOLID WASTE AREA

No changes or refinements to the sampling plan were recommended for the solid waste area.

RIVER DREDGINGS

The following strategy was recommended for sampling the south bank of the river:

- Collect samples at regular intervals to identify dredgings that were leveled and may blend with the topography.
- Collect spot samples from representative areas where dredgings have been placed in piles.

Contaminated soil was not expected on the north bank of the river, but verification with random samples along the bank and spot samples of representative piles of dredgings and in clearings along the bank was considered appropriate.

STANDING LIQUID AREA

The dimensions of the standing liquid area, measured from an aerial photograph taken June 13, 1969, are approximately 130 by 70 feet. Because of the limited size of the area, the following recommendations were made:

- Dig two test holes approximately 40 feet apart in the center of the area for the first round of sampling.

- If contamination is detected, collect additional samples to identify the extent of the contamination.

LANDFILL AREA

The following strategy was recommended to identify the location and verify the extent of the landfill area:

- Collect one sample from the center of each of the patches of tarry deposits to determine the depth and general character of the deposits. It was not considered necessary or desirable to go deeper than 4 feet for these samples. Four-foot holes would verify whether the deposits were entrenched or merely spread on the surface. If the deposits were entrenched, then the shallow soil boring planned for the area would identify the vertical extent of the creosote contaminated fill.

- Construct four trenches or a series of closely spaced test pits extending radially outward from the edge of the tarry deposits in the four compass directions. Again, the intention was to identify the lateral extent of the deposits. Once tarry substances were encountered it would not be necessary to dig deeper. The maximum depth of the trench should not exceed 4 feet.

- If the tarry deposits were determined to be the landfill, samples should be taken from a 200-foot grid for random evaluations of the rest of the field. If the tarry deposits are not the landfill, samples should be collected on a 100-foot grid.

TECHNICAL MEMORANDUM

TO: Angela Porter/U.S. EPA Region V

FROM: Kevin Olson/CH2M HILL
Don Johnson/CH2M HILL

DATE: October 25, 1988

RE: Surface Soil Investigations
Moss-American Site

PROJECT: GLO63341.G1
GLO63341.G2

INTRODUCTION

TASK SUMMARY

This technical memorandum describes the fieldwork and results of Tasks G1 and G2, Initial Soil Screening and Confirmatory Soil Analysis, for the Moss-American site. The objective of the tasks was to provide the data necessary to determine the native and lateral extent of contamination at the site.

Soil samples were collected at depths of zero to 4 feet from clean and contaminated areas onsite and from background locations offsite. Samples were generally collected from test pits dug with a backhoe. However, offsite samples and samples from wooded and swampy areas onsite were collected from holes dug with a hand-held post hole digger, and samples beneath paved areas onsite were collected using split-spoon samplers in auger borings advanced with a truck-mounted drill rig.

All test pits and holes were screened in the field for evidence of contamination by visual observation, odor detection, and organic vapor monitoring. Total extractable organics of at least one sample from each location was measured by the onsite close support laboratory (CSL). Following an evaluation of results from the initial screening, 40 samples were sent to an offsite laboratory to determine the concentration of polyaromatic hydrocarbons (PAHs) and phenolic acids. On the basis of the results from the offsite laboratory, 16 sites were resampled and samples were submitted to CLP laboratories for analysis of Target Compound List parameters, dioxin, and several treatment parameters.

TASK SCHEDULE AND PERSONNEL

Surface soil sampling began on May 18 and continued through May 31. Sampling in the paved area was performed on June 29. Confirmatory soil sampling was (Task G2) done on June 30.

Test pit excavation by backhoe and augering in the paved area was subcontracted to Exploration Technology, Inc., of Madison, Wisconsin. Samples were collected and logged by CH2M HILL personnel. Kevin Olson, Stu Grubb, Ned Pennock, John Gannon, and Don Johnson performed field work under these tasks. Brian Laude and Dave Shekoski analyzed samples in the CSL for extractable organic compounds. Results from the onsite screening and priority pollutant PAH and phenolic acid determination are included in this memorandum. Analytical results from the confirmatory sampling will be presented in the remedial investigation report.

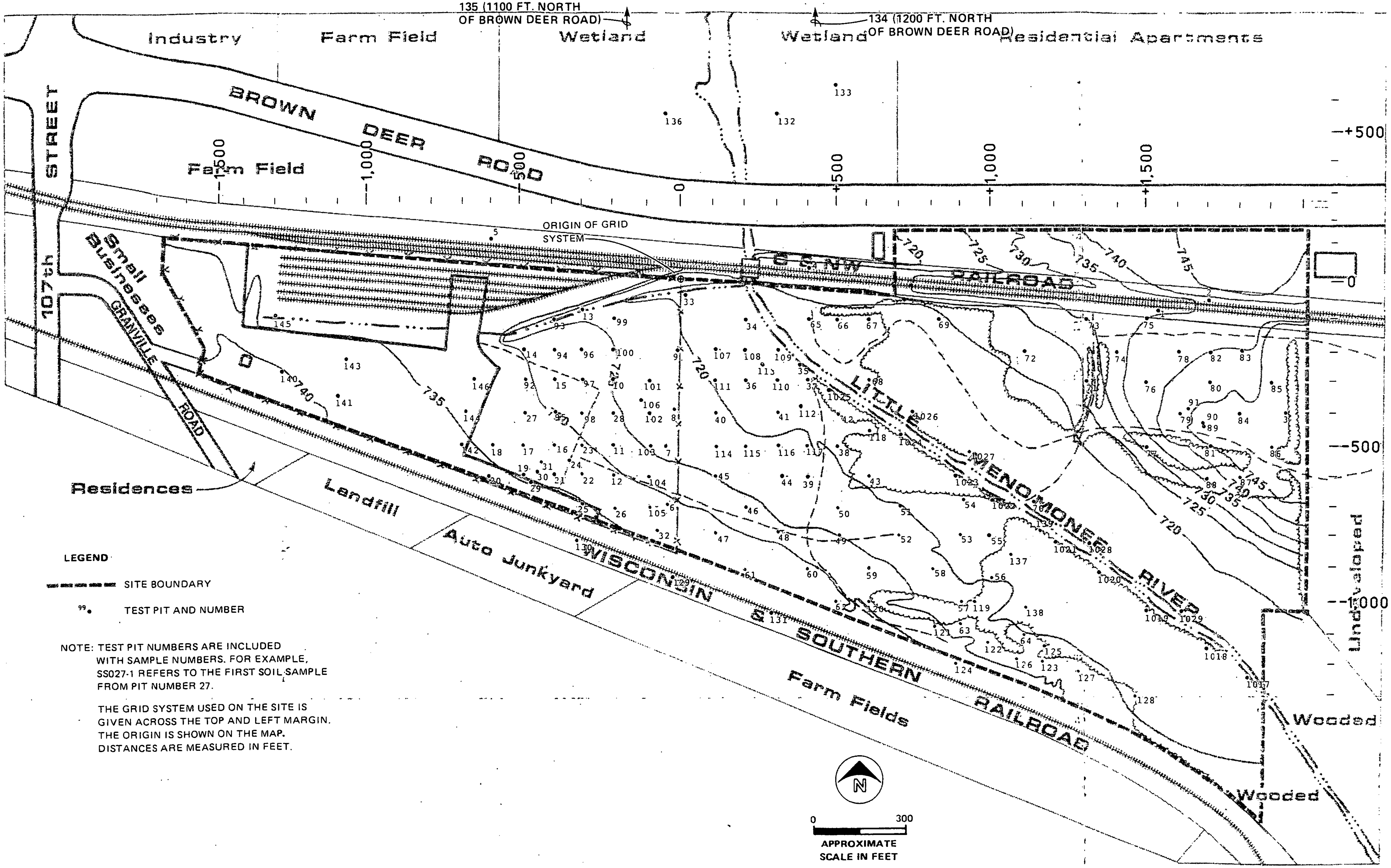
OBJECTIVES

The overall objective of these tasks was to determine the nature and extent of contamination on the site. In addition, geologic and other factors affecting contaminant migration at the site were identified, and organic vapor concentrations were monitored for assessment of air quality.

METHODS

STRATEGY

Based on past site activities and a site inspection, an initial set of sample locations was identified as part of Task FM. A 100-foot-square grid was established over most of the site to locate sampling points in the field. Samples were generally collected at 200-foot intervals. Samples were collected at 100-foot intervals from the processing area and other areas of high contaminant levels. In addition, 14 offsite samples were collected: 7 near active railroad beds and 7 from areas with physical characteristics similar to those on the site. The samples near the railroad beds were collected to compare the compounds present near offsite railroad tracks with those found where tracks once existed on the site. Figure 1 shows the sampling locations.



LEGEND

▬ ▬ ▬ SITE BOUNDARY

⁹⁹• TEST PIT AND NUMBER

NOTE: TEST PIT NUMBERS ARE INCLUDED WITH SAMPLE NUMBERS. FOR EXAMPLE, SS027-1 REFERS TO THE FIRST SOIL SAMPLE FROM PIT NUMBER 27.

THE GRID SYSTEM USED ON THE SITE IS GIVEN ACROSS THE TOP AND LEFT MARGIN. THE ORIGIN IS SHOWN ON THE MAP. DISTANCES ARE MEASURED IN FEET.

FIGURE 1
SOIL SAMPLING LOCATIONS
FOR EXTRACTABLE ORGANIC ANALYSIS
MOSS-AMERICAN RI

Samples taken from the test pits were assumed to be representative of the material surrounding the pit. However, localized areas of high contamination were expected near the processing building, in the landfill east of the river, and possibly surrounding the old settling ponds. The test pits were lengthened into trenches in those areas to better define the limits of contamination.

Each location was screened in the field for evidence of contamination. Field screening consisted of making visual observations, detecting odors, and monitoring with an HNu during soil disturbance. The sample from each pit was collected in a plastic bag and a 4-ounce glass jar. The most visibly contaminated soil was collected at each pit. Organic vapors in the headspace of the plastic bag were measured with the HNu. The CSL analyzed each jarred sample for extractable organic compounds. A site map was kept up-to-date with data on extractable organic compounds, field screening data, and pertinent field observations. Additional sample locations were then selected, as necessary, to further define the limits of contamination. Generally, additional sample locations were on the 100-foot grid nodes.

Upon completion of sampling and evaluation of results from the CSL, about 30 percent of the samples were sent to an offsite laboratory and analyzed for priority pollutant PAHs and phenolic acid compounds. A total of 40 samples were analyzed: 30 from areas with high concentrations of extractable organic compounds and 10 from areas with concentrations less than 1,000 ppm (Figure 2). CH2M HILL's Montgomery laboratory performed the GC/FID analyses.

Following receipt of laboratory results, 16 locations were resampled for submittal to CLP laboratories for more extensive analyses. Ten sample locations representative of contaminated areas and six in clean areas were selected for this phase of sampling (Figure 3). Samples were collected using the same procedures as before. New test pits were dug adjacent to the original test pits at each location. Samples were collected from the same depth and soil horizon as the original samples. Samples were analyzed for the Target Compound List of organic compounds, dioxin, and several treatment parameters. The treatment parameters consisted of the proximate and ultimate analysis for coal and coke, heating value, flash point, total organic carbon, and water soluble chlorides.

SAMPLING PROCEDURES

Three methods were used to excavate surface soils to screen and collect samples during this task: 1) tractor-mounted backhoe; 2) post hole digger; and 3) truck-mounted auger. Most of the onsite samples were collected with the backhoe. The post hole digger was used where backhoe access was difficult and offsite. Truck-mounted augers were used in the paved area to minimize destruction of private property and interference with the existing business.

Backhoe

Backhoe excavation was preferred because it allowed observation of the near-surface stratigraphy and contamination at each location. Each test pit was dug to a depth of about 4 feet, which was adjusted as necessary at the direction of the field engineer. Generally, the depth was increased if it was felt the additional depth could aid estimation of volume of contaminated soil. The depth was decreased when contamination was obvious and additional depth information was not warranted. The test pit area and disturbed soil were monitored for organic vapor using an HNu.

Samples from each pit were collected from the backhoe bucket, from the pile of excavated material, or directly from the wall of the excavated pit. Samples were collected in glass jars using a stainless steel spoon and in plastic bags using either a spoon or by hand (sampler wearing gloves). In most cases the sample was from an identifiable soil horizon or depth, and care was taken to avoid sampling material in contact with the backhoe bucket and other soil horizons. However, when no contaminated material was identified, a representative sample was taken from the excavated spoils. In those cases, the depth of the sample was estimated on the basis of the depth of similar material in the pit.

The backhoe bucket and sampling equipment were decontaminated between each pit. The bucket was scraped and brushed to remove dirt. When oily soils were encountered, the backhoe was steam-cleaned before the next pit was excavated. Other sampling equipment (spoons, gloves, pans) was washed and

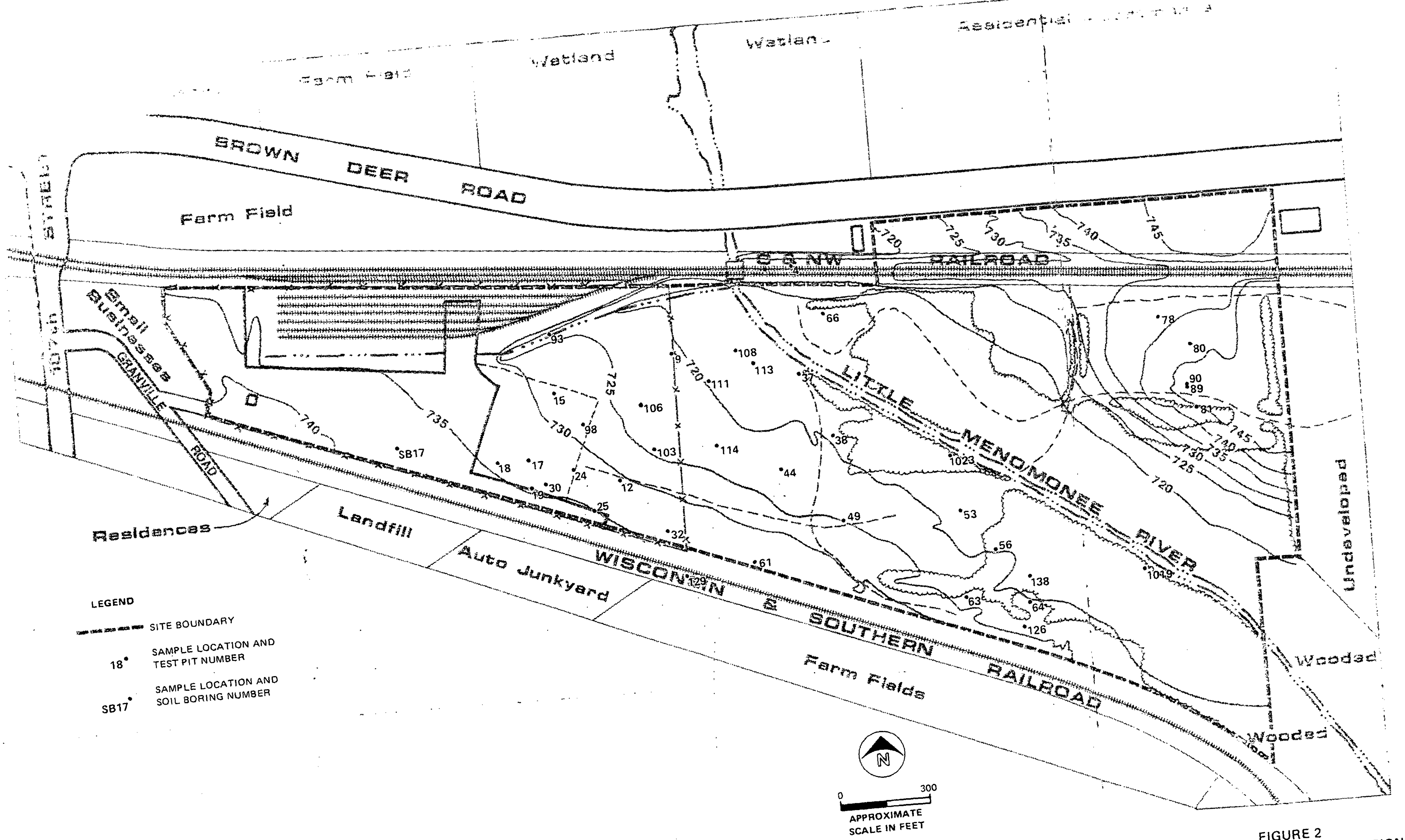


FIGURE 2
SAMPLING LOCATIONS FOR PAH AND PHENOLIC ACID COMPOUND ANALYSIS
MOSS-AMERICAN RI

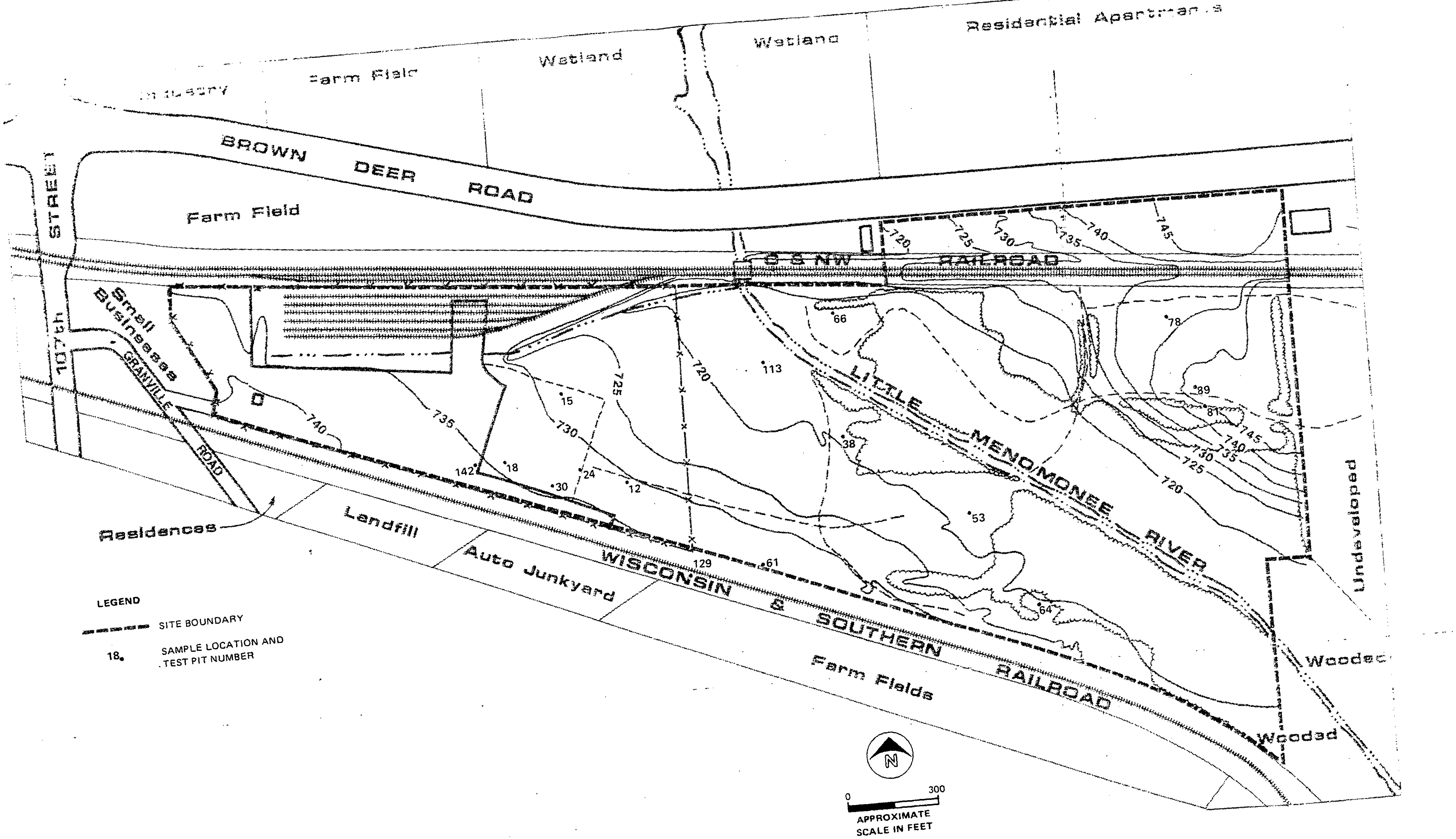


FIGURE 3
SAMPLING LOCATIONS
FOR CLP ANALYSES
MOSS-AMERICAN RI

rinsed in a detergent solution and potable water followed by spray rinses with methanol and distilled water.

Following excavation and sample collection, the soils were described on test pit logs along with other pertinent information regarding the extent of contamination in each pit.

Test pits were backfilled before the team left for lunch and at the end of each day. Spoils were returned to the pit as closely as possible to their original position. Each pit was covered with either the original vegetation, clean spoils, or clean gravel fill.

Post Hole Digger

A post hole digger was used to collect samples from piles of dredgings along the river, from other wooded areas onsite, and for all offsite samples. All sampling and logging procedures were identical to those used with the backhoe, except that decontamination of the post hole digger consisted of a detergent wash, freshwater rinse, methanol rinse, and distilled water rinse.

Truck-Mounted Auger

Samples from under the asphalt were collected by drilling a 4-inch hole with continuous flight augers and then driving a 2.5-inch I.D. split-spoon sampler 2 feet into the undisturbed soil at the bottom of the hole. Flight augers were steam cleaned between each hole. Split-spoon samplers were cleaned with a detergent solution and rinsed with water, methanol, and distilled water between each sample interval. Samples were transferred from the split spoons to the sample containers using a stainless steel spoon. Boreholes were backfilled with spoils and capped with approximately 2 feet of concrete.

RESULTS

DATA

Sample locations, extractable organic concentrations and field observations are given in Tables 1 and 2. Table 1 is arranged according to sample number; Table 2 in order of decreasing extractable organic concentration. Values for

TABLE 1
SOIL SCREENING RESULTS
(arranged by sample number)

SAMPLE NUMBER	GRID LOCATION(1)		EO(2) ppm	HEAD-SPACE(3) ppm	FIELD OBSERVATIONS
	X	Y			
SS001-1	1540	-65	210	NR	Offsite-RR, between tracks, silt
SS002-1	1700	-55	140	NR	Offsite-RR, below ballast, clay
SS003-1	1950	-400	220	NR	Offsite, Fence row, silty clay
SS004-1	400	60	140	NR	Offsite-RR, edge of ballast, sand
SS005-1	-600	130	210	NR	Offsite-RR, natural peaty soil
SS006-1	-40	-680	17	.0	
SS007-1	-50	-500	2,600	.0	
SS008-1	-15	-390	21	.5	Oil floating on water at 1.2′
SS009-1	-15	-200	220	.0	
SS010-1	-200	-300	130	1.0	Odor, .1 ppm HNu, oily water at 3′
SS011-1	-200	-500	140	.0	
SS012-1	-200	-600	1,200	.0	Oil floating at 1.3′, odor
SS013-1	-300	-70	170	.0	
SS014-1	-500	-200	3,600	.0	Black, appears tarry, no odors
SS015-1	-400	-300	19,000	10.0	Creosote odor, slightly tarry
SS016-1	-400	-500	180	.2	
SS017-1	-500	-500	87	.2	Possibly tarry soils at 4′
SS017-2	-500	-500	930	NR	Tarry soil w/ wood & ties at 2′
SS018-1	-600	-500	39,000	.5	Creosote odor, tarry
SS019-1	-500	-600	13,000	1.0	Creosote odor
SS020-1	-600	-620	160	.0	
SS021-1	-400	-600	1,100	.0	Creosote odor, rubble in pit
SS022-1	-300	-600	1,200	.0	
SS023-1	-300	-500	540	.0	
SS023-2	-300	-500	620	.0	More contaminated than SS023-1
SS024-1	-350	-550	41,000	1.2	Tarry seam at 1′, creosote odor
SS025-1	-300	-680	460	.0	Rubble
SS026-1	-200	-700	400	.0	
SS027-1	-500	-400	140	.0	Slight creosote odor
SS028-1	-200	-400	9	.2	
SS029-1	-470	-630	1,400	.4	Creosote odor, foundation at 2′
SS030-1	-460	-590	108,000	20.0	Free product under foundation
SS031-1	-450	-550	54	6.0	Contm. less just N. of foundation
SS032-1	-80	-790	2,400	.0	
SS033-1	20	-25	160	.5	
SS034-1	200	-100	30	.4	
SS035-1	360	-230	36,000	2.0	Odor, oily luster on soil
SS036-1	200	-300	430	.4	
SS037-1	400	-300	39,000	1.3	Trash and wood chips, v. oily
SS038-1	500	-500	57,000	1.0	Strong creosote odor
SS039-1	400	-600	60	.0	
SS040-1	100	-400	11	.2	
SS041-1	300	-400	110	.0	
SS042-1	500	-400	7,200	.0	Trash and rubble
SS043-1	600	-600	35	NR	
SS044-1	300	-590	1,200	.4	

TABLE 1
SOIL SCREENING RESULTS
(arranged by sample number)

SAMPLE NUMBER	GRID LOCATION(1) X	Y	EO(2) ppm	HEAD-SPACE(3) ppm	FIELD OBSERVATIONS
SS045-1	100	-600	42	.0	
SS046-1	200	-700	190	.0	
SS047-1	100	-800	56	1.0	
SS048-1	300	-800	33	.0	
SS049-1	500	-800	8,900	5.0	Creosote odor
SS050-1	500	-700	25	.2	Slight creosote odor
SS051-1	700	-700	0	.0	
SS052-1	700	-800	17	.0	
SS053-1	900	-800	8	.5	
SS054-1	910	-670	20	.0	
SS055-1	1000	-8000	120	.0	
SS056-1	1010	-930	570	.0	
SS057-1	900	-1000	38	.0	
SS058-1	800	-900	59	.0	
SS059-1	600	-900	140	NR	
SS060-1	400	-900	140	NR	
SS061-1	200	-900	140	NR	
SS062-1	500	-1000	510	NR	
SS063-1	900	-1060	24,000	NR	Slight creosote odor
SS064-1	1100	-1100	38,000	1.0	Creosote odor, RR ties at 3′
SS065-1	400	-100	430	.0	
SS066-1	500	-100	900	.0	
SS067-1	600	-100	310	NR	
SS068-1	600	-300	300	.0	
SS069-1	820	-100	160	.0	
SS070-1	1160	-570	46	.0	
SS071-1	1300	-300	45	.0	
SS072-1	1100	-200	0	.0	
SS073-1	1300	-100	0	.0	
SS074-1	1400	-200	0	.0	
SS075-1	1500	-100	0	.0	
SS076-1	1500	-300	24	.0	
SS077-1	1500	-500	8	.0	
SS078-1	1600	-200	24	.0	
SS079-1	1600	-400	23	.0	
SS080-1	1700	-300	920	4.0	Oil coating in fractures
SS080-2	1700	-300	11,000	1.0	Black tarry, HNU=1 ppm in pit
SS081-1	1700	-500	0	.0	Sheen on cobbles and some soil
SS082-1	1700	-200	29	0.0	
SS083-1	1800	-200	69	.0	
SS084-1	1800	-400	65	.0	
SS085-1	1900	-300	34	.0	
SS086-1	1900	-500	42	.0	
SS087-1	1800	-600	24	.0	
SS088-1	1700	-620	56	.0	
SS089-1	1680	-440	63,000	.0	Very oily, tarry, 2 ppm HNu in pit

TABLE 1
SOIL SCREENING RESULTS
(arranged by sample number)

SAMPLE NUMBER	GRID LOCATION(1) X	Y	EO(2) ppm	HEAD-SPACE(3) ppm	FIELD OBSERVATIONS
SS089-2	1680	-440	17,000	11.0	Free product in pit
SS090-1	1670	-430	112	.0	
SS091-1	1630	-380	44,000	13.0	
SS092-1	-500	-300	63	.0	Slight odor
SS093-1	-400	-100	32	.0	
SS094-1	-400	-200	200	.0	
SS095-1	-400	-400	100	.0	
SS096-1	-300	-200	14,000	.5	Odor, tarry silt at 3′
SS097-1	-300	-300	790	.5	Creosote odor
SS098-1	-300	-400	22,000	.5	Odor, sheen on soil/chips at 4′
SS098-2	-300	-400	7,400	.0	Wood chips and cable at 4′
SS099-1	-200	-100	340	.0	Possibly tarry
SS100-1	-200	-200	66	.0	
SS101-1	-100	-300	540	2.0	Oil sheen on water at 3′
SS102-1	-100	-400	730	.0	
SS103-1	-100	-500	3,300	5.0	Slight odor
SS104-1	-100	-600	5,000	1.0	Oil mixed w/water at 3′, odor
SS105-1	-100	-700	530	.5	
SS106-1	-130	-360	100	.0	Oil stringers in water at 1′
SS106-2	-130	-360	170	.0	Oily water flowing from culvert
SS107-1	100	-200	320	.0	
SS108-1	200	-200	3,700	.4	
SS109-1	300	-200	20,000	5.5	Oily water at 2′, odor
SS110-1	300	-300	310	.0	Oily odor
SS111-1	100	-300	71	NR	
SS112-1	370	-370	4,300	NR	Slight odor
SS113-1	250	-250	98,000	4.5	Odor and oil in hay and wood chips
SS114-1	100	-500	1,200	.0	
SS115-1	200	-500	30	.0	
SS116-1	300	-500	160	.0	
SS117-1	400	-500	440	.0	
SS118-1	600	-450	580	.0	Slight odor
SS119-1	950	-1000	300	.0	Dump site, rubbish
SS120-1	600	-1000	140	.0	
SS121-1	800	-1060	61	.0	
SS122-1	1000	-1130	420	.0	Dump
SS123-1	1160	-1200	2,200	6.0	Dump, creosote odor, sheen at 3′
SS124-1	870	-1110	120	.0	
SS125-1	1180	-1120	19,000	.0	Dump
SS126-1	1070	-1180	2,000	.0	Dump
SS127-1	1275	-1230	55	.0	Dump
SS128-1	1460	-1300	130	.0	
SS129-1	0	-900	10	NR	Offsite-RR, Organic Silt
SS130-1	-300	-800	27	NR	Offsite-RR, ditch by ballast, silt
SS131-1	270	-1000	17	NR	Offsite-RR, Silty sand
SS132-1	300	550	18	NR	Offsite, cattails, silt loam

TABLE 1
SOIL SCREENING RESULTS
(arranged by sample number)

SAMPLE NUMBER	GRID LOCATION(1) X	Y	EO(2) ppm	HEAD-SPACE(3) ppm	FIELD OBSERVATIONS
SS132-2	300	550	6	NR	Offsite, cattails, alluvial clay
SS133-1	500	650	10	NR	Offsite, grassy, org. silty clay
SS134-1	550	1450	0	NR	Offsite, grassy meadow, silt-sand
SS135-1	-500	1350	22	NR	Offsite, woods, lowland, org. clay
SS136-1	-50	550	270	NR	Offsite, cattail marsh, org. silt
SS137-1	1060	-850	14	NR	
SS138-1	1110	-1030	0	NR	
SS139-1	1150	-790	0	NR	
SS140-1	-1270	-280	22	.0	
SS141-1	-1100	-350	1,500	.0	
SS141-2	-1100	-350	15	.0	
SS142-1	-700	-500	28	.0	
SS143-1	-1070	-240	0	.0	
SS144-1	-690	-400	0	.0	Tarry seam at 3′
SS145-1	-1300	-100	24	.0	
SS146-1	-660	-300	41	.0	Tarry seam at 3′
SS1017A-1	1880	-1220	0	NR	
SS1018-1	1730	-1100	0	NR	
SS1019-1	1550	-995	450	NR	
SS1020-1	1370	-880	14	NR	
SS1021-1	1220	-770	790	NR	
SS1022-1	1040	-660	300	NR	
SS1023-1	980	-560	720	NR	
SS1024-1	710	-440	0	NR	
SS1025-1	510	-310	2,400	NR	Scrap metal in fill on bank
SS1026-1	740	-395	7	NR	Dredging pile
SS1027-1	930	-520	0	NR	
SS1028-1	1370	-795	31	NR	
SS1029-1	1640	-980	21	NR	

NOTES: (1) Grid Location:
X = distance east (+) or west (-) of the origin,
Y = distance north (+) or south (-) of the origin.
The origin is the north east corner of the auto storage lot. It is shown on Figure 1.

(2) EO = Extractable Organic Concentration

(3) HEADSPACE = Organic vapor concentration of the air in a plastic bag containing the soil sample. Concentrations are reported in parts per million of benzene equivalents

TABLE 2
SOIL SCREENING RESULTS
(arranged by descending EO concentration)

SAMPLE NUMBER	GRID LOCATION(1) X	Y	EO(2) ppm	HEAD-SPACE(3) ppm	FIELD OBSERVATIONS
SS030-1	-460	-590	108,000	20.0	Free product under foundation
SS113-1	250	-250	98,000	4.5	Odor and oil in hay and wood chips
SS089-1	1680	-440	63,000	.0	V. oily and tarry, 2 ppm (HNu pit)
SS038-1	500	-500	57,000	1.0	Strong creosote odor
SS091-1	1630	-380	44,000	13.0	
SS024-1	-350	-550	41,000	1.2	Tarry seam @ 1′, creosote odor
SS089-2	1680	-440	41,000	11.0	Free product in hole
SS018-1	-600	-500	39,000	.5	Creosote odor, tarry
SS037-1	400	-300	39,000	1.3	Trash and wood chips, v. oily
SS064-1	1100	-1100	38,000	1.0	Creosote odor, RR ties @ 3′
SS035-1	360	-230	36,000	2.0	Odor, oily luster on soil
SS063-1	900	-1060	24,000	.0	Slight creosote odor
SS098-1	-300	-400	22,000	.5	Odor, sheen on soil/chips @ 4′
SS109-1	300	-200	20,000	5.5	Oily water at 2′, odor
SS015-1	-400	-300	20,000	10.0	Creosote odor
SS125-1	1180	-1120	19,000	.0	Dump
SS089-2	1680	-440	17,000	11.0	Free product in hole
SS096-1	-300	-200	14,000	.5	Odor, black silt at 3′ is tarry
SS019-1	-500	-600	13,000	1.0	Creosote odor
SS080-2	1700	-300	11,000	1.0	Black tarry, 1 ppm in pit
SS049-1	500	-800	8,900	5.0	Creosote odor
SS098-2	-300	-400	7,400	.0	Wood chips and cable at 4′
SS042-1	500	-400	7,200	.0	Trash and rubble
SS104-1	-100	-600	5,006	1.0	Oil mixed w/water @ 3′, odor
SS112-1	370	-370	4,300	.0	Slight odor
SS108-1	200	-200	3,700	.4	
SS014-1	-500	-200	3,600	.0	Black, appears contam., no odor
SS103-1	-100	-500	3,300	5.0	Slight odor
SS007-1	-50	-500	2,600	.0	
SS032-1	-80	-790	2,400	.0	
SS1025-1	510	-310	2,400	.0	Scrap metal in fill on bank
SS123-1	1160	-1200	2,200	6.0	Dump, creosote odor, sheen @3′
SS126-1	1070	-1180	2,000	.0	Dump
SS141-1	-1100	-350	1,500	.0	
SS029-1	-470	-630	1,400	.4	Creosote odor, pad @ 2′
SS128-1	1460	-1300	1,300	.0	
SS114-1	100	-500	1,200	.0	
SS044-1	390	-590	1,200	.4	
SS022-1	-300	-600	1,200	.0	
SS012-1	-200	-600	1,200	.0	Oil floating @ 1.3′, odor
SS021-1	-400	-600	1,100	.0	Creosote odor, rubble in pit
SS066-1	500	-100	1,000	.0	
SS017-2	-500	-500	930	.0	Tarry soil w/ wood & ties @ 2′
SS080-1	1700	-300	920	4.0	Oil coating in fractures
SS1021-1	1220	-770	800	.0	
SS097-1	-300	-300	790	.5	Creosote odor

TABLE 2
SOIL SCREENING RESULTS
(arranged by descending EO concentration)

SAMPLE NUMBER	GRID LOCATION(1) X	Y	EO(2) ppm	HEAD-SPACE(3) ppm	FIELD OBSERVATIONS
SS102-1	-100	-400	730	.0	
SS1023-1	980	-560	720	.0	
SS023-2	-300	-500	620	.0	
SS118-1	600	-450	580	.0	Slight odor
SS056-1	1010	-930	570	.0	
SS023-1	-300	-500	540	.0	
SS101-1	-100	-300	540	2.0	Oil sheen on water at 3′
SS105-1	-100	-700	530	.5	
SS062-1	500	-1000	510	.0	
SS025-1	-300	-680	460	.0	Rubble
SS1019-1	1550	-995	450	.0	
SS117-1	400	-500	440	.0	
SS065-1	400	-100	430	.0	
SS036-1	200	-300	430	.4	
SS122-1	1000	-1130	420	.0	Dump
SS026-1	-200	-700	400	.0	
SS099-1	-200	-100	340	.0	Black, appears contaminated
SS107-1	100	-200	320	.0	
SS110-1	300	-300	310	.0	Oily odor
SS067-1	600	-100	310	.0	
SS068-1	600	-300	300	.0	
SS1022-1	1040	-660	300	.0	
SS119-1	950	-1000	300	.0	Dump site, rubbish
SS136-1	-50	550	270	.0	Offsite, cattail marsh, org. silt
SS009-1	-15	-200	220	.0	
SS003-1	1950	-400	220	.0	Offsite, Fence row, silty clay
SS005-1	-600	130	210	.0	Offsite-RR, natural peaty soil
SS001-1	1540	-65	210	.0	Offsite-RR, between tracks, silt
SS094-1	-400	-200	200	.0	
SS046-1	200	-700	190	.0	
SS016-1	-400	-500	180	.2	
SS013-1	-300	-70	170	.0	
SS106-2	-130	-360	170	.0	Oily water flowing from culvert
SS069-1	820	-100	160	.0	
SS020-1	-600	-620	160	.0	
SS033-1	20	-25	160	.5	Black, creosote odor
SS116-1	300	-500	160	.0	
SS004-1	400	60	140	.0	Offsite-RR, edge of ballast, sand
SS002-1	1700	-55	140	.0	Offsite-RR, below ballast, clay
SS027-1	-500	-400	140	.0	Slight creosote odor
SS120-1	600	-1000	140	.0	
SS059-1	600	-900	140	.0	
SS011-1	-200	-500	140	.0	
SS060-1	400	-900	140	.0	
SS061-1	200	-900	140	.0	
SS010-1	-200	-300	130	1.0	Odor, .1 PPM HNu, Oily water at 3′

TABLE 2
SOIL SCREENING RESULTS
(arranged by descending EO concentration)

SAMPLE NUMBER	GRID LOCATION(1) X	Y	EO(2) ppm	HEAD-SPACE(3) ppm	FIELD OBSERVATIONS
SS124-1	870	-1110	120	.0	
SS055-1	1000	-8000	120	.0	
SS041-1	300	-400	120	.0	
SS090-1	1670	-430	110	.0	
SS095-1	-400	-400	110	.0	
SS106-1	-130	-360	100	.0	Oil stringers in water @ 1′
SS017-1	-500	-500	87	.2	Possibly tarry soils @ 4′
SS111-1	100	-300	71	.0	
SS083-1	1800	-200	69	.0	
SS100-1	-200	-200	66	.0	
SS084-1	1800	-400	65	.0	
SS092-1	-500	-300	63	.0	Slight odor
SS121-1	800	-1060	61	.0	
SS039-1	400	-600	60	.0	
SS058-1	800	-900	59	.0	
SS088-1	1700	-620	56	.0	
SS047-1	100	-800	56	1.0	
SS127-1	1275	-1230	55	.0	Dump
SS031-1	-450	-550	54	6.0	
SS070-1	1160	-570	46	.0	
SS071-1	1300	-300	45	.0	
SS086-1	1900	-500	42	.0	
SS045-1	100	-600	42	.0	
SS146-1	-660	-300	41	.0	Tarry seam @ 3′
SS057-1	900	-1000	38	.0	
SS043-1	600	-600	35	.0	
SS085-1	1900	-300	34	.0	
SS048-1	300	-800	33	.0	
SS093-1	-400	-100	32	.0	
SS1028-1	1370	-795	31	.0	
SS115-1	200	-500	30	.0	
SS034-1	200	-100	30	.4	Black, possibly due to contam.
SS082-1	1700	-200	29	.0	
SS102-1	-100	-400	28	.0	
SS142-1	-700	-500	28	.0	
SS130-1	-300	-800	27	.0	Offsite-RR, ditch by ballast, silt
SS050-1	500	-700	25	.2	Slight creosote odor
SS087-1	1800	-600	24	.0	
SS145-1	-1300	-100	24	.0	
SS078-1	1600	-200	24	.0	
SS076-1	1500	-300	24	.0	
SS079-1	1600	-400	23	.0	
SS135-1	-500	1350	22	.0	Offsite, woods, lowland, org. clay
SS140-1	-1270	-280	22	.0	
SS008-1	-15	-390	21	.5	Oil floating on wtr @ 1.2′
SS1029-1	1640	-980	21	.0	

TABLE 2
SOIL SCREENING RESULTS
(arranged by descending EO concentration)

SAMPLE NUMBER	GRID LOCATION(1) X	Y	EO(2) ppm	HEAD-SPACE(3) ppm	FIELD OBSERVATIONS
SS054-1	910	-670	20	.0	
SS132-1	300	550	18	.0	Offsite, cattails, silt loam
SS052-1	700	-800	17	.0	
SS006-1	-40	-680	17	.0	
SS131-1	270	-1000	17	.0	Offsite-RR, Silty sand
SS141-2	-1100	-350	15	.0	
SS1020-1	1370	-880	14	.0	
SS137-1	1060	-850	14	.0	
SS040-1	100	-400	11	.2	
SS133-1	500	650	10	.0	Offsite, grassy, org. silty clay
SS129-1	0	-900	10	.0	Offsite-RR, Organic Silt
SS028-1	-200	-400	9	.2	
SS077-1	1500	-500	8	.0	
SS053-1	900	-800	8	.5	
SS1026-1	740	-395	7	.0	Dredging pile
SS132-2	300	550	6	.0	Offsite, cattails, alluvial clay
SS139-1	1150	-790	0	.0	
SS134-1	550	1450	0	.0	Offsite meadow, silt and sand
SS081-1	1700	-500	0	.0	Sheen on cobbles & some soil
SS075-1	1500	-100	0	.0	
SS138-1	1110	-1030	0	.0	
SS1018-1	1730	-1100	0	.0	
SS072-1	1100	-200	0	.0	
SS051-1	700	-700	0	.0	
SS074-1	1400	-200	0	.0	
SS143-1	-1070	-240	0	.0	
SS073-1	1300	-100	0	.0	
SS1027-1	930	-520	0	.0	
SS144-1	-690	-400	0	.0	Tarry seam at 3'

NOTES: (1) Grid Location:
X = distance east (+) or west (-) of the origin,
Y = distance north (+) or south (-) of the origin.
The origin is the north east corner of the auto storage lot. It is shown on Figure 1.

(2) EO = Extractable Organic Concentration

(3) HEADSPACE = Organic vapor concentration of the air in a plastic bag containing the soil sample. Concentrations are reported in parts per million of benzene equivalents

offsite extractable organic measurements are given in Table 3.

The distribution of extractable organic concentrations across the site is shown in Figure 4. The distribution of total PAH concentrations is shown in Figure 5. The results of the PAH analysis for individual compounds are given in Table 4. No phenols were detected in any of the samples.

The correlation between extractable organics (measured onsite) and the sum of the 16 priority pollutant PAH concentrations is shown in Figure 6. The correlation coefficient (r) is 0.89. A test of significance was performed on the correlation coefficient to determine if it is spuriously high by assuming that no relationship exists between the EO and PAH concentrations. The test concluded that a linear relationship does exist and that higher EO concentrations correspond to higher total PAH contractions.

INTERPRETATION

Four primary areas of soil contamination at the Moss-American site are shown in Figure 7:

Area I -- Processing area and vicinity
Area II -- Contaminated fill east of the storage area
Area III -- Contaminated fill to the southeast
Area IV -- Landfill for dredgings

Low levels of contamination were detected south of Area I west of the fence and between areas I and II (see Figure 7).

The areas shown on Figure 7 were identified on the basis of:

- EO concentrations greater than 1,000 ppm
- Visible contamination or strong creosote odors
- Proximity to other pits deemed contaminated with similar soil horizons, especially when samples may have been taken from uncontaminated horizons.

The extent of each areas was determined by the interpretation of available data. Risk-based criteria were not used. The extent of contamination will be modified as necessary

TABLE 3
OFFSITE SOIL SAMPLES

SAMPLE NUMBER	GRID LOCATION(1) X	Y	EXTRACTABLE ORGANICS ppm	FIELD OBSERVATIONS
SS003-1	1950	-400	215	Fence row, silty clay
SS134-1	550	1450	0	Grassy meadow, silt and sand
SS135-1	-500	1350	22	Woods, lowland, organic clay
SS133-1	500	650	10	Grassy, organic silty clay
SS136-1	-50	550	270	Cattail marsh, organic silt
SS132-1	300	550	18	Cattails, silt loam
SS132-2	300	550	6	Cattails, alluvial clay
SS005-1	-600	130	211	RR, natural peaty soil
SS004-1	400	60	143	RR, edge of ballast, sand
SS002-1	1700	-55	139	RR, under ballast, clay
SS001-1	1540	-65	210	RR, between tracks, silt
SS130-1	-300	-800	27	RR, ditch by ballast, silt
SS129-1	0	-900	10	RR, organic silt
SS131-1	270	-1000	17	RR, silty sand

NOTES: (1) Grid Location: Distance in feet from the origin as shown on Figure 1

(2) EO = Extractable Organic Concentration

(3) HEADSPACE = Organic vapor concentration of the air in a plastic bag containing the soil sample. Concentrations measured with an HNu.

TABLE 4 - POLYAROMATIC HYDROCARBON CONCENTRATIONS IN ONSITE SOILS
Concentrations in ppm (wet weight)

SAMPLE	PERCENT MOISTURE	NAP	ACY	ACE	FLR	PHEN	ANT	FLN	PYR	BAA	CHR	BBF	BKF	BAP	IDP	DBA	BGHIP
SS098-1	16	10	2	64	26	53	29	190 D	170 D	72	60	37	26	47	24	1 U	12
SS103-1	12	6	1 U	34	34	92	17	73	50	19	18	9	6	7	7	1 U	10
SS106-1	24	2	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SS108-1	54	1 U	1 U	1 U	1 U	1 U	1 U	10	9	5	4	4	4	4	6	1 U	1 U
SS111-1	40	1 U	1 U	1 U	2	7	13 B	6	4	1 U	2	1 U	1 U	1 U	2	1 U	1 U
SS113-1	47	1800	20 U	700	660	1900	780	830	560	200	230	80	80	73	65	20 U	83
SS114-1	43	1 U	1 U	1 U	1 U	2 B	2 B	2	4	3	3	4	3	3	5	1 U	9
SS126-1	43	1 U	1 U	1	1 U	3 B	2 B	7	5	3	2	3	1	2	5	1 U	6
SS129-1	29	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SS138-1	50	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SB-17-5	18	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SB-17-5R	19	1 U	1 U	1 U	1 U	1 B	1 U	1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SSFB-1	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SSFB-2	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SS038-1	13	71	20 U	1000	600	1300	1300	1500	1400	200	320	110	110	88	95	20 U	52
SS044-1	26	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SS049-1	40	96	10 U	380	320	100	260	620	400	100	100	30	25	33	20	10 U	23
SS053-1	22	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SS056-1	21	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2	1	1 U	1 U	1	3	1 U	1 U
SS061-1	9	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SS063-1	0	5 U	5 U	5 U	5 U	65	76	150	140	52	58	29	29	38	41	5 U	43
SS064-1	11	8	5 U	230	5 U	230	79	420	290	110	120	42	42	42	45	5 U	41
SS066-1	26	1 U	1 U	2	1 U	2 B	1 B	3	4	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SS078-1	14	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SS080-2	15	5 U	12	440	41	64	110	350	250	110	85	27	27	30	25	5 U	20
SS081-1	11	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SS089-1	30	1700	50 U	1700	1200	2700	930	1100	710	290	210	69	69	71	150	50 U	120
SS090-1	13	1 U	1 U	1	1	3 B	1 U	3	6	4	3	1	1	2	1 U	1 U	1 U
SS093-1	13	1 U	1 U	1 U	1 U	1 U	1 U	2	2	1	1	1 U	1 U	1	1 U	1 U	1 U
SS004-1	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SS1019-1	21	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SS1023-1	28	2	1 U	1 U	1 U	2 B	1 U	2	2	4	2	2	1	3	8	1 U	7
SS1023-1R	27	1	1 U	1 U	1 U	1 B	1 U	2	1 U	5	3	3	3	5	15	1 U	13
SS009-1	23	1 U	1 U	1 U	1 U	1 B	1 U	1	2	4	2	1 U	1 U	4	4	1 U	5
SS012-1	18	3	2 U	53	50	130	22 B	10	71	29	30	11	10	12	14	2 U	12
SS015-1	22	100	20 U	250	230	760	95 B	370	260	91	92	50	40	32	40	20 U	90
SS017-2	14	3	1 U	1	1	13	2 B	11	8	4	4	2	2	2	3	1 U	8
SS018-1	12	25	20 U	270	200	270	140 B	660	460	200	200	80	80	76	78	20 U	94
SS019-1	14	79	5 U	180	150	370	79	230	150	57	56	20	20	18	19	5 U	19
SS024-1	5	9	1	4	3	13	5 B	15	13	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SS025-1	13	4	1 U	1 U	1 U	10	1 B	7	5	3	2	2	2	2	3	1 U	6
SS030-1	22	3800	100 U	2900	3200	6800	3500	2000	1300	510	430	170	160	180	100 U	100 U	100 U
SS032-1	23	7	1 U	2	47	59	480	17	12	10	29	10	10	8	13	1 U	13
SS037-1	60	31	24	300	280	940	170 B	610	400	170	180	70	60	57	50	20 U	34

ABBREVIATIONS:
NAP = Naphthalene
ACY = Acenaphthalene
ACE = Acenaphthene
FLR = Fluorene
PHEN = Phenanthrene
ANT = Anthracene
FLN = Fluoranthene
PYR = Pyrene
BAA = Benzo(a)anthracene
CHR = Chrysene
BBF = Benzo(b)fluoranthene
BKF = Benzo(k)fluoranthene
BAP = Benzo(a)pyrene
IDP = Indeno(1,2,3-cd)pyrene
DBA = Dibenzo(a,h)ahthracene
BGHIP = Benzo(g,h,i)perylene

QUALIFIERS:
U = Compound analyzed but not detected
B = Compound was detected in the QC blank
D = Secondary dilution result

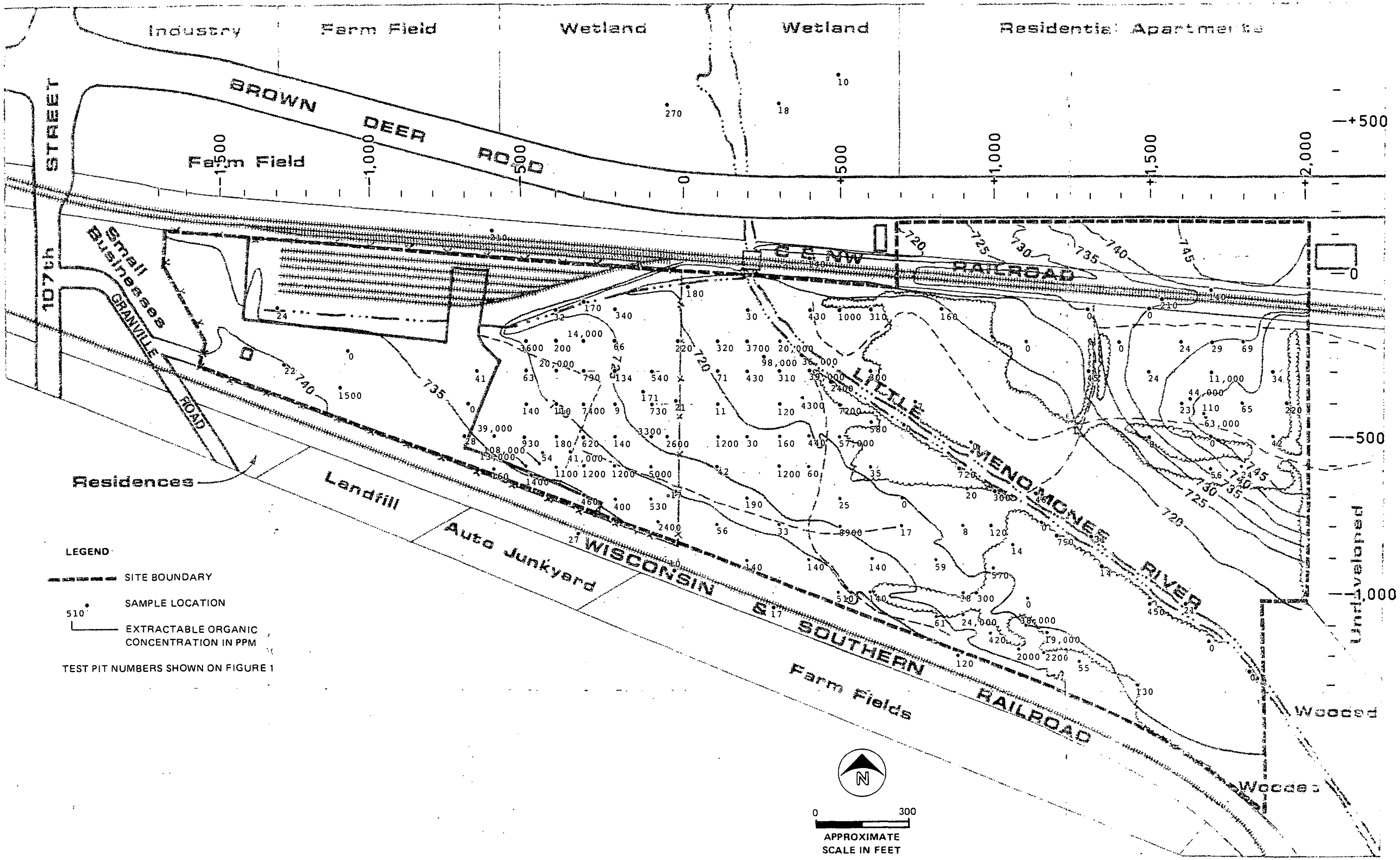


FIGURE 4
CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS
MOSS-AMERICAN RI

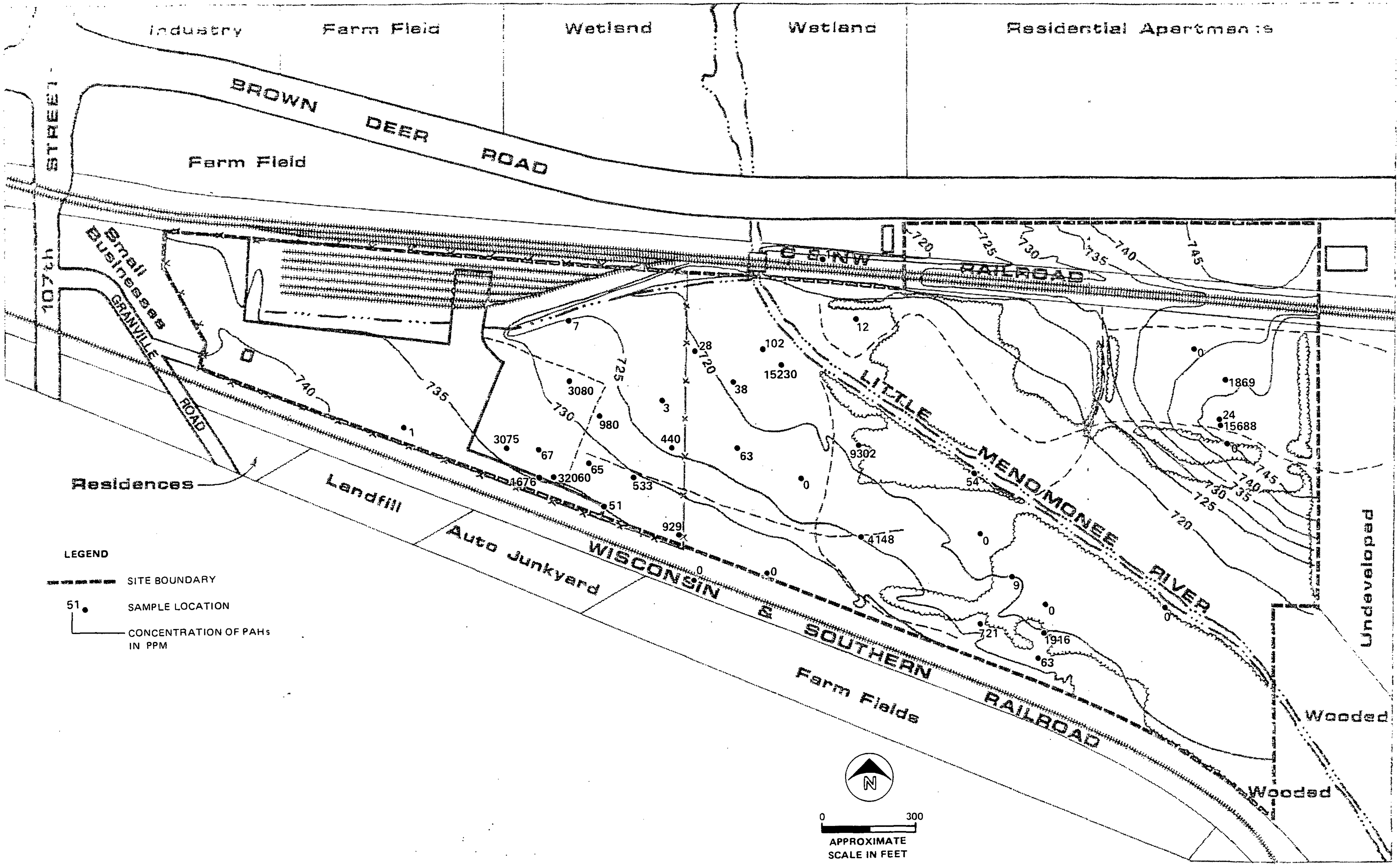


FIGURE 5
TOTAL PAH CONCENTRATIONS
IN SOIL
MOSS-AMERICAN RI

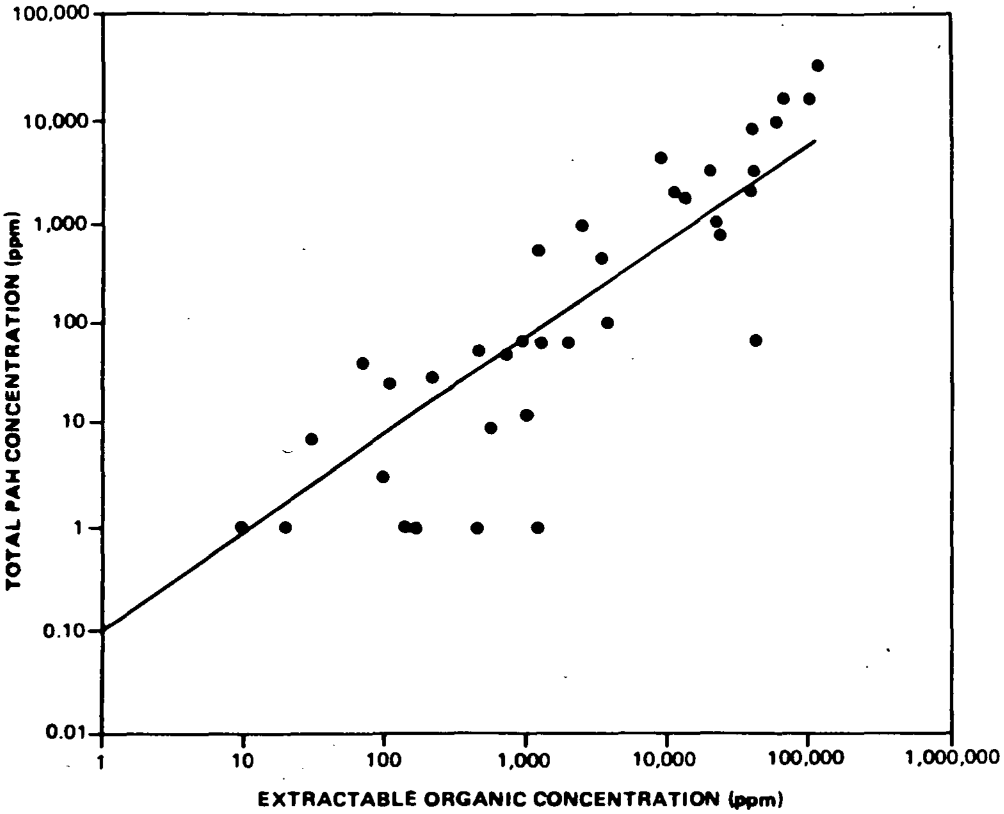


FIGURE 6
RELATIONSHIP BETWEEN CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS AND TOTAL PAHs IN ONSITE SOIL
MOSS-AMERICAN RI

following completion of the public health and environmental assessment.

Area I

Extractable organic concentrations in the processing area (the southern third of Area I excluding the panhandle) ranged from negligible to over 10 percent. Inasmuch as spatial variability and high localized levels of contamination characterize the area, it is likely that unidentified "hot spots" are present.

The northern two-thirds of Area I was categorized as the clean, or untreated, lumber storage area in earlier parts of the investigation. However, extractable organic concentrations as high as 2 percent and several visibly contaminated pits indicate contamination in the area.

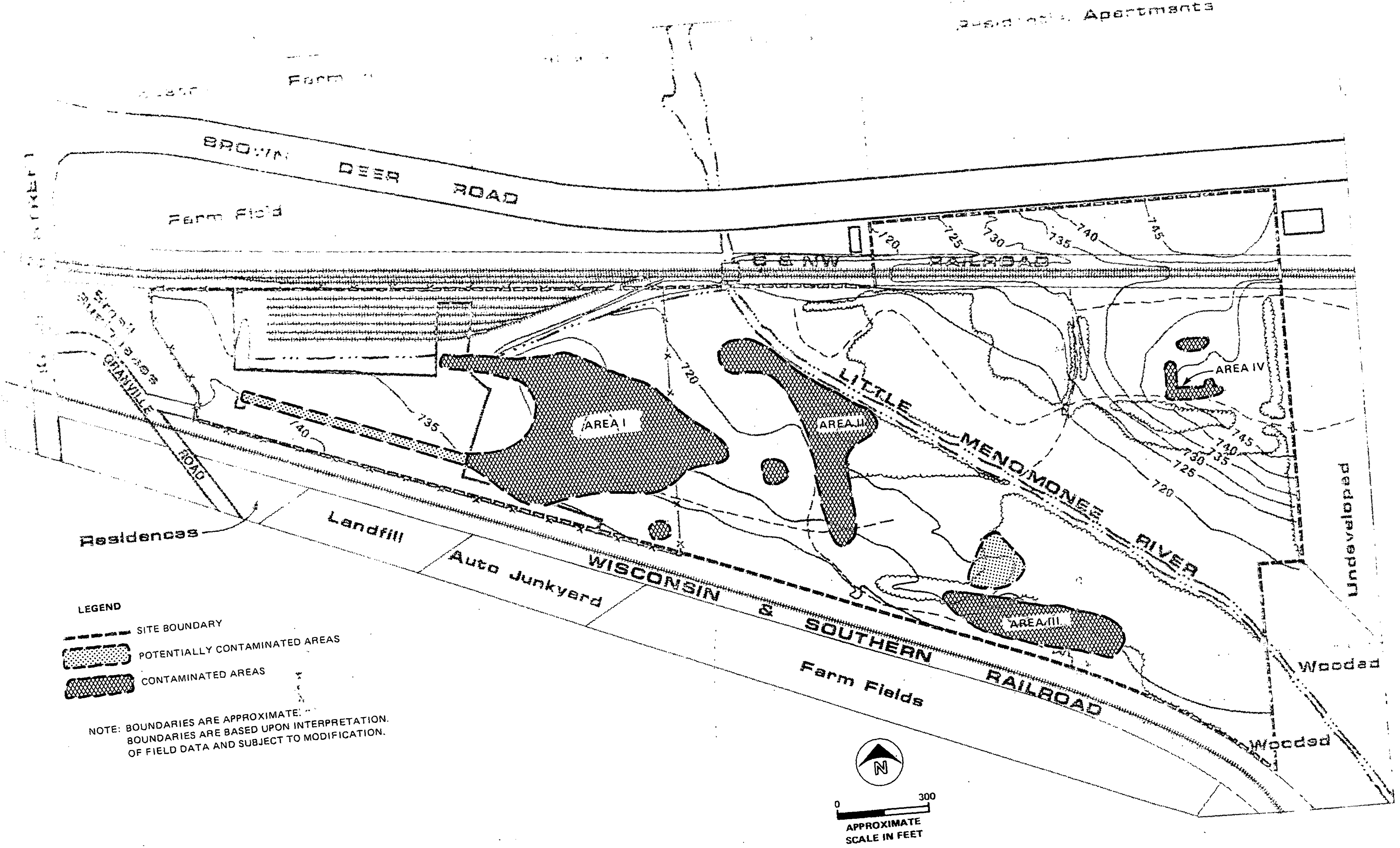
Existing data describing the history of the site do not explain the contaminated soils found here. Three possible explanations are:

- Contaminants were deposited during site activities not described in the background information.
- Contamination is the result of being in the vicinity of and downhill from the processing area.
- Contaminated soils were reworked following site closure and placed in this area.

The southern panhandle of Area I is the drip track area. Low levels of contamination with limited horizontal and vertical extent may be present there as indicated by one soil boring, or the area may be relatively clean as indicated by three soil borings. The area is shown as potentially contaminated because of the potential for spatial variability.

Areas II and III

Areas II and III were both used as either solid waste disposal areas or fill areas in which the fill included solid waste. Lumber, railroad ties, scrap metal, and other debris is buried in soils containing up to 5.7 percent



NOTE: BOUNDARIES ARE APPROXIMATE. BOUNDARIES ARE BASED UPON INTERPRETATION OF FIELD DATA AND SUBJECT TO MODIFICATION.

FIGURE 7
LATERAL EXTENT OF SOIL CONTAMINATION
MOSS-AMERICAN RI

extractable organic compounds. The area north of Area III contained similar material; however, the extractable organic concentration and visual observations of that solid waste pile did not indicate the presence of contamination. The northern part of Area II coincides with the outfall of the old settling ponds.

Area IV

Dredgings contaminated with creosote from the old settling ponds are buried in the landfill in Area IV. The lateral extent of the landfill is well-defined by stressed surface vegetation. Extractable organic concentrations in the landfill range up to 6 percent.

No dredgings were observed in the area north of Area IV; however, the extractable organic concentration in one test pit was 1.1 percent. Fracture surfaces of the blocky soil were coated with oil. The contamination at that location is believed to be the result of vertical percolation from landfilled dredgings that have since been removed from the site. The area was excavated, presumably for use as fill material, sometime after the dredgings were landfilled.

Other Areas

No evidence of contamination was found in the sludge disposal area or in the standing liquid area. The treated lumber storage area was not found to be contaminated, except for the eastern margin of the area used for waste disposal.

GLT595/59

TECHNICAL MEMORANDUM

TO: Angela Porter/U.S. EPA Region V

FROM: Stuart Grubb/CH2M HILL
Don Johnson/CH2M HILL
Kevin Olson/CH2M HILL

DATE: October 25, 1988

RE: Monitoring Well Installation
and Findings on Site Geology
Moss-American Site

PROJECT: GLO63341.FI
GLO63341.FS

INTRODUCTION

This memorandum summarizes the soil boring and monitoring well installation performed by CH2M HILL at the Moss-American site and the interpretation of the site geology. Well locations, well logs, and construction diagrams are included in this memorandum. The fieldwork was part of Task FI, Fieldwork--Monitoring Well Installation, and Task FS, Fieldwork--Subsurface Soil.

Monitoring wells were installed between June 2 and July 1, 1988. Exploration Technology, Inc., of Madison, Wisconsin drilled and constructed the wells.

SUMMARY OF FIELDWORK

Monitoring well, soil boring, and cross section locations are shown on Figure 1. The well locations were chosen:

- To monitor contaminants migrating offsite or to the Little Menomonee River
- To monitor contaminant migration away from known source areas
- To monitor the quality of the groundwater coming onsite
- To define the horizontal extent of groundwater contamination onsite

- To determine horizontal and vertical groundwater gradients

Well nests were installed downgradient from known source areas to monitor vertical contaminant migration. At each well site except MW-14, shallow wells were completed above less permeable silt and till layers. Deeper wells were completed in sandier zones when they were encountered.

Soil borings were completed at four locations where high levels of surface contamination were detected in test pits. Monitoring wells were not installed at those locations because of the potential for cross-contamination during drilling, especially during construction of the deep wells.

Specific objectives for the wells and observations made during installation are as follows:

- MW-1S and MW-1I were installed as "background" wells to monitor groundwater coming onto the site. MW-1I monitors groundwater in the silty clay and sand seams below MW-1S. MW-1S is completed at the interface between the fill and weathered till.

- MW-2S is in a filled ditch that had drained from the process area to a ditch along the north boundary of the site. It is screened in weathered till and a silty fine sand seam immediately above a dense unweathered till.

- MW-3S and MW-3I monitor an area where some soil contamination was detected during the digging of test pits (see the Technical Memorandum for Task G1). MW-3S monitors groundwater in the silty fine sand that lies beneath a silty clay till. MW-3I is screened in the silt and silty clay till below the screened interval for MW-3S. The well nest is at the outfall of a spring that drains the gravel beneath the paved parking lot.

Surface H_2O effects

- MW-4S, MW-4I, and MW-4D are in a well nest immediately downgradient of the former process area--the most contaminated part of the site. MW-4S is screened close to the water table. Free product was seen initially in the water purged from the well; however it was removed during development and not observed during sampling. MW-4I was installed immediately above the reddish brown lacustrine clay encountered at a depth of 39 feet.

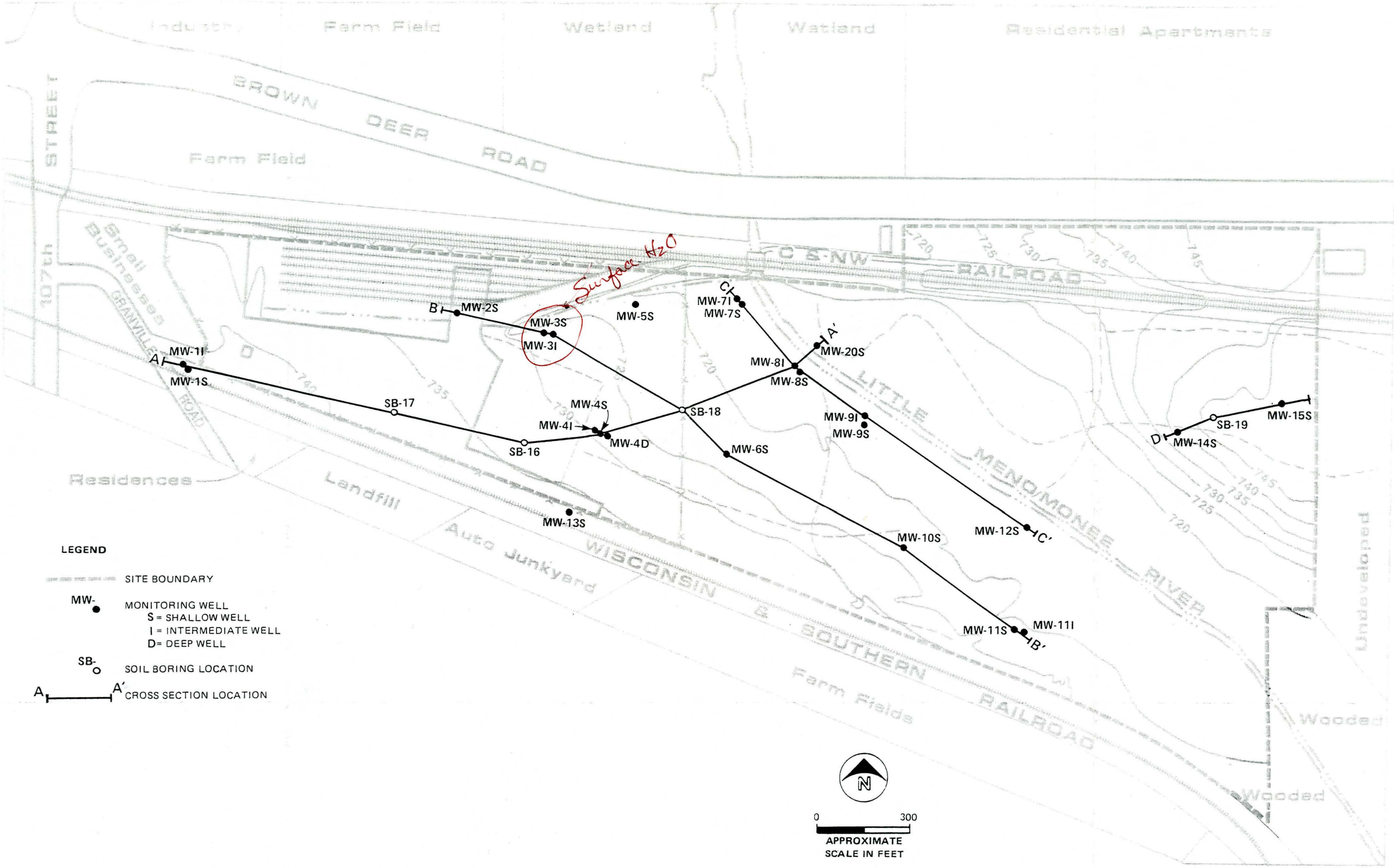


FIGURE 1
MONITORING WELL AND SOIL BORING LOCATIONS
MOSS-AMERICAN RI

MW-4D monitors the lacustrine silt and fine sand below the reddish brown clay. A deep well was installed at that location to determine the depth to which groundwater quality has been affected at the most contaminated part of the site.

- MW-5S was positioned to monitor contaminants that may be migrating offsite to the north. The base of the screen is set at the top of a dense silty clay till to monitor contaminants migrating laterally along the top of this low permeability till.

- MW-6S monitors shallow groundwater in the former storage area. As with MW-5S, the well is positioned above the silty clay till to monitor contaminants migrating along the top of the till.

- MW-7S and MW-7I, well nests MW-8 and MW-9, and well MW-12S make up a network for monitoring groundwater contaminants as they approach the river. MW-7I is installed in a sandier section of the till. The reddish brown silty clay below the well may be related to the reddish brown clay below MW-4I.

- MW-8S and MW-8I are in a well nest near the river and at the end of the series of former settling ponds. The nest is between the river and the subsurface clay barrier constructed in 1971. The soil boring for MW-8S did not appear highly contaminated; however, one coarse sand and gravel seam contained small amounts of black, oily liquid. When the well was sampled approximately 2 feet of free product had accumulated in the well. MW-8I is completed in a silt and sand zone and did not appear contaminated when it was installed. The clay immediately below the well screen may be related to the clay below wells MW-4I and MW-7I.

- MW-9S and MW-9I are in an area where the shallow soils appear to be contaminated. The subsurface soils and the water purged from the well during development and sampling did not appear to be contaminated. MW-9I is installed in the Oak Creek Formation at a depth containing silt and sand seams. The well is set at an elevation close to that of MW-7I and MW-8I so that the lateral extent of deep contamination can be determined.

- MW-10S is located in an area that may have been intended for use as a storage area. The area has been graded an covered with crushed rock. MW-10S is screened in what appears to be alluvial sediments.

- MW-11S and MW-11I--The southeast portion of the site was used as a landfill for various types of waste, as described in the Technical Memorandum on surface soils. MW-11S is installed between the landfill and the top of the till. Although the landfill material contains some treated railroad ties and oily liquids, the wells there do not appear to contain any free product. MW-11I was installed because of the contamination found in the surface soils. It is completed in a sandy layer within the Oak Creek Formation.

- MW-12S is in a small clearing in the woods near the river. Although site activities apparently did not take place there, the well is generally downgradient from the southeast landfill and the storage areas. It is also near the outfall of a low, swampy area that receives drainage from much of the southeastern part of the site.

- MW-13S is a background well use to determine groundwater gradients in the south central part of the site.

- MW-14S is downgradient of the landfill in the northeastern part of the site. It is deeper than other shallow wells and is screened in unweathered till and lacustrine deposits of the Oak Creek Formation.

- MW-15S is a background well intended to monitor groundwater quality upgradient of the landfill. During drilling and installation the soil appeared saturated from 6 feet below ground to the bottom of the screened interval 20 feet below ground; however, the well did not yield water.

- SB-16 was completed through the former process building area.

- SB-17 is in the former drip track area. No evidence of soil contamination was observed at this boring.

- SB-18--In 1971 the settling ponds were excavated. The excavated soil was mixed with clean soil and placed in the landfill in the northeast part of the site. The trench was backfilled with clean soil. Boring SB-18 was made to determine the depth of the excavated trench and to determine if the soil below the trench is contaminated.

- SB-19 was drilled to determine the depth of the northeast landfill and whether contaminants have migrated below the landfill.

- MW-20S was installed to determine whether the Little Menomonee River is actually the groundwater divide for the area. When MW-8S was found to be highly contaminated, there was concern that contaminants may have migrated to the other side of the river, especially through thin sand and gravel seams. MW-20S does not appear contaminated, but the results of the groundwater and soils analyses must be evaluated before final conclusions can be made.

DRILLING METHODS

Exploration Technology used track- and truck-mounted Dietrich D-50 rigs and an ATV-mounted CME 550 drill rig to drill the borings. The drill rigs were steam cleaned at the beginning and end of the job. All down-hole equipment was steam cleaned between borings.

The shallow soil borings and borings not used for monitoring wells were completed using 4-1/4-inch I.D. hollow-stem augers. The borings not used for monitoring wells were filled with cement grout after completion.

For the intermediate and deep borings, hollow-stem augers were used for the first 15 feet of drilling. A temporary 6-inch I.D. steel casing was put in the borehole to prevent migration of contaminant from shallow to deep areas. The casing was driven into a silt or till formation and sealed at the bottom with granular bentonite. Soil that fell to the bottom of the borehole was washed out with clean water before proceeding, and the wash water was drummed. The borehole was advanced below the casing using rotary wash methods and a 4-7/8-inch bit.

Exceptions to the above procedures are described below:

- MW-1I is located in an area where contamination was neither expected nor observed. The boring was advanced using 4-1/4-inch I.D. hollow-stem augers for the entire length of the boring.
- MW-4D--The 6-inch I.D. steel casing used to drill MW-4D was grouted permanently in place. A 4-inch protective casing was installed around the well.
- MW-8I was advanced to 30 feet below ground with 4-1/4-inch I.D. hollow-stem augers. The boring was continued using the rotary wash method with a 3-7/8-inch bit. The augers were left in place and acted as a temporary casing for the borehole.

WELL CONSTRUCTION

Well construction diagrams are included on the well logs in Attachment 1.

All wells were constructed with 2-inch I.D. stainless steel well screens and riser pipe and installed with 0.010-inch slotted, continuous wire-wound screens. The riser pipe joints above the well screen were covered with teflon tape before installation. The well construction materials were steam cleaned before the well was installed.

Shallow wells were installed with 5-foot screens, with the exception of MW-14S which has a 10-foot screen. The intermediate wells were screened in the till, which was not expected to yield much water. They were installed with 10-foot screens to make sampling and aquifer testing possible. The one deep well, MW-4D, was installed with a 5-foot screen.

The annular space between the well and the outside of the borehole was backfilled with No. 30 Flint sand to approximately 2 feet above the well screen, a bentonite seal, and cement-bentonite grout to the ground surface. On a few wells the bentonite seal was extended to the surface, and no grout was necessary. The natural formation collapsed during some of the constructions as well. The details of each construction are noted on the well logs.

A 6-foot-long, 4- or 6-inch O.D. locking protective standpipe was installed over all but three wells. Each is locked with a Number 1 Master padlock. Wells in high traffic areas (MW-01S, MW-01D, and MW-2S) were installed with flush-mounted casings. A concrete pad that slopes away from the protective casing was constructed around each standpipe. Protective posts were installed around the wells in potential traffic areas.

SOIL SAMPLING AND ANALYSIS

Split-spoon samples were collected continuously during drilling to a depth of approximately 20 feet below ground and every 5 feet thereafter. A depth interval was sampled only once at each well nest. For example, if the interval from 0 to 20 feet below ground had already been sampled during the intermediate well installation, it was not sampled during the shallow well installation.

The split-spoon samplers used were 2 feet long and 2.5 inches in diameter (larger than standard samplers) to collect the necessary volume for laboratory analysis. If the sample recovery from the sampler was not large enough for the analysis, two or three successive samples were composited. The samplers were driven with a standard 140-pound hammer. The sample intervals and penetration test results are reported on the well logs.

Samples were collected directly from the split-spoon sampler, or they were transferred to a clean stainless steel pan before being put into jars. The samples were put into jars using a stainless steel spoon. Sample jars to be analyzed for volatile organic compounds were filled first before mixing. If the sample was not very cohesive, it was mixed in a pan. Cohesive samples were composited by filling a sample jar with several pieces of cohesive soil from different parts of the sampler. The sampling equipment, including the split-spoon samplers, was decontaminated between samples using a detergent wash, methanol rinse, and distilled water rinse.

Each of the split-spoon samples was analyzed for extractable organic compounds content by the onsite close support laboratory (CSL). The analytical methods are described in the Quality Assurance Project Plan. The results of these analyses are reported on the well logs. One, two, or three of the split-spoon samples from each well were sent through the U.S. EPA Contract Laboratory Program (CLP) for analysis of organic priority pollutants, metals, cyanide, carbon, hydrogen, sulfur, oxygen, nitrogen, moisture content, ash content, volatile matter, fixed carbon, total organic carbon, water soluble chlorides, dioxin, heating value, flash point, and pH. These sample locations are also reported on the well logs.

WELL DEVELOPMENT

All wells were developed by purging with a stainless steel bailer. Water was removed from the well until pH, conductivity, and clarity stabilized. Wells that did not recharge quickly were bailed dry several times until clarity did not improve with successive bailings. All development ✓ water was retained in labeled 55-gallon drums. Development equipment was decontaminated with a detergent wash, potable water rinse, methanol rinse, and distilled water rinse between wells. Rather then decontaminating the bailer used at MW-8S, which contained substantial oil, that bailer was dedicated to the well.

FINDINGS

GENERAL GEOLOGIC SETTING

The bedrock below the Moss-American site is dolomite and shale of either the Milwaukee Formation or the Thiensville Formation. Pre-glacial erosion cut deep valleys in these rocks. Glacial erosion tended to widen the valleys and leave glacial deposits 0 to 250 feet thick. The unconsolidated deposits below the site are probably about 150 feet thick (SEWRPC 1976).

The glacial deposits encountered at the site are interpreted to be the Oak Creek Formation. The Oak Creek formation has been described as follows:

> Till of the Oak Creek Formation was deposited by ice of the Lake Michigan Lobe as it moved west-

> southwestward out of the Lake Michigan basin and crossed a large area of southeastern Wisconsin. Lacustrine sediment in the formation was laid down mainly in proglacial environments during brief intervals of ice-front recession.
>
> The Oak Creek Formation includes fine-textured glacial till, lacustrine clay, silt and sand, and some glaciofluvial sand and gravel. The till is strongly calcareous and fine grained, commonly containing between 80 and 90 percent silt and clay in the matrix (less-than-2-mm fraction). Because the relative amounts of silt and clay vary from place to place, the texture of the till ranges from silty clay through clay loam and silty clay loam to silt loam. Commonly, however, the deposit is silty clay or silty clay loam till. The average composition is about 12 percent sand, 43 percent silt, and 45 percent clay. Stones are generally small and not terribly abundant. Illite is the dominant clay mineral in the less-than-0.002-mm fraction, averaging 72 percent of the clays; expandable clay minerals and kaolinite plus chlorite are about equal, 15 and 13 percent, respectively. Dolomite dominates the pebble assemblage, but the drift contains a considerable variety of igneous and metamorphic rock types from the Canadian Shield; basalt is particularly common. Perhaps the most diagnostic item, however, is the presence of dark gray shale fragments, which are presumably derived from the Lake Michigan basin. (Mickelson, et al. 1984)

SITE HYDROGEOLOGIC SETTING

Interpretation of site-specific stratigraphy was made by comparing units identified in the field to the known regional geology. Four general units were encountered during the field investigation: fill, recent alluvium, glacial till, and lacustrine deposits of interbedded silt, clay, and fine sand.

Fill materials are described in the technical memorandum for Mapping and Surveying (Task FM) and Surface Soil Screening (Task G1). The location and composition of the fill varies considerably across the site, and has changed over time as land use changed. The alluvial sediments are associated with the Little Menomonee River. They consist of silty flood deposits and sand and gravel channel deposits. The alluvial deposits are 4 to 8 feet thick and traverse the center of the site on both sides of the river.

The glacial till and lacustrine deposits make up the Oak Creek Formation. On the site, the till was generally weathered to a depth of 2 to 10 feet. The weathered till and lacustrine deposits are generally brown rather than the gray that is characteristic of Oak Creek till. In addition the penetration resistance (N) is two to four times higher in the unweathered till than in the weathered zones. ("N" was determined by dropping a 140-pound hammer 2 feet to drive a 3-inch O.D. split-spoon sampler). These two features were used to estimate the boundary between the weathered and unweathered Oak Creek till.

Hydrogeolocally, the site consists of a surficial "aquifer" and a confining unit. It is questionable, however, whether the surficial aquifer would yield enough water to be classified as a true aquifer. It consists of a thin mantle of fill, alluvium, and weathered till. The confining unit is the unweathered Oak Creek Formation.

Slug tests conducted on the Oak Creek Formation in the deep and intermediate wells indicate average conductivities in the screened zones of 1×10^{-5} cm/s to 1×10^{-6} cm/s. The screened zones of the deep and intermediate wells were completed in sandy layers when encountered, or in the zone believed to be most permeable in the absence of well defined sand zones. Therefore, the bulk conductivity of the entire unit is probably less than the reported values. In addition, the stratigraphy of the screened section of the intermediate wells typically included interbedded lacustrine silts, sands and clays. In those cases, because the silt and clay layers would impede vertical flow, the reported values of hydraulic conductivity are probably due to horizontal flow. Bulk vertical conductivities are probably much lower. Hendry (1988) estimated bulk vertical conductivity of a non-weathered till formation to be 1×10^{-8} cm/s. Hendry's estimate was based on an 11-year pump test of a thick till overlying a buried valley in Canada.

The surficial "aquifer" comprises everything above the confining unit, including the weathered Oak Creek Formation, alluvial sediments, and fill. The hydraulic conductivities from the tests on shallow wells completed in the alluvium and weathered Oak Creek Formation ranged from 1 x 10^{-3} cm/s to 1 x 10^{-4} cm/s. Hydrogeologic properties of the fill are probably comparable; however more variability should be expected because of the variability in fill material.

The cross sections were constructed to reflect these hydraulic similarities, rather than following a strict geologic interpretation (see Figures 2 through 5). Accordingly, three units are shown.

Fill

The fill unit consists of a variety of materials that have been added to the surface between 1920 and the present. It is coarse gravel beneath the paved area; cinders and wood chips in the treated storage areas; silty loam in the old settling ponds; dredgings along the river and in the landfill; and trash and miscellaneous debris along the old stream channels (roughly coincident with the edge of the wooded areas.

Recent Alluvium and Weathered Oak Creek Formation

The recent alluvium is associated with the Little Menomonee River. It consists of silt and clay flood deposits and sand and gravel channel deposits. These deposits are hydraulicaly connected to the weathered Oak Creek Formation. This formation is typically a brown till; however, interbedded proglacial lacustrine deposits are present at several elevations.

Oak Creek Formation

The unweathered part of the Oak Creek Formation is gray. It is dense and typically comprised of silty clay till and interbedded lacustrine deposits. The lacustrine beds consist of laminated or thinly bedded clays, silts, fine sands, and occasionally medium sands.

REFERENCES

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Mickelson, D. M., L. Clayton, R. W. Baker, W. N. Mode and A. F. Schneider. Pleistocene Stratigraphic Units of Wisconsin. Geological and Natural History Survey, Misc. Paper 84-1 University of Wisconsin--Extension, Madison, Wisconsin. 1984

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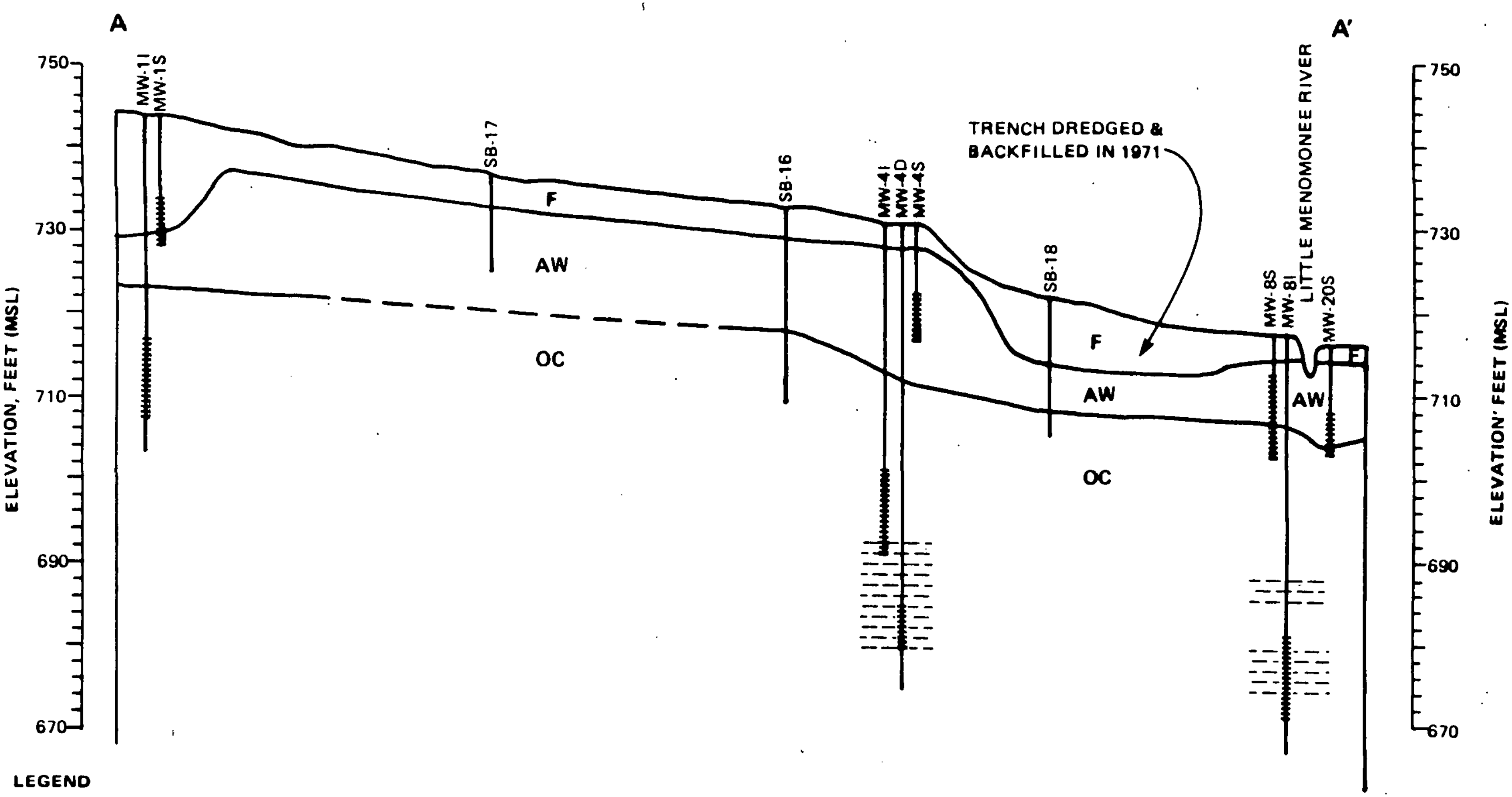


LEGEND

Fill

F	Gravel, cinders, woodchips, silty loam, river dredgings, trash, railroad ties, other debris.

Recent Alluvium and Weathered Oak Creek Formation

AW	Fine-grained flood deposits, sand and gravel channel deposits, brown silty clay till, with interbedded red, brown and gray lacustrine clays, silts and sands.

Oak Creek Formation

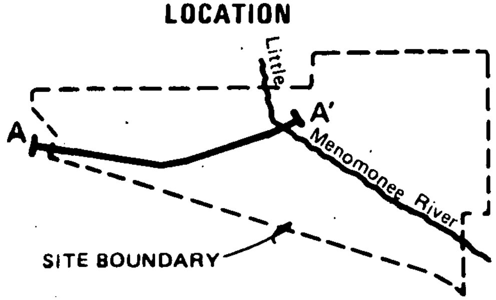
OC	Dense gray silty clay till with interbedded silts, clays and fine sands.

Laminated or thinly bedded clays, silts and fine sands.

SB — SOIL BORING

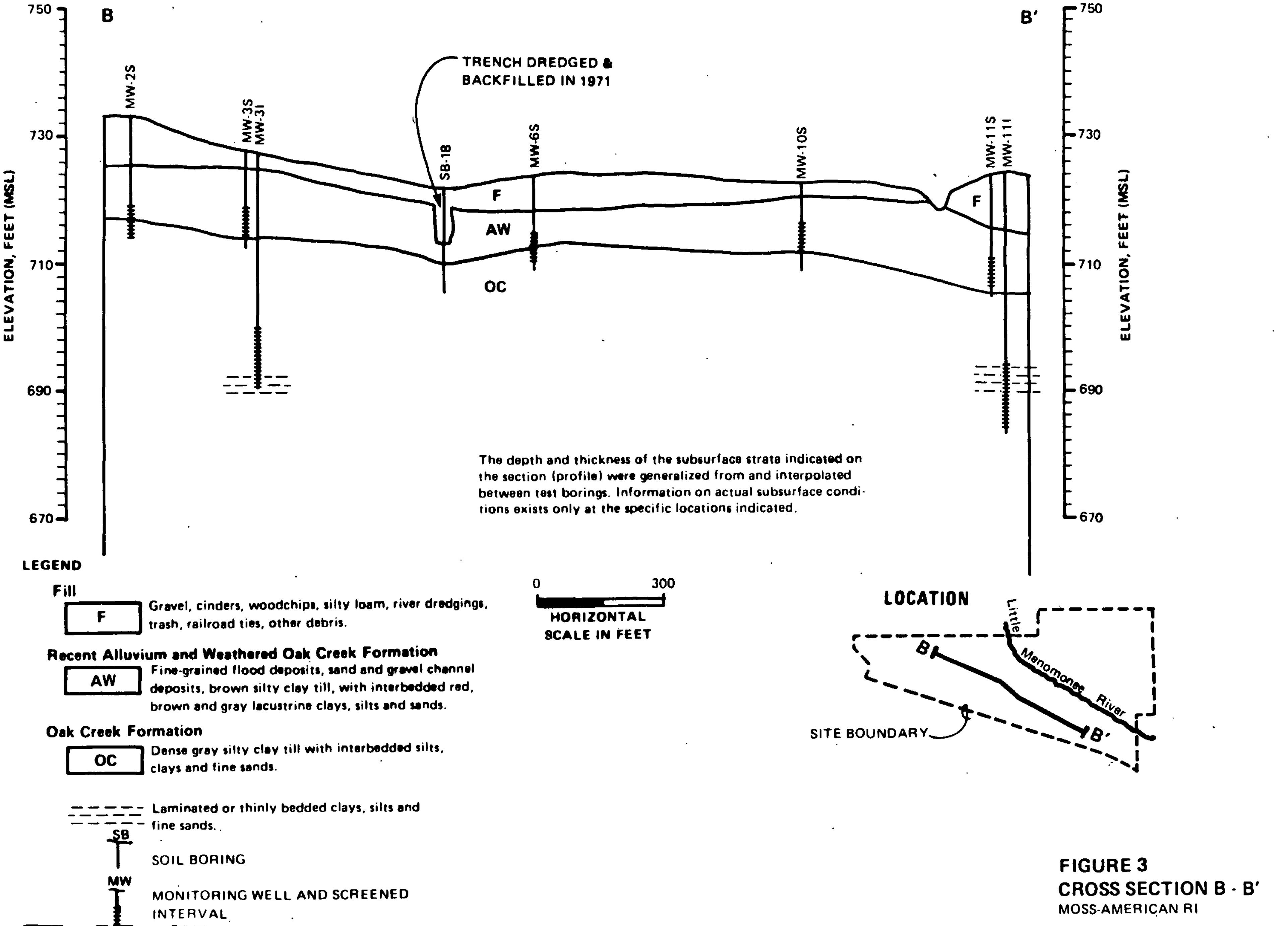
MW — MONITORING WELL AND SCREENED INTERVAL

0 300
HORIZONTAL SCALE IN FEET



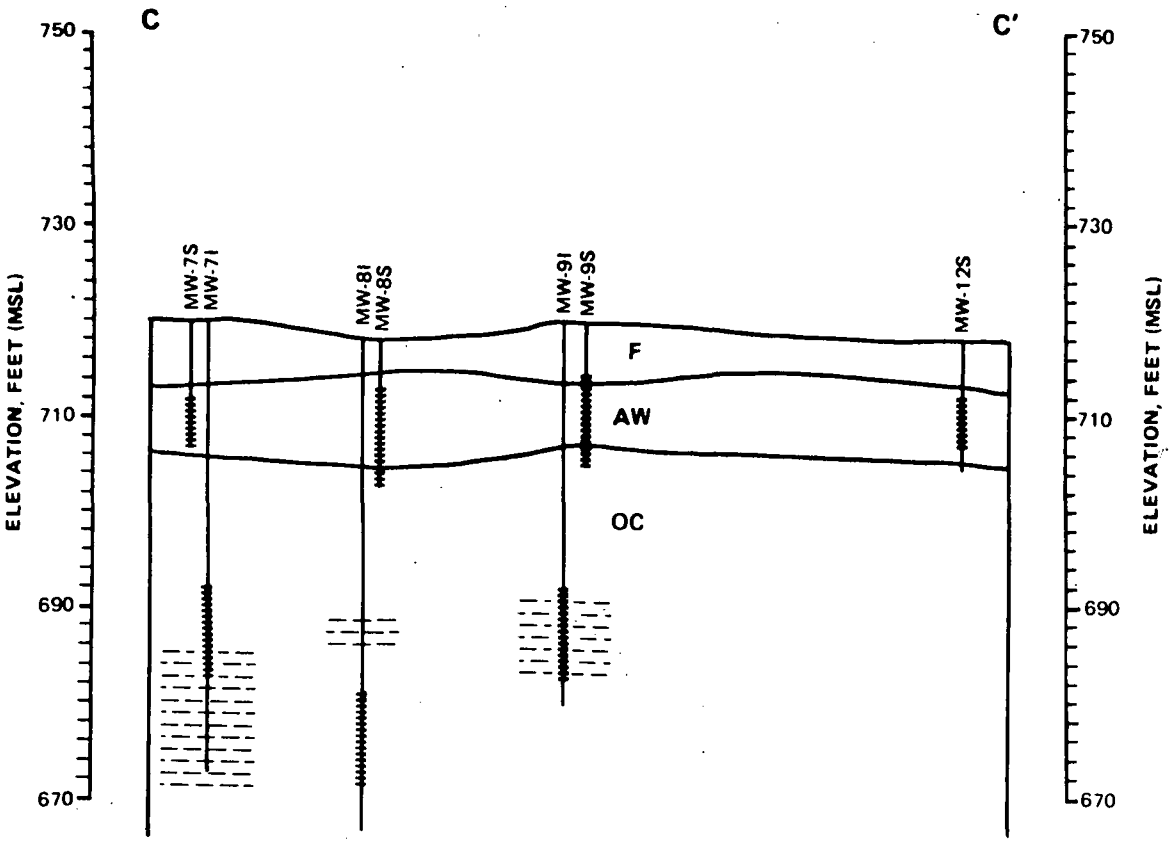
The depth and thickness of the subsurface strata indicated on the section (profile) were generalized from and interpolated between test borings. Information on actual subsurface conditions exists only at the specific locations indicated.

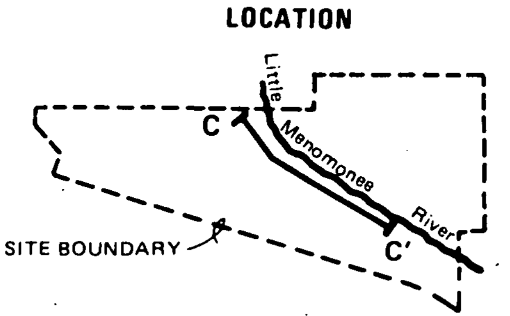
FIGURE 2
CROSS SECTION A - A'
MOSS-AMERICAN RI



The depth and thickness of the subsurface strata indicated on the section (profile) were generalized from and interpolated between test borings. Information on actual subsurface conditions exists only at the specific locations indicated.

FIGURE 3
CROSS SECTION B - B'
MOSS-AMERICAN RI





LEGEND

Fill

F Gravel, cinders, woodchips, silty loam, river dredgings, trash, railroad ties, other debris.

Recent Alluvium and Weathered Oak Creek Formation

AW Fine-grained flood deposits, sand and gravel channel deposits, brown silty clay till, with interbedded red, brown and gray lacustrine clays, silts and sands.

Oak Creek Formation

OC Dense gray silty clay till with interbedded silts, clays and fine sands.

— — — Laminated or thinly bedded clays, silts and fine sands.

SB SOIL BORING

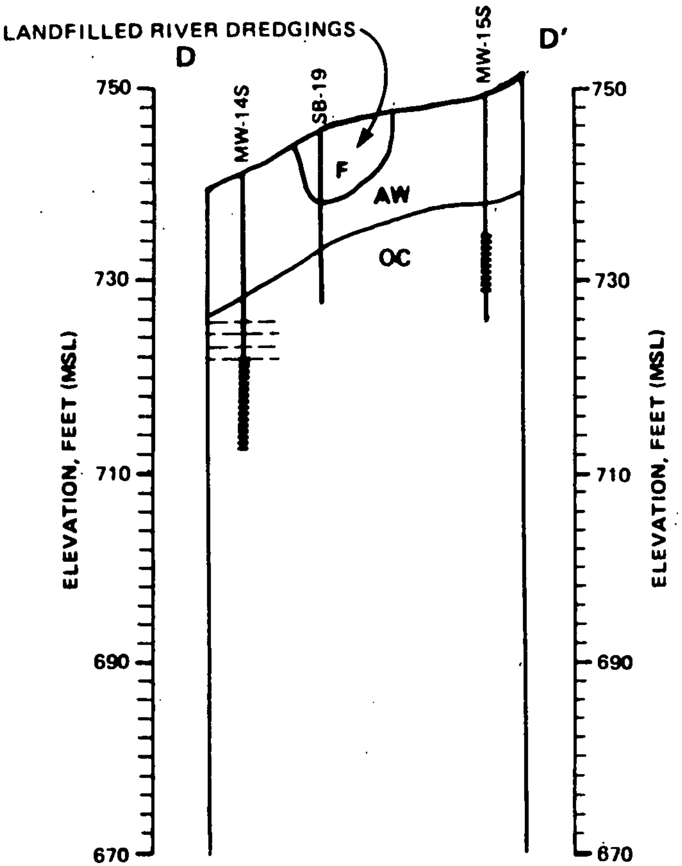
MW MONITORING WELL AND SCREENED INTERVAL

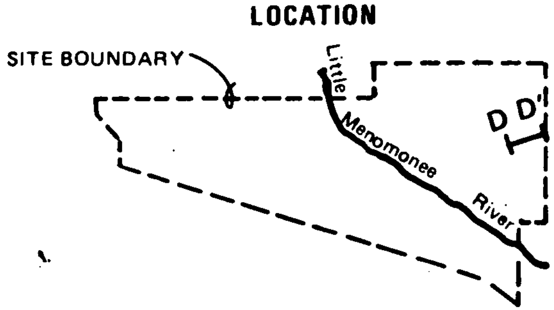
0 300

HORIZONTAL SCALE IN FEET

The depth and thickness of the subsurface strata indicated on the section (profile) were generalized from and interpolated between test borings. Information on actual subsurface conditions exists only at the specific locations indicated.

FIGURE 4
CROSS SECTION C - C'
MOSS-AMERICAN RI





LEGEND

Fill

F — Gravel, cinders, woodchips, silty loam, river dredgings, trash, railroad ties, other debris.

Recent Alluvium and Weathered Oak Creek Formation

AW — Fine-grained flood deposits, sand and gravel channel deposits, brown silty clay till, with interbedded red, brown and gray lacustrine clays, silts and sands.

Oak Creek Formation

OC — Dense gray silty clay till with interbedded silts, clays and fine sands.

– – – – Laminated or thinly bedded clays, silts and fine sands.

SB — SOIL BORING

MW — MONITORING WELL AND SCREENED INTERVAL

The depth and thickness of the subsurface strata indicated on the section (profile) were generalized from and interpolated between test borings. Information on actual subsurface conditions exists only at the specific locations indicated.

FIGURE 5
CROSS SECTION D - D'
MOSS-AMERICAN RI

Attachment 1
WELL LOGS AND SAMPLING INFORMATION

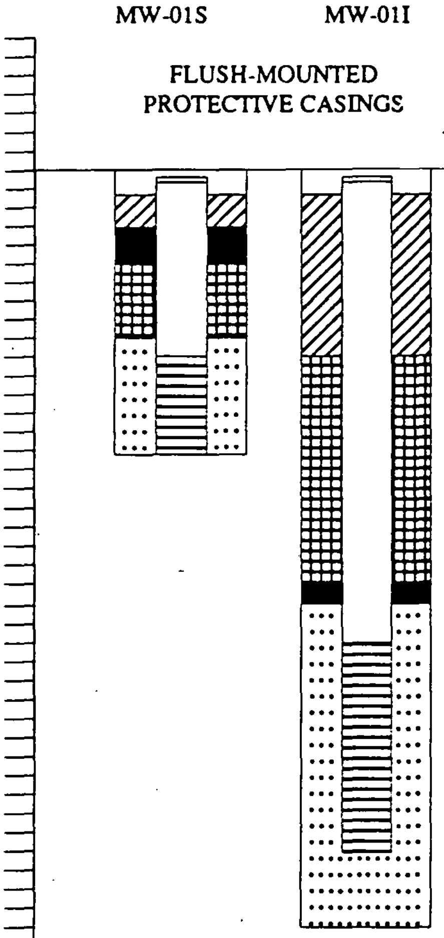
MONITORING WELL BORING LOGS

MOSS-AMERICAN SITE

Legend

▤	2" ID #10 SLOT STAINLESS STEEL WELL SCREEN
▯	2" ID STAINLESS STEEL WELL RISER WITH CAP
▯	6" ID STEEL OUT CASING
⊓	STEEL PROTECTIVE CASING WITH NO. 1 MASTER LOCK
▨	CEMENT/BENTONITE GROUT
■	BENTONITE SEAL
░	NO. 30 "FLINT" SAND PACK
▦	NATURAL FORMATION COLLAPSE

MOSS-AMERICAN MONITORING WELL MW-01S and MW-01I
MW-01S COMPLETED 6/27/88, MW-01I COMPLETED 6/27/88



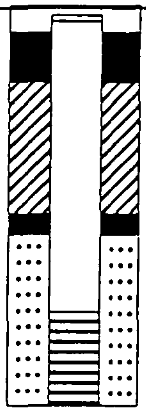
SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRAC-TABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Brown and gray loose silty SAND and GRAVEL (SM and GM) (Fill). Asphalt on surface.	0.00		50-25-20-18
	0.01		100/9
	0.02		3-3-4-5
	0.01		30-14-10-7
	0.01		24-14-19-32
	0.00	SB-01-01	24-39-44-58
Gray, wet, dense silty SANDS.	0.01		4-8-18-24
Gray, fine sandy SILT (ML). Laminated.	0.01		8-13-13-12
	0.01		7-7-9-14
Gray silty CLAY with pebbles, wet (CL). Oak Creek till.	0.01		16-27-41-52
	0.00		19-28-46-48
	0.01		26-31-33-39
			21-29-18-27

CH2M HILL

MOSS-AMERICAN MONITORING WELL MW-02S
MW-02S COMPLETED 6/28/88

MW-02S

FLUSH-MOUNTED PROTECTIVE CASING



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Brown silty SAND (SM) grading to clayey SILT (ML). Some gravel. Moist (FILL). Asphalt on surface.	2.05		12-8-10-10
	0.21		?-?-6-4
	0.21		5-5-4-5
	0.01		3-3-4-8
Light brown wet silty CLAY (CL). Trace sand and pebbles (Till).	0.00		2-5-7-10
	0.00		10-10-26-26
			8-17-19-30
Gray silty fine SAND (ML). Trace clay.	0.01	SB-02-01	7-10-12-15
Gray silty CLAY (CL). Trace pebbles. Wet (Till).	0.00		8-11-27-33

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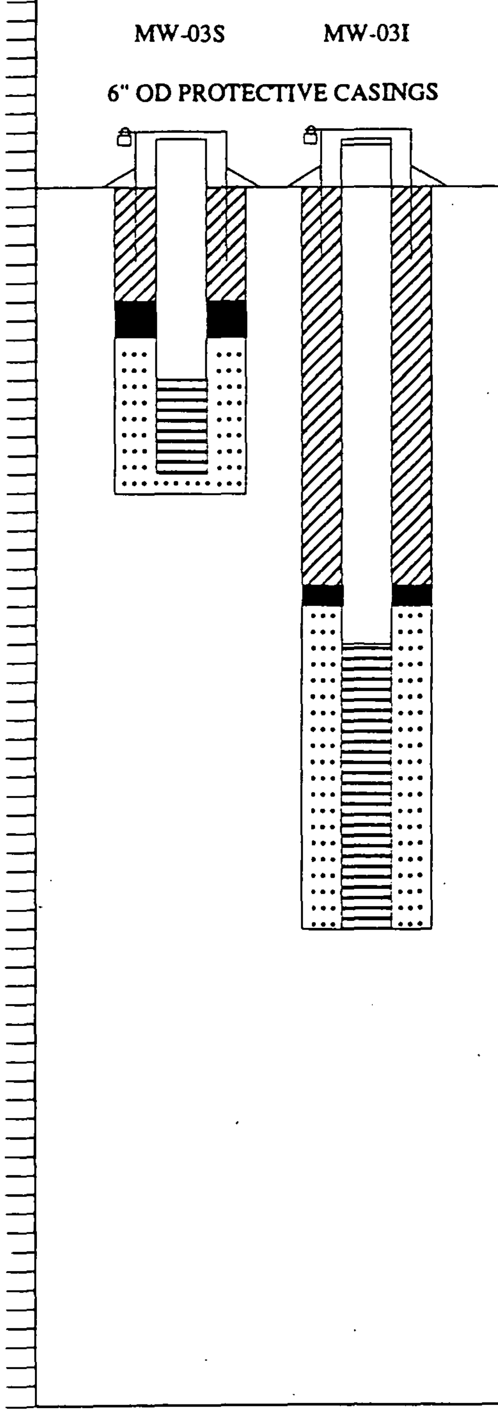
Rev.9-12-88

MOSS-AMERICAN MONITORING WELL MW-03S AND MW-03I
MW-03S COMPLETED 6/23/88, MW-03I COMPLETED 6/24/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Brown, dry SILT and SAND. Some cinders, gravel and clay (Fill)	1.36		12-18-19-23
	0.03		19-20-22-11
Brown silty CLAY (CL). Trace pebbles, silty sand in seams (Till).	0.00		7-9-11-20
	0.00		7-9-10-10
Laminated, moist to wet, reddish brown SILTS, gray fine SANDS, golden brown silty SANDS, and gray medium SANDS. Occasionally interbedded with SILTY CLAY TILL.	0.00		5-10-11-19
	0.00	SB-03-01	12-32-54-41
	0.00		11-22-41-46
Gray wet silty CLAY (CL)(Till). Trace pebbles and sand. NOTE: Additional sample collected from 714-712' had 0.00% extractable organics, penetration test results 10-19-22-27.	0.00		5-15-25-20
	Not Analyzed		36-56-56-80
	0.00		6-22-27-100/5"
	0.00		25-22-30-46
	0.00		22-27-21-70
			28-67-100/5"
Gray SILT with clay. Poorly laminated to massive, little very fine sand. Fragments of red clay.	0.00	SB-03-02	30-47-75-100/5"

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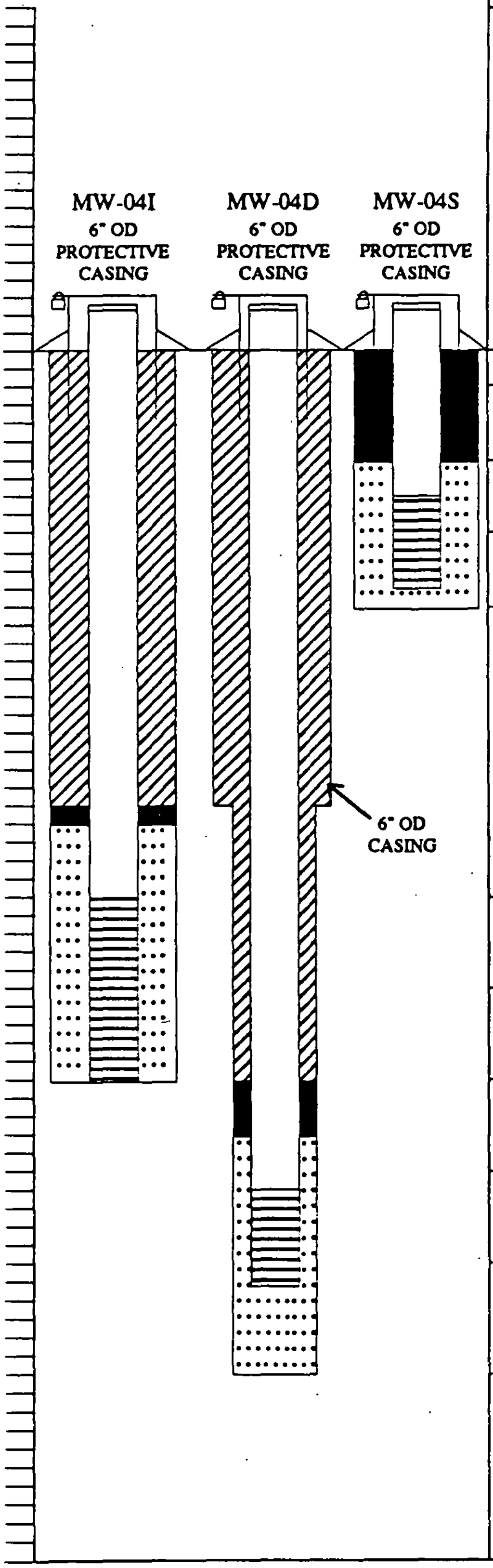
Rev.9-12-88

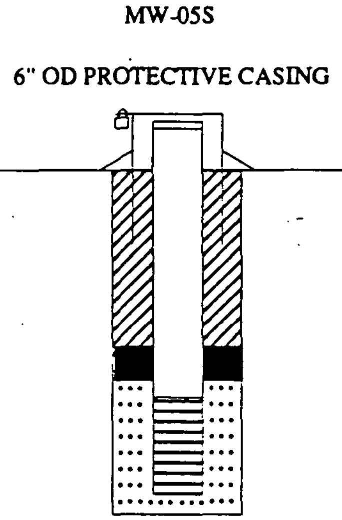
MOSS-AMERICAN MONITORING WELL MW-04S, MW-04I, AND MW-04D
MW-04S COMPLETED 6/7/88, MW-04I COMPLETED 6/20/88, MW-04D COMPLETED 6/9/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Brown gray SAND and GRAVEL (Fill)			
Black silty SAND (SM). Contains oil or creosote.	1.62 0.02		11-12-15-13 20-8-7-9
Brown silty CLAY (CL). Contains oil or creosote.	0.34 0.12		7-6-4-5 4-10-9-9
Gray brown sandy SILT (ML). Contains oil or creosote. Some sand seams.	0.08 Not analyzed	SB-04-01	6-9-9-11 4-27-36-48
Light brown silty CLAY (CL). Oil or creosote present on a few surfaces. Sand and silt in seams (Till). Color changes to gray at 711'.	0.05 0.00 0.00		17-42-61-88 3-5-23-76 8-18-36-54
Gray fine SAND with silt. Wet. No evidence of contamination.	0.00	SB-04-02	22-57-87-162
No recovery.	0.00		59-50/0.3'
Reddish brown CLAY (CH). Fine laminations	0.00		6-16-19-23
Gray laminated SILTS, CLAYS, and FINE SANDS, moist.	0.00		7-24-43-60/0.1'
Gray CLAY with a little gravel (to 2"). Moist (CL)(Till).	0.00 Not Analyzed	SB-04-03	44-49-100/0.5' 44-100/0.4'

Rev.9-12-88

MOSS-AMERICAN MONITORING WELL MW-05S
MW-05S COMPLETED 6/29/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Brown, blocky sandy SILT (ML)(Fill)	0.01		7-21-27-31
Black hard sandy SILT (ML)(Fill) with small rocks, cinders, no visible oil.	0.04		21-27-27-15
	0.03		20-22-31-10
Black soft clayey sandy SILT (ML-CL).	0.01		21-5-6-8
Weathered cobbles of varying lithology. Some brown silt.	0.00		10-6-11-13
			3-4-5-6
Light brown soft clayey sandy SILT (ML-CL) Small gravel	0.01	SB-05-01	8-9-12-13
Grey, soft wet clayey SANDY SILT (ML) Laminated.	0.00		8-10-17-21
Gray moist silty CLAY (CL)(Till). Trace pebbles.	0.00		26-100/5"

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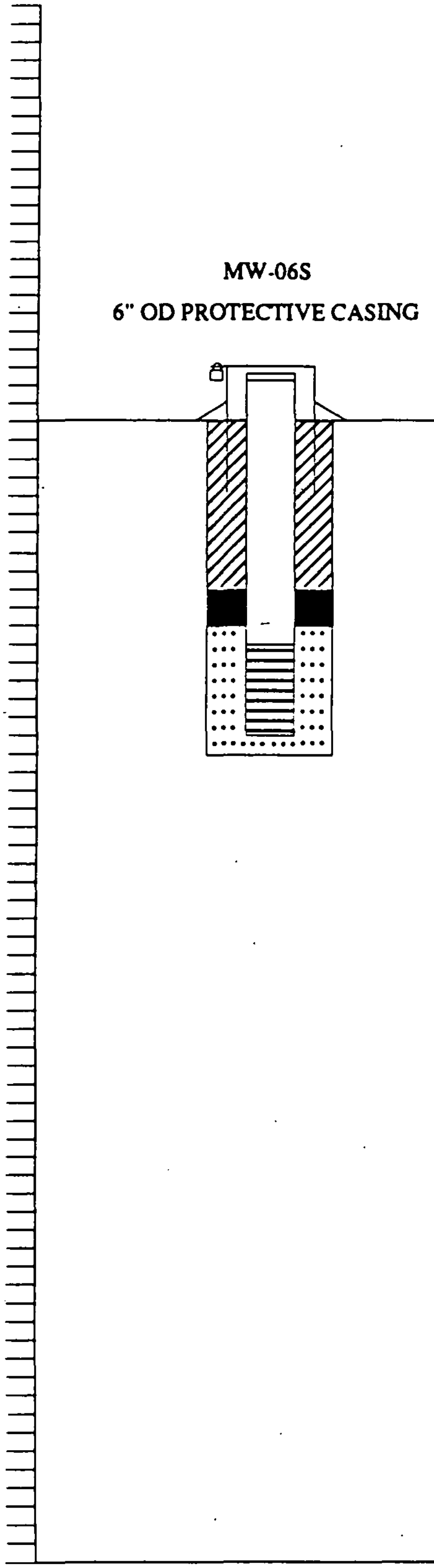
MOSS-AMERICAN MONITORING WELL MW-06S
MW-06S COMPLETED 6/28/88

MW-06S

6" OD PROTECTIVE CASING



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Black-brown cinder SAND (SM)(Fill). Pebbles, dry, some silt	0.96		3-3-4-6
Brown-black to black-grey, dry loose SILTY SAND (SM)(Fill). Some pebbles, some cinders.	0.21		10-9-5-8
Brown, moist, soft sandy SILT (ML)	0.13		7-5-6-5
Brown, moist, loose, poorly sorted silty SAND (SM). Some gravel.	0.01		5-6-11-26
	Not analyzed		6-8-10-12
Brown, wet, sandy SILT (ML) with some gravel (1-2" diameter)	0.0	SB-01-01	10-13-15-25
Light grey, wet, stiff silty CLAY (ML-CL)(Till). Some sand and well-rounded gravel.	0.00		13-17-25-36

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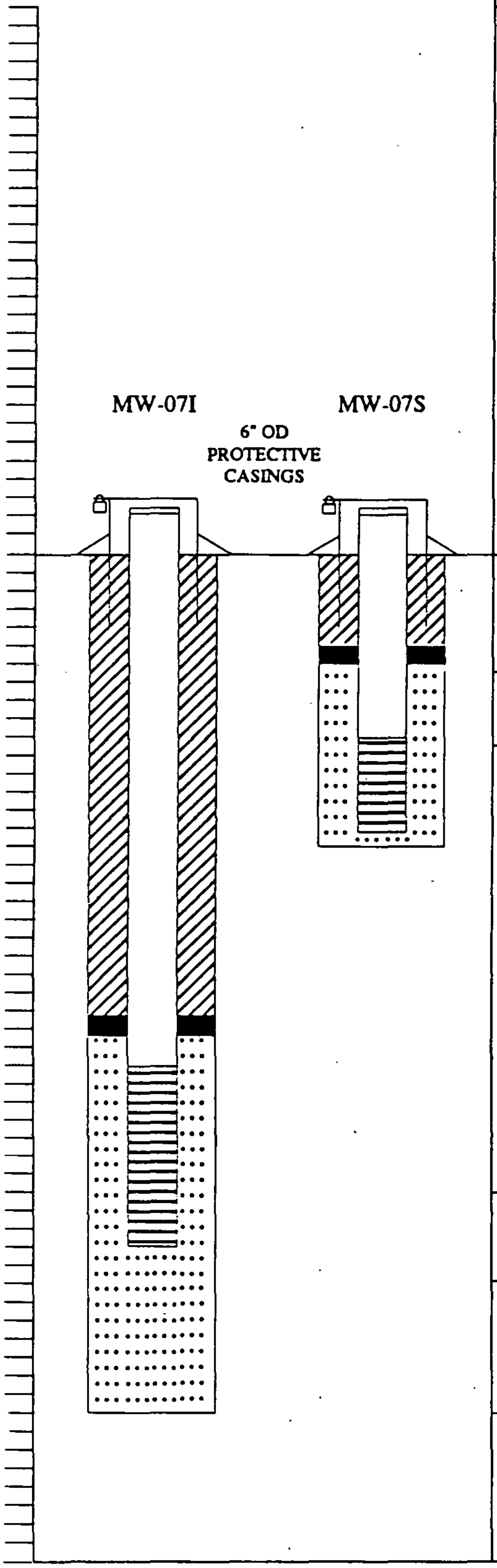
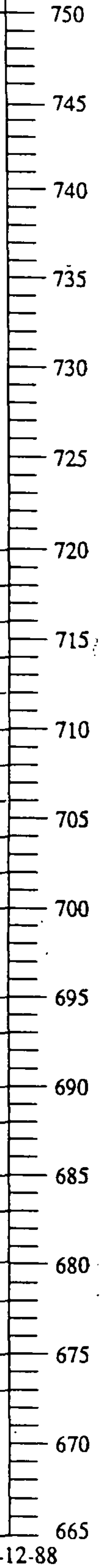
Rev.9-12-88

MOSS-AMERICAN MONITORING WELL MW-07S AND MW-07I
MW-07S COMPLETED 6/15/88, MW-07I COMPLETED 6/15/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Light brown SILT (ML)(Fill). Some roots and wood chips. Localized accumulations of organic material.	0.02 0.00 0.10		6-10-18-18 15-23-18-19 8-5-7-6
Grey, moist, poorly graded very fine SAND and SILT (ML).	0.00	SB-01-01	3-3-6-7 10-23-23-22
Grey, wet SILTY CLAY with a little sand and trace pebbles (CL). Till.	0.00 0.00 0.00 0.00 0.00 0.00 0.00		9-10-13-23 7-20-22-15 19-38-26-26 9-12-15-21 10-15-31-80 6-18-64-73 3-30-46-40
Reddish brown, moist, silty CLAY (CL) (Till). Trace pebbles.	0.00		10-15-42-48
Gray CLAY (CL) with silt. Clasts of reddish-brown silty clay. Finely laminated. SAND seam at 673'.	0.00 0.00		33-45-55-78 20-36-100/5"



Rev.9-12-88

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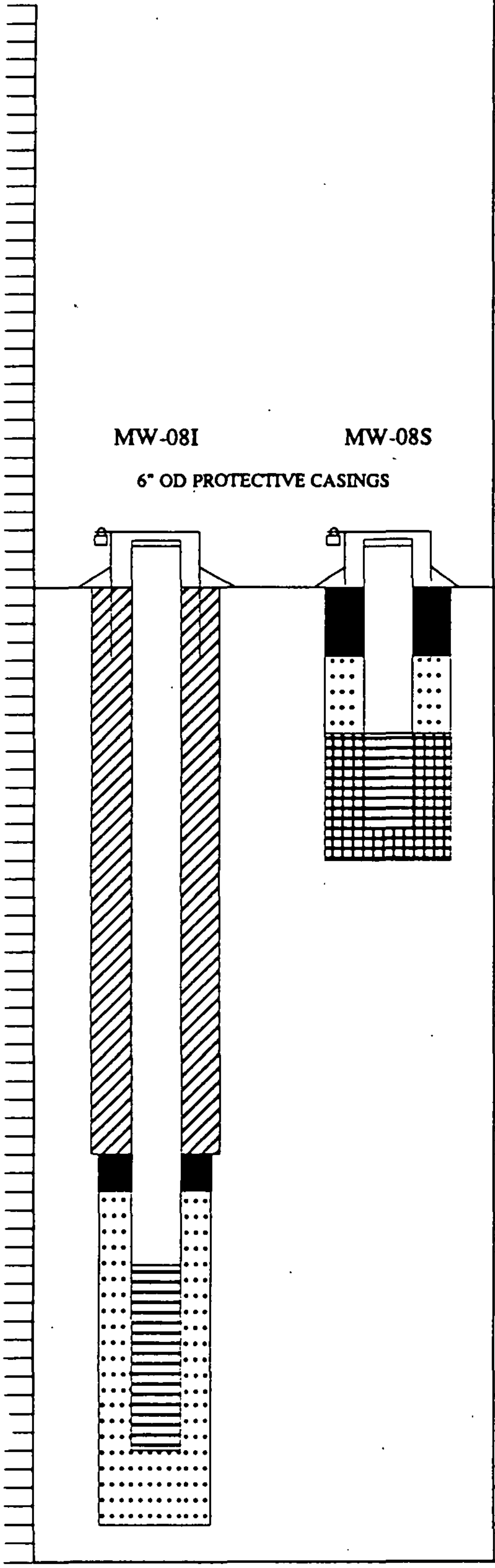
MOSS-AMERICAN MONITORING WELL MW-08S MW-08I
MW-08S COMPLETED 6/13/88 MW-08I COMPLETED 6/13/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Brown, sandy SILT (ML). Some pebbles.	0.60		5-6-23-23
	0.00		13-5-5-5
Gray clayey fine sandy SILT (ML-CL)(Alluvium). Laminated.	0.01		4-3-5-9
Gray silty fine SAND (ML)(Alluvium). Medium sand in seams. Oil in seams.	0.00	SB-08--02	11-10-15-23
	0.00		6-10-15-18
Gray, soft silty CLAY (CL). Trace pebbles.	0.00		7-8-7-9
	0.00		21-21-25-23
	0.00		17-25-31-90
Gray, moist sandy SILT (ML) with pebbles.	0.00		10-20-50-95
Gray, hard silty CLAY (CL)(Till). No pebbles. Little sand.	0.00		100/5"
No recovery.	Not Analyzed		100/3"
Gray, moist silty CLAY with sand and gravel (CL). Silty SAND seams.	0.00		65-75-100/3"
No recovery.	0.00		30-23-90-100/4"
	0.00		17-27-45-50
Grey, moist, poorly sorted SILT to coarse SAND (ML) with little gravel.	Not Analyzed		48-80-100/3"
Grey, moist CLAY (CL). Reddish-brown clay clasts	Not Analyzed	SB-08-01	25-48-28-26

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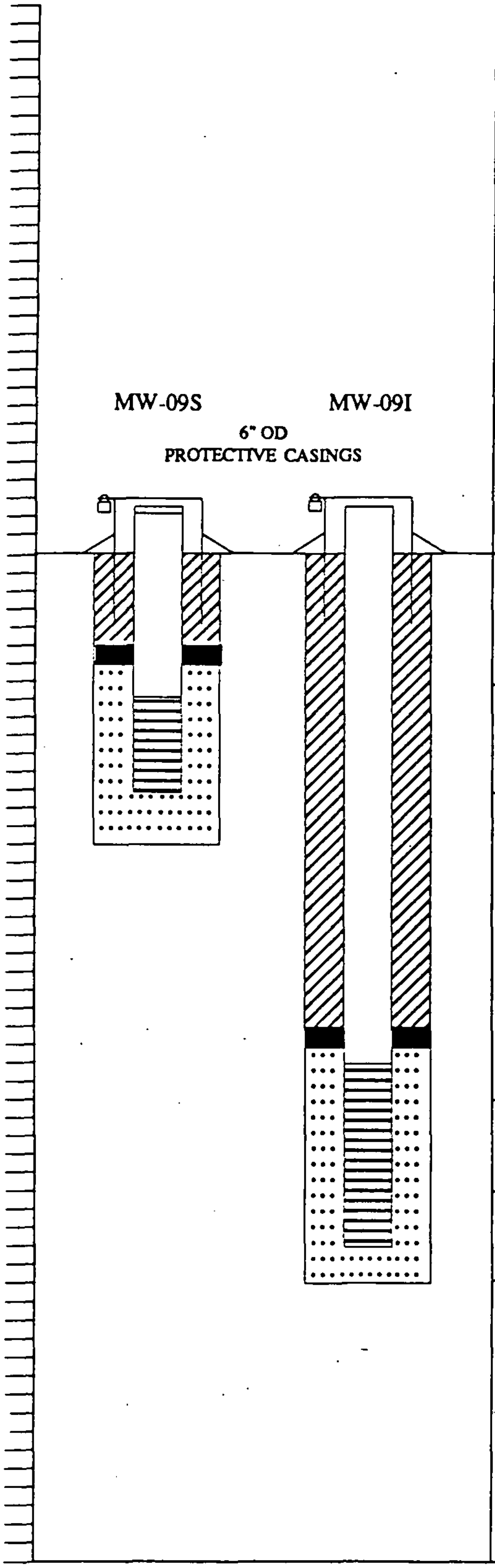
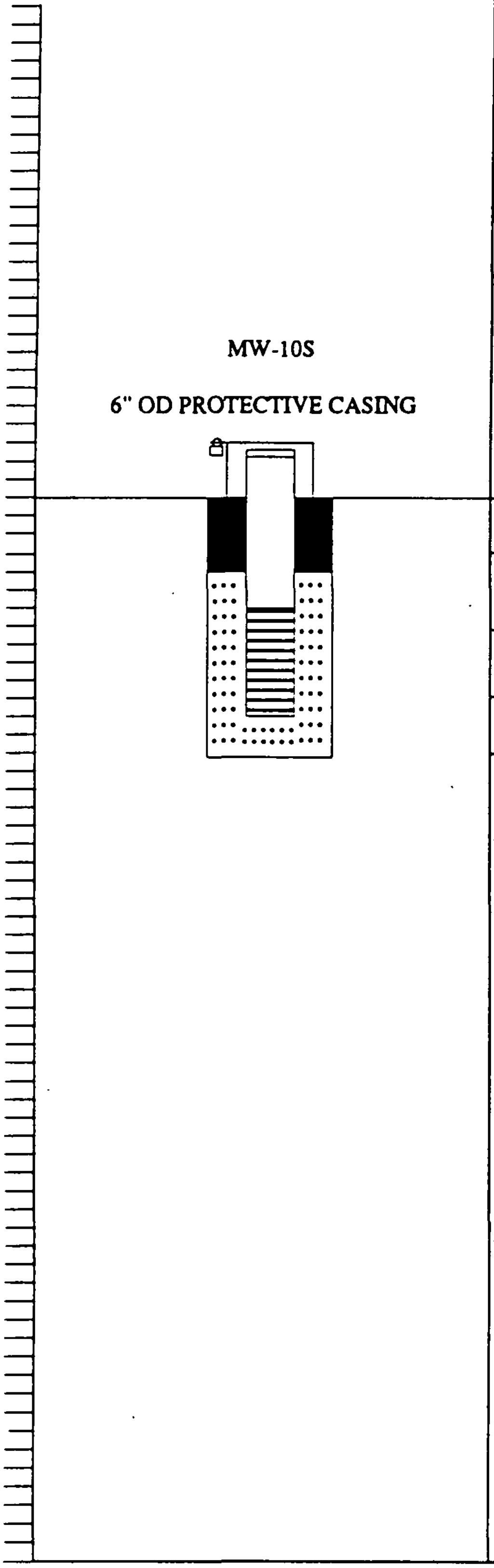
Rev. 9-12-88

MOSS-AMERICAN MONITORING WELL MW-09S AND MW-09I
MW-09S COMPLETED 6/17/88, MW-09I COMPLETED 6/16/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Light brown silty SAND (Fill). Some gravel and wood chips.	0.00		10-20-15-18
	2.67		12-25-10-5
	0.21		6-4-5-8
	0.00		4-4-10-11
Gray poorly sorted gravelly SAND (SP) (Alluvium).	0.00	SB-09-01	4-10-19-34
			10-22-34-62
			24-23-21-20
Gray, fine sandy silty CLAY (CL)(Till). Trace pebbles and gravel.	0.00		10-24-26-48
	0.01		10-20-36-45
	0.01		20-35-80-50/0.2
	0.00		16-41-56-58
	0.01		22-27-40-45
Interbedded SILTS, CLAYS, FINE and MEDIUM SANDS. 3" to 4" seams.	Not Analyzed	SB-09-02	44-98-100/0.4'
Gray SILT and CLAY Till, trace pebbles, moist.	0.01		75-60-95-25/0'
	Not Analyzed		100/0.4'

MOSS-AMERICAN MONITORING WELL MW-10S
MW-10S COMPLETED 6/21/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRAC-TABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Dark brown weathered sandy SILT (ML). Some gravel fill and pebbles.	0.00		10-11-10-11
Gray and brown unweathered sandy SILT (ML)(Alluvium). Some pebbles.	0.00		75-15-9-11
	0.00		8-5-5-9
Light brown poorly sorted fine to coarse SAND (SM). Some pebbles and cobbles, various lithologies.	0.00		6-19-18-32
	0.00		14-27-43-17
Gray silty CLAY (CL)(Till). Trace pebbles.	0.00	SB-10-01	15-11-12-9
			15-21-35-32

750
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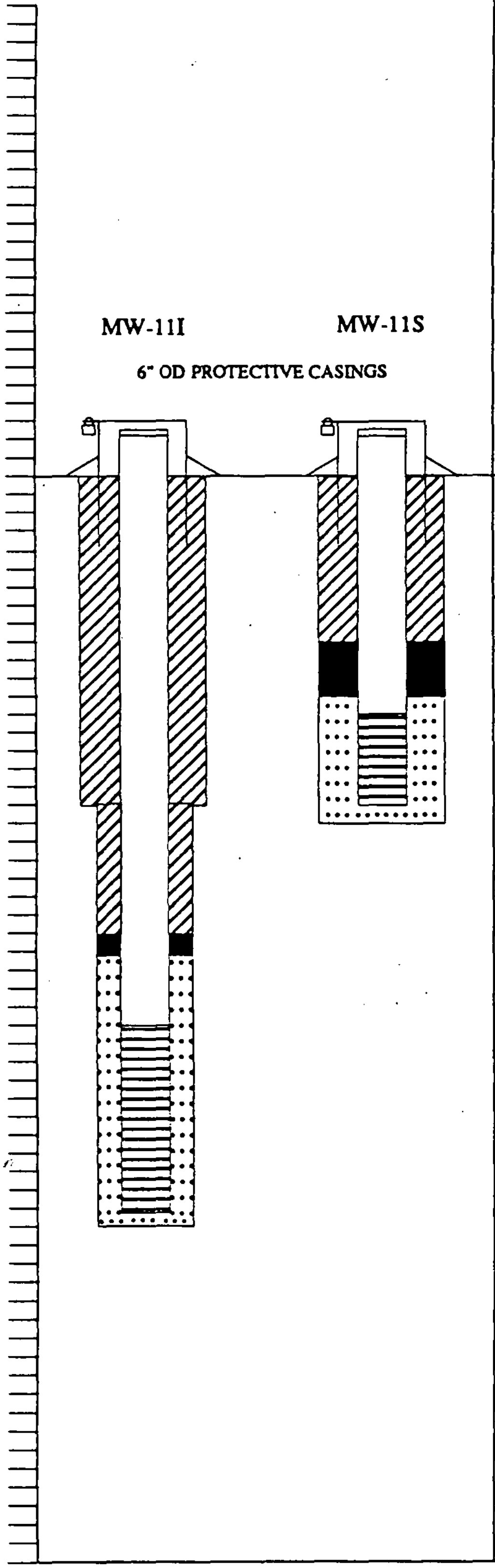
Rev.9-12-88

MOSS-AMERICAN MONITORING WELL MW-11S, MW-11I
MW-11S COMPLETED 6/28/88, MW-11I COMPLETED 6/27/88.

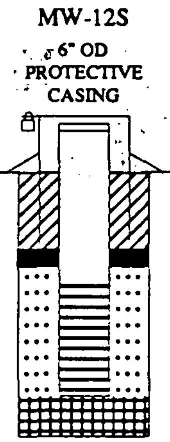


SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"	
				750
				745
				740
				735
				730
				725
Light brown, dry, loose silty SAND (SM) (Fill). Some pebbles and roots.	0.00		11-22-31-65	
	0.00		22-30-65-18	
	5.88		5-6-10-11	720
Wood chips (Fill). Wet, black oily fluid.	3.58		17-27-61-5	
Gray brown, wet, loose well-sorted silty SAND (SM).	0.05		3-2-2-10	715
	0.01		2-2-3-6	
Gray, wet, very soft interlayered silty CLAY, SILTS and SANDS (CL-SM). Moss & snail shells in clay.	0.01		1-1-1-2	
	0.00*		3-6-10-27	710
Brown, soft, wet clayey SILT (ML)(Till). Some subangular gravel.	0.00	SB-11-02	16-11-9-7	
	0.00		3-5-7-9	705
	0.00		9-19-20-70	700
Gray, wet, stiff silty CLAY (CL)(Till). Some pebbles.	0.00		15-28-35-48	695
Gray, wet, stiff SILTY CLAY, interbedded wed SILTY CLAY layer.	0.00		9-9-11-13	690
Gray, wet, silty SAND (SM). Some well rounded gravel.	0.00	SB-11-01	35-96-110/5"	685
				680
				675
				670
				665

* Standard penetration tests and extractable organics samples overlap at interval 14'-16' and 15'-17'. Reported interval is 15'-17'. The results were similar for all samples.

Rev. 9-12-88

MOSS-AMERICAN MONITORING WELL MW-12S
MW-12S COMPLETED 6/21/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Dark brown, dry, loose, weathered silty fine SAND (SM).	0.00		7-10-13-12
	0.01		10-8-8-9
Gray and brown fine sandy SILT (ML). Increasing sand with depth.	0.00		4-10-13-15
	0.00		1-4-6-8
Gray fine to medium SAND (SP).	0.00	SB-12-01	5-13-23-29
Brown fine to medium SAND (SP).	0.00		5-11-13-45
Brown silty CLAY(CL)(Till). Cohesive silty fine sand in seams (Till).	Not Analyzed		3-5-7-9

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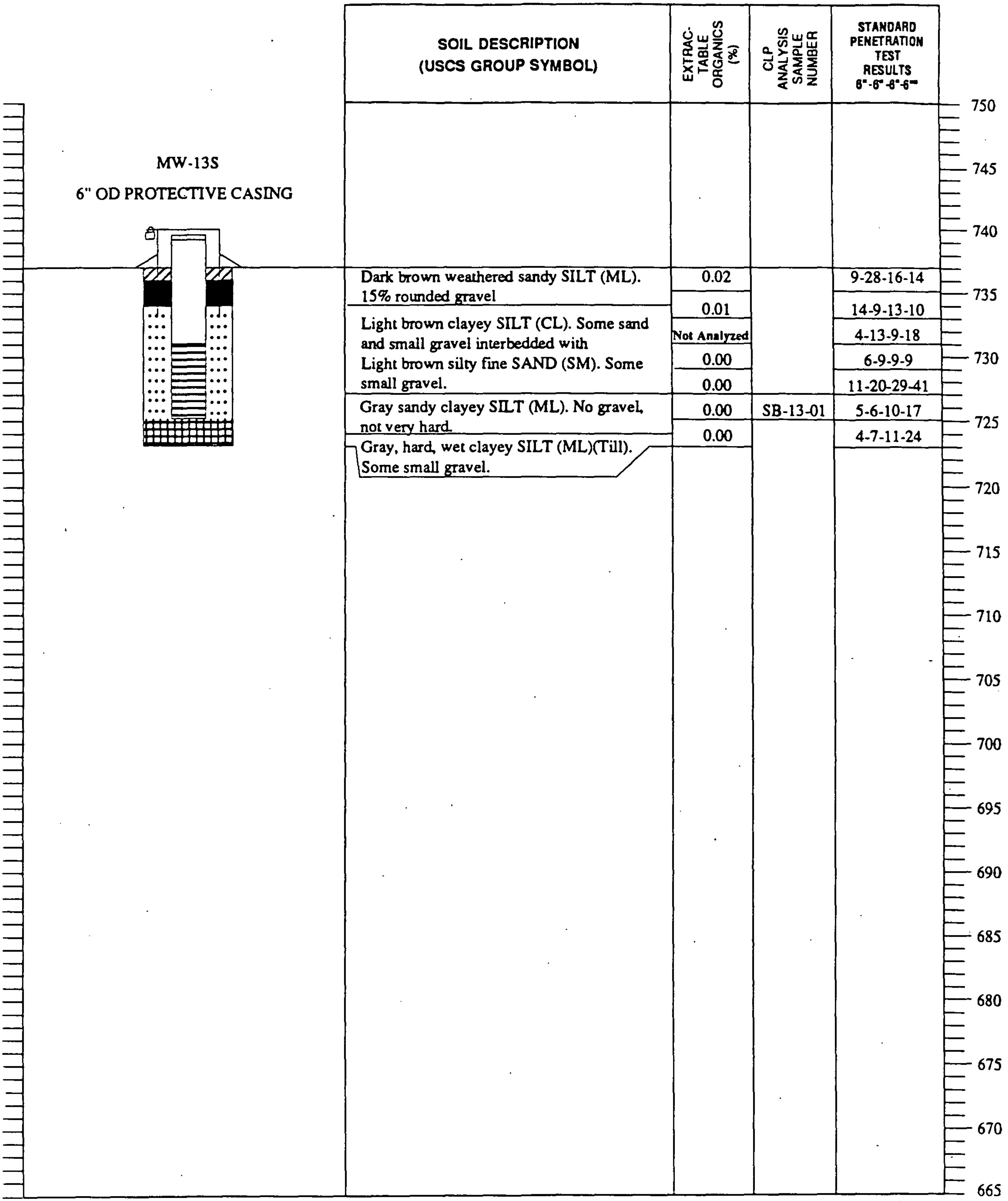
Rev.9-12-88

MOSS-AMERICAN MONITORING WELL MW-13S
MW-13S COMPLETED 6/29/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Dark brown weathered sandy SILT (ML). 15% rounded gravel	0.02		9-28-16-14
	0.01		14-9-13-10
Light brown clayey SILT (CL). Some sand and small gravel interbedded with Light brown silty fine SAND (SM). Some small gravel.	Not Analyzed		4-13-9-18
	0.00		6-9-9-9
	0.00		11-20-29-41
Gray sandy clayey SILT (ML). No gravel, not very hard.	0.00	SB-13-01	5-6-10-17
	0.00		4-7-11-24
Gray, hard, wet clayey SILT (ML)(Till). Some small gravel.			

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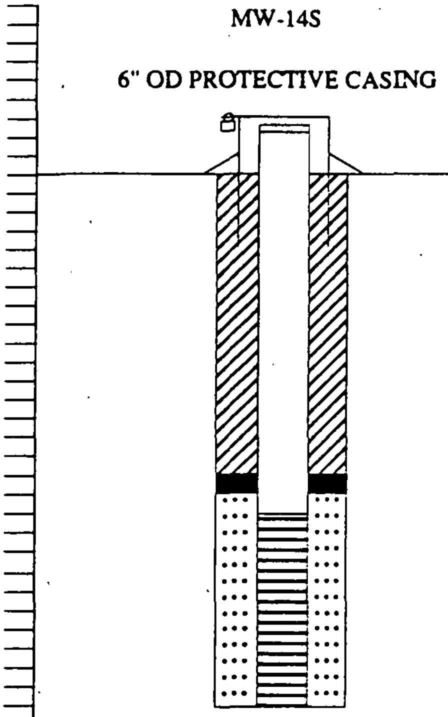
MOSS-AMERICAN MONITORING WELL MW-14S
MW-14S COMPLETED 6/22/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Brown SILT (ML). Some sand and gravel, roots.	0.00		10-15-21-22
	0.00		15-27-51-57
Brown silty CLAY (CL). Some sand and gravel (Till).	0.00		15-37-51-57
	0.00		19-25-31-47
	0.00		10-19-36-31
	0.00		22-31-41-45
	0.00		12-17-29-21
Gray CLAY (CL). Some silt and sand in seams.	0.00		5-10-20-19
	0.00	SB-14-01	5-10-17-28
Gray, hard, sandy SILT (SM-ML)(Till). Trace gravel.	0.00		17-30-100/0.4'
	0.00		51-62-100/0.4'
	Not Analyzed		100/0.4'
	0.00		12-100/0.4'

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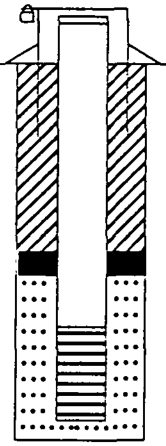
Rev.9-12-88

MOSS-AMERICAN MONITORING WELL MW-15S
MW-15S COMPLETED 6/22/88

MW-15S

6" OD PROTECTIVE CASING



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Brown dry silty CLAY (CL). Trace pebbles and sand-size shale chips. Formation is moist below 735 ft.	0.00		15-30-30-33
	0.00		45-58-45-50
	0.00		31-19-21-23
	0.00		12-19-24-30
	0.00		2-15-9-12
	0.00		7-10-17-17
	Not analyzed		10-13-15-17
	0.00		15-20-25-30
	0.00	SB-15-01	7-15-23-20
	0.00		14-21-25-25

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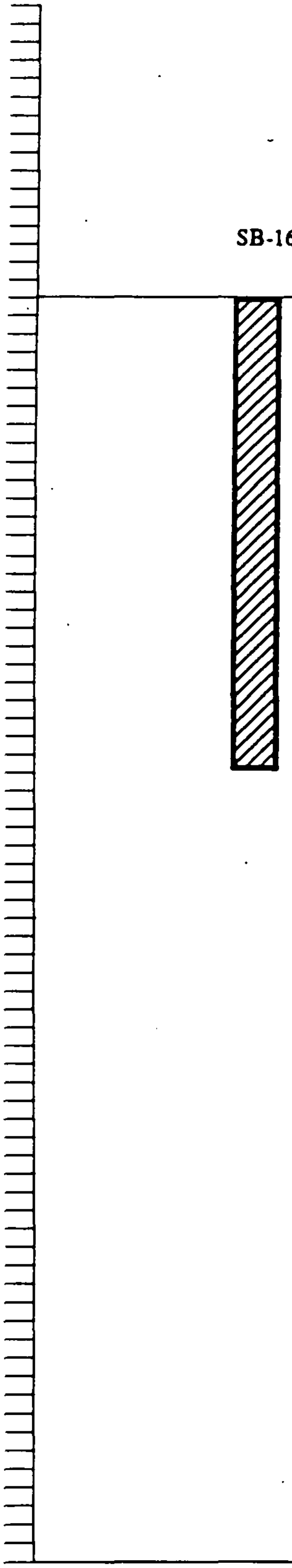
Rev.9-12-88

MOSS-AMERICAN SOIL BORING SB-16
SB-16 COMPLETED 6/2/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Well sorted sandy GRAVEL (Fill). Pieces of former concrete floor.			
			16-10-5-9
Gray, dry to moist stiff silty CLAY (CL-ML).	1.49		5-8-10-13
Visibly contaminated.	0.45	SB-16-01	5-8-48-67
Light brown, dry, hard SILT (ML). Some sand	0.00		100/8"
and gravel.	0.00		100/6"
Brown to gray, moist hard silty CLAY (CL-ML)(Till). Some gravel and sand. Dark red mottling throughout.	0.03		100/6"
	0.00		8-12-34
			12-50/4"
	0.01		27-48-50/5"

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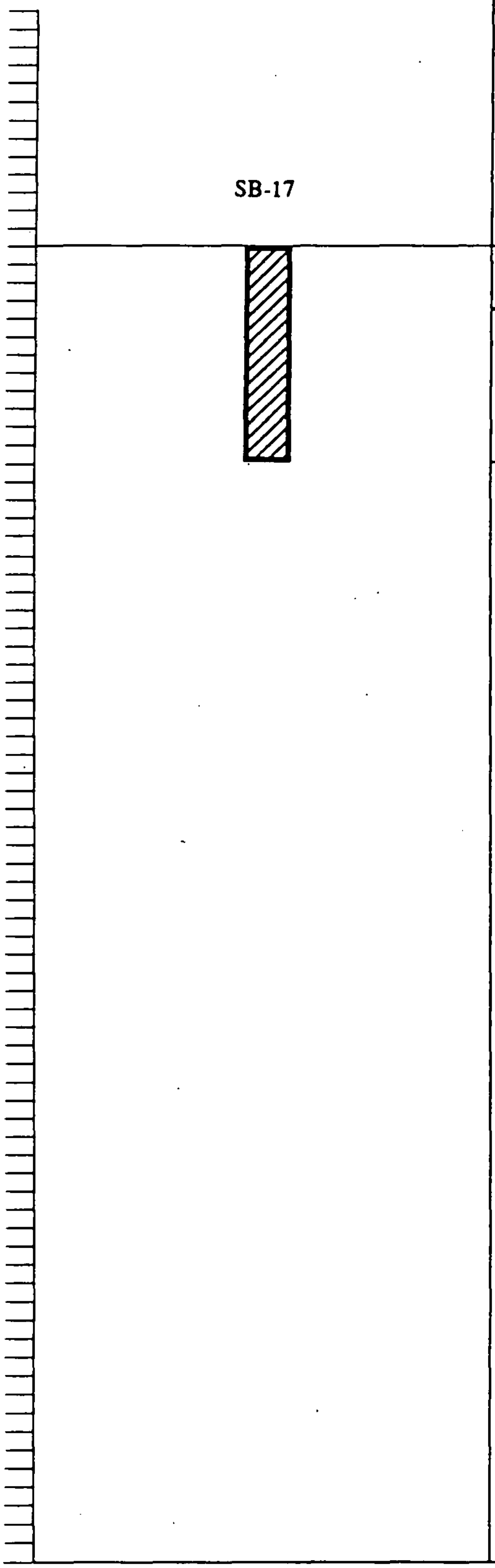
Rev.9-12-88

CH2M HILL

MOSS-AMERICAN SOIL BORING SB-17
SB-17 COMPLETED 6/3/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRAC-TABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Asphalt and gravel (Fill).			
	0.05		15-12-10-8
Black, light brown, and gray silty CLAY and CLAY. Finely laminated. Oxidized and mottled.	0.03		9-9-12
	0.00	SB-17-01	6-5-8-12
	0.00		8-12-15-22
	0.00	SB-17-02	6-22-17-21

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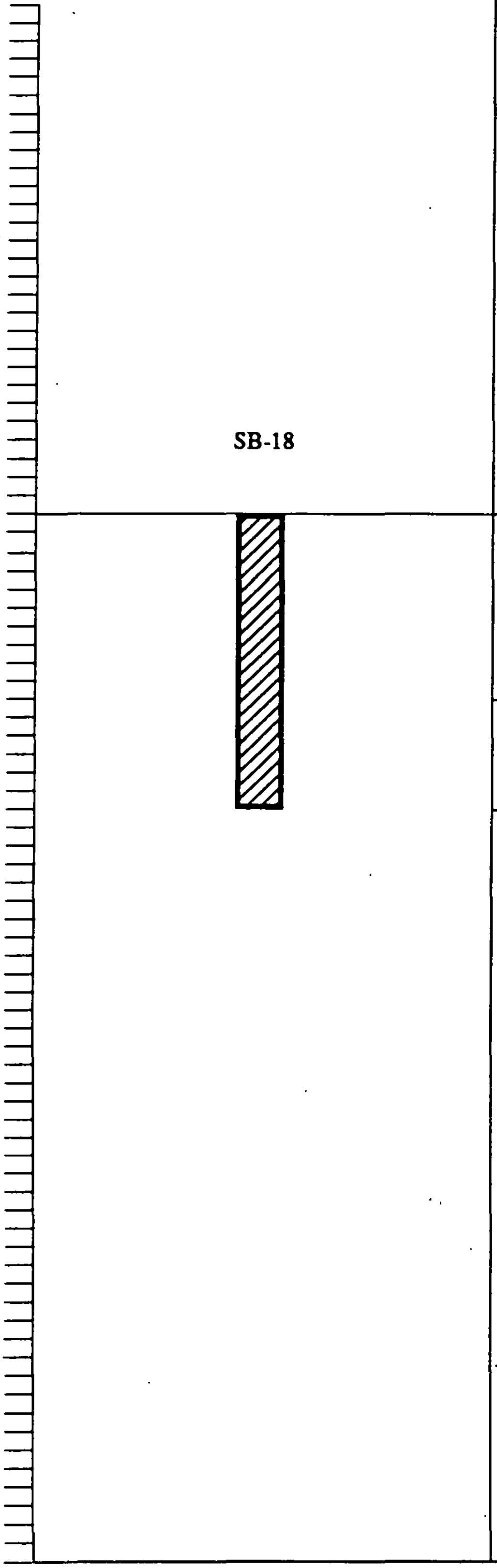
MOSS-AMERICAN SOIL BORING SB-18
SB-18 COMPLETED 6/17/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRAC-TABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Brown sandy silty CLAY (CL)(Fill).	0.00		4-7-4-6
	0.00		3-5-7-11
	0.00		4-5-5-6
	0.27	SB-18-01	4-11-10-9
	0.00		7-7-7-8
Brown sandy silty CLAY (CL)(Till).	0.00		4-10-35-100/5"
	Not Analyzed		40-100/6"
	0.00	SB-18-02	56-40-67-100

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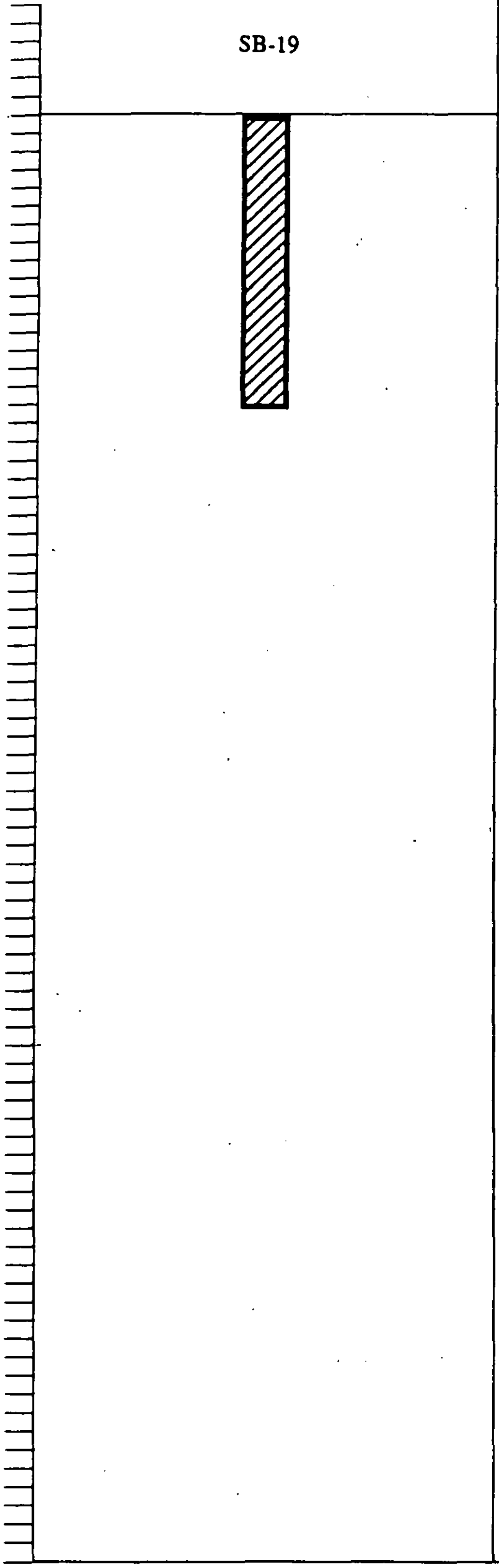
MOSS-AMERICAN SOIL BORING SB-19
SB-19 COMPLETED 6/23/88



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRAC-TABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Dark blackish brown SILT (ML) with sand, clay. Some oil (landfill).	0.98		
	1.80		8-5-4-5
	3.73		4-4-7-10
	2.48	SB-19-01	4-3-3-4
Brown, moist, hard silty CLAY (CL). Trace pebbles and gravel. Oxidized surfaces and oil stains present (Till).	0.00		6-32-65-73
	0.00	SB-19-02	21-25-47-65
	0.00		10-20-20-41
	Not Analyzed	SB-19-03	6-19-30-41

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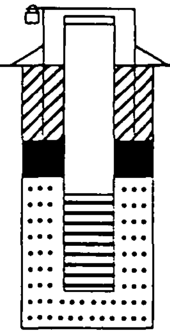
MOSS-AMERICAN MONITORING WELL MW-20S
MW-20S COMPLETED 6/29/88

MW-20S

6" OD PROTECTIVE CASING



SOIL DESCRIPTION (USCS GROUP SYMBOL)	EXTRACTABLE ORGANICS (%)	CLP ANALYSIS SAMPLE NUMBER	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"
Dark brown, dry, soft SILT (ML).	0.00		3-4-4-5
	0.00		4-5-6-8
Gray brown, wet, sandy SILT (ML). Some clay, trace gravel. Interbedded with fine sand.	0.00		6-7-7-7
	0.01		6-7-8-9
Gray silty CLAY(CL)(Till).	0.00		5-7-55-25
Yellowish brown wet sandy SILT (ML).	0.00		3-5-10-18
Gray, moist, silty CLAY (CL). Trace pebbles and gravel (Till).	0.00		12-35-21-27

750 745 740 735 730 725 720 715 710 705 700 695 690 685 680 675 670 665

Rev. 9-12-88

TECHNICAL MEMORANDUM

TO: Angela Porter/U.S. EPA Region V

FROM: Kevin Olson/CH2M HILL
Don Johnson/CH2M HILL

DATE: October 25, 1988

RE: Task FQ--Hydraulic Conductivity Testing and
Groundwater Elevations
Moss-American Site

PROJECT: GLO63341.FQ

INTRODUCTION

Tests were conducted at the Moss-American site to determine hydraulic conductivities, and groundwater elevations were measured. This memorandum describes the methods and results.

HYDRAULIC CONDUCTIVITY TESTING

Recovery tests were performed on July 5, 6, and 7, 1988 by Kevin Olson, Stu Grubb, Don Johnson, and Dorothy Hall of CH2M HILL. Each recovery test consisted of measuring water levels in a well following the rapid removal of water from the well. Well locations are shown in Figure 1. Well recovery data were evaluated using the Bouwer and Rice method.

METHODOLOGY

The tests were conducted as follows:

1. Depth to water (i.e., the static water level) was measured. All depth measurements were done with an electric water level indicator using a tape with 0.1-foot divisions.

2. About 1 gallon of water was quickly removed from the well using a 4-foot-long stainless steel bailer (about three bailer volumes).

3. The depth to water was measured and time was recorded until approximately 90 percent of the initial drawdown in the well recovered.

4. The recovery data for each well were plotted as drawdown versus time. Drawdown is the difference between the static water level (measured before the start of the test) and each measurement taken during the test. Drawdown is plotted on a log scale and a straight line drawn through the plotted data. The drawdown at time = t and at time = 0 are determined from the plot and used in the equation in the next step.

5. The hydraulic conductivity (K) was calculated using the equation

$$K = [r_c^2 * \ln (R_e/r_w)]/2L * 1/t * \ln(y_o/y_t)$$

where,

r_c = Radius of the section of the well in which water rises during the test. When water rose in the sand pack during the test, r_c was corrected to include the pore space in the sand pack.

$\ln (R_e/r_w)$ = Empirical value determined for each well which depends on aquifer and monitoring-well geometry. Each of the screened intervals at the Moss-American site as assumed to be fully penetrating. Therefore:

$$\ln (R_e/r_w) = \left[\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}\right]^{-1}$$

L = Screen length if the static water level is above the top of the screen; or H, if the static water level is below the top of the screen

H = Static hydraulic head in the well, measured from the bottom of the screen

r_w = Radius of the borehole

C = Emperical constant obtained from Bouwer and Rice

y_o = Initial drawdown in the well (at t = 0) (taken from the graph)

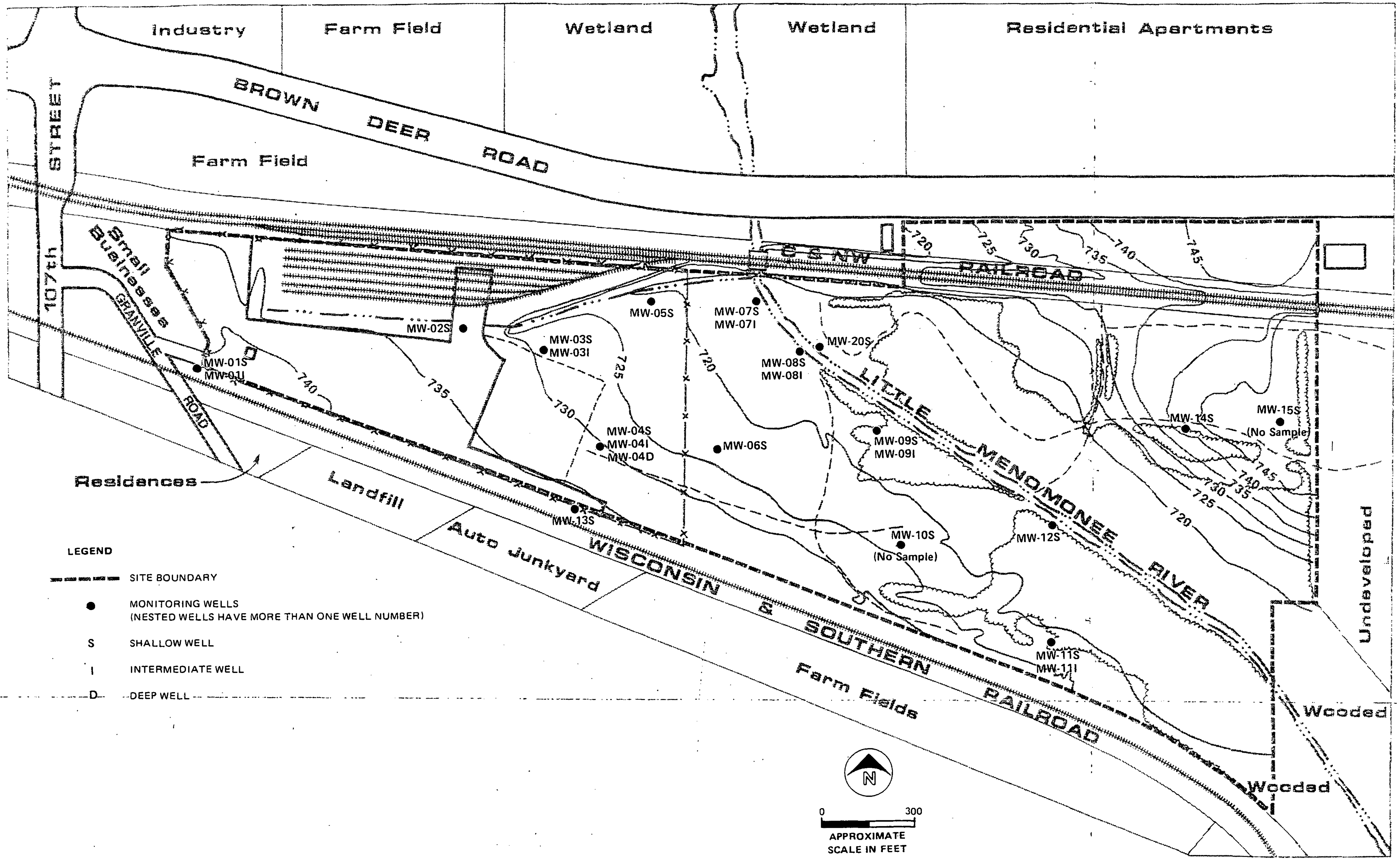


FIGURE 1
MONITORING WELL LOCATIONS
MOSS-AMERICAN RI

y_t = Drawdown in well at time t (taken from the graph)

RESULTS

Hydraulic conductivities range from 1.7 x 10^{-3} cm/s to 3.9 x 10^{-6} cm/s. The values of the parameters used to calculate hydraulic conductivity for each well are given in Table 1. A plot of drawdown versus time for each test is shown in Attachment 1.

Values of hydraulic conductivity across the site indicate the values are consistent with published values of hydraulic conductivity for glacial tills (Todd 1980). Hydraulic conductivities of the shallow wells generally range from 1 x 10^{-3} cm/s to 5 x 10^{-4} cm/s in wells completed in zones of alluvium and weathered till. Exceptions to this are MW-14S, MW-06S, MW-01S, and MW-10S, with conductivities of 1 x 10^{-5} to 1 x 10^{-6} cm/s. Although MW-14S is classified as a shallow well, it is completed in dense till and interbedded silts and fine sands and is therefore more comparable to the intermediate wells. Hydraulic conductivity at MW-06S is also lower than at other shallow wells (2.5 x 10^{-5}). The conductivities calculated at MW-01S and MW-10S are probably not indicative of the soils near those wells. Caving around the screen at MW-01S and the low water level at MW-10S resulted in poor development of the sand pack around the wells. Also, the small number of data points obtained during the tests make the results questionable.

Conductivities in the deep and intermediate wells are distinctly lower than for the shallow wells. The values range from 1.2 x 10^{-4} cm/s to 4.5 x 10^{-6} cm/s. The stratigraphy adjacent to the screemed section of the wells consists of unweathered glacial till and interbedded lacustrine silts, sands, and clays.

GROUNDWATER ELEVATIONS

Groundwater elevations were collected to define the groundwater flow system and the relationship between groundwater and the Little Menomonee River. Groundwater levels were used to contour groundwater elevations on the site.

Table 1
AQUIFER SLUG TEST CALCULATIONS
MOSS AMERICAN SUPERFUND SITE

WELL NUMBER	HYDRAULIC CONDUCTIVITY K (ft/day)	HYDRAULIC CONDUCTIVITY K (cm/s)	CASING RADIUS r (ft)	ln(Re/rw)	SATURATED SCRN LGTH L (ft)	DRAWDOWN @ T=0 Yo (ft)	DRAWDOWN @ T=t Yt (ft)	TIME t (seconds)	HYDRAULIC HEAD H (ft)	BOREHOLE RADIUS r (in)	CONSTANT C unitless
MW-01S	0.011	3.9E-06	0.2	2.17	5	6.85	5.01	21000	7.3	4	1.5
MW-01I	0.136	4.8E-05	0.08	3.2	10	8.57	2.51	800	29.0	4	2
MW-02S	1.064	3.8E-04	0.2	2.4	5	4.19	1.58	760	7.9	4	1.5
MW-03S	1.373	4.8E-04	0.2	2.2	5	2.84	1.26	450	32.0	4	1.5
MW-03I	0.332	1.2E-04	0.08	3.64	10	5.19	1.58	360	31.9	2.5	2.7
MW-04S	NOT TESTED DUE TO EXCESSIVE CONTAMINATION IN WELL										
MW-04I	0.161	5.7E-05	0.08	3.64	10	4.05	1.26	730	31.9	2.5	2.7
MW-04D	0.471	1.7E-04	0.08	3.5	5	4.5	2.51	240	35.2	2.5	1.7
MW-05S	0.968	3.4E-04	0.2	2.5	5	3.2	1.58	630	13.8	4	1.5
MW-06S	0.070	2.5E-05	0.2	2.2	5	5.89	4.9	2000	8.1	4	1.5
MW-07S	1.041	3.7E-04	0.08	2.2	5	1.66	0.3	200	8.0	4	1.5
MW-07I	0.071	2.5E-05	0.08	3.64	10	3.62	1.26	1500	32.4	2.5	2.7
MW-08S	NOT TESTED DUE TO EXCESSIVE CONTAMINATION IN WELL										
MW-08I	0.051	1.8E-05	0.08	4.1	10	3.83	2.45	1000	42.6	2	3.1
MW-09S	1.487	5.2E-04	0.2	1.8	4	0.71	0.4	300	4.0	4	1.2
MW-09I	0.013	4.5E-06	0.08	3.64	10	5.52	2	8000	31.0	2.5	2.7
MW-10S	0.012	4.1E-06	0.2	1.3	2	1.75	1.62	7500	2.0	4	0.9
MW-11S	0.388	1.4E-04	0.08	2.4	5	3.8	1.58	300	10.2	4	1.5
MW-11I	0.182	6.4E-05	0.08	3.64	10	4.89	1.58	625	30.8	2.5	2.7
MW-12S	4.746	1.7E-03	0.2	1.3	2	0.48	0.16	260	2.0	4	0.9
MW-13S	3.669	1.3E-03	0.2	2.4	5	2	0.79	210	7.3	4	1.5
MW-14S	0.119	4.2E-05	0.2	2.5	9	0.86	0.76	500	9.0	4	1.8
MW-15S	NOT TESTED, DRY WELL										
MW-20S	0.840	3.0E-04	0.2	2.2	5	1.51	0.5	1000	6.9	4	1.5

METHODOLOGY

Groundwater within each well was measured using an electric water level indicator graduated in 0.01-foot increments. All measurements were taken from the top of the riser pipe in each well and converted to feet above an arbitrary datum. The datum was estimated for the side topographic map.

Surface water elevations were measured at the site concurrently with groundwater level measurements. Surface water elevation data were used to determine the relationship between surface and groundwater at the site. Surface water measurements were recorded to the nearest 0.01 foot from a staff gauge installed in the river between MW-08S and MW-20S.

Groundwater and surface water elevations are summarized in Table 2 and plotted and contoured in Figure 2.

RESULTS

Contoured groundwater elevations indicate that a trough exists on the west side of the Little Menomonee River. Limited data exist for the east side, but a similar trough is assumed to exist there. The data indicate that the Little Menomonee River is a gaining stream above monitoring well nest 8 and a losing stream downstream of the well nest. The losing stream may be due to unusually low water levels because of this year's drought. The gaining reach of river upstream of MW-08S is probably due to the swamp north of Brown Deer Road that acts as a constant head boundary and continuous source of groundwater recharge.

Water level measurements should be taken during a period of normal rainfall to determine if these conditions are typical.

REFERENCES

Bouwer, Herman, and R. C. Rice. A slug test for determining conductivity of unconfined aquifers with completely or partially penetrating wells. Water Resources Research. 12(1976): 423-8.

Todd, David K. Groundwater Hydrology. New York: John Wiley and Sons. 1980.

TABLE 2 - WATER LEVEL DATA
MOSS AMERICAN

WELL NO.	RISER ELEVATION	LAND SURFACE ELEVATION	7-5-88		7-5-88		7-19-88	
			DEPTH TO WATER	ELEVATION	DEPTH TO BOTTOM	ELEVATION	DEPTH TO WATER	ELEVATION
MW-01S	742.19	742.94	8.15	734.04	15.47	726.72	8.02	734.17
MW-01I	742.29	742.84	7.27	735.02	35.52	706.77	7.29	735.00
MW-02S	734.52	735.00	10.35	724.17	20.26	714.26	10.30	724.22
MW-03S	731.55	728.89	9.40	722.15	17.31	714.24	9.51	722.04
MW-03I	730.65	728.78	8.50	722.15	40.54	690.11	8.63	722.02
MW-04S	732.91	731.13	5.04	727.87	NOT TAKEN	NOT TAKEN	5.03	727.88
MW-04I	733.10	730.88	8.80	724.3	40.69	692.41	9.09	724.01
MW-04D	732.49	731.15	16.25	716.24	51.66	680.83	17.15	715.34
MW-05S	724.97	723.15	6.42	718.55	20.42	704.55	6.67	718.30
MW-06S	725.50	722.71	7.15	718.35	15.39	710.11	8.09	717.41
MW-07S	721.84	719.79	7.35	714.49	15.37	706.47	7.46	714.38
MW-07I	721.66	720.06	5.82	715.84	38.81	682.85	6.68	714.98
MW-08S	721.08	718.50	7.57	713.51	NOT TAKEN	NOT TAKEN	8.73	712.35
MW-08I	721.73	718.60	7.79	713.94	50.57	671.16	7.92	713.81
MW-09S	722.03	719.77	11.26	710.77	15.38	706.65	12.09	709.94
MW-09I	721.44	719.50	9.72	711.72	40.86	680.58	10.50	710.94
MW-10S	726.48	724.13	10.44	716.04	12.55	713.93	11.52	714.96
MW-11S	725.57	723.56	10.02	715.55	20.29	705.28	10.74	714.83
MW-11I	725.80	723.49	10.52	715.28	42.57	683.23	12.42	713.38
MW-12S	719.87	717.74	8.21	711.66	12.45	707.42	8.35	711.52
MW-13S	738.55	737.93	5.21	733.34	12.49	726.06	5.73	732.82
MW-14S	742.97	740.97	22.48	720.49	30.58	712.39	22.63	720.34
MW-15S	750.53	749.39	DRY	DRY	10.43	740.1	DRY	
MS-20S	720.13	716.98	9.53	710.6	15.65	704.48	8.30	711.83
Little Menominee River		711.97	1.47	713.44			1.5	713.5

ALL MONITORING WELL MEASUREMENTS TAKEN FROM NORTH SIDE OF TOP OF RISER.
STAFF GAGE REFERENCE: 0 = 711.97'

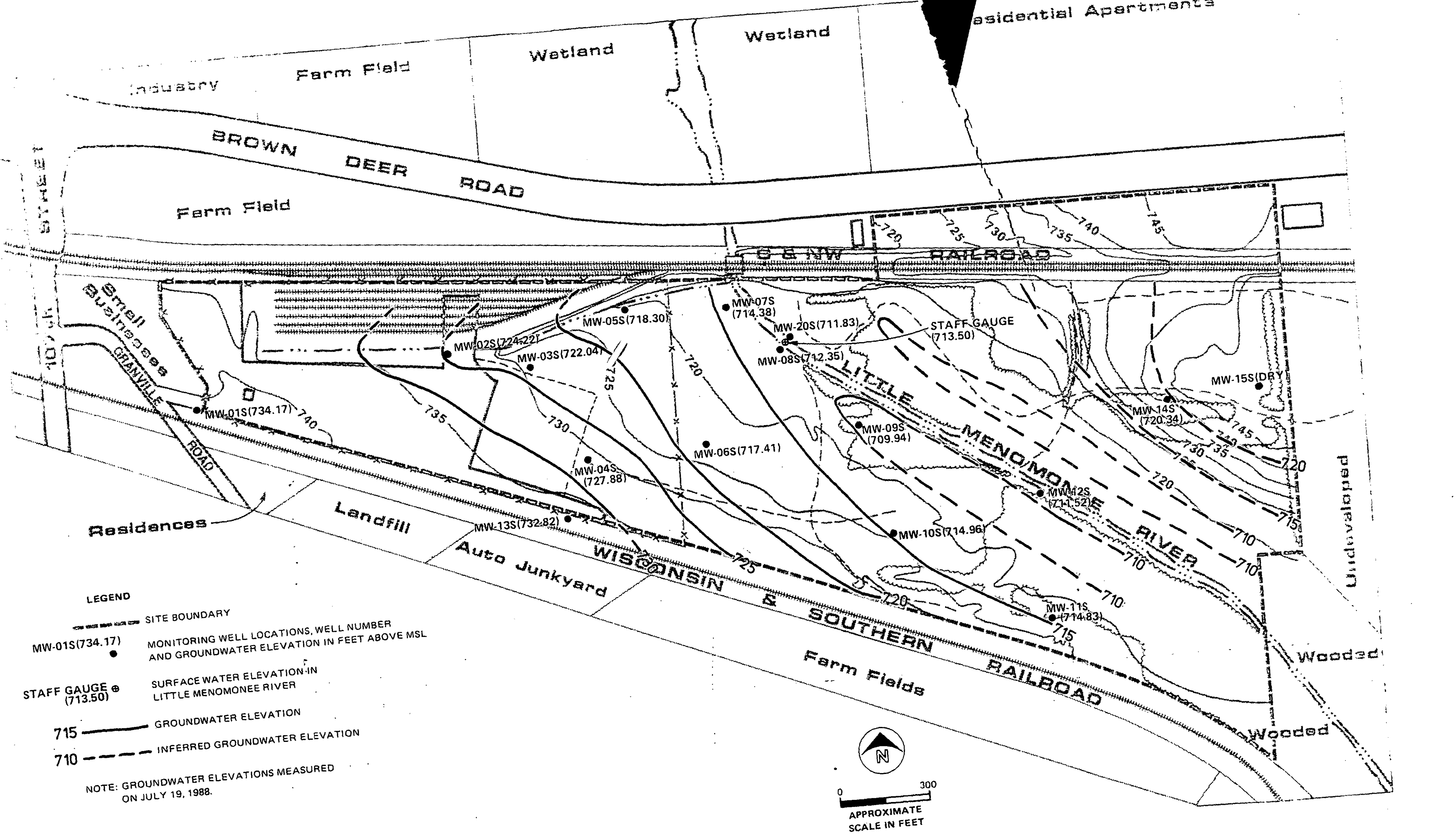
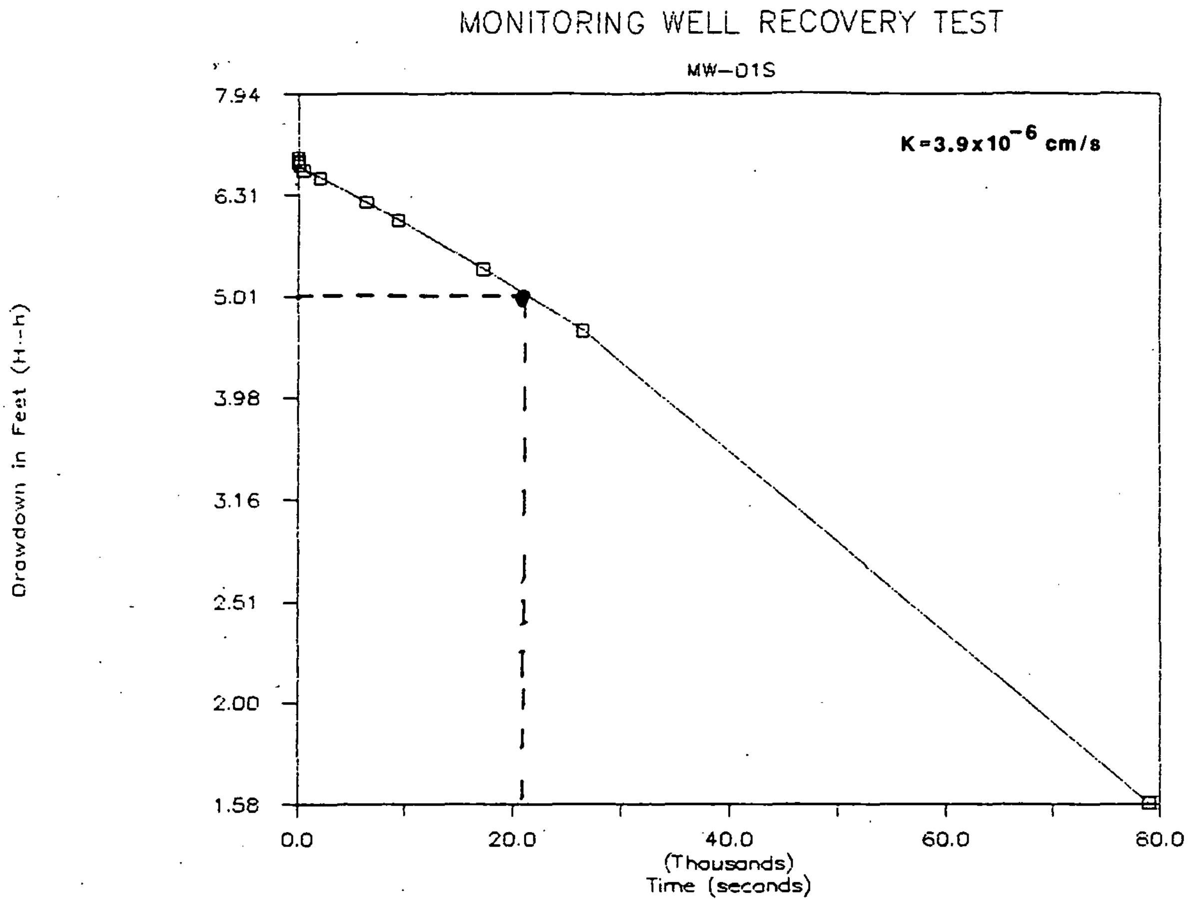
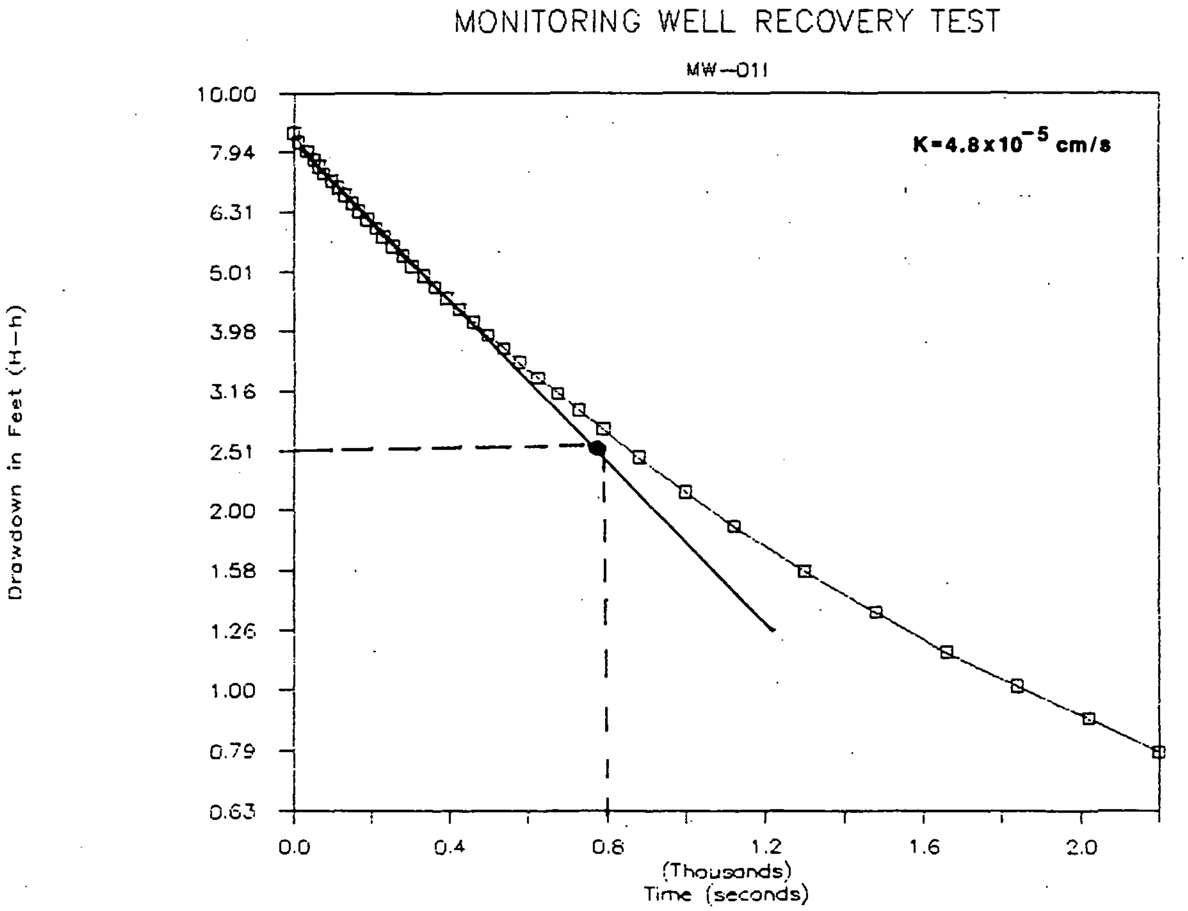


FIGURE 2
GROUNDWATER ELEVATION CONTOUR MAP
MOSS-AMERICAN RI

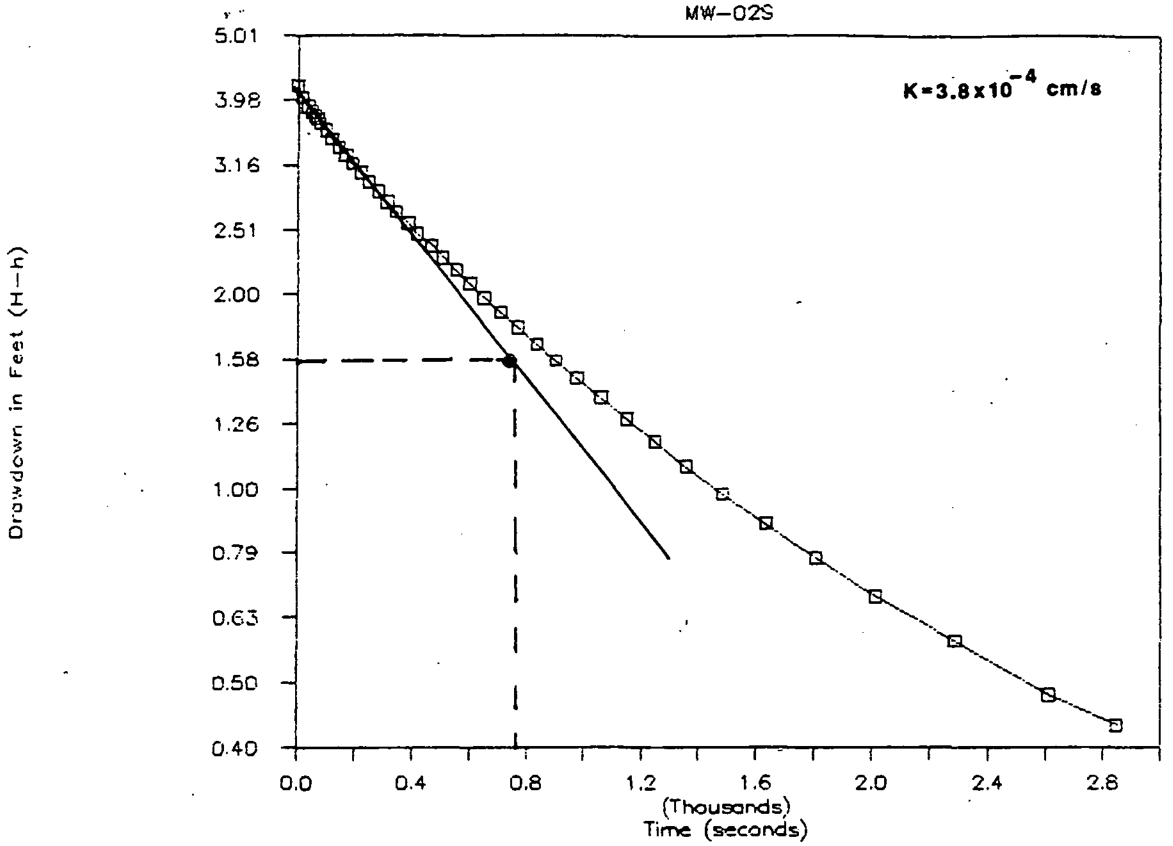
Attachment 1
AQUIFER TEST DATA PLOTS


MONITORING WELL RECOVERY TEST
MW-01S
K=3.9x10^-6 cm/s
Drawdown in Feet (H-h)
7.94
6.31
5.01
3.98
3.16
2.51
2.00
1.58
0.0
20.0
40.0
60.0
80.0
(Thousands)
Time (seconds)


MONITORING WELL RECOVERY TEST
MW-01I
K=4.8x10^-5 cm/s
Drawdown in Feet (H-h)
10.00
7.94
6.31
5.01
3.98
3.16
2.51
2.00
1.58
1.26
1.00
0.79
0.63
0.0
0.4
0.8
1.2
1.6
2.0
(Thousands)
Time (seconds)

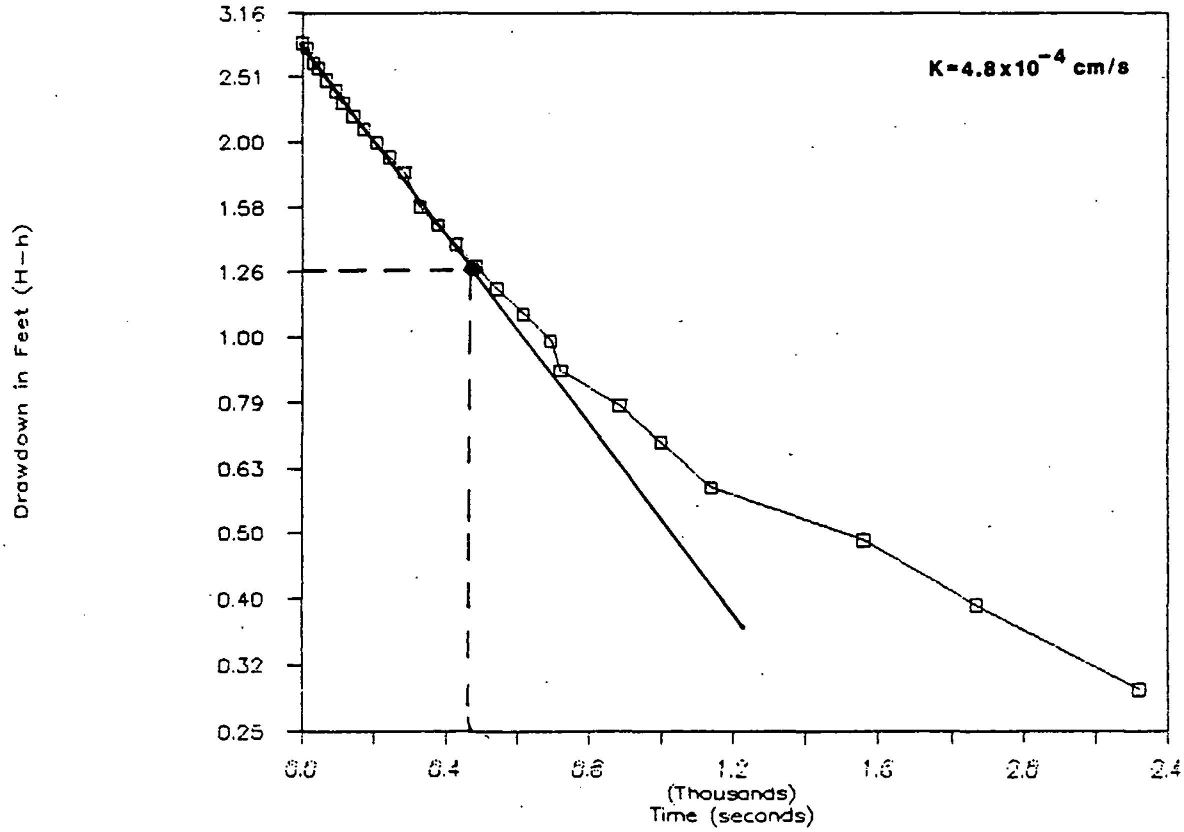
MONITORING WELL RECOVERY TEST

MW-02S



MONITORING WELL RECOVERY TEST

MW-03S



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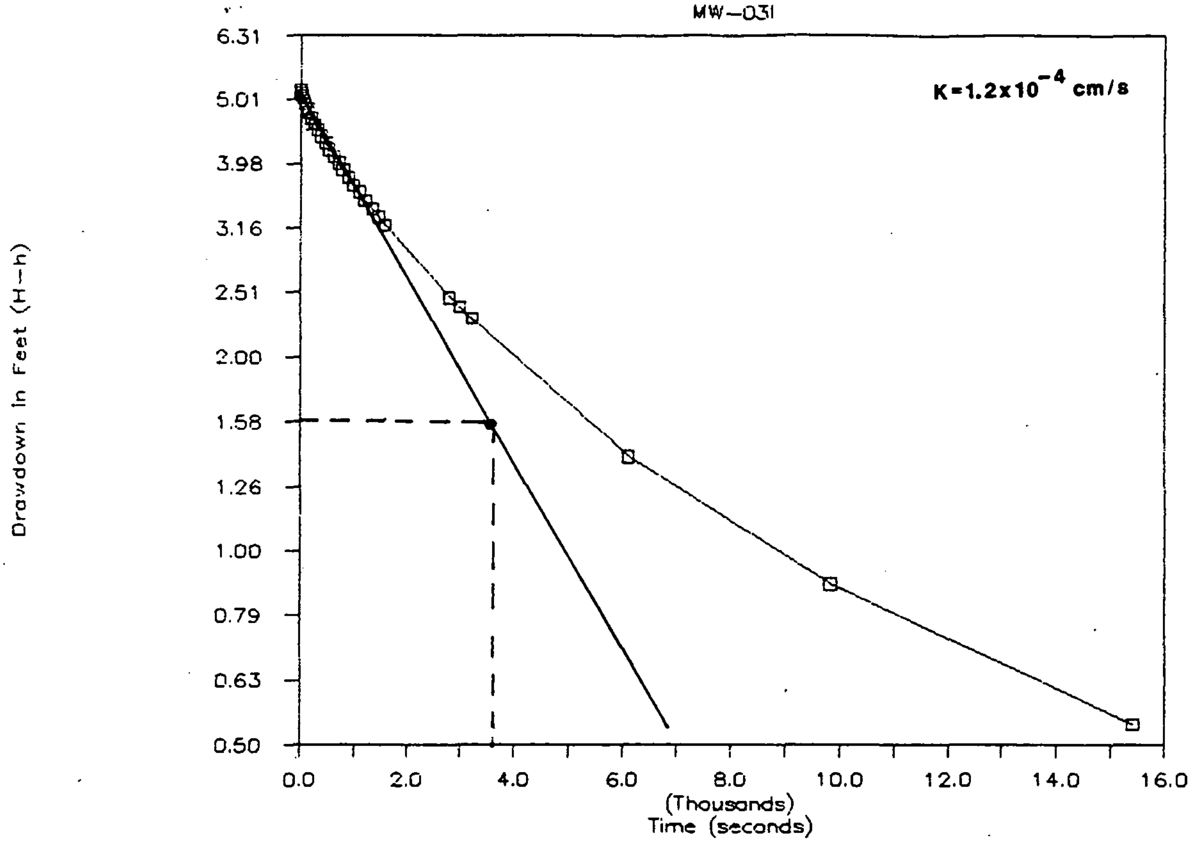

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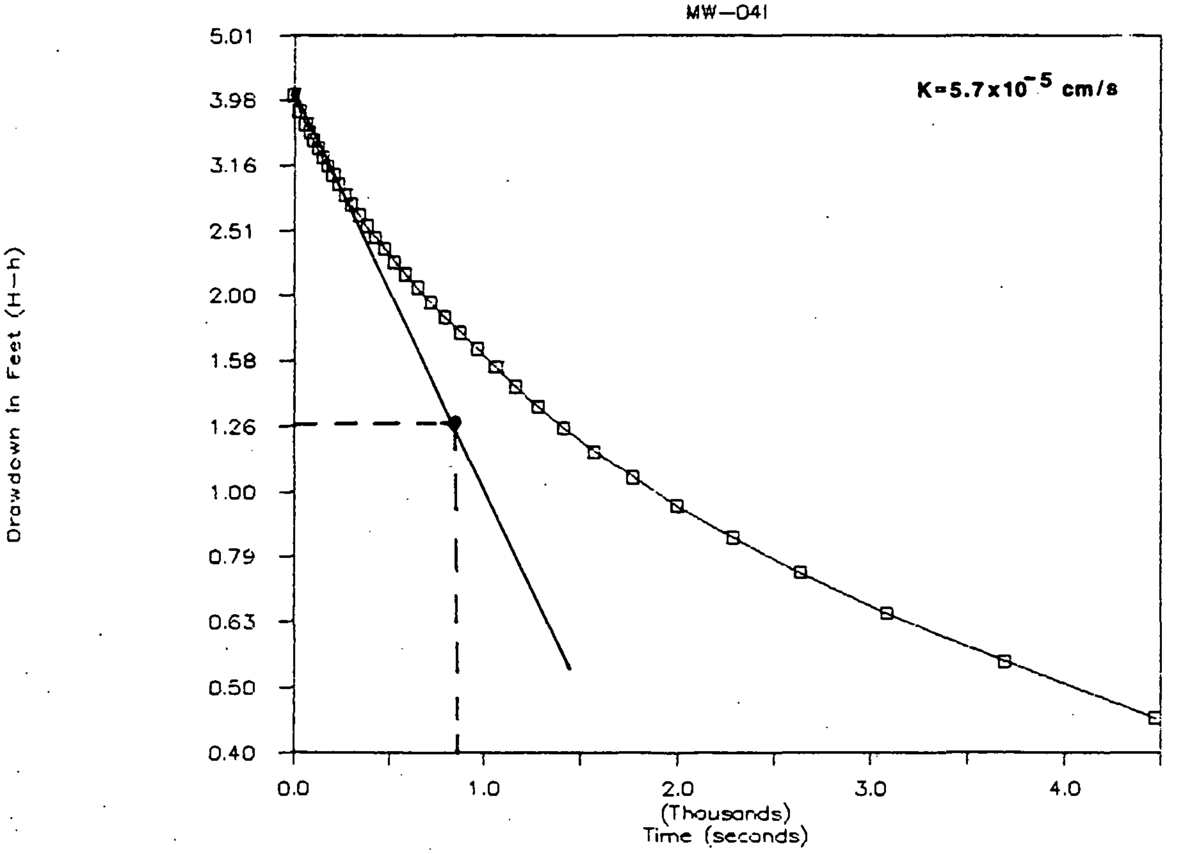

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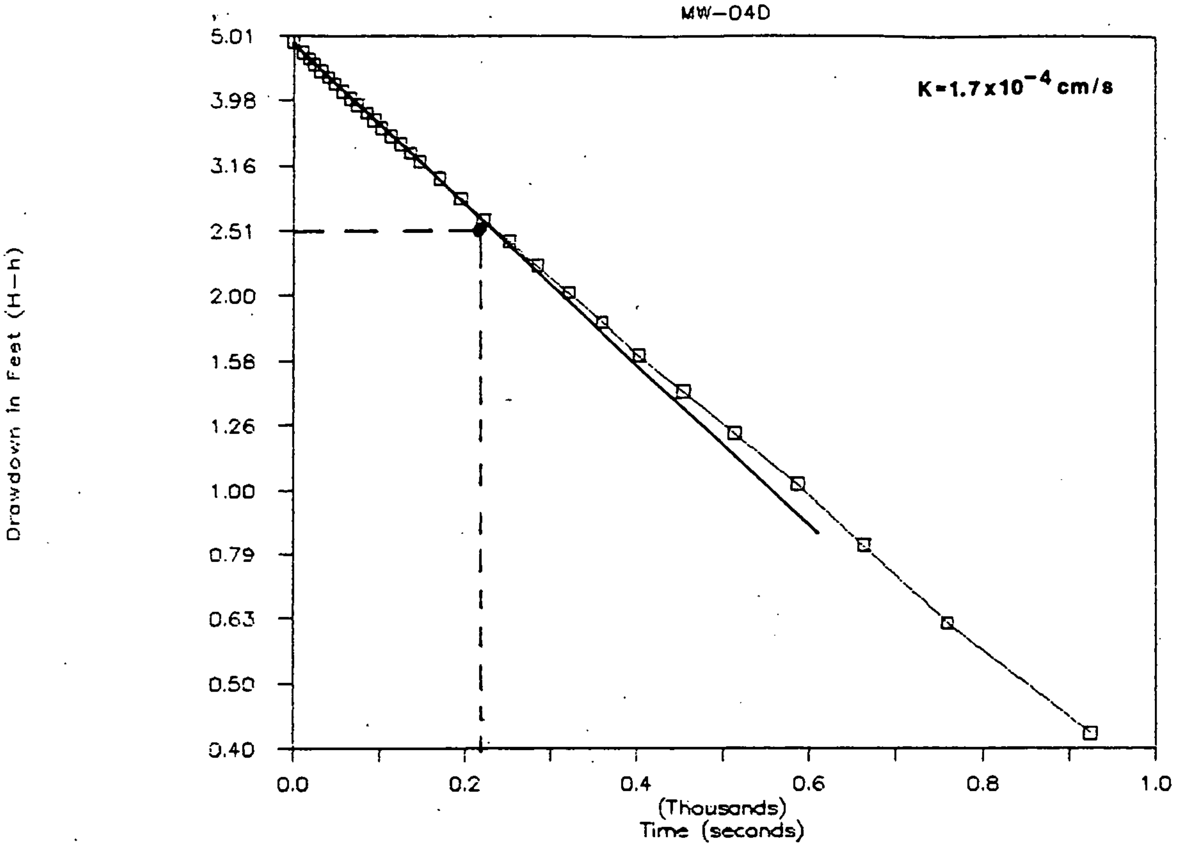

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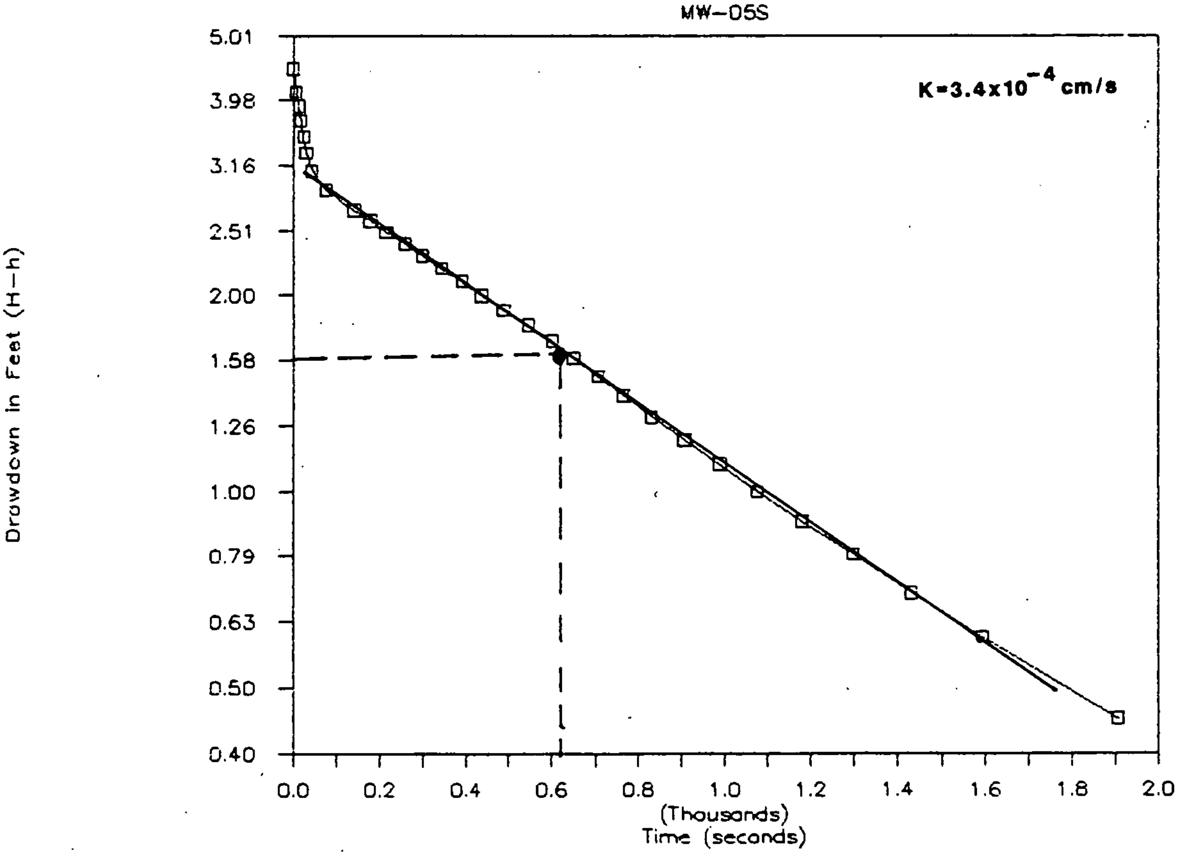

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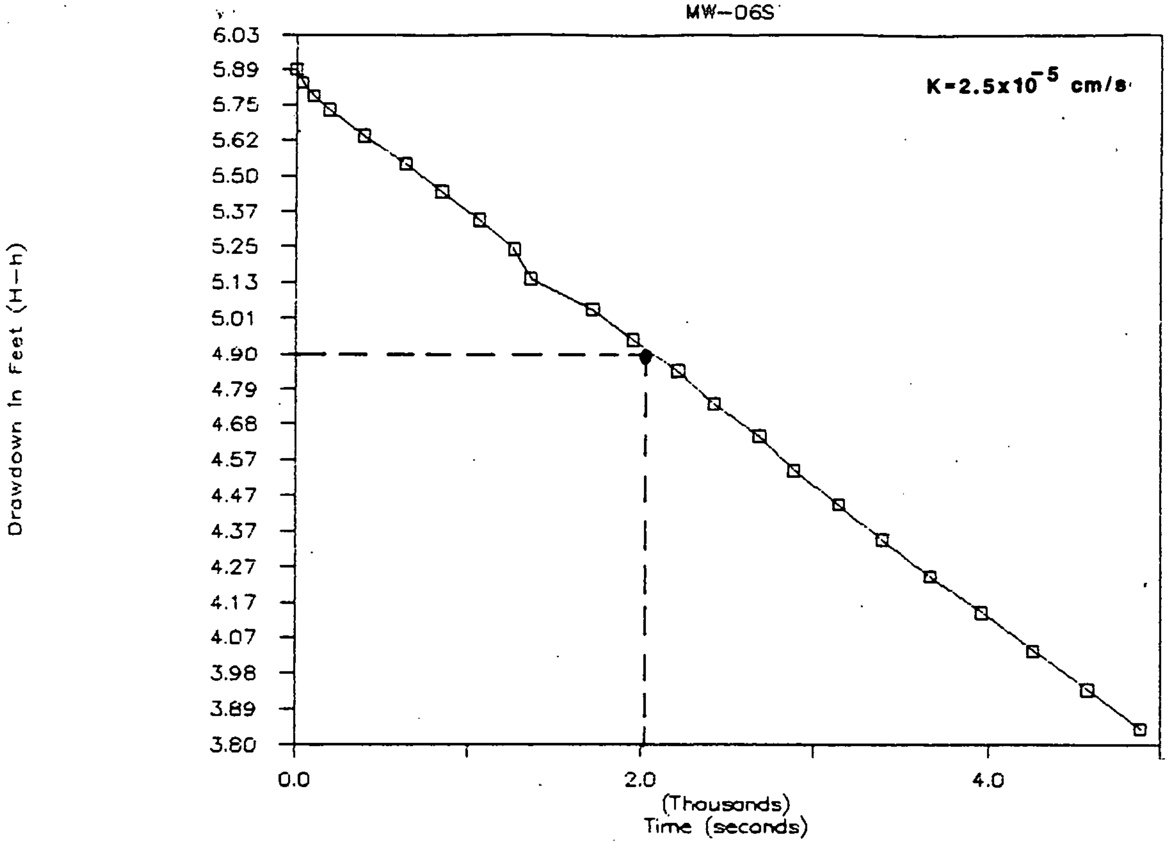

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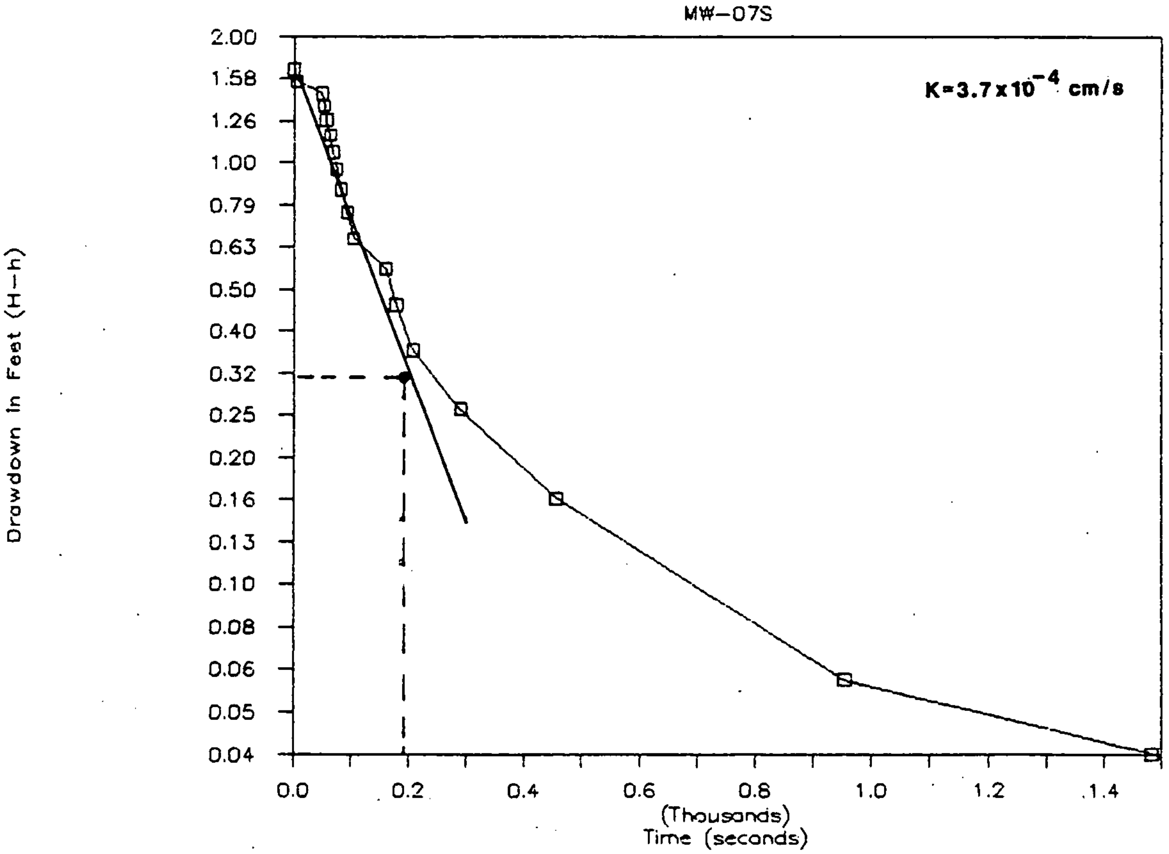
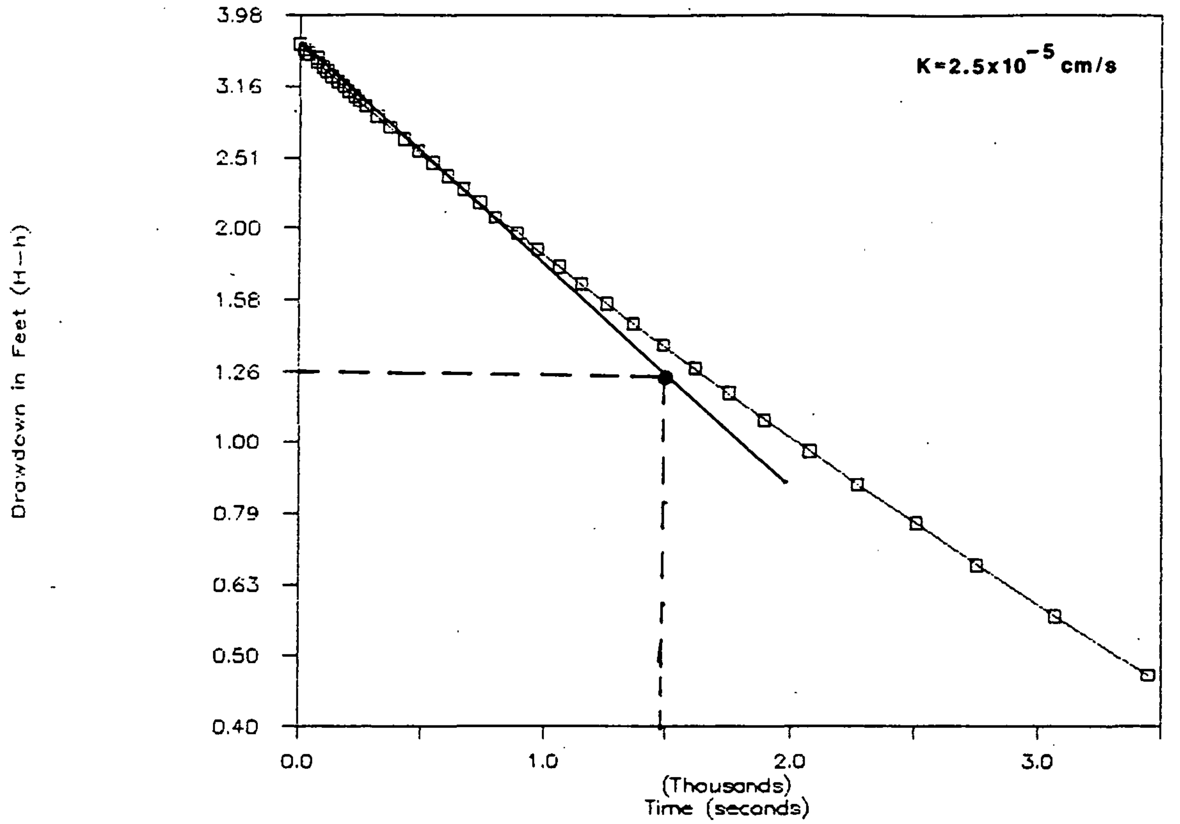


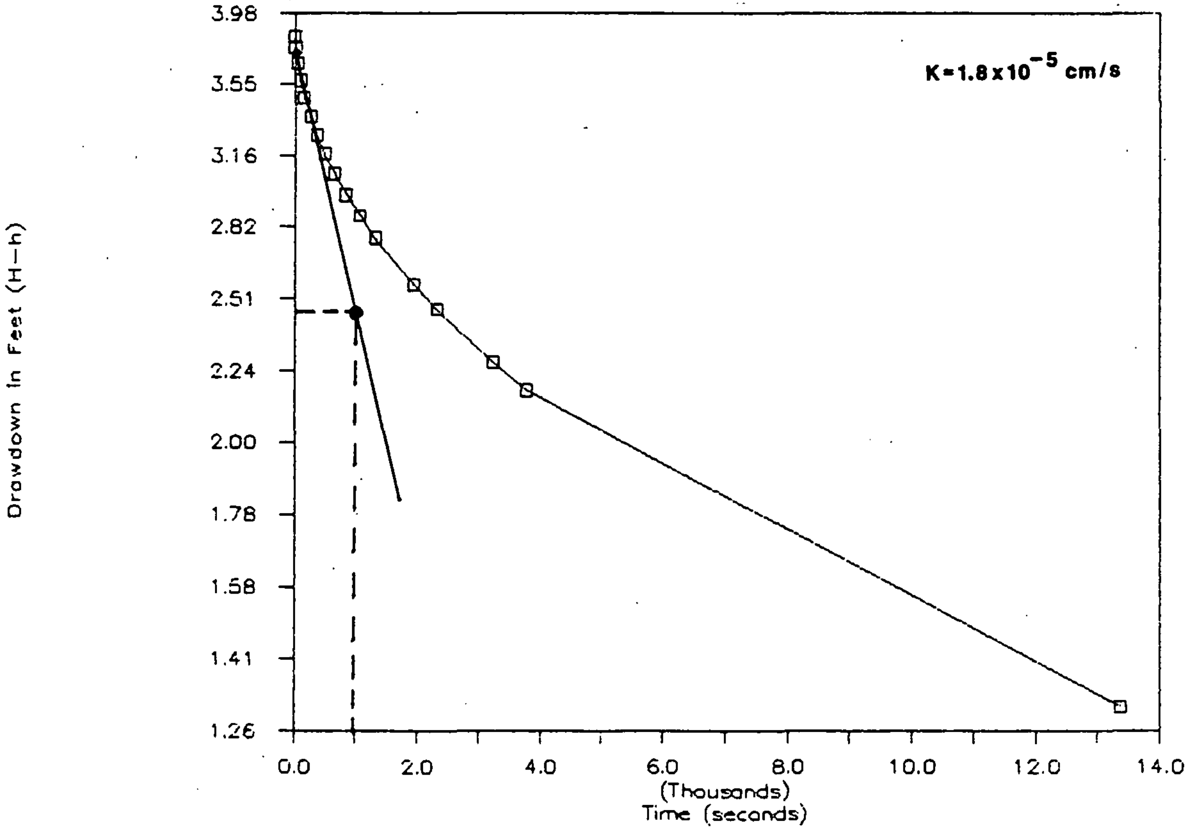
MONITORING WELL RECOVERY TEST

MW-071



MONITORING WELL RECOVERY TEST

MW-081



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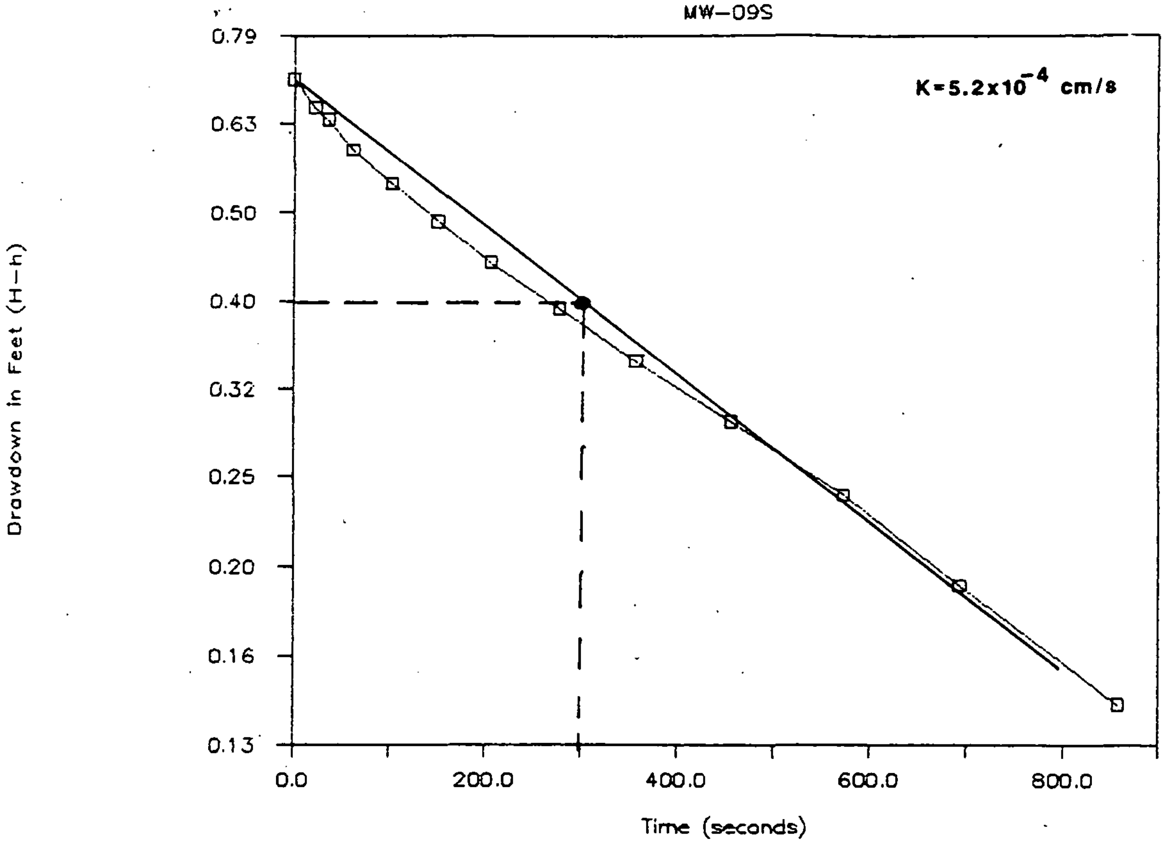

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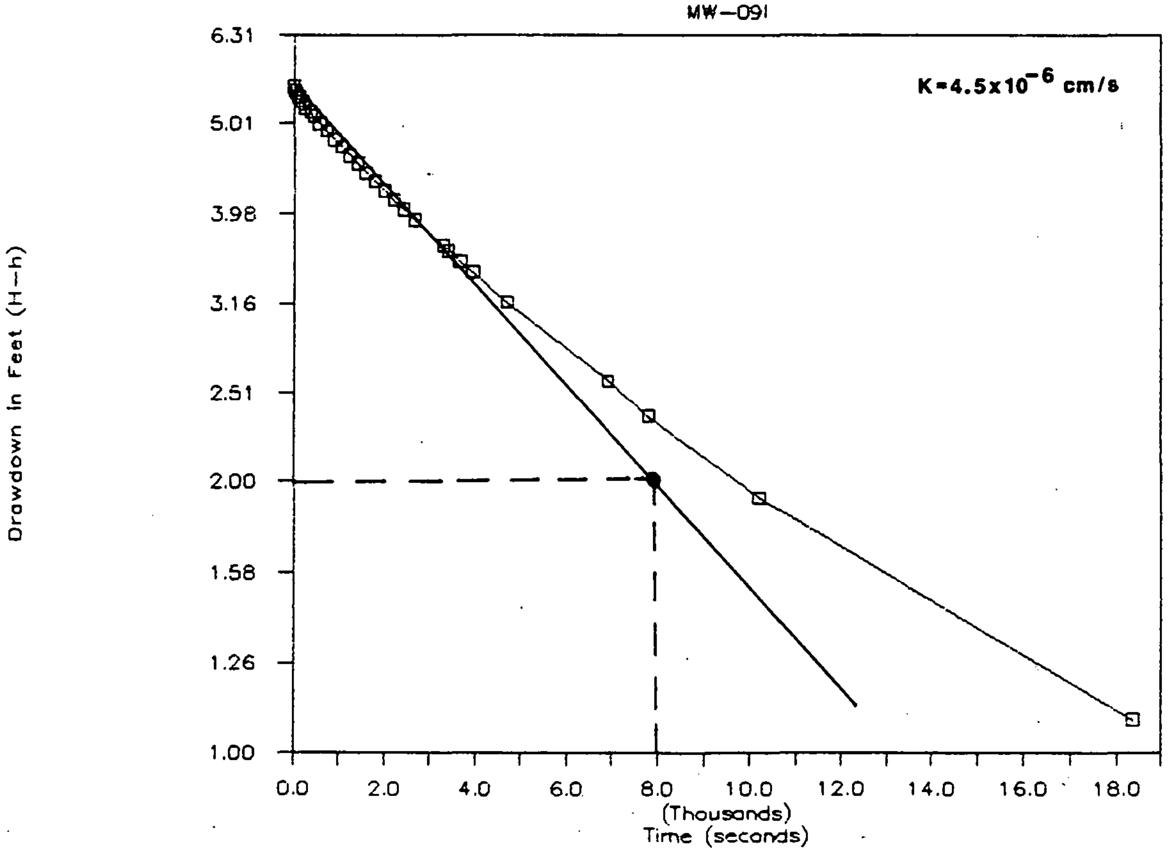

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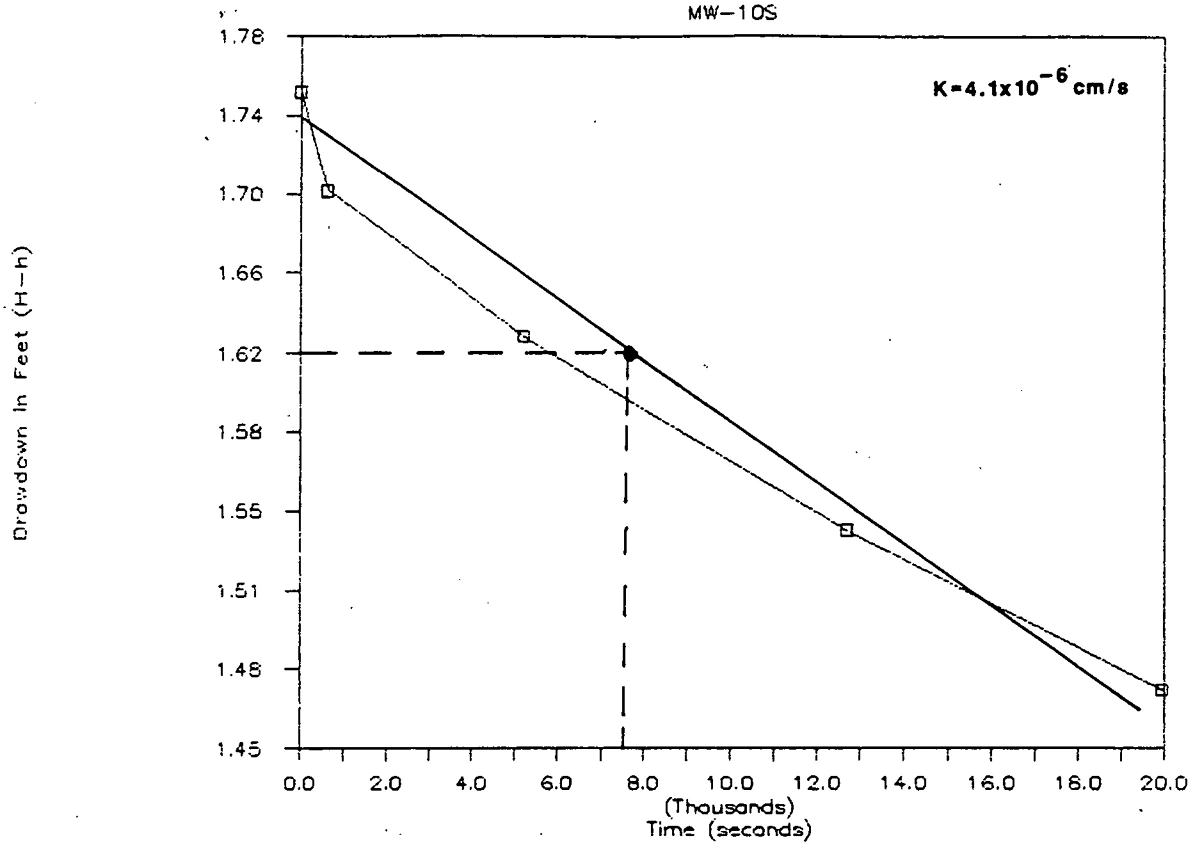

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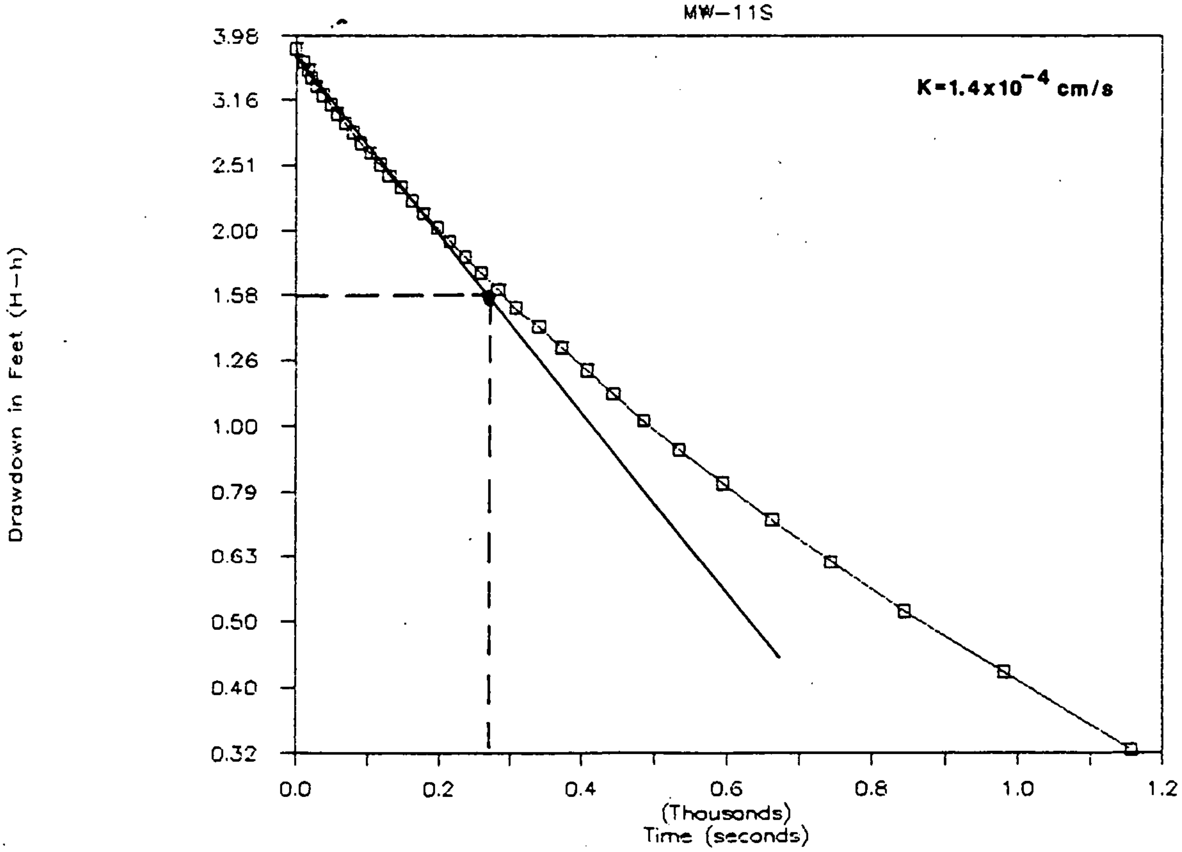

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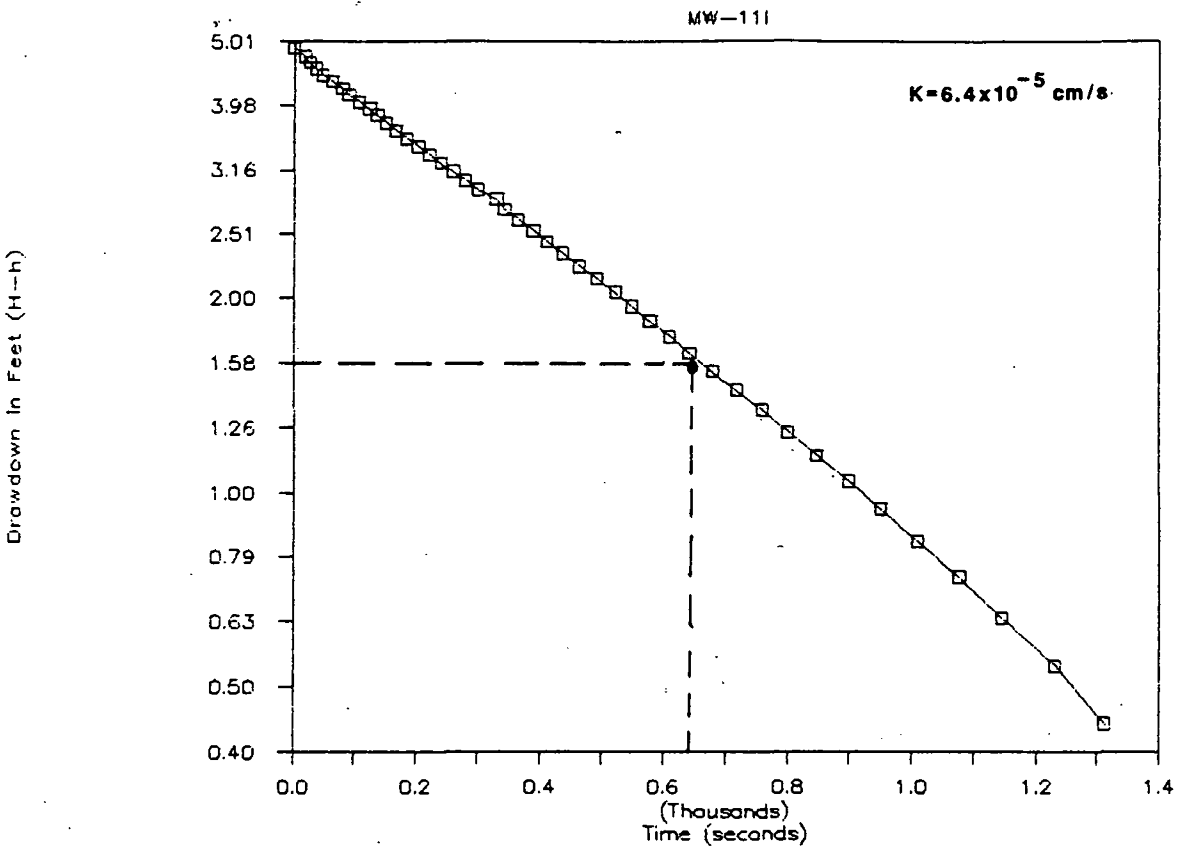

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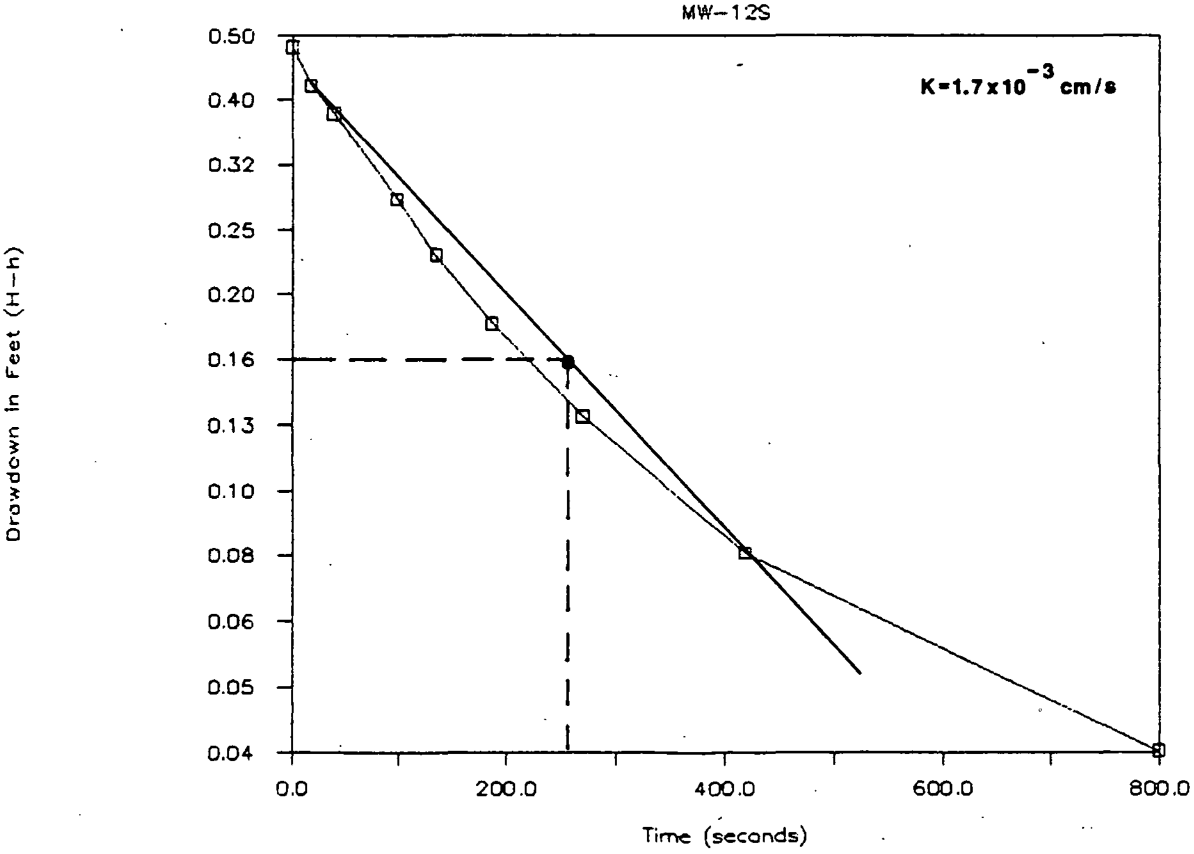
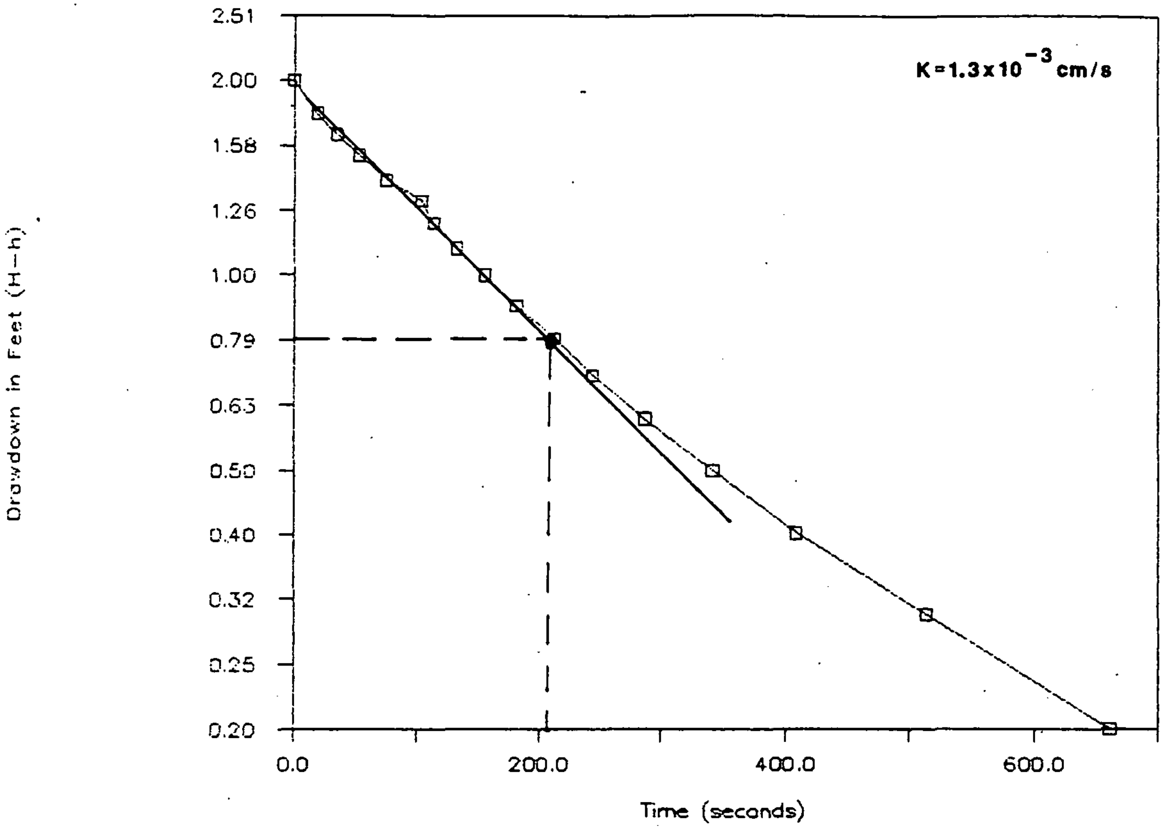
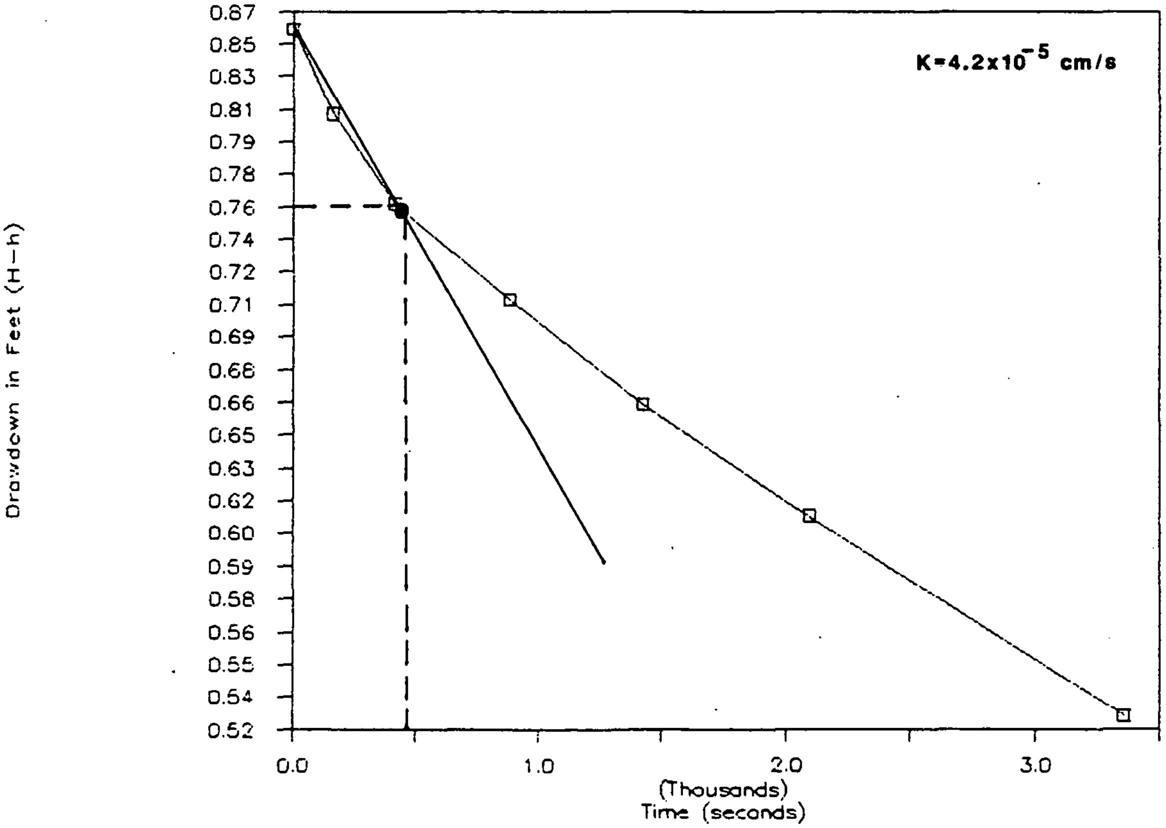



MONITORING WELL RECOVERY TEST

MW-13S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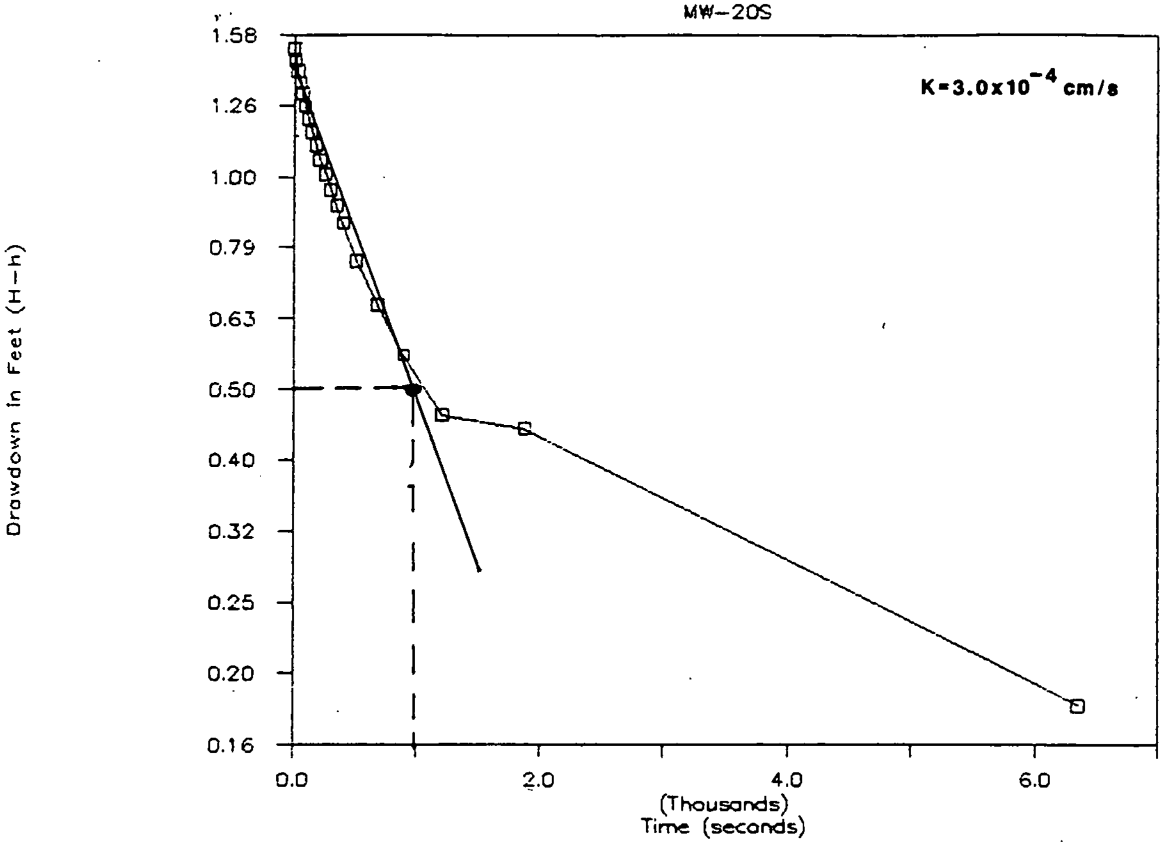
MW-14S

MONITORING WELL RECOVERY TEST



TECHNICAL MEMORANDUM

TO: Angela Porter/U.S. EPA Region V

FROM: Kevin Olson/CH2M HILL
Don Johnson/CH2M HILL

DATE: October 25, 1988

RE: Task FQ--Groundwater Sampling
Moss-American Site

PROJECT: GLO63341.FQ

INTRODUCTION

Groundwater monitoring wells at the Moss-American site were sampled by Kevin Olson, Stu Grubb, Dorothy Hall, and Don Johnson of CH2M HILL on July 11, 12, and 13, 1988. Sample temperature, pH, and conductivity were measured onsite. Samples sent to CLP laboratories were analyzed for BOD, COD, TOC, TDS, TSS, acidity (or alkalinity), total phenols, sulfate, organic compounds, and inorganic chemicals.

SAMPLING PROCEDURE

EQUIPMENT

Four-foot-long, stainless steel, bottom-loading bailers were used to purge and sample each well. Bailers were raised and lowered with 1/8-inch-diameter nylon string. Five-gallon buckets were used to collect and measure purge water. Purge water was stored onsite in 55-gallon drums for disposal by the EPA.

DECONTAMINATION

Bailers were cleaned between each well by scrubbing with a detergent wash and rinsing in tap water, followed by spray rinses with a methanol and distilled water solution and finally with distilled water. Bailer string was discarded after each well and replaced with new string.

PURGING

Each well was purged immediately before sampling. At least five well volumes were removed from wells with sufficient recovery to allow continuous bailing. Other wells were bailed dry three times before sampling. Between each successive bailing the wells were allowed to recover approximately 50 percent. Purge volumes for each well are listed in Table 1.

SAMPLING

Sample bottles were filled in the field by pouring the sample from the bailer. Following collection, the sample was taken to the field trailer for measurement of pH, conductivity, and temperature, and for preservation and filtering. Information regarding containers, preservation, and filtration of samples is provided in the project Quality Assurance Project Plan. Sampling locations are shown on Figure 1.

FIELD OBSERVATIONS

The following observations were made during sampling:

- Purge water from MW-04 contained occasional slight oil sheens.
- Creosote odor was detected in MW-07 during purging, although that may have been due to the proximity of a creosoted railroad bridge.
- Occasional oil sheens were noted on purge water from MW-08I.
- Approximately 2 feet of oil had accumulated in MW-08S prior to sampling. The only contamination detected during well construction was in one small sand seam.

The field measurements of pH, conductivity, and temperature are listed in Table 2. The field parameters were used to indicate abnormal conditions. If any had been found to be abnormal, then resampling after additional purging would have been considered. However, no wells were resampled on the basis of field parameter measurements.

The temperature readings do not accurately reflect the actual groundwater temperature. Ambient air temperature was in the 90s and the warm sensor may have affected the readings. Field measurements of the sample took place with 5 to 10 minutes of sample collection, but some warming may have occurred in that time.

Table 1
MONITORING WELL PURGE VOLUMES

Well No.	Depth of Water in Well (ft)	Well Volume (gal)	Gallons Purged Before Sampling		
			1st Purge	2nd Purge	3rd Purge
MW-01S	7.3	1.2	1	1	--
MW-01I	28.2	4.6	28	--	--
MW-02S	9.9	1.6	10	--	--
MW-03S	7.9	1.3	5	3	--
MW-03I	32.0	5.2	13	5	10
MW-04S	10	1.6	4	4	--
MW-04I	31.9	5.2	31	--	--
MW-04D	35.4	5.8	35	--	--
MW-05S	14.0	2.3	Bailed dry three times, 5 gal (total) removed		
MW-06S	8.2	1.3	2	1	1
MW-07S	7.9	1.3	8	--	--
MW-07I	33.0	5.4	33	--	--
MW-08S	5	0.8	(a)	--	--
MW-08I	42.8	7.0	42	--	--
MW-09S	4.1	0.7	5	--	--
MW-09I	31.1	5.1	9	5	5
MW-10S	2.1	0.3	0.5	0.1	(b)
MW-11S	10.3	1.7	10	--	--
MW-11I	32.1	5.2	17	14	--
MW-12S	4.2	0.7	4	--	--
MW-13S	7.3	1.2	4.5	3	--
MW-14S	8.1	1.3	8	--	--
MW-15S	Dry	0	--	--	--
MW-20S	6.1	1.0	5	--	--

---

[a] Sampled without purging
[b] Not sampled due to insufficient recovery

Table 2
FIELD MEASUREMENTS

Well No.	Date	Time	Temperature[a] (°C)	pH	Conductivity (umhos)
MW-01S	7/13/88	1652	22	7.80	1,050
MW-01I	7/11/88	1130	22	7.53	680
MW-02S	7/11/88	1401	19	7.65	480
MW-03S	7/11/88	1504	22	7.35	960
MW-03I	7/11/88	1511	20	8.50	280
MW-04S	7/13/88	1542	26	7.64	1,020
MW-04I	7/13/88	1113	22	8.14	820
MW-04D	7/12/88	1320	20	8.12	280
MW-05S	7/11/88	1614	16	7.47	800
MW-06S	7/12/88	1457	17	7.61	570
MW-07S	7/12/88	1632	17	6.79	970
MW-07I	7/12/88	1728	19	8.61	350
MW-08S		Not analyzed due to oil contamination			
MW-08I	7/13/88	1028	26	8.41	250
MW-09S	7/12/88	955	24	6.79	860
MW-09I	7/12/88	1653	17	8.21	310
MW-10S			Not sampled--dry		
MW-11S	7/13/88	1611	19	7.11	950
MW-11I	7/12/88	1656	16	7.59	640
MW-12S	7/12/88	1142	23	7.08	770
MW-13S	7/11/88	1218	24	7.11	1,120
MW-14S	7/13/88	1406	20	7.37	600
MW-15S			Not sampled--dry		
MW-20S	7/13/88	1518	21	7.00	1,240

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[a] Temperature measurements are not indicative of actual groundwater temperature.

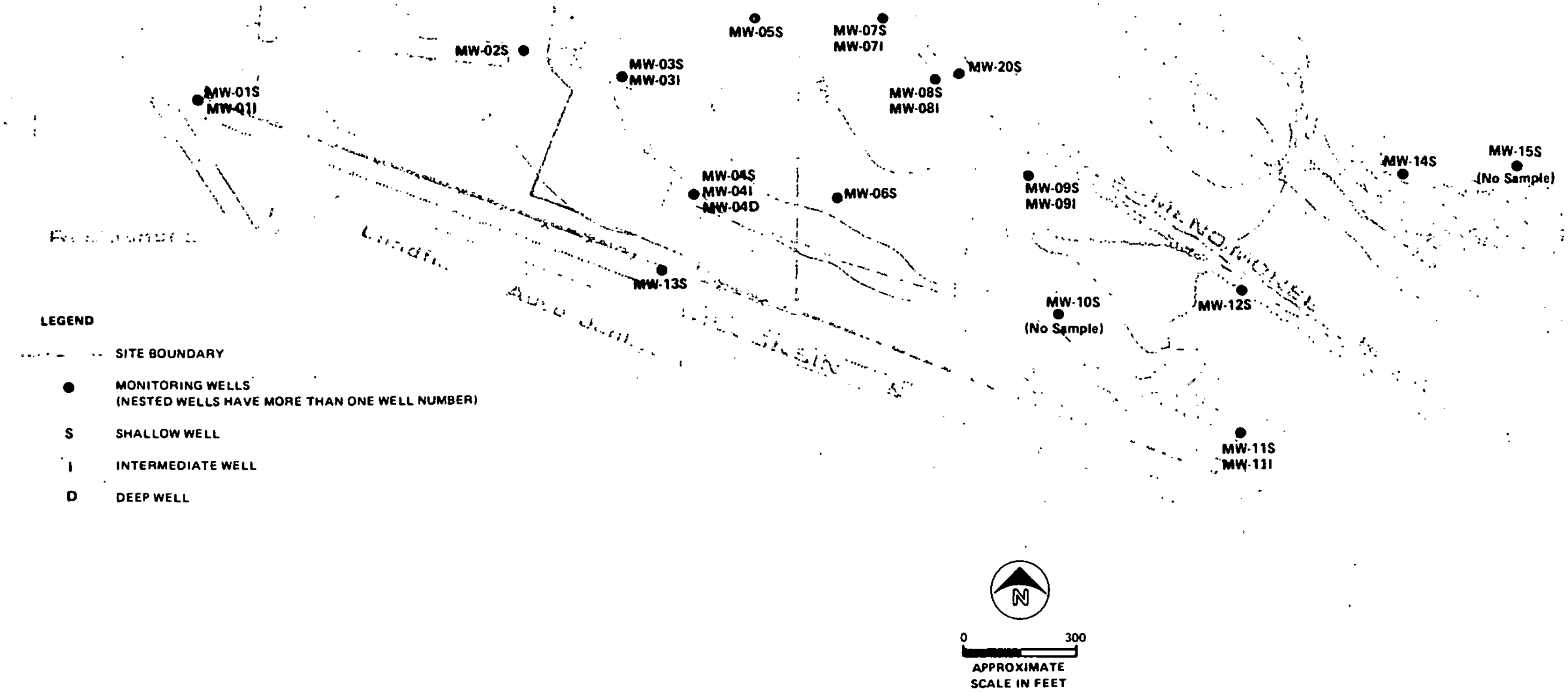

FIGURE 1
MONITORING WELL LOCATIONS
MOSS-AMERICAN RI

The values obtained for pH fall within a reasonable range. The slightly basic conditions are typical of natural waters in carbonaceous environments. The soils at the Moss-American site are derived from a carbonate-rich glacial till, and part of the site is covered with either dolomite or limestone gravel.

Conductivity in shallow groundwater ranged from 480 to 1,240 umhos/cm (mean = 875 umhos/cm). Groundwater from intermediate and deep wells was less conductive, ranging from 250 to 820 umhos/cm (mean = 450 umhos/cm). Conductivity measurements are indicative of differences in dissolved ion concentrations in groundwater. The relevance, if any, of the variability in conductivity measurements at the Moss-American site will be evaluated further when complete analytical results are available.

GLT779/17