

Fraser Shipyards, Inc.

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***Additional Investigation Work Plan***

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Superior, Wisconsin

SEH No. FRASE9401.00

March 1996

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SHORT ELLIOTT HENDRICKSON INC.



MULTIDISCIPLINED.  
SINGLE SOURCE.



March 13, 1996

Mr. Stephen LaValley  
Hazardous Waste Specialist  
Wisconsin Dept. of Natural Resources  
1705 Tower Avenue  
Superior, WI 54880

Reference: Fraser Shipyards, Inc.  
Additional Investigation Work Plan  
Superior, Wisconsin  
SEH No. FRASE9401.00

Dear Mr. LaValley:

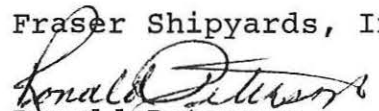
Enclosed are four copies of a work plan for additional investigation at selected areas of concern (ACOs) for the Fraser Shipyards, Inc. (Fraser) facility located in Superior, Wisconsin. This work plan was prepared on behalf of Fraser by our consultant, Short Elliott Hendrickson Inc. (SEH).

The work plan is submitted in response to a January 4, 1996 correspondence from the Wisconsin Department of Natural Resources (WDNR) regarding review of Fraser's November 1995 Closure Documentation Report and additional information which is required for complete closure of the landside AOCs at the site.

Fraser requests written approval of this work plan prior to the initiation of additional field activities. Please contact Cy Ingraham at SEH or myself if you have any questions regarding this document.

Sincerely,

Fraser Shipyards, Inc.

  
Ronald Peterson  
Yard Superintendent

RP:cd

## Distribution List

No. of Copies	Sent to
4	Steven LaValley Hazardous Waste Specialist Wisconsin Department of Natural Resources 1705 Tower Avenue Superior, WI 54880
2	Ron Peterson, Superintendent Fraser Shipyards, Inc. Third Street and Clough Avenue Superior, WI 54880
3	Cyrus Ingraham, P.E. Short Elliott Hendrickson Inc. 421 Frenette Drive Chippewa Falls, WI 54729

**Additional Investigation Work Plan**

**Fraser Shipyards, Inc.**

**Prepared for:  
Fraser Shipyards, Inc.  
Superior, Wisconsin**

**Prepared by:  
Short Elliott Hendrickson Inc.  
421 Frenette Drive  
Chippewa Falls, WI 54729  
(715) 720-6200**

I, John E. Guhl, hereby certify that I am a Hydrogeologist as that term is defined in s. NR 712.03(1) Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.

John E. Guhl # 120 3-15-1996  
John E. Guhl, P.G. P.G. Number Date  
Hydrogeologist

I, Gloria Chojnacki, hereby certify that I am a scientist as that term is defined in s. NR 712.03(3), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.

Gloria Chojnacki 3/15/96  
Gloria Chojnacki, CHMM Date  
Environmental Scientist

I, Cyrus W. Ingraham, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.

Cyrus W. Ingraham 024690E March 15, 1996  
Cyrus W. Ingraham, P.E. P.E. Number Date  
Senior Project Manager



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# Additional Investigation Work Plan

**Fraser Shipyards, Inc.**

Superior, Wisconsin

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## 1.0 Introduction

This Additional Investigation Work Plan was prepared by Short Elliott Hendrickson Inc. (SEH) on behalf of Fraser Shipyards, Inc. (Fraser) and has been written in accordance with s. NR 716.09 Wisconsin Administrative Code. The work plan was prepared to address concerns expressed by the Wisconsin Department of Natural Resources (WDNR) regarding additional information required to document closure of select areas of concern (AOCs) at the Fraser facility (also referred to as the site). The tasks outlined in this work plan have been selected to provide the data necessary to meet the requirements of ch. NR 700-728. The required activities for Fraser to perform are outlined in a WDNR correspondence dated January 4, 1996.

## 1.1 Project Contacts

1. Ron Peterson, Superintendent  
Fraser Shipyards, Inc.  
Third Street and Clough Avenue  
Superior, WI 54880  
(715) 394-7787
2. Steve LaValley  
Hazardous Waste Specialist  
Wisconsin Department of Natural Resources  
1705 Tower Avenue  
Superior, WI 54880  
(715) 392-7988



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3. Cyrus Ingraham, P.E., Senior Project Manager  
Short Elliott Hendrickson Inc.  
421 Frenette Drive  
Chippewa Falls, WI 54729  
(715) 720-6231

## 2.0 General Background Information

An initial site investigation of 14 AOCs was conducted at the Fraser facility in January 1994 following receipt of a WDNR Notice of Violation (June 10, 1993) and Enforcement Conference Summary (July 20, 1993). The purpose of the initial investigation was to determine the presence or absence of contamination in specific AOCs. Documentation of the initial site investigation was presented in the Site Investigation Report and Closure Plan (May 1994). Additional investigative information was subsequently gathered in March, May, June and July 1995. The additional information was presented to the WDNR in two documents: Partial Closure Documentation Report (April 1995) and Closure Documentation Report and Monitoring Plan AOCs #1, 3, 5, 7, 8, 9, 11, 12, and 13 (November 1995). As a result of petroleum contamination identified at AOCs #1, 3, 7, and 9, contaminated soil was excavated by Fraser and transported to Clean Soils Minnesota Inc. of Roseville, Minnesota on August 26, 1995 and treated by thermal destruction.

In a July 14, 1995 correspondence from the WDNR, the District Close-Out Committee agreed that AOC #2 (Sandblasting Grit Waste Stockpile), AOC #6 (600 KVA Substation) and AOC #10 (Dry Dock #1 Upper Landing) did not need further work and were considered "closed". AOC #13 (SE Fill Area) contains soil, timbers and minor quantities of demolition debris. Based on the July 14, 1995 WDNR correspondence, removal of the fill will not be required by the WDNR and formal closure of AOC #13 will not be required under hazardous waste authority. The closure of AOC #3 (Dirty Solvent Staging), AOC #4 (Bilge Water Staging), AOC #7 (Transformer Staging), and AOC #9 (Fuel Storage) was approved on December 6, 1995.

According to the January 4, 1996 WDNR correspondence, the WDNR has determined that the AOCs requiring further investigation or additional information include AOC #1 (Waste Oil Staging), AOC #5 (Paint Waste Staging), AOC #8 (Paint Room Storage Pad), AOC #11 (Dry Dock #1 Base), and AOC #12 (NW Fill Area).

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## **2.1 Site Description**

The site is owned and operated by Fraser and is located at Third Street and Clough Avenue in Superior Wisconsin as shown on Figure 1, "Site Location Map." The site is located on Howard's Bay and further described as being in Section 11, T49N, R14W in Douglas County, Wisconsin. Specific site information regarding site history, waste materials, handling procedures, and other pertinent project information as required by s. NR 716.07 regarding site scoping can be found in the initial Site Investigation Work Plan submitted by Fraser to the WDNR in November 1993.

## **3.0 Work Plan**

SEH will perform the following activities based on our current understanding of the WDNR requirements as stated in the January 4, 1996 correspondence. The activities performed will be conducted in accordance with SEH's Standard Operating Procedures (SOPs) and Quality Assurance/Quality Control (QA/QC) Program which can be found in Appendix A, "Standard Operating Procedures" and Appendix B, "Documentation and Quality Assurance/Quality Control." A site specific Health and Safety Plan can be found in Appendix E of the initial Site Investigation Work Plan (November 1993) and will be adhered to during field activities at the site.

Laboratory analysis for both soil and groundwater samples for this phase of the investigation will be conducted by Enviroscan Corp. According to specified WDNR and EPA methods at the time of sample collection. The address and phone number of Enviroscan is:

Enviroscan Corp.  
303 West Military Road  
Rothschild, WI 54474  
(800) 338-7226  
WI Lab Certification No. 737053130

Drilling and well installation activities for this investigation phase will be conducted by Maxim Technologies, Inc. The address and phone number of Maxim is:

Maxim Technologies, Inc.  
555 South 72nd Avenue  
Wausau, WI 54401  
(715) 845-4100

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### **3.1 AOC #1 – Waste Oil Staging Area**

#### **3.1.1 Description**

Fraser staged waste oil along the southern fence line between the Fraser Shipyards and Reuben Johnson Construction Company properties. The wastes previously staged in this area were primarily waste lubricating oils in 55 gallon containers. This waste oil was used to fuel a waste oil powered boiler. The location of AOC #1 is indicated on Figure 2, "Site Plan."

#### **3.1.2 Prior Investigation Findings**

AOC #1 was investigated for the presence of contaminated soils resulting from waste handling activities. The initial investigation indicated elevated levels of diesel range organics (DRO) and xylene. A remedial excavation was performed at AOC #1 on May 3, 1995 at which time a concrete slab was identified approximately 1.5 feet below the ground surface. The edge of the concrete extended from approximately 23 feet west of the eastern edge of the AOC to beyond the western edge of the soil excavation (soil sample EE-1). The edges of the concrete slab to the north, south, and west were not identified. Another underground obstacle located in AOC #1 is a buried high voltage power cable. The exact location of this cable is not known, however, locations of the adjacent power poles indicates that the cable runs through AOC #1. When the cable was installed, wooden planking was reportedly placed over the cable. Initial boring logs at AOC #1 in January 1994 indicate the presence of subsurface wood fragments at several locations within the AOC.

Initial soil samples indicated DRO concentrations ranging from none detected to 4,730  $\mu\text{g/g}$ . Post excavation confirmatory soil samples indicate that Diesel Range Organic (DRO) concentrations range from none detected to 266  $\mu\text{g/g}$  for soil left in place, with the majority of the contamination source having been removed. However, concentrations of DRO above standards set in ch. NR 720 and various Volatile Organic Compounds (VOCs) still remain. Additional excavation at the AOC is prohibitive due to the underground obstacles. Analytical results for select AOCs, including AOC #1, are summarized in Table 1, "Field and Analytical Results." The locations and depths of the soil samples are indicated on Figure 3, "AOC #1."

#### **3.1.3 Additional activities**

##### **3.1.3.1 Extent of Slab Determination**

The WDNR has requested that the extent of the concrete slab be defined in order to determine the potential for contaminants to migrate. Examination of historic photos has revealed the presence of a relatively large multi-story building located in the AOC. A photo dated October 23, 1962 indicates that the building appears to be located on First Street and

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extends north over the area which is currently AOC #1. The building appears to extend northward almost to the bay. The dimensions of the building cannot be ascertained from the photo. The building does not exist in a photo dated 1962-1963 indicating that demolition of the structure occurred early during the winter of 1962-1963.

Further subsurface investigation of the limits of the slab is prohibitive at this time due to the presence of the buried high voltage cable. Based on the assumption that the majority of the contamination source has already been excavated, Fraser proposes that further subsurface investigation at AOC #1 be waived until groundwater monitoring results are received. The additional groundwater information will be useful in determining if a significant contaminant source continues to exist.

#### 3.1.3.2 Monitoring Well Installation

A groundwater monitoring well, MW-1, will be installed north of AOC #1 in order to evaluate the potential for groundwater contamination at the AOC. The proposed monitoring well location is shown on Figure 4, "Proposed Well Locations."

The monitoring well will be installed in general accordance with ch. NR 141. However, depth to groundwater is anticipated to be approximately five feet below grade at the proposed well location. Therefore, the filter pack seal has been reduced to allow for the placement of an adequate annular space seal. A "Monitoring Well Construction Diagram" is submitted for WDNR review and approval (Figure 5, "Monitoring Well Construction Diagram"). Well screens will be positioned to intersect the water table. Upon completion of well installation, the well will be developed to remove fine grained materials from within and around the well screen. The monitoring well will be developed in accordance with ch. NR 141. Well construction and development information will be documented on WDNR Forms 4400-113A and 4400-113B.

At the time of well installation, a soil sample will be collected from the area immediately above the water table. The soil sample will be analyzed for DRO and Petroleum VOCs (PVOCs). A summary of the soil analytical parameters along with the current accepted WDNR protocols are shown on Table 2, "Soil Analytical Parameters/Methods." Following well installation, the well will be surveyed to the nearest 0.01 foot. The adjacent ground surface will be surveyed to the nearest 0.1 foot.

#### 3.1.3.3 Groundwater Sampling and Analysis

An area-wide groundwater monitoring plan was proposed in Fraser's Closure Documentation Report and Monitoring Plan (November 1995) to evaluate the potential for groundwater contamination in the western portion of the facility. The WDNR required additional well locations based

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on their review of the above stated document. The additional well locations (which will be discussed individually with the appropriate specific AOCs) have now changed the focus of the monitoring plan to individual AOCs. Therefore, some monitoring parameters may have been altered from those originally proposed to reflect this change.

SEH will collect two rounds of groundwater samples at a three month interval from the monitoring well. The well will be sampled with disposable bailers and disposable nylon string. The samples will then be collected, preserved as necessary and placed in the appropriate sample bottles using a polyethylene, bottom-emptying device. Analytical samples will be maintained at a temperature of less than four degrees Celsius in ice filled coolers and shipped to the laboratory using one day service under standard chain of custody procedures. Groundwater samples will be analyzed for VOCs, Polynuclear Aromatic Hydrocarbons (PAHs), and select dissolved metals. If groundwater monitoring indicates no contamination above ch. NR 140 Preventive Action Limits (PALs) for at least two consecutive rounds, groundwater monitoring will be discontinued. A summary of the groundwater analytical parameters along with the current accepted WDNR protocols are shown on Table 3, "Groundwater Analytical Parameters and Methods."

### **3.2 AOC #5 - Paint Waste Staging Area**

#### **3.2.1 Description**

Fraser historically staged paint wastes from their painting operations at AOC#5. The wastes were staged in two portable aboveground storage containers. Various other containers were also stored in this area which were required of Fraser under the U.S. Coast Guard Oily Waste Reception Facility program to provide emergency storage capacity for oily wastes from ships. All containers, with the exception of fuel oil tanks in the AOC have been cleaned, cut up, and recycled. The location of AOC #5 is indicated on Figure 2.

#### **3.2.2 Prior Investigation Findings**

AOC #5 was investigated for the presence of absence of contaminated soils. The initial investigation indicated total lead and chromium concentrations at the 2 to 2.5 foot depth interval greater than ch. NR 720 residual soil standards for an industrial site based on risk to human health from direct contact. Total mercury and cadmium were also detected at this depth interval, however, in concentrations which do not exceed ch. NR 720 standards. A Toxicity Characteristic Leaching Procedure (TCLP) performed on the samples with the highest concentrations of total lead and total chromium and an ASTM water leach procedure performed on the sample with the highest total lead concentration indicated no detectable concentrations of leachable lead or chromium above the laboratory

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detection limits. An additional soil sample collected from the 0 to 0.5 foot depth interval indicated concentrations of total lead, chromium, and cadmium which do not exceed ch. NR 720 standards. Soil samples collected from AOC #5 and analyzed for VOCs did not indicate concentrations above laboratory detection limits at either the 2 to 2.5 foot or the 0 to 0.5 foot depth intervals. Analytical results of selected AOCs, including AOC #5 are summarized in Table 1. The locations and depths of the soil samples are indicated on Figure 6, "AOC #5."

### **3.2.3 Additional Activities**

#### **3.2.3.1 Soil Sample Collection**

Three additional surficial soil samples will be collected by SEH from the 0 to 0.5 foot depth interval in order to determine if surface soil concentrations of select heavy metals pose a significant threat to human contact. The proposed surface sample locations are shown on Figure 6.

Soil samples will be collected using hand auger techniques according to the SEH SOP found in Appendix A. The samples will be maintained at a temperature of less than four degrees Celsius in ice filled coolers and shipped to the laboratory using one day service under standard chain of custody procedures. Soil samples will be analyzed for total lead and chromium. A summary of the soil analytical parameters along with the current accepted WDNR protocols are shown on Table 2.

#### **3.2.3.2 Monitoring Well Installation and Sampling**

A groundwater monitoring well, MW-2, will be installed at AOC #5. The proposed monitoring well location is shown on Figure 4. Monitoring well installation and sampling will be conducted according to procedures indicated in Section 3.1.3.2, "Monitoring Well Installation" and Section 3.1.3.3, "Groundwater Sampling and Analysis." Groundwater samples will be analyzed for total lead and chromium. If groundwater monitoring indicates no contamination above ch. NR 140 PALs for at least two consecutive rounds, groundwater monitoring will be discontinued. A summary of the groundwater analytical parameters along with the current accepted WDNR protocols are shown on Table 3.

#### **3.2.3.3 Stormwater Sampling**

In an effort to expedite closure activities for AOC #5, Fraser proposes to sample stormwater runoff from the AOC independently from the outfall sampling required under the facility Stormwater Pollution Prevention Plan (SWPPP). The sampling will be performed in accordance with the sampling procedures for the outfall, however the contributing runoff area will be limited to the AOC. This will eliminate the potential for stormwater contamination from other areas being misinterpreted as originating from the AOC.

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The sampling procedures will include the determination of the drainage patterns around AOC #5 to select the appropriate location for sample collection. Once identified, a sampling sump will be temporarily constructed in the area where runoff first appears to channelize downstream from the AOC. The sump will be constructed by installing a stainless steel pan in the runoff channel. The sampling will occur during the "first flush" of a storm. The storm must occur between March through November and produce greater than 0.1 inches of rainfall. The storm will not be preceded by a similar rainfall within 72 hours of the sampling event.

The sample will consist of one composite sample collected within the first 30 minute of the storm. The composite will be comprised of three subsamples collected at uniform intervals during the sampling period. The subsamples will be collected by collecting a water grab sample from the sampling sump with a laboratory clean glass bottle and placing the subsample into a larger laboratory clean bottle. Two additional subsamples will be collected in a similar manner to form the composite sample. The sample will be filtered and preserved as necessary and transported on ice to the laboratory under standard chain of custody procedures. The sample will be analyzed for dissolved chromium and lead.

### **3.3 AOC #8 – Paint Room Storage Pad**

#### **3.3.1 Description**

A paint room located in the Fabrication Shop. A small storage pad is located south of the paint room. This storage pad had a crushed stone base. The storage area stone base was graded and a concrete pad was constructed over AOC #8 in July 1994. Fraser's intended purpose for placing concrete over the area was to protect the soils in the area from potential contamination as a result of future releases. This had been discussed as a possible option for Fraser in a conversation with the WDNR early in the project before the site had been investigated. The materials associated with this AOC include paint and solvents. Scrap metal and solid wastes (paper, rags, etc.) were also staged in this area. The location of AOC #8 is indicated on Figure 2.

#### **3.3.2 Prior Investigative Findings**

AOC #8 was investigated for the presence or absence of contaminated soils associated with potential release from materials staged at the AOC. The initial investigation indicated the presence of low concentrations of benzene, toluene, lead, cadmium, chromium, and mercury which appears to be confined to the upper 0 to 1 foot interval based on one test pit.

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Additional surficial floor samples collected from the floor of the Fabrication Shop adjacent to the concrete pad indicated low level concentrations of various volatile compounds which appear to be petroleum and manufacturing related. Analytical results for select AOCs, including AOC #8, are summarized in Table 1. The locations and depths of the soil samples are indicated in Figure 7, "AOC# 8."

### **3.3.3 Additional Activities**

#### **3.3.3.1 Soil Sample Collection**

Four additional soil samples will be collected by SEH beneath the concrete pad for the purpose of defining the degree and extent of contamination at AOC #8. After coring through the concrete pad, SEH will follow the original work plan submitted to the WDNR in November 1993. The proposed soil sample locations are shown on Figure 7.

Soil samples will be collected using hand auger techniques according to the SEH SOP found in Appendix A. The samples will be maintained at a temperature of less than four degrees Celsius in ice filled coolers and shipped to the laboratory using one day service under standard chain of custody procedures. Soil samples will be analyzed for VOCs and total lead, chromium, cadmium and mercury. A summary of the soil analytical parameters along with the current accepted WDNR protocols are shown on Table 2.

### **3.4 AOC #11 – Dry Dock #1 Base**

#### **3.4.1 Description**

Dry Dock #1 is a graving-type dock used for ship building and repair. The dry dock was originally constructed with a concrete base over a very dense, low permeability red clay in the southern portion of the dock and a crushed stone and wooden base over the clay in the remaining northern portion. As ships are repaired within the dock, materials could potentially fall onto the stone base and become difficult to remove. In order to prevent the migration of potential contaminants into the stone base, Fraser poured concrete over much of the northern section of the dry dock during July/August 1994. Potential materials which may be generated in this AOC include sandblasting grit wastes and solid wastes. The location of AOC #11 is indicated on Figure 2.

#### **3.4.2 Prior Investigative Findings**

Prior to placement of the concrete in the AOC, soil samples were collected both from the surface of the clay and 6 to 10 inches into the clay floor. Analytical results indicated lead concentrations greater than ch. NR 720 residual soil standards at the clay surface, however, six inches below the clay surface lead concentrations are reduced to levels well below acceptable residual standards. Analytical results for select AOCs,



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including AOC #11, are summarized in Table 1. The locations and depths of the soil samples are indicated on Figure 8, "AOC #11." A cross section of the dry dock through the sampling locations is shown on Figure 9, "Dry Dock #1/Cross Section."

### **3.4.3 Dry Dock #1 Gate Detail**

Dry dock #1 is flooded through five flooding valves located in the dry dock gate. The flooding valves are approximately three feet above the bottom of the gate and the gate sill is approximately 1.5 feet above the outside bay floor. Therefore, water is not drawn off the bay floor to fill the dry dock. After flooding is complete and the level of the water is the same in the bay and the dock, dock flooding valves are closed and air is introduced into the gates to float them out of the recess in the sill. Gate detail of dry dock #1 is shown in Figure 10, "Gate and Sump Detail."

The sill lines up with the top of the blocks at five feet above the dock floor. This presents an effective barrier to heavier particulates within the dock from entering the bay when the gates are opened. Once a ship has docked, the gates are floated closed over the sill. Water then replaces the air inside the gates to lower the gates securely within the sill recess. A rubber gasket on the gate bottom forms a tight seal when the gates are firmly seated. Water is pumped from the dry dock through the sump located in the dry dock floor.

### **3.4.4 Additional Activities**

#### **3.4.4.1 Seepage Lysimeter Installation and Sampling**

In an effort to document that groundwater contamination has not occurred below the dry dock floor, Fraser proposes to install a seepage lysimeter to collect groundwater samples. The lysimeter will be used in lieu of a monitoring well due to the anticipated low permeability of the underlying clay soil. The seepage lysimeter will be installed in an area of the dry dock not currently covered with concrete as shown on Figure 8. The lysimeter will be installed to a sampling depth of approximately five feet below the existing dock floor with a hand auger. Two soil samples will be collected from the hand auger cuttings for laboratory analysis. One sample will be collected from the 0 to 6 inch sampling interval and the second from the 2.0 to 2.5 foot depth. These samples will be analyzed for total lead. A summary of the soil analytical parameters along with the current accepted WDNR protocols are shown on Table 2.

The lysimeter, L-1, will be installed in accordance with the manufacture's recommendations. A copy of the lysimeter detail and manufacturer's information regarding the lysimeter is provided in Appendix D, "Lysimeter Specifications." Once installed, two groundwater samples will be collected and analyzed for dissolved lead. The groundwater samples will be collected in accordance with the groundwater sampling schedule

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for the other wells onsite. A summary of the groundwater analytical parameters along with the current accepted WDNR protocols are shown on Table 3.

3.4.4.2 Dry Dock #1 Water Sampling

Water samples from Dry Dock #1 and Howards Bay will be collected. Representative samples of the water column will be collected at two depths from within the dock and from a location in Howards Bay directly adjacent to the dry dock gate. The samples will be collected approximately five feet from the top and bottom of the water column. Samples will be collected with a brass Kemmerer bottle. The water samples will be analyzed for total lead.

**3.5 AOC #12 – NW Fill Area**

**3.5.1 Description**

Fill materials were placed along the shoreline at AOC #12 in the late 1980's to form a berm five to eight feet high. The intended purpose of the berm was to prevent surface runoff into the Bay. Test pits conducted by SEH in 1994 indicated that material in the fill is comprised primarily of concrete, wood fragments, and scrap metal pieces. The berm was capped with onsite soils and seeded to minimize erosion into Howard's Bay. However, loading and earthwork activities associated with the transfer of bulk materials (rock, etc.) have occurred at this AOC in the past. The location of AOC #12 is indicated on Figure 2.

**3.5.2 Prior Investigative Findings**

The initial investigation of AOC #12 consisted of the excavation of four test pits with soil sample collection. Soil sample analysis indicated the presence of low concentrations of toluene. Three additional shallow hand auger borings were completed for the purpose of defining the extent of possible contamination. The laboratory results of these additional soil samples indicated low concentrations of various non-specific petroleum related hydrocarbons which do not appear to be associated with a specific release. The most likely source of the non-specific hydrocarbons at the AOC is past earthwork activities in the area. Correspondence from the WDNR (January 4, 1996) suggested that Fraser place monitoring wells at the AOC to determine if groundwater has been impacted and to aid in determining the possible source and extent of contamination. Analytical results for select AOCs, including AOC #12, are summarized in Table 1. The locations and depths of the soil samples are indicated on Figure 11, "AOC #12."

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**3.5.3 Additional Investigative Activities**  
**3.5.3.1 Monitoring Well Installation and Sampling**

Two groundwater monitoring wells, MW-3 and MW-4 will be installed at AOC #12. The proposed monitoring well locations are shown on Figure 4. Monitoring well installation and sampling will be conducted according to procedures indicated in Section 3.1.3.2, "Monitoring Well Installation" and Section 3.1.3.3, "Groundwater Sampling and Analysis." Groundwater samples will be analyzed for VOCs. If groundwater monitoring indicates no contamination above ch. NR 140 PALs for at least two consecutive rounds, groundwater monitoring will be discontinued. A summary of the groundwater analytical parameters along with the current accepted WDNR protocols are shown on Table 3. In addition, a soil sample will be collected from each monitoring well from the area immediately above the water table. Soil samples will be analyzed for PVOCs. A summary of the soil analytical parameters along with the current accepted WDNR protocols are shown on Table 2.

**3.6 Background Groundwater Monitoring Well**

An upgradient background groundwater monitoring well, MW-5, is proposed to evaluate the potential for groundwater contamination moving onto the Fraser facility from offsite sources. The proposed location of MW-5 is shown on Figure 4. Monitoring well installation and sampling will be conducted according to procedures indicated in Section 3.1.3.2 and Section 3.1.3.3. If groundwater monitoring indicates no contamination above ch. NR 140 PALs for at least four consecutive rounds, groundwater monitoring will be discontinued. A summary of the groundwater analytical parameters along with the current accepted WDNR protocols are shown on Table 3.

**4.0 Investigative Waste Storage and Disposal**

Soils generated during the additional investigation activities will be managed and disposed according to regulatory requirements. Soil cuttings will be drummed and stored onsite for future disposal, if necessary. Groundwater will be containerized for future disposal if obvious contamination is indicated in any monitoring well during development and purging activities. Disposable equipment (i.e., bailers, personal protective equipment) will be placed in plastic waste bags and disposed as solid waste.

**5.0 Report Preparation**

Following completion of field activities and laboratory analyses, SEH will prepare a Closure Documentation Report for submittal to the WDNR. The results of the additional investigation will be evaluated along with prior investigative results where appropriate to determine the degree and extent

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of contamination in the various AOCs. Recommendations for future closure activities (if required) will also be included in the narrative. Analytical results will be summarized in tabular format with complete copies of analytical reports provided in the appendices. Other relevant documentation, including Monitoring Well Construction and Development Forms will also be included in the report appendices.

## 6.0 Project Schedule

A proposed schedule of activities at the Fraser Shipyards, Inc. site is as follows:

Task	Estimated Time for Completion*
1. Soil boring/sampling, monitoring well installation	4 weeks
2. Groundwater sampling	6 weeks and 4 months
3. Stormwater sampling	8 weeks
4. Closure Documentation	6 months
*Time required following WDNR approval of Additional Investigation Work Plan	

GGC/ggc/ls/CWI

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## **Tables**

Table 1 – Field and Analytical Results

Table 2 – Soil Analytical Parameters/Methods

Table 3 – Groundwater Analytical Parameters and Methods

**TABLE 1  
FRASER SHIPYARDS, INC.  
FIELD AND ANALYTICAL RESULTS**

AOC #	SAMPLE ID DEPTH	DATE	FIELD SCREEN					ANALYTICAL PARAMETERS							
			FID units	PID units	PCB* ppm	PCB (8080) ug/g	DRO** ug/g	VOC (8010/8020 or 8021) ug/g	PVOC (8021a) ug/g	Pb (6010) ug/g	Cd (6010) ug/g	Cr (6010) ug/g	Hg (7471) ug/g		
1	<b>WASTE OIL STAGING AREA</b>														
	B-1	(2.5-3')	1-11-94	1000+	331	--	--	94.4	--	--	--	--	--	--	
	B-2	(2-2.5')	1-11-94	20	96	--	--	4,370	--	--	--	--	--	--	
	B-3	(2-2.5')	1-11-94	1000+	31	--	--	X	--	--	--	--	--	--	
	B-4	(2-2.5')	1-11-94	300	27	--	--	176	--	--	--	--	--	--	
	B-5	(2-2.5')	1-11-94	600	104	--	--	--	--	--	--	--	--	--	
	B-6	(2-2.5')	1-11-94	180	108	--	--	--	--	--	--	--	--	--	
	<b>COMPOSITE</b>		1-11-94	--	--	--	--	--	0.0444 xylenes	--	--	--	--	--	--
	S-1	(1.5')	5-3-95	1.22	--	--	--	96.9	--	--	--	--	--	--	--
	S-2	(1.5')	5-3-95	49.63	--	--	--	266	--	0.013 benzene	--	--	--	--	--
	S-3	(1.5')	5-3-95	236	--	--	--	73.1	--	0.0069 1,3,5-trimethylbenzene	--	--	--	--	--
										0.0065 m- & p-xylene	--	--	--	--	--
	S-4	(1.5')	5-3-95	1.08	--	--	--	222	--		--	--	--	--	--
	E-1	(1.5')	5-3-95	40	--	--	--	257	--		--	--	--	--	--
EE-1	(1.5')	5-3-95	120	--	--	--	X	--		--	--	--	--	--	
BW-1	(3.0')	5-3-95	584	--	--	--	246	--	0.0776 m-&p- xylenes	--	--	--	--	--	
									0.0418 o-xylene & styrene	--	--	--	--	--	
5	<b>PAINT WASTE STAGING AREA</b>														
	B-9	(2-2.5')	1-11-94	1000+	42	--	--	--	X	--	685***	0.18	22.7	0.083	
	B-10	(0-6")	1-11-94	0	36	--	--	--	--	--	--	--	--	--	
	B-10	(2-2.5')	1-11-94	--	--	--	--	--	X	--	270	0.28	274****	0.25	
	B-11	(0-6")	1-11-94	0	34	--	--	--	--	--	66.1	0.64	22.2	X	
	B-12	(0-6")	1-11-94	1.4	34	--	--	--	--	--	--	--	--	--	--
	B-12	(2-2.5')	1-11-94	1000+	50	--	--	--	X	--	177	0.38	23.1	X	
8	<b>PAINT ROOM STORAGE PAD</b>														
	B-20	(0-1')	1-25-94	1	--	--	--	--	0.0058 benzene 0.150 toluene	--	167	0.218	7.53	0.0509	
	B-21	(2-2.5')	1-25-94	1	--	--	--	--	X	--	X	X	4.94	X	
	HAX-1	(8")	8-23-95	--	--	--	--	--	0.104 n-butylbenzene 0.240 naphthalene	--	--	--	--	--	
								0.0665 1,2,4 trimethylbenzene 0.194 m- & p-xylene 0.131 o-xylene & styrene 3.24 n-butylbenzene 0.910 sec-butylbenzene 0.557 tert-butylbenzene 1.24 ethylbenzene 0.469 p-isopropyltoluene 5.11 naphthalene 0.658 n-propylbenzene 2.01 1,2,4-trimethylbenzene 0.696 1,3,5-trimethylbenzene 6.45 m- & p-xylene 3.02 o-xylene & styrene	--	--	--	--	--		
HAX-2	(1')	8-23-95	--	--	--	--	--		--	--	--	--	--		

-- indicates parameter not analyzed

X = analyzed but not detected

\* DTech Immunoassay PCB Test Kit - EM Industries, Gibbstown, NJ

\*\* WDNR Modified DRO

\*\*\*TCLP - Pb, B-9 (2-2.5') = none detected

ASTM - Pb, B-9 (2-2.5') = none detected

\*\*\*\*TCLP - Cr, B-10 (2-2.5') = none detected

TABLE 1 (continued)  
FRASER SHIPYARDS, INC.  
FIELD AND ANALYTICAL RESULTS

AOC #	SAMPLE ID DEPTH	DATE	FIELD SCREEN					ANALYTICAL PARAMETERS						
			FID units	PID units	PCB* ppm	PCB (8080) ug/g	DRO** ug/g	VOC (8010/8020 or 8021) ug/g	PVOC (8021a) ug/g	Pb (6010) ug/g	Cd (6010) ug/g	Cr (6010) ug/g	Hg (7471) ug/g	
11	DRY DOCK #1 BASE													
	DD001 (6" into the clay)	7-7-94	--	--	--	--	--	--	--	--	--	272	--	--
	DD002	7-7-94	--	--	--	--	--	--	--	--	--	30.1	--	--
	DD003	8-4-94	--	--	--	--	--	--	--	--	--	34.1	--	--
	T1 (clay)	8-17-94	--	--	--	--	--	--	--	--	--	927	--	--
	T2 (surface)	8-17-94	--	--	--	--	--	--	--	--	--	832	--	--
	T3	8-17-94	--	--	--	--	--	--	--	--	--	958	--	--
	T4	8-17-94	--	--	--	--	--	--	--	--	--	855	--	--
12	NW FILL AREA													
	TP-5 (2.5')	1-25-94	15	--	--	--	--	--	0.356 toluene	--	--	--	--	--
	TP-6 (5')	1-25-94	13	--	--	--	--	--	X	--	--	--	--	--
	TP-7 (6')	1-25-94	350	--	--	--	--	--	0.42 toluene	--	--	--	--	--
	TP-8 (4')	1-25-94	2	--	--	--	--	--	--	--	--	--	--	--
	HA-1 (1.5')	8-23-95	--	--	--	--	--	--	0.0491 ethylbenzene	--	--	--	--	--
									0.0387 1,3,5-trimethylbenzene	--	--	--	--	--
									0.0313 m- & p-xylene	--	--	--	--	--
									0.0568 ethylbenzene	--	--	--	--	--
									0.0560 toluene	--	--	--	--	--
									0.0794 1,2,4-trimethylbenzene	--	--	--	--	--
									0.0718 1,3,5-trimethylbenzene	--	--	--	--	--
									0.0685 m- & p-xylene	--	--	--	--	--
									0.0401 o-xylene & styrene	--	--	--	--	--
	HA-2 (1.5')	8-23-95	--	--	--	--	--	--	0.0604 ethylbenzene	--	--	--	--	--
								0.0777 toluene	--	--	--	--	--	
								0.0802 1,2,4-trimethylbenzene	--	--	--	--	--	
								0.092 m- & p-xylene	--	--	--	--	--	
HA-3 (1')	8-23-95	--	--	--	--	--	--	0.0793 o-xylene & styrene	--	--	--	--	--	

-- indicates parameter not analyzed  
X = analyzed but not detected  
\* DTech Immunoassay PCB Test Kit - EM Industries, Gibbstown, NJ  
\*\* WDNR Modified DRO

**Table 2**  
**Soil Analytical Parameters/Methods**

Parameters	Methods	Method Detection Limit (MDL)	Sample Preservation	Sample Shipment	AOC No.				
					1	5	8	11	12
DRO	WDNR Modified DRO	5 mg/kg	None	On Ice	X				
PVOC	EPA 8021a	10 µg/kg	MeOH	On Ice	X				X
VOC	EPA 8021	Varies	MeOH	On Ice			X		
Pb	EPA 6010	4.0 mg/kg	None	On Ice		X	X	X	
Cr	EPA 6010	0.83 mg/kg	None	On Ice		X	X		
Cd	EPA 6010	0.33 mg/kg	None	On Ice			X		
Hg	EPA 7471	0.04 mg/kg	None	On Ice			X		



**Table 3**  
**Groundwater Analytical Parameters/Methods**

Parameters	Methods	Method Detection Limit (MDL)	Sample Preservation	Sample Shipment	Monitoring Wells (AOC No.)					
					MW-1 (1)	MW-2 (5)	MW-3 (12)	MW-4 (12)	MW-5 (Back- ground)	L-1 (11)
VOC <sup>1</sup>	EPA 8021	Varies	HCL	On Ice	X		X	X	X	
PAH	EPA 8310	Varies	None	On Ice	X				X	
Pb	EPA 7421	1.55 µg/l	HNO <sub>3</sub>	On Ice	X <sup>2</sup>	X			X	X
Cr	EPA 7191	2 µg/l	HNO <sub>3</sub>	On Ice		X			X	
Cd	EPA 7131	0.15 µg/l	HNO <sub>3</sub>	On Ice	X <sup>2</sup>				X	

<sup>1</sup> = Analyze for full list of VOCs in the first round of samples. Subsequent rounds may be limited to the PVOCs or as requested by the WDNR project manager.

<sup>2</sup> = Analyze for Pb and Cd in the first round of samples.

Notes: 1) WDNR LUST Guidance (7/93) used as reference for waste fuel oil contaminated groundwater.

2) All groundwater samples will be field filtered using a 0.45 micron filter.

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## **Figures**

**Figure 1 – Site Location Map**

**Figure 2 – Site Plan**

**Figure 3 – AOC #1**

**Figure 4 – Proposed Well Locations**

**Figure 5 – Monitoring Well Construction Diagram**

**Figure 6 – AOC #5**

**Figure 7 – AOC# 8**

**Figure 8 – AOC #11**

**Figure 9 – Dry Dock #1/Cross Section**

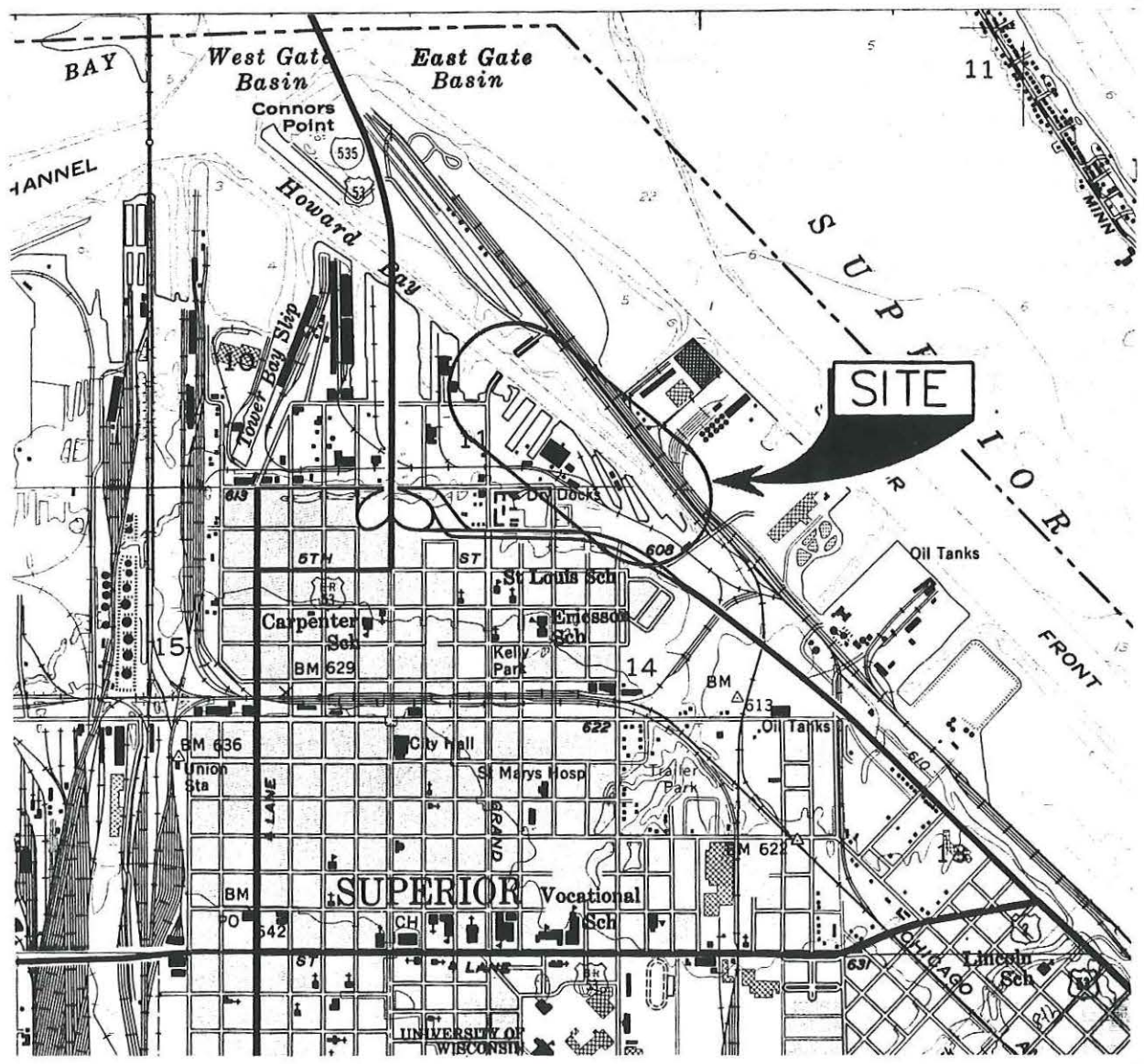
**Figure 10 – Gate and Sump Detail**

**Figure 11 – AOC #12**

REPRODUCED FROM  
**USGS SUPERIOR QUADRANGLE**  
 WISCONSIN - DOUGLAS CO. 7.5 MINUTE SERIES



SCALE: 1"=2,000'



DRAWN BY:  
 KEA 10/18/93  
 CHECKED BY:

**FIGURE 1**  
**FRASER SHIPYARDS, INC.**  
**SUPERIOR, WISCONSIN**

FILE NO.  
 FRASE9401  
 DRG. NO.  
 9401FZA1



STOREROOM

AOC #12

HOWARDS BAY

TRAILERS

PORTABLE LUNCH ROOM

GATE

AOC #1

AOC #1  
HOWARDS BAY

FIRST STREET

AOC #2

BOXCAR

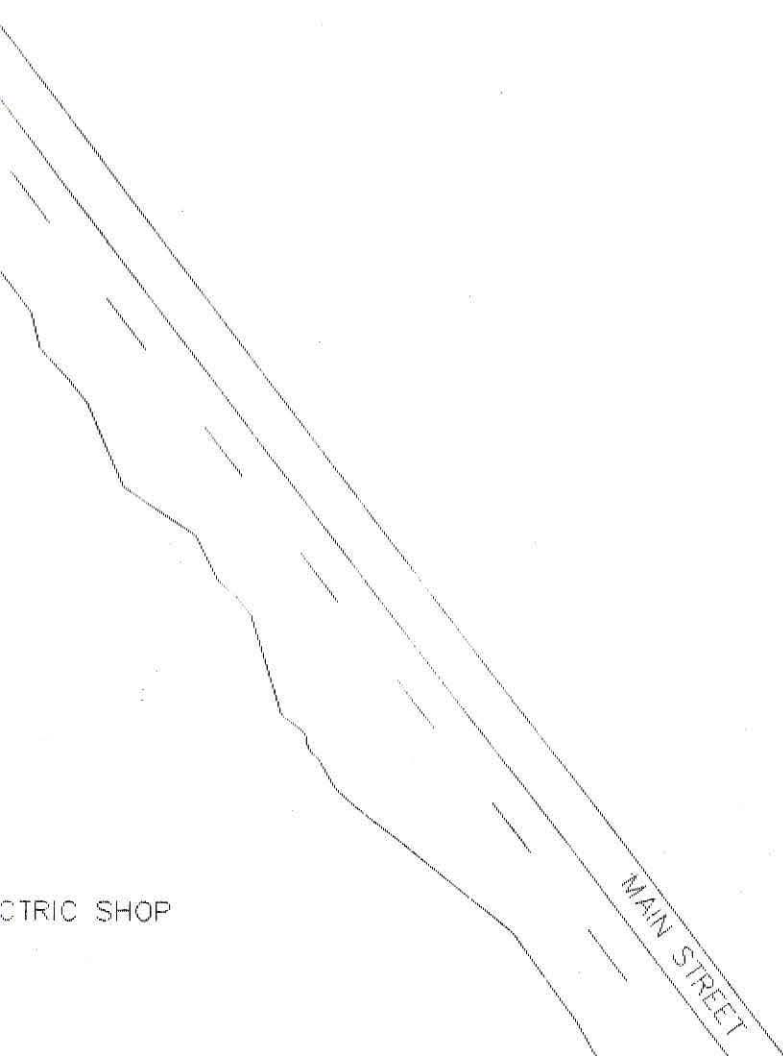
AOC #3

#2 FUEL OIL ASY'S  
AOC #5  
CRANES

BUILDING DOCK

2.5 SLAB

3 SLAB



N



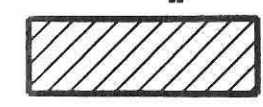
SCALE IN FEET

0 75 150 300



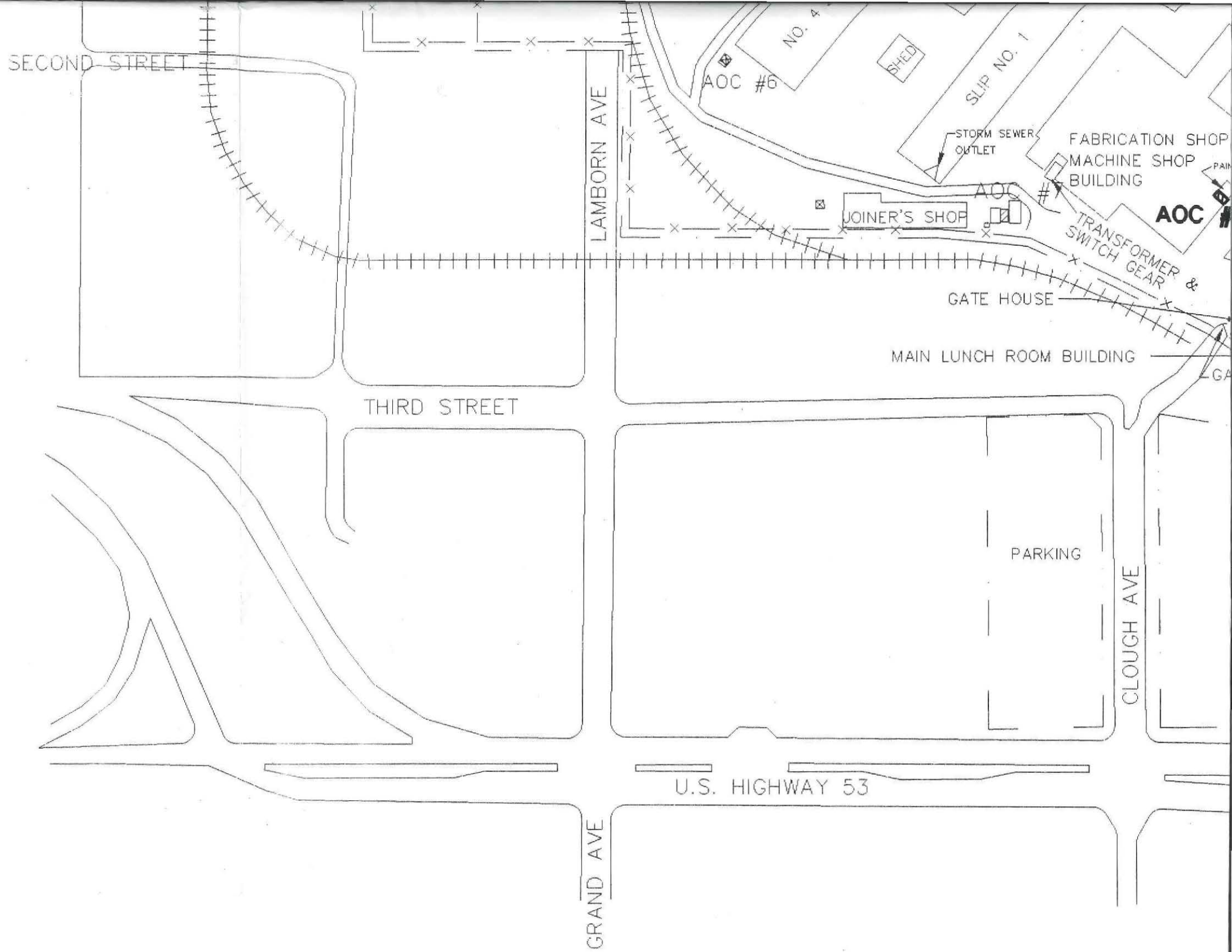
LEGEND

AOC #11

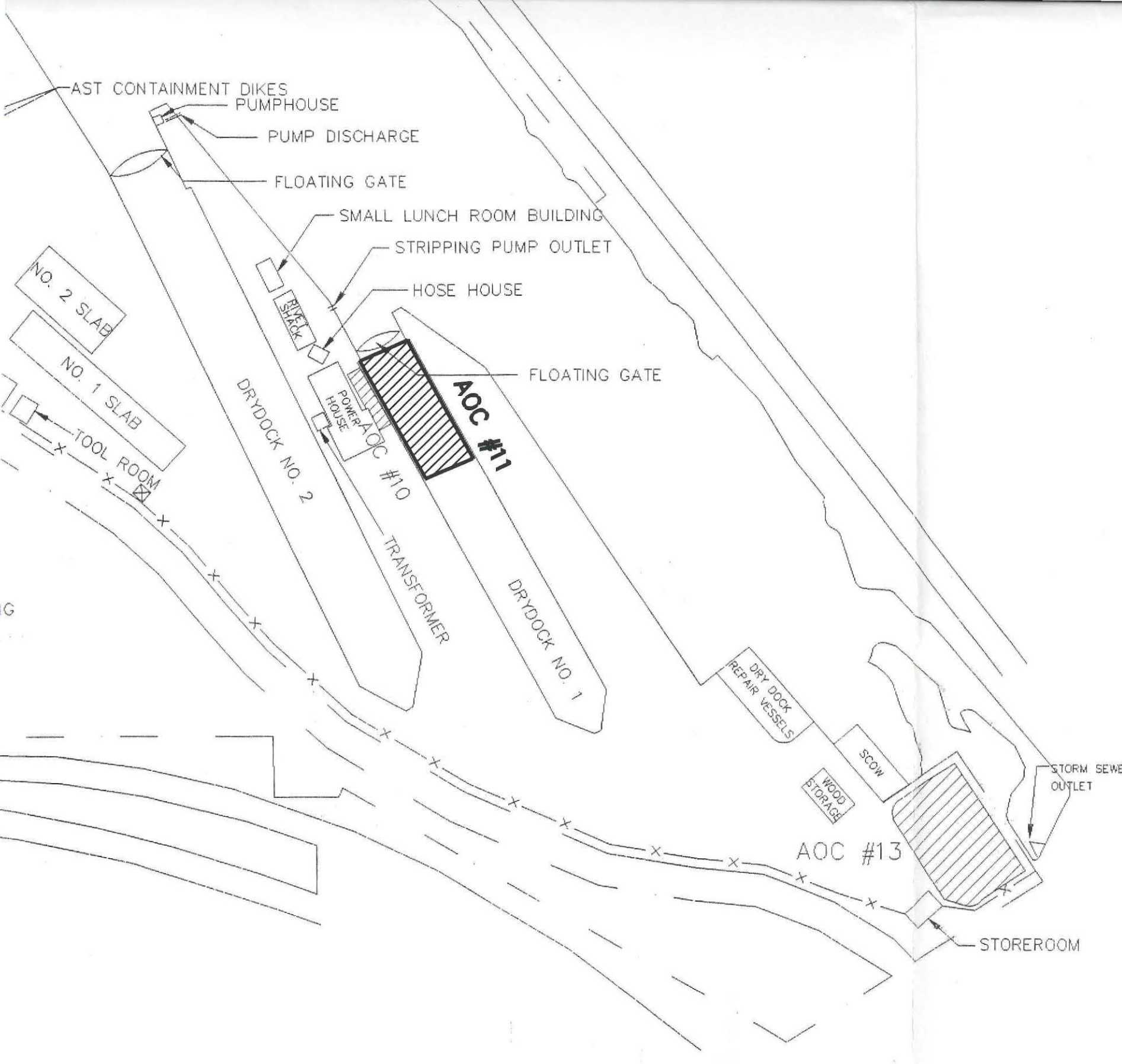






AREAS OF CONCERN

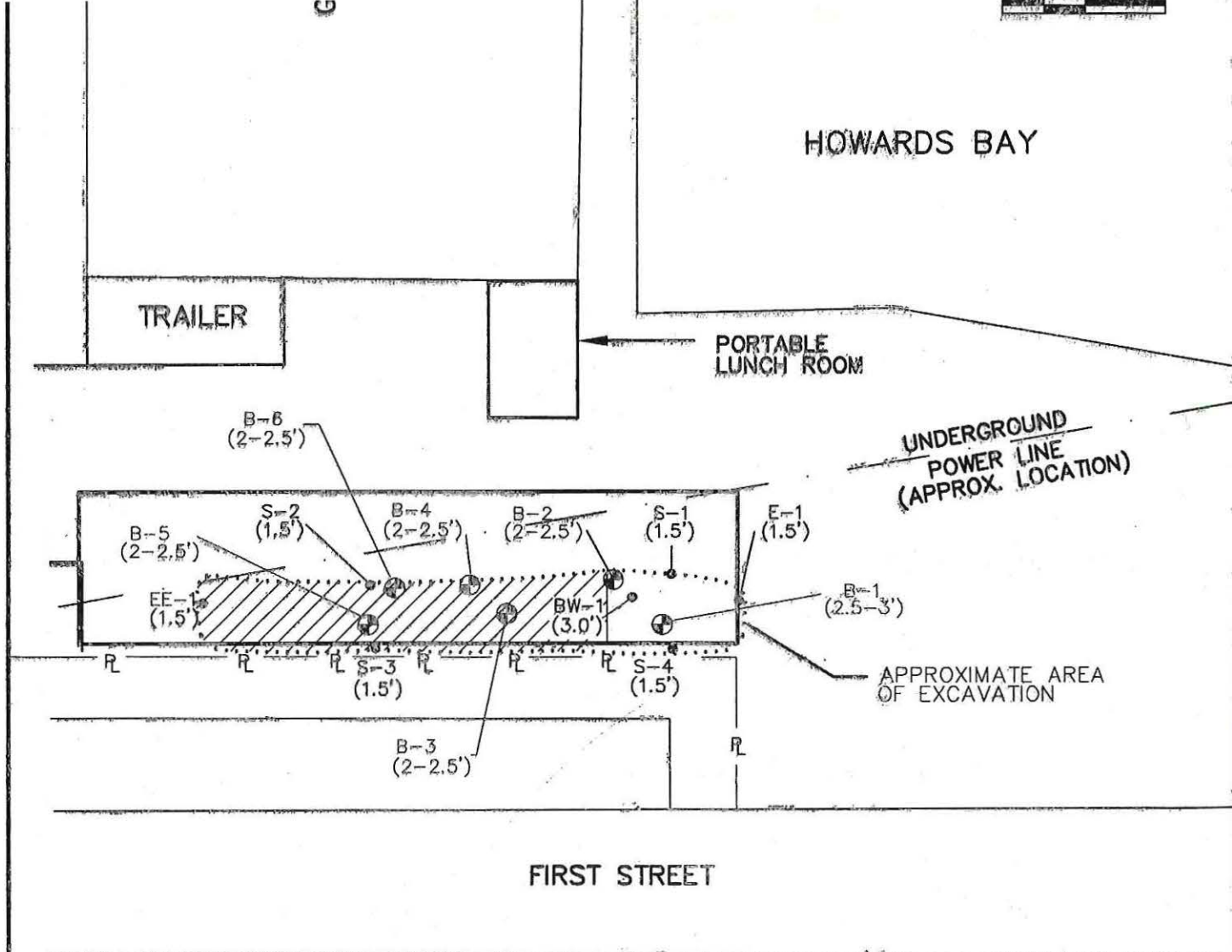
E:\WASTE\FRAS9401\RECORD\FKE1



NO.	DATE	ISSUE/REVISIONS	DRAWN BY	DESIGN	FIELD REVIEW	QC CHECK
1	03/12/96		JLE	03/96		



-  STORM SEWER OUTLET
-  SUB STATION (600 KVA)
-  PROPERTY BOUNDARY
-  FENCE



**LEGEND**

B-4 (2-2.5') ⊕ SOIL BORING LOCATION AND NUMBER (DEPTH)

S-1 (1.5') ● POST EXCAVATION SAMPLE (DEPTH)

--- UNDERGROUND POWER LINE

— R — APPROXIMATE PROPERTY LINE AND FENCE

□ APPROX. LOCATION OF AOC

▨ APPROX. LOCATION OF CONCRETE SLAB  
— EXTENT UNDETERMINED

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1	03/12/96		JLE	03/96				
NO.	DATE	ISSUE/REVISIONS	DRAWN BY	DESIGN	FIELD REVIEW	QC CHECK		



FRASER SHIPYARDS, INC.

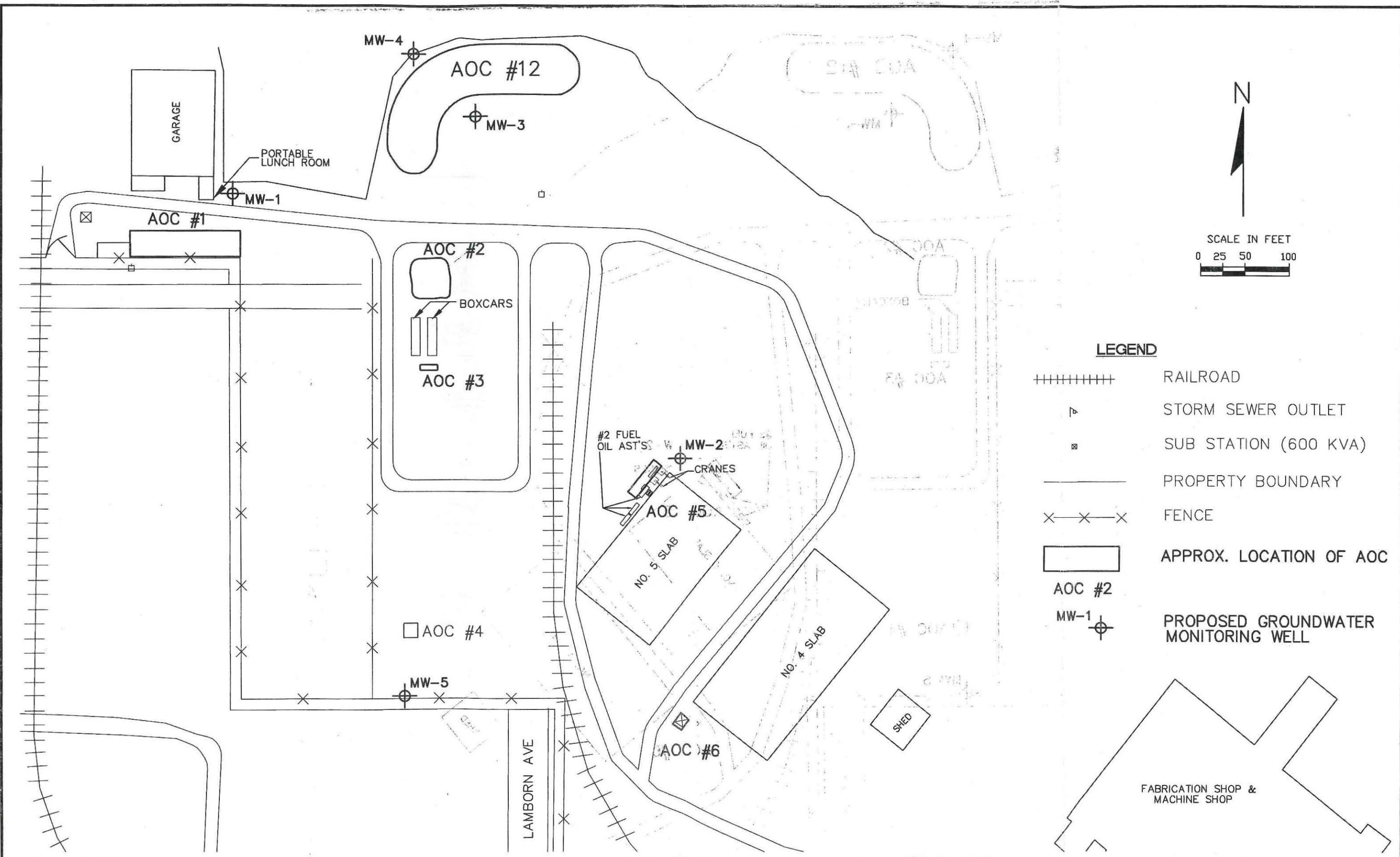
FIGURE 3  
AOC #1

PROJ. NO.  
FRAS9401  
DATE  
03/12/96

3

11





**LEGEND**

- +++++ RAILROAD
- ▲ STORM SEWER OUTLET
- SUB STATION (600 KVA)
- PROPERTY BOUNDARY
- ×-×-× FENCE
- APPROX. LOCATION OF AOC
- AOC #2
- MW-1
- PROPOSED GROUNDWATER MONITORING WELL

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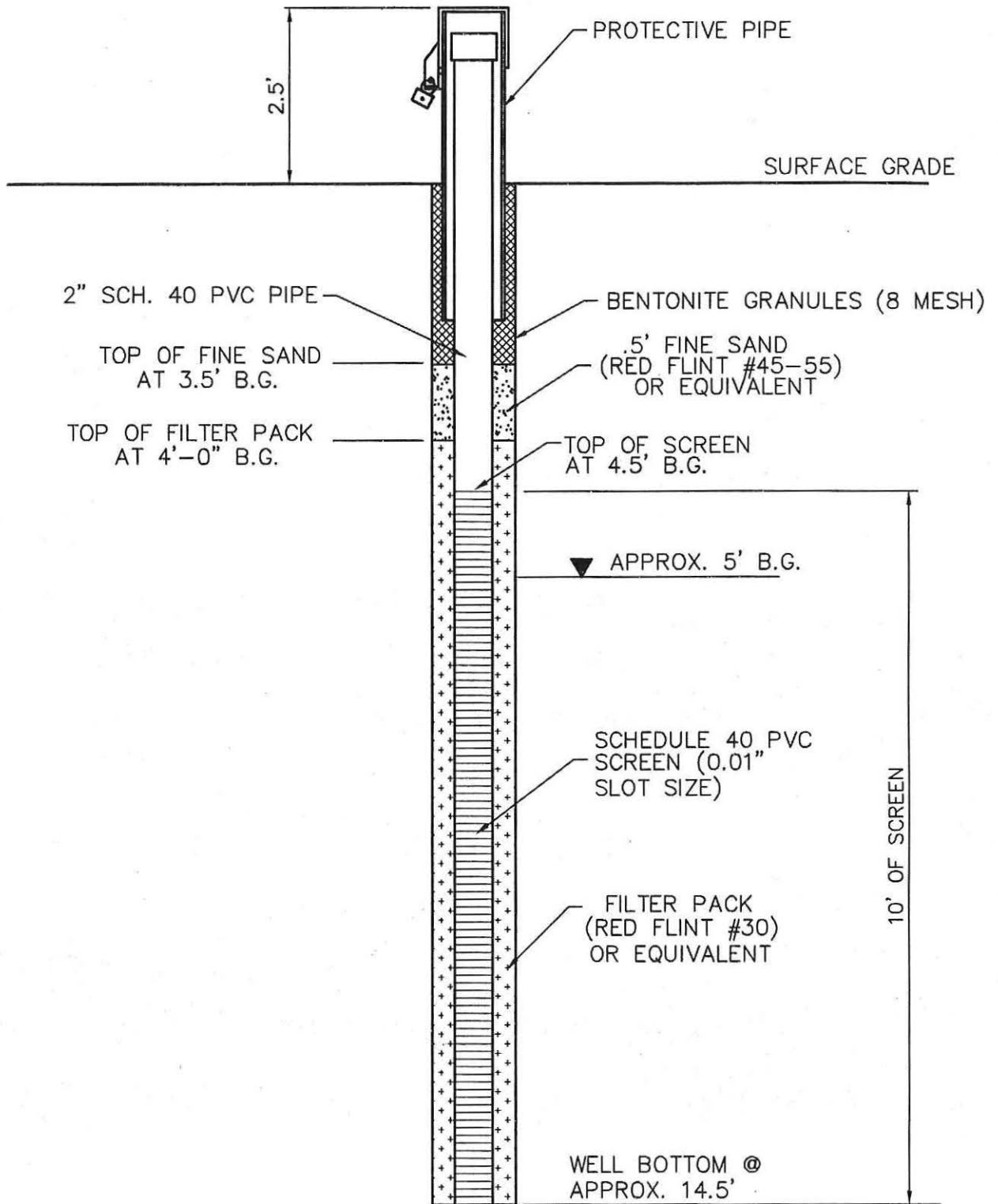
1	03/12/96	JLE	03/96						
NO.	DATE	ISSUE/REVISIONS	DRAWN BY	DESIGN	FIELD REVIEW	QC CHECK			



FRASER SHIPYARDS, INC.

FIGURE 4  
PROPOSED WELL LOCATIONS

PROJ. NO.	11x17	4
DATE	03/12/96	11



NTS

1	03/12/98		JLE	03/98				
NO.	DATE	ISSUE/REVISIONS	DRAWN BY	DESIGN	FIELD REVIEW	QC CHECK		



FRASER SHIPYARDS, INC.

FIGURE 5  
MONITORING WELL  
CONSTRUCTION  
DIAGRAM

PROJ. NO. FRAS9401	<b>5</b>
DATE 03/12/98	
<b>11</b>	

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PAINT WASTE STAGING AREA

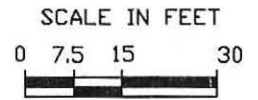
**AOC #5**

B-10  
(0-6")  
(2-2.5')

B-9  
(2-2.5')

B-12  
(0-6")  
(2-2.5')

B-11  
(0-6")



CRANES

PORTABLE  
CONTAINERS  
(NORMALLY EMPTY)

NO. 5 SLAB

**LEGEND**

B-12  
(0-6")  
(2-2.5')



BORING LOCATION, NUMBER AND  
SAMPLE DEPTH



PROPOSED HAND AUGER SOIL SAMPLE



APPROX. LOCATION OF AOC

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1	03/12/96	J.E	03/96				
NO.	DATE	ISSUE/REVISIONS	DRAWN BY	DESIGN	FIELD REVIEW	QC CHECK	



FRASER SHIPYARDS, INC.

FIGURE 6  
AOC #5

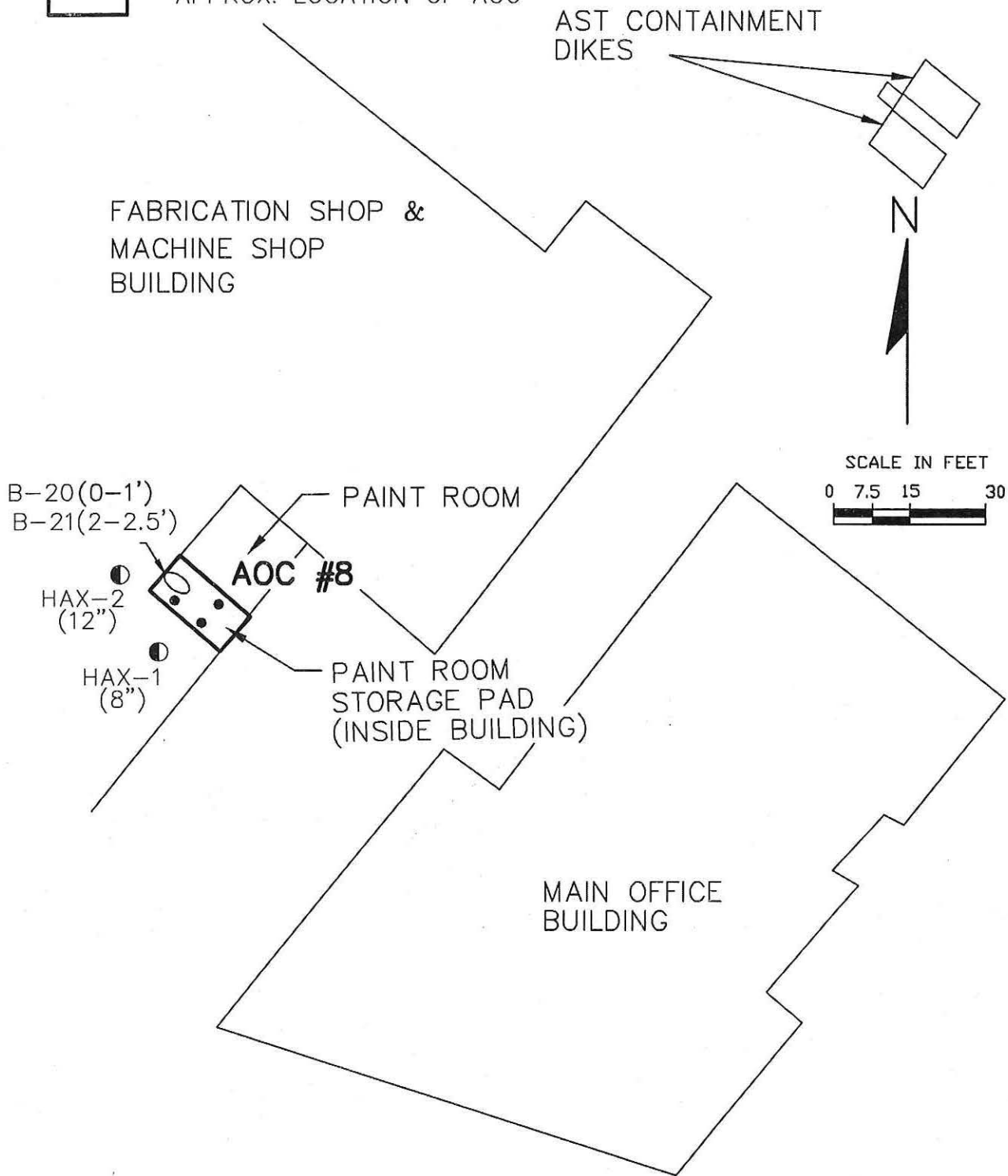
PROJ. NO.  
FRAS9401  
DATE  
03/12/96

6

11

**LEGEND**

- B-21 ○ BACKHOE SAMPLE LOCATION AND NUMBER
- HAX-1 (8") ● HAND AUGER SAMPLE (DEPTH)
- PROPOSED HAND AUGER SAMPLE DEPTH
- APPROX. LOCATION OF AOC



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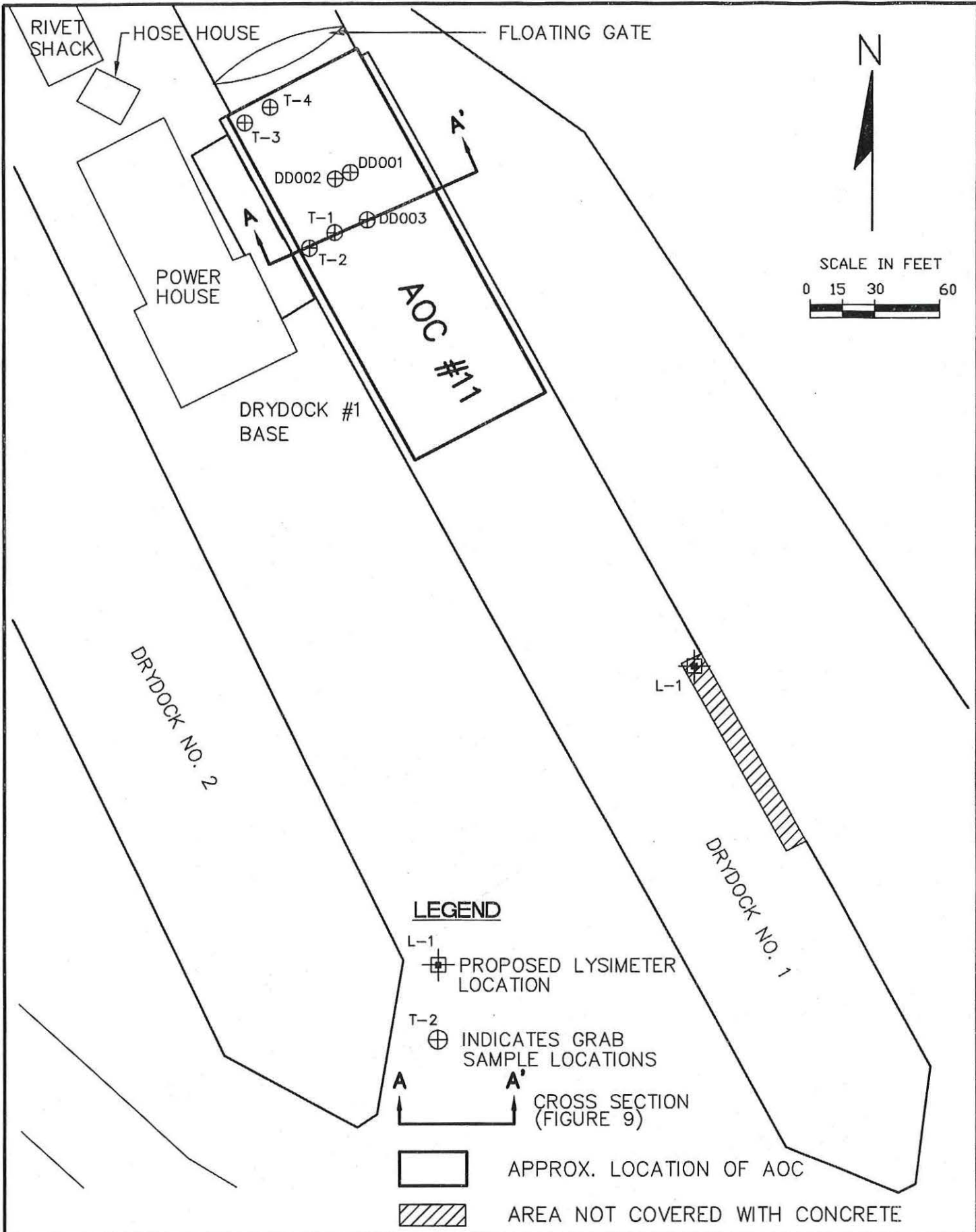
1	03/12/96		JLE	03/96				
NO.	DATE	ISSUE/REVISIONS	DRAWN BY	DESIGN	FIELD REVIEW	QC CHECK		



FRASER SHIPYARDS, INC.

FIGURE 7  
AOC #8

PROJ. NO. FRAS9401	<b>7</b>
DATE 03/12/96	



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1	03/12/96		JLE	03/96				
NO.	DATE	ISSUE/REVISIONS	DRAWN BY	DESIGN	FIELD REVIEW	QC CHECK		

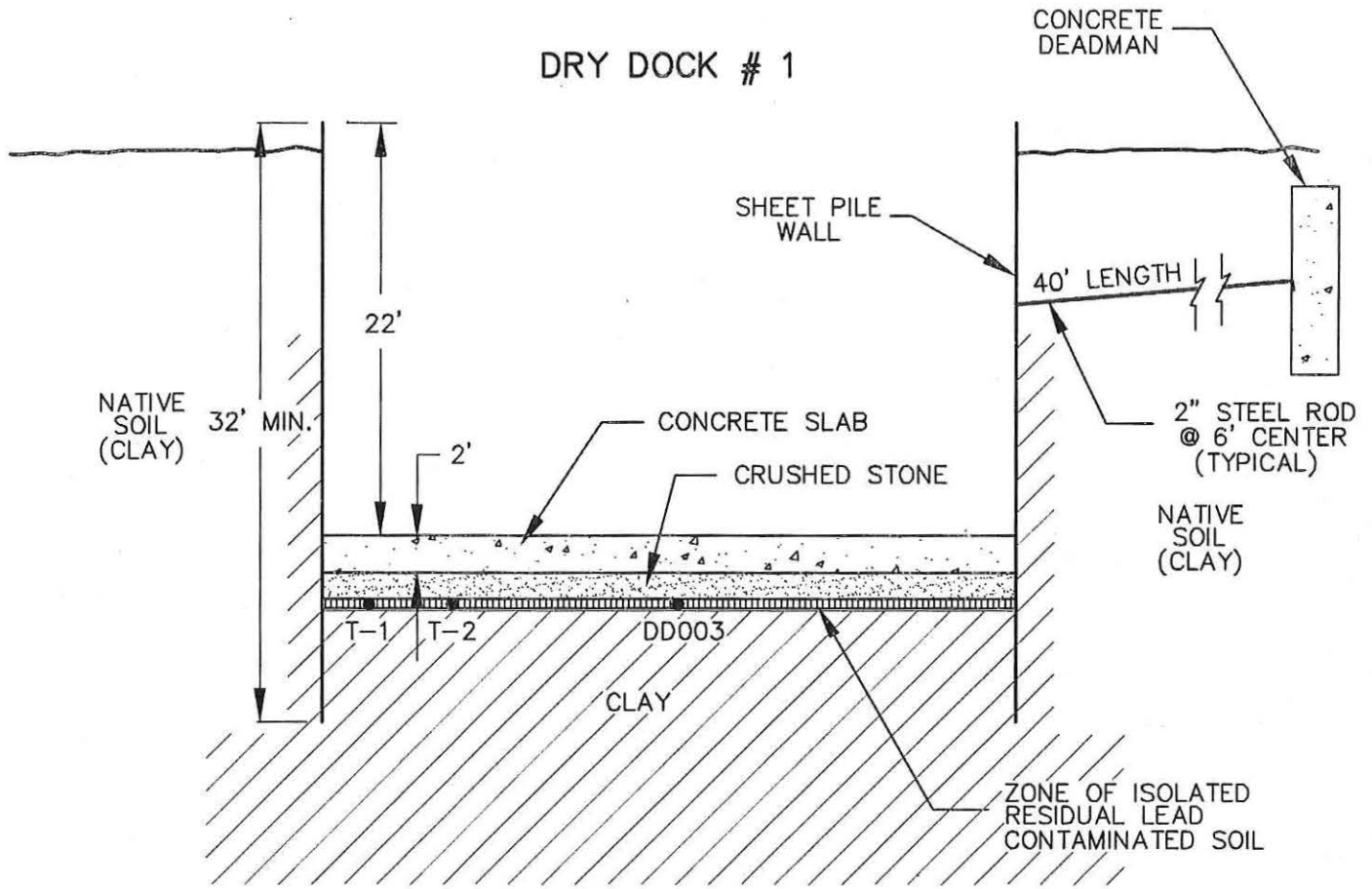


FRASER SHIPYARDS, INC.

FIGURE 8  
AOC #11

PROJ. NO. FRAS9401	<b>8</b>
DATE 03/12/96	

# DRY DOCK # 1



## LEAD CONCENTRATIONS

SAMPLE	ug/g	VERTICLE LOCATION
T-1	927	TOP OF CLAY
T-2	832	TOP OF CLAY
DD003	34.1	6" INTO CLAY

### SECTION A-A'

(SEE FIGURE 8 FOR CROSS-SECTION LOCATION)

SCALE VERTICAL 1"=10'  
HORIZONTAL 1"=20'

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NO.	DATE	ISSUE/REVISIONS	DRAWN BY	DESIGN	FIELD REVIEW	QC CHECK		



FRASER SHIPYARDS, INC.

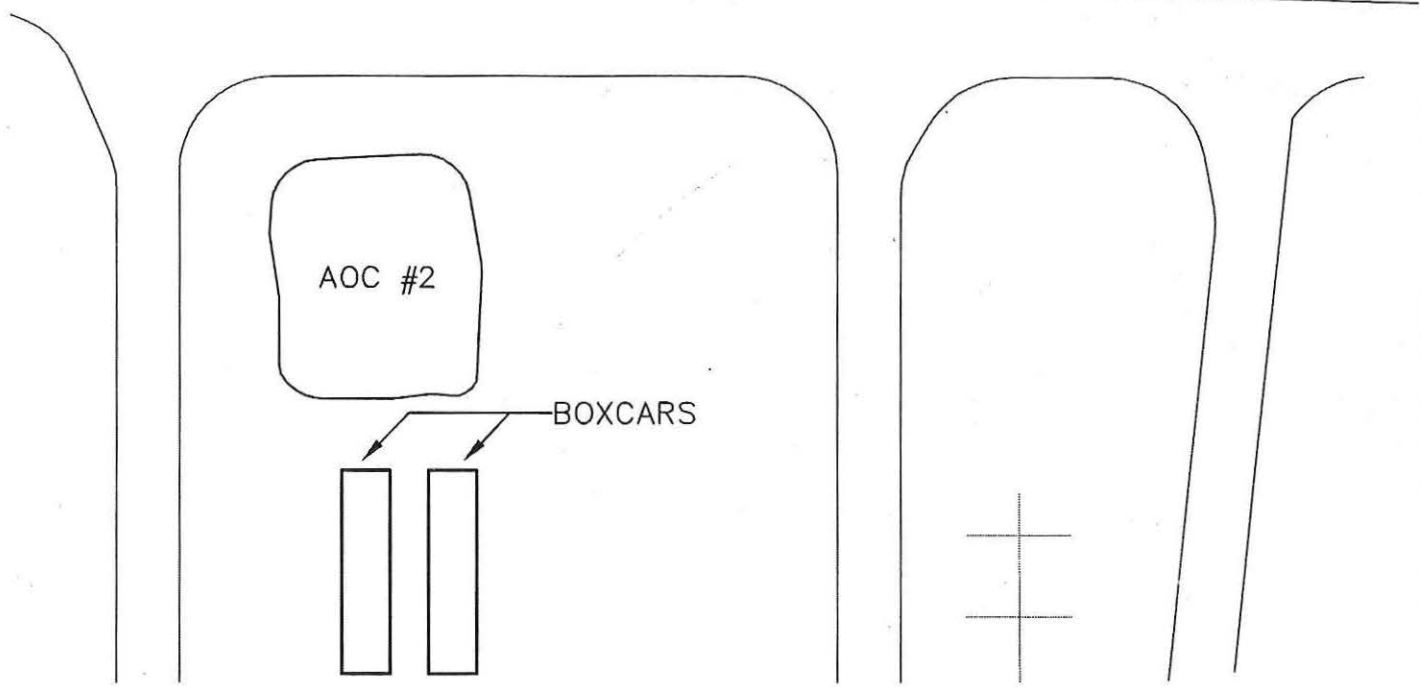
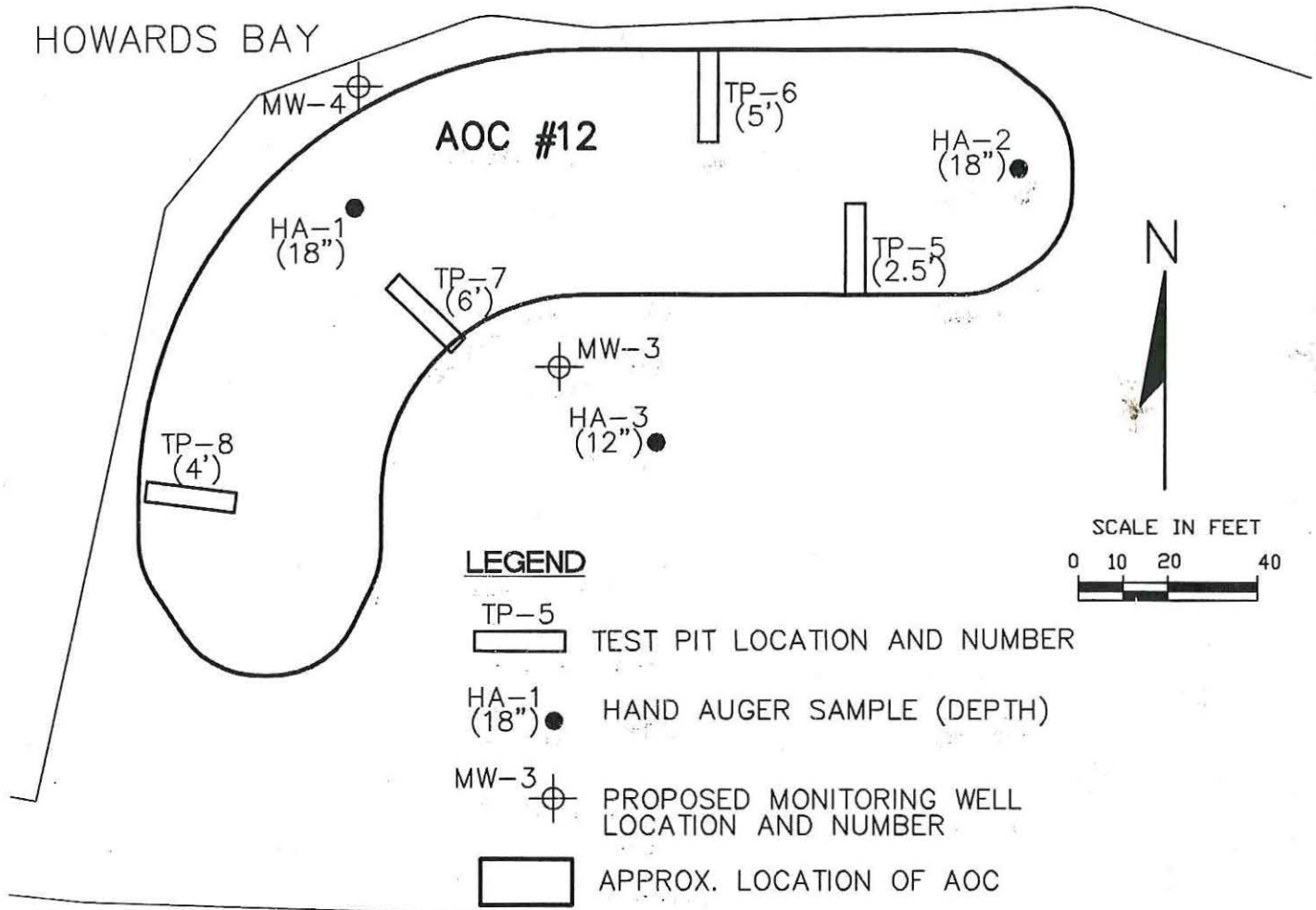
FIGURE 9  
DRY DOCK # 1  
CROSS SECTION

PROJ. NO.  
FRAS9401  
DATE  
03/12/96

9

11

HOWARDS BAY



1	03/12/96	JLE	03/96				
NO.	DATE	ISSUE/REVISIONS	DRAWN BY	DESIGN	FIELD REVIEW	QC CHECK	



FRASER SHIPYARDS, INC.

FIGURE 11  
AOC #12

PROJ. NO. FRAS9401	11
DATE 03/12/96	11

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## **Appendix A**

### Standard Operating Procedures



## Soil Vapor Monitoring - Simultaneous FID and PID

Soil vapor (headspace) measurements are made on soil samples collected during soil boring and excavation activities. The field instrument used is a portable Foxboro Toxic Vapor Analyzer (TVA) Model 1005 with simultaneous flame ionization detector (FID) and photoionization detector (PID) capabilities. The TVA-1000 has been laboratory calibrated. The calibration of the FID is verified in the field using 105 ppm methane and the PID is verified in the field with 98 ppm isobutylene prior to conducting any sample measurements. This instrument has the following standard specifications:

Accuracy	<p><i>PID Instrument</i> - <math>\pm 25\%</math> of reading or <math>\pm 2.5</math> ppm, whichever is greater, from 0.5 to 500 ppm. Accuracy listed is achieved using isobutylene with a 1-point calibration in the range of 100 to 300 ppm (including drift) at the temperature and humidity of the calibration.</p> <p><i>FID Instrument</i> - <math>\pm 25\%</math> of reading or <math>\pm 2.5</math> ppm, whichever is greater, from 1.0 to 10,000 ppm. Accuracy listed is achieved using methane with a 1-point calibration in the range from 100 to 500 ppm (including drift) at the temperature and humidity of the calibration.</p>
Repeatability	<p><i>PID Instrument</i> - <math>\pm 1\%</math> at 100 ppm of isobutylene</p> <p><i>FID Instrument</i> - <math>\pm 2\%</math> at 100 ppm of methane</p>
Dynamic Range	<p><i>PID Instrument</i> - <math>\pm 0.5</math> to 2,000 ppm of isobutylene</p> <p><i>FID Instrument</i> - <math>\pm 1.0</math> to 50,000 ppm of methane</p>
Linear Range	<p><i>PID Instrument</i> - <math>\pm 0.5</math> to 500 ppm of isobutylene</p> <p><i>FID Instrument</i> - <math>\pm 1.0</math> to 10,000 ppm of methane</p>
Minimum Detectable Level	<p>The minimum detectable level is defined as two times the peak-to-peak noise.</p> <p><i>PID Instrument</i> - 100 ppb of benzene</p> <p><i>FID Instrument</i> - 300 ppb of hexane</p>
Response Time Using Close Area Sampler	<p><i>PID Instrument</i> - Less than 3.5 seconds for 90% of final value, using 100 ppm of isobutylene</p> <p><i>FID Instrument</i> - Less than 3.5 seconds for 90% of final value, using 10,000 ppm of methane</p>
Response Time Using Charcoal Filter Adapter	<p><i>PID Instrument</i> - Less than 20 seconds for 90% of final value, using 100 ppm of isobutylene</p> <p><i>FID Instrument</i> - Less than 20 seconds for 90% of final value, using 10,000 ppm of methane</p>
Data Storage Rate	From 1 per second to 1 per 999 minutes, user selectable
Sample Flow Rate	1 l/minute, nominal, at sample probe inlet
PID Lamp Life	Greater than 2,000 hours for 10.6 eV lamp, with normal cleaning
FID Life	Greater than 2,000 hours
Normal Operating Temperature	0 to $+40^{\circ}$ C

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The following procedure is used in determining headspace gas concentrations in each soil sample:

1. Quart size plastic Ziploc bags were used for soil headspace containers. Soil samples were placed in bags using disposable spatulas or decontaminated stainless steel spatulas. The containers were filled half way with soil from specific sample locations then quickly sealed and labeled to record sample number and depth from which the sample was taken.
2. Headspace is allowed to develop for 10 minutes. The Ziploc bag is vigorously shaken for 15 seconds both at the beginning and end of the headspace development period. Clods of cohesive soil are broken to facilitate development of vapors in the headspace. Where ambient temperatures are below 32° F (0° C), headspace development is conducted within a heated vehicle or building so samples can warm to approximately 70° F.
3. After headspace development, the plastic bag is punctured with the instrument sampling probe to a point about one-half of the headspace depth. Care is exercised to avoid intake of water droplets or soil particles.
4. Following probe insertion through the plastic bag, the highest meter response is recorded as the headspace concentration.

Samples are also examined visually by an environmental professional for staining or other signs of contamination.

## Soil Description SOP

Method: Used references ASTM D2487, D2488

Description:

MAIN SOIL DESCRIPTOR, (USCS Abbreviation), color, grain size distribution with % of additional components, grading, moisture descriptor, other notes such as staining, odor, mottling, sedimentary structures.

Descriptor Details:

MAIN SOIL DESCRIPTOR (Capitalized): SAND, SILT, CLAY, SILTY SAND, GRAVEL, PEAT

(USCS Abbreviation): SP, SM, CL, ML, SP-SM, GP, etc.

Color: Tan, Reddish-brown, Gray, Gray-Black

Grain Size Distribution with % of Additional Components: Medium-fine grain sand with 10-20% \_\_\_\_\_ granules.

Grading (sorting): Well-graded, poorly graded.

Moisture Descriptor: Moist, wet, dry.

Other Descriptors: Staining, odor, mottling, bedding (planer, cross-bedded), reddish mottling.

## **Protocol for Hand Auger Sampling of Shallow Surface Soils**

Surface soil sampling is performed using a stainless-steel soil auger with stainless-steel extension handles. As samples are collected, they are visually observed for soil type and the presence of staining potentially indicative of contamination. Similarly, soils are screened for the presence of volatile organic compounds (VOCs) using a photoionization detector (PID) or flame ionization detector (FID). VOCs are common components of a variety of environmental contaminants, including industrial solvents, petroleum products and a wide range of other industrial compounds.

The PID and FID are also used to monitor ambient air concentrations at the borehole and within the work zone during the hand auger sampling, in accordance with SEH's Site Safety Plan. Personal protective equipment is utilized by sampling personnel, as specified in the Site Safety Plan.

To avoid cross-contamination, the auger bucket extensions, and handles are decontaminated prior to initial use at the site and between sampling locations. This procedure includes a soap and water or trisodium phosphate (TSP) wash, followed by a triple distilled or deionized water rinse. During sampling the hand auger bucket is retracted slowly from the boring to prevent soil sloughing. Soil samples are normally collected over the following intervals in hand-augered borings; 0-.5', 2-2.5', 4-4.5', 6-6.5' and at 2 foot intervals below 6 feet as necessary. Samples are transferred from the bottom of the bucket auger using stainless steel sampling equipment to laboratory clean, glass sample jars. The jars are then labelled with the sample designation, location, date, time and sampler. Stainless steel sampling equipment used to collect the soil sample from the bucket is decontaminated between samples using a soap and water wash followed by a distilled water rinse. Sample collection and preservation will follow the latest WDNR LUST Guidance protocol. Collected samples are preserved on ice and shipped to the contracted analytical laboratory. SEH standard chain of custody procedures are followed regarding the shipment and receipt of samples.

Contaminated soils generated during the boring and sampling procedures are stockpiled on plastic sheeting at the location for later treatment/disposal. After sampling is completed, borings are abandoned with a clean soil/bentonite mixture and documented on WDNR borehole abandonment forms.

## **Protocol for Split-Spoon Sampling of Subsurface Soils**

Subsurface soil samples are collected by performing soil borings at selected locations at the site. Soil borings are performed using hollow stem auger (HSA) and split-spoon sampling techniques. Soil samples are collected at 2.5 foot intervals from 0 to 10 feet, and at 5 foot intervals thereafter to the borehole bottom, in accordance with American Society of Testing and Materials (ASTM) standards (ASTM:D 1586-84). A standard 2 inch OD split-spoon sampler is used for collection of soil samples. The drilling is directed by SEH's Site Representative, who logs geologic materials encountered during drilling, field screens auger cuttings and soil samples, and observes the drilling activities and supervises sample collection.

As samples are obtained in the field, they are visually classified by SEH's Site Representative. Sample lithology is recorded using the Unified Soil Classification System. Soil boring logs, documenting soil types and subsurface conditions, are completed by SEH's Site Representative. Actual borehole depth and selection of soil samples for analysis is based upon instrument screening, visual observation and odor.

Drill cuttings and liquid generated by boring activities are left on site. Contaminated soils are either stockpiled on plastic sheeting or when required by site conditions are contained in 55-gallon steel drums. When sampling is completed, borings are backfilled with bentonite mixed with clean soil cuttings. Borehole abandonment procedures follow WDNR guidelines and are documented on standard forms. The split-spoon sampler is cleaned between samples to minimize cross contamination. The cleaning procedure consists of a soap and water or trisodium phosphate (TSP) wash, followed by a rinse with clean tap or distilled water. Split-spoons are typically cleaned by the drilling contractor. To avoid cross-contamination between soil borings, drilling augers are steam-cleaned between borings.

In accordance with SEH's Site Safety Plan, a photoionization detector (PID) or flame ionization detector (FID) and explosimeter are used to monitor ambient air concentrations at the borehole and within the work zone during drilling. The PID and FID are also used for field screening soil samples for the presence of volatile organic compounds. Personal protective equipment is utilized by site personnel during performance of sampling activities, as specified in the Site Safety Plan.

Stainless-steel sampling equipment used to collect the soil sample from the bucket is decontaminated between samples using a soap and water wash followed by a distilled water rinse.

The latest WDNR LUST Guidance protocols are followed in collecting and preserving soil samples for laboratory analyses. Soil samples are placed in laboratory cleaned glass jars and labelled, identifying sample number, location, date, time and sampling personnel. Samples submitted for analysis are preserved on ice and shipped in a cooler overnight to the contracted analytical laboratory. SEH standard chain of custody procedures are followed regarding shipment and receipt of samples.

## **Well Development, Stabilization and Sampling**

Groundwater monitoring wells are developed and sampled according to WDNR guidelines outlined in NR 141.21. Wells which cannot be purged dry are surged and purged for 30 minutes prior to well development using a bottom-loading disposable plastic bailer. Ten well volumes are removed from the well during development. Wells that can be purged dry are bailed slowly to avoid agitation. The well is purged dry twice and allowed to recover prior to sampling. Following development, water is collected from the well using a bottom sampling bailer and placed in laboratory supplied sample bottles. The sample bottles are placed in an ice-filled cooler, stored under refrigerated conditions and sent to the laboratory following chain-of-custody procedures.

Sampling procedures used after the initial round of groundwater monitoring follow WDNR guidelines outlined in PUBL-WR-168. In low permeability formations, the well is bailed dry using a disposable plastic bailer. The well is sampled after a sufficient volume of water is present in the well for the required analyses. In high permeability formations, four well volumes are bailed from the well prior to sampling.

# Groundwater Sampling Procedures

## Monitoring Wells

Groundwater samples are collected from monitoring wells after initial well development following WDNR Guidelines contained in PUBL-WR-16887, "Groundwater Sampling Procedures".

### Wells that can be Purged Dry

- (1) Pump or bail the well dry.
- (2) Allow the well to recover after purging.
- (3) Purge the well a second time (if time permits).
- (4) Collect the water sample as soon as there is a sufficient volume of water for the intended analysis.

### Wells that Cannot be Purged Dry

- (1) Remove four well volumes.
- (2) Purge wells by bailing as near the water surface as possible. Disposable bailers are used to purge and collect water samples. Bailer rope is kept as clean as possible during purging and sampling activities. Water samples are collected from the bottom of the bailer and poured into laboratory provided glass containers. Sample bottles are filled until a positive meniscus is formed at the brim of the container. Agitation and turbulence is avoided while filling the sample bottles. Disposable nitrile gloves are worn while collecting samples. Sample bottles are tightly sealed after filling, placed on ice in a cooler, repacked in the office, and sent to the laboratory following chain of custody protocol.

### Private Water Supplies

Water samples are collected prior to entering any treatment system and from a tap as close as possible to the well. The tap is opened and water allowed to run at least five minutes before sampling. Sample collection procedures follow those previously described in the previous section.

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## **Appendix B**

### Documentation and Quality Assurance/Quality Control



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## Documentation and Quality Assurance/Quality Control (QA/QC)

Specific documentation and QA/QC procedures will be followed during the investigative activities at the site to ensure that accurate and representative data are collected. This section describes the procedures to be followed during field activities only. Additional information regarding site activities is contained in Appendix C, "Standard Operating Procedures." The laboratory QA/QC procedures will be performed in accordance with specific method requirements and laboratory standard operating procedures.

A written log will be used to document field procedures and conditions. The written log will be kept in a bound field book with pre-numbered pages. Field notes will be entered with an indelible ink pen at the time information is obtained. Field notes will be entered daily when activities occur. The field notes will include at least the following information:

- Date
- Field personnel (including owner, consultants, subcontractors, regulatory agency)
- Weather (temperature, cloud cover, wind, precipitation)
- Equipment (including screening, sampling, subcontractor equipment)
- Calibrations performed, calibration curves or standards
- Results and techniques used for field screening
- Sampling locations (this requires an accurate map)
- Methods and/or devices used in sampling
- Decontamination procedures used
- Time and date of sample collection
- Type of sample (soil, groundwater, surface water, etc.)
- Field preservation performed
- Field QC data associated with the sample
- Sample ID (must clearly correlate to sample locations shown on a map)
- Any deviations from work plan, SOP or special conditions

In addition to the written log, a photographic log may also be prepared documenting pertinent field conditions and sampling procedures. The photographs will be labeled to indicate the subject, date, time, direction and other relevant information. Upon completion of the field activities, the photographs will be assembled and placed in the project file.

For this project, quality assurance is the overall program for assuring reliability of field and analytical data. Quality control is the routine application of procedures for obtaining prescribed standards of performance during the field activities.

All sampling equipment will be stainless steel and decontaminated prior to use in the field, or disposable and dedicated to a single sample. When field equipment will be reused in the field (i.e., collect samples at different depths or locations), the non-disposable equipment will be decontaminated prior to reuse. The decontamination method involves a detergent or trisodium phosphate (TSP) wash, and a triple rinse with

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deionized water. The sampling equipment for the project will include a stainless steel split spoon, stainless steel or disposable bailers, and stainless steel spatulas. Sample collection will begin at the point of assumed least contamination and continue toward the areas of potential higher contamination. Samples will be transferred directly into laboratory clean glass bottles with Teflon caps.

Individual labels describing the sample, number, location, sampler's name, date, preservatives, and other relevant information will be attached to the bottles upon collection. All samples will be tracked using strict chain-of-custody procedures. Sample bottles will be tracked from the laboratory, to the field and back to the analytical laboratory. The chain-of-custody will also document relevant sampling and preservation.

Field QA samples will include the following:

- Duplicate samples are discrete samples obtained from the same location and time. These samples are generally formed by splitting a larger sample into two subsamples.
- Temperature blanks are additional water samples collected in the same manner as samples, used to determine the temperature of samples on receipt by the lab.
- Field blanks are water samples processed through the same sampling and filtering equipment, used as a check on decontamination procedures (not collected when sampling with disposable bailers).
- Trip blanks are reagent water samples analyzed before leaving the lab and on their return as a check on contamination from sources outside samples (unless otherwise specified).

Field QA samples will be handled and stored in an identical manner as actual samples. Results of the analysis of duplicates, temperature, field, and trip blanks will be included in the SI report.

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## **Appendix C**

### Lysimeter Specifications



# TIMCO™ LYSIMETER MANUAL

## OPERATING PRINCIPLES

The TIMCO™ Lysimeter System is designed for long term use in one location. Care must be taken with the installation to ensure correct operation for a long period. The assembled system should be checked for leaks prior to being put in the ground.

A tube or cup type Lysimeter has an outside diameter of 1.9" and should be placed in boreholes of at least 6" in diameter, this allows for an adequate silica slurry pack to surround the Lysimeter.

The Lysimeter has the vacuum/pressure outlet marked on the Lysimeter top plug. This connection leads to the vacuum gauge on the head assembly. It allows a vacuum to be applied to the system, thereby creating a vacuum gradient between the inside of the Lysimeter, the slurry pack, and the soil under investigation. The second marked connection is the sample evacuation tube. This is connected to the head assembly sample line.

The specification of the silica flour used to surround the installed Lysimeter is optional and can be purchased from TIMCO™. If a 6" borehole is used, a single 50 lb. pail will be sufficient for each Lysimeter installation. The silica slurry is used to establish a continuum between the Lysimeter and the surrounding soil. Since the TIMCO™ silica is not water soluble, it immediately begins to separate itself from the distilled water. When placed in the ground the water migrates into the soil and establishes the continuity required for surface tension to be transmitted in an outward direction upon application of a vacuum. This allows any moisture attached to the soil particles to be drawn into the Lysimeter through the silica pack.

It must be mentioned here that TIMCO™ suggests that the use of silica flour in a Lysimeter installation is optional. Alternate materials can be used in establishing continuity between the porous filter and the soils under investigation. Sifted or filtered backfill can be used with TIMCO™ Lysimeters.

TIMCO™ manufactures a variety of Lysimeters for use in vadose zone investigations. The Ceramic Filter models and Teflon® Filter models have different applications and varied situations within an application. Typically the Teflon® Filter models are used in saturated vadose zone situations like golf courses or irrigated farmland, and the Ceramic Filter models are used in dry soil conditions. The cup-type models (filter media in cup form at the bottom of Lysimeter) will pull a sample from a larger area than the tube-type. The tube-type (filter media in the center of Lysimeter) insures the sample will not migrate back into the soil. The Shallow Sampling Lysimeter is designed for placement at 20 feet or less. For installations at depths of 20 feet to 300 feet a Deep Sampling Lysimeter is required. While all models are manufactured to the highest quality standards, TIMCO™ cautions the user to be careful in the choice of a Lysimeter, and to be certain the choice made is one that is compatible with the Lysimeter capability.

### Ceramic Filters with PVC Bodies



TIMCO™  
Cup Type Lysimeter



TIMCO™  
Tube Type Lysimeter



TIMCO™  
Deep Sampling Lysimeter  
Cup Type



TIMCO™  
Deep Sampling Lysimeter  
Tube Type



## TIMCO™ LYSIMETER MANUAL

### SYSTEM REQUIREMENTS

The following items will be required for a typical TIMCO™ Lysimeter Installation up to 20 feet beneath the ground surface.

- A TIMCO™ Shallow Cup-Type or Tube-Type Lysimeter
- A TIMCO™ Lysimeter Head Assembly
- A 50 lb. Pail of TIMCO™ Silica Flour (200 mesh, 99.88% pure)
- Up to 40 feet of Teflon® or Polyethylene Tubing, and tube groover
- A TIMCO™ Vacuum/Pressure Hand Pump
- Up to 20 feet of TIMCO™ Deka-Seal™, Teflon®, or PVC flush threaded casing
- TIMCO™ Surface Protective Cover

#### Additional items not provided by TIMCO™ :

- Chemicals and distilled water for decontamination (optional)
- Distilled water for pressure testing, de-airing and prefilling
- Plastic gloves for handling the decontaminated system
- A latex membrane for vacuum testing the system
- Clean plastic bags to wrap the assembled system for transfer to the installation site
- 2 gallons of distilled water for each 50 lb. pail of TIMCO™ Silica Flour
- A large clean silica flour mixing container
- A large rigid spatula to mix the silica slurry
- A clean sample collection container with a 2 port stopper seal compatible with the TIMCO™ Teflon® tubing. The capacity should be greater than that of the Lysimeter.
- Bentonite to seal the borehole above the Lysimeter
- A padlock for the protective cover



## TIMCO™ LYSIMETER MANUAL

### ASSEMBLING THE LYSIMETER

If properly installed, the typical Lysimeter system will be expected to produce representative samples for several decades. It is therefore important to check out the system thoroughly before taking it to the installation site. Prior to installation the system should be pressure and/or vacuum tested to ensure it is leak free.

The Lysimeter system components supplied by TIMCO™ are cleaned and packed in plastic bags. They have not been subjected to the rigorous decontamination procedures required for equipment used to obtain samples for subsequent micro-analysis of trace pollutants. If complete decontamination is required, see the section titled "Decontamination Procedures" and/or follow those specified for the specific job. Note: If the Lysimeter body is decontaminated it will be necessary to pass at least 2 liters of distilled water through the porous section to ensure complete removal of liquids used for the decontamination. After this procedure is completed, the components should be bagged. Subsequent handling should be done in a clean area using sterile gloves.

The system components supplied are manufactured by TIMCO™ to satisfy the requirements of the order. Mixing these with components from other sources may lead to incompatibility problems resulting in leakage or failure of the Lysimeter system.

#### Assembly of Tubing to Fittings

Tubing, because of its slippery nature and rigidity, has to be specially grooved before a fitting is attached. Failure to do so will allow the tubing to slip out of the fitting and cause leakage. TIMCO™ normally grooves each end of the tubing supplied with the order. If the installation requires the tubing to be shortened the new end will need to be grooved using a special grooving tool available from TIMCO™. The tool not only cuts the groove but also places the groove at the correct distance from the end of the tube.

#### Assembling the System

- 1) As mentioned earlier, it is suggested the complete system be assembled away from the installation site. This will allow for the assembly and testing under clean conditions. The assembled Lysimeter may then be easily placed at the job site.
- 2) Attach the vacuum/pressure and sample evacuation lines to the Lysimeter top plug. If necessary cut each to length, making certain the cuts are clean and vertical to the horizontal length of the tubing.
- 3) Follow the previous instructions for the grooving. Note the vacuum/pressure outlet at the top of the Lysimeter plug is marked with a "V". Make certain the other end of the tube connected to this fitting is suitably marked or tagged. (A piece of tape works well.) This will assure the tubing is correctly connected to the TIMCO™ Head Assembly.
- 4) If the installation is to involve threaded casing, assemble it at this time.
- 5) Pass the two tubes from the Lysimeter through the casing string.
- 6) To complete the assembly attach the sample evacuation and vacuum/pressure lines to the bottom of the head assembly. The TIMCO™ vacuum/pressure hand pump is connected on the vacuum mode. The black female hose connector should be used to attach the end of the tubing to the hand pump (black end).



## TIMCO™ LYSIMETER MANUAL

### TESTING THE SYSTEM

Effective use of the Lysimeter Systems requires there be no air leaks. Two methods are described to check the assembled system for leaks.\*

#### Pressure Testing

Completely immerse the Lysimeter and the tubing connections in distilled water. Connect the pressure outlet of the TIMCO™ hand pump to the vacuum/pressure line fitting on the head assembly. Close the sample port on the head assembly. Apply 15 psi of air pressure. Observe all connections for evidence of bubble leakage. The porous filter section should give off bubbles over its entire surface area. If leaks are observed in the tubing fittings, disassemble and check for correct assembly and retighten. Leaks at the fitting connections to the Lysimeter body or the head assembly may be wrapped with Teflon® tape prior to reassembly. Leaks involving the body components of the Lysimeter should be checked for cleanliness, particularly the surface that touches the O-rings.

#### Vacuum Testing

The porous filter media of the Lysimeter body is sealed off with a latex or flexible plastic membrane. Secure a seal by placing rubber bands over the membrane and securing it to the body of the Lysimeter above the porous filter. Shut off the sample valve. Connect the vacuum inlet of the pump to the vacuum/pressure port on the head assembly, and apply a vacuum in excess of 20 inches of mercury. Shut off the vacuum valve. Note the vacuum reading on the gauge. Leave the system for several hours and then recheck the vacuum reading. A small drop of up to 3 inches of mercury may be expected. If a large drop is noted, check and retighten all connections as described above.

#### Prewetting the Porous Filter Media

Finally, before taking the assembled Lysimeter system to the installation site, TIMCO™ recommends that the Lysimeter body be placed in distilled water and a vacuum of about 15 inches of mercury be applied for 1 hour. This procedure prevents all surfaces of the porous filter media, eliminating any entrapped air in the filter media. The Lysimeter should be installed with the body filled with distilled water if no riser casing is used. An empty, unsupported Lysimeter will float on the wet silica slurry when placed in the borehole.

\*Note — All TIMCO™ Lysimeters are tested at TIMCO™ prior to shipping. Fittings may loosen during transit.



## TIMCO™ LYSIMETER MANUAL

### INSTALLATION AND EVACUATION OF THE SHALLOW LYSIMETER

The installation of a TIMCO™ Lysimeter System should be in accordance with the following procedure. It is suitable for depths of up to 20 feet. For greater depths a TIMCO™ Deep-Sampling Lysimeter should be used.

#### 1.) Borehole Preparation

The borehole must provide adequate space to allow the Lysimeter body to be surrounded by the silica slurry pack. For a 1.9" diameter Lysimeter use a 6" or larger borehole. The borehole must allow for at least a 1.5" thickness of silica slurry all around the porous filter of the Lysimeter. If difficulties are anticipated in maintaining an open borehole, use casing to hold back the material. Immediately after installation of the silica pack and Lysimeter, pull back the casing and install a bentonite plug.

#### 2.) Mixing the Silica Flour Slurry

The TIMCO™ 200 mesh, 99.88% pure crystalline silica flour is mixed with distilled water using a ratio of 150 mls. water to 450 grams of silica flour. The TIMCO™ Silica Flour is supplied in a 50 lb. sealed pail. This will require about 2 gallons of distilled water to make the slurry and will be sufficient for a single Lysimeter installation on a 6" borehole. Add the flour slowly to the distilled water with constant stirring. The mix must be completely blended and lumpfree. Constant stirring is essential as the silica is not water soluble and will settle if not agitated.

#### 3.) Placing the Silica Slurry Pack

Pour part of the silica slurry into the borehole to provide a bed for the Lysimeter. A minimum of 4" depth for the cup-type Lysimeter and 2" for the tube-type Lysimeter. Depending upon the borehole diameter, between a quarter and a third of the total mix is usually sufficient.

The TIMCO™ Lysimeter System should now be lowered into the borehole. Take particular care to make certain that the Lysimeter body is centrally located within the borehole diameter. A minimum of 1.5" of silica slurry around the annular area of the unit is essential. TIMCO™ suggests Deka-Seal® casing be used for support and accurate placement. Centralizers will also assure correct placement.

The balance of the silica slurry should now be poured into the borehole to completely cover and surround the Lysimeter body. Note that you must have the Lysimeter in intimate contact with the silica slurry and the slurry must fill all voids in the bottom of the borehole. The Lysimeter should be supported at the surface with stakes for at least 2 hours until the silica sets.

A bentonite seal should be installed next, followed by tamped backfill. A second bentonite seal is suggested near the surface. Protection at the surface can be achieved with the TIMCO™ Lysimeter Head Assembly and a TIMCO™ Protective Cover set in concrete.

#### 4.) Activating the Lysimeter

If the Lysimeter was filled with distilled water before installation, this should now be removed and discarded. TIMCO™ recommends the use of a two port rubber stopper in a collection flask. The flask should be of adequate size to hold the sample from a full Lysimeter. This method is unlikely to disturb the silica pack and break the seal between the pack and the porous section of the Lysimeter which would result in a Lysimeter system failure.





## TIMCO™ LYSIMETER MANUAL

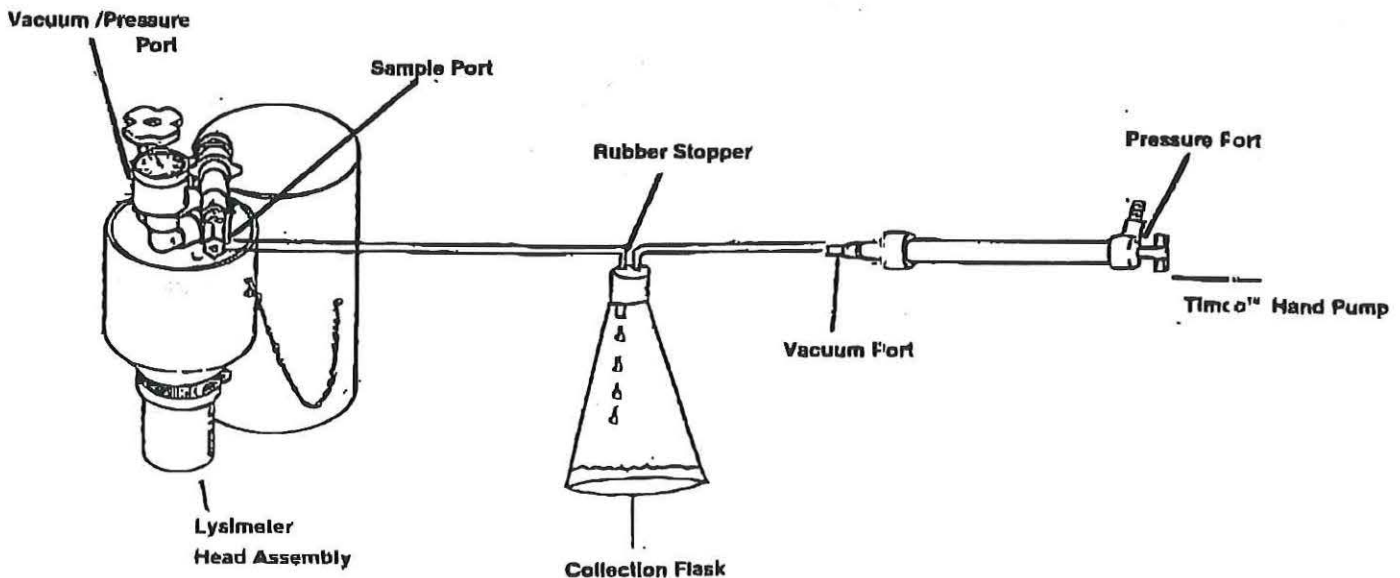
1. Close the vacuum/pressure valve and open the sample valve on the head assembly.
2. Attach the tube from the sample port on the head assembly to the hole in the rubber stopper, (Tube to protrude about 1" into the flask.)
3. Attach the second tube from the flask to the vacuum/pressure inlet on the TIMCO™ Hand Pump. (Tube to be flush with the bottom of the rubber stopper.)
4. Apply a gentle vacuum to the system, the distilled water will flow into the collection flask. (See illustration)

### 5.) Evacuating the Lysimeter

After removing the distilled water from the Lysimeter you are ready to charge the Lysimeter to obtain a sample. If you start the charging procedure immediately after installation, it will be necessary to discard the distilled water used to make up the silica pack. (\*Remove a water volume equivalent to approximately one third of that used to make up the slurry.) If the installation is left for a few days, the water in the silica pack will migrate into the surrounding soil and establish the continuity needed between the porous filter media and the soil. Samples collected in this situation should be considered representative.

1. Close the vacuum/pressure valve and open the sample valve on the head assembly.
2. Continue applying a gentle vacuum to the Lysimeter until a reading of 18-21 inches of mercury is reached. Quickly close the sample port.
3. When the gauge reads 10 inches of mercury or less, evacuation of water should be attempted. (Up to 24 hours may be needed.)

\*Example: Using 2 gallons (7570 ml.) to mix the silica slurry would mean that the first .6 gallons (2271 ml.) of distilled water should be discarded.



Sample capacity:	1.9" Cup-Type	400 MLS
	1.9" Tube-Type	550 MLS



## TIMCO™ LYSIMETER MANUAL

### TIMCO™ Deep-Sampling Cup and Tube Type Lysimeters

The TIMCO™ Deep-Sampling Lysimeters are used when the area to be investigated is deeper than 20 feet. The maximum operational depth is 300 feet. This system is operated exactly the same as a shallow installation except that pressure must be used to evacuate the sample. All instructions for installation, and activating the system are the same as the shallow installation.

If sampling deeper than 100 feet, the pressure supplied by the hand pump may not be sufficient to remove the sample. A pressure of .44 psi is required for each foot of depth. A portable nitrogen tank or air compressor may be used as an alternate pressure source.

### Evacuating the Deep-Sampling Lysimeter

- 1) Open the sample evacuation valve and the vacuum/pressure valve.
- 2) Connect the pressure outlet of the TIMCO™ Hand Pump to the vacuum/pressure port of the head assembly.
- 3) Gently increase pressure until 9 psi is achieved to lift the sample into the holding chamber of the Deep-Sampling Lysimeter. (If 9 psi were applied instantly, it is possible the silica pack would be damaged resulting in a Lysimeter system failure.)
- 4) Apply the correct amount of pressure required to lift the sample to the surface and into a collection flask. (Example: 100 feet x .44 psi = 44 psi of lift to evacuate the Lysimeter.)



## TIMCO™ LYSIMETER MANUAL

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### CLEANING AND DECONTAMINATION

The following advice is provided by TIMCO™. TIMCO™ can assume no liability and provides no guarantee the procedures will ensure that a TIMCO™ product has been 100% cleaned. TIMCO™ does however believe the procedures will give the proper purity characteristic required under state of the art conditions.

#### Teflon® & Ceramic Components

- Step 1 - Disassemble all components.
- Step 2 - Prepare a normal solution of Hydrochloric Acid.  
(120 g. concentrated HCL diluted in 1 liter distilled water).
- Step 3 - Rinse all components in distilled water.
- Step 4 - Submerge all components in this solution for 30 minutes minimum. Use a tool to remove from the solution. Soak in distilled water.
- Step 5 - Resubmerge the components in clean water at least 2 more times to remove all traces of Hydrochloric Acid.
- Step 6 - TIMCO™ believes an additional step of an Isopropyl Alcohol (IPA) bath and then another bath of Hydrogen Peroxide should render the equipment clean.
- Step 7 - In all cases a final rinse in distilled, deionized water should ensure that the device is then suitable for representative sampling.

#### PVC Components

- Step 1 - All products must be thoroughly cleaned of loose PVC particles, machining burrs and any other loose materials both inside and out.  
(Timco normally does this with all products shipped, but occasionally mistakes happen).
- Step 2 - Prepare a suitable Isopropyl Alcohol (IPA) bath which will allow total immersion of the product to be decontaminated.
- Step 3 - Allow products to remain fully immersed for a period of no less than 10 minutes.
- Step 4 - Remove products with clean surgical gloves to reduce chances of new contamination. Allow excess IPA to drain off.

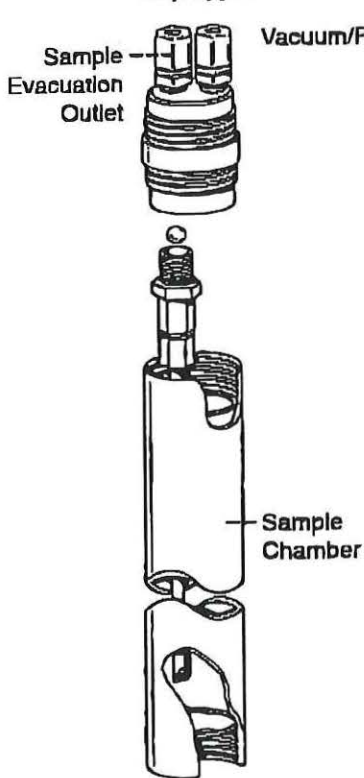


# TIMCO™ LYSIMETER MANUAL

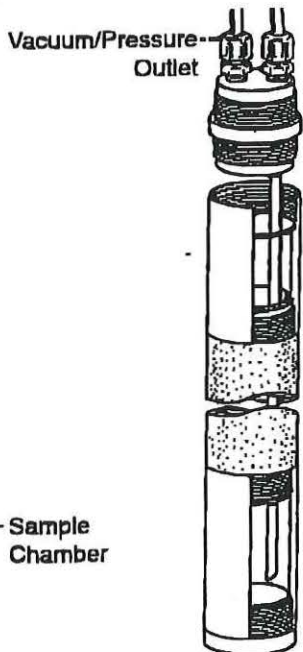
## LYSIMETER MODELS

Available with Teflon® filters in Teflon® or PVC Bodies or with Cerarnic filters in PVC Bodies.

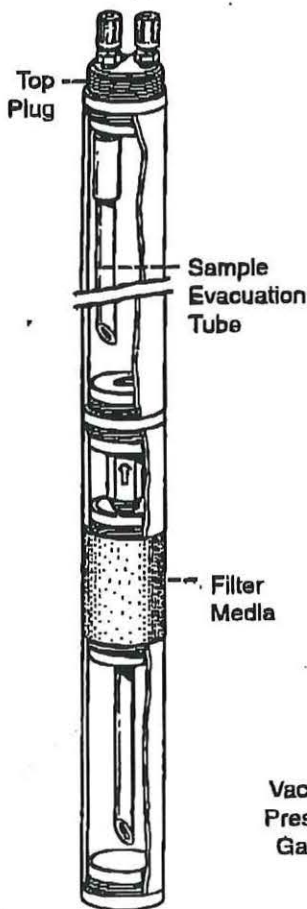
### TIMCO™ Deep Sampling Lysimeter Cup Type



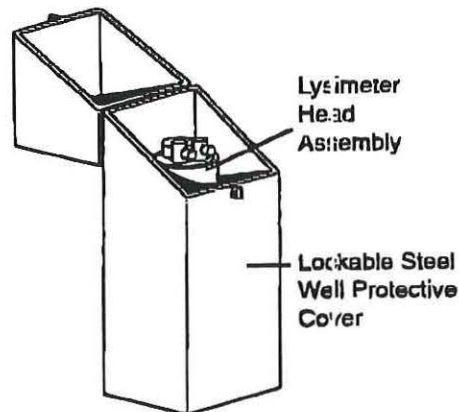
### TIMCO™ Tube Type Lysimeter



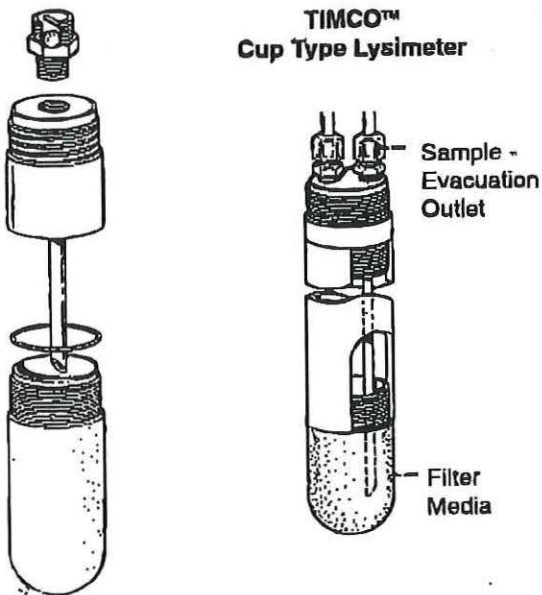
### TIMCO™ Deep Sampling Lysimeter Tube Type



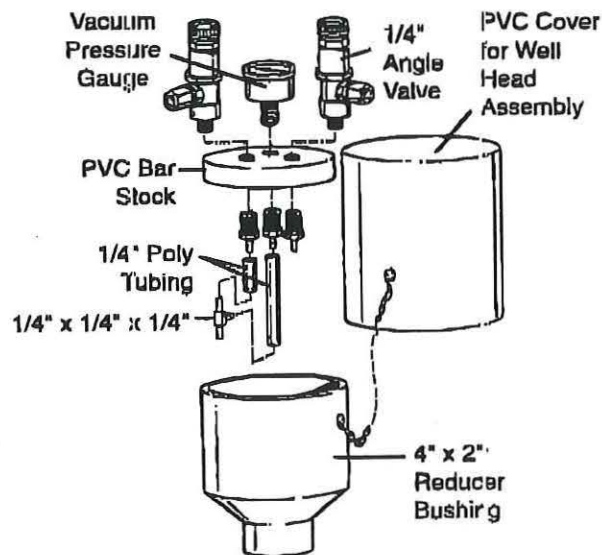
### TIMCO™ Steel Well Protective Cover



### TIMCO™ Cup Type Lysimeter



### TIMCO™ Lysimeter Head Assembly



TIMCO™ Cup Type Lysimeter with Porous Ceramic Filter



PVC

# TIMCO™ Lysimeters for Vadose Zone Monitoring



## TIMCO™ Porous Ceramic Lysimeters

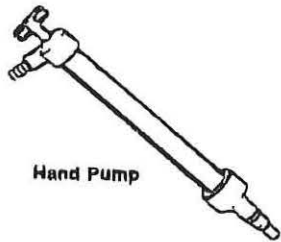
TIMCO'S™ Porous Ceramic Lysimeters are constructed similar to the TIMCO™ Porous Teflon® Lysimeters. Advanced machining techniques allow the ceramic filter to be threaded. This permits, for the first time, a totally adhesive and sealant free construction. Sealants, potential sources of contamination, are eliminated. The TIMCO™ Ceramic Filter Elements have a pore size of 0.446 micrometers by the mercury penetration porosimetry method (ASTM C-899).

The TIMCO™ Porous Ceramic Filter element may be easily removed from the body for decontamination or replacement if accidental breakage occurs. TIMCO™ uses Viton® O-rings in the flush threaded ceramic joints, to ensure a leak-free seal. The top plug is threaded to allow attachment of casing. If the lysimeter unit is located more than 20' (6M) below the ground surface, a TIMCO™ Deep Sampling Lysimeter will be required. Sample recovery in excess of 10 psi may damage the filter and/or silica pack and force the collected pore water sample out of the lysimeter, back into the soil. TIMCO™ recommends the use of its Select Silica Flour as a pack around the installed lysimeter. Cup type available in 1.9" O.D. x 17.5" length.

Lysimeter Accessories



Silica Flour



Hand Pump

## TIMCO™ Lysimeter Accessory Items

### Tubing

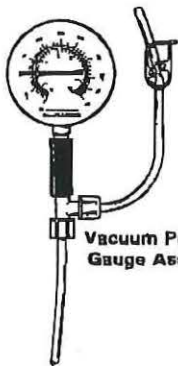
TIMCO™ provides tubing to connect the lysimeter to the surface. Usually 1/4" OD Teflon® or polyethylene is suitable.

### TIMCO™ Select Silica Flour

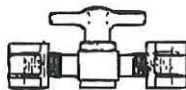
Silica, 200 mesh (99.8% pure) is available in 50lb (23kg) plastic pails. Allow a minimum of 1 pail per installed lysimeter. Mix each pail with 2 gallons of distilled water to make about 6 gallons of silica slurry.

## Electric Vacuum Pump (12 Volt)

Capable of pulling 25 inches of mercury on several lysimeters simultaneously.



Vacuum Pressure Gauge Assembly



Teflon® Stopcock

### Vacuum Pressure Hand Pump

The pump is used to apply vacuum to the lysimeter during the pore water extraction phase. Pressure or vacuum is applied to deliver the sample to the surface.

### Vacuum Pressure Gauge Assembly

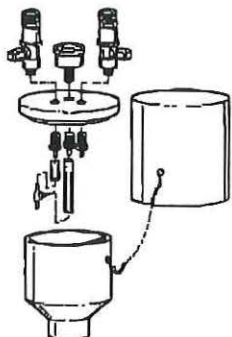
When installed on the lysimeter vacuum/pressure tube, allows for constant monitoring during the pore water extraction phase. During the sample recovery phase, it will alert the user to potential over-pressurization.

### Teflon® Stopcock and Delrin® Shut-Off Valves

Designed to allow easy sealing of the sample delivery and vacuum/pressure lines when not using a lysimeter well head assembly. The Teflon® stopcock is used with Teflon® tubing, the Delrin® shut off valve is used with polyethylene tubing.



Delrin® Shut-off Valve



Lysimeter Head Assembly

### Lysimeter Head Assembly

Designed for placement on the casing at the ground surface, it provides a neat and secure termination of the tubes from the lysimeter. A permanent vacuum/pressure gauge and taps for the vacuum/pressure and sample line are mounted beneath the weatherproof cap. Stopcocks and gauge assembly are not needed with Head Assembly.

## TIMCO™ Lysimeters for Vadose Zone Monitoring

Investigation of the vadose or unsaturated zone is an essential part of many environmental monitoring programs. The ability to detect groundwater pollutants as they travel towards the water table is possible with the use of TIMCO™ Lysimeters. Early detection, by removing samples of soil pore water, usually results in less expensive remedial measures.

The TIMCO™ Lysimeter is a soil pore water collection device, designed for permanent installation beneath the ground surface. It is a closed tubular device with a porous filter element either at one end (cup type) or mid way, (tube type). The TIMCO™ Lysimeter is provided with two ports, one to allow application of a vacuum or pressure, the other to allow delivery of collected water samples to the surface.

It operates by establishing continuity between the soil pores and those in the porous element of the lysimeter. Usually the lysimeter will be surrounded by a TIMCO™ Select Silica Flour Pack to ensure intimate contact and effectively increase the operating range. An equilibrium will be established between the water in the soil pores, the silica pack and the porous lysimeter filter element. Application of a vacuum to the inside of the TIMCO™ Lysimeter will cause the pore water to flow from the soil pores through the silica flour pack and porous filter element into the lysimeter body. The soil pore water may then be transferred to the ground surface via the sample line.

### TIMCO™ Porous Teflon® Lysimeters

TIMCO™ makes Porous Teflon® lysimeters, (U.S. Pat. 4,692,287 and 4,759,227), in both cup and tubular forms. They have the unique properties of Teflon® (inertness, and stability) plus no effect on the pH of collected samples, less likelihood of ion absorption and susceptibility to clogging. The TIMCO™ manufacturing method offers a unique pore within a pore microstructure, yet retains good mechanical stability. These elements are made with a pore size range of 1.544 to 30 micrometers as determined by the mercury penetration porosimetry method (ASTM C-699).

The TIMCO™ Porous Teflon® Lysimeters are available with a PVC body and Teflon® filter element or an all Teflon® device. They use flush threaded joints with Teflon® O-rings for security. This also permits simple disassembly for decontamination. No adhesives or sealants are used. To facilitate installation, the lysimeter top plug is threaded to allow attachment of the casing. If placed deeper than 20' (6M), a TIMCO™ Deep Sampling Lysimeter will be needed.

Porous Teflon® Lysimeter Sizes Available with PVC or Teflon® Body	
Tube type	1.90" (48.3mm) O.D. x 17.5" (44.5cm)
Cup type	1.90" (48.3mm) O.D. x 17.5" (44.5cm)

### TIMCO™ Deep-Sampling Lysimeter

TIMCO'S™ Deep-Sampling Lysimeter eliminates the use of a transfer vessel at depths greater than 20'. The use of a ball check above the porous chamber prevents pressurization of the porous media and subsequently protects the silica pack. A second ball check is installed in the sample line. The Deep-Sampling Lysimeter is operational to 300'.



TIMCO™ Tube Type Lysimeter  
with Porous Teflon® Filter

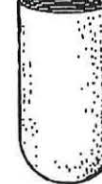


Also Available In Cup Type  
Body in Teflon® or PVC

TIMCO™  
Deep Sampling Lysimeter  
Tube Type  
with Porous Teflon® Filter



TIMCO™  
Deep Sampling Lysimeter  
Cup Type



**TIMCO POROUS TEFLON LYSIMETERS  
FOR PLACEMENT AT DEPTHS UP TO 20' MAXIMUM**

DESCRIPTION	ITEM #	EA
1.9"OD X 17.5" TUBE TYPE W/PVC BODY	ZG-LPT19-T	181.90
1.9"OD X 17.5" TUBE TYPE W/TEFLON BODY	ZG-LTT19-T	246.95
1.9"OD X 17.5" CUP TYPE W/PVC BODY	ZG-LPC19-T	181.90
1.9"OD X 17.5" CUP TYPE W/TEFLON BODY	ZG-LTC19-T	234.80
REPLACEMENT TEFLON TUBE POROUS FILTER	ZG-LR19T-T	70.55
REPLACEMENT TEFLON CUP POROUS FILTER	ZG-LR19C-T	58.40

**TIMCO POROUS TEFLON DEEP SAMPLING LYSIMETERS  
FOR PLACEMENT AT DEPTHS UP TO 300' MAXIMUM**

DESCRIPTION	ITEM #	EA
1.9"OD X 30" TUBE TYPE W/PVC BODY	ZG-LDPT19-T	293.25
1.9"OD X 30" TUBE TYPE W/TEFLON BODY	ZG-LDTT19-T	326.30
1.9"OD X 27" CUP TYPE W/PVC BODY	ZG-LDPC19-T	264.50
1.9"OD X 27" CUP TYPE W/TEFLON BODY	ZG-LDTC19-T	326.30
REPLACEMENT TEFLON TUBE POROUS FILTER	ZG-LR19T-T	70.55
REPLACEMENT TEFLON CUP POROUS FILTER	ZG-LR19C-T	58.40

**TIMCO POROUS CERAMIC LYSIMETERS  
FOR PLACEMENT AT DEPTHS UP TO 20' MAXIMUM**

DESCRIPTION	ITEM #	EA
1.9"OD X 17.5" CUP TYPE W/PVC BODY	ZG-LPC19-C	147.70
REPLACEMENT CERAMIC CUP POROUS FILTER	ZG-LR19C-C	33.10

**TIMCO POROUS CERAMIC DEEP SAMPLING LYSIMETER  
FOR PLACEMENT AT DEPTHS UP TO 300' MAXIMUM**

DESCRIPTION	ITEM #	EA
1.9"OD X 27" CUP TYPE W/PVC BODY	ZG-LDPC19-C	230.40
REPLACEMENT CERAMIC CUP POROUS FILTER	ZG-LR19C-C	33.10

**TIMCO LYSIMETER ACCESSORIES**

DESCRIPTION	ITEM #	EA
LYSIMETER HEAD ASSEMBLY WITH PVC FITTINGS	ZG-LPHED	220.00
LYSIMETER HEAD ASSEMBLY WITH TEFLON FITTINGS	ZG-LTHED	300.00
200 MESH SILICA FLOUR, 50LB PAIL	ZG-LFLR	55.70
VACUUM PRESSURE GAUGE ASSEMBLY	ZG-LVPGA	49.60
VACUUM PRESSURE HAND PUMP	ZG-LVPHP	52.40
ELECTRIC VACUUM PUMP (12 VOLT)	LYEVP	352.80
DELRIIN SHUT-OFF VALVE FOR 1/4" NYLON TUBING	ZG-LSTOP-D	22.70
TEFLON SHUT-OFF VALVE FOR 1/4" TEFLON TUBING	ZG-LSTOP-T	53.50

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PAGE 5

Subsurface investigations and soils engineering analyses at the Portage landfill (Warzyn Engineering, Inc., 1970, 1971, and 1974) and at the Sauk County landfill (Warzyn Engineering, Inc., 1973) were quite useful for an overall understanding of the hydrogeologic environments at these sites.

## METHODS OF INVESTIGATION

### Site Location and Selection

Two landfill sites, one near Prairie du Sac in Sauk County, Wisconsin and the other near Reedsburg, also in Sauk County (Figure 1) were selected for study with the help of the Wisconsin Department of Natural Resources-Solid Waste Management Section. The Prairie du Sac landfill is located approximately 2.5 miles west of the City of Prairie du Sac, between County Highways PG and O, and west of Otter Creek. The Sauk County landfill is located approximately 5.5 miles east of the City of Reedsburg, south of State Highway 33.

A third landfill, near Portage in Columbia County, Wisconsin (Figure 1), was also instrumented for study. The landfill is located approximately one mile north of the City of Portage, south of County Highway X. Lack of significant data over an extended period of time forced abandonment of this landfill as one of the primary study sites. The limited data that were collected from the Portage landfill are, however, summarized in the Appendix.

The landfills included in this study were chosen for these reasons:

1. The sites were within a reasonable traveling distance of Madison.
2. The refuse had been in place long enough to be producing leachate.
3. The combination of refuse thickness and depth to the water table permitted adequate instrumentation of the unsaturated zone.
4. Permission to conduct the study was given by the owner-operator.
5. A portion of the landfill could be set aside for study without interfering with disposal operations.

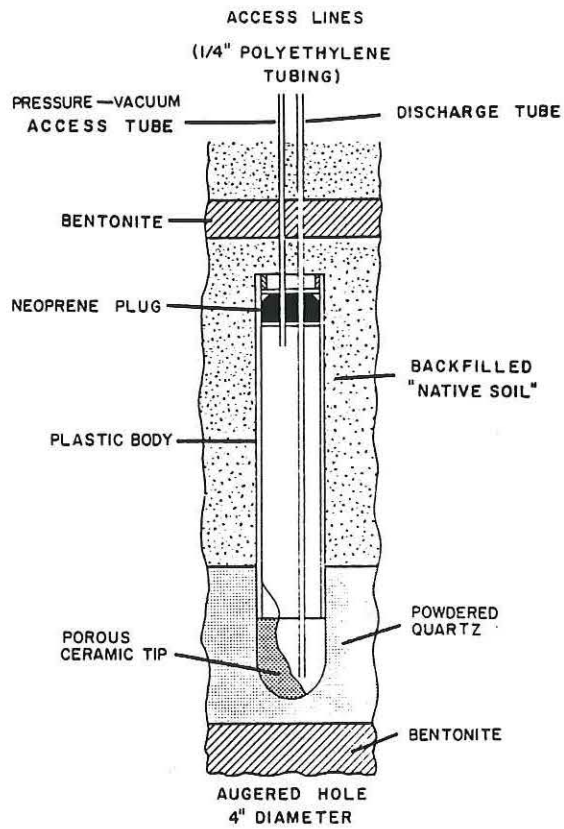
### Components of the Data Collection and Monitoring Network

#### Lysimeter Network

Leachate and soil-moisture samples were collected from the refuse and unsaturated earth materials by means of pressure-vacuum or suction lysimeters. Suction lysimeters were chosen as sampling devices because (1) previous researchers have demonstrated their efficiency and reliability in obtaining soil-moisture samples and (2) they are the only devices available that allow sample collection over extended periods of time.

The design and operation of suction lysimeters has been discussed in detail by Wagner (1962), Lane and Parizek (1968), and Parizek and Lane (1970). The suction lysimeter (Figure 2) consists of a plastic cylinder 25 inches long and 1.9 inches in diameter with a 2.5 inch porous ceramic cup attached to the bottom. When the ceramic cup is in contact with soil moisture, capillary suction causes the pores of the cup to become filled with water. Due to the small pore size





MODIFIED AFTER PARIZEK AND LANE (1970). NO SCALE.

Figure 2. Cross-section of a suction lysimeter and typical installation sequence.

(one micron or less), water is held tightly enough to become sealed against an air pressure of at least 15 psi. Thus, soil-moisture flow can be induced into the lysimeter by creating and maintaining a vacuum. Two access tubes (1/4-inch polyethylene tubing) inserted through separate holes in a neoprene stopper provide ports for sample discharge and for pressurization and evacuation. The capacity of a lysimeter is 1 liter of water.

Lysimeter installation (see Figure 2) was accomplished by drilling a hole to the desired depth using a truck-mounted continuous flight 4-inch auger. Pelletized bentonite was placed in the bottom of the hole (through temporary casing) to isolate the lysimeter from the soil below. A layer (approximately 6 inches thick) of powdered quartz (200 mesh) was placed on the top of the bentonite to insure good hydraulic contact between the pores of the ceramic cup and adjacent soil. The lysimeter was then positioned in the hole using  $\frac{1}{2}$ -inch conduit as a ramrod to force the lysimeter past protrusions in the drill hole and to seat the lysimeter firmly in the powdered quartz. The hole was then backfilled with native soil to a level slightly above the lysimeter. A second layer of pelletized bentonite was then added to further isolate the lysimeter and to guard against down-hole contamination. Intervals between lysimeters were backfilled with native soil. The base of the refuse and the surface were also sealed with bentonite.

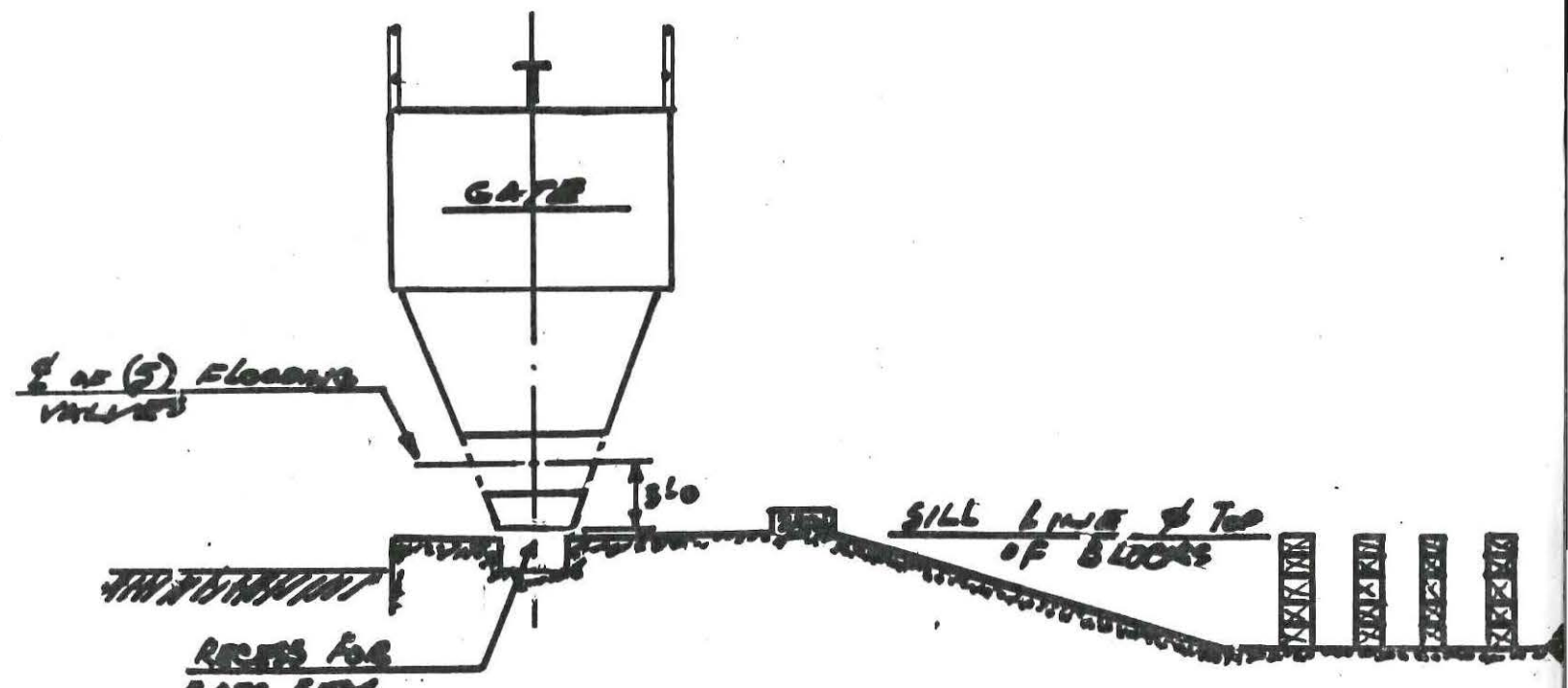
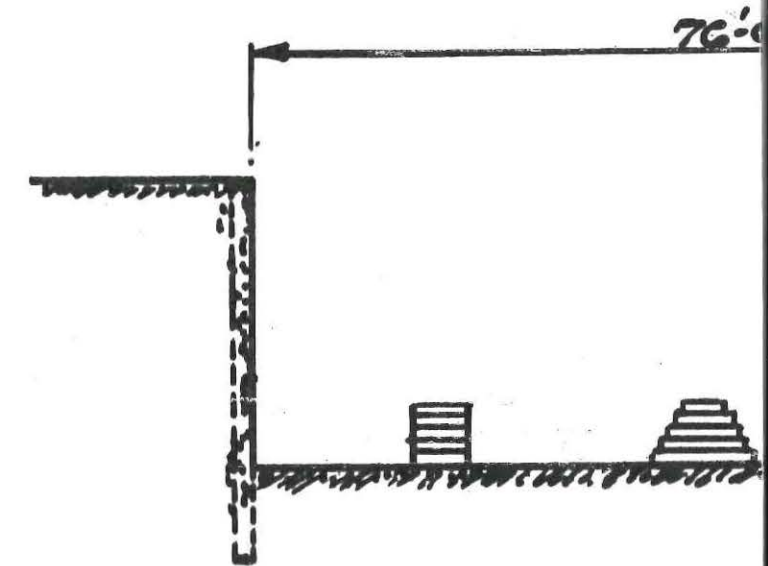
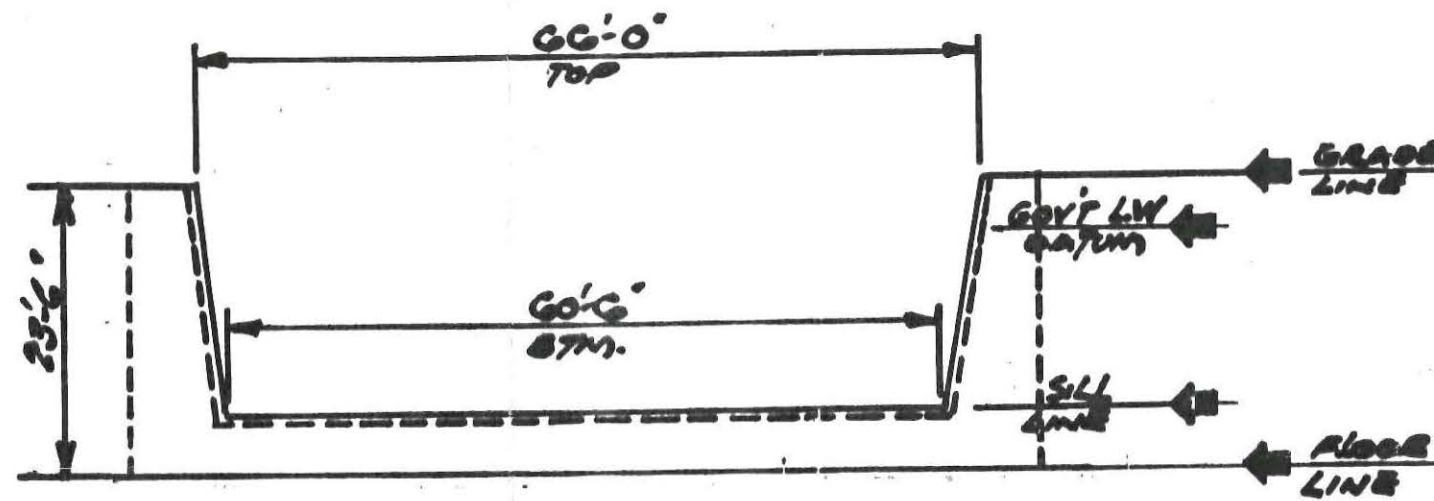
Two lysimeter nests were installed at each landfill study site. Each nest contained from 2 to 6 lysimeter units terminating at various intervals in the unsaturated zone (including units within the refuse). Most placement holes contained multiple lysimeter units. In most cases only one or two lysimeters were placed in a single drill hole. If successively shallower installations within the same drill hole could not be properly sealed, or placed at the desired depth, additional holes were drilled to complete the instrumentation. Placement holes for each lysimeter nest were separated horizontally by 5 feet or less. A total of 6 nests containing 28 lysimeters were installed at the three study landfills. These lysimeter nests provided data on the vertical changes in leachate concentrations within the unsaturated zone.

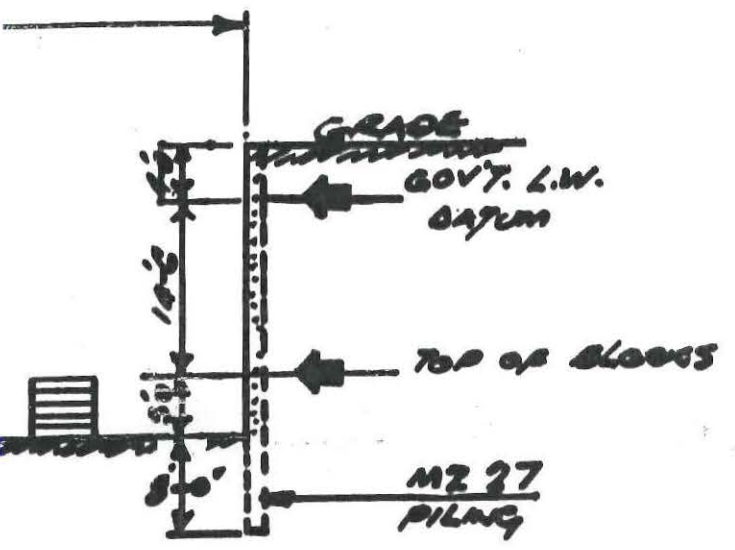
Two single lysimeter units were installed outside the waste disposal area at the Prairie du Sac landfill during the second year of the study to provide additional data.

Soil-moisture and leachate samples for chemical analysis were collected from the lysimeters by using a portable two-way hand pump. The pressure port of the pump is attached to the lysimeter pressure-vacuum access tube. Positive air pressure is applied to force the sample out of the lysimeter, through the discharge access tube, into a 1-liter plastic sample bottle. Each sample collected was then placed in ice and transported to the laboratory for analysis. After sampling, a vacuum was placed on the lysimeter through the pressure-vacuum access tube and maintained until the next sample collection date.

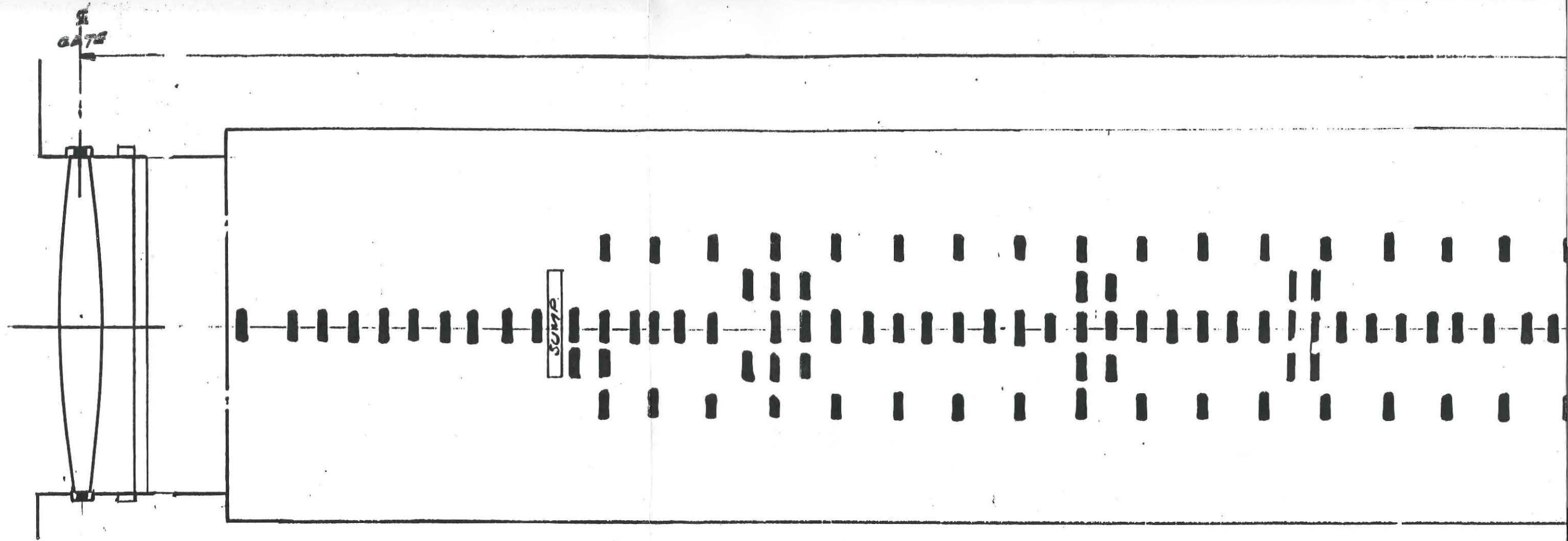
#### Observation-Monitoring Well Network

A network of observation-monitoring wells within and adjacent to each landfill site was utilized in an effort to determine the dynamics of the ground-water flow system and the nature and extent of ground-water contamination. Thirteen wells were drilled within and adjacent to the three landfill sites and 5 existing monitoring wells were incorporated into the network. At these observation-monitoring wells, water level measurements and water quality samples were obtained.





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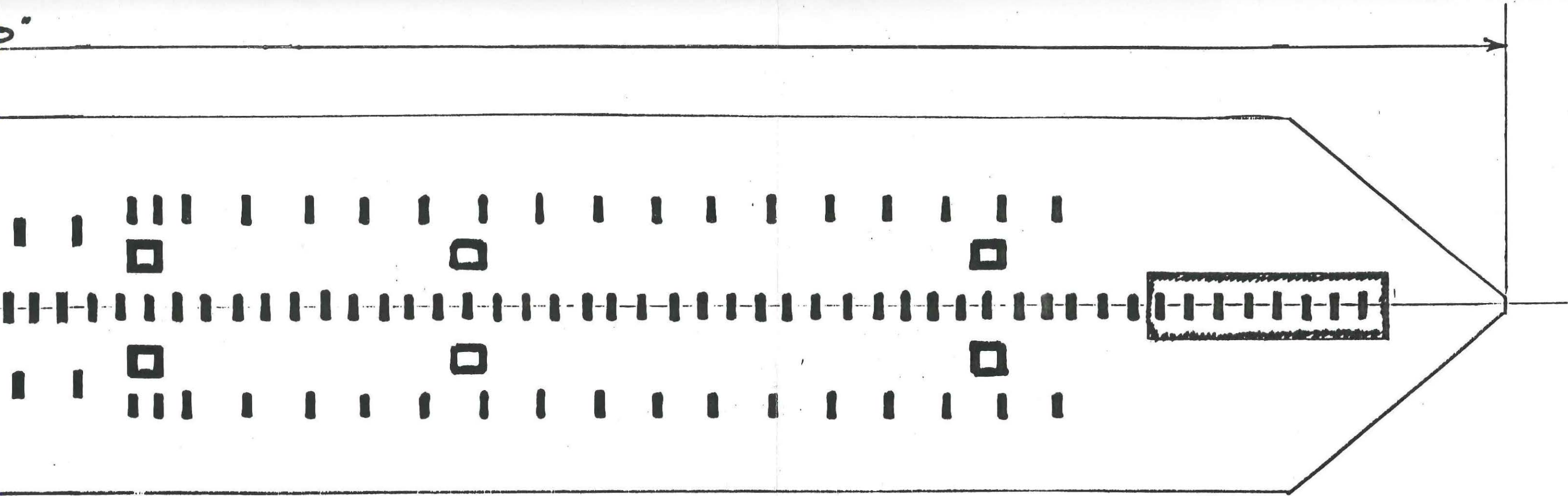


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DECLIVITY = 45° N LENGTH



NOTE: DRY DOCK #1 DRAWING

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1	03/12/96		JLE	03/96		



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FIGURE 10  
 GATE AND SUMP DETAIL

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