DRAFT REPORT

# EVALUATION OF REMEDIAL ALTERNATIVES FOR THE AEROVOX PROPERTY NEW BEDFORD, MA

JANUARY 11, 1983

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DRAFT REPORT

# EVALUATION OF REMEDIAL ALTERNATIVES FOR THE AEROVOX PROPERTY, NEW BEDFORD, MASSACHUSETTS

SUBMITTED TO:

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# EVALUATION OF REMEDIAL ALTERNATIVES FOR THE AEROVOX PROPERTY, NEW BEDFORD, MASSACHUSETTS

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# EVALUATION OF ALTERNATIVE RESPONSES FOR THE AEROVOX PROPERTY, NEW BEDFORD, MASSACHUSETTS

## 1.00 INTRODUCTION

This report presents the results of an evaluation of remedial action alternatives for the Aerovox plant site in New Bedford. The evaluation was prepared for Aerovox by GHR Engineering Corporation in accordance with the Consent Orders entered into by Aerovox in May 1982 with the U.S. EPA and the Massachusetts DEQE. In October 1982 the results of soil and groundwater sampling and analysis conducted at the Aerovox site were provided to EPA and DEQE.[1] This evaluation of remedial alternatives for the site was based on the results of the previous sampling and analysis program, supplemented with the additional field investigations described herein in Section 3.00.

### 1.10 Study Area Description

The Aerovox property is located at 740 Belleville Avenue in New Bedford, MA. As illustrated in Figure 1-1, the property is situated at the northern end of the Acushnet River estuary. The existing conditions of the eastern portion of the property are shown in detail on Drawing SP-1 which is an oversized site plan included with this report. The study area for the sampling and analysis program and the remedial response evaluation consists of: (1) the unpaved area at the eastern end of the site bordering on the Acushnet River; and (2) an unpaved strip of land

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1. "Report of Sampling and Analysis Program at the Aerovox Property, New Bedford, Massachusetts," prepared for Aerovox Incorporated by GHR Engineering Corporation, New Bedford, Massachusetts, October 7, 1982.

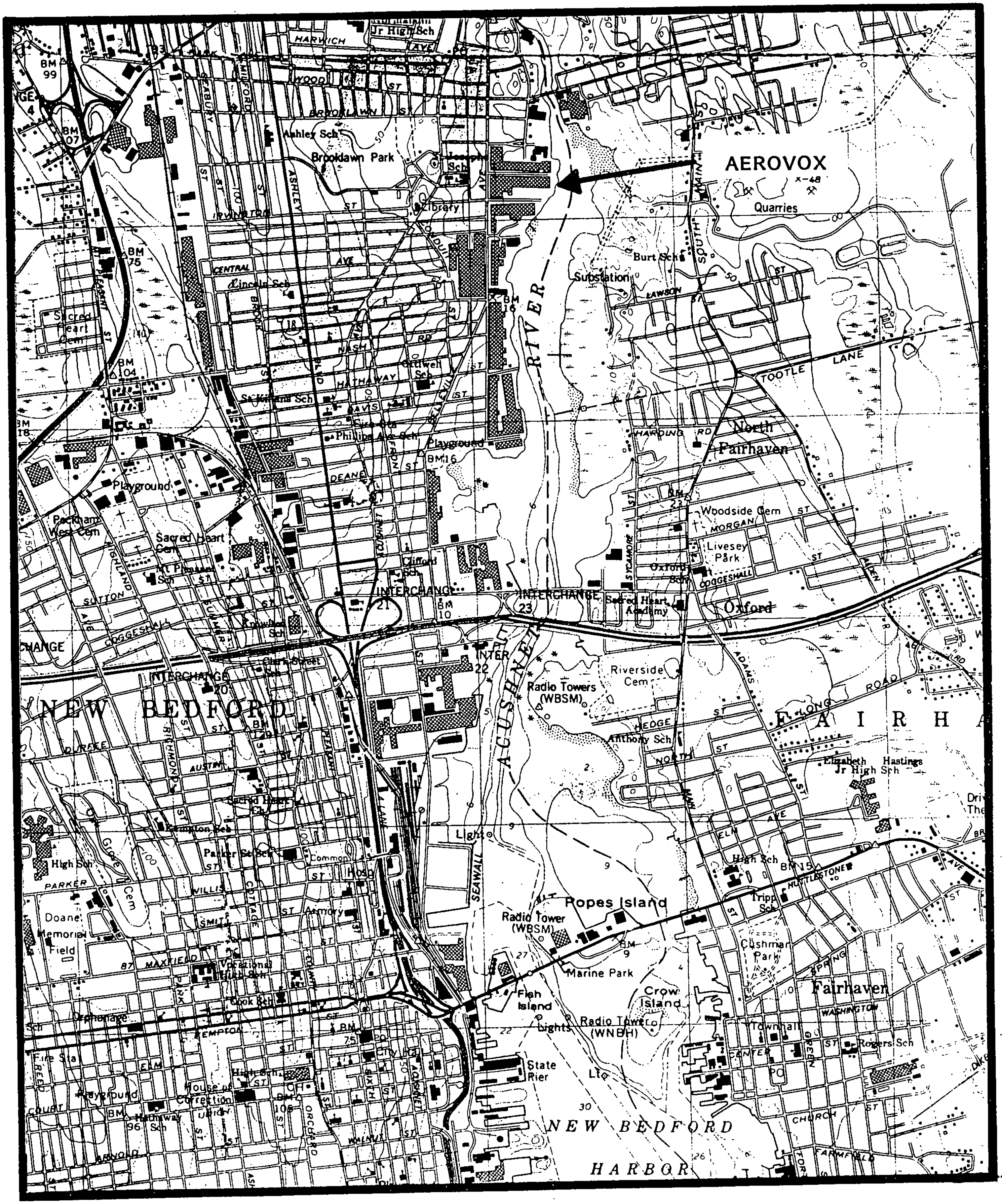


FIGURE 1-1 LOCUS MAP, AEROVOX PROPERTY, NEW BEDFORD, MA
(from USGS New Bedford North Quadrangle)

running along the length of the building on the north side. In total, the area of investigation encompasses about 1/2-acre of unpaved Aerovox property. Figure 1-2 is a schematic diagram of the eastern portion of the Aerovox property showing the study area.

## 1.20 Purpose and Scope

The purpose of this study was to determine the most appropriate remedial response for the Aerovox site. The EPA and DEQE Consent Orders specified that the relative costs and benefits of each alternative course of remedial action be assessed, and that a recommendation for remedial action be included in the evaluation. The Consent Orders further specified that the evaluation include:

1. An engineering analysis of each remedial course of action evaluated;
2. Estimated costs and schedules for completion for each remedial course of action evaluated;
3. Post-cleanup monitoring and maintenance measures for each course of action evaluated; and,
4. Measures for provision of recorded notice to subsequent owners and operators of Aerovox' property and facilities of any measures taken for long term containment of PCBs on the property, and any related maintenance or monitoring required to assure continued implementation of such measures.

Using the overall methodology established by the U.S. EPA for selecting remedial responses under the Superfund program[2], alternative remedial actions for the Aerovox site have been identified and evaluated on the basis of engineering/technical feasibility, environmental effects,

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2. 40 CFR 300, Subpart F, National Oil and Hazardous Substance Contingency Plan (NCP), 47 Federal Register 31203, July 26, 1982.

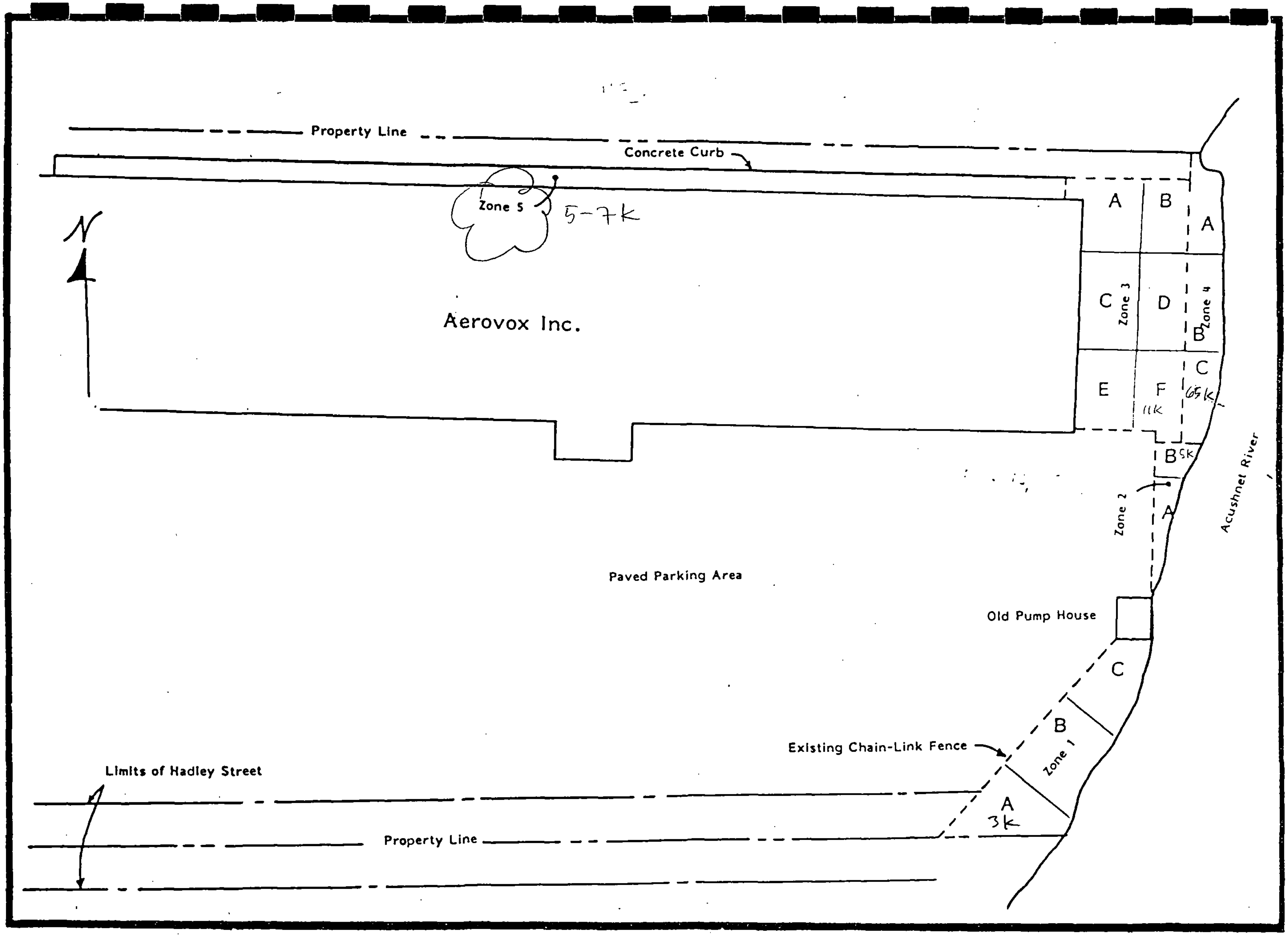



FIGURE 1-2 SCHEMATIC STUDY AREA SHOWING SAMPLING ZONES
(Not to Scale)

and costs. The results of the alternatives evaluation are discussed in Section 6.00, and the recommended remedial action plan is presented in Section 7.00.

The scope of this study included additional field investigations to supplement and clarify the results of the initial sampling and analysis program completed in October 1982. The additional field investigations reported herein in Section 3.00 included:

1. Test borings to further investigate subsurface stratigraphy and material continuity;

2. Water level monitoring to determine the effect of tidal extremes on groundwater levels; and,

3. Surface and groundwater testing to further define water quality in the study area.

A brief summary of the previous on-site sampling and analysis work is provided in Section 2.00. The results of all field investigations conducted at the site to date are utilized in the description of the site's hydrogeology presented in Section 4.00 and in the intrepretation of chemical analyses presented in Section 5.00.

## 2.00 SUMMARY OF PREVIOUS FIELD INVESTIGATIONS

The initial field investigation of the Aerovox site was conducted in two phases designed to acquire physical and chemical data to characterize the surface and subsurface conditions of the site. Phase 1 of the field investigation consisted of an evaluation of PCB levels in soils at the surface and to depths of up to 2 feet below the surface throughout the approximately 1/2-acre study area. Based on the Phase 1 test results, locations for Phase 2 soil sampling at depth via borings were selected. The Phase 2 subsurface investigation included the installation of groundwater monitoring wells in eight on-site locations. The results of the previous exploration and testing program are summarized below.

### 2.10 Phase 1 Results: PCB Distribution in Surface Soils

During the initial phase of the previous study, field sampling and laboratory testing focused on defining the distribution and levels of PCBs in surface and near-surface soils. For Phase 1 sampling, the study area was divided into five major sampling zones, identified as Zones 1 through 5, corresponding to the five natural subareas created by the actual features of the site. Each sampling zone was then divided into subzones, identified by capital A, B, C, etc., as shown on Figure 1-2 in Section 1.00.

In each sampling subzone, composite soil samples for each depth were prepared from several individual grab samples collected at the surface and at 1-foot and 2-foot depths. The data obtained during Phase 1 soil sampling (0 to 2-foot depth) are presented in Table 2-1.

TABLE 2-1

RESULTS OF PHASE 1 SAMPLING AND ANALYSIS (SURFACE TO 2-FOOT DEPTH)
AEROVOX PROPERTY, NEW BEDFORD, MASSACHUSETTS

| SAMPLING ZONE[1] | PCBs IN COMPOSITE SEDIMENT SAMPLES (ug/g)[2,3] SURFACE | 1-FOOT DEPTH | 2-FOOT DEPTH | PCBs GRAB SAMPLES (ug/g)[2,3] 2-FOOT DEPTH |
|---|---|---|---|---|
| Zone 1 | | | | |
| Subzone A | 3030 | -- | -- | 3685 |
| B | 770 | -- | 13 | -- |
| C | 365 | -- | Tr[4] | -- |
| Zone 2 | | | | |
| Subzone A | 4835 | -- | 3770 | -- |
| B | 1995 | -- | -- | 115[5] |
| Zone 3 | | | | |
| Subzone A | 1335 | -- | 540 | -- |
| B | 4525 | 5940 | 3750 | -- |
| C | 4280 | -- | 455 | -- |
| D | 2090 | -- | 4505 | -- |
| E | 4565 | 2025 | 265 | -- |
| F | 1395 | 10560 | 7095 | -- |
| Subzone Fa | -- | -- | -- | 40 |
| Fc | -- | -- | -- | 4850 |
| Zone 4 | | | | |
| Subzone A | 2380 | -- | 1330 | -- |
| B | 2685 | -- | 175 | -- |
| C | 65070 | -- | 2335 | -- |
| Zone 5 | | | | |
| Subzone A | 6870 | 270 | 120 | -- |
| B | 4940 | 500 | 345 | -- |
| C | 5445 | -- | 75 | -- |

1. See Figure 1-2 for location of sampling zones.
2. PCB levels reported are totals for Aroclor 1242 and 1254, computed on a dry weight basis.
3. ug/g = parts per million.
4. Tr = less than lower limit of quantitation (2 ppm).
5. Mass spectral analysis of sample indicates presence of chlorinated napthalenes.

Dashes (--) in table indicate no sample analyzed at that location and depth.

Samples collected July 1-2, 1982; analyses by Cambridge Analytical Associates.

The top several feet at the site were found to consist of various sand and gravel fill materials and debris, including cinders, pieces of masonry and concrete, wood scraps, and miscellaneous plastic, rubber and metal items. The Phase 1 test results confirmed the presence of PCBs dispersed throughout the top 2 feet of material examined. In many locations tested, order of magnitude decreases in PCB levels were found at the 2-foot depth relative to the surface, while in other sampling locations PCB levels were as high or higher at the 2-foot level than at the surface.

## 2.20 Phase 2 Results: PCB Distribution in Subsurface Soils

The second phase of the previous study was conducted to examine subsurface conditions at depth in terms of both the types of materials present and the distribution of PCBs within those materials. Phase 2 also included an assessment of the groundwater system in terms of water quality as well as tidal influences on groundwater levels within the study area.

To obtain subsurface stratigraphic data and collect samples at depth for PCB analysis, a series of eight test borings were executed. In each boring location, soil samples were collected at 2-foot intervals and groundwater monitoring wells were installed. An inventory of the monitoring wells is provided in Table 2-2. The locations of the wells are shown on Drawing SP-1 and on various figures discussed later in this report.

Twenty-six subsurface samples obtained during Phase 2 well drilling were analyzed for PCBs. A summary tabulation of the results obtained is given in Table 2-3. A generalized interpretation of the three dimensional distribution of PCBs

TABLE 2-2

INVENTORY OF MONITORING WELLS
AEROVOX PROPERTY, NEW BEDFORD, MASSACHUSETTS

| WELL NO. | BORING NO. | SAMPLING ZONE[1] | ELEVATION (FT.) GROUND | ELEVATION (FT.) TOP OF PIPE | TOTAL DEPTH (FT.)[2] |
|---|---|---|---|---|---|
| 1 | 1 | 1A | 5.2 | 8.83 | 24.5 |
| 1A | | 1A | 5.2 | 8.16 | 12.5 |
| 2 | 2 | 2B | 4.3 | 7.07 | 21.0 |
| 2A | | 2B | 4.3 | 7.17 | 6.0 |
| 3 | 3 | 3F | 5.2 | 7.16 | 19.0 |
| 3A | | 3F | 5.2 | 8.56 | 7.0 |
| 4 | 4 | 3B | 7.2 | 11.21 | 20.0 |
| 4A | | 3B | 7.2 | 10.96 | 6.5 |
| 5 | 5 | (see note 3) | 13.4 | 15.57 | 19.5 |
| 6 | 6 | 5B | 6.5 | 9.22 | 45.0 |
| 6A | | 5B | 6.5 | 9.77 | 10.0 |
| 7 | 7 | 4C | 4.9 | 7.98 | 22.0 |
| 7A | | 4C | 4.9 | 7.71 | 8.5 |
| 8 | 8 | 3D | 5.0 | 7.85 | 12.0 |

1. Sampling zones established for the study area are shown on Figure 1-2. Actual well locations are shown on Drawing SP-1.
2. Total depth measured from ground surface.
3. Well No. 5 is an upgradient well not located in any of the sampling zones into which the study area was divided. See Drawing SP-1 for the location of this well.

TABLE 2-3

RESULTS OF PHASE 2 SAMPLING AND ANALYSIS (SUBSURFACE SOIL CORES[1])
AEROVOX PROPERTY, NEW BEDFORD, MASSACHUSETTS

| DEPTH OF SAMPLE (FT.)[4] | PCBs IN SOIL CORE SAMPLES (ug/g)[2,3] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | BORING 1 (Zone 1A) | BORING 2 (Zone 2A) | BORING 3 (Zone 3F) | BORING 4 (Zone 3B) | BORING 5 (upgradient) | BORING 6 (Zone 5B) | BORING 7 (Zone 4C) | BORING 8 (Zone 3D) |
| 2 to 4 | 160 | 90 | 790 | -- | -- | 23 | 158 | 986 |
| 4 to 6 | < 2 | 1,385 | 138 | 72 | < 2 | -- | -- | -- |
| 4 to 8 | -- | -- | -- | -- | -- | -- | 1,790 | -- |
| 6 to 9 | -- | -- | -- | -- | -- | -- | -- | 11 |
| 8 to 11 | -- | -- | -- | -- | -- | -- | 49 | -- |
| 9 to 12 | -- | -- | -- | -- | -- | -- | -- | 32 |
| 10 to 12 | -- | ~ 1 | Tr | 23 | Tr | -- | -- | -- |
| 12 to 14 | -- | -- | -- | -- | -- | < 2 | -- | -- |
| 13 to 15 | -- | -- | -- | -- | -- | -- | ~ 2 | -- |
| 15 to 17 | Tr[5] | -- | -- | -- | -- | -- | -- | -- |
| 17 to 19 | -- | < 2 | Tr | -- | -- | -- | -- | -- |
| 18 to 20 | -- | -- | -- | Tr | -- | -- | -- | -- |
| 20 to 22 | -- | -- | -- | -- | -- | -- | ~ 7 | -- |

1. For boring locations, see Drawing SP-1. Boring 1 was executed for Well 1, Boring 2 for Well 2, etc.
2. PCB levels reported are totals for Aroclor 1242 and 1254, computed on a dry weight basis.
3. ug/g = parts per million.
4. Core samples recovered using 2-foot long split spoon samplers were thoroughly mixed to prepare a composite of the 2-foot core for laboratory analysis.
5. Tr = less than 1.0 parts per million.

Dashes (--) in table indicate no sample analyzed at that location and depth.

Samples collected July 26-30, 1982

in the soils behind the Aerovox plant can be developed by considering the Phase 1 and Phase 2 results together (Tables 2-1 and 2-3).

Generally, the soil test results showed that reductions in PCB levels of one to two orders of magnitude occur within 4 to 6 feet of the surface throughout the study area. None of the soil samples collected from below a depth of 6 feet were found to exceed 50 ppm PCBs.

In addition to PCB analyses, soil samples from the site were also tested for pH, oil and grease content, and volatile solids. These test results, which are tabulated in Table 2-4, point out the variability of the materials that form that top 4 to 6 feet of the study area. The pH of the soils varied from 3.4 to 8.4 over the site. The variation was less at different depths at the same boring location than at different locations. Generally, the highest oil and grease concentrations were seen in Zones 1 through 4 and in the surface soil of Zone 5.

From examination of soil cores recovered during Phase 2 borings the various subsurface materials in the study area were found to include, generally: (1) from 5 to 10 feet of sand and gravel fill material containing miscellaneous types of debris and rubble; (2) from 2 to 4 feet of organic peat material containing sand and silt layers; and (3) stratified sand and gravel deposits. It was recognized in the earlier report that discontinuities in the various subsurface materials could be present. Additional test borings were conducted in this study to better characterize the peat strata.

TABLE 2-4

OIL AND GREASE, pH AND VOLATILE SOLIDS TEST RESULTS
AEROVOX PROPERTY, NEW BEDFORD, MASSACHUSETTS

| SAMPLE NO. | DEPTH (FT)[1] | SUBZONE OR BORING NO. | pH | OIL & GREASE (ug/g)[2] | VOLATILE SOLIDS (%) | TOTAL PCB (ug/g) |
|---|---|---|---|---|---|---|
| Phase 1[3] | | Subzone | | | | |
| AV 25 | 0 | 3D | 4.1 | 3,600 | 11.7 | 2,090 |
| AV 30 | 2 | 3F | 7.0 | 12,000 | 7.8 | 7,095 |
| AV 34 | 0 | 4C | 5.3 | 192,300 | 23.2 | 65,070 |
| AV 43 | 0 | 5A | 3.8 | 47,100 | 8.2 | 6,870 |
| AV 53 | 2 | 3F | 4.8 | 51,450 | 9.0 | 4,850 |
| Phase 2 | | Boring[4] | | | | |
| AV 55 | 2 to 4 | 1 (1A) | 7.1 | 6,580 | 3.8 | 160 |
| AV 65 | 4 to 6 | 2 (2A) | 3.4 | 6,030 | 10.5 | 1,385 |
| AV 72 | 2 to 4 | 3 (3F) | 7.4 | 3,470 | 11.2 | 790 |
| AV 73 | 4 to 6 | 3 (3F) | 8.4 | 1,150 | 3.3 | 138 |
| AV 80 | 4 to 6 | 4 (3B) | 3.8 | 2,510 | 9.2 | 72 |
| AV 87 | 4 to 6 | 5 (upgr.) | 6.0 | 243 | 1.7 | NT |
| AV 94 | 2 to 4 | 6 (5B) | 5.5 | 273 | 2.2 | 23 |
| AV 108 | 4 to 8 | 7 (4C) | 4.8 | 11,800 | 11.0 | 1,790 |

1. Depth measured from ground surface = 0
2. ug/g = parts per million (dry weight basis).
3. Phase 1 samples are composite samples for the given subzone, except for sample AV 53, which is a grab sample.
4. Sampling subzones in which borings are located as given in parentheses.

NT = not tested

## 2.30 Phase 2 Results: Groundwater Flow and Tidal Effects

Monitoring of groundwater levels along with tide levels was conducted during the previous study to develop an assessment of the effects of tidal cycles on groundwater flow. Dual monitoring wells with screens set at elevations both above and below the peat materials had been installed in several boring locations. It was found that the groundwater levels in the shallow wells completed in the fill materials behind the Aerovox plant (Zones 3 and 4) were not influenced by normal tidal fluctuations in the river. A "perched" water table condition was found to exist in this area, with the peat materials serving as the confining layer.

Based on the water elevation data, the net flow in the perched system was estimated to be toward the river under normal tidal conditions. It was suggested that the perched system in Zones 3 and 4 is recharged from the estuary under higher than normal tidal conditions. Additional monitoring of tidal effects on groundwater levels was conducted during the present study to investigate such higher tide conditions.

The water levels in the deeper wells, which were completed in the stratified sands and gravels underlying the peat deposit, were found to be subject to a reversal of hydraulic gradient with the changing of the tide. The water level readings for the deeper wells indicated a net groundwater flow from the estuary into the deeper aquifer system during high tide conditions. At low tide this gradient is reversed and the net groundwater flow is from the deeper system to the estuary.

## 2.40 Phase 2 Results: Groundwater Quality

During the previous study, groundwater samples from the various monitoring wells installed at the site were collected and analyzed for PCBs, volatile organics, oil and grease, and specific conductance. The PCB and volatile organics results are presented and discussed in Section 5.00 along with the results of follow-up testing done during the current study.

The Phase 2 results of the oil and grease and specific conductance tests are presented in Table 2-5. Oil and grease were found at detectable levels only in Well No. 7A (13 ppm). Specific conductance tests were performed to obtain data on the salinity of the groundwater. In estuarine conditions, such as in the river adjacent to Aerovox, conductance values could range from approximately 5,000 to 40,000 umhos/cm depending upon river flow and tidal conditions. Specific conductance values for the deep wells behind the Aerovox plant indicated the intrusion of river water into the deeper aquifer system along the shoreline, resulting in brackish groundwater conditions.

In the shallow wells closest to the shoreline behind the plant, conductances were between 12,500 and 26,200 umhos/cm. In Zones 1 and 2, the conductance values in the shallow wells of 12,000 and 16,600 umhos/cm indicated the lateral infiltration of river water. In Zone 4, the conductance value of 26,200 umhos/cm in Well No. 7A, which did not respond to normal tidal changes, suggested that under certain tidal conditions river water can infiltrate into the perched zone behind the plant.

This concludes the summary of the previous field investigations. The complete Phase 1 and 2 results are presented in detail in the October 1982 Sampling and Analysis Program report cited on page 1-1 above.

TABLE 2-5

RESULTS OF GROUNDWATER TESTING FOR pH, OIL & GREASE AND SPECIFIC CONDUCTANCE, AEROVOX PROPERTY, NEW BEDFORD, MASSACHUSETTS

| WELL NO. | SAMPLING ZONE[3] | pH | OIL & GREASE (mg/l)[1] | SPEC. COND. (umhos/cm)[2] |
|---|---|---|---|---|
| 1 | 1A | -- | < 5 | 675 |
| 1A | 1A | 6.1 | < 5 | 12,000 |
| 2 | 2B | 6.0 | -- | 1,070 |
| 2A | 2B | 7.6 | -- | 16,600 |
| 3 | 3F | 6.6 | -- | 1,900 |
| 3A | 3F | 6.4 | < 5 | 1,330 |
| 4 | 3B | 6.0 | -- | 1,180 |
| 4A | 3B | -- | < 5 | 400 |
| 5 | (upgr.) | 6.7 | < 5 | 350 |
| 6 | 5B | 5.5 | -- | 275 |
| 6A | 5B | -- | -- | 350 |
| 7 | 4C | -- | < 5 | 1,680 |
| 7A | 4C | 6.7 | 13 | 26,200 |
| 8 | 3D | -- | -- | 2,500 |

1. mg/l = parts per million.
2. umhos/cm = micromhos per centimeter.
3. Sampling Zones established for the study area are shown on Figure 1-2. Actual well locations are shown on Drawing SP-1.

Dashes (--) in table indicate not tested.

## 3.00 DESCRIPTION OF CURRENT FIELD INVESTIGATIONS

To supplement and extend the previous findings, additional field investigations were included in the Aerovox remedial response study. These investigations, referred to as Phase 3 of the field work at the site, included the following:

1. Execution of eight test borings to further define subsurface conditions;
2. Extended monitoring of groundwater levels over normal and extreme tidal cycles; and,
3. Additional sampling and analysis of groundwater and surface water.

Each of these additional field tasks are briefly described below.

### 3.10 Test Borings

The previous borings executed at the site during monitoring well installation indicated the presence of a peat-rich unit underlying the fill materials. The peat layer was interpreted as serving as the confining layer for the perched groundwater zone and a natural barrier to the vertical movement of groundwater and associated contaminants between the perched system and the aquifer below peat. The importance of the peat materials to the evaluation of the site necessitated additional borings to confirm and expand the previous subsurface interpretations.

Eight additional test borings were conducted at the site during the week of November 8-12, 1982. The borings were supervised and logged by a GHR geologist and drilling was done by D.L. Maher, Inc. of North Reading, MA. The locations of the borings, labelled TB-1 through TB-8, are shown on Figure 3-1 and Drawing SP-1. The borings were completed using an auger rig and continuous split-spoon samples were retained for inspection and analysis. Boring logs were prepared and are provided in Appendix A. A number of subsurface samples were selected for grain size analysis and these results are provided in Appendix B. No chemical analyses were performed on the Phase 3 soil samples.

The results of the test borings work are discussed in detail in Section 4.00.

## 3.20 Water Level Monitoring

In this task, the existing groundwater monitoring wells were utilized to record on-site water level changes with tidal fluctuations over a three week period, excluding weekends. As described briefly in Section 2.00 above, the previous water level monitoring results indicated variable tidal responses in the perched and deeper systems depending upon well location relative to the river's edge, well depth and tide elevation. The extended water level monitoring in Phase 3 was undertaken to further examine these factors as they affect the connections among the estuary, the perched system and the deeper aquifer.

Water level monitoring began on November 2 and continued until November 19, 1982. On November 2 and November 16, readings were made on an hourly basis to establish the actual tidal schedule and range needed for comparison of effects under varying tidal conditions. The remainder of the monitoring period consisted of daily readings at high and low tide. The monitoring program began during the full moon period of the lunar month. Therefore, peak tidal effects were observed at the commencement of the program

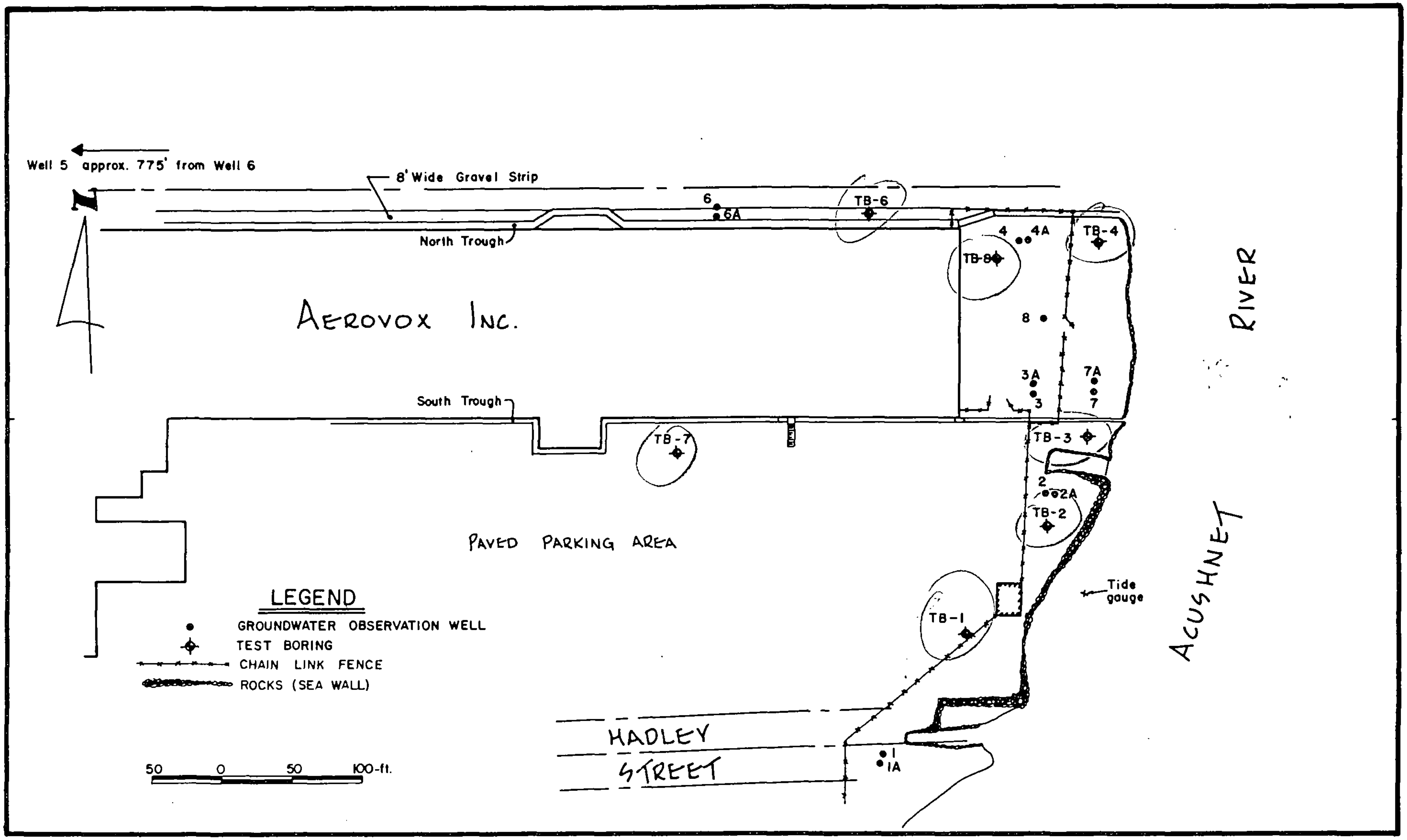



FIGURE 3-1 SITE PLAN SHOWING TEST BORING AND OBSERVATION WELL LOCATIONS

and then decreased. The highest high tide recorded on the staff gauge placed directly in the Acushnet River was at elevation 4.24 feet on November 4. The lowest high tide recorded was at elevation 1.58 feet on November 11. The new moon period was observed on November 12 when the tidal range again increased, this time peaking on November 15 at 3.22 feet.

The results of the Phase 3 water level monitoring are tabulated and presented in detail in Section 4.00.

3.30 Sampling and Analysis of Groundwater and River Water

The Phase 3 field studies included collection and analysis of additional water samples from on-site monitoring wells and from the Acushnet River in the vicinity of the Aerovox site. These samples were collected in order to further define contaminant distribution and to assess the potential for off-site migration of the contaminants. In the previous study the shallow wells located in the perched water table were sampled and several were found to contain small amounts of PCBs and volatile organic compounds. Phase 3 focused on monitoring the deeper on-site wells and the river waters adjacent to the site.

Water samples were collected on November 17 and December 22, 1982. Three near-shore surface water samples were collected from the Acushnet River at locations upstream from and adjacent to the Aerovox site. Both groundwater and river water samples were analyzed for total suspended solids, total dissolved solids and specific conductance. Selected samples were also analyzed for total PCBs, water soluble PCBs and volatile organic compounds. The results of these Phase 3 analyses are presented and discussed in Section 5.00. A brief description of the analytical methods used is presented in Appendix C.

# 4.00 SITE HYDROGEOLOGY

## 4.10 Geology

### 4.11 Regional Geology

The study area is part of the Atlantic Coastal Plain physiographic province of the New England Upland region. This area of Southeastern Massachusetts is characterized by a crystalline basement complex of Precambrian to Devonian age rock. The bedrock surface through most of the region has been contoured by glaciation into a series of sub-parallel valleys and ridges. Fracturing of the rock in the form of joints and faults is common throughout the area. The unconsolidated sediments which blanket most of the bedrock consist of glacial deposits which range from very dense till to highly permeable outwash deposits of sand and gravel.

### 4.12 Site Characterization

The Aerovox site is located in a highly developed urban/industrial area of New Bedford, MA. The site borders the western bank of the Acushnet River approximately 7,000 feet north of the Coggeshall Street bridge. The topography of the site is generally flat-lying with a relief which ranges from elevation 0 at the sea wall to 15 feet above sea level along Belleville Avenue over 1,000 feet west of the river's edge.

No bedrock was observed in the general area surrounding the site and Well 6 was drilled to 45 feet without encountering bedrock. Research of existing literature indicates that the bedrock in the area is granite.

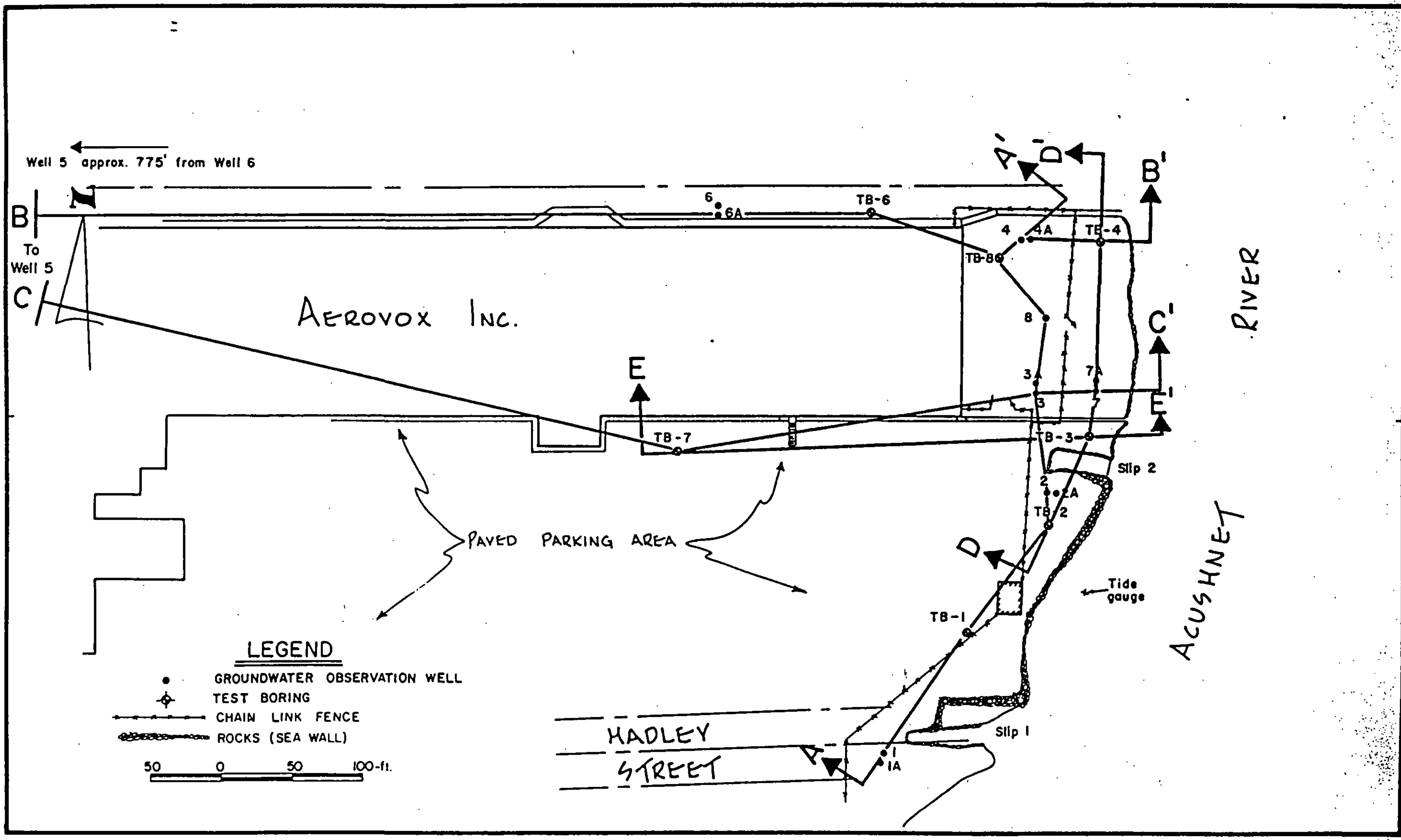
### 4.13 Stratigraphic Description and Interpretation

Site stratigraphy was determined through the examination of split-spoon samples extracted during test boring operations. These samples were logged by a geologist and representative samples of each strata were analyzed for grain-size determination.

The boring logs and samples were compiled to create a series of cross-sections through the study area along the lines shown in Figure 4-1. Sections A-A', B-B', C-C' D-D' and E-E' are shown in Figures 4-2 through 4-5. The stratigraphic units represented in these sections are generalized for the purpose of graphic presentation. These units were determined on the basis of physical characteristics (grain size, texture, morphology), and their relative stratigraphic positioning. More detailed descriptions are provided below:

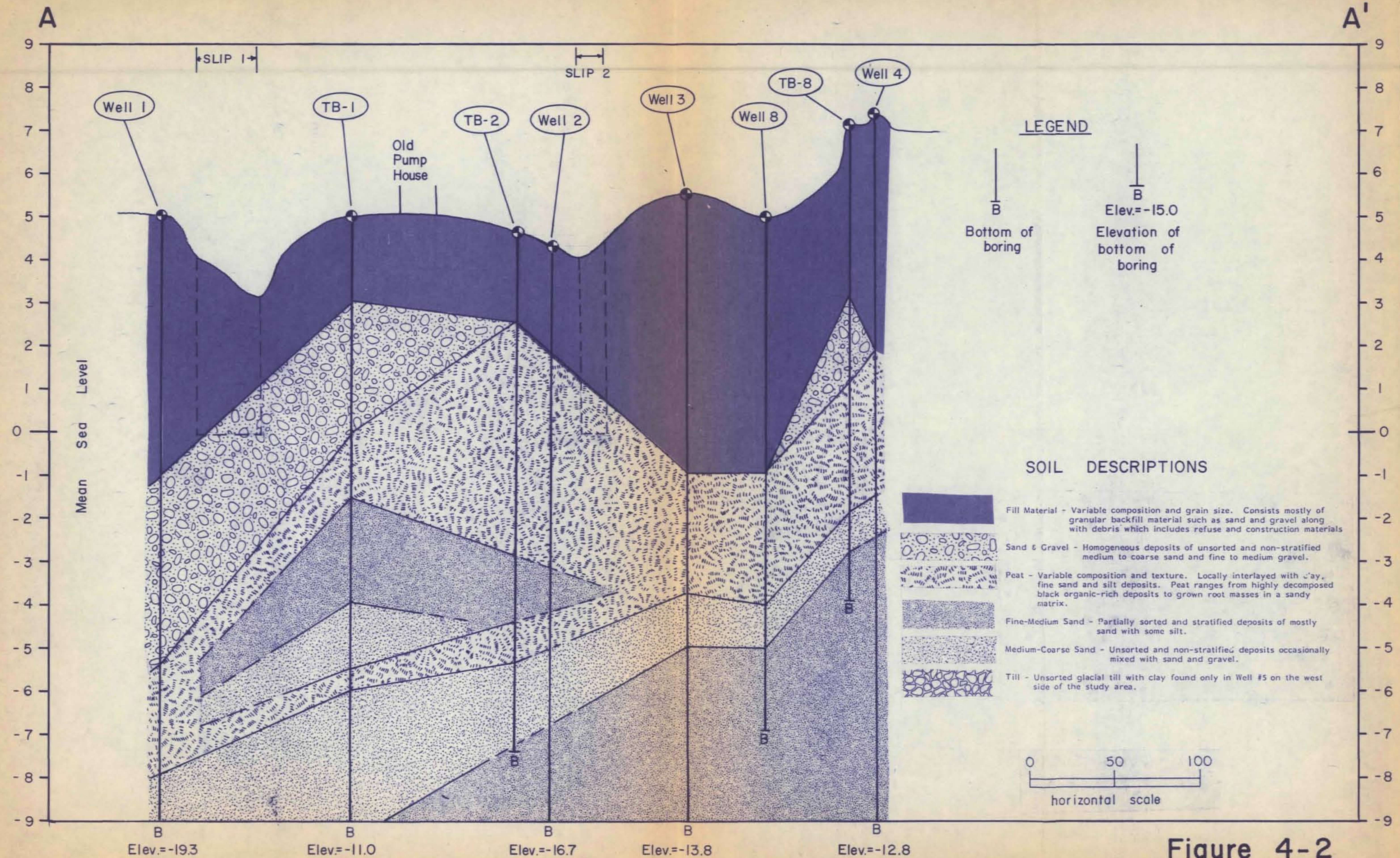
Fill Materials - No grain size determination was performed on these materials because of the lack of homogeneity in the samples. In general, the fill materials are granular backfill which consist mostly of medium to coarse sand and fine to medium gravel. This fill varies in the amount and composition of construction debris and refuse mixed in with the granular matrix. Materials such as concrete, steel, wood, paper, rubber, brick and general manufacturing refuse were encountered in these fill materials. The depth of this unit ranged from 2-5 feet. The maximum depth of fill material encountered was 6 feet in the area of Wells 3 and 8.

Sand and Gravel - Light brown to gray, fine- to coarse-grained sand and fine- to medium-grained gravel deposits occur mostly in the area of Well 6 and between Wells 1 and 2. The sand and gravel is non-sorted and has minor graded sequences.



Well 5 approx. 775' from Well 6
B
To Well 5
C
AEROVOX INC.
6
6A
TB-6
TB-8
4
4A
TB-4
8
3A
7A
3
TB-3
TB-7
E
E'
A'
D'
B'
C'
RIVER
ACUSHNET
Slip 2
2
2A
TB-2
D
Tide gauge
TB-1
Slip 1
1
1A
A
HADLEY STREET
PAVED PARKING AREA
LEGEND
GROUNDWATER OBSERVATION WELL
TEST BORING
CHAIN LINK FENCE
ROCKS (SEA WALL)
50
0
50
100-ft.


Figure 4-1



A
A'
SLIP 1
SLIP 2
Well 1
TB-1
Old Pump House
TB-2
Well 2
Well 3
Well 8
TB-8
Well 4
Mean Sea Level
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
B
Elev.=-19.3
Elev.=-11.0
Elev.=-16.7
Elev.=-13.8
Elev.=-12.8
LEGEND
B
Bottom of boring
B
Elev.=-15.0
Elevation of bottom of boring
SOIL DESCRIPTIONS
Fill Material - Variable composition and grain size. Consists mostly of granular backfill material such as sand and gravel along with debris which includes refuse and construction materials
Sand & Gravel - Homogeneous deposits of unsorted and non-stratified medium to coarse sand and fine to medium gravel.
Peat - Variable composition and texture. Locally interlayed with clay, fine sand and silt deposits. Peat ranges from highly decomposed black organic-rich deposits to grown root masses in a sandy matrix.
Fine-Medium Sand - Partially sorted and stratified deposits of mostly sand with some silt.
Medium-Coarse Sand - Unsorted and non-stratified deposits occasionally mixed with sand and gravel.
Till - Unsorted glacial till with clay found only in Well #5 on the west side of the study area.
0
50
100
horizontal scale


Figure 4-2

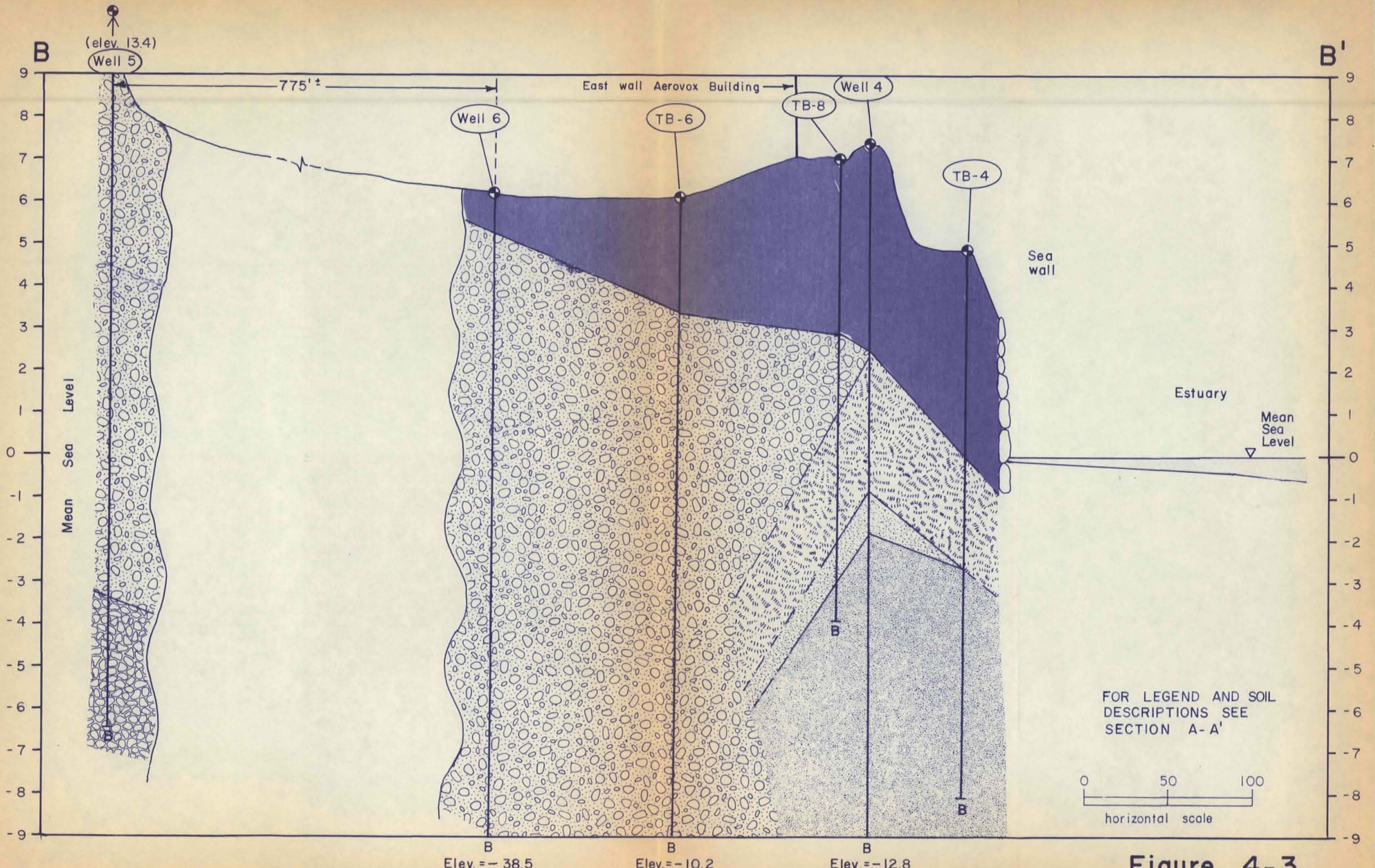
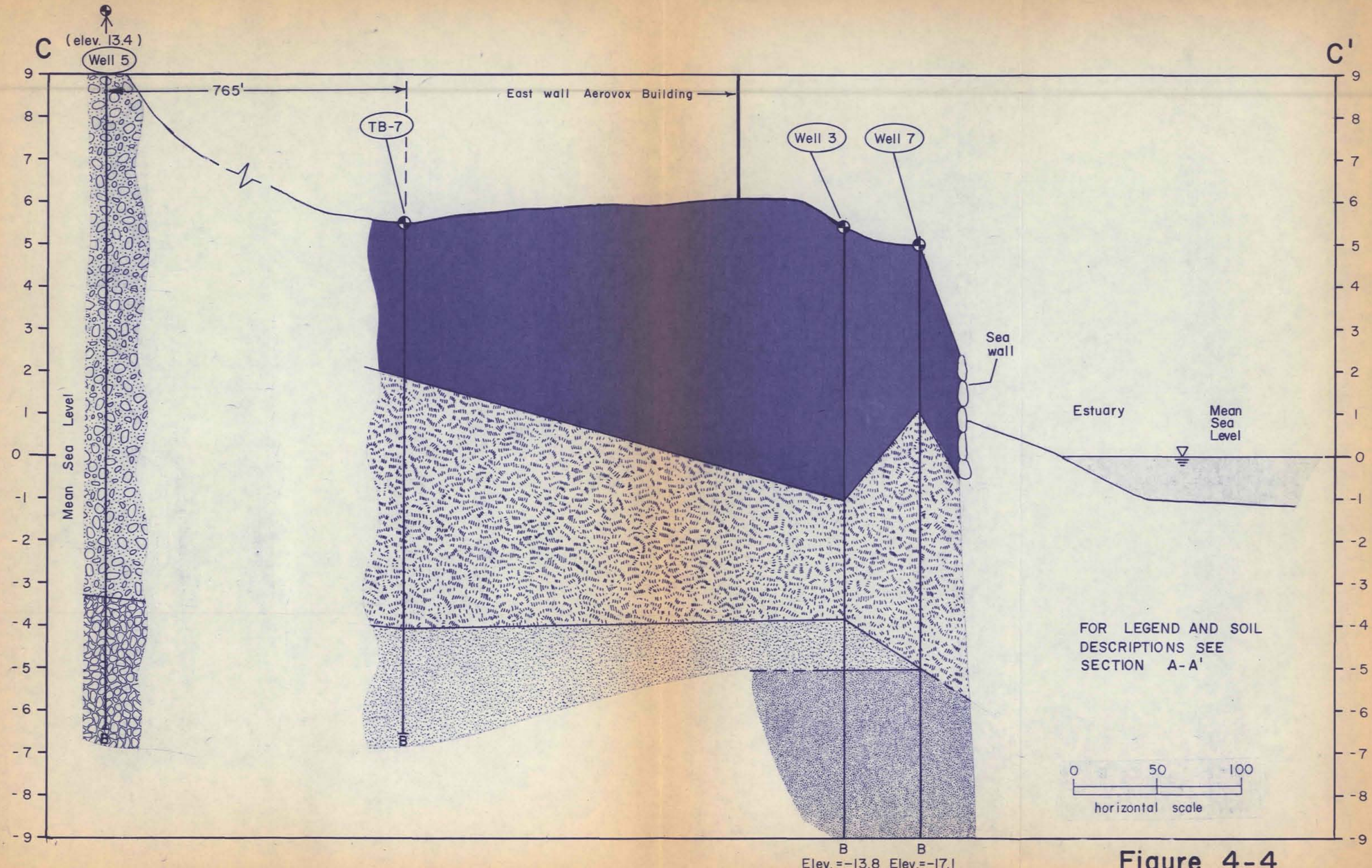
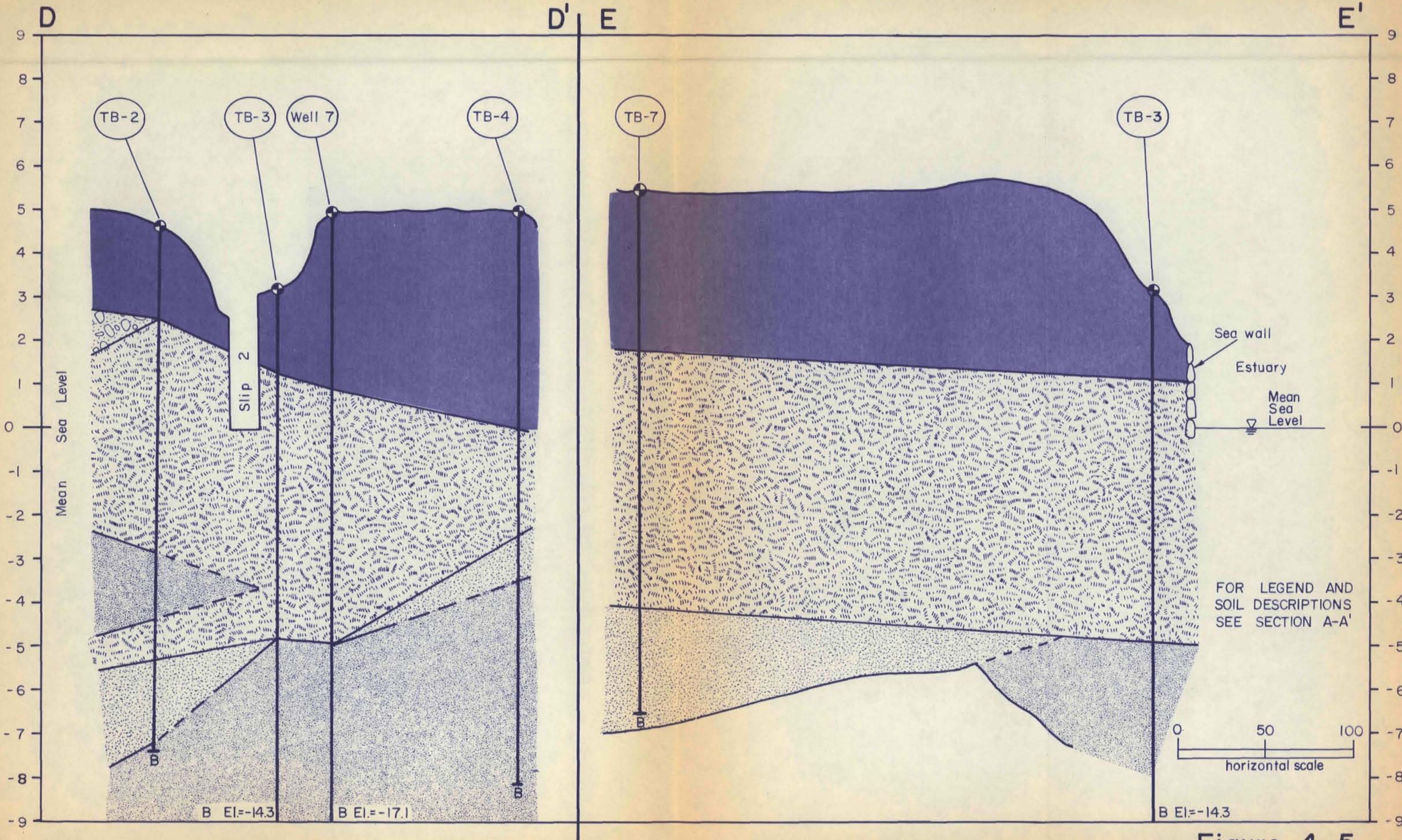

B
B'
(elev. 13.4)
Well 5
775' ±
East wall Aerovox Building
Well 6
TB-6
TB-8
Well 4
TB-4
Sea wall
Estuary
Mean Sea Level
Mean Sea Level
B
Elev. = − 38.5
B
Elev. = − 10.2
B
Elev. = − 12.8
FOR LEGEND AND SOIL DESCRIPTIONS SEE SECTION A- A'
0
50
100
horizontal scale

Figure 4-3



C
C'
(elev. 13.4)
Well 5
765'
East wall Aerovox Building
TB-7
Well 3
Well 7
Sea wall
Estuary
Mean Sea Level
Mean Sea Level
B
B
B
B
Elev. =-13.8
Elev.=-17.1
FOR LEGEND AND SOIL DESCRIPTIONS SEE SECTION A-A'
0
50
100
horizontal scale


Figure 4-4



D
D'
E
E'
TB-2
TB-3
Well 7
TB-4
TB-7
TB-3
Slip 2
Mean Sea Level
Sea wall
Estuary
Mean
Sea
Level
FOR LEGEND AND
SOIL DESCRIPTIONS
SEE SECTION A-A'
B
B El.=-14.3
B El.=-17.1
B El.=-14.3
0
50
100
horizontal scale
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9


Figure 4-5

Peat - The nature of the peat in the study area is extremely variable. The peat ranges in the degree of its decomposition from intact brown root-masses to highly decomposed black organic-rich layers. The matrix materials also vary from a dense clay to a medium sand. The peat layer is continuous throughout most of the study area varying in thickness and randomly interlayered with sand. The peat is absent along Section B-B' in the area from Well 5 to TB-6 but this is probably due to excavation for the building foundation.

Fine to Medium Sand - This unit consists of well-sorted and graded sequences of light brown to yellow, fine to medium sand with some coarse-grained beds approximately 2 inches thick.

Medium to Coarse Sand - This unit is found mostly beneath the peat layer. The sand contains small layers of gravel material and pebbles.

Till - A unit of clay-rich gray till was encountered in Well 5 at 17 feet. This unit was not located in any of the other borings.

### 4.14 Grain Size Determinations

Table 4-1 summarizes the results of the laboratory grain size analyses performed by LBH Associates of Newton, MA. The complete report is contained in Appendix B. The laboratory analysis was performed to identify the relative percentage of fines in the samples and to confirm the visual classifications performed in the field.

Prior to sieving and hydrometer analysis, the samples were ashed in order to remove the organic materials such as peat, and the results are expressed in terms of percent carbon content. A dispersing agent was added to prevent flocculation of the finer materials.

TABLE 4-1

SUMMARY OF GRAIN SIZE DETERMINATIONS

| BORING NO.[1] | SAMPLE NO. | SAMPLE DEPTH | MATERIAL CLASSIFICATION | PERCENT CARBON CONTENT IN | |
|---|---|---|---|---|---|
| | | | | COARSE FRACTION | FINE FRACTION |
| TB-1 | 1-2 | 2 to 3.5 | Silt sandy gravel | 11.31 | 1.02 |
| TB-1 | 1-4 | 4.5 to 6.5 | Gravelly silty medium sand | 6.76 | 1.73 |
| TB-1 | 1-6B | 8.5 to 10 | Clayey gravel | 86.67 | 2.59 |
| TB-1 | 1-6A | 10 to 11 | Gravelly silty fine sand | 10.87 | 1.36 |
| TB-1 | 1-8 | 14.5 to 16 | Silt sandy gravel | 0.16 | 1.69 |
| TB-2 | 2-4 | 7.5 to 10 | Gravelly silty medium sand | 11.02 | 2.78 |
| TB-3 | 3-6 | 10 to 12 | Fine sand | 0.25 | 1.54 |
| TB-6 | 6-6 | 12 to 14 | Fine sand | 0.17 | 1.94 |
| TB-7 | 7-5 | 5 to 9.5 | Gravelly silty medium sand | 50.45 | 1.06 |
| TB-8 | 8-4 | 6 to 8.5 | Slightly gravelly medium sand | 64.43 | 2.03 |

1. See Figure 4-1 or Drawing EC-1 for boring locations.
See Appendix B for complete grain size results.

The coarse fraction of most samples contained the greatest amount of carbon with the exception of TB-1-8, TB-3-6 and TB-6-6. The sample containing the greatest amount of organic material (89.26) was TB-1-6B, the matrix of which was classified as a clayey gravel. The sample was taken from the 8.5 to 10 foot depth interval and was originally noted as peat with clay.

## 4.20 Hydrology

### 4.21 Surface Water

The Aerovox property drains through man-made channels in an easterly to southeasterly direction. Surface drainage enters the Acushnet River estuary and continues to flow in a southerly direction. The estuary at this point is approximately 500 feet wide. The mean tidal range is reported as 3.7 feet with a spring tidal range of 4.6 feet. During the water level monitoring program, the mean tidal fluctuation observed was 4.25 feet. A maximum high tide elevation of 4.24 feet was observed on Nov. 4, 1982 (full moon), while an extreme low tide elevation of -2.10 was observed on Nov. 16, 1982 (new moon). The means of the observed high and low tide elevations were 2.94 and -1.57 respectively.

According to U.S. Geological Survey, Water Resources Data, the average annual precipitation for this area is about 44 inches. About 12 inches of the 44 inches of precipitation can be expected to infiltrate the ground surface in areas with non-impervious ground cover and enter the underlying groundwater system. The remainder of the precipitation either enters surface waters as runoff or returns to the atmosphere via evapo-transpiration.

### 4.22 Groundwater

The direction of regional groundwater flow is to the east and southeast. Recharge to the system occurs in areas north and west of the site while discharge of groundwater occurs along the edge of the Acushnet River.

As a result of the previous investigations at the Aerovox site, two groundwater systems were identified. A shallow or "perched" water table exists above the underlying peat layer. The saturated thickness of the perched system is a function of the elevation of the peat layer as well as the fluctuation of the tidal level. At extreme high tides, the saturated thickness has been observed to be as much as 4 feet in the area of Wells 8 & 3A. At low tide the saturated thickness of the perched zone decreases to less than 1 foot in areas along the river.

The peat layer supporting the "perched system" acts as a confining layer for the deeper "confined" aquifer. The deep system is defined by the fine to coarse sands and gravels underlying the peat layer. Exploratory data indicates that this deeper system runs from west to east throughout the site and appears to extend beneath the Acushnet River. The hydraulic connections between the estuary and the groundwater systems are discussed in the following section.

### 4.23 Groundwater Levels and Flow Directions

The results of the water level monitoring program discussed in Section 3.20 are presented in Tables 4-2 through 4-5. An analysis of this information enables the development of conclusions relative to the direction and quantity of groundwater flow and the identification of hydraulic connections between surface and groundwater systems.

Figures 4-6 through 4-9 present contour maps for the two groundwater systems. These figures are based on the high and low tide readings for Nov. 3, 1982, which is the day that the maximum observed tidal fluctuation of 5.48 feet was recorded. This fluctuation was caused by the influence of the "full moon" on the tidal range and is representative of a monthly occurrence.

Figure 4-6 depicts the phreatic surface of the perched groundwater system during a full moon high tide. Under such conditions, the perched groundwater system demonstrates a hydraulic connection with the river water by developing a hydraulic gradient with a negative slope in an inland direction from the river. At low tide, the gradient reverses in the perched areas along the edge of the site such that flow is toward the river in the portions of the perched zone located east of an approximate line running from Well 7A to Well 4A. To the west of this line, the gradient in the perched system is from westerly to a southeasterly direction, leading to Slip #2 (see Figure 4-7). The directions of flow in the perched system at low tide are dependent on the configuration of the surface of the peat layer. Figures 4-2 through 4-5 above present the general surficial features of the peat layer. From examination of the cross-sections it can be seen that in the area immediately behind the Aerovox plant, the surface of the peat layer is concave in shape. The upper edge of the peat layer behind the plant follows the approximate line referred to above (from Well 7A to Well 4A).

TABLE 4-2

TIDE AND GROUNDWATER ELEVATIONS RECORDED DURING HOURLY READINGS TAKEN AT AEROVOX ON NOVEMBER 2, 1982

| TIME OF INITIAL READING | | ELEVATIONS (MSL) RECORDED DURING HOURLY READINGS | | | | | | | TOTAL NET CHANGE (FT.) |
|---|---|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | |
| 0814 | Tide Gauge | 3.95 | 3.31 | 2.20 | 0.71 | -.78 | -1.23 | -1.38 | 5.33 |
| | Wells | | | | | | | | |
| 0818 | 1 | 2.58 | 2.25 | 1.80 | 1.29 | 0.85 | 0.69 | 0.72 | 1.89 |
| 0819 | 1A | 2.62 | 2.77 | 2.41 | 1.99 | 1.56 | 1.35 | 1.23 | 1.54 |
| 0822 | 2 | 2.43 | 2.23 | 1.88 | 1.43 | 1.06 | 0.88 | 0.88 | 1.55 |
| 0823 | 2A | 3.58 | 2.08 | 2.17 | 1.22 | 1.03 | 1.03 | 1.03 | 2.55 |
| 0827 | 3 | 2.20 | 2.10 | 1.87 | 1.55 | 1.27 | 1.13 | 1.11 | 1.09 |
| 0828 | 3A | 2.61 | 2.66 | 2.65 | 2.58 | 2.57 | 2.57 | 2.57 | 0.09 |
| 0830 | 4 | 2.47 | 2.17 | 1.75 | 1.22 | 0.90 | 0.80 | 0.82 | 1.67 |
| 0831 | 4A | 2.55 | 2.55 | 2.56 | 2.56 | 2.57 | 2.59 | 2.58 | -0.03 |
| 0842 | 5 | 2.28 | 2.26 | 2.26 | 2.27 | 2.27 | 2.28 | 2.28 | -0.02 |
| 0837 | 6 | 1.78 | 1.76 | 1.68 | 1.56 | 1.48 | 1.43 | 1.43 | 0.35 |
| 0838 | 6A | 1.71 | 1.73 | 1.73 | 1.61 | 1.59 | 1.52 | 1.53 | 0.21 |
| 0824 | 7 | 2.71 | 2.34 | 1.79 | 1.13 | 0.69 | 0.54 | 0.63 | 2.17 |
| 0825 | 7A | 3.12 | 3.26 | 3.26 | 3.21 | 3.15 | 3.15 | 3.17 | 0.11 |
| 0833 | 8 | 2.53 | 2.25 | 1.86 | 1.29 | 0.94 | 0.82 | 0.86 | 1.71 |

ND = no data

TABLE 4-3

TIDE AND GROUNDWATER ELEVATIONS RECORDED DURING HOURLY READINGS TAKEN AT AEROVOX ON NOVEMBER 16, 1982

| TIME OF INITIAL READING | | ELEVATIONS (MSL) RECORDED DURING HOURLY READINGS | | | | | | | TOTAL NET CHANGE (FT.) |
|---|---|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | |
| 0750 | Tide Gauge | 2.32 | 2.66 | 1.67 | 0.32 | -0.83 | -1.58 | -2.08 | 4.74 |
| | Wells | | | | | | | | |
| 0755 | 1 | 2.19 | 2.24 | 1.89 | 1.34 | 0.94 | 0.72 | 0.72 | 1.52 |
| 0756 | 1A | 1.80 | 2.00 | 1.88 | 1.52 | 1.22 | 1.09 | 0.95 | 1.05 |
| 0800 | 2 | 2.15 | 2.10 | 1.93 | 1.50 | 1.18 | 1.00 | 0.98 | 1.17 |
| 0801 | 2A | 2.24 | 2.43 | 1.83 | 1.03 | 1.03 | 1.00 | 1.00 | 1.43 |
| 0805 | 3 | 2.04 | 2.10 | 1.92 | 1.66 | 1.42 | 1.24 | 1.22 | 0.88 |
| 0806 | 3A | 2.85 | 2.85 | 2.80 | 2.82 | 2.77 | 2.74 | 2.70 | 0.15 |
| 0809 | 4 | 2.18 | 2.19 | 1.87 | 1.36 | 1.00 | 0.89 | 0.94 | 1.30 |
| 0810 | 4A | 3.50 | 3.50 | 3.48 | 3.47 | 3.49 | 3.49 | 3.49 | 0.03 |
| 0819 | 5 | 2.38 | 2.36 | 2.39 | 2.38 | 2.40 | ND | 2.40 | -0.04 |
| 0817 | 6 | 1.86 | 1.92 | 1.83 | 1.76 | 1.66 | ND | 1.62 | 0.30 |
| 0818 | 6A | 1.87 | 1.88 | 1.85 | 1.89 | 1.78 | ND | 1.71 | 0.17 |
| 0802 | 7 | 2.29 | 2.29 | 1.87 | 1.23 | 0.79 | 0.61 | 0.69 | 1.68 |
| 0803 | 7A | 3.10 | 3.08 | 3.09 | 3.07 | 3.06 | 3.04 | 3.05 | 0.06 |
| 0812 | 8 | 2.26 | 2.24 | 1.92 | 1.41 | 1.02 | 0.92 | 0.96 | 1.34 |

ND = no data

TABLE 4-4

RESULTS OF DAILY WATER LEVEL READINGS AT HIGH AND LOW TIDE

| DATE | November 2 | | November 3 | | November 4 | | November 5 | | November 8 | | November 9 | | November 10 | | November 11 | | November 12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TIDE STAGE | H | L | H | L | H | L | H | L | H | L | H | L | H | L | H | L | H | L |
| TIDE GAUGE | 3.95 | -1.38 | 4.15 | -1.33 | 4.24 | -1.08 | 3.84 | -1.23 | 2.37 | - .98 | 2.27 | -1.28 | 2.27 | -1.58 | 2.38 | -1.58 | 2.22 | -1.28 |
| WELL 1 | 2.58 | 0.69 | 2.62 | 0.74 | 2.72 | 0.89 | 2.59 | 0.87 | 2.07 | 0.84 | 1.99 | 0.54 | 1.81 | 0.60 | 1.98 | 0.54 | 2.10 | 0.68 |
| WELL 1A | 2.77 | 1.23 | 2.91 | 1.31 | 3.02 | 1.33 | 2.66 | 1.42 | 1.27 | 0.52 | 1.04 | 0.40 | 1.12 | 0.50 | 1.22 | 0.57 | 1.47 | 0.83 |
| WELL 2 | 2.43 | 0.88 | 2.50 | 0.93 | 2.58 | 1.06 | 2.53 | 1.06 | 2.00 | 0.98 | 1.90 | 0.76 | ND | 0.78 | 1.94 | 0.63 | 2.03 | 0.88 |
| WELL 2A | 3.58 | 1.03 | 3.73 | 1.03 | 3.81 | 1.08 | 3.53 | 1.08 | 2.20 | 0.98 | 1.98 | 0.92 | 2.03 | 0.93 | 2.05 | 0.88 | 2.37 | 0.98 |
| WELL 3 | 2.20 | 1.11 | 2.23 | 1.14 | 2.22 | 1.25 | 2.31 | 1.26 | 1.87 | 1.13 | 1.74 | 0.95 | ND | 0.97 | 1.77 | 0.82 | 1.87 | 1.08 |
| WELL 3A | 2.66 | 2.57 | 2.74 | 2.62 | 2.79 | 2.67 | 2.96 | 2.93 | 2.62 | 2.55 | 2.42 | 2.43 | 2.32 | 2.32 | 2.33 | 2.17 | 2.32 | 2.32 |
| WELL 4 | 2.47 | 0.80 | 2.52 | 0.87 | 2.59 | 0.97 | 2.58 | 0.89 | 1.98 | 1.01 | 1.89 | 0.72 | 1.74 | 0.72 | 2.02 | ND | 2.12 | 0.84 |
| WELL 4A | 2.55 | 2.58 | 2.63 | 2.61 | 2.69 | 2.71 | 2.80 | 2.84 | 3.19 | 3.19 | 3.07 | 3.13 | 2.87 | 3.05 | ND | 2.99 | 2.82 | 2.84 |
| WELL 5 | 2.26 | 2.28 | 2.26 | 2.26 | 2.28 | 2.25 | 2.28 | 2.29 | 2.26 | 2.30 | 2.26 | 2.27 | 2.23 | 2.23 | ND | 2.18 | 2.26 | 2.23 |
| WELL 6 | 1.78 | 1.43 | 1.81 | 1.47 | 1.87 | 1.50 | 1.91 | 1.58 | 1.68 | 1.43 | 1.58 | 1.35 | 1.56 | 1.31 | 1.53 | 1.23 | 1.68 | 1.38 |
| WELL 6A | 1.73 | 1.52 | 1.73 | 1.55 | 1.80 | 1.60 | 1.84 | 1.67 | 1.67 | 1.50 | 1.56 | 1.40 | 1.53 | 1.40 | 1.53 | 1.33 | 1.58 | 1.45 |
| WELL 7 | 3.01 | 0.54 | 2.74 | 0.69 | 2.84 | 0.79 | 2.83 | 0.66 | 2.14 | 0.89 | 2.03 | 0.51 | 1.79 | 0.51 | 2.17 | ND | 2.27 | 0.64 |
| WELL 7A | 3.26 | 3.15 | 3.87 | 3.20 | 4.04 | 3.22 | 3.79 | 3.28 | 2.80 | 2.80 | 2.72 | 2.73 | 2.57 | 2.62 | 2.60 | 2.57 | ND | 2.57 |
| WELL 8 | 2.53 | 0.82 | 2.58 | 0.93 | 2.66 | 0.99 | 2.65 | 0.95 | 2.04 | 1.04 | 1.93 | 0.76 | 1.78 | 0.72 | 2.06 | ND | 2.16 | 0.85 |

| DATE | November 15 | | November 16 | | November 17 | | November 18 | | November 19 | |
|---|---|---|---|---|---|---|---|---|---|---|
| TIDE STAGE | H | L | H | L | H | L | H | L | H | L |
| TIDE GAUGE | 3.32 | -1.92 | 2.66 | -2.10 | 2.52 | -2.10 | 2.42 | -2.10 | 2.52 | -2.10 |
| WELL 1 | 2.46 | 0.63 | 2.24 | 0.72 | 2.14 | 1.06 | 2.19 | 0.89 | 2.04 | 0.94 |
| WELL 1A | 2.25 | 1.34 | 2.00 | 0.95 | ND | 0.85 | 1.65 | 0.81 | 1.39 | 0.70 |
| WELL 2 | ND | 0.94 | 2.15 | 0.98 | 2.12 | 1.16 | 2.16 | 1.16 | 2.06 | 1.11 |
| WELL 2A | ND | 1.08 | 2.43 | 1.00 | ND | 0.93 | 2.34 | 0.94 | 2.07 | 0.93 |
| WELL 3 | 2.22 | 1.22 | 2.10 | 1.22 | 2.03 | 1.32 | 2.04 | 1.25 | 1.95 | 1.27 |
| WELL 3A | 2.82 | 2.85 | 2.85 | 2.70 | 2.67 | 2.62 | 2.54 | 2.47 | 2.42 | 2.39 |
| WELL 4 | 2.49 | 0.87 | 2.19 | 0.89 | 2.00 | 1.07 | 2.22 | 1.00 | 2.15 | 1.14 |
| WELL 4A | 3.44 | 3.50 | 3.50 | 3.47 | ND | 3.37 | 3.30 | 3.31 | 3.20 | 3.19 |
| WELL 5 | 2.33 | 2.34 | 2.36 | 2.40 | 2.36 | 2.45 | 2.45 | 2.50 | 2.50 | 2.53 |
| WELL 6 | 1.92 | 1.58 | 1.92 | 1.62 | ND | 1.65 | 1.88 | 1.60 | 1.85 | 1.63 |
| WELL 6A | 1.88 | 1.68 | 1.88 | 1.71 | ND | 1.73 | 1.88 | 1.71 | 1.82 | 1.68 |
| WELL 7 | 2.69 | 0.61 | 2.29 | 0.61 | 2.34 | 0.88 | 2.31 | 0.82 | 2.22 | 0.96 |
| WELL 7A | 3.02 | 3.39 | 3.10 | 3.04 | ND | 2.94 | 2.84 | 2.82 | 2.72 | 2.72 |
| WELL 8 | 2.56 | 0.91 | 2.26 | 0.92 | ND | 1.13 | 2.25 | 1.02 | 2.20 | 1.16 |

NOTES:

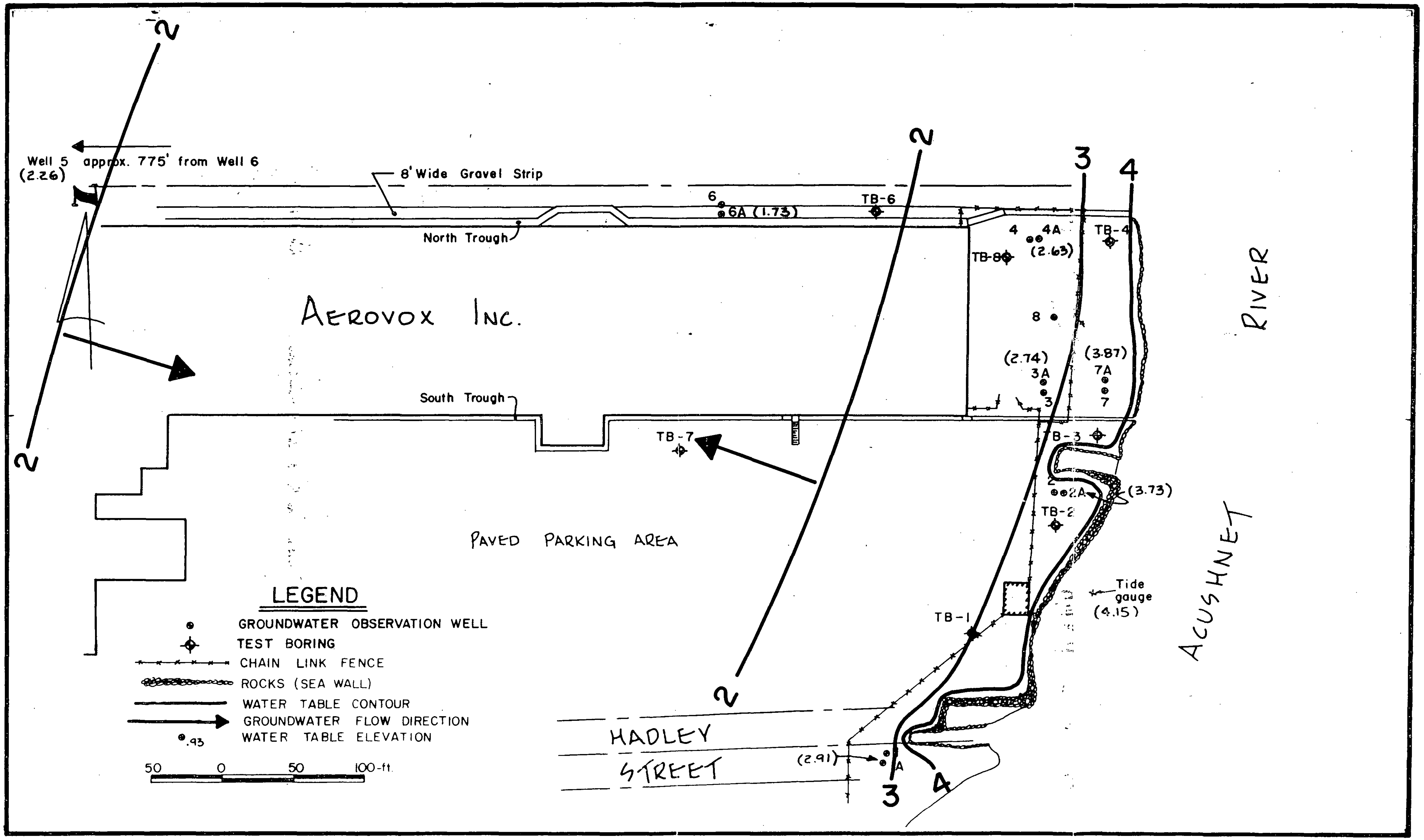
1. Low tide readings for November 16, 17, 18 and 19 are approximate due to extreme low tides.
2. ND = No reading taken.

TABLE 4-5

MEASURED DAILY TOTAL FLUCTUATIONS IN TIDE AND GROUNDWATER ELEVATIONS
AEROVOX PROPERTY, NEW BEDFORD, MASSACHUSETTS 1

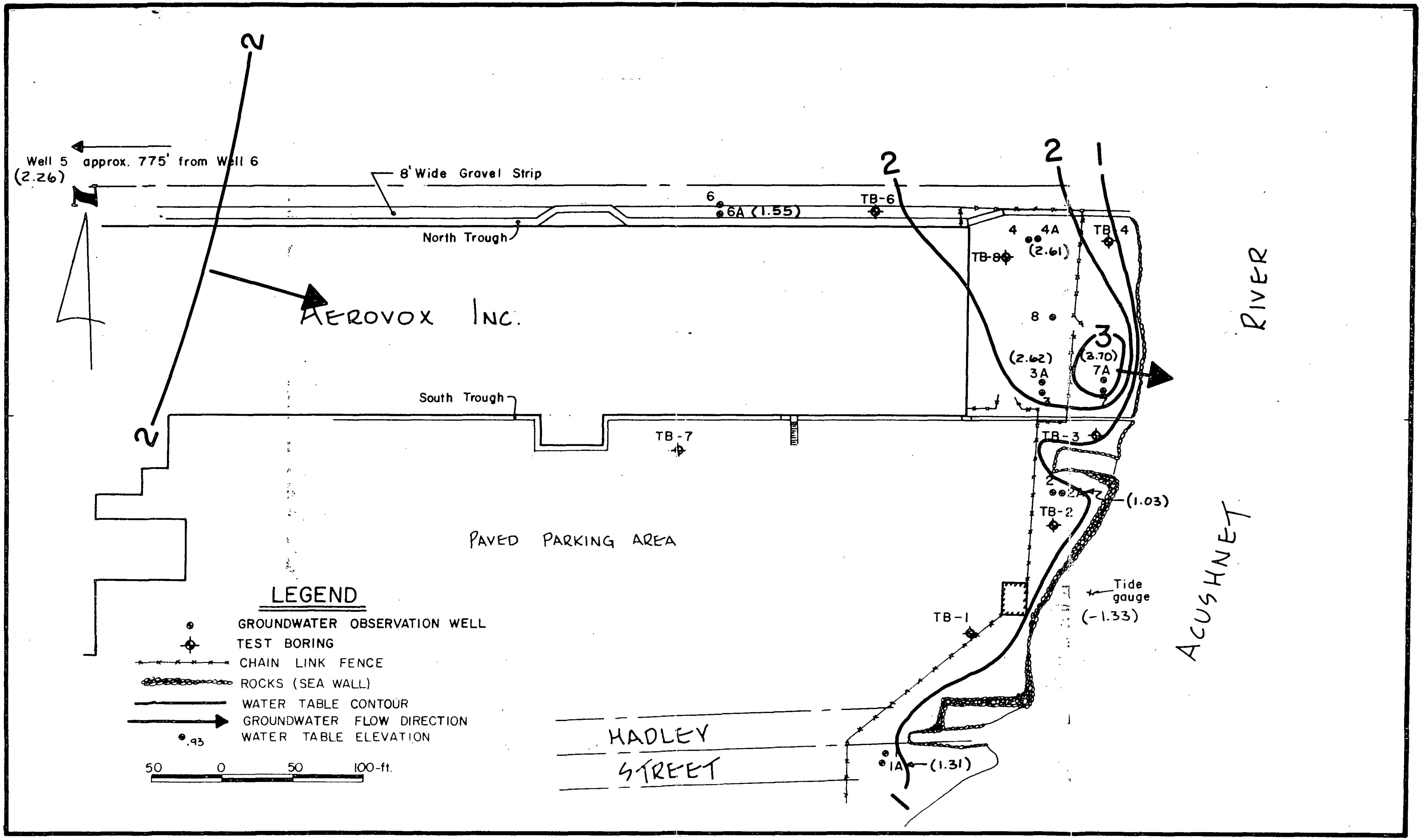
| DATE | 11/2/82 | 11/3 | 11/4 | 11/5 | 11/8 | 11/9 | 11/10 | 11/11 | 11/12 | 11/15 | 11/16 | 11/17 | 11/18 | 11/19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TIDE GAUGE | 5.33 | 5.48 | 5.32 | 5.07 | 3.35 | 3.55 | 3.85 | 3.96 | 3.50 | 5.24 | 4.74 | 3.40 | 3.30 | 3.40 |
| WELLS | | | | | | | | | | | | | | |
| 1 | 1.89 | 1.88 | 1.83 | 1.72 | 1.23 | 1.45 | 1.21 | 1.44 | 1.42 | 1.83 | 1.52 | 1.08 | 1.30 | 1.10 |
| 1A | 1.54 | 1.60 | 1.69 | 1.24 | 0.75 | 0.64 | 0.62 | 0.65 | 0.64 | 0.91 | 1.05 | ND | 0.84 | 0.69 |
| 2 | 1.55 | 1.57 | 1.52 | 1.47 | 1.02 | 1.14 | ND | 1.31 | 1.15 | ND | 1.17 | 0.96 | 1.00 | 0.95 |
| 2A | 2.55 | 2.70 | 2.73 | 2.45 | 1.22 | 1.06 | 1.1 | 1.17 | 1.39 | 1.89 | 1.43 | ND | 1.40 | 1.14 |
| 3 | 1.09 | 1.09 | ND | 1.05 | 0.74 | 0.79 | ND | 0.95 | 0.79 | 1.00 | 0.88 | 0.71 | 0.79 | 0.68 |
| 3A | 0.09 | 0.12 | 0.12 | 0.03 | 0.07 | 0.01 | 0.00 | 0.16 | 0.00 | 0.03 | 0.15 | 0.05 | 0.07 | 0.03 |
| 4 | 1.67 | 1.65 | 1.62 | 1.69 | 0.97 | 1.17 | 1.02 | ND | 1.28 | 1.62 | 1.30 | 0.93 | 1.22 | 1.01 |
| 4A | 0.03 | 0.02 | 0.02 | 0.04 | 0.00 | 0.06 | 0.18 | ND | 0.02 | 0.06 | 0.03 | ND | 0.07 | 0.01 |
| 7 | 2.47 | 2.05 | 2.05 | 2.17 | 1.25 | 1.52 | 1.28 | 2.08 | 1.63 | 2.08 | 1.68 | 1.46 | 1.49 | 1.26 |
| 7A | 0.11 | 0.67 | 0.82 | 0.51 | 0.00 | 0.01 | 0.05 | 0.03 | ND | 0.37 | 0.06 | ND | 0.02 | 0.00 |
| 6 | 0.35 | 0.34 | 0.37 | 0.33 | 0.25 | 0.23 | 0.25 | 0.30 | 0.30 | 0.34 | 0.30 | ND | 0.28 | 0.22 |
| 6A | 0.21 | 0.18 | 0.20 | 0.17 | 0.17 | 0.16 | 0.13 | 0.20 | 0.13 | 0.20 | 0.17 | ND | 0.17 | 0.14 |
| 5 | 0.02 | 0.00 | 0.03 | 0.01 | 0.04 | 0.01 | 0.00 | ND | 0.03 | 0.01 | 0.04 | 0.09 | 0.05 | 0.03 |
| 8 | 1.71 | 1.65 | 1.67 | 1.70 | 1.00 | 1.17 | 1.06 | ND | 1.31 | 1.65 | 1.34 | ND | 1.23 | 1.04 |

ND = no data
1. Daily fluctuations expressed as net differences in elevations from highest reading to lowest reading for each station each day.



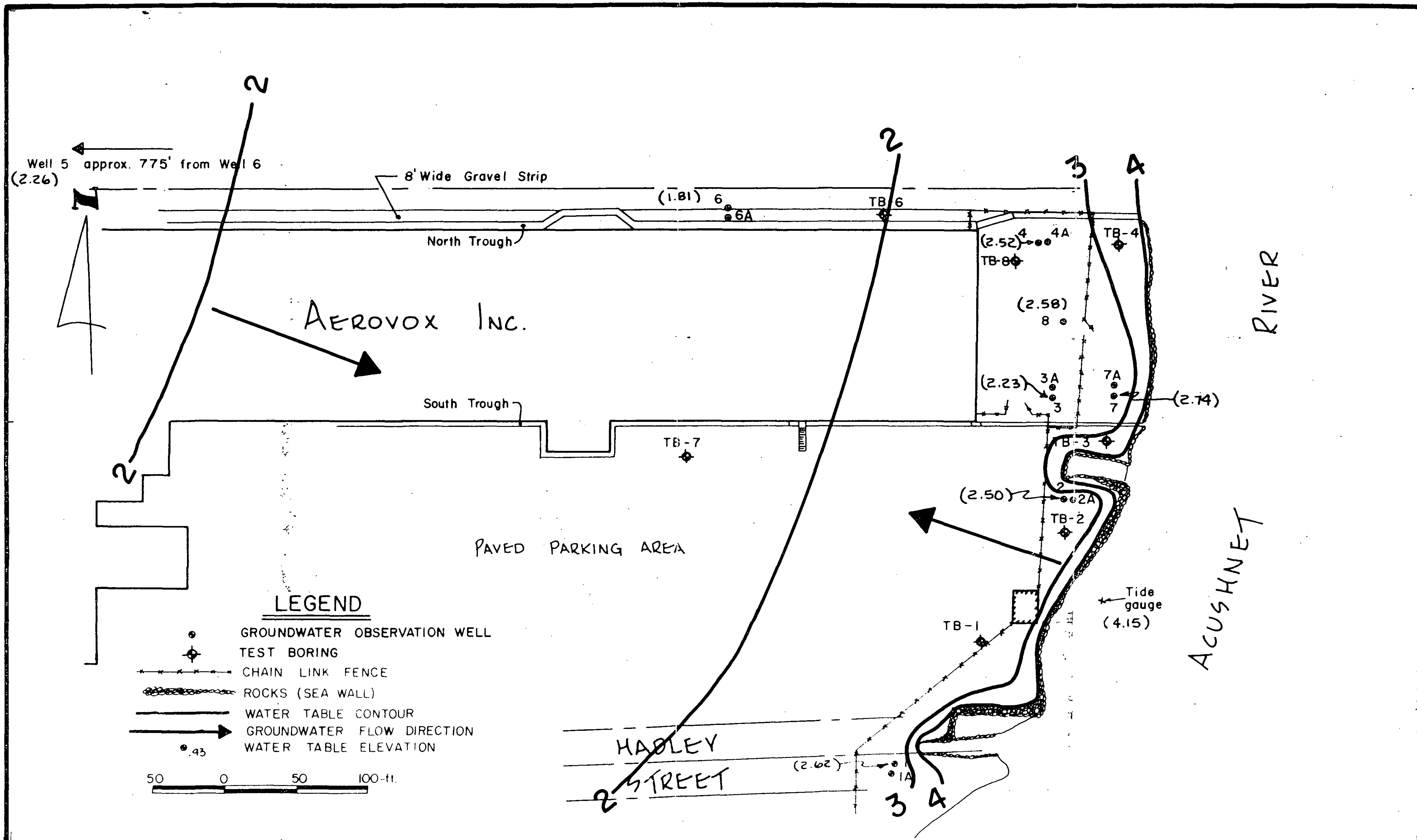

GROUNDWATER CONTOURS FOR SHALLOW (PERCHED) SYSTEM AT HIGH TIDE
(Water Levels Recorded in Shallow Wells on November 3, 1982)

FIGURE 4-6



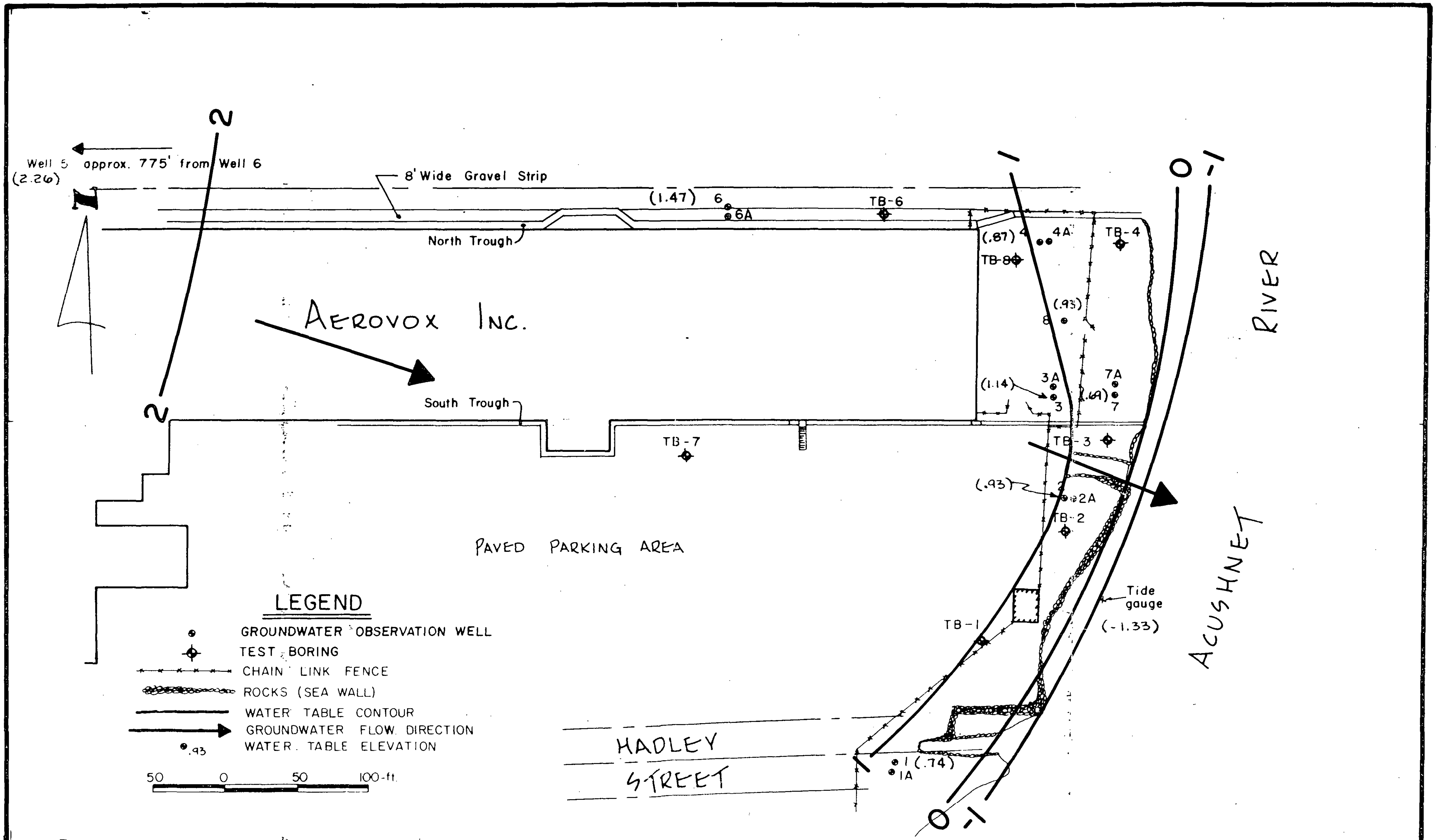

GROUNDWATER CONTOURS FOR SHALLOW (PERCHED) SYSTEM AT LOW TIDE
(Water Levels Recorded in Shallow Wells on November 3, 1982)

FIGURE 4-7




GROUNDWATER CONTOURS FOR DEEP SYSTEM AT HIGH TIDE
(Water Levels Recorded in Deep Wells on November 3, 1982)

FIGURE 4-8




GROUNDWATER CONTOURS FOR DEEP SYSTEM AT LOW TIDE
(Water Levels Recorded in Deep Wells on November 3, 1982)

FIGURE 4-9

Tidal recharge to this portion of the perched system is controlled by the elevation of the upper edge of the "bowl" formed by the peat. This upper edge is estimated to be at or near elevation 2.5. Unless the tide level is above 2.5 feet, the perched system behind the edge of the "dish" receives no recharge from the river. The dish-shaped area discharges in a southeasterly direction to the general area of Slip #2. The discharge appears to be controlled by the elevation of the peat at the seawall which is at approximately elevation 0.7 feet. Some recharge to the area could occur from Slip #2 during high tides.

Figures 4-8 and 4-9 depict the piezometric surface of the deeper "confined" aquifer as observed during the tidal cycle on Nov. 3, 1982. As with the perched system, the deep system demonstrates a negatively sloping gradient in an inland direction during high tide. At low tide, the gradient reverses direction. The effects of tidal action were barely distinguishable at Well 6, located about 300 feet from the river, and no tidal effects were detected at Well 5 near Belleville Avenue.

From the water level information presented in Tables 4-2 through 4-5, several observations relative to the hydrology of the site can be made.

Under normal tidal conditions, the perched system underlying Zone 3 receives little infiltration due to the elevation of the peat surface with respect to the tidal fluctuation. Water level information for Wells 3A, 4A and 7A did not demonstrate any significant fluctuation from high to low tide. There was, however, a discernable relationship between the water level within this zone and the level of the high tide. This supports the theory that the peat "bowl" receives small quantities of recharge from the estuary then discharges over a relatively long period of time. If this area always received recharge from the estuary at high tide, then it would always discharge at low tide and, therefore, a pronounced fluctuation in water levels from high to low tide would have been observed.

The lack of significant water level fluctuation in Wells 3A, 4A and 7A from high to low tide also indicates that the above area exhibits little to no hydraulic connection with the deeper system. This in turn indicates continuity of the peat layer.

The perched system in Zones 1, 2 and the easterly portion of Zone 4 exhibits a direct hydraulic connection with the estuary for every tidal condition. The quantity of water introduced during high tide discharges, in about the same manner that it entered, at low tide.

### 4.24 Groundwater Flow Volumes

In order to assess the potential for the release of PCBs into the estuary from the site, it is necessary to quantify the groundwater discharge for the study area. The approach used in quantifying groundwater leaving the site is a mass balance calculation. This approach is simplified due to the relatively small amount of surface area through which infiltration can occur. As discussed previously, recharge to the perched system occurs as infiltration of direct precipitation and as recharge from the estuary. Groundwater recharge from areas westerly of the site enters the deeper system and, therefore, does not encounter the contaminated soils in the perched system.

For the purpose of assessing groundwater flow volumes, the site has been divided into four distinct areas corresponding closely to Zones 1 through 4 defined in previous sections of this report. The only deviation from the zones is in the area behind the Aerovox building (Zones 3 and 4). This area has been divided into: (1) the area referred to in Section 4.23 as the "bowl" shape which underlies Zone 3 and part of 4, and (2) an area easterly of the "bowl" which discharges directly to the estuary.

The unpaved surface area of Zone 1 is about 4,800 square feet. Twelve inches of infiltration per year represents a total of 35,900 gallons or 98 gallons per day. Based on an average tidal range, an influence reaching inland about 300 feet and an average porosity of 25 percent, a discharge of 56,000 gallons per tidal cycle or 112,000 gallons per day is calculated.

The unpaved surface area of Zone 2 is about 5,500 square feet. The resulting infiltration would be 41,100 gallons per year or 112 gallons per day. The discharge resulting from tidal action based on the same criteria as Zone 1 and the physical characteristics of Zone 2 would 64,000 gallons per tidal cycle or 128,000 gallons per day.

The pervious area within a portion of Zone 4 and portions of Zone 3 immediately adjacent to the estuary is about 7700 square feet. The calculated quantity of infiltration for this zone is 57,600 gallons per year or an average of 158 gallons per day. The calculated discharge resulting from tidal action would be 39,400 gallons per tidal cycle or 78,000 gallons per day.

Calculation of the flow volumes within Zone 3 requires a different approach due to the configuration of the underlying peat. The infiltration over the 10,000 square feet of pervious surface area in Zones 1, 2 and 4 is calculated as 74,800 gallons per year or an average of 205 gallons per day. The quantity of groundwater discharged as a result of the tidal action, however, is not calculated as in the other zones where the water flushes in and out with each tidal change. Tidal water enters the zone during certain tides and discharges over a much longer period of time.

In order to estimate the quantity of water flowing in a given time, the water levels within this area (Wells 3A, 4A, 7A) were evaluated to determine drops in elevation over extended periods of time. One such time period was from Nov. 5 to Nov. 12, where an average of 0.8 foot of drop in water level over the area was observed. From Nov. 15 to Nov. 19 an average of about 0.5 foot drop was observed. This average daily drop over these two periods is calculated as 0.1 feet. The corresponding flow of water from the 10,000 s.f. area, based on the 0.1 foot drop and a porosity of 25 percent is calculated as 1900 gallons per day. The following table summarizes the above groundwater flow estimates:

| Zone | Infiltration (GPD) | Tidal Discharge (GPD) | Total Discharge (GPD) |
|---|---|---|---|
| 1 | 98 | 112,000 | 112,098 |
| 2 | 112 | 128,000 | 128,112 |
| 3 | 205 | 1,900 | 2,105 |
| 4 | 158 | 78,800 | 78,958 |
| | | | 321,273 |

# 5.00 WATER QUALITY TESTING RESULTS

In this Section, the water quality data for the project area are used to present an assessment of contaminant distribution in both the perched and deep groundwater systems and in the Acushnet River adjacent to the site. In addition, estimates of water soluble PCB concentrations in the groundwater are presented. These estimates provide the basis for evaluating the potential for various remedial action alternatives to reduce off-site migration of PCBs found in the soil at the Aerovox site.

The results of PCB and specific conductance testing are discussed first. Volatile organics test results for the study area are addressed separately in Section 5.14.

## 5.10 PCB Concentrations and Tidal Intrusion

PCB and specific conductance testing results of groundwater and river water samples in the study area are tabulated in Tables 5-1 through 5-3:

- Table 5-1 PCBs in Groundwater
- Table 5-2 PCBs in River Water
- Table 5-3 Specific Conductance and Solids in Groundwater and River Water

### 5.11 Perched Groundwater System

The chemical characteristics of the perched groundwater system described in Section 4.00 are affected by brackish water recharge received from the Acushnet River. Groundwater samples collected from shallow wells within 25 feet

TABLE 5-1

RESULTS OF GROUNDWATER TESTING FOR PCBs
AEROVOX PROPERTY, NEW BEDFORD, MASSACHUSETTS

(ALL RESULTS IN ug/l(PPB))

| WELL NUMBER | SAMPLING OF 8-5-82 UNFILTERED | | SAMPLING OF 10-4-82 UNFILTERED | | SAMPLING OF 10-4-82 FILTERED | | SAMPLING of 11-17-82 HIGH TIDE UNFILTERED | | SAMPLING of 11-17-82 HIGH TIDE FILTERED | | SAMPLING OF 11-17-82 LOW TIDE UNFILTERED | | SAMPLING OF 11-17-82 LOW TIDE FILTERED | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PCB-1242 | PCB-1254 | PCB-1242 | PCB-1254 | PCB-1242 | PCB-1254 | PCB-1242 | PCB-1254 | PCB-1242 | PCB-1254 | PCB-1242 | PCB-1254 | PCB-1242 | PCB-1254 |
| Background Station Near Belleville Avenue | | | | | | | | | | | | | | |
| Well No. 5 | 3.5 | < 1 | | | | | < 1.5 | 5.2 | ND[2] | ND | | | | |
| Shallow Wells Between Plant and River | | | | | | | | | | | | | | |
| Well No. 1A | 2.3 | < 1 | | | | | | | | | | | | |
| Well No. 2A | 15.5 | 21.3 | | | | | | | | | | | | |
| Well No. 3A | 4.6 | 19.8 | 26.0 | 41.0 | 3.0 | < 1 | | | | | | | | |
| Well No. 4A | 14.4 | 11.0 | 101.0 | 115.0 | 4.0 | < 1 | | | | | | | | |
| Well No. 7A | | | 14.0 | 21.0 | 2.0 | < 1 | | | | | | | | |
| Deeper Wells Between Plant and River | | | | | | | | | | | | | | |
| Well No. 1 | < 1 | < 1 | | | | | | | | | | | | |
| Well No. 2 | 2.8 | ND | | | | | | | | | | | | |
| Well No. 3 | < 1 | 1.8 | | | | | < 1.5 | 1.5 | 1.8 | ND | 5.6 | 9.5 | 3.5 | < 1.5 |
| Well No. 4 | 4.5 | ND | | | | | 55.6 | 94.1 | 6.0 | 1.5 | 3.5 | 1.8 | ND | ND |
| Well No. 7 | | | | | | | < 1.5 | 1.8 | 1.3 | ND | 1.5 | ND | 3.9 | ND |
| Well No. 8 | | | | | | | 85.6 | 45.2 | 14.0 | 4.4 | | | | |

1. Concentrations of Aroclors in parts per billion (ug/l). Due to the matrix of the samples, all low-chlorine isomers were calculated as PCB-1242, although PCB-1016 and PCB-1248 may be present.
2. ND = not detected. Lower limit of detection reported as 0.2 ppb for samples collected 8-5-82 and 10-4-82, and as 0.5 ppb for samples collected 11-17-82.

Analyses by Cambridge Analytical Associates, Inc., Watertown, MA

TABLE 5-2

RESULTS OF RIVER WATER TESTING FOR PCBs

(ALL RESULTS IN ug/l (PPB))[1]

| SAMPLING LOCATION[1] | SAMPLING OF 11-17-82 HIGH TIDE | | | |
|---|---|---|---|---|
| | UNFILTERED | | FILTERED | |
| | PCB-1242 | PCB-1254 | PCB-1242 | PCB-1254 |
| Acushnet River Upstream of Aerovox at Wood Street Bridge | 1.5 | ND[3] | 2.8 | ND |
| Acushnet River Adjacent to Aerovox Sampling Zone 4B | 4.4 | < 1.5 | 3.9 | ND |
| Acushnet River at Old Pump House on Aerovox Property | 2.0 | ND | 2.2 | ND |

1. Concentration of Arochlors in parts per billion (ug/l). Due to the complex nature of PCBs, all low-chlorine isomers were calculated as PCB-1242, although PCB-1016 and PCB-1248 may be present.
2. See Figure 3 for sampling locations.
3. ND = not detected. Lower limit of detection = 0.5 ppb.

TABLE 5-3

RESULTS OF GROUNDWATER AND RIVER WATER TESTING FOR SUSPENDED SOLIDS, DISSOLVED SOLIDS AND SPECIFIC CONDUCTANCE AT HIGH AND LOW TIDE

| SAMPLING LOCATION | TIDE STAGE | TOTAL SUSPENDED SOLIDS (mg/l)[1] | TOTAL DISSOLVED SOLIDS (mg/l) | SPECIFIC CONDUCTANCE (umhos/cm)[2] |
|---|---|---|---|---|
| Samples Collected November 17, 1982[3] | | | | |
| Well No. 1 | H | 592 | 288 | 490 |
| Well No. 1 | L | 256 | 290 | 500 |
| Well No. 1A | H | 1,600 | 7,050 | 11,500 |
| Well No. 1A | L | 81 | 6,830 | 10,500 |
| Well No. 2 | H | 1,540 | 616 | 1,180 |
| Well No. 2 | L | 202 | 652 | 1,170 |
| Well No. 2A | H | 2,100 | 10,000 | 15,600 |
| Well No. 2A | L | 691 | 10,620 | 15,700 |
| Well No. 3 | H | 381 | 1,200 | 1,410 |
| Well No. 3 | L | 25 | 951 | 1,370 |
| Well No. 3A | H | 9,570 | 1,130 | 1,950 |
| Well No. 4 | H | 814 | 608 | 975 |
| Well No. 4 | L | 109 | 544 | 900 |
| Well No. 4A | H | 1,335 | 393 | 475 |
| Well No. 7 | H | 602 | 889 | 1,550 |
| Well No. 7 | L | 299 | 812 | 1,400 |
| Well No. 7A | H | 1,200 | 12,300 | 19,500 |
| Well No. 8 | H | 6,090 | 619 | 970 |
| Well No. 8 | L | 116 | 617 | 950 |
| Acushnet River Upstream at Wood St. Bridge | H | 3 | 2,170 | 4,100 |
| Acushnet River Adjacent to Aerovox Sampling Zone 4B | H | 12 | 9,890 | 15,300 |
| Acushnet River at Old Pump House on Aerovox Site | H | 22 | 7,080 | 12,100 |
| Samples Collected December 22, 1982 | | | | |
| Well No. 3A | H | 1,480 | 658 | 1,100 |
| Well No. 3A | L | 2,093 | 751 | 1,260 |
| Well No. 4A | H | 96 | 269 | 450 |
| Well No. 4A | L | 200 | 172 | 480 |
| Well No. 7A | H | 365 | 7,550 | 13,600 |
| Well No. 7A | L | 200 | 7,590 | 12,900 |

1. mg/l = parts per million.
2. umhos/cm = micromhos per centimeter.
3. River water samples collected at the east river bank in approximately 1 to 1.5 feet of water.

of the shoreline were found to be composed primarily of brackish water which had entered the site as a result of tidal action. This observation is based on the fact that the specific conductance values in Well 1A, 2A and 7A, all located within 25 feet of the sea wall, were in the same range as the conductance observed in the Acushnet River at the time of sampling (i.e., 10,000 to 20,000 umhos/cm).

The brackish water influence diminishes with distance from the sea wall in Zones 3 and 4. Conductance levels observed in Well 3A, located approximately 65 feet from the shoreline, have been found to be consistently in the range of 1,000 to 2,000 umhos/cm. Conductance levels observed in Well 4A, located in Zone 3 approximately 75 feet from the shore, were from 400 to 500 umhos/cm, nearly approaching the upgradient background groundwater levels of 250 to 350 umhos/cm. Thus, the conclusion drawn in Section 4.00--that the actual penetration distance of river water into the perched groundwater system directly behind the Aerovox plant is limited by the peat zone--is supported by the specific conductance test results in Table 5-3.

Groundwater samples were analyzed before and after filtering in order to evaluate both total and water soluble PCBs. The total PCB content of the samples includes both the fraction of PCB dissolved in the groundwater and the fraction of PCB adsorbed onto suspended matter in the water sample. The water soluble PCB content, on the other hand, includes only the fraction of PCB dissolved in the water. From Table 5-1, the total PCB concentrations (unfiltered samples) in the perched groundwater system ranged from 2.3 to 216 ug/l, or parts per billion (ppb), while water soluble PCB concentrations (filtered samples), ranged from 2 to 5 ppb.

The highest total PCB value found in the perched system was in a sample from Well 4A that was observed to contain a large amount of suspended sediment. After filtering the sample, the PCB concentration decreased to 4 ppb, a level indicative of the dissolved PCB concentration in the sample. The concentrations of dissolved PCBs found in the perched groundwater system are extremely low when one considers the PCB levels in the soils in the study area. This is consistent with the findings of other researchers that PCBs exhibit a high affinity for adsorption onto soils and that PCB migration in groundwater is not typically a major pathway for off-site movement of PCBs (see Section 5.20 below).

### 5.12 Deep Groundwater System

The chemical characteristics of the deep groundwater system as defined in Section 4.00 are influenced by intrusion of brackish water from the Acushnet River. Brackish water entering into the deeper system, however, is subject to considerable dilution by fresh groundwater flowing to the estuary within the aquifer. As Table 5-3 indicates, in the deeper wells at the site, specific conductances ranged from 500 to 2000 umhos/cm. This translates to total dissolved solids (TDS) concentration range of 300 to 900 mg/l, or parts per million (ppm). In nearshore Wells 1, 2 and 7, conductances were roughly an order-of-magnitude lower than in their shallow well counterparts (Wells 1A, 2A, and 7A). The brackish water penetrates further inland in the deep system than in the perched system. Conductance values of approximately 950 umhos/cm were measured in Well 4 versus 450 umhos/cm in Well 4A. The higher conductance in the deep system suggests that the saltwater gradient is less abrupt in the deep system and extends further inland than in the perched water system. The existence of different brackish water intrusion gradients in the deep and perched water systems adds support to the argument that the two systems are effectively isolated from one another by the intervening peat materials.

Water samples from the deep groundwater system were analyzed for both total (unfiltered samples) and water soluble (filtered samples) PCBs. The results are presented in Table 5-1. Total PCB concentrations ranged from a low of 1.5 to a high of 150 parts per billion. The highest concentrations were observed in Wells 4 and 8 on Nov. 17, 1982. All other samples from the deep wells contained less than 20 ppb of total PCBs. The total PCB values for Well 5, the background observation well, were in the 5 ppb range. However, in the single filtered sample analyzed for Well 5, no water soluble PCBs were detected.

A total of five samples from Well 4 have been analyzed for PCBs since the Aerovox site investigation began. Of these, only the sample collected at high tide on Nov. 17, 1982 contained an elevated concentration of total PCB. That sample was collected in the morning at high tide and was followed by an afternoon sample collected at low tide. The low tide sample contained low levels of both total and water soluble PCBs (5 ppb and none detected, respectively). Since the total suspended solid content of the high tide sample was substantially higher (814 mg/l) than in the low tide sample (109 mg/l), it was believed that the PCB value obtained at high tide could be attributed to the amount of suspended matter in the sample. To confirm this, an additional set of high and low tide samples for Well 4 was collected on Dec. 22, 1982. The results of this testing (14 ppb in the unfiltered sample, none detected in the filtered sample) support the conclusion that the higher total PCB values obtained on Nov. 17, 1982 were not representative. Both Wells 4 and 8, along with all the other wells in the study area, were each pumped for about 1/2-hour with a gasoline-powered pump on Nov. 10, 1982. It is possible that during this pumping the bentonite seals in the wells were short-circuited and upper level contaminants were drawn down below the seals, eventually to be reflected in samples taken a week later. It should be remembered that the higher PCB levels were recorded for unfiltered samples, and thus do not reflect PCBs dissolved in groundwater.

Water soluble PCB concentrations in the deep system ranged from none detected to a high of 18 ppb. The two highest values were observed in Wells 4 and 8 on Nov. 17, 1982. As discussed above, these values may reflect the prior pumping of the wells and the high suspended solids content of the samples. With the exception of these two samples, water soluble PCB concentrations did not exceed 5 ppb in the deep water system.

### 5.13 Acushnet River

The Acushnet River in the vicinity of the Aerovox site can be described as a brackish estuarine environment. This area serves as a mixing zone where freshwater from the river mixes with saltwater which enters the estuary from Buzzards Bay. Specific conductance values in the river near the site ranged from 12,000 to 16,000 umhos/cm at high tide. This translates to a total dissolved solids (TDS) concentration range of 7,000 to 10,000 mg/l. The TDS of seawater is approximately 32,000 mg/l, or roughly three times higher than values observed in the river on Nov. 17, 1982. Freshwater dilution becomes even more pronounced 1/2-mile upriver at the Wood Street bridge where specific conductance decreased to 4,100 umhos/cm (TDS = 2,170 mg/l) at high tide.

Table 5-2 shows that total PCB concentrations ranged from 1.5 to 4.4 ppb in water samples collected along the west shore of the river with the lowest value measured at the Wood Street bridge. Unlike the groundwater, water soluble PCBs comprised a major portion of the total PCBs in the river water, and while the absolute concentrations are very low, it is likely that river water which intrudes into the Aerovox property during tidal cycles would contain approximately 2 to 4 ppb of water soluble PCBs. Thus, river water entering either the deep or perched water systems would enter with water soluble PCB concentrations in the same range as those observed in the majority of samples collected from the groundwater system.

### 5.14 Summary of Volatile Organics Data

Volatile organics test results for groundwater at the site are presented in Table 5-4. The test results for samples from the Acushnet River are tabulated in Table 5-5. In the perched water system, the total volatile organic concentrations were less than 0.5 ppm in all wells sampled. The compounds identified included the solvents ethylbenzene, chlorobenzene, and trichloroethylene. These compounds are commonly associated with industrial processes and their presence in the groundwater at low levels at industrial sites is not unusual. Vinyl chloride, a highly volatile compound used in rubber and plastics manufacturing, was also detected.

# TABLE 5-4

## RESULTS OF GROUNDWATER TESTING FOR VOLATILE ORGANICS
## AEROVOX PROPERTY, NEW BEDFORD, MASSACHUSETTS
## (ALL RESULTS IN ug/l (PPB))

| | SAMPLING OF 8-5-82 | | | | SAMPLING OF 11-17-82 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | WELL NO. 2 | | WELL NO. 3 | | WELL NO. 4 | | WELL NO. 7 | |
| | WELL NO. 2A | WELL NO. 3A | WELL NO. 4A | WELL NO. 5 | HIGH TIDE | LOW TIDE | HIGH TIDE | LOW TIDE | HIGH TIDE | LOW TIDE | HIGH TIDE | LOW TIDE |
| Acrolein[1] | | | | | | | | | | | | |
| Acrylonitrile[1] | | | | | | | | | | | | |
| Benzene | | | | | Tr[2] | Tr | | | | | | |
| Bis (Chloromethyl) Ether | | | | | | | | | | | | |
| Bromoform | | | | | | | | | | | | |
| Carbon Tetrachloride | | | | | | | | | | | | |
| Chlorobenzene | 14 | 114 | | | 60 | 77 | 25 | 30 | Tr | Tr | | |
| Chlorodibromomethane | | | | | | | | | | | | |
| Chloroethane | | | | | | | | | | | | |
| Chloroethylvinyl Ether | | | | | | | | | | | | |
| Chloroform | | 10 | | | | | | | | | | |
| Dichlorobromomethane | | | | | | | | | | | | |
| Dichlorodifluoromethane | | | | | | | | | | | | |
| 1,1-Dichloroethane | Tr | | | | | | | | | | | |
| 1,2-Dichloroethane | | | | | | | | | | | | |
| 1,1-Dichloroethylene | | | | | | | | | | | 31 | 30 |
| 1,2-Dichloropropane | | | | | | | | | | | | |
| 1,3-Dichloropropylene | | | | | | | | | | | | |
| Ethylbenzene | | 269 | | | | | Tr | Tr | | | | |
| Methyl Bromide | | | | | | | | | | | | |
| Methyl Chloride | | | | | | | | | | | | |
| Methylene Chloride | | | | | | | | | | | | |
| 1,1,2,2-Tetrachloroethane | | | | | | | | | | | | |
| Tetrachloroethylene | | | | | | | | | | | | |
| Toluene | | | | | 16 | 14 | | | | | | |
| t-1,2-Dichloroethylene | Tr | | 23 | | 22 | 22 | | | 1830 | 1830 | 645 | 660 |
| 1,1,1-Trichloroethane | | | | | | | | | | | | |
| 1,1,2-Trichloroethane | | | | | | | | | | | | |
| Trichloroethylene | | | 99 | | 59 | 54 | | | 227 | 170 | 4490 | 3020 |
| Trichlorofluoromethane | | | | | | | | | | | | |
| Vinyl Chloride | | 90 | 70 | | 245 | 1090 | 2070 | 1548 | 3500 | 2300 | 2690 | 2390 |

1. Limit of detection = 250 ppb for acrolein and acrylontrile.
2. Tr = Trace = less than 10 ppb (detected, but not quantifiable).
   Blank spaces indicate not detected (lower limit of detection = 10 ppb).

TABLE 5-5

RESULTS OF RIVER WATER TESTING FOR VOLATILE ORGANICS
(ALL RESULTS IN ug/l(PPB))

| | ACUSHNET RIVER UPSTREAM OF AEROVOX AT WOOD ST. BRIDGE | | ACUSHNET RIVER ADJACENT TO AEROVOX SAMPLING ZONE 4B | |
|---|---|---|---|---|
| | HIGH TIDE | LOW TIDE | HIGH TIDE | LOW TIDE |
| Acrolein[1] | | | | |
| Acrylonitrile[1] | | | | |
| Benzene | | | | |
| Bis (Chloromethyl) Ether | | | | |
| Bromoform | | | | |
| Carbon Tetrachloride | | | | |
| Chlorobenzene | | | | |
| Chlorodibromomethane | | | | |
| Chloroethane | | | | |
| Chloroethylvinyl Ether | | | | |
| Chloroform | | | | Tr[2] |
| Dichlorobromomethane | | | | |
| Dichlorodifluoromethane | | | | |
| 1,1-Dichloroethane | | | | |
| 1,2-Dichloroethane | | | | |
| 1,1-Dichloroethylene | | | 13 | |
| 1,2-Dichloropropane | | | | |
| 1,3-Dichloropropylene | | | | |
| Ethylbenzene | | | | |
| Methyl Bromide | | | | |
| Methyl Chloride | | | | |
| Methylene Chloride | | | | |
| 1,1,2,2-Tetrachloroethane | | | | |
| Tetrachloroethylene | | | | |
| Toluene | | | | |
| 1,2-Trans Dichloroethylene | Tr | ND | | |
| 1,1,1-Trichloroethane | | | | |
| 1,1,2-Trichloroethane | | | | |
| Trichloroethylene | Tr | Tr | 12 | 74 |
| Trichlorofluoromethane | | | | |
| Vinyl Chloride | | | | 23 |

1. Limit of detection = 250 ppb for acrolein and acrylonitrile.
2. Tr = Trace = less than 10 ppb (detected, but not quantifiable).
   Blank spaces indicate not detected (lower limit of detection = 10 ppb).

In the deeper water system, total volatile organic compound concentrations ranged from 0.4 ppm to 7.65 ppm. The volatile compounds identified in the deep system included vinyl chloride, trichloroethylene, 1,2-trans dichloroethylene, and chlorobenzene. The fact that the volatile levels in the deep system were higher than those observed in the perched system suggests an up-gradient source. If the perched system had been the source of these compounds in the deeper system, then one would have expected that the relationship between the concentrations would have been reversed. Thus, the source of the volatile organics in the deeper system is unknown at present. Additional field sampling over a wider area would be required before source identification would be possible. Since groundwater from this area does not serve as a source of potable water, these levels do not pose an immediate threat to human health. Furthermore, since groundwater discharge into the estuary occurs at a relatively low rate, subsequent dilution effects would substantially reduce the concentrations of volatile organics.

In the Acushnet River samples, total volatile organic concentrations were less than 10 ppb at the Wood Street bridge and below 100 ppb at the shoreline adjacent to the Aerovox site. The level observed (95 ppb) at low tide adjacent to the site is roughly two orders of magnitude lower than levels observed in the deep water system at the site. While the data is admittedly sparse, it does support the conclusion that volatile organics entering the estuary would be rapidly dissipated by the large tidal flow past the site.

## 5.20 Subsurface Contaminant Migration Assessment

### 5.21 PCBs

PCBs have been shown by numerous studies to be strongly adsorbed by soils and, because of this, have a very low probability of transport by leaching through subsurface materials. Griffin and Chian (1980) reported little or no movement of PCBs from landfills or leaching from soils in lab tests.[5] They noted that "PCBs have a strong affinity for soil and that the nature of the surface, the organic matter content and the chlorine content and/or hydrophobicity of the individual PCB isomers are factors affecting adsorption." Their results indicated that higher chlorinated isomers were preferentially adsorbed over lower chlorinated isomers. They also observed a high correlation between adsorption rate of PCBs and total organic carbon and particle surface area, that Aroclor 1242 and 1254 were immobile in soils as determined by soil thin layer chromatography when leached with water or landfill leachate.

Studies performed on land disposal sites have shown little or no groundwater contamination from leaching of PCBs. Stratton, Tuttle and Allan[6] and Moon, Leighton and Huebner[7] found less than 1 ppb PCBs in groundwater from monitoring wells at the New Bedford Landfill although the

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5. Griffin, R.A., and Chian, E.S.K., "Attenuation of Water-Soluble Polychlorinated Biphenyls by Earth Materials"; Illinois Geological Survey Environmental Geology Notes No. 81, 1979.

6. Stratton, C.L., Tuttle, K.L., and Allan J.M., "Environmental Assessment of Polychlorinated Biphenyls (PCBs) Near New Bedford, Mass. Municipal Landfill", EPA 560/6-78-006, 1978.

7. Moon, D.K., Leighton, I.W., and Huebner, D.A., "New England PCB Waste Management Study", Region I EPA Report, 1976.

surface soil contained up to 6,500 ppb PCB. Miller, Braids and Walker[8] studied fifty PCB land disposal sites including ten sites in New England. Of these, eight sites had no detectable PCBs in groundwater samples and two sites had concentrations of 1 to 2 ppb. Sharpenseel, Theng and Stephan[9] reported that adsorption can occur with clay minerals alone, particularly cationic forms, but that in experiments with undisturbed natural soil cores, PCBs preferentially adsorbed to rotted organic matter.

At the Aerovox site, it has been found that the geohydrologic characteristics of the site tend to minimize off-site migration of PCBs via groundwater transport. These characteristics include the low volumes of water which pass through the perched system, and the separation of the perched and deep systems by a layer of organic peat. These site characteristics combine to naturally minimize the volumes of water which pass through PCB-contaminated soil, and to reduce the rate of migration of PCBs as a result of adsorption on organic soil parcilcles. The organic peat materials isolate the PCB-contaminated soils in the perched system from the deep groundwater system. This physical isolation prevents the groundwater flowing beneath the site from encountering PCB-contaminated soil.

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8. Miller, D., Braids, O., and Walker W., "The Prevalence of Subsurface Migration of Hazardous Chemical Substances at Selected Industrial Waste Land Disposal Sites"; EPA Report SW-634, 1977.

9. Sharpenseel, H.W., Theng, B.K.G., and Stephan S., "Polychlorinated Biphenyls (C) in Soils: Adsorption Infiltration, Translocation, and Decomposition", in Environmental Biochemistry and Geomicrobioloty, the Terrestrial Environment: Ann Arbor Science Publishers, Inc., Ann Arbor, MI, 1978.

There are two sources of recharge to the perched water system: (1) precipitation; and (2) tidal inflow from the Acushnet River. Precipitation contributes an average of approximately 575 gallons per day to the 28,000 square feet of unpaved surface area behind the Aerovox plant. This small volume will be reduced to zero upon installation of a surface cap over the exposed area. Tidal inflow to Zones 1, 2, 3 and 4 behind the plant have been estimated at approximately 160,675 gallons per tidal cycle. The majority of this flow is restricted to within 20 to 30 feet of the shoreline, thereby further reducing the net groundwater flow through much of the site. An estimated 1 billion gallons of water flow past the site in the Acushnet River during a full tidal cycle under mean tidal conditions. Thus, outflow from the perched water system at Aerovox contributes less than 0.016 percent of the tidal flow past the site.

PCBs are nearly insoluble in water and, furthermore, the rate at which PCBs dissolve in water is extremely slow, requiring a contact time of several months to reach saturation. This factor is important in those nearshore portions of the site continually "washed" by tidal flow where contact time is measured in hours, rather than months. When coupled with the high affinity of PCBs for adsorption onto particulates, this suggests that PCB concentrations in water leaving the site will be very low. This is supported by the current field studies which have recorded water soluble PCB levels in the range of 1 to 5 ppb in the nearshore shallow wells where tidal flux is the major source of groundwater flow.

Ignoring the observed ambient PCB levels in the river water of 2 to 4 ppb, the estimated rate of release of dissolved PCBs from the site via groundwater discharge is from 2 to 5 lbs. per year. This estimate is based on the recorded water soluble PCB levels in the shallow wells of from 2 to 5 ppb.

5.22 Volatile Organics

Volatile organic compounds are a general group of hydrocarbon chemicals having a characteristically low molecular weight and a propensity to vaporize at ambient environmental temperatures. Volatile compounds detected at the site include representatives of the two main classes of hydrocarbons--aliphatics and aromatics. In general, aliphatics are open-chain hydrocarbons and aromatics are compounds whose chemical structure is based on the cyclic hydrocarbon--benzene. Many compounds are composed of both aliphatic and aromatic units.

The aromatic compounds found at the site include chlorobenzene and compounds composed of the cyclic benzene ring and an attached, straight-chain hydrocarbon, such as ethylbenzene and toluene (or methyl benzene). These are colorless, pleasant smelling and highly flammable volatile solvents of low molecular weight. All except chlorobenzene are less dense than water. When present in groundwater, their distribution is governed chiefly by density and solubility factors and being less dense than water would tend to "float" on the water table. Attenuation in soil is not significant as a fate mechanism for the aromatics, but some natural biodegradation can be expected.

Aliphatic hydrocarbons found at the site include several common halogenated compounds such as chloroform, dichloroethylene, dichloeoethane and trichloroethylene. All are colorless liquids at ambient temperatures, have a characteristic sweet odor, are more dense than water, are highly volatile, and are soluble in water. They are used as metal degreasers, paint and varnish removers and in various other cleaning, solvent and cement applications. Trichloroethylene is commonly used in dry cleaning operations. In groundwater, their characteristic low molecular weight and relatively high water solubility results in a high degree of mobility. Being typically heavier than water, most chlorinated solvent compounds tend to migrate to lower groundwater levels.

The mechanisms available to atttenuate volatile contaminants in the ground include dispersion, adsorption, volatilization, and natural chemical and biological processes which break down or degrade the contaminants. Volatilization will not occur below the water table and some substances do not react and are not readily degraded by bacteria. Adsorption will tend to retard volatile pollutant movement but it is essentially only a delaying process--eventually contamination will break through. Consequently, the main process available for attenuation of volatile organic contamination is dispersion and dilution.

The available data on volatile organics at the Aerovox site are not sufficient to identify the sources of these compounds in either the deeper groundwater zone or the river near the site. The low levels of volatile organics in the perched system at Aerovox may be the result of prior on-site activities.

The available data indicate that discharges from the perched system can contribute low levels (less than .5 ppm) of volatile organics to the estuary. The volatile compounds in the deeper system are also discharged to the estuary. However, the point of discharges from the deeper system are unknown. Thus, the volatile compounds detected in the river samples collected adjacent to the site may be attributable to the Aerovox site or to other as yet unknown sources in the area.

Concern has also been expressed that volatile organic compounds may affect the solubility of PCBs in the groundwater. This concern has merit considering the fact that PCBs are highly soluble in pure solvents. At this site, solvents were detected at trace levels in groundwater. However, no increase in water soluble PCBs was observed in groundwater samples which contained up to 7 ppm of volatile organic compounds. The effect of such low solvent concentrations (7 ppm = 0.0007 percent) on PCB solubility is not expected to be substantial. It has been reported that even a small amount of water (9 percent) mixed with a solvent (methanol) significantly reduced the solvent's ability to desorb PCBs.[10] It is therefore not reasonable to expect that PCB solubility would be increased to any measurable degree in a mixture containing 99.999 percent water (.001 percent of 10 ppm of solvents).

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10. Griffin, R.A., and Chian, E.S.K., "Attenuation of Water-Soluble Polychlorinated Biphenyls by Earth Materials"; Illinois Geological Survey Environmental Geology Notes No. 81, 1979.

## 6.00 EVALUATION OF REMEDIAL MEASURES

The various remedial measures identified for the Aerovox site are discussed and evaluated in this Section. The approach used in the evaluation is to develop a cost-benefit analysis using as a guide the overall methodology established by the U.S. EPA for selecting remedial responses under the Superfund program[11]. The objective of the evaluation, in general terms, is to determine the appropriate extent of remedial response and select the remedial alternative that is most cost-effective. In the National Contingency Plan, the cost-effective alternative is defined as,

> "the lowest cost alternative that is technologically feasible and reliable, and which effectively mitigates and minimizes damage to and provides adequate protection of public health, welfare, or the environment."[12]

The specific remedial goals set for the Aerovox site in this study and the criteria by which the various engineering measures have been evaluated are outlined next.

### 6.10 Remedial Objectives and Evaluation Criteria

#### 6.11 Remedial Objectives

The basic remedial objective for the Aerovox site, consistent with the National Contingency Plan, is to minimize the potential for PCBs in the upland soils to move off the site. This means that three potential environmental transport mechanisms or pathways by which PCBs might be released

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11. 40 CFR 300, Subpart F, National Oil and Hazardous Substance Contingency Plan (NCP), 47 Federal Register 31203, July 26, 1982.

12. Ibid, Section 300.68(j).

from the site must be controlled:

1. Subsurface movement with groundwater;
2. Erosion of surface soils by rainfall runoff and tidal fluctuations along the shoreline; and,
3. Evaporation or volatilization into the atmosphere from surface soils.

The site-specific factors controlling the subsurface movement of PCBs via groundwater were outlined in Sections 4.00 and 5.00. Based on the available data, it was conservatively estimated that, under existing conditions, PCBs may be transported from the site via groundwater to the estuary at the rate of from 2 to 5 lbs. per year.

Potential releases of PCBs from the site as a result of surface erosion or volatilization have not been documented in this study. It had been conceded at the outset that any remedial plan proposed for the site would be designed to effectively eliminate all potential for surface runoff and air transport of PCBs.

The basic remedial objective of minimizing the movement of PCBs from the site has not been quantified in terms of, for example, an environmentally "acceptable" PCB concentration in groundwater discharges. Instead, the approach to remedial solutions has been based on the rationale that releases of PCBs from the site will be further minimized by minimizing contact between groundwater or surface water and PCB-contaminated soils.

From a practical engineering standpoint, then, the remedial objectives for the Aerovox site can be summarized as including:

1. Minimization of potential surface erosion of soils containing PCBs;

2. Minimization of potential air transport of PCBs from the surface of the study area;

3. Minimization of rainfall infiltration through contaminated soils; and,

4. Minimization of groundwater contact with and groundwater discharges from the contaminated soils.

The first three listed objectives would be achieved by installing a permanent low permeability cover or cap over the contaminated soils. The fourth objective would be achieved by minimizing the flow of estuarine water into the perched water system by installing a vertical barrier along the edge of the river. Each of the various technical options available for achieving these remedial goals has been evaluated according to the criteria described in the next section.

### 6.12 Evaluation Criteria

The remedial alternatives identified in this study for the Aerovox site were evaluated according to the following set of criteria:

1. Costs
   - installed capital cost
   - monitoring and maintenance costs

2. Remedial Benefits
   - expected performance in terms of minimizing PCB releases from the site

3. Technical Feasibility
   - applicability to the site location and conditions
   - engineering constructability
   - reliability in meeting objectives

4. Environmental Effects
   - adverse effects of implementation

These criteria provided the framework for comparing the remedial options in a two-step approach. In step 1, an initial screening of the various options was carried out primarily on the basis of preliminary concepts and associated general costs estimates. Other factors were also considered during screening, including possible environmental effects during construction, and estimated environmental benefits (qualitative). Based on the initial screening, the following alternatives were eliminated from further consideration for the reasons listed:

<u>1. No Action</u>

- inconsistent with remedial objectives established for the site
- unacceptable to the local community and to the cognizant regulatory agencies

<u>2. Complete Excavation of Contaminated Soils</u>
(For Out-of-State Secure Landfill Disposal)

- estimated cost to excavate, transport and dispose of all materials containing greater than 50 ppm PCB is $950,000 to $1,000,000.
- other source control alternatives would provide substantial remedial benefits at less than 1/10th this cost

<u>3. Bentonite Slurry Trench Cut-Off Wall Along Shoreline To Prevent Tidal Flux Into Contaminated Soils</u>

- construction technique not applicable to the Aerovox site
- a bentonite cut-off wall could be installed without using slurry method

- other vertical barriers could achieve substantially the same result with similar or lower costs and much less site disturbance and adverse impacts during construction

After the initial screening, the following remedial measures were analyzed in more detail in step 2:

1. Capping contaminated areas;
2. Installation of a vertical barrier to impede flows across the boundary defined by the existing sea wall;
3. Limited excavation of contaminated soils for replacement on-site beneath areas to be capped; and,
4. Combinations of the above.

This analysis involved preparing preliminary designs for the options under study, developing engineering cost estimates, and evaluating the technical feasibility and environmental effects of each option, including effects during construction as well as estimated remedial benefits. Long-term monitoring and maintenance requirements were included in the detailed engineering analysis of options.

The remedial alternatives appropriate for the Aerovox site are "source control" measures, i.e., measures that can mitigate and minimize impacts of the site by controlling the source of contamination at or near the location where the contaminants were originally placed. The technical advantages and disadvantages of the various options are outlined first below.

## 6.20 Capping Alternatives

In evaluating capping measures for the site, key decisions must be made concerning: (1) the material to be used in constructing the cap; and (2) the areas to be covered. The actual design of a cap is a relatively straightforward civil engineering problem. The material used, and how much of it is required, will determine cap performance and costs. All capping methods have associated maintenance procedures which are necessary to insure the integrity of the cap and to insure the effectiveness of the cap. The following discussions include the maintenance necessary for the cap along with associated costs.

### 6.21 Asphaltic Paving

Two types of asphaltic paving materials were considered in this study: (1) hydraulic asphalt concrete; and (2) standard roadway paving material.

Hydraulic asphalt concrete (HAC) is a hot mixture of asphalt cement and a high quality mineral aggregate. The aggregate used for this type of mix is a dense-graded aggregate with a maximum particle size of approximately 1/4-inch. The HAC can be specially prepared at a hot-mix plant and trucked to the site for spreading and compaction. Delivery temperatures of between 300 to 400°F are required for ease in spreading and compaction. Permeability tests on HAC have yielded permeabilities in the $10^{-8}$ to $10^{-9}$ centimeter per second (cm/sec) range.[13, 14] Base preparation for use of this material consists of the spreading and compacting of a 6-inch gravel base.

Standard roadway paving material is a hot mix of asphalt cement and aggregate. This material differs from HAC in the

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13. "Evaluation of Liner Materials Exposed to Leachate, Second Interim Report," Henry E. Haxo, Jr., Richard M. White, Matrecon, Inc., EPA 600/2-76-255, September 1976.

14. "Liner Materials Exposed to Hazardous and Toxic Sludges," Henry E. Haxo, Jr., Robert S. Haxo, Richard M. White, EPA 600/2-77-081, June 1977.

type of aggregate used and a higher percentage of asphalt cement. Solids are ideally a well-graded mix comprised of grain sizes running from gravel down to about 10 percent passing a No. 200 sieve.[15] Permeability tests on this type of material have been found to be in the $10^{-7}$ to $10^{-8}$ cm/sec range.[16] As with the HAC, a gravel base must be prepared before placing of the asphalt.

For both the hydraulic asphalt concrete and the standard roadway paving material, the factors which can effect degradation are frost heaves, traffic loading, temperature extremes, settlement, chemical deterioration and base failure. These potential degradation factors can be effectively eliminated through proper base preparation, minimization of vehicle traffic, prevention of chemical discharge onto the area and the establishment of comprehensive maintenance program. The surface soils at the Aerovox site consist of granular sandy material which will essentially eliminate any base problems. The fencing surrounding the site will effectively deter any undesireable vehicle loading.

Although proper design and construction methods are fundamental, the importance of maintaining an impermeable cover requies that preventative maintenance be provided. It is unrealistic to assume that all cracking will be prevented since the proposed base course as well as the existing soils do contain some fine grain particles which may make the surface cap subject to cracking. To negate the effects of cracking and other surface defects that may develop over time, a seal coating would applied periodically, perhaps every 2 to 3 years as needed. The seal coating would revitalize the

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15. "Design and Construction of Covers for Solid Waste Landfills," R.J. Lutton, G.L. Regan, and L.W. Jones, EPA 600/2-79-165, August 1979.

16. "Evaluation of Liner Materials Exposed to Leachate, Second Interim Report," Henry E. Haxo, Jr., Richard M. White, Matrecon, Inc., EPA 600/2-76-255, September 1976.

dryed, weathered surface and seal and fill any cracks that have formed.

Two types of pavement sealers may be required depending on the extent of surface maintenance needed. A fog seal, which is a slow-setting asphalt emulsion diluted with water, can be utilized if small cracks and surface voids are all that develop. If large cracking or scaling has occurred, then an emulsion slurry seal will be required. This slurry is a mixture of slow-setting asphalt emulsion, fine aggregate, mineral filler and water.

With adequate maintenance and limited vehicle access, the design life of the pavement-type cap will be in excess of 25 years.

### 6.22 Bentonite/Soil Mixture

An adequate surface cap could be achieved by mixing bentonite with clean soil to form a layer over the site having a permeability in the $10^{-7}$ cm/sec range. Bentonite is a naturally occurring clay mineral commercially prepared for use as a sealant. When contracted with water, this material will swell to several times its original volume. For this project, a specially treated bentonite is required because of the potential for liquids with a high dissolved solids concentration coming into prolonged contact with the bentonite cap.

The application of bentonite requires that a sandy base material first be spread over the area to be capped. A 6-inch layer in the case of the Aerovox site would be sufficient. The soil is moistened to attain an optimum moisture content for mixing and compaction. The bentonite is then spread at the prescribed rate to achieve a specified permeability and mixed with the sand layer using a standard roto-tiller or other suitable equipment. The bentonite/soil mix is then compacted to 80 percent of its maximum dry density. A 6-inch loam and seed cover is placed over the bentonite/soil mix to act as a protective barrier and to provide erosion protection. Because of the site's proximity to a tidal river, a grouted rip-rap layer would be required, in place of the loam and seed, along the shoreline up to the high water mark. The rip-rap would have to be anchored in a 6-inch sand layer to preserve the bentonite barrier.

### 6.23 Synthetic Cover

There are numerous synthetic liner materials available that would be suitable for use as a surface cover at the Aerovox site. A 40 mil (.040 inch = 1 mil) high-density polyethylene (HDPE) liner would be recommended because of its resistance to oils, puncturing, and bacterial action.

Base preparation is essential for the use of a HDPE liner. It is typically recommended that a 6-inch layer of sandy material be spread and compacted, making sure that no large stones or other sharp objects are exposed which might puncture the liner material. Sheets of the HDPE liner are then spread with field joints being formed with a heat welding device. As with the bentonite/soil mix, a 6-inch loam and seed cover is required to protect the liner from weathering, with grouted rip-rap used in place of loam and seeding along the shoreline up to the high water line.

Maintenance of both the bentonite/soil mix and the HDPE liner would be limited to repairing damage which may occur to the cover material.

Erosion of the loam and seed cover could occur resulting in the exposing of the actual cap. The greatest degree of erosion will occur during the first 60 days following loaming and seeding. During this time period, a rigid erosion repair program will be required to allow a stable vegetative growth to be established over the capped surface. Once the vegetation has been firmly established, maintenance of this portion of the cover will be limited to periodic refertilization and trimming of the grassed areas.

Because of its exposure to tidal action, the grouted rip-rap will also require periodic maintenance. Regrouting between the individual stones will be necessary when cracking or spalling has been detected. Inspections should be made on a quarterly basis with the necessary repairs made immediately upon detection.

With proper maintenance, the bentonite/soil mix should be effective for a minimum of 25 to 30 years as a water tight barrier. Similarly, the HDPE liner, because it is protected from ultra-violet radiation, heat, ozone, and weathering in general, should be effective for a minimum of 25 years.

### 6.24 Remedial Benefits and Environmental Effects of Capping the Site

The installation of a low permeability cap over contaminated soils at the site will result in substantial remedial benefits, including:

1. Virtual elimination of potential surface erosion of soils containing PCBs;
2. Virtual elimination of potential air transport of PCBs from the surface soils;
3. Virtual elimination of rainfall infiltration through contaminated soils; and

4. Elimination of potential for direct contact of contaminated soils by humans or animals.

Soil Erosion. There is no straightforward analytical method to quantify the amounts of PCBs which may leave the plant yard as a result of soil erosion. Erosional losses of soil vary with factors such as rainfall intensity, soil erodability (based on types of soils), topography, slope length and gradient, and density of vegetation. Engineering equations describing soil erosion do exist. However, it was decided that their application was not appropriate in this case for two reasons. First, the small size and physical variability of the site do not allow valid approximations that would be necessary for the use of these equations. Second, any control technology implemented at the facility will be designed to completely control surface erosion to satisfy the governing environmental criteria. Thus, an exact quantification of surface erosion is not necessary since the remedial plan for the site will achieve a 100% reduction in erosion transport.

Air Transport. The air transport of PCBs from surface soils can occur as a result of volatilization or from wind erosion (dust). Volatilization of PCBs can occur from either the dissolved state in water or from the pure liquid phase where it is predominantly adsorbed onto soil solids. There is essentially no opportunity for gas/liquid contact in the case of PCBs dissolved in groundwater. Volatilization of PCBs from solids is a function of the exposure area, time and mass flux. The mass flux is affected by the compound's vapor pressure and its rate of molecular diffusion through the immediately surrounding air. The bulk of the PCBs in soil are adsorbed onto soil particles, and the adsorption decreases the effective vapor pressure. On the other hand, the effective surface area is increased by the PCB film being spread out on the soil particles.

Another potential source of air emissions of PCBs is release of dust contaminated by adsorbed PCBs. The rate of emissions by this route is affected by soil particle size and density, wind speed, soil moisture content, soil particle adhesion and disturbance by traffic or other activity over the contaminated area. Decreasing particle size, density, moisture and adhesion increase the rate. Decreasing wind and site disturbance decrease the dust emissions.

In this study, no attempts to measure or calculate PCB losses through volatilization or wind erosion were made. As in the case of surface runoff erosion, the remedial plan selected for the site will be designed to approach a 100% reduction in airborne migration of PCBs. It is noteworthy that the ambient air study recently conducted by the U.S. EPA in the New Bedford area found no degradation of ambient air near the Aerovox factory. This conclusion supports the concept that the air migration route is not a significant pathway for the migration of PCBs from Aerovox. (Note: this statement must be confirmed with EPA).

<u>Rainfall Infiltration</u>. Due to the small size of the study area, the infiltration of rainwater into the site is limited. Assuming 12 inches per year of infiltration over the approximately 28,000 square feet of unpaved surface area between the Aerovox plant and the river, the annual rate of infiltration through the surface of the site is estimated at approximately 210,000 gallons per year (or about 575 gallons per day). The installation of a low permeability surface cap will effectively eliminate this vertical flow through the more contaminated near-surface soils.

Direct Contact. Transport and direct exposure to PCBs in place may occur when humans or animals occupy a contaminated site. Direct contact may be through breathing air or dust, or direct skin contact. Transport off-site may be through inadvertent movement of materials, and on a much smaller scale, transport off-site on shoes, clothing and equipment. Capping the Aerovox site will eliminate any future direct contact with soils containing PCBs.

Environmental Effects of Capping. All of the capping methods under consideration for the site will require disturbance of the top 6 to 12 inches of soil. This disturbance is necessary to provide a uniformly graded base upon which the capping material can be placed. The grade changes incorporated into the cap design can be limited in order to minimize environmental impact while still eliminating all potential water pocketing areas. Preliminary grading plans incorporate some redistribution of material on the site, but this will be limited in order to minimize the potential for contaminating areas outside of the immediate work area.

Upon completion of the base grading, the selected cap can be installed utilizing standard construction practices. Capping of the 8-foot wide strip (Zone 5) along the north building line will require a great deal of manual labor as opposed to using standard construction equipment because of the space limitations. This constraint results in a higher cost per square foot for this area; however, greater contamination transport control can be achieved because of the restriction on equipment and overall access.

In summary, the installation of a cap on the site can be conducted with limited adverse impacts if construction is carefully planned and executed.

## 6.25 Estimated Capping Costs

All of the alternatives under consideration for capping the Aerovox site will achieve the same substantial remedial benefits with minimal adverse impacts during installation. All materials examined will result in the desired low permeability surface cover. Thus, installed costs, maintenance costs, and material suitability for this application are the key factors to consider in selecting the capping material.

For the cost comparisions presented below, it has been assumed that the entire surface of the study area, approximately 33,000 square feet, is to be capped. Differences in labor costs associated with Zone 5 are also incorporated into the analysis. The capital and maintenance cost estimates for capping are as follows (estimates include 20% for engineering and contingencies):

Installed Capital Costs

- Hydraulic asphalt concrete .................. $41,000.00
- Standard asphalt pavement .................. 30,500.00
- Bentonite/soil mixture ...................... 82,000.00
- Synthetic (HDPE) cover ...................... 62,500.00

Maintenance Costs (based on current prices)

- Hydraulic asphalt concrete .................. $1,600/year
- Standard asphalt pavement .................. 2,400/year
- Bentonite/soil mixture and HDPE ............ 2,600/year

The design and maintenance assumptions and the unit costs used, in estimating costs are outlined in Appendix D.

In addition to the materials and labor costs listed above, all capping options have an associated fixed cost of $5,500 for items such as removal and replacement of chain-link fencing, rough grading of the site, manhole adjustments, and reconstruction of a portion of the south trough. Also, all capping options will have further fixed costs of $3,500 for abandonment and grouting of existing monitoring wells extending through the peat layer.

An economic comparison of the capping costs on a present worth basis is presented below. The present worth comparison is based on the installed capital costs, annual maintenance costs over a 25-year period (which is a conservative estimate of the cap design life) and a 7% annual interest rate. The results are as follows:

Present Worth of Capping Alternatives

- Hydraulic asphalt concrete .................... $59,500
- Standard asphalt pavement .................... 58,500
- Bentonite/soil mixture ....................... 112,000
- Synthetic (HDPE) cover ....................... 93,000

Note that on a present worth basis, the lower maintenance costs of the HAC option result in the two asphaltic materials having almost identical values.

### 6.26 Recommended Capping Material

Based on the above techical, environmental and economic factors, the choice of capping material is between HAC and standard asphalt paving material. The latter is less costly to install, but may require more maintenance. In the plant yard behind the building, the cap will be subjected to occasional vehicular traffic due to the need to service equipment and utilities in that area. Such traffic, however, is very limited and both paving materials should be unaffected by those site activities. Based on its added flexibility and durability, the HAC material is recommended for use in capping the Aerovox plant.

## 6.30 Vertical Barrier Alternatives

To minimize groundwater contact with the contaminated soils at the site it will be necessary to control the landward intrusion of river water into the nearshore soils located above the peat layer. A vertical barrier or cutoff wall installed behind the existing sea wall, and extending down into the peat layer, would provide this control. The cutoff wall would extend upward to meet the design elevation of the surface cap where a watertight joint would be constructed. Since the peat layer is located close to the surface, the cutoff wall would average only about 7 feet in depth.

Three alternative types of vertical barriers were considered in this study:

1. A barrier trench backfilled with silt washings;
2. A barrier trench backfilled with a bentonite/soil mixture; and,
3. A steel sheet pile cutoff wall.

As an alternative to the above barriers, all of which would be installed behind the existing sea wall, the option of rebuilding and sealing the sea wall was also examined.

### 6.31 Silt Washings

Silt washings are the fines resulting from the washing of crushed stone and sand at a gravel pit. With adequate compaction, a silt washings barrier can achieve a permeability of $10^{-6}$ cm/sec.[17] Installing a vertical barrier composed of silt washings would involve excavating a 3-foot wide trench

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17. "Liner Materials Exposed to Hazardous and Toxic Sludges," Henry E. Haxo, Jr., Robert S. Haxo, Richard M. White, EPA 600/2-77-081, June 1977.

that will vary in depth so as to be keyed into the peat layer by a minimum of 1-foot along the entire length of the trench. The excavated material would be reused on-site as part of the capping base preparation, thereby eliminating the need for costly off-site disposal of the material. The trenching, backfilling and compaction of the silt washings will be done as the trench excavation proceeds. Provisions for forming a tightly-sealed joint between the cap and the vertical barrier would be needed to insure the integrity of the barrier.

### 6.32 Bentonite/Soil Mixture

The use of a bentonite/soil mix to construct a vertical barrier trench was considered as an alternative to the use of silt washings. As with the bentonite proposed for the cap, a treated bentonite would be used due to the potential for liquids having a high dissolved solids content contacting the barrier. Permeabilities in the $10^{-7}$ to $10^{-8}$ cm/sec range can be achieved with a bentonite/soil mix, depending on the quality of the soil used and the quantity of bentonite blended with the soil. A mixture of one part bentonite to eight parts soil, properly hydrated, is usually sufficient to achieve permeabilities of less than $10^{-7}$ cm/sec.

The installation method for the bentonite/soil barrier would be identical to that of the silt washings barrier with the critical points being keying the trench into the peat and sealing the joint between the trench and the surface cap.

### 6.33 Steel Sheet Piles

Steel sheet piling is a third possible means of achieving a vertical barrier between the contaminated area and the river. The use of sheet piling will involve less disturbance of the contaminated soils since trenching would not be required. However, there are other drawbacks of using sheet piles to construct a low permeability barrier. In order to achieve a properly keyed-in barrier, extensive test borings along the proposed barrier line would be necessary to accurately determine the depth of the peat layer. In addition, due to the potential corrosion of the steel by river water, the piles will have to be pre-coated with an elastomeric compound. These addition steps will add to the already high costs of sheet pile wall.

### 6.34 Reconstruct Existing Sea Wall

The Aerovox property is presently separated from the Acushnet River is an unmortared, random stone retaining wall. This wall is approximately 600 feet long and varies in width at the top from 2 to 4 feet. The depth and base width of the sea wall are unknown. An alternative to installing a separate vertical barrier would be to reconstruct and seal this existing retaining wall. Portions of the wall are in disrepair and general reconstruction will be necessary.

Upon rebuilding the damaged portions of the wall, a sealing operation would be undertaken. The sealing compound would strengthen the wall and minimize further deterioration. Grouting the wall will also reduce the void spaces in the wall, thereby providing increased resistance to the flow of water into and out of the site. Since any capping system for the site will extend to the sea wall, the grouting would minimize the potential for undermining or washout of the cap and base materials by tidal action.

The effectiveness of the repaired and grouted sea wall as a vertical barrier to tidal flux across the site boundary would be less than that of a separate barrier installed behind the wall. This is because the grouting operation will not seal all the voids and cracks in the sea wall. Also, to avoid disturbance of the river sediments, the grouting would be applied to portions of the wall that are accessible above the sediments. The buried portions of the sea wall would remain in its present condition.

### 6.35 Remedial Benefits and Environmental Effects of a Vertical Barrier

Remedial Benefits. The installation of a low permeability vertical barrier at the Aerovox site would result in remedial benefits derived from the hydraulic separation of the river water and the contaminated soils. Such benefits would include:

1. Minimization of tidal recharge to the perched groundwater zone;
2. Minimization of subsurface discharges from the perched groundwater system; and,
3. Minimization of daily contact between river water and contaminated soils located along the eastern edge of the property.

Each of the three vertical barrier alternatives described will effectively achieve these benefits. Due to the cyclic nature of the hydraulic head that will be acting against the barrier, the permeability of the barrier is less critical to its effectiveness than other factors. Specifically, as long as the barrier wall is continuous, is keyed into the underlying peat materials, and is sealed where it meets the surface cap, then the silt washings barrier will be as effective as the bentonite/soil trench or the sheet pile cutoff wall. The repairing and grouting of the existing sea wall, as outlined above, would be less effective than installation of a new, continuous barrier. This is due to the lack of control over the extent to which the voids in the wall would be sealed, and also to the fact that the sealant would not be applied below the surface of the mud flats.

The groundwater quality data for the site showed dissolved PCB levels in the perched system of from 2 to 5 ppb. The potential remedial benefits of preventing tidal inflow into, and subsequent discharge from, the perched system are not, however, limited to the minimization of the release of dissolved PCBs at those levels (which are equivalent to the release of 2 to 5 lbs. per year of PCBs). This is because the soils at the site have been shown in the previous study, summarized in Section 2.00 of this report, to contain substantial levels of oil and grease. Groundwater testing for oil indicated that an extremly thin film of oil had formed on the free water surface within the casings of the shallow wells. Attempts to measure the thickness of the oil film were unsuccessful, but through the use of oil absorbent wicks, concentrated samples of the oil film were collected and tested for PCBs.

Although the amounts of oil recovered by the wicks after suspension in the groundwater for 7 days were very small (between 0.027 and 0.053 grams) total PCB levels in the oil ranged from 1,700 to 9,000 ppm. Thus, the potential for releases of PCBs from the perched zone via any oil that may be moving through the soil along the surface of the water table was identified. This potential subsurface transport mechanism for PCBs would be virtually eliminated by the installation of the barrier wall. The silt washings and bentonite/soil barriers would also serve to adsorb oils and organics from any liquids that may slowly permeate the barrier.

The rate of movement of water through a 3-foot wide vertical barrier trench having a permeability of $10^{-6}$ cm/sec, under a constant hydraulic head of 1 foot, would be equivalent to approximately 1 foot per year. At the Aerovox site, the tidal factor will result in a variable, rather than constant, hydraulic head acting on the barrier wall as the tide rises and falls. The net rate of flow through the barrier trench will be less than 1 foot per year. At this rate of movement, suspended soil particles in the water would be filtered out by the barrier wall, including any sub-micron size particles.

In summary, a vertical barrier trench or sheet pile cutoff wall will produce substantial benefits in terms of minimizing subsurface PCB releases from the Aerovox site.

Environmental Effects of Barrier Wall Construction. Constructing a barrier trench would involve the excavation of several hundred cubic yards of contaminated soil. The proper handling of this soil is essential to the minimization of construction impacts. Soil excavated from the trenches will be spread and compacted in the areas which will be capped. During construction, the exposure of this soil to the elements will create the potential for contaminant transport by erosion. Some of the soil is to be excavated from nearshore areas affected by tidal recharge. Excavation at these locations would have to be conducted only during low tides. This will minimize the amount of water in the excavated soil and thereby minimize the potential quantities of runoff coming from any soils temporarily stockpiled on-site.

Due to inherent problems common to construction projects, the potential exists for the release of contaminants as a result of barrier wall construction. Methods such as control of surface runoff (both from rainfall and from excavated material), efficient sequencing of excavation and backfill operations, and the judicious placement and handling of contaminated soils can be employed to minimize contaminant releases during construction.

These effects would not be associated with the installation of a sheet pile cut-off wall. Environmental impacts resulting from this technique would be minimal. There are, however, several other factors which make the use of sheet piling impractical. These would include very high costs (see Section 6.36 below), and installation problems associated with underground utilities and subsurface conditions.

### 6.36 Vertical Barrier Costs

The costs of the alternative vertical barriers for the site vary by an order of magnitude. For cost estimating purposes only, it was assumed that the barrier wall would extend along the entire length of the existing sea wall, which is approximately 600 linear feet. An average wall depth of 7 feet was used in the calculations. Other assumptions and unit costs are presented in Appendix D. The estimated barrier wall costs on this basis (including 20% for engineering and contingencies) are:

Installed Capital Cost

- Silt washings barrier trench . . . . . $10,000.
- Bentonite/soil barrier trench . . . . 31,000.
- Steel sheet piling . . . . . . . . . . 63,000.

For the alternative measure of rebuilding and grouting the existing sea wall, it is estimated that initial repair work on the sea wall will involve the reconstruction of approximately 400 square feet of wall surface. An approximate cost for this work would be about $5,000. Upon completing the repair work, the entire wall surface above the mud flats would be sealed with gunite. Gunite has been used extensively in sea wall repair projects and is recommended for salt-water applications. Gunite is applied using a spray nozzle which can penetrate the crevices of a wall for more effective void filling. The costs for sealing with this product in this location can be expected to be in the $30,000. range.

The optional plans for installing a surface cap and a vertical barrier wall at the site are discussed next in Section 7.00.

APPENDIX A

BORING LOGS FOR TEST BORINGS AT AEROVOX ON NOVEMBER 10 AND 11, 1982

# BORING / OBSERVATION WELL SUMMARY LOG

**BORING No.** TB- 1

**PROJECT** PCB Soil Survey **SHEET** one **OF** one

**LOCATION** New Bedford, MA **CONTRACTOR** D.L. Maher

**CLIENT** Aerovox, Inc **DATE INSTALLED** 11/10/82

**GHR FIELD ENGR.** R.J. Bouchard Ground Elevation = 4.97

| DEPTH | STRATA DESCRIPTIONS | INSTALLATION LOG | FIELD SAMPLING I.D. No. | FIELD SAMPLING DEPTH | FIELD SAMPLING SAMPLE DESCRIPTIONS | NOTES |
|---|---|---|---|---|---|---|
| | | | 1 | 0-2 | black-brown granular back- | |
| 2 | fill | | | | fill with pebbles | |
| | sand | 4-6-8 | 2 | 2-3.5 | light gray sand & gravel | |
| | | 8 | 3 | 3.5-4 | wet | |
| | | 1-2-2-5 | 4 | 4.5-6.5 | light gray sand, wet 8" | |
| 5 | | | | | | |
| 6.5 | peat | | | | dark,gray clay with peat 12" | |
| | | | | | laminations (2") moist | |
| | fine-medium sand | | | | black, organic-rich fine- | |
| 9 | | | | | medium sand and silt | |
| | medium-coarse sand | 2-1-1-1 | 5 | 6.5-9 | black fine-medium sand with | |
| 10 | | | | | organic inch layers | |
| 10.5<br>11 | peaty clay | | | | 3" peat layer at 9' | |
| | coarse sand | | 6 | 8.5-11 | gray medium-coarse sand | |
| | | 1-1-1-1-4 | | | graded sequence with organics | |
| 14.5 | | | | | | |
| 15 | fine-medium | | 7 | 10-12 | coarse sand with roots | |
| 16 | sand | 2-5-5-4 | 8 | 14.5-16 | gray fine-meidum sand with | |
| | bottom of boring | 17-21-32 | | | pebbles | |
| 20 | | | | | | |

NOTES:

GHR

ACCT. No. 2463

# BORING / OBSERVATION WELL SUMMARY LOG

BORING No. TB- 2

PROJECT PCB Soil Survey SHEET one OF one

LOCATION New Bedford, MA CONTRACTOR D.L. Maher

CLIENT Aerovox, Inc DATE INSTALLED 11/10/82

GHR FIELD ENGR. R.J. Bouchard Ground Elevation = 4.47

| DEPTH | STRATA DESCRIPTIONS | INSTALLATION LOG | FIELD SAMPLING I.D. No. | FIELD SAMPLING DEPTH | FIELD SAMPLING SAMPLE DESCRIPTIONS | NOTES |
|---|---|---|---|---|---|---|
| | fill | | 1 | 0-2 | granular fill with wood | 1 |
| 2 | | | | | boulders, bricks | |
| | peaty clay | | 2 | 2-4 | 2" brown sandy fill | |
| | | | | | 1" black organic layer | |
| 5 | | | | | 12" dary gray clay, dense | |
| | | | | | with peat layers and silty | |
| | | | | | laminations | |
| 7.5 | | | 3 | 5--7.5 | same as above | |
| 9 | fine sand | | 4 | 7.5-10 | gray silty find sand with | |
| 10 | peaty clay | | | | organic laminations 1" | |
| | coarse sand and gravel | | | | 6" peaty clay coarsens to | |
| 12 | | | | | pebbly sand - 4" | |
| | | bottom of boring | 5 | 10-12 | gray coarse sand and gravel | |

NOTES:

1 No sample retained

GHR

ACCT. No. 2463

# BORING / OBSERVATION WELL SUMMARY LOG

BORING No. TB- 3

PROJECT PCB Soil Survey SHEET one OF one

LOCATION New Bedford, MA CONTRACTOR D.L. Maher

CLIENT Aerovox, Inc DATE INSTALLED 11/10/82

GHR FIELD ENGR. R.J. Bouchard Ground Elevation = 3.20

| DEPTH | STRATA DESCRIPTIONS | INSTALLATION LOG | FIELD SAMPLING I.D. No. | DEPTH | SAMPLE DESCRIPTIONS | NOTES |
|---|---|---|---|---|---|---|
| 0 | Fill | | 1 | 0-1.5 | black granular backfill | 1 |
| 2 | | | 2 | 1.5-3.5 | 8" fill, organic layer | |
| 3.5 | peaty clay | | | | 4" gray clay with peat | |
| 4.5 | peaty sand | | 3 | 3.5-5.5 | 4" blueish gray sand | |
| | peaty clay | | | | 4" brown peat, dense | |
| 5.5 | fine-medium sand with peat | | | | ~~4" black fine silty sand~~ | |
| | | | | | 12" clay with peat | |
| | | | 4 | 5.5-8 | medium sand with organic | |
| 8 | fine sand and silt | | | | laminations at 6' | |
| | | | | | 4" gray-black clay | |
| | | | | | 12" fine-medium sand | |
| 10 | | | | | with organics | |
| | | | 5 | 8-10 | gray fine sand grades to | |
| | | | | | silt | |
| | | | 6 | 10-12 | silt | |
| | | | 7 | 12-14 | fine sand and silt | |
| 15 | | | 8 | 14-15.5 | fine sand and silt | |
| 17.5 | | | 9 | 15.5-17.5 | fine sand and silt | |
| | | bottom of boring | | | | |

NOTES: 1 No recovery

GHR

ACCT. No. 2463

# BORING / OBSERVATION WELL SUMMARY LOG

BORING No. TB-4

PROJECT PCB Soil Survey SHEET one OF one

LOCATION New Bedford, MA CONTRACTOR D.L. Maher

CLIENT Aerovox, Inc DATE INSTALLED 11/1 /82

GHR FIELD ENGR. R.J. Bouchard Ground Elevation = 4.80

| DEPTH | STRATA DESCRIPTIONS | INSTALLATION LOG | FIELD SAMPLING I.D. No. | FIELD SAMPLING DEPTH | SAMPLE DESCRIPTIONS | NOTES |
|---|---|---|---|---|---|---|
| | fill | | 1 | 0-2 | fill - gravel and refuse | 1 |
| 2 | | | 2 | 2-4 | dark orange-brown mud, oily | 2 |
| | refuse | | | 3-5 | with black rubber artifacts | 3 |
| 5 | | | 3 | 5-7.5 | 18" black oily clay | |
| | clay | | | | dark gray sandy clay grades | 4 |
| 7.5 | | | | | to fine sand | |
| | fine sand grades to medium-coarse sand | | 4 | 7-9.5 | 6" clay black | |
| | | | | | 12" coarse sand with | |
| 10 | | | | | peat, roots | |
| 13 | | | 5 | 9-11 | 18" brown medium sand | |
| | | bottom of boring | | | 6" gray sand | |
| | | | 6 | 11-13 | sand and gravel | |

NOTES:

1 No sample retained
2 No recovery
3 2nd run at 3-5'
4 Minor peat laminations (¼")

GHR

ACCT. No. 2463

# BORING / OBSERVATION WELL SUMMARY LOG

**BORING No.** TB-5

PROJECT PCB Soil Survey SHEET one OF one

LOCATION New Bedford, MA CONTRACTOR D.L. Maher

CLIENT Aerovox, Inc DATE INSTALLED 11/11/82

GHR FIELD ENGR. R.J. Bouchard

| DEPTH | STRATA DESCRIPTIONS | INSTALLATION LOG | FIELD SAMPLING I.D. No. | FIELD SAMPLING DEPTH | FIELD SAMPLING SAMPLE DESCRIPTIONS | NOTES |
|---|---|---|---|---|---|---|
| | blacktop | | | 0-1.9 | Blacktop and gravel | |
| 2 | | | 1 | 2-3 | Medium-coarse sandfill | 1 |
| | fill | | | | | |

NOTES:

1 Boring abandoned at 3'

GHR

ACCT. No. 2463

# BORING / OBSERVATION WELL SUMMARY LOG

BORING No. TB- 6

PROJECT PCB Soil Survey SHEET one OF one

LOCATION New Bedford, MA CONTRACTOR D.L. Maher

CLIENT Aerovox, Inc DATE INSTALLED 11/11/82

GHR FIELD ENGR. R.J. Bouchard Ground Elevation = 5.80

| DEPTH | STRATA DESCRIPTIONS | INSTALLATION LOG | FIELD SAMPLING I.D. No. | FIELD SAMPLING DEPTH | FIELD SAMPLING SAMPLE DESCRIPTIONS | NOTES |
|---|---|---|---|---|---|---|
| | fill | | | 0-2.5 | Sand and gravel fill | 1 |
| | | 3-2-2-3 | 1 | 2.5-4.5 | Sand | |
| 5 | | 2-1-2-8 | 2 | 4.5-6.5 | Medium-coarse sand | |
| | sand | 6-8-14-19 | 3 | 6.5-8.5 | Light brown to yellow | |
| | | | | | medium-coarse sand | |
| 10 | | 10-16-18-24 | 4 | 8.0-10 | Fine-medium sand 10" | |
| | | | | | coarse sand, gravel 4" | |
| | | 4-7-14-22 | 5 | 10-12 | medium-coarse sand | |
| | | 3-8-16-21 | 6 | 12-14 | Fine-medium sand | |
| 15 | | 3-9-18-23 | 7 | 14-16 | Fine-medium sand | |
| 16 | | | | | | |
| | | bottom of boring | | | | |

NOTES: 1 Dug by hand

GHR

ACCT. No. 2463

# BORING / OBSERVATION WELL SUMMARY LOG

BORING No. TB- 7

PROJECT PCB Soil Survey SHEET one OF one

LOCATION New Bedford, MA CONTRACTOR D.L. Maher

CLIENT Aerovox, Inc DATE INSTALLED 11/11/82

GHR FIELD ENGR. R.J. Bouchard Ground Elevation = 5.30

| DEPTH | STRATA DESCRIPTIONS | INSTALLATION LOG | FIELD SAMPLING I.D. No. | FIELD SAMPLING DEPTH | FIELD SAMPLING SAMPLE DESCRIPTIONS | NOTES |
|---|---|---|---|---|---|---|
| 1 | pavement | | | 0-1.5 | pavement, gravel | 1 |
| | fill | | 1 | .5-2 | gray-black granular fill | 1 |
| | | | | | coarse sand | |
| 3 | | | 2 | 2-3 | 5" oily sand ← | |
| | peat | | 3 | 2.5-4.5 | 12" black coarse sand | |
| 4 | sand | | | | 1" organic layers and | |
| 5 | peat | | | | decomposed peat | |
| | | | 4 | 4.0-6.5 | black coarse sand, wet | |
| | | | 5 | 5-9.5 | 24" organic rich peat | |
| 9.5 | | | | | with sandy layers | |
| | sand | | 6 | 8-10.5 | peat with coarse sand at | |
| | | | | | 9.5 | |
| 12 | | | 7 | 10-12 | coarse sand | |
| | | bottom of boring | | | | |

NOTES:

1 No sample retained

GHR

ACCT. No. 2463

# BORING / OBSERVATION WELL SUMMARY LOG

**BORING No.** TB- 8

**PROJECT** PCB Soil Survey **SHEET** one **OF** one

**LOCATION** New Bedford, MA **CONTRACTOR** D.L. Maher

**CLIENT** Aerovox, Inc **DATE INSTALLED** 11/11 /82

**GHR FIELD ENGR.** R.J. Bouchard Ground Elevation = 7.01

| DEPTH | STRATA DESCRIPTIONS | INSTALLATION LOG | FIELD SAMPLING I.D. No. | FIELD SAMPLING DEPTH | FIELD SAMPLING SAMPLE DESCRIPTIONS | NOTES |
|---|---|---|---|---|---|---|
| | fill | | 1 | 0-2 | black-brown granular | |
| | | | | | backfill with peat and clay | |
| | | | | | at 2' | |
| 4 | | | 2 | 2-4 | fill with clean fine sand | |
| | sand | | | | and cinders at 4' | |
| 6 | | | 3 | 4-6.5 | fine sand with black | |
| | peaty clay | | | | organic rich peat layers | |
| | | | 4 | 6-8.5 | 4" organic silt | |
| | | | | | 4" gray caly with roots | |
| 8 | | | | | 6" dense peat | |
| | sandy peat | | | | 8" gray clay | |
| 9 | sand & gravel | | 5 | 8-9 | 12" sandy peat with black | |
| | fine sand | | | | layers, pebbles | |
| | | | | | 2" rock fragments | |
| | | | 6 | 9-11 | 6" coarse sand and gravel | |
| 11 | | | | | fill sand at 10' | |
| | | bottom of boring | | | | |

NOTES:

GHR

ACCT. No. 2463

# APPENDIX B

## GRAIN SIZE ANALYSES FOR SOIL SAMPLES COLLECTED DURING TEST BORINGS AT AEROVOX ON NOVEMBER 10 AND 11, 1982

(Analyses by LBH Associates, Newton, MA)

LBH ASSOC SEDIMENT SIZE ANALYSIS

| IDENTIFICATION | LATITUDE | LONGITUDE | DEPTH(M) | NUMBER OF SAMPLE POINTS | PHI SIZE FOR INTERPOLATION |
|---|---|---|---|---|---|
| TB 1-2 | 0 0.00 | 0 0.00 | 0.000 | 32 | 0.25 |

HYDRAULIC EQUIVALENT PERCENT GRAVEL, SAND, SILT AND CLAY,
GRAVEL 30.06%
SAND 38.54%
SILT 28.79%
CLAY 2.60%

| MM SIZE | PHI SIZE | PSI SIZE | FREQ.PERCENT | CUM.FREQ.PERCENT |
|---|---|---|---|---|
| 5.65685 | -2.50 | -5.2483 | 9.54 | 9.54 |
| 4.75683 | -2.25 | -5.2322 | 8.11 | 17.65 |
| 4.00000 | -2.00 | -5.2132 | 2.73 | 20.38 |
| 3.36359 | -1.75 | -5.1908 | 4.35 | 24.73 |
| 2.82843 | -1.50 | -5.1643 | 0.93 | 25.66 |
| 2.37841 | -1.25 | -5.1331 | 1.67 | 27.33 |
| 2.00000 | -1.00 | -5.0965 | 2.73 | 30.06 |
| 1.68179 | -0.75 | -5.0535 | 1.80 | 31.86 |
| 1.41421 | -0.50 | -5.0032 | 2.78 | 34.64 |
| 1.18921 | -0.25 | -4.9444 | 2.28 | 36.92 |
| 1.00000 | 0.00 | -4.8761 | 1.34 | 38.26 |
| 0.84090 | 0.25 | -4.7968 | 2.72 | 40.98 |
| 0.70711 | 0.50 | -4.7052 | 2.73 | 43.71 |
| 0.59460 | 0.75 | -4.5998 | 5.75 | 49.46 |
| 0.50000 | 1.00 | -4.4793 | 0.00 | 49.46 |
| 0.42045 | 1.25 | -4.3420 | 0.19 | 49.65 |
| 0.35355 | 1.50 | -4.1868 | 4.66 | 54.31 |
| 0.29730 | 1.75 | -4.0123 | 2.52 | 56.83 |
| 0.25000 | 2.00 | -3.8175 | 1.78 | 58.61 |
| 0.21022 | 2.25 | -3.6016 | 1.88 | 60.49 |
| 0.17678 | 2.50 | -3.3643 | 0.98 | 61.47 |
| 0.14865 | 2.75 | -3.1053 | 2.28 | 63.75 |
| 0.12500 | 3.00 | -2.8252 | 1.46 | 65.21 |
| 0.10511 | 3.25 | -2.5246 | 1.48 | 66.69 |
| 0.08839 | 3.50 | -2.2050 | 1.33 | 68.02 |
| 0.07433 | 3.75 | -1.8683 | 0.34 | 68.36 |
| 0.06250 | 4.00 | -1.5169 | 0.24 | 68.60 |
| 0.03125 | 5.00 | -0.0429 | 8.01 | 76.61 |
| 0.01563 | 6.00 | 1.2524 | 9.79 | 86.40 |
| 0.00781 | 7.00 | 1.9990 | 7.20 | 93.60 |
| 0.00391 | 8.00 | 2.2617 | 3.79 | 97.39 |
| 0.00195 | 9.00 | 2.3239 | 2.60 | 99.99 |

INTERPOLATED VALUES ARE USED IN THE STATISTICAL AND GRAPHIC DESCRIPTIONS

FOLK'S GRAPHIC MEASURES

| MM | PHI | |
|---|---|---|
| 0.34 | 1.57 | GRAPHIC MEAN |
| | 3.51 | INCLUSIVE GRAPHIC STANDARD DEVIATION |
| | 0.16 | INCLUSIVE GRAPHIC SKEWNESS |
| | 0.62 | GRAPHIC KURTOSIS |

INMAN'S MEASURES

| MM | PHI | |
|---|---|---|
| 0.30 | 1.72 | MEAN |
| | 4.02 | GRAPHIC STANDARD DEVIATION |
| | 0.11 | FIRST GRAPHIC SKEWNESS(A) |
| | 0.27 | SECOND GRAPHIC SKEWNESS(A2) |
| | 0.23 | KURTOSIS |

MOMENT MEASURES

| MM | PHI | |
|---|---|---|
| 0.32 | 1.65 | MEAN |
| | 3.39 | STANDARD DEVIATION |
| | 0.18 | SKEWNESS |
| | -1.15 | KURTOSIS |
| 0.42 | 1.27 | MEDIAN |

SILT SANDY GRAVEL
THE DISTRIBUTION IS FINE-SKEWED
THE DISTRIBTUTION IS VERY PLATYKURTIC

SAHUS'S MODALITY INDEX 2.85 HIS DISPERSION COEFFICIENT IS 6.61
BOGARDI'S VELOCITY(M/SEC) 4.467

THESE FIGURES ARE ON A CARBON FREE BASIS. THERE IS 11.31% CARBON IN THE COARSE SECTION

THESE FIGURES ARE ON A CARBON FREE BASIS.  THERE IS 11.31% CARBON IN THE COARSE SECTION
AND 1.02% CARBON IN THE FINE FRACTION.

LBH ASSOC SEDIMENT SIZE ANALYSIS

| IDENTIFICATION | LATITUDE | LONGITUDE | DEPTH(M) | NUMBER OF SAMPLE POINTS | PHI SIZE FOR INTERPOLATION |
|---|---|---|---|---|---|
| TB 1-4 | 0 0.00 | 0 0.00 | 0.000 | 31 | 0.25 |

HYDRAULIC EQUIVALENT PERCENT GRAVEL, SAND, SILT AND CLAY,
GRAVEL 24.26%
SAND 42.44%
SILT 33.29%
CLAY 0.00%

| MM SIZE | PHI SIZE | PSI SIZE | FREQ.PERCENT | CUM.FREQ.PERCENT |
|---|---|---|---|---|
| 5.65685 | -2.50 | -5.2483 | 8.28 | 8.28 |
| 4.75683 | -2.25 | -5.2322 | 7.17 | 15.45 |
| 4.00000 | -2.00 | -5.2132 | 2.22 | 17.67 |
| 3.36359 | -1.75 | -5.1908 | 2.22 | 19.89 |
| 2.82843 | -1.50 | -5.1643 | 1.43 | 21.32 |
| 2.37841 | -1.25 | -5.1331 | 1.15 | 22.47 |
| 2.00000 | -1.00 | -5.0965 | 1.79 | 24.26 |
| 1.68179 | -0.75 | -5.0535 | 1.65 | 25.91 |
| 1.41421 | -0.50 | -5.0032 | 3.55 | 29.46 |
| 1.18921 | -0.25 | -4.9444 | 2.47 | 31.93 |
| 1.00000 | 0.00 | -4.8761 | 1.22 | 33.15 |
| 0.84090 | 0.25 | -4.7968 | 2.08 | 35.23 |
| 0.70711 | 0.50 | -4.7052 | 2.69 | 37.92 |
| 0.59460 | 0.75 | -4.5998 | 2.29 | 40.21 |
| 0.50000 | 1.00 | -4.4793 | 2.51 | 42.72 |
| 0.42045 | 1.25 | -4.3420 | 1.97 | 44.69 |
| 0.35355 | 1.50 | -4.1868 | 1.65 | 46.34 |
| 0.29730 | 1.75 | -4.0123 | 2.80 | 49.14 |
| 0.25000 | 2.00 | -3.8175 | 2.87 | 52.01 |
| 0.21022 | 2.25 | -3.6016 | 3.12 | 55.13 |
| 0.17678 | 2.50 | -3.3643 | 1.83 | 56.96 |
| 0.14865 | 2.75 | -3.1053 | 3.15 | 60.11 |
| 0.12500 | 3.00 | -2.8252 | 1.94 | 62.05 |
| 0.10511 | 3.25 | -2.5246 | 1.72 | 63.77 |
| 0.08839 | 3.50 | -2.2050 | 1.47 | 65.24 |
| 0.07433 | 3.75 | -1.8683 | 0.86 | 66.10 |
| 0.06250 | 4.00 | -1.5169 | 0.60 | 66.70 |
| 0.03125 | 5.00 | -0.0429 | 8.39 | 75.09 |
| 0.01563 | 6.00 | 1.2524 | 12.78 | 87.87 |
| 0.00781 | 7.00 | 1.9990 | 6.78 | 94.65 |
| 0.00391 | 8.00 | 2.2617 | 5.34 | 99.99 |

INTERPOLATED VALUES ARE USED IN THE STATISTICAL AND GRAPHIC DESCRIPTIONS

FOLK'S GRAPHIC MEASURES

| MM | PHI | |
|---|---|---|
| 0.29 | 1.77 | GRAPHIC MEAN |
| | 3.42 | INCLUSIVE GRAPHIC STANDARD DEVIATION |
| | 0.03 | INCLUSIVE GRAPHIC SKEWNESS |
| | 0.67 | GRAPHIC KURTOSIS |

INMAN'S MEASURES

| MM | PHI | |
|---|---|---|
| 0.30 | 1.74 | MEAN |
| | 3.93 | GRAPHIC STANDARD DEVIATION |
| | -0.02 | FIRST GRAPHIC SKEWNESS(A) |
| | 0.10 | SECOND GRAPHIC SKEWNESS(A2) |
| | 0.22 | KURTOSIS |

MOMENT MEASURES

| MM | PHI | |
|---|---|---|
| 0.26 | 1.93 | MEAN |
| | 3.20 | STANDARD DEVIATION |
| | 0.04 | SKEWNESS |
| | -1.29 | KURTOSIS |
| 0.28 | 1.82 | MEDIAN |

GRAVELLY SILTY MEDIUM SAND
THE DISTRIBUTION IS NEAR SYMMETRICAL
THE DISTRIBUTION IS PLATYKURTIC

SAHUS'S MODALITY INDEX 2.61 HIS DISPERSION COEFFICIENT IS 6.37
BOGARDI'S VELOCITY(M/SEC) 4.467

THESE FIGURES ARE ON A CARBON FREE BASIS. THERE IS 6.76% CARBON IN THE COARSE FRACTION AND 1.73% CARBON AIN THE FINE FRACTION.

LBH ASSOC SEDIMENT SIZE ANALYSIS

| IDENTIFICATION | LATITUDE | LONGITUDE | DEPTH(M) | NUMBER OF SAMPLE POINTS | PHI SIZE FOR INTERPOLATION |
|---|---|---|---|---|---|
| TB 1-6 (B)8.5-10 | 0 0.00 | 0 0.00 | 0.000 | 22 | 0.25 |

HYDRAULIC EQUIVALENT PERCENT GRAVEL, SAND, SILT AND CLAY,
GRAVEL 68.53%
SAND 0.00%
SILT 20.35%
CLAY 11.11%

| MM SIZE | PHI SIZE | PSI SIZE | FREQ.PERCENT | CUM.FREQ.PERCENT |
|---|---|---|---|---|
| 0.70711 | 0.50 | -4.7052 | 7.34 | 7.34 |
| 0.59460 | 0.75 | -4.5998 | 7.50 | 14.84 |
| 0.50000 | 1.00 | -4.4793 | 14.00 | 28.84 |
| 0.42045 | 1.25 | -4.3420 | 15.80 | 44.64 |
| 0.35355 | 1.50 | -4.1868 | 7.50 | 52.14 |
| 0.29730 | 1.75 | -4.0123 | 7.30 | 59.44 |
| 0.25000 | 2.00 | -3.8175 | 4.62 | 64.06 |
| 0.21022 | 2.25 | -3.6016 | 2.98 | 67.04 |
| 0.17678 | 2.50 | -3.3643 | 1.49 | 68.53 |
| 0.14865 | 2.75 | -3.1053 | 0.00 | 68.53 |
| 0.12500 | 3.00 | -2.8252 | 0.00 | 68.53 |
| 0.10511 | 3.25 | -2.5246 | 0.00 | 68.53 |
| 0.08839 | 3.50 | -2.2050 | 0.00 | 68.53 |
| 0.07433 | 3.75 | -1.8683 | 0.00 | 68.53 |
| 0.06250 | 4.00 | -1.5169 | 0.00 | 68.53 |
| 0.03125 | 5.00 | -0.0429 | 2.46 | 70.99 |
| 0.01563 | 6.00 | 1.2524 | 6.22 | 77.21 |
| 0.00781 | 7.00 | 1.9990 | 9.39 | 86.60 |
| 0.00391 | 8.00 | 2.2617 | 2.28 | 88.88 |
| 0.00195 | 9.00 | 2.3239 | 7.31 | 96.19 |
| 0.00098 | 10.00 | 2.3326 | 2.18 | 98.37 |
| 0.00049 | 11.00 | 2.3309 | 1.62 | 99.99 |

INTERPOLATED VALUES ARE USED IN THE STATISTICAL AND GRAPHIC DESCRIPTIONS

FOLK'S GRAPHIC MEASURES

| MM | PHI | |
|---|---|---|
| 0.13 | 2.96 | GRAPHIC MEAN |
| | 2.75 | INCLUSIVE GRAPHIC STANDARD DEVIATION |
| | 0.77 | INCLUSIVE GRAPHIC SKEWNESS |
| | 0.72 | GRAPHIC KURTOSIS |

INMAN'S MEASURES

| MM | PHI | |
|---|---|---|
| 0.08 | 3.73 | MEAN |
| | 2.96 | GRAPHIC STANDARD DEVIATION |
| | 0.78 | FIRST GRAPHIC SKEWNESS(A) |
| | 1.08 | SECOND GRAPHIC SKEWNESS(A2) |
| | 0.42 | KURTOSIS |

MOMENT MEASURES

| MM | PHI | |
|---|---|---|
| 0.10 | 3.26 | MEAN |
| | 3.53 | STANDARD DEVIATION |
| | 0.73 | SKEWNESS |
| | 1.01 | KURTOSIS |
| 0.37 | 1.43 | MEDIAN |

CLAYEY GRAVEL
THE DISTRIBUTION IS STRONGLY FINE-SKEWED
THE DISTRIBUTION IS PLATYKURTIC

SAHUS'S MODALITY INDEX 3.27 HIS DISPERSION COEFFICIENT IS 6.66
BOGARDI'S VELOCITY(M/SEC) 1.579

THESE FIGURES ARE ON A CARBON FREE BASIS. THERE IS 86.67% CARBON IN THECOARSE FRACTION
AND 2.59% IN THE FINE FRACTION.

LBH ASSOC SEDIMENT SIZE ANALYSIS

| IDENTIFICATION | LATITUDE | LONGITUDE | DEPTH(M) | NUMBER OF SAMPLE POINTS | PHI SIZE FOR INTERPOLATION |
|---|---|---|---|---|---|
| TB 1-6 (A) | 0 0.00 | 0 0.00 | 0.000 | 32 | 0.25 |

HYDRAULIC EQUIVALENT PERCENT GRAVEL, SAND, SILT AND CLAY,
GRAVEL 15.42%
SAND 56.77%
SILT 27.80%
CLAY 0.00%

| MM SIZE | PHI SIZE | PSI SIZE | FREQ.PERCENT | CUM.FREQ.PERCENT |
|---|---|---|---|---|
| 8.00000 | -3.00 | -5.2733 | 6.67 | 6.67 |
| 6.72717 | -2.75 | -5.2619 | 1.60 | 8.27 |
| 5.65685 | -2.50 | -5.2483 | 0.91 | 9.18 |
| 4.75683 | -2.25 | -5.2322 | 0.89 | 10.07 |
| 4.00000 | -2.00 | -5.2132 | 1.08 | 11.15 |
| 3.36359 | -1.75 | -5.1908 | 0.50 | 11.65 |
| 2.82843 | -1.50 | -5.1643 | 1.23 | 12.88 |
| 2.37841 | -1.25 | -5.1331 | 1.35 | 14.23 |
| 2.00000 | -1.00 | -5.0965 | 1.19 | 15.42 |
| 1.68179 | -0.75 | -5.0535 | 0.85 | 16.27 |
| 1.41421 | -0.50 | -5.0032 | 1.08 | 17.35 |
| 1.18921 | -0.25 | -4.9444 | 1.13 | 18.48 |
| 1.00000 | 0.00 | -4.8761 | 0.62 | 19.10 |
| 0.84090 | 0.25 | -4.7968 | 0.90 | 20.00 |
| 0.70711 | 0.50 | -4.7052 | 1.95 | 21.95 |
| 0.59460 | 0.75 | -4.5998 | 1.81 | 23.76 |
| 0.50000 | 1.00 | -4.4793 | 3.12 | 26.88 |
| 0.42045 | 1.25 | -4.3420 | 1.27 | 28.15 |
| 0.35355 | 1.50 | -4.1868 | 7.90 | 36.05 |
| 0.29730 | 1.75 | -4.0123 | 6.74 | 42.79 |
| 0.25000 | 2.00 | -3.8175 | 6.20 | 48.99 |
| 0.21022 | 2.25 | -3.6016 | 5.90 | 54.89 |
| 0.17678 | 2.50 | -3.3643 | 5.24 | 60.13 |
| 0.14865 | 2.75 | -3.1053 | 2.81 | 62.94 |
| 0.12500 | 3.00 | -2.8252 | 2.81 | 65.75 |
| 0.10511 | 3.25 | -2.5246 | 2.74 | 68.49 |
| 0.08839 | 3.50 | -2.2050 | 2.23 | 70.72 |
| 0.07433 | 3.75 | -1.8683 | 0.66 | 71.38 |
| 0.06250 | 4.00 | -1.5169 | 0.81 | 72.19 |
| 0.03125 | 5.00 | -0.0429 | 10.49 | 82.68 |
| 0.01563 | 6.00 | 1.2524 | 14.09 | 96.77 |
| 0.00781 | 7.00 | 1.9990 | 3.22 | 99.99 |

INTERPOLATED VALUES ARE USED IN THE STATISTICAL AND GRAPHIC DESCRIPTIONS

FOLK'S GRAPHIC MEASURES

| MM | PHI | |
|---|---|---|
| 0.23 | 2.10 | GRAPHIC MEAN |
| | 2.83 | INCLUSIVE GRAPHIC STANDARD DEVIATION |
| | -0.06 | INCLUSIVE GRAPHIC SKEWNESS |
| | 1.04 | GRAPHIC KURTOSIS |

INMAN'S MEASURES

| MM | PHI | |
|---|---|---|
| 0.23 | 2.13 | MEAN |
| | 2.96 | GRAPHIC STANDARD DEVIATION |
| | 0.03 | FIRST GRAPHIC SKEWNESS(A) |
| | -0.22 | SECOND GRAPHIC SKEWNESS(A2) |
| | 0.50 | KURTOSIS |

MOMENT MEASURES

| MM | PHI | |
|---|---|---|
| 0.24 | 2.07 | MEAN |
| | 2.62 | STANDARD DEVIATION |
| | -0.17 | SKEWNESS |
| | -0.51 | KURTOSIS |
| 0.24 | 2.04 | MEDIAN |

GRAVELLY SILTY FINE SAND
THE DISTRIBUTION IS NEAR SYMMETRICAL
THE DISTRIBUTION IS MESOKURTIC

SAHUS'S MODALITY INDEX 2.90 HIS DISPERSION COEFFICIENT IS 6.28
BOGARDI'S VELOCITY(M/SEC) 5.313

THESE FIGURES ARE ON A CARBON FREE BASIS. THERE IS 10.87% CARBON IN THE COARSE FRACTION
AND 1.36% CARBON IN THE FINE FRACTION.

[illegible] ASSOC SEDIMENT SIZE ANALYSIS

| IDENTIFICATION | LATITUDE | LONGITUDE | DEPTH(M) | NUMBER OF SAMPLE POINTS | PHI SIZE FOR INTERPOLATION |
|---|---|---|---|---|---|
| TB 1-8 | 0 0.00 | 0 0.00 | 0.000 | 30 | 0.25 |

HYDRAULIC EQUIVALENT PERCENT GRAVEL, SAND, SILT AND CLAY,
GRAVEL 32.84%
SAND 50.94%
SILT 16.21%
CLAY 0.00%

| MM SIZE | PHI SIZE | PSI SIZE | FREQ.PERCENT | CUM.FREQ.PERCENT |
|---|---|---|---|---|
| 5.65685 | -2.50 | -5.2483 | 5.86 | 5.86 |
| 4.75683 | -2.25 | -5.2322 | 7.56 | 13.42 |
| 4.00000 | -2.00 | -5.2132 | 8.73 | 22.15 |
| 3.36359 | -1.75 | -5.1908 | 3.31 | 25.46 |
| 2.82843 | -1.50 | -5.1643 | 2.92 | 28.38 |
| 2.37841 | -1.25 | -5.1331 | 2.14 | 30.52 |
| 2.00000 | -1.00 | -5.0965 | 2.32 | 32.84 |
| 1.68179 | -0.75 | -5.0535 | 2.95 | 35.79 |
| 1.41421 | -0.50 | -5.0032 | 1.95 | 37.74 |
| 1.18921 | -0.25 | -4.9444 | 1.80 | 39.54 |
| 1.00000 | 0.00 | -4.8761 | 1.20 | 40.74 |
| 0.84090 | 0.25 | -4.7968 | 1.95 | 42.69 |
| 0.70711 | 0.50 | -4.7052 | 3.31 | 46.00 |
| 0.59460 | 0.75 | -4.5998 | 6.72 | 52.72 |
| 0.50000 | 1.00 | -4.4793 | 0.00 | 52.72 |
| 0.42045 | 1.25 | -4.3420 | 0.42 | 53.14 |
| 0.35355 | 1.50 | -4.1868 | 6.41 | 59.55 |
| 0.29730 | 1.75 | -4.0123 | 3.94 | 63.49 |
| 0.25000 | 2.00 | -3.8175 | 3.69 | 67.18 |
| 0.21022 | 2.25 | -3.6016 | 2.85 | 70.03 |
| 0.17678 | 2.50 | -3.3643 | 1.84 | 71.87 |
| 0.14865 | 2.75 | -3.1053 | 4.48 | 76.35 |
| 0.12500 | 3.00 | -2.8252 | 2.16 | 78.51 |
| 0.10511 | 3.25 | -2.5246 | 2.48 | 80.99 |
| 0.08839 | 3.50 | -2.2050 | 1.20 | 82.19 |
| 0.07433 | 3.75 | -1.8683 | 0.81 | 83.00 |
| 0.06250 | 4.00 | -1.5169 | 0.78 | 83.78 |
| 0.03125 | 5.00 | -0.0429 | 8.45 | 92.23 |
| 0.01563 | 6.00 | 1.2524 | 3.92 | 96.15 |
| 0.00781 | 7.00 | 1.9990 | 3.84 | 99.99 |

INTERPOLATED VALUES ARE USED IN THE STATISTICAL AND GRAPHIC DESCRIPTIONS

FOLK'S GRAPHIC MEASURES

| MM | PHI | |
|---|---|---|
| 0.56 | 0.84 | GRAPHIC MEAN |
| | 2.79 | INCLUSIVE GRAPHIC STANDARD DEVIATION |
| | 0.16 | INCLUSIVE GRAPHIC SKEWNESS |
| | 0.75 | GRAPHIC KURTOSIS |

INMAN'S MEASURES

| MM | PHI | |
|---|---|---|
| 0.53 | 0.93 | MEAN |
| | 3.10 | GRAPHIC STANDARD DEVIATION |
| | 0.09 | FIRST GRAPHIC SKEWNESS(A) |
| | 0.29 | SECOND GRAPHIC SKEWNESS(A2) |
| | 0.32 | KURTOSIS |

MOMENT MEASURES

| MM | PHI | |
|---|---|---|
| 0.54 | 0.88 | MEAN |
| | 2.70 | STANDARD DEVIATION |
| | 0.24 | SKEWNESS |
| | -0.64 | KURTOSIS |
| 0.64 | 0.65 | MEDIAN |

SILT SANDY GRAVEL
THE DISTRIBUTION IS FINE-SKEWED
THE DISTRIBUTION IS PLATYKURTIC

SAHUS'S MODALITY INDEX 2.92 HIS DISPERSION COEFFICIENT IS 6.20
BOGARDI'S VELOCITY(M/SEC) 4.467

THESE FIGURES ARE ON A CARBON FREE BASIS. THERE IS 0.16% CARBON IN THE COARSE FRACTION
AND [illegible]% CARBON IN THE FINE FRACTION

LBH ASSOC          SEDIMENT SIZE ANALYSIS

| IDENTIFICATION | LATITUDE | LONGITUDE | DEPTH(M) | NUMBER OF SAMPLE POINTS | PHI SIZE FOR INTERPOLATION |
|---|---|---|---|---|---|
| TB 2-4 | 0 0.00 | 0 0.00 | 0.000 | 29 | 0.25 |

HYDRAULIC EQUIVALENT PERCENT GRAVEL, SAND, SILT AND CLAY,
GRAVEL 17.69%
SAND 53.14%
SILT 29.16%
CLAY 0.00%

| MM SIZE | PHI SIZE | PSI SIZE | FREQ.PERCENT | CUM.FREQ.PERCENT |
|---|---|---|---|---|
| 4.75683 | -2.25 | -5.2322 | 2.37 | 2.37 |
| 4.00000 | -2.00 | -5.2132 | 7.16 | 9.53 |
| 3.36359 | -1.75 | -5.1908 | 2.58 | 12.11 |
| 2.82843 | -1.50 | -5.1643 | 1.29 | 13.40 |
| 2.37841 | -1.25 | -5.1331 | 2.79 | 16.19 |
| 2.00000 | -1.00 | -5.0965 | 1.50 | 17.69 |
| 1.68179 | -0.75 | -5.0535 | 0.97 | 18.66 |
| 1.41421 | -0.50 | -5.0032 | 2.16 | 20.82 |
| 1.18921 | -0.25 | -4.9444 | 1.79 | 22.61 |
| 1.00000 | 0.00 | -4.8761 | 1.29 | 23.90 |
| 0.84090 | 0.25 | -4.7968 | 1.83 | 25.73 |
| 0.70711 | 0.50 | -4.7052 | 3.12 | 28.85 |
| 0.59460 | 0.75 | -4.5998 | 3.66 | 32.51 |
| 0.50000 | 1.00 | -4.4793 | 4.45 | 36.96 |
| 0.42045 | 1.25 | -4.3420 | 0.87 | 37.83 |
| 0.35355 | 1.50 | -4.1868 | 5.95 | 43.78 |
| 0.29730 | 1.75 | -4.0123 | 4.54 | 48.32 |
| 0.25000 | 2.00 | -3.8175 | 3.20 | 51.52 |
| 0.21022 | 2.25 | -3.6016 | 3.45 | 54.97 |
| 0.17678 | 2.50 | -3.3643 | 2.29 | 57.26 |
| 0.14865 | 2.75 | -3.1053 | 4.91 | 62.17 |
| 0.12500 | 3.00 | -2.8252 | 3.66 | 65.83 |
| 0.10511 | 3.25 | -2.5246 | 2.87 | 68.70 |
| 0.08839 | 3.50 | -2.2050 | 1.42 | 70.12 |
| 0.07433 | 3.75 | -1.8683 | 0.42 | 70.54 |
| 0.06250 | 4.00 | -1.5169 | 0.29 | 70.83 |
| 0.03125 | 5.00 | -0.0429 | 8.95 | 79.78 |
| 0.01563 | 6.00 | 1.2524 | 14.62 | 94.40 |
| 0.00781 | 7.00 | 1.9990 | 5.59 | 99.99 |

INTERPOLATED VALUES ARE USED IN THE STATISTICAL AND GRAPHIC DESCRIPTIONS

FOLK'S GRAPHIC MEASURES

| MM | PHI | |
|---|---|---|
| 0.26 | 1.97 | GRAPHIC MEAN |
| | 2.88 | INCLUSIVE GRAPHIC STANDARD DEVIATION |
| | 0.03 | INCLUSIVE GRAPHIC SKEWNESS |
| | 0.76 | GRAPHIC KURTOSIS |

INMAN'S MEASURES

| MM | PHI | |
|---|---|---|
| 0.25 | 2.01 | MEAN |
| | 3.28 | GRAPHIC STANDARD DEVIATION |
| | 0.04 | FIRST GRAPHIC SKEWNESS(A) |
| | 0.02 | SECOND GRAPHIC SKEWNESS(A2) |
| | 0.25 | KURTOSIS |

MOMENT MEASURES

| MM | PHI | |
|---|---|---|
| 0.24 | 2.05 | MEAN |
| | 2.68 | STANDARD DEVIATION |
| | 0.03 | SKEWNESS |
| | -0.97 | KURTOSIS |
| 0.27 | 1.88 | MEDIAN |

GRAVELLY SILTY MEDIUM SAND
THE DISTRIBUTION IS NEAR SYMMETRICAL
THE DISTRIBUTION IS PLATYKURTIC

SAHUS'S MODALITY INDEX 2.87 HIS DISPERSION COEFFICIENT IS 6.14
BOGARDI'S VELOCITY(M/SEC) 4.097

THESE NUMBERS ARE ON A CARBON FREE BASIS. THERE IS 11.02% CARBON IN THE COARSE FRACTION
AND 2.78% CARBON IN THE FINE FRACTION.

LBH ASSOC SEDIMENT SIZE ANALYSIS

| IDENTIFICATION | LATITUDE | LONGITUDE | DEPTH(M) | NUMBER OF SAMPLE POINTS | PHI SIZE FOR INTERPOLATION |
|---|---|---|---|---|---|
| TB 3-6 | 0 0.00 | 0 0.00 | 0.000 | 29 | 0.25 |

HYDRAULIC EQUIVALENT PERCENT GRAVEL, SAND, SILT AND CLAY,
GRAVEL 0.58%
SAND 94.10%
SILT 3.48%
CLAY 1.83%

| MM SIZE | PHI SIZE | PSI SIZE | FREQ.PERCENT | CUM.FREQ.PERCENT |
|---|---|---|---|---|
| 2.37841 | -1.25 | -5.1331 | 0.51 | 0.51 |
| 2.00000 | -1.00 | -5.0965 | 0.07 | 0.58 |
| 1.68179 | -0.75 | -5.0535 | 0.36 | 0.94 |
| 1.41421 | -0.50 | -5.0032 | 0.43 | 1.37 |
| 1.18921 | -0.25 | -4.9444 | 0.51 | 1.88 |
| 1.00000 | 0.00 | -4.8761 | 0.43 | 2.31 |
| 0.84090 | 0.25 | -4.7968 | 0.52 | 2.83 |
| 0.70711 | 0.50 | -4.7052 | 0.35 | 3.18 |
| 0.59460 | 0.75 | -4.5998 | 0.41 | 3.59 |
| 0.50000 | 1.00 | -4.4793 | 0.36 | 3.95 |
| 0.42045 | 1.25 | -4.3420 | 0.80 | 4.75 |
| 0.35355 | 1.50 | -4.1868 | 1.16 | 5.91 |
| 0.29730 | 1.75 | -4.0123 | 1.45 | 7.36 |
| 0.25000 | 2.00 | -3.8175 | 3.04 | 10.40 |
| 0.21022 | 2.25 | -3.6016 | 13.66 | 24.06 |
| 0.17678 | 2.50 | -3.3643 | 12.28 | 36.34 |
| 0.14865 | 2.75 | -3.1053 | 18.01 | 54.35 |
| 0.12500 | 3.00 | -2.8252 | 15.34 | 69.69 |
| 0.10511 | 3.25 | -2.5246 | 12.12 | 81.81 |
| 0.08839 | 3.50 | -2.2050 | 8.24 | 90.05 |
| 0.07433 | 3.75 | -1.8683 | 2.46 | 92.51 |
| 0.06250 | 4.00 | -1.5169 | 2.17 | 94.68 |
| 0.03125 | 5.00 | -0.0429 | 0.13 | 94.81 |
| 0.01563 | 6.00 | 1.2524 | 1.01 | 95.82 |
| 0.00781 | 7.00 | 1.9990 | 1.16 | 96.98 |
| 0.00391 | 8.00 | 2.2617 | 1.18 | 98.16 |
| 0.00195 | 9.00 | 2.3239 | 0.86 | 99.02 |
| 0.00098 | 10.00 | 2.3326 | 0.78 | 99.80 |
| 0.00049 | 11.00 | 2.3309 | 0.19 | 99.99 |

INTERPOLATED VALUES ARE USED IN THE STATISTICAL AND GRAPHIC DESCRIPTIONS

FOLK'S GRAPHIC MEASURES

| MM | PHI | |
|---|---|---|
| 0.15 | 2.70 | GRAPHIC MEAN |
| | 0.90 | INCLUSIVE GRAPHIC STANDARD DEVIATION |
| | 0.17 | INCLUSIVE GRAPHIC SKEWNESS |
| | 1.92 | GRAPHIC KURTOSIS |

INMAN'S MEASURES

| MM | PHI | |
|---|---|---|
| 0.15 | 2.71 | MEAN |
| | 0.61 | GRAPHIC STANDARD DEVIATION |
| | 0.03 | FIRST GRAPHIC SKEWNESS(A) |
| | 0.97 | SECOND GRAPHIC SKEWNESS(A2) |
| | 2.25 | KURTOSIS |

MOMENT MEASURES

| MM | PHI | |
|---|---|---|
| 0.12 | 3.07 | MEAN |
| | 2.43 | STANDARD DEVIATION |
| | 1.78 | SKEWNESS |
| | 12.44 | KURTOSIS |
| 0.16 | 2.69 | MEDIAN |

SLIGHTLY GRAVELLY FINE SAND
THE DISTRIBUTION IS FINE-SKEWED
THE DISTRIBUTION IS VERY LEPTOKURTIC

SAHUS'S MODALITY INDEX 8.77 HIS DISPERSION COEFFICIENT IS 7.44
BOGARDI'S VELOCITY(M/SEC) 2.897

THESE FIGURES ARE ON A CARBON FREE BASIS. THERE IS 0.25% CARBON IN THE COARSE FRACTION AND 1.54% CARBON IN THE FINE FRACTION.

| IDENTIFICATION | LATITUDE | LONGITUDE | DEPTH(M) | NUMBER OF SAMPLE POINTS | PHI SIZE FOR INTERPOLATION |
|---|---|---|---|---|---|
| TB 6-6 | 0 0.00 | 0 0.00 | 0.000 | 27 | 0.25 |

HYDRAULIC EQUIVALENT PERCENT GRAVEL, SAND, SILT AND CLAY,
GRAVEL 0.60%
SAND 97.87%
SILT 1.21%
CLAY 0.31%

| MM SIZE | PHI SIZE | PSI SIZE | FREQ.PERCENT | CUM.FREQ.PERCENT |
|---|---|---|---|---|
| 1.68179 | -0.75 | -5.0535 | 0.33 | 0.33 |
| 1.41421 | -0.50 | -5.0032 | 0.27 | 0.60 |
| 1.18921 | -0.25 | -4.9444 | 0.13 | 0.73 |
| 1.00000 | 0.00 | -4.8761 | 0.17 | 0.90 |
| 0.84090 | 0.25 | -4.7968 | 0.23 | 1.13 |
| 0.70711 | 0.50 | -4.7052 | 0.40 | 1.53 |
| 0.59460 | 0.75 | -4.5998 | 1.00 | 2.53 |
| 0.50000 | 1.00 | -4.4793 | 0.83 | 3.36 |
| 0.42045 | 1.25 | -4.3420 | 5.49 | 8.85 |
| 0.35355 | 1.50 | -4.1868 | 10.47 | 19.32 |
| 0.29730 | 1.75 | -4.0123 | 16.62 | 35.94 |
| 0.25000 | 2.00 | -3.8175 | 16.95 | 52.89 |
| 0.21022 | 2.25 | -3.6016 | 11.64 | 64.53 |
| 0.17678 | 2.50 | -3.3643 | 16.59 | 81.12 |
| 0.14865 | 2.75 | -3.1053 | 8.48 | 89.60 |
| 0.12500 | 3.00 | -2.8252 | 4.42 | 94.02 |
| 0.10511 | 3.25 | -2.5246 | 2.79 | 96.81 |
| 0.08839 | 3.50 | -2.2050 | 1.00 | 97.81 |
| 0.07433 | 3.75 | -1.8683 | 0.46 | 98.27 |
| 0.06250 | 4.00 | -1.5169 | 0.20 | 98.47 |
| 0.03125 | 5.00 | -0.0429 | 0.17 | 98.64 |
| 0.01563 | 6.00 | 1.2524 | 0.40 | 99.04 |
| 0.00781 | 7.00 | 1.9990 | 0.28 | 99.32 |
| 0.00391 | 8.00 | 2.2617 | 0.36 | 99.68 |
| 0.00195 | 9.00 | 2.3239 | 0.18 | 99.86 |
| 0.00098 | 10.00 | 2.3326 | 0.08 | 99.94 |
| 0.00049 | 11.00 | 2.3309 | 0.05 | 99.99 |

INTERPOLATED VALUES ARE USED IN THE STATISTICAL AND GRAPHIC DESCRIPTIONS

FOLK'S GRAPHIC MEASURES

| MM | PHI | |
|---|---|---|
| 0.25 | 1.99 | GRAPHIC MEAN |
| | 0.60 | INCLUSIVE GRAPHIC STANDARD DEVIATION |
| | 0.10 | INCLUSIVE GRAPHIC SKEWNESS |
| | 1.00 | GRAPHIC KURTOSIS |

INMAN'S MEASURES

| MM | PHI | |
|---|---|---|
| 0.25 | 2.00 | MEAN |
| | 0.58 | GRAPHIC STANDARD DEVIATION |
| | 0.08 | FIRST GRAPHIC SKEWNESS(A) |
| | 0.21 | SECOND GRAPHIC SKEWNESS(A2) |
| | 0.73 | KURTOSIS |

MOMENT MEASURES

| MM | PHI | |
|---|---|---|
| 0.20 | 2.29 | MEAN |
| | 2.28 | STANDARD DEVIATION |
| | 2.47 | SKEWNESS |
| | 22.00 | KURTOSIS |
| 0.26 | 1.96 | MEDIAN |

SLIGHTLY GRAVELLY FINE SAND
THE DISTRIBUTION IS FINE-SKEWED
THE DISTRIBUTION IS MESOKURTIC

SAHUS'S MODALITY INDEX11.90 HIS DISPERSION COEFFICIENT IS 7.38
BOGARDI'S VELOCITY(M/SEC) 2.436

THESE NUMBERS ARE ON A CARBON FREE BASIS. THERE IS 0.17% CARBON IN THE COARSE FRACTION AND 1.94% CARBON IN THE FINE FRACTION.

LBH ASSOC SEDIMENT SIZE ANALYSIS

| IDENTIFICATION | LATITUDE | LONGITUDE | DEPTH(M) | NUMBER OF SAMPLE POINTS | PHI SIZE FOR INTERPOLATION |
|---|---|---|---|---|---|
| TB 7-5 | 0 0.00 | 0 0.00 | 0.000 | 30 | 0.25 |

HYDRAULIC EQUIVALENT PERCENT GRAVEL, SAND, SILT AND CLAY,
GRAVEL 23.37%
SAND 61.71%
SILT 12.56%
CLAY 2.35%

| MM SIZE | PHI SIZE | PSI SIZE | FREQ.PERCENT | CUM.FREQ.PERCENT |
|---|---|---|---|---|
| 4.00000 | -2.00 | -5.2132 | 8.29 | 8.29 |
| 3.36359 | -1.75 | -5.1908 | 4.99 | 13.28 |
| 2.82843 | -1.50 | -5.1643 | 4.99 | 18.27 |
| 2.37841 | -1.25 | -5.1331 | 2.10 | 20.37 |
| 2.00000 | -1.00 | -5.0965 | 3.00 | 23.37 |
| 1.68179 | -0.75 | -5.0535 | 2.70 | 26.07 |
| 1.41421 | -0.50 | -5.0032 | 4.39 | 30.46 |
| 1.18921 | -0.25 | -4.9444 | 4.50 | 34.96 |
| 1.00000 | 0.00 | -4.8761 | 2.30 | 37.26 |
| 0.84090 | 0.25 | -4.7968 | 2.99 | 40.25 |
| 0.70711 | 0.50 | -4.7052 | 5.49 | 45.74 |
| 0.59460 | 0.75 | -4.5998 | 5.29 | 51.03 |
| 0.50000 | 1.00 | -4.4793 | 5.49 | 56.52 |
| 0.42045 | 1.25 | -4.3420 | 4.99 | 61.51 |
| 0.35355 | 1.50 | -4.1868 | 7.99 | 69.50 |
| 0.29730 | 1.75 | -4.0123 | 4.69 | 74.19 |
| 0.25000 | 2.00 | -3.8175 | 3.09 | 77.28 |
| 0.21022 | 2.25 | -3.6016 | 2.50 | 79.78 |
| 0.17678 | 2.50 | -3.3643 | 1.30 | 81.08 |
| 0.14865 | 2.75 | -3.1053 | 1.80 | 82.88 |
| 0.12500 | 3.00 | -2.8252 | 0.90 | 83.78 |
| 0.10511 | 3.25 | -2.5246 | 0.80 | 84.58 |
| 0.08839 | 3.50 | -2.2050 | 0.50 | 85.08 |
| 0.07433 | 3.75 | -1.8683 | 0.00 | 85.08 |
| 0.06250 | 4.00 | -1.5169 | 0.00 | 85.08 |
| 0.03125 | 5.00 | -0.0429 | 1.63 | 86.71 |
| 0.01563 | 6.00 | 1.2524 | 4.40 | 91.11 |
| 0.00781 | 7.00 | 1.9990 | 2.74 | 93.85 |
| 0.00391 | 8.00 | 2.2617 | 3.79 | 97.64 |
| 0.00195 | 9.00 | 2.3239 | 2.35 | 99.99 |

INTERPOLATED VALUES ARE USED IN THE STATISTICAL AND GRAPHIC DESCRIPTIONS

FOLK'S GRAPHIC MEASURES

| MM | PHI | |
|---|---|---|
| 0.61 | 0.72 | GRAPHIC MEAN |
| | 2.60 | INCLUSIVE GRAPHIC STANDARD DEVIATION |
| | 0.21 | INCLUSIVE GRAPHIC SKEWNESS |
| | 1.45 | GRAPHIC KURTOSIS |

INMAN'S MEASURES

| MM | PHI | |
|---|---|---|
| 0.60 | 0.73 | MEAN |
| | 2.34 | GRAPHIC STANDARD DEVIATION |
| | 0.01 | FIRST GRAPHIC SKEWNESS(A) |
| | 0.81 | SECOND GRAPHIC SKEWNESS(A2) |
| | 1.01 | KURTOSIS |

MOMENT MEASURES

| MM | PHI | |
|---|---|---|
| 0.47 | 1.09 | MEAN |
| | 2.68 | STANDARD DEVIATION |
| | 0.55 | SKEWNESS |
| | 0.58 | KURTOSIS |
| 0.62 | 0.70 | MEDIAN |

GRAVELLY SILTY MEDIUM SAND
THE DISTRIBUTION IS FINE-SKEWED
THE DISTRIBUTION IS LEPTOKURTIC

SAHUS'S MODALITY INDEX 3.46 HIS DISPERSION COEFFICIENT IS 6.64
BOGARDI'S VELOCITY(M/SEC) 3.757

THESE NUMBERS ARE ON A CARBON FREE BASIS. THERE IS 50.45% CARBON IN THE COARSE FRACTION AND 1.06% CARBON IN THEFINE FRACTION.

LBH ASSOC SEDIMENT SIZE ANALYSIS

| IDENTIFICATION | LATITUDE | LONGITUDE | DEPTH(M) | NUMBER OF SAMPLE POINTS | PHI SIZE FOR INTERPOLATION |
|---|---|---|---|---|---|
| TB 8-4 | 0 0.00 | 0 0.00 | 0.000 | 28 | 0.25 |

HYDRAULIC EQUIVALENT PERCENT GRAVEL, SAND, SILT AND CLAY,
GRAVEL 4.67%
SAND 66.01%
SILT 26.99%
CLAY 2.32%

| MM SIZE | PHI SIZE | PSI SIZE | FREQ.PERCENT | CUM.FREQ.PERCENT |
|---|---|---|---|---|
| 2.82843 | -1.50 | -5.1643 | 1.49 | 1.49 |
| 2.37841 | -1.25 | -5.1331 | 1.49 | 2.98 |
| 2.00000 | -1.00 | -5.0965 | 1.69 | 4.67 |
| 1.68179 | -0.75 | -5.0535 | 0.00 | 4.67 |
| 1.41421 | -0.50 | -5.0032 | 2.49 | 7.16 |
| 1.18921 | -0.25 | -4.9444 | 2.39 | 9.55 |
| 1.00000 | 0.00 | -4.8761 | 1.29 | 10.84 |
| 0.84090 | 0.25 | -4.7968 | 1.49 | 12.33 |
| 0.70711 | 0.50 | -4.7052 | 4.98 | 17.31 |
| 0.59460 | 0.75 | -4.5998 | 5.48 | 22.79 |
| 0.50000 | 1.00 | -4.4793 | 7.47 | 30.26 |
| 0.42045 | 1.25 | -4.3420 | 8.46 | 38.72 |
| 0.35355 | 1.50 | -4.1868 | 11.95 | 50.67 |
| 0.29730 | 1.75 | -4.0123 | 6.97 | 57.64 |
| 0.25000 | 2.00 | -3.8175 | 4.58 | 62.22 |
| 0.21022 | 2.25 | -3.6016 | 3.49 | 65.71 |
| 0.17678 | 2.50 | -3.3643 | 1.49 | 67.20 |
| 0.14865 | 2.75 | -3.1053 | 1.49 | 68.69 |
| 0.12500 | 3.00 | -2.8252 | 1.99 | 70.68 |
| 0.10511 | 3.25 | -2.5246 | 0.00 | 70.68 |
| 0.08839 | 3.50 | -2.2050 | 0.00 | 70.68 |
| 0.07433 | 3.75 | -1.8683 | 0.00 | 70.68 |
| 0.06250 | 4.00 | -1.5169 | 0.00 | 70.68 |
| 0.03125 | 5.00 | -0.0429 | 3.83 | 74.51 |
| 0.01563 | 6.00 | 1.2524 | 10.17 | 84.68 |
| 0.00781 | 7.00 | 1.9990 | 6.62 | 91.30 |
| 0.00391 | 8.00 | 2.2617 | 6.37 | 97.67 |
| 0.00195 | 9.00 | 2.3239 | 2.32 | 99.99 |

INTERPOLATED VALUES ARE USED IN THE STATISTICAL AND GRAPHIC DESCRIPTIONS

FOLK'S GRAPHIC MEASURES

| MM | PHI | |
|---|---|---|
| 0.16 | 2.62 | GRAPHIC MEAN |
| | 2.62 | INCLUSIVE GRAPHIC STANDARD DEVIATION |
| | 0.54 | INCLUSIVE GRAPHIC SKEWNESS |
| | 0.80 | GRAPHIC KURTOSIS |

INMAN'S MEASURES

| MM | PHI | |
|---|---|---|
| 0.11 | 3.18 | MEAN |
| | 2.75 | GRAPHIC STANDARD DEVIATION |
| | 0.62 | FIRST GRAPHIC SKEWNESS(A) |
| | 0.70 | SECOND GRAPHIC SKEWNESS(A2) |
| | 0.50 | KURTOSIS |

MOMENT MEASURES

| MM | PHI | |
|---|---|---|
| 0.17 | 2.53 | MEAN |
| | 2.61 | STANDARD DEVIATION |
| | 0.37 | SKEWNESS |
| | -0.68 | KURTOSIS |
| 0.36 | 1.49 | MEDIAN |

SLIGHTLY GRAVELLY MEDIUM SAND
THE DISTRIBUTION IS STRONGLY FINE-SKEWED
THE DISTRIBUTION IS PLATYKURTIC

SAHUS'S MODALITY INDEX 3.33 HIS DISPERSION COEFFICIENT IS 6.54
BOGARDI'S VELOCITY(M/SEC) 3.159

THESE FIGURES ARE ON A CARBON FREE BASIS. THERE IS 64.43% CARBON IN THE COARSE FRACTION AND 2.03% CARBON IN THE FINE FRACTION.

# APPENDIX C

## METHODS FOR THE ANALYSIS OF WATER SAMPLES

APPENDIX C

# METHODS FOR THE ANALYSIS OF WATER SAMPLES

## C.1 Total Suspended Solids

Total suspended solids, also referred to as total non-filtrable residue, were analyzed according to Method 160.2, Methods for the Chemical Analysis of Water and Wastes, EPA 600/4-79-020, 1979. An aliquot of sample is passed through a tared gooch crucible containing a glass fiber filter (Gelman Type A). The crucible and filter are then dried at 105°C for a minimum of 2 hours, transferred to a dessicator, cooled and weighed periodically until two subsequent weighings differ by less than 0.5 milligrams.

## C.2 Total Dissolved Solids

Total dissolved solids, also referred to as total filtrable residue, were analyzed according to Method 160.1, Methods for the Chemical Analysis of Water and Wastes, EPA 600/4-79-020, 1979. An aliquot of sample which has been passed through a membrane filter (maximum pore size 0.45 microns) is transferred to a tared evaporating dish. The dish is placed in an oven still at 105°C until the water has completely evaporated. The oven temperature is then increased to 180°C and the samples remain at this temperature for a minimum of 2 hours. The samples are then transferred to a dessicator, cooled and weighed periodically until two subsequent weighings differ by less than 0.5 milligrams.

C.3 Specific Conductance

Specific conductance is a measure of a water's ability to conduct an electric current. The analysis is performed according to Method 120.1, Methods for the Analysis of Water and Wastes,EPA 600/4-79-020, 1979. The sample temperature is brought up to 25°C in a water bath. An aliquot of sample is transferred to a 150 ml beaker and its conductance is measured with a Hach Model 16300 conductivity meter.

C.4 Volatile Organic Compounds

Samples were analyzed for volatile organic compounds according to EPA Method 624. Volatile organics were purged from an aliquot of sample onto a tenax trap for 11 minutes. The trap was heated to 220°C to desorb the organics. The organics were then analyzed by gas chromatography/mass spectrometry.

C.5 Polychlorinated Biphenyls - Total

Samples were analyzed for polychlorinated biphenyls according to EPA Method 608. An aliquot of sample was transferred to a 1000 ml separatory funnel and extracted three times with 60 ml of chloroform. The combined extracts are passed through a pre-rinsed 5 cm column of anhydrous sodium sulfate and collected in a Kuderna-Danish concentrator. The column is rinsed with an additional 20 ml of chloroform and collected in the concentrator. The concentrator is placed in a hot water bath, the extract evaporated to 5 ml and 20 ml of hexane was added. The extract was again concentrated to 50 ml and analyzed by gas chromatography using an electron capture detector.

C.6 Polychlorinated Biphenyls - Water Soluble

Samples were analyzed for water soluble PCBs by passing an aliquot of sample (approximately 200 ml) through glass fiber filter (Millipore Type AP) prior to extraction. The extraction and analysis are performed as described above in Section C.5 Polychlorinated Biphenyls - Total.

# APPENDIX D

## COST ESTIMATE ASSUMPTIONS AND CALCULATIONS

PRELIMINARY

## 7.00 RECOMMENDED REMEDIAL PLAN

On the basis of the technical, economic and environmental considerations discussed in the preceding Sections, it is recommended that the final remedial action plan for the Aerovox property include both:

1. Capping of the five contaminated soil areas by paving with hydraulic asphalt concrete (HAC); and,

2. Installation of a silt washings trench to serve as a vertical barrier to groundwater and tidal flow into and out of the contaminated soils in Zones 1 through 4.

All of the alternative materials considered for capping the site will achieve the same substantial remedial benefits with minimal adverse impacts during installation. All materials examined will result in the desired low permeability surface cover. Thus, installed costs, maintenance costs, and material suitability for this application were key factors in selecting the capping material.

The higher costs associated with the bentonite/soil cover and the HDPE liner options do not result in increased remedial benefits. Thus, from a cost-effectiveness view, the choice of capping material was between HAC and standard asphalt paving material. The latter is less costly to install, but may require more maintenance. In the plant yard behind the building, the cap will be subjected to occasional vehicular traffic due to the need to service equipment and utilities in that area. Such traffic, however, is very limited and both paving materials should be unaffected by those site activities. Based on its added flexibility and durability, the HAC material was selected. Although HAC is more expensive initially, the estimated lower maintenance costs for HAC over a 25-year design life results in the two asphalt materials having almost equivalent present worth costs.

Each of the alternative materials considered for construction of a vertical barrier wall would result in achievement of the desired remedial effects outlined in Section 6.35. Since the barrier wall would not be expected to function as a total isolation measure, but rather as an effective means of minimizing both tidal influences and groundwater discharges into and from the site, the substantial additional costs associated with the bentonite/ soil barrier trench and the sheet pile cutoff wall cannot be justified.

The installation of a vertical barrier trench constructed of compacted silt fines will be effective in preventing tidal exchange in the nearshore contaminated areas, and in dampening out the fluctuation of groundwater levels in the perched groundwater system directly behind the plant. Furthermore, the compacted silty material will provide an effective, low permeability barrier to the movement of groundwater and any associated oily film from the contaminated subsurface zones. Finally, the compacted silty fines will provide additional advantages in terms of adsorption capacity for any organic contaminants attempting to pass through the wall, and will effectively negate any potential for contaminated microparticulate soil particles to exit the site.

The selected plan for installing the surface cap and vertical barrier wall at the site is outlined next.

## 7.10 Description of Recommended Plan

The recommended remedial action plan for the Aerovox site is shown graphically in Figure 7-1 through 7-4. The HAC surface cap will have a thickness of 2.5 inches, and the silt washings barrier trench will be approximately 3 feet in width and from 7 to 9 feet in depth. The actual depth of the wall will be controlled by the depth of the peat layer into which the wall will be keyed.

### 7.11 Areas to be Capped

The proposed surface cap will be designed to cover all the presently unpaved areas on the Aerovox property along the river's edge. In addition, the approximately 8-foot wide unpaved gravel strip adjacent to the north trough on the north side of the building will be paved. These areas are shown in Figure 7-1. The proposed paving details for these areas are shown in Figures 7-3 and 7-4.

### 7.12 Barrier Wall Locations

The proposed locations of the vertical barrier walls are shown on Figure 7-2. In Zones 1 and 2, the contaminated soils will be encircled by the barrier wall to minimize any flow of groundwater from upgradient areas through the contaminated soils. In the vicinity of Slip #2, the contaminated soils to a depth of approximately 2 feet, will be removed and replaced elsewhere on-site beneath the cap. By leaving an opening in the barrier ✓ wall near Slip #2, an outlet for any perched groundwater flow beneath the Aerovox parking lot is provided. This will eliminate the possibility of a buildup of hydraulic pressure on the barrier walls encircling Zones 1 and 2.

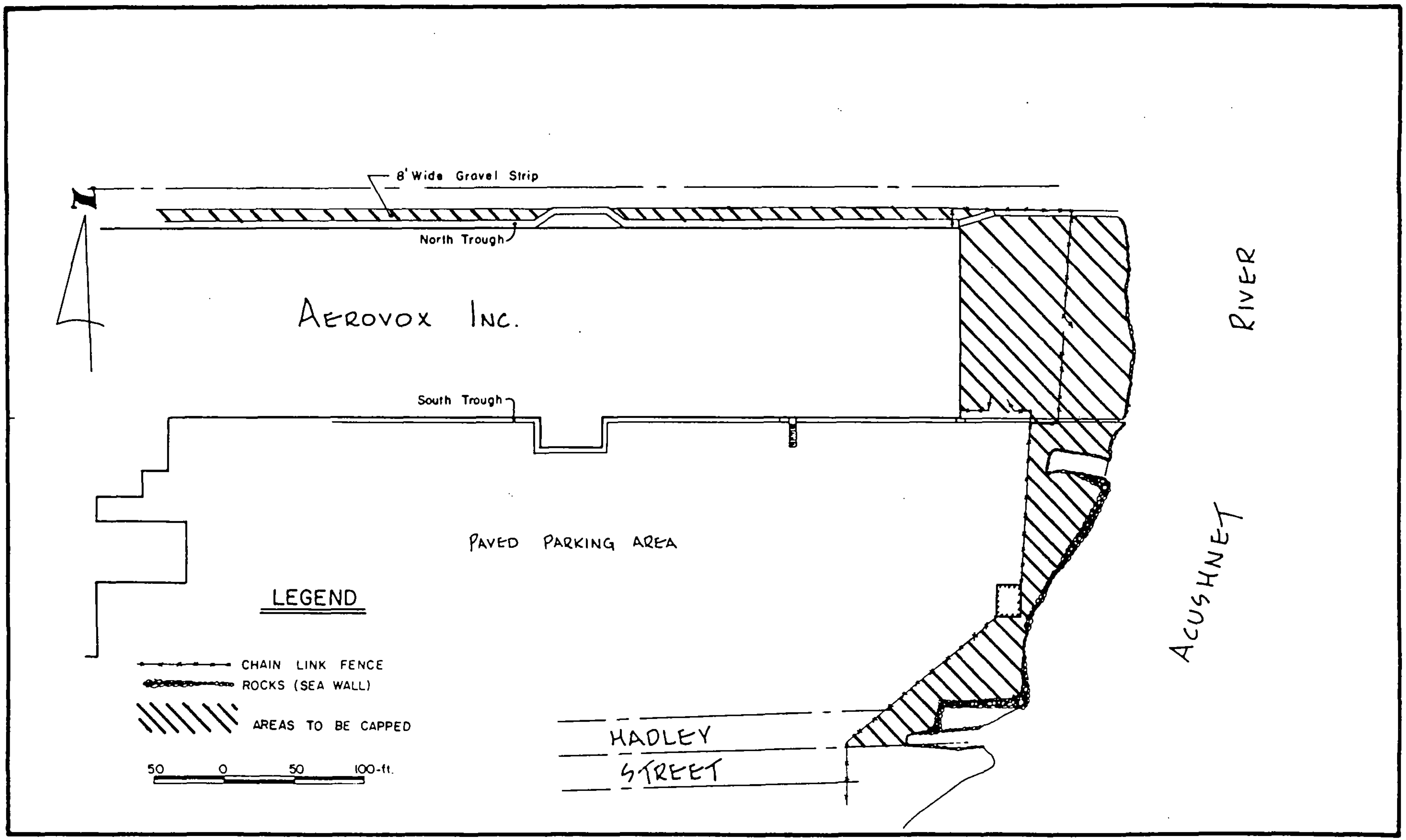
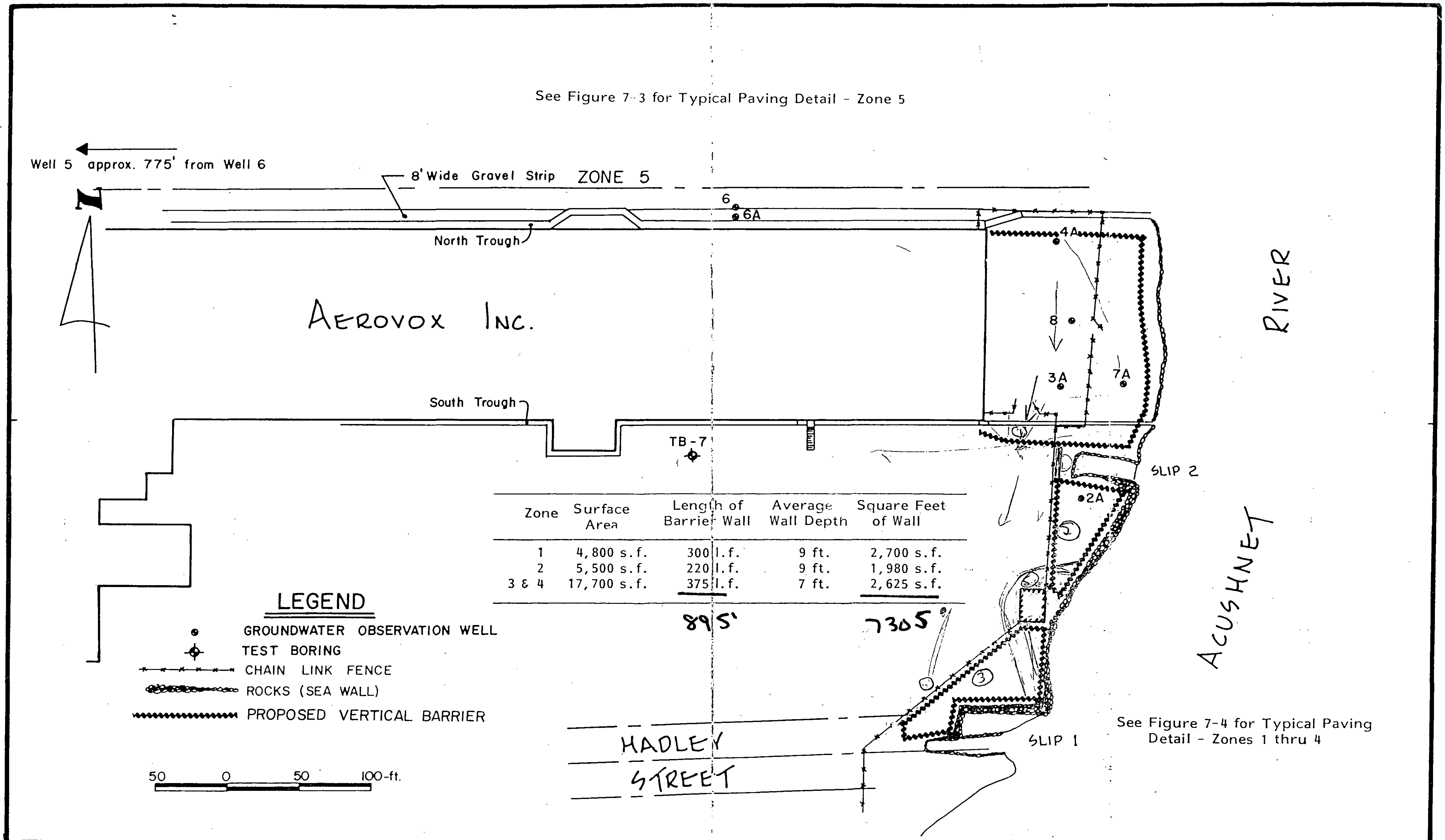



FIGURE 7-1 SITE PLAN SHOWING AREAS TO BE CAPPED




| Zone | Surface Area | Length of Barrier Wall | Average Wall Depth | Square Feet of Wall |
|---|---|---|---|---|
| 1 | 4,800 s.f. | 300 l.f. | 9 ft. | 2,700 s.f. |
| 2 | 5,500 s.f. | 220 l.f. | 9 ft. | 1,980 s.f. |
| 3 & 4 | 17,700 s.f. | 375 l.f. | 7 ft. | 2,625 s.f. |
| | | 895' | | 7305 |

Figure 7-2

PROPOSED LOCATIONS OF VERTICAL BARRIER WALLS

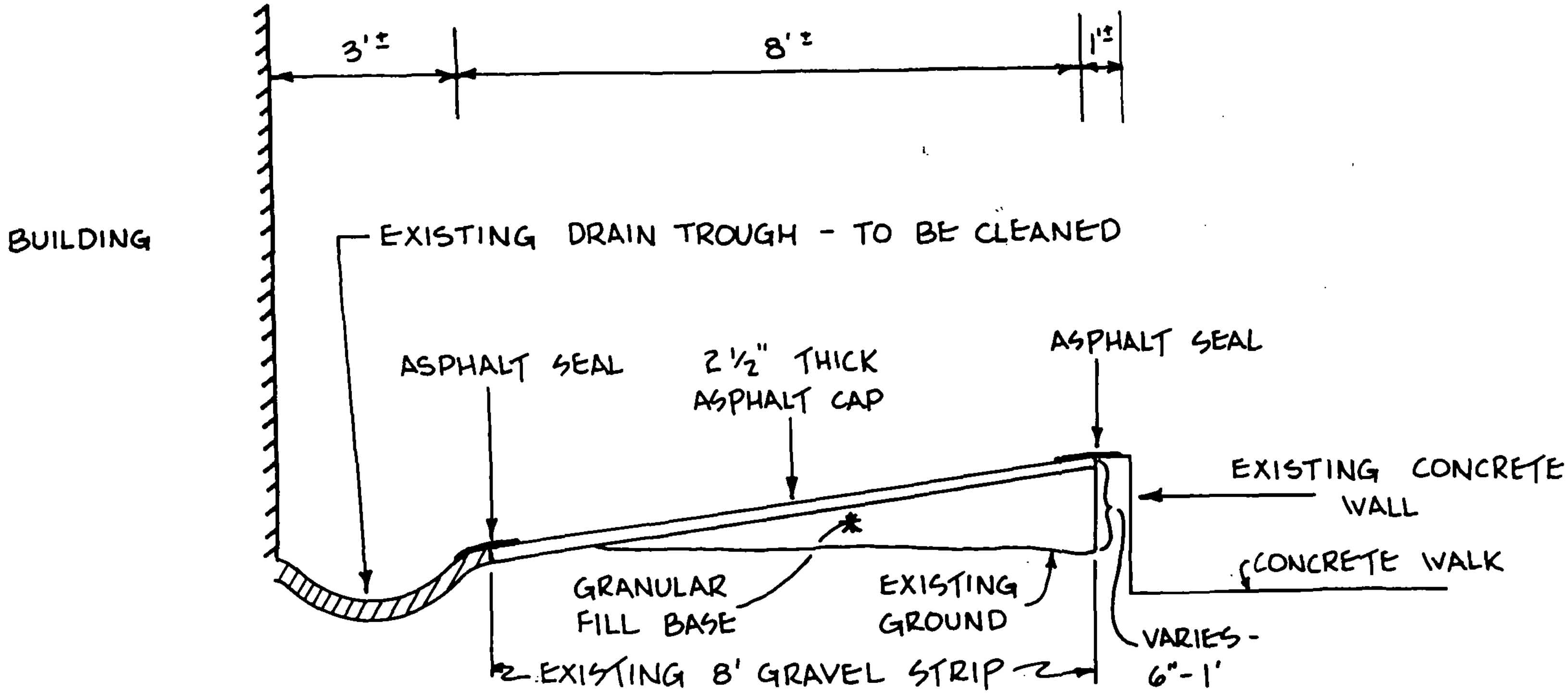
In Zones 3 and 4, the barrier wall will extend around three sides of the contaminated area as shown on Figure 7-2. Based on the hydrogeologic evaluation of the site it was concluded that extending the wall across Zone 3 along the back wall of the building is unnecessary. This conclusion is based on the fact that tidal influences were minimal at that distance from the seawall. Furthermore, the presence of the building and the configuration of the peat layer behind Zone 3 effectively prevent upgradient groundwater recharge into the perched zone behind the building.

## 7.13 Estimated Costs

The estimated cost to implement the recommended plan is approximately $78,000. This estimate includes the necessary engineering supervision during construction. A breakdown of the estimated costs is as follows:

| | | |
|---|---|---|
| 1. | Fixed costs - fencing work, repair of the south trough, and well abandonment . . . . | $10,000. |
| 2. | Installation of HAC cap and silt washings barrier walls . . . . . . . . . . . . . . | 68,000. |
| | Total Estimated Installed Cost - | $78,000. |

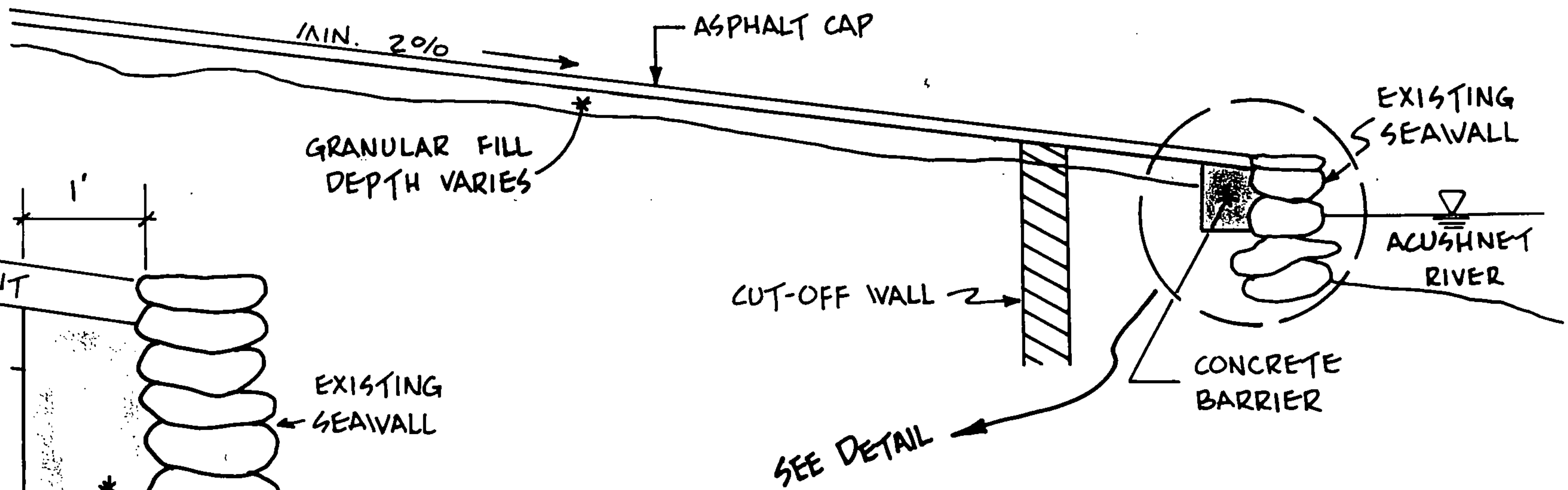
Maintenance costs for the HAC surface cap are estimated at approximately $1,600. per year, which is equivalent to the application of a seal coating over the entire area every 3 years.

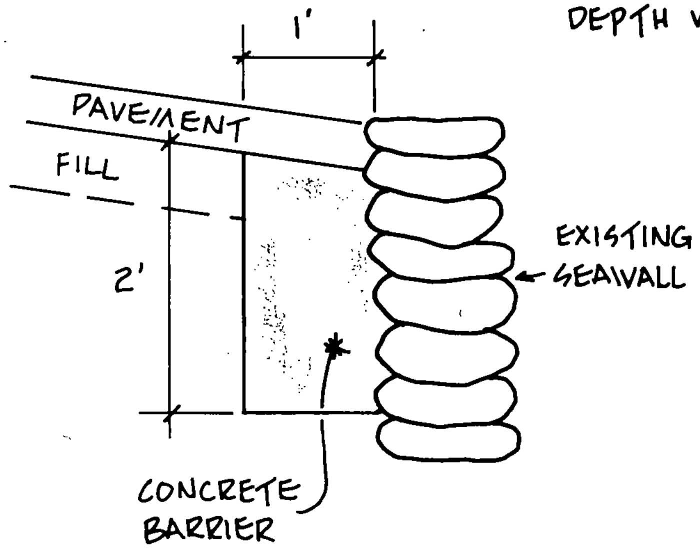



TYPICAL PAVING DETAIL – ZONE 5

NOT TO SCALE

Figure 7-3



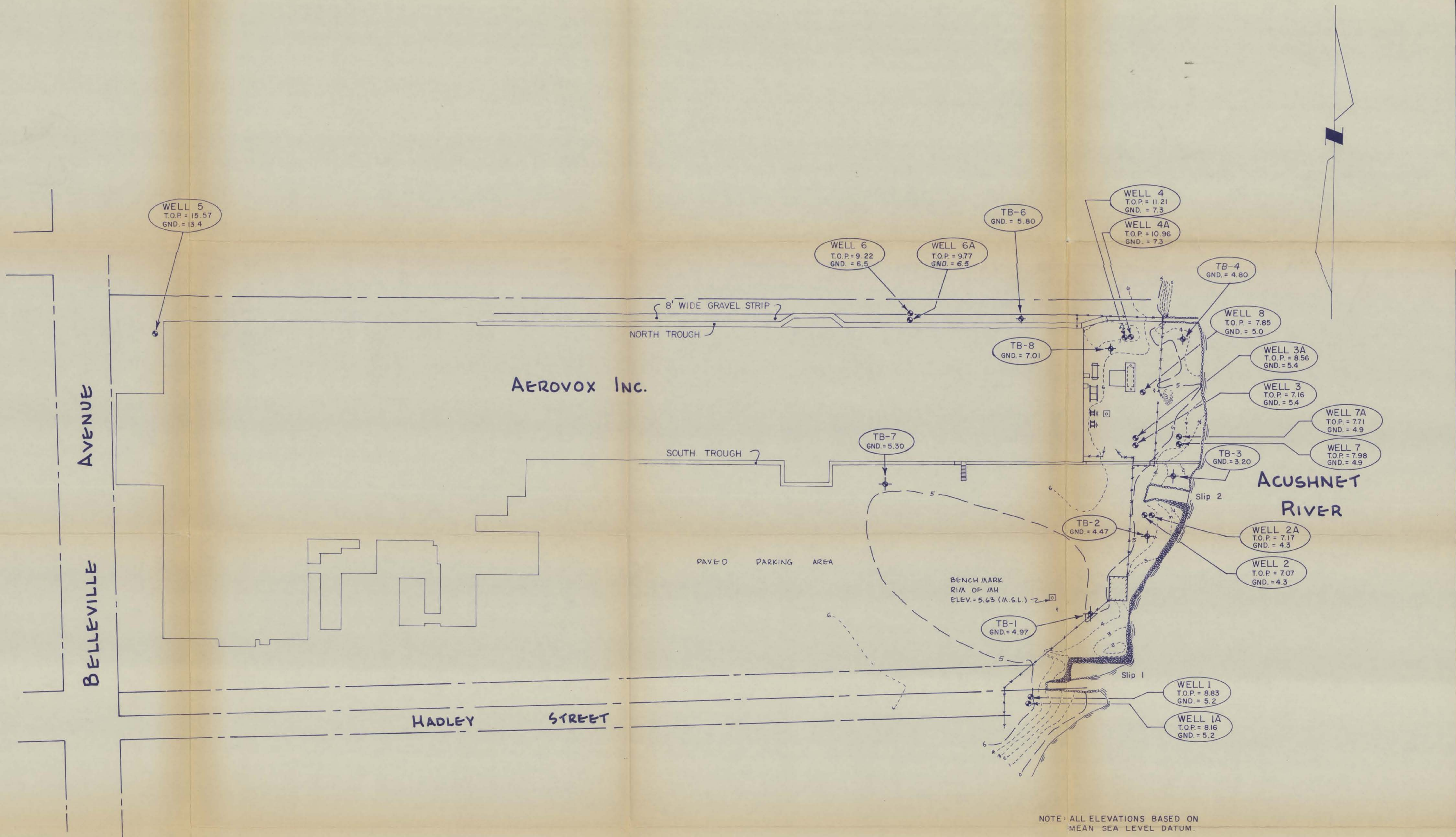

DETAIL

N.T.S.

PAVING DETAIL

NOT TO SCALE

Figure 7-4




NOTE: ALL ELEVATIONS BASED ON MEAN SEA LEVEL DATUM.

**LEGEND**

- HYDRANT
- POWER POLE
- CHAIN LINK FENCE
- EXISTING CONTOUR
- ROCKS (SEA WALL)
- M.S.L. MEAN SEA LEVEL
- GND. GROUND ELEVATION
- T.O.P. ELEV. OF TOP OF EXTERIOR PIPE
- GROUNDWATER OBSERVATION WELL
- TEST BORING

REVISED – JAN. 6, 1983

AEROVOX PLANT, NEW BEDFORD, MASS.

GHR ENGINEERING CORPORATION
75 TARKILN HILL ROAD · NEW BEDFORD, MA. 02745

DATE: 9-17-82
SCALE: 1" = 50'
DRAWN: D.F.
CHECKED: J.J.G.
JOB NO: 2463

CLIENT: AEROVOX INCORPORATED

DWG. TITLE: SITE PLAN SHOWING MONITORING WELL LOCATIONS

DWG. NO. SP-1