REPORT TO
TOWN OF SHARON, MASSACHUSETTS
LAKE MASSAPOAG AND MOUNTAIN STREET
LANDFILL DIAGNOSTIC/FEASIBILITY STUDY
DECEMBER, 1987
December 18, 1987

J-2109

Mr. Benjamin Puritz, Secretary
Town of Sharon Board of Selectmen
Town Office Building
Sharon, MA 02067

Dear Mr. Puritz:

We are pleased to submit the final report on the Diagnostic/Feasibility Study of Lake Massapoag, Sharon, Massachusetts. The report presents our findings on the project, including the field data collected as part of this project and an assessment of landfill impacts on Lake Massapoag.

The staff of Metcalf & Eddy enjoyed working with the Town of Sharon on this project, and we hope to continue our association with the town.

If we can be of any further assistance, please do not hesitate to contact us.

Very truly yours,

David R. Bingham
Project Manager
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INTRODUCTION

Lake Massapoag is located in Sharon, Massachusetts in close proximity to the town center, and is considered to be one of the Town's most important natural resources. The surface area of Lake Massapoag is 400 acres. The mean depth is 14.6 feet and the maximum depth is 45 feet. Lake Massapoag drains an area of 2,212 acres. The principal inlets to the lake are Sucker Brook and two unnamed tributaries on the southern shore. Massapoag Brook is the lake outlet and is located at the northeastern end of the lake. The lake level is controlled by an outlet structure. The lake provides recreational opportunities for swimmers and boaters. Fishing is also popular on the lake.

The Town of Sharon landfill is located on Mountain Street approximately one-half mile east of Lake Massapoag (see Figure 1). The total area of the landfill is approximately 35 acres, with approximately 23 acres of actual fill area. The site has been used for waste disposal for over 50 years. Open burning of refuse was conducted prior to 1971, and the site has been used as a covered landfill since then. Due to concern over potential pollution impact on Lake Massapoag, the landfill was closed to public waste disposal on April 30, 1985. The planned capacity of the landfill has not yet been reached. Formal closure of the landfill (capping) has not been undertaken, and thus the Massachusetts DEQE considers the landfill to be officially open.
FIGURE 1. PROJECT LOCATION
The Mountain Street landfill is located within the Lake Massapoag drainage area. Topography slopes gently down toward the lake. Wetlands occupy approximately two-thirds of the area between the landfill and the lake. Sucker Brook drains the wetland and discharges into Lake Massapoag. Two tributaries bounding the northwest and southwest corners of the landfill feed into Sucker Brook. Flows in these tributaries are routed under Mountain Street through culverts. All residences in the area are served by public water, and no wells exist in the area.

Three studies have been completed on the study area to date. SEA Consultants prepared a report entitled "Disposal of Refuse, Town of Sharon, Massachusetts," (SEA, 1974). The report was prepared to furnish the Town of Sharon with information regarding the operation of the existing town landfill. Items that were addressed in the report include: an evaluation of the present methods of waste disposal, a survey of present wastes and projection of future wastes, and recommended procedures for continuing operations at the site as well as for final closure of the landfill.

A report entitled "Diagnostic/Feasibility Study, Lake Massapoag, Sharon, Massachusetts," was prepared by IEP Consultants (1984). The focus of this report was a detailed description of the existing conditions of Lake Massapoag and its watershed, and the development of a management program to insure the future viability of the lake as a recreational resource. The report stated that the water quality in Lake Massapoag in 1981...
and 1982 was generally good. A review of past water quality data did not indicate any trends in the parameters studied. However, historical data and undocumented reports of nuisance algae, aquatic weed growth, and other biological parameters indicated acceleration toward eutrophication. Annual drawdown of the lake was instituted in 1976, in an attempt to control nuisance weeds growing in shallow shoreline areas. Drawdown has helped control growth of watermilfoil.

The 1984 report indicated that Lake Massapoag is phosphorus limited. The phosphorus budget indicated that the major source of phosphorus was the watershed surface, which included leaching of rocks and soil, septic systems near tributaries, decomposing vegetation, fertilizer, bottom sediments and landfill leachate. Septic systems within 300 feet of the shoreline were also identified as a significant source of phosphorus loading to Lake Massapoag. The lake was classified as being in a mesotrophic to borderline mesotrophic/eutrophic state based on 1981 and 1982 data. The report predicted that the lake would be in a eutrophic state by the year 2000 if the existing septic systems were not upgraded or replaced. Recommendations of the report included sewering of the lake area, watershed management practices to reduce dispersed sources of phosphorus, continued periodic lake drawdown, with weed harvesting as needed, and closure of the landfill.

A report has recently been completed evaluating alternatives for reopening the landfill for a limited time period (Metcalf &
Eddy, 1987). Data collected as part of this landfill project is also presented herein. For purposes of presentation, this recently completed project will be referred to as the "landfill study", and the current report will be referred to as the "lake study". At the April, 1987 Sharon Town Meeting it was voted to keep the landfill closed, and not to reopen it.

The subject of this report is an investigation conducted by Metcalf & Eddy as part of the State Chapter 628 Clean Lakes Program to evaluate the potential impact of landfill contamination on Lake Massapoag. This report presents the results of the Lake Massapoag Clean Lakes Project. Results from the landfill study are included where appropriate. The report contains a summary and analysis of topographic, hydrogeologic, and environmental data collected to assess landfill impacts, final closure recommendations for the landfill, guidelines for future monitoring around the landfills, and potential post-closure uses of the landfill.

DATA COLLECTION PROGRAMS

Topographic Mapping, Well Installations, and Hydrologic Measurements

A topographic map showing existing contours of the sanitary landfill area was prepared from aerial photographs taken on December 15, 1985. The map covers an area of approximately 60 acres and was prepared at a scale of 1 in. = 80 ft., with 2 ft. contour intervals. The map has been reduced and included in this report (Figure 2). A full scale copy of this map is included in the map pocket at the back of this report.
FIGURE 2. EXISTING CONTOURS: MOUNTAIN STREET LANDFILL
DECEMBER 15, 1985
Four groundwater monitoring wells were installed at the landfill site in conjunction with the lake study. One well (B-4) was installed upgradient of the landfill and three (Bl-A, B-2, and B-3) were installed downgradient of the landfill along its western edge. It should be noted that during the installation of well B-3 refuse was encountered near the surface, indicating that the well is on the edge of the actual fill area. Three additional wells were installed in conjunction with the landfill project. Two wells (B-5 and B-6) were installed downgradient of the landfill to assess possible off-site migration of leachate. Well B-5 is located across Mountain Street about 100 feet from the landfill. Well B-6 is located further off-site between the landfill and Lake Massapoag, approximately one-third of a mile downgradient of the landfill, near Sucker Brook. An additional upgradient well (B-7) was installed northeast of the landfill area near the water tower. The well locations are shown in Figure 3. Characteristics of the wells are listed in Table 1.

Water table elevations were measured at wells B-1A, B-2, B-3 and B-4 on October 29, 1986, at wells B-2, B-3 and B-4 on February 4, 1987, and at wells B-5, B-6 and B-7 on March 10, 1987. Water table elevations were measured at all seven wells on March 17, 1987. Water table elevations were obtained by measuring the distance from the top of the well casing to the groundwater surface. The well casing elevations were tied into
FIGURE 3. DIAGNOSTIC SURVEY STATIONS
<table>
<thead>
<tr>
<th>Well Number</th>
<th>Date Installed</th>
<th>Type of Well</th>
<th>Depth of Well Casing (feet)</th>
<th>Screened Interval (feet)</th>
<th>Top of Well Casing Elevation (2)</th>
<th>Materials Encountered</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1A</td>
<td>9/20/86</td>
<td>Overburden</td>
<td>15</td>
<td>5-15</td>
<td>285.59</td>
<td>Coarse/fine silty sand, gravel, cobbles, boulder</td>
</tr>
<tr>
<td>B-2</td>
<td>9/18/86</td>
<td>Overburden</td>
<td>25.5</td>
<td>15.5-25.5</td>
<td>289.76</td>
<td>Coarse/fine sand, gravel, cobble, boulder, little silt</td>
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<tr>
<td>B-3</td>
<td>9/19/86</td>
<td>Overburden</td>
<td>15.3</td>
<td>5.3-15.3</td>
<td>287.45</td>
<td>Silty gravelly sand, cobbles, boulders, fill, trash</td>
</tr>
<tr>
<td>B-4</td>
<td>9/23/86</td>
<td>Overburden, upgradient</td>
<td>25.5</td>
<td>15.5-25.5</td>
<td>306.10</td>
<td>Coarse/fine sand and gravel, silt, cobbles, boulders</td>
</tr>
<tr>
<td>B-5</td>
<td>2/23/87</td>
<td>Overburden</td>
<td>12</td>
<td>7-12</td>
<td>276.28</td>
<td>Peat, brown and gray fine to coarse sand and gravel, little silt, occasional cobble</td>
</tr>
<tr>
<td>B-6</td>
<td>2/23/87</td>
<td>Overburden</td>
<td>17</td>
<td>12-17</td>
<td>266.33</td>
<td>Organic silt, brown fine sand, little silt, little fine gravel, occasional cobble</td>
</tr>
<tr>
<td>B-7</td>
<td>2/24/87</td>
<td>Well screened in overburden and bedrock, upgradient</td>
<td>23</td>
<td>13-23</td>
<td>324.57</td>
<td>Top soil, brown and gray fine to coarse sand and gravel, little silt, occasional cobbles and boulders, granite</td>
</tr>
</tbody>
</table>

1. Inside diameter of casing is 2 inches.
2. Based on USGS datum.
USGS datum by means of a ground survey. Wells B-1A, B-2, B-3, B-4 and B-5 were tied into specific reference points established at the landfill during the topographic survey conducted as part of the Lake Massapoag project. Well B-6 was tied into a reference elevation obtained from the town assessor's topographic mapping. Well B-7 was tied into a bench mark established by the Dunn Surveying Company as part of the subdivision work being conducted to the east of the landfill. All reference elevations are with regard to USGS datum. Top of well casing elevations are included in Table 1.

The water surface elevation of Lake Massapoag is approximately 252 feet above sea level. The water table at well B-6, closest to the lake, is approximately 14 feet higher than the surface elevation of Lake Massapoag. Water table elevations measured in the monitoring wells increase from B-6, which is the westernmost well to B-7, the easternmost well. The water table at well B-7 is approximately 56-58 feet higher than at B-6. A summary of measured water table elevations is provided in Table 2. These measurements confirm the expected groundwater flow direction, toward the west.

Flows were measured in the two culverts running under Mountain Street located at the northwest and southwest corners of the landfill (S-2 and S-1) and at the Sucker Brook inlet to Lake Massapoag (S-3) on several occasions. The measured flows are presented in Table 3. Measurement locations are indicated where
<table>
<thead>
<tr>
<th>Date</th>
<th>B-1A</th>
<th>B-2</th>
<th>B-3</th>
<th>B-4</th>
<th>B-5</th>
<th>B-6</th>
<th>B-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/29/86</td>
<td>278.65</td>
<td>279.66</td>
<td>280.07</td>
<td>290.14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/04/87</td>
<td>281.09</td>
<td>280.85</td>
<td>292.64</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>03/10/87</td>
<td></td>
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<td>276.28</td>
<td>266.33</td>
<td>324.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/17/87</td>
<td>279.34</td>
<td>280.70</td>
<td>281.52</td>
<td>293.30</td>
<td>276.12</td>
<td>266.19</td>
<td>322.52</td>
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TABLE 3. FLOWS MEASURED IN CULVERTS AND SUCKER BROOK INLET

<table>
<thead>
<tr>
<th>Date of Measurement</th>
<th>Station S-1</th>
<th>Flow (cfs)</th>
<th>Station S-2</th>
<th>Flow (cfs)</th>
<th>Station S-3</th>
<th>Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>07/15/86</td>
<td>0.25(1)</td>
<td>0.07(1)</td>
<td>0.07(1)</td>
<td>0.07(1)</td>
<td>NM(2)</td>
<td>0.07(1)</td>
</tr>
<tr>
<td>07/31/86</td>
<td>0.04(1)</td>
<td>0.04(1)</td>
<td>0.04(1)</td>
<td>0.04(1)</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>10/29/86</td>
<td>0.08(3)</td>
<td>0.01(1)</td>
<td>1.7</td>
<td>1.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/04/87</td>
<td>0.18(3)</td>
<td>0.13(1)</td>
<td>NM</td>
<td>NM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/17/87</td>
<td>0.2(3)</td>
<td>0.18(1)</td>
<td>4.9</td>
<td>4.9</td>
<td></td>
<td></td>
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</table>

1. Measurement taken on upstream side of Mountain Street.
2. NM = Not measured.
3. Measurement taken on downstream side of Mountain Street.

...appropriate, i.e. flow in the culverts was measured several times on the upstream and several times on the downstream side of Mountain Street. In the south culvert, the flow varies between the upstream and downstream side of Mountain Street because a 24-inch pipe drains into the culvert under Mountain Street.

**Water Quality Sampling**

Three water quality sampling programs were conducted. Two programs were conducted in conjunction with the lake study, one in October, 1986, and one in February, 1987. In conjunction with the landfill study, one sampling program was conducted in March, 1987. The October sampling was conducted October 29th, within two days of the largest rainfall day during the month. On October 27, 0.85 inches of rain was reported to have fallen at the recording station in Walpole, MA (NOAA, 1986). In addition...
to sampling the wells, surface water samples were collected as part of the October, 1986 sampling program. These samples were collected from the downstream ends of the two culverts running under Mountain Street located at the northwest and southwest corners of the landfill, as shown in Figure 3. Samples were collected from the downstream side of Mountain Street. A surface water sample was also collected from Sucker Brook near the point of discharge to Lake Massapoag (see Figure 2). Wells B-2, B-3 and B-4 were sampled in February, 1987. Wells B-5, B-6 and B-7 were sampled in March, 1987. The well samples and surface water samples were analyzed for a variety of parameters, which are listed in Table 4. These parameters were selected in consultation with DEQE and in accordance with the EPA Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities (U.S. EPA, 1977). This parameter list is comprehensive in that it includes a number of indicator parameters (i.e. alkalinity, dissolved solids and chemical oxygen demand) as well as extended analysis parameters (i.e. volatile organics and heavy metals).

The results of the analyses of samples collected in October, 1986 and February, 1987 are summarized in Table 5. The results of the analyses of samples collected in March, 1987 are summarized in Table 6. Only those volatile compounds that were detected in the samples are included in Tables 5 and 6.
## Table 4. Analyses Performed on Ground and Surface Water Samples

<table>
<thead>
<tr>
<th>Volatile organics:</th>
<th>Inorganics:</th>
<th>Metals:</th>
<th>pH</th>
<th>Conductivity</th>
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<tr>
<td>chloromethane</td>
<td>total phosphate</td>
<td>arsenic</td>
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<td></td>
</tr>
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<td>vinyl chloride</td>
<td>chemical oxygen demand</td>
<td>cadmium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chloroethane</td>
<td>ammonia</td>
<td>chromium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bromomethane</td>
<td>total Kjeldahl nitrogen</td>
<td>copper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>methylene chloride</td>
<td>alkalinity</td>
<td>iron</td>
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</tr>
<tr>
<td>1,1-dichloroethylene</td>
<td>total chloride</td>
<td>mercury</td>
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<td></td>
</tr>
<tr>
<td>1,1-dichloroethene</td>
<td>nitrate</td>
<td>manganese</td>
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<td></td>
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<tr>
<td>1,2-trans-dichloroethylene</td>
<td>nitrite</td>
<td>sodium</td>
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<td></td>
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<tr>
<td>chloroform</td>
<td>total dissolved solids</td>
<td>lead</td>
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<tr>
<td>1,2-dichloroethane</td>
<td>sulfate</td>
<td>zinc</td>
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</tr>
<tr>
<td>1,1,1-trichloroethane</td>
<td>total volatile solids</td>
<td>total cyanide</td>
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<tr>
<td>carbon tetrachloride</td>
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<td>bromodichloromethane</td>
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<td>1,2-dichloropropane</td>
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<td>1,3-trans-dichloropropene</td>
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<td>trichloroethylene</td>
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<td>2-chloroethyl vinyl ether</td>
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<td>dibromochloromethane</td>
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<td>vinyl acetate</td>
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</tr>
<tr>
<td>2-hexanone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>styrene</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xylenes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Relevant water quality standards and criteria are provided as a basis for comparison. It should be noted that the water quality standards shown are generally for drinking water supplies, and thus are very stringent. These criteria are used
### TABLE 5
**SUMMARY OF GROUNDWATER AND SURFACE WATER SAMPLING**
**NEAR MOUNTAIN STREET LANDFILL, OCTOBER 29, 1986/FEBRUARY 4, 1987**

#### Sample Location

<table>
<thead>
<tr>
<th>Well</th>
<th>Well</th>
<th>Well</th>
<th>Well</th>
<th>Well</th>
<th>Well</th>
<th>Well</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1A(a)</td>
<td>B-2</td>
<td>B-3</td>
<td>B-4</td>
<td>Culvert Upgradient</td>
<td>S-1</td>
<td>S-2</td>
</tr>
</tbody>
</table>

#### Volatile Organics: (29 October 1986/4 February 1987) (ug/l)

<table>
<thead>
<tr>
<th>Compound</th>
<th>B-1A</th>
<th>B-2</th>
<th>B-3</th>
<th>Culvert Upgradient</th>
<th>S-1</th>
<th>S-2</th>
<th>S-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>140</td>
<td>140</td>
<td>420/40</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

#### Inorganics: (29 October 1986/4 February 1987) (mg/l)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>B-1A</th>
<th>B-2</th>
<th>B-3</th>
<th>Culvert Upgradient</th>
<th>S-1</th>
<th>S-2</th>
<th>S-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Phosphate</td>
<td>3</td>
<td>10/2</td>
<td>8.6/0.32</td>
<td>2.7/5.8</td>
<td>0.03</td>
<td>0.06</td>
<td>0.02</td>
</tr>
<tr>
<td>COD</td>
<td>51</td>
<td>180/100</td>
<td>261/750</td>
<td>31/67</td>
<td>33</td>
<td>24</td>
<td>31</td>
</tr>
<tr>
<td>Ammonia</td>
<td>0.26</td>
<td>23/23</td>
<td>66/51</td>
<td>0.22/0.10</td>
<td>2.8</td>
<td>0.91</td>
<td>0.19</td>
</tr>
<tr>
<td>TKN</td>
<td>0.37</td>
<td>27/24</td>
<td>69/72</td>
<td>1.76/0.12</td>
<td>5.7</td>
<td>1.9</td>
<td>0.42</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>51</td>
<td>450/510</td>
<td>1200/1300</td>
<td>44.7/1.4</td>
<td>200</td>
<td>83</td>
<td>34</td>
</tr>
<tr>
<td>Total Chloride</td>
<td>13</td>
<td>71/69</td>
<td>130/220</td>
<td>15/10</td>
<td>28</td>
<td>28</td>
<td>18</td>
</tr>
<tr>
<td>Nitrate</td>
<td>0.65</td>
<td>&lt;0.01/0.05</td>
<td>0.03/0.03</td>
<td>0.20/0.58</td>
<td>0.05</td>
<td>0.02</td>
<td>0.23</td>
</tr>
<tr>
<td>Nitrite</td>
<td>&lt;0.01</td>
<td>&lt;0.01/0.05</td>
<td>&lt;0.01/0.05</td>
<td>&lt;0.01/0.05</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>TDS</td>
<td>52</td>
<td>530/530</td>
<td>1600/1600</td>
<td>74/65</td>
<td>220</td>
<td>180</td>
<td>130</td>
</tr>
<tr>
<td>Sulfate</td>
<td>14</td>
<td>0.12/0.29</td>
<td>0.68/0.68</td>
<td>0.7/1.6</td>
<td>4.4</td>
<td>15</td>
<td>8.1</td>
</tr>
<tr>
<td>TVS</td>
<td>72</td>
<td>800/170</td>
<td>630/720</td>
<td>120/45</td>
<td>56</td>
<td>40</td>
<td>30</td>
</tr>
</tbody>
</table>

#### Metals: (29 October 1986/4 February 1987) (mg/l)

<table>
<thead>
<tr>
<th>Compound</th>
<th>B-1A</th>
<th>B-2</th>
<th>B-3</th>
<th>Culvert Upgradient</th>
<th>S-1</th>
<th>S-2</th>
<th>S-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>0.045</td>
<td>&lt;0.01/0.01</td>
<td>0.034/0.01</td>
<td>0.037/0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Cadmium</td>
<td>&lt;0.005</td>
<td>&lt;0.005/0.005</td>
<td>&lt;0.005/0.005</td>
<td>&lt;0.005/0.005</td>
<td>&lt;0.005</td>
<td>&lt;0.005</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>0.07</td>
<td>0.04/0.01</td>
<td>0.06/0.01</td>
<td>0.09/0.02</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Copper</td>
<td>0.19</td>
<td>0.07/0.01</td>
<td>0.07/0.01</td>
<td>1.35/0.16</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Iron</td>
<td>56</td>
<td>94/53</td>
<td>56/4.23</td>
<td>56/0.42</td>
<td>23</td>
<td>6.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Mercury</td>
<td>&lt;0.001</td>
<td>&lt;0.001/0.005</td>
<td>&lt;0.001/0.007</td>
<td>&lt;0.001/0.005</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Manganese</td>
<td>2.5</td>
<td>6.67/0.49</td>
<td>7.0/0.3</td>
<td>3.5/0.25</td>
<td>2.3</td>
<td>2.8</td>
<td>0.29</td>
</tr>
<tr>
<td>Sodium</td>
<td>19</td>
<td>60/78</td>
<td>160/150</td>
<td>93/0.3</td>
<td>21</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>Lead</td>
<td>0.05</td>
<td>0.03/0.05</td>
<td>0.12/0.05</td>
<td>0.12/0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.47</td>
<td>0.27/0.005</td>
<td>0.51/0.005</td>
<td>1.2/0.1</td>
<td>0.27</td>
<td>0.15</td>
<td>0.18</td>
</tr>
<tr>
<td>Cyanide (total)</td>
<td>&lt;0.01</td>
<td>&lt;0.01/0.01</td>
<td>&lt;0.01/0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>pH</td>
<td>6.1</td>
<td>6.5/7.2</td>
<td>6.4/6.9</td>
<td>6.4/9</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>D.O.</td>
<td>3.3</td>
<td>3.7</td>
<td>0.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

#### Standards and Criteria

- **National Secondary Drinking Water Regulatons**
- **Massachusetts Groundwater Standards**
- **Federal MCLG**
- **Federal MCL**
- **EPA Freshwater Criteria (Acute)**

#### Notes:

- Well B-1A was only sampled on October 29, 1986.
- Proposed maximum contaminant level (Federal Register, June 13, 1986).
- Proposed maximum contaminant level goal (Federal Register, Nov. 13, 1985).
- Proposed Maximum Contaminant Level (Federal Register, June 13, 1986).
- Safe drinking water exposure level suggested by the USEPA Environmental Criteria and Assessment Office.
- Underlined values indicate exceedance of standard or criteria.
- Analyses for total metals.
- Analyses for dissolved metals.
- Estimated minimum value, criteria dependent on other factors also.
- Health advisory level for at-risk population.
<table>
<thead>
<tr>
<th>Volatile Organics:</th>
<th>(ug/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inorganics:</th>
<th>(mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Phosphate</td>
<td>5.9</td>
</tr>
<tr>
<td>OOD</td>
<td>2.9</td>
</tr>
<tr>
<td>Ammonia</td>
<td>2.1</td>
</tr>
<tr>
<td>TKN</td>
<td>2.1</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>430</td>
</tr>
<tr>
<td>Total Chloride</td>
<td>110</td>
</tr>
<tr>
<td>Nitrate (Acute)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Nitrate (Chronic)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>TDS</td>
<td>510</td>
</tr>
<tr>
<td>Sulfate</td>
<td>22</td>
</tr>
<tr>
<td>TDS</td>
<td>280</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metals: (Total/Dissolved)</th>
<th>(mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>&lt;0.024/0.01</td>
</tr>
<tr>
<td>Cadmium</td>
<td>&lt;0.005/0.005</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>0.14/0.01</td>
</tr>
<tr>
<td>Copper</td>
<td>0.27/0.01</td>
</tr>
<tr>
<td>Iron</td>
<td>64/100</td>
</tr>
<tr>
<td>Mercury</td>
<td>&lt;0.0005/0.0005</td>
</tr>
<tr>
<td>Manganese</td>
<td>9/0.6</td>
</tr>
<tr>
<td>Sodium</td>
<td>64/63</td>
</tr>
<tr>
<td>Lead</td>
<td>0.12/0.05</td>
</tr>
<tr>
<td>Zinc</td>
<td>1,770/0.039</td>
</tr>
<tr>
<td>Cyanide (total)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

| pH                         | 6.34 |

<table>
<thead>
<tr>
<th>Standards and Criteria</th>
<th>Well B-5</th>
<th>Well B-6</th>
<th>Well B-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Secondary Drinking Water Regulations</td>
<td>Massachusetts Groundwater Standards</td>
<td>Federal MCL (g)</td>
<td>Federal MCL (h)</td>
</tr>
<tr>
<td>Volatile organics (Acute)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetone</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inorganics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Phosphate</td>
<td>5.9</td>
<td>2.9</td>
<td>2.1</td>
</tr>
<tr>
<td>OOD</td>
<td>220</td>
<td>190</td>
<td>35</td>
</tr>
<tr>
<td>Ammonia</td>
<td>2.7</td>
<td>0.28</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>TKN</td>
<td>6.2</td>
<td>2.3</td>
<td>0.14</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>430</td>
<td>34</td>
<td>8.5</td>
</tr>
<tr>
<td>Total Chloride</td>
<td>110</td>
<td>15</td>
<td>7.6</td>
</tr>
<tr>
<td>Nitrate</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>0.17</td>
</tr>
<tr>
<td>Nitrate (Chronic)</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td></td>
</tr>
<tr>
<td>TDS</td>
<td>510</td>
<td>91</td>
<td>66</td>
</tr>
<tr>
<td>Sulfate</td>
<td>12</td>
<td>20</td>
<td>9.4</td>
</tr>
<tr>
<td>TDS</td>
<td>280</td>
<td>130</td>
<td>26</td>
</tr>
</tbody>
</table>

| Metals (Total/Dissolved)        |          |          |          |
| Arsenic                         | <0.024   | 0.087    | <0.01    |
| Cadmium                         | <0.005   | 0.003    | <0.005   |
| Lead                            | 0.12     | 0.12     | 0.03     |
| Manganese                       | 9.0      | 0.47     | 0.24     |
| Sodium                          | 64/63    | 14/13    | 14/14    |
| Zinc                            | 1,770    | 0.47     | 0.24     |
| Cyanide (total)                 | <0.01    | <0.01    | <0.01    |
| pH                              | 6.34     | 7.3      | 6.34     |

a. Proposed maximum contaminant level (Federal Register, June 13, 1986).
b. Proposed maximum contaminant level goal (Federal Register, Nov. 13, 1985).
d. Health advisory level for at-risk population.
e. Underlined values indicate exceedance of standard or criteria.
f. Approximate minimum value; criteria dependent on other factors also.
g. Safe drinking water exposure level suggested by the USEPA Environmental Criteria and Assessment Office.
here as a basis of comparison only, since all residents in the project area are served by public water and there are no water supply wells in the area. MCLs are USEPA proposed maximum contaminant levels, which if approved will be enforceable standards. MCLGs are USEPA proposed maximum contaminant level goals, which if adopted will not be enforceable. Massachusetts Class I groundwater standards were established for nonsaline groundwaters designated as suitable for potable water supplies. Class II groundwaters are saline waters suitable for conversion to potable supplies. Class III groundwaters are not suitable for potable use. The following paragraphs describe the significance of the water quality sampling results.

Volatile Organics. Volatile organics are carbon containing compounds that will dissipate into the air if left uncovered. Benzene was detected in well B-3 on October 29, 1986 at a concentration that just exceeds the USEPA proposed maximum contaminant level (MCL). On February 4, 1987, however, benzene was detected in B-3 at only a "trace" concentration which could not be quantified. Toluene was detected in B-3 on the first sampling occasion at a trace concentration, but on the second sampling occasion, the concentration detected was 49 µg/l. This concentration is still far below the USEPA proposed maximum contaminant level goal (MCLG) of 2000 µg/l. Ethylbenzene was detected in B-3 at trace concentrations on both sampling dates. Xylenes were detected in well B-3 on both sampling occasions at concentrations far below the MCLG for xylenes. Benzene, toluene,
ethylbenzene and xylenes (BTEX) are generally associated with petroleum products.

Tetrahydrofuran (THF) was detected in well B-3 on both sampling dates. This compound is used in the fabrication of food packaging articles, and also as a solvent for polyvinyl chloride (Windholz, M., et al 1976). Numerical drinking water criteria have not been established for this compound. Verschueren (1983) reports that a test animal (rat) breathing air containing 3,000,000 ppb THF for 8 hours a day over 20 months will experience no clinical symptoms. Sax (1984) reports a lethal dose of 3000 mg/kg body weight for a test animal group (rat). This is equivalent to the test animal ingesting 5100 gallons of water at the concentration measured in well B-3. Concentrations detected in well B-3 were only 110 to 140 parts per billion. THF was not detected off-site. No adverse effects due to these levels of THF are thus anticipated.

Methyl isobutyl ketone (MIBK) was detected in well B-3 only on the second sampling occasion. The concentration detected was far below the safe drinking water exposure level suggested by the USEPA Environmental Criteria Assessment Office. MIBK is moderately soluble in water and is used as a solvent (Windholz, M. et al, 1976). Methyl butyl ketone (MBK) was detected in well B-3 only during the second sampling occasion. MBK is a solvent and is slightly soluble in water (Hawley, 1971). Sax (1984) reports a lethal dose of 914 mg/kg body weight for a test animal group (guinea pig). This is equivalent to the test animal
ingesting 5000 gallons of water at the concentration measured in well B-3.

Acetone was detected in well B-4 which is upgradient of the landfill, and well B-1A during the October, 1986 sampling, and wells B-3 and B-4 during the February, 1987 sampling. These results are somewhat questionable since only at the upgradient well was acetone detected during both surveys, and at well B-3 acetone was not detected during the first sampling round, but was detected in a significant concentration during the second sampling round. Acetone is a common laboratory solvent and its detection in samples is frequently a result of laboratory contamination. However, it is conceivable that the acetone measurements obtained are actually present in the well. Regardless, the acetone concentrations detected at all wells were far below the safe drinking water exposure level suggested by the USEPA Environmental Criteria and Assessment Office.

As shown in Table 6, acetone was the only volatile organic compound detected in the wells sampled in March, 1987 (B-5, B-6, and B-7). Acetone was detected in well B-5, located across Mountain Street from the landfill at a concentration far below the safe drinking water exposure level suggested by the USEPA. Again, the actual presence of acetone in well B-5 is questionable for reasons stated earlier. With the exception of acetone, no volatile organic compounds were detected at any of the wells or surface water stations except well B-3. The data suggest that offsite migration of volatile organics is not occurring.
Inorganics. Concentrations of inorganic species detected during October, 1986 and February, 1987 in wells B-1A, B-2, and B-3 are generally below or on the low side of typical values reported in landfill leachate (see Table 7). There does not seem to be a significant difference between inorganic parameter concentrations detected in well B-4, located upgradient of the landfill area, and well B-1A, although elevated levels of some constituents were measured in wells B-2 and B-3. The total dissolved solids (TDS) concentration detected in wells B-2 and B-3 on both sampling occasions exceeded the National Secondary Drinking Water Regulations standard for TDS.

Measured inorganic species concentrations in the monitoring wells were generally similar on the two sampling dates. However, there are several exceptions. The total volatile solids (TVS) concentration detected in B-2 on February 4, 1987 was much less than that detected on October 29, 1986. In well B-3, total phosphate decreased between October and February. Alternately, the COD concentration increased significantly. In well B-4, the upgradient well, alkalinity measured in February was much less than that measured in October. These variations are probably a result of high variability in the leachate quality.

Concentrations of inorganic species detected in well B-5 were generally similar to concentrations in well B-2, although ammonia and TKN were lower and sulfate was higher. The total dissolved solids concentration exceeded the National Secondary Drinking Water Regulation. Inorganic concentrations in well B-6,
TABLE 7. REPRESENTATIVE RANGES FOR VARIOUS INORGANIC CONSTITUENTS IN LEACHATE FROM SANITARY LANDFILLS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Representative range (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺</td>
<td>200-1200</td>
</tr>
<tr>
<td>Cl⁻</td>
<td>300-3000</td>
</tr>
<tr>
<td>SO₄²⁻</td>
<td>10-1000</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>500-10,000</td>
</tr>
<tr>
<td>Fe (total)</td>
<td>1-1000</td>
</tr>
<tr>
<td>Mn</td>
<td>0.01-100</td>
</tr>
<tr>
<td>Cu</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Zn</td>
<td>0.1-100</td>
</tr>
<tr>
<td>Pb</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Hg</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>0.1-10</td>
</tr>
<tr>
<td>P as PO₄³⁻</td>
<td>1-100</td>
</tr>
<tr>
<td>COD (chemical oxygen demand)</td>
<td>1000-90,000</td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td>5000-40,000</td>
</tr>
<tr>
<td>pH</td>
<td>4-8</td>
</tr>
</tbody>
</table>


Water quality samples were collected at the surface water stations in October, 1986. Inorganic species concentrations in surface water samples (S-1, S-2, and S-3) were not observed to exceed water quality standards for those parameters for which standards have been established (chloride, nitrate, TDS, sulfate). By comparing concentrations at the culverts with concentrations at the Sucker Brook inlet to the lake it is shown that concentrations of inorganics in the surface water are reduced by the time the water discharges into Lake Massapoag.
Metals. Metals concentrations were measured in wells B-1A, B-2, B-3 and B-4 and surface water stations S-1, S-2 and S-3 on October 29, 1986, and in wells B-2, B-3, and B-4 on February 4, 1986. The October 29 samples were analyzed for total metals and the February 4 samples were analyzed for dissolved metals. Results of the total metals analyses include all metals present in the sample, including any metals associated with suspended particulate matter. Total metals were analyzed in the first round of sampling to obtain an indication of the bulk metals present in the wells and streams. Massachusetts Class I and II Groundwater Standards pertain to total metals. For purposes of assessing the transport of metals in groundwater, dissolved metals are of primary concern since particulate matter is not as mobile in the groundwater. Thus, in the second round of well sampling (February 4, 1986) dissolved metals were analyzed. As expected, dissolved metals concentrations were generally lower than total metals concentrations. On March 10, 1987, wells B-5, B-6, and B-7 were sampled and analyzed for both total and dissolved metals concentration.

Concentrations of metals detected in wells B-1A, B-2 and B-3 are within ranges reported for typical landfill leachate (see Table 7). The total metals concentrations of chromium in wells B-1A and B-3, iron and manganese in B-1A, B-2, and B-3, and lead in B-3 measured in October, 1986 are in excess of Massachusetts Class I and II groundwater standards. Dissolved chromium and lead were not detected in well B-3. Concentrations of dissolved
iron and manganese in wells B-2 and B-3 were in excess of groundwater standards. Dissolved and total sodium concentrations in wells B-2 and B-3 exceeded the Federal health advisory level for at-risk populations. The concentrations of total arsenic, chromium, copper, iron, manganese and lead detected during the October sampling period in well B-4, located upgradient of the landfill, exceeded the Massachusetts Class I and II groundwater standards. Only the concentrations of dissolved iron and manganese in well B-4 exceeded Class I and II standards, although the dissolved concentrations were much less than the total concentrations.

Samples collected in March, 1987 were analyzed for both dissolved and total metals. As expected, dissolved metals concentrations were lower than total metals concentrations. Dissolved concentrations of iron, manganese, and sodium in well B-5, iron and manganese in well B-6, and manganese in well B-7 were in excess of Massachusetts Class I and II Groundwater Standards. Total metal concentrations of chromium, iron, manganese, sodium, and lead in well B-5, arsenic, chromium, iron, manganese, and lead in well B-6, and arsenic, iron, and manganese in well B-7 were in excess of Massachusetts Class I and II Groundwater Standards.

The higher iron, manganese and sodium concentrations measured at the downgradient wells indicate the presence of landfill leachate. However, the measurements indicate low concentrations of other metals. In general, where metals
concentrations exceeded Class I and II standards, it was by a small margin. In several cases background well B-4 had similar or higher concentrations, indicating that these higher levels may already occur in the groundwater upgradient of the landfill. Iron and manganese measurements were in excess of Class I and II standards in both the upgradient and downgradient wells, and iron is known to be present at elevated levels in this area naturally. The iron and manganese standards are primarily for aesthetic (taste and odor) purposes, as opposed to human health protection.

Summary of Water Quality Results. There is a groundwater contaminant plume emanating from the landfill which mainly affects well B-3, and wells B-2 and B-5 to a lesser extent. This plume appears to discharge to the wetlands and tributaries of Sucker Brook. Water quality measurements in this plume, collected in conjunction with the landfill study, indicate that elevated levels of several parameters characteristic of landfill leachate are present (i.e. sodium, iron, dissolved solids, and chemical oxygen demand). However, concentrations of potentially toxic parameters such as volatile organic compounds and heavy metals were either not detected or detected at low levels. Where elevated levels of parameters were measured in groundwater near the landfill, these same parameters were generally measured at much lower concentrations in the downgradient well further from the landfill (B-6) and at the surface water stations.
Several violations of groundwater quality standards for drinking water were measured, however many of these violations occur naturally and are not due to the landfill. Surface water violations of drinking water criteria are limited to iron and manganese. These are violations of drinking water criteria only and there are no existing or planned uses of groundwater in this area for drinking water purposes. No adverse impacts on aquatic life are expected.

Leachate Break-out Survey

In conjunction with the landfill study, a survey of local leachate break-outs at the landfill was conducted on March 17, 1987. Break-outs are characterized by iron stained soils, stained vegetative cover, and standing or trickling water. Several leachate break-outs were observed at the site, including along the northern side slope where vertically aligned patches of stained soils can be observed. In addition, the brook that runs along the north toe of the slope is stained. The northeast corner of the top of the landfill has a localized low area of stained, ponded water, and in the southwest sector of the landfill the driveway soils are highly colored. Some stained, standing water exists in this area and vegetative grasses are iron colored as well.

At the southeast corner of the landfill a 15-inch outlet pipe was observed near the bottom of the landfill side slope. This pipe enters the slope of the landfill, and its purpose could not be directly ascertained since there are no records of its
construction. Given that the landfill area was once a lowland, it is expected that this pipe was installed to allow for drainage of the wetland area beneath the landfill. On March 17, 1987, following a period of snowmelt, this pipe was found to be discharging iron stained water to a tributary to Sucker Brook. The pipe flow on this day was approximated at 0.2 cfs by measuring depth of flow and approximate discharge velocity. There was little or no flow in the tributary to which this pipe discharges, and the water in the upstream tributary was not visibly stained. During a previous survey (October 29, 1986) samples were collected at a point downstream of this discharge, at the south culvert under Mountain Street (station S-1). The sample at this station did not indicate the presence of volatile organic compounds or elevated heavy metals concentrations. Results of the sample analysis from station S-1 are presented in Table 5. Figure 4 shows this pipe discharge location and major areas of leachate break-outs.

LANDFILL IMPACTS ON LAKE MASSAPOAG

This section contains an assessment of environmental impacts of the landfill on Lake Massapoag and is divided into several sections. The first section contains a discussion of nutrient loading to Lake Massapoag from the landfill and a comparison of data collected in Sucker Brook for this study with data collected in 1981 and 1982 as part of "Diagnostic/Feasibility Study, Lake Massapoag, Sharon, Massachusetts" (IEP, 1984). The second
STAINING ALONG RIDGE AREA OF PONDED LEACHATE

STAINED SOIL - VERTICAL PATCHES

STANDING LEACHATE ON RIDGE

STAINED SOILS AND PONDED WATER

STAINED SOILS AND VEGETATION

STAINED AREA

PIPE INTERCEPTING TRIBUTARY AND LANDFILL DRAINAGE

PIPE DRAINING LANDFILL

AREA OF PONDED LEACHATE

STAINED SOILS AND PONDED WATER IN ROADWAY

FIGURE 4. LEACHATE BREAK-OUT SURVEY: MOUNTAIN STREET LANDFILL - MARCH 17, 1987
section contains an assessment of environmental impacts, including aesthetic impacts, from inorganics contained in leachate. Following is a discussion of the potential for contamination from toxic substances.

Nutrients

Annual nutrient loads to Lake Massapoag from Sucker Brook were estimated as the product of the flow and concentration measured on October 29, 1986 at the location where Sucker Brook discharges to the lake (see Table 8). These estimates are similar to the loads presented in "Diagnostic/Feasibility Study, Lake Massapoag, Sharon, Massachusetts" (IEP, 1984). Nutrient loads from the Sucker Brook area, which includes the landfill, represent less than 5 percent to 10 percent of the total annual nutrient loads to Lake Massapoag from all sources. Much of this total nutrient load from Sucker Brook would occur even without the landfill present. The landfill area represents less than six percent of the total Sucker Brook drainage area. The 1984 Diagnostic/Feasibility Study of Lake Massapoag estimates the percentage contribution from the landfill itself to the total annual nutrient load to be 1 to 2 percent.

The two culverts running under Mountain Street along the northwest and southwest corners carry much of the leachate that enters Sucker Brook. Nutrient loads from these culverts were estimated as the product of the flow (see Table 3) and concentration measured on October 29, 1986 on the downstream side of Mountain Street. Using these estimates, the annual total
TABLE 8. ANNUAL NUTRIENT LOADS TO LAKE MASSAPOAG

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Load from Sucker Brook (kg/yr)</th>
<th>Total load from all sources (kg/yr)</th>
<th>Percent of total load from Sucker Brook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Phosphate</td>
<td>&lt;28.6</td>
<td>312-617</td>
<td>&lt;5-10%</td>
</tr>
<tr>
<td>Total Nitrogen(^2)</td>
<td>&lt;942</td>
<td>11718-13220</td>
<td>7-8%</td>
</tr>
</tbody>
</table>

1. Reported in the 1984 Diagnostic/Feasibility Study.
2. Total Kjeldahl nitrogen, nitrate, and nitrite.

Phosphate and total nitrogen loads from the culverts are approximately 3 and 447 kg respectively. These represent about 10 percent and 50 percent of the total phosphorus and total nitrogen loads to Lake Massapoag from the Sucker Brook drainage basin or .5 to 1 percent of the total phosphorus and 3.5 to 4 percent of the total nitrogen load to Lake Massapoag from all sources. The presence of other nutrient sources in the watershed that enter Sucker Brook both downstream and upstream of the landfill is thus demonstrated.

There are a number of natural and man-made sources of nutrients in the watershed. Weathering of bedrock and sediments releases phosphorus. Other phosphorus sources include human and animal wastes, detergents, fertilizers, decaying plants and animals, and atmospheric deposition. Nitrogen may be fixed by bacteria in the soil and converted to nitrate. Decaying plant and animal matter, fertilizers and septic leachate are also sources of nitrogen in the drainage basin.

Table 9 provides a summary of flow and chemical data collected in Sucker Brook near the mouth between March, 1981 and
March, 1982 by IEP, and by Metcalf & Eddy in October, 1986. The flow data indicates highest flows during the spring corresponding with snowmelt and high precipitation, lowest flows during the summer and early fall, and moderate flows during the winter months. The chemical data does not appear to follow clear trends, although several parameters had maximum concentrations in January, 1982. Concentrations observed during late summer and early fall tended to be lower than those observed during other months. Parameter concentrations were similar between data collected by Metcalf & Eddy and IEP.

Inorganics

A tributary of Sucker Brook which originally flowed through the landfill area was partially rerouted through a 24-inch aluminum drain pipe. The pipe runs along the side of the landfill adjacent to Whipporwill Road in a westerly direction and discharges to the culvert that runs under Mountain Street at the southwest corner of the landfill (see Figure 4). The receiving end of the pipe is adjacent to the discharging end of a 15-inch aluminum pipe draining the landfill. Discharge from the landfill drainage pipe is stained, most likely due to iron staining from background iron levels and landfill leachate. The discharge flows directly into the 24-inch pipe along with the flow from the Sucker Brook tributary. The tributary flow upstream of the 15-inch pipe was not stained during the March 17, 1987 survey. The majority of the flow into the 24-inch pipe is from the
# TABLE 9

## SUMMARY OF SUCKER BROOK INLET DATA

<table>
<thead>
<tr>
<th>Date</th>
<th>Flow (cfs)</th>
<th>Alkalinity (mg/l as CaCO₃)</th>
<th>NH₃ (mg/l)</th>
<th>Nitrite (mg/l)</th>
<th>Total Solids (mg/l)</th>
<th>TKN (mg/l)</th>
<th>Nitrate (mg/l)</th>
<th>TP (mg/l)</th>
<th>Cl (mg/l)</th>
<th>Fe (mg/l)</th>
<th>Mn (mg/l)</th>
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<tr>
<td>1981/82 Data(1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/03/81</td>
<td>8.82</td>
<td>7</td>
<td>.33</td>
<td>48</td>
<td>.50</td>
<td>.70</td>
<td>.06</td>
<td>13</td>
<td>.50</td>
<td>.1</td>
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<tr>
<td>04/16/81</td>
<td>3.24</td>
<td>21</td>
<td>.45</td>
<td>52</td>
<td>.97</td>
<td>.30</td>
<td>.03</td>
<td>16</td>
<td>.65</td>
<td>.06</td>
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<tr>
<td>04/30/81</td>
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<td>.39</td>
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<td>16</td>
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<td>06/11/81</td>
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<td>.22</td>
<td>114</td>
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<td>.04</td>
<td>108</td>
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<td>.78</td>
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<td></td>
<td>.41</td>
<td>.01</td>
<td></td>
<td>24.6</td>
<td>.12</td>
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<td>11/20/81</td>
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<td>20.1</td>
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<tr>
<td>01/27/82</td>
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<td>.92</td>
<td>&lt;0.01</td>
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<td>1.60</td>
<td>.47</td>
<td>.12</td>
<td>22</td>
<td>1.50</td>
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<tr>
<td>03/25/82</td>
<td>1.87</td>
<td>18.7</td>
<td>.55</td>
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<td>.77</td>
<td>.46</td>
<td>.01</td>
<td>16</td>
<td>1.54</td>
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<tr>
<td>Average</td>
<td>2.66</td>
<td>19.3</td>
<td>.38</td>
<td>0.01</td>
<td>71</td>
<td>.76</td>
<td>.36</td>
<td>.04</td>
<td>16.4</td>
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<tr>
<td>10/29/86</td>
<td>1.6</td>
<td>34</td>
<td>.19</td>
<td>&lt;0.01</td>
<td>130</td>
<td>.42</td>
<td>.23</td>
<td>&lt;0.02</td>
<td>18</td>
<td>1.3</td>
<td>.29</td>
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<tr>
<td>03/17/87</td>
<td>4.9</td>
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</tr>
</tbody>
</table>

1. Collected by IRP.
2. Collected by Metcalf & Eddy.
15-inch landfill drainage pipe. Thus, the 15-inch drainage pipe is likely a primary source of leachate in Sucker Brook.

Iron and manganese concentrations detected in samples from all seven monitoring wells, including B-4 and B-7, and all surface water samples exceeded Massachusetts Class I groundwater standards. However, iron concentrations are reduced by the time the surface water reaches Lake Massapoag. This is seen by comparing monitoring well concentrations to the concentration in Sucker Brook near its inlet to the lake. In-lake iron concentrations are typically less than 0.1 mg/l (IEP, 1984). The study area is naturally high in iron, as evidenced by the detection of iron in wells B-4 and B-7, located upgradient of the landfill, at concentrations well in excess of Massachusetts Class I and II groundwater standards. Local residents report that the area has historically had very high naturally occurring iron levels.

Groundwater standards for iron and manganese are based on the aesthetic considerations of taste and odor. When exposed to air (oxygen) these waters can become turbid and aesthetically unacceptable because oxidized iron and manganese form colloidal precipitates (Sawyer and McCarty, 1978). Fe²⁺ and Fe³⁺ are the primary forms of concern in the aquatic environment. Ferrous (Fe²⁺) exists mainly in water devoid of dissolved oxygen. Practically speaking, the ferric form (Fe³⁺) is insoluble. Black or brown swamp waters may contain iron concentrations of several mg/l in the presence or absence of oxygen, but this iron has
little effect on aquatic life (USEPA, 1986). Based on these considerations, it appears that the landfill leachate does not cause a substantial increase in iron loading to Lake Massapoag, and that the iron itself results in no adverse impacts on the water body. However, leachate from the landfill does present an aesthetic problem in terms of surface water staining in the swamp just across Mountain Street due to high iron concentrations and odors attributed to chemical oxygen demand and low dissolved oxygen.

Toxics

Several volatile organics (benzene, toluene, xylene, tetrahydrofuran, MIBK and MBK) were detected at low levels in well B-3, but were not detected in the other monitoring wells or surface water samples. Benzene, toluene and xylene are generally associated with petroleum products. THF is an oxygenated solvent used in the plastics industry and food packaging industry to glue plastics together. MIBK and MBK are solvents which may be present in paint wastes. The presence of these compounds in well B-3 could be a result of disposal of household refuse containing food packaging materials, oils, or paint wastes at the landfill. Refuse was encountered during the installation of well B-3, indicating that this well is within the actual fill area. The data indicate that only low levels of these compounds are present, and that they are not present at detectable levels off-site. Thus, the data indicate that these compounds are not causing any adverse impacts on Lake Massapoag.
Based on these data, no significant adverse impacts on Lake Massapoag due to toxics, nutrients, iron, and other parameters were found.

FINAL LANDFILL CLOSURE AND FUTURE USES

Closure Recommendations

The current State DEQE Regulations for the Disposal of Solid Wastes by Sanitary Landfill were promulgated in April, 1971. Revised regulations have been drafted (February, 1983), but have not yet been adopted. In general, the revised regulations have more stringent requirements with respect to site assignments, supervision and inspection of operation, runoff/runon control, and permeability of cover material. The draft regulations also require provisions for control of gas and leachate production, and groundwater monitoring. Although the 1971 regulations are still in effect, the DEQE is often requiring that the stricter, draft regulations be adhered to in operational and final closure plans.

The operating plan for the Mountain Street Landfill (SEA, 1974) includes a plan for the final configuration and final cover of the landfill. This operating plan was approved by the DEQE in June, 1974. The proposed maximum final elevation of the landfill is 312 feet. The proposed top surface slope and side slope are approximately 2 and 2.5 percent, respectively. Although the DEQE will approve plans with slopes of 2 percent, slopes of 3 percent are highly preferred as they provide for much more efficient
drainage of surface water. It is, therefore, recommended that the existing closure plan be revised to provide drainage slopes of 3 percent, if a configuration of this shape is possible given site constraints. The proposed final configuration from the 1974 operating plan is shown in Figure 5.

Final landfill closure requires placement of a relatively impervious material over the last daily cover to prevent infiltration, followed by a layer of soil that will support vegetation. The DEQE requires that the impervious layer have a permeability of no greater than $1 \times 10^{-7}$ cm/sec, and that this layer be 1 foot thick. If material with the desired permeability is not available in the area, then the DEQE will consider plans for material with higher permeability if compensated for with increased depth of the impervious layer and/or increased slope. It must be demonstrated that the planned cover will perform as well as a cover of material with $1 \times 10^{-7}$ cm/sec permeability.

Clay or clay mix is the best option if available in the area. Soil bentonite is also an effective alternative. A synthetic membrane material may be considered, however, there are some associated risks. For example, without proper inspection during installation, the operation of heavy equipment on top of the membrane to spread soil for vegetation could cause the membrane to tear, thus providing a pathway for infiltration into the landfill. Also, as the landfilled materials continue to settle and decompose, severe differential settlement may cause overstressing and possible tearing of the membrane. Coal fly
FIGURE 5. PROPOSED FINAL LANDFILL CONFIGURATION FROM 1974 OPERATING PLAN

SOURCE: SEA (1974)
ash has been used as cover material at several landfills. However, its use is in the experimental stage and ash has not been proven as a viable option. The great advantage of coal fly ash is that it is often free of charge and can be supplied by incinerator operators, although transport costs must generally be paid. However, an example of one of the problems that can be encountered with fly ash occurred at Danvers, Mass., where coal fly ash used for capping experienced instability in the cap and subsequent slippage of the material from its original placement. The DEQE generally prefers that ash materials not be used for capping but will consider it if the landfill has a liner and an ongoing groundwater monitoring program. The Sharon landfill does not have a liner, but has wells in place for a groundwater monitoring program.

Production of methane gas accompanies decomposition of rubbish. Placement of an impervious cap over the fill area prevents release of the gas and can lead to underground migration. It is possible that gas can migrate into the basements of nearby residences and buildings, thus, posing threat of explosion. There are residences in close proximity to the Mountain Street Landfill. Therefore, in conjunction with placement of the final cover, a gas venting system would be required to prevent buildup and migration of methane gas. The gas venting system would most likely consist of a gravel trench installed around the perimeter of the landfill, with vent pipes spaced along the trench and on top of the landfill.
Existing contours at the landfill do not allow for proper drainage of surface runoff. Procurement and grading of clean fill or regrading of the existing refuse will be required prior to placement of the final cap. A final landfill configuration similar to the proposed final closure configuration, but with steeper top slope and at a lower peak elevation, would need to be achieved.

Local control of leachate breakout and improper drainage should be corrected as soon as possible, regardless of the schedule for final capping. The primary need for leachate control at the Sharon landfill is in regard to localized side slope and surface breakouts of leachate. Systems for controlling these types of breakouts can be either collection systems or diversion systems. A local collection system would consist of packing the area of leachate breakout with an impervious material and installing a collector trench at the base of the slope, with leachate routed to a holding tank. This system requires periodic emptying of the holding tank, analysis of the leachate, possible pretreatment and disposal at an appropriate treatment facility.

Another possible solution is to reduce the amount of infiltration which is causing the generation of leachate in the localized area. Depending on the location and source of the leachate breakout, this may be handled by either diverting localized surface runoff patterns or by sealing localized areas of infiltration and/or leachate breakout. These techniques would
involve construction of localized diversion berms and/or sealing areas with a low permeability soil.

As discussed previously, a survey to identify areas of leachate breakout was conducted on March 17, 1987, shortly after a period of significant snow melt. The most significant areas of leachate breakout were observed at (1) the ponded depression area on the top northeast section of the landfill, and (2) the 15-inch pipe at the base of the southeast side of the landfill. Other areas of leachate seams were observed, but were less severe. Figure 5, presented earlier, shows the areas of identified leachate breakouts. To correct the ponded depression area it is suggested that clean fill should be brought in to fill this area. This would eliminate the depression and the potential for leachate ponding. During the March 17 survey the 15-inch pipe was estimated to be flowing at a rate of approximately 0.2 cfs, or 130,000 gallons per day. At this flow rate it would not be realistic to collect this flow and transport it off-site for disposal. As discussed previously, sampling downstream of this discharge indicated the presence of landfill leachate, but no volatile organic compounds or elevated heavy metals. There are several options for addressing this 15-inch piped discharge. One is to leave the pipe as is, and do nothing. Leachate would continue to cause aesthetic problems in Sucker Brook but significant contamination at Lake Massapoag is not expected. Another option would be to remove the pipe from the landfill slope to eliminate the point source discharge. However, due to
the high flow rate observed it is possible that drainage problems could occur if it was removed. A third option would be to install a holding tank to collect the leachate and periodically pump the tank out for off-site disposal. One potential location for this leachate disposal is the Charles River Pollution Control Facility in Medway, which currently accepts septage from the town. The holding tank would need to be designed to be overtopped during periods of high flow rate, such as that observed on March 17, 1987. To assure that a holding tank installation is feasible, it is necessary to monitor the flow rate at this pipe over several months. This should be done prior to selecting an alternative to address this discharge.

For areas of local side seam breakouts, it is suggested that these areas and the areas above the breakout be covered with an impermeable cover, such as clay, to reduce infiltration and leachate surface discharge.

The estimated cost for final closure of the landfill is $2,845,000 plus annual costs for post closure monitoring. Recent bid prices for closure of the Braintree landfill, which is 28 acres in size, ranged from $2,235,000 to $2,530,000. The final closure cost includes:

- Drainage improvements, including grading and filling
- Final landfill capping and seeding
- Gas venting
- Post closure monitoring
The estimated cost of each of these items is discussed below.

Drainage Improvements - Excavation and grading of the existing landfill refuse would be required to prepare the landfill before putting the final cap on. An estimated 12,000 c.y. of excavation and grading of the existing landfill material would be required. This volume estimate is based on providing a final landfill configuration similar to the planned final closure configuration, only at a lower elevation. It is possible that the final closure configuration could be modified to reduce the volume of grading required, but this estimate provides an upper limit to the volume of grading that may be necessary. The estimated cost for this type of excavation and grading is between $6.75 and $11.80 per cubic yard (U.S. EPA, 1978), for an estimated total cost of approximately $195,000.

Final Landfill Capping - For purposes of this estimate, it is assumed that 4 inches of soil bentonite would be used for the impermeable layer with 12 inches of cover soil over the soil bentonite. Based on a total covered landfill area of 23 acres, 111,000 sq. yd. of soil bentonite cover and 37,000 c.y. of cover soil will be required. Unit costs of $5.00 per sq. yd. for soil bentonite and $8.00 per c.y. for cover soil have been used to estimate cost. Loam and seeding for the final cover is estimated at $3.00 per sq. yd. Approximately 5,000 c.y. of screened gravel would be required for mix with the bentonite cover, at an estimated cost of $20 per c.y.
In conjunction with placement of the final cover, a gas venting system would be required to prevent buildup of methane gas. The cost for a system consisting of a perimeter gravel trench with perimeter vent pipes and top vent pipes would be approximately $420,000.

Post Closure Monitoring - Following final closure, a program for monitoring groundwater and surface water should be conducted. For purposes of this cost estimate annual monitoring is assumed, with analyses for the parameters listed previously in Table 4. The estimated annual cost of collecting and analyzing these samples is $7,000.

A summary of estimated closure costs for Alternative 1 is presented in Table 10. It should be noted that this table includes a significant mark-up to account for engineering, contingency for unknowns, and a provision for contractor overhead and profit. It should also be escalated as necessary until the time that the closure occurs.

Several funding sources exist that may be available to help defray the sizeable expense of closure. House Bill No. 5230, which was passed in the House in March and is expected to pass in the Senate (Mr. John McNab, personal communication, April 29, 1987), contains $50,000,000 for solid waste facility closure and construction. Under this program, the DEQE may make no interest loans to public bodies for the costs of closure of a landfill provided the closure project is related to the applicant's
TABLE 10. LANDFILL CLOSURE COST ESTIMATE SUMMARY

<table>
<thead>
<tr>
<th>Item</th>
<th>Capital Cost($)</th>
<th>Annual Cost($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grading existing refuse</td>
<td>195,000</td>
<td></td>
</tr>
<tr>
<td>Final capping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cover placement</td>
<td>1,280,000</td>
<td></td>
</tr>
<tr>
<td>gas venting</td>
<td>420,000</td>
<td></td>
</tr>
<tr>
<td>Post closure monitoring</td>
<td>---</td>
<td>7,000</td>
</tr>
<tr>
<td>Subtotal</td>
<td>1,895,000</td>
<td></td>
</tr>
<tr>
<td>25% Engineering and contingency</td>
<td>475,000</td>
<td></td>
</tr>
<tr>
<td>20% Contractor Overhead and profit</td>
<td>475,000</td>
<td></td>
</tr>
<tr>
<td>Total Closure Costs</td>
<td>2,845,000</td>
<td>7,000</td>
</tr>
</tbody>
</table>

subsequent disposal of solid waste in a regional disposal facility (H5230, Section 4, Chapter 21H, Section 3(b)1).

The DEQE Division of Solid Wastes is working on draft regulations for a competitive grant program that has $10,000,000 for landfill capping. Eligibility requirements include public ownership of the landfill. The maximum grant amount to a municipality has not been determined, but will be between $500,000 and $1,000,000. The State/municipality contributions will be an 80 percent/20 percent split. The DEQE wants to gain new information on landfill closure through the implementation of this grant program. Therefore, the proposed landfill closure plan must include some "demonstration" or model component that represents a new method for some aspect of closure or post closure of the landfill. Draft regulations for the administration of this grant program are under review are expected to be out on June 30, 1987. The DEQE plans to be
accepting grant applications by the end of 1987 (Mr. Todd Collin, personal communication, April 29, 1987).

The DEQE also sponsors a Technical Assistance Program (TAP) that provides funds for feasibility studies to be conducted at landfills. Items that may be addressed in feasibility studies include but are not limited to landfill capacity and potential for resource/recovery. TAP is currently out of money, but is expecting new funds during the summer, 1987 (Mr. Joseph Selle, personal communication, April 30, 1987).

**Monitoring Program**

Following final closure, a program for monitoring groundwater and surface water should be conducted. Current DEQE regulations do not require a specific frequency or duration of monitoring. It is recommended that monitoring be conducted at the three wells on the downgradient face of the landfill (B-1A, B-2 and B-3), at well B-7, upgradient of the landfill, adjacent to the water tower, at the two culverts under Mountain Street, and at the Sucker Brook inlet to Lake Massapoag. The purpose of this monitoring program is to assess the effect of the landfill closure on surface water and groundwater. Annual monitoring conducted during the spring when leachate production is most likely highest is recommended. The estimated cost per monitoring event of collecting and analyzing samples for the parameters listed in Table 4 is $7,000.
Future Uses

After completion of final closure of the landfill, the town must decide how to use the area. An extensive nationwide survey on use of landfills conducted by the County of Los Angeles and Engineering - Science, Inc. (1973) indicated that the major uses are recreation and parks (35%), industrial development (10%), commercial development (10%), housing (8%), storage yards (7%) and parking lots (6%).

The town has indicated that it wants to avoid uses that would attract non-residents to the area. Any uses that could potentially disturb the cap should be avoided. Any vegetative species that has long roots and could potentially disturb the impermeable layer should not be planted. The Department of Public Works would like a portion of the area to be reserved for stump disposal, and this could most likely be easily accommodated. Provided that the post closure use selected does not generate pollutant laden runoff or disturb the impervious cover, no negative impacts on Lake Massapoag should occur.

Recommendations

Although no significant impact from the landfill on Lake Massapoag was found, it is recommended that final closure of the landfill be conducted as soon as possible to reduce production and subsequent migration of leachate to Sucker Brook, its associated wetlands, and Lake Massapoag. Leachate will continue to be produced after the landfill is capped because of moisture
that has already infiltrated the fill, but production will slow and eventually stop with the cap in place.

Existing drainage problems and areas of local leachate break-outs should be corrected as soon as possible, regardless of when final closure will be conducted. A cost of $20,000 is estimated for filling of the depression on the top northeast section of the landfill. Depending on the alternative selected for the 15-inch pipe discharge at the southeast slope, the cost for this correction will be from zero for no action to an estimate of $6,000 in capital cost for the holding tank option with a 5,000 gallon tank, plus pumping and disposal costs. Until a more accurate estimate of the 15-inch pipe flow rate is made an allowance of $5,000 per year is estimated for tank pumping and disposal. To seal areas of infiltration and leachate breakout at side seams a cost of $4,000 has been estimated. This cost is based on covering a total of 700 sq. yd. of area with a low permeability material, and providing localized grading at another 200 sq. yd. of area. The areas where side seam breakouts were observed were presented previously. It is anticipated that town DPW staff could apply this material.

The wells installed at the landfill, and the surface water stations should continue to be monitored for any changes in parameter concentrations.

Recommended plan costs are summarized in Table 11.
## TABLE 11. RECOMMENDED PLAN COST SUMMARY

<table>
<thead>
<tr>
<th>Item</th>
<th>Capital Cost($)</th>
<th>Annual Cost($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill Closure</td>
<td>2,845,000</td>
<td>----</td>
</tr>
<tr>
<td>Drainage Improvements/</td>
<td>30,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Leachate Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring</td>
<td>----</td>
<td>7,000</td>
</tr>
</tbody>
</table>
REFERENCES


SEA Consultants, "Disposal of Refuse, Town of Sharon", prepared for the Town of Sharon, Massachusetts, June, 1974.


APPENDIX A

WELL INSTALLATION BORING LOGS
**GROUNDWATER OBSERVATIONS**

<table>
<thead>
<tr>
<th>Type (spin)</th>
<th>HW</th>
<th>SS</th>
<th>NX</th>
<th>Size I.D.</th>
<th>1-3/8&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hammer Wt.</td>
<td>300 lbs.</td>
<td>140 lbs.</td>
<td>BIT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hammer Fall</td>
<td>24&quot;</td>
<td>30&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LOCATION OF BORING:**

<table>
<thead>
<tr>
<th>Sample Depth From - To</th>
<th>Type of Sample</th>
<th>Blows per 6&quot; on Sampler</th>
<th>Blows per 6&quot; on Sampler</th>
</tr>
</thead>
<tbody>
<tr>
<td>0'-6'</td>
<td>SS</td>
<td>120</td>
<td>0&quot;</td>
</tr>
<tr>
<td>0'-5.0'</td>
<td>SS</td>
<td>85</td>
<td>0&quot;</td>
</tr>
<tr>
<td>0'-10.0'</td>
<td>SS</td>
<td>50/0&quot;</td>
<td>50/0&quot;</td>
</tr>
<tr>
<td>0'-15.0'</td>
<td>SS</td>
<td>50/0&quot;</td>
<td>50/0&quot;</td>
</tr>
</tbody>
</table>

**Blow Counts for Clay**

<table>
<thead>
<tr>
<th>&lt; 2 Very Soft</th>
<th>9-15 Stiff</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-4 Soft</td>
<td>16-30 Very Stiff</td>
</tr>
<tr>
<td>5-8 Medium</td>
<td>&gt; 30 Hard</td>
</tr>
</tbody>
</table>

**Blow Counts for Granular Material**

<table>
<thead>
<tr>
<th>&lt; 4 Very Loose</th>
<th>31-50 Dense</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-10 Loose</td>
<td>&gt; 50 Very Dense</td>
</tr>
<tr>
<td>11-30 Medium</td>
<td></td>
</tr>
</tbody>
</table>

Proportion used:
- trace = 0 - 10%
- little = 10 - 20%
- some = 20 - 35%
- and = 35 - 50%

**Field Identification of Soil**

- Moist, light brown, coarse/fine silty sand, gravels and cobbles, (Casing to 7', Roller Bit to 8.5')
- Casing to 8.5', Roller Bit to 10'
- Casing to 10' 9-19-86)
- Gravel, Cobbles, Boulder in brown Silty, coarse/fine sand

- End of Boring at 15.0'
- 10' Screen, 6' PVC Riser, Sand to 4', Bentonite seal 4'-3', Locking Protector Pipe, 1-1/2 bags cement grout
- Well development - 1 hr.
- Decon - Equipment - 1 hr.
### GROUNDWATER OBSERVATIONS

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Blow Count</th>
<th>Type</th>
<th>Hammer Wt.</th>
<th>Hammer Falls</th>
<th>Core Bar.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 2.0'</td>
<td>7</td>
<td>SS</td>
<td>300 lbs.</td>
<td>24''</td>
<td>30''</td>
</tr>
<tr>
<td>5.0 - 7.0'</td>
<td>12</td>
<td>SS</td>
<td>140 lbs.</td>
<td>30''</td>
<td>30''</td>
</tr>
<tr>
<td>10.0 - 12.0'</td>
<td>100</td>
<td>SS</td>
<td>140 lbs.</td>
<td>30''</td>
<td>30''</td>
</tr>
<tr>
<td>15.0 - 17.0'</td>
<td>31</td>
<td>SS</td>
<td>140 lbs.</td>
<td>30''</td>
<td>30''</td>
</tr>
<tr>
<td>20.0 - 22.0'</td>
<td>19</td>
<td>SS</td>
<td>140 lbs.</td>
<td>30''</td>
<td>30''</td>
</tr>
<tr>
<td>25.0 - 25'6''</td>
<td>100</td>
<td>SS</td>
<td>140 lbs.</td>
<td>30''</td>
<td>30''</td>
</tr>
</tbody>
</table>

### LOCATION OF BORING:

- **Casing Depths:**
  - 0.0 - 2.0': SS 7 blows per 6'' on sampler
  - 5.0 - 7.0': SS 12 blows per 6'' on sampler
  - 10.0 - 12.0': SS 100 blows per 6'' on sampler
  - 15.0 - 17.0': SS 31 blows per 6'' on sampler
  - 20.0 - 22.0': SS 19 blows per 6'' on sampler
  - 25.0 - 25'6'': SS 100 blows per 6'' on sampler

- **Strata and Observations:**
  - 1.0': Brown and black, fill material, roots, silty sand and gravel, trash
  - 11.0': Grey-brown, coarse/fine sand, gravel, trace silt, occasional cobbles/boulder (moist)
  - 23'6": Greyish Silty sand, wash, cobble, boulder
  - 25'6": End of Boring at 25'6"

### BLOW COUNTS FOR CLAY

- Very Soft: 9-15
- Stiff: 16-30
- Very Stiff: 31-50

### BLOW COUNTS FOR GRANULAR MATERIAL

- Very Loose: 1-10
- Loose: 11-30
- Medium: 31-50

Proportion used: trace = 0 - 10% little = 10 - 20% some = 20 - 35% and = 35 - 50%
<table>
<thead>
<tr>
<th>Casing Blows per foot</th>
<th>Sample Depths From - To</th>
<th>Type of Sample</th>
<th>Blow per 6th on Sampler from 0-6, 6-12, 12-18, 18-24</th>
<th>Stress Change Depth</th>
<th>Field Identification of Soil Remarks (incl. color, loss of wash water, seams in rock, etc.)</th>
<th>SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>0.0 - 2.0'</td>
<td>SS</td>
<td>5                                  10                                      26                              27</td>
<td>Brown, Black, roots, FILL, silt trash 0&quot;-6&quot;  Tan, Brown, silty gravelly sand, occasional cobbles</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>89</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>37</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>5.0 - 7.0'</td>
<td>SS</td>
<td>10                                  33                                      37                              89</td>
<td>Grey, (moist), silty gravelly sand coarse/fine sand layers, occasional boulder</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>99</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>10.0 - 12.0'</td>
<td>SS</td>
<td>14                                  17                                      21                              29</td>
<td>Tan-brown, coarse/fine sand and gravel, little silt, cobbles, boulders</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>200/7&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.0 - 15.4&quot;</td>
<td>SS</td>
<td>120</td>
<td>4&quot;</td>
<td></td>
<td>Grey, silty coarse/fine sand and gravel, occasional cobble and boulder End of Boring at 15'4&quot;</td>
<td></td>
</tr>
</tbody>
</table>

- **BLOW COUNTS FOR CLAY**
  - < 2 Very Soft
  - 2-4 Soft
  - 5-8 Medium
  - > 30 Hard

- **BLOW COUNTS FOR GRANULAR MATERIAL**
  - < 4 Very Loose
  - 5-10 Loose
  - > 50 Very Dense

- **Proportion used:**
  - trace = 0 - 10%
  - little = 10 - 20%
  - some = 20 - 35%
  - and = 35 - 50%
**GROUNDWATER OBSERVATIONS**

<table>
<thead>
<tr>
<th>At 13'4&quot; ft. after 12 Hours in casing</th>
<th>Type</th>
<th>CASING</th>
<th>SAMPLER</th>
<th>CORE BAR.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hammer Wt. 300 lbs.</td>
<td>HW/NW</td>
<td>4&quot;</td>
<td>SS</td>
<td>1-3/8&quot;</td>
</tr>
<tr>
<td>Hammer Fall 24&quot;</td>
<td>HW/NW</td>
<td>3&quot;</td>
<td>NX</td>
<td>30&quot;</td>
</tr>
</tbody>
</table>

**LOCATION OF BORING:**

<table>
<thead>
<tr>
<th>Casing Blows per foot</th>
<th>Sample Depths From - To</th>
<th>Type of Sample</th>
<th>Blows per 6&quot; on Sampler</th>
<th>Strata Change Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.0 - 2.0' SS</td>
<td>2</td>
<td>1 2 3</td>
<td>Elevation 0-3&quot;</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>5.0 SS</td>
<td>30</td>
<td>0&quot;</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>11.5 - 12.5' NX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>104</td>
<td>15.0 - 16.4' SS</td>
<td>18 70 100</td>
<td>4&quot;</td>
<td></td>
</tr>
<tr>
<td>20.0 - 20.4&quot; SS</td>
<td>43 72 100</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Field Identification of Soil:**

- Black roots, leaf litter
- Organic, tan, medium/fine sandy silt
- Tan, coarse/fine sand and gravel, little/some silt, cobble/boulders
- SS Refusal steady grinding with R. Bit, to refusal at 11.3', HW casing to 11.5', NW casing from 11.5'
- Boulder (12")
- Tan, coarse/fine sand and gravel, some silt, occasional cobble, boulder
- Some silt layers and silty coarse/fine sand layers (moist) occasional gravel, cobble, boulder
- Casing spun to 21'R. Bit to 22', Casing to 22' (9-22-86), no further advance casing not advancing beyond 22' Roller Bit ahead of casing to 25'6" (Still on boulder about 1'6" into Boulder)
- End of Boring at 25'6"
- Well development 1 hour

**BLOW COUNTS FOR CLAY**

- < 2 Very Soft
- 2-4 Soft
- 5-8 Medium

**BLOW COUNTS FOR GRANULAR MATERIAL**

- < 4 Very Loose
- 5-10 Loose
- > 30 Hard

Proportion used: trace = 0 - 10% little = 10 - 20% some = 20 - 35% and = 35 - 50%
# Sharon Landfill Boring Report

## Client
Metcalf & Eddy

## Project Name
Sharon Landfill

## Location
Sharon, MA

## Boring Number
B-5

## Driller
T. Carpenter

## Inspector
R. Bolich

## Date Start
2/23/87

## Date Finish
2/23/87

## Depth

<table>
<thead>
<tr>
<th>SAMPLE PENETRATION RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>140 lb. Wt. falling 30&quot; on 2&quot; O.D. Sampler</td>
</tr>
<tr>
<td>Coefficient of Consistency</td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>0-2</td>
</tr>
<tr>
<td>3-8</td>
</tr>
<tr>
<td>5-10</td>
</tr>
<tr>
<td>10-29</td>
</tr>
<tr>
<td>30-49</td>
</tr>
<tr>
<td>50+</td>
</tr>
</tbody>
</table>

## Strata Change

<table>
<thead>
<tr>
<th>Depth Range</th>
<th>Blows per 6&quot; on Sampler</th>
<th>Rec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0-7.0</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>10.0-12.0</td>
<td>23</td>
<td>49</td>
</tr>
<tr>
<td>12.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Remarks

- **Peat**
- **Br. Fine-Crs. Sand, and Gravel, Little Silt, Occasional Cobbles**
- **Gray Fine-Crs. Sand and Gravel, Little Silt, Occasional Cobbles**

Bottom of Boring 12.0'

Water @ 6.0'

Monitor Well Set @ 10.0

Materials:
- 5'x2" PVC Well Screen
- 7.5'x2" PVC Riser
- 1/2 Bag Ottawa Sand
- 25 Lbs. Bentonite Pellets
- 1 Locking Protector Pipe

**Screened Interval:** 7'-12'

---

**NOTES:**

1. The classification units represent the approximate boundaries between soil types. Transitions may be gradual.

2. Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to other factors than those present at the time measurements were made.
<table>
<thead>
<tr>
<th>DEPTH</th>
<th>NO.</th>
<th>DEPTH RANGE</th>
<th>BLOWS PER 6&quot; ON SAMPLER</th>
<th>REC</th>
<th>COL A</th>
<th>STRATA CHANGE</th>
<th>FIELD CLASSIFICATION AND REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0-6</td>
<td>6-12</td>
<td>12-18</td>
<td></td>
</tr>
<tr>
<td>5'</td>
<td>S1</td>
<td>5.0-7.0</td>
<td>8</td>
<td>3</td>
<td>11</td>
<td>16</td>
<td>14&quot;</td>
</tr>
<tr>
<td>10'</td>
<td>S2</td>
<td>10.0-12.0</td>
<td>44</td>
<td>39</td>
<td>45</td>
<td>41</td>
<td>12&quot;</td>
</tr>
<tr>
<td>15'</td>
<td>S3</td>
<td>15.0-17.0</td>
<td>10</td>
<td>6</td>
<td>9</td>
<td>9</td>
<td>18&quot;</td>
</tr>
<tr>
<td>20'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FIELD CLASSIFICATION AND REMARKS**

- **2.0**
  - Organic Silt

- **17.0**
  - Br. Fine Sand, Little Silt, Little Fine Gravel, Occasional Cobbles

- **Bottom of Boring 17.0′**
  - Water @ 2.0′

- Monitor Well Set @ 14.0
  - Materials: 5'x2" PVC Well Screen
  - 10'x2" PVC Riser
  - 1/2 Bag Ottawa Sand
  - 25 Lbs. Bentonite Pellets
  - 1 Locking Protector Pipe

- **SCREENED INTO: 12'-17'**

**SAMPLE PENETRATION RESISTANCE**

<table>
<thead>
<tr>
<th>140 lb Wt. falling 30&quot; on 2&quot; D.D. Sampler</th>
<th>PROPORTIONS</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohesionless Density</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-4 Very Loose</td>
<td>trace 0 to 10%</td>
<td></td>
</tr>
<tr>
<td>5-9 Very Loose</td>
<td>little 10 to 20%</td>
<td></td>
</tr>
<tr>
<td>10-29 Very Loose</td>
<td>some 20 to 35%</td>
<td></td>
</tr>
<tr>
<td>30-49 Very Dense</td>
<td>and 35 to 50%</td>
<td></td>
</tr>
<tr>
<td>50+ Very Dense</td>
<td>COL. A</td>
<td></td>
</tr>
<tr>
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<td>16-20 V/Stiff</td>
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<tr>
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*Note: The stippled lines represent the approximate boundary between soil types. Intercourse may be gradual.*

*Note: Water level readings have been made in the drill holes at times and under conditions stated in the boring logs. Fluctuations in the level of groundwater may be due to other factors than those present at the time measurements were made.*
### Field Classification and Remarks

- **Top Soil**
- **Br. Fine Sand, Tr. Silt**
- **Gray Br. Fine-Crs. Sand and Gravel, Little Silt, Occasional Cobbles and Boulders**
- **Run #1 - 14.0-19.0**
  - Cored 5.0 of Granite
  - Rec. 60"
- **Run #2 - 19.0-23.0**
  - Cored 4.0 of Granite
  - Rec. 48"
- **Bottom of Boring 23.0'**
- **Water @ 15.0'**

**Monitor Well Set @ 23.0**

**Materials:**
- 10'x2" PVC Well Screen
- 16'x2" PVC Riser
- 1 Bag Ottawa Sand
- 25 Lbs. Bentonite Pellets
- 1 Locking Protector Pipe

**Screened Interval:** 13'-23'

---

### Sample Penetration Resistance

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<td>50+</td>
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**PROPORTIONS**

- trace 0 to 10%
- little 10 to 20%
- some 20 to 35%
- and 35 to 50%

**REMARKS**

- COL. A
APPENDIX B

LABORATORY REPORTS
RESULTS OF SAMPLING:

OCTOBER 29, 1986
**VOLATILE ORGANICS**

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**BDL** = BELOW DETECTION LIMIT

**METHOD REFERENCE:** EPA 600/4-82-057 Method 624

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BDL = BELOW DETECTION LIMIT  
METHOD REFERENCE: EPA 600/4-82-057 METHOD 624  

Resource Analysts, Incorporated
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"Trace" denotes probable presence below listed detection limit.

BDL = BELOW DETECTION LIMIT

METHOD REFERENCE: EPA 600/4-82-057 METHOD 624

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BDL = BELOW DETECTION LIMIT

METHOD REFERENCE: EPA 600/4-82-057 METHOD 624

Resource Analysts, Incorporated
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**BDL = BELOW DETECTION LIMIT**

**METHOD REFERENCE:** EPA 600/4-82-057 METHOD 624

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BDL = BELOW DETECTION LIMIT
METHOD REFERENCE: EPA 600/4-82-057 METHOD 624

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BDL = Below Detection Limit

Method Reference: EPA 600/4-82-057 Method 624

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*Resource Analysts, Incorporated*
**Field Identification: B-3**

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Matrix: Water

Resource Analysts, Incorporated
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# Field Identification: 5-60 S-1

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*Resource Analysts, Incorporated*
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Matrix: Water

Resource Analysts, Incorporated
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References:
1) Standard Methods, 16th Edition
2) EPA SW 846, 2nd Edition
3) EPA 600/4-82-057
RESULTS OF SAMPLING:

FEBRUARY 4, 1987
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BDL = BELOW DETECTION LIMIT

METHOD REFERENCE: 40 CFR PART 136, FRIDAY, OCTOBER 26, 1984
METHOD 624

Resource Analysts, Incorporated
Lab Number: 8864-8  
Sample Designation: B-3  
Date Analyzed: 2/9/87  
Matrix: Water

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"Trace" denotes probable presence below listed detection limit.

BDL = BELOW DETECTION LIMIT

METHOD REFERENCE: 40 CFR PART 136, FRIDAY, OCTOBER 26, 1984  
METHOD 624

Resource Analysts, Incorporated
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BDL = BELOW DETECTION LIMIT

METHOD REFERENCE: 40 CFR PART 136, FRIDAY, OCTOBER 26, 1984
METHOD 624

Resource Analysts, Incorporated
Lab Number: 8864-22
Sample Designation: Trip Blank
Date Analyzed: 2/9/87
Matrix: Water

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BDL = BELOW DETECTION LIMIT

METHOD REFERENCE: 40 CFR PART 136, FRIDAY, OCTOBER 26, 1984
METHOD 624

Resource Analysts, Incorporated
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<th>Parameter</th>
<th>Lab No.</th>
<th>Date Analyzed</th>
<th>Method/Ref.</th>
<th>Conc.</th>
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<td>2/19/87</td>
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**Matrix:** Water

Resource Analysts, Incorporated
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<th>Method/Ref</th>
<th>Conc.</th>
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**References:**
1) Standard Methods, 16th Edition
2) 40 CFR Part 136, Friday, October 26, 1984

*Resource Analysts, Incorporated*
RESULTS OF SAMPLING:

MARCH 10, 1987
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BDL = BELOW DETECTION LIMIT

METHOD REFERENCE: 40 CFR PART 136, FRIDAY, OCTOBER 26, 1984

METHOD 624

Resource Analysts, Incorporated
Lab Number: 9111-2  
Sample Designation: B-6  
Date Analyzed: 3/17/87  
Matrix: Water  

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BDL = BELOW DETECTION LIMIT

METHOD REFERENCE: 40 CFR PART 136, FRIDAY, OCTOBER 26, 1984
METHOD 624

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METHOD 624

Resource Analysts, Incorporated
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Lab No.</th>
<th>Date Analyzed</th>
<th>Method/Ref.</th>
<th>Conc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic, dissolved (mg/L)</td>
<td>9111-5</td>
<td>3/24/87</td>
<td>304/1</td>
<td>&lt;0.01</td>
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<tr>
<td>Cadmium, dissolved (mg/L)</td>
<td>9111-5</td>
<td>3/19/87</td>
<td>303A/1</td>
<td>&lt;0.005</td>
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<tr>
<td>Chromium, dissolved (mg/L)</td>
<td>9111-5</td>
<td>3/16/87</td>
<td>303A/1</td>
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<tr>
<td>Copper, dissolved (mg/L)</td>
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<td>Iron, dissolved (mg/L)</td>
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<td>Mercury, dissolved (mg/L)</td>
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<td>7470/2</td>
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<td>Manganese, dissolved (mg/L)</td>
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<tr>
<td>Sodium, dissolved (mg/L)</td>
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<td>Zinc, dissolved (mg/L)</td>
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<td>Total Phosphate (mg/L)</td>
<td>9111-8</td>
<td>3/13/87</td>
<td>424CIII,F/1</td>
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<tr>
<td>Chemical Oxygen Demand (mg/L)</td>
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<td>304,3010/1,2</td>
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<tr>
<td>Arsenic, recoverable (mg/L)</td>
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<td>3/19/87</td>
<td>303A,3010/1,2</td>
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<td>Cadmium, recoverable (mg/L)</td>
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<td>303A,3010/1,2</td>
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<td>Chromium, recoverable (mg/L)</td>
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<td>303A,3010/1,2</td>
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<td>Copper, recoverable (mg/L)</td>
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<td>Iron, recoverable (mg/L)</td>
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<td>7470/2</td>
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<td>Sodium, recoverable (mg/L)</td>
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<td>Zinc, recoverable (mg/L)</td>
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<td>303A,3010/1,2</td>
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<tr>
<td>Alkalinity (mg/L)</td>
<td>9111-17</td>
<td>3/11/87</td>
<td>403/1</td>
<td>430</td>
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<tr>
<td>Total Chloride (mg/L)</td>
<td>9111-17</td>
<td>3/18/87</td>
<td>429/1</td>
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<td>Nitrate (mg/L)</td>
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<td>Nitrite (mg/L)</td>
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<td>3/11/87</td>
<td>429/1</td>
<td>&lt;0.1</td>
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<td>Total Dissolved Solids (mg/L)</td>
<td>9111-17</td>
<td>3/12/87</td>
<td>209B/1</td>
<td>510</td>
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<td>Sulfate (mg/L)</td>
<td>9111-17</td>
<td>3/18/87</td>
<td>429/1</td>
<td>12</td>
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<td>Volatile Solids (mg/L)</td>
<td>9111-17</td>
<td>3/17/87</td>
<td>209D/1</td>
<td>280</td>
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<td>Ammonia (mg/L)</td>
<td>9111-20</td>
<td>3/16/87</td>
<td>417A,B/1</td>
<td>2.7</td>
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<tr>
<td>Total Kjeldahl Nitrogen (mg/L)</td>
<td>9111-20</td>
<td>3/16/87</td>
<td>420A/1</td>
<td>4.2</td>
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<tr>
<td>Total Cyanide (mg/L)</td>
<td>9111-23</td>
<td>3/23/87</td>
<td>335.2/3</td>
<td>&lt;0.01</td>
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</tbody>
</table>
**Parameter** | **Lab No.** | **Date Analyzed** | **Method/Ref.** | **Conc.**  
--- | --- | --- | --- | ---  
Arsenic, dissolved (mg/L) | 9111-6 | 3/24/87 | 304/1 | <0.01  
Cadmium, dissolved (mg/L) | 9111-6 | 3/19/87 | 303A/1 | <0.005  
Chromium, dissolved (mg/L) | 9111-6 | 3/16/87 | 303A/1 | <0.01  
Copper, dissolved (mg/L) | 9111-6 | 3/13/87 | 303A/1 | <0.01  
Iron, dissolved (mg/L) | 9111-6 | 3/19/87 | 303A/1 | 15  
Mercury, dissolved (mg/L) | 9111-6 | 3/18/87 | 7470/2 | <0.0005  
Manganese, dissolved (mg/L) | 9111-6 | 3/20/87 | 303A/1 | 0.20  
Sodium, dissolved (mg/L) | 9111-6 | 3/20/87 | 325B/1 | 13  
Lead, dissolved (mg/L) | 9111-6 | 3/13/87 | 303A/1 | <0.05  
Zinc, dissolved (mg/L) | 9111-6 | 3/20/87 | 303A/1 | <0.005  
Total Phosphate (mg/L) | 9111-9 | 3/13/87 | 424CIII,F/1 | 2.9  
Chemical Oxygen Demand (mg/L) | 9111-12 | 3/13/87 | 508A/1 | 190  
Arsenic, recoverable (mg/L) | 9111-15 | 3/24/87 | 304,3010/1,2 | 0.087  
Cadmium, recoverable (mg/L) | 9111-15 | 3/19/87 | 303A,3010/1,2 | <0.005  
Chromium, recoverable (mg/L) | 9111-15 | 3/16/87 | 303A,3010/1,2 | 0.13  
Copper, recoverable (mg/L) | 9111-15 | 3/13/87 | 303A,3010/1,2 | 0.19  
Iron, recoverable (mg/L) | 9111-15 | 3/19/87 | 303A,3010/1,2 | 95  
Mercury, recoverable (mg/L) | 9111-15 | 3/18/87 | 7470/2 | <0.0005  
Manganese, recoverable (mg/L) | 9111-15 | 3/20/87 | 303A,3010/1,2 | 1.1  
Sodium, recoverable (mg/L) | 9111-15 | 3/20/87 | 325B,3010/1,2 | 16  
Lead, recoverable (mg/L) | 9111-15 | 3/13/87 | 303A,3010/1,2 | 0.12  
Zinc, recoverable (mg/L) | 9111-15 | 3/20/87 | 303A,3010/1,2 | 0.41  
Alkalinity (mg/L) | 9111-18 | 3/11/87 | 403/1 | 34  
Total Chloride (mg/L) | 9111-18 | 3/11/87 | 429/1 | 16  
Nitrate (mg/L) | 9111-18 | 3/11/87 | 429/1 | <0.05  
Nitrite (mg/L) | 9111-18 | 3/11/87 | 429/1 | <0.05  
Total Dissolved Solids (mg/L) | 9111-18 | 3/12/87 | 209B/1 | 91  
Sulfate (mg/L) | 9111-18 | 3/18/87 | 429/1 | 20  
Volatile Solids (mg/L) | 9111-18 | 3/17/87 | 209D/1 | 130  
Ammonia (mg/L) | 9111-21 | 3/16/87 | 417A,B/1 | 0.28  
Total Kjeldahl Nitrogen (mg/L) | 9111-21 | 3/16/87 | 420A/1 | 2.3  
Total Cyanide (mg/L) | 9111-24 | 3/23/87 | 335.2/3 | <0.01
## Field Identification: B-7

### Parameter
- Arsenic, dissolved (mg/L)
- Cadmium, dissolved (mg/L)
- Chromium, dissolved (mg/L)
- Copper, dissolved (mg/L)
- Iron, dissolved (mg/L)
- Mercury, dissolved (mg/L)
- Manganese, dissolved (mg/L)
- Sodium, dissolved (mg/L)
- Lead, dissolved (mg/L)
- Zinc, dissolved (mg/L)
- Total Phosphate (mg/L)
- Chemical Oxygen Demand (mg/L)
- Arsenic, recoverable (mg/L)
- Cadmium, recoverable (mg/L)
- Chromium, recoverable (mg/L)
- Copper, recoverable (mg/L)
- Iron, recoverable (mg/L)
- Mercury, recoverable (mg/L)
- Manganese, recoverable (mg/L)
- Lead, recoverable (mg/L)
- Sodium, recoverable (mg/L)
- Zinc, recoverable (mg/L)
- Alkalinity (mg/L)
- Total Chloride (mg/L)
- Nitrate (mg/L)
- Nitrite (mg/L)
- Total Dissolved Solids (mg/L)
- Sulfate (mg/L)
- Volatile Solids (mg/L)
- Ammonia (mg/L)
- Total Kjeldahl Nitrogen (mg/L)
- Total Cyanide (mg/L)

### Method/Ref.

### Conc.

### Matrix: Water

### References:
1) Standard Methods, 16th Edition
2) EPA SW 846, 2nd Edition