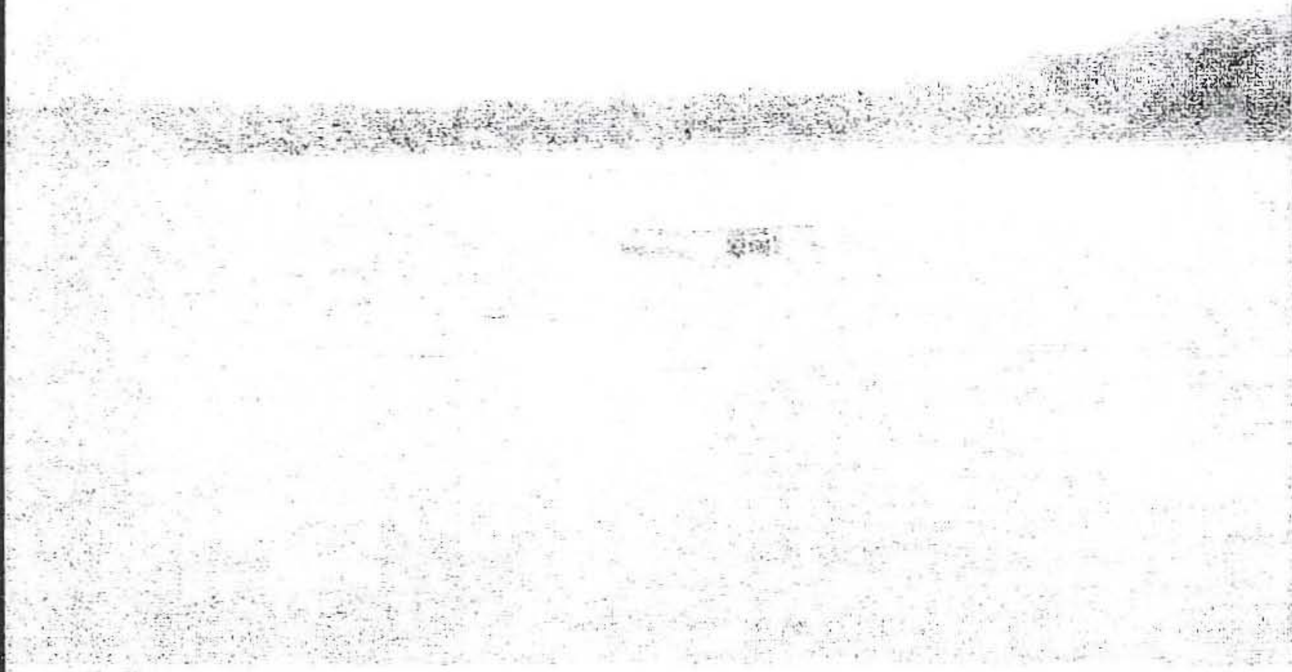
Orange Lake
Summary of Field Activities

Prepared for:

Orange Lake Improvement Board
Bloomfield Township, Michigan



Prepared by:

ECT
Environmental Consulting & Technology, Inc.

719 Griswold, Suite 520
Detroit, Michigan 48226
(313) 963-6600
www.ectinc.com

July 2003

TABLE OF CONTENTS

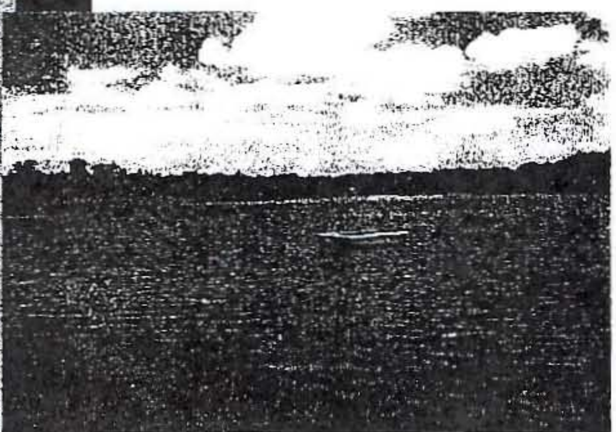
LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

The Orange Lake Improvement Board (OLIB) contracted with Environmental Consulting & Technology, Inc. (ECT) to conduct a preliminary assessment of Orange Lake. Orange Lake is located in Bloomfield Township, south of Hickory Grove, east of Telegraph, and west of Lahser Road. Land use surrounding the lake is predominantly residential with the exception of the southeast corner of the lake, which is occupied by the Bloomfield Township School District's Lahser High School. Figure 1 shows the location of Orange Lake.



The purpose of the work reported here is to provide the OLIB with enough information to: 1) make some preliminary lake management decisions, and 2) apply for potential grant funding. Due to limited funding currently available, a full lake diagnostic study and restoration plan will not be developed at this time, as one of the main elements of that plan would most likely include a dredge plan and implementation. However, this work will provide information on each of the areas usually included in a full diagnostic study.

ECT performed the field assessment and sampling during the week of July 7th, 2003. The preliminary assessment included collection of water quality data, bathymetry and sediment thickness measurements.

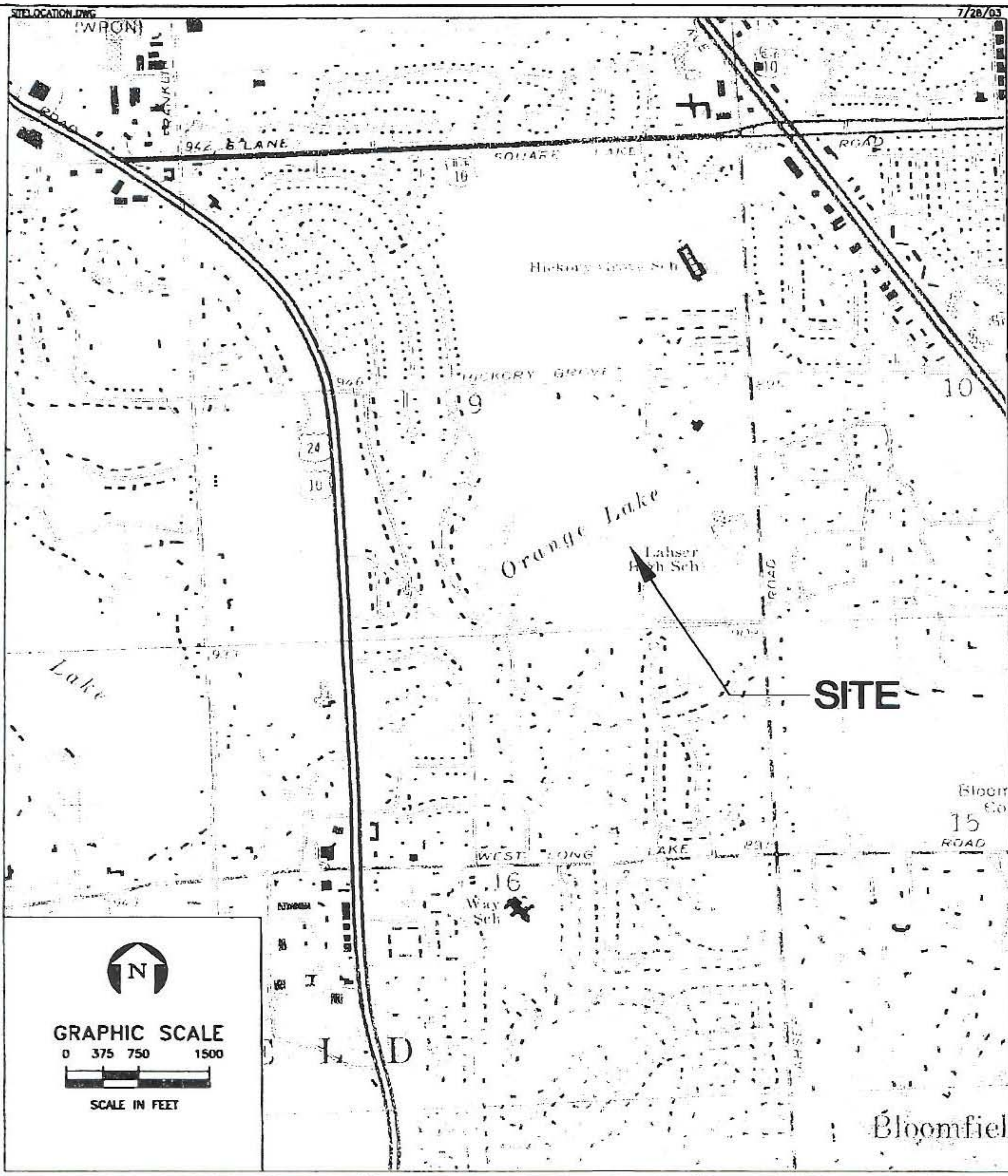


FIGURE 1.
SITE LOCATION MAP

Source: ECT, 2003

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ECT
Environmental Consulting & Technology, Inc.
The Dime Building
719 Griswold Street, Suite 520
Detroit, Michigan 48226
Phone: (313) 963-6600 Fax: (313) 963-1707

2.0 FIELD ACTIVITIES

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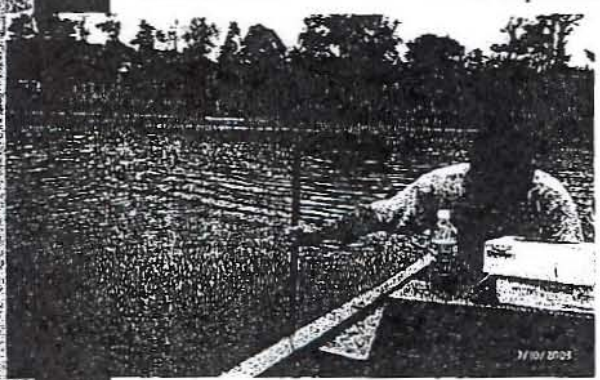
Field activities were conducted the week of July 7th, 2003. The objective of the field activities was to collect data in order to provide a preliminary assessment the condition of Orange Lake. The field activities were comprised of four components:

1. Water depth measurements (bathymetry)
2. Sediment thickness measurements
3. Sediment and water sampling
4. Aquatic plant/algae data collection

Water depth measurements were made using a sounding rod equipped with a photoelectric device (PED). The PED allows water depth measurements to be recorded to the top of the unconsolidated sediment where the sediment water interface is otherwise difficult to detect. Several transects were established across the lake and water depth measurements were collected at several points along each transect.

The locations of the water depth data points were recorded using a global positioning system (GPS) and are depicted on Figure 2.



Sediment thickness measurements were collected along the transects. Sediment thickness was determined using a rod to push through the unconsolidated sediments to the natural lake bottom. The natural lake bottom is assumed to correspond to that point where the rod can no longer be advanced. The sediment depth was then calculated by subtracting the water depth, determined using the sounding rod/PED, from the total depth of the rod penetration into the sediment. The sediment thickness data collection points were located using GPS and are depicted on Figure 2.

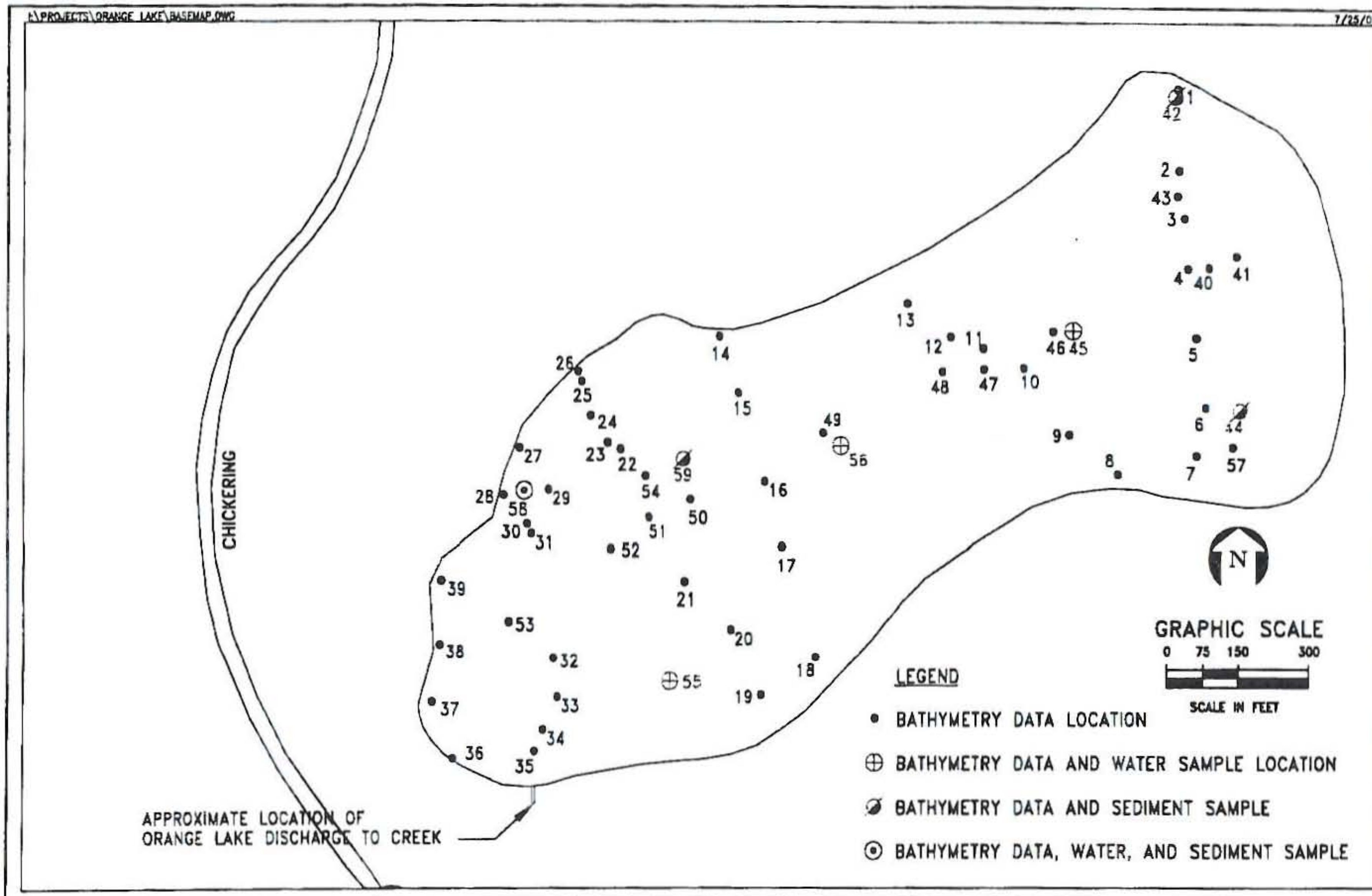


FIGURE 2.
SITE MAP WITH SAMPLE LOCATIONS

Source: ECT, 2003.

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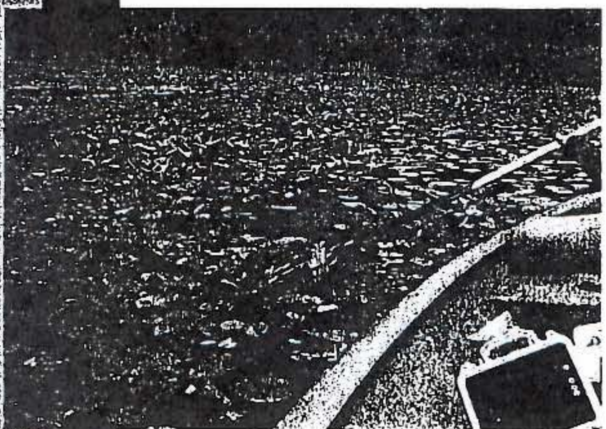
Environmental Consulting & Technology, Inc.
The Dime Building
719 Griswold Street, Suite 820
Detroit, Michigan 48226
Phone: (313) 963-6600 Fax: (313) 963-1707

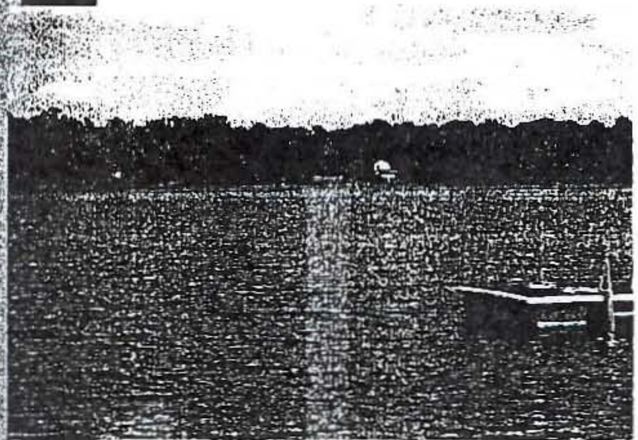
The sediment samples collected were focused on the unconsolidated muck that exists above the native lake bottom. Sampling methodology was designed to screen the overall sediment layer. Sample locations were located using GPS and are shown on Figure 2.



At a subset of the points selected for the bathymetric survey, lake water samples were collected so that a water quality analysis could be performed. A multiparameter water quality monitoring instrument (Hydrolab Minisonde) was used to determine the dissolved oxygen (DO) concentration, oxidation-reduction potential, pH, temperature, and conductivity. The number of discrete depth water quality profile samples at each sample location depended on the lake depth. Deeper locations have two or more samples; in shallow water a single reading was recorded. In addition to the field measurements, samples were collected for laboratory analysis of nutrients, biochemical oxygen demand, and total and dissolved solids.

3.0 BATHYMETRY

A manual method was used for water depth (bathymetry) measurements. The method for obtaining water depth measurements consists of using a photoelectric device to detect the uppermost layer of the sediment water interface. A Markland Specialty Engineering Sludge Gun was used as the PED device.



The results of the bathymetric survey as well as a discussion of the characteristics of the lake, are presented in the following. Table 1 summarizes the key morphometric parameters of the lake. A brief discussion of the significance of some of these morphometric parameters follows.

- **Centerline Length (I_c)** - distance along the centerline of the longest axis of a lake
- **Maximum Length (I)** – distance between the two most distant points on a lake that are uninterrupted by land i.e., the fetch or distance over which wind can interact with the waters surface.
- **Maximum Breadth (b)** – maximum width of the lake along a line normal to the maximum length as described above.
- **Surface Area (A_0)** - surface area of the lake excluding any islands
- **Mean Breadth (b)** -- area of lake divided by the maximum length
- **Volume (V)** – volume of the lake is the integral of the areas of each stratum at successive depths from the surface to maximum depth
- **Maximum Depth (z_m)** – maximum observed depth. Greater depths may exist but may not have been observed during the survey
- **Mean Depth (z)** – volume of the lake divided by the area of the lake. This value may differ from the mean depth calculated from actual depths in part because the survey cannot access every point in the lake

- **Shoreline** - distance around the shoreline of the lake measured with AutoCAD®.
- **Shoreline Development (D_l)** – ratio of the shoreline length to the circumference of a circle of equal area to that of the lake with a value of 1 representing a circular lake. Shoreline development is of interest because it reflects the potential for far greater development of littoral communities (the littoral zone is defined as the shallow water region of a lake where light penetrates to the bottom; typically occupied by rooted plants)

Table 1: Morphometric Parameters

Morphometric Parameter	Units	Orange Lake
Centerline Length (I_c)	ft	2203
Maximum Length (I)	ft	2203
Maximum Breadth (b)	ft	854
Surface Area (A_0)	ft^2	1,451,957
Mean Breadth (b)	ft	642
Volume (V)	ft^3	4,274,454
Maximum Depth (z_m)	ft	10.5
Mean Depth (z)	ft	2.9
Shoreline	ft	5,471
Shoreline Development (D_l)		1.30

The general average water depth for Orange Lake is less than 4.0 feet. The deepest point measured depth was 10.5 feet, located at point 31, located in the northwest portion of the lake. The mean depth of the lake calculated by dividing the volume of the lake by the lake's surface area was 2.9 feet. The resulting bathymetric map for Orange Lake is presented in Figure 3. The total shoreline perimeter of Orange Lake is 5,471 feet. The elongated shape of the lake results in a shoreline development value of 1.30, i.e., the potential for development of littoral communities is higher than it would be for a circular lake of the same size. Perhaps the most notable fact about the depths in the lake is that the eastern three quarters of the lake is generally 2.5 feet or less. The greatest depths occur at the western end near the spring influent. The steepest slopes also occur at this end of the lake. The total shoreline perimeter of Orange Lake is 5,471 ft. The total open surface area of the lake is approximately 33 acres. This is a decrease of approximately 7 acres from the shoreline establish Michigan Conservation Department map of 1947 (Appendix A).

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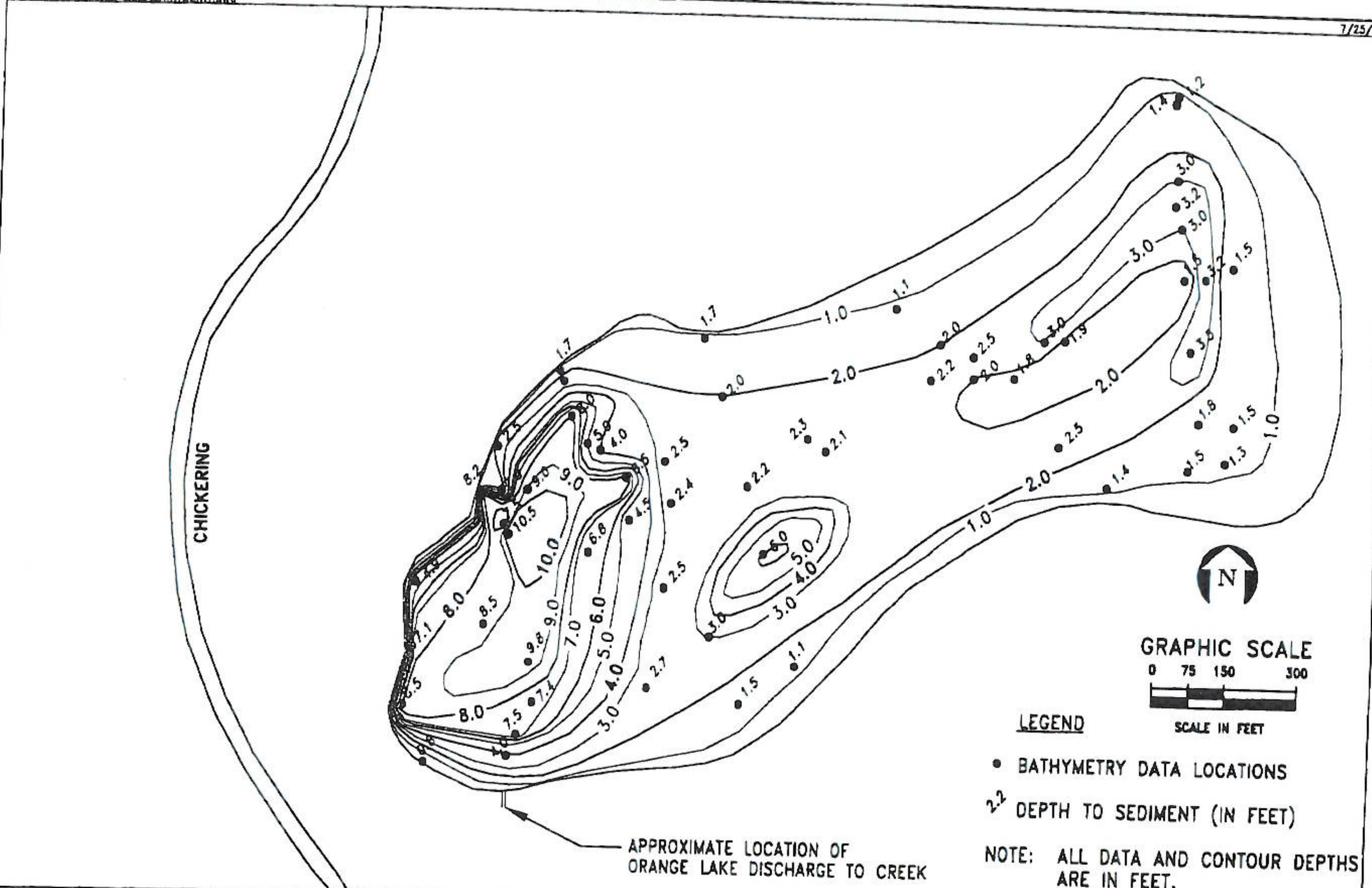

FIGURE 3.
BATHYMETRY MAP

Source: ECT, 2003.

ORANGE LAKE
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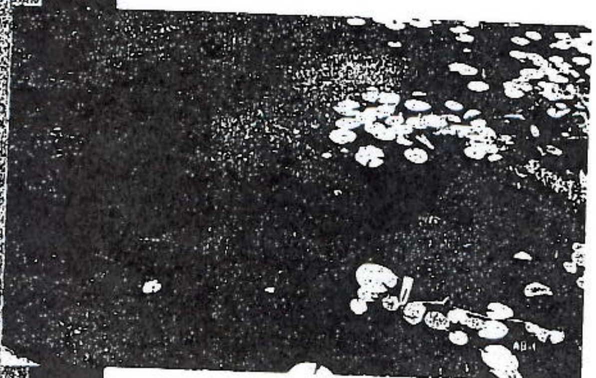
ECT
Environmental Consulting & Technology, Inc.
The Dime Building
719 Griswold Street, Suite 520
Detroit, Michigan 48226
Phone: (313) 963-6600 Fax: (313) 963-1707

4.0 SEDIMENT CHARACTERIZATION

The sediment thickness was measured by pushing 4-foot lengths of metal rod into the sediment until the point of refusal or the extent of the equipment. The point of refusal was assumed to indicate the natural lake bottom. The water depth was then subtracted from the total depth to obtain the sediment thickness. The measured water depth and sediment thickness were then recorded onto ECT bathymetric/sediment depth data form.



Sampling points and data collection points were selected along north/south and east/west transects. Each time data was collected at a point along the transects, the location was recorded using a GPS. The data collected at each point were also manually recorded on appropriate ECT field forms.

Unconsolidated sediment has accumulated in Orange Lakes at thicknesses exceeding 10 feet. The lake bottom sediment thickness appears to be the shallowest along the northeast and southwest shorelines. Sediment accumulation appears the greatest in the northeast section of the lake and along the north and south shores of the lake. However, the majority of the lake consistently had 6 feet or greater of sediment accumulation, of which some is historic. As indicated in the Bathymetry Section of this summary, the lake has been reduced in size from the 1947, 40 acres to approximately 33 acres today. This could be do impart to sediment accumulation (other factors could be filling in of pasture or marshlands during development) reducing the surface area. Additionally, a comparison of the two maps shows that will there has been some reduction in water depths in the western end of the lake, the eastern end of the lake has had the greatest decrease in water depth and therefore increase in the sediment thickness.

The lake bottom material along southwest shoreline consists of sand with some gravel. The northeast shoreline consists of a brown sandy muck that is underlain by a black sandy muck. The unconsolidated sediment in the lake often contained undecayed organic debris such as wood. A contour map illustrating sediment thickness is included in Figure 4. Cross-Section of the lake based on the water and sediment thickness are shown in Figures 5A, 5B, 5C, and 5D.

4.1 SEDIMENT ANALYTICAL RESULTS

Collection of the sediment samples was focused on the unconsolidated muck that has accumulated on the native sand lake bottom. The sampling methodology was designed to encompass the overall sediment layer, as opposed to simply grabbing surface sediment samples. This method provides an initial assessment for chemical constituents as well as a preliminary evaluation of physical characteristics of the sediment layer.

Samples were collected at four locations around the lake, distributed to collect data from areas where sediments were found to have accumulated. Sample locations are depicted on Figure 2.

Samples were collected and analyzed for total nitrogen, total organic carbon and phosphorus. The total nitrogen content was highest in sample 44 and ranged from 19,000 mg/kg to 29,000 mg/kg. Total organic carbon was highest in sample 59 and ranges from 8.3% to 38.9%. Phosphorus content was highest in sample 58 and ranges from 440 mg/kg to 750 mg/kg. Sample 59 was not collected with a sediment corer, but with a ponar. An attempt was made to collect the samples with the corer but no sediment was recovered. A ponar was then used to collect a surface sediment sample.

Table 2: Sediment Analytical Summary Table

	Sample ID			
	42 (0-11')	44 (0-11')	58 (0-11')	59 (0-5')
Nitrogen - Kjeldahl (TKN) *mg/kg* *Method 351.3*	19,000	29,000	21,000	20,000
Total Organic Carbon (TOC) *%* *Method WB*	14.0	8.3	8.9	38.9
Total Phosphorus *mg/kg* *Method 3050, 6020*	440	660	750	610

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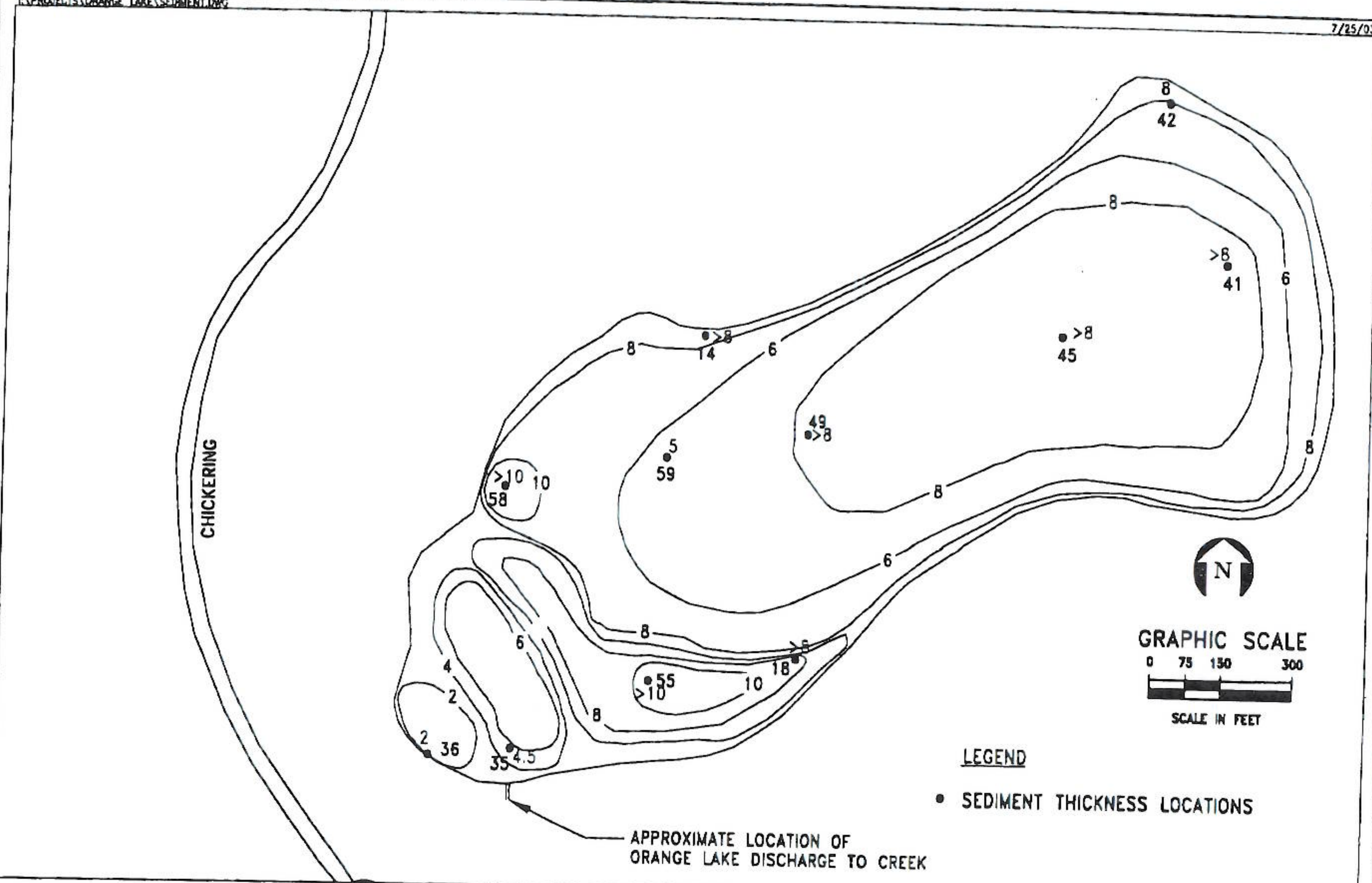

FIGURE 4.
SEDIMENT THICKNESS CONTOURS

Source: ECT, 2003.

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BLOOMFIELD TWP., MI

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Environmental Consulting & Technology, Inc.
The Dime Building
719 Griswold Street, Suite 520
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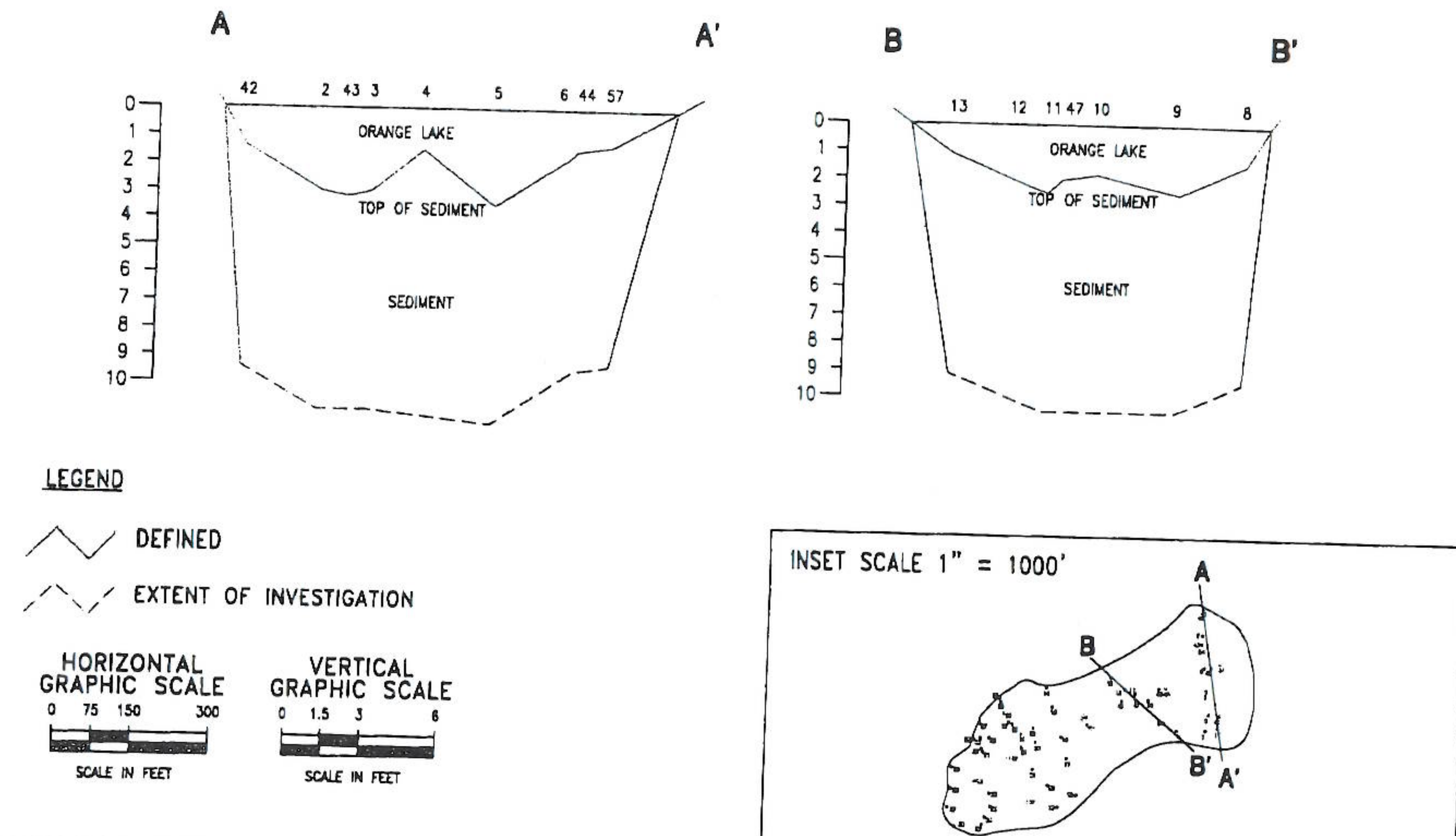

FIGURE 5A.
CROSS-SECTIONS A-A' AND B-B'

Source: ECT, 2003.

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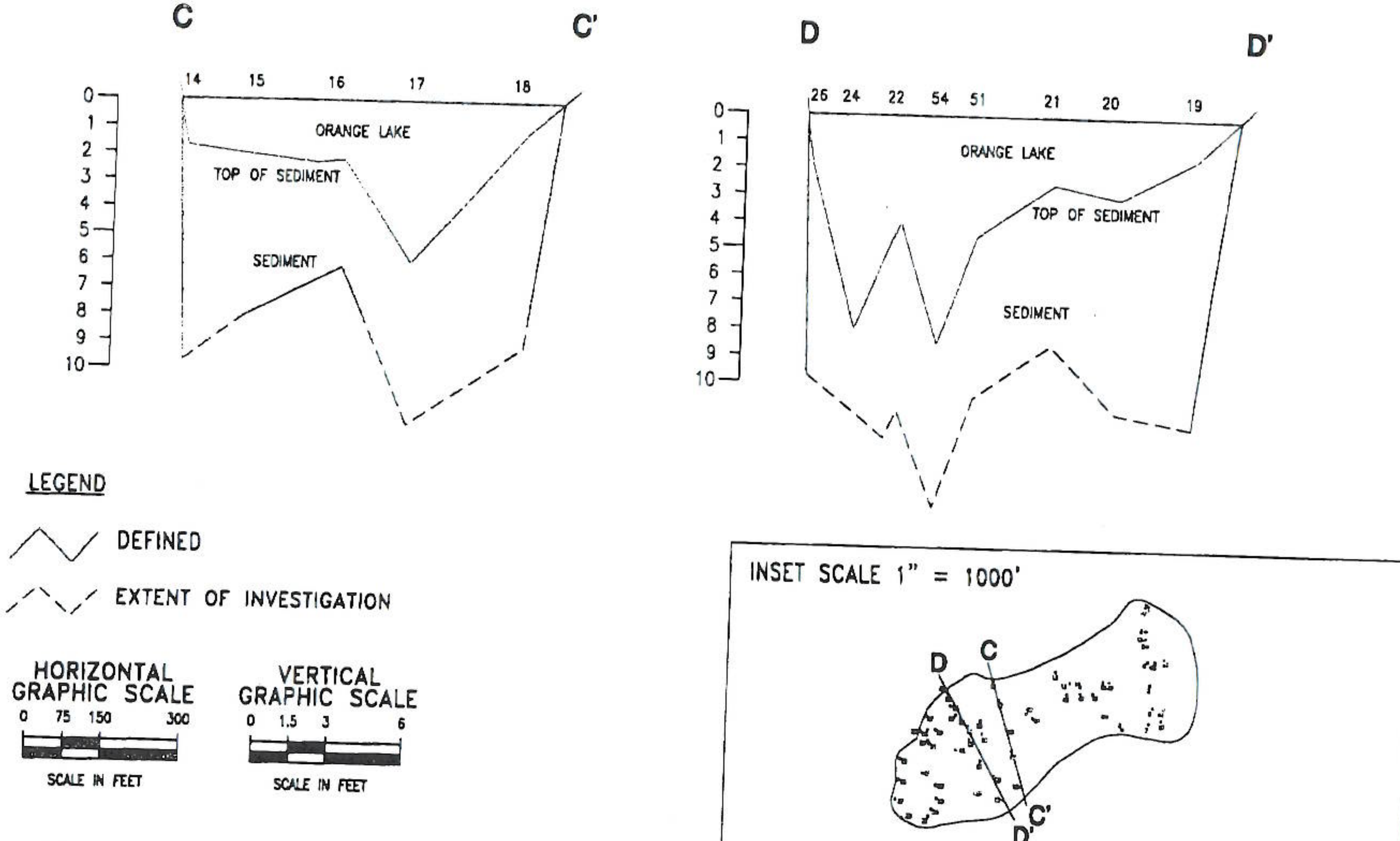

FIGURE 5B.
CROSS-SECTIONS C-C' AND D-D'

Source: ECT, 2003.

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Detroit, Michigan 48226
Phone: (313) 963-6600 Fax: (313) 963-1707

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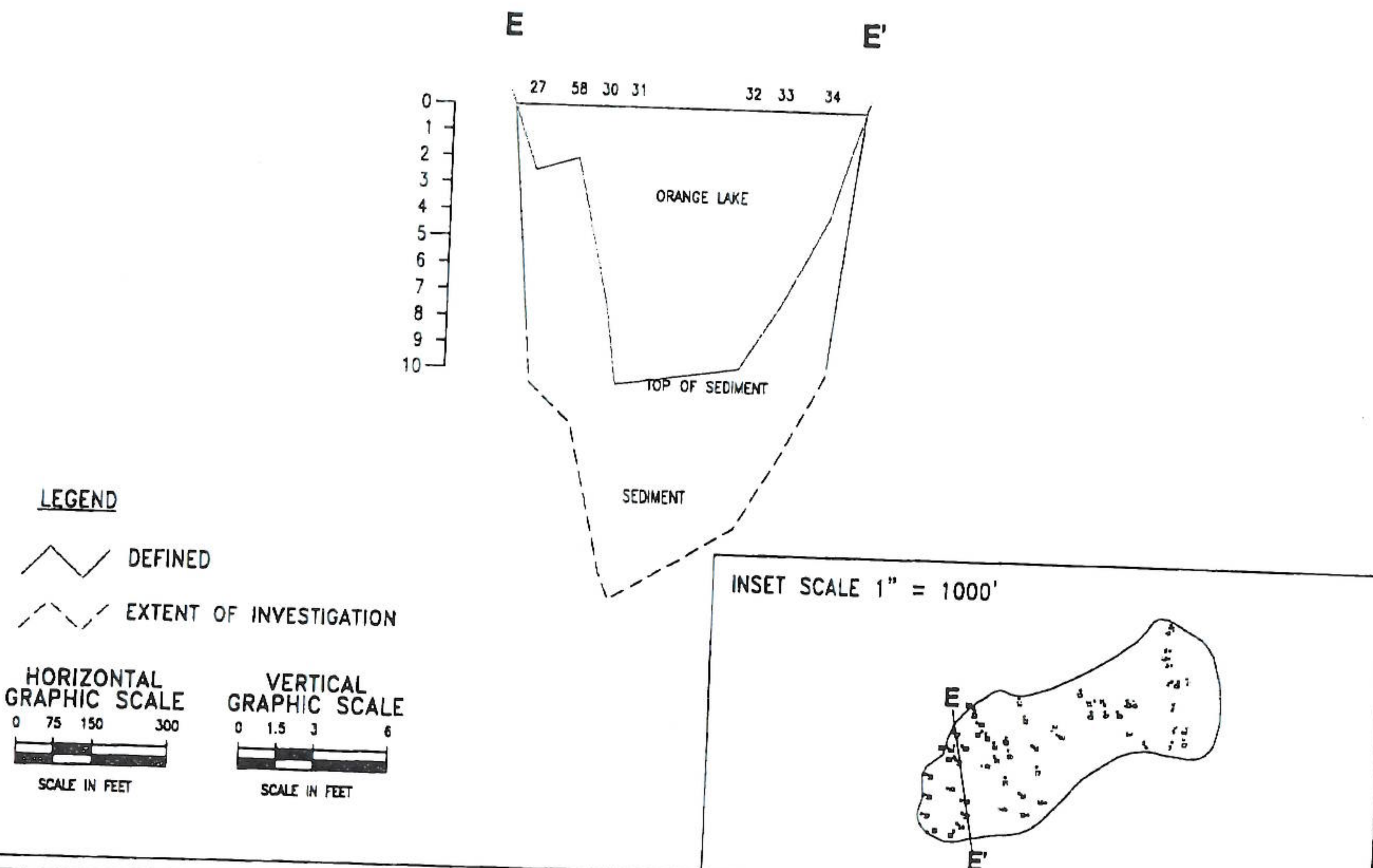

FIGURE 5C.
CROSS-SECTION E-E'

Source: ECT, 2003.

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BLOOMFIELD TWP., MICHIGAN

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The Dime Building
719 Griswold Street, Suite 820
Detroit, Michigan 48226
Phone: (313) 963-6600 Fax: (313) 963-1707

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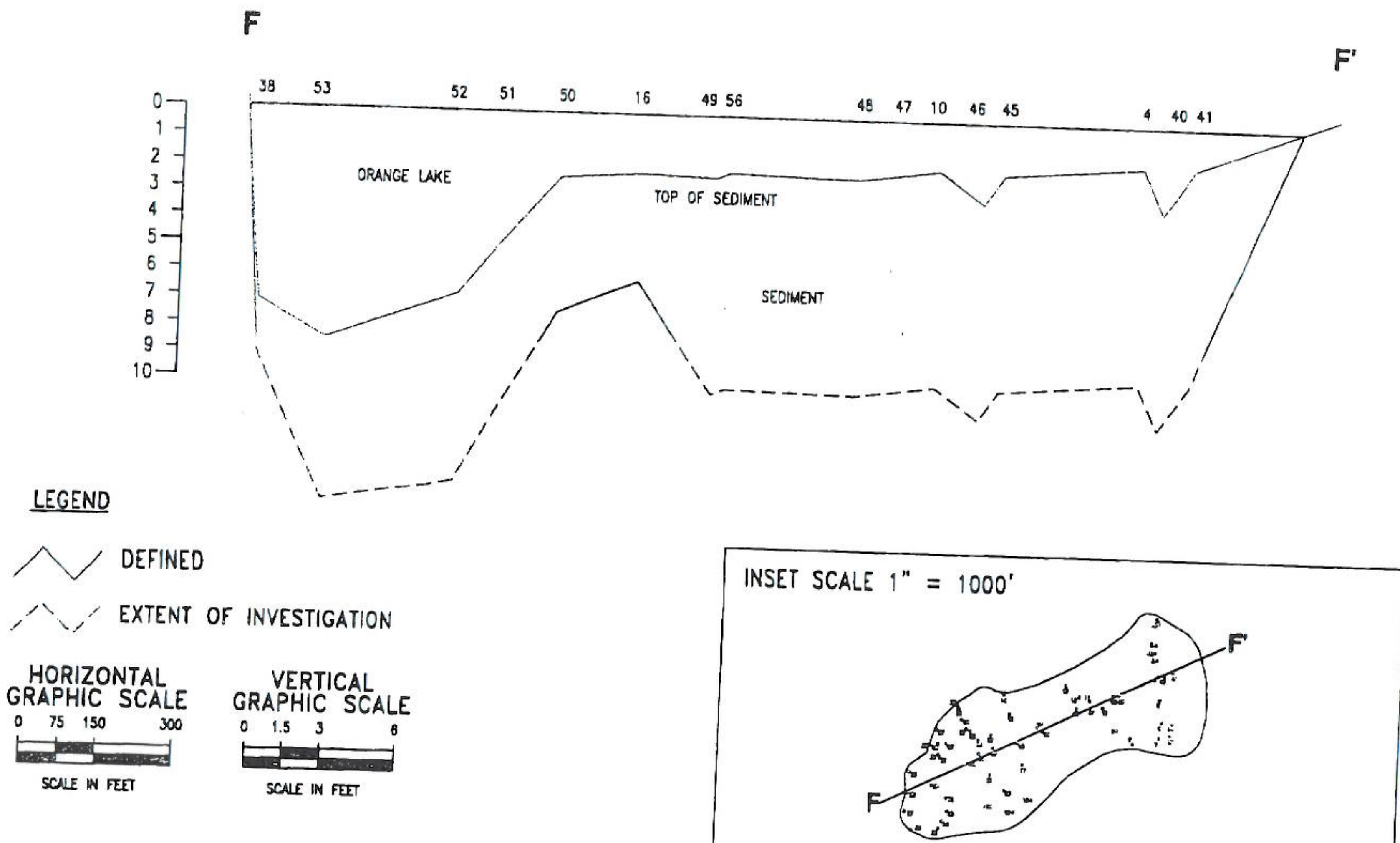

FIGURE 5D.
CROSS-SECTION F-F'

Source: ECT, 2003.

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The Dime Building
719 Griswold Street, Suite 820
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Phone: (313) 963-6600 Fax: (313) 963-1707

These results do not indicate excessive nutrient enrichment of the sediment, but a moderate level of nutrients and organic content, much as would be expected considering the surrounding land use and hydrology.

5.0 WATER QUALITY DATA

At a subset of the points selected for the bathymetric survey, water quality sampling was performed. A multiparameter water quality instrument was used to determine the dissolved oxygen concentration, pH, temperature, and conductivity. The number of discrete depth water quality profile samples at each station depended on the lake depth at the sample location. Deeper locations have two or more samples; in shallow water a single reading was recorded. In addition to the field measurements, samples were collected for laboratory analysis of nutrients, biochemical oxygen demand, and total and dissolved solids. Table 3 is a summary of the water quality data collected for Orange Lake. Table 4 is the summary of the laboratory analytical data.

Water quality data was collected along north/south and east/west transects along Orange Lake. Each data collection point was located using a GPS unit.

TEMPERATURE

The average temperature for Orange Lake is 78°. The highest temperature recorded is 79.5°, located at Point 58 on the northwest section of the lake. The temperature was recorded 1 foot below the surface and the total depth of the water was 2 feet. The lowest temperature recorded is 74.57°, located at Point 42 in the northeast section of the lake. The temperature was recorded at a depth of 1.1 feet below the surface and the total depth was1.4 feet.

DISSOLVED OXYGEN

The average dissolved oxygen (DO) for the lake is 4.907 mg/L. This level is just marginally lower than the State of Michigan criterion of 5.0 mg/L. The highest concentration of DO is 7.078 mg/L located at Point 53 in the southwest area of the lake at 4.9 feet below the surface. The total depth at this point was 8.5 feet. The lowest DO is 0.755 mg/L, recorded at Point 42 in the northeast section of the lake at 1.1 feet below the surface. The total depth at this point was 1.4 feet. The depleted DO values are generally found throughout the eastern half of the lake, where the sediment accumulation has reduced water depth. The influent spring water influences the western half of the lake, and the DO concentrations in this area are higher.

Table 3: Water Quality Field Screening Results

Location	Depth To Sediment (ft)	Temp. (F)	Sample Depth (ft)	ORP	pH	Dissolved Oxygen (mg/L)	Cond (uS/cm)
41	1.5	76.4	1.0	-132	7.6	1.9	880
42	1.4	74.6	1.1	-197	7.4	0.8	843
43	3.2	77.3	1.0	-68	7.6	6.7	838
43	3.2	77.3	2.1	-127	7.5	1.0	849
43	3.2	77.3	2.9	-229	7.1	0.4	917
44	1.5	76.7	1.0	-146	7.9	3.8	881
45	1.9	76.3	1.1	-43	8.8	3.8	774
45	1.9	75.9	2.0	-169	7.5	1.1	825
47	2.0	75.9	1.1	-22	7.9	3.2	809
49	2.3	76.7	1.0	-9	8.0	3.6	815
50	2.4	77.0	1.1	-12	8.5	6.3	806
52	6.8	78.9	1.1	-8	8.4	6.0	805
52	6.8	78.9	2.0	-6	8.5	6.0	809
52	6.8	78.9	3.0	-1	8.4	6.1	807
52	6.8	78.8	4.0	3	8.8	6.3	810
52	6.8	78.8	5.3	7	8.3	6.3	814
52	6.8	78.4	6.3	8	7.9	4.1	817
53	8.5	79.2	1.1	-6	8.6	6.5	815
53	8.5	79.2	2.0	-3	8.6	6.6	811
53	8.5	79.2	3.2	0	8.6	6.6	810
53	8.5	79.2	4.2	3	8.5	6.5	804
53	8.5	79.1	4.9	4	8.6	7.1	815
54	8.5	78.9	1.1	23	8.4	6.4	816
54	8.5	78.9	2.0	24	8.4	6.4	811
54	8.5	78.8	3.0	25	8.4	6.3	807
54	8.5	78.8	4.1	26	8.4	6.3	806
54	8.5	78.7	5.0	27	8.3	5.6	811
55	2.7	78.9	1.0	6	8.8	6.9	813
56	2.1	77.5	1.0	-15	8.3	4.3	812
57	1.3	75.1	1.0	-40	7.3	3.6	879
58	2.0	79.5	1.0	-137	8.4	5.6	809

OXIDATION-REDUCTION POTENTIAL

This parameter gives an indication of the type of metabolic activity that will be prevalent in the lake, i.e., whether conditions are reducing (anaerobic) or oxidizing (aerobic). The ORP usually correlates with DO concentration. The average oxygen reduction potential (ORP) for Orange Lake is –39 mV, a value that is mildly reducing but not indicative of truly anaerobic conditions. The lowest ORP reading recorded was –229 mV, reflecting strongly anaerobic conditions. It was collected at Point 43 in the northeast section of the lake at 1.1 feet below the surface. The highest ORP reading is 27 mV, observed at point 54, located in the northwest section of the lake, 5.0 feet below the surface. The total water depth at this point is 8.5 feet.

pH

The average pH of Orange Lake is 8.19, a value that is within the normal range for small freshwater lakes. The highest pH reading is 8.83. It was collected at Point 52, located in the northwest section of the lake at 4.0 feet below the surface. The total water depth at this point is 6.8 feet. The lowest pH reading is 7.28. It was collected at Point 57 in the southeast section of the lake, at 1.0 foot below the surface. The total water depth at this point is 1.3 feet

CONDUCTIVITY

Conductivity reflects in general the level of dissolved substances in the water. The average conductivity of Orange Lake is 823 μSiemens/cm. The conductivity values observed during this survey did not vary greatly from one location to another, and fall in the normal range. The highest conductivity is 917 μS/cm, located at Point 43 in the northeast section of the lake and recorded at 2.9 feet below the surface. The total water depth at this point is 3.2 feet. The lowest conductivity is 774 μS/cm, located at Point 45 in the eastern section of the lake. The conductivity was recorded at 1.1 feet below the surface and the total water depth is 1.9 feet.

The water quality screening results do not indicate any specific problems with lake water quality, aside from the large areas of oxygen depletion. Anaerobic conditions affect a variety of water chemistry components, most related to nutrient cycling. For example, in the absence of oxygen, sediment phosphorus is released to the water column where it is available for uptake by plants and algae.

5.1 WATER ANALYTICAL RESULTS

Four surface water samples were collected and analyzed for total solids (TS), total dissolved

5.1 WATER ANALYTICAL RESULTS

Four surface water samples were collected and analyzed for total solids (TS), total dissolved solids (TDS), biological oxygen demand (BOD), ammonia, phosphorus, total Kjeldahl nitrogen (TKN), ortho-phosphate, nitrate and chlorophyll a. Samples were collected at four locations in the lake and are shown on Figure 2. Samples locations were recorded using a GPS unit. Sample 45 was collected in the east central part of the lake. Sample 55 was collected in the southwest section of the lake. Sample 56 was collected in the center of the lake and sample 58 was collected in the northwest section.

Total solids were highest at sampling point 45. The total solids ranged from 455 to 515 mg/L. Total dissolved solids were highest at sampling point 45 and results ranged from 330 mg/L to 410 mg/L. Biological oxygen demand was less than 10 mg/L in all of the samples. Ammonia is highest in sample 45. Ammonia concentrations ranged from less than 0.10 to 0.37 mg/L. Ammonia toxicity is typically observed at concentrations of 0.2 mg/L or higher. Phosphorus concentrations are 0.02 mg/L for samples 45 and 55 and are less than 0.01 mg/L in samples 56 and 58. Concentrations of TKN ranged from 1.0 to 1.4 mg/kg with the highest concentration in sample 45. Ortho-phosphate concentrations are less than 0.010 mg/L in all of the samples. Nitrate is less than 0.10 mg/L in all of the samples. The chlorophyll a concentration in sample 45 is 4 mg/L; the remaining concentrations are less than 0.500 mg/L.

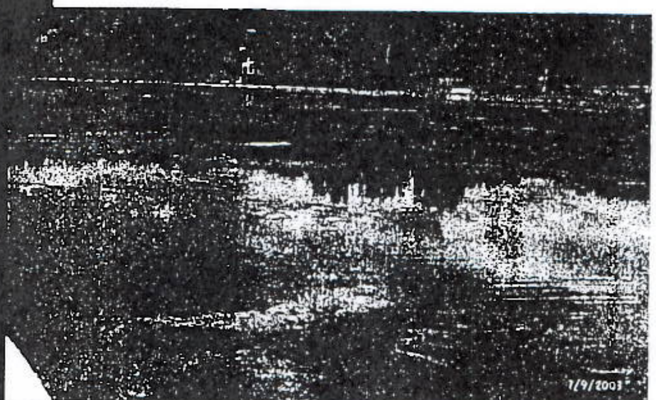
Table 4: Water Sample Analytical Summary Table

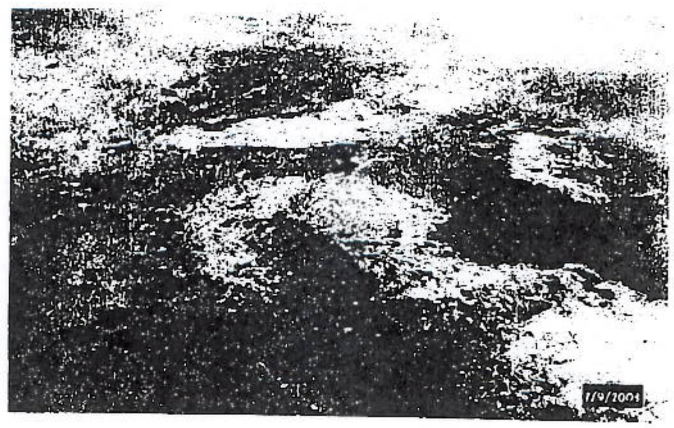
Normal Value	Parameter	Sample ID			
		45	55	56	58
100	**Total Solids, TS** *mg/L* **Method 160.3**	515	455	470	460
200	**Dissolved Residue** *mg/L* *Method 160.1*	410	352	350	330
10	**Biochemical Oxygen Demand** *mg/L* *Method 405.1*	<10.0	<10.0	<10.0	<10.0
0.5-1.0	**Ammonia-Nitrogen** *mg/L* *Method 350.2*	0.37	0.16	0.13	<0.10
<0.025	**Total Phosphorus** *mg/L* *Method 365.2*	0.02	0.02	<0.01	<0.01
1.0	**Total Kjeldahl Nitrogen (TKN)** *mg/L* *Method 351.3*	1.4	1.3	1.2	1.0
<0.01	**Ortho Phosphate** *mg/L*	<0.010	<0.010	<0.010	<0.010

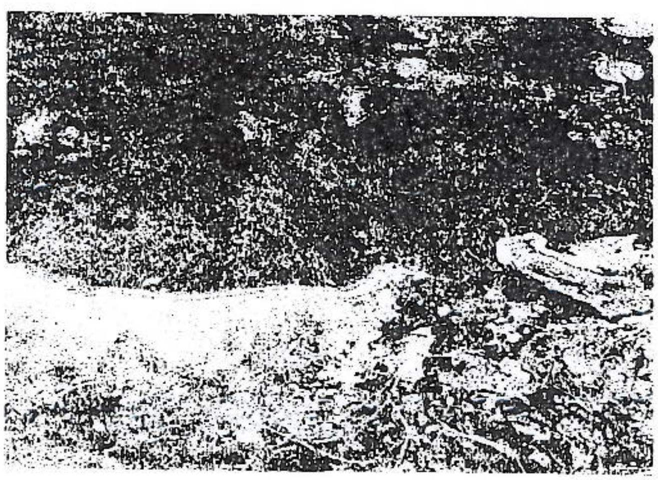
Normal Value	Parameter	Sample ID 45	55	56	58
	Method 365.2				
<0.01	**Nitrate-Nitrogen** *mg/L* *Method 300.0*	<0.10	<0.10	<0.10	<0.10
5-10	**Chlorophyll a** *mg/L* *Method SM102000H*	4	<0.500	<0.500	<0.500

5.2 ALGAE AND PLANTS

Algae and aquatic plants were observed and identified in Orange Lake. The plants observed included Eurasian water milfoil, American elodea, coontail and water lilies. *Chara,* a macroscopic alga, was also found to be widespread in the lake. *Chara* is the dominant algae type on Orange Lake. It grows very dense on the northeast half of the lake but is also present elsewhere in the lake. Milfoil and elodea were more numerous in the southwest portion of the lake and are occasionally observed on the northeast portion of the lake. Figure 6 shows the location of aquatic plants and algae.







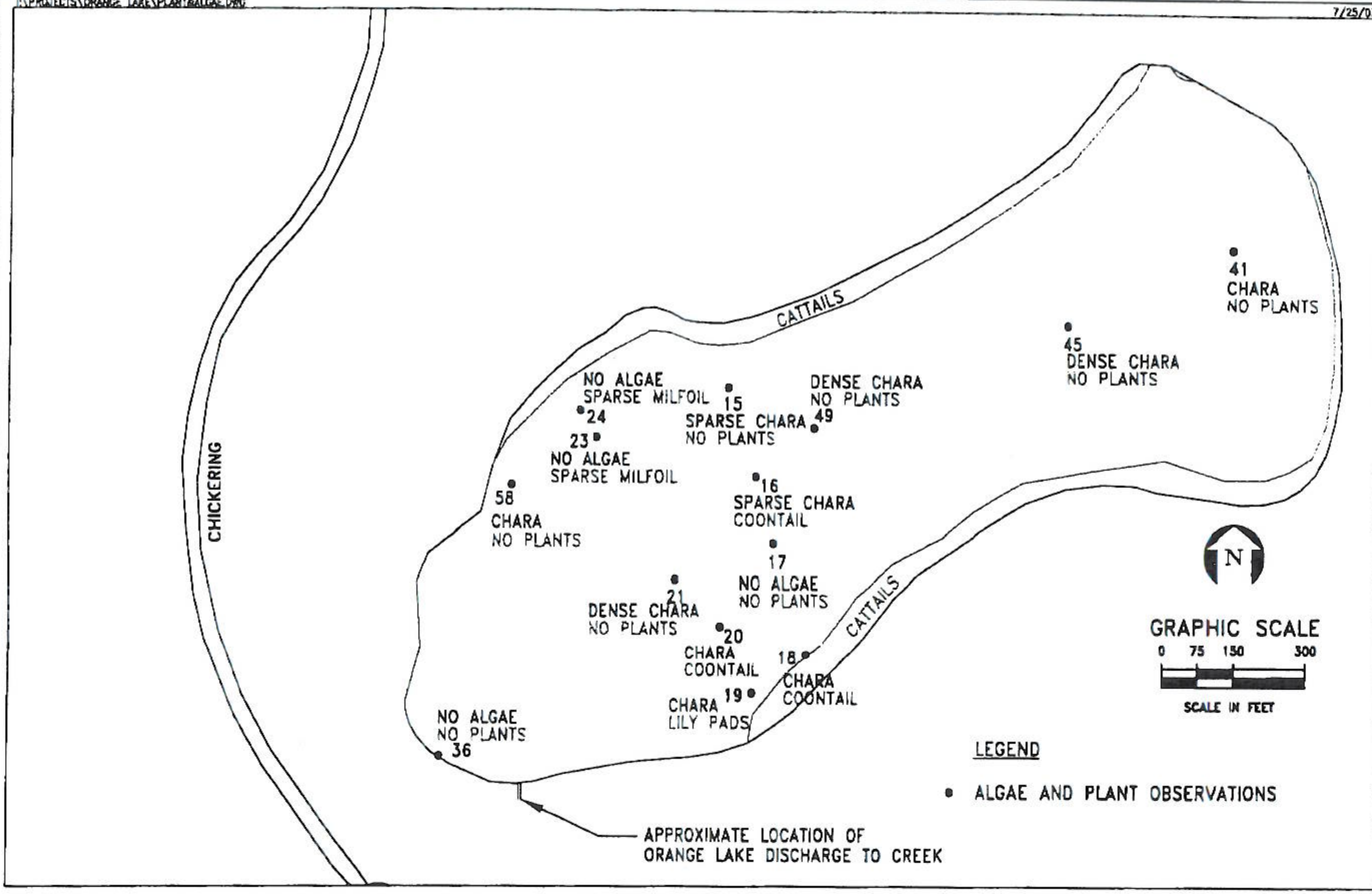


FIGURE 6.
ALGAE AND PLANT OBSERVATIONS

Source: ECT, 2003.

ORANGE LAKE
BLOOMFIELD TWP., MI

ECT
Environmental Consulting & Technology, Inc.
The Dime Building
719 Griswold Street, Suite 820
Detroit, Michigan 48226
Phone: (313) 963-6600 Fax: (313) 963-1707

6.0 SUMMARY OF FINDINGS

- *Chara* is the dominant algae type and grows at a high density in the northeastern portion of the lake.
- Eurasian water milfoil, American Elodea, and coontail are the dominant aquatic plants in the lake.
- Surface area of the lake is approximately 33 acres compared to 40 acres in 1947.
- High water temperatures (>75° F) are due to the shallow water depth.
- Nutrient accumulation is significant but not excessive (based on one time snap-shot).
  - Phosphorus is the limiting nutrient
  - Ammonia is present at concentrations that may be toxic to fish.
- Dissolved oxygen concentrations are severely depleted at many locations, particularly in the eastern half of the lake.
- Sediment accumulation is widespread in the lake with an average thickness of about 6 feet.
- Sediment accumulation has been greatest in the eastern half of the lake over the last 55 years.
- The volume of accumulated unconsolidated sediment is estimated to be approximately 343,000 cubic yards.
- The spring has prevented sediment accumulation and provided better oxygen levels in the western portion of the lake.

7.0 RECOMMENDATIONS

The following recommendations provide the Orange Lake Improvement Board with some lake management starting points to solve the issues associated with the lake.

7.1 AQUATIC PLANTS AND ALGAE

Chemical treatments to control aquatic plants and algae will provide temporary relief to the issues associated with them. However, based on the time in the season this activity should be contracted to start in 2004. This is based in part on the 30-60 days required to obtain a Michigan Department of Environmental Quality (MDEQ) permit. Therefore, it would be at the earliest mid September before a potential treatment could be scheduled and a treatment at this time would be an unwise use of scarce funds. Starting in spring 2004 a program of about 5 treatments of Diquat a season (late spring – early fall) should be considered. This would include 3-4 whole lake algae treatments for *Chara* control.

It should be noted that in areas of water depth less than approximately 20-inches, chemical treatment might have minimal effect. This is in large part due to the chemicals rapid absorption and neutralization by the sediments. The treatment chemical, Diquat, is a positively charged ion, and soils and sediments tend to strongly adsorb positively charged substances. In these areas either no action or "hard raking" from a low draft boat or in waders is the best short-term solution.

Task:	**Estimated Cost:**
MDEQ Permit Fee:	$800
Chemical Treatment:	$9,000 - $11,000

7.2 DREDGING OF SEDIMENTS

Serious consideration should be eventually given to formulating a dredging plan. Since sediment accumulation has resulted in the very shallow water depths of the lake and the nutrients that are contained in sediment provide an ongoing source of "food" for the plants/algae, a dredge plan is recommended. However, dredging the entire lake is an expensive prospect, based on an estimated >300,000 cubic yards of unconsolidated sediments.

Dredging: 343,000 @ \$6.5 yd^3 = \$2,315,250 (excluding engineering and permits)

Transportation/Disposal: 290,000 @ \$15/ton = \$4,350,000

A dredge plan can be developed based on the desires of the OLIB for a wide variety of dredging scopes including full lake dredging. For example, the OLIB may desire to have the lake in all areas to be a defined minimum water depth or for certain areas to have deep pools. Among the issues that need to be addressed prior to assessing more completely the costs of dredging include the goals of the OLIB, and the potential for sediment contaminants, and more detail on the physical characteristics of the sediment (water content, dewatering capability, grain size). One thing that is clear in any dredge plan to be developed the requirement for a minimum sediment cover to be left on the bottom of the lake. This is necessary to maintain the basic geological and hydraulic conditions of a spring feed lake and to prevent the lake from becoming "sterile" (i.e. no macroinvertebrate habitat). The other major factor influencing the costs for dredging is the availability of sediment disposal areas (in lake, near shore or landfill). These are the types of issues that would get resolved during the development if a dredge plan. Cost aside, dredging is the only way for this lake to increase the depth of the water and greatly aids in the control of aquatic plants.

Example of Differing dredge concepts:

1. Making the in lake portion of the lake close to the water depth of 1947 would yield a removal of approximately 80-100,000 cubic yards. A dredging cost alone of approximately \$650,000.
2. Making the lake a minimum depth of 4 feet would yield a removal of approximately 60,000 cubic yards. A dredging cost of approximately \$390,000.

However, as stated earlier, the OLIB needs to define what they would like to see in the final lake first before time and money should be spent on dredging due to its inherent cost.

Estimated Cost:

Sediment dredge sampling & analysis:	$5,000
Dredge Plan Development:	
Small area /basic:	$30,000
Other	$70,000 - $200,000
MDEQ Permit Fee:	$2,000
Dredging & Construction Management:	? based on cubic yards Estimate $10/yd^3

7.3 NUTRIENT DISCUSSIONS

Regardless of whether either of the aforementioned recommendations pursued, further discussions/investigations of sources of nutrients should be completed. Limiting the sources of nutrients into the lake will in any type of treatment option assist in the continued recurrence of plants/algae.

Potential sources to be discussed would include:

- Runoff from the entire high school property appears to be collected in an on-site collection drain and discharged into the lake. Both dry weather and wet weather sampling of this discharge is recommended.
- Lawn fertilization. Do all riparian residents use buffer zones before lake or low nitrogen/phosphorus fertilizations? A "Lake Friendly" lawn program could be established through some public outreach and education.

7.4 WATER QUALITY MONITORING

A continued water quality-sampling program should be established. ECT was able to provide a snapshot of conditions, however, any lake management approach is only as good as the data that is collected over time. A monitoring plan could be established that utilizes a consultant, a volunteer program, or through the high school, supplemented with volunteers or consultants. Sampling should take place throughout the year and on a monthly basis from April – October in order to maintain a representative picture of water quality.

Given a little oversight, volunteers and students can collect good data and since water quality monitoring is a labor intensive endeavor the use of these individuals greatly reduces the cost.

7.5 GRANTS

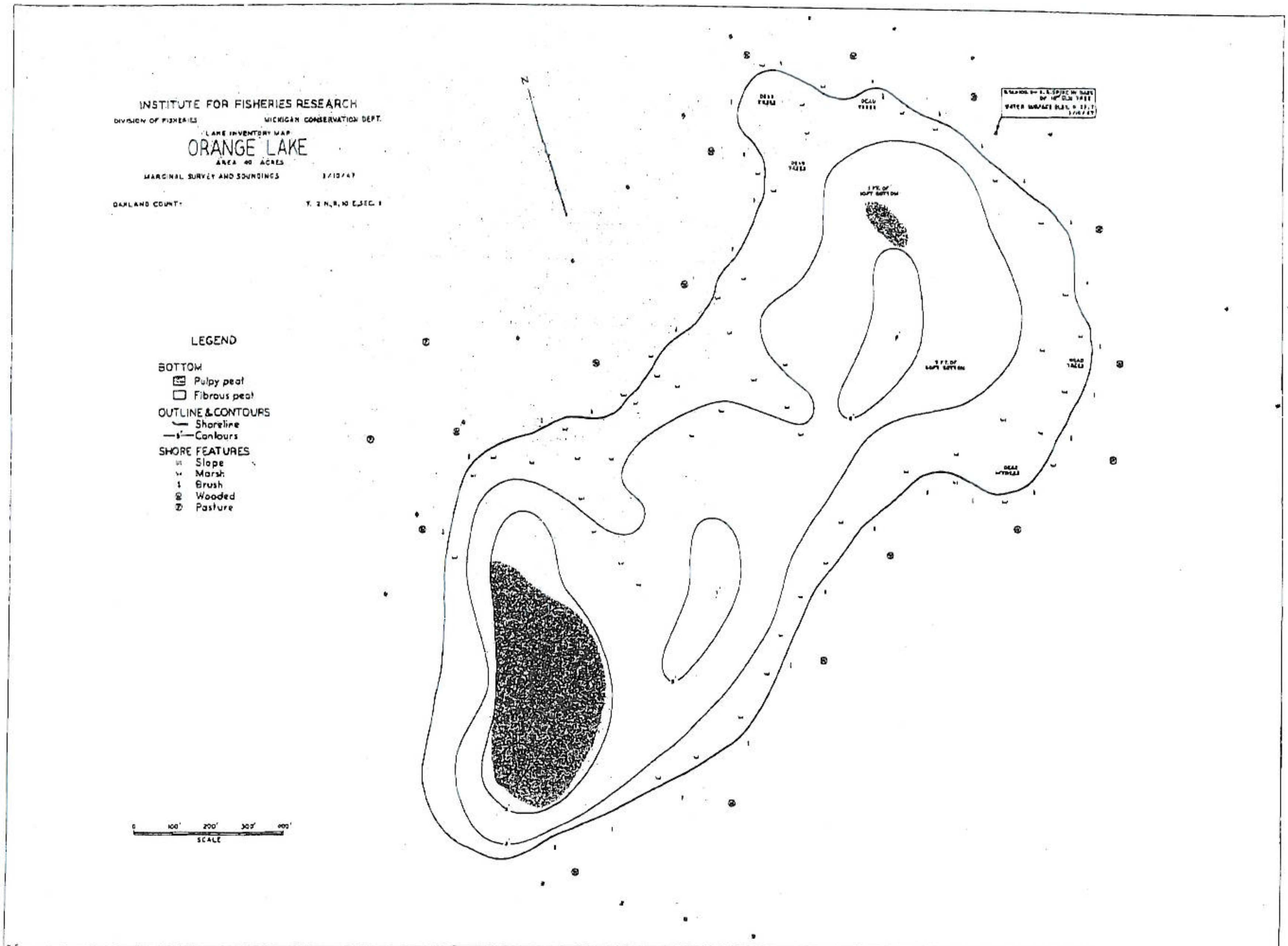
Due to the fact that Lahser High School is located on the lake and therefore there is direct public access (and ownership), grant submittals should be strongly considered. A public entity such as the school district or the Township would need to act as the fiduciary in most grant submittals. The fiduciary would be required to provide a percentage of the amount requested for a match. Match requirements vary from funding source. For example it could be a 50/50 project, with half the cost to be provided by the grantee. Match can consist of hard money (cash payments) or in-kind services. In-kind services could include grantee or other volunteers' time spent working on the project. This can greatly reduce the amount of total hard dollars needed. It is recommended that the OLIB as a minimum measure discuss the possibility with the school district and the Township.

7.6 IN SUMMARY

1. Define final lake
2. Chemical lake treatments to begin in 2004
3. Nutrient sources
4. Water quality sampling
5. Sampling to support sediment dredge plan
6. Dredge plan development
7. Grant submittals. Fiduciary discussions
8. Grant application submittals

APPENDIX A

1947 Orange Lake



ORANGE LAKE Oakland County T. 2 N., R. 10 E., Sec. 9