NORTHERN LAKE SERVICE

GROUND HEMLOCK LAKE, RT. 1 • CRANDON, WISCONSIN 54520 • (715) 478-2777

May 25, 1977

Mr. Oliver Williams, Director
Office of Inland Lake Renewal
Wisconsin DNR, P.O. Box 450

Dear Mr. Williams:

Attached herewith are the data collected during the second quarter of the Pine Lake Study. Please replace appropriate first quarter report pages with these updated ones and add any new pages to bring your files on this study up to date.

The study is progressing smoothly with good in-kind help from the district. As with our other studies, the cold, dry winter caused frozen and dry wells, but this problem disappeared with the coming of spring.

A reliable stage-discharge curve has not yet been developed on the Wolf River below the lake. A few more gagings at the lower end should suffice. Included are the instantaneous flows obtained by direct gaging.

The macrophyte surveys have been scheduled for June 27-28 and August 4-5.

Yours truly

Ron Krueger

Ron Krueger

copy: Pine Lake District

NORTHERN LAKE SERVICE

GROUND HEMLOCK LAKE, RT. 1 • CRANDON, WISCONSIN 54520 • (715) 478-2777

June 30, 1977

Mr. Oliver Williams
Office of Inland Lake Renewal
Wisconsin DNR, Box 450
Madison, WI 53701

Dear Ollie:

When daily flows were determined for Pine Creek on the Pine Lake Study, we mistakenly calculated for only one of the two weirs on the outlet structure and reported these results in the second quarterly report. The enclosed pages are corrected values. Please discard the appropriate pages in your copies of the report and replace them with the corrected enclosed pages.

Yours truly

Ron Krueger

copy: Pine Lake District

NORTHERN LAKE SERVICE

GROUND HEMLOCK LAKE, RT. 1 • CRANDON, WISCONSIN 54520 • (715) 478-2777

January 27, 1978

Pine Lake District
% Mrs. Grace Winkler, President
Rt. 1
Hiles, Wisconsin 54533

Dear Commissioners:

Enclosed herewith is the final report on the data collection survey recently concluded on Pine Lake, two copies of which have been mailed to the Office of Inland Lake Renewal.

Also included are two copies of our final accounting of the project: one is for your records and the second might be useful should the State audit your records. As has been the case with our other studies, the final cost figure is lower than the bid price due to such factors as our inability to install three wells and samples which were not collected due to frozen wells, etc. Only items completed were charged to the district.

We enjoyed working the Pine Lake study and were happy to see the in-kind participation which will undoubtedly lead to a better understanding of the lake by those individuals who were involved. The macrophyte and sediment surveys were particularly fun.

Rick and I included some general interpretations of the data in the report and some very general management alternatives. No doubt the boys in Madison will be more specific. On page 5 of the report is a rather unscientific interpretation of the trophic status of the lake. While I hesitate to use this "symptoms" approach, it may be more easily understood by laymen than wading through the data. I will be happy to explain the study results at your annual meeting next summer if you feel it would be helpful.

Good luck on your lake management efforts. We're always available if you need future help.

Yours truly

Ron Krueger

Ron Krueger

LIMNOLOGICAL STUDY OF

PINE LAKE, FOREST COUNTY, WISCONSIN

NOVEMBER 1976 THROUGH OCTOBER 1977

by

Ronald Krueger and Richard Martens

Northern Lake Service, Inc., Crandon, Wisconsin

Submitted January 27, 1978

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INTRODUCTION AND FINDINGS

In compliance with Chapter 33 of the Wisconsin Statutes, and Chapter NR60 Wisconsin Administrative Code, the Pine Lake Protection and Rehabilitation District, contracted with Northern Lake Service of Crandon, Wisconsin, on June 2, 1976, to carry out data collection survey as outlined in Department of Natural Resources specifications of February 21, 1976. The purpose of this data collection survey was to provide hydrological and limnological information on which personnel from DNR's Office of Inland Lake Renewal may base lake protection, management, and/or rehabilitation alternatives.

This final report contains all the data collected during the twelve month study and general interpretations of the data.

The study design called for an extensive ground water survey to identify vertical and horizontal flows and ground water chemistry evaluation. The in-lake portion of the study consisted of Secchi disc readings and Chlorophyll a determinations, and extensive macrophyte surveys in June and August, and a depth of sediment survey conducted in January, 1978. The watershed portion of the study was conducted to determine flows and water chemistry evaluation of Pine Creek and the Wolf River.

The lake district furnished a substantial portion of the study labor needs including providing help on well installation and monthly well sampling and sample delivery, providing help during the macrophyte and sediment surveys. This use of district personnel served as an educational tool which should help the district people understand the intricacies of lake management when making future decisions regarding protection and rehabilitation techniques.

As a result of knowledge gained through this study and other available information, the following general statements may be offered:

Pine Lake is a natural lake with a level artificially established about one foot above the apparent natural lake level. The lake is large (1,670 acres) and shallow (maximum depth of 16 feet, average depth 9.5-10 feet).

Pine Lake with its tributaries is the headwaters lake for the main stem of the Wolf River drainage basin. Ground water flows toward the lake, both vertically and horizontally, at all points where piezometric observations were taken. Rough calculations indicate that less than five percent of the

in-flow to the lake is due to horizontal ground water flow. Approximately thirty percent comes from Hiles Pond via Pine Creek. Wildcat Creek and the two small intermittant streams on the east shore probably supply twenty to thirty percent. Twenty to forty percent is unaccounted for, but vertical ground water contributions are included in this category. Measured outlet flows may be somewhat high due to the location of this gaging station being about one mile downstream.

Hydrologic and nutrient balances are difficult to quantitate because the survey began during a drought and ended during a rainy recovery period. Thus, ground water and surface water data is not easily interpreted.

Ground water nutrients were extremely low, however the upward vertical flow patterns may have precluded observing the affects of septic systems because samples were collected from a point three feet beneath the water table, septic system discharge might be expected to remain near the surface of the ground water under vertical recharge conditions.

Surface water nutrients in Pine Creek were low to moderate; levels were what might be expected from a eutropic impoundment like Hiles Pond. Wildcat Creek water chemistry is probably similar to that of Pine Creek since it drains a marshy waterfowl area to the southwest. The streams entering from the east are intermittant and drain wooded areas, thus they are probably not major nutrient sources. The reduction in nutrient content noted in samples collected from the Wolf River at the dam indicates that some nutrient retention does occur in the lake.

The shallow nature of Pine Lake makes it a very efficient nutrient system. Thermal stratification does not occur and with sunlight available to plants in up to twelve feet of water, much of the lake is available for primary plant production. The result is a fairly productive macrophyte community and an excellent fishery.

The plant community is diverse with over twenty species of macrophytes identified during this study. Secchi disc visibilities exceeding six feet on most occasions and moderate chlorophyll a concentrations suggest a good balance between macrophytes and planktonic algae. No "pea soup" algae blooms occurred during the hot, dry survey period; algae is apparently seldom a nuisance. Weeds do become a nuisance in some areas, however, particularly at the north end of the lake. While weeds do occupy the deeper areas of the lake, only in a few areas were they close enought to the surface to foul an outboard prop during the survey year. Reportedly,

this changes from year to year with some years being more severe than others. The biggest weed related nuisance appears to be the accumulations of wind broken and cut weeds along windward shorelines.

Pine Lake produces an excellent fishery. Northern pike, walleyes, bulegills, pumpkinseed sunfish, crappies, large-mouth bass, and perch are harvested in large quantity, summer and winter from what is probably the best fish producing lake in the county. There is some evidence of stunting of bluegills and perch, but the other species observed during the survey year appeared in healthy balanced populations. These were merely casual observations. DNR fish management personnel are better qualified to discuss the fishery.

The excellent fishing was undoubtedly the drawing card for early development of Pine Lake as a residential and seasonal recreational lake. Development apparently began several decades with the similar haphazzard development patterns seen on most early developed lakes. Subdivisions sprang up with little regard to septic system suitability, lot size, waterline setbacks, or shoreline protection. This is especially true along the low lying western shore of the lake. The most obvious symptom is reduced shoreline aesthetics. The presence of man does not go unnoticed. The vastness of the lake area does have a tendency to dilute this deterring feature,however. The natural shoreline adjacent to the National Forest Campground and the state owned land at the far north end of the lake also provide a refreshing view of wild shoreline.

The sites chosen for ground water evaluation did not pick up septic system influences, however, with the type of systems which generally accompany prezoning develpment, we feel that there is definitely some nutrient contribution arising from this source. Considering the vast volume of water in Pine Lake (16,000 acre feet), the nutrient additions may not be significant to productivity and eutrophication, but even so, the public health implications should not be regarded lightly. Many systems were on land so low that the drain field had to be submerged in the ground water. Others were on steep slopes toward the lake. Still others were very close to the lake.

Autochthanous sedimentation has filled about a third of Pine Lake's original volume. This process has taken about 10,000 years, so fears of an early death for Pine Lake seem unwarrented at this time. Given the shallow nature of the original basin (about 30 feet) it is likely that productivity has not drastically increased during the past several hundred years.

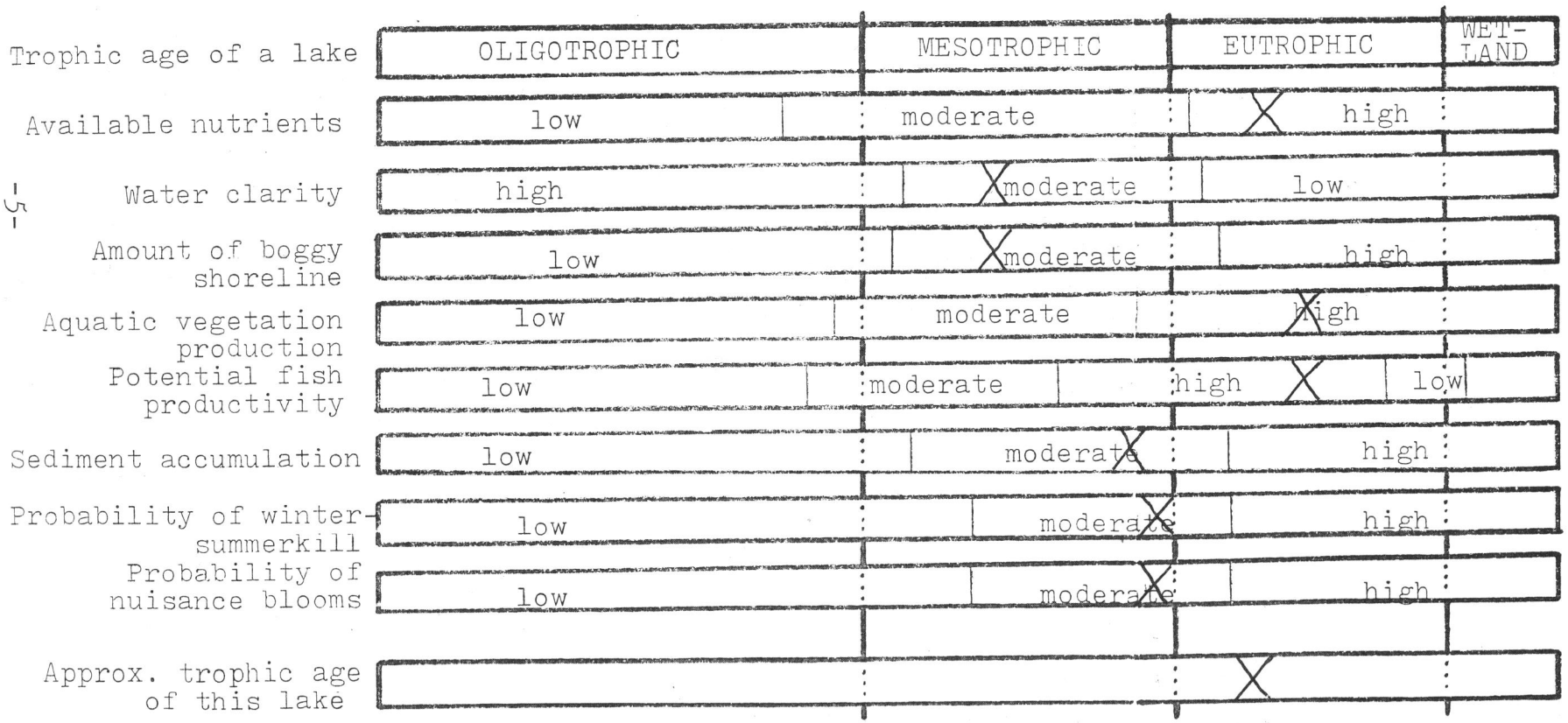
In summary, Pine Lake is a eutrophic lake which provides excellent fishing, good boating, and fair swimming and aesthetics. As such it serves as an important recreational

resource to Forest County, particularly with regard to the excellent fishing. Residential development is moderately dense and reduces shoreline aesthetics in some areas. Septic systems are generally old and obsolete and probably contribute nutrients to the lake system, however such contributions may well be insignificant to productivity. Lake weeds occasionally create a nuisance to swimming, boating, and fishing.

THE TROPHIC EVOLUTION OF A LAKE

All lakes are subject to evolution from a sterile, oligotrophic lake to a fertile, eutrophic lake. This aging process is known as eutrophication. If eutrophication is caused by the natural chain of events, and not interfered with by man's endeavors, water quality and recreational values will usually deteriorate at a negligible rate. In general, oligotrophic and early mesotrophic lakes are more suitable for swimming and boating. Late mesotrophic and eutrophic lakes produce more fish and are more highly valued as waterfowl habitat; but water clarity, bottom type, and profuse vegetation might interfere with the recreational value as a swimming and boating lake.

If there were such a thing as a "typical" lake, the characteristics in the chart below might help to describe the life cycle of a lake. An attempt has been made to interpret the age and best recreational potential of the lake surveyed using these criteria.



RECREATIONAL USE POTENTIAL 0 = Lowest 7 = Highest

Aesthetics 3 Small Boats 3 Large Boats 5 Swimming 3 Fishing 7 Waterfowl 3

PINE L.

Opinion by: Rod Krueger Northern Lake Service

LAKE MANAGEMENT ALTERNATIVES

Two conditions are considered problems by property owners on Pine Lake: sediment accumulations on the north end of the lake and excessive lake weeds. The large surface area of the lake makes both these problems difficult to deal with.

Weed beds are present in over 1000 acres. Many of these areas are in deep water where weeds are present in varying densities and generally do not reach the surface. These weeds are seldom a severe nuisance in the areas where they grow, but do supply the windward shores with nuisance amounts of broken plant material. Chemical treatment of these areas would be prohibitively expensive (over $200 per acre for herbicides alone in 8 feet of water), and probably not environmentally sound. Harvesting might also be difficult if weeds are not close enough to the surface for the operator to see where he is going or has been. Thus, weed control efforts where submergents do not reach the surface are probably not justifiable.

Harvesting might be a good alternative in areas where water depths are four to ten feet and dense stands of submergents reach the lake surface. There are probably 300 to 400 acres in various areas which would fall into this category. Whether or not the cost of harvesting equipment can be justified for weed control in only about a third of the weed growth area will involve further study by the lake district. It appears that about sixty percent of the macrophyte biomass is produced between the four and ten foot contours. This is also the depth range in which coontail and millfoil are most often found. These should be the target species since they are most apt to break up and accumulate along shorelines.

Sediment removal by dredging has been mentioned by district members as a possible method of reducing weed producing areas. In theory dredging is probably the only real way to back up the eutrophication process of Pine Lake. The cost of any large scale dredging program probably would be prohibitive, however, and finding a disposal site to accomodate 13 million cubic yards of wet sediments would not be a simple task. (If this material were concrete, Pine Lake sediments could pave a highway 6,500 miles long!) Selective dredging at the north end of the lake has also been suggested. The benefits of such a project might be questionable since this area is mostly undeveloped.

Perhaps the most feasible management program would be

selective weed harvesting along with a district advisory suggesting a shoreline raking program to keep beach areas free of wind blown weeds and detritus. Such an advisory or lake district philosophy should also include common sense lake protection practices such as avoiding lawn fertilizing where run-off can reach the lake, proper maintanence of septic systems and private wells, establishing a natural vegitation buffer zone along shorelines, and avoiding major excavations near the lake shore.

The lake district should also support county zoning and might ask the county zoning committee to advise the commissioners of any variance requests within the district. Generally county and town governments will respect the lake district's opinions concerning variances, zoning changes, registered plots, etc. within the district. A working relationship with the local town and county zoning administrator can result in district participation in land use decisions within the lake district.

The suitability of Pine Lake for most recreational purposes is high. Compatibility of the various uses is probably not a problem at the present use densities. Should motorboating and skiing become a future problem, the district might request that the township establish "quiet hours" for fishermen and solitude seekers. The size of the lake and its feature diversity should not exclude any of the accepted recreational uses but some regulation to insure compatibility may become necessary.

The lake district might wish to formally request fish management attention from the DNR to keep a running inventory of the fishery. Fish management personnel are generally very responsive to the needs of a public access lake when the lake community as a unit shows interest and requests their help.

Any lake use and protection philosophy should promote and protect the recreational use the lake is best suited for. Fishing is Pine Lake's big attribute. District property owners should realize that, while Lake Metonga and Lake Lucerne have clearer, more "swimmable" water, they don't begin to compare to Pine Lake in the fish productivity department.

GROUND WATER STUDY

As part of the Pine Lake study fifteen sample wells and six deep (vertical flow measurement) wells were installed at eight locations around the lake. Samples were collected on a monthly basis with biweekly samplings in May through August to more accurately examine high use periods. At the time of sampling, the elevation of water standing in each pipe was measured along with the lake elevation to determine the directions of ground water flow.

A map showing the directions of ground water flow is given in this report and indicates that horizontal flow is toward the lake at all locations. The vertical flow at five of the six locations where measured is upward, with only site "B" showing a possible break in the trend. Unfortunately, this movement of ground water into the lake provides a means by which septic system wastes could supply undesireable nutrients to the lake.

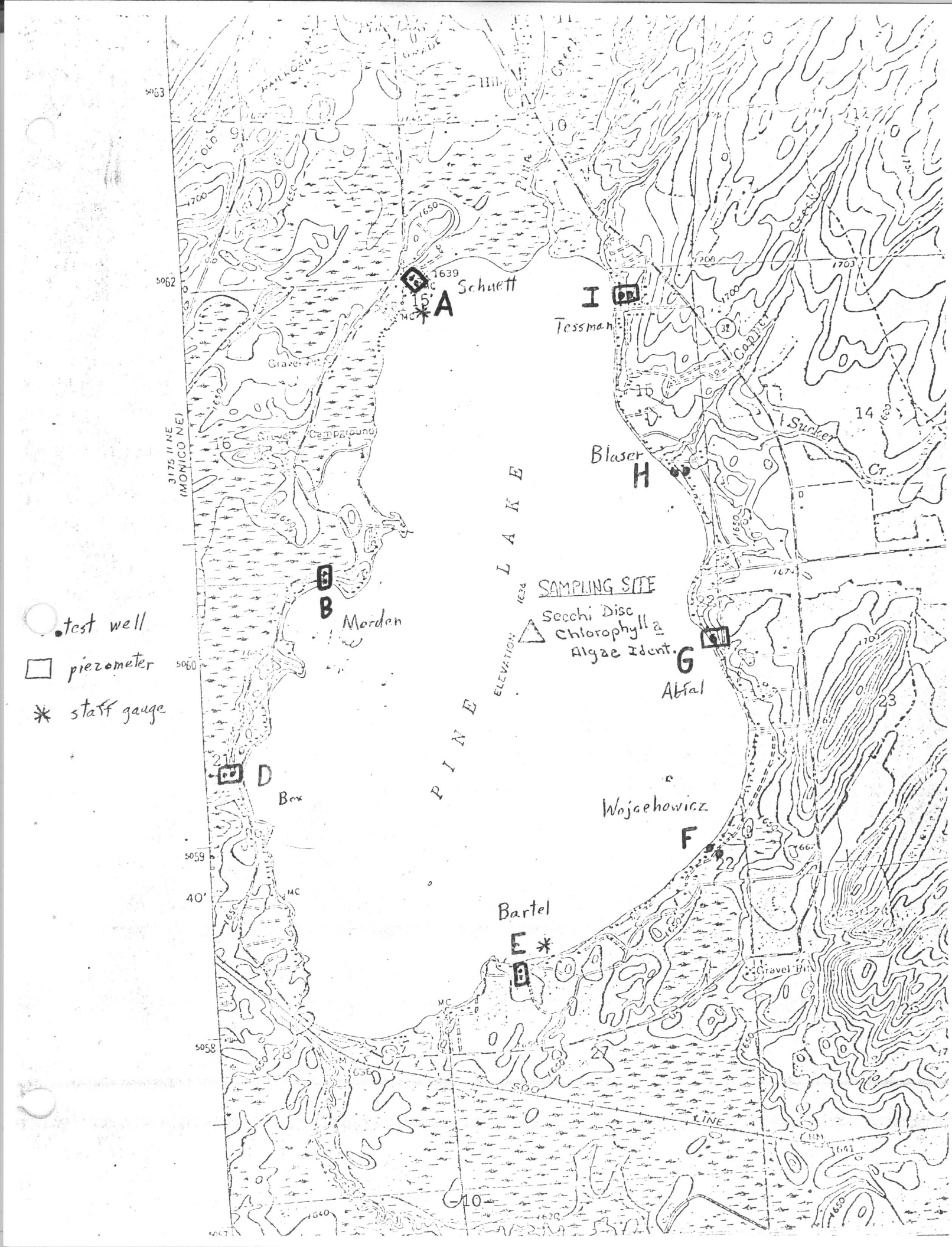
Sites for sample well installation were chosen with hopes of picking up some septic system effluents and observing their movements. However, from all the samples collected and analyzed only well "IL" shows any great variation from the off-lake well. Here the concentrations of chlorides are about five times those from well "IH" and although chlorides are good indicators of human influence they are not directly harmful to the lake.

Of greatest concern are the concentrations of nutrients which will encourage plant growth in the lake. The nutrients tested for are nitrogen, in various forms, and phosphates both of which are in very low concentrations in all samples collected throughout the study.

This does not mean that nutrients of septic system origin are not entering the lake anywhere but only that our study did not pick up any direct evidence of it. In other words, although the water chemistry data is encouraging it does not negate the possibility of localized septic system influence on lake water quality. Proper septic system installation and maintenance are still important to lake protection, especially in light of the fact that in many areas around Pine Lake the water table is very close to the surface.

The volume of ground water flow into Pine Lake is very hard to estimate, however it is probable that it accounts for only a small percentage of all the water entering the lake. During winter months when stream flow and surface run-off are minimal

the flow of ground water could be a major contributor to the lake. Fortunately, this is also the time when septic systems are being used the least. When the weather is warmer the amount of stream flow greatly overshadows the ground water inputs.


PINE LAKE
ELEVATION 1634
SAMPLING SITE
Secchi Disc
Chlorophyll a
Algae Ident.
test well
piezometer
staff gauge
A
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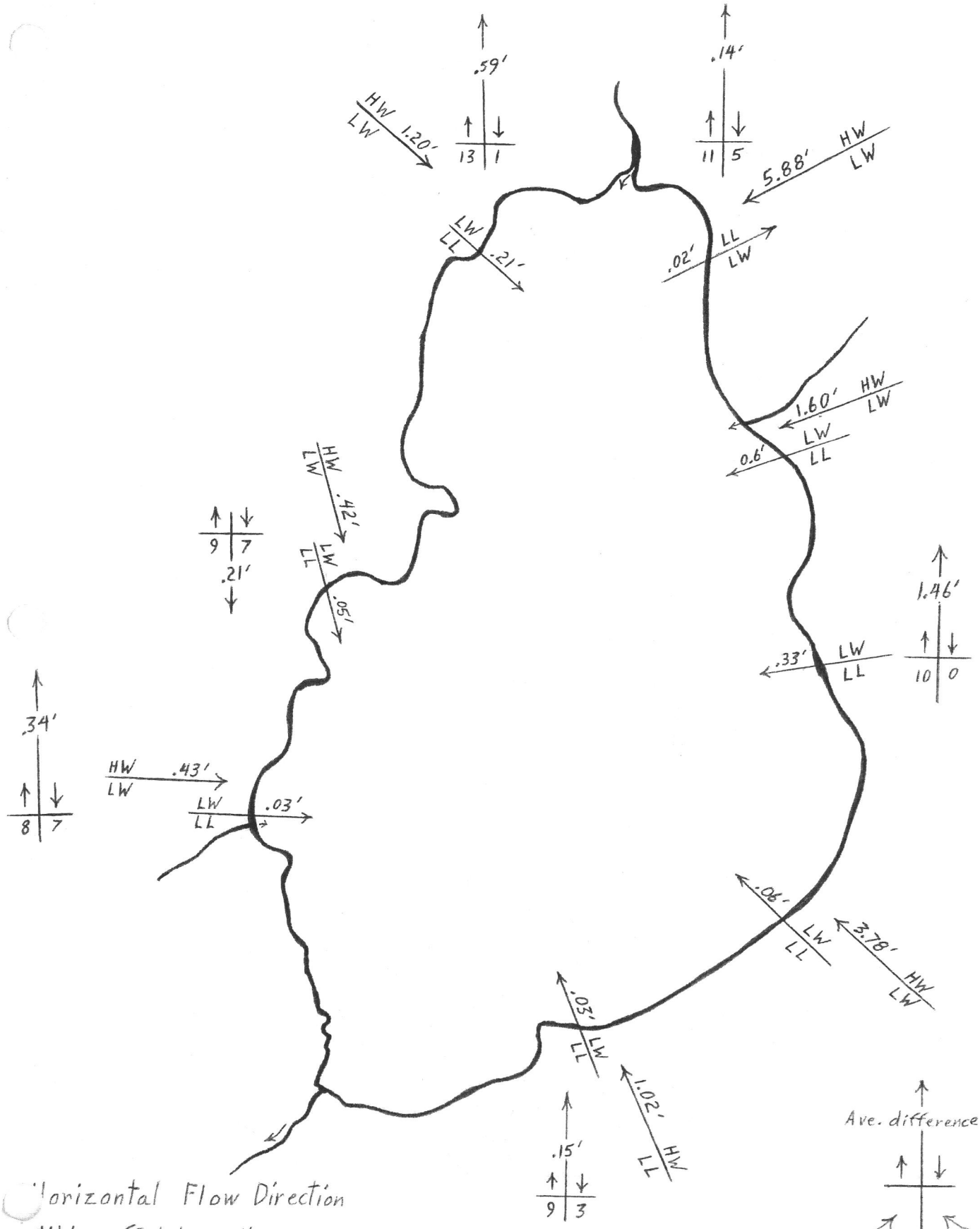
Morden
D
Box
E
Bartel
F
Wojcehowicz
G
Abfal
H
Blaser
I
Tessman
Campground
Gravel Pit
Sucker Cr.
RAILROAD
3175 II NE
(MONICO NE)
LINE

PINE LAKE GROUNDWATER FLOW



Horizontal Flow Direction

HW = off lake well

LW = near lake well

LL = lake level

Vertical FLow Direction

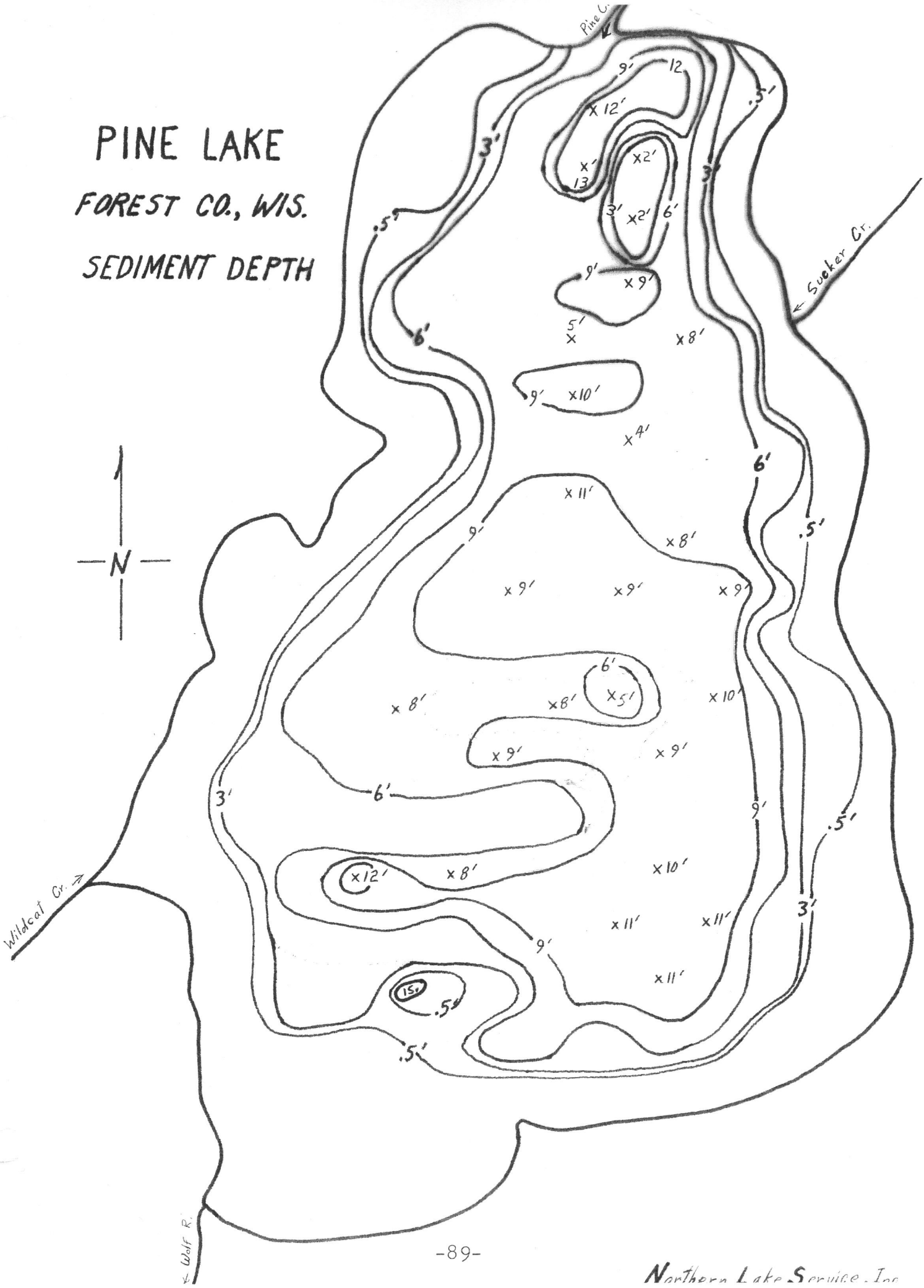
LAKE SEDIMENTS

A bottom survey was conducted on January 4 and 5, 1978, by the district and consultant to determine the depth of soft sediment. In much of the central area of the lake the twenty foot probe was not long enough to reach hard bottom, so the district used a longer pole on January 12, 1978, to recheck about twenty additional sites. Detailed isopach and hydrologic maps were drawn using this data.

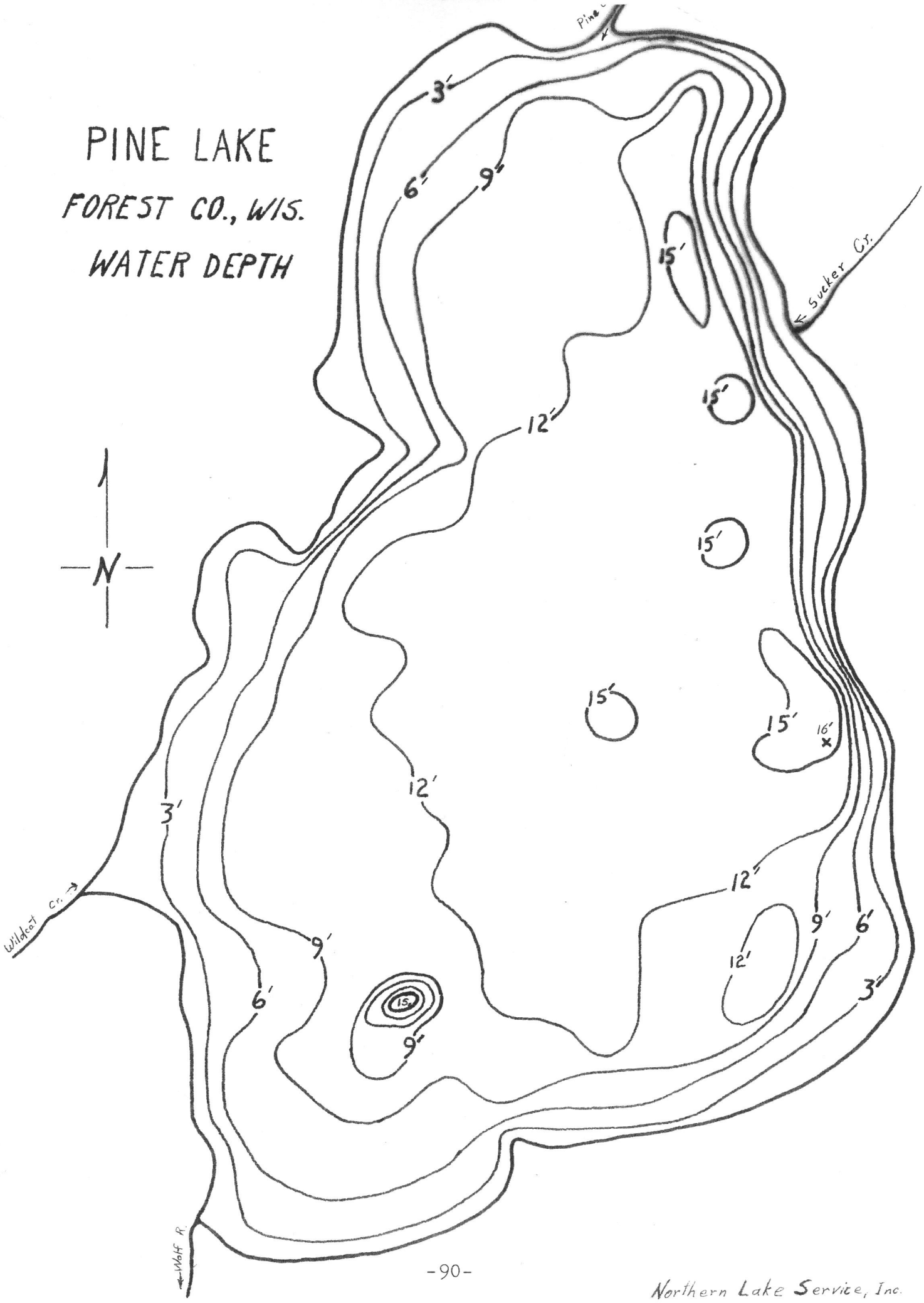
The 600 foot grid pattern appears to have produced adequate detail, however, the southeast corner of the lake protrudes somewhat, suggesting that measurements and/or directional transects could have been more accurate. The transects on the south end of the lake were run on the second day when snow squalls interferred with siting a straight line. Some of these transects were a mile and a half long. The information appears plenty accurate for the scope of this study.

Sediment depths do not seem to follow any specific pattern in the lake. The suggestion of local residents that high sediment loads were transported via Pine Creek during lumber mill days upstream is not substantiated by this survey. Somewhat higher sediment depths are noted near the mouth of Pine Creek, but this narrow north end of the lake might be considered the "leeward bay", the area in which sediments are not dispersed by wind action. Most lakes commonly have such an area where sediments tend to accumulate. If Pine Creek were a major sediment contributor, the isopach contours would indicate a delta pattern. This is not to say that Pine Creek and the other tributaries do not contribute sediments to the lake system, but it does appear that such contributions have not been significant.

Probably much of the sediments present have resulted from plant material produced within the lake. Except for the far north end, wave and wind action prevents sediments from accumulating in most shoreline areas out to the five or six foot depth contour. Thus, a sandy, relatively weed sparce area extends out from 300 to 600 feet from most unprotected shorelines.



Northern Lake Service, Inc.



Northern Lake Service, Inc.