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SPATIAL CHARACTERIZATION OF ACID RAIN STRESS IN CANADIAN SHIELD LAKES

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The lake acidification in Northern Ontario has been investigated using Landsat TM to sense lake volume reflectance and also to provide important vegetation and terrain characteristics. The purpose of this project was to determine the ability of Landsat to assess water quality characteristics associated with lake acidification. Results from this study demonstrate that a remote sensor can discriminate lake clarity based upon reflection. Our basic hypothesis is that seasonal and multi-year changes in lake optical transparency are indicative of sensitivity to acidic deposition. In many acid-sensitive lakes optical transparency is controlled by the amount of dissolved organic carbon (DOC) present. Seasonal changes in the optical transparency of lakes can potentially provide an indication of the stress due to acid deposition and loading.

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FOREWORD

The authors wish to acknowledge the helpfulness of the many individuals who contributed to this study and especially John Fortescue of the Ontario Geological Survey who organized and coordinated the August 1986 field measurements and to John Colwell and Norm Roller of ERIM who developed the approach to eco-physical stratification and who also reviewed this final report.

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1.0 TECHNICAL SUMMARY

The lake acidification in Northern Ontario has been investigated using Landsat TM to sense lake volume reflectance and also to provide important vegetation and terrain characteristics. The purpose of this project was to determine the ability of Landsat to assess water quality characteristics associated with lake acidification. Our basic hypothesis is that seasonal and multi-year changes in lake optical transparency are indicative of reaction to acidic deposition. Results from this study demonstrate that a remote sensor can discriminate lake transparency based upon measured reflectance. In many acid sensitive lakes, optical transparency is controlled by the amount of dissolved organic carbon (DOC) present. DOC is a strong absorbing non-scattering material which has the greatest impact at short visible wavelengths including TM band one. Acid sensitive lakes have high concentrations of aluminum, which have been mobilized by acidic components contained in the runoff. Aluminum complexing with DOC is considered to be the primary mechanism to account for increased lake transparency.

When eco-physical properties developed from vegetation, soil/bedrock, sulfate deposition, and topographic relief characteristics were stratified across the study regions, it was determined that these regions could be described as ten separate environments based upon a simple acid sensitivity index model. This classification of the environment predicts location of regions containing acid sensitive lakes. The spatial co-occurrence of acid sensitive eco-physical parameters showed that acidification of a lake is driven mostly by local geology and soil conditions and less by the rate of sulfate deposition. Geologies which are weather resistant containing quartz rich sandstones and other quartz rock with bare or shallow sandy soils are most susceptible to regional acid deposition. These geologies produce naturally very low buffered acid sensitive lakes, contain very low amounts of DOC, and tend to have lower values of pH.

This study involved gathering an extensive amount of supporting data from 1986 and 1987. During August 1986, data were gathered from several sites representative of the range of ecosystems found in Northern Ontario. These data include limnological parameters, subsurface spectral irradiance, subsurface beam attenuation, airborne radiometry, and Landsat TM coverage. Based on these data, lake reflectance was modelled in terms of DOC and chlorophyll-a pigment concentrations. It was demonstrated that acid lakes having abnormally small amounts of DOC show greater reflectance than lakes with normal pH and DOC values. Significant correlation was found between in-situ and above surface lake volume reflectances. The model-predicted changes in TM band one signal response were consistent with observed values.

A second data set was gathered during May and June of 1987 on eight lakes to observe possible seasonal changes in subsurface and Landsat TM reflectance measurements. It was expected that spring runoff would produce decreases in DOC concentration and an increase in reflectance as a result of aluminum complexing. Actually, seasonal changes in TM observations of the lakes were very small as were the changes in the subsurface reflectance data. The significance of these changes was doubtful. In addition, little seasonal change could be demonstrated in lake water chemistry from May to June for this data set. Many of these latter constituent concentrations were near the reported lower limit of detection. During the winter of 1986 and 1987, the precipitation was particularly anomalous. Lack of snow during the winter left water levels down an average of three to four feet in the Sudbury area during spring, 1987. The lack of snow and subsequent runoff may explain the absence of a seasonal change in TM reflectance. More extensive seasonal observations are necessary to validate the season transparency hypothesis.

An historical TM scene pair (1985-1986), however, did demonstrate multi-year changes that were consistent with expected changes in water chemistry, but lacks the chemistry and in situ optical data needed for hypothesis validation. Lakes displaying the greatest TM changes are also the ones which were identified to be in acid sensitive strata. We conclude that there is likely some seasonal changes in transparency which can be related to the acidification process but it is also likely that year to year variability is significant. Strong relationships were found between chemical and optical properties of sampled lakes and the eco-physical strata within a single date. Optical transparency in clear acidified lakes is sensitive to water quality changes.

Results show that a remote sensor can discriminate clear acid lakes from colored high DOC lakes based upon reflection. The clear acid lakes may be naturally clear. TM signals were found to be generally higher for these lakes due to higher volume reflectance and greater effective transparency. Subsurface and airborne spectral reflectance measurements confirm this result. High DOC lakes in the same sensitive environments are less prone to pH change and certainly to changes in reflectance. Many of these lakes were originally acidic and will remain so but seem to be less impacted by acid deposition than the clearer low DOC lakes. Both lake types can be distinguished by remote sensing but it is necessary to first stratify the region to identify the acid sensitive environments. When stratification of eco-physical properties is used to identify acid sensitive areas TM can be used to pick lakes which are likely to be most sensitive to acid deposition and which also are indicators of temporal change.

The opportunities for using TM to monitor multitemporal lake reflectance changes remains positive but additional data collections are considered necessary to confirm or deny the interpretations made in the present study. However, it is apparent that remote sensing of lake reflectance provides a means to identify many of these lakes and to possibly monitor their decline or recovery over extended period of time.

2.0 INTRODUCTION

2.1 STATEMENT OF THE PROBLEM

The acidification of lake waters from airborne pollutants is of continental proportions both in North America and Europe. A major problem with acid deposition is the cumulative ecosystem damage to lakes and forests. The number of lakes affected by this in northeastern United States and on the Canadian Shield is thought to be enormous.

2.2 STATEMENT OF THE OBJECTIVES

This research had three principal objectives. First, determine how lake constituent concentration and lake transparency are related to annual acidic load. Second, investigate the utility of Thematic Mapper (TM) based observations to measure changes in the optical transparency in acid lakes. Third, examine the relationships between variations in lake acidification and eco-physical properties.

2.3 BACKGROUND

Previous investigations have suggested that DOC, which originates from the dissolution of humic substances, controls transparency in many Canadian Shield Lakes (Howard and Perley, 1982). It has also been established that aluminum, which is abundant in the local rocks and soils, is easily mobilized by acidic components contained in spring runoff (Hendry and Brezonik, 1984). The presence of any significant amount of aluminum induces a loss of DOC from the water column by coagulation and complexing resulting in increased optical transparency. This process has not been observed in lakes with normal pH levels associated with buffered geologies. In a normal lake, transparency would tend to decrease in time with the seasonal phytoplankton productivity cycle. Thus seasonal changes in the optical transparency of lakes should potentially provide an indication of the stress due to acid deposition.

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The potential for this optical response is related to a number of local eco-physical features with soil/geology being, perhaps, the most important. Other important factors include sulfate deposition, vegetation type, vegetation cover, and topographic relief. The area of northern Ontario under study contains a wide variety of geologies from acid-sensitive quartzite to acid-insensitive dolomite. Annual sulfate deposition ranges from 1.0 to 4.0 grams per square meter (Environmental '82 Committee, 1982).

An acidifying lake undergoes a process of decay known as oligotrophication. Fewer and fewer ions of acid within the lake can be neutralized by the biological community. Increasing acidity further hampers the normal biological processes. Even though the acidity is not yet fatal to most fish, the lake is considered acid-sensitive and scientists would most like to monitor a lake at this delicate point. An acid-sensitive lake is thought to have, in general, high aluminum ion concentrations, low pH values, low alkalinity concentrations, and low DOC concentrations.

Several investigators including Almer [1974], Malley [1982], Schofield [1972], and Yan [1983] have reported a reduction in water attenuation with acidification. Almer proposed that the changes resulted from probable interaction between aluminum mobilized in the watershed and DOC and argued that an aqueous solution with pH below 5 will result in the precipitation of humic substances (such as DOC) from the water column. At pH's above 5.5 the aluminum, as aluminum hydroxide, will precipitate from the water column. The concentration of soluble aluminum will increase significantly if watershed soils are acidified and thus there is correlation between dissolved aluminum and lake pH. Acidified lakes with high concentrations of aluminum should also be relatively clear because of the complexing reductions of DOC. Almer, however, suggests in lakes with very high humus the aluminum complexing does not result in precipitation. Effler's [et.al., 1985] description of experiments in Dart Lake not only confirm the strong relationship between DOC and lake transparency but also demonstrate the coagulation/adsorption of DOC by aluminum. The following discussions relate how chemical and optical properties will be effected by the acidification process.

2.3.1 PH

Many lakes in the Northern Ontario region have experienced a 100-fold increase in acidity (i.e., from pH=6.8 to pH=4.4) in one decade. Much of this is due to abnormally acidic atmospheric deposition and the low buffering capacity of the Shield. The present average acid deposition over Ontario has a pH level of 4, which is ten times more acidic than normal rain and 1000 times more acidic than neutral water. Two classifications of lakes based on pH are made most often. Lakes with pH's less than 6.5 are typically acid-sensitive lakes. These lakes have severe pH fluctuations, especially during spring thaw, resulting in obvious negative biotic impacts. Lakes with a pH of 5.0 or less can only support a few acid-insensitive plankton and are generally considered "acidified". Near pH 6.5 the effects are not as noticeable, but the pH fluctuations kill off most of the young biotic generations. The process leading to an "acidified" lake begins at a pH of 6.5. Those lakes with pH's greater than 6.5 are considered more or less "normal" and the water chemistry remains fairly stable (Environment '82 Committee, 1982).

2.3.2 Aluminum

Acidification transforms organic weak-acid dominated lakes to mineral strong-acid dominated lakes. More specifically, acidification decreases the availability of organic ligands for binding metals such as aluminum (Davis et al., 1985). As a result, aluminum ions are usually found in high concentrations in acid lakes, and aluminum ion data could be used to predict acid-sensitive lakes. High concentrations of aluminum ions will ensure the absence of fish since aluminum hydroxide forms on their gills, making it difficult for the fish to intake oxygen. In general, if the aluminum concentrations reach 200

$\mu g/l$, the lake becomes toxic to fish (Environment '82 Committee, 1982).

Since precipitation has a very low aluminum concentration, the aluminum found in a lake's water column reflects mineral weathering within watersheds or mineral dissolution from lake sediments. Therefore, we would expect that a relationship would exist between surrounding terrain and within-lake concentrations.

2.3.3 Dissolved Organic Carbon

Acidified lakes found in Norway undergo a precipitation of the colored organic matter (DOC) in the water by acid-mobilized metals such as aluminum (Davis, Anderson and Berge, 1985). Increasing mineral acids actually protonate organic molecules and increase their tendency to aggregate and precipitate. The mobilization of aluminum in inorganic form provides further charge neutralization of organic functional groups leading to their precipitation. Dissolved organic carbon measured from lake samples represents the amount of organics still within the water column and may reflect the nutrient status of the lake.

2.3.4 Alkalinity

Alkalinity is a measure of the ability of water to neutralize acid. The presence or absence of hydroxide, bicarbonate, and carbonate strongly influence the alkalinity or "buffering capacity" of a lake. Alkalinity is determined by measuring the amounts of acid required to neutralize alkaline water to pH 8.2 and pH 4.5 (pH 8.2 indicates the conversion of the carbonate to bicarbonate ions and pH 4.5 indicates the conversion of the bicarbonate ions to carbonic acid). These two acid levels determine the buffering capacity of the lake. A pH of 7.0, that of neutral water, bears little significance in the determination or expression of alkalinity (Chow, 1964). Therefore, alkalinity levels provide information not acquired with pH data alone.

When using Total Inflection Point (TIP) as a measure of alkalinity, an acidified lake is indicated when the TIP is less than or equal to zero (Keller and Pitblado, 1985).

A review of the literature shows that in-lake pH levels, and concentrations of DOC, aluminum and alkalinity all indicate the acid sensitivities of a lake. These parameters, however, are not just a function of in-lake processes and atmospheric loading; they are also a function of terrigenous loading, i.e., a function of bedrock, soil, vegetation, and possibly terrain relief (Effler, Schafran, and Driscoll, 1985).

2.3.5 Optical Effects

The bio-optical state is a measure of the total effect of biological and chemical processes on the lake optical properties. This concept maintains that diverse constituents in natural waters can be described by a few optical parameters which represent a meaningful average estimate of the material present at any time and place.

The reflectance of a lake is optically determined from the scattering and absorption processes which occur in the epilimnion (i.e. to the depth where the downward irradiance medium can be predicted by means of the radiative transfer equation). The absorption and scattering properties are inherent optical properties and do not depend on the light field external to the medium. There are three inherent properties which together are sufficient to describe the behavior of light in the medium. The absorption coefficient is the fraction of energy absorbed from the collimated beam per unit distance traversed in the medium. The scattering coefficient is the fraction of energy which is scattered out of a collimated beam per unit distance traversed by the beam. The volume scattering function describes the fraction of energy scattered in a specific direction per unit scattering volume. These three inherent properties can be used to predict the subsurface irradiance reflectance which is described as an apparent property of the medium. The subsurface reflectance can in turn be related to the above surface upwelling radiance which is also controlled by the radiance distribution parameters and the Fresnel transmittance. This latter radiance is a component of the radiance observed by an airborne radiometer or by Landsat TM.

The scattering and absorbing agents in natural waters can be divided into three categories: water, dissolved materials, and suspended materials. If the absorption and scattering characteristics of the medium are known, the behavior of light with the suspended and dissolved materials in the water column can be estimated. The reflectance can be related to the constituent concentrations using a simple model described later in Section 7.0 since the absorption and scattering coefficients for constituents are additive.

For lakes in slow-weathering soil/rock conditions the amount of suspended mineral content is minimal. The remaining components in these lakes which have an optical impact are chlorophyll-a pigment and DOC. Both of these components have large absorption coefficients in the blue-green spectral region. Scattering by chlorophyll-based phytoplankton is small so we are essentially dealing, in many cases, with an aquatic medium which is dominated by absorption. An increase in DOC results in increased absorption and a decrease in reflectance. Since the absorption cross section for DOC is large in the blue-green spectral region, small changes in the DOC concentration may produce significant changes in reflectance especially when the base concentration is low.

2.4 DATA COLLECTED

Water quality parameters were measured along with in-situ optical data in representative lakes of the Canadian Shield. This was done to calibrate a Bio-Optical Model which defines the linkages between the acid-deposition induced chemical lake processes and the upwelling radiometric signals measured by the Landsat Thematic Mapper sensor. A spring/summer TM scene pair and companion field measurements were obtained for the selected study sites located in northern Ontario.

These data will be used to investigate possible formulations of the multitemporal remote sensing causal relationships between water chemistry and observed changes in water transparency.

2.5 DESCRIPTION OF THE STUDY REGION

The study region of Northern Ontario consisted of four principal sites located within the following three Landsat scenes: Sudbury, Algoma, and Dorset. Relative locations of the study sites are shown in Figure 2.1 and their general characteristics are described in the section below.

2.5.1 Sudbury Site

Location: The Sudbury Site is located within the Landsat TM scene 19-27 and has the following coordinates:

Upper Left: 47^{o} 40.05' -80^{o} 49.40'
Lower Right: 46^{o} 16.51' -80^{o} 36.50'

Geology: The geology of the Sudbury site is dominated by the Lorrain formation which consists of quartzite, arkose, quartz sandstone, micaceous and aluminous quartz sandstone, quartz feldspar sandstone, and minor conglomerate and siltstone. Mafic intrusive diabase and granophyte dikes and sheets are distributed evenly throughout the site except near lake Wanaptei Significant amounts of conglomerate, sandstone, siltstone and argillite are found in the southern half and northern tip of the site. In addition scattered areas of felsic intrusive and metamorphic rocks, and felsic to intermediate metavolcanics occur.

Vegetation: Approximately 65% of the test site has conifer forest cover and approximately 35% is classified as mixed forest.

Soil Sensitivity: Approximately 90% of this site has low potential to reduce acidity and the soil is predominantly shallow. The remaining 10% of the site has a moderate potential to reduce acidity with shallow soils and ultramafic bedrock.

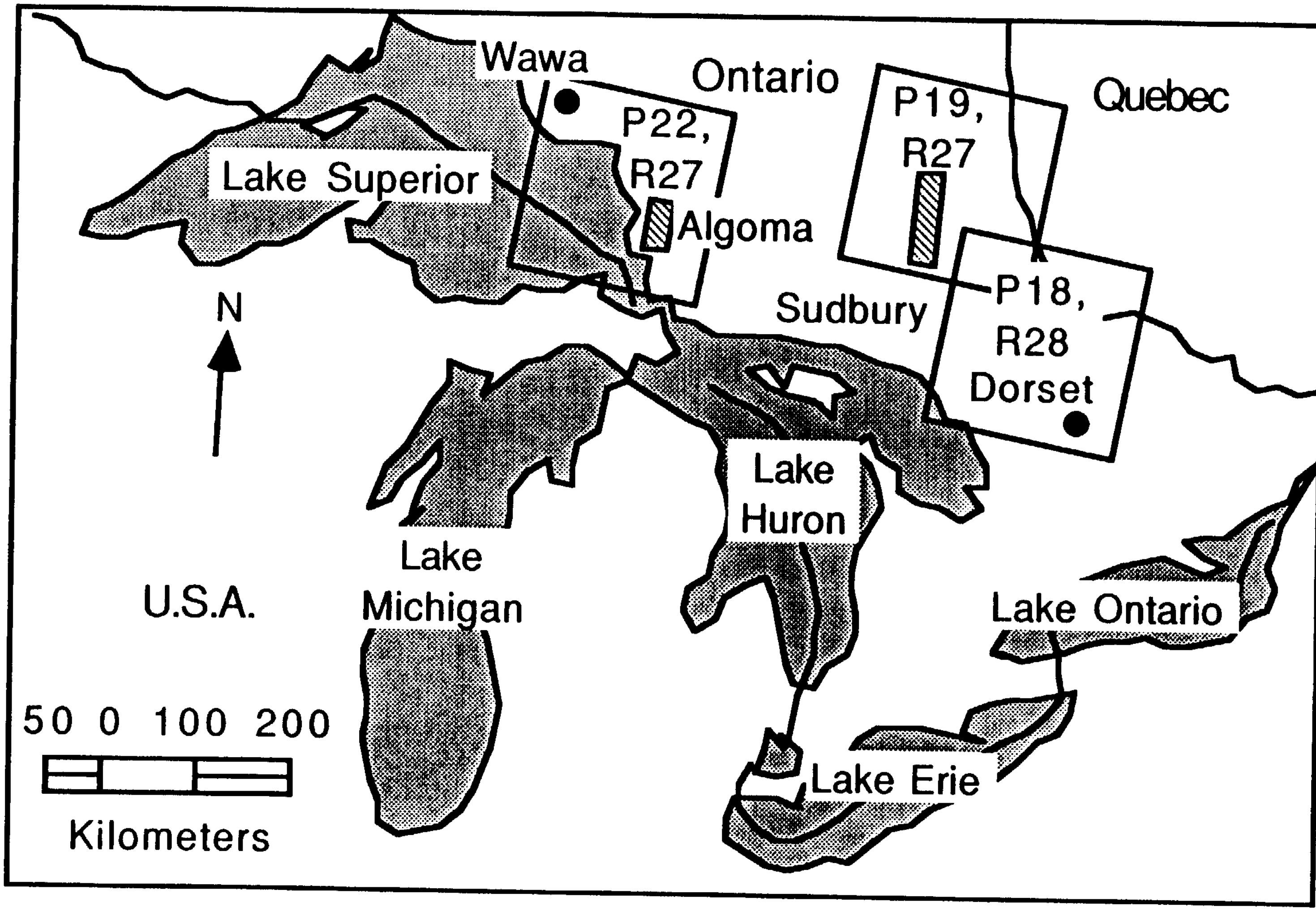


Figure 2.I. The Location of the Three Study Areas

Limnology/Water Chemistry: The quartzite regions have very transparent lakes (e.g., Sunnywater has a Secchi depth of 25-30 meters) with high concentrations of aluminum, low pH values (4-5.5), low DOC concentrations, and metal fallout from the Sudbury smelter. The dark humic lakes tend to have higher pH values.

Acid Deposition: Annual deposition in 1982 was 1.24 g/m^2 of sulfate

2.5.2 Algoma Site

Location: The Algoma site is located within the TM scene 22-27 and has the following coordinates:

Upper Left: 47^o 21.5', -84^o 25.8'
Lower Right: 47^o 00.0', -84^o 13.8'

Geology: Granitic rock predominates (60%) in the Algoma site and is concentrated in the northeast and southwest corners. Approximately 25% of the geology consists of acid to intermediate metavolcanics and 15% is basic and undifferentiated metavolcanics. Several lakes are situated in greywacke-slate-arkose and grabbro formations.

Vegetation: Hardwood forests predominate (Sugar Maple, Birch, Trembling Aspen) with a few mixed stands in the lowland areas (White Birch, Black Spruce, and White Spruce).

Soil Sensitivity: The northern half (approximately 55%) of the site has a high sensitivity to acid deposition with 0.25 to 1 meter soil depth with sandy texture and granite and associated alkalic bedrock. The southern corner(5%) is the same as the northern half of the site. A moderate potential to reduce acidity is found in the southern part of the test site (35%), which stems from a differing bedrock (ultramafic serpentine, non-calcareous silicic sediments and anorthosite)

Limnology/Water Chemistry: Lakes in this region are less transparent due to a higher DOC content. Levels of pH are typically between 5 and 6.

Acid deposition: Annual deposition of sulfate 1.5-2.0 g/m^2

2.5.3 Dorset Site

Location: the Dorset site is located near the southern edge of TM scene 18-28.

Geology: Acid intrusives occur throughout this area including granite, syenite, granite gneiss, grantized sedimentary and volcanic rocks.

Vegetation: Predominantly hardwoods (Sugar Maple, Red Maple, Yellow Birch, Trembling Aspen) occur in this area. Hemlock and Eastern white pine are found in selected areas.

Soil Sensitivity: The Dorset area is in the center of a large region of high deposition. West of Dorset there is less than 50% exposed bedrock and to the east 50 to 75% is exposed.

Limnology/Water Chemistry: Lakes in this region are poorly buffered. DOC levels are higher and secchi depths are lower compared to the Sudbury area.

Acid Deposition: Annual deposition of sulfate 2.90 g/m^2.

2.5.4 Wawa Site

Location: The Wawa site is located northeast of Wawa, Ontario near Michipicoten Bay.

Geology: The northern third of the Wawa site consists of mafic metavolcanics. Felsic metavolcanics occur in the southern tip of the site and are also interspersed with metasediments (conglomerate, greywacke, shale, arkose, and quartzite) near the middle of the site.

Vegetation: This site contains large non-vegetated areas which have been impacted by the smelter fumes from Wawa.

Soil Sensitivity: This area is primarily moderately sensitive to acid deposition. A small area of high sensitivity exists along the Maple River in the southern part of the Wawa plume.

Limnology/Water Chemistry

Lakes in this region are buffered , have higher pH values, high DOC levels, and relatively low transparency except in the immediate vicinity of the Wawa smelter plume where the lakes are acid and clear and highly contaminated with smelter waste.

Acid Deposition: Annual deposition in 1982 was 1.5 g/m^2

2.6 SUPPORTING RESEARCH

An historical water quality database, has been obtained from the Ministry of Environment for all of Ontario which contains many lakes within our proposed field sites. A second database is being acquired for approximately 300 lakes in the Sudbury area, many of which are located within the proposed sampling sites. The most important parameters within this database are those which have impact on the optical transparency of the water. These parameters are chlorophyll pigments, suspended mineral particles, and dissolved organic carbon. Of these DOC is considered to have the greatest influence on optical properties in Northern Ontario.

One obvious feature indicating a declining lake is low pH, but a low pH is not the only characteristic of an acidified lake. Chemical levels within a lake can also indicate its health. A study involving lake classification near Sudbury, Ontario used principal component analysis to show that chemical variability of acidified lakes is attributed to three main components: nutrient status, buffering status, and atmospheric deposition status (Pitblado et al., 1980). Nutrient status of a lake could be indicated by levels of dissolved organic carbon, while buffering status could be indicated by the alkalinity of a lake. Atmospheric deposition status might be indicated by the annual rate of sulfate deposition within an area.

Some historical data collected by John Fortescue at OGS, using the PROBAR/helicopter over a portion of the Algoma site, were made available to be analyzed with coincident limnological data. These data were collected on August 22, 1984 and on September 6, 1985. Fortescue had attempted to used these data to separate clear and colored acidic and normal pH lakes within the site [Fortescue, 1986]. Since many of the same lakes were to be sampled during the August 1986 field work using the PROBAR radiometer, it seem reasonable to examine these data for potential relationships between the PROBAR measurements in TM bands and the measured values of DOC, pH, etc. The data set consisted of 113 sample locations and a representative subset was selected for data reduction. The reported reflectances at 10 nm intervals were first reduced to simulate TM band reflectances in bands 1 through 4. These data were then statistically correlated to the available limnological data.

Attempts to run analyses on the combined 1984/1985 data set yielded very poor correlations. The 1985 data were found to be suspect because of reported instrumentation problems and further analysis of the 1985 PROBAR data set was therefore discontinued. The pH values of the 1984 data set ranged from 4.9 to 5.57 with a mean value of 5.24. DOC values were high and ranged from 3.1 to 14.1 mg/l with a mean value of 6.7 mg/l. Correlations with estimated TM reflectance values were considered modest (-0.73 for pH and TM band 3, -0.71 for pH and TM band 4). Similarly, coefficients of 0.62 and 0.64 were determined between the two TM bands and measured DOC. Correlations of comparable magnitude were observed between pH, DOC, and Secchi depth transparency. The lack of strong correlation was attributed to the relatively high levels of DOC which almost completely absorb the radiation in TM bands 1 and 2.

2.7 STUDY ORGANIZATION

This study was divided it into four types of activities: 1) stratification of eco-physical sensitivity, 2) water quality measurements, 3) lake optical measurements, and 4) remote sensing measurements. These activities in turn supported calibration of an optical model which would describe the reflectance sensitivity to changes in water parameters and relationships between spatial eco-physical features. These eco-physical features describe the environmental sensitivity to acidification. Our approach is outlined with the organizational flow chart contained in Figure 2.2. The desired result from this effort was to be able to identify which environments contain lakes which are sensitive to acidification and can be monitored using Landsat TM data.

2.8 STUDY PARTICIPANTS

A cooperative program with Canadian agencies and Universities interested in the remote sensing aspects of the acid deposition problem have resulted in an informal joint program which includes four major Canadian participants. These are Professor Roger Pitblado of Laurentian University in Sudbury, Ontario, Dr. John Fortescue of the Ontario Geological Survey (OGS), Dr. Vernon Singroy of the Ontario Centre for Remote Sensing (OCRS), and Professor Michael Dickman from Brock University in Saint Catherine, Ontario.

The Canadians are funded through the Ministry of Environment (MOE) and the Ontario Geological Survey for a one year period to work collaboratively on the program. These funds were budgeted to support equally remote sensing data collection and analysis and a geochemical survey.

The Canadian effort was based on meeting two separate but highly complementary objectives. The OGS objective was designed to look the relationships between environmental and geochemical studies involving lake acidification and remote sensing. The geochemical survey techniques developed by John Fortescue of the OGS involve analysis of chemical constituents in lake water samples and in bottom sediment cores. A mineral resource appraisal was a specific objective of the OGS. The MOE support was directed at examining the role remote sensing can play in the study of lake acidification in both the short and in the long term. The MOE had stressed that effort be placed on the Sudbury site where there exists an extensive limnological database.

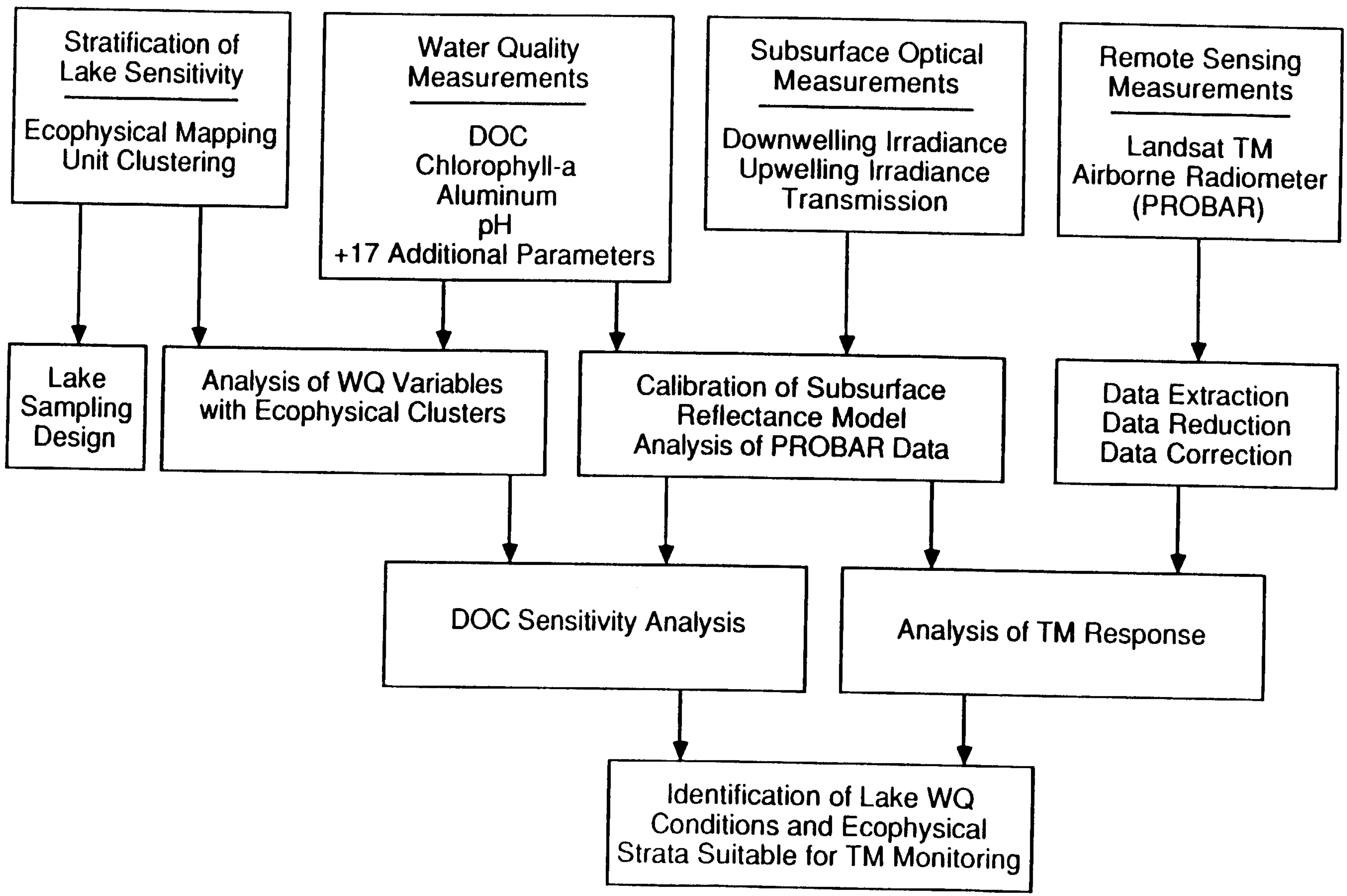


Figure 2.2. Study Organization

The MOE plan includes examination of several historical Landsat TM and MSS collections.

3.0 ECO-PHYSICAL CHARACTERIZATION

3.1 OBJECTIVE

The objective of the eco-physical stratification and characterization of acid-sensitive parameters was to reveal the location and co-occurrence of environmental attributes that influence lake acidification. The study areas were stratified into the following four parameters:

1. type and percent cover of vegetation,
2. soil and bedrock buffering capacity,
3. topographic relief,
4. sulfate deposition rate.

The acid sensitivities of these areas were then determined, based on these four parameters. Each of these parameters affects the sensitivity of the ecosystem a lake is found in and ultimately affects the water chemistry and optical signature of that lake. Stratification also provided a basis to characterize lakes within study areas which aided in the sampling design.

3.2 PROCEDURE

The three Landsat scenes were stratified into eco-physical units, or "polygons", based upon soil/bedrock sensitivity, vegetation sensitivity, topographic-relief sensitivity and acid- deposition sensitivity. Sensitivity values were assigned to each polygon and combined in a linear function which produced a "sensitivity index" for each polygon using a sensitivity model. Maximum-likelihood clustering of these sensitivity indexes then revealed the location and co-occurrence of similar polygons.

3.3 STRATIFICATION OF ECO-PHYSICAL FEATURES

The Algoma, Sudbury, and Dorset study areas were stratified in terms of bedrock/soil, vegetation, relief and sulfate deposition.

Four mylar overlays were constructed, one for each of the variables, at a scale of 1:250,000.

3.3.1 Vegetation and Percent Cover

The lowest pH values are found in coniferous forests. Fir trees are often found growing on weathering-resistant soils and bedrock. When precipitation falls on this type of area, the acidic water flows largely unaltered into nearby lakes at a pH of 5.6. Broadleaf forests are generally found in terrain of higher pH, so precipitation is neutralized more before it enters a lake. A much higher rate of sulfate deposition would be necessary to make the pH of runoff from a deciduous forest reach that of a coniferous forest (Environment '82 Committee, 1982).

Percent cover of vegetation also plays a factor in lake acidification. If percent cover is low, the extent and volume of surface runoff is frequently higher than for average cover conditions increases. Under these conditions, very little of the precipitation has time to penetrate into the rock and/or soil and become neutralized by the buffering systems.

TM satellite images were used for vegetation classification and lines were drawn between areas of different vegetation types and different percent covers of these types. Vegetation was categorized as conifer, hardwood, mixed or barren. If an area's vegetation consisted of 80% or more of either conifer forest or hardwood forest, then it was classified hardwood or conifer, otherwise it was classified as a mixed forest.

Percent cover for an area was derived using existing soil and bedrock sensitivity maps published by the Environment Canada Lands Directorate in 1983. These maps outline percent exposed bedrock at three levels: 0-24%, 25-50%, and 50-99%. Since there were no extensive areas of low vegetation, such as prairies, marshes, etc., the following equation was used:

$$(\text{Percent forest cover}) = 1 - (\text{Percent exposed bedrock}) \ .$$

Percent forest cover was divided into three classifications:

1. 0 - 49 % cover,
2. 50 - 74 % cover,
3. 75 - 99 % cover.

Vegetation and percent cover sensitivities were derived from the literature (Environment '82 Committee) and are shown in Table 3.1.

TABLE 3.1. VEGETATION AND PERCENT COVER SENSITIVITIES

Cover	Percent	Sensitivity Value
hardwood	0 - 49 %	3.33 x .75
hardwood	50 - 74 %	3.33 x .5
hardwood	75 - 99 %	3.33 x .25
mixed	0 - 49 %	6.67 x .75
mixed	50 - 74 %	6.67 x .5
mixed	75 - 99 %	6.67 x .25
conifer	0 - 49 %	10 x .75
conifer	50 - 74 %	10 x .5
conifer	75 - 99 %	10 x .25

These sensitivity values rank the combinations of vegetation type and percent cover on a scale from 1 to 10. Terrain with conifer forest cover was rated most sensitive and terrain with hardwood forest cover was rated least sensitive. The higher the percent cover the less sensitive the polygon was rated for potential damage.

3.3.2 Sulfate Deposition

Large emissions of sulfur dioxide and nitrogen oxide from combustion (usually within coal burning industries) lead to their oxidation in the atmosphere to sulfuric acid and nitric acid. These acids dissolve in water droplets and fall to the ground via some form of precipitation. The presence of sulfuric acid in precipitation over the Continental Shield results in 100 times more acid entering these already poorly buffered ecosystems (Hendry and Brezonick, 1984).

The sulfate deposition overlay was drawn from enlarged 1981 meteorologic maps (Chan, et al. 1983) provided by the Ontario Ministry of the Environment (see Figure 3.1) Sulfate deposition was measured in grams/m^2/year. Across all three areas, the following six classifications were derived from the maps in terms of deposition rates:

1. 1.0-1.5,
2. 1.5-2.0,
3. 2.0-2.5,
4. 2.5-3.0,
5. 3.0-3.5,
6. 3.5-4.0.

Sulfate deposition was assigned sensitivity values based on amount of sulfate deposited. Each of the six levels was assigned equally spaced sensitivity values on a scale from 1 to 10. The highest sulfate deposition was given the highest sensitivity value. The results are given below in Table 3.2.

TABLE 3.2. SENSITIVITY VALUES OF SULFATE DEPOSITION LEVELS

gm/m^2/year	Sensitivity Value
1.0-1.5	1.67
1.5-2.0	3.33
2.0-2.5	5.00
2.5-3.0	6.67
3.0-3.5	8.33
3.5-4.0	10.00

3.3.3 Bedrock and Soil

In general, the easier the ground materials around a lake weather, the less susceptible that lake is to acidification. Thus, weatherability of the lake's surrounding bedrock and soil play a large factor

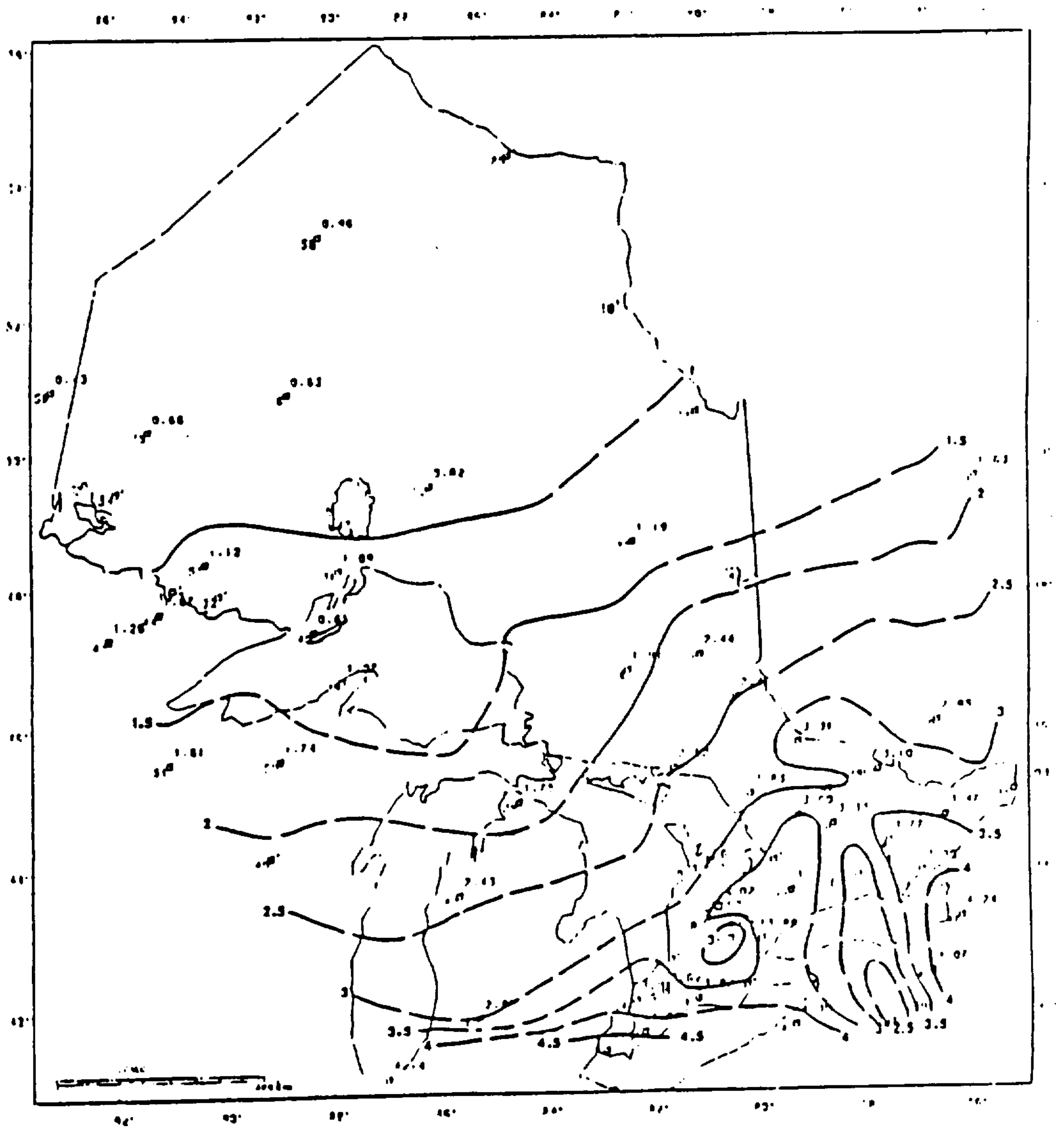


Figure 3.1. The Annual Deposition (G/M**2) of Sulfate in Ontario (from Chan, Tang and Lusis, 1983).

on the lake's acidity. The rate at which bedrock and soil weather depend on their hardness and their ability to release buffering ions which counter lake acidification by reducing the impact of the water runoff.

Bedrock resistant to weathering does not neutralize acid rainwater therefore it is associated with acidic lake systems. Sensitivities for bedrock/soil combinations were derived from the Environment Canada Sensitivity Maps. Bedrock was divided into four categories based on its sensitivity. These four categories are found in Table 3.3.

TABLE 3.3 BEDROCK SENSITIVITY CATEGORIES

Type	Description
1	limestone, marble, dolomite
2	carbonate-rich siliceous sedimentary: shale, limestone; noncalcareous siliceous with carbonate interbeds: shale, siltstone, dolomite; quartzose sandstone with carbonates.
3	ultramafic rocks, serpentine, noncalcareous siliceous sedimentary rocks: black shale, slate, chert; gabbro, anorthosite: gabbro, diorite; basaltic and associated sedimentary: mafic volcanic rocks.
4	granite, gneiss, quartzose sandstone, syenitic and associated alkalic rocks.

The ability of the soil to neutralize the acid was found to be the most important factor influencing the susceptibility of a lake to acidification. Lime-rich, easy-weathering soils protected the lakes, but lakes surrounded with sandy soil and expanses of flat bare rock are mostly acid (Environment '82 Committee, 1982). Basically three categories of soil can be defined: easy-weathering clay, normal-weathering loam, and resistant-weathering sand.

The soil's depth also affects the neutralization of precipitation. A deeper soil will contain larger quantities of weatherable minerals and other buffering substances. Thin soils are often leached of such buffering substances. In the stratification, one of the soil types (clay, loam or sand) was assigned to each polygon. Each polygon was also assigned a unique soil depth. The soil depth categories used are shown in Table 3.4.

TABLE 3.4. SOIL DEPTH CATEGORIES

Category	Definition
deep:	> 1 m average soil thickness
shallow:	25 cm - 1 m average soil thickness
bare:	< 25 cm average soil thickness

Different combinations of bedrock type, soil type, and soil depth were already ranked on the Environment Canada maps from most to least sensitive. Since there were 28 soil/bedrock combinations, the most sensitive combination was assigned a 10.0. The other combinations were assigned sensitivities ranging from 1 to 10 separated by units of 10/28. These combinations are shown in Table 3.5.

TABLE 3.5. BEDROCK/SOIL SENSITIVITY INDEX VALUES

ROCK TYPE	SOIL TYPE	SOIL DEPTH	SENSITIVITY VALUE
1	clay	deep	.36
1	loam	deep	.71
1	sand	deep	1.07
1	clay	shallow	1.43
1	loam	shallow	1.79
1	sand	shallow	2.14
1	none	bare	2.5
2	clay	shallow	2.86
3	clay	shallow	3.21
2	clay	deep	3.57
3	clay	deep	3.93
4	clay	deep	4.29
2	loam	deep	4.64
3	loam	deep	5.
2	sand	deep	5.36
3	sand	deep	5.71
2	loam	shallow	6.07
3	loam	shallow	6.43
2	sand	shallow	6.79
3	sand	shallow	7.14
2	none	bare	7.5
3	none	bare	7.86
4	clay	shallow	8.21
4	loam	shallow	8.57
4	loam	deep	8.93
4	sand	deep	9.29
4	none	bare	9.64
4	sand	shallow	10.00

3.3.4 Relief

Since the extent and volume of surface runoff plays an important factor in lake acidification, the topographic relief of the terrain surrounding a lake would help determine its acidification state. An area with steep topographic relief would allow less time for precipitation to penetrate the soil and bedrock and become neutralized. Flat topographic relief would contribute more to the neutralization of precipitation since the extent and volume of surface runoff would be less.

Relief was divided into three categories: steep, rolling, and level. This information was extracted from standard topographic maps at a scale of 1:250,000. Change in elevation across unit distances was measured perpendicular to elevation contours and categorized into one of three types for each polygon. These categories are shown in Table 3.6.

TABLE 3.6. TOPOGRAPHIC RELIEF CATEGORIES

Category	Definition
level:	< 400 ft change in 2 kilometers
rolling:	> 400 ft < 800 ft change in 2 km
steep:	> 800 ft change in 2 kilometers

Topographic relief levels were assigned three sensitivity values, equally spaced from 1 to 10. These three values are shown below in Table 3.7.

TABLE 3.7. RELIEF SENSITIVITY VALUES

Relief	Sensitivity Value
level	3.33
rolling	6.7
steep	10.00

3.4 COMPOSITE MAP CONSTRUCTION

The four maps were produced for each of the ecosystem parameters (bedrock and soil, sulfate deposition, terrain relief, and vegetation type and percent cover). Each map consisted of polygons that represented uniform ecosystem parameters and that were assigned corresponding sensitivity values. A composite map was then produced for each of the study areas by overlaying the four ecosystem parameter maps, and tracing them on to one overlay (see Figure 3.2). Ultimately, the new polygons created with the composite map had four sensitivity values:

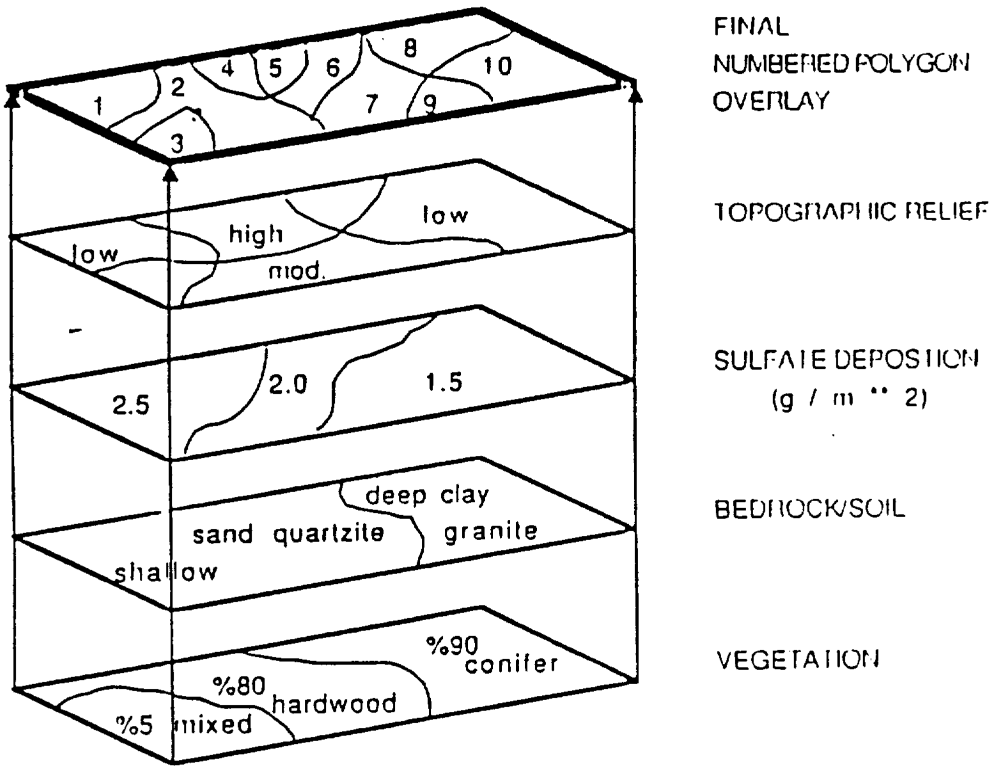


Figure 3.2. The Stratification Procedure.

one for bedrock/soil, one for vegetation, one for relief and one for the sulfate deposition.

The three composite maps produced 694 polygons with a minimum polygon size of 25 square kilometers. Each polygon was numbered from 1 to 694. A computer program was written and used to read the polygon number, forest type, percent cover, bedrock type, soil type, soil depth, topographic relief and sulfate deposition into computer memory. A program subroutine was used to assign four ecosystem sensitivity values, ranging from 1 to 10, to each polygon and compute the sensitivity index for each polygon using the sensitivity index model.

A list of the polygons with eco-physical characteristics and sensitivity index values is found in Appendix A.

3.5 SENSITIVITY INDEX MODEL

A sensitivity index model was developed which assigned a sensitivity index to each composite map polygon. The sensitivity index, SI, is a function of a linear combination of the four ecosystem parameters within the polygon:

SI = A x (bedrock/soil sensitivity value)
B x (vegetation sensitivity value)
C x (sulfate deposition sensitivity value)
D x (topographic relief sensitivity value).

The coefficients A, B, C and D were derived from the literature, but in the absence of quantitative information. An ecosystem sensitivity study in Sweden concluded that bedrock and soil were found to be the most important factors influencing the susceptibility of a lake to acidification (Environment '82 Committee). Also, areas of nearly equal rates of sulfate deposition, but differing types of bedrock and soil, have been found to contain lakes of different buffering capacities, supporting the idea that bedrock and soil are the most important eco-physical parameters in terms of lake sensitivity. Therefore the coefficient "A" equals four, the highest number assigned to a coefficient. A review of the literature indicated that vegetation type was highly correlated with soil and bedrock type in terms of sensitivity, so the vegetation sensitivity value was weighted as the second most important variable.

If the vegetation and soil/bedrock sensitivity values were identical in two areas, it is assumed that sulfate deposition would affect the sensitivity of a lake within the area more than topographic relief would. Therefore the following equation was developed:

SI = 4 x (bedrock/soil sensitivity value)
3 x (vegetation sensitivity value)
2 x (sulfate deposition sensitivity value)
1 x (topographic relief sensitivity value).

The sensitivity index of an eco-physical polygon is driven by the bedrock/soil and vegetation sensitivity values. The sulfate deposition and topographic relief sensitivity values still contribute to an area's sensitivity, so they are included in the model but weighted as less important. Therefore, it is hypothesized that the sensitivity index rates the acid sensitivity of an eco-physical area on a scale from 1 to 10.

3.6 CLUSTERING OF MODEL SENSITIVITY VALUES

The sensitivity indexes of the polygons (approximately 694) were then clustered using a maximum likelihood hierarchical clustering procedure. The results of this clustering procedure has produced 10 significantly ($p > .95$) different clusters (see Appendix B). These clusters are summarized in Table 3.8.

TABLE 3.8 SENSITIVITY RATINGS AND TYPE VALUES FOR THE TEN SIGNIFICANTLY DIFFERENT CLUSTERS

CLUSTER RATING	BEDROCK/SOIL	VEGETATION	RELIEF	SULFATE	DEPOSITION
1	5.66	7.04	4.67	5.57	4.40
2	6.36	8.05	4.65	5.78	5.82
3	6.74	8.16	5.83	5.28	5.00
4	6.02	7.67	4.63	5.25	5.18
5	7.41	8.47	7.13	5.62	6.59
6	3.55	3.28	2.08	5.57	5.27
7	7.07	8.50	6.37	5.36	6.10
8	5.14	5.96	4.71	5.46	3.97
9	7.83	8.71	8.53	5.20	6.29
10	4.34	5.21	3.82	5.01	3.05

The ten clusters are described in terms of their mean eco-physical sensitivity values in the following paragraphs.

Cluster 1 is characterized by shallow sandy soils over rock types 3 and 4 with less than 50% cropping out. Vegetative cover is a mixture of conifers and hardwoods with a dominance of the hardwoods. The terrain is level to rolling. The average acid deposition is approximately 2.0 $g/m^2/yr$.

Cluster 2 is characterized by moderate depth soils over rock type 4 with less than 50% cropping out. Vegetative cover is a mixture of conifers and hardwoods with a dominance of the hardwoods. The terrain is level to rolling. The average acid deposition is approximately 2.5 $g/m^2/yr$.

Cluster 3 is characterized by deep sandy soils over rock type 4 with less than 50% cropping out. Vegetative cover is a mixture of conifers and hardwoods with a dominance of the hardwoods. The terrain is level to rolling. The average acid deposition is approximately 2.5 $g/m^2/yr$.

Cluster 4 is characterized by moderately deep soils over rock type 4 with less than 50% cropping out. Vegetative cover is a mixture of conifers and hardwoods with a dominance of the hardwoods. The terrain is level to rolling. The average acid deposition is approximately 2.25 $g/m^2/yr$.

Cluster 5 is characterized by moderately deep sandy soils over rock type 4 with less than 50% cropping out. Vegetative cover is a mixture of conifers and hardwoods with a dominance of the hardwoods. The terrain is level to rolling. The average acid deposition is approximately 2.75 $g/m^2/yr$.

Cluster 6 is characterized by deep clay soils over rock type 3 with less than 30% cropping out. Vegetative cover is mostly hardwood. The terrain is level to rolling. The average acid deposition is approximately 2.25 $g/m^2/yr$.

Cluster 7 is characterized by shallow sandy soils over rock type 4 with less than 50% cropping out. Vegetative cover is a mixture of conifers and hardwoods with a dominance of the conifers. The terrain is level to rolling. The average acid deposition is approximately 2.5 $g/m^2/yr$.

Cluster 8 is characterized by moderately deep sandy soils over rock type 3 with less than 50% cropping out. Vegetative cover is a mixture of conifers and hardwoods. The terrain is level to rolling. The average acid deposition is approximately 2.0 $g/m^2/yr$.

Cluster 9 is characterized by shallow sandy soils over rock type 4 with less than 25% cropping out. Vegetative cover is dominated by conifers. The terrain is level to rolling. The average acid deposition is approximately 2.5 $g/m^2/yr$.

Cluster 10 is characterized by deep sandy soils over rock types 3 and 4 with less than 50% cropping out. Vegetative cover is a mixture of conifers and hardwoods with a dominance of the hardwoods. The terrain is level to rolling. The average acid deposition is approximately 1.5 $g/m^2/yr$.

These clusters are separated by only small changes in the mean value for each sensitivity index. The standard deviations of the above mean sensitivity index values was typically only one or two percent. Each cluster was color coded as shown in Figure 3.3. Color coded maps that show the location of the polygons within each cluster are shown in Figures 3.4 3.5 and 3.6. The listing of all eco-physical polygons by cluster with the strata descriptors is given as Appendix A. The summary statistics for the clusters is given in Appendix C.

The above clusters were further grouped into three classes which are shown in Table 3.9.

TABLE 3.9. CLUSTER CLASSES

Class	Clusters
insensitive	1, 6, 8, 10
mildly sensitive	2, 3, 4
sensitive	5, 7, 9

3.7 SAMPLE SITE SELECTION

Site selection for in situ lake measurements was based upon the stratification and clustering analysis described above and each of the following considerations: (1) availability of historical water quality and remote sensing data, (2) existing Canadian initiatives to collect site-specific data, (3) accessibility, and (4) coverage of eco-physical lake types. Sites selected included (1) Algoma, (2) Sudbury, (3) Wawa, and (4) Dorset. Nine of the ten clusters were represented by the selected sites.

The Canadian program recommended the use of the Algoma and Sudbury sites, each comprising approximately 1000 sq. km. Priorities were set

Ecophysical Areas	Color Code	Sensitivity Index Mean Value
Cluster 1		5.66
Cluster 2		6.36
Cluster 3		6.74
Cluster 4		6.07
Cluster 5		7.41
Cluster 6		3.55
Cluster 7		7.07
Cluster 8		5.14
Cluster 9		7.83
Cluster 10		4.34

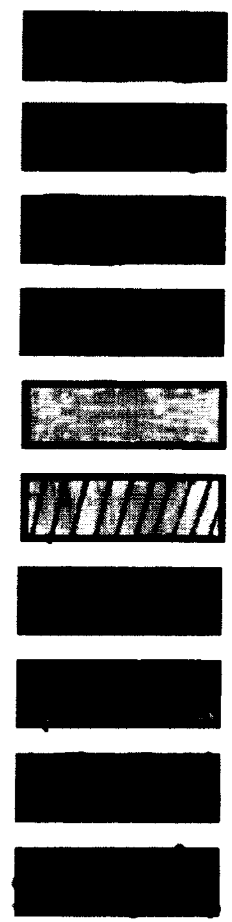
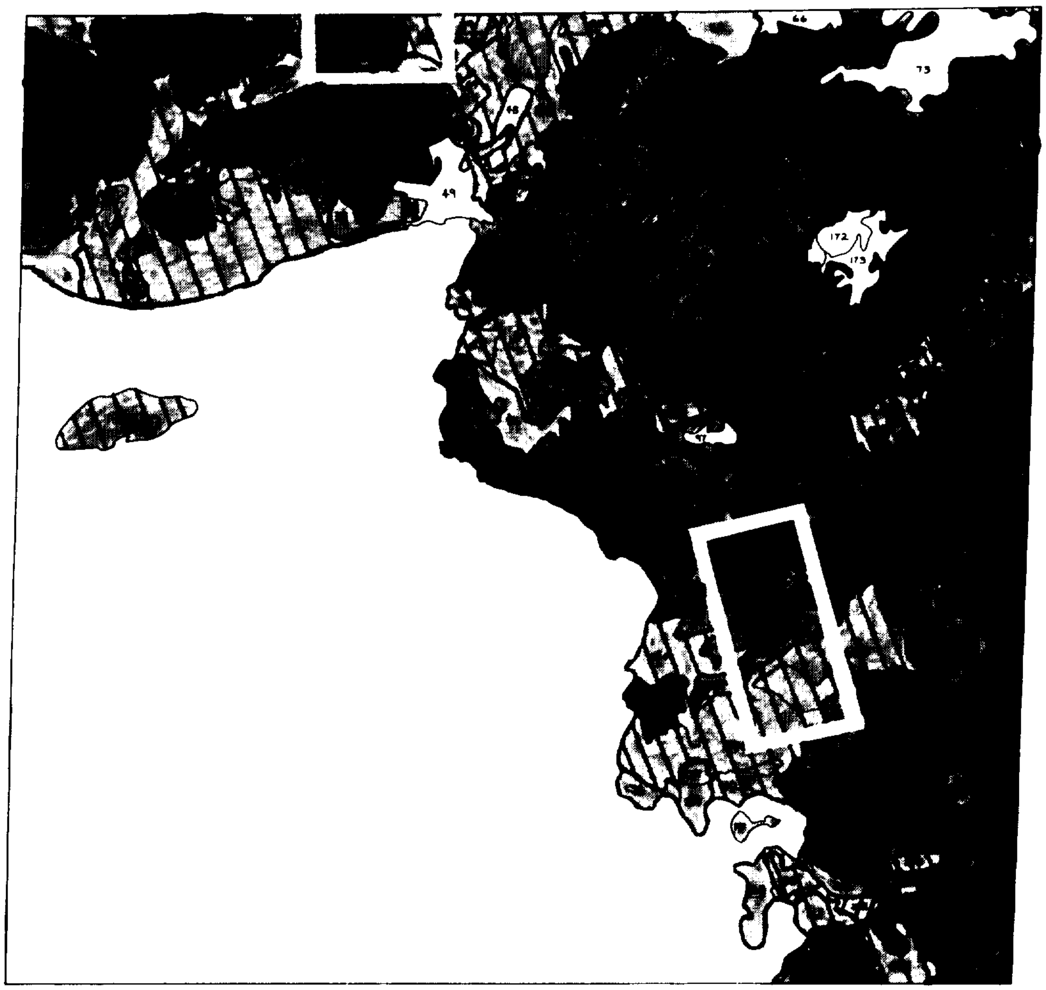
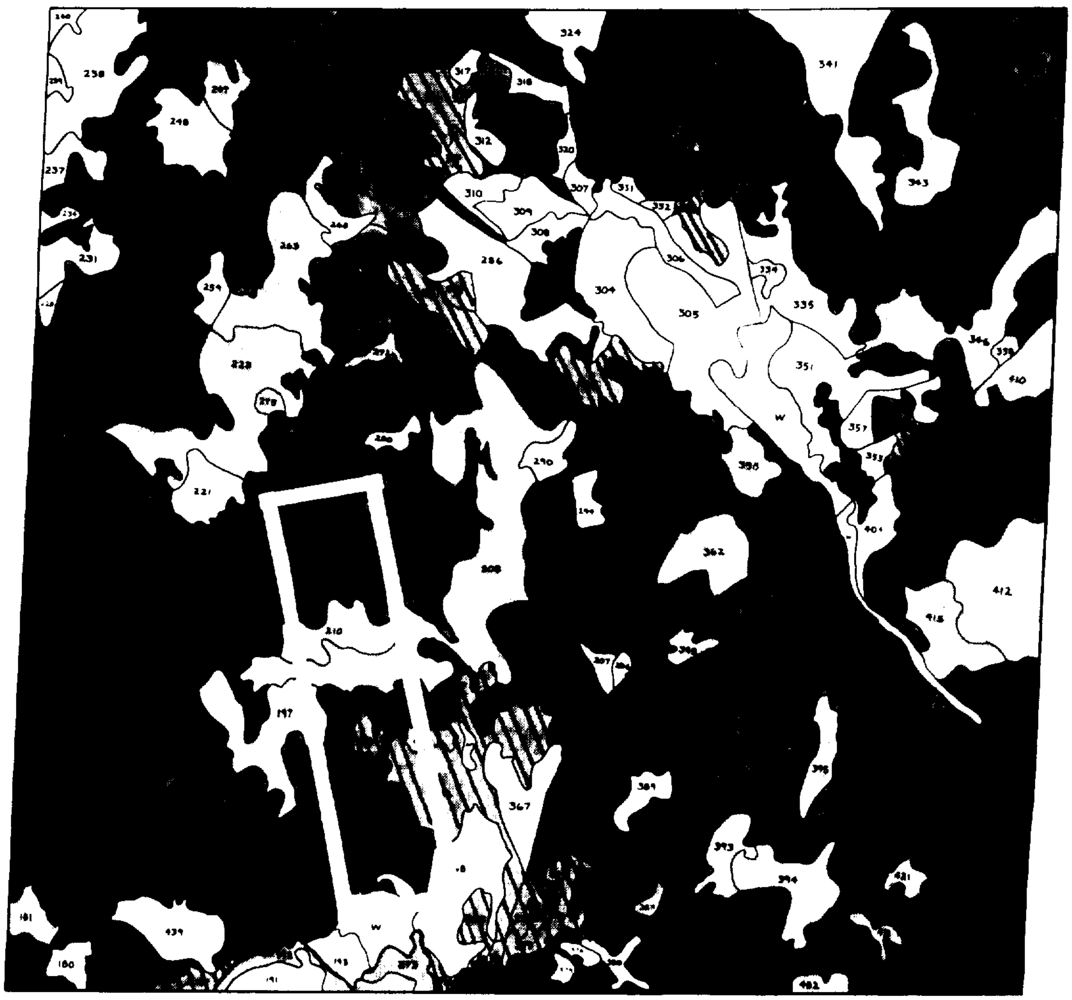


Figure 3.3 Color Code for Test Site Clusters



30 km

Figure 3.4 The Algoma Area Clusters and Sampling Sites



30km

Figure 3.5 The Sudbury Area Clusters and Sampling Site

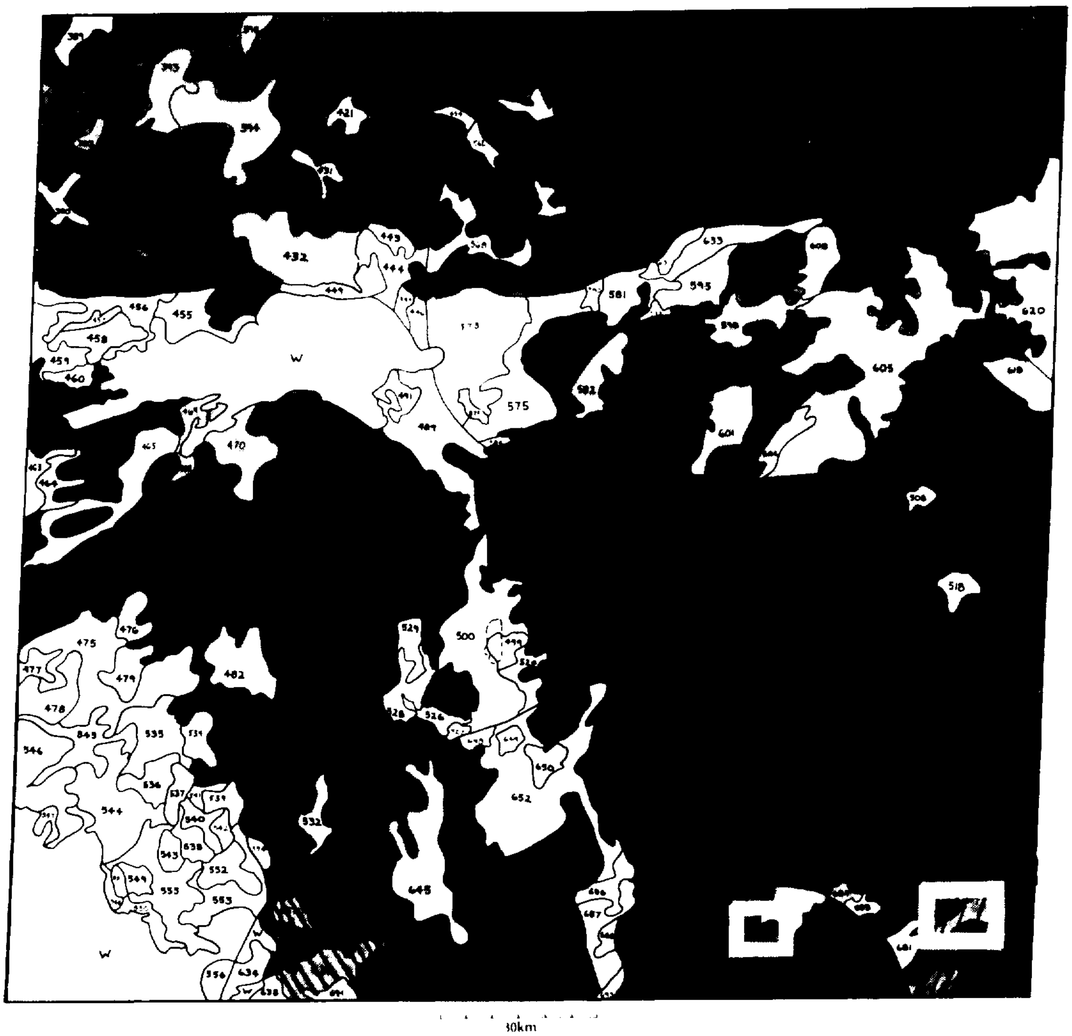


Figure 3.6 The Algonquin Area Clusters and Sampling Sites

for each of the four collection sites based upon group interests and availability of resources. First priority was given to the Sudbury site, second to Algoma, and third to Wawa. The Dorset site was viewed to be largely beyond the reach of a one-month field program and would only be addressed after the other data objectives had all been met. A lake sampling budget of approximately 300 samples was divided between the first three sites with 150 samples allocated to Sudbury, 130 allocated to Algoma, and 20 to Wawa. An additional 25 samples would be taken to support the Dorset sampling if resources were available.

4.0 DATA COLLECTION METHODS

4.1 LAKE SAMPLING STRATEGY

The ERIM field plan specified sampling at three different levels and with three different optical measurements. Field data collections were made during the summer of 1986 and spring of 1987. The August 1986 collections included three sites: Sudbury, Algoma, and Wawa. At each of these sites, water samples were gathered from a well distributed set of lakes using a helicopter. Radiometric measurements were made using Landsat TM, a helicopter (BELL-206) spectral radiometer (PROBAR), a subsurface spectral irradiance meter, and a subsurface beam transmissometer. The sampling strategy was to gather subsurface measurements from a small number of lakes and in sufficient number to calibrate a subsurface reflectance model. Airborne spectral measurements were gathered over a much larger set to be used to extend the subsurface results to a broader set of lake conditions. Finally these lake reflectance spectral characteristics were used to predict the reflectance characteristics of the still larger TM lake sample data set. The strategy in this three-tier sampling scheme was to develop a model/relationship from the in situ optical measurements and the measured limnological parameters. This "optical response model", once validated, was extended to the PROBAR data set and finally to the Landsat data set where it aided in the interpretation of TM observations.

During August 1986 field data were gathered from each of the three sites which included 21 water quality parameters (296 lakes), detailed subsurface optical measurements (12 lakes), airborne spectral radiometer measurements (102 lakes), and Landsat data. Most of these measurements were made in the Algoma and Sudbury sites (shown as Figures D.1 and D.2). All water chemistry data are compiled as Appendix D. PROBAR spectral radiometer measurements were made in most of the lakes that were larger than 20 hectares. The subsurface optical measurements were made in a representative set of lakes at each site. Water parameters were determined from collected samples by the MOE on-site or at the Toronto Laboratory. Water parameters especially important to this study included DOC, conductivity, total chlorophyll-a pigment concentration, pH, sulfate, alkalinity, TIP, turbidity, suspended solids, and aluminum.

The May-June 1987 field effort involved collecting subsurface MER reflectance and transmissometer data on four separate dates from eight lakes. Water samples were also collected and were processed by the MOE. Field data collections were made on 5 May, 14 May, 13 June, and 29 June at four to eight lakes in the Sudbury site. These data were collected coincident with the TM overpass on each of those dates. Two of these TM acquisitions (12 May and 13 June) were of excellent quality and were requested from NASA GSFC. No PROBAR airborne radiometer data were collected during the spring period because the unit was not available for project use.

4.2 SUBSURFACE OPTICAL MEASUREMENTS

Two instruments were used to make the subsurface optical measurements: a subsurface spectroradiometer (Biospherical Inc. MER-1000) with 11 narrow spectral bands (410, 441, 488, 520, 540, 560, 589, 625, 671 and 694 nm) and a transmissometer (SEATECH Inc.) with a single wavelength at 664 nm. These instruments were used to characterize the optical properties in several of the PROBAR-sampled lakes.

The MER-1000 subsurface upwelling and downwelling spectral spectral scans were collected in the field at variable sampling depths below the lake-water surface. MER data collections were made from a canoe (August 1986) and from a float plane pontoon (May-June 1987). The canoe measurements each consisted of 20 scans and the float plane measurements consisted of 10 scans. Fewer scans were used during the plane measurements since the instrument was allowed to drop through the water column at a faster rate. At each station a series of upwelling and downwelling irradiance measurements were made in succession. A pressure sensor in the MER recorded the depth of each spectral scan.

4.3 AIRBORNE RADIOMETER MEASUREMENTS

A helicopter-mounted (BELL 206) spectroradiometer (PROBAR) was used to collect radiometric data in each of 10 narrow spectral bands (443, 470, 520, 550, 580, 610, 640, 670, 700 and 732 nm) at the center of each sample lake.

PROBAR data was collected on four days in 1986:

August 12	15 Lakes
August 13	54 Lakes
August 14	18 Lakes
August 18	46 Lakes

Lakes sampled with the PROBAR were limited to those large enough to be visible in TM imagery and sufficiently deep not to produce a bottom reflected signal. The PROBAR unit had been rented from Moniteq Ltd., Toronto, Ontario and was controlled with an IBM PC that also was mounted in the helicopter. The PC logged the radiometer data and allowed easy transfer to the DEC VAX780 for data analysis.

4.4 LANDSAT TM ACQUISITIONS

All possible Landsat TM acquisitions were requested for the Algoma, Sudbury, and Dorset scenes for the month of August 1986. Algoma and Sudbury coverage were requested for May and June 1987. Of the scenes collected, four were considered sufficiently cloud- free to be useful. Image tapes were obtained from NASA GSFC Landsat office and are listed in Table 4.1.

TABLE 4.1. IMAGE TAPES REQUESTED FROM NASA GSFC LANDSAT OFFICE

Path/Row	Date
19/27	August 13, 1986
19/27	May 12, 1987
19/27	June 13, 1987
22/28	August 18, 1986

All of the other acquisitions were considered non-usable based upon the positive print of TM band one received from GSFC.

4.5 DATA QUALITY MEASURES

Provisions were made to ensure the quality of the data measurements. During the MER data collection, deck cell measurements of downwelling hemispherical irradiance were taken coincidentally. This ensured that the MER downwelling and upwelling profile measurements were taken while the downwelling irradiance remained constant.

When TM signals were being extracted, band four signals of water surfaces were examined for high standard deviations (> 0.5). If the standard deviation was higher than 0.5, it was assumed that the data were contaminated with either bottom or land reflectance, and they were not used.

Before transmissometer measurements were made, the air voltage was checked and recorded. The transmissometer measurement was only made if the air voltage was in the appropriate range. This air voltage was later used for calibration when calculating attenuation coefficients.

PROBAR measurements were corrected for the time of day and were calibrated using a white card of known reflectance. Instrument calibration was also done in the lab before the field work.

5.0 SUBSURFACE AND AIRBORNE RADIOMETRIC DATA REDUCTION

Radiometric data collected with the Biospherical MER-1000 radiometer, the SeaTECH transmissometer, the PROBAR spectral radiometer, and Landsat TM were reduced as described in the following sections.

5.1 MER DATA REDUCTION

MER-1000 data were first used to interpolate the irradiance data to common depths on a logarithmic scale before computing values of subsurface reflectance. The slope of the depth log-irradiance regression equation defines the average irradiance attenuation coefficient (K). The irradiance attenuation coefficient changes very little within the mixed layer, but rapidly within the transition zone (thermocline). The thickness of the mixed layer was easily determined from the temperature depth profile. Therefore only irradiance measurements from the mixed layer were used to determine K. Downwelling irradiance attenuation for low DOC lakes (Sunnywater and Wolf) and high DOC lakes (Whitepine and Barbara) are shown in Figure 5.1.

Subsurface spectral reflectances were calculated at 2, 4, 6, and 8 meters below the surface. Example reflectance curves are shown in Figure 5.2, along with the DOC and Chlorophyll-a measurements. The impact of DOC and Chlorophyll-a on reflectance is apparent. As DOC increases the blue-green portion of the reflectance spectrum is diminished due to highly selective absorption. Chlorophyll-a also diminishes the measured reflectance below 520 nm, due to absorption. Wavelengths greater than 520 nm absorption are reduced and backscattering is increased. The reflectance calculations at 700 nm are not considered valid since the irradiances are very small and contaminated by sensor noise.

In the spring of 1987 the MER pressure sensor was calibrated so measurement depths were available without depth correction. The pressure sensor in August 1986 sampling period was precise but it was not accurate. A control profile was made during which actual and measured

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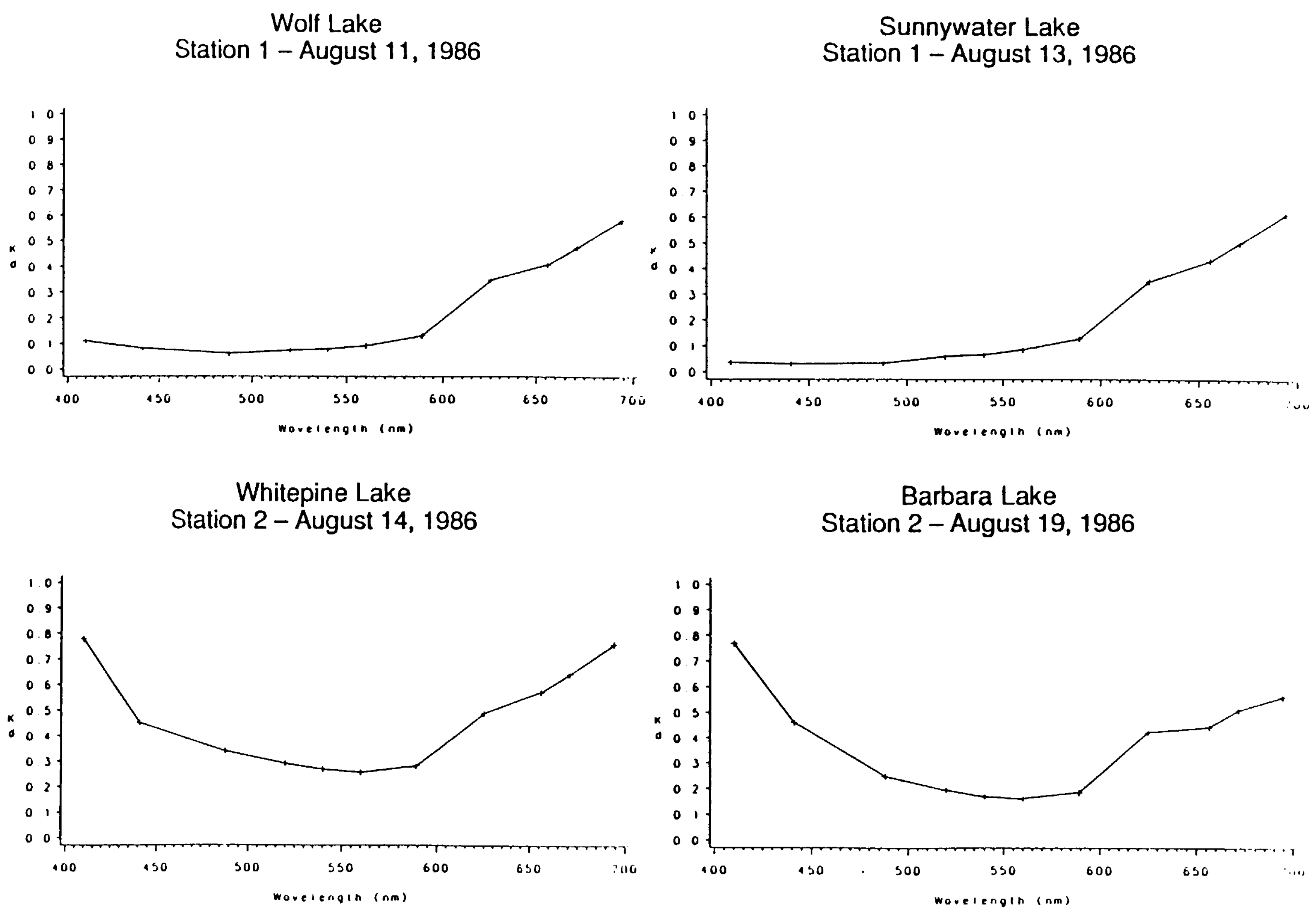

Figure 5.1 Downwelling Irradiance Attenuation $K_d(\lambda)$

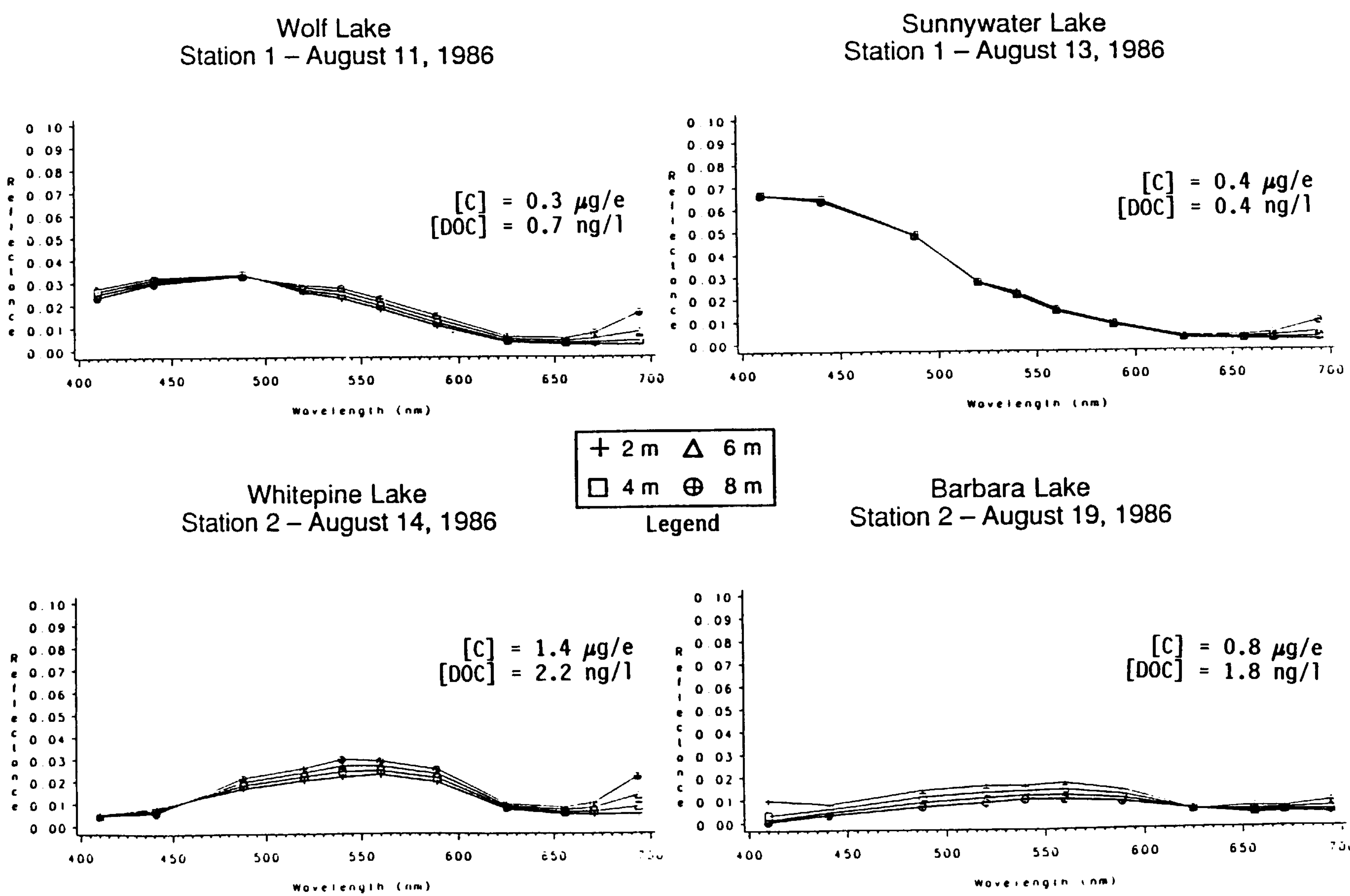

Figure 5.2 Subsurface Reflectance $R(\lambda)$

depths were recorded and a simple linear relationship was found between them.

Depth = Measured Depth / .567

To obtain reflectance values it was necessary to develop two linear equations describing the relationship between the natural logarithm of irradiance (ln(E)) and corrected depth for both the upwelling and downwelling profiles. The diffuse attenuation coefficient determines the rate of irradiance loss through the water column and is defined by the following equation.

$$K(\lambda) = \frac{-1}{E(\lambda,z)} \frac{dE}{dz}$$

The irradiance data collect at multiple depths were first used to estimate K from the solution to the above equation as given by the following linear form.

$$\ln(E(\lambda,z)) = K(\lambda)*z + \text{intercept}$$

Depths of 2, 4, 6 and 8 meters were then entered into the linear equation to estimate $\ln(E_u)$ and $\ln(E_d)$. Reflectance at these four depths were then produced using the following equation:

$$R(\lambda,z) = EXP(\ln(E_u(\lambda,z)) - \ln(E_d(\lambda,z))$$

Where $E_u(\lambda,z)$ = upwelling irradiance at z meters
and $Ed(\lambda,z)$ = downwelling irradiance at z meters.

5.2 TRANSMISSOMETER DATA REDUCTION

SeaTECH transmissometer profiles were made at every station coincident with the MER measurements. Voltage measurements were made usually at 2, 4, 6, and 8 meters after an air reading was made at each station.

Corrected voltage was then obtained using the following equation:

Cvolt = (Lab Air/Field Air) x (Mvolt - .003)

where Cvolt = Corrected voltage
Lab Air = Lab air reading = 4.775 volts
Field Air = Field air reading
Mvolt = Measured voltage

Fractional transmission could be determined since it is known that 100% transmission through 25 cm of pure water has a corrected voltage of 5 volts. Fractional transmission through 25 cm of lake water is found using the following relationship:

$$T(664nm) = (Cvolt) / 5 \text{ volts.}$$

The beam attenuation coefficient (c) can be derived using the fractional transmission in the following equation:

$$c(664nm) = -4 \text{ LOG}(T(664nm)$$

The reduced transmission and beam attenuation coefficients for all SeaTECH measurements are given as Appendix E.

5.3 PROBAR DATA REDUCTION

One objective in reducing the PROBAR data was to estimate illumination independent reflectance values which could be compared to the MER data derived values. The airborne PROBAR measurements, however, were made complicated by the helicopter blade motion and by the need for irradiance reflectance given the PROBAR is a radiance device. The rotating blade interfered with the downwelling irradiance meter and also possibly with the upwelling radiance measurements as well. The raw data from several dates showed a significant change in downwelling irradiance between measurements taken on the ground using a standardized white reflectance card. This effect was dependent on time of day and date illumination conditions. These conditions necessitated a series of five corrections be made to these data in order to make them compatible to the MER reflectance data. These corrections were (1) for standardized white card reflectance, (2) for airborne conditions, (3) for time of day, (4) for day-to-day variations in sky illumination, and (5) for surface reflectance.

Upwelling radiance, $L_u(\lambda)$, and downwelling irradiance values were read for ten 20 nm - wide bands ranging from 433 nm to 710 nm. Reflectance was computed in the following manner:

$$R(\lambda,0) = M(\lambda,0)/E_d(\lambda,0)$$

$$\text{where } M(\lambda,0) = L_u(\lambda)*\pi$$

All dates show a large change in downwelling irradiance between measurements taken on the ground (white card measurements) and measurements taken when the helicopter was airborne (all lake measurements). This discrepancy was accounted for in the change in helicopter blade tilt. When the instrument was airborne, the blades were tilted at a higher angle, thus allowing more light to reach the downwelling irradiance sensor. A correction was made by producing a second order regression equation of all airborne downwelling irradiances as a function of time. The true white card downwelling irradiance was then estimated using the resultant equation. This correction was made for each PROBAR band.

All data needed to be normalized to one unique white card reflectance for each band. The white card used for correcting the data was known to have a nearly constant reflectance value (.989) for the bands being studied. The white card reflectances were fit to a second order equation using time as the independent variable producing the measured white card reflectance curve. The true lake reflectance is adjusted by the same percent difference as that between the measured white card reflectance (MWCR) the known white card reflectance curve.

$$R(\text{true}) = R(\text{measured}) \times \left[1 - \left[\frac{\text{MWCR} - .989}{\text{MWCR}}\right]\right]$$

A final correction was made to PROBAR measurements which was lake-dependent. The assumption was made that no internal lake reflectance was measured in the band centered at 700 nm. This measurement was assumed to be an indication of wave induced surface reflected noise and thus was subtracted at all wavelengths. This correction only changed the offset of the spectral reflectance curve, not its shape.

The above and below surface corrected PROBAR reflectances are given as Appendix B.

6.0 LANDSAT TM PROCESSING METHODS

6.1 LAKE SIGNATURE EXTRACTION

Extraction software was applied to all three TM scenes. Lake signals were extracted from the TM images by finding the latitude and longitude of lakes of interest on topographic maps and using these latitudes and longitude to extract lake signatures from geometrically corrected imagery using extraction software. Nine brightness values were extracted from each lake and their means were used in subsequent processing. A three by three pixel area was extracted and the mean signal and its standard deviation for each band were recorded. To ensure that the spectral signatures represented water and not cloud, shoreline or bottom reflectance, TM band 4 signals were inspected. Average signals in TM band four were found to range between 11.0 and 14.0 with a standard deviation for values within an individual samples of less than 1.0. Thus for samples which had mean values outside this range or with sample standard deviations greater than 1.0 the sample was rejected and considered to indicate a non-water mixed reflectance. The rejected samples were replaced with values extracted from another part of the lake surface. Brightness values were extracted from the approximate center of each lake based upon the latitude and longitude of each lake center. These extracted mean values were then correlated to historical water chemistry data available for the same lakes as discussed in Section 8.0.

The TM data extracted is summarized in Table 6.1.

TABLE 6.1. THEMATIC MAPPER DATA EXTRACTED

Path/Row	Quad	Date
22/27	1	8/18/86
22/27	4	8/18/86
22/27	4	5/27/85
19/27	3	8/13/86
19/27	3	5/22/85

6.2 SOLAR ELEVATION ANGLE CORRECTION

All lake data were corrected for the solar elevation angle of each scene. This correction simply involved dividing each brightness value mean by the cosine of the solar zenith angle.

6.3 ATMOSPHERIC HAZE CORRECTIONS

A haze correction needed to be applied to the TM data so that real comparisons could be made between lakes within and between scenes which had varying amounts of haze distorting the signals. Lakes of equivalent Dissolved Organic Carbon (DOC) concentrations should have similar TM signals in band one but these data showed instead wide variations. The lakes with elevated TM band one counts also had elevated counts in bands two, three, and four. Since band 4 counts represent virtually no internal lake reflectance, it was hypothesized that relative differences between lakes in band four represented differences in atmospheric haze. Linear regression analyses between bands one and four, bands two and four, and bands three and four showed nearly linear behavior but with different slope and a small intercept. Also, these derived slope values were found to be scene dependent. The slopes between bands were derived using regression analyses and used directly in the haze correction algorithms. Thus the correction for haze was both wavelength dependent and scene dependent. The following three equations are the haze correction algorithms for the three TM bands used:

$$\text{TM-1(corr)} = \text{TM-1} - (\text{TM-4} \times M_1)$$
$$\text{TM-2(corr)} = \text{TM-2} - (\text{TM-4} \times M_2)$$
$$\text{TM 3(corr)} = \text{TM 3} - (\text{TM 4} \times M_3)$$

M_1, M_2, and M_3 are the slopes between bands one and four, bands two and four, and bands three and four, respectively.

This procedure reduced the impact of haze as indicated by the improved correlation between TM band one signals and DOC (i.e. from 0.62 to 0.83).

7.0 DEVELOPMENT OF A BIO-OPTICAL REFLECTANCE MODEL

7.1 REFLECTANCE MODEL

A TM radiative transfer model was developed to predict possible changes in radiometer signal levels which result from field-measured changes in chemical properties. Work on this model included specific calibration for the Landsat TM sensor. The model treats atmospheric optics, water optics, and the wind ruffled air-water interface. A solar ephemeral model has also been implemented to provide a capability to simulate the entire sun-sensor geometry. For many of the lakes involved in this study absorbing effects of DOC dominate the scattering effects of suspended minerals and organic particles. Under these conditions subsurface reflectance can be estimated as the ratio of backscattered radiation to the total lost by both backscattering (Bb) and absorption (a).

The specific values of a and Bb will depend on the concentrations of silt (mineral particles), chlorophyll-a pigments (C), and DOC. The absorption and scattering cross sections used in the present study were those derived by Bukata [1985] in his detailed optical analysis of Lake Ontario waters. These cross sections are shown in Figures 7.1 and 7.2.

The specific concentrations of each component were used together with these cross sections to estimate the absorption and backscattering coefficient. The following equation gives the general subsurface reflectance model:

$$R(\lambda) = C_o(\lambda) \bullet \frac{Bb(\lambda)}{a(\lambda) + Bb(\lambda)}$$

where $R(\lambda)$ = Subsurface irradiance reflectance

$C_o(\lambda)$ = Constant (typical value = .33)

$Bb(\lambda)$ = Total backscattering coefficient

$a(\lambda)$ = Total absorption coefficient

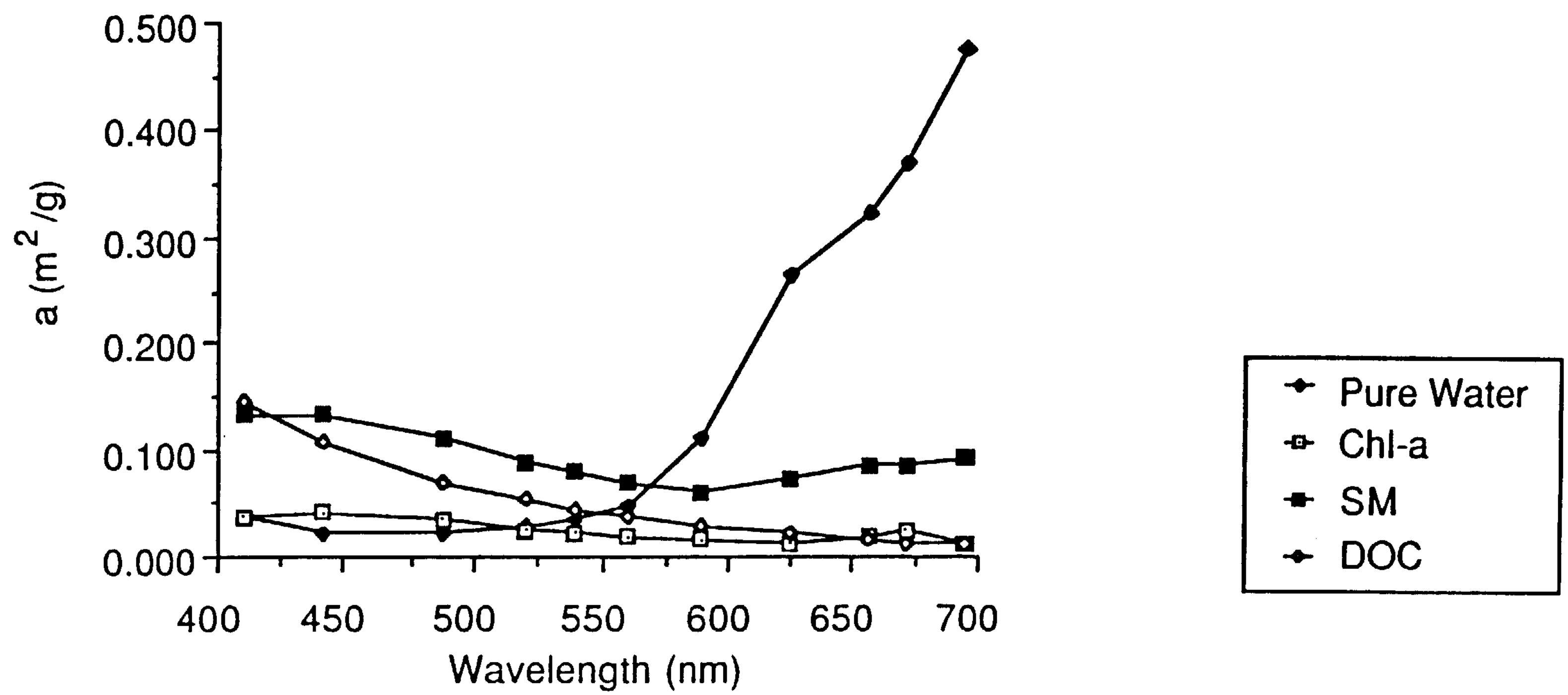

Figure 7.1. Absorption Cross Sections for Chlorophyll-a, DOC, Suspended Minerals, and the Absorption Coefficient of Pure Water.

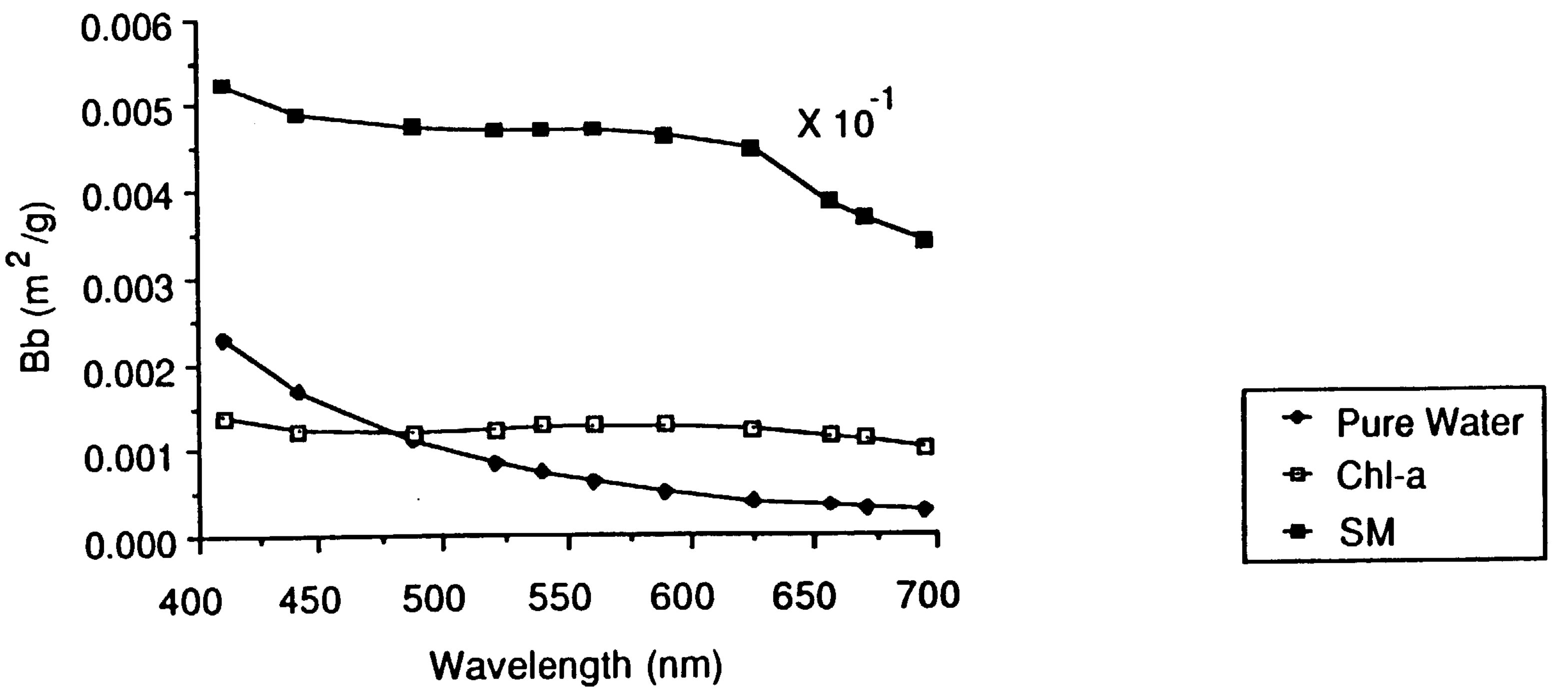

Figure 7.2. Backscatter Cross Sections for Chlorophyll-a, Suspended Minerals, and the Backscatter Coefficient of Pure Water.

This model calculates subsurface reflectances (at the wavelengths measured by the MER) given the concentrations of chlorophyll, DOC, and suspended solids as shown in the following equation:

$$R(\lambda) = C_0(\lambda) \cdot \frac{(Bb_w(\lambda) + Bb_C(\lambda)\bullet[C] + Bb_{SM}(\lambda)\bullet[SM])}{(a_w(\lambda) + a_C(\lambda)\bullet[C] + a_{SM}(\lambda)\bullet[SM] + a_{DOC}(\lambda)\bullet[DOC] + Bb's)}$$

where R = Subsurface hemispherical reflectance
SM = suspended solid concentration (mg/l)
C = chlorophyll concentration (μg/l)
DOC = Dissolved organic carbon concentration (mg/l)

7.2 MODEL CALIBRATION

Backscattering and absorption values were regressed with the MER-1000 estimated subsurface reflectance at each wavelength producing an estimate of constant coefficient (C_0) which is listed in Table 7.1. The resulting set of reflectance equations can be used to examine the spectral reflectance dependence on DOC and other constituents. The mineral particle concentrations were found to be extremely small, on the order of 0.1 mg/l. If one assumes a chlorophyll-a concentration of 1.0 μg/l (a typical value) then the DOC reflectance varies between 1% and 6% in TM band one as depicted in Figure 7.3.

7.3 MODEL EXTENSION WITH PROBAR DATA

The PROBAR above-surface reflectance data were collected in August 1986. These data were converted to subsurface reflectances for over one-hundred lakes using a regression procedure (described in Section 8.5).

The model developed for the MER subsurface reflectance data was tested using the PROBAR-predicted subsurface reflectance data. The Marquardt method was used for developing the non-linear model. This method is equivalent to performing a series of ridge regressions and is most useful when the parameter estimates are highly correlated.

Table 7.1.

Reflectance Model Coefficients

λ (nm)	C_o	Std. Error
410	0.731	0.1382
441	0.678	0.1193
488	0.525	0.0063
520	0.360	0.0318
540	0.319	0.0373
560	0.301	0.0520
589	0.374	0.0679
625	0.300	0.0753
656	0.345	0.0930
671	0.383	0.0936
694	0.519	0.1156

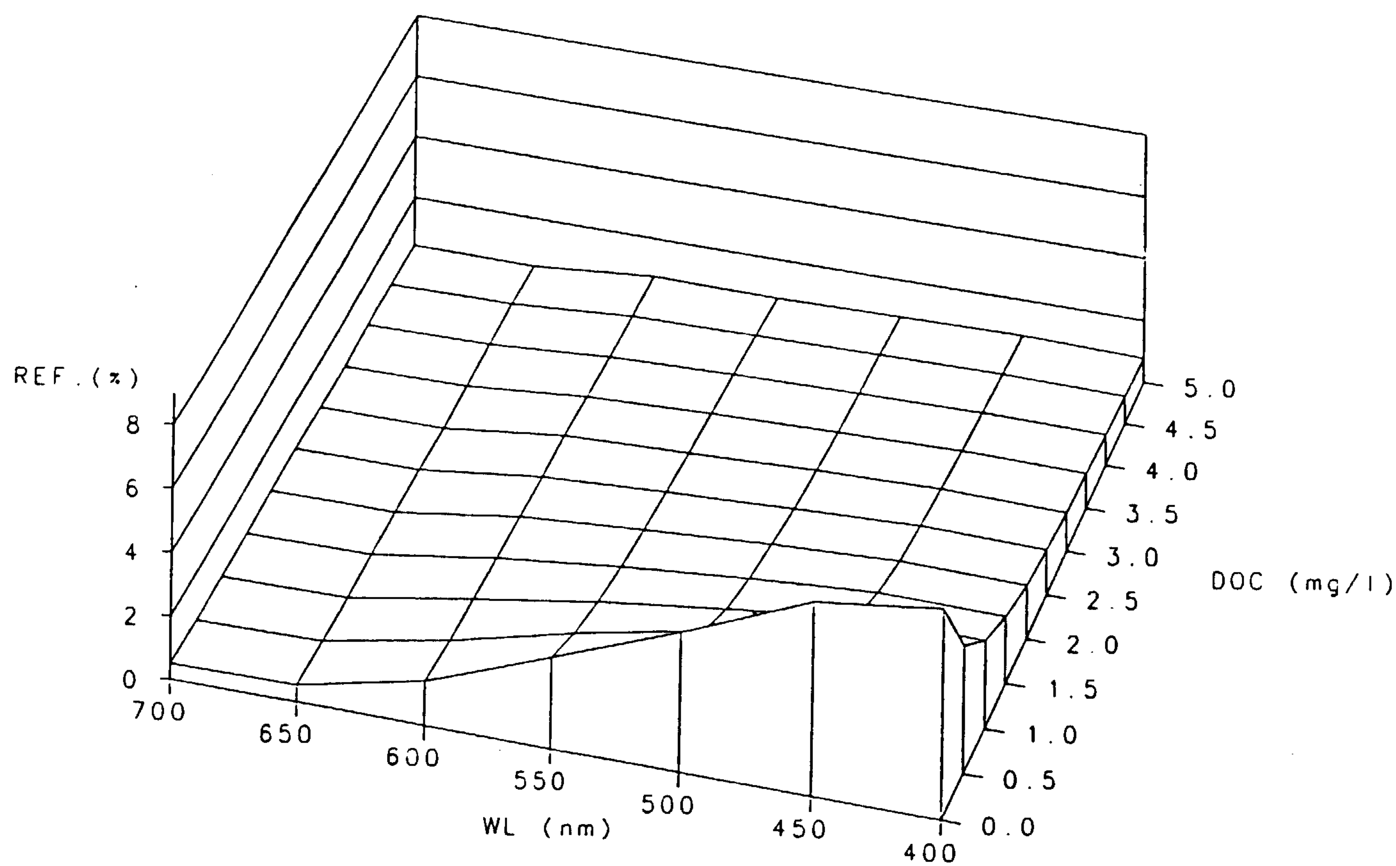

Figure 7.3. Reflectance Model for Dissolved Organic Carbon (DOC)

Since DOC and chlorophyll, (the two model parameters), have a correlation coefficient of about 0.73, the Marquardt method seemed appropriate.

To estimate how well this model fit the PROBAR predicted subsurface reflectance data, the coefficients produced using these data were compared to those produced using the MER data. The results of using the non-linear model on data from wavelengths of 443, 470, 520 and 540 μm are listed in Table 7.2.

TABLE 7.2. COMPARISON OF PROBAR AND MER MODEL COEFFICIENTS

	PROBAR	MER
C_{443}	.51	.73
C_{470}	.48	.68
C_{520}	.42	.36
C_{550}	.32	.32

The model fits the data best in the longer wavelengths. At worst, the model coefficients are different by .22, or approximately 30% (for λ=443 nm). At best, there is no difference between the coefficients (λ=550 nm).

A comparison of the actual PROBAR predicted subsurface reflectance and the model-predicted subsurface reflectance was made to test the performance of the reflectance model. The correlation between the predicted and actual subsurface reflectance models was quite high, ranging from .81 to .89, depending on the wavelength. Model-predicted versus PROBAR-predicted subsurface reflectances at 440 nm and 470 nm are shown in Figures 7.4 and 7.5, respectively.

7.4 REFLECTANCE SENSITIVITY TO CHANGES IN WATER CHEMISTRY

The sensitivity of reflectance to changes in DOC is given by the following derivative of the model equation:

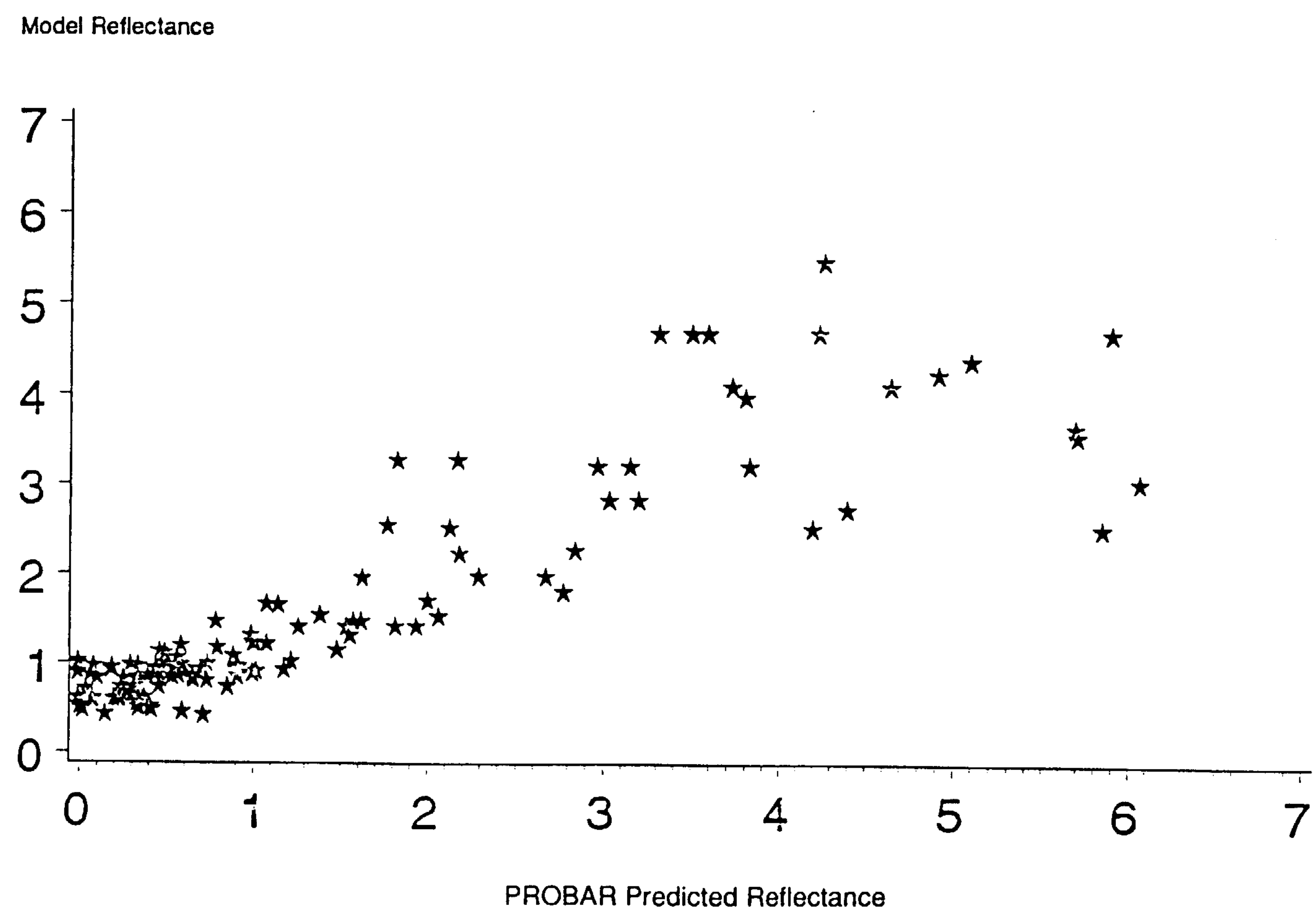

Figure 7.4. Model Predicted Versus PROBAR Predicted Subsurface Reflectance at 440nm. PROBAR Data Collected From Algoma and Sudbury Site, August 1986.

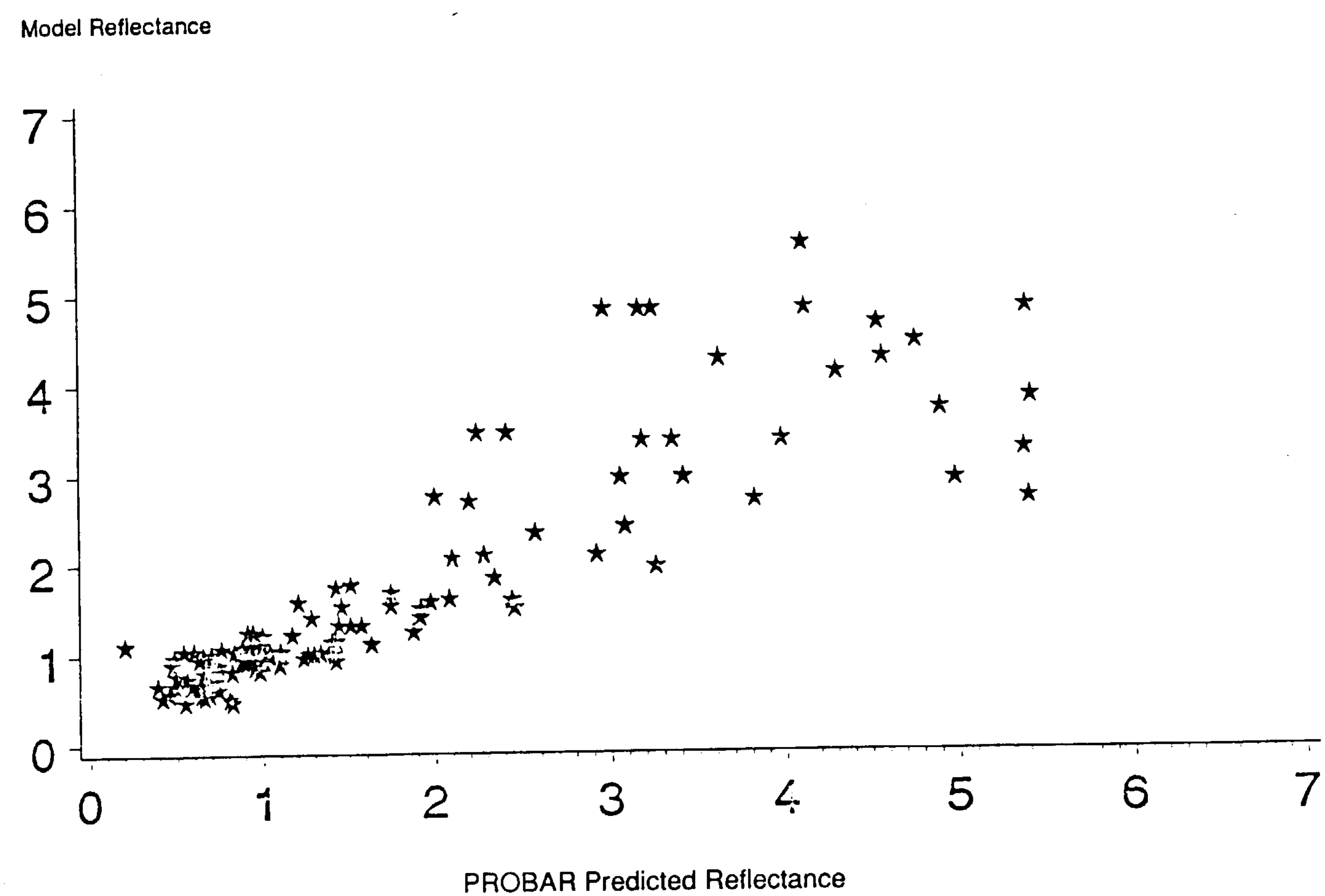

Figure 7.5. Model Prdicted Versus PROBAR Predicted Subsurface Reflectance at 470nm. PROBAR Data Collected From Algoma and Sudbury Site, August 1986.

$$\frac{dR(\lambda)}{d[DOC]} = \frac{a_{DOC}(\lambda)\bullet(Bb_w(\lambda)+Bb_{SM}(\lambda)\bullet[SM]+Bb_C(\lambda)\bullet[C]\bullet Co(\lambda)}{(a_{DOC}(\lambda)\bullet[DOC]+a_C(\lambda)\bullet[C]+a_{SM}(\lambda)\bullet[SM]+a_w(\lambda))^2}$$

Figure 7.6 shows the change in reflectance sensitivity for a given DOC concentration. The plotted sensitivity values are for the Sudbury site, calculated using the above equation and measured values of DOC and chlorophyll-a.

7.5 MODEL-PREDICTED SENSITIVITY OF TM

The ability to detect a seasonal change using depended on the measured TM reflectance changes, and on the sensitivity of reflectance to changes in DOC and chlorophyll-a pigment concentration.

The impact of DOC changes on reflectance can be calculated using the sensitivity equation in Section 7.4. The expected TM band one signal change per percent subsurface reflectance change was estimated previously to be 2.86 counts/percent. If it is assumed that seasonal changes in DOC are on the order of 50%, then background levels of two to three count changes are projected in the TM response. These predictions are summarized as Table 7.3.

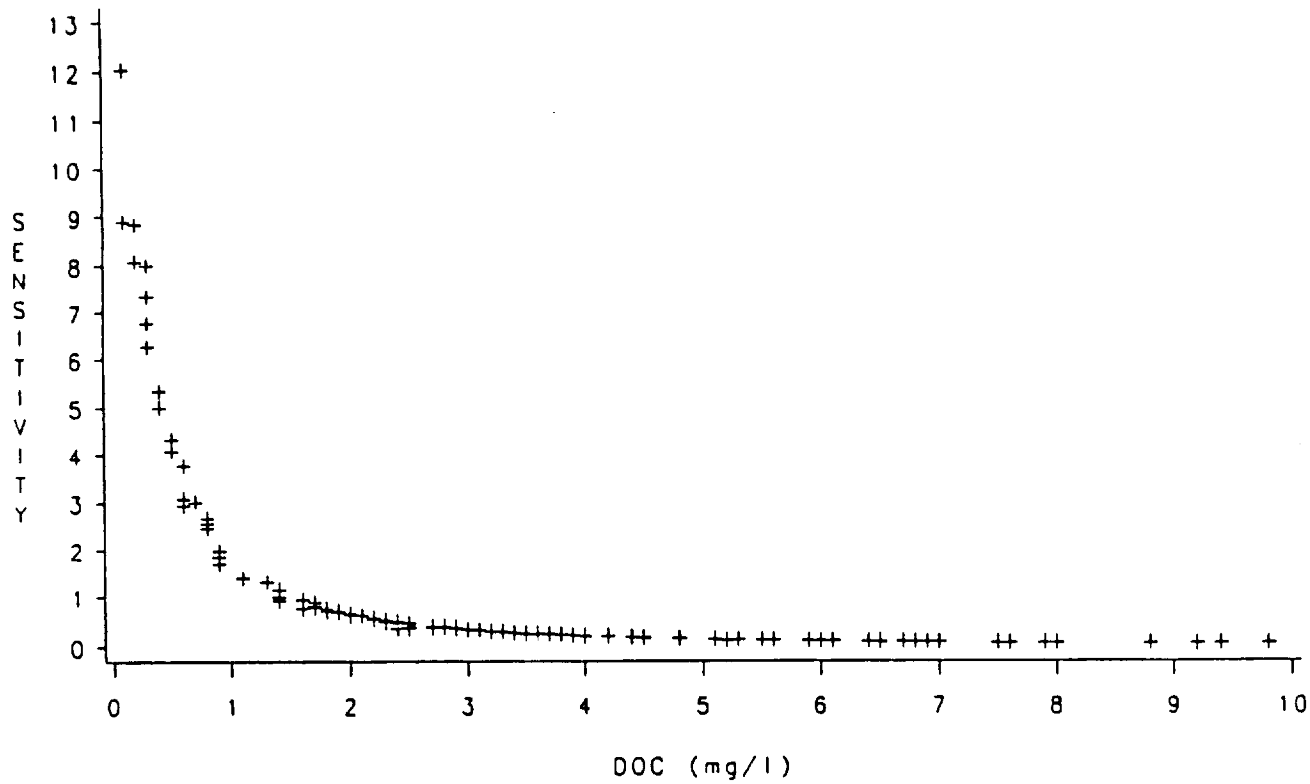

Figure 7.6. Sensitivity of Reflectance to Changes in DOC Concentration for a Clear Lake Typical of the Sudbury Site.

Table 7.3.

PREDICTED CHANGES IN REFLECTANCE AND TM BAND 1 COUNTS

DOC Sensitivity	DOC(mg/l)	ΔDOC (mg/l)	ΔR(%)	ΔTM Counts
5.6	0.3	0.15	0.84	1.7
4.0	0.5	0.25	1.00	2.0
1.6	1.0	0.50	0.80	1.6
0.8	2.0	1.00	0.80	1.6
0.3	3.0	1.00	0.30	0.6

8.0 ANALYSIS OF RADIOMETRIC DATA RELATIONSHIPS

8.1 CHARACTERIZATION OF WATER CHEMISTRY OF STUDY AREA LAKES

The August 1986 water chemistry data collected in this experiment contain twenty-eight in-lake water parameters for 300 lakes across Ontario. Pearson correlation coefficients and their significance probabilities were produced for a subset of these data set and are listed in Table 8.1. There were strong correlations between pH and total inflection point alkalinity and aluminum (.88 and -.75, respectively). The correlation between pH and DOC was found to be much lower at 0.61 but which still indicates a significant relationship exists. A scatter plot of pH and DOC is shown as Figure 8.1. It is evident from these data that the strongest relationship exists for DOC values less than 3.0 mg/1.

8.2 ANALYSIS OF SUBSURFACE IRRADIANCE MEASUREMENTS

Based upon the reflectance model analysis high correlations were expected between lake water chemistry and MER optical measurements. The Pearson correlation coefficients and their significant probabilities are tabulated in Table 8.2 for the August 1986 water chemistry data. In general, there is a high correlation between the short wavelength reflectances (λ < 540 nm) with Secchi depth (SD), chlorophyll-a (CHLOR), DOC, aluminum (AL), and pH. The high correlations with SD, DOC, and AL support the phenomenological relationships between water chemistry parameters and optical properties as discussed previously in Chapter 2.0. The lower correlations with chlorophyll-a values were expected since pigment concentrations measured in many of these lakes was so small.

Mer spectral reflectances were plotted for selected lakes which are given as Appendix F. The clear acid lakes were found to have spectral reflectances with peaks in the 400-450 nm range and shape similar to that obtained for Sunnywater Lake (see Figure 8.2). By contrast the high DOC lakes have spectral reflectance curves which

Table 8.1. Pearson Correlation Coefficient for Water Chemistry Parameters With Their Significance Probabilities Given Directly Below Each Value.

	PH	DOC	AL	S04	TTLCHL_A	TIP
PH	1.00000	0.61434	-0.74745	-0.07978	0.38638	0.87665
	0.0000	0.0001	0.0001	0.5085	0.0009	0.0001
DOC	0.61434	1.00000	-0.52390	-0.26801	0.63197	0.60011
	0.0001	0.0000	0.0001	0.0238	0.0001	0.0001
AL	-0.74745	-0.52390	1.00000	0.17498	-0.39310	-0.55308
	0.0001	0.0001	0.0000	0.1445	0.0007	0.0001
S04	-0.07978	-0.26801	0.17498	1.00000	-0.31333	-0.08545
	0.5085	0.0238	0.1445	0.0000	0.0078	0.4788
TTLCHL_A	0.38638	0.63197	-0.39310	-0.31333	1.00000	0.27312
	0.0009	0.0001	0.0007	0.0078	0.0000	0.0212
TIP	0.87665	0.60011	-0.55308	-0.08545	0.27312	1.00000
	0.0001	0.0001	0.0001	0.4788	0.0212	0.0000
TM1M	-0.37128	-0.62291	0.29944	0.04549	-0.41944	-0.30883
	0.0014	0.0001	0.0112	0.7084	0.0003	0.0088
TM2M	-0.12047	-0.02355	0.08366	-0.27447	0.17102	-0.11600
	0.3170	0.8454	0.4879	0.0205	0.1539	0.3354
TM3M	0.09888	0.30388	-0.10660	-0.41955	0.38174	0.08820
	0.4120	0.0100	0.3763	0.0003	0.0010	0.4645
TM4M	0.00220	0.15893	-0.07001	-0.20989	0.31086	-0.03466
	0.9855	0.1855	0.5618	0.0789	0.0083	0.7742

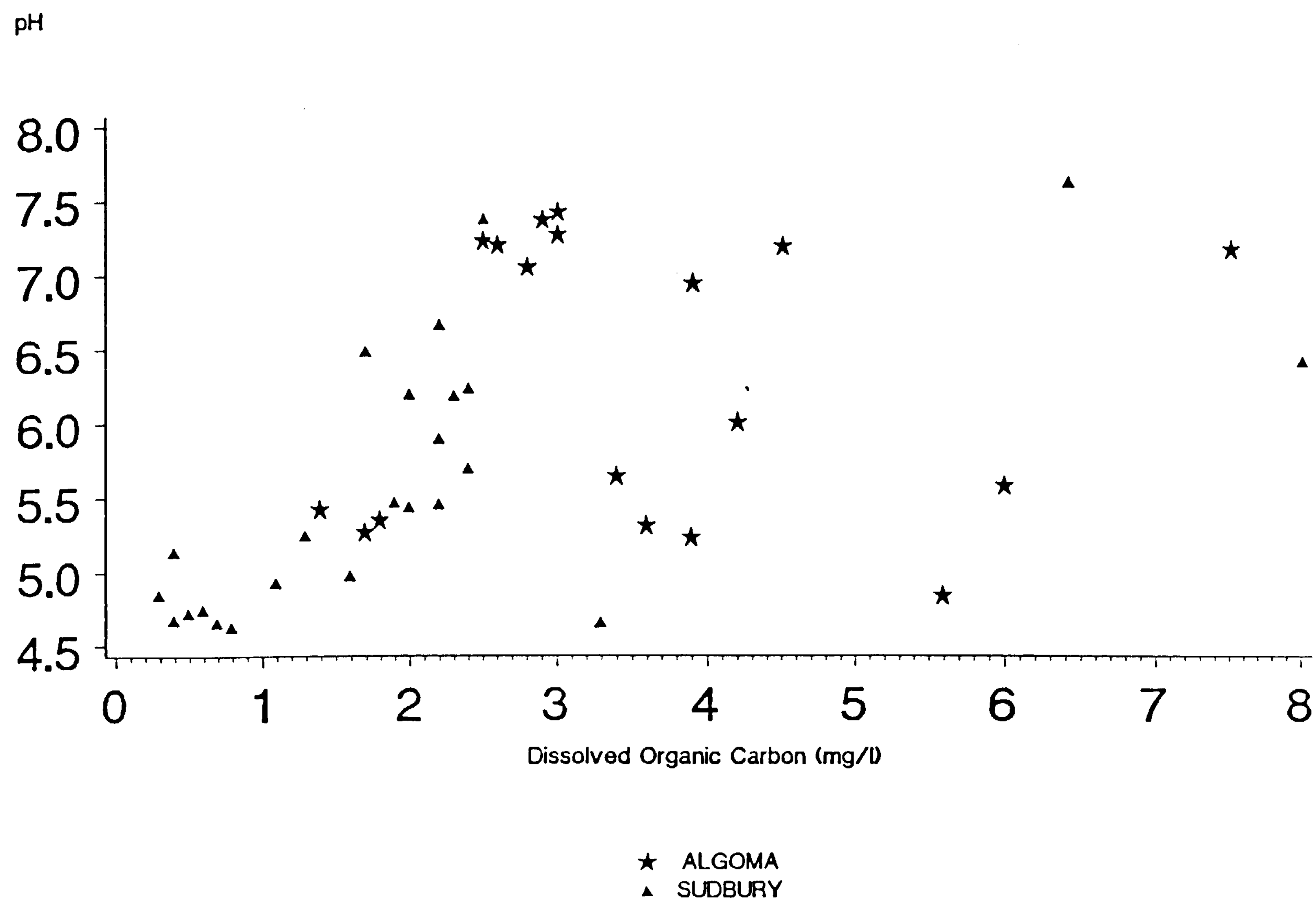

Figure 8.1. Dissolved Organic Carbon Versus pH Value for Water Samples Collected From the Algoma and Sudbury Sites, August 1986.

Table 8.2. Pearson Correlation Coefficient for Water Chemistry Parameters With MER Derived Reflectances.

	SD	CHLOR	DOC	PH	S04	AL
R410	0.87358	-0.40861	-0.68363	-0.65564	0.47815	0.75800
	0.0102	0.3628	0.0904	0.1098	0.2778	0.0483
R441	0.94129	-0.67301	-0.85663	-0.71163	0.47624	0.75093
	0.0051	0.1429	0.0294	0.1127	0.3397	0.0853
R488	0.94829	-0.54928	-0.78658	-0.75139	0.65595	0.78604
	0.0011	0.2016	0.0359	0.0515	0.1096	0.0361
R520	0.90124	-0.52573	-0.69532	-0.62782	0.76237	0.59270
	0.0056	0.2255	0.0828	0.1311	0.0463	0.1608
R540	0.53591	-0.15807	-0.25555	-0.16285	0.62424	0.14878
	0.2150	0.7350	0.5802	0.7272	0.1340	0.7502
R560	-0.55033	0.70762	0.77824	0.80694	-0.26848	-0.72104
	0.2005	0.0753	0.0393	0.0283	0.5605	0.0675
R589	-0.76855	0.88722	0.94489	0.92644	-0.55073	-0.76152
	0.0435	0.0077	0.0013	0.0027	0.2001	0.0467

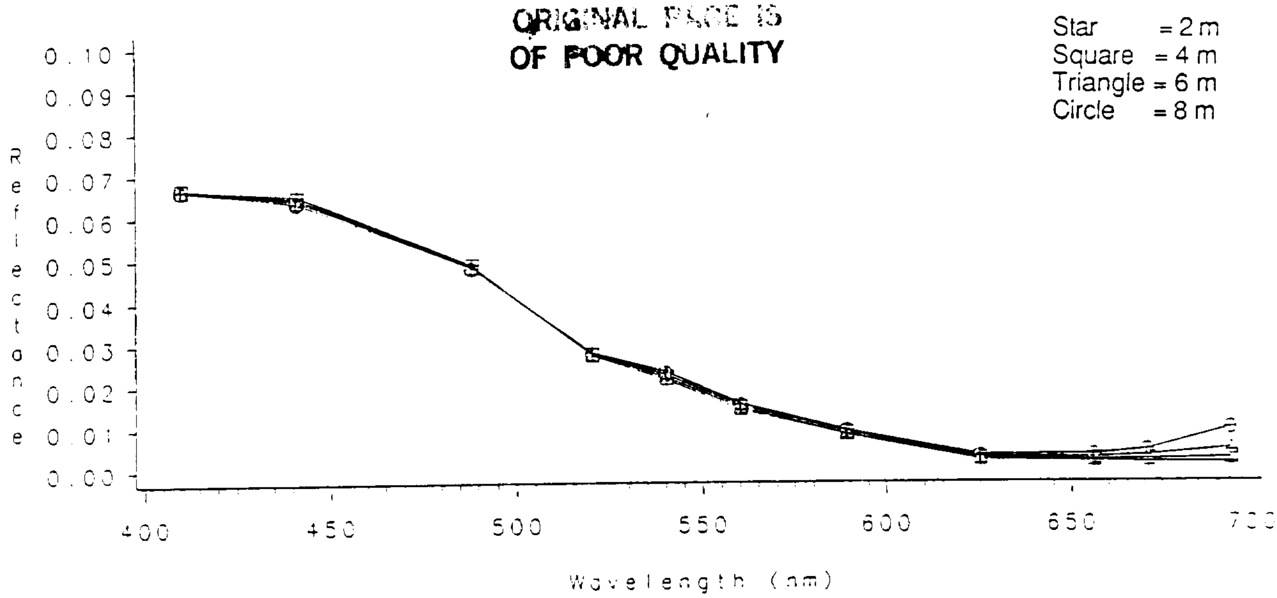

Figure 8.2. Spectral Reflectance for Sunnywater Lake as Derived From MER Data Collected 13 August 1986.

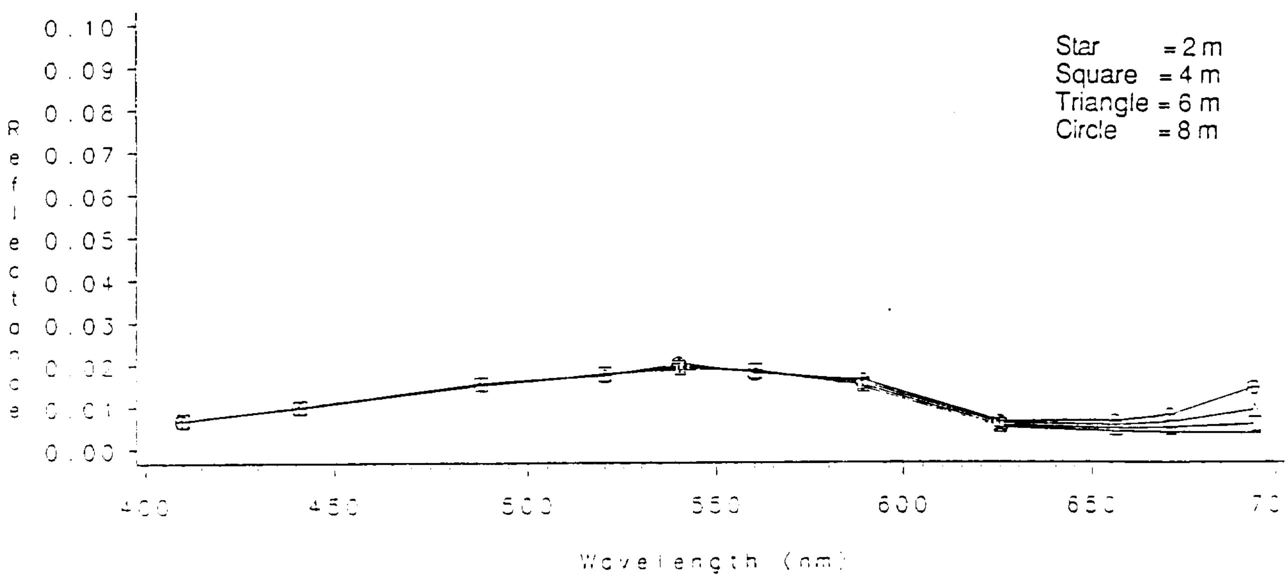

Figure 8.3. Spectral Reflectance for Center Lake as Derived From MER Data Collected 22 August 1986.

have generally lower reflectances values and a spectral peak at approximately 550 nm. For these lakes, the high DOC concentrations (2.0 - 4.0 mg/1) are consistent with the low reflectance values derived for the shorter wavelengths.

The high-DOC basic lakes have curves shaped more like Center Lake (see Figure 8.4). Therefore, the following indicator for characterizing acid and basic lakes using these spectral data could be calculated:

$$I = \frac{\text{Reflectance (500 } \mu\text{m)}}{\text{Reflectance (560 } \mu\text{m)}}$$

This suggested indicator, I, which takes advantage of the difference in the shapes of spectral curves, is greater than 1.0 for acidified lakes and is less than 1.0 for buffered, high DOC lakes.

The MER reflectances were also analyzed using the non-linear reflectance model described in Section 7.0. The suspended solids were assumed to be constant at 0.1 mg/1. The model converged for all the MER data collected and the following coefficients $C_0(\lambda)$ are shown in Table 8.3.

TABLE 8.3. COEFFICIENTS FOR SUBSURFACE REFLECTANCE MODEL USING MER DATA

	1986	1987			
Wavelength (μm)	Aug	May 5	May 12	June 13	June 30
488	.524	.388	.523	.779	.89
560	.302	.338	.332	.523	.667

The August data were collected under the best conditions, so the coefficients produced for these data were used as standards to compare the other dates. The May 12 data produced coefficients nearly equal to those produced using the August data. The June reflectance data do not seem to fit the same model suggesting that the water chemistry had

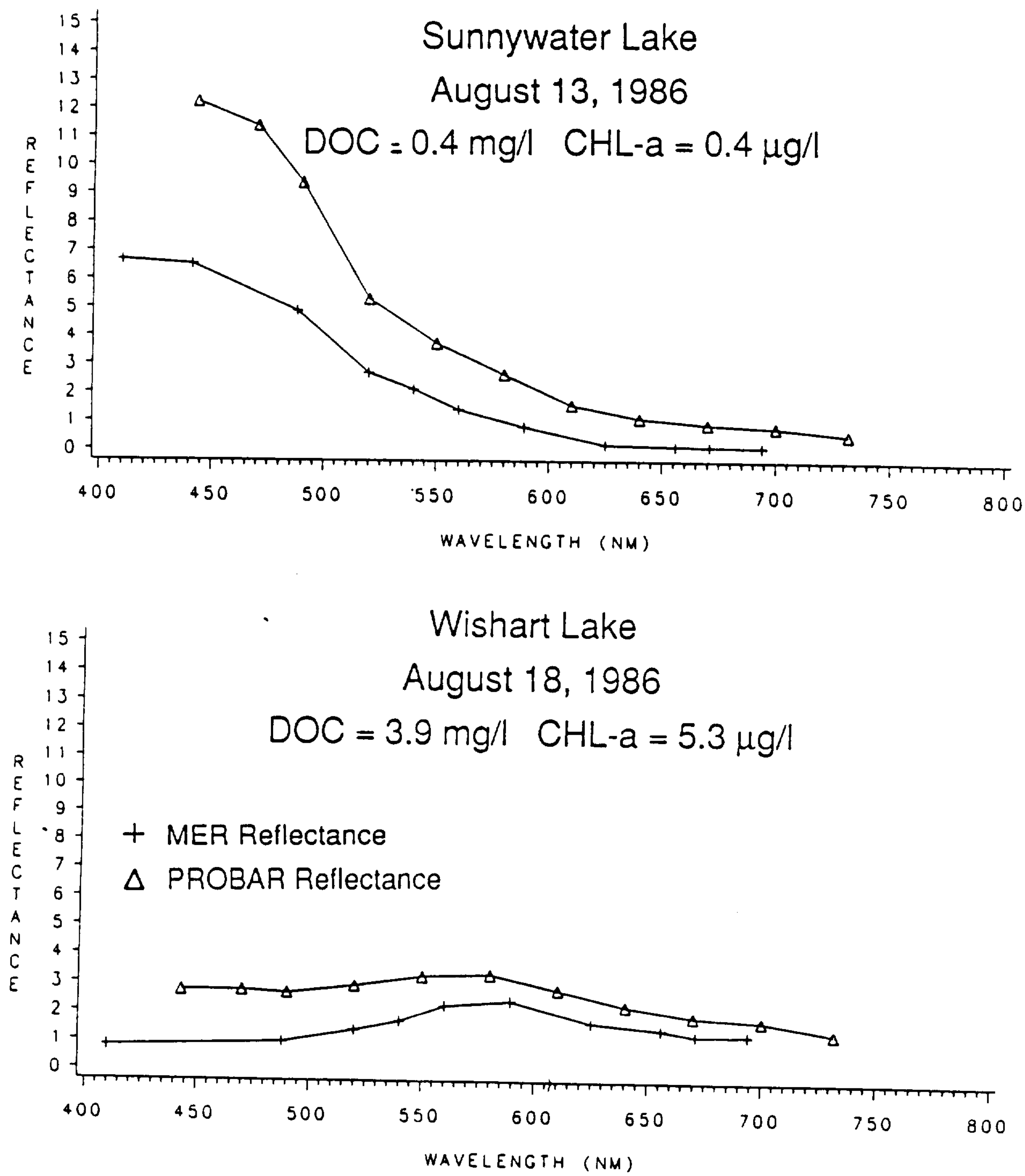

Figure 8.4. **Comparison of MER and PROBAR Derived Spectral Reflectances.**

changed dramatically and the DOC reflectance model assumptions were no longer valid.

To find out how well the model worked for each date, the correlations between actual and model-predicted subsurface reflectances were calculated. There was no correlation between actual and predicted subsurface reflectance for any of the spring data at 560 μm. For 488 μm the correlation between actual and predicted reflectances was less than .24 for the two June dates. However, the same correlations for May 5 and May 12 are .93 and .97, respectively. The reflectance differences between actual and predicted reflectances were less than 1.15% for these two dates.

8.3 ANALYSIS OF SURFACE MEASUREMENT DATA

The PROBAR-derived surface reflectance data were found to be highly correlated with the MER subsurface reflectance data as shown by the examples in Figure 8.3. To determine if the correlations of water chemistry with PROBAR data were similar to those with the MER data, another correlation matrix was calculated. Table 8.4 contains PROBAR correlations with water chemistry at multiple wavelengths. The correlations of reflectance with the water chemistry are much lower, but still reach -.80, -.68, and -.64 for DOC, pH and chlorophyll. This was expected, however, since varying lake surface waves and atmospheric haze introduced more noise in the signal measured by the PROBAR.

8.4 THE COMPARISON OF SURFACE AND SUBSURFACE MEASUREMENTS

An experiment was conducted to determine the relationship between the surface and the subsurface measurements of lake volume reflectance. The surface reflectance was measured using the PROBAR spectral radiometer mounted in a helicopter and the subsurface reflectance was measured using the MER submersible radiometer. Modeling theory predicted that the relationship between these two measurements would be

Table 8.4. Pearson Correlation Coefficient for Water Chemistry Parameters With PROBAR Derived Reflectances.

	PH	DOC	TIP	TTLCHL_A	AL	S04
R443	-0.64108	-0.73158	-0.44737	-0.62890	0.57202	0.57597
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
R470	-0.65695	-0.75080	-0.46922	-0.63443	0.57275	0.58581
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
R490	-0.66094	-0.75960	-0.47927	-0.63707	0.56906	0.58866
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
R520	-0.68095	-0.79678	-0.50436	-0.64002	0.58672	0.62239
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
R550	-0.62813	-0.78275	-0.47444	-0.58288	0.54829	0.59749
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

linear. Therefore, the relationship between PROBAR and MER measurements could be described using the equation:

$$R_i(\text{mer}) = m \times R_1(\text{PROBAR}) + b$$

where m = slope
b = y-axis intercept
R_i = reflectance at band i

The results of a linear regression analysis of each spectral band and the corresponding statistical significance (α = .05) of each regression are found in the following table:

Wavelength	b	m	Significant (α < .05)
443	- .33	.53	yes
470	.215	.44	yes
490	.43	.42	yes
520	.55	.44	yes
550	1.17	.19	no (p = .36)
580	1.04	.14	no (p = .76)
610	-1.11	1.59	yes
640	- .57	1.86	yes
670	- .27	1.49	yes
700	0.0	1.0	yes

The results shown in Section 5.5 support the hypothesis that there is a linear relationship between the MER and the PROBAR data for all but wavelengths 550 and 580 nm. At most wavelengths, then, subsurface lake volume reflectance can be predicted with reasonable accuracy when only the PROBAR reflectance data are available. This result is significant since acquiring lake reflectance data with the PROBAR is less expensive and quicker that with the in situ measurements.

8.5 ANALYSIS OF TM MEASUREMENTS

The haze normalized TM data for August 1986 show sensitivity to lake DOC concentrations as indicated by the data plotted in Figure 8.5. These results confirm the model predicted sensitivity of the TM band on signals to changes in DOC. The model predicted a DOC reflectance range of about 5% which corresponds to a 14.3 signal count spread in the TM band one data. TM data from the Sudbury site are consistent with the predicted spread in DN counts. The Algoma data appear to lack sensitivity to changes in DOC which is likely due to the fact that most lakes in the Algoma region have high values of DOC and chlorophyll-a.

8.6 MULTITEMPORAL RELATIONSHIPS

Multitemporal analyses could be made for TM and MER data only since these were the only measurements made in the spring of 1987. PROBAR multitemporal relationships could not be examined since this instrument was not available to the project in 1987.

8.6.1 MER Multitemporal Analysis

The corrected MER data yielded several multitemporal trends. These trends differed depending on the buffering capacity of the lake. Acidified lakes, such as Dougherty and Wolf, (TIP < 0), had small multitemporal reflectance changes from 500 μm to 600 μm (< .4% reflectance). All the acid lakes showed large reflectance differences in to 400 μm to 500 μm region. Each lake showed a decrease in reflectance form August, 1986 to May 5, 1987, and then an increase in reflectance from May 5, 1987 to May 12, 1987 between 400 μm to 500 μm. These data for three lakes' reflectances at 441 μm are tabulated below:

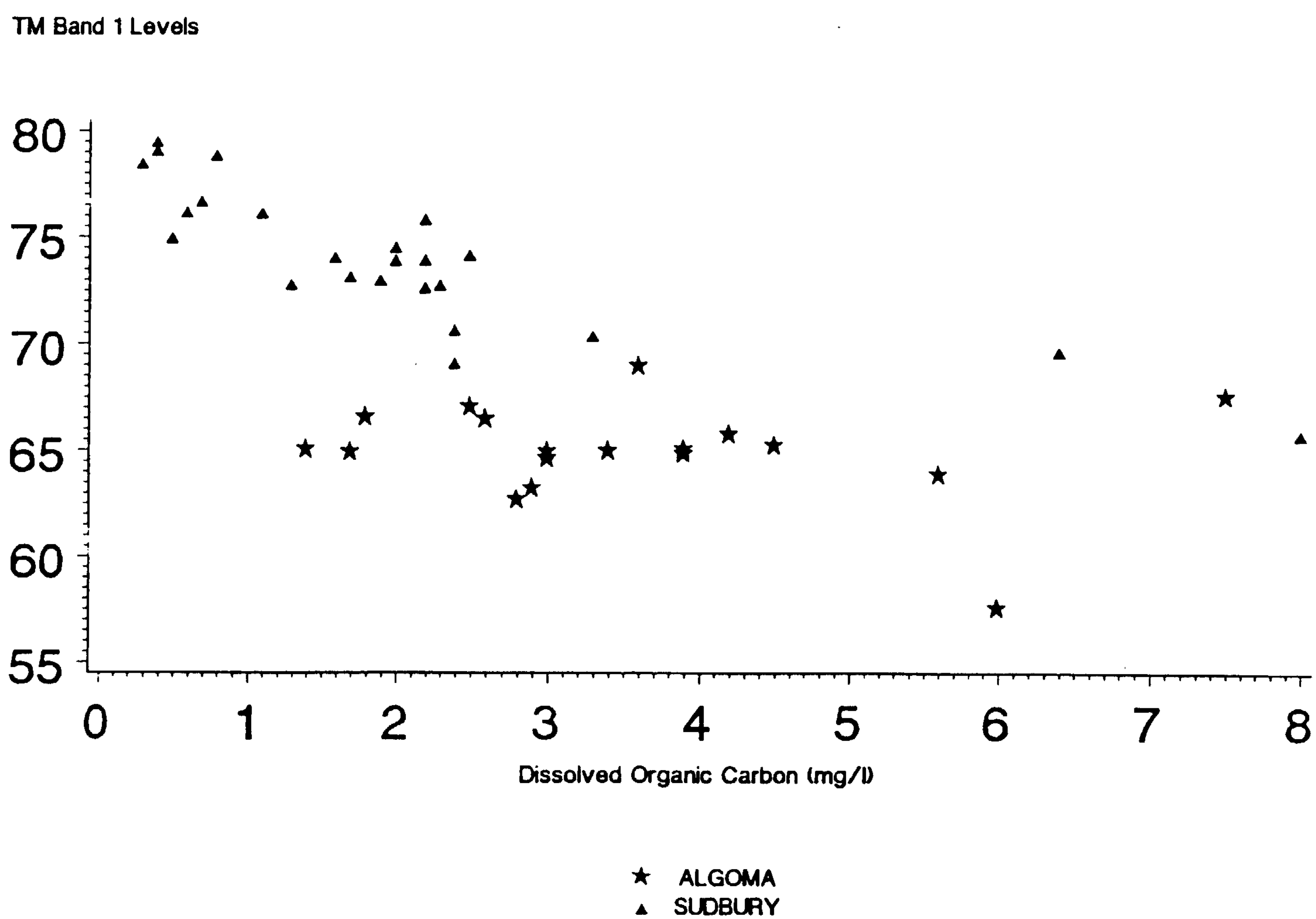

Figure 8.5. TM Band 1 Versus Dissolved Organic Carbon Using the August 13, 1986 (P19, R27) and August 18, 1986 (P22, R27) Data Sets.

Name	8/86	5/5/87	5/12/87
Sunnywater	6.5	-	7.4
Wolf	3.2	2.1	3.2
Dougherty	3.8	2.3	2.6

In contrast, the buffered lakes, (TIP > 0), did not show a large difference (> .4% reflectance) in the 400 μm to 500 μm region but did show large multitemporal differences from 500 μm to 600 μm. At 560 μm, the basic lakes increased in reflectance form August 1986 to May 5, 1987. No consistent change in reflectance from May 5, 1987 to May 12, 1987 was found for the buffered lakes. The reflectance data for 560 μm measured from buffered lakes are found below:

Name	8/86	5/5/87	5/12/87
Centre	1.8	2.6	1.7
Whitepine 2	1.2	1.6	2.0

In conclusion, differences in multitemporal MER reflectance trends between buffered and acidified lakes were found. Acidified lakes had a decrease in reflectance for the 400 μm to 500 μm region and relatively no change for the 500 μm to 600 μm region. Buffered lakes had an increase in reflectance for the 500 μm to 600 μm region and relatively no change to the 400 μm to 500 μm region.

8.6.2 TM Multitemporal Analysis

The TM band one seasonal change patterns are similar to those indicated for the August 1986 data. The August low DOC lakes were found to have larger TM DN values than with the May 12, 1987 and June 13, 1987 collection dates. These data are shown in Figures 8.6 and 8.7, respectively. The extracted and atmospherically normalized TM data are given as Appendix G. The size of the TM band one count changes for Sudbury are substantially larger than predicted. Furthermore,

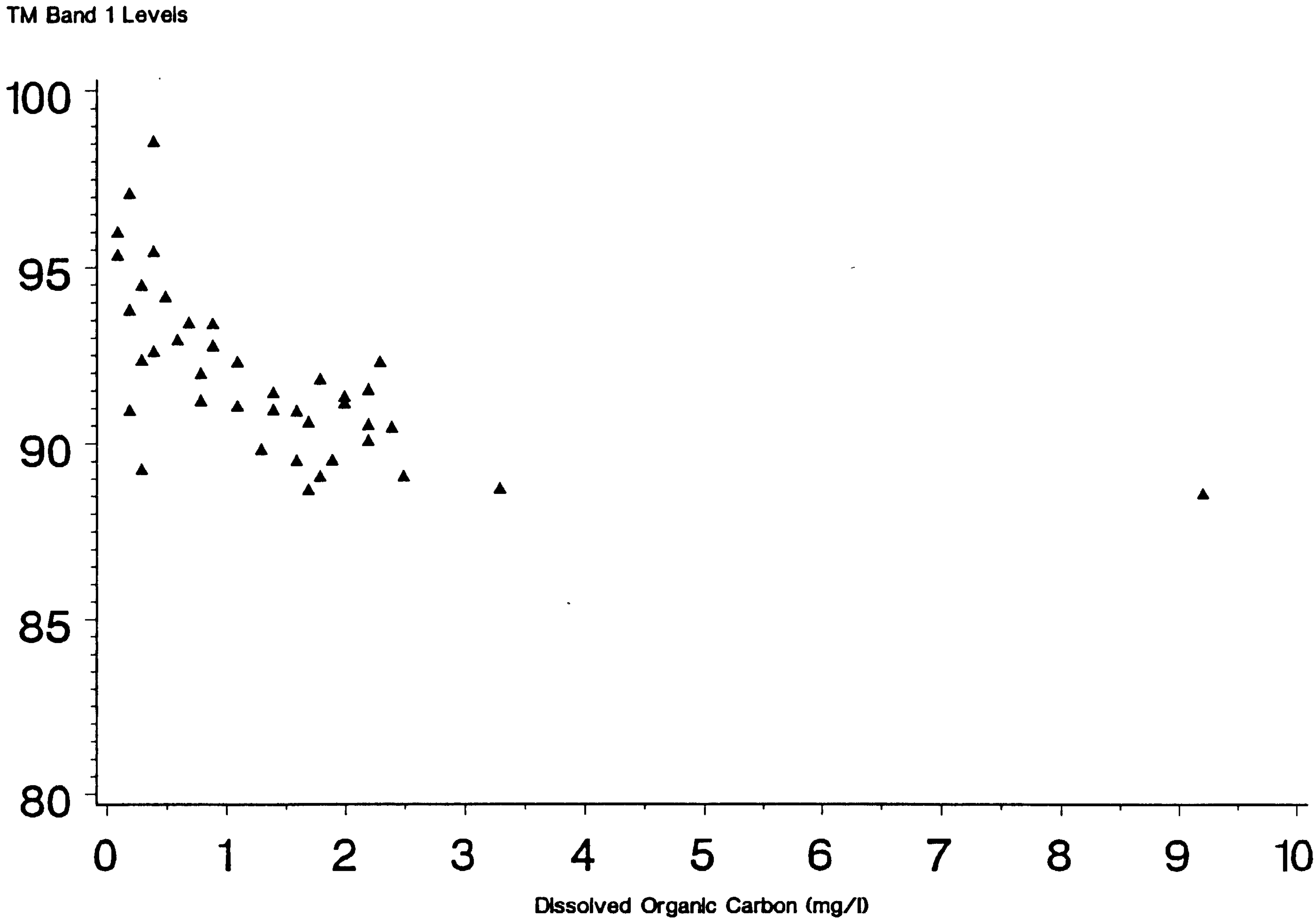

Figure 8.6. TM Band 1 Versus Dissolved Organic Carbon Using the May 12, 1987 (P19, R27) Scene Data.

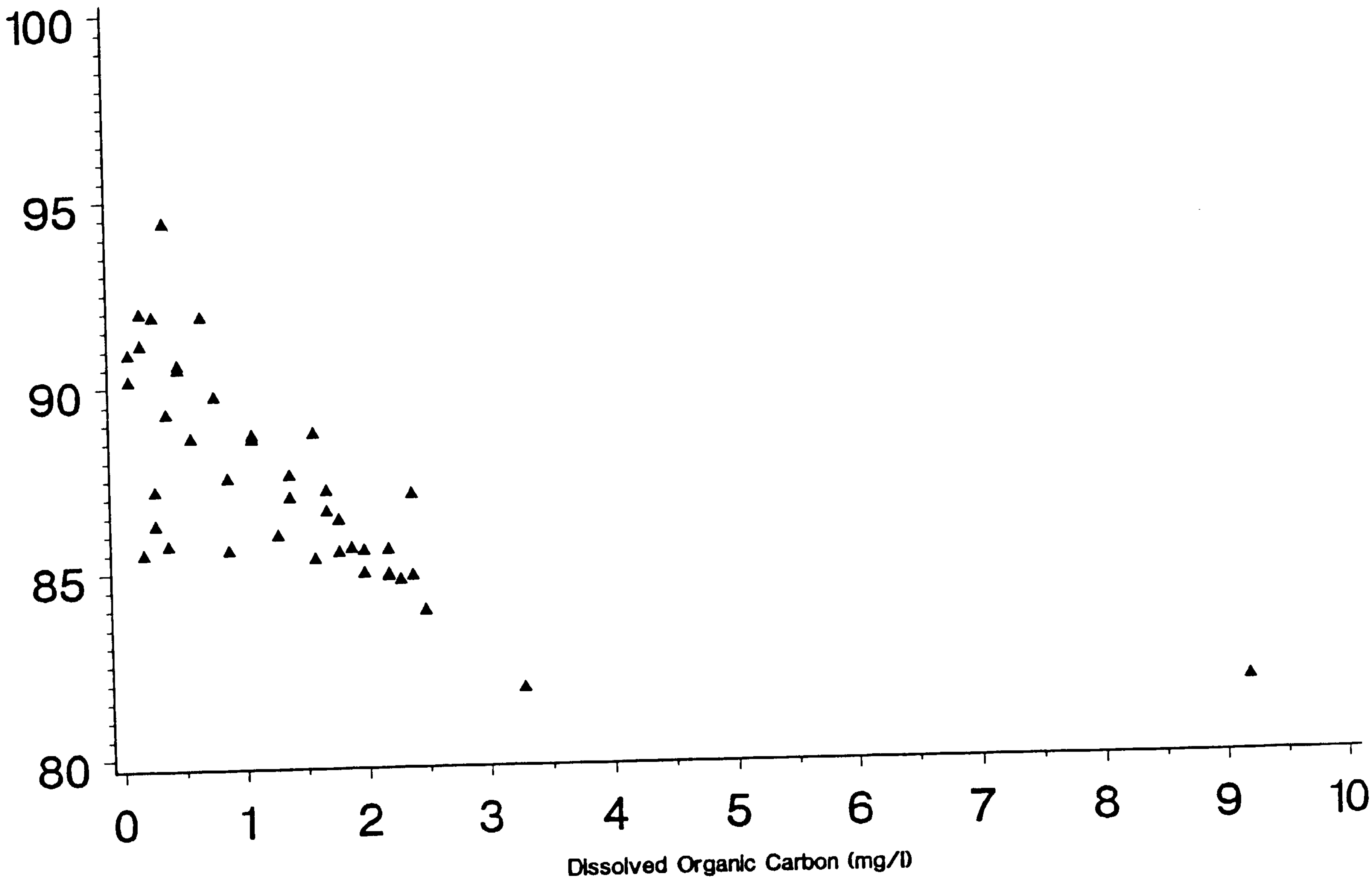

Figure 8.7 TM Band 1 Versus Dissolved Organic Carbon Using the June 13, 1987 (P19, R27) Scene Data.

these count differences suggest a two to three percent change in subsurface reflectance, needed a greater DOC change sensitivity than predicted in Table 7.3.

Multitemporal differences were calculated for the following pairs of dates:

August 1986 - May 1987
August 1986 - June 1987
June 1987 - May 1987

These differences were analyzed to determine whether or not they aided in identifying acidified and buffered lakes.

The multitemporal changes in MER-derived subsurface reflectance were used to determine the expected changes in TM signal counts for bands one and two using the conversion factors given in Section 2.5. The expected changes in TM signal counts for band two were all found to be within the noise level for band two data. Therefore, the band two multitemporal differences were insignificant for the 1986-1987 scene pair. Furthermore, approximately 90% of the TM band 1 differences were also in the noise level. As a result, obvious multitemporal differences using TM data were not found.

The majority of the multitemporal analyses were based on the August - May scene pair. When all of the lakes ($n = 41$) are analyzed for significant differences ($\alpha = .1$) between August and May reflectance changes, no difference is found between acidified and buffered lakes.

Another test was made to determine if the August - May TM band one differences were a function of DOC, TIP, chlorophyll and/or aluminum levels measured in 1986. A multivariate regression analysis was done and all of the parameter estimates were insignificant ($\alpha = .5$). These results lead to conclusion that the TM band one differences were not a function of water chemistry.

Data were also extracted from a May 22, 1985 scene for the Sudbury site and the differences in TM band 1 were formed with the August 13, 1986 scene. These differences were then compared to DOC values collected in August 1986. The results are shown in Figure 8.8 and indicated a possibly strong seasonal relationship to DOC concentrations and especially for those lakes with less than 3.0 mg/1 DOC.

8.7 ANALYSIS OF TRANSMISSOMETER ATTENUATION DATA

A study was conducted which examined the relationship between the water attenuation coefficient (α) at 600 μm and the suspended solid concentrations in eight lakes. The attenuation coefficient correlates positively with the suspended solids (ρ = .845). These data are shown in Figure 8.9 and shows and a linear relationship between the attenuation coefficient and the suspended solids. This further supported the possibility of suspended solid concentrations affecting the accuracy of the subsurface reflectance model since the suspended solids concentration correlates with the attenuation coefficient and the attenuation coefficient affects lake volume reflectance.

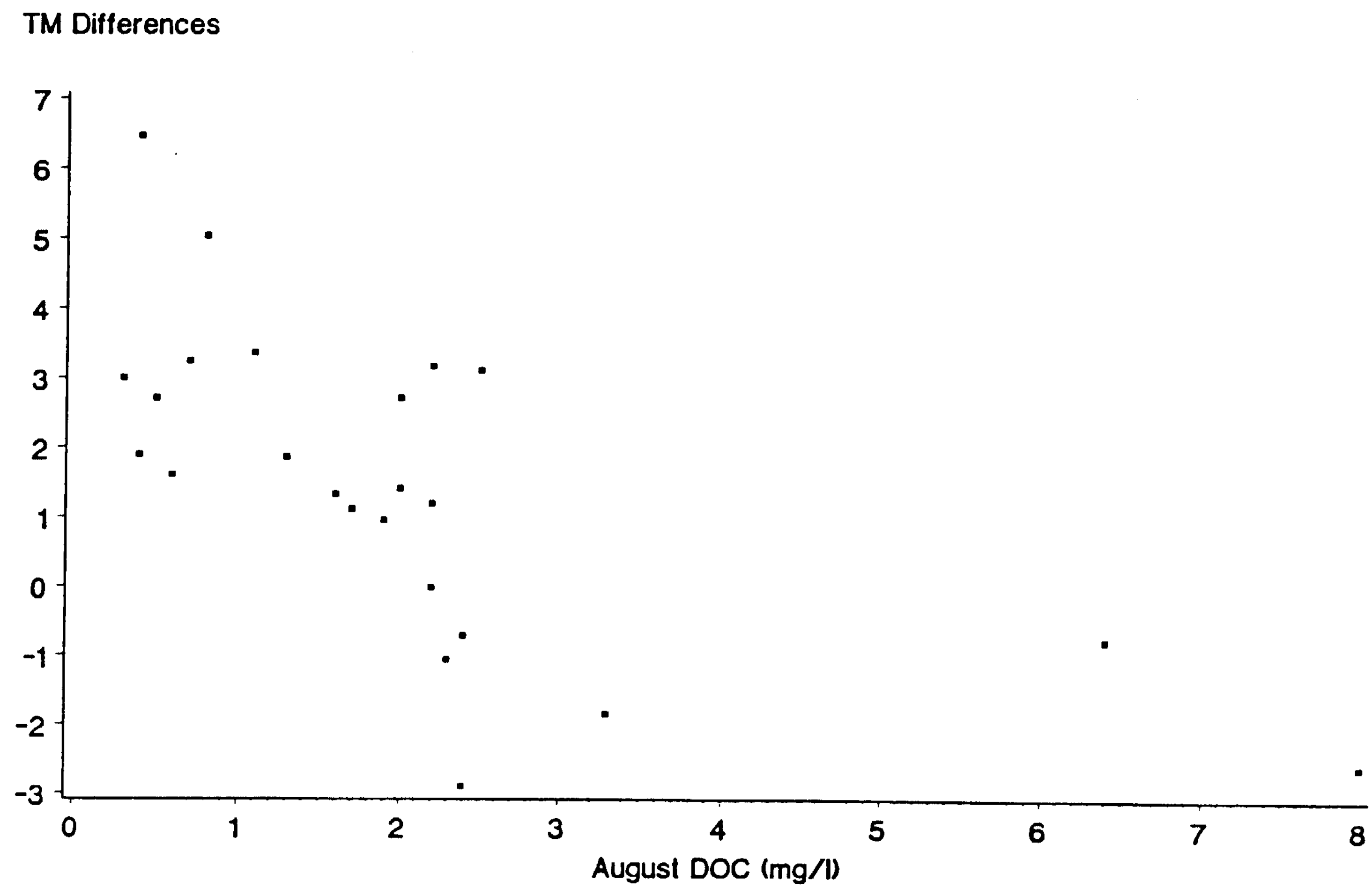

Figure 8.8. TM Band 1 Multitemporal (August 13, 1986 and May 22, 1985) Differences Versus DOC Concentration Sudbury Field Site August 1986 Water Chemistry Data.

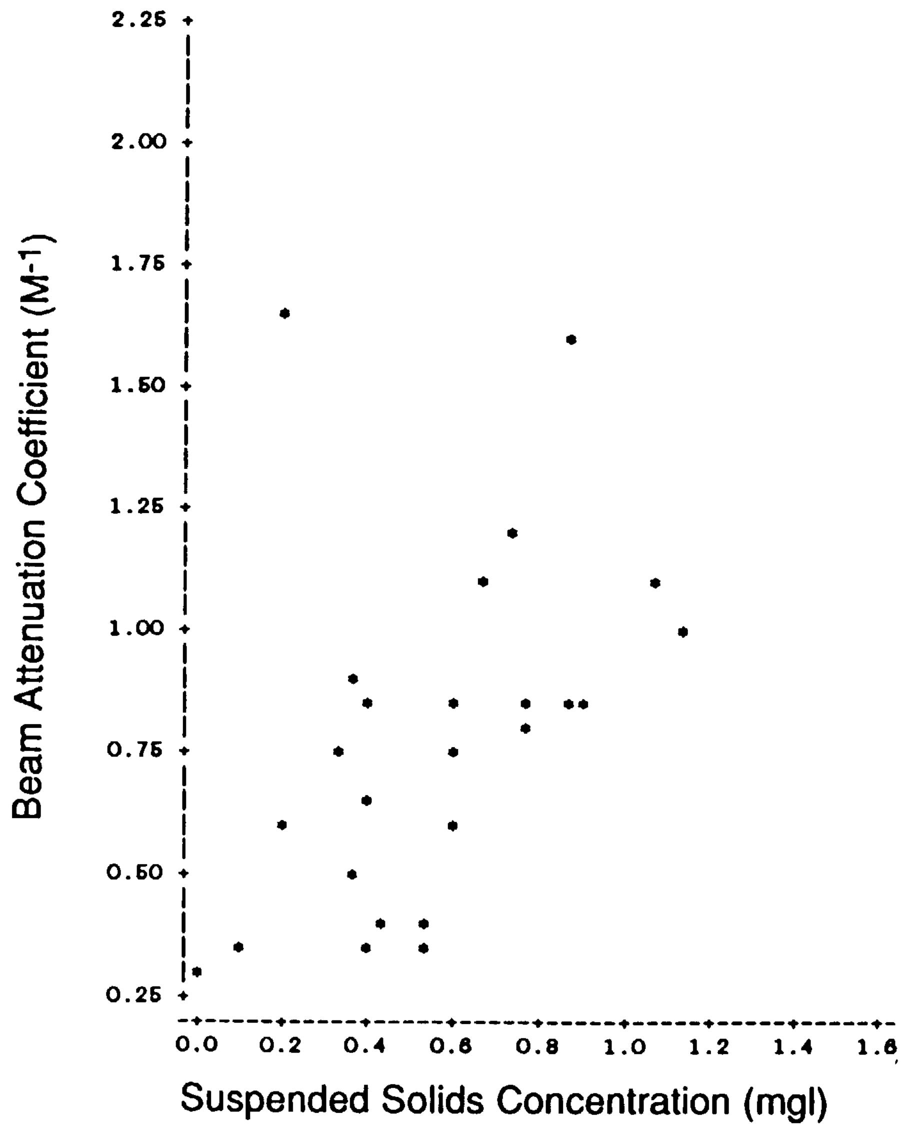

Figure 8.9. Beam Attenuation Coefficient Versus Suspended Solids Concentration 1987 Spring/Summer Data.

9.0 ANALYSIS OF ECO-PHYSICAL CLUSTERS

9.1 RELATIONSHIP OF WATER CHEMISTRY WITH ECO-PHYSICAL CLUSTERS

Since the eco-physical clusters represented unique acid-sensitivities across the Ontario test sites, it is reasonable to expect to find significantly different water-quality parameters for lakes that occurred in different clusters. An analysis was performed to test the hypothesis that the mean water-quality parameters were different at the 5% significance level between clusters. The following water variables were analyzed: dissolved organic carbon (DOC), Secchi depth, sulfate concentration, aluminum ion concentration, pH and total chlorophyll-a concentration. This analysis is summarized in Table 9.1.

TABLE 9.1. RESULTS FOR TUKEY'S STUDENTIZED RANGE TEST FOR SIGNIFICANTLY DIFFERENT MEAN WATER-QUALITY PARAMETERS

Chlorophyll-a	DOC	Secchi Depth	Sulfate	Aluminum	pH	
1-7	2-5	1-7	7-1	7-5	1-2	8-2
1-9	2-9	2-7	7-2	3-7	1-3	8-3
1-8	2-7	2-9	7-3	4-5	1-4	8-5
1-5	4-5	4-7	7-4	5-9	1-5	8-7
	4-7	5-7	8-9	7-8	1-6	3-9
	7-5		1-2		1-7	2-7
	4-9		7-8		1-8	4-2
	3-9		7-9		1-9	4-3
	3-7		9-1		1-10	4-5
	1-7		9-3		6-2	4-7
	2-8		9-4		6-3	4-9
	3-5		5-1		6-5	3-2
	4-8		5-4		6-7	3-7
	7-8		3-1		6-9	5-7
			1-4		10-2	9-7
			1-6		10-3	
			5-7		10-5	
					10-7	
					10-9	

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Clustering was especially successful in separating different levels of lake pH. For significantly different clusters, the most acid-sensitive clusters (5,7,9) had lake waters with lower DOC and pH values and a higher sulfate concentration than those with less sensitivity (1,2,3,4). Thus, the clustering analysis appears to have produced significant eco-physical clusters that contain lakes that also have some significantly different water-quality parameters. Of the three most significantly different water-quality parameters (DOC, pH and sulfate), changes in DOC provide the basis for remote sensing monitoring and identification.

9.2 RELATIONSHIP BETWEEN TM SIGNALS AND ECO-PHYSICAL CLUSTERS

An analysis was performed to determine if significant differences existed among the eco-physical clusters based on the TM signals of lakes within the clusters. For the August 1986 Algoma and Sudbury data sets, two groupings were identified. Group A (lakes in clusters 5, 7 and 9) had mean signals (73.5 to 75.9) that were significantly different (α= .05) than signals (64.8 to 67.5) from lakes in group B (clusters 2, 4 and 8). The results are shown in Table 9.2.

TABLE 9.2. TM RELATIONSHIPS TO ECO-PHYSICAL SENSITIVITY -- AUGUST TM 1 DATA

Group	Mean TM 1	Cluster	Significantly Different at 5%
A	75.86	7	2, 4, 8
A	74.14	9	2, 4, 8
A	73.47	5	2, 4, 8
B	67.50	8	5, 7, 9
B	66.37	2	5, 7, 9
B	64.77	4	5, 7, 9

The mean eco-physical sensitivity of group A clusters was 7.44 and group B mean sensitivity was 5.85. The largest signals measured were from cluster 7 with a mean sensitivity index of 7.07 and the smallest from cluster 4 with a sensitivity index of 6.07. The primary difference in these two eco-physical clusters was the soil type and soil depth over the underlying bedrock. Cluster 7 had shallow (i.e. less than one meter) sandy soils while cluster 4 had soils of mixed types (sand, clay, loam) that had depths greater than one meter.

9.3 RELATIONSHIP BETWEEN TM MULTITEMPORAL DIFFERENCES AND ECO-PHYSICAL CLUSTERS

Examination of the August 1986 - May 1985 difference signals for TM band one produced similar results which are shown in Table 9.3. Group A and group B contained the same clusters as in Section 9.2 and the largest and smallest mean differences were found in clusters 7 and 4, respectively.

TABLE 9.3 TM RELATIONSHIPS TO ECO-PHYSICAL SENSITIVITY ANALYSIS OF VARIANCE OF AUGUST-MAY DIFFERENCE

Group	Mean Diff	Cluster	Significantly Diff. at 5%
A	4.94	7	2, 4, 8
A	2.91	9	2, 4, 8
A	2.68	5	2, 4, 8
B	0.61	8	5, 7, 9
B	-0.96	2	5, 7, 9
B	-2.45	4	5, 7, 9

9.4 Analysis of TM Signal Changes Due to Acid Deposition Changes

This analysis examined the relationship between the August - May signal differences from polygons that have similar eco-physical properties with the exception of sulfate deposition. For this case, lakes were selected from polygons with sandy soils over granitic rock types and the sulfate deposition was 1.5 or 2.5 g/m2/yr. The TM band one signals were found to be significantly different (at 5% level) based upon deposition level alone. This preliminary analysis suggests that

TM signal seasonal changes may be dependent upon changes in acid deposition.

9.5 ANALYSIS OF DOC REFLECTANCE SENSITIVITY

In addition to seasonal analyses, the spatial aspects of DOC reflectance sensitivity were investigated. Measured water-quality parameters were used together with the equation given Section 7.4 to calculate a lake value of reflectance sensitivity based to change in DOC concentration. The larger the derivative of reflectance with respect to DOC the more sensitive lake reflectance is to changes in DOC. As shown in Table 7.3, a reflectance sensitivity value of 4.0 corresponds to an expected count change in TM band 1 of at least two counts. The lake DOC sensitivity values were analyzed with the eco-physical clusters and the mean sensitivity was determined for each cluster as shown in Figure 9.1. These results indicated that clusters 5, 7, 8 and 9 have lakes most sensitive to DOC changes. These clusters also have the higher stratification sensitivity index values.

This preliminary analysis shows that TM band one seasonal difference signals will differentiate acid-sensitive from acid-insensitive areas.

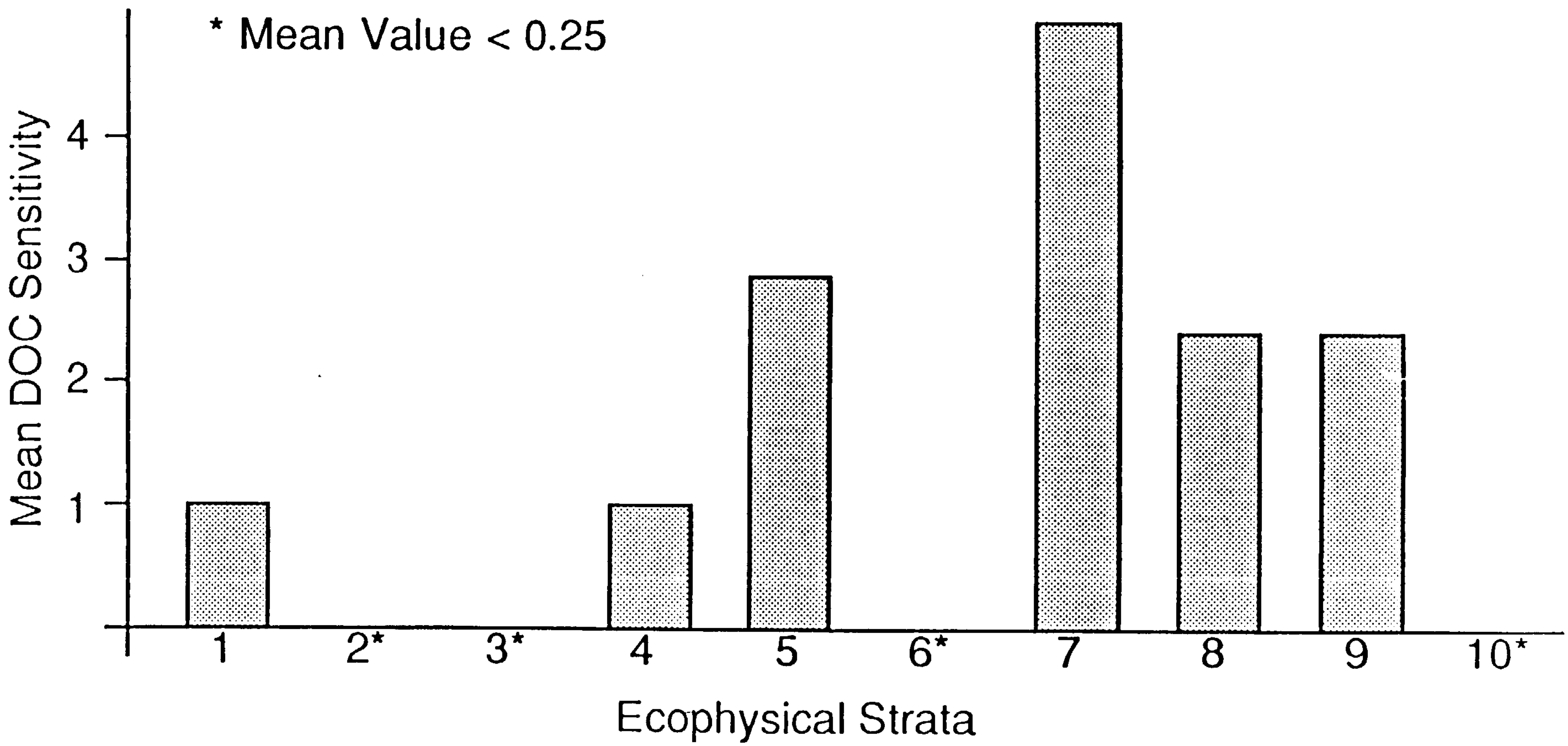

Figure 9.1. Mean DOC Induced Reflectance Sensitivity for Each Ecophysical Strata Estimates Based Upon August 1986 Water Chemistry Measurements.

10.0 CONCLUSIONS AND RECOMMENDATIONS

10.1 GENERAL CONCLUSION

Modeling, field measurements, and TM observations suggest that TM is useful to identify acid sensitive lakes and to monitor water quality changes associated with lake acidification.

10.2 SPECIFIC CONCLUSIONS

1. Modeling surface and subsurface reflectance measurements have shown the important relationships between lake optical properties and water chemistry.

   a. A simple DOC reflectance model accounts for observed subsurface hemispherical reflectance and also for the companion airborne (PROBAR) reflectance measurements.

   b. We found that clear acid sensitive lakes can be distinguished from the colored high DOC lakes using PROBAR data. The colored lakes tend to have greater buffering capacity than clear lakes in acid sensitive areas.

   c. The blue-green reflectance of clear lakes is highly sensitive to the presence of DOC. Modeling predicts a one percent change in subsurface reflectance for an expected seasonal fluctuation of about 50% in DOC concentration.

2. Modeling has shown that TM is sufficiently sensitive to monitor expected lake reflectance associated with acid deposition and acidification.

   a. An historical TM seasonal pair (August 1986 - May 1985) for the same Sudbury Lakes in a normal snowfall year supports our expectations but lacks the chemistry and in situ optical data needed for hypothesis validation.

   b. The expected seasonal changes (August 1986 to May/June 1987) in water chemistry did not occur nor did we observe

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a significant change in TM response. This lack of change may be due to the unusually small snow pack and spring runoff. While these TM data and water chemistry are consistent with our hypothesis, they do not validate it.

c. In areas of high acid deposition Landsat TM DN values were found to separate high DOC lakes (moderate acidity) found to separate high DOC lakes (moderate acidity) from low DOC lakes (high acidity). The expected TM band one signal change per percent subsurface reflectance change was estimated to be 2.86 counts/percent. In clear acid lakes seasonal change of two or three counts are expected from DOc fluctuations.

3. Stratification of eco-physical properties provides a way to locate areas which are sensitive to acid deposition.

   a. When stratification of eco-physical properties was applied to our study sites, we could identify acid sensitive areas and use TM to pick lakes which are likely to be sensitive to acid deposition.

   b. Clustering of eco-physical strata suggests that areas with shallow sandy soils over slow weathering granitic bedrock types are most sensitive to acid deposition and lakes located within these areas will have lower concentrations of DOC and lower pH values than for other soil and bedrock types.

   c. TM band one lake response was found to be related to eco-physical sensitivity. The (August 1986 - May 1985) TM seasonal pair produced signal differences in eco-physically sensitive strata (1-6 DN) but not so in non-sensitive strata (-2 to 0 DN).

   d. Nearly identical and sensitive eco-physical strata with different sulfate deposition rates were found to have different TM lake signal response.

10.3 RECOMMENDATIONS

While studies thus far are consistent with our seasonal change hypothesis they do not confirm its validity. Further study is needed to provide confirmation to the above results.

1. Collect lake chemistry and TM data in years of typical snowfall to demonstrate the capability of using TM data to monitor acidification under a wider range of environmental conditions (i.e., normal snowfall years).

2. Develop a TM based capability for assessing effects of acid deposition on terrestrial vegetation. Apply the vegetation monitoring technique and compare with lake monitoring technique.

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APPENDIX A
ECO-PHYSICAL CLUSTER ANALYSIS

The maximum likelihood method was used to produce 10 clusters of polygons based on the sensitivity values for percent cover, vegetation type, soil depth, soil texture, bedrock type, relief and sulfate deposition. The data are sorted by cluster. Descriptions for each polygon are in the printout. The "cluster" data are either missing data or have vegetation types which were not used in the data.

MAXIMUM LIKELIHOOD METHOD CLUSTERS

-----CLUSTER=.-----

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
1	48	0-49	BARREN	SHALLOW	SAND	3	MODERATE	ROLLING	1.5-2.0
2	66	0-49	MIXED	DEEP	SAND	4	HIGH	UNKNOWN	1.5-2.0
3	73	0-49	MIXED	SHALLOW	SAND	4	HIGH	UNKNOWN	1.5-2.0
4	191	0-49	AGRIC	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
5	238	0-49	CLOUD	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
6	239	0-49	CLOUD	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
7	240	0-49	CLOUD	DEEP	CLAY	3	LOW	LEVEL	2.0-2.5
8	280	0-49	BARREN	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
9	304	0-49	AGRIC	DEEP	CLAY	3	LOW	LEVEL	2.0-2.5
10	305	0-49	AGRIC	DEEP	CLAY	1	LOW	LEVEL	2.0-2.5
11	306	0-49	AGRIC	ANY	ORGANICS	1	HIGH	LEVEL	2.0-2.5
12	307	0-49	AGRIC	DEEP	LOAM	2	MODERATE	LEVEL	2.0-2.5
13	308	0-49	AGRIC	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
14	309	0-49	AGRIC	DEEP	CLAY	4	LOW	LEVEL	2.0-2.5
15	318	0-49	SC U.CON	DEEP	SAND	3	HIGH	UNKNOWN	2.0-2.5
16	320	0-49	AGRIC	DEEP	CLAY	4	LOW	LEVEL	2.0-2.5
17	324	0-49	UP CON	DEEP	SAND	3	HIGH	UNKNOWN	2.0-2.5
18	331	0-49	AGRIC	DEEP	LOAM	2	MODERATE	LEVEL	2.0-2.5
19	335	0-49	AGRIC	DEEP	LOAM	4	MODERATE	LEVEL	2.0-2.5
20	341	0-49	AGRIC	DEEP	LOAM	4	MODERATE	LEVEL	2.0-2.5
21	351	0-49	AGRIC	DEEP	LOAM	3	MODERATE	LEVEL	2.0-2.5
22	353	0-49	AGRIC	DEEP	LOAM	3	MODERATE	LEVEL	2.0-2.5
23	357	0-49	AGRIC	DEEP	LOAM	4	MODERATE	LEVEL	2.0-2.5
24	404	0-49	AGRIC	DEEP	LOAM	4	MODERATE	LEVEL	2.5-3.0
25	439	0-49	LO CON	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
26	443	0-49	URBAN	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
27	444	0-49	URBAN	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
28	445	0-49	URBAN	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
29	446	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
30	455	0-49	AGRIC	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
31	456	0-49	AGRIC	DEEP	LOAM	4	MODERATE	LEVEL	2.5-3.0
32	457	0-49	AGRIC	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
33	458	0-49	AGRIC	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
34	459	0-49	AGRIC	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
35	460	0-49	AGRIC	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
36	463	0-49	AGRIC	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
37	464	0-49	AGRIC	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
38	465	0-49	SC&BARE	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
39	475	0-49	CONIFER	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
40	476	0-49	MIXED	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
41	477	0-49	MIXED	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
42	478	0-49	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
43	479	0-49	MIXED	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
44	482	0-49	SC&BARE	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
45	489	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
46	491	0-49	AG&HRDWD	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
47	499	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
48	500	0-49	AG&HRDWD	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
49	524	0-49	AG&HRDWD	DEEP	LOAM	4	MODERATE	LEVEL	2.5-3.0
50	526	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
51	527	0-49	AG&HRDWD	ANY	ORGANICS	4	HIGH	LEVEL	2.5-3.0
52	528	0-49	AG&HRDWD	DEEP	LOAM	4	MODERATE	LEVEL	2.5-3.0
53	529	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0

MAXIMUM LIKELIHOOD METHOD CLUSTERS

--CLUSTER=.--

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
54	534	0-49	MIXED	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
55	535	0-49	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
56	536	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
57	537	50-74	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
58	538	0-49	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
59	539	50-74	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
60	540	0-49	CONIFER	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
61	541	0-49	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
62	542	0-49	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
63	543	50-74	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
64	544	50-74	CONIFER	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
65	545	50-74	MIXED	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
66	546	50-74	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
67	547	50-74	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
68	548	75-99	SC&BARE	SHALLOW	ANY	4	HIGH	UNKNOWN	2.5-3.0
69	549	50-74	HARDWOOD	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
70	550	0-49	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
71	551	50-74	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
72	552	50-74	SC&BARE	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
73	553	50-74	HARDWOOD	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
74	554	0-49	MIXED	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
75	555	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	UNKNOWN	2.5-3.0
76	556	0-49	HARDWOOD	DEEP	SAND	3	HIGH	UNKNOWN	2.5-3.0
77	573	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
78	574	0-49	AG&HRDWD	ANY	ORGANICS	4	HIGH	LEVEL	3.0-3.5
79	57[illegible]	0-49	AG&HRDWD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
80	580	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
81	581	0-49	AG&HRDWD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
82	584	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
83	631	0-49	AG&HRDWD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
84	633	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
85	634	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	UNKNOWN	3.0-3.5
86	638	0-49	HARDWOOD	SHALLOW	SAND	3	MODERATE	UNKNOWN	2.5-3.0
87	648	0-49	AG&HRDWD	ANY	ORGANICS	4	HIGH	ROLLING	3.0-3.5
88	649	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
89	650	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
90	652	0-49	AG&HRDWD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
91	656	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
92	657	0-49	AG&HRDWD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
93	660	0-49	AG&HRDWD	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
94	693	0-49	AG&HRDWD	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0

--CLUSTER=1--

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
95	4	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.0-1.5
96	18	0-49	CONIFER	SHALLOW	SAND	3	MODERATE	ROLLING	1.0-1.5
97	24	0-49	CONIFER	SHALLOW	SAND	3	MODERATE	ROLLING	1.0-1.5
98	28	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	1.0-1.5
99	31	0-49	CONIFER	SHALLOW	SAND	3	MODERATE	ROLLING	1.0-1.5
100	36	0-49	CONIFER	SHALLOW	SAND	3	MODERATE	ROLLING	1.0-1.5
101	46	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0

MAXIMUM LIKELIHOOD METHOD CLUSTERS

----------CLUSTER=1----------

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
102	52	0-49	CONIFER	DEEP	SAND	3	HIGH	ROLLING	1.5-2.0
103	55	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
104	56	0-49	HARDWOOD	DEEP	SAND	4	HIGH	STEEP	1.5-2.0
105	57	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
106	67	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
107	70	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	1.5-2.0
108	71	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	1.5-2.0
109	76	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
110	87	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
111	89	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
112	91	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
113	93	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
114	96	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
115	99	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
116	103	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
117	105	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
118	106	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	1.5-2.0
119	121	0-49	HARDWOOD	DEEP	SAND	4	HIGH	STEEP	1.5-2.0
120	129	0-49	HARDWOOD	DEEP	SAND	4	HIGH	STEEP	1.5-2.0
121	130	0-49	CONIFER	SHALLOW	SAND	3	MODERATE	LEVEL	1.5-2.0
122	132	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
123	142	0-49	HARDWOOD	DEEP	SAND	4	HIGH	STEEP	1.5-2.0
124	144	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
125	147	0-49	HARDWOOD	DEEP	SAND	4	HIGH	STEEP	1.5-2.0
126	152	0-49	HARDWOOD	DEEP	SAND	4	HIGH	STEEP	1.5-2.0
127	157	0-49	MIXED	SHALLOW	SAND	3	MODERATE	STEEP	1.5-2.0
128	160	0-49	HARDWOOD	DEEP	SAND	4	HIGH	STEEP	1.5-2.0
129	166	0-49	HARDWOOD	DEEP	SAND	4	HIGH	STEEP	1.5-2.0
130	172	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	1.5-2.0
131	173	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	1.5-2.0
132	180	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
133	193	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	2.0-2.5
134	203	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
135	207	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
136	221	0-49	LO CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
137	228	0-49	LO CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
138	231	0-49	UP CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
139	234	0-49	UP CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
140	237	0-49	UP CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
141	248	0-49	UP CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
142	259	0-49	UP CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
143	268	0-49	UP CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
144	286	0-49	SC U.CON	DEEP	CLAY	4	LOW	LEVEL	2.0-2.5
145	290	0-49	UP CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
146	294	0-49	LO CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
147	310	0-49	SC U.CON	DEEP	CLAY	4	LOW	LEVEL	2.0-2.5
148	312	0-49	SC U.CON	DEEP	CLAY	4	LOW	LEVEL	2.0-2.5
149	317	0-49	SC U.CON	DEEP	CLAY	4	LOW	LEVEL	2.0-2.5
150	332	0-49	SC U.CON	DEEP	CLAY	3	LOW	LEVEL	2.0-2.5
151	367	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
152	368	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
153	375	0-49	MIXED	SHALLOW	SAND	3	MODERATE	LEVEL	2.5-3.0
154	376	0-49	MIXED	SHALLOW	SAND	3	MODERATE	LEVEL	2.5-3.0

MAXIMUM LIKELIHOOD METHOD CLUSTERS

CLUSTER=1

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	SO4_DEPO
155	380	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
156	389	0-49	MIXED	DEEP	SAND	3	HIGH	ROLLING	2.5-3.0
157	449	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
158	454	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
159	508	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
160	518	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
161	532	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
162	562	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
163	568	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
164	593	0-49	HARDWOOD	SHALLOW	SAND	3	MODERATE	ROLLING	3.0-3.5
165	681	50-74	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
166	694	0-49	HARDWOOD	SHALLOW	SAND	3	MODERATE	ROLLING	3.0-3.5

CLUSTER=2

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	SO4_DEPO
167	12	0-49	CONIFER	SHALLOW	SAND	4	HIGH	LEVEL	1.0-1.5
168	20	0-49	MIXED	SHALLOW	SAND	4	HIGH	STEEP	1.0-1.5
169	28	0-49	CONIFER	DEEP	SAND	4	HIGH	ROLLING	1.0-1.5
170	65	0-49	CONIFER	DEEP	SAND	4	HIGH	LEVEL	1.5-2.0
171	68	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
172	72	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
173	75	0-49	CONIFER	DEEP	SAND	4	HIGH	LEVEL	1.5-2.0
174	81	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
175	88	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
176	98	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
177	100	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
178	108	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
179	111	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
180	114	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
181	115	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
182	123	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
183	135	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
184	145	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
185	146	0-49	MIXED	DEEP	SAND	4	HIGH	STEEP	1.5-2.0
186	150	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
187	151	0-49	MIXED	DEEP	SAND	4	HIGH	STEEP	1.5-2.0
188	156	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
189	158	0-49	MIXED	DEEP	SAND	4	HIGH	STEEP	1.5-2.0
190	170	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
191	178	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
192	182	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
193	184	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.0-2.5
194	185	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
195	194	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.0-2.5
196	199	0-49	LO CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
197	204	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
198	226	0-49	LO CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
199	230	0-49	UP CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
200	236	0-49	SC L.CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
201	251	0-49	LO CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
202	256	0-49	LO CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5

MAXIMUM LIKELIHOOD METHOD CLUSTERS

-----CLUSTER=2-----

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	SO4_DEPO
203	302	0-49	SC U.CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
204	303	0-49	SC U.CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
205	323	0-49	SC U.CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
206	325	0-49	UP CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
207	329	0-49	SC U.CON	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
208	352	0-49	SC L.CON	DEEP	LOAM	3	MODERATE	ROLLING	2.0-2.5
209	363	0-49	LO CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
210	365	0-49	LO CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
211	371	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
212	381	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
213	387	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
214	415	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
215	419	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
216	422	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
217	424	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
218	425	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
219	426	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
220	427	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
221	428	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
222	430	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
223	448	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
224	452	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
225	453	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
226	481	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
227	492	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
228	494	0-49	HARDWOOD	DEEP	SAND	4	HIGH	STEEP	2.5-3.0
229	495	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
230	496	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
231	505	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
232	509	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
233	511	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
234	516	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
235	558	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
236	560	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
237	561	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
238	564	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
239	567	0-49	HARDWOOD	DEEP	SAND	4	HIGH	STEEP	2.5-3.0
240	569	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
241	571	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
242	572	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
243	586	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
244	611	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
245	613	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
246	614	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
247	619	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
248	625	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
249	626	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
250	628	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
251	630	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
252	640	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
253	644	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
254	651	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
255	655	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5

MAXIMUM LIKELIHOOD METHOD CLUSTERS

CLUSTER=2

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
256	658	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
257	659	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
258	662	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
259	668	50-74	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
260	669	50-74	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
261	670	50-74	HARDWOOD	DEEP	SAND	4	HIGH	STEEP	3.0-3.5
262	672	50-74	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
263	675	50-74	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
264	682	50-74	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
265	692	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0

CLUSTER=3

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
266	7	0-49	CONIFER	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
267	27	0-49	CONIFER	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
268	30	0-49	CONIFER	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
269	35	0-49	CONIFER	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
270	46	0-49	MIXED	SHALLOW	SAND	4	HIGH	STEEP	1.5-2.0
271	59	0-49	MIXED	SHALLOW	SAND	4	HIGH	STEEP	1.5-2.0
272	109	0-49	CONIFER	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
273	117	0-49	CONIFER	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
274	124	0-49	CONIFER	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
275	125	0-49	CONIFER	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
276	133	0-49	MIXED	SHALLOW	SAND	4	HIGH	STEEP	1.5-2.0
277	155	0-49	MIXED	SHALLOW	SAND	4	HIGH	STEEP	1.5-2.0
278	177	0-49	LO CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
279	183	0-49	LO CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
280	189	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
281	190	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
282	205	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
283	206	0-49	LO CON	SHALLOW	SAND	4	HIGH	LEVEL	1.5-2.0
284	213	0-49	LO CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
285	216	0-49	UP CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
286	218	0-49	SC L.CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
287	219	0-49	LO CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
288	222	0-49	UP CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
289	232	0-49	SC U.CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
290	242	0-49	SC U.CON	DEEP	SAND	3	HIGH	ROLLING	2.0-2.5
291	243	0-49	UP CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
292	246	0-49	UP CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
293	249	0-49	UP/LO CO	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
294	250	0-49	LO CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
295	254	0-49	UP CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
296	255	0-49	SC L.CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
297	260	0-49	SC L.CON	DEEP	SAND	3	HIGH	ROLLING	2.0-2.5
298	264	0-49	LO CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
299	269	0-49	UP CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
300	274	0-49	LO CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
301	279	0-49	UP CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
302	283	0-49	LO CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
303	284	0-49	UP CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5

MAXIMUM LIKELIHOOD METHOD CLUSTERS

--CLUSTER=3--

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
304	288	0-49	LO CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
305	289	0-49	LO CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
306	291	0-49	UP CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
307	298	0-49	SC U.CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
308	300	0-49	SC U.CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
309	315	0-49	SC U.CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
310	322	0-49	SC U.CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
311	336	0-49	UP CON	DEEP	LOAM	4	MODERATE	LEVEL	2.0-2.5
312	342	0-49	UP CON	DEEP	LOAM	4	MODERATE	LEVEL	2.0-2.5
313	344	0-49	UP CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
314	347	0-49	UP CON	DEEP	LOAM	4	MODERATE	LEVEL	2.0-2.5
315	356	0-49	LO CON	DEEP	LOAM	4	MODERATE	LEVEL	2.0-2.5
316	359	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
317	361	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
318	374	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
319	384	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
320	391	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
321	392	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
322	397	0-49	LO CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.5-3.0
323	400	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
324	414	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
325	429	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
326	435	0-49	LO CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.5-3.0
327	436	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
328	441	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
329	442	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
330	450	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
331	462	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
332	471	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
333	473	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
334	483	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
335	484	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
336	488	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
337	497	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
338	502	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
339	503	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	STEEP	2.5-3.0
340	514	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
341	515	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
342	517	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
343	519	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	STEEP	2.5-3.0
344	520	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
345	521	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
346	531	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
347	559	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
348	566	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
349	570	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
350	576	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
351	578	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
352	585	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
353	588	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
354	592	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
355	597	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
356	600	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5

MAXIMUM LIKELIHOOD METHOD CLUSTERS

------------------------------CLUSTER=3------------------------------

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
357	602	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
358	609	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
359	623	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
360	624	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	STEEP	3.0-3.5
361	627	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
362	639	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
363	643	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
364	654	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	STEEP	3.0-3.5
365	663	50-74	MIXED	DEEP	SAND	4	HIGH	STEEP	3.0-3.5
366	666	50-74	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
367	671	50-74	MIXED	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
368	673	50-74	MIXED	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
369	683	50-74	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
370	685	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.5-4.0
371	689	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	3.5-4.0
372	691	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0

------------------------------CLUSTER=4------------------------------

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
373	5	0-49	CONIFER	DEEP	SAND	4	HIGH	LEVEL	1.0-1.5
374	6	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
375	8	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
376	10	0-49	CONIFER	DEEP	SAND	4	HIGH	LEVEL	1.0-1.5
377	11	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
378	13	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
379	19	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
380	22	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
381	29	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
382	32	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
383	34	0-49	CONIFER	DEEP	SAND	4	HIGH	LEVEL	1.0-1.5
384	54	0-49	CONIFER	SHALLOW	SAND	3	MODERATE	ROLLING	1.5-2.0
385	58	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
386	64	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
387	74	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
388	77	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	1.5-2.0
389	78	0-49	CONIFER	SHALLOW	SAND	3	MODERATE	ROLLING	1.5-2.0
390	80	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
391	85	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
392	92	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
393	94	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
394	97	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
395	102	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	1.5-2.0
396	104	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	STEEP	1.5-2.0
397	107	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	1.5-2.0
398	113	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
399	116	0-49	CONIFER	SHALLOW	SAND	3	MODERATE	ROLLING	1.5-2.0
400	118	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
401	120	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
402	126	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	STEEP	1.5-2.0
403	127	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	STEEP	1.5-2.0
404	128	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0

MAXIMUM LIKELIHOOD METHOD CLUSTERS

CLUSTER=4

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
405	143	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	STEEP	1.5-2.0
406	148	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	STEEP	1.5-2.0
407	149	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
408	154	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	STEEP	1.5-2.0
409	168	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	STEEP	1.5-2.0
410	171	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
411	174	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	1.5-2.0
412	175	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	1.5-2.0
413	179	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
414	188	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
415	198	0-49	UP CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
416	212	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
417	214	0-49	LO CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
418	217	0-49	UP CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
419	224	0-49	LO CON	DEEP	SAND	3	HIGH	ROLLING	2.0-2.5
420	233	0-49	UP CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
421	235	0-49	UP CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
422	241	0-49	LO CON	DEEP	SAND	3	HIGH	ROLLING	2.0-2.5
423	245	0-49	UP CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
424	252	0-49	UP CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
425	258	0-49	LO CON	DEEP	SAND	3	HIGH	ROLLING	2.0-2.5
426	261	0-49	UP CON	DEEP	SAND	3	HIGH	ROLLING	2.0-2.5
427	265	0-49	UP CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
428	293	0-49	UP CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
429	297	0-49	UP CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
430	316	0-49	UP CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
431	319	0-49	SC U.CON	DEEP	CLAY	4	LOW	ROLLING	2.0-2.5
432	321	0-49	UP CON	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
433	327	0-49	SC U.CON	DEEP	LOAM	3	MODERATE	LEVEL	2.0-2.5
434	330	0-49	SC U.CON	DEEP	LOAM	2	MODERATE	LEVEL	2.0-2.5
435	350	0-49	SC L.CON	DEEP	LOAM	3	MODERATE	LEVEL	2.0-2.5
436	360	0-49	MIXED	SHALLOW	SAND	3	MODERATE	STEEP	2.0-2.5
437	364	0-49	LO CON	DEEP	SAND	3	HIGH	ROLLING	2.0-2.5
438	382	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
439	388	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	2.5-3.0
440	401	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	2.5-3.0
441	418	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
442	423	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
443	437	0-49	UP CON	DEEP	SAND	3	HIGH	LEVEL	2.5-3.0
444	447	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
445	451	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
446	461	50-74	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
447	467	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
448	468	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
449	472	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
450	474	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
451	486	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
452	487	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
453	490	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
454	493	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
455	498	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
456	501	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
457	506	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0

MAXIMUM LIKELIHOOD METHOD CLUSTERS

CLUSTER=4

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	SO4_DEPO
458	513	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
459	522	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
460	523	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
461	525	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
462	530	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
463	557	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
464	583	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
465	589	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
466	590	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
467	591	0-49	MIXED	SHALLOW	SAND	3	MODERATE	LEVEL	3.0-3.5
468	594	0-49	MIXED	SHALLOW	SAND	3	MODERATE	LEVEL	3.0-3.5
469	599	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
470	606	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
471	632	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
472	641	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
473	646	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
474	647	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
475	653	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
476	661	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
477	664	50-74	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
478	667	50-74	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
479	674	50-74	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
480	676	50-74	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
481	678	50-74	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
482	690	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0

CLUSTER=5

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	SO4_DEPO
483	181	0-49	LO CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
484	197	0-49	UP CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
485	208	0-49	LO CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
486	210	0-49	UP CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
487	223	0-49	LO CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
488	247	0-49	LO CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
489	263	0-49	UP CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
490	272	0-49	UP CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
491	275	0-49	UP CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
492	334	0-49	SC U.CON	DEEP	LOAM	4	MODERATE	LEVEL	2.0-2.5
493	338	0-49	SC U.CON	DEEP	LOAM	4	MODERATE	LEVEL	2.0-2.5
494	343	0-49	SC U.CON	DEEP	LOAM	4	MODERATE	LEVEL	2.0-2.5
495	346	0-49	SC L.CON	DEEP	LOAM	4	MODERATE	LEVEL	2.0-2.5
496	358	0-49	LO CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
497	362	0-49	LO CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
498	383	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
499	393	0-49	UP CON	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
500	394	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
501	395	0-49	LO CON	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
502	398	0-49	SC L.CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.5-3.0
503	410	0-49	LO CON	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
504	412	0-49	UP CON	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0
505	413	0-49	SC MIXED	DEEP	SAND	4	HIGH	ROLLING	2.5-3.0

MAXIMUM LIKELIHOOD METHOD CLUSTERS

CLUSTER=5

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
506	421	0-49	LO CON	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
507	431	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
508	432	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
509	469	0-49	CONIFER	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
510	470	0-49	CONIFER	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
511	480	0-49	CONIFER	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
512	582	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
513	595	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
514	598	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
515	601	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
516	604	0-49	MIXED	DEEP	SAND	4	HIGH	STEEP	3.0-3.5
517	605	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
518	608	0-49	CONIFER	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
519	618	0-49	CONIFER	DEEP	SAND	4	HIGH	LEVEL	3.0-3.5
520	620	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
521	645	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
522	684	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
523	688	50-74	MIXED	DEEP	SAND	4	HIGH	STEEP	3.5-4.0

CLUSTER=6

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
524	39	0-49	HARDWOOD	DEEP	SAND	3	HIGH	ROLLING	1.0-1.5
525	42	0-49	HARDWOOD	SHALLOW	SAND	3	MODERATE	LEVEL	1.0-1.5
526	162	0-49	HARDWOOD	DEEP	SAND	2	HIGH	LEVEL	1.5-2.0
527	677	50-74	HARDWOOD	DEEP	SAND	1	LOW	ROLLING	3.0-3.5
528	679	50-74	HARDWOOD	SHALLOW	SAND	1	LOW	ROLLING	3.0-3.5
529	680	50-74	HARDWOOD	DEEP	SAND	1	LOW	ROLLING	3.0-3.5

CLUSTER=7

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
530	63	0-49	CONIFER	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
531	69	0-49	CONIFER	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
532	101	0-49	CONIFER	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
533	119	0-49	CONIFER	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
534	122	0-49	CONIFER	SHALLOW	SAND	4	HIGH	ROLLING	1.5-2.0
535	195	0-49	MIXED	SHALLOW	SAND	4	HIGH	STEEP	2.0-2.5
536	196	0-49	LO CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
537	211	0-49	MIXED	SHALLOW	SAND	4	HIGH	STEEP	2.0-2.5
538	215	0-49	LO CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
539	227	0-49	LO CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
540	229	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
541	244	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
542	257	0-49	SC L.CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
543	271	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
544	276	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
545	281	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
546	282	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
547	287	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5

MAXIMUM LIKELIHOOD METHOD CLUSTERS

CLUSTER=7

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	SO4_DEPO
548	292	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
549	299	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
550	339	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
551	340	0-49	UP CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
552	349	0-49	LO CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
553	355	0-49	LO CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
554	366	0-49	SC L.CON	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
555	385	0-49	UP CON	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
556	396	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
557	402	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
558	406	0-49	LO CON	DEEP	LOAM	4	MODERATE	LEVEL	2.5-3.0
559	407	0-49	LO CON	DEEP	LOAM	4	MODERATE	LEVEL	2.5-3.0
560	416	0-49	UP CON	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
561	417	0-49	LO CON	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
562	433	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
563	466	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
564	485	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
565	504	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
566	507	0-49	MIXED	DEEP	SAND	4	HIGH	STEEP	2.5-3.0
567	510	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
568	512	0-49	CONIFER	DEEP	SAND	4	HIGH	LEVEL	2.5-3.0
569	533	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
570	563	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
571	565	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
572	577	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
573	579	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
574	587	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
575	610	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
576	615	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
577	617	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
578	629	0-49	MIXED	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
579	635	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
580	642	0-49	MIXED	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
581	665	50-74	MIXED	SHALLOW	SAND	4	HIGH	STEEP	3.0-3.5
582	686	50-74	HARDWOOD	SHALLOW	SAND	4	HIGH	STEEP	3.5-4.0

CLUSTER=8

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	SO4_DEPO
583	1	0-49	HARDWOOD	SHALLOW	SAND	4	HIGH	ROLLING	1.0-1.5
584	2	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	1.0-1.5
585	9	50-74	MIXED	DEEP	SAND	4	HIGH	ROLLING	1.0-1.5
586	14	0-49	CONIFER	SHALLOW	SAND	3	MODERATE	LEVEL	1.0-1.5
587	17	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	1.0-1.5
588	21	0-49	CONIFER	SHALLOW	SAND	3	MODERATE	LEVEL	1.0-1.5
589	23	0-49	CONIFER	DEEP	SAND	3	HIGH	LEVEL	1.0-1.5
690	38	0-49	CONIFER	DEEP	SAND	3	HIGH	LEVEL	1.0-1.5
591	40	0-49	MIXED	DEEP	SAND	4	HIGH	LEVEL	1.0-1.5
592	49	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	1.5-2.0
593	50	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	1.5-2.0
594	51	0-49	MIXED	DEEP	SAND	3	HIGH	ROLLING	1.5-2.0
595	60	0-49	MIXED	DEEP	SAND	3	HIGH	ROLLING	1.5-2.0

MAXIMUM LIKELIHOOD METHOD CLUSTERS

---CLUSTER=8---

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
596	61	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	1.5-2.0
597	79	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	1.5-2.0
598	83	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	1.5-2.0
599	84	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
600	90	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	1.5-2.0
601	95	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
602	110	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
603	112	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
604	131	0-49	MIXED	SHALLOW	SAND	3	MODERATE	ROLLING	1.5-2.0
605	134	0-49	HARDWOOD	DEEP	SAND	4	HIGH	ROLLING	1.5-2.0
606	136	0-49	HARDWOOD	SHALLOW	SAND	3	MODERATE	STEEP	1.5-2.0
607	140	0-49	HARDWOOD	DEEP	SAND	4	HIGH	LEVEL	1.5-2.0
608	153	0-49	HARDWOOD	SHALLOW	SAND	3	MODERATE	STEEP	1.5-2.0
609	159	0-49	HARDWOOD	SHALLOW	SAND	3	MODERATE	STEEP	1.5-2.0
610	161	0-49	CONIFER	DEEP	SAND	2	HIGH	LEVEL	1.5-2.0
611	164	0-49	HARDWOOD	SHALLOW	SAND	3	MODERATE	STEEP	1.5-2.0
612	169	0-49	HARDWOOD	SHALLOW	SAND	3	MODERATE	STEEP	1.5-2.0
613	176	75-99	MIXED	SHALLOW	ANY	4	HIGH	ROLLING	1.5-2.0
614	186	0-49	MIXED	DEEP	SAND	3	HIGH	ROLLING	2.0-2.5
615	187	0-49	MIXED	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
616	200	0-49	MIXED	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
617	201	0-49	MIXED	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5
618	202	0-49	MIXED	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
619	270	0-49	UP CON	DEEP	CLAY	3	LOW	LEVEL	2.0-2.5
620	285	0-49	UP CON	DEEP	CLAY	4	LOW	LEVEL	2.0-2.5
621	296	0-49	UP CON	DEEP	CLAY	4	LOW	LEVEL	2.0-2.5
622	311	0-49	UP CON	DEEP	CLAY	4	LOW	LEVEL	2.0-2.5
623	314	0-49	UP CON	DEEP	CLAY	4	LOW	LEVEL	2.0-2.5
624	328	0-49	UP CON	DEEP	LOAM	3	MODERATE	LEVEL	2.0-2.5
625	333	0-49	UP CON	DEEP	CLAY	3	LOW	LEVEL	2.0-2.5
626	354	0-49	LO CON	DEEP	LOAM	3	MODERATE	LEVEL	2.0-2.5
627	369	0-49	HARDWOOD	SHALLOW	SAND	3	MODERATE	ROLLING	2.0-2.5
628	372	0-49	MIXED	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
629	377	0-49	HARDWOOD	DEEP	SAND	3	HIGH	ROLLING	2.5-3.0
630	378	0-49	MIXED	DEEP	SAND	3	HIGH	LEVEL	2.5-3.0
631	379	0-49	HARDWOOD	SHALLOW	SAND	3	MODERATE	LEVEL	2.5-3.0
632	434	0-49	MIXED	DEEP	SAND	3	HIGH	LEVEL	2.5-3.0
633	636	0-49	HARDWOOD	DEEP	SAND	3	HIGH	ROLLING	3.0-3.5
634	637	0-49	HARDWOOD	DEEP	SAND	3	HIGH	ROLLING	3.0-3.5

---CLUSTER=9---

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
635	209	0-49	SC L.CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
636	220	0-49	SC L.CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
637	225	0-49	SC L.CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
638	253	0-49	SC U.CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
639	262	0-49	SC L.CON	SHALLOW	SAND	4	HIGH	ROLLING	2.0-2.5
640	266	0-49	UP CON	ANY	ORGANICS	4	HIGH	LEVEL	2.0-2.5
641	267	0-49	SC U.CON	ANY	ORGANICS	4	HIGH	LEVEL	2.0-2.5
642	273	0-49	SC U.CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
643	277	0-49	SC U.CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5

MAXIMUM LIKELIHOOD METHOD CLUSTERS

---CLUSTER=9---

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
644	278	0-49	LO CON	SHALLOW	SAND	4	HIGH	STEEP	2.0-2.5
645	295	0-49	SC U.CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
646	301	0-49	SC U.CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
647	313	0-49	SC U.CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
648	326	0-49	SC U.CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
649	337	0-49	SC U.CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
650	345	0-49	SC U.CON	DEEP	SAND	4	HIGH	LEVEL	2.0-2.5
651	348	0-49	SC L.CON	SHALLOW	SAND	4	HIGH	LEVEL	2.0-2.5
652	386	0-49	UP CON	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
653	390	0-49	UP CON	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
654	399	0-49	LO CON	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
655	403	0-49	LO CON	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
656	405	0-49	SC L.CON	DEEP	LOAM	4	MODERATE	ROLLING	2.5-3.0
657	408	0-49	LO CON	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
658	409	0-49	SC U.CON	DEEP	LOAM	4	MODERATE	ROLLING	2.5-3.0
659	411	0-49	SC U.CON	SHALLOW	SAND	4	HIGH	LEVEL	2.5-3.0
660	420	0-49	LO CON	ANY	ORGANICS	4	HIGH	LEVEL	2.5-3.0
661	438	0-49	UP CON	ANY	ORGANICS	4	HIGH	LEVEL	2.5-3.0
662	440	0-49	LO CON	SHALLOW	SAND	4	HIGH	ROLLING	2.5-3.0
663	596	0-49	CONIFER	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
664	603	0-49	CONIFER	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
665	607	0-49	CONIFER	SHALLOW	SAND	4	HIGH	LEVEL	3.0-3.5
666	612	0-49	CONIFER	DEEP	SAND	4	HIGH	ROLLING	3.0-3.5
667	616	0-49	MIXED	SHALLOW	SAND	4	HIGH	STEEP	3.0-3.5
668	621	0-49	CONIFER	SHALLOW	SAND	4	HIGH	ROLLING	3.0-3.5
669	622	0-49	MIXED	SHALLOW	SAND	4	HIGH	STEEP	3.0-3.5
670	687	0-49	MIXED	SHALLOW	SAND	4	HIGH	ROLLING	3.5-4.0

---CLUSTER=10---

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
671	3	0-49	MIXED	DEEP	SAND	3	HIGH	LEVEL	1.0-1.5
672	15	0-49	MIXED	DEEP	SAND	3	HIGH	ROLLING	1.0-1.5
673	18	0-49	MIXED	SHALLOW	SAND	3	MODERATE	LEVEL	1.0-1.5
674	25	0-49	MIXED	DEEP	SAND	3	HIGH	LEVEL	1.0-1.5
675	33	75-99	MIXED	SHALLOW	ANY	4	HIGH	ROLLING	1.0-1.5
676	37	0-49	MIXED	DEEP	SAND	3	HIGH	ROLLING	1.0-1.5
677	41	0-49	MIXED	SHALLOW	SAND	3	MODERATE	LEVEL	1.0-1.5
678	43	0-49	MIXED	DEEP	SAND	3	HIGH	LEVEL	1.5-2.0
679	44	0-49	HARDWOOD	DEEP	SAND	3	HIGH	ROLLING	1.5-2.0
680	47	0-49	HARDWOOD	DEEP	SAND	3	HIGH	ROLLING	1.5-2.0
681	53	0-49	MIXED	DEEP	SAND	3	HIGH	LEVEL	1.5-2.0
682	62	0-49	MIXED	DEEP	SAND	3	HIGH	LEVEL	1.5-2.0
683	82	0-49	HARDWOOD	DEEP	SAND	3	HIGH	ROLLING	1.5-2.0
684	86	0-49	HARDWOOD	DEEP	SAND	3	HIGH	ROLLING	1.5-2.0
685	137	0-49	HARDWOOD	DEEP	SAND	3	HIGH	STEEP	1.5-2.0
686	138	0-49	MIXED	DEEP	SAND	3	HIGH	LEVEL	1.5-2.0
687	139	0-49	MIXED	DEEP	SAND	2	HIGH	LEVEL	1.5-2.0
688	141	0-49	MIXED	DEEP	SAND	2	HIGH	LEVEL	1.5-2.0
689	163	0-49	MIXED	DEEP	SAND	2	HIGH	LEVEL	1.5-2.0
690	165	0-49	HARDWOOD	DEEP	LOAM	3	MODERATE	STEEP	1.5-2.0
691	167	0-49	HARDWOOD	DEEP	SAND	3	HIGH	ROLLING	1.5-2.0

MAXIMUM LIKELIHOOD METHOD CLUSTERS

--CLUSTER=10--

OBS	POLYGON	PERCENT	VEG	DEPTH	TEXTURE	BEDROCK	SENSI	RELIEF	S04_DEPO
692	192	0-49	HARDWOOD	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
693	370	0-49	HARDWOOD	DEEP	SAND	3	HIGH	LEVEL	2.0-2.5
694	373	0-49	HARDWOOD	SHALLOW	SAND	3	MODERATE	LEVEL	2.0-2.5

APPENDIX B
PROBAR REFLECTANCE DATA

Table B.1. Corrected PROBAR reflectances above the water surface and water chemistry data.

Table B.2. PROBAR subsurface predicted reflectances.

Table B.1.

CORRECTED PROBAR REFLECTANCES AND LIMNOLOGICAL DATA

LAKE_ID	NAME	PROFILE	PH	SD	TTLCHL_A	DOC	SO4	AL	TR443	TR470
12A	WABUN	61	4.93	8.7	1.0	1.1	9.32	220	0.045070	0.050680
13A	SUNNYWAT	55	4.68	20.0	0.4	0.4	10.90	280	0.122220	0.113410
14F	JERRY	48	5.14	13.5	0.3	0.4	10.50	180	0.125050	0.127920
15A	X	45	5.06	15.0	0.1	0.3	11.40	380	0.108530	0.103130
17A	X	42	4.80	16.0	0.2	0.3	9.73	290	0.102820	0.105870
17C	MIHELL	72	7.38	6.8	1.2	2.5	10.30	10	0.026340	0.028620
18B	NORTH YO	39	5.25	11.0	0.4	1.3	10.50	110	0.073940	0.083700
19A	X	36	4.94	5.0	0.4	1.7	10.20	280	0.047400	0.052720
19C	X	78	5.51	5.0	1.9	1.6	8.85	41	0.057270	0.062220
20D	X	81	5.52	7.4	1.3	2.8	10.60	150	0.038840	0.041470
22C	PILGRIM	30	5.46	6.8	1.1	2.2	8.71	20	0.031540	0.034190
22D	MAGGIE	27	6.67	7.0	1.4	2.2	10.00	16	0.035640	0.041010
22E	X	59	5.65	5.8	1.5	3.8	9.13	51	0.040014	0.041412
23A	BLUESUCK	33	5.53	8.3	1.0	1.7	9.85	84	0.047320	0.051070
23E	SOLACE	24	5.70	8.4	1.3	2.4	10.40	36	0.046240	0.049460
23F	X	57	5.79	4.2	2.5	3.4	9.35	55	0.040103	0.044324
24B	X	10	5.69	5.9	1.8	3.2	9.88	46	0.038950	0.035540
26D	MUDDING	48	5.82	2.0	1.4	3.6	9.10	52	0.033820	0.035960
27A	X	13	7.61	13.5	0.5	1.8	29.20	13	0.044400	0.043720
27D	X	45	5.02	4.3	1.6	3.6	8.71	120	0.021720	0.023620
27D	X	47	5.02	4.3	1.6	3.6	8.71	120	0.057060	0.060970
28C	STOUFFER	16	4.99	6.5	1.4	1.8	11.70	110	0.089740	0.085260
28C	STOUFFER	50	4.99	6.5	1.4	1.8	11.70	110	0.103530	0.113440
28D	X	19	5.57	7.5	1.0	3.1	10.40	81	0.048820	0.046570
29C	FREDERIC	38	4.75	5.0	0.6	0.6	12.90	200	0.114430	0.114860

TR520	TR550	TR580	TR610	TR640	TR670	TR700	TR732
0.045250	0.041970	0.032900	0.0208600	0.0140200	0.0088700	0.0080100	0.0048700
0.052740	0.037090	0.026340	0.0156000	0.0109700	0.0089100	0.0078800	0.0053900
0.084930	0.067610	0.049690	0.0264400	0.0169600	0.0135900	0.0109100	0.0056200
0.054860	0.039210	0.027320	0.0158500	0.0103300	0.0066300	0.0057200	0.0040900
0.066720	0.049650	0.033900	0.0148600	0.0065200	0.0060500	0.0034800	0.0024600
0.027520	0.028300	0.026020	0.0209600	0.0149000	0.0128000	0.0107800	0.0085000
0.074520	0.067830	0.057550	0.0383400	0.0262700	0.0187500	0.0150200	0.0118500
0.051520	0.050580	0.045330	0.0300700	0.0170000	0.0132000	0.0104300	0.0064000
0.059310	0.058600	0.045440	0.0282100	0.0189000	0.0143500	0.0118600	0.0083900
0.041130	0.039470	0.034090	0.0253400	0.0179000	0.0127400	0.0094000	0.0080800
0.033020	0.030680	0.028670	0.0174200	0.0110900	0.0070900	0.0047900	0.0043600
0.039440	0.038830	0.038410	0.0287200	0.0185600	0.0162400	0.0102200	0.0100000
0.041389	0.041012	0.036782	0.0332665	0.0289932	0.0257150	0.0213783	0.0196251
0.053590	0.051940	0.048120	0.0335600	0.0200000	0.0171400	0.0112300	0.0077000
0.047490	0.043570	0.043180	0.0281500	0.0186400	0.0159700	0.0118700	0.0080900
0.045279	0.050358	0.043729	0.0362167	0.0300574	0.0244625	0.0205955	0.0161411
0.033150	0.033620	0.032170	0.0281900	0.0204200	0.0181400	0.0154000	0.0136900
0.037520	0.038390	0.040580	0.0340000	0.0259100	0.0234700	0.0200600	0.0184300
0.036500	0.032740	0.027960	0.0193300	0.0140200	0.0142100	0.0090600	0.0080300
0.023950	0.023810	0.023250	0.0216900	0.0178800	0.0159500	0.0141900	0.0107200
0.058440	0.057420	0.048540	0.0438500	0.0425400	0.0359600	0.0335300	0.0300500
0.081660	0.078500	0.074550	0.0621300	0.0543900	0.0498200	0.0467200	0.0450500
0.116020	0.120060	0.101820	0.0868100	0.0773200	0.0694200	0.0627800	0.0578700
0.042400	0.040640	0.039510	0.0320000	0.0255300	0.0225200	0.0201600	0.0183100
0.098580	0.089580	0.080280	0.0641000	0.0570800	0.0637200	0.0507100	0.0493600

CORRECTED PROBAR REFLECTANCES AND LIMNOLOGICAL DATA

LAKE_ID	NAME	PROFILE	PH	SD	TTLCHL_A	DOC	SO4	AL	TR443	TR470
29C	FREDERIC	41	4.75	5.0	0.60	0.6	12.90	200	0.095150	0.100440
30B	DOUGHERT	35	4.61	17.4	0.20	0.8	13.40	260	0.050320	0.050930
30C	DOUGHERT	32	4.63	19.0	0.30	0.8	13.50	250	0.103260	0.098760
30C	DOUGHERT	38	4.63	19.0	0.30	0.8	13.50	250	0.187600	0.187260
31A	X	21	5.69	3.4	3.10	5.2	11.00	110	0.022700	0.022210
31C	X	22	5.97	4.8	2.30	3.6	11.30	49	0.068950	0.066970
32A	X	18	5.95	7.7	1.30	2.7	11.20	27	0.034720	0.045310
32B	CHINIGUC	25	5.12	12.3	0.30	0.8	12.50	170	0.069540	0.067880
33A	LAURA	15	6.24	8.3	0.70	2.4	14.20	11	0.023480	0.025070
33B	CHINIGUC	35	4.54	18.0	0.30	0.3	12.60	410	0.129130	0.132950
33E	X	32	4.98	2.4	0.80	0.9	10.40	180	0.065940	0.071590
34B	X	28	4.44	4.5	0.30	0.2	11.50	360	0.091450	0.084490
34C	CHINIGUC	26	4.85	10.0	0.30	0.3	12.00	180	0.093430	0.093330
34E	X	29	4.40	9.0	0.30	0.1	10.50	440	0.116640	0.117270
35A	MARJORIE	12	4.41	6.5	0.40	0.3	12.00	760	0.091180	0.104920
35B	DEWDNEY	9	4.73	4.2	0.40	0.5	12.60	240	0.090590	0.096650
35C	CHINIGUC	29	4.84	9.0	0.40	0.5	12.00	140	0.113520	0.118410
35C	CHINIGUC	24	4.84	9.0	0.40	0.5	12.00	140	0.098630	0.103110
36C	CHINIGUC	31	4.60	12.5	0.30	0.2	13.50	250	0.103600	0.097590
36C	CHINIGUC	21	4.60	12.5	0.30	0.2	13.50	250	0.116000	0.117530
36D	LAWLOR	18	4.51	7.4	0.60	0.9	11.30	320	0.082880	0.087460
37B	WOLF	6	4.66	11.0	0.30	0.7	12.90	300	0.101920	0.119690
37D	X	34	4.29	7.5	0.80	1.1	11.60	770	0.092920	0.090040
37D	X	12	4.29	7.5	0.80	1.1	11.60	770	0.096560	0.100680
37E	X	15	5.17	11.2	0.20	0.8	13.10	150	0.137310	0.132330

TR620	TR550	TR580	TR610	TR640	TR670	TR700	TR732
0.082380	0.072160	0.0536600	0.0401300	0.0352000	0.0309600	0.0282500	0.0247800
0.047890	0.046070	0.0409200	0.0231900	0.0143600	0.0132900	0.0105000	0.0080500
0.072560	0.061060	0.0495300	0.0307800	0.0235700	0.0236800	0.0174500	0.0161200
0.144560	0.125990	0.0950500	0.0821700	0.0791100	0.0716700	0.0704900	0.0657800
0.022780	0.021320	0.0203500	0.0241900	0.0173200	0.0160000	0.0156900	0.0123600
0.063260	0.062960	0.0597800	0.0560100	0.0603500	0.0472300	0.0437900	0.0412100
0.042540	0.040510	0.0420300	0.0320900	0.0217800	0.0173100	0.0177900	0.0100800
0.057870	0.052940	0.0445500	0.0345700	0.0275200	0.0256300	0.0229700	0.0206200
0.021170	0.021790	0.0168300	0.0150600	0.0111300	0.0071500	0.0084500	0.0042100
0.093660	0.077940	0.0571900	0.0453200	0.0420600	0.0382300	0.0349000	0.0325500
0.065160	0.061610	0.0471800	0.0330200	0.0261900	0.0225400	0.0182900	0.0151900
0.065570	0.058700	0.0483500	0.0336800	0.0268500	0.0238300	0.0224200	0.0206600
0.062400	0.049440	0.0338400	0.0250800	0.0210500	0.0191600	0.0165800	0.0138200
0.101930	0.093610	0.0678900	0.0443600	0.0364200	0.0315200	0.0296900	0.0246300
0.091140	0.084740	0.0733200	0.0429600	0.0221200	0.0149900	0.0129100	0.0096600
0.075550	0.063630	0.0486300	0.0262400	0.0184400	0.0116400	0.0118400	0.0072500
0.111270	0.106260	0.0919000	0.0648500	0.0519000	0.0490600	0.0475800	0.0425300
0.086810	0.077580	0.0590300	0.0475200	0.0426300	0.0386300	0.0361600	0.0329700
0.073390	0.062850	0.0516200	0.0407800	0.0337000	0.0315000	0.0293300	0.0277300
0.083140	0.070330	0.0494300	0.0403800	0.0354000	0.0331000	0.0295900	0.0276200
0.079040	0.075350	0.0546400	0.0364900	0.0296200	0.0245900	0.0227300	0.0197200
0.090300	0.072200	0.0588600	0.0309800	0.0231800	0.0151300	0.0123000	0.0090600
0.086030	0.083790	0.0773500	0.0622800	0.0515600	0.0471100	0.0432000	0.0402000
0.102000	0.100290	0.0806300	0.0607300	0.0464700	0.0422800	0.0395900	0.0327100
0.100560	0.085350	0.0562800	0.0309200	0.0223300	0.0197000	0.0161600	0.0131300

CORRECTED PROBAR REFLECTANCES AND LIMNOLOGICAL DATA

LAKE_ID	NAME	PROFILE	PH	SD	TTLCHL_A	DOC	SO4	AL	TR443	TR470
38C	SILVESTE	26	4.64	6.8	0.30	0.5	12.80	280.0	0.051610	0.056640
38C	SILVESTE	9	4.64	6.8	0.30	0.5	12.80	280.0	0.081360	0.083750
38D	OTTER	23	4.34	10.5	0.30	0.2	15.20	520.0	0.107730	0.101710
38D	OTTER	6	4.34	10.5	0.30	0.2	15.20	520.0	0.137890	0.136320
39A	MATAGAMA	15	5.16	0.6	1.10	3.2	11.80	120.0	0.039120	0.040730
39B	THOMAS	18	6.24	4.8	2.00	3.8	11.90	25.0	0.019810	0.017700
39D	X	21	4.75	3.4	2.20	3.2	10.50	250.0	0.049170	0.050080
40A	MATAGAMA	12	4.84	3.7	1.60	1.4	11.10	180.0	0.035810	0.035330
40B	RATHBUN	9	7.03	3.6	1.90	3.5	13.90	16.0	0.024030	0.024450
40C	WANAPITE	6	7.53	3.7	1.00	4.1	13.60	13.0	0.029000	0.024000
AA	ATOMIC	18	6.29	5.2	1.90	3.3	4.58	22.0	0.041621	0.042745
AD	EAST	15	5.20	2.6	2.10	5.9	3.20	240.0	0.024075	0.023480
AG	L. AGAWA	12	6.01	4.8	1.20	4.2	3.76	160.0	0.024440	0.023420
AH	MADER	6	5.43	4.5	1.20	1.4	4.08	100.0	0.034780	0.037520
BA	MALLOT	21	5.59	2.3	2.10	6.0	4.05	220.0	0.020582	0.022593
BF	MONTREAL	80	7.19	3.5	0.90	7.5	4.39	100.0	0.057290	0.051480
BH	X	9	5.28	5.5	1.10	1.7	4.01	120.0	0.030190	0.031580
CA	DYER	27	5.20	2.4	1.70	6.1	3.70	190.0	0.027555	0.027038
CD	UNION	24	5.38	3.3	2.00	5.6	3.83	190.0	0.027499	0.024716
DF	BARBARA	74	5.36	8.5	0.80	1.8	4.30	87.0	0.041360	0.039360
DI	X	39	5.24	3.7	2.90	3.9	3.57	220.0	0.034200	0.034935
ED	ALVIN	36	5.65	3.9	2.70	3.4	3.78	120.0	0.031007	0.031223
EH	HAILEY	71	5.32	4.7	1.41	3.6	4.04	150.0	0.030640	0.030110
EJ	ROI	42	4.86	3.8	1.80	5.6	3.77	310.0	0.022758	0.022007
FF	BIG PIKE	68	5.64	4.5	1.98	4.0	4.10	150.0	0.029150	0.026110

TR520	TR550	TR580	TR610	TR640	TR670	TR700	TR732
0.055330	0.055200	0.046380	0.027490	0.015090	0.012510	0.010710	0.0077600
0.079010	0.074530	0.057520	0.045350	0.041080	0.036620	0.033980	0.0306900
0.089190	0.081220	0.070920	0.053400	0.043050	0.039110	0.035150	0.0343300
0.106730	0.090640	0.061960	0.032990	0.025870	0.021920	0.019900	0.0160700
0.046720	0.051290	0.050170	0.036610	0.021790	0.019290	0.013550	0.0100500
0.018150	0.018520	0.020750	0.016010	0.011090	0.010430	0.006980	0.0046100
0.048890	0.051620	0.052360	0.049270	0.046330	0.045040	0.041280	0.0370700
0.042910	0.045730	0.045150	0.028870	0.016400	0.011740	0.007800	0.0060500
0.033420	0.040170	0.046940	0.037900	0.028290	0.026750	0.018240	0.0147400
0.018650	0.017860	0.016690	0.014850	0.011730	0.010220	0.006530	0.0055500
0.039075	0.039005	0.038411	0.030030	0.022911	0.021263	0.018197	0.0144802
0.022379	0.020696	0.019475	0.016801	0.015714	0.015540	0.013962	0.0112732
0.019730	0.019070	0.018410	0.016010	0.013660	0.012180	0.009490	0.0055900
0.037030	0.035410	0.030630	0.017720	0.012950	0.010310	0.008060	0.0050500
0.019109	0.017561	0.018063	0.015175	0.014116	0.013154	0.012817	0.0106496
0.047950	0.044960	0.042330	0.040310	0.040020	0.037350	0.037530	0.0345400
0.032570	0.031530	0.028580	0.019840	0.014550	0.011770	0.009060	0.0065900
0.024310	0.021717	0.018794	0.018227	0.015623	0.014608	0.014895	0.0119849
0.022868	0.020270	0.020098	0.017833	0.015463	0.016127	0.014069	0.0117354
0.037050	0.035150	0.031030	0.022630	0.015670	0.013940	0.011100	0.0090900
0.035361	0.036472	0.037134	0.032112	0.024144	0.023084	0.019590	0.0155981
0.029523	0.030584	0.030597	0.024464	0.020332	0.019801	0.016329	0.0134950
0.028590	0.029730	0.028530	0.022430	0.018010	0.015360	0.012090	0.0084800
0.021638	0.020270	0.019532	0.017167	0.013621	0.014373	0.012226	0.0081074
0.026370	0.026600	0.026790	0.023000	0.019000	0.016770	0.013990	0.0107800

CORRECTED PROBAR REFLECTANCES AND LIMNOLOGICAL DATA

LAKE_ID	NAME	PROFILE	PH	SD	TTLCHL_A	DOC	SO4	AL	TR443	TR470
FH	SHOEPACK	46	7.16	3.2	2.10	5.1	4.38	55.0	0.0238015	0.0208779
GF	PATTERSO	49	5.81	6.9	3.61	2.9	4.27	65.0	0.0384164	0.0422418
GI	RAND	65	6.22	3.8	1.60	3.2	4.13	38.0	0.0242600	0.0223600
HB	CARPENTE	52	6.27	5.5	1.80	3.0	4.42	62.0	0.0239783	0.0231927
HD	MITCHELL	55	7.07	2.9	2.60	5.5	4.23	30.0	0.0293471	0.0288405
II	FULLER	62	6.66	2.4	4.30	4.5	4.16	91.0	0.0175700	0.0153400
JA	QUINTET	38	6.83	7.0	1.40	3.0	4.93	52.0	0.0228000	0.0217400
JB	TAY	41	5.83	0.9	4.40	10.5	2.77	210.0	0.0194300	0.0179600
KB	X	35	6.69	5.2	1.80	3.3	4.79	54.0	0.0192800	0.0206000
KD	MCCOLLOU	44	6.27	3.5	2.80	4.9	2.91	120.0	0.0203900	0.0196500
KG	DICK	47	7.20	4.0	3.60	4.5	4.31	71.0	0.0348700	0.0315500
KK	X	59	6.63	5.9	1.40	3.5	4.61	45.0	0.0222400	0.0203700
LE	MCGOVERN	53	7.43	6.5	1.80	3.0	4.38	10.0	0.0204800	0.0209500
LG	X	50	7.14	5.1	2.70	4.1	4.38	34.0	0.0236600	0.0222300
LK	GRIFFIN	56	7.06	10.2	0.60	2.8	5.04	23.0	0.0268500	0.0244200
MB	X	29	7.21	5.4	4.11	2.6	5.04	19.0	0.0378000	0.0381500
MC	ADELAIDE	26	7.24	5.8	3.88	2.5	5.04	20.0	0.0262800	0.0249400
MF	X	17	6.47	4.8	0.90	4.2	4.46	58.0	0.0224400	0.0211000
NA	X	32	6.55	6.8	1.50	3.2	5.10	76.0	0.0324700	0.0333200
NF	BONE	23	6.49	5.8	1.11	3.1	4.68	18.0	0.0224000	0.0219900
NI	WISHART	14	6.95	2.8	5.30	3.9	4.90	53.0	0.0275000	0.0275700
NJ	LITTLE T	9	7.28	5.6	1.40	3.0	5.48	36.0	0.0231400	0.0237500
NK	TURKEY	12	7.38	5.9	1.80	2.9	5.65	29.0	0.0996100	0.0946200
OC	DREW	20	7.02	3.5	1.20	3.7	4.91	49.0	0.0209100	0.0201600
OC	DREW	33	7.02	3.5	1.20	3.7	4.91	49.0	0.0272646	0.0261403

TR520	TR550	TR580	TR610	TR640	TR670	TR700	TR732
0.020392	0.017882	0.017809	0.015913	0.015282	0.014397	0.012936	0.0098599
0.043466	0.045654	0.044273	0.030277	0.021083	0.019709	0.015329	0.0124171
0.019950	0.020510	0.019430	0.015480	0.011960	0.009650	0.007410	0.0050300
0.024135	0.024245	0.022902	0.016697	0.011281	0.010795	0.007978	0.0056122
0.025852	0.025115	0.026215	0.023111	0.020201	0.019350	0.017162	0.0144335
0.014020	0.014530	0.017240	0.015930	0.011700	0.011400	0.009310	0.0064900
0.018370	0.017250	0.016580	0.013060	0.008580	0.007880	0.005430	0.0043100
0.013440	0.014230	0.013210	0.011770	0.011140	0.012240	0.010270	0.0100800
0.020300	0.020290	0.020820	0.018230	0.012570	0.012050	0.009480	0.0066700
0.015720	0.017330	0.016310	0.013290	0.012310	0.010820	0.009490	0.0067100
0.026650	0.026970	0.026390	0.022170	0.019170	0.015020	0.014720	0.0113300
0.018730	0.018140	0.016620	0.012660	0.008640	0.007170	0.005240	0.0040500
0.020680	0.022330	0.021590	0.014140	0.010030	0.007050	0.004830	0.0032300
0.019440	0.019430	0.018430	0.015540	0.012230	0.010090	0.011150	0.0080100
0.022770	0.020800	0.019170	0.014120	0.010970	0.008520	0.006630	0.0047400
0.039250	0.043140	0.044500	0.034710	0.021960	0.018720	0.016480	0.0132200
0.025340	0.023370	0.022440	0.017130	0.011860	0.010050	0.008990	0.0058800
0.019900	0.021330	0.020010	0.016420	0.012660	0.011170	0.010060	0.0065800
0.026760	0.027130	0.025180	0.022520	0.017670	0.017380	0.014490	0.0112000
0.016790	0.018200	0.017780	0.013190	0.009750	0.009250	0.007800	0.0052700
0.029230	0.032450	0.033160	0.027980	0.022410	0.018930	0.017570	0.0133400
0.024920	0.023600	0.023330	0.019150	0.015940	0.013350	0.011230	0.0086400
0.131230	0.165130	0.162290	0.142140	0.109440	0.119360	0.113450	0.0939300
0.018400	0.017190	0.015140	0.012370	0.011710	0.011090	0.009740	0.0064600
0.024323	0.021219	0.021587	0.019682	0.017772	0.016734	0.014738	0.0134473

CORRECTED PROBAR REFLECTANCES AND LIMNOLOGICAL DATA

LAKE_ID	NAME	PROFILE	PH	SD	TTLCHL_A	DOC	SO4	AL	TR443	TR470
OF	NORTH TI	6	7.35	2.8	4.4	3.5	5.17	47.0	0.0228400	0.0252100
W1	PAINT	34	7.44	999.9	2.8	6.1	5.93	100.0	0.0222200	0.0200200
W2	CRAYFISH	31	7.44	999.9	2.2	7.9	5.18	999.9	0.0284600	0.0245900
W3	WEST KAB	28	7.44	999.9	3.9	8.8	4.77	999.9	0.0287800	0.0247700
W4	NEMATEGU	25	7.30	999.9	3.9	6.7	4.77	999.9	0.0304900	0.0290600
W5	LINE	22	7.41	999.9	4.0	6.7	4.11	999.9	0.0301900	0.0293000
W6	FUNGUS	16	7.34	999.9	5.2	9.8	4.30	999.9	0.0310000	0.0291000
W7	KABENUNG	19	7.37	999.9	6.0	9.4	4.78	94.0	0.0150200	0.0142400
W8	DESOLATI	12	7.30	999.9	1.9	6.8	8.29	999.9	0.0257300	0.0225900
W9	PRINCESS	6	7.69	999.9	1.2	6.5	11.70	999.9	0.0263700	0.0233700
X01	LAUNDRIE	7	5.67	4.5	2.3	3.2	8.63	66.0	0.0410600	0.0375700
X01	LAUNDRIE	53	5.67	4.5	2.3	3.2	8.63	66.0	0.0195900	0.0222600
X02	CENTRE	41	6.20	7.5	1.3	2.0	10.90	10.0	0.0454700	0.0446800
X02	CENTRE	44	6.20	7.5	1.3	2.0	10.90	10.0	0.0798900	0.0826000
X03	WHITEPIN	75	5.90	9.0	1.4	2.2	9.29	10.0	0.0360300	0.0386400
X09	GREYOWL	30	5.33	4.2	1.8	3.7	3.79	130.0	0.0294323	0.0289538

TR520	TR550	TR580	TR610	TR640	TR670	TR700	TR732
0.0290200	0.0341200	0.0374600	0.0295100	0.0228200	0.0213600	0.0177100	0.0139500
0.0183400	0.0189600	0.0198400	0.0170000	0.0140200	0.0122500	0.0114400	0.0087600
0.0198400	0.0192400	0.0173700	0.0160400	0.0132700	0.0127200	0.0110200	0.0087300
0.0209200	0.0199900	0.0208100	0.0194500	0.0174100	0.0176300	0.0145600	0.0122600
0.0305700	0.0343700	0.0381300	0.0342600	0.0284600	0.0284400	0.0226600	0.0187800
0.0318200	0.0347200	0.0408400	0.0387300	0.0320100	0.0316900	0.0251100	0.0220800
0.0262400	0.0271400	0.0279600	0.0270700	0.0250800	0.0256100	0.0243100	0.0226500
0.0128000	0.0114000	0.0094200	0.0097700	0.0096600	0.0087400	0.0085900	0.0059000
0.0190900	0.0193800	0.0201700	0.0177200	0.0144700	0.0138000	0.0116800	0.0088100
0.0218400	0.0216700	0.0219400	0.0192100	0.0174700	0.0153000	0.0135600	0.0089000
0.0323800	0.0317200	0.0299200	0.0243100	0.0222200	0.0208000	0.0174300	0.0151400
0.0176200	0.0166800	0.0143600	0.0129400	0.0102900	0.0088000	0.0068100	0.0038200
0.0446300	0.0447400	0.0422500	0.0318700	0.0247700	0.0236900	0.0204500	0.0182000
0.0852700	0.0837400	0.0695100	0.0588900	0.0510000	0.0452700	0.0441400	0.0382500
0.0389600	0.0391500	0.0336100	0.0248400	0.0172600	0.0137700	0.0108200	0.0083600
0.0258734	0.0255852	0.0252301	0.0217321	0.0181032	0.0163905	0.0130534	0.0096605

Table B.2.

PREDICTED SUBSURFACE REFLECTANCE AT DEPTH = 2 METERS
ALL PROBAR LAKES

OBS	LAKEID	NAME	NM443	NM470	NM490	NM520	NM550	NM580	NM610	NM640	NM670	NM700
1	OF	N.TILLEY	0.00000	0.54865	0.77986	1.06232	1.48311	1.31005	0.75460	0.372809	0.273390	0
2	NJ	L.TURKEY	0.30118	0.77176	0.91867	1.16827	1.40514	1.20635	0.13852	0.298341	0.045068	0
3	NK	TURKEY	0.00000	0.21532	0.42776	1.35034	2.16382	1.70440	3.43590	0.000000	0.610649	0
4	NI	WISHART	0.19663	0.65976	0.81160	1.07790	1.45358	1.25366	0.53383	0.322543	0.000000	0
5	MF	X	0.32599	0.70599	0.86577	0.99689	1.38391	1.17720	0.00000	0.000000	0.000000	0
6	OC	DREW	0.26211	0.67843	0.84292	0.94436	1.31019	1.11552	0.00000	0.000000	0.000000	0
7	NF	BONE	0.44321	0.84598	0.89074	0.95905	1.36712	1.17761	0.00000	0.000000	0.000000	0
8	MC	ADELAIDE	0.58524	0.92421	1.13111	1.28668	1.44393	1.22465	0.17346	0.000000	0.000000	0
9	MB	X	0.79803	1.17843	1.26146	1.57247	1.68094	1.42218	1.77531	0.441692	0.062975	0
10	NA	X	0.62167	1.05220	1.01812	1.10506	1.41035	1.18723	0.15599	0.013501	0.159975	0
11	KB	X	0.18977	0.70954	0.78197	1.04061	1.37503	1.19605	0.27029	0.000000	0.112221	0
12	JA	QUINTET	0.58947	0.94021	1.03970	1.13488	1.39453	1.19347	0.09248	0.007916	0.094314	0
13	JB	TAY	0.15598	0.55710	0.68802	0.69997	1.24283	1.08217	0.00000	0.000000	0.022683	0
14	KD	MCCOLLOU	0.24785	0.66688	0.75193	0.83619	1.31771	1.13477	0.00000	0.000000	0.000000	0
15	KG	DICK	0.73625	0.96332	1.02235	1.08992	1.40283	1.20052	0.06391	0.249937	0.000000	0
16	LG	X	0.33286	0.70776	0.78113	0.92789	1.32620	1.14101	0.00000	0.000000	0.000000	0
17	LE	MCGOVERN	0.49865	0.93176	1.07229	1.26442	1.50415	1.26952	0.35920	0.389564	0.059991	0
18	LK	GRIFFIN	0.73995	1.00598	1.10868	1.27733	1.43988	1.21231	0.07026	0.229458	0.010745	0
19	KK	X	0.56993	0.88776	1.06763	1.15937	1.41537	1.19659	0.05915	0.054458	0.016714	0
20	II	FULLER	0.10846	0.48332	0.70918	0.76853	1.26715	1.14982	0.00000	0.000000	0.040591	0
21	GI	RAND	0.56201	0.87976	0.98850	1.11708	1.41923	1.20526	0.16234	0.268554	0.048052	0
22	FF	BIG_PIKE	0.47278	0.75399	0.97453	1.10996	1.40977	1.21584	0.31157	0.354192	0.143559	0
23	EH	HAILEY	0.65177	1.01620	1.08752	1.29336	1.50685	1.26477	0.52272	0.523606	0.216682	0
24	DF	BARBARA	1.27006	1.47131	1.54543	1.71402	1.63057	1.31249	0.71164	0.272277	0.152513	0
25	BF	MONTREAL	0.71566	0.83532	0.91655	1.02271	1.30980	1.10739	0.00000	0.000000	0.000000	0
26	W9	PRINCESS	0.34870	0.65132	0.75954	0.92744	1.32292	1.15592	0.00000	0.149405	0.000000	0
27	X	BRANT	0.00000	0.30955	0.49420	0.70754	1.23395	1.12108	0.00000	0.000000	0.000000	0
28	W8	DESOLATI	0.41417	0.70021	0.84884	0.88872	1.31501	1.15741	0.00000	0.000000	0.045068	0
29	W6	FUNGUS	0.02556	0.42821	0.55387	0.64477	1.22102	1.09180	0.00000	0.000000	0.000000	0
30	W7	KABENUNG	0.01183	0.46643	0.53144	0.74627	1.22063	1.05357	0.00000	0.000000	0.000000	0
31	W5	LINE	0.00000	0.40154	0.57630	0.85756	1.35187	1.25556	1.04344	0.706053	0.710633	0
32	W4	NEMATEGU	0.08575	0.49977	0.62835	0.91097	1.39240	1.25203	0.72275	0.501266	0.591249	0
33	W3	WEST_KAB	0.42315	0.66910	0.77520	0.84198	1.27120	1.12705	0.00000	0.000000	0.186836	0
34	W2	CRAYFISH	0.59316	0.81843	0.88862	0.95148	1.32505	1.12840	0.00000	0.000000	0.000000	0
35	W1	PAINT	0.24151	0.59665	0.75870	0.86601	1.31154	1.15619	0.00000	0.000000	0.000000	0
36	X	LAKE_SUP	2.22785	2.21397	2.26952	2.26423	1.81681	1.38285	0.69576	0.141958	0.000000	0
37	X	LAKE_SUP	2.32923	2.46375	2.48155	2.45832	1.86525	1.41728	1.16092	0.555255	0.358451	0
38	AH	MADER	1.08315	1.52464	1.65377	1.84846	1.69426	1.34787	0.41476	0.331851	0.064468	0
39	BH	X	0.78799	1.21620	1.33129	1.60541	1.60007	1.30693	0.59257	0.443553	0.133113	0
40	AG	L.AGAWA	0.46169	0.83443	0.97326	1.01469	1.35129	1.16324	0.00000	0.197809	0.130129	0
41	AD	EAST	0.20626	0.63833	0.83799	0.93352	1.29636	1.11705	0.00000	0.000000	0.000000	0
42	AA	ATOMIC	0.90913	1.30632	1.34526	1.48824	1.56799	1.31634	0.75979	0.299104	0.186179	0
43	BA	MALLOT	0.08236	0.64983	0.75367	0.83896	1.25796	1.11344	0.00000	0.000000	0.000000	0
44	CD	UNION	0.38142	0.68854	0.80934	0.95055	1.28607	1.12405	0.00000	0.000000	0.035741	0
45	CA	DYER	0.34079	0.75503	0.77723	0.97796	1.29807	1.09517	0.00000	0.000000	0.000000	0
46	XO9	GREYOWL	0.53714	0.92200	1.03283	1.12954	1.40826	1.20739	0.25897	0.361601	0.226695	0
47	OC	DREW	0.33375	0.72210	0.88282	0.98553	1.29149	1.13517	0.00000	0.000000	0.026548	0
48	ED	ALVIN	0.44731	0.87728	1.02732	1.14618	1.44153	1.23574	0.17102	0.166700	0.246767	0
49	DI	X	0.44374	0.89728	1.12122	1.26087	1.49221	1.28015	0.86900	0.269317	0.250065	0
50	EJ	ROI	0.22839	0.65003	0.84711	0.97784	1.32164	1.14135	0.00000	0.000000	0.049037	0
51	FH	SHOEPACK	0.24601	0.56828	0.85566	0.89076	1.26186	1.10837	0.00000	0.000000	0.000000	0
52	GF	PATTERSO	0.89134	1.41144	1.60083	1.81139	1.75167	1.43469	1.25419	0.492739	0.382268	0
53	HB	CARPENTE	0.51717	0.89155	1.08415	1.27809	1.48037	1.24464	0.26547	0.036455	0.149126	0

PREDICTED SUBSURFACE REFLECTANCE AT DEPTH = 2 METERS
ALL PROBAR LAKES

OBS	LAKEID	NAME	NM443	NM470	NM490	NM520	NM550	NM580	NM610	NM640	NM670	NM700
54	HD	MITCHELL	0.31573	0.73439	0.81973	0.94673	1.31990	1.16505	0.00000	0.00000	0.055305	0
55	40C	WANAPITE	0.85875	0.99176	1.11419	1.09838	1.38507	1.18005	0.20203	0.38956	0.279359	0
56	40B	RATHBUN	0.00000	0.49132	0.81762	1.23460	1.58965	1.43138	2.00233	1.29249	0.998647	0
57	40A	MATAGAMA	1.15126	1.43887	1.66900	2.12178	1.89845	1.54864	2.22618	1.02254	0.316666	0
58	39A	MATAGAMA	1.02243	1.42331	1.70455	2.03542	1.89478	1.53874	2.54210	0.95552	0.585280	0
59	39B	THOMAS	0.34975	0.69178	0.88904	1.05609	1.38912	1.22899	0.31474	0.18664	0.243544	0
60	39D	X	0.08892	0.60843	0.74050	0.89762	1.36598	1.19252	0.14964	0.36184	0.289805	0
61	38D	OTTER	3.50465	3.17352	3.20522	2.98446	2.05555	1.52722	1.77848	0.89222	0.319651	0
62	38C	SILVESTE	1.83185	2.25664	2.42865	2.54512	2.02506	1.52586	1.54511	0.23690	0.000000	0
63	35C	CHINIGUC	3.15398	3.36329	3.51161	3.39402	2.29892	1.64312	1.62290	0.22573	0.000000	0
64	30C	DOUGHERT	4.20310	3.82907	3.60387	3.01208	2.00807	1.47720	0.99740	0.56084	0.858403	0
65	30B	DOUGHERT	1.77483	2.01219	2.08173	2.22328	1.85290	1.45469	0.89579	0.14010	0.145052	0
66	29C	FREDERIC	3.03675	3.06641	3.00631	2.88979	1.91659	1.44317	1.00692	0.60738	0.177882	0
67	X02	CENTRE	0.99339	1.29220	1.45613	1.63523	1.63520	1.33784	0.69417	0.22573	0.212205	0
68	27D	X	0.06991	0.63443	0.80737	0.99333	1.35207	1.16514	0.07185	0.10845	0.000000	0
69	26D	MUDDING	0.39886	0.92198	1.11334	1.33609	1.52017	1.32049	1.09424	0.51057	0.237574	0
70	X01	LAUNDRIE	0.91999	1.11043	1.08837	1.22438	1.44220	1.21163	0.00000	0.31323	0.231605	0
71	24B	X	0.91577	1.11043	1.07737	1.34900	1.51805	1.26965	0.59418	0.35805	0.137590	0
72	27A	X	1.53828	1.75575	1.65800	1.78035	1.62342	1.29853	0.51160	0.34488	0.497235	0
73	28C	STOUFFER	1.94379	1.92820	1.67239	2.11421	1.77975	1.41958	1.32761	0.84940	0.191313	0
74	28D	X	1.18558	1.34465	1.23607	1.54887	1.56168	1.30463	0.76085	0.42121	0.080883	0
75	31C	X	1.00078	1.24554	0.99781	1.42557	1.53638	1.25908	0.82118	0.64278	0.242051	0
76	32B	CHINIGUC	2.13123	2.21130	1.97624	2.11243	1.74482	1.33486	0.72275	0.26855	0.125852	0
77	34B	X	3.31711	2.97398	2.43826	2.47968	1.86660	1.39383	0.66877	0.24621	0.000000	0
78	36C	CHINIGUC	3.59379	3.24907	2.67537	2.52019	1.81334	1.34448	0.69894	0.23504	0.052529	0
79	37D	X	2.29755	2.29708	2.04988	2.46544	1.94979	1.50526	1.91025	0.97786	0.312189	0
80	37B	WOLF	4.40427	4.98817	4.90733	4.03103	2.32247	1.67349	1.84675	1.44701	0.151021	0
81	35B	DEWDNEY	3.83033	3.98462	4.00507	3.39491	2.16595	1.54105	1.16727	0.65020	0.000000	0
82	35A	MARJORIE	3.80499	4.30462	4.22809	4.04127	2.55272	1.86124	3.65181	1.13611	0.039098	0
83	33A	LAURA	0.46591	0.95398	1.17682	1.12509	1.42386	1.15592	0.00000	0.00000	0.000000	0
84	32A	X	0.58623	1.43842	1.44132	1.66061	1.60490	1.37092	1.15139	0.16430	0.000000	0
85	31A	X	0.04246	0.50510	0.73500	0.87447	1.27506	1.10549	0.23080	0.00000	0.000000	0
86	23E	SOLACE	1.48707	1.88597	2.12521	2.14448	1.77821	1.46676	1.46573	0.68185	0.340543	0
87	22D	MAGGIE	1.01451	1.58375	1.75026	1.85959	1.71857	1.42446	1.81817	0.97414	0.627065	0
88	22C	PILGRIM	1.08473	1.52198	1.65631	1.81552	1.66608	1.36604	0.88627	0.59435	0.071929	0
89	23A	BLUESUCK	1.57788	1.98597	2.35756	2.44452	1.95210	1.54240	2.42621	1.05419	0.610849	0
90	19A	X	1.62435	2.09486	2.38082	2.38798	1.94130	1.51542	1.99915	0.64462	0.142067	0
91	18B	N.YORSTO	2.78331	3.26774	3.36942	3.20750	2.18563	1.61886	2.58338	1.51589	0.285328	0
92	17A	X	4.91748	4.76595	4.28522	3.37399	2.05748	1.45469	0.68782	0.00000	0.112221	0
93	15A	X	5.10070	4.54461	3.99914	2.74633	1.81276	1.33513	0.48938	0.27972	0.000000	0
94	14F	JERRY	5.69892	5.41572	4.98181	3.85386	2.26071	1.56802	1.34666	0.54781	0.128638	0
95	13D	SMOOTHWA	1.39203	1.75709	1.91700	2.00028	1.74791	1.38298	0.99740	0.06563	0.013729	0
96	13A	SUNNYWAT	5.70948	4.90550	4.04019	2.55680	1.73015	1.29256	0.10677	0.00000	0.000000	0
97	12A	WABUN	1.62910	2.11175	2.27248	2.21660	1.82183	1.37973	0.92119	0.54036	0.000000	0
98	14H	WHITEPIN	2.00926	2.35619	2.36051	2.22817	1.74154	1.32849	0.63226	0.57015	0.000000	0
99	17C	MIHELL	0.49390	1.00820	1.16963	1.30404	1.50454	1.24891	0.49731	0.18850	0.030145	0
100	X03	WHITEPIN	1.00342	1.45178	1.72740	1.81151	1.71317	1.35126	1.10694	0.62041	0.168929	0
101	19C	X	2.06998	2.45352	2.65590	2.67110	2.06848	1.49753	1.47684	0.73212	0.100283	0
102	20D	X	1.22678	1.64064	1.73968	1.97132	1.74675	1.37702	1.41175	1.00393	0.227128	0
103	38D	OTTER	5.90220	5.38949	4.97504	4.42410	2.53168	1.61249	0.95930	0.53291	0.030146	0
104	38C	SILVESTE	2.17399	2.42730	2.56619	2.56337	1.94902	1.36116	0.68623	0.74329	0.122667	0
105	37D	X	2.68035	2.93041	3.20479	3.33704	2.33791	1.59866	2.23729	0.70233	0.130129	0
106	37E	X	8.06905	5.37838	5.06307	4.31593	2.50177	1.58619	1.22442	0.57015	0.256974	0

PREDICTED SUBSURFACE REFLECTANCE AT DEPTH = 2 METERS
ALL PROBAR LAKES

OBS	LAKEID	NAME	NM443	NM470	NM490	NM520	NM550	NM580	NM610	NM640	NM67
107	36D	LAWLOR	2.84825	3.09218	3.21326	3.06550	2.18197	1.47489	1.06566	0.70419	0.0082
108	36C	CHINIGUC	4.23478	4.12373	3.75326	2.94264	1.95268	1.31127	0.59416	0.50313	0.2524
109	35C	CHINIGUC	2.97075	3.19085	3.14004	2.81354	1.98581	1.35235	0.68465	0.62600	0.0972
110	34C	CHINIGUC	3.73001	3.62640	3.31313	2.59854	1.80060	1.27630	0.23060	0.25366	0.1137
111	34E	X	4.26329	4.10773	3.91831	3.77462	2.40006	1.56016	1.21013	0.67440	0.0017
112	33E	X	2.18825	2.58419	2.62501	2.64528	2.00248	1.43395	1.21966	0.89222	0.3629
113	33B	CHINIGUC	4.64767	4.57306	4.04992	3.17456	1.99707	1.34448	0.53542	0.75446	0.2258
114	30C	DOUGHERT	5.85574	5.40505	4.90902	3.85609	2.23755	1.37526	0.73545	1.02627	0.0000
115	29C	FREDERIC	3.20465	3.42374	3.31906	2.96846	2.01386	1.38678	0.76720	0.71536	0.1331
116	X02	CENTRE	1.55993	1.92464	2.27122	2.38976	1.93068	1.38624	1.22283	0.89861	0.0000
117	27D	X	0.91471	1.43487	1.54077	1.66773	1.62748	1.24580	0.51954	1.09887	0.0913
118	28C	STOUFFER	1.82393	2.46686	2.59200	2.92884	2.27190	1.57155	2.69610	2.12839	0.7195
119	X01	LAUNDRIE	0.34711	0.90198	0.93433	1.04007	1.35689	1.14467	0.00000	0.06935	0.0258
120	23F	X	0.70233	1.26989	1.37956	1.65784	1.74081	1.35592	1.36114	1.18300	0.3057
121	22E	X	0.65631	1.10568	1.33212	1.44965	1.54534	1.25113	0.76850	0.83916	0.375

DIFFERENCED, CORRECTED PROBAR VALUES FOR ALL LAKES

OBS	LAKEID	NAME	R443	R470	R490	R520	R550	R580	R610	R640	R670	R700
1	OF	N.TILLEY	0.0051300	0.0075000	0.0083200	0.0113100	0.0164100	0.0197500	0.0118000	0.0051100	0.0036500	0
2	NJ	L.TURKEY	0.0119100	0.0125200	0.0116000	0.0136900	0.0123700	0.0121000	0.0079200	0.0047100	0.0021200	0
3	NK	TURKEY	0.0000000	0.0000000	0.0000000	0.0177800	0.0516800	0.0488400	0.0286900	0.0000000	0.0059100	0
4	NI	WISHART	0.0099300	0.0100000	0.0090700	0.0116600	0.0148800	0.0155900	0.0104100	0.0048400	0.0013600	0
5	MF	X	0.0123800	0.0110400	0.0103500	0.0098400	0.0112700	0.0099500	0.0063600	0.0026000	0.0011100	0
6	OC	DREW	0.0111700	0.0104200	0.0098100	0.0086600	0.0074500	0.0054000	0.0026300	0.0019700	0.0013500	0
7	NF	BONE	0.0146000	0.0141900	0.0109400	0.0089900	0.0104000	0.0099800	0.0053900	0.0019500	0.0014500	0
8	MC	ADELAIDE	0.0172900	0.0159500	0.0166200	0.0163500	0.0143800	0.0134500	0.0081400	0.0028700	0.0010600	0
9	MB	X	0.0213200	0.0216700	0.0197000	0.0227700	0.0266600	0.0280200	0.0182300	0.0054800	0.0022400	0
10	NA	X	0.0179800	0.0188300	0.0139500	0.0122700	0.0126400	0.0106900	0.0080300	0.0031800	0.0028900	0
11	KB	X	0.0098000	0.0111200	0.0083700	0.0108200	0.0108100	0.0113400	0.0087500	0.0030900	0.0025700	0
12	JA	QUINTET	0.0173700	0.0163100	0.0144600	0.0129400	0.0118200	0.0111500	0.0076300	0.0031500	0.0024500	0
13	JB	TAY	0.0091600	0.0076900	0.0061500	0.0031700	0.0039600	0.0029400	0.0015000	0.0008700	0.0019700	0
14	KD	MCCOLLOU	0.0109000	0.0101600	0.0076600	0.0062300	0.0078400	0.0068200	0.0038000	0.0028200	0.0013300	0
15	KG	DICK	0.0201500	0.0168300	0.0140500	0.0119300	0.0122500	0.0116700	0.0074500	0.0044500	0.0003000	0
16	LG	X	0.0125100	0.0110800	0.0083500	0.0082900	0.0082800	0.0072800	0.0043900	0.0010800	0.0000000	0
17	LE	MCGOVERN	0.0156500	0.0161200	0.0152300	0.0158500	0.0175000	0.0167600	0.0093100	0.0052000	0.0022200	0
18	LK	GRIFFIN	0.0202200	0.0177900	0.0160900	0.0161400	0.0141700	0.0125400	0.0074900	0.0043400	0.0018900	0
19	KK	X	0.0170000	0.0151300	0.0151200	0.0134900	0.0129000	0.0113800	0.0074200	0.0034000	0.0019300	0
20	II	FULLER	0.0082600	0.0060300	0.0066500	0.0047100	0.0052200	0.0079300	0.0066200	0.0023900	0.0020900	0
21	GI	RAND	0.0168500	0.0149500	0.0132500	0.0125400	0.0131000	0.0120200	0.0080700	0.0045500	0.0021400	0
22	FF	BIG_PIKE	0.0151600	0.0121200	0.0129200	0.0123800	0.0126100	0.0128000	0.0090100	0.0050100	0.0027800	0
23	EH	HAILEY	0.0185500	0.0180200	0.0155900	0.0165000	0.0176400	0.0164100	0.0103400	0.0059200	0.0032700	0
24	DF	BARBARA	0.0302600	0.0282600	0.0264100	0.0259500	0.0240500	0.0199300	0.0115300	0.0046700	0.0028400	0
25	BF	MONTREAL	0.0197600	0.0139500	0.0115500	0.0104200	0.0074300	0.0048000	0.0027800	0.0024900	0.0000000	0
26	W9	PRINCESS	0.0128100	0.0098100	0.0078400	0.0082800	0.0081100	0.0083800	0.0056500	0.0039100	0.0017400	0
27	X	BRANT	0.0036400	0.0021200	0.0015700	0.0033400	0.0035000	0.0058100	0.0042100	0.0017000	0.0016000	0
28	W8	DESOLATI	0.0140500	0.0109100	0.0099500	0.0074100	0.0077000	0.0084900	0.0060400	0.0027900	0.0021200	0
29	W6	FUNGUS	0.0066900	0.0047900	0.0029800	0.0019300	0.0028300	0.0036500	0.0027600	0.0007700	0.0013000	0
30	W7	KABENUNG	0.0064300	0.0056500	0.0024500	0.0042100	0.0028100	0.0008300	0.0011800	0.0010700	0.0001500	0
31	W5	LINE	0.0050800	0.0041900	0.0035100	0.0067100	0.0096100	0.0157300	0.0136200	0.0069000	0.0065800	0
32	W4	NEMATEGU	0.0078300	0.0064000	0.0047400	0.0079100	0.0117100	0.0154700	0.0116000	0.0058000	0.0057800	0
33	W3	WEST_KAB	0.0142200	0.0102100	0.0082100	0.0063600	0.0054300	0.0062500	0.0048900	0.0028500	0.0030700	0
34	W2	CRAYFISH	0.0174400	0.0135700	0.0108900	0.0088200	0.0082200	0.0063500	0.0050200	0.0022500	0.0017000	0
35	W1	PAINT	0.0107800	0.0085800	0.0078200	0.0069000	0.0075200	0.0084000	0.0055600	0.0025800	0.0008100	0
36	X	LAKE_SUP	0.0484000	0.0449700	0.0435200	0.0383100	0.0337000	0.0251200	0.0114300	0.0038700	0.0011300	0
37	X	LAKE_SUP	0.0503200	0.0505900	0.0485300	0.0426700	0.0362100	0.0276600	0.0143600	0.0060900	0.0042200	0
38	AH	MADER	0.0267200	0.0294600	0.0289700	0.0289700	0.0273500	0.0225400	0.0096600	0.0048900	0.0022500	0
39	BH	X	0.0211300	0.0225200	0.0213500	0.0235100	0.0224700	0.0195200	0.0107800	0.0054900	0.0027100	0
40	AG	L.AGAWA	0.0149500	0.0139300	0.0128900	0.0102400	0.0095800	0.0089200	0.0065200	0.0041700	0.0026900	0
41	AD	EAST	0.0101124	0.0095178	0.0096936	0.0084164	0.0067336	0.0055126	0.0028389	0.0017519	0.0015776	0
42	AA	ATOMIC	0.0234243	0.0245476	0.0216801	0.0208780	0.0208078	0.0202137	0.0118333	0.0047141	0.0030656	0
43	BA	MALLOT	0.0077658	0.0097765	0.0077011	0.0062922	0.0047439	0.0052464	0.0023584	0.0012992	0.0003370	0
44	CD	UNION	0.0134297	0.0106474	0.0090166	0.0087991	0.0062005	0.0060287	0.0037642	0.0013941	0.0020575	0
45	CA	DYER	0.0126602	0.0121434	0.0082578	0.0094149	0.0068222	0.0038989	0.0033320	0.0007281	0.0000000	0
46	XO9	GREYOWL	0.0163789	0.0159004	0.0142977	0.0128200	0.0125318	0.0121767	0.0086787	0.0050498	0.0033371	0
47	OC	DREW	0.0125269	0.0114026	0.0107529	0.0095848	0.0064815	0.0068497	0.0049446	0.0030341	0.0019959	0
48	ED	ALVIN	0.0146776	0.0148942	0.0141674	0.0131937	0.0142552	0.0142680	0.0081247	0.0040029	0.0034716	0
49	DI	X	0.0146100	0.0153442	0.0163861	0.0157703	0.0168813	0.0175439	0.0126212	0.0045541	0.0034937	0
50	EJ	ROI	0.0105315	0.0097810	0.0099092	0.0094122	0.0080437	0.0073054	0.0049406	0.0013949	0.0021468	0
51	FH	SHOEPACK	0.0108652	0.0079416	0.0101112	0.0074559	0.0049461	0.0048722	0.0029763	0.0023457	0.0014603	0
52	GF	PATTERSO	0.0230874	0.0269128	0.0277191	0.0281373	0.0303247	0.0289443	0.0149476	0.0057542	0.0043798	0
53	HB	CARPENTE	0.0160008	0.0152152	0.0155103	0.0161571	0.0162678	0.0149248	0.0087196	0.0033033	0.0028173	0
54	HD	MITCHELL	0.0121856	0.0116790	0.0092621	0.0086907	0.0079533	0.0090533	0.0059498	0.0030391	0.0021886	0

SAS

OBS	LAKEID	NAME	R443	R470	R490	R520	R550	R580	R610	R640	R670	R700
55	40C	WANAPITE	0.02247	0.01747	0.01622	0.01212	0.01133	0.01016	0.00832	0.00520	0.00369	0
56	40B	RATHBUN	0.00579	0.00621	0.00921	0.01518	0.02193	0.02870	0.01966	0.01005	0.00851	0
57	40A	MATAGAMA	0.02801	0.02753	0.02933	0.03511	0.03793	0.03735	0.02107	0.00860	0.00394	0
58	39A	MATAGAMA	0.02557	0.02718	0.03017	0.03317	0.03774	0.03662	0.02306	0.00824	0.00574	0
59	39B	THOMAS	0.01283	0.01072	0.01090	0.01117	0.01154	0.01377	0.00903	0.00411	0.00345	0
60	39D	X	0.00789	0.00880	0.00739	0.00761	0.01034	0.01108	0.00799	0.00505	0.00376	0
61	38D	OTTER	0.07258	0.08658	0.08563	0.05404	0.04607	0.03577	0.01825	0.00790	0.00396	0
62	38C	SILVESTE	0.04090	0.04593	0.04728	0.04462	0.04449	0.03567	0.01678	0.00438	0.00180	0
63	35C	CHINIGUC	0.08594	0.07083	0.07287	0.06369	0.05868	0.04432	0.01727	0.00432	0.00148	0
64	30C	DOUGHERT	0.08581	0.08131	0.07505	0.05511	0.04361	0.03208	0.01333	0.00612	0.00623	0
65	30B	DOUGHERT	0.03982	0.04043	0.03861	0.03739	0.03557	0.03042	0.01269	0.00386	0.00279	0
66	29C	FREDERIC	0.06372	0.06415	0.06093	0.04787	0.03887	0.02957	0.01339	0.00637	0.00301	0
67	X02	CENTRE	0.02502	0.02423	0.02430	0.02418	0.02429	0.02180	0.01142	0.00432	0.00324	0
68	27D	X	0.00753	0.00943	0.00897	0.00976	0.00962	0.00906	0.00750	0.00369	0.00176	0
69	26D	MUDDING	0.01376	0.01590	0.01620	0.01746	0.01833	0.02052	0.01394	0.00585	0.00341	0
70	X01	LAUNDRIE	0.02363	0.02014	0.01561	0.01495	0.01429	0.01249	0.00688	0.00479	0.00337	0
71	24B	X	0.02355	0.02014	0.01535	0.01776	0.01822	0.01677	0.01079	0.00502	0.00274	0
72	27A	X	0.03534	0.03466	0.02907	0.02744	0.02368	0.01890	0.01027	0.00496	0.00515	0
73	28C	STOUFFER	0.04302	0.03854	0.02941	0.03494	0.03178	0.02783	0.01541	0.00767	0.00310	0
74	28D	X	0.02868	0.02541	0.01910	0.02224	0.02048	0.01935	0.01184	0.00537	0.00238	0
75	31C	X	0.02518	0.02318	0.01347	0.01947	0.01917	0.01599	0.01222	0.00658	0.00344	0
76	32B	CHINIGUC	0.04657	0.04491	0.03659	0.03490	0.02997	0.02158	0.01160	0.00455	0.00266	0
77	34B	X	0.06903	0.06207	0.04746	0.04315	0.03628	0.02593	0.01128	0.00443	0.00141	0
78	36C	CHINIGUC	0.07427	0.06826	0.05311	0.04406	0.03352	0.02229	0.01145	0.00437	0.00217	0
79	37D	X	0.04972	0.04684	0.03833	0.04283	0.04059	0.03415	0.01908	0.00836	0.00391	0
80	37B	WOLF	0.08962	0.10739	0.10585	0.07800	0.05990	0.04656	0.01868	0.01088	0.00283	0
81	35B	DEWDNEY	0.07875	0.08481	0.08453	0.06371	0.05179	0.03679	0.01440	0.00660	0.00000	0
82	35A	MARJORIE	0.07827	0.09201	0.08980	0.07823	0.07183	0.06041	0.03005	0.00921	0.00208	0
83	33A	LAURA	0.01503	0.01662	0.01770	0.01272	0.01334	0.00838	0.00661	0.00268	0.00000	0
84	32A	X	0.01693	0.02752	0.02395	0.02475	0.02272	0.02424	0.01430	0.00399	0.00000	0
85	31A	X	0.00701	0.00852	0.00728	0.00709	0.00563	0.00466	0.00850	0.00163	0.00031	0
86	23E	SOLACE	0.03437	0.03759	0.04011	0.03562	0.03170	0.03131	0.01628	0.00677	0.00410	0
87	22D	MAGGIE	0.02542	0.03079	0.03125	0.02922	0.02861	0.02819	0.01850	0.00834	0.00602	0
88	22C	PILGRIM	0.02675	0.02940	0.02903	0.02823	0.02589	0.02388	0.01263	0.00630	0.00230	0
89	23A	BLUESUCK	0.03609	0.03984	0.04560	0.04236	0.04071	0.03689	0.02233	0.00877	0.00591	0
90	19A	X	0.03697	0.04229	0.04615	0.04109	0.04015	0.03490	0.01964	0.00657	0.00277	0
91	18B	N.YORSTO	0.05892	0.06868	0.06951	0.05950	0.05281	0.04253	0.02332	0.01125	0.00373	0
92	17A	X	0.09934	0.10239	0.09115	0.06324	0.04617	0.03042	0.01138	0.00304	0.00257	0
93	15A	X	0.10281	0.09741	0.08439	0.04914	0.03349	0.02160	0.01013	0.00461	0.00091	0
94	14F	JERRY	0.11414	0.11701	0.10761	0.07402	0.05670	0.03878	0.01553	0.00605	0.00268	0
95	13D	SMOOTHWA	0.03257	0.03469	0.03519	0.03238	0.03013	0.02513	0.01333	0.00346	0.00191	0
96	13A	SUNNYWAT	0.11434	0.10563	0.08538	0.04488	0.02921	0.01846	0.00772	0.00309	0.00103	0
97	12A	WABUN	0.03706	0.04287	0.04359	0.03724	0.03398	0.02489	0.01285	0.00601	0.00086	0
98	14H	WHITEPIN	0.04426	0.04817	0.04567	0.03750	0.02980	0.02111	0.01103	0.00617	0.00111	0
99	17C	MIHELL	0.01556	0.01784	0.01753	0.01674	0.01752	0.01524	0.01018	0.00412	0.00202	0
100	X03	WHITEPIN	0.02521	0.02782	0.03071	0.02814	0.02833	0.02279	0.01402	0.00644	0.00295	0
101	19C	X	0.04541	0.05036	0.05265	0.04746	0.04674	0.03358	0.01635	0.00704	0.00249	0
102	20D	X	0.02944	0.03207	0.03100	0.03173	0.03007	0.02469	0.01594	0.00850	0.00334	0
103	38D	OTTER	0.11799	0.11642	0.10746	0.08683	0.07074	0.04208	0.01309	0.00597	0.00202	0
104	38C	SILVESTE	0.04738	0.04977	0.05053	0.04603	0.04055	0.02352	0.01137	0.00710	0.00264	0
105	37D	X	0.05697	0.06109	0.06562	0.06241	0.06070	0.04104	0.02114	0.00688	0.00269	0
106	37E	X	0.12115	0.11617	0.10963	0.08440	0.06919	0.04012	0.01476	0.00617	0.00354	0
107	36D	LAWLOR	0.06015	0.06473	0.06582	0.05631	0.05262	0.03191	0.01376	0.00689	0.00188	0
108	38C	CHINIGUC	0.08641	0.08794	0.07858	0.05355	0.04074	0.01984	0.01079	0.00581	0.00351	0

SAS

OBS	LAKEID	NAME	R443	R470	R490	R520	R550	R580	R610	R640	R670	R700
109	35C	CHINIGUC	0.062470	0.066950	0.064090	0.0506500	0.0414200	0.0228700	0.0113600	0.0064700	0.0024700	0
110	34C	CHINIGUC	0.076850	0.076750	0.068180	0.0458200	0.0328600	0.0172600	0.0085000	0.0044700	0.0025800	0
111	34E	X	0.086950	0.087580	0.082480	0.0722400	0.0639200	0.0382000	0.0146700	0.0087300	0.0018300	0
112	33E	X	0.047650	0.053300	0.051920	0.0468700	0.0433200	0.0288900	0.0147300	0.0079000	0.0042500	0
113	33B	CHINIGUC	0.094230	0.098050	0.085590	0.0587600	0.0430400	0.0222900	0.0104200	0.0071600	0.0033300	0
114	30C	DOUGHERT	0.117110	0.116770	0.105890	0.0740700	0.0555000	0.0245600	0.0116800	0.0086200	0.0011800	0
115	29C	FREDERIC	0.066900	0.072190	0.068320	0.0541300	0.0439100	0.0254100	0.0118800	0.0069500	0.0027100	0
116	X02	CENTRE	0.035750	0.038460	0.043560	0.0411300	0.0396000	0.0253700	0.0147500	0.0068600	0.0011300	0
117	27D	X	0.023530	0.027440	0.026300	0.0249100	0.0238900	0.0150100	0.0103200	0.0090100	0.0024300	0
118	28C	STOUFFER	0.040750	0.050660	0.051140	0.0532400	0.0572800	0.0390400	0.0240300	0.0145400	0.0068400	0
119	X01	LAUNDRIE	0.012780	0.015450	0.011970	0.0108100	0.0098700	0.0075500	0.0061300	0.0034800	0.0019900	0
120	23F	X	0.019508	0.023728	0.022491	0.0246834	0.0297622	0.0231338	0.0156212	0.0094619	0.0038670	0
121	22E	X	0.018636	0.020033	0.021370	0.0200109	0.0196340	0.0154038	0.0118882	0.0076149	0.0043367	0

APPENDIX C
SUMMARY STATISTICS FOR THE ECO-PHYSICAL POLYGON CLUSTER ANALYSIS

The following table shows the computer mean and standard deviation estimates for the set of Eco-physical polygons within each cluster. Estimates are computed for the total sensitivity rating (STRATRAT), vegetation sensitivity (VEGVAL), bedrock and soil sensitivity (SENSVAL), relief sensitivity (RELVAL), and sulfate deposition sensitivity (SO4VAL).

TABLE C-1

SUMMARY STATISTICS ON EACH CLUSTER
MAXIMUM LIKELIHOOD CLUSTER ANALYSIS

VARIABLE	MEAN	STANDARD DEVIATION
Cluster=		
STRATRAT		
SENSVAL	3.13	0.71
VEGVAL	1.42	0.69
RELVAL	0.38	0.12
SO4VAL	1.30	0.24
Cluster=1		
STRATRAT	5.66	0.07
SENSVAL	7.04	0.66
VEGVAL	4.68	0.75
RELVAL	5.57	0.23
SO4VAL	4.40	0.33
Cluster=2		
STRATRAT	6.36	0.06
SENSVAL	8.05	0.42
VEGVAL	4.65	0.66
RELVAL	5.78	0.20
SO4VAL	5.82	0.38
Cluster=3		
STRATRAT	6.74	0.09
SENSVAL	8.16	0.32
VEGVAL	5.83	0.64
RELVAL	5.28	0.22
SO4VAL	6.00	0.36
Cluster=4		
STRATRAT	6.02	0.07
SENSVAL	7.67	0.52
VEGVAL	4.63	0.67
RELVAL	5.25	0.21
SO4VAL	5.18	0.42

Cluster=5

STRATRAT	7.41	0.06
SENSVAL	8.47	0.20
VEGVAL	7.13	0.47
RELVAL	5.62	0.19
SO4VAL	6.58	0.29

Cluster=6

STRATRAT	3.55	0.29
SENSVAL	3.28	0.92
VEGVAL	2.08	0.14
RELVAL	5.57	0.17
SO4VAL	5.27	0.68

Cluster=7

STRATRAT	7.07	0.05
SENSVAL	8.50	0.21
VEGVAL	6.37	0.48
RELVAL	5.36	0.22
SO4VAL	6.10	0.32

Cluster=8

STRATRAT	5.14	0.20
SENSVAL	5.96	0.57
VEGVAL	4.71	0.59
RELVAL	5.46	0.22
SO4VAL	3.97	0.33

Cluster=9

STRATRAT	7.83	0.20
SENSVAL	8.72	0.22
VEGVAL	8.53	0.49
RELVAL	5.20	0.22
SO4VAL	6.30	0.29

Cluster=10

STRATRAT	4.34	0.22
SENSVAL	5.22	0.29
VEGVAL	3.82	0.40
RELVAL	5.00	0.22
SO4VAL	3.05	0.21

APPENDIX D
WATER CHEMISTRY DATA

Maps shown in Figures D.1 (80798) and D.2 (80799) were compiled by J. Fortescue and D. Stahl of the Mines and Minerals Division, Ontario Geological Survey, 1987.

Table D.1

AUGUST 1986 WATER CHEMISTRY

LAKE_ID	NAME	Iron mg/l	Suspended Solids mg/l	Mn mg/l	Al ug/l	Total Alkalinity mg/l	Total Inflection Point	pH	Sulfate mg/l	Dissolved Organic Carbon	Conductivity	Total Chlorophyll A ug/l
AA	ATOMIC	22.0	1	11	22	3.47	1.64	6.290	4.58	3.3	20	1.90
AB	X99	160.0	2	30	200	1.97	0.15	5.230	3.86	6.5	17	1.20
AC	X99	87.0	2	31	210	999.90	0.29	5.350	3.45	4.9	15	2.20
AD	EAST	130.0	2	32	240	999.90	0.10	5.200	3.20	5.9	16	2.10
AE	X99	72.0	2	54	250	1.54	-0.33	5.030	3.92	3.8	17	1.40
AF	X99	100.0	1	31	190	2.36	0.50	5.600	4.05	4.5	17	1.20
AG	LITTLE A	41.0	1	38	160	2.78	0.96	6.010	3.76	4.2	17	1.20
AH	MADER	17.0	1	51	100	1.79	-0.05	5.430	4.08	1.4	15	1.20
BA	MALLOT	130.0	1	50	220	2.53	0.67	5.590	4.05	6.0	18	2.10
BB	X99	22.0	1	33	130	2.22	0.37	5.590	4.08	3.1	16	1.20
BC	MONTREAL	84.0	1	6	100	16.66	14.86	7.190	4.46	7.6	44	0.60
BD	X99	60.0	1	44	210	1.56	-0.33	5.038	4.17	3.6	17	1.90
BE	X99	150.0	4	35	420	1.16	-0.75	4.780	3.01	8.7	22	2.60
BF	MONTREAL	100.0	1	4	100	16.01	14.19	7.190	4.39	7.5	43	0.90
BG	X99	92.0	1	41	190	2.00	0.11	5.290	3.86	3.4	16	1.90
BH	X99	24.0	1	51	120	1.75	-0.31	5.280	4.01	1.7	16	1.10
BI	X99	79.0	2	32	270	1.01	-0.87	4.770	3.17	3.6	17	3.60
CA	DYER	170.0	1	44	190	999.90	0.09	5.200	3.70	6.1	18	1.70
CB	X99	65.0	1	24	160	2.77	0.86	5.820	4.33	4.8	19	2.20
CC	DYER	160.0	1	48	200	2.11	0.18	5.310	3.83	5.9	17	2.10
CD	UNION	100.0	1	44	190	999.90	0.32	5.380	3.83	5.6	17	2.00
CE	X99	80.0	1	29	160	1.75	-0.19	5.140	3.45	4.1	16	2.60
CF	X99	40.0	1	24	95	2.46	0.57	5.770	4.08	3.8	17	1.70
CG	X99	550.0	3	39	300	1.53	-0.44	4.920	3.32	5.6	17	5.40
CH	X99	540.0	1	35	140	2.19	0.27	5.410	3.57	3.9	16	2.70
CI	X99	130.0	3	37	380	1.41	-0.60	4.850	3.10	8.5	17	3.60
CJ	X99	28.0	1	38	140	1.58	-0.35	5.060	3.55	3.2	15	2.89
CK	X99	52.0	1	15	180	999.90	-0.94	4.710	3.16	3.9	16	1.50
DA	X99	180.0	1	40	280	1.98	0.07	5.160	3.67	6.1	18	2.00
DB	X99	360.0	1	27	480	0.24	-1.55	4.540	2.29	19.0	23	3.50
DC	X99	170.0	2	48	250	1.99	0.10	5.200	4.00	5.5	18	2.60
DD	ALVIN	60.0	2	35	130	2.27	0.36	5.660	3.83	3.9	16	2.80
DE	X99	420.0	1	43	100	1.90	-0.06	5.320	3.89	3.5	16	1.70
DF	BARBARA	61.0	1	53	87	1.73	-0.07	5.360	4.30	1.8	16	0.80
DG	BARBARA	25.0	1	50	110	1.69	-0.11	5.240	3.89	3.3	16	1.00
DH	BARBARA	19.0	1	54	83	1.78	-0.01	5.370	4.23	2.5	16	0.70
DI	X99	93.0	1	40	220	1.78	-0.06	5.240	3.57	3.9	15	2.90
DJ	X99	67.0	1	21	200	1.64	-0.19	5.120	3.42	4.1	15	1.60
EA	X99	999.9	1	38	390	1.53	-0.41	4.980	3.89	4.2	18	2.10
EB	X99	120.0	2	49	280	1.97	0.06	5.190	3.69	5.2	17	2.70
EC	X99	96.0	1	33	200	2.71	1.04	5.740	3.47	5.3	18	2.60
ED	ALVIN	43.0	1	34	120	2.28	0.37	5.650	3.78	3.4	16	2.70
EE	X99	94.0	1	31	68	1.95	0.10	5.470	2.99	2.9	12	1.80
EF	X99	200.0	2	34	340	1.96	0.10	5.230	3.93	6.2	17	2.10
EG	X99	58.0	1	36	250	999.90	-0.13	5.170	3.82	4.6	16	2.80
EH	HAILEY	57.0	1	40	150	999.90	-0.02	5.320	4.04	3.6	15	1.41
EI	X99	58.0	1	35	150	1.70	-0.05	5.240	4.16	3.5	17	2.33
EJ	ROI	66.0	1	26	310	1.22	-0.59	4.850	3.77	5.6	17	1.80
EK	X99	140.0	2	17	180	5.05	3.27	6.480	3.96	4.6	19	2.50
EL	X99	110.0	1	35	380	1.99	0.22	5.310	3.51	5.2	18	1.40
FA	X99	32.0	1	40	150	1.68	-0.21	5.250	4.73	1.3	17	1.30
FB	X99	92.0	1	32	330	1.14	-0.64	4.820	3.72	4.4	19	1.70
FC	BIG PIKE	130.0	1	38	220	2.30	0.49	5.540	4.04	4.7	16	999.90

Table D.1 (Cont.)

AUGUST 1986 WATER CHEMISTRY

LAKE_ID	NAME	Iron mg/l	Suspended Solids mg/l	Mn mg/l	Al ug/l	Total Alkalinity mg/l	Total Inflection Point	pH	Sulfate mg/l	Dissolved Organic Carbon	Conductivity	Total Chlorophyll A ug/l
FD	X99	210	4	18	250	0.89	-0.97	4.70	2.32	9.2	16	6.01
FE	BIG PIKE	93	2	41	170	2.13	0.33	5.57	4.04	4.0	16	1.52
FF	BIG PIKE	77	1	39	150	2.08	0.30	5.64	4.10	4.0	16	1.98
FG	X99	91	1	14	79	3.73	1.98	6.31	4.52	3.9	19	1.67
FH	SHOEPACK	51	1	6	55	11.43	9.63	7.16	4.38	5.1	33	2.10
FI	X99	45	1	17	110	1.34	-0.46	4.98	4.18	3.1	16	4.00
FJ	X99	160	3	28	490	0.92	-0.88	4.73	3.24	7.0	17	2.90
FK	X99	41	1	28	240	1.90	0.17	5.33	3.31	4.5	15	2.10
GA	X99	8	1	5	28	4.11	2.19	6.54	4.68	2.2	19	1.30
GB	X99	100	1	37	230	1.80	-0.17	5.12	3.86	4.3	17	1.50
GC	X99	100	1	51	150	1.98	0.26	5.39	3.95	3.3	16	1.10
GD	X99	220	1	36	250	2.01	0.26	5.36	4.56	3.7	18	1.20
GE	X99	84	1	31	200	1.59	-0.23	5.11	4.73	3.6	19	1.20
GF	PATTERSO	22	1	32	65	2.28	0.47	5.81	4.27	2.9	16	3.61
GG	X99	52	2	20	150	999.90	0.45	5.57	4.04	5.5	17	1.43
GH	X99	230	2	35	260	1.78	-0.06	5.19	3.55	5.4	16	2.60
GI	RAND	37	2	11	38	3.01	1.21	6.22	4.13	3.2	18	1.60
GJ	X99	30	2	14	59	2.45	0.63	5.85	4.21	3.4	16	2.40
GK	BUTTER	22	2	10	31	3.21	1.39	6.18	4.04	3.3	19	2.70
GL	X99	170	2	15	230	3.11	1.43	5.75	3.21	8.1	18	2.00
HA	X99	65	1	24	79	4.42	2.57	6.46	4.65	4.9	21	1.80
HB	CARPENTE	44	1	8	62	3.10	1.33	6.27	4.42	3.0	18	1.80
HC	CARPENTE	41	1	8	67	3.13	1.32	6.37	4.53	2.9	18	1.70
HD	MITCHELL	100	2	10	30	8.91	7.09	7.07	4.23	5.5	28	2.60
HE	MITCHELL	140	3	19	84	8.70	6.83	6.71	4.05	5.2	29	17.00
HF	X99	72	1	36	140	2.10	0.30	5.47	3.85	4.3	16	1.70
HG	X99	310	2	39	230	2.96	1.09	5.68	3.02	5.8	15	4.90
HH	X99	150	2	13	210	4.60	2.88	6.07	3.12	8.1	20	4.50
IA	X99	83	1	24	90	4.21	2.31	5.94	3.53	5.1	19	4.40
IB	X99	340	2	29	150	3.90	2.03	5.92	3.13	7.2	18	2.50
IC	X99	430	3	71	100	3.79	1.87	5.70	3.39	4.5	18	10.00
ID	X99	260	1	21	290	3.26	1.57	5.58	3.13	13.4	20	2.30
IE	X99	270	1	21	280	3.14	1.28	5.44	3.04	12.6	20	4.80
IF	X99	77	1	7	74	9.84	7.98	6.83	4.74	5.0	31	2.30
IG	X99	32	1	11	75	3.59	1.79	6.25	4.68	3.9	19	2.40
IH	FULLER	130	2	12	88	6.54	4.71	6.70	4.13	4.6	24	4.10
II	FULLER	130	3	12	91	6.51	4.67	6.66	4.16	4.5	24	4.30
JA	QUINTET	6	1	5	52	5.08	3.14	6.83	4.93	3.0	23	1.40
JB	TAY	280	2	31	210	3.87	2.17	5.83	2.77	10.5	19	4.40
JC	X99	350	2	14	150	3.97	2.17	5.98	2.95	5.9	17	4.30
JD	NORTH Mc	120	1	18	110	6.54	4.71	6.34	3.10	6.9	23	2.20
JE	NORTH Mc	37	1	8	79	9.28	7.45	7.10	4.01	9.1	29	2.00
JF	X99	69	1	5	58	6.14	4.27	6.41	3.88	6.4	23	3.60
JG	X99	83	1	24	190	2.72	0.87	5.73	3.88	6.6	18	2.20
JH	X99	41	1	5	100	9.92	8.10	6.92	4.13	5.1	29	1.60
KA	QUINTET	8	1	2	49	5.09	3.16	6.79	4.90	3.1	23	1.50
KB	X99	13	1	9	54	6.10	4.17	6.69	4.79	3.3	25	1.80
KC	X99	110	2	15	100	7.61	5.84	6.69	3.78	7.6	26	3.80
KD	McCOLLOU	150	2	16	120	6.18	4.33	6.27	2.91	4.9	22	2.80
KE	X99	69	1	5	65	13.24	11.35	6.84	3.39	5.9	35	3.20
KF	X99	63	2	13	53	10.46	8.68	7.02	4.14	4.8	31	2.70
KG	DICK	39	2	5	71	11.15	9.42	7.20	4.31	4.5	33	3.60
KH	X99	100	1	18	180	4.48	2.66	6.34	3.61	6.3	21	3.90

Table D.1 (Cont.)

AUGUST 1986 WATER CHEMISTRY

LAKE_ID	NAME	Iron mg/l	Suspended Solids mg/l	Mn mg/l	Al ug/l	Total Alkalinity mg/l	Total Inflection Point	pH	Sulfate mg/l	Dissolved Organic Carbon	Conductivity	Total Chlorophyll A ug/l
KI	X99	130.0	1.0	24.0	230.0	3.23	1.33	5.70	3.71	8.0	19.0	4.20
KJ	X99	30.0	1.0	7.0	140.0	3.87	2.09	6.36	4.58	3.4	20.0	1.00
KK	CHAIN	11.0	1.0	8.0	45.0	5.02	3.17	6.63	4.61	3.5	23.0	1.40
LA	X99	13.0	1.0	7.0	35.0	11.32	9.42	7.20	4.48	3.8	32.0	2.40
LB	X99	120.0	2.0	14.0	97.0	16.66	14.95	6.90	2.94	9.2	41.0	4.80
LC	X99	38.0	2.0	8.0	68.0	10.87	9.09	6.89	3.97	7.1	33.0	2.30
LD	X99	48.0	2.0	6.0	64.0	11.62	9.78	6.91	4.10	6.8	32.0	4.51
LE	McGOVERN	9.0	1.0	8.0	10.0	16.37	14.56	7.43	4.38	3.0	41.0	1.80
LF	X99	35.0	1.0	7.0	36.0	6.62	4.83	6.60	4.01	3.5	25.0	3.40
LG	X99	17.0	1.0	4.0	34.0	9.88	8.08	7.14	4.38	4.1	31.0	2.70
LH	X99	22.0	1.0	4.0	34.0	9.75	8.03	7.13	4.44	4.1	31.0	2.80
LI	X99	34.0	1.0	12.0	82.0	2.59	0.84	5.87	3.77	4.3	17.0	3.60
LJ	GRIFFIN	5.0	1.0	3.0	21.0	7.62	5.83	7.03	5.07	3.6	30.0	0.60
LK	GRIFFIN	7.0	1.0	3.0	23.0	7.63	5.82	7.06	5.04	2.8	30.0	0.60
LL	LOWER GR	6.0	1.0	1.0	30.0	7.46	5.65	6.99	5.11	2.9	29.0	0.70
LM	X99	200.0	1.0	13.0	110.0	10.30	8.46	6.39	2.38	13.0	31.0	1.20
LN	X99	46.0	2.0	11.0	34.0	12.92	11.03	6.65	3.69	6.8	39.0	4.20
MA	X99	210.0	2.0	27.0	230.0	2.88	0.95	5.51	2.60	8.1	16.0	3.70
MB	X99	14.0	1.0	6.0	19.0	9.61	7.74	7.21	5.04	2.6	31.0	4.11
MC	ADELAIDE	9.0	1.0	3.0	20.0	9.22	7.36	7.24	5.04	2.5	31.0	3.88
MD	ADELAIDE	14.0	1.0	4.0	20.0	9.66	7.73	7.19	5.04	2.5	32.0	3.25
ME	X99	28.0	1.0	4.0	25.0	9.32	7.45	6.93	5.17	3.8	31.0	2.00
MF	X99	41.0	2.0	6.0	58.0	4.61	2.77	6.47	4.46	4.2	22.0	0.90
MG	LOWER GR	11.0	1.0	2.0	34.0	7.54	5.66	7.05	5.11	2.9	29.0	0.50
NA	X99	25.0	1.0	3.0	76.0	4.87	2.96	6.55	5.10	3.2	24.0	1.50
NB	X99	14.0	1.0	9.0	28.0	6.44	4.62	6.89	4.42	3.0	24.0	3.80
NC	ADELAIDE	13.0	2.0	4.0	21.0	9.22	7.30	7.20	5.07	2.6	31.0	3.30
ND	X99	16.0	1.0	6.0	47.0	3.28	1.39	6.19	4.90	3.0	20.0	2.42
NE	X99	37.0	1.0	11.0	39.0	4.38	2.48	6.46	4.43	4.0	21.0	3.62
NF	BONE	28.0	1.0	7.0	18.0	4.81	2.84	6.49	4.68	3.1	21.0	1.11
NG	X99	5.0	1.0	3.0	12.0	4.30	2.37	6.60	4.85	2.1	21.0	3.59
NH	X99	700.0	4.0	64.0	55.0	16.28	14.38	6.87	4.39	5.1	43.0	15.10
NI	X99	66.0	3.0	18.0	53.0	8.08	6.19	6.95	4.90	3.9	28.0	5.30
NJ	LITTLE T	14.0	1.0	5.0	36.0	9.93	8.10	7.28	5.48	3.0	33.0	1.40
NK	TURKEY	10.0	1.0	3.0	29.0	11.39	9.55	7.38	5.65	2.9	37.0	1.80
NL	X99	68.0	1.0	6.0	150.0	4.51	2.69	6.18	4.50	4.9	22.0	1.50
OA	X99	30.0	1.0	12.0	200.0	2.95	1.04	5.83	4.37	3.7	18.0	1.30
OB	X99	49.0	1.0	20.0	130.0	3.06	1.11	5.84	3.82	5.7	18.0	2.69
OC	DREW	57.0	1.0	6.0	49.0	9.84	8.14	7.02	4.91	3.7	33.0	1.20
OD	LITTLE D	57.0	2.0	7.0	38.0	10.87	9.11	7.03	4.53	4.4	33.0	3.60
OE	X99	49.0	3.0	8.0	39.0	14.07	12.31	7.06	5.21	4.5	41.0	6.60
OF	TILLEY	60.0	3.0	16.0	47.0	13.92	12.14	7.35	5.17	3.5	40.0	4.40
OG	X99	120.0	1.0	12.0	84.0	14.86	13.16	7.04	3.58	7.4	40.0	1.50
OH	X99	150.0	1.0	9.0	97.0	12.26	10.61	6.61	2.60	9.7	33.0	1.40
OI	X99	67.0	1.0	4.0	60.0	16.87	15.07	6.82	3.78	8.4	44.0	1.00
PP	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.90
S01	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.90
S02	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.90
S03	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.90
S04	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.90
S05	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.90
S06	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.90

Table D.1 (Cont.)

AUGUST 1986 WATER CHEMISTRY

LAKE_ID	NAME	Iron mg/l	Suspended Solids mg/l	Mn mg/l	Al ug/l	Total Alkalinity mg/l	Total Inflection Point	pH	Sulfate mg/l	Dissolved Organic Carbon	Conductivity	Total Chlorophyll A ug/l
S08	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S09	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S10	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S11	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S12	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S13	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S14	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S15	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S16	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S17	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S18	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S19	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S20	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S21	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S22	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S23	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S24	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S25	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S26	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S27	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S28	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S29	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
S30	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.90	999.90	999.9	999.9	999.9
X09	GREYOWL	53.0	1.0	42.0	130.0	1.93	0.02	5.33	3.79	3.7	16.0	1.8
W1	PAINT	170.0	2.0	15.0	100.0	22.16	20.34	7.44	5.93	6.1	61.0	2.8
W2	CRAYFISH	39.0	1.0	999.9	999.9	17.44	15.70	7.44	5.18	7.9	56.0	2.2
W3	WEST KAB	66.0	2.0	999.9	999.9	18.07	16.35	7.44	4.77	8.8	59.0	3.9
W4	NEMATEGU	49.0	2.0	999.9	999.9	13.44	11.62	7.30	4.77	6.7	39.0	3.9
W5	LINE	60.0	2.0	999.9	999.9	19.73	18.02	7.41	4.11	6.7	53.0	4.0
W6	FUNGUS	110.0	2.0	999.9	999.9	23.26	21.49	7.34	4.30	9.8	61.0	5.2
W7	KABENUNG	84.0	3.0	9.0	94.0	17.69	15.86	7.37	4.78	9.4	60.0	6.0
W8	DESOLATI	120.0	2.0	999.9	999.9	16.65	14.95	7.30	8.29	6.8	124.0	1.9
W9	PRINCESS	23.0	1.0	999.9	999.9	33.62	31.92	7.69	11.70	6.5	294.0	1.2
11A	X99	55.0	1.0	64.0	260.0	0.62	-1.10	4.66	8.73	3.3	31.0	0.9
11B	MADDEN	67.0	1.0	78.0	290.0	0.62	-1.10	4.65	9.54	2.5	33.0	0.8
11C	LAMY	14.0	1.0	39.0	40.0	2.64	0.83	6.19	9.73	2.3	29.0	0.8
11D	LADY DUF	26.0	1.0	12.0	31.0	6.03	4.19	6.89	10.60	2.4	37.0	1.4
11E	X99	110.0	1.0	48.0	320.0	0.86	-0.90	4.73	9.40	4.4	32.0	2.1
12A	WABUN	23.0	1.0	180.0	220.0	1.25	-0.55	4.93	9.32	1.1	29.0	1.0
12B	X99	50.0	1.0	69.0	430.0	0.78	-0.99	4.70	9.09	0.3	31.0	0.3
12C	X99	110.0	2.0	54.0	470.0	0.00	-2.16	4.40	9.07	6.2	36.0	1.9
12D	SMOOTHWA	15.0	1.0	17.0	28.0	3.20	1.39	6.49	10.90	1.7	33.0	0.8
13A	SUNNYWAT	32.0	1.0	150.0	280.0	0.71	-1.10	4.68	10.90	0.4	36.0	0.4
13B	SUNNYWAT	26.0	1.0	140.0	260.0	0.71	-1.09	4.69	10.80	0.2	36.0	0.3
13C	X99	42.0	1.0	130.0	230.0	0.49	-1.32	4.62	10.70	0.6	36.0	0.7
13D	WHITEPIN	35.0	1.0	110.0	160.0	1.35	-0.44	4.98	9.32	1.6	30.0	0.5
13E	MARINA	27.0	1.0	89.0	120.0	999.90	0.00	5.47	9.84	1.9	29.0	0.7
13G	SMOOTHWA	17.0	1.0	19.0	32.0	2.43	0.61	6.17	10.90	1.4	32.0	0.5
13H	X99	62.0	1.0	50.0	140.0	1.98	0.11	5.56	9.95	2.4	29.0	0.9
13I	X99	54.0	1.0	59.0	210.0	0.89	-0.94	4.75	9.29	1.9	30.0	1.1
14A	LITTLE A	30.0	1.0	32.0	100.0	1.61	-0.23	5.16	9.41	2.8	31.0	1.0
14B	WHITEPIN	32.0	1.0	100.0	160.0	1.45	-0.45	5.01	8.71	1.6	31.0	0.5
14D	WHIRLIGI	55.0	1.0	72.0	130.0	1.24	-0.61	4.90	8.12	2.4	29.0	1.6

Table D.1 (Cont.)

AUGUST 1986 WATER CHEMISTRY

LAKE_ID	NAME	Iron mg/l	Suspended Solids mg/l	Mn mg/l	Al ug/l	Total Alkalinity mg/l	Total Inflection Point	pH	Sulfate mg/l	Dissolved Organic Carbon	Conductivity	Total Chlorophyll A ug/l
14E	LITTLE W	14	1	38	47	1.86	-0.07	5.44	8.46	2.0	26	0.8
14F	JERRY	19	1	98	180	999.90	-0.03	5.14	10.50	0.4	33	0.3
14H	SMOOTHWA	15	1	20	35	2.46	0.56	6.18	10.70	1.4	33	0.5
14I	X99	39	1	71	150	1.37	-0.49	4.97	9.27	3.1	30	1.7
15A	X99	23	1	120	380	1.54	-0.39	5.06	11.40	0.3	37	0.1
15B	X99	21	1	72	540	0.63	-1.24	4.64	9.86	1.9	34	1.0
15C	X99	12	1	6	11	7.42	5.47	6.76	11.20	1.9	42	1.2
15D	APEX	24	2	13	10	7.07	5.09	6.85	10.10	2.3	39	3.5
16A	X99	36	2	13	140	4.27	2.29	6.84	12.80	5.1	42	2.0
16B	X99	20	1	67	380	0.00	-2.17	4.39	10.90	2.8	40	0.8
16C	X99	11	1	8	10	3.89	1.98	6.66	10.10	1.9	33	0.7
16D	X99	33	1	94	500	0.92	-0.97	4.74	10.10	0.7	34	0.5
17A	X99	57	1	105	290	1.03	-0.73	4.80	9.73	0.3	33	0.2
17B	X99	28	1	82	230	1.52	-0.34	5.02	11.90	3.8	38	1.0
17C	MIHELL	14	1	11	10	13.94	12.05	7.38	10.30	2.5	54	1.2
18A	X99	61	1	79	570	0.00	-2.66	4.30	10.40	3.9	41	1.3
18B	NORTH YO	47	1	92	110	1.68	-0.17	5.25	10.50	1.3	32	0.4
18C	X99	110	1	61	720	0.00	-2.73	4.30	10.80	5.0	44	0.8
18D	X99	59	1	77	380	0.61	-1.17	4.64	9.88	1.6	35	0.4
18E	X99	55	1	73	390	0.53	-1.26	4.61	9.80	2.2	38	0.7
19A	X99	27	1	110	280	1.35	-0.51	4.94	10.20	1.7	33	0.4
19B	X99	54	1	62	100	1.84	-0.06	5.43	10.30	2.0	32	0.9
19C	X99	8	1	48	41	1.76	-0.04	5.51	8.85	1.6	28	1.9
19D	X99	42	1	89	540	0.45	-1.33	4.60	11.10	0.7	40	1.0
20A	X99	41	1	74	400	0.00	-2.16	4.40	9.91	0.2	39	0.4
20B	X99	100	1	53	350	0.89	-0.88	4.77	9.52	3.6	34	1.2
20C	X99	810	1	23	200	3.17	1.45	5.72	6.92	10.3	28	6.6
20D	X99	25	1	57	150	1.82	0.11	5.52	10.60	2.8	33	1.3
21A	X99	59	1	68	520	0.39	-1.27	4.58	10.60	0.2	38	0.3
21B	PILGRIM	84	1	31	39	1.76	0.06	5.46	8.68	2.3	28	1.5
21C	X99	51	1	54	87	2.01	0.30	5.69	10.30	2.1	31	0.7
21D	X99	46	1	60	10	2.59	0.74	5.99	11.20	2.3	34	2.1
21E	X99	31	1	62	10	2.07	0.30	5.68	9.72	2.4	31	1.1
22A	X99	56	1	30	27	3.24	1.58	6.26	10.40	2.6	34	1.4
22B	X99	9	1	6	40	2.45	0.77	6.07	10.50	2.3	33	1.5
22C	PILGRIM	19	1	35	20	1.70	-0.01	5.46	8.71	2.2	27	1.1
22D	MAGGIE	31	1	8	16	4.21	2.36	6.67	10.00	2.2	38	1.4
22E	X99	29	1	59	51	2.06	0.27	5.65	9.13	3.8	30	1.5
23A	BLUESUCK	28	1	60	84	1.88	0.11	5.53	9.85	1.7	33	1.0
23B	X99	72	2	42	130	0.00	-1.96	4.43	10.60	0.9	40	1.1
23C	RODD	35	1	14	15	2.20	0.43	5.87	9.09	2.7	29	2.3
23D	X99	110	2	34	250	0.56	-1.17	4.63	8.95	4.5	35	2.3
23E	SOLACE	6	1	60	36	1.98	0.25	5.70	10.40	2.4	31	1.3
23F	X99	94	3	32	55	2.17	0.39	5.79	9.35	3.4	30	2.5
24A	X99	400	3	27	330	2.71	0.99	5.26	8.13	15.9	34	1.6
24B	X99	42	2	43	46	2.07	0.25	5.89	9.88	3.2	30	1.8
24C	X99	150	3	61	280	1.39	-0.48	4.92	9.18	5.6	31	4.1
24D	X99	55	1	13	47	3.73	1.92	6.29	10.10	4.8	34	2.7
25A	X99	230	1	62	69	4.27	2.48	6.23	9.38	4.8	33	1.5
25B	MUCK	93	1	44	75	2.61	0.80	5.80	9.35	5.1	31	2.0
25C	X99	18	1	81	200	1.08	-0.66	4.87	10.70	2.1	34	1.1
25D	X99	240	2	18	71	5.60	3.85	6.58	9.13	4.5	34	4.6
26A	X99	220	2	45	74	4.72	2.93	6.44	9.15	5.5	34	1.4

Table D.1 (Cont.)

AUGUST 1986 WATER CHEMISTRY

LAKE_ID	NAME	Iron mg/l	Suspended Solids mg/l	Mn mg/l	Al ug/l	Total Alkalinity mg/l	Total Inflection Point	pH	Sulfate mg/l	Dissolved Organic Carbon	Conductivity	Total Chlorophyll A ug/l
26B	LIMIT	340	4	19	140	4.55	2.79	6.07	7.43	10.5	31	5.0
26C	HAZEL	160	2	35	50	20.25	18.48	7.40	9.19	7.0	64	1.5
26D	MUDDING	30	1	24	52	2.20	0.43	5.82	9.10	3.6	29	1.4
26E	X99	11	1	27	21	2.22	0.44	6.00	11.00	1.7	33	1.3
26F	X99	50	1	66	210	0.87	-0.88	4.77	10.70	3.4	35	1.9
27A	X99	13	1	3	13	20.83	18.90	7.61	29.20	1.8	109	0.5
27B	STURGEON	160	1	35	44	19.54	17.76	7.40	9.25	6.9	63	1.1
27C	PUDDLE	260	10	55	180	2.26	0.46	5.48	8.48	7.0	29	1.8
27D	X99	100	1	51	120	1.37	-0.43	5.02	8.71	3.6	29	1.6
28A	STURGEON	140	3	30	18	19.17	17.36	7.32	9.48	5.8	63	1.3
28B	X99	420	2	28	320	0.00	-3.39	4.21	7.79	9.3	40	2.1
28C	STOUFFER	30	1	110	110	1.13	-0.48	4.99	11.70	1.8	37	1.4
28D	X99	19	1	37	81	1.97	0.12	5.57	10.40	3.1	32	1.0
29A	X99	170	2	13	99	5.18	3.37	6.43	12.50	8.0	43	2.9
29B	X99	260	3	40	190	0.00	-2.00	4.43	6.83	4.0	30	3.7
29C	FREDERIC	24	1	180	200	0.84	-0.93	4.75	12.90	0.6	41	0.6
29D	X99	10	1	7	2	7.09	5.26	7.03	8.42	2.0	34	1.2
30A	X99	140	3	79	200	1.38	-0.47	4.95	11.30	5.6	38	1.2
30B	DOUGHERT	59	1	220	260	0.44	-1.29	4.61	13.40	0.8	44	0.2
30C	DOUGHERT	44	1	220	250	0.55	-1.27	4.63	13.50	0.8	43	0.3
30D	X99	46	1	50	250	0.00	-2.01	4.38	10.00	2.9	37	3.4
30E	X99	58	1	68	130	999.90	-0.32	5.03	10.20	2.5	30	1.3
31A	X99	160	2	88	110	2.78	0.99	5.69	11.00	5.2	35	3.1
31B	ADELAIDE	100	1	23	10	9.96	8.23	7.16	10.60	2.4	44	4.9
31C	X99	41	1	27	49	2.47	0.81	5.97	11.30	3.6	34	2.3
31D	X99	200	1	8	44	6.60	4.93	6.94	10.30	2.9	40	1.0
32A	X99	31	1	39	27	2.26	0.54	5.96	11.20	2.7	34	1.3
32B	CHINIGUC	57	1	140	170	1.49	-0.28	5.12	12.50	0.8	37	0.3
32C	X99	75	1	38	100	2.80	1.00	5.98	11.50	3.8	35	1.3
32D	X99	200	1	96	190	1.27	-0.49	4.91	10.00	3.2	33	2.7
32E	X99	57	1	150	180	1.29	-0.41	4.98	10.50	0.8	33	0.8
33A	LAURA	14	1	29	11	2.46	0.73	6.24	14.20	2.4	42	0.7
33B	CHINIGUC	51	1	160	410	0.17	-1.51	4.54	12.60	0.3	41	0.3
33C	CHINIGUC	44	1	190	430	0.22	-1.49	4.54	12.60	0.3	41	0.3
33D	CHINIGUC	35	1	160	180	1.06	-0.62	4.86	12.00	0.4	38	0.3
33E	X99	71	1	140	180	1.28	-0.43	4.98	10.40	0.9	33	0.8
34A	X99	48	1	160	490	0.00	-2.13	4.39	12.00	0.7	42	0.3
34B	X99	68	1	200	360	0.00	-1.91	4.44	11.50	0.2	41	0.3
34C	CHINIGUC	31	1	160	180	1.08	-0.65	4.85	12.00	0.3	38	0.3
34D	X99	38	1	110	340	0.00	-2.06	4.40	10.20	0.1	38	0.6
34E	X99	34	1	130	440	0.00	-2.14	4.40	10.50	0.1	40	0.3
35A	X99	73	1	160	760	0.00	-2.04	4.41	12.00	0.3	43	0.4
35B	DEWDNEY	33	1	150	240	0.81	-0.93	4.73	12.60	0.5	40	0.4
35C	CHINIGUC	31	1	150	140	999.90	-0.71	4.84	12.00	0.5	38	0.4
35D	X99	53	1	220	520	0.00	-2.74	4.30	10.30	0.2	43	0.3
36A	X99	220	1	73	470	0.00	-2.84	4.28	10.40	4.4	42	0.7
36B	FRANKS	42	1	140	500	0.42	-1.30	4.59	13.10	0.3	43	0.3
36C	CHINIGUC	32	1	130	250	0.41	-1.26	4.60	13.50	0.2	46	0.3
36D	LAWLOR	49	1	130	320	0.09	-1.54	4.51	11.30	0.9	40	0.6
37A	X99	130	1	67	470	0.00	-3.00	4.26	11.00	3.2	45	2.2
37B	WOLF	34	1	170	300	0.61	-1.15	4.66	12.90	0.7	42	0.3
37C	SILVESTE	43	1	170	300	0.59	-1.15	4.65	12.80	0.8	42	0.4
37D	X99	110	1	74	770	0.00	-2.79	4.29	11.60	1.1	46	0.8

Table D.1 (Cont.)

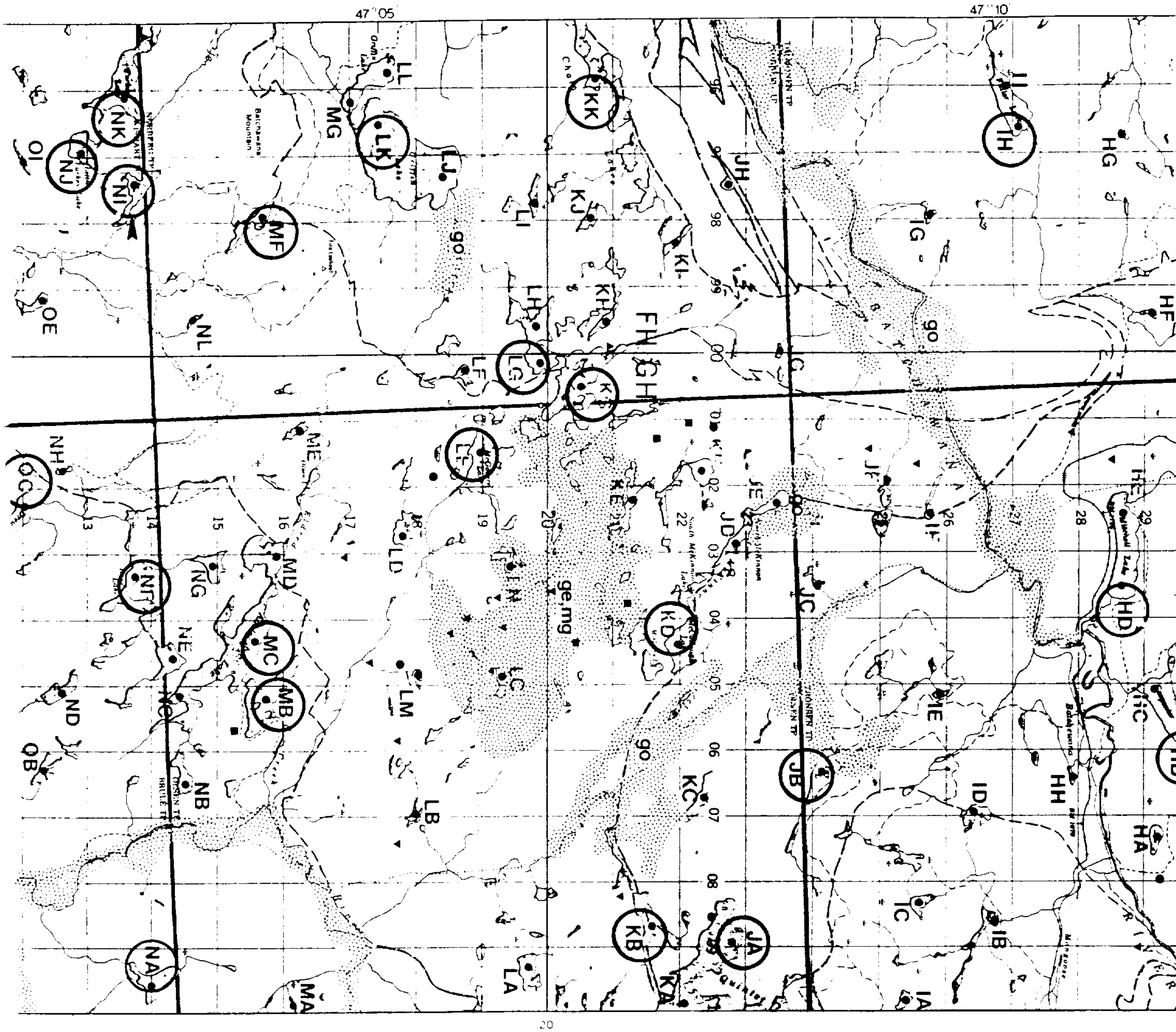
AUGUST 1986 WATER CHEMISTRY

LAKE_ID	NAME	Iron mg/l	Suspended Solids mg/l	Mn mg/l	Al ug/l	Total Alkalinity mg/l	Total Inflection Point	pH	Sulfate mg/l	Dissolved Organic Carbon	Conductivity	Total Chlorophyll A ug/l
37E	X99	46.0	1.0	150.0	150.0	1.53	-0.25	5.170	13.10	0.6	38.0	0.2
38A	X99	44.0	1.0	130.0	180.0	999.90	-1.39	4.580	10.40	1.6	35.0	0.6
38B	MATAGAMA	53.0	1.0	170.0	280.0	0.53	-1.22	4.630	12.60	0.8	42.0	0.4
38C	SILVESTE	42.0	1.0	160.0	280.0	0.56	-1.18	4.640	12.80	0.5	40.0	0.3
38D	OTTER	64.0	1.0	290.0	520.0	0.00	-2.46	4.340	15.20	0.2	54.0	0.3
38E	X99	92.0	1.0	49.0	34.0	4.95	3.14	6.154	11.60	4.9	39.0	2.3
39A	MATAGAMA	130.0	1.0	130.0	120.0	999.90	-0.23	5.160	11.80	3.2	35.0	1.1
39B	THOMAS	88.0	1.0	52.0	25.0	3.48	1.66	6.240	11.90	3.8	37.0	2.0
39C	X99	75.0	1.0	120.0	270.0	0.51	-1.23	4.620	12.40	2.5	47.0	0.5
39D	X99	260.0	1.0	130.0	250.0	0.89	-0.89	4.750	10.50	3.2	37.0	2.2
40A	MATAGAMA	64.0	1.0	130.0	180.0	1.06	-0.72	4.840	11.10	1.4	39.0	1.6
40B	RATHBUN	54.0	1.0	16.0	16.0	9.42	7.51	7.030	13.90	3.5	54.0	1.9
40C	WANAPITE	43.0	1.0	6.0	13.0	17.20	15.33	7.530	13.60	4.1	69.0	1.0
D27	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T01	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T02	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T03	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T04	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T05	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T06	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T07	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T08	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T09	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T10	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T11	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T12	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T13	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T14	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T15	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T16	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T17	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T18	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T19	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T20	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T21	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T22	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T23	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T24	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T25	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T26	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T27	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T28	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T29	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
T30	X99	999.9	999.9	999.9	999.9	999.90	999.90	999.900	999.90	999.9	999.9	999.9
X03	WHITEPIN	8.0	1.0	20.0	10.0	2.25	0.39	5.900	9.29	2.2	30.0	1.4
X01	LAUNDRIE	58.0	1.0	38.0	66.0	2.03	0.18	5.670	8.63	3.2	29.0	2.3
X02	CENTRE	11.0	1.0	26.0	10.0	2.62	0.71	6.200	10.90	2.0	37.0	1.3
X04	McKEE	31.0	1.0	3.0	10.0	29.58	27.74	7.630	8.87	6.4	82.0	2.3
X05	WISHBONE	170.0	2.0	34.0	110.0	3.51	1.68	5.720	8.23	8.4	40.0	10.5
X06	THEODORE	72.0	1.0	4.0	10.0	25.73	23.87	7.400	8.16	9.2	72.0	2.4
X07	ELEANOR	160.0	1.0	28.0	10.0	14.04	12.14	7.180	6.44	5.3	44.0	2.1
X08	FINLAY	72.0	1.0	15.0	10.0	8.91	6.90	7.050	7.83	4.7	39.0	2.1

Table D.2

SPRING 1987 WATER CHEMISTRY

LAKE_ID	NAME	DATE	Iron mg/l	Mn mg/l	Al ug/l	Total Alkalinity mg/l	Total Inflection Point	pH	Sulfate mg/l	Turbidity Formazin Units	Dissolved Organic Carbon	Conductivity	Total Chlorophyll A ug/l
30C	DOUGHERT	5/5/87	0.033	0.250	220	1.3	0.10	4.890	12.8	1.21	0.4	.	0.14
37B	WOLF	5/5/87	0.056	0.180	280	1.2	0.10	4.810	12.1	0.28	0.7	.	0.18
X02	CENTRE	5/5/87	0.062	0.046	510	3.0	1.31	6.430	10.4	0.46	1.8	.	0.65
X03	WHITEPIN	5/5/87	0.036	0.022	34	2.8	1.03	6.320	9.5	0.57	2.2	.	1.24
13D	WHITEPIN	5/12/87	0.027	0.019	220	.	0.93	6.113	8.8	1.15	2.4	29.0	1.50
X02	CENTRE	5/12/87	0.041	0.037	35	.	1.34	6.301	9.7	0.89	2.0	34.0	0.60
30C	DOUGHERT	5/12/87	0.036	0.220	250	.	-1.10	4.655	11.6	0.54	0.7	43.0	0.20
37B	WOLF	5/12/87	0.043	0.160	280	.	0.73	4.760	11.3	0.33	0.7	40.0	0.20
X03	WHITEPIN	5/12/87	0.089	0.089	120	.	-0.18	5.100	9.1	0.66	2.0	30.0	1.00
13A	SUNNYWAT	5/12/87	0.032	0.240	300	.	-0.88	4.734	10.0	0.24	0.2	37.0	0.10
14H	SMOOTHWA	5/12/87	0.009	0.018	34	.	0.78	6.036	9.8	0.93	1.5	33.0	0.50
22D	MAGGIE	5/12/87	0.110	0.039	39	.	2.95	6.601	9.2	0.72	2.2	35.0	0.60
30C	DOUGHERT	6/10/87	0.100	0.300	330	.	-1.10	4.627	13.6	0.37	0.6	43.0	0.20
X02	CENTRE	6/10/87	0.029	0.037	25	.	1.40	6.350	10.3	0.45	1.9	33.0	0.50
18B	NORTH YO	6/10/87	0.100	0.094	140	.	-0.02	5.298	10.7	0.72	1.4	32.0	0.30
37B	WOLF	6/10/87	0.043	0.200	300	.	-0.84	4.738	13.0	0.38	0.6	40.0	0.30
13D	WHITEPIN	6/10/87	0.014	0.017	23	.	0.78	6.144	9.1	0.65	2.2	28.5	0.70
X03	WHITEPIN	6/10/87	0.059	0.110	170	.	-0.23	5.060	9.9	0.63	1.7	30.0	0.50
14H	SMOOTHWA	6/10/87	0.013	0.022	34	.	0.81	6.155	10.5	0.58	1.3	33.0	0.50
13A	SUNNYWAT	6/10/87	0.073	0.300	310	.	-0.81	4.736	11.7	0.37	0.2	37.0	0.10
X02	CENTRE	6/30/87	0.008	0.024	22	.	.	.	8.7	1.58	2.0	.	0.82
X01	LAUNDRIE	6/30/87	0.029	0.028	65	.	.	.	14.9	0.44	3.7	.	0.95
34C	CHINIGUC	6/30/87	0.018	0.140	170	.	.	.	14.9	0.19	0.5	.	0.33
30C	DOUGHERT	6/30/87	0.013	0.150	160	.	.	.	15.0	0.18	0.6	.	0.20
37B	WOLF	6/30/87	0.029	0.170	270	.	.	.	16.1	0.31	0.4	.	0.11
13D	WHITEPIN	6/30/87	0.010	0.014	22	.	.	.	16.6	0.59	2.2	.	0.61
14H	SMOOTHWA	6/30/87	0.007	0.016	25	.	.	.	8.8	0.28	1.3	.	0.33
13A	SUNNYWAT	6/30/87	0.024	0.250	270	.	.	.	9.4	0.20	0.3	.	0.10
X03	WHITEPIN	6/30/87	0.047	0.093	140	.	.	.	7.8	0.31	1.7	.	0.51
18B	NORTH YO	6/30/87	0.060	0.076	108	.	.	.	8.8	0.32	1.2	.	0.37



○ PROBAR Data Collection Station

◄ MER Data Collection Station

FOLDOUT FRAME

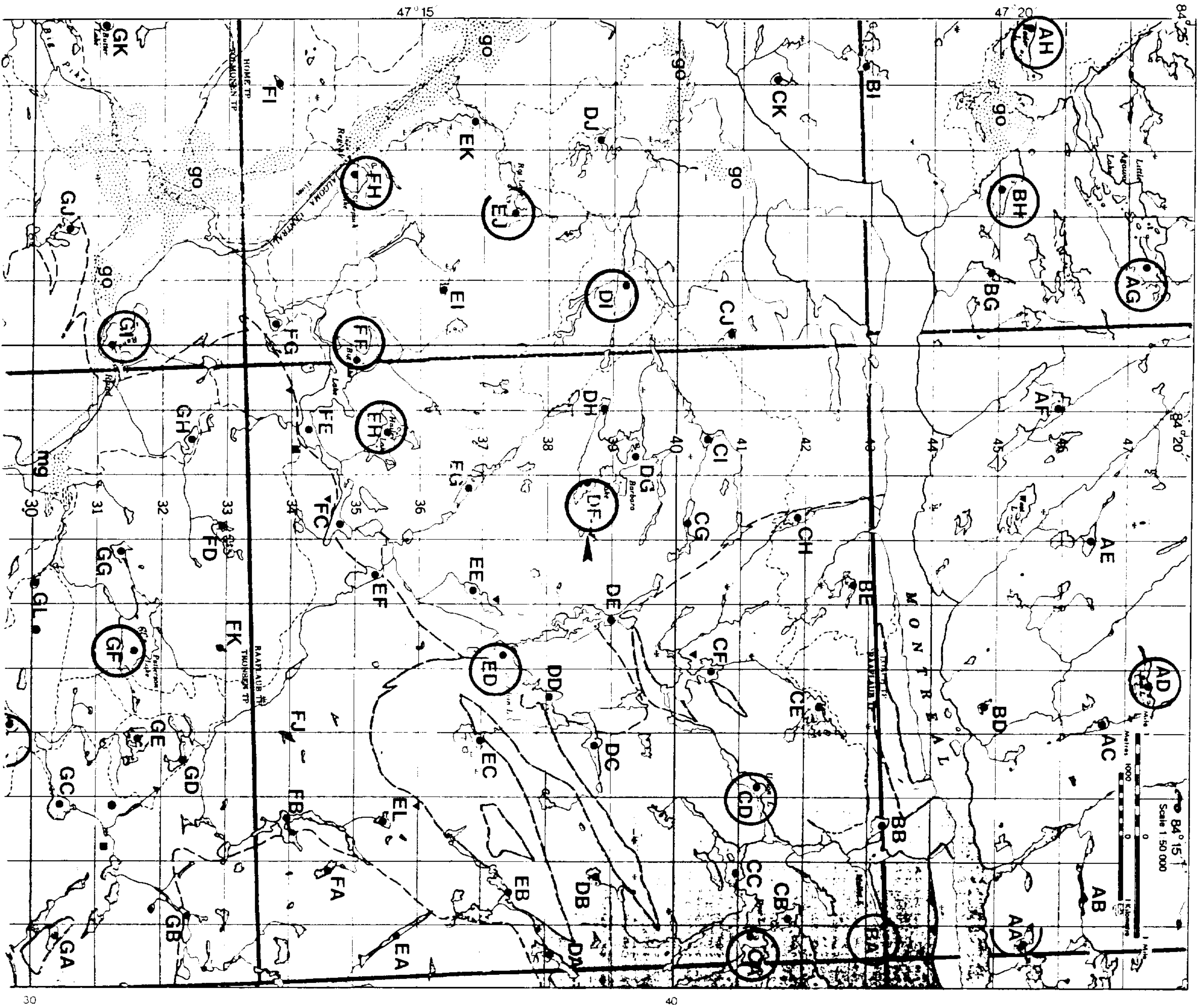


Figure D.1. MER and PROBAR Sampling Stations
for the Algoma Site

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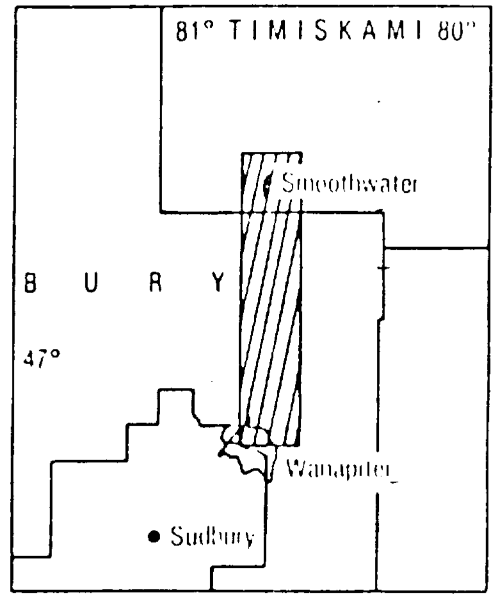
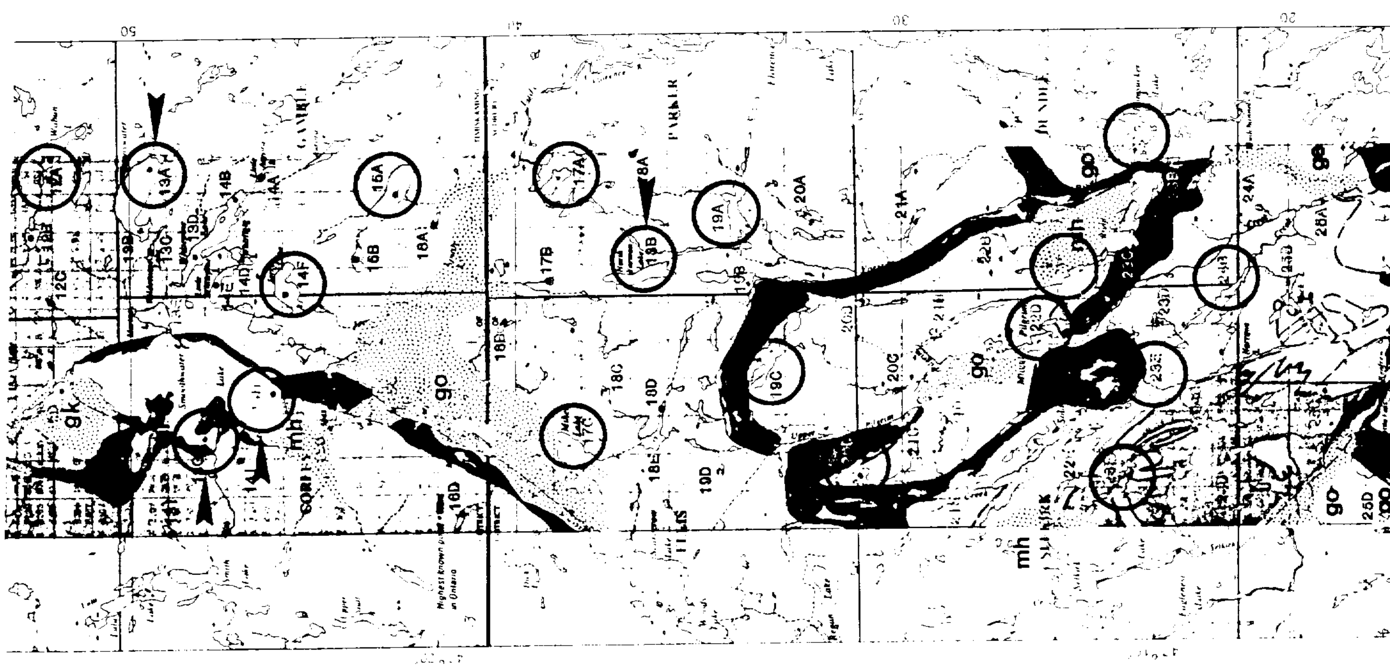


Location Map



◯ PROBAR Data Collection Station

◀ MER Data Collection Station

FOLDOUT FRAME

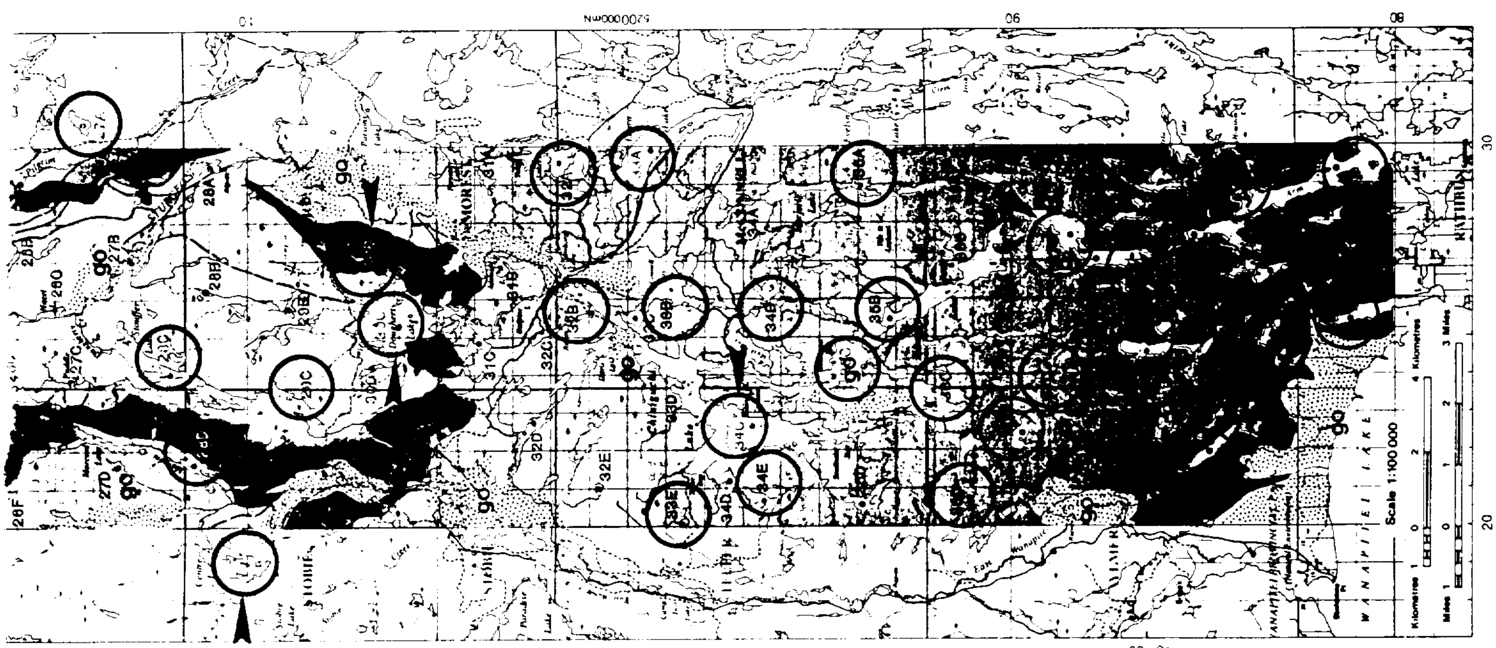


Figure D.2. MER and PROBAR Sampling Stations for the Sudbury Site

APPENDIX E

TRANSMISSOMETER DATA DERIVED TRANSMISSION AND ATTENUATION COEFFICIENTS

SEA TECH TRANSMISSOMETER
SUMMER AND SPRING DATA
DEPTH = 2M

LAKE	DATE	TRANSMITTED LIGHT	ATTENUATION COEFFICIENT
ASPREY	8/29/87	0.751936	1.14042
BARBARA	8/19/86	0.844196	0.67748
BLUE_CHAULK	8/25/86	0.818252	0.80234
CENTRE	8/22/86	0.824069	0.77400
CENTRE	5/5/87	0.804136	0.87195
CENTRE	5/12/87	0.806193	0.86173
CENTRE	6/10/87	0.855159	0.62587
CENTRE	6/30/87	0.813888	0.82373
CLEAR	6/29/87	0.813284	0.82670
CRAYFISH	8/20/86	0.770734	1.04165
DOUGHERTY	8/18/86	0.893302	0.45132
DOUGHERTY	5/5/86	0.907250	0.38935
DOUGHERTY	5/12/87	0.859706	0.60466
DOUGHERTY	6/10/87	0.888233	0.47409
DOUGHERTY	6/30/87	0.881084	0.50641
EAGLE	8/24/86	0.776856	1.01000
FROOD	6/29/87	0.791837	0.93360
LANG	6/29/87	0.816148	0.81264
LAUNDRIE	6/30/87	0.811852	0.83376
LONG	6/29/87	0.809194	0.84687
MAGGIE	5/12/87	0.808093	0.85231
NORTH_YORSTON	6/10/87	0.859293	0.60658
NORTH_YORSTON	7/01/87	0.852577	0.63797
RAMSEY	6/29/87	0.801563	0.88477
RED_CHAULK	8/25/86	0.806377	0.86082
SMOOTHWATER	5/12/87	0.925734	0.30867
SMOOTHWATER	6/10/87	0.863427	0.58738
SMOOTHWATER	7/01/87	0.878723	0.51714
SPANISH_R	6/29/87	0.663725	1.63955
SUNNYWATER	8/13/86	0.895210	0.44279
SUNNYWATER	5/12/87	0.905094	0.39887
SUNNYWATER	6/10/87	0.917172	0.34584
SUNNYWATER	7/01/87	0.913576	0.36156
WABAGISHIK	6/29/87	0.531323	2.52954
WHITEPINE_1	5/12/87	0.919011	0.33783
WHITEPINE_1	6/10/87	0.836048	0.71628
WHITEPINE_1	7/01/87	0.825830	0.76546
WHITEPINE_2	8/14/86	0.830178	0.74446
WHITEPINE_2	5/5/87	0.775708	1.01592
WHITEPINE_2	5/12/87	0.758855	1.10378
WHITEPINE_2	6/10/87	0.852950	0.63622
WHITEPINE_2	7/01/87	0.837823	0.70779
WISHART	8/18/86	0.589901	2.11120
WOLF	8/11/86	0.883426	0.49579
WOLF	5/5/87	0.911533	0.37061
WOLF	5/12/87	0.863822	0.58555
WOLF	6/10/87	0.869829	0.55876
WOLF	6/30/87	0.908203	0.39397

APPENDIX F

MER-SUBSURFACE SPECTRAL RADIOMETER MULTITEMPORAL LAKE REFLECTANCES

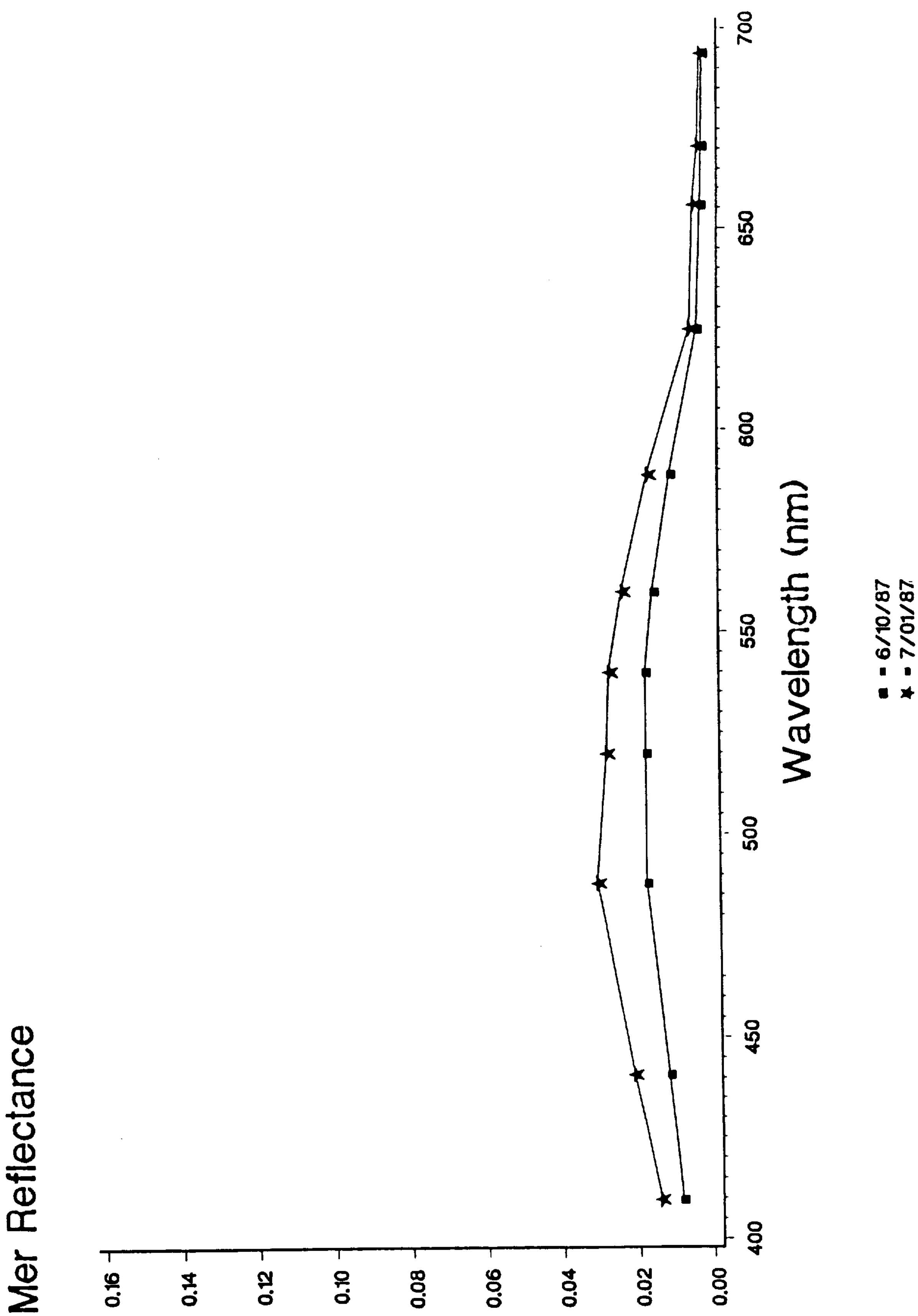


Figure F.1 Smoothwater Lake

Smoothwater Lake Mer Data at 2 Meters
Multitemporal
Mer Reflectance

Center Wavelength	Reflectance 6/10/87	Reflectance 7/01/87
410	0.0084	0.0142
441	0.0116	0.0210
488	0.0172	0.0303
520	0.0173	0.0277
540	0.0173	0.0269
560	0.0151	0.0233
589	0.0104	0.0163
625	0.0030	0.0050
656	0.0021	0.0041
671	0.0017	0.0029
694	0.0015	0.0022

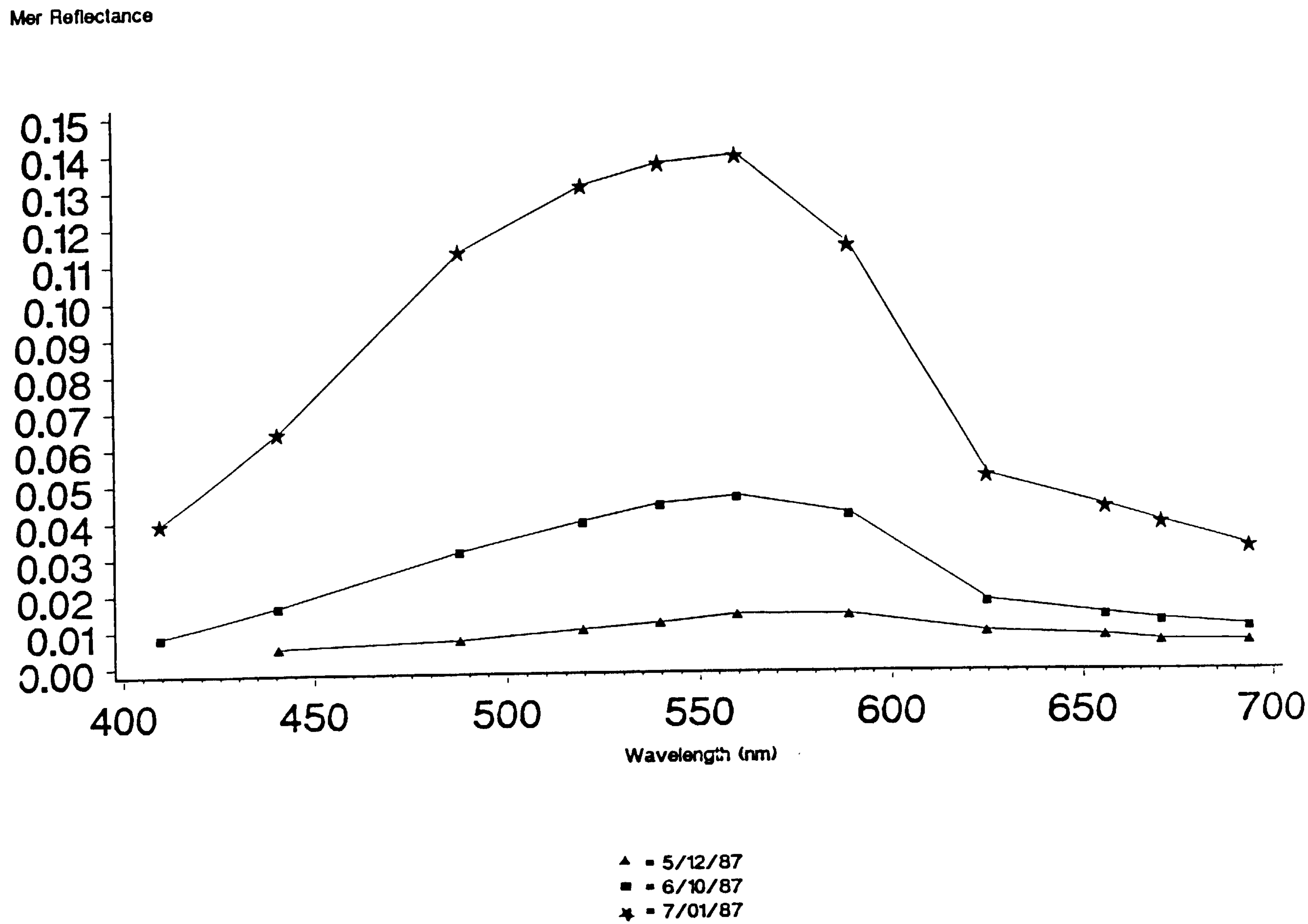


Figure F.2 Whitepine #1 Lake

Whitepine_#1 Lake Mer Data at 2 Meters
Multitemporal Data
Mer Reflectance

Center Wavelength	Reflectance 5/12/87	Reflectance 6/10/87	Reflectance 7/01/87
410	.	0.0085	0.0396
441	0.0050	0.0166	0.0642
488	0.0070	0.0314	0.1132
520	0.0097	0.0394	0.1307
540	0.0114	0.0440	0.1366
560	0.0135	0.0460	0.1387
589	0.0133	0.0410	0.1143
625	0.0084	0.0170	0.0513
656	0.0072	0.0132	0.0426
671	0.0057	0.0115	0.0382
694	0.0056	0.0097	0.0316

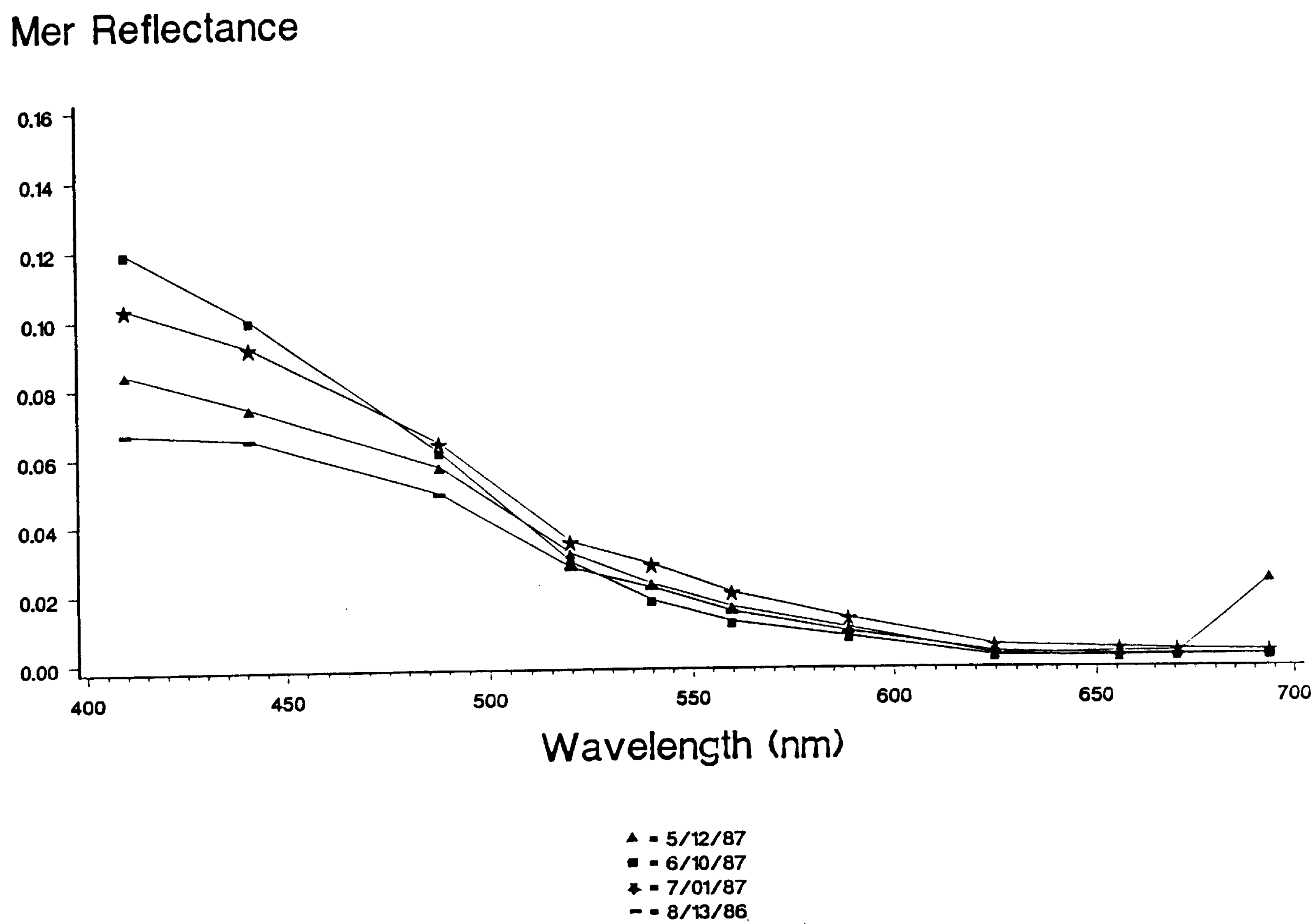


Figure F.3 Sunnywater Lake

Sunnywater Lake Mer Data at 2 Meters
Multitemporal
Mer Reflectance

Center Wavelength	Reflectance 5/12/87	Reflectance 6/10/87	Reflectance 7/01/87	Reflectance 8/13/88
410	0.0840	0.1192	0.1033	0.067
441	0.0740	0.0995	0.0917	0.065
488	0.0587	0.0610	0.0637	0.049
520	0.0312	0.0287	0.0346	0.027
540	0.0222	0.0174	0.0279	0.021
560	0.0153	0.0111	0.0196	0.014
589	0.0091	0.0066	0.0120	0.008
625	0.0013	0.0008	0.0040	0.002
656	0.0018	0.0006	0.0030	0.001
671	0.0019	0.0008	0.0025	0.001
694	0.0233	0.0009	0.0021	0.001

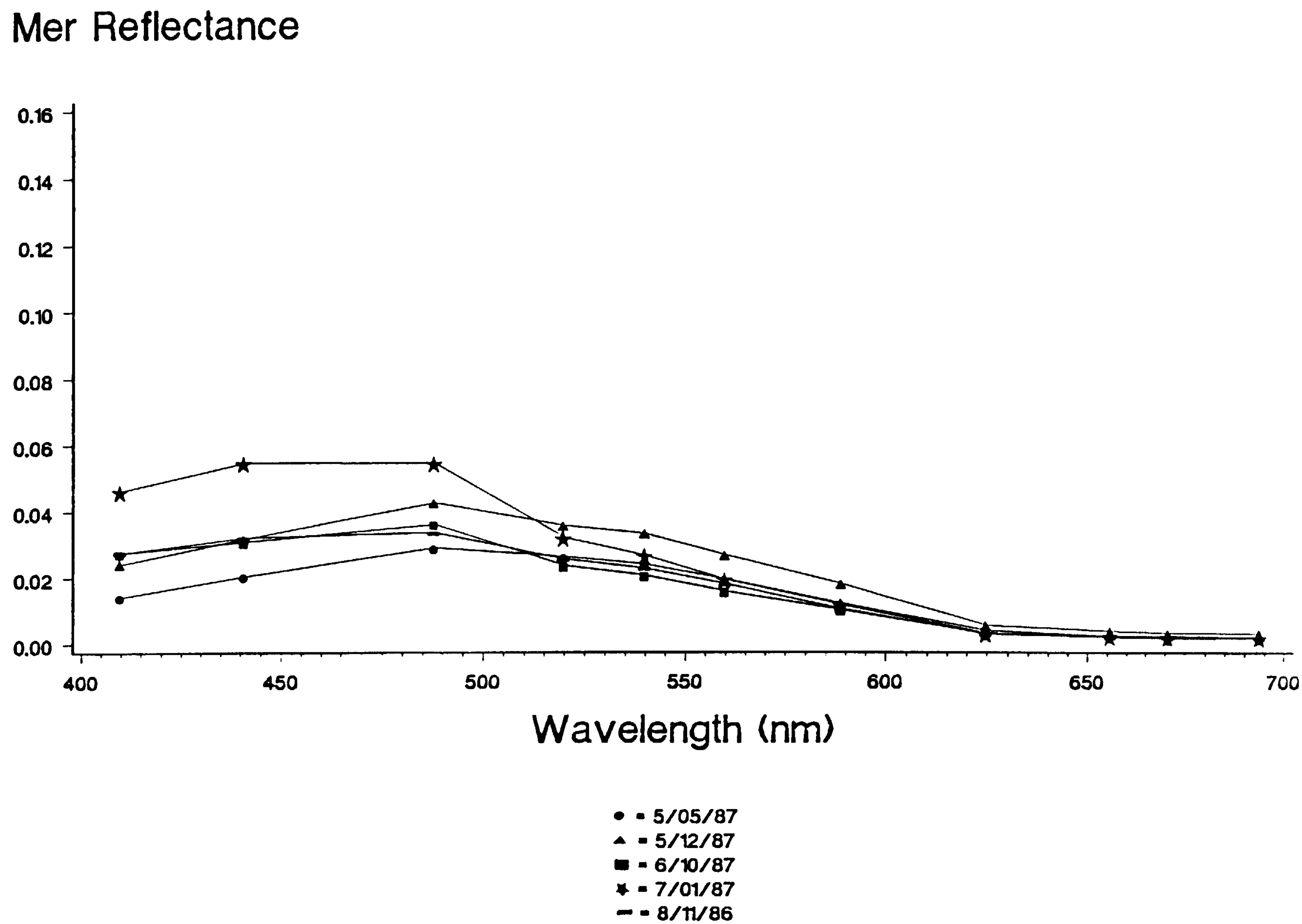


Figure F.4 Wolf Lake

Wolf Lake Mer Data at 2 Meters
Multitemporal
Mer Reflectance

Center Wavelength	Reflectance 5/05/87	Reflectance 5/12/87	Reflectance 6/10/87	Reflectance 7/01/87	Reflectance 8/11/86
410	0.0144	0.0242	0.0275	0.0463	0.02760
441	0.0206	0.0318	0.0309	0.0547	0.03210
488	0.0291	0.0427	0.0361	0.0546	0.03355
520	0.0263	0.0357	0.0236	0.0320	0.02550
540	0.0240	0.0332	0.0207	0.0266	0.02270
560	0.0195	0.0267	0.0159	0.0194	0.01800
589	0.0122	0.0180	0.0102	0.0117	0.01050
625	0.0040	0.0055	0.0030	0.0030	0.00290
656	0.0023	0.0039	0.0020	0.0023	0.00200
671	0.0023	0.0033	0.0016	0.0021	0.00190
694	0.0019	0.0032	0.0017	0.0019	0.00170

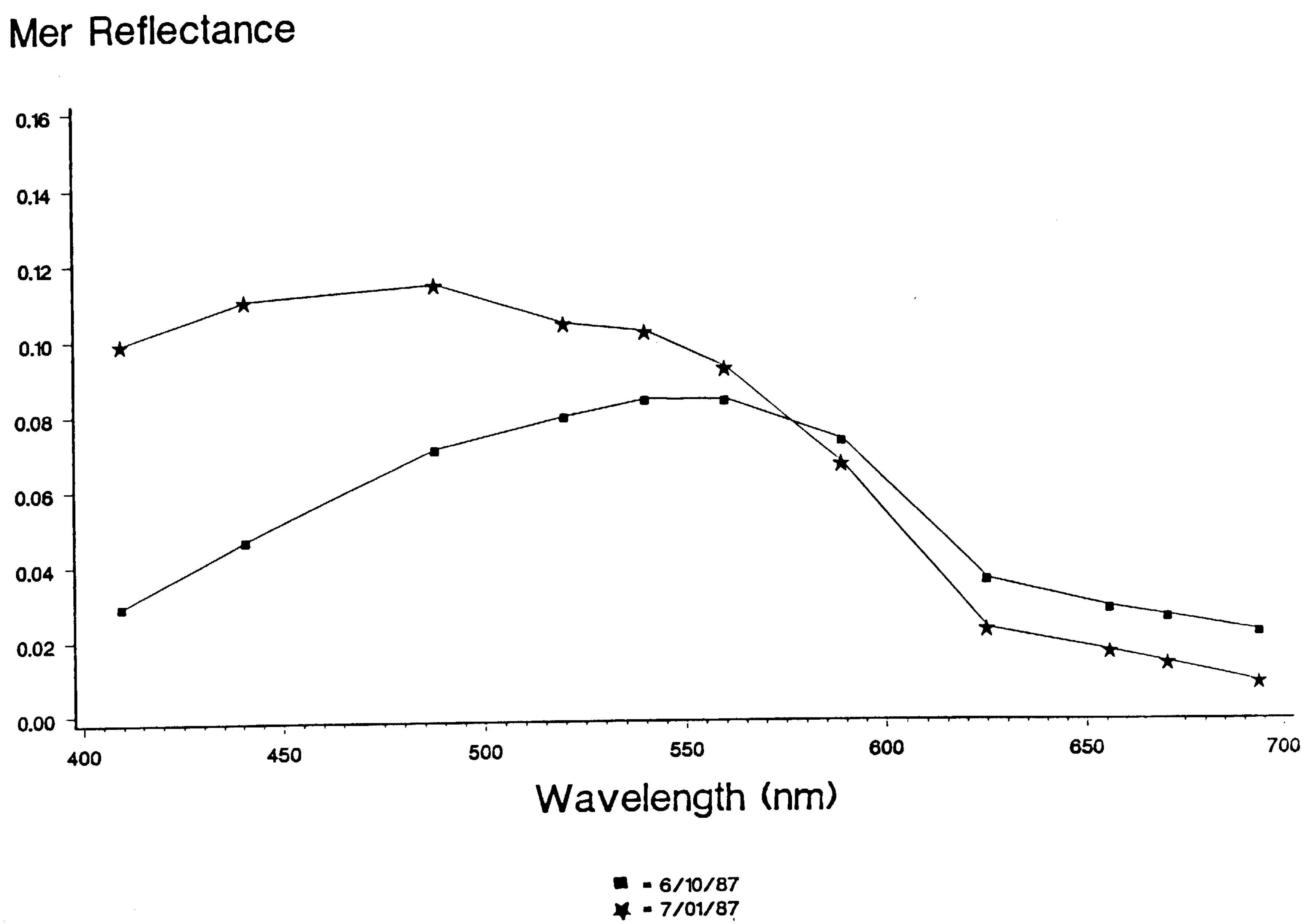


Figure F.5 North Yorkston Lake

North_Yorston Lake Mer Data at 2 Meters
Multitemporal
Mer Reflectance

Center Wavelength	Reflectance 6/10/87	Reflectance 7/01/87
410	0.0293	0.0992
441	0.0467	0.1104
488	0.0708	0.1144
520	0.0792	0.1039
540	0.0836	0.1016
560	0.0834	0.0918
589	0.0726	0.0662
625	0.0354	0.0221
656	0.0278	0.0161
671	0.0254	0.0129
694	0.0214	0.0077

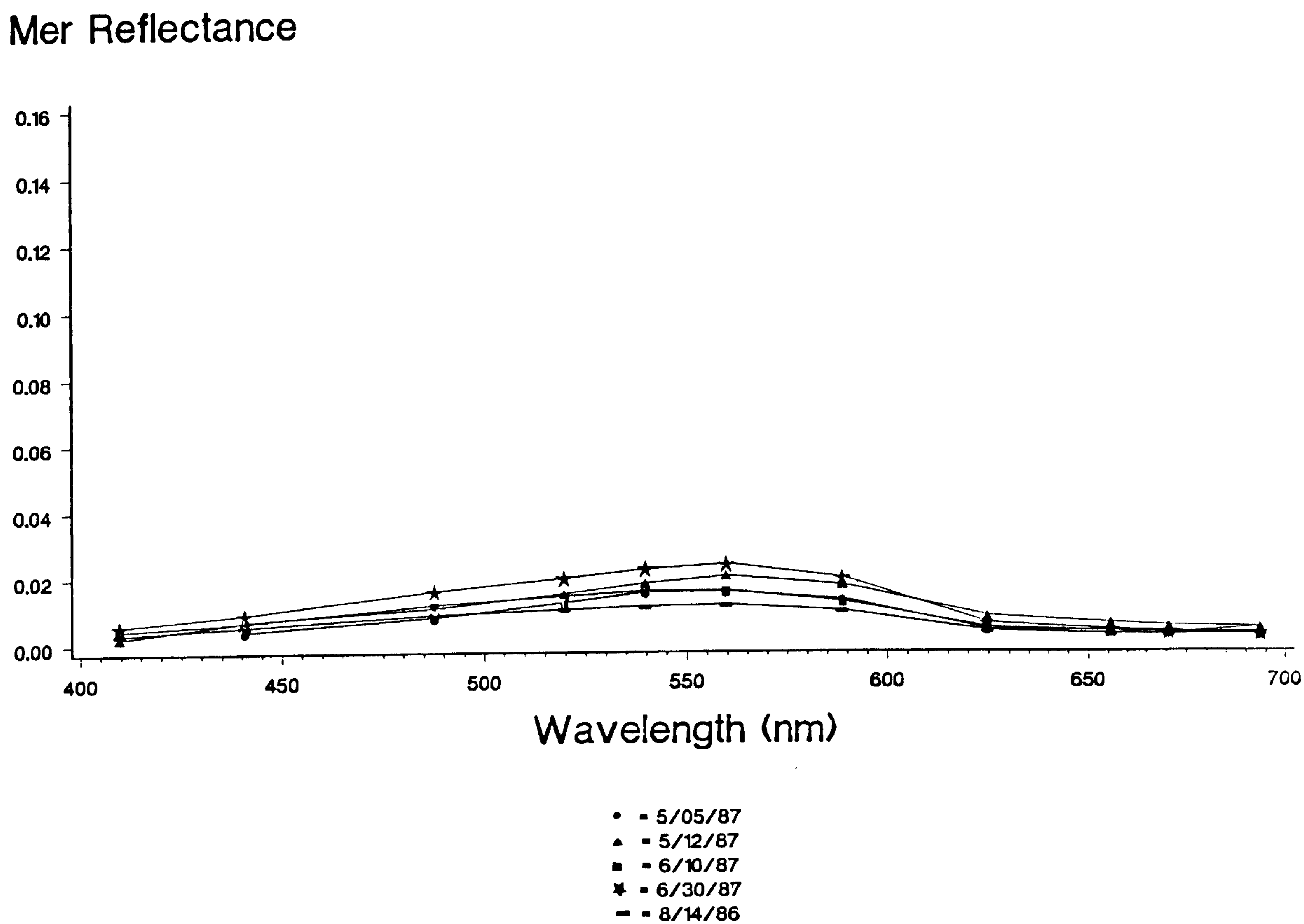


Figure F 6 Whitepine #2 Lake

Whitepine_#2 Lake Mer Data at 2 Meters
Multitemporal
Mer Reflectance

Center Wavelength	Reflectance 5/05/87	Reflectance 5/12/87	Reflectance 6/10/87	Reflectance 6/30/87	Reflectance 8/14/86
410	.	0.0021	0.0043	0.0057	0.0032
441	0.0040	0.0070	0.0087	0.0091	0.0053
488	0.0080	0.0109	0.0118	0.0160	0.0088
520	0.0123	0.0151	0.0144	0.0198	0.0103
540	0.0154	0.0182	0.0159	0.0225	0.0111
560	0.0155	0.0203	0.0159	0.0239	0.0116
589	0.0132	0.0175	0.0123	0.0196	0.0098
625	0.0039	0.0079	0.0044	0.0057	0.0035
656	0.0036	0.0059	0.0033	0.0040	0.0025
671	0.0028	0.0049	0.0029	0.0033	0.0024
694	0.0044	0.0045	0.0024	0.0028	0.0024

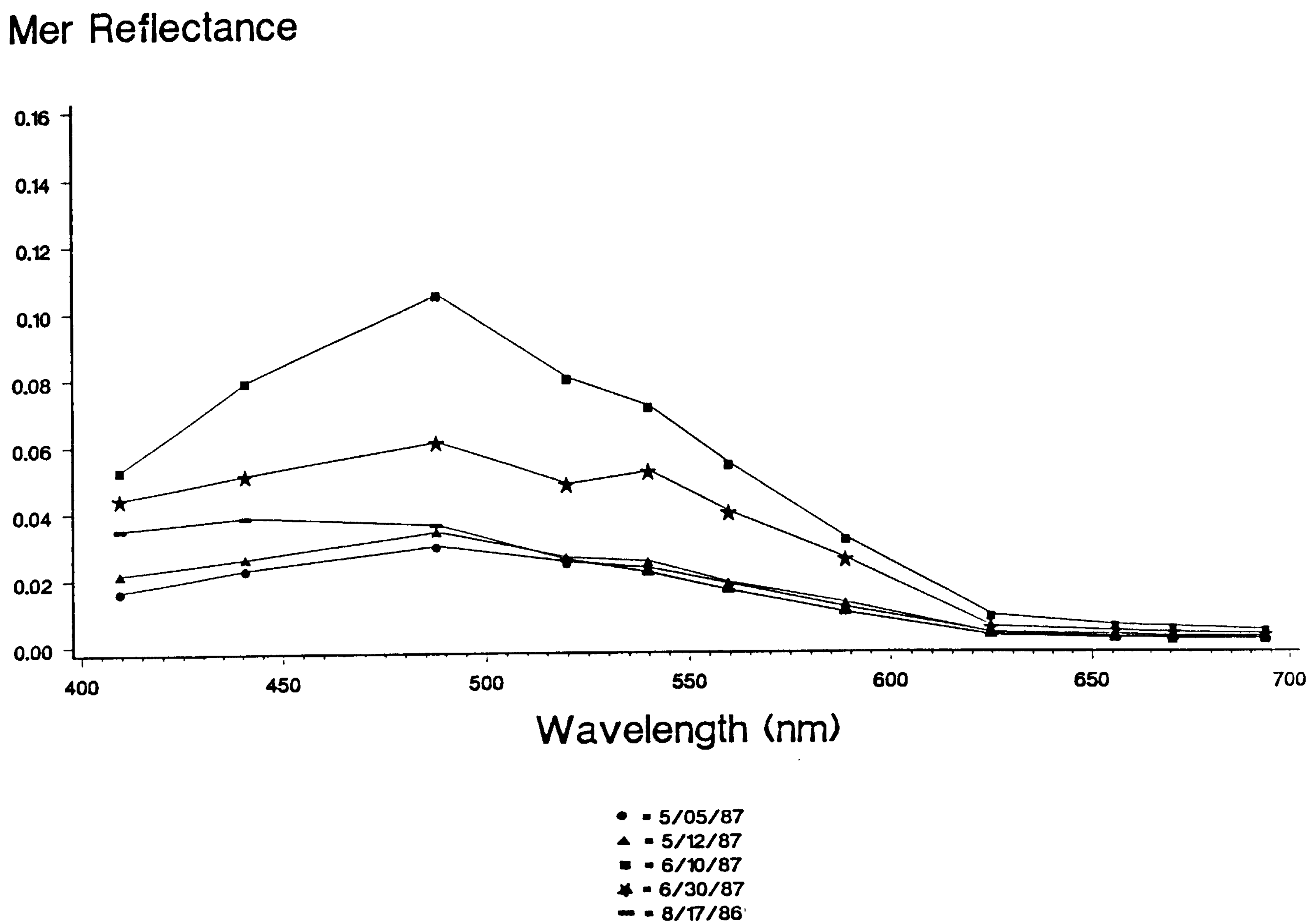


Figure F.7 Dougherty Lake

Dougherty Lake Mer Data at 2 Meters
Multitemporal
Mer Reflectance

Center Wavelength	Reflectance 5/05/87	Reflectance 5/12/87	Reflectance 6/10/87	Reflectance 6/30/87	Reflectance 8/17/86
410	0.0166	0.0217	0.0529	0.0443	0.0350
441	0.0229	0.0261	0.0793	0.0512	0.0385
488	0.0299	0.0340	0.1052	0.0611	0.0361
520	0.0249	0.0262	0.0800	0.0483	0.0254
540	0.0230	0.0249	0.0714	0.0520	0.0215
560	0.0180	0.0186	0.0540	0.0395	0.0161
589	0.0110	0.0123	0.0316	0.0256	0.0094
625	0.0032	0.0030	0.0085	0.0049	0.0023
656	0.0025	0.0017	0.0055	0.0037	0.0014
671	0.0020	0.0012	0.0049	0.0032	0.0014
694	0.0018	0.0012	0.0040	0.0026	0.0012

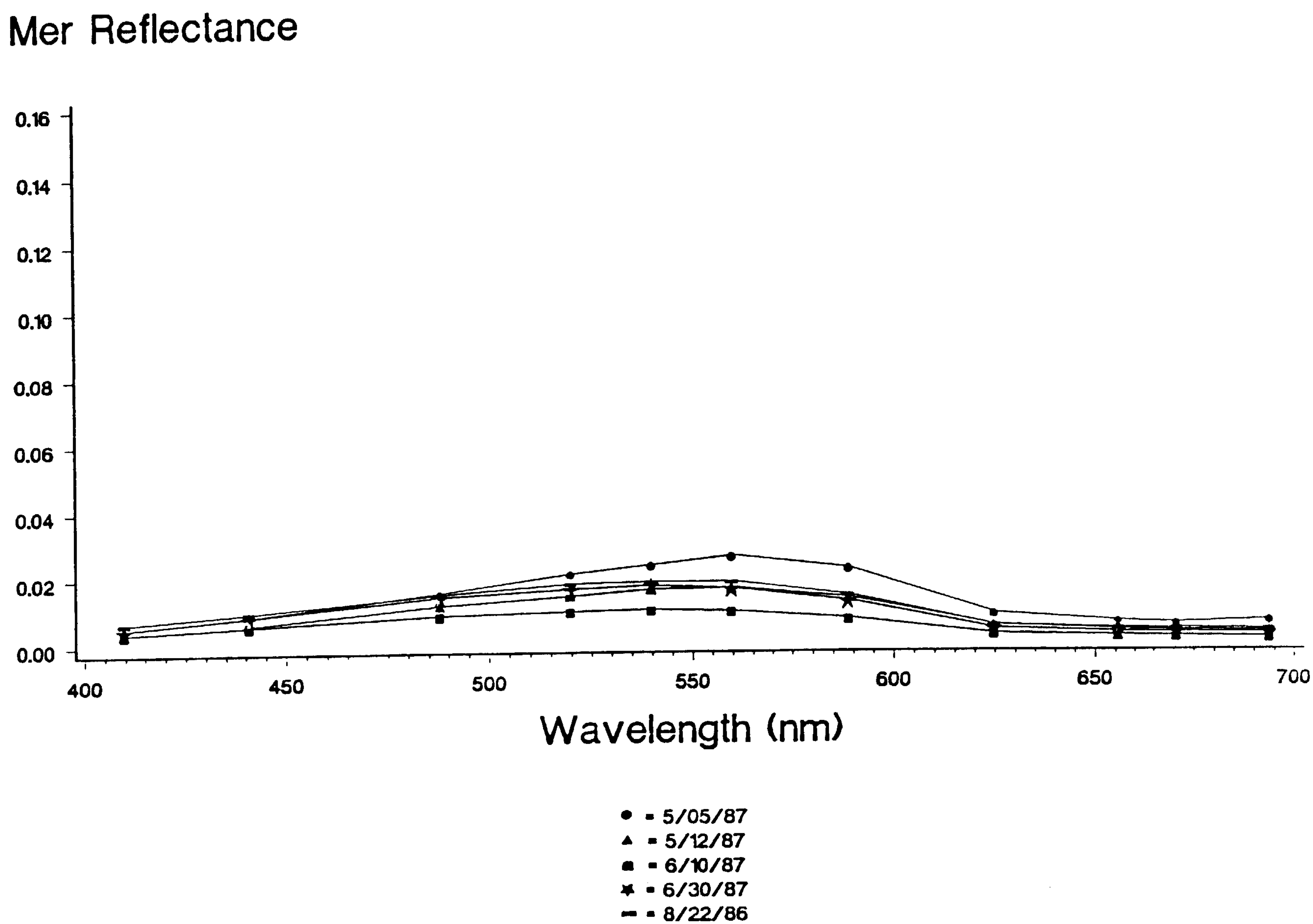


Figure F.8 Centre Lake

Centre Lake Mer Data at 2 Meters
Multitemporal
Mer Reflectance

Center Wavelength	Reflectance 5/05/87	Reflectance 5/12/87	Reflectance 6/10/87	Reflectance 6/30/87	Reflectance 8/22/88
410	.	.	0.0038	0.0052	0.00680
441	0.0084	0.0060	0.0058	0.0084	0.00970
488	0.0164	0.0116	0.0086	0.0142	0.01498
520	0.0211	0.0143	0.0097	0.0164	0.01800
540	0.0236	0.0162	0.0102	0.0175	0.01850
560	0.0263	0.0168	0.0097	0.0165	0.01850
589	0.0225	0.0135	0.0073	0.0125	0.01440
625	0.0086	0.0051	0.0024	0.0040	0.00500
656	0.0061	0.0036	0.0017	0.0028	0.00400
671	0.0055	0.0032	0.0015	0.0028	0.00380
694	0.0064	0.0030	0.0011	0.0024	0.00380

APPENDIX G
LAKE EXTRACTED TM SIGNAL VALUES AND ATMOSPHERIC CORRECTED VALUES

Thematic mapper (TM) signal digital count value for lake extracted samples are listed in the following tables. Also listed are the standard deviation estimates for each sample.

Table G.1. August 13, 1986 (P19,R27)
Table G.2. August 18, 1986 (P22,R27)
Table G.3. May 12, 1987 (P19,R22)
Table G.4. June 13, 1987 (P19,R27)

Atmospherically normalized value are listed in the following tables.

Table G.5. August 13, 1986 (P19,R27)
Table G.6. August 18, 1986 (P22,R27)
Table G.7. May 12, 1987 (P19,R27)
Table G.8. June 13, 1987 (P19,R27)

Table G.1

SUDBURY QUAD 3
AUGUST 13, 1986
RAW TM SIGNALS AND STANDARD DEVIATIONS

LAKE_ID	NAME	Band 1	Band 2	Band 3	Band 4	Band 1 S.D.	Band 2 S.D.	Band 3 S.D.	Band 4 S.D.
11A	X99	70.44	21.56	17.22	13.11	0.73	0.53	0.44	0.33
11C	LAMY	70.67	22.33	17.44	13.00	0.87	0.50	0.73	0.00
12A	WABUN	72.78	21.56	15.78	12.00	1.30	0.53	0.97	0.00
12B	X99	72.56	21.22	17.00	12.22	1.59	0.44	0.00	0.44
13A	SUNNYWAT	78.00	21.78	16.89	13.00	1.58	0.67	0.78	0.00
13D	WHITEPIN	73.00	21.22	17.00	12.67	1.22	0.44	0.00	0.50
13E	MARINA	72.44	22.00	17.33	12.56	1.51	0.87	0.71	0.53
14E	LITTLE W	72.67	21.56	17.33	12.78	1.41	0.73	0.71	0.44
14F	JERRY	75.89	21.56	16.33	12.00	1.62	0.53	0.87	0.00
14H	SMOOTHWA	73.44	21.11	16.78	11.00	1.88	0.33	0.44	0.00
17C	MIHELL	73.33	22.44	18.89	13.89	1.22	0.88	1.62	0.33
18B	NORTH YO	70.22	20.89	16.89	11.22	2.17	0.33	0.33	0.44
19A	X99	71.44	22.00	17.11	12.89	2.92	0.87	0.33	0.33
19C	X99	71.22	21.11	16.89	12.00	1.72	0.33	0.33	0.00
22C	PILGRIM	74.00	21.89	17.11	12.11	1.22	0.33	0.33	0.33
22D	MAGGIE	73.55	21.67	18.22	13.00	1.81	0.50	0.83	0.00
23A	BLUESUCK	70.56	21.11	17.00	11.22	1.74	0.33	0.00	0.44
28C	STOUFFER	72.33	21.33	16.55	12.00	1.00	0.50	0.88	0.00
29C	FREDERIC	72.78	20.89	16.67	11.00	1.39	0.33	0.71	0.00
30C	DOUGHERT	73.67	20.56	16.22	11.00	1.12	0.53	0.83	0.00
33A	LAURA	67.89	20.67	16.78	11.00	0.60	0.50	0.44	0.00
33D	CHINIGUC	72.44	21.00	16.00	11.00	0.88	0.00	1.22	0.00
33E	X99	70.22	21.33	16.55	11.11	1.09	0.71	0.73	0.33
34B	X99	75.78	22.44	17.33	13.89	1.39	0.53	0.50	0.33
34D	X99	71.00	21.33	16.67	12.00	2.34	0.50	0.50	0.00
34E	X99	71.89	20.89	14.89	11.11	0.33	0.33	1.36	0.33
35A	X99	73.33	20.89	16.44	11.00	1.73	0.33	0.73	0.00
35B	DEWDNEY	70.67	20.89	15.78	10.89	1.50	0.93	0.97	0.33
35D	X99	73.67	21.00	15.67	11.11	1.73	0.00	0.50	0.33
36B	FRANKS	70.78	20.67	16.00	11.22	1.56	0.50	1.00	0.44
36D	LAWLOR	71.00	21.33	15.56	11.11	1.66	0.50	1.01	0.33
37B	WOLF	72.67	20.33	15.56	11.00	0.71	0.50	1.24	0.00
37D	X99	70.25	21.00	14.44	11.44	1.49	0.00	0.88	0.53
38B	MATAGAMA	68.33	20.78	16.78	10.67	1.87	0.44	0.44	0.87
38C	SILVESTE	73.11	19.89	14.67	11.00	1.90	0.78	1.22	0.00
38D	OTTER	73.11	19.89	14.67	11.00	1.90	0.78	1.22	0.00
40A	MATAGAMA	70.55	21.11	16.78	10.89	1.59	0.60	0.67	0.33
X02	CENTRE	70.44	21.11	16.67	11.22	1.01	0.33	0.71	0.44
X03	WHITEPIN	71.44	21.44	17.11	12.22	1.13	0.88	0.33	0.44

Table G.2

ALGOMA QUAD 4
AUGUST 18, 1986
RAW TM SIGNALS AND STANDARD DEVIATIONS

LAKE_ID	NAME	Band 1	Band 2	Band 3	Band 4	Band 1 S.D.	Band 2 S.D.	Band 3 S.D.	Band 4 S.D.
AA	ATOMIC	62.333	18.889	13.889	11.111	1.155	0.737	0.314	0.314
AD	EAST	60.778	18.000	14.667	10.556	1.685	0.943	0.471	0.686
AG	LITTLE A	62.222	17.444	14.222	10.222	2.096	0.956	1.227	0.629
AH	MADER	63.000	19.111	16.444	11.222	1.333	0.314	0.497	0.416
BA	MALLOT	61.778	18.556	15.444	14.556	2.439	1.165	1.086	8.355
BF	MONTREAL	64.444	19.000	15.889	10.889	1.423	0.667	1.100	0.314
BH	X99	62.333	19.444	14.778	10.778	1.054	0.497	1.133	0.416
CA	DYER	61.444	18.000	14.778	12.333	1.423	1.155	1.133	3.232
DC	X99	61.000	17.889	14.778	10.889	1.491	1.100	0.786	0.567
DF	BARBARA	63.111	18.333	14.222	10.444	0.994	0.471	1.030	0.686
DI	X99	62.556	19.111	13.556	11.000	2.587	0.567	0.497	0.000
ED	ALVIN	62.222	17.667	14.000	10.667	0.916	0.817	0.816	0.471
EH	HAILEY	62.667	19.000	14.444	10.889	1.563	0.667	0.685	0.314
EJ	ROI	62.556	18.556	14.667	11.556	2.061	0.497	0.471	0.497
FA	X99	64.100	19.800	14.000	11.200	1.000	0.440	0.860	0.440
FF	BIG PIKE	62.444	19.333	16.556	11.000	1.066	0.471	0.497	0.471
GA	X99	63.200	19.200	15.700	11.400	0.970	0.440	1.300	0.530
GI	RAND	61.889	19.222	14.556	11.222	0.994	0.629	0.831	0.786
GI	PATTERSO	62.667	19.333	14.778	11.000	1.491	0.471	1.030	0.000
GK	BUTTER	63.444	19.111	14.889	12.556	1.257	0.875	1.286	0.831
KD	McCOLLOU	62.222	17.778	14.667	11.667	2.096	1.030	0.667	0.471
KG	DICK	62.556	17.778	13.667	11.222	0.956	0.629	0.816	0.416
LE	McGOVERN	63.000	19.556	15.333	11.222	1.563	0.497	0.816	0.416
LG	X99	62.778	18.333	14.222	11.111	1.030	1.155	1.030	0.567
LK	GRIFFIN	62.667	18.333	13.889	10.778	0.471	0.471	0.875	0.416
MB	X99	62.111	18.222	13.667	10.556	0.994	0.629	0.943	0.497
MC	ADELAIDE	62.889	18.556	14.889	11.556	0.875	0.831	1.286	0.497
MD	ADELAIDE	61.778	17.222	14.222	11.000	0.416	1.133	1.030	0.000
NI	X99	63.556	19.778	15.333	11.667	1.499	0.416	0.943	0.471
NJ	LITTLE T	62.556	18.667	14.556	11.444	1.066	0.817	0.685	0.685
NK	TURKEY	63.333	19.556	14.333	11.667	0.667	0.497	0.943	0.471
OC	DREW	62.111	18.111	14.444	11.889	0.875	0.567	1.066	0.314
OD	LITTLE D	62.667	19.222	15.333	11.778	1.247	0.416	1.054	0.416
X	SPECKLED	62.667	18.778	15.000	10.889	1.414	0.629	0.816	0.737
X	LIONEL	61.333	18.222	16.222	10.333	0.667	0.416	0.416	0.471
X	HUBERT	63.444	18.444	13.889	11.000	1.771	0.685	0.737	0.000
X	CHARLIE	62.889	18.222	14.333	11.000	1.370	0.786	1.054	0.000
X	WEST	62.222	18.889	13.667	10.556	2.043	0.567	0.471	0.497
X	ROTUNDA	60.111	17.778	14.444	9.889	1.523	0.916	0.831	0.737
X	DOYLE	60.222	17.889	14.778	10.667	1.872	0.737	1.397	0.667
X	REDCLIFF	61.222	17.556	13.667	10.333	0.786	0.831	0.667	0.471
X	UNION	61.000	17.556	14.000	10.778	1.563	0.685	1.155	0.416
X	DIXON	60.778	18.000	14.444	10.000	1.397	1.054	0.831	0.667
X	SNYDER	64.444	19.444	15.000	10.111	1.499	0.831	1.247	0.737
X	VACHER	61.556	18.889	14.444	9.000	1.257	0.314	0.831	0.667
X	LITTLE Q	60.222	17.333	14.667	8.889	1.812	1.247	1.054	1.100
X	EMERSON	60.333	18.222	14.667	9.556	1.764	0.916	0.816	1.066
X	NORTH CH	60.889	17.000	13.889	9.556	0.875	1.054	0.737	1.165
X	QUINN	60.889	18.111	14.222	9.667	1.100	0.314	0.629	0.471
X	WATSON	62.444	18.889	15.889	10.889	1.707	0.737	1.100	0.737
X	BROWNE	61.333	16.889	14.222	10.444	1.764	0.567	1.030	0.831
X	RED PINE	62.333	18.556	15.000	10.889	1.700	0.685	1.155	0.314
X	BUTTER T	63.111	20.667	17.667	17.556	0.994	1.414	1.828	10.035

Table G.2 (Cont.)

ALGOMA QUAD 4
AUGUST 18, 1986
RAW TM SIGNALS AND STANDARD DEVIATIONS

LAKE_ID	NAME	Band 1	Band 2	Band 3	Band 4	Band 1 S.D.	Band 2 S.D.	Band 3 S.D.	Band 4 S.D.
X	HANES	61.667	17.444	13.667	10.222	1.491	1.066	0.667	0.416
X	PRIVATE	61.444	18.333	15.889	11.000	0.685	0.667	1.100	0.000
X	COWIE	62.000	18.556	15.333	11.000	0.817	0.497	1.247	0.000
X	MORRISON	61.778	19.111	15.556	11.000	0.786	0.737	0.956	0.667
X	TEPEE	61.667	18.444	14.111	11.667	1.700	1.066	0.737	0.471
X	CHUBB	62.000	19.444	15.111	19.222	1.247	2.061	3.348	17.106
X	POINT	61.222	16.667	14.333	9.444	1.685	0.817	1.247	0.956
X	GRAHAM	61.556	17.667	14.667	11.111	1.571	1.054	0.943	0.314
X	LIMERICK	60.778	17.667	14.222	10.889	1.685	1.155	0.916	0.737
X	PATTERSO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X	GOULAIS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X	GULL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X	MIRROR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X	SPOOK	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X	WELCOME	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X	ARMOUR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X	SOUTH BR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X	TUJAK	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X	LAC CHER	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X	ANNIBAL	61.556	18.000	14.778	10.667	0.956	0.943	1.227	0.471
X	NEGICK	63.333	18.333	14.889	12.000	1.247	0.667	0.994	0.000
X	TRIM	64.111	19.556	16.111	11.667	1.852	0.497	0.314	0.471
X	S.TILLEY	63.778	20.556	16.222	11.222	1.315	0.956	0.629	0.416
X	MEENACH	62.111	18.111	14.444	10.556	0.314	0.737	0.685	0.685
X	EAST	61.778	18.556	14.556	11.778	1.133	0.956	0.956	0.629
X	DILL	62.556	18.111	13.556	11.444	1.165	0.567	0.685	0.497
X	TURTLE	62.444	18.778	15.778	11.556	0.832	0.629	1.030	0.497
X	TROUT	61.556	18.000	14.000	11.333	0.685	1.054	1.155	0.471
X	LILY PAD	61.556	19.111	14.778	11.556	1.499	0.314	1.315	0.497
X	ALVA	62.556	17.889	14.222	10.778	1.342	0.994	1.030	0.416
X	ALGOCEN	61.778	18.444	14.222	11.333	1.685	0.831	0.786	0.816
X	CURRY	62.667	19.000	14.889	13.000	1.054	0.667	1.286	2.261
X	ELMER	61.889	17.889	14.000	11.444	1.663	0.737	0.816	0.497
X	GAVOR	61.444	18.111	14.111	8.889	0.685	0.567	0.567	1.100
X	WONASHIN	61.667	18.778	15.667	13.556	1.633	1.397	1.054	3.095
X	GUYATT	61.111	17.444	14.444	11.000	1.792	0.685	1.257	0.000
X	SPRUCE	61.556	17.222	13.889	11.000	1.499	1.227	0.567	0.471
X	MONGOOSE	61.222	17.000	13.444	10.444	0.416	0.943	0.497	0.685
X	WART	61.667	18.333	14.444	9.667	1.155	0.667	0.956	0.471
X	MARTIN	61.111	18.333	14.222	11.222	1.197	0.667	0.629	0.416
X	TRIBBLE	62.778	19.778	15.556	10.444	0.628	0.916	0.831	0.685
X	LITTLE H	61.333	17.333	14.889	10.778	1.054	0.816	0.994	0.416
X	MASTEN	61.889	18.333	14.111	10.222	1.523	0.667	0.737	0.916
X	RAINE	60.556	18.333	13.889	10.222	1.771	0.943	0.314	0.416
X	LOGAN	61.444	18.000	15.222	10.444	1.066	0.000	1.133	0.497
X	OLD WOMA	60.444	18.778	14.111	12.889	0.956	0.786	1.370	2.131
X	LAKE SUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X	HARRYS	63.333	18.667	14.222	10.667	1.054	0.817	0.786	0.471
X	FIRST	62.444	17.889	15.778	12.000	1.257	0.567	1.030	0.000
X	WAGON WH	63.000	19.111	15.778	18.333	2.867	1.370	1.030	8.769
X	BLACK BE	64.889	19.222	14.000	10.444	1.100	0.629	0.943	0.685
X	HOWLING	63.444	19.444	15.667	10.889	0.956	0.497	0.943	0.737
X	WELLS	62.111	19.000	14.444	11.333	1.523	0.667	0.831	0.471

Table G.2 (Cont.)

ALGOMA QUAD 4
AUGUST 18, 1986
RAW TM SIGNALS AND STANDARD DEVIATIONS

LAKE_ID	NAME	Band 1	Band 2	Band 3	Band 4	Band 1 S.D.	Band 2 S.D.	Band 3 S.D.	Band 4 S.D.
X	SPECKLED	63.000	19.444	16.111	11.111	1.633	0.685	0.875	0.314
X	STAN	62.667	18.556	14.000	11.333	1.054	0.685	0.816	0.816
X	FRATER	63.111	19.222	16.000	11.556	1.663	0.786	0.667	0.497
X	DOTTIE	62.667	18.556	14.444	11.000	1.247	0.497	0.685	0.667
X	LOST	62.556	18.778	15.000	12.000	1.257	1.133	1.054	0.667
X	MACGREGO	62.333	18.333	15.333	11.222	1.054	0.816	0.943	0.416
X	KENNY	66.111	19.667	14.333	11.222	0.874	0.471	0.816	0.786
X	MUDHOLE	64.222	19.222	15.222	12.000	1.685	0.416	1.315	0.816
X	CRESCENT	62.889	18.222	15.000	11.333	1.370	0.629	1.333	1.333
XO9	GREYOWL	61.222	18.333	14.000	9.889	1.315	0.816	1.247	0.314

Table G.3

SUDBURY QUAD 3
MAY 12, 1987
RAW TM SIGNALS AND STANDARD DEVIATIONS

LAKE_ID	NAME	Band 1	Band 2	Band 3	Band 4	Band 1 S.D.	Band 2 S.D.	Band 3 S.D.	Band 4 S.D.
11A	X99	74.22	22.44	20.11	13.00	1.64	0.530	1.760	0.00
11C	LAMY	75.89	22.44	19.00	12.00	2.03	0.530	1.220	0.00
12A	WABUN	74.89	22.55	18.00	12.00	1.27	0.730	0.500	0.00
12B	X99	74.00	22.67	19.33	12.44	1.12	0.870	0.500	0.53
13A	SUNNYWAT	80.89	21.78	17.67	12.00	1.05	0.440	0.870	0.00
13D	WHITEPIN	75.00	23.00	20.22	13.11	2.12	1.000	0.970	0.60
13E	MARINA	73.67	21.78	17.67	12.00	1.50	0.440	1.000	0.00
14E	LITTLE W	75.89	23.67	20.67	12.78	1.54	0.870	1.410	0.44
14F	JERRY	76.50	22.33	18.50	12.30	2.18	0.500	1.010	0.50
14H	SMOOTHWA	74.80	22.00	18.11	11.67	1.86	0.000	0.780	0.50
17C	MIHELL	73.30	22.00	17.89	12.00	0.71	0.000	0.600	0.00
18B	NORTH YO	74.44	22.55	19.89	12.44	1.59	0.730	1.360	0.73
19A	X99	73.00	22.33	18.33	12.00	1.41	0.500	1.000	0.00
19C	X99	74.78	22.44	17.89	12.00	2.17	0.530	0.330	0.00
22C	PILGRIM	74.11	22.00	18.11	12.00	1.05	0.500	0.780	0.00
22D	MAGGIE	75.30	23.20	20.00	12.70	1.00	0.830	1.000	0.87
23A	BLUESUCK	76.00	22.89	19.20	12.40	1.73	0.330	1.600	0.53
27A	X99	75.50	22.10	18.50	12.00	0.88	0.780	1.420	0.00
28C	STOUFFER	73.30	21.89	17.89	12.00	1.22	0.330	0.601	0.00
29C	FREDERIC	76.40	22.20	18.00	12.00	1.59	0.440	0.000	0.00
30C	DOUGHERT	74.89	21.67	17.22	11.89	1.05	0.500	0.440	0.33
33A	LAURA	74.40	21.80	17.30	12.00	1.40	0.440	0.500	0.00
33D	CHINIGUC	78.40	22.30	17.70	12.00	1.30	0.500	0.500	0.00
33E	X99	76.50	22.50	19.00	12.20	1.51	0.530	1.320	0.44
34B	X99	78.40	23.40	17.89	13.10	1.13	0.880	0.600	0.60
34D	X99	79.20	22.90	18.20	12.30	1.39	0.330	0.670	0.50
34E	X99	78.80	22.50	17.50	12.40	1.71	0.880	0.530	0.88
35A	X99	78.00	23.00	18.40	12.30	2.12	0.870	0.880	0.50
35B	DEWDNEY	77.50	24.00	18.80	12.10	0.88	0.710	1.480	0.33
35D	X99	74.80	22.00	18.67	12.00	1.30	0.000	1.120	0.00
36B	FRANKS	76.30	23.10	18.20	12.30	0.87	1.170	0.440	0.50
36D	LAWLOR	77.00	24.10	18.10	12.20	1.00	0.780	0.601	0.44
37B	WOLF	76.90	21.70	17.20	12.10	1.50	0.500	0.970	0.33
37D	X99	76.70	23.20	17.67	12.67	1.22	0.670	0.710	0.71
38B	MATAGAMA	76.70	24.30	19.33	12.89	1.00	1.000	1.580	0.78
38D	OTTER	80.20	22.30	17.50	12.40	0.83	0.710	0.530	0.53
40A	MATAGAMA	74.80	22.67	20.55	12.00	0.97	0.500	1.500	0.00
X02	CENTRE	74.30	22.10	18.11	11.33	1.60	0.601	0.780	0.50
X03	WHITEPIN	75.00	22.89	17.89	11.78	1.32	1.050	0.500	0.44
X06	THEODORE	72.90	21.10	18.00	12.00	1.36	0.330	0.710	0.00

Table G.4

SUDBURY QUAD 3
JUNE 13, 1987
RAW TM SIGNALS AND STANDARD DEVIATIONS

LAKE_ID	NAME	Band 1	Band 2	Band 3	Band 4	Band 1 S.D.	Band 2 S.D.	Band 3 S.D.	Band 4 S.D.
11A	X99	71.55	22.00	17.90	13.00	1.59	0.71	0.60	0.71
11C	LAMY	73.67	21.67	16.11	12.67	1.32	0.50	1.05	0.50
12A	WABUN	76.11	22.67	17.22	12.00	1.54	0.71	0.67	0.00
12B	X99	75.33	22.00	16.78	13.00	1.22	0.00	0.44	0.87
13A	SUNNYWAT	81.00	21.67	16.55	12.00	1.32	0.50	1.01	0.00
13D	WHITEPIN	73.78	21.67	16.33	12.33	1.64	0.50	1.00	0.50
13E	MARINA	73.11	22.55	16.89	11.55	0.93	0.88	0.33	0.73
14E	LITTLE W	74.33	21.67	17.44	12.67	1.22	0.71	0.73	0.50
14F	JERRY	76.33	21.67	16.78	11.67	1.73	0.50	0.44	0.71
14H	SMOOTHWA	73.89	21.00	16.33	10.78	2.02	0.50	1.00	0.44
17C	MIHELL	70.80	21.56	17.00	10.78	1.72	0.88	0.50	0.44
18B	NORTH YO	75.20	22.00	17.90	13.11	0.67	0.50	0.93	0.60
19A	X99	74.33	21.89	17.00	11.89	1.66	0.33	0.00	0.33
19C	X99	76.22	22.33	17.55	12.00	1.48	0.50	1.01	0.00
22C	PILGRIM	72.44	21.22	16.78	11.00	1.01	0.44	0.44	0.00
22D	MAGGIE	72.22	21.89	17.22	11.33	0.83	0.93	0.44	0.50
23A	BLUESUCK	73.78	21.55	17.00	11.00	0.97	1.01	0.71	0.00
23E	SOLACE	74.44	22.22	17.00	11.67	1.59	0.83	0.00	0.50
27A	X99	73.89	21.89	16.78	11.67	1.40	1.05	1.10	0.50
28C	STOUFFER	71.89	20.89	16.44	10.55	1.05	0.60	0.53	0.53
29C	FREDERIC	75.00	21.22	16.20	11.00	1.66	0.44	0.44	0.50
30C	DOUGHERT	75.30	20.89	15.00	10.44	1.30	0.60	1.20	0.73
33A	LAURA	73.11	21.00	17.33	12.11	1.17	0.00	0.50	0.60
33D	CHINIGUC	72.33	21.44	17.00	10.78	0.71	0.53	0.00	0.67
33E	X99	73.22	21.89	16.89	11.67	1.30	0.78	0.60	0.50
34B	X99	79.22	24.11	16.89	12.22	0.44	0.78	0.33	0.44
34D	X99	78.22	24.44	18.00	12.67	2.05	1.01	1.12	0.71
34E	X99	77.55	22.11	17.22	11.55	2.24	0.60	0.83	0.88
35A	X99	78.00	22.33	17.00	11.22	1.66	0.71	0.50	0.44
35B	DEWDNEY	77.55	23.22	16.89	11.78	1.42	1.30	0.33	0.83
35D	X99	73.78	22.33	17.44	12.22	2.44	1.00	0.73	0.44
36B	FRANKS	75.33	22.55	17.78	12.33	1.50	0.73	0.44	0.87
36D	LAWLOR	75.11	22.44	16.89	11.89	1.36	0.53	0.78	0.78
37B	WOLF	78.11	22.11	17.11	11.33	1.83	1.17	0.60	0.50
37D	X99	77.22	24.55	18.75	12.89	1.72	0.53	1.48	0.78
38C	SILVESTE	77.33	23.55	17.55	11.67	1.87	0.53	0.73	0.50
38D	OTTER	77.89	22.00	17.11	11.67	2.09	0.87	0.33	1.00
40A	MATAGAMA	74.78	23.11	18.89	12.00	1.56	0.60	1.69	0.00
X02	CENTRE	71.67	20.89	16.22	10.78	1.00	0.33	0.97	0.44
X03	WHITEPIN	71.89	21.44	17.00	11.00	1.27	0.73	0.00	0.00
X06	THEODORE	69.22	19.89	16.11	11.00	2.39	0.33	0.78	0.00

Table G.5

SUDBURY QUAD 3
AUGUST 13, 1986
CORRECTED TM SIGNALS AND STANDARD DEVIATIONS

LAKE_ID	NAME	Band 1	Band 2	Band 3	Band 4	Band 1 S.D.	Band 2 S.D.	Band 3 S.D.	Band 4 S.D.
11A	X99	88.7465	25.8936	19.5342	15.8597	0.73	0.53	0.44	0.33
11C	LAMY	89.1746	26.9856	19.9223	15.7149	0.87	0.50	0.73	0.00
12A	WABUN	93.0912	26.6828	18.6321	14.3983	1.30	0.53	0.97	0.00
12B	X99	92.5511	26.0788	20.0413	14.6880	1.59	0.44	0.00	0.44
13A	SUNNYWAT	98.8247	26.2615	19.1982	15.7149	1.58	0.67	0.78	0.00
13D	WHITEPIN	92.6179	25.7588	19.6385	15.2804	1.22	0.44	0.00	0.50
13E	MARINA	92.0059	26.8639	20.1714	15.1356	1.51	0.87	0.71	0.53
14E	LITTLE W	92.0581	26.1283	19.9744	15.4252	1.41	0.73	0.71	0.44
14F	JERRY	97.1856	26.6828	19.3562	14.3983	1.62	0.53	0.87	0.00
14H	SMOOTHWA	95.0989	26.8013	20.8439	13.0818	1.88	0.33	0.44	0.00
17C	MIHELL	91.6630	26.4977	21.0345	16.8866	1.22	0.88	1.62	0.33
18B	NORTH YO	90.6092	26.3552	20.7917	13.3714	2.17	0.33	0.33	0.44
19A	X99	90.3136	26.6293	19.5863	15.5700	2.92	0.87	0.33	0.33
19C	X99	91.0374	26.0903	20.0934	14.3983	1.72	0.33	0.33	0.00
22C	PILGRIM	94.5721	27.0390	20.2846	14.5431	1.22	0.33	0.33	0.33
22D	MAGGIE	92.9662	26.1167	20.9492	15.7149	1.81	0.50	0.83	0.00
23A	BLUESUCK	91.0568	26.6449	20.9366	13.3714	1.74	0.33	0.00	0.44
28C	STOUFFER	92.4988	26.3800	19.6458	14.3983	1.00	0.50	0.88	0.00
29C	FREDERIC	94.2300	26.5116	20.6991	13.0818	1.39	0.33	0.71	0.00
30C	DOUGHERT	95.4017	26.0772	20.1066	13.0818	1.12	0.53	0.83	0.00
33A	LAURA	87.7922	26.2220	20.8439	13.0818	0.60	0.50	0.44	0.00
33D	CHINIGUC	93.7824	26.6564	19.8170	13.0818	0.88	0.00	1.22	0.00
33E	X99	90.7344	27.0127	20.4426	13.2266	1.09	0.71	0.73	0.33
34B	X99	94.8885	26.4977	18.9807	16.8866	1.39	0.53	0.50	0.33
34D	X99	90.7478	26.3800	19.8038	14.3983	2.34	0.50	0.50	0.00
34E	X99	92.9330	26.4334	18.2572	13.2266	0.33	0.33	1.36	0.33
35A	X99	94.9541	26.5116	20.3962	13.0818	1.73	0.33	0.73	0.00
35B	DEWDNEY	91.5774	26.5898	19.6258	12.9370	1.50	0.93	0.97	0.33
35D	X99	95.2765	26.5782	19.2840	13.2266	1.73	0.00	0.50	0.33
36B	FRANKS	91.3464	26.0656	19.6200	13.3714	1.56	0.50	1.00	0.44
36D	LAWLOR	91.7613	27.0127	19.1392	13.2266	1.66	0.50	1.01	0.33
37B	WOLF	94.0862	25.7744	19.2377	13.0818	0.71	0.50	1.24	0.00
37D	X99	90.3981	26.3436	17.3693	13.6611	1.49	0.00	0.88	0.53
38B	MATAGAMA	88.7473	26.6014	21.1393	12.6473	1.87	0.44	0.44	0.87
38C	SILVESTE	94.6645	25.1951	18.0660	13.0818	1.90	0.78	1.22	0.00
38D	OTTER	94.6645	25.1951	18.0660	13.0818	1.90	0.78	1.22	0.00
40A	MATAGAMA	91.4194	26.8795	20.9423	12.9370	1.59	0.60	0.67	0.33
X02	CENTRE	90.8988	26.6449	20.5021	13.3714	1.01	0.33	0.71	0.44
X03	WHITEPIN	91.0765	26.3684	20.1861	14.6880	1.13	0.88	0.33	0.44

Table G.6

ALGOMA QUAD 4
AUGUST 18, 1986
CORRECTED TM SIGNALS AND STANDARD DEVIATIONS

LAKE_ID	NAME	Band 1	Band 2	Band 3	Band 4	Band 1 S.D.	Band 2 S.D.	Band 3 S.D.	Band 4 S.D.
FA	X99	66.6667	17.1498	6.7824	15.0720	1.000	0.440	0.860	0.440
AH	MADER	65.1479	16.2039	10.0476	15.1016	1.333	0.314	0.497	0.416
BH	X99	65.0270	17.0285	8.2837	14.5041	1.054	0.497	1.133	0.416
DF	BARBARA	66.6583	15.8166	7.8950	14.0546	0.994	0.471	1.030	0.685
GA	X99	65.1056	16.1728	8.8548	15.3411	0.970	0.440	1.300	0.530
MC	ADELAIDE	64.4142	15.1739	7.5955	15.5511	0.875	0.831	1.286	0.497
MB	X99	65.1167	15.5722	7.0276	14.2054	0.994	0.629	0.943	0.497
LK	GRIFFIN	65.4765	15.5334	7.0873	14.5041	0.471	0.471	0.875	0.416
NK	TURKEY	64.8175	16.4255	6.7278	15.7004	0.667	0.497	0.943	0.471
LE	McGOVERN	65.1479	16.8028	8.5526	15.1016	1.563	0.497	0.816	0.416
NJ	LITTLE T	64.1620	15.4182	7.2679	15.4003	1.066	0.817	0.685	0.685
ED	ALVIN	65.0719	14.7312	7.3562	14.3547	0.916	0.817	0.816	0.471
EH	HAILEY	65.2823	16.3369	7.7147	14.6535	1.563	0.667	0.685	0.314
DI	X99	64.9388	16.3921	6.4002	14.8029	2.587	0.567	0.497	0.000
NI	X99	65.1176	16.7242	8.0735	15.7004	1.499	0.416	0.943	0.471
AG	LITTLE A	65.8504	14.8084	8.1340	13.7559	2.096	0.956	1.227	0.629
KG	DICK	64.5504	14.4101	6.3106	15.1016	0.956	0.629	0.816	0.416
EJ	ROI	63.9661	15.1739	7.2967	15.5511	2.061	0.497	0.471	0.497
BA	MALLOT	57.6708	12.6305	5.1126	19.5882	2.439	1.165	1.066	8.355
BF	MONTREAL	67.6737	16.3369	9.6593	14.6535	1.423	0.667	1.100	0.314

Table G.7

SUDBURY QUAD 3
MAY 12, 1987
CORRECTED TM SIGNALS AND STANDARD DEVIATIONS

LAKE_ID	NAME	Band 1	Band 2	Band 3	Band 4	Band 1 S.D.	Band 2 S.D.	Band 3 S.D.	Band 4 S.D.
X06	THEODORE	88.5940	24.1140	19.8325	13.6256	1.36	0.330	0.710	0.00
19A	X99	88.7192	25.6641	20.2457	13.6256	1.41	0.500	1.000	0.00
11A	X99	88.7443	24.5021	20.9612	14.8778	1.64	0.530	1.760	0.00
17C	MIHELL	89.0949	25.2409	19.6947	13.6256	0.71	0.000	0.600	0.00
28C	STOUFFER	89.0949	25.1032	19.6947	13.6256	1.22	0.330	0.601	0.00
12B	X99	89.3102	25.5124	20.8320	14.1766	1.12	0.870	0.500	0.53
13D	WHITEPIN	89.5557	25.0615	20.9324	15.0155	2.12	1.000	0.970	0.60
13E	MARINA	89.5582	24.9654	19.4193	13.6256	1.50	0.440	1.000	0.00
18B	NORTH YO	89.8612	25.3621	21.5331	14.1766	1.59	0.730	1.360	0.73
22C	PILGRIM	90.1091	25.2409	19.9702	13.6256	1.05	0.500	0.780	0.00
33A	LAURA	90.4722	24.9905	18.9560	13.6256	1.40	0.440	0.500	0.00
22D	MAGGIE	90.5474	25.8407	21.2774	14.5021	1.00	0.830	1.000	0.87
23A	BLUESUCK	90.6225	25.8394	20.7297	14.1265	1.73	0.330	1.600	0.53
19C	X99	90.9480	25.7918	19.6947	13.6256	2.17	0.530	0.330	0.00
35D	X99	90.9731	25.2409	20.6714	13.6256	1.30	0.000	1.120	0.00
40A	MATAGAMA	90.9731	26.0798	23.0254	13.6256	0.97	0.500	1.500	0.00
12A	WABUN	91.0858	25.9298	19.8325	13.6256	1.27	0.730	0.500	0.00
14E	LITTLE W	91.1659	26.3260	21.9953	14.6023	1.54	0.870	1.410	0.44
30C	DOUGHERT	91.2511	24.9698	19.0223	13.4879	1.05	0.500	0.440	0.33
X02	CENTRE	91.3537	26.2302	20.9841	12.7867	1.60	0.601	0.780	0.50
14H	SMOOTHWA	91.4689	25.6665	20.4696	13.2124	1.86	0.000	0.780	0.50
X03	WHITEPIN	91.5541	26.6390	20.0277	13.3502	1.32	1.050	0.500	0.44
27A	X99	91.8496	25.3661	20.4585	13.6256	0.88	0.780	1.420	0.00
38B	MATAGAMA	92.0149	26.9730	20.1510	14.7400	1.00	1.000	1.580	0.78
11C	LAMY	92.3379	25.7918	21.0846	13.6256	2.03	0.530	1.220	0.00
37D	X99	92.3454	25.8794	18.4053	14.4646	1.22	0.670	0.710	0.71
36B	FRANKS	92.4005	26.2313	19.6289	14.0013	0.87	1.170	0.440	0.50
14F	JERRY	92.6509	25.2672	20.0045	14.0013	2.18	0.500	1.010	0.50
33E	X99	92.8012	25.6090	20.7819	13.8761	1.51	0.530	1.320	0.44
29C	FREDERIC	92.9765	25.4913	19.8325	13.6256	1.59	0.440	0.000	0.00
36D	LAWLOR	93.4273	27.6124	19.6550	13.8761	1.00	0.780	0.601	0.44
37B	WOLF	93.4523	24.7363	18.6794	13.7509	1.50	0.500	0.970	0.33
34B	X99	93.8280	25.5752	18.0301	15.0030	1.13	0.880	0.600	0.60
35B	DEWDNEY	94.2036	27.6162	20.6829	13.7509	0.88	0.710	1.480	0.33
35A	X99	94.5291	26.1061	19.8793	14.0013	2.12	0.870	0.880	0.50
34E	X99	95.3806	25.3511	18.6011	14.1265	1.71	0.880	0.530	0.88
33D	CHINIGUC	95.4808	25.6165	19.4588	13.6256	1.30	0.500	0.500	[illegible]
34D	X99	96.0317	25.9809	19.6289	14.0013	1.39	0.330	0.670	[illegible]
38D	OTTER	97.1336	25.1007	18.6011	14.1265	0.83	0.710	0.530	0.53
13A	SUNNYWAT	98.5986	24.9654	19.4193	13.6256	1.05	0.440	0.870	0.00

Table G.8

SUDBURY QUAD 3
JUNE 13, 1987
CORRECTED TM SIGNALS AND STANDARD DEVIATIONS

LAKE_ID	NAME	Band 1	Band 2	Band 3	Band 4	Band 1 S.D.	Band 2 S.D.	Band 3 S.D.	Band 4 S.D.
11A	X99	81.8247	24.0434	19.6675	15.5007	1.59	0.71	0.60	0.71
11C	LAMY	84.8023	23.9321	17.7492	15.1073	1.32	0.50	1.05	0.50
12A	WABUN	88.6248	25.6972	19.5113	14.3084	1.54	0.71	0.67	0.00
12B	X99	86.3319	24.0434	18.3321	15.5007	1.22	0.00	0.44	0.87
13A	SUNNYWAT	94.4554	24.5049	18.7124	14.3084	1.32	0.50	1.01	0.00
13D	WHITEPIN	85.3968	24.2227	18.2341	14.7018	1.64	0.50	1.00	0.50
13E	MARINA	85.6610	25.9389	19.4124	13.7718	0.93	0.88	0.33	0.73
14E	LITTLE W	85.5892	23.9321	19.3351	15.1073	1.22	0.71	0.73	0.50
14F	JERRY	89.3368	24.7870	19.2027	13.9149	1.73	0.50	0.44	0.71
14H	SMOOTHWA	87.6404	24.7490	19.2487	12.8537	2.02	0.50	1.00	0.44
17C	MIHELL	83.9560	25.4167	20.0476	12.8537	1.72	0.88	0.50	0.44
18B	NORTH YO	86.0269	23.9494	19.5955	15.6319	0.67	0.50	0.93	0.60
19A	X99	86.6523	24.8612	19.3210	14.1772	1.66	0.33	0.00	0.33
19C	X99	88.7559	25.2918	19.9048	14.3084	1.48	0.50	1.01	0.00
22C	PILGRIM	85.6117	24.8232	19.6413	13.1160	1.01	0.44	0.44	0.00
22D	MAGGIE	84.8996	25.3400	19.9499	13.5095	0.83	0.93	0.44	0.50
23A	BLUESUCK	87.2094	25.2167	19.9036	13.1160	0.97	1.01	0.71	0.00
23E	SOLACE	87.0833	25.4428	19.4650	13.9149	1.59	0.83	0.00	0.50
27A	X99	86.4275	25.0493	19.2027	13.9149	1.40	1.06	1.10	0.50
28C	STOUFFER	85.5692	24.8145	19.5305	12.5794	1.05	0.60	0.53	0.53
29C	FREDERIC	88.6641	24.8232	18.9497	13.1160	1.66	0.44	0.44	0.50
30C	DOUGHERT	89.7850	24.9085	17.8855	12.4483	1.30	0.60	1.20	0.73
33A	LAURA	84.8978	23.6119	19.5705	14.4395	1.17	0.00	0.50	0.60
33D	CHINIGUC	85.7803	25.2736	20.0476	12.8537	0.71	0.53	0.00	0.67
33E	X99	85.6286	25.0493	19.3339	13.9149	1.30	0.78	0.60	0.50
34B	X99	92.0332	27.2261	18.9738	14.5707	0.44	0.78	0.33	0.44
34D	X99	90.2275	27.2349	20.0028	15.1073	2.05	1.01	1.12	0.71
34E	X99	90.9551	25.4142	19.8059	13.7718	2.24	0.60	0.83	0.88
35A	X99	91.9414	25.9587	19.7596	13.3783	1.66	0.71	0.50	0.44
35B	DEWDNEY	90.6416	26.5411	19.2619	14.0460	1.42	1.30	0.33	0.83
35D	X99	85.5467	25.1037	19.6296	14.5707	2.44	1.00	0.73	0.44
36B	FRANKS	87.2450	26.2720	19.9630	14.7018	1.50	0.73	0.44	0.87
36D	LAWLOR	87.5823	25.5170	19.1899	14.1772	1.36	0.53	0.78	0.78
37B	WOLF	91.9226	25.6023	19.8188	13.5095	1.83	1.17	0.60	0.50
37D	X99	88.7353	27.1780	20.7530	15.3696	1.72	0.53	1.48	0.78
38C	SILVESTE	90.5292	27.0286	20.1208	13.9149	1.87	0.53	0.73	0.50
38D	OTTER	91.1969	25.1805	19.5962	13.9149	2.09	0.87	0.33	1.00
40A	MATAGAMA	87.0389	26.2219	21.5026	14.3084	1.56	0.60	1.69	0.00
X02	CENTRE	84.9934	24.6178	19.1176	12.8537	1.00	0.33	0.97	0.44
X03	WHITEPIN	84.9559	25.0865	19.9036	13.1160	1.27	0.73	0.00	0.00
X06	THEODORE	81.7723	23.2374	18.8424	13.1160	2.39	0.33	0.78	0.00